TITANIUM

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In 2000, the titanium industry was engaged in a high level of mineral exploration and development activity. In addition to exploration activity, a number of expansion projects were underway in the mineral and titanium dioxide (TiO_2) pigment industries. In the titanium metal industry, rising demand in certain sectors allowed producers to use some of the excess capacity.

Approximately 95% of titanium is consumed as TiO_2 pigment, a pigment used in paints, paper, and plastics. The superiority of TiO_2 as a pigment is attributed to its high opacity and brightness. Titanium metal alloys are used in aerospace and other industries for their high strength-to-weight ratio and corrosion resistance.

Titanium is not naturally found in its metallic form but occurs in many mineral forms, such as oxides, titanates, and silicotitanates. As the ninth most abundant element in the Earth's crust, titanium is present in most rocks and soil. The titanium-bearing minerals that have significant economic importance include ilmenite, leucoxene, and rutile.

Legislation and Government Programs

The Defense National Stockpile Center met its target for the sale of titanium sponge from the U.S. Government stockpile. For fiscal year 2000, 4,540 metric tons (t) of titanium sponge was offered for sale. In accordance with section 3305 of the National Defense Authorization Act for Fiscal Year 1996 (Public Law 104-106), 250 t of titanium sponge was transferred to the Army's Tank and Automotive Command for use in the weight-reduction portion of the main battle tank upgrade program. Fiscal year 2000 is the fifth year of this program, which provides for transfers of up to 250 metric tons per year (t/yr) of titanium sponge to continue through fiscal year 2003. Although this material is provided to the Army without charge, the law specifies that the Army will pay the costs for transportation and handling (U.S. Department of Defense, 2000). At yearend 2000, the National Defense Stockpile held 26,300 t of titanium sponge.

Production

Mineral Concentrates.—Commercial forms of titanium mineral concentrates include ilmenite, leucoxene, rutile, slag, and synthetic rutile. Mining of titanium minerals is usually performed using surface methods. A dredge is often used for the recovery of titanium-mineral placer deposits. Gravity spirals are used for wet separation of heavy minerals (HM), while magnetic and high-tension separation circuits are used to separate the HM constituents. Ilmenite is often further beneficiated to produce synthetic rutile and 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 up to 95%, is produced using a pyrometallurgical process.

Australia, Canada, India, Norway, and South Africa led the world's production of titanium mineral concentrate. U.S. mineral concentrate producers included E.I. du Pont de Nemours & Co. Inc. (DuPont), Kerr-McGee Chemical Corp., and Iluka Resources Inc. (a subsidiary of Iluka Resources Ltd.). DuPont's Trail Ridge mining operations in Starke, FL, produced a mixed product containing ilmenite, leucoxene, and rutile that was used as a feedstock in DuPont's TiO_2 pigment operations. Iluka's mining operations in Green Cove Springs, FL, and Stony Creek, VA, produced both rutile and ilmenite concentrates. Kerr-McGee's operation in Mobile, AL, produced synthetic rutile from purchased ilmenite concentrate. Titanium slag was not produced in the United States.

Altair International Inc. was proceeding with feasibility

Titanium in the 20th Century

In the early 1900s, titanium minerals were primarily used in steelmaking for railways and as an arc stabilizer in electric lamps. Although little statistical data are available, domestic consumption of titanium minerals prior to 1920 was less than 2,000 metric tons per year, and domestic production was less than a few hundred tons per year. Composite pigments, containing approximately 25% titanium dioxide (TiO_2) and 75% barium sulfate, were not introduced to the commercial market until 1919. Commercial production of relatively pure TiO_2 pigments did not start until the early 1940s, and commercial production of titanium metal followed shortly thereafter.

In 2000, domestic consumption of titanium minerals was about 1.42 million tons (TiO_2 content). Imports were about 1.06 million tons (TiO_2 content), and roughly 0.3 million tons (TiO_2 content) of titanium minerals were produced. About 95% of titanium mineral concentrates produced was used in TiO_2 pigments, while the remainder was used in welding rod coatings and to manufacture metals, carbides, and chemicals. TiO_2 pigments produced in the United States, valued at about $2.6 billion, were used mainly in coatings (49.5%), plastics (21.3%), and paper (20.4%). Other uses of TiO_2 pigments (8.8%) in 2000 included catalysts, ceramics, coated textiles, floor coverings, printing ink, and roofing granules. The value of sponge metal consumed in the United States was about $170 million. Since its commercialization, the major end use for titanium metal has been in aerospace products. Other end uses include armor, chemical processing equipment, consumer goods, power generation equipment, marine goods, medical implants, and sporting goods.

studies at its heavy mineral deposits near Camden, TN. In 2000, Altair began construction of a pilot mineral separation plant. If further studies are successful, Altair expects to produce 250,000 t to 300,000 t of a high TiO_2 mineral concentrate (North American Minerals News, 2000).

Iluka Resources studied the feasability of increasing capacity by 70% in four years at its Florida and Virginia mineral operations. The expansion project was expected to begin in 2001 (Iluka Resources Ltd., March 9, 2001, Annual report, accessed August 28, 2001, at URL http://www.iluka.com/files/annual%20report%202000.pdf).

Metal.—Titanium sponge is the rudimentary form of titanium metal. The initial production step involves the chlorination of titanium-containing mineral feedstocks to produce titanium tetrachloride ($TiCl_4$). The next step is usually based on the Kroll process where $TiCl_4$ is reduced with magnesium to form titanium sponge. In 2000, titanium sponge was produced in China, Japan, Kazakhstan, Russia, Ukraine, and the United States. U.S. producers of titanium sponge included The Alta Group, Allegheny Technologies Inc., and Titanium Metals Corp. At yearend, domestic operating capacity of titanium sponge was estimated to be 21,600 t/yr (table 2). Data on domestic production of titanium sponge have not been published in order to avoid disclosing company proprietary data.

U.S. production of ingot decreased by about 3% compared with that of 1999 (table 3). 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, plasma, and vacuum arc reduction are the commercial melting methods used to produce ingot. In 2000, commercial ingot production capacity existed in France, Germany, Japan, Russia, the United Kingdom, and the United States.

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 and strip, wire, etc. Major producers of titanium mill products were located primarily in China, Europe, Japan, Russia, and the United States. More than 30 domestic companies were known to produce titanium mill products and castings from ingot and billet. In 2000, U.S. production of mill products increased by 7% compared with that of 1999.

Titanium castings are commonly produced by two techniques: investment casting and rammed graphite mold casting. In 2000, U.S. producers of titanium castings included Cast Alloys Inc., Coastcast Corp., Flowserve Corp., Howmet Corp., Precision Cast Parts Corp., Reactive Alloy Manufacturing Inc., RTI International Metals Inc., Selmet Inc., and Titanium Industries Inc.

Ferrotitanium is usually produced by induction melting of titanium scrap with iron or steel. U.S. producers of ferrotitanium included Galt Alloys Inc., Global Titanium Inc., and Shieldalloy Metallurgical Corp. The two standard grades of ferrotitanium contain 40% and 70% titanium. Data on production of ferrotitanium were not available.

Honeywell International Inc. announced it was investing $8.5 million in The Alta Group of its wafer fabrication materials division to meet the surge in demand for high purity titanium.Alta is the largest producer of high purity titanium ranging from 99.995% titanium to 99.9995% titanium. According to the company, demand had increased because of new semiconductor fabrication capacity coming online (Honeywell International Inc., November 1, 2000, Honeywell Electronic Materials (HEM) ALTA announces $8.5 million investment to meet demand for high purity titanium, accessed August 24, 2001, at URL http://www.electronicmaterials.com/mediakit/news/fb110100.htm).

TiO_2 Pigment.—TiO_2 pigment is produced from titanium mineral concentrates by either the chloride process or the sulfate process. In the sulfate process, ilmenite or titanium slag is reacted with sulfuric acid. Titanium hydroxide is precipitated by hydrolysis, filtered, and calcined. 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 fine-size 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 in the rutile crystalline form.

Although either process may be used to produce pigment, the decision to use one process instead of the other is based on a number of 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, silica, and organic compounds.

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

World production of TiO_2 pigment was estimated to have increased slightly compared with that of 1999. In 2000, France, Germany, Japan, the United Kingdom, and the United States were the leading producing countries of TiO_2 pigment, while DuPont and Millennium Inorganic Chemicals Inc. were the largest corporate producers of TiO_2 pigment. U.S. production of TiO_2 pigment in 2000 was 1.40 million metric tons (Mt), a 3.6% increase compared with that of 1999. U.S. producers of TiO_2 pigment were DuPont, Millennium, Kerr-McGee, and Louisiana Pigment Co. LP (a NL Industries Inc. and Huntsman Corp. joint venture). In addition, TOR Minerals International Inc. produced a buff pigment from finely ground synthetic rutile (table 4). Capacity utilization for the domestic pigment industry was about 89%.

DuPont completed an expansion at its New Johnsonville, TN, TiO_2 pigment facility by adding a third line to the existing chloride route plant. New Johnsonville is the world's largest TiO_2 pigment facility (Industrial Minerals, 2000k). At yearend, capacity at New Johnsonville was estimated to be 380,000 t/yr.

Hitox Corp. of America changed its name to TOR Minerals International. TOR Minerals operates a facility in Corpus Christi, TX, where buff TiO_2 pigment is produced by fine grinding of synthetic rutile (Industrial Minerals, 2000b).

In April, Kerr-McGee completed the acquisition of Kemira Oyj's TiO_2 pigment facility at Savannah, GA. The Savannah

facility included both a chloride-route plant and a sulfate-route plant. Kerr-McGee planned to upgrade these facilities in 2001 (Kerr-McGee Chemical Corp., April 6, 2000, Kerr-McGee completes acquisition of Kemira's Savannah plant, accessed August 21, 2001, at URL http://www.kerr-mcgee.com/news2000/040600.html).

Consumption

Mineral Concentrates.—Titanium mineral concentrates are primarily used as a feedstock for TiO_2 pigment production. About 5% of global mineral consumption is for miscellaneous uses such as ceramics, glass, steel, titanium metal, and welding rod coatings.

Based on TiO_2 content, domestic consumption of titanium minerals concentrates was 1.42 Mt, a 3% increase compared with that of 1999. Although consumption of ilmenite and slag decreased by 5%, consumption of rutile and synthetic rutile increased by 20% compared with that of 1999. On a gross weight basis, about 98% of the domestic consumption of titanium mineral concentrates was used to produce TiO_2 pigment.

Consumption data for titanium concentrates are developed by the U.S. Geological Survey from a voluntary survey of domestic operations. Of the 19 operations canvassed, 14 responded, representing 68% of the data in table 6. Data for nonrespondents were estimated based on prior-year consumption with some adjustments for present-year trends (table 6).

Metal.—Overall consumption of titanium sponge and scrap decreased by 8% compared with that of 1999. Scrap consumption by the titanium industry decreased by 15% compared with that of 1999, while sponge consumption was nearly unchanged. Scrap supplied a calculated 50% of ingot feedstock. Estimated U.S. mill product usage by application was as follows: aerospace, 60%, and nonaerospace uses, 40%. Nonaerospace uses included those in the consumer goods, marine, medical, oil and gas, pulp and paper, and specialty chemical industries. Reported consumption of titanium products in steel and other alloys increased by 3% compared with that of 1999 (tables 3, 7).

TiO_2 Pigment.—Global consumption of TiO_2 pigment was estimated to have increased moderately compared with that of 1999. In the United States, apparent consumption of TiO_2 pigment was about 1.15 Mt, virtually unchanged from 1999. The largest uses of TiO_2 pigment, based on TiO_2 pigment shipments in the United States, were paint and coatings (49.5%), paper (20.4%), and plastics (21.3%). Other uses of TiO_2 included catalysts, ceramics, coated fabrics and textiles, floor coverings, printing ink, and roofing granules.

In the paint and coatings industry, TiO_2 pigment is used in architectural, equipment, and special-purpose applications and is widely used in white and color formulations. The TiO_2 content for paint and coatings varies significantly.

The plastics industry primarily consumes rutile-grade pigment. TiO_2 pigment is used in a variety of plastics applications. Primarily, TiO_2 pigment provides opacity and acts as a barrier against ultraviolet light degradation. TiO_2 pigment often is introduced as pelletized concentrate containing up to 50% by weight TiO_2 in a carrier resin; however, liquid and dry concentrates also are used by the industry. The TiO_2 content for plastics normally ranges from 3% to 25% by weight of the finished product.

TiO_2 pigment in paper products provides opacity and brightness. The paper industry consumes TiO_2 pigment as filler and in coatings. Paper products contain a high percentage of non-TiO_2 base minerals as filler material with the typical TiO_2 content less than 5% of the dry weight of paper. Anatase-grade pigment is preferred in the paper industry because it is less abrasive to papermaking machinery (tables 5, 8).

Stocks

On a TiO_2 content basis, yearend consumer inventories of titanium mineral concentrates decreased by 17% compared with those of 1999 (table 9). While consumer stocks of rutile and synthetic rutile rose by 5%, stocks of ilmenite and slag decreased by 24% compared with that of 1999.

On a gross weight basis, yearend producer stocks of TiO_2 pigment were about 141,000 t, a 3% increase compared with those of 1999. During the year, pigment stocks had fallen to a low of 124,000 t in September, then rose significantly in the last quarter.

Compared with those of 1999, industry stocks of titanium sponge and scrap decreased by 37% and 56%, respectively. Reduced consumption of ingot in 2000 resulted in a 33% increase in ingot stocks compared with those of 1999.

Prices

The yearend published price range for bulk rutile mineral concentrates was $470 to $500 per ton, a decrease of 6% compared with that of 1999. Meanwhile, the price range for bagged rutile concentrates commonly used in the welding rod coatings industry was $480 to $570 per ton, an increase of 2% compared with that of 1999. Owing in part to changes in currency exchange rates, yearend prices of ilmenite concentrates decreased by 3% compared with those of 1999. Published prices for titanium slag were not available. Based on U.S. Customs value of imports, however, prices for Canadian slag increased by 9%, while prices for South African slag were unchanged compared with those of 1999 (table 10).

Yearend published prices for anatase- and rutile-grade pigment were unchanged. Based on U.S. Customs value of imports, the average unit value of unfinished pigments and TiO_2 pigments with less than 80% TiO_2 content decreased by 8% and 6%, respectively. The average unit value of imported TiO_2 pigment with more than 80% TiO_2 content was unchanged.

The averaged yearend prices for ferrotitanium decreased by 66% compared with that of 1999. Average yearend prices unprocessed scrap turnings increased by 45% compared with those of 1999.

Foreign Trade

Mineral Concentrates.— The U.S. Census Bureau collects import and export data for mineral concentrates on a gross weight basis. Imports and exports of titaniferous iron ore from Canada (classified as ilmenite by the U.S. Census Bureau) are excluded from ilmenite statistics in this report. In 2000, the leading import sources of ilmenite were Australia (54%), Ukraine (31%), and India (8%). Imports of ilmenite for 2000 were 386,000 t, a slight decrease compared with those of 1999. Although imports of ilmenite from Australia decreased by 17%,

imports from Ukraine increased by 14%. Owing to a significant drop in imports from Canada and South Africa, gross imports of titanium slag for 2000 fell to 533,000 t, a 21% decrease compared with those of 1999. Increases in natural rutile imported from Australia and South Africa helped to increase overall imports of natural rutile by 18%. Synthetic rutile imports, primarily from Australia, were 173,000 t, a 46% increase compared with imports in 1999 (table 12). Although small relative to imports, exports of titanium mineral concentrates were 18,900 t, a 102% increase compared with exports in 1999 (table 11).

Metal.—Imports of titanium metal are primarily in the form of titanium sponge (37%) and waste and scrap (39%). Compared with those of 1999, imports of unwrought metal, including sponge and waste and scrap, increased by 14% in 2000. Imports of wrought products and castings were unchanged. Although the United States was import reliant on unwrought titanium, the Nation was a net exporter of wrought products. In 2000, exports of wrought products were 35% of all metal exports. Total metal exports for 2000 decreased by 7% compared with those of 2000 (table 13).

TiO_2 Pigment.—Although the United States was a net exporter of TiO_2 pigment, a significant quantity of TiO_2 pigment was imported. During 1999, TiO_2 pigment imports increased by 13%, and the leading import sources of titanium pigment were Canada, France, Germany, Japan, and Spain. Compared with those of 1998, imports of titanium pigment containing more than 80% TiO_2 increased by 25% to 190,000 t; other titanium pigment increased by 58% to 9,320 t; and titanium oxide remained nearly unchanged at 25,700 t (table 14). Exports of TiO_2 pigment were 344,000 t, nearly unchanged compared with those of 1998. Exports of titanium oxide (unfinished pigment) were 39,000 t, a 7% decrease compared with those of 1998.

As has been the case for many years, the United States was a net exporter of TiO_2 pigments and oxides. In 2000, exports outpaced imports by more than 2 to 1. Compared with those of 1999, exports of TiO_2 pigment and oxides in 2000 increased by 21% on a gross weight basis. Meanwhile, imports of TiO_2 pigment and oxides decreased by 3%.

World Review

In 2000, Australia, Canada, India, Norway, and South Africa continued to lead the world's production of titanium mineral concentrates (table 15). Production of titanium mineral concentrates was estimated to be slightly higher compared with that of 1999.

Australia.—The Murray Basin in southeastern Australia has become an area of considerable interest to the titanium mineral industry. The basin covers a large area in New South Wales, Victoria, and South Australia, and numerous deposits are in various stages of exploration and development. According to one industry review, the indicated and inferred resources of contained heavy minerals in the Murray Basin are about 44 Mt (TZ Minerals International Pty. Ltd, 2000).

Basin Minerals Ltd., formerly Craton Resources NL, increased its estimate of inferred resources at its Douglas project in the Murray Basin. Inferred resources were estimated to be 20.8 Mt of concentrate. The Douglas project includes the Acapulco, Bondi East, Bondi, and Echo deposits. During 2000, Basin Minerals was conducting a prefeasibility study (Industrial Minerals, 2000a).

BeMax Resources NL reported the completion of a prefeasibility study on its Ginkgo heavy minerals project with Probo Mining Pty. Ltd. in the Murray Basin. According to BeMax, the study found no major impediments that would prevent the Ginkgo project from proceeding through a feasibility study. The indicated resource at Ginkgo was reported to be 252 Mt containing 2.8% heavy minerals (Industrial Minerals, 2001).

Murray Basin Minerals NL doubled the estimate of the heavy mineral resource at its Mercunda deposit in the Murray Basin. At yearend 2000, the resource was estimated to be 44 Mt of ore containing 3.4% heavy minerals. Feasibility studies were underway in 2000.

Murray Basin Titanium Pty. Ltd., a joint venture of RZM Pty. Ltd. and Sons of Gwalia Ltd., began construction of a mine site at its Wemen deposit in the Murray Basin. Mine plans included a separation plant at nearby Mildura. Production at the 30,000-t/yr plant was expected to begin in 2001. Other deposits under study included Cylinder, Birthday Gift, Karra, Jacks Tank North, Jacks Tank South, and Finnigans Tank (Industrial Minerals, 2000i).

Tiwest Pty. Ltd. announced plans to increase capacity at its TiO_2 pigment operation near Kwinana, Western Australia. Capacity is expected to increase to 95,000 t/yr (a 10% increase) in 2001. Tiwest is a 50-50 joint venture between KMCC Western Australia Pty Ltd., a subsidiary of Kerr-McGee Chemical LLC, and Ticor Resources Pty. Ltd. (Industrial Minerals, 2000g).

Brazil.—Millennium Inorganic Chemicals Inc. made plans to lower operating costs and improve ore recovery at the Titananio do Brazil S.A. operation near Mataraca, Paraiba. The project was expected to be completed by yearend 2001 and could raise ilmenite capacity at Mataraca to 120,000 t/yr, an increase of about 30,000 t/yr (Millennium Inorganic Chemicals Inc., 2000).

Canada.—Rio Tinto plc was in the process of increasing capacity at its upgraded slag (UGS) plant at Sorel, Quebec, to 250,000 t/yr (a 50,000 t/yr increase). Future expansions of its UGS plant are expected to increase capacity to 350,000 t/yr. Compared with the standard grade of slag from Sorel, UGS has a higher TiO_2 content and is suitable for use by chloride-route pigment producers (Rio Tinto plc, 2000).

Syncrude Canada Ltd. continued to investigate the recovery of heavy minerals from tailings of the Athabasca oil sands operations in northern Alberta. According to Syncrude, 220,000 t/yr of TiO_2 could be recovered. In 2000, Syncrude's research was focused on finding an alternative to calcining as a method for bitumen removal (J. Oxenford, Syncrude Canada Ltd., written commun. February 1, 2001).

NAR Resources Ltd. continued to study its heavy minerals deposit near Truro, Nova Scotia. At yearend 2000, the company was conducting a drilling program to confirm positive results of seismic studies and previous shallow drilling (NAR Resources Ltd., January 30, 2001, Quarterly report, accessed August 21, 2001, at URL http://www.nar-resources.com/Financial/quarter1.2001.pdf).

Germany.—Sachtleben Chemie GmbH neared completion of a 25% capacity expansion at its Duisberg sulfate-route TiO_2 pigment facility. The company planned to increase capacity to 100,000 t/yr through process improvements (Sachtleben Chemie GmbH, July 9, 2000, Capacity to increase to 100,000 tonnes titanium dioxide p.a., accessed August 21, 2001, at URL

http://www.sachtleben.de/h/e/new/0970e.phtml?id=11,2).

India.—Kerala Minerals and Metals Ltd. made plans for a 2-year project to increase titanium mineral and pigment capacities at its Charava complex. A new separation plant is expected to increase ilmenite production capacity to 300,000 t/yr. By 2002, synthetic rutile capacity will be increased to 130,000 t/yr from 30,000 t/yr, and TiO_2 pigment capacity is expected to be increased to 60,000 t/yr from the current [2000] 22,000 t/yr (Industrial Minerals, 2000j).

Iscor and Mineral Deposits Ltd. formed an agreement to study several heavy mineral sands deposits in Tamil Nadu. The Kudiraimozhi deposit is located about 90 kilometers southwest of Tuticorin, with an estimated resource of 23 Mt of ilmenite and 1.3 Mt of rutile. Two other deposits under study include one near Sattankulam and another stretching between the cities of Navaladi and Sattankulam (Industrial Minerals, 2000h).

Kazakhstan.—Ust-Kamengorsk Titanium and Magnesium Combine (UKTMC) commissioned a slag plant at its titanium metal facility in Ust-Kamengorsk (Analysis and Strategic Research Center, October 2000, N. Nazarbayev visited eastern Kazakhstan oblast, accessed October 24, 2001, via URL http://www.president.kz/articles/News/News.asp?lng=&art=news2001_october). UKTMC planned to commission its Satpayev ilmenite mine near Bekmir in 2001 (Interfax International Ltd., 2000).

Kenya.—Tiomin Resources Inc. submitted an environmental impact assessment (EIA) for its Kwale mineral sands project to the Ministry of Environment and Natural Resources. Approval of the EIA was pending at yearend (Tiomin Resources Inc., March 31, 2001, Poised for development—2000 annual report, accessed August 21, 2001, at URL http://www.tiomin.com/i/pdf/tio-ar00.pdf).

Malaysia.—Huntsman Tioxide was in the process of increasing capacity at its Teluk Kalung sulfate-route TiO_2 pigment facility. When completed, capacity will be expanded to 56,000 t/yr (a 6,000 t/yr increase) through process improvements (Hunstman Corp, March 31, 2000, Huntsman Tioxide announces capacity increases, accessed October 24, 2001, at URL http://www.huntsman.com/tioxide/ShowPage.cfm?PageID=925&News_ID=647).

TOR Minerals acquired Malaysian Titanium Corp. (MTC). MTC's Ipoh facility is the sole supplier of synthetic rutile for TOR Minerals' buff TiO_2 pigment facility in Corpus Christi, TX (Industrial Minerals, 2000c).

Mozambique.—Kenmare Resources plc acquired the wet separation plant from BHP Minerals' defunct Beenup mining operation in Australia. The plant was shipped to Kenmare's Moma Mineral Sands project in Mozambique. Kenmare expects to begin production by yearend 2002. Capacity at Moma is projected to reach 600,000 t/yr of ilmenite and 16,500 t/yr of rutile (Industrial Minerals, 2000e).

WMC Ltd., Southern Mining Corp., and the state-owned Industrial Development Corp. were proceeding with the development of the Corridor Sands project in Mozambique. In 2000, a feasibility study concluded there were no technical issues to be resolved and the project could proceed. Reserves were estimated to be 45 Mt of ilmenite (Industrial Minerals, 200l).

Netherlands.—In May, Kerr-McGee completed the acquisition of Kemira's TiO_2 pigment plant at Botlek. Capacity at Botlek is based on chloride route technology and is reported to be 56,000 t/yr (Kerr-McGee Chemical Corp., May 4, 2000, Kerr-McGee completes acquisition of Botlek pigment plant, accessed August 21, 2001, at URL http://www.kerr-mcgee.com/news2000/050400.html).

Saudi Arabia.—Kerr-McGee sold its 25% interest in National Titanium Dioxide Co. Ltd., also known as the Cristal joint-venture, to the remaining joint venture partners Shairco for Trading and Contracting, the National Industrialization Co., and Gulf Investment Corp. Cristal is the only TiO_2 pigment producer in Saudi Arabia with 70,000 t/yr of chloride-route capacity (Industrial Minerals, 2000f).

South Africa.—Iscor Ltd. was proceeding with plans to develop its Hillendale deposit near Richards Bay. The company planned to begin mining operations in 2001. In the second phase of the project, Iscor hopes to construct a 250,000-t/yr slag plant at nearby Empangeni. Hillendale reserves are estimated to contain about 4 Mt of heavy minerals (Industrial Minerals, 2000d).

Spain.—Huntsman Corp. was in the process of increasing capacity at its Huelva sulfate-route TiO_2 pigment facility. When completed, capacity will be expanded to 90,000 t/yr (a 17,000 t/yr increase) through process improvements (Huntsman Tioxide, March 9, 2001, Huntsman Tioxide approves $40M expansion of Huelva, Spain plant, accessed August 21, 2001, at URL http://www.huntsman.com/tioxide/ShowPage.cfm?PageID=925&News_ID=642).

United Kingdom.—In September, Huntsman Corp. announced plans to proceed with the construction of a new chloride-route TiO_2 pigment plant at its Greatham facility. The new plant is expected to be completed in 2002 and is expected to bring capacity up to 100,0000 t/yr (Huntsman Tioxide, September 22, 2000, Huntsman Tioxide announces go-ahead for new £50 million plant at Greatham, Deeside, UK, accessed August 21, 2001, at URL http://www.huntsman.com/tioxide/ShowPage.cfm?PageID=925&News_ID=644).

Outlook

Demand for TiO_2 pigment is expected to remain near its current level in the coming year. Over the next 5 years, global economic growth is expected to increase TiO_2 pigment consumption by 3% to 4% per year. Because approximately 95% of all titanium minerals are consumed to produce TiO_2 pigment, consumption of titanium minerals is expected to follow a similar trend.

In the titanium metal industry, the resumption of some aerospace orders is expected to increase demand for some titanium metal products over the coming year. An overall economic slowdown, however, may result in negative growth within the industry. Long-term growth in passenger traffic and nonaerospace markets is expected to result in a 5% per year demand growth over the next decade.

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TABLE 1
SALIENT TITANIUM STATISTICS 1/

(Metric tons, unless otherwise specified)

	1996	1997	1998	1999	2000
United States:					
Ilmenite and titanium slag:					
Imports for consumption	939,000	952,000	1,010,000	1,070,000	918,000
Consumption	1,400,000 2/	1,520,000 2/	1,300,000 3/	1,280,000 3/	1,250,000 3/
Rutile concentrate, natural and synthetic:					
Imports for consumption	324,000	336,000	387,000	344,000	438,000
Consumption	398,000	489,000	421,000	494,000	537,000
Sponge metal:					
Imports for consumption	10,100	16,100	10,900	6,000	7,240
Consumption	28,400	32,000	28,200	18,100	18,200
Price, December 31 dollars per pound	4.25-4.50	4.25-4.50	4.25-4.50	3.70-4.80	3.70-4.80
Titanium dioxide pigment:					
Production	1,230,000	1,340,000	1,330,000	1,350,000	1,400,000
Imports for consumption	167,000	194,000	200,000	225,000	218,000
Consumption, apparent 4/	1,070,000	1,130,000	1,140,000	1,160,000	1,150,000
Price, December 31:					
Anatase dollars per pound	1.06-1.08	1.01-1.03	0.96-0.98	0.92-0.94	0.92-0.94
Rutile do.	1.08-1.10	1.04-1.06	0.97-0.99	0.99-1.02	0.99-1.02
World production:					
Ilmenite concentrate 5/	4,380,000 r/	4,470,000 r/	4,530,000 r/	4,160,000 r/	4,770,000 e/
Rutile concentrate, natural 5/	366,000	406,000	441,000	359,000 r/	417,000 e/
Titaniferous slag	1,830,000	1,950,000	2,050,000	2,050,000	2,070,000 e/

e/ Estimated. r/ Revised.
1/ Data are rounded to no more than three significant digits, except prices.
2/ Includes consumption to produce synthetic rutile.
3/ Excludes consumption used to produce synthetic rutile.
4/ Production plus imports minus exports plus stock decrease or minus stock increase.
5/ Excludes U.S. production data to avoid disclosing company proprietary data.

TABLE 2
U.S. TITANIUM METAL PRODUCTION CAPACITY IN 2000 1/ 2/

(Metric tons)

		Yearend capacity	
Company	Plant location	Sponge	Ingot 3/
Allegheny Technologies Inc.	Albany, OR	6,800	10,900
Do.	Monroe, NC	--	11,800
Do.	Richland, WA	--	10,000
Alta Group	Salt Lake City, UT	340	--
Howmet Corp.	Whitehall, MI	--	3,200
Lawrence Aviation Industries Inc.	Port Jefferson, NY	--	1,400
RMI Titanium Co.	Niles, OH	--	16,300
Titanium Metals Corp.	Henderson, NV	14,500	13,000
Do.	Morgantown, PA	--	24,500
Do.	Vallejo, CA	--	450
Total		21,600	91,600

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

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

(Metric tons)

Component	1999	2000
Production:		
Ingot	40,700	39,600
Mill products	24,200	25,900
Exports:		
Sponge	807	1,930
Waste and scrap	8,130	5,060
Other unwrought 2/	2,470	3,200
Wrought products and castings 3/	5,260	5,380
Total	16,700	15,600
Imports:		
Sponge	6,000	7,240
Waste and scrap	6,870	7,550
Other unwrought 2/	1,610	1,790
Wrought products and castings 3/	2,910	2,900
Total	17,400	19,500
Stocks, yearend:		
Government, sponge (total inventory)	31,200	26,300
Industry:		
Sponge	7,970	5,010
Scrap	9,450	5,150
Ingot	5,180	6,910
Reported consumption:		
Sponge	18,100	18,200
Scrap	21,900	18,500
Receipts:		
Home	11,600	5,820
Purchased	14,500	15,600
Ingot	30,800	27,400
Mill products (net shipments):	21,600	23,600
Forging and extrusion billet	10,100	12,500
Plate, sheet, strip	7,170	7,200
Rod, bar, fastner stock, wire	3,240	3,350
Other 4/	1,100	548
Castings (shipments)	757	658

1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Includes billet, blooms, ingot, powder, sheet bar, slab, and other.
3/ Includes castings, foil, pipes, profiles, tubes, other wrought and articles of titanium not elsewhere specified or included.
4/ Data for extrusions, (other than tubing), pipe and tubing, and other have been combined to avoid disclosing company proprietary data.

TABLE 4
CAPACITIES OF U.S. TITANIUM DIOXIDE PIGMENT PLANTS ON DECEMBER 31, 2000 1/ 2/ 3/

(Metric tons per year)

		Yearend capactiy		
Company	Plant location	Sulfate process	Chloride process	Total
E.I. du Pont de Nemours & Co. Inc.	De Lisle, MS	--	280,000	280,000
Do.	Edgemoor, DE	--	154,000	154,000
Do.	New Johnsonville, TN	--	380,000	380,000
Kemira, Inc.	Savannah, GA	60,000	100,000	160,000
Kerr-McGee Chemical Corp.	Hamilton, MS	--	190,000	190,000
Louisiana Pigment Co. LP	Lake Charles, LA	--	120,000	120,000
Millennium Inorganic Chemicals Inc.	Ashtabula, OH	--	198,000	198,000
Do.	Baltimore, MD	44,000	51,000	95,000
Total		104,000	1,470,000	1,580,000

-- Zero.
1/ Operating capacity based on 7-day-per-week full production.
2/ Table does not include TOR Minerals International's Corpus Christi, TX, production capacity of about 16,400 metric tons per year of buff TiO_2 pigments 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.

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

(Metric tons, unless otherwise specified)

	1999		2000	
	Gross weight	TiO_2 content	Gross weight	TiO_2 content
Production 2/	1,350,000	1,300,000 e/	1,400,000	1,320,000 e/
Shipments: 3/				
Quantity	1,430,000	1,350,000	1,470,000	1,380,000
Value thousands	$2,700,000	$2,700,000	$2,760,000	$2,760,000
Exports	384,000	368,000 e/	464,000	436,000 e/
Imports for consumption	225,000	216,000 e/	218,000 e/	205,000 e/
Stocks, yearend	137,000	130,000 r/	141,000 e/	133,000 e/
Consumption, apparent 4/	1,160,000	1,110,000 e/	1,150,000 e/	1,090,000 e/

e/ Estimated. r/ Revised.
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 plus stock decrease or minus stock increase.

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

TABLE 6
U.S. CONSUMPTION OF TITANIUM CONCENTRATES 1/

(Metric tons)

	1999		2000	
	Gross weight	TiO_2 content	Gross weight	TiO_2 content
Ilmenite and titanium slag: 2/ 3/				
Pigments	1,270,000	NA	1,240,000	NA
Miscellaneous 4/	13,400	NA	13,900	NA
Total	1,280,000	963,000	1,250,000	919,000
Rutile, natural and synthetic:				
Pigments	469,000	NA	513,000	NA
Miscellaneous 4/	25,800	NA	24,100	NA
Total	494,000	413,000	537,000	497,000
Total concentrates:				
Pigments	1,740,000	NA	1,750,000	NA
Miscellaneous 4/	39,100	NA	38,000	NA
Total	1,780,000	1,380,000	1,790,000	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 rutile, leucoxene, and altered ilmenite.
3/ Excludes ilmenite used to produce synthetic rutile.
4/ Includes alloys, carbide, welding-rod coatings and fluxes, ceramics, chemicals, glass fibers, and titanium metal.

TABLE 7
U.S. CONSUMPTION OF TITANIUM PRODUCTS IN STEEL AND OTHER ALLOYS 1/ 2/

(Metric tons)

	1999	2000
Carbon steel	3,630	3,690
Stainless and heat-resisting steel	1,760	1,520
Other alloy steel (includes HSLA and tool steel)	676	777
Total steel	6,060	5,990
Superalloys	681	918
Alloys, other than above	586	684
Miscellaneous and unspecified	79	8
Total consumption	7,410	7,600

1/ Includes ferrotitanium, titanium scrap, and other titanium additives.
2/ Data are rounded to no more than three significant digits; may not add to totals shown.

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

(Percent)

Industry	1999	2000
Coated fabrics and textiles	0.2	0.2
Paint, varnish, lacquer	50.2	49.5
Paper	20.0	20.4
Plastics	21.0	21.3
Printing ink	0.5	0.5
Rubber	0.8	1.0
Other 2/	7.3	7.1
Total	100.0	100.0

1/ Excludes exports.
2/ Includes agricultural, building materials, ceramics, coated fabrics and textiles, cosmetics, food, and paper; also includes shipments to distributors.

TABLE 9
U.S. STOCKS OF TITANIUM CONCENTRATES AND PIGMENT, DECEMBER 31, 2000 1/

(Metric tons)

	1999		2000	
	Gross weight	TiO_2 content	Gross weight	TiO_2 content
Concentrates: 2/				
Ilmenite and titanium slag	489,000	343,000	337,000	262,000
Rutile, natural and synthetic	106,000	96,400	109,000	101,000
Titanium pigment 3/	137,000	130,000 e/	141,000	133,000 e/

e/ Estimated.
1/ Data are rounded to no more than three significant digits.
2/ Consumer stocks.
3/ Data from U.S. Census Bureau. Producer stocks only.

TABLE 10
PUBLISHED PRICES OF TITANIUM CONCENTRATES AND PRODUCTS

		1999	2000
Concentrates:			
Ilmenite, f.o.b. Australian ports	dollars per metric ton	90.00-103.00	83.00-105.00
Rutile, bagged, f.o.b. Australian ports	do.	500.00-530.00	480.00-570.00
Rutile, bulk, f.o.b. Australian ports	do.	435.00-510.00	470.00-500.00
Titanium slag, 80% TiO_2, Canada 1/	do.	390.00	349.00
Titanium slag, 85%TiO_2, South Africa 1/	do.	406.00	407.00
Metal:			
Sponge	dollars per pound	3.70-4.80	3.70-4.80
Ferrotitanium	do.	2.20-2.40	.75-.80
Scrap, turnings, unprocessed	do.	1.08-1.12	1.55-1.63
Pigment:			
Titanium dioxide pigment, f.o.b. U.S. plants, anatase	do.	.92-.94	.92-.94
Titanium dioxide pigment, f.o.b. U.S. plants, rutile	do.	.99-1.02	.99-1.02

1/ Unit value based on U.S. imports for consumption.

Sources: American Metal Market, American Paint and Coatings Journal, Chemical Market Reporter, Industrial Minerals (London), Metal Bulletin, Platt's Metals Week, and industry contacts.

TABLE 11
U.S. EXPORTS OF TITANIUM PRODUCTS, BY CLASS 1/

Class	1999 Quantity (metric tons)	1999 Value (thousands)	2000 Quantity (metric tons)	2000 Value (thousands)
Metal:				
Unwrought:				
Sponge	807	$5,750	1,930	$11,400
Waste and scrap	8,130	11,700	5,060	12,700
Other unwrought:				
Billet	327	8,120	263	6,320
Blooms and sheet bars	848	25,900	1,460	51,700
Ingot	683	12,600	829	11,900
Other	616	11,800	649	12,600
Wrought products and castings:				
Bars and rods	1,870	62,800	2,400	81,000
Other	3,390	176,000	2,980	172,000
Total metal	16,700	314,000	15,600	360,000
Ores and concentrates	9,380	5,350	18,900	7,920
Pigment and oxides:				
80% or more titanium dioxide and other titanium dioxide pigments	344,000	558,000	423,000	703,000
Titanium oxides	39,300	69,000	41,000	80,500
Total	384,000	627,000	464,000	784,000

1/ Data are rounded to no more than three significant digits, may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 12
U.S. IMPORTS FOR CONSUMPTION OF TITANIUM CONCENTRATES, BY COUNTRY 1/

Concentrate and country	1999 Quantity (metric tons)	1999 Value (thousands)	2000 Quantity (metric tons)	2000 Value (thousands)
Ilmenite:				
Australia	252,000	$21,100	209,000	$23,100
India	30,100	2,450	29,400	2,560
Malaysia	--	--	26,000	1,240
Norway	100	8	--	--
Sierra Leone	2,600	153	--	--
Ukraine	106,000	9,130	121,000	10,300
Total	391,000	32,800	386,000	37,200
Titanium slag:				
Canada	208,000	78,200	123,000	52,600
Norway	10,000	3,690	10,000	3,800
South Africa	459,000	183,000	400,000	162,000
Other	--	--	30	27
Total	678,000	265,000	533,000	219,000
Rutile, natural:				
Australia	72,500	28,600	113,000	47,600
Canada	22,600	19,100	1,080	724
Korea, Republic of	34 r/	44 r/	172	223
Siera Leone	4,730	1,180	--	--
South Africa	125,000	50,600	140,000	58,500
Ukraine	--	--	10,000	3,920
Other 2/	78 r/	103 r/	4	8
Total	225,000	99,700	265,000	111,000
Rutile, synthetic:				
Australia	114,000	37,000	159,000	51,600
India	--	--	9,050	3,750
Malaysia	4,230	2,780	5,700	3,080
Other	95 r/	69 r/	45	61
Total	119,000	39,800	173,000	58,400
Titaniferous iron ore, Canada 4/	10,700	2,620	88,200	4,890

See footnotes at end of table.

TABLE 12--Continued
U.S. IMPORTS FOR CONSUMPTION OF TITANIUM CONCENTRATES, BY COUNTRY 1/

r/ Revised. -- Zero.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Data being verified by the U.S. Census Bureau.
3/ Less than 1/2 unit.
4/ Includes materials consumed for purposes other than production of titanium commodities, principally heavy aggregate and steel-furnance flux.

Source: U.S. Census Bureau. Data adjusted by the U.S. Geological Survey. Titaniferous iron ore from Canada is classified as ilmenite under the Harmonized Tariff Schedule of the United States.

TABLE 13
U.S. IMPORTS FOR CONSUMPTION OF TITANIUM METAL, BY CLASS AND COUNTRY 1/

	1999		2000	
Class and country	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Unwrought:				
Sponge:				
Japan	2,070	$17,500	3,790	$29,200
Kazakhstan	814	5,540	2,170	13,500
Russia	2,570	16,500 r/	1,200	6,780
United Kingdom	417	2,210	--	--
Other	135 r/	441 r/	77	381
Total	6,000	42,200	7,240	49,900
Waste and scrap:				
Belgium	293	547	280	568
Canada	264	409	155	373
France	955	2,160	1,220	3,910
Germany	479	1,380	693	2,350
Italy	586	1,960	491	1,550
Japan	1,790	6,420	1,760	5,760
Russia	692	1,940	692	2,280
Sweden	177	279	251	881
United Kingdom	1,090	2,840	1,360	4,670
Other	540 r/	1,610	648	1,760
Total	6,870	19,500	7,550	24,100
Ingot and biller:				
China	347	4,760	13	188
Japan	134	1,450	105	3,570
Russia	787	10,600	1,240	14,800
United Kingdom	113	3,660	76	3,710
Other	--	--	103	976
Total	1,380	20,400	1,540	23,200
Powder	224	1,170	250	2,610
Other: 2/				
Canada	(3/)	11	17	102
Japan	1	260	(3/)	130
Russia	9	92	--	--
United Kingdom	--	--	4	87
Other	(3/) r/	60 r/	2	79
Total	10	423	23	398
Wrought products and castings: 4/				
Canada	124	3,630	123	3,170
China	133	3,180	59	1,220
Italy	253	5,600	113	2,010
Japan	566	17,200	643	15,700
Russia	1,520	30,300	1,510	24,800
United Kingdom	118	6,240	152	4,800
Other	197 r/	7,920 r/	300	8,950
Total	2,910	74,100	2,900	60,600
Ferrotitanium and ferrosilicon-titanium	4,750	8,620	6,050	15,900

See footnotes at end of table.

TABLE 13--Continued
U.S. IMPORTS FOR CONSUMPTION OF TITANIUM METAL, BY CLASS AND COUNTRY 1/

r/ Revised. -- Zero.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Includes blooms, sheet, bars, slabs, and other unwrought.
3/ Less than 1/2 unit.
4/ Includes bars, castings, foil, pipes, plates, profiles, rods, sheet, strip, tubes, wire, and other.

Source: U.S. Census Bureau.

TABLE 14
U.S. IMPORTS FOR CONSUMPTION OF TITANIUM PIGMENTS, BY COUNTRY 1/

	1999		2000	
Country	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
80% or more titanium dioxide:				
Australia	6,230	$11,600	20	$32
Belgium	3,740	6,450	3,030	5,410
Canada	75,200	129,000	64,000	111,000
China	5,650	6,660	5,910	7,450
Finland	3,220	6,650	1,870	4,230
France	6,080	10,300	5,760	9,290
Germany	25,900	52,800	24,100	50,300
Italy	3,380	5,830	8,400	13,900
Japan	12,900	28,000	6,920	18,900
Norway	4,310	7,580	6,290	11,000
Poland	441	660	440	778
Singapore	3,390	5,500	3,010	5,300
Slovenia	2,700	4,560	2,730	5,040
South Africa	5,380	8,790	7,690	13,800
Spain	14,000	25,100	15,700	27,300
United Kingdom	4,060	6,890	3,980	6,770
Other	13,200	20,700	20,600	30,300
Total	190,000	337,000	180,000	320,000
Other titanium dioxide:				
Belgium	1,870	4,450	2,610	6,110
Canada	3,480	5,850	3,110	5,560
Germany	2,400	8,090	1,670	4,930
United Kingdom	171	1,220	81	256
Other	1,400 r/	3,930 r/	1,280	3,870
Total	9,320	23,500	8,760	20,700
Titanium oxide:				
Australia	3,380	5,930	--	--
Belgium	1,660	2,720	1,440	2,400
Canada	487	812	--	--
China	3,470	3,670	6,350	7,040
Czech, Republic of	2,240	3,960	2,030	3,660
France	7,850	11,900	7,180	10,900
Germany	809	1,830	935	2,140
Japan	653	7,130	630	6,640
Poland	1,300	2,200	2,520	4,540
Ukraine	2,020	2,700	7,050	8,800
Other	1,860 r/	2,970 r/	830	1,380
Total	25,700	45,900	29,000	47,500
Grand total	225,000	406,000	218,000	389,000

r/ Revised. -- Zero.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 15
TITANIUM: WORLD PRODUCTION OF MINERAL CONCENTRATES, BY COUNTRY 1/ 2/

(Metric tons)

Concentrate type and country	1996	1997	1998	1999	2000 e/
Ilmenite and leucoxene: 3/					
Australia:					
Ilmenite	2,028,000	2,233,000	2,379,000	1,990,000	2,156,000 4/
Leucoxene	33,000	32,000	30,000	32,000	27,000 4/
Brazil 5/	97,955	97,174	103,000	96,000 r/ e/	96,000
China e/	165,000	170,000	175,000	180,000	185,000
Egypt	124,000	125,000	125,000	130,000	125,000 4/
India e/	330,000	332,000	378,000	378,000	380,000
Malaysia	244,642	167,504	124,689	127,695	110,000
Norway e/	746,583 4/	750,000	590,000	600,000 r/	610,000
Sri Lanka	62,810	17,970	34,118	-- r/	--
Ukraine	500,000 r/ e/	500,000 r/ e/	507,435 r/	536,542 r/	576,749
United States	W	W	W	W	400,000 6/
Vietnam e/	50,000	50,000	80,000	91,000 r/	109,000
Total	4,380,000 r/	4,470,000 r/	4,530,000 r/	4,160,000 r/	4,770,000
Rutile:					
Australia	180,000	214,000	241,000	190,000	237,000 4/
Brazil	2,018	1,742	1,800 e/	4,300 r/ e/	4,000
India e/	15,000	14,000	16,000	16,000	17,000
South Africa e/	115,000	123,000	130,000	100,000 r/	100,000
Sri Lanka	3,532	2,970	1,930	-- r/	--
Ukraine e/	50,000	50,000	50,000	49,000 r/	58,600
United States	W	W	W	W	(7/)
Total	366,000	406,000	441,000	359,000 r/	417,000
Titaniferous slag: e/ 8/					
Canada	825,000	850,000	950,000	950,000	950,000
South Africa	1,000,000	1,100,000	1,100,000	1,100,000	1,120,000
Total	1,830,000	1,950,000	2,050,000	2,050,000	2,070,000

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data; not included in "Total." -- 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 13, 2001.

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/ Reported figure.

5/ Excludes production of unbeneficiated anatase ore.

6/ Includes rutile to avoid revealing company proprietary data. Rounded to one significant digit.

7/ Included with ilmenite to avoid revealing company proprietary data; not included in "Total."

8/ Slag is also produced in Norway, but this output is not included under "Titaniferous slag" to avoid duplicative reporting.