USGS
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2012 Minerals Yearbook

TITANIUM [ADVANCE RELEASE]

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TITANIUM

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Domestic production of titanium dioxide (TiO_2) pigment decreased by 12% compared with that of 2011 (table 5). U.S. consumption of titanium used in steel and other alloys increased by 4% from that in 2011 (table 7). U.S. production of titanium mineral concentrates in 2012 was unchanged from that of 2011. The United States was 78% import reliant for titanium mineral concentrates and 71% for titanium sponge, and continued to be a net exporter of TiO_2 pigment and wrought titanium metal products. The leading sources of imported titanium mineral concentrates were Australia, Canada, and South Africa (table 11). World production of titanium mineral concentrates in 2012 was 8.31 million metric tons (Mt) of contained TiO_2, a 4% decrease from revised totals of 2011. The leading producers of titanium mineral concentrates were, in descending order of production, Australia, China, South Africa, and Vietnam.

Legislation and Government Programs

ADMA Products, Inc. received funding from the 2012 Defense Appropriations Bill to increase the production of hydrogenated titanium powder. In 2012, a 800 kilogram-per-day (kg/d) pilot scale unit was constructed. Future plans included expansion of titanium powder production capacity to 1,800 metric tons per year (t/yr) (Duz and others, 2013, p. 15).

Production

Titanium industry data for this report were collected by the U.S. Geological Survey (USGS) from annual and quarterly surveys of domestic titanium operations. In 2011, the USGS annual survey canvassed titanium mineral and pigment producers. The two producers of titanium mineral concentrates responded. Of the six active domestic TiO_2 pigment operations, four responded. Production data for the operations that did not respond were estimated on the basis of prior year production levels and industry trends. Production data for titanium ingot and mill products were aggregated from a quarterly survey of producers.

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 dredging and dry surface mining techniques for the recovery of heavy minerals, including titanium minerals. Gravity spirals are used to isolate the heavy-mineral suite, and magnetic and high-tension separation circuits are used to separate the heavy-mineral constituents. Ilmenite and rutile are the two principal minerals for titanium. Ilmenite is the most abundant titanium mineral with contained TiO_2 content ranging from 35% to 65%. 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. Rutile, naturally occurring TiO_2, has the highest TiO_2 content but is less abundant.

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. Iluka produced titanium mineral concentrates from its heavy-mineral operations near Stony Creek, VA.

Metal.—Commercial production of titanium metal involves the chlorination of titanium-containing mineral concentrates to produce titanium tetrachloride ($TiCl_4$), which is then reduced with magnesium (Kroll process) or sodium (Hunter process) to produce 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 and slab are produced by melting titanium sponge and (or) scrap, usually with other alloying elements such as aluminum and vanadium. Electron beam (EB), plasma arc melt (PAM), scull, and vacuum-arc remelting (VAR) are the commercial methods used to produce ingot and slab. Titanium mill products are formed by drawing, forging, and rolling of titanium 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.

In 2012, U.S. producers of titanium sponge were Allegheny Technologies Inc. (ATI), Honeywell Electronic Materials Inc., and Titanium Metals Corp. (Timet) (table 2). ATI's Rowley, UT, plant and Timet's Henderson, NV, plant produced titanium sponge using the Kroll process. Honeywell Electronic Materials' plant in Salt Lake City, UT, used the Hunter process to produce titanium sponge feed for the company's production of electronic-grade titanium. Data on domestic production of titanium sponge were withheld to avoid disclosing company proprietary data. U.S. production of titanium ingot increased in 2012 by 14% and mill products decreased slightly (table 3).

Ferrotitanium is usually produced by induction melting of titanium scrap with iron or steel, but may be produced through the aluminothermic reduction of ilmenite. The two standard grades of ferrotitanium that are normally produced contain 40% or 70% titanium. U.S. producers of ferrotitanium were RTI International Metals, Inc. (Canton, OH) (7,250 t/yr capacity) and Global Titanium Inc. (Detroit, MI) (<10,000 t/yr capacity). Data on production of ferrotitanium were not available.

TiO_2 Pigment.— TiO_2 pigment is produced from titanium mineral concentrates by either the chloride process or the

sulfate process. In the chloride process, natural rutile, chloride-grade ilmenite, or slag 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 during 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. Either process may be used to produce pigment, and the decision of which process to use 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 particle size distribution and surface treated or coated to improve its functional behavior in various media. Some typical surface treatments include alumina, organic compounds, and silica. The TiO_2 pigment produced 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 wide range of functional properties, including dispersion, durability, opacity, and tinting.

U.S. production of TiO_2 pigment was 1.14 Mt in 2012, a 12% decrease compared with that in 2011 (table 5). U.S. producers of TiO_2 pigment by the chloride process were Cristal Global, DuPont, Louisiana Pigment Co. L.P. (a joint venture of Kronos Worldwide, Inc. and Huntsman Corp.), and Tronox Ltd. (table 4). TOR Minerals International, Inc. produced a buff TiO_2 pigment from finely ground synthetic rutile.

Consumption

Mineral Concentrates.—On a gross weight basis, 94% of domestic consumption of titanium mineral concentrates was used to produce TiO_2 pigment. The remaining 6% was used to produce metal and other miscellaneous products, including fluxes, and welding rod coatings. Based on TiO_2 content, domestic consumption of titanium mineral concentrates was 1.59 Mt, a 6% increase compared with that of 2011 (table 6).

Consumption data for titanium concentrates were estimated by the USGS owing to insufficient response by industry to the voluntary survey for consumption data.

Metal.—Titanium metal alloys are used for their high strength-to-weight ratio and corrosion resistance. In general, production of titanium mill products precede aircraft deliveries by about 1 year. In 2012, mill product shipments decreased by 13% from those of 2011 (table 3). The aerospace industry (75%) was the leading end use for mill products. Other uses included consumer goods and the 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 control and stabilization of 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 12,900 t, a 4% increase compared with that of 2011 (table 7).

TiO_2 Pigment.—Domestic production of TiO_2 pigment decreased by 12% but apparent domestic consumption (not accounting for changes in inventory) increased slightly from that of 2011 (table 5). The leading uses of TiO_2 pigment, based on TiO_2 pigment shipments in the United States by domestic producers, were paint and coatings (59.8%), plastics and rubber (24.6%), and paper (10.6%). Other uses (5.0%) included catalysts, ceramics, coated fabrics and textiles, floor coverings, printing ink, and roofing granules (table 8).

Stocks

Insufficient data were available to determine yearend consumer inventories of titanium mineral concentrates and TiO_2 pigment producer stocks. Yearend domestic stocks of sponge and ingot increased by 67% and 4%, respectively, from yearend 2011 levels owing to anticipated demand by the aerospace industry and higher feedstock prices (table 3).

Prices

Yearend titanium mineral concentrate prices are listed in table 9. Owing to increased global demand from TiO_2 pigment producers, prices for bulk ilmenite and rutile concentrates were considerably higher than prices in 2011. Published prices for titanium slag were not available. Based on U.S. Census Bureau data, the value of slag imports in December 2012, rose to a range of $512 to $763 per metric ton from $468 to $494 per ton in December 2011, owing to rising feedstock prices. The U.S. Department of Labor, Bureau of Labor Statistics, producer price index (PPI) for TiO_2 pigment began the year at 268, rose to a high of 305 in May, and then decreased to 268 by yearend. In December 2012, the monthly PPI for titanium mill products was 179, a decrease from 203 in December 2011. Sponge and ingot prices were generally unchanged owing to long-term contracts (U.S. Department of Labor, Bureau of Labor Statistics, 2013).

Foreign Trade

Mineral Concentrates.—U.S. Imports of titanium mineral concentrates included ilmenite, rutile, synthetic rutile, and titaniferous slag. The United States was heavily reliant on imports of titanium mineral concentrates because domestic consumption of titanium minerals greatly exceeded domestic production and capacity. In 2012, the TiO_2 content of imports was estimated to be 1.12 Mt, primarily in the form of titaniferous slag (47%), rutile (23%), and ilmenite (21%). South Africa, Australia, Canada, and Mozambique were, in descending order of TiO_2 quantity, the leading import sources. The combined value for all forms of titanium concentrate imports in 2012 was $1.01 billion (table 11). Imports of titaniferous iron ore from Canada (classified as ilmenite by the U.S. Census Bureau), which totaled 96 t in 2011, increased to 286 t in 2012. Exports of titanium concentrates were minor relative to imports (tables 10–11).

Metal.—Total imports of titanium metal decreased by 5% from those in 2011. Imports of titanium metal were primarily in the form of sponge (58%), waste and scrap (27%), and wrought products and castings (13%). In descending order, Japan, Kazakhstan, and China were the leading sources of imported titanium sponge, and the United Kingdom, Germany, Japan, and France were, in descending order, the leading sources of imported scrap. Germany and Russia supplied all of the imported titanium ingot, and China was the major source of titanium powder. Imports of other unwrought forms of titanium more than doubled compared with those of 2011, yet still constituted less than 1% of titanium metal imports. Imports of titanium wrought products and castings were primarily in the form of plate, sheet, strip, and foil (60%); bar, rod, profiles, and wire (26%); and billets (15%). Russia was the leading source of wrought products and castings. Imports of wrought products and castings were almost identical to those of 2011, at 6,840 t. Imports of ferrotitanium were 2,410 t, a 16% increase compared with those of 2011. The leading import sources were, in descending order, by weight, Canada, Russia, and the Netherlands. Exports of ferrotitanium were 3,610 t, a 12% increase compared with those of 2011.

TiO_2 Pigment.—In 2012, the United States continued to be a net exporter of TiO_2 pigment, with exports exceeding imports by a ratio of 3.1 to 1. Exports of TiO_2 pigment were 624,000 t, a 21% decrease compared with those of 2011. During 2012, 203,000 t of TiO_2 pigment was imported, a slight increase compared with those of 2011. About 94% of TiO_2 pigment exports was in the form of finished pigment with 80% or more TiO_2 content (table 10). The leading import sources of TiO_2 pigment were Canada (38%) and China (21%). Seventy-five percent of pigment imports was in the form of finished pigment with more than 80% TiO_2 content (table 13).

World Review

Australia.—In Australia, production of rutile decreased by 7% from that of 2011 and production of ilmenite increased by 5% as pigment producers switched to lower grade ilmenite feedstocks owing to the sharp increase in rutile prices.

In June, Tronox completed the acquisition of Exxaro Resources Ltd.'s mineral sand operations in Western Australia and South Africa in exchange for 38.5% of Tronox equity. The acquisition included Exxaro's 50% interest in the Tiwest Joint Venture in Western Australia that was jointly owned with Tronox (Tronox Ltd., 2012). The combined capacity of these three operations totaled 723,000 t/yr of titanium feedstock and 265,000 t/yr of zircon production (Tronox Ltd., 2013, p. 24).

In 2012, Iluka Resources Ltd. produced 220,000 t of rutile and 248,000 t of synthetic rutile from its Australian operations in the Eucla Basin, South Australia; Perth Basin, Western Australia; and Murray Basin, Victoria, a decrease of 22% and 13%, respectively, from those of 2011. Iluka's 2012 production of salable ilmenite from these basins was 459,000 t, an increase of 23% from 2011 production (Iluka Resources Ltd., 2013, p. 15).

Murray Zircon Pty. Ltd. restarted mining operations at its Mindarie Mineral Sands project in South Australia in October. The mixed heavy mineral concentrates, containing ilmenite, leucoxene, rutile, and zircon, would be bulk shipped to a facility in China for further processing and sale. The Mindarie Mineral Sands was expected to produce 120,000 t/yr of mixed heavy mineral concentrate over a period of 15 years. (Murray Zircon Pty. Ltd., 2012, p. 13, 14).

Gunson Resources Ltd. upgraded the reserves at its Coburn heavy mineral sands project to an estimated 49,500 t/yr of zircon, 109,000 t/yr or ilmenite, and 23,500 t/yr of higher titanium dioxide mineral products (rutile and leucoxene combined into a 90% TiO_2 product). Anticipated mine life was reduced to 19 years from 23 years (Gunson Resources Ltd., 2013, p. 10).

Matilda Zircon Ltd. continued the development of the Keysbrook deposit, 70 kilometers (km) south of Perth. Matilda planned to begin mine construction in the second quarter 2013 and to begin mining in early 2014. The Keysbrook project was expected to operate for at least 7 years with a potential expansion to 15 years with additional approvals and land access arrangements. Average annual production was expected to be 62,200 t/yr of leucoxene and 28,700 t/yr of zircon (Matilda Zircon Ltd., 2013, p. 3).

China.—In 2012, exports of sponge and mill products were 4,500 t and 12,300 t, respectively. The 14 leading manufacturers produced 81,000 t of sponge in 2012, an increase of 25% from that of 2011, and 52,000 t of titanium mill products, a slight increase from that in 2011 (Metal-Pages, 2013).

China produced 1.9 Mt of TiO_2 pigment in 2012, an increase of 8% from that of 2011, with a utilization rate of 48% of an estimated 4.0 Mt/yr of capacity (Metal-Pages, 2012a). In June, Henan Billions Chemicals Co., Ltd., signed an agreement with PPG Industries under which PPG was to provide chloride-based titanium dioxide technologies for use at Henan Billions' TiO_2 production facilities in China (PPG Industries, 2013, p. 9). Subsequent to the agreement, Henan Billions signed an agreement with Ti-Cons to build and operate a 100,000 t/yr chloride-based TiO_2 production facility. Production was expected to begin in 2015 (Lismore, 2012a, Ti-Cons, 2013). The only confirmed chloride-based TiO_2 producer in China was Jinzhou Titanium Industrial Co. Ltd. with a capacity of 60,000 t/yr (Ollett, 2012).

India.—Kerala Minerals and Metals Ltd. commissioned a titanium sponge plant at the Chavara industrial complex in a joint venture with the Vikram Sarabhai Space Center. The plant was expected to produce 1,000 t/yr eventually (Metal-Pages, 2012b).

Japan.—Exports of titanium sponge totaled about 30,700 t in 2012, an increase of 22% from those of 2011. Exports to the United States accounted for 62% of this total, an increase of 18% compared with 2011 owing to aerospace industry demand (Roskill's Letters from Japan, 2013).

Kenya.—Base Resources Ltd. was to begin mining operations at its Kwale prospect in July 2013. During the first 7 years of operation, production was expected to average 330,000 t/yr of ilmenite, 79,000 t/yr of rutile, and 30,000 t/yr of zircon (Base Resources Ltd., 2012, p. 7).

Mozambique.—The Jinan Yuxaio Group of China was granted a mining license for a heavy-mineral sands deposit in the Zambeze province along the Quelmaine coast (Mineral Sands Report, 2012).

Kenmare Resources plc's production of heavy-mineral concentrates at its Moma operation was 772,000 t, a decrease of 10% relative to that of 2011, and ilmenite production was 574,500 t, a decrease of 10% from that of 2011 owing to electric supply disruptions and challenges associated with elevating the dredge pond. Kenmare was working to increase capacity from 800,000 t/yr to 1.2 Mt/yr with an expected completion date of late 2013 (Kenmare Resources plc, 2013, p. 14, 20).

Norway.—TiZir Ltd.'s Tyssedal ilmenite upgrading facility in southwest Norway produced 181,100 t of titanium slag in 2012, a slight increase from that of 2011. Ilmenite for the Tyssedal operation was mostly sourced from the production of Titania AS's nearby Tellnes Mine in Norway (Mineral Deposits Ltd., 2013, p. 12; 2014).

Russia.—In 2012, the first year of full production, IRC Ltd. produced 125,000 t of ilmenite at its Kurankh deposit, an increase of 97% from that of 2011. The Kurankh deposit is located in the Amur region in the Russian Far East (IRC Ltd., 2013).

Saudi Arabia.—In June, Cristal Global announced that the titanium slag plant originally scheduled to be built in Yanbu had been relocated to Jazan Economic City. The plant was to have an initial capacity of 500,000 t/yr of 85% titanium slag with 235,000 t/yr of pig iron as a coproduct and was scheduled to begin operating in 2014 (Cristal Global, 2012).

Senegal.—Astron Ltd. updated its ore reserve estimate for the Niafarang mineral sands project, south of Dakar. Probable ore reserves were 4.7 Mt containing 11% heavy minerals. The heavy mineral suite included 75% ilmenite, 14% zircon, and 2.3% rutile (Astron Ltd., 2012).

Mineral Deposits continued with development and construction of the mine and separation plants at its Grande Cote heavy-minerals deposit, and initial production was scheduled for 2013. Mineral Deposits entered into a joint-venture agreement with ERAMET SA (Paris, France), whereby Mineral Deposits 90% stake in the Grande Cote deposit was combined with ERAMET's 100% stake in the Tyssedal ilmenite upgrading plant in Norway to form a new entity, TiZir Ltd. After the Grande Cote Mine and separation plants are operational, TiZir is expected to produce an average of 575,000 t/yr of ilmenite, 85,000 t/yr of zircon, and small amounts of rutile and leucoxene over a mine life of 20 years (Mineral Deposits Ltd., 2013, p. 11).

Sierra Leone.—Sierra Rutile Ltd. (SRL) produced 94,490 t of rutile in 2012, a 39% increase from 2011. In October, SRL announced the development of its Gangama dry mining project, which was projected to produce an average of 83,400 t/yr of rutile, 46,000 t/yr of ilmenite and 9,500 t/yr of zircon and other concentrates for 6 years. A feasibility study of this project was scheduled for completion in the second quarter 2013 (Sierra Rutile Ltd., 2012, p. 1, 11).

Ukraine.—Volnogorsk AG announced expansion of its rutile and ilmenite capacity from its deposits in the Dnepropetrovsk region. By 2015, Volnogorsk expected to increase its capacity to produce 90,000 t/yr of rutile and 950,000 t/yr of ilmenite from the current levels of 60,000 t/yr and 720,000 t/yr, respectively (Lismore, 2012b).

Vietnam.—In July, VSMPO-Avisma of Verkhnyaya Salda, Russia, signed a memorandum of understanding with the Vietnam National Coal-Mineral Industries Holding Corp. (Vinacomin). The two companies planned to create a joint venture to process titanium minerals after Vinacomin secured licenses to develop mineral resources in the Binh Thuan province (Metal-Pages, 2012c).

Outlook

The market for titanium minerals was expected to be driven by the production of TiO_2 pigment. Growth in global demand for TiO_2 was expected to trend with economic growth and the production of paint, paper, and plastics. Although existing mines in the United States were expected to be depleted by 2020, two new mines were to commence production of heavy-mineral concentrates in the near future. Southern Ionics Inc. expected to begin production of heavy-mineral concentrates in its South Mission Mine in the second quarter 2014 and at its North Mission Mine in the first quarter 2015 in Charlton County and Brantley County, GA, respectively. Mining operations were projected to last 25 years (Mineral Sands Report, 2013).

Aerospace, defense, and industrial uses were expected to strongly influence consumption of titanium metal for the foreseeable future. Commercial aircraft production was expected to remain the dominant consumer of titanium metal. The global aircraft fleet was projected to increase by an average 3.6% per year from 2013 to 2032 (Boeing Co., The, 2013, p. 4). According to one industry estimate, consumption of titanium metal by the aerospace industry was expected to climb to 40,400 t by 2017 from 22,300 t in 2012 (Hickton, 2013, p. 43). Government and private industry programs in the United States and foreign countries to develop commercial-scale lower cost methods of producing titanium metal may further increase titanium demand if they are successful.

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*Corrections posted September 15, 2014.

TABLE 1
SALIENT TITANIUM STATISTICS[1]

		2008	2009	2010	2011	2012
United States:						
Mineral concentrate:						
Imports for consumption	metric tons	1,380,000	943,000	1,200,000	1,270,000	1,380,000
Consumption[e, 2]	do.	1,780,000	1,700,000	1,850,000	1,830,000	1,940,000
Sponge metal:						
Imports for consumption	do.	23,900	16,600	20,500	33,800	33,600
Consumption	do.	W	W	34,900	48,400	35,100
Price, yearend[3]	dollars per pound	6.16–8.02	4.50–7.07	3.50–6.24	3.27–6.74	3.53–6.95
Titanium dioxide pigment:						
Production	metric tons	1,350,000	1,230,000	1,320,000	1,290,000	1,140,000
Imports for consumption	do.	183,000	175,000	204,000	200,000	203,000
Consumption, apparent[4]	do.	800,000	757,000	767,000	706,000	722,000
Producer price index, yearend[5]	(1982=100)	170	164	194	268	268
World, production:						
Ilmenite concentrate[6]	metric tons	7,010,000 r	6,260,000 r	7,530,000 r	7,570,000 r	7,800,000
Rutile concentrate, natural[7]	do.	641,000 r	577,000 r	734,000 r	808,000 r	809,000
Titaniferous slag[e]	do.	2,250,000 r	1,850,000 r	2,340,000 r	2,220,000 r	2,300,000

[e]Estimated. [r]Revised. do. Ditto. W Withheld to avoid disclosing company proprietary data.
[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. Excludes stock changes.
[5]Source: U.S. Department of Labor, Bureau of Labor Statistics.
[6]Includes U.S. production of ilmenite, leucoxene, and rutile rounded to one significant digit to avoid disclosing company proprietary data.
[7]U.S. production of rutile included with ilmenite to avoid disclosing company proprietary data.

TABLE 2
U.S. TITANIUM METAL PRODUCTION CAPACITY IN 2012[1, 2]

(Metric tons per year)

		Yearend capacity[e]	
Company	Plant location	Sponge	Ingot[3]
Alcoa Howmet	Whitehall, MI	--	3,200
Allegheny Technologies Inc.	Albany, OR	(4)	10,900
Do.	Monroe, NC	--	23,200
Do.	Richland, WA	--	10,000
Do.	Rowley, UT	10,900	--
Alloy Works LLC	Greensboro, NC	--	1,800
Honeywell Electronic Materials Inc.	Salt Lake City, UT	500	--
Perryman Co.	Houston, PA	--	1,800
RTI International Metals, Inc.	Niles, OH	--	13,600
Titanium Metals Corp.	Henderson, NV	12,600	12,300
Do.	Morgantown, PA	--	40,700
Do.	Vallejo, CA	--	800
Total		24,000	118,000

[e]Estimated. Do. Ditto. -- 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.
[4]In July 2009, sponge capacity of 9,980 metric tons per year was temporarily idled, and did not operate in 2012.

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

(Metric tons)

Component	2011	2012
Production:		
Ingot	60,300	68,800
Mill products	40,500	39,800
Exports:		
Waste and scrap	5,150	8,760
Sponge	256	1,420
Other unwrought	1,180	3,920
Wrought products and castings	31,300 r	37,400
Total	37,900 r	51,500
Imports:		
Waste and scrap	13,900	14,400
Sponge	33,800	33,600
Other unwrought	918 r	991
Wrought products and castings	6,820	6,840
Total	55,400	55,900
Stocks, industry, yearend:		
Sponge	10,800	18,100
Scrap	12,900	13,500
Ingot	3,850	4,170
Consumption, reported:		
Sponge	48,400	35,100
Scrap	30,900	38,700
Ingot	55,900	57,300
Shipments:		
Ingot	15,400	20,500
Mill products (net shipments):		
Forging and extrusion billet	16,800	16,700
Other	28,700	23,000
Total	45,500	39,600
Castings (shipments)	W	W
Receipts, scrap:		
Home	18,900 r	21,900
Purchased	21,200	26,800
Total	40,200 r	48,800

rRevised. 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.

TABLE 4
U.S. PRODUCERS OF TITANIUM DIOXIDE PIGMENT IN 2012[1, 2, 3]

(Metric tons per year)

Company	Plant location	Yearend capacity[4]
Cristal Global	Ashtabula, OH	220,000
Du Pont Titanium Technologies	De Lisle, MS	340,000
Do.	Edgemoor, DE	190,000
Do.	New Johnsonville, TN	400,000
Louisiana Pigment Co. L.P.	Lake Charles, LA	150,000
Tronox Ltd.	Hamilton, MS	230,000
Total		1,530,000

Do. Ditto.

[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 (t/yr) of buff TiO_2 pigment 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 total shown.

[4]All plants use the chloride process to manufacture TiO_2 pigment.

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

		2011		2012	
		Gross weight	TiO_2 content	Gross weight	TiO_2 content
Production[2]	metric tons	1,290,000	1,220,000	1,140,000	1,080,000
Shipments:[3]					
Quantity	do.	1,320,000	1,220,000	1,080,000	1,020,000
Value	thousands	$4,400,000	XX	$3,920,000	XX
Exports	metric tons	789,000	741,000 e	624,000	587,000 e
Imports for consumption	do.	200,000	188,000 e	203,000	190,000 e
Consumption, apparent[e, 4]	do.	706,000	662,000 r	722,000	678,000

[e]Estimated. [r]Revised. do. Ditto. 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)

	2011		2012	
	Gross weight	TiO_2 content	Gross weight	TiO_2 content
Pigment	1,700,000	NA	1,820,000	NA
Miscellaneous[3]	131,000	NA	123,000	NA
Total	1,830,000	1,500,000	1,940,000	1,590,000

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)

	2011	2012
Steel:		
Carbon	6,670	7,050
Stainless and heat-resisting	3,120	3,360
Other alloy[3]	737	690
Total	10,500	11,100
Cast irons	16	16
Superalloys	636	568
Alloys, other than above	1,120	1,050
Miscellaneous and unspecified	156	138
Grand total	12,500	12,900

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

(Percent)

Industry	2011	2012
Paint, varnish, lacquer	58.5	59.8
Paper	8.6	10.6
Plastics and rubber	27.9	24.6
Other[2]	5.0	5.0
Total	100.0	100.0

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

TABLE 9
YEAREND PRICES OF TITANIUM PRODUCTS

		2011	2012
Concentrate:			
Ilmenite, free on board (f.o.b.) Australian ports[1]	dollars per metric ton	140–250	250–350
Rutile, bagged, f.o.b. Australian ports[1]	do.	1,348–1,600	2,500–2,800
Rutile, bulk, f.o.b. Australian ports[1]	do.	1,300–1,400	2,050–2,400
Titaniferous slag, import, 80% to 95% TiO_2[2]	do.	468–494	512–763
Metal:			
Sponge import[2]	dollars per pound	3.27–6.74	3.53–6.95
Scrap, turnings, unprocessed[3]	do.	2.00–2.20	1.70–1.75
Ferrotitanium, 70% Ti[3]	do.	3.45–3.55	3.20–3.25
Mill products[4]	producer price index	203	179
Titanium dioxide pigment[4]	do.	268	268

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

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

Class	HTS[2]	2011 Quantity (metric tons)	2011 Value (thousands)	2012 Quantity (metric tons)	2012 Value (thousands)
Metal:					
Scrap	8108.30.0000	5,150	$33,300	8,760	$45,300
Unwrought:					
Sponge	8108.20.0010	256	1,860	1,420	9,500
Ingot	8108.20.0030	252	6,000	3,760	70,600
Other	8108.20.0090	923	16,500	159	5,270
Wrought:					
Billet	8108.90.6010	3,500	131,000	3,660	137,000
Bloom, sheet bar, slab	8108.90.6020	1,560	49,400	2,180	67,200
Bar, rod, profile, wire	8108.90.6031	4,060	224,000	3,560	203,000
Other	8108.90.8000	15,600	863,000	13,800	893,000
Total		31,300	1,320,000	37,400	1,430,000
Ferrotitanium and ferrosilicon titanium	7202.91.0000	3,210	17,600	3,610	17,300
Ores and concentrates	2614.00.0000	26,600	11,000	43,000	31,900
Pigment:					
80% or more titanium dioxide pigment	3206.11.0000	741,000	2,110,000	587,000	1,910,000
Other titanium dioxide pigment	3206.19.0000	40,000	104,000	33,100	114,000
Unfinished titanium dioxide[3]	2823.00.0000	7,160	19,700	4,570	12,700
Total		789,000	2,230,000	624,000	2,040,000

[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]	2011 Quantity (metric tons)	2011 Value (thousands)	2012 Quantity (metric tons)	2012 Value (thousands)
Ilmenite:	2614.00.6020				
Australia		244,000	$26,800	245,000	$39,900
Mozambique		114,000	8,980	99,800	16,200
Ukraine		10,000	2,220	--	--
Other		9,340	1,540	29,400	7,080
Total		377,000	39,600	374,000	63,200
Titaniferous slag:	2620.99.5000				
Canada		191,000	90,600	303,000	203,000
South Africa		323,000	144,000	315,000	249,000
Other		--	--	1	3
Total		513,000	235,000	618,000	453,000
Rutile, natural:	2614.00.6040				
Australia		106,000	62,100	131,000	142,000
Sierra Leone		10,100	9,030	--	--
South Africa		133,000	76,600	135,000	164,000
Other[3]		13,500	9,900	10,200	17,500
Total		262,000	158,000	277,000	324,000
Rutile, synthetic:	2614.00.3000				
Australia		112,000	80,300	107,000	163,000
Other[3]		6,960	7,730	4,380	7,770
Total		119,000	88,000	112,000	170,000
Titaniferous iron ore, Canada[4]	2614.00.6020	96	23	286	52

-- Zero.

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

[2]Harmonized Tariff Schedule of the United States.

[3]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]	2011 Quantity (metric tons)	2011 Value (thousands)	2012 Quantity (metric tons)	2012 Value (thousands)
Waste and scrap:	8108.30.0000				
Canada		738	$4,920	757	$3,150
France		1,790	16,100	1,950	13,000
Germany		1,930	17,900	2,260	19,300
Israel		523	4,490	410	3,150
Italy		329	2,610	301	2,170
Japan		2,260	20,100	2,040	15,300
Korea, Republic of		655	5,960	605	4,770
Mexico		369	1,770	541	2,790
Russia		158	1,240	--	--
Singapore		179	2,000	192	2,710
Spain		220	2,040	--	--
Sweden		80	755	314	2,730
Taiwan		813	6,880	383	2,540
United Kingdom		28`7	20,600	3,540	18,100
Other		1,070 r	8,150 r	1,150	8,800
Total		13,900	116,000	14,400	98,500
Unwrought:					
Sponge:	8108.20.0010				
China		5,860	62,900	3,510	42,000
Japan		16,100	176,000	18,900	241,000
Kazakhstan[e]		8,610	81,800	8,030	398,000
Russia		1,260	7,710	--	--
Other		1,990	20,500	--	--
Total		33,800	349,000	30,500	681,000
Ingot:	8108.20.0030				
Germany		344	6,310	109	1,890
Russia		302	5,830	401	6,620
Other		9	325	--	--
Total		655	12,500	510	8,500
Powder:	8108.20.0015				
Canada		4	905	3	905
China		33	602	22	602
Germany		3	369	1	410
Japan		8	1,480	3	783
Other		3 r	128 r	4	413
Total		51	3,490	33	3,110
Other:	8108.20.0091				
China		40	663	21	382
Germany		64	1,270	171	3,070
Russia		31	804	153	3,750
United Kingdom		48	3,440	82	4,760
Other		26 r	1,320 r	21	1,760
Total		209	7,500	448	13,700
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				
China		958	31,400	1,010	31,400
Germany		311	10,500	173	10,500
Japan		468	23,400	348	23,400
Russia		3,920	146,000	4,120	146,000
Taiwan		215	7,970	162	6,090
United Kingdom		351	28,700	364	28,700
Other		597 r	40,100 r	667	56,500
Total		6,820	288,000	6,840	302,000
Ferrotitanium and ferrosilicon titanium	7202.91.0000	2,070	11,700	2,410	12,000

See footnotes at end of table.

TABLE 12—Continued
U.S. IMPORTS FOR CONSUMPTION OF TITANIUM METAL, BY CLASS AND COUNTRY[1]

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

		2011		2012	
Country	HTS[2]	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
80% or more titanium dioxide pigment:	3206.11.0000				
Canada		79,000	$226,000	68,300	$252,000
China		10,300	29,100	25,300	77,700
Finland		6,790	17,200	5,990	16,100
France		4,910	14,500	5,110	19,900
Germany		6,450	17,400	8,380	29,100
Italy		3,460	10,100	2,620	10,200
Japan		4,180	20,800	4,220	24,500
Spain		2,980	8,770	3,140	12,900
Netherlands		1,800	4,390	--	--
Ukraine		11,700	25,600	11,100	28,700
Other		8,890 [r]	23,900 [r]	16,500	57,400
Total		140,000	397,000	151,000	529,000
Other titanium dioxide:	3206.19.0000				
Canada		8,820	25,900	8,190	27,600
China		1,110	4,040	1,750	6,410
France		174	385	427	1,510
Germany		666	2,720	656	2,690
Japan		552	6,670	789	6,140
Other		853 [r]	7,810 [r]	1,320	10,100
Total		12,200	47,500	13,100	54,400
Unfinished titanium dioxide:[3]	2823.00.0000				
China		24,200	70,800	15,800	45,700
Czech Republic		2,460	6,390	2,620	8,680
Finland		2,910	9,590	2,450	8,250
France		5,720	18,200	2,760	10,500
Germany		4,270	9,580	3,340	9,610
Italy		3,120	8,930	2,730	11,800
Korea, Republic of		2,630	5,890	4,490	12,400
Other		2,430	11,100	4,560	18,600
Total		47,700	141,000	38,800	126,000
Grand total		200,000	585,000	203,000	709,000

[r]Revised. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Harmonized Tariff Schedule of the United States.
[3]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	2008	2009	2010	2011	2012
Ilmenite and leucoxene:[3, 4]					
Australia	2,230,000	1,611,000	1,651,000 r	1,501,000	1,572,000
Brazil[5]	130,000 r	52,800 r	166,000 r	166,000 r	166,000 e
China[e]	1,100,000	900,000	1,400,000 r	1,700,000 r	1,600,000
India[e]	610,000	700,000	540,000	550,000	560,000
Indonesia	9,000	9,000	60,000	18,000	20,000
Kazakhstan[e]	25,000	25,000	25,000	25,000	25,000
Madagascar	--	160,000	287,000 [6]	470,000	660,000
Malaysia	36,779	15,983	19,036	28,782	22,275
Mozambique	328,875	471,500 r	678,400	636,800	574,500
Norway	915,000	671,000	864,000 r	870,000 r	831,000
Sierra Leone	17,528	15,161	18,206	15,946	22,590
Sri Lanka	22,159	122,424	52,637	52,000 e	53,000 e
Ukraine[e]	520,000	500,000	500,000	260,700 r, 6	246,800 6
United States[e, 5, 7]	400,000	300,000	400,000	400,000	300,000
Vietnam[8]	709,500	698,700	912,000	840,600 r	1,143,800
Total[9]	7,010,000 r	6,260,000 r	7,530,000 r	7,570,000 r	7,800,000
Rutile:[4]					
Australia	325,000	285,000 r	429,000	474,000	439,000
Brazil[5]	2,309	2,737	2,331 r	2,350 r	1,881
India[e]	21,000	21,000	24,000	25,000	26,000
Madagascar[e]	--	3,200	5,700	9,400 r	13,000
Malaysia	1,834	1,502	7,567	10,810	20,008
Mozambique	6,552	1,800 r	4,700 r	6,455 r	3,713
Sierra Leone	78,908	63,864	68,198	67,916	94,493
South Africa[e]	134,000 r	136,000 r	130,000 r	149,000 r	150,000
Sri Lanka	11,335	2,276	2,568	2,700 e	2,800 e
Ukraine[e]	60,000	60,000	60,000	60,000	58,000
United States	(10)	(10)	(10)	(10)	(10)
Total	641,000 r	577,000 r	734,000 r	808,000 r	809,000
Titaniferous slag:[e, 11]					
Canada	1,000,000	765,000	1,090,000	878,000	900,000
South Africa	1,252,000 r	1,084,000 r	1,252,000 r	1,346,000 r	1,400,000
Total	2,250,000 r	1,850,000 r	2,340,000 r	2,220,000 r	2,300,000

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

[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 June 9, 2014.

[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]Reported figure.

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

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

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

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

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