

# TITANIUM

By Joseph M. Gambogi

Titanium (Ti) is a lightweight metal well known for corrosion resistance and its high strength-to-weight ratio. Titanium comprises about 0.62% of the Earth's crust and occurs primarily in the minerals, anatase, brookite, ilmenite, leucosene, perovskite, rutile, and sphene. Although titanium is best known for its use as a metal alloy, it is primarily used in the form of titanium dioxide (TiO<sub>2</sub>) as a white pigment in paints, paper, and plastics. Other minor uses of titanium minerals include ceramics, chemicals, welding rod coatings, heavy aggregate, and steel furnace flux.

An expanding world economy drove demand for titanium minerals and pigments upward in 1994. According to industry reports, global consumption of TiO<sub>2</sub> pigment grew by an estimated 5%, the highest growth rate since 1989. Demand for titanium mineral ores and concentrates (feedstocks) underwent a similar growth rate. Increased demand for TiO<sub>2</sub> pigment was met though higher production levels. However, increased demand for mineral feedstocks was met though a reduction in inventory levels. Domestic production of TiO<sub>2</sub> pigment was at a record level. Overall imports of mineral feedstocks and TiO<sub>2</sub> pigment were nearly unchanged. (*See table 1.*)

## Legislation and Government Programs

At yearend 1994, the Defense Logistics Agency (DLA) Defense National Stockpile Center (DNSC) held an inventory of 18,895 short dry tons of rutile. Under a modernization program, all of the rutile held in the stockpile was authorized for disposal. For much of the year, rutile was offered for sale each month on a sealed bid basis, and several offers were awarded. In December, DLA offered rutile under a consolidated solicitation of offers on a long-term basis. The new solicitation format allowed the Government to negotiate issues regarding price, quantity, or any other provision of the solicitation. The DNSC inventory in December also contained 25,964 short tons of stockpile grade titanium sponge metal and 10,866 tons of nonstockpile grade material.

## Production

U.S. producers of ilmenite in 1994 were RGC (USA) Mineral Sands, Inc. at Green Cove

Springs, FL; E. I. du Pont de Nemours & Co. Inc. (Du Pont), Starke, FL, both from mineral sands deposits; and P. W. Gillibrand Co., Simi Valley, CA, as a coproduct of its rock, sand, and gravel operations. RGC was the only U.S. producer of natural rutile. Kerr-McGee Chemical Corp. was the sole domestic producer of synthetic rutile at Mobile, AL.

Teck Resources Inc. was reported to be studying the development of the large Powderhorn perovskite deposit near Gunnison, CO. However, the successful development of the deposit required the development of a unique commercial process of extracting TiO<sub>2</sub> from the perovskite ore.<sup>1</sup>

Ferrotitanium was produced by Galt Alloys Inc., Canton, OH, and Shieldalloy Metallurgical Corp., Newfield, NJ. The two standard grades produced were 40% and 70% titanium. Data on production of ferrotitanium were not available.

Titanium sponge metal was produced by Oregon Metallurgical Corp. (Oremet), Albany, OR, and Titanium Metals Corp. Of America (Timet), Henderson, NV. Titanium ingot was produced by the two sponge producers and by nine other firms in seven States. About 30 companies are known to produce titanium mill products and castings. Production of ingot and increased by 6% while mill product production decreased by about 5%. Production of titanium sponge was withheld to avoid disclosing company proprietary data. (*See tables 2 and 3.*)

Production at Timet's new Vacuum Distillation Process (VDP) titanium sponge plant at Henderson, NV, was temporarily interrupted by a failure in the shearing operation. The shearing failure caused the company to restart the older sponge plant at Henderson that had been shut down in 1993. At midyear, Timet ended a 12-month strike at the Henderson facility. Later in the year, Timet ended a 3-month strike at its mill product facility at Toronto, OH.

U.S. producers of titanium dioxide pigments were Du Pont, Kemira, Inc., Kerr-McGee, Louisiana Pigment Co. LP (formerly Kronos Inc.), and SCM Chemicals Inc.. U.S. production of TiO<sub>2</sub> pigment in 1994 was 8% higher than in 1993. Capacity utilization for the domestic pigment industry was about 93%. (*See tables 4 and 5.*)

## Consumption

On a gross weight basis, U.S. reported consumption of TiO<sub>2</sub> in titanium slag and rutile concentrates increased 8% from the 1993 level. Consumption of ilmenite was withheld to avoid disclosing company proprietary data.

Consumption data for titanium materials are developed by the U.S. Bureau of Mines (USBM) from one voluntary survey of domestic operations. Of the 32 operations canvassed, 28 responded, representing 85% of the data in table 6. Data for nonrespondents were estimated based on prior year consumption levels. (*See table 6.*)

Reported consumption of titanium in the form of ferrotitanium and scrap in steel and other alloys was 6,090 metric tons, a 3% increase from the 1993 level. Carbon, stainless, and heat-resisting steels were the largest end-use categories of ferrotitanium and scrap.

Increased ingot production caused titanium sponge and scrap consumption to increase by 14% and 3%, respectively. Scrap supplied a calculated 53% of ingot feedstock. Poor demand for titanium mill products resulted in a 5% decrease in ingot consumption and in mill product shipments. Reflecting the strong demand for titanium castings, castings shipments increased by about 15%. Estimated U.S. mill product usage by application was as follows: commercial aerospace, 49%; military aerospace, 23%; and nonaerospace uses, 28%. Nonaerospace uses include those in the specialty chemical, pulp and paper, oil and gas, marine, and medical industries.

Titanium dioxide pigments account for over 95% of all prime white pigments and are produced as two major types: rutile and anatase pigment. The three largest end uses are paint and coatings, paper, and plastics. Other consuming industries included ceramics, fabrics and textiles, floor coverings, printing ink, and rubber. Apparent domestic consumption of TiO<sub>2</sub> pigments was about 1.09 million tons, 6% more than in 1993. (*See tables 7 and 8.*)

## Stocks

Based on TiO<sub>2</sub> content, consumer inventories of titanium concentrates decreased 25%. Producer stocks of TiO<sub>2</sub> pigments were about 106,000 tons, a 14% increase from 1993.

Reflecting an increased reliance on imported sources of titanium sponge, industry stocks of sponge increased 92%. Stocks of titanium scrap were nearly unchanged. (See table 9.)

## Prices

Published prices for titanium concentrates, pigments, and metal are presented in table 10. However, published prices do not always agree with market trends. Based on the customs value of imported sponge, the price for titanium sponge decreased significantly in 1994. Increased demand for titanium concentrates by the pigment industry resulted in a significant increase in the price for ilmenite. Based on the U.S. Customs Service value of imports, prices for ilmenite, titanium slag, natural rutile, and synthetic rutile were estimated to have increased 28%, 6%, 1%, and 8%, respectively. Published prices for titanium pigments decreased slightly. (See table 10.)

## Foreign Trade

Kazakhstan and Ukraine were granted General System of Preferences (GSP) status by the President of the United States. Under the GSP program, selected products are eligible to enter the United States duty-free. Titanium mill products and castings are included on the list of eligible products.

The U.S. Department of Commerce, International Trade Administration (ITA), revoked antidumping findings on titanium sponge from Armenia, Azerbaijan, Belarus, Estonia, Kyrgyzstan, Latvia, Lithuania, Moldova, Tajikistan, Turkmenistan, and Uzbekistan. The countries listed on the finding were not known to produce titanium sponge, and domestic producers did not object to the revocation.

The ITA published the final results of an antidumping duty administrative review covering exports of titanium sponge to the United States from Kazakhstan. The ITA concluded that no shipments took place during the period of review and let stand the 83.96% rate established in the last review.

The ITA also completed an administrative review of an antidumping order on titanium sponge from Japan. The ITA found no dumping margin for Showa Denko K.K. (Showa) and determined that Showa met the requirements for revocation. (See tables 11, 12, 13, and 14.)

## World Review

**Capacity.**—The capacity data in this report are for mines and beneficiation plants, sponge metal facilities, and TiO<sub>2</sub> pigment plants as of

December 31, 1994. Rated capacity is defined as the maximum quantity of product that can be produced in a period of time at a normally sustainable long-term operating rate, based on the physical equipment of the plant, and given acceptable routine operating procedures involving labor, energy, materials, and maintenance. Capacity includes both operating plants and temporarily closed facilities that, in the opinion of the author, can be brought into production within a short period of time and with minimum capital expenditure. Mine and mill capacity for the production of titanium concentrates, metal production plant capacity, and TiO<sub>2</sub> pigment plant capacity are generally based on close to 365 days per year operation, 3 shifts per day. Capacity figures are based on information obtained from the producing companies, from news items, and from USBM estimates.

Reflecting improved global demand for TiO<sub>2</sub> pigment, several companies were developing programs to produce titanium mineral concentrates. Almost all of the new projects were focused on producing higher TiO<sub>2</sub> grades of mineral feedstocks.

In response to industry estimates of improved TiO<sub>2</sub> demand, several TiO<sub>2</sub> pigment producers announced plans to expand pigment capacity on a global basis. At present, most of the expansions are to be made through debottlenecking of existing plants. Du Pont plans a 185,000-ton-per-year increase in capacity by 1997. The Tioxide Group PLC plans to increase its capacity by 115,000 tons per year and SCM Chemical is debottlenecking several plants to raise its total capacity by 52,000 tons per year. Kerr-McGee announced plans to increase pigment capacity by 30,000 tons per year in 1995 and may add 55,000 tons per year by 1997 if market conditions are favorable.<sup>2</sup> (See table 15.)

**Australia.**—Cable Sands Ltd. commissioned its Jangardup mineral sands operation in Western Australia. The new operation was expected to double Cable Sands' mine capacity. BHP Minerals announced plans to proceed with the development of its Beenup deposit in Western Australia. Ilmenite concentrate produced at Beenup is expected to be used as a feedstock for the Tinfos Titan & Iron KS slag operations at Tyssedal, Norway.<sup>3</sup>

**Canada.**—Tiomin Resources continued to study the development of its mineral deposit near Natashquan, Quebec. Tiomin announced the completion of the first stage of the project in June 1994. After completing a prefeasibility review, Tiomin concluded that the project is feasible from technological, engineering, environmental, and economic standpoints.<sup>4</sup>

**Japan.**—Showa Titanium Co., one of the

three producers of titanium sponge in Japan, closed its 3,000-ton-per-year sponge facility at Chigasaki. Showa Titanium was a subsidiary of Showa Denko K.K. The closure will leave Japan with about 25,800 tons of annual capacity. The remaining titanium sponge producers were Sumitomo Sitix Corp. and Toho Titanium Co.

**Russia.**—Aircraft builder Boeing Co., Seattle, WA, qualified the Russian titanium ingot and mill product producer Verkhnesaldinskoye Metallurgical Production Association (Salda) as a supplier of a specific grade of ingot used in airframes. In 1994, Salda was the largest producer of titanium mill products in the world, with an estimated capacity of more than 100,000 tons per year.

**South Africa.**—Anglo American Corp. commissioned its Namakwa Sands project. Production of ilmenite concentrate commenced in midyear, and production of titanium slag was expected to begin in 1995. Iscor announced plans to acquire Natal Mineral Sands (Pty.) Ltd. Following the acquisition, Iscor planned to pursue the development of two heavy mineral deposits in Natal and Transkei. Iscor's future plan called for the capability to produce titanium slag and TiO<sub>2</sub> pigment. A feasibility study to develop the Natal deposit was expected to be conducted during the next year. Late in 1994, maintenance downtime and a labor strike at Richards Bay Minerals interrupted slag production at Natal.<sup>5</sup>

**Taiwan.**—Du Pont started production of TiO<sub>2</sub> pigment from the front end of its new TiO<sub>2</sub> pigment plant at Kuan Yin, Taiwan. The finishing end of the plant was commissioned in early 1994 and was temporarily supplied with pigment from other Du Pont facilities. The new plant adds 60,000 tons per year of chloride-process capacity.<sup>6</sup>

## Outlook

For the next few years, global demand for titanium pigments is expected to grow between 3% and 4% annually. The Latin America and Asia/Pacific regions are anticipated to experience a somewhat higher growth rate. Initially, increased demand is expected to be met through debottlenecking of existing TiO<sub>2</sub> capacity. At the same time, some facilities may be forced to close because of environmental pressures to regulate effluent levels.

Because demand for mineral feedstocks is driven by demand for TiO<sub>2</sub> pigments, feedstock demand is expected to increase moderately for the next few years. Concurrent with increased demand, consumers of mineral feedstocks are expected to demand higher grades of TiO<sub>2</sub> material, such as high-grade ilmenite (60%

TiO<sub>2</sub>), natural and synthetic rutile, and titanium slag. Another factor that is shaping demand for minerals feedstocks is the rising concern over naturally occurring radioactive elements found in ore deposits. Several countries have proposed regulating the allowable radioactivity level for titanium feedstocks. Consequently, producers are exploring methods to reduce the radioactivity of titanium feedstocks or developing deposits with naturally low levels of radioactivity.

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<sup>1</sup>Industrial Minerals. Teck Acquires TiO<sub>2</sub> Project. No. 328, Jan. 1995, p. 17.

<sup>2</sup>Chemical Marketing Reporter. TiO<sub>2</sub> Balance Tips to the Tight Side. V. 246, No.18, Nov. 4, 1994, p. 9.

<sup>3</sup>Industrial Minerals. Jangarup Enters Production, No. 322, July 1994, p. 74.

<sup>4</sup>———. Tiomin Minsands Project Advances. No. 323, Aug. 1994, p. 11.

<sup>5</sup>———. Iscor Buys Mineral Sands. No. 322, July 1994, p. 13.

<sup>6</sup>European Chemical News. Du Pont Startup Dents U.S. TiO<sub>2</sub>. V. 61, No. 1615, Apr. 25, 1994, p. 10.

## **OTHER SOURCES OF INFORMATION**

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TABLE 1  
SALIENT TITANIUM STATISTICS 1/

(Metric tons unless otherwise specified)

	1990	1991	1992	1993	1994
<b>United States:</b>					
<b>Ilmenite concentrate:</b>					
Imports for consumption	346,000	214,000	295,000	301,000	336,000
Consumption 2/	689,000	738,000	685,000	694,000	W
<b>Titanium slag:</b>					
Imports for consumption	374,000	408,000	537,000	476,000	472,000
Consumption	391,000	341,000	539,000	546,000	583,000
<b>Rutile concentrate, natural and synthetic:</b>					
Imports for consumption	275,000	240,000	317,000	371,000	332,000
Consumption	369,000	369,000	461,000	465,000	510,000
<b>Sponge metal:</b>					
Production	24,700	13,400	W	W	W
Imports for consumption	1,090	612	684	2,160	6,470
Consumption	23,200	13,600	14,200	15,100	17,200
Price, Dec. 31, per pound	\$4.50-\$5.00	\$4.50-\$5.00	\$3.50-\$4.00	\$3.50-\$4.00	3.75-\$4.25
<b>Titanium dioxide pigment:</b>					
Production	979,000	992,000	1,140,000	1,160,000	1,250,000
Imports for consumption	148,000	166,000	169,000	172,000	176,000
Consumption, apparent 3/	925,000	936,000	1,000,000	1,030,000	1,100,000
<b>Price, Dec. 31, cents per pound:</b>					
Anatase	99	99	99	99	94-96
Rutile	100	99	92-95	92-95	92-94
<b>World production:</b>					
Ilmenite concentrate 4/	4,070,000	3,410,000	3,580,000	3,580,000	3,440,000
Rutile concentrate, natural 4/	481,000	458,000	442,000	464,000	459,000
Titaniferous slag	1,890,000	1,510,000	1,640,000	1,550,000	1,510,000

W Withheld to avoid disclosing company proprietary data.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; except prices.

2/ Includes consumption to produce synthetic rutile.

3/ Production plus imports minus exports plus stock decrease or minus stock increase.

4/ Excludes U.S. production data to avoid disclosing company proprietary data.

TABLE 2  
U.S. TITANIUM METAL PRODUCTION CAPACITY IN 1994 1/

Company	Plant location	Yearend capacity (metric tons)	
		Sponge	Ingot 2/
Howmet Corp., Titanium Ingot Div.	Whitehall, MI	--	2,300
A. Johnson Metals Corp.	Morgantown, PA	--	2,300 3/
Lawrence Aviation Industries Inc.	Port Jefferson, NY	--	1,400
Oregon Metallurgical Corp. (Oremet)	Albany, OR	6,800	7,300
RMI Co.	Niles, OH	--	16,300
Teledyne Allvac	Monroe, NC	--	7,300
Teledyne Wah Chang Albany	Albany, OR	--	900
Titanium Hearth Technologies of America	Morgantown, PA	--	4,500
Titanium Metals Corp. of America	Henderson, NV	22,700	13,600
Viking Metallurgical Corp.	Verdi, NV	--	2,300 3/
Wyman-Gordon Co.	Worcester, MA	--	3,200 4/
<b>Total</b>		<b>29,500</b>	<b>61,400</b>

1/ Data rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ Based on 7-day-per-week full production. Includes 55,400 tons vacuum-arc double-triple melt, of which triple melt generally ranged from 10% to 30%. The remaining 6,000 tons was single melt (electron-beam and plasma) capacity.

3/ Single melt only.

4/ Includes 1,400 tons of single melt capacity.

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

(Metric tons)

Component	1993	1994
<b>Production:</b>		
Sponge	W	W
Ingot	27,900	29,500
Mill products	18,900	17,900
<b>Exports:</b>		
Sponge	104	126
Other unwrought	654	297
Scrap	3,890	4,120
Ingot, slab, sheet bar, etc.	857	1,260
Other articles of titanium	2,390	3,850
Total	7,890	9,660
<b>Imports:</b>		
Sponge	2,160	6,470
Scrap	5,520	5,870
Ingot and billet	272	1,730
Other unwrought	168	723
Other wrought (mill products)	497	675
Other articles of titanium	103	127
Total	8,720	15,600
<b>Stocks, yearend:</b>		
Government: Sponge (total inventory)	33,400	33,400
<b>Industry:</b>		
Sponge	2,910	5,570
Scrap	8,130	7,930
Ingot	2,430	3,270
Other	W	W
Total industry	13,500	16,800
<b>Reported consumption:</b>		
Sponge	15,100	17,200
Scrap	15,300	15,700
<b>Receipts:</b>		
Home	8,240	9,090
Purchased	9,870	11,300
Ingot	25,700	24,300
<b>Mill products (net shipments):</b>		
Forging and extrusion billet	6,940	5,910
Rod and bar	2,150	2,070
Other 2/	7,440	7,670
Castings (shipments)	469	540

W Withheld to avoid disclosing company proprietary data.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ Data for sheet and strip, plate, 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, 1994 1/ 2/

Company	Plant location	Pigment capacity (metric tons per year)	
		Sulfate process	Chloride process
E. I. du Pont de Nemours & Co. Inc.:	Antioch, CA	--	40,000
	De Lisle, MS	--	245,000
	Edge Moor, DE	--	129,000
	New Johnsonville, TN	--	297,000
Kemira, Inc.	Savannah, GA	54,000	91,000
Kerr-McGee Chemical Corp.	Hamilton, MS	--	114,000
Louisiana Pigment Co. LP	Lake Charles, LA	--	100,000
SCM Chemicals Inc.:	Ashtabula, OH	--	165,000
	Baltimore, MD	66,000	50,000
Total		120,000	1,230,000

1/ Data rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ Table does not include Hitox Corp.'s Corpus Christi, TX, production capacity of about 16,400 tons per year of buff TiO<sub>2</sub> pigment that is produced by refining and fine grinding of synthetic rutile.

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

(Metric tons unless otherwise specified)

Component	1993		1994	
	Gross weight	TiO <sub>2</sub> content	Gross weight	TiO <sub>2</sub> content
Production 2/	1,160,000	1,090,000	1,250,000	1,180,000
Shipments: 3/				
Quantity	1,290,000	1,200,000	1,370,000	1,260,000
Value      thousands	\$2,480,000	\$2,480,000	\$2,540,000	\$2,540,000
Exports	290,000	272,000 e/	352,000	331,000 e/
Imports for consumption	172,000	161,000 e/	176,000	165,000 e/
Stocks, yearend	123,000	116,000 e/	106,000	99,300 e/
Consumption, apparent 4/	1,030,000	966,000 r/ e/	1,090,000	1,030,000 e/

e/ Estimated. r/ Revised.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to 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.

Sources: Bureau of the Census and U.S. Bureau of Mines.

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

(Metric tons)

	Ilmenite 2/ 3/		Titanium slag		Rutile (natural and synthetic) 4/	
	Gross weight	TiO2 content	Gross weight	TiO2 content	Gross weight	TiO2 content
1993:						
Pigments	693,000	434,000	546,000	454,000	433,000	406,000
Miscellaneous 5/	733	451	(6/)	(6/)	31,900	30,200
Total	694,000	435,000	546,000	454,000	465,000	436,000
1994:						
Pigments	W	W	583,000	479,000	491,000	460,000
Miscellaneous 5/	1,000	637	(6/)	(6/)	19,800	18,500
Total	W	W	583,000	479,000	510,000	478,000

W Withheld to avoid disclosing company proprietary data.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

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

3/ Includes ilmenite consumed to produce synthetic rutile.

4/ Includes synthetic rutile made in the United States.

5/ Includes alloys, carbide, welding-rod coatings, fluxes, ceramics, chemicals, glass fibers, and titanium metal.

6/ Included with "Pigments" to avoid disclosing company proprietary data.

TABLE 7  
U.S. DISTRIBUTION OF DOMESTIC TITANIUM PIGMENT  
SHIPMENTS, TITANIUM DIOXIDE CONTENT, BY INDUSTRY

(Percent)

Industry	1993	1994
Ceramics	0.3	0.2
Coated fabrics and textiles	.4	.4
Floor coverings	1.0	1.0
Paint, varnish, lacquer	46.0	46.7
Paper	26.2	23.8
Plastics	17.9	18.0
Printing ink	1.5	1.5
Roofing granules	W	W
Rubber	1.9	2.1
Other	4.8	6.3
Total	100.0	100.0

W Withheld to avoid disclosing company proprietary data; included in "Other."

TABLE 8  
U.S. CONSUMPTION OF TITANIUM PRODUCTS 1/ 2/  
IN STEEL AND OTHER ALLOYS

(Metric tons)

	1993	1994
Carbon steel	2,060	2,390
Stainless and heat-resisting steel	2,100	1,930
Other alloy steel (includes HSLA)	472	408
Tool steel	W	W
Total steel	4,630	4,720
Cast irons	W	W
Superalloys	504	609
Alloys, other than above	455	456
Miscellaneous and unspecified	357	299
Total consumption	5,940	6,090

W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous and unspecified."

1/ Includes ferrotitanium, titanium scrap, and other titanium additives.

2/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

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

(Metric tons)

Concentrates	1993		1994	
	Gross weight	TiO2 content	Gross weight	TiO2 content
Ilmenite 2/	173,000	105,000	72,700	43,900
Titanium slag 2/	137,000	113,000	135,000	113,000
Rutile 2/	190,000	179,000	149,000	141,000
Titanium pigment 3/	123,000	116,000 e/	106,000	99,300 e/

e/ Estimated.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits.

2/ Consumer stocks.

3/ Bureau of the Census. Producer stocks only.

TABLE 10  
PUBLISHED PRICES OF TITANIUM CONCENTRATES AND PRODUCTS 1/

	1993	1994
Concentrates:		
Ilmenite, f.o.b. Australian ports	per metric ton	\$61.00-\$64.00 \$74.00-\$80.00
Rutile, bagged, f.o.b. Australian ports	do.	370.00-400.00 450.00-480.00
Rutile, bulk, f.o.b. Australian ports	do.	365.00-390.00 410.00-430.00
Titanium slag, 80% TiO2, Canada e/	do.	276.00 278.00
Titanium slag, 85% TiO2, Republic of South Africa e/	do.	330.00 334.00
Metal:		
Sponge	per pound	3.50- 4.00 3.75- 4.25
Ferrotitanium:	do.	1.15- 1.20 1.60- 1.72
Scrap:		
Turnings, unprocessed	do.	.40- .45 .75- .80
Pigment:		
Titanium dioxide pigment, f.o.b. U.S. plants, anatase	do.	.99 .94- .96
Titanium dioxide pigment, f.o.b. U.S. plants, rutile	do.	.92- .95 .92- .94

e/ Estimated.

1/ Yearend.

Sources: American Metal Market, American Paint and Coatings Journal, Chemical Marketing 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	1993		1994	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Metal:				
Sponge	104	\$748	126	\$738
Scrap	3,890	9,070	4,120	7,440
Other unwrought:				
Billet	240	4,790	258	5,250
Blooms and sheet bars	342	6,280	630	12,000
Ingot	275	4,010	374	5,970
Other	654	12,000	297	4,440
Wrought:				
Bars and rods	663	18,000	863	22,500
Other	1,720	54,700	2,990	108,000
Total	7,890	110,000	9,660	166,000
Ores and concentrates	15,200	4,890	19,000	6,070
Pigment and oxides:				
Titanium dioxide pigments	261,000	363,000	313,000	429,000
Titanium oxides	29,200	41,900	39,300	55,800
Total	290,000	405,000	352,000	485,000

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits, may not add to totals shown.

Source: Bureau of the Census.

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

Concentrate and country	1993		1994	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
<b>Ilmenite:</b>				
Australia	233,000	\$12,500	278,000	\$18,600
India	40,100	2,610	4,150	2,770
Other	27,900 r/	3,320 r/	53,700	4,860
Total	301,000	18,400	336,000	26,200
<b>Titanium slag:</b>				
Canada	88,400	24,200	44,900	12,500
Norway	10,600	2,920	(2/)	(2/)
South Africa, Republic of	377,000	123,000	413,000	141,000
Other	--	--	14,400	4,770
Total	476,000	150,000	472,000	158,000
<b>Rutile, natural:</b>				
Australia	79,900	29,600	83,600	32,300
Sierra Leone	55,100	21,000	45,300	19,500
South Africa, Republic of	140,000	50,800	92,700	31,100
Other	270 r/	431 r/	107	77
Total	275,000	102,000	222,000	82,900
<b>Rutile, synthetic:</b>				
Australia	90,200	29,800	105,000	39,100
Malaysia	6,410	3,370	5,250	2,720
Other	5	2	1	3
Total	96,600	33,200	110,000	40,900
<b>Titaniferous iron ore: 3/</b>				
Canada	66,300	2,850	43,700	2,270

r/ Revised.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ Revised to zero.

3/ Includes materials consumed for purposes other than production of titanium commodities, principally heavy aggregate and steel-furnace flux.

Source: Bureau of the Census. Data adjusted by the U.S. Bureau of Mines.

TABLE 13  
U.S. IMPORTS FOR CONSUMPTION OF TITANIUM PIGMENTS, BY COUNTRY 1/

Country	1993		1994	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
<b>80% or more titanium dioxide:</b>				
Belgium	1,590	\$2,490	905	\$1,390
Canada	33,600	57,500	44,600	70,000
China	1,770	1,640	2,310	2,190
Finland	4,750	7,590	3,060	5,170
France	5,380	8,590	6,360	9,300
Germany	14,600	28,600	20,000	38,200
Japan	5,480	10,800	6,310	12,100
Norway	5,470	9,380	4,310	6,660
Singapore	6,300	9,490	4,700	6,950
United Kingdom	3,320	5,030	2,670	3,560
Other	10,600 r/	15,700 r/	10,300	14,700
Total	93,000	157,000	106,000	170,000
<b>Other titanium dioxide:</b>				
Canada	6,160	10,500	15,400	23,300
France	9,510	14,400	7,320	9,630
Germany	3,010	9,580	1,740	7,640
Italy	532	900	601	889
South Africa, Republic of	6,870	9,890	7,960	10,100
Spain	7,070	10,500	2,620	3,530
United Kingdom	18,300	27,000	7,540	11,500
Other	2,890 r/	5,480 r/	3,450	7,250
Total	54,300	88,200	46,600	73,900
<b>Titanium oxide:</b>				
Belgium	2,730	4,130	1,800	2,540
Canada	8,360	12,700	10,100	15,700
France	6,710	9,370	3,720	5,450
Germany	2,710	4,360	2,840	4,710
Norway	1,240	2,050	895	1,370
Other	2,880 r/	6,020 r/	4,370	9,260
Total	24,600	39,100	23,700	39,000
Grand total	172,000	284,000	176,000	283,000

r/ Revised.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown

Source: Bureau of the Census.

TABLE 14  
U.S. IMPORTS FOR CONSUMPTION OF TITANIUM METAL, BY CLASS AND COUNTRY 1/

Class and country	1993		1994	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
<b>Unwrought:</b>				
<b>Sponge:</b>				
China	180	\$1,330 r/	86	\$452
Japan	338	2,830	819	5,690
Russia	1,160	3,910 r/	5,460	15,400
Ukraine	292	727 r/	--	--
United Kingdom	101	1,310	94	975
Other	89	375	4	7
Total	2,160	10,500	6,470	22,500
<b>Waste and scrap:</b>				
Canada	186	447	214	364
France	559	1,770	307	1,030
Germany	986	3,060	425	1,130
Japan	1,180	4,610	1,560	5,480
Russia	578	1,620	1,140	3,540
United Kingdom	1,500	4,760	1,430	4,560
Other	429 r/	1,510 r/	794	2,970
Total	5,520	18,100	5,870	19,100
<b>Ingot and billets:</b>				
Russia	109	578	377	2,330
United Kingdom	160	2,030	749	9,530
Other	2 r/	428 r/	603	3,640
Total	272	3,030	1,730	15,500
Powder	37	813	79	981
<b>Other: 2/</b>				
United Kingdom	36	167	176	504
Other	95 r/	594 r/	469	4,040
Total	131	761	644	4,540
<b>Wrought products and castings: 3/</b>				
Japan	231	6,710	320	11,900
Russia	33	299	107	1,140
United Kingdom	195	5,370	178	5,490
Other	141 r/	4,860 r/	196	5,140
Total	600	17,200	801	23,700

r/ Revised.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ Includes blooms, sheet, bars, slabs, and other unwrought.

3/ Includes bars, castings, foil, pipes, plates, profiles, rods, sheet, strip, tubes, wire, and other.

Source: Bureau of the Census.

TABLE 15  
TITANIUM: WORLD PRODUCTION OF CONCENTRATES (ILMENITE, LEUCOXENE, RUTILE,  
AND TITANIFEROUS SLAG), BY COUNTRY 1/ 2/

(Metric tons)

Concentrate type and country	1990	1991	1992	1993	1994 e/
<b>Ilmenite and leucoxene: 3/</b>					
Australia:					
Ilmenite	1,600,000	1,360,000	1,790,000 r/	1,800,000 r/	1,770,000
Leucoxene	19,000	18,000	20,000 r/	21,000 r/	35,000
Brazil 4/	114,000	69,100	76,600 r/	90,600 r/	91,000
China e/	150,000	150,000	150,000	155,000	155,000
India e/	280,000	312,000 5/	300,000	320,000	300,000
Malaysia	530,000	336,000	338,000	289,000 r/	116,000 5/
Norway	814,000	625,000	708,000	713,000 r/	700,000
Portugal e/	45	40	30	25	25
Sierra Leone	54,600	60,400	60,300	62,900	47,000 5/
Sri Lanka	66,400	60,900	33,300	76,900	60,400 5/
Thailand	10,700	17,100	2,970 r/	20,800 r/	16,000
Ukraine e/ 6/	XX	XX	250,000 r/	200,000 r/	150,000
U.S.S.R. e/ 6/ 7/	430,000	350,000 r/	XX	XX	XX
United States	W	W	W	W	W
<b>Total</b>	<b>4,070,000</b>	<b>3,360,000 r/</b>	<b>3,720,000 r/</b>	<b>3,750,000</b>	<b>3,440,000</b>
<b>Rutile:</b>					
Australia	245,000	201,000	183,000 r/	186,000 r/	223,000
Brazil	1,810	1,090	1,800 r/	1,740 r/	1,800
India e/	11,000	13,600 5/	10,000	13,900	14,000
Sierra Leone	144,000	155,000	149,000	152,000	137,000 5/
South Africa, Republic of e/	64,100 5/	77,000 r/	84,000 r/	85,000	78,000
Sri Lanka	5,460	3,090	2,740	2,640	2,410 5/
Thailand	--	76	281	87 r/	100
Ukraine e/ 6/	XX	XX	5,000	4,000	3,000
U.S.S.R. e/ 6/ 7/	9,500	9,000	XX	XX	XX
United States	W	W	W	W	W
<b>Total</b>	<b>481,000</b>	<b>460,000 r/</b>	<b>436,000 r/</b>	<b>445,000 r/</b>	<b>459,000</b>
<b>Titaniferous slag: 8/</b>					
Canada 9/	1,050,000	701,000	753,000	653,000	764,000 5/
South Africa, Republic of 10/ 11/	672,000 r/	808,000	884,000	892,000	744,000
<b>Total</b>	<b>1,720,000</b>	<b>1,510,000</b>	<b>1,640,000</b>	<b>1,550,000</b>	<b>1,510,000</b>

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data; not included in "Total." XX Not applicable.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ Table includes data available through July 26, 1995.

3/ Ilmenite is also produced in Canada and in the Republic of South Africa, but this output is not included here because an estimated 90% 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/ Excludes production of unbeneficiated anatase ore.

5/ Reported figure.

6/ All production in the U.S.S.R. from 1990-91 came from Ukraine.

7/ Dissolved in Dec. 1991.

8/ Slag is also produced in Norway but is not included under "Titaniferous slag" to avoid duplicative reporting. Beginning in 1990, about 25% of Norway's ilmenite production was used to produce slag containing 75% TiO<sub>2</sub>.

9/ Refined scoria slag contained 80% TiO<sub>2</sub> in 1990. TiO<sub>2</sub> content in 1991-94 is not reported.

10/ Contains 85% TiO<sub>2</sub>.

11/ Excludes 42,000 to 48,000 metric tones of titanium slag from Highveld Steel.