CHROMIUM

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In 2001, the U.S. chromium supply (measured in contained chromium) was 122,000 metric tons (t) from recycled stainless steel scrap; 239,000 t from imports; and 840,000 t from Government and industry stocks. Supply distribution was 37,900 t to exports; 832,000 t in stocks; and 332,000 t in apparent consumption. Chromium apparent consumption decreased by 43.7% compared with that of 2000.

The United States exported about 110,000 t, gross weight, of chromium-containing materials valued at about $89.4 million and imported about 505,000 t, gross weight, valued at about $239 million.

Chromium has a wide range of uses in chemicals, metals, and refractories. Its use in iron, nonferrous alloys, and steel enhances hardenability and resistance to corrosion and oxidation; production of stainless steel and nonferrous alloys are two of its more important applications. Other applications are in alloy steel, catalysts, leather processing, pigments, plating of metals, refractories, and surface treatments.

Chromium is an essential trace element for human health. Some chromium compounds, however, are acutely toxic, chronically toxic, and/or carcinogenic. The U.S. Environmental Protection Agency (EPA) regulates chromium releases into the environment. The Occupational Safety and Health Administration (OSHA) regulates workplace exposure.

Because the United States has no chromite ore reserves and a small reserve base, domestic supply has been a concern during every national military emergency since World War I. World chromite resources, mining capacity, and ferrochromium production capacity are concentrated in the Eastern Hemisphere. World chromite ore reserves are more than adequate to meet anticipated world demand. In recognition of the vulnerability of long supply routes during a military emergency, chromium was held in the National Defense Stockpile (NDS) in various forms, including chromite ore, chromium ferroalloys, and chromium metal. As a result of improved national security, stockpile goals have been reduced, and inventory is being sold. Recycling is the only domestic supply source of chromium.

The U.S. Geological Survey (USGS) has conducted mineral-resource surveys of the United States to assess the potential for occurrences of chromium and other mineral resources. The National Aeronautics and Space Administration, the National Institute of Standards and Technology, the U.S. Department of Defense, and the U.S. Department of Energy conduct alternative materials research.

Legislation and Government Programs

The United States applied import tariffs on steel products. The duties ranged from 8% to 30% depending on the steel product. Stainless steel bar and rod had a 15% duty and stainless steel wire had an 8% duty. The tariffs were to apply for 3 years and mostly decreased in the later years (Platts Metals Week, 2001b).

The Defense Logistics Agency (DLA) disposed of chromium materials under its Fiscal Year (FY) 2001 (October 1, 2000, through September 30, 2001) Annual Materials Plan (AMP). DLA's FY-01 AMP (as revised in April 2002) set maximum disposal goals for chromium materials at 90,700 t of chemical grade chromite ore; 227,000 t of metallurgical grade chromite ore; 90,700 t of refractory grade chromite ore; 136,000 t of chromium ferroalloys; and 454 t of chromium metal. DLA also developed its FY-02 AMP, which set maximum disposal goals of 90,700 t of chemical grade chromite ore, 90,700 t of metallurgical grade chromite ore, 90,700 t of refractory grade chromite ore, 136,000 t of chromium ferroalloys, and 454 t of chromium metal (U.S. Department of Defense, 2002, p. 6, 9).

Production

The major marketplace chromium materials are chromite ore and chromium chemicals, ferroalloys, and metal. In 2001, the United States produced chromium ferroalloys, metal, and chemicals, but no chromite ore. The United States is a major world producer of chromium metal and chemicals, and of stainless steel. Domestic data for chromium materials are developed by the USGS by means of the "Chromite Ores and Chromium Products" (consumers, monthly) and the "Consolidated Consumers" (consumers, monthly) surveys.

North American Stainless, a subsidiary of Acerinox, started stainless steel production from a new melt shop in Kentucky with a capacity of 726,000 metric tons per year (t/yr) (Jones, 2002).

Health and Nutrition

Aitio (2001) described the carcinogenic risk of chromic acid mist in electroplating, an area where information has recently been improved. He found insufficient information to quantify the risk; the available information indicates significant increase of lung cancer risk resulting from the inhalation of chronic acid mist. He recommended a range of chromium plating processing modifications to mitigate the health effect risk.

Aw (2002) reported on the health effects of chromium compounds. He found that the effect of chromium compounds depends on the chemical species. He also found that the health risk posed by hexavalent chromium compounds is established, while that of other classes of compounds is uncertain.

Consumption

The domestic chemical and refractory industry consumed chromite ore and concentrate in 2001. Chromium has a wide range of uses in chemical, metallurgical, and refractory industries. The chemical industry consumed chromite for the manufacture of sodium dichromate, chromic acid, and other chromium chemicals and pigments. Sodium dichromate is the material from which a wide range of chromium chemicals is made. The primary use of chromium in the refractory industry was in the form of chromite to make refractory bricks for furnace applications. It was also used as a refractory sand in the casting industry. Ferrochromium was consumed to make chromium metal and special grades of ferrochromium. In the metallurgical industry, the principal use of chromium was in production of stainless steel. Other important uses for chromium include the production of ferrous and nonferrous alloys.

Stocks

Consumer stocks of ferroalloys, metal, and other chromium materials were 16,600 t, contained chromium, in 2001. At the 2001 annual rate of chromium ferroalloy, chromium metal, and other chromium material consumption, these consumer stocks represented a 26-day supply. The Government managed the NDS. Government inventories of chromium-containing materials declined as the DLA disposed of stocks.

Prices

Chromium materials are not openly traded. Purchase contracts are confidential information between buyer and seller; however, trade journals report composite prices based on interviews with buyers and sellers, and traders declare the value of materials they import or export. Thus industry publications and U.S. trade data are sources of chromium material prices and values, respectively.

Foreign Trade

Chromium material exports from, and imports to, the United States included chromite ore and chromium chemicals, ferroalloys, metal, and pigments. In 2001, the amount of foreign trade of these chromium materials measured in dollars was $89 million for exports and $239 million for imports. Value of imports in 2001 was only 56% that of 2000. The decline in value of imports resulted from both lower quantity of high-carbon ferrochromium imports and a lower unit value of those imports.

World Review

Industry Structure.—The chromium industry comprises chromite ore, ferrochromium, and chromium metal producers and consumers. Producers and consumers of these materials are part of chemical, metallurgical, and refractory industries. Several trends are occurring simultaneously in the chromium industry. Chromite chemical production has been growing slowly, while the industry eliminates excess capacity, concentrating production and growth in the surviving plants. Chromite refractory use has been declining; however, foundry use has been growing slowly. Chromite ore production is moving from independent producers to vertically integrated producers. In other words, chromite ore mines tend to be owned and operated by ferrochromium or chromium chemical producers. This trend is associated with the migration of ferrochromium production capacity from stainless steel-producing countries to chromite ore-producing countries. Historically, as ferrochromium production capacity was rationalized in predominantly stainless steel-producing countries, new furnaces or plants were constructed in chromite ore-producing areas. The electrical power and production capacities of submerged-arc electric furnaces used to produce ferrochromium have been increasing. Production process improvements such as agglomeration of chromite ore, preheating and prereduction of furnace feed, and closed furnace technology have been retrofitted at major-producer plants and are being incorporated into newly constructed plants. When ferrochromium plants started to be built, furnaces rated in the low kilovolt-ampere range were common. Furnaces built recently have an electrical capacity in the tens of megavolt-amperes. Since the introduction of post-melting refining processes in the steel industry after 1960, there has been a shift in production from low-carbon ferrochromium to high-carbon ferrochromium. After years of ferrochromium production, slag stockpiles have built up. Recently developed processes efficiently recover ferrochromium from that slag. These processes have been, or are being, installed at plant sites. In South Africa, the major chromite ore- and ferrochromium-producing country, two trends are emerging: ferrochromium plants are being developed in the western belt of the Bushveld Complex, and chromite ore produced as a byproduct from platinum operations is being accommodated by new production processes.

Capacity.—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 plants temporarily closed that could be brought into production within a short period of time with minimum capital expenditure. Because not all countries or producers make information about production capacity available, historical chromium trade data have been used to estimate production capacity. Production capacity changes result both from changes in facilities and changes in knowledge about facilities. Production capacities have been rated for the chromite ore, ferrochromium, chromium chemical, chromium metal, and stainless steel industries.

Reserves.—The United States has no chromite ore reserves. However, the United States has a reserve base and resources that could be exploited. The U.S. reserve base is estimated to be about 7 million metric tons (Mt) of chromium. World reserves are about 3,600 Mt of chromium and the reserve base is about 7,300 Mt. About 42% of world reserves and about 75% of the world reserve base are located in South Africa. The USGS includes reserves and reserve base information in the annual

Mineral Commodity Summaries.

Production.—In 2001, world chromite ore production was 12 Mt gross weight. World ferrochromium production in 2001 was 5 Mt gross weight. World production of ferrochromium silicon is small compared to that of ferrochromium.

Albania.—Albania produced chromite ore and ferrochromium. The Government of Albania (GOA) privatized chromite ore mines and ferrochromium smelters. GOA contracted Darfo S.p.A. (Italy) to operate the Burrel ferrochromium smelter and the Bulquiza chromite ore mine and mill for 30 years. There are three 9-megavolt-ampere furnaces at the smelter. Darfo took control of the smelter in Elbassan in 2000. Darfo planned to produce about 80,000 t/yr of chromite ore and 40,000 t/yr of ferrochromium (Ryan's Notes, 2001a).

Brazil.—Brazil produced chromite ore, ferrochromium, and stainless steel. In 2000, Brazil produced 600,000 t (46.0% Cr_2O_3) of chromite ore, exported 69,271 t of chromite ore, and imported 2,624 t. In 2000, Brazil produced 142,522 t of chromium ferroalloys of which 124,000 t was high-carbon ferrochromium, 10,400 t was low-carbon ferrochromium, and the remainder was ferrochromium-silicon. Brazil imported 10,917 t of chromium ferroalloys and metal and exported 135 t (Gonçalves, 2001). Based on reported production and trade, chromium apparent consumption was 174,000 t.

China.—China produced chromite ore, ferrochromium, stainless steel, and chromium chemicals and metal. China reported its national chromium-material trade statistics for 2000. Chromite ore imports were 1,112,791 t in 2000. High-carbon ferrochromium exports were 119,972 t in 2000. Low-carbon ferrochromium exports were 13,533 t in 2000 (TEX Report, 2002a, b, c). Based on this reported trade, apparent consumption of chromium was 416,000 t.

Huazheng (2002) reported that chromium chemical production started in China in 1958. Of the five companies that produced in 1960, three are included among the 25 producers in 2001 that accounted for production of nearly 200,000 t-sodium dichromate equivalent. He reported China's sodium dichromate equivalent chromium chemical production capacity in 2001 to have been 250,000 t.

Hu (2002) reported stainless steel production and distribution of consumption in 2001. China's stainless steel consumption has increased from 262,000 t in 1990 to 1.73 Mt in 2000. Production in 2001 was about 730,000 t. The end uses of stainless steel in China (and relative percent) were: metal products (36%), petrochemical and paper (17.4%), building decoration (16.7%), pipe products (8.9%), motor and electric products (5.7%), transportation (4.5%), and others (10.8%). Stainless steel expansions and new plant construction in China were estimated to add 2.28 Mt of products between 2003 and 2006.

Finland.—AvestaPolariat Chrome produced chromite ore and ferrochromium and AvestaPolariat produced stainless steel as part of a vertically integrated company structure within Outokumpu Oy and integrated mine-smelter-steel works in Kemi and Tornio Finland. Outokumpu reported chromite ore run-of-mine production at 1.2 Mt in 2001 at its Kemi Mine. That was processed into marketable production of 220,000 t of lump and concentrate graded at 36% Cr_2O_3 and 420,000 t of metallurgical grade concentrate graded at 44% Cr_2O_3. The ferrochromium smelter produced 260,000 t of ferrochromium. The Kemi chromite deposit comprised 11 economic ore bodies in an area 15 kilometers (km) by 4.5 km and contained about 180 Mt of resources of which 60 Mt graded at 26% Cr_2O_3 was its reserve. The Kemi Mine is an open pit mine that is now developing underground operations with production planned to start in 2003 at an annual capacity of 2.7 Mt. AvestaPolariat, from an annual production capacity of 2.75 Mt distributed among Finland, Sweden, and the United Kingdom, produced 1.75 Mt of stainless steel of which 635,000 t was produced at its Tornio works (Riikonen, 2001; Outokumpu Oy, 2002).

France.—Delachaux Metals Division produced chromium metal by aluminothermic reduction at its plant in Marly-Lez-Valenciennes. Since the plant was built, production capacity has been increased to 9,000 t/yr. Production was reported to have been 6,800 t in 2001; 6,000 t in 2000; and 5,000 t in 1999 (TEX Report, 2001a).

Germany.—Electrowerk Weisweiler GmbH produced ferrochromium at its plant in Eschweiler-Weisweiler.

India.—India reported production of chromite ore and ferrochromium in fiscal years 1999 and 2000 and trade in fiscal year 1999. Chromite ore production was 1,696,000 t in 2000 and 1,418,119 t in 1999. Chromite ore trade in 1999 was 492,540 t of exports and 686 t of imports. Ferrochromium production was 146,616 t in 2000 and 187,465 t in 1999. Ferrochromium trade in 1999 was 110,722 t of exports and 2,904 t of imports. India imported 67 t of chromium metal in 1999. Based on chromite ore production and chromite ore, ferrochromium, and chromium metal trade, chromium apparent consumption was 220,000 t in 1999. After having chromite ore exports of about 1 Mt in fiscal year 2001, India set export limits for April 2002 through March 2003 at 400,000 t. Exports were limited to fines with chromic oxide not exceeding 52% and silica not exceeding 4%; lumps with chromic oxide not exceeding 40%. There was no limit set on exports of concentrates (Indian Bureau of Mines, 2001a, b).

Lobo reported that since economic liberalization started in 1991, ferrochromium import duties have declined, the rupee has weakened (from 18 rupees per U.S. dollar in 1991 to 47 in 2001), railway freight costs have increased (by 100%), and domestic power prices have increased by 100% to 200%. Ferrochromium production started at about 220,000 t, peaked in fiscal year 1996 at about 350,000 t, and was about 299,000 t in fiscal year 2000 (Lobo, 2001).

The Orissa State government planned to lease 436 hectares (ha) of chromite ore resources for development. The Orissa State government was awaiting approval from the national government to lease the area to Orissa Mining Corp., an Orissa State owned mining company that currently produces about 500,000 t/yr of chromite ore from a 150-ha lease (Metal Bulletin, 2001a).

Ferro Alloys Corp. Ltd. produced ferrochromium at its Garividi plant in Shreeram Nagar, Andra Pradesh State, and at its D.P. Nagar plant in Randia, Orissa State. The Garividi plant stopped production owing to a shortage of chromite ore; the D.P. Nagar plant stopped production owing to market price (TEX Report, 2002d).

IMFA Group (IMFA) produced chromite ore, ferrochromium, and electrical power in the Sukinda Valley of Orissa State.

IMFA produced chromite ore from three mines: Sukinda Valley, Nuasahi, and Chingudipal. Chromite ore production from Sukinda Valley Mine was about 160,000 t; Nuasahi Mine, 50,000 t from both open pit and underground operations; and Chingudipal Mine, 20,000 t from an open pit. IMFA leased 190 ha holding 21 Mt of chromite ore reserves. IMFA produced ferrochromium at two plants in Orissa State, Indian Metals and Ferro Alloys Ltd. and Indian Charge Chrome Ltd. For the production of ferrochromium, Indian Metals and Ferro Alloys Ltd. operated a 24-megavolt-ampere furnace at Therubali, and Indian Charge Chrome Ltd. operated a 48 megavolt-ampere furnace at Choudwar. IMFA supplied its own electrical power from a coal-fired powerplant (TEX Report 2001b).

Ispat Alloys Ltd. produced chromite ore and ferrochromium in Orissa State. Ispat produced chromite ore from 100 ha that it leases in Sukinda Valley. Ispat produced ferrochromium at its 50,000 t/yr plant in Balgopalpur, Orissa State.

The OP Jindal Group held chromite ore leases in Orissa State and produced ferrochromium through its Jindal Strips Ltd. subsidiary in Andhra Pradesh State and Madhya Pradesh State. Jindal Steel and Power Co. proposed construction of a 100,000 t/yr ferrochromium plant and captive coal-fired powerplant in Chhattisgarh State. Ferrochromium was to be produced from a submerged-arc furnace with electrical power rating of 24 megavolt-ampere (Metal Bulletin, 2001c).

Nava Bharat Ferro Alloys Ltd. produced ferrochromium from its plant in Dhenkanal District, Orissa State. Nava Bharat was in the process of constructing a 30-megawatt, coal-based, powerplant for the ferroalloy plant (Metal Bulletin, 2001c).

GMR Vasavi Industries Ltd. produced ferrochromium at Tekkali, Andhra Pradesh State. Vasavi planned to stop production and move its furnaces to Iran (Metal Bulletin, 2001b).

VBC Ferro Alloys Ltd. stopped ferrochromium production at its Rudraram, Andhra Pradesh State plant (Metal Bulletin, 2001c).

Tata Iron and Steel Co. Ltd. stopped production at its 50,000-t/yr-capacity plant at Bamnipal, Orissa State.

Italy.—Acciai Speciali Terni (AST) produced stainless steel at Terni, Umbria.

Japan.—Japan established an import quota for ferrochromium and applied a preferential import duty on material imported below the quota and a temporary duty on material imported in excess of that quota. The quota for ferrochromium, set at 27,670 t from April 2001 through March 2002, was down from 28,100 t from April 2000 through March 2001. The preferential duty on ferrochromium was 3.18% ad valorem; the temporary duty, 5.3% ad valorem. In order to encourage the distribution of imports from a variety of countries, the preferential duty is suspended for material from a country that has supplied over one-fifth of the quota (TEX Report, 2001f).

In 2001, Japan imported 411,120 t of chromite ore; 685,967 t of high-carbon and 53,497 t of low-carbon ferrochromium; and 3,315 t of chromium metal. Japan produced 104,311 t of high- and 7,671 t of low-carbon ferrochromium. Stainless steel production was 3.1378 Mt. Ferrochromium net imports represented 87% of market share. Japan exported 2,686 t of ferrochromium and 1.203 Mt of stainless steel. Japan had stainless steel scrap imports of 131,593 t and exports of 125,883 t. Stainless steel net exports were 31% of stainless steel production (TEX Report, 2002e, f, g, h, i, j, l). Based on chromite ore, ferrochromium, chromium metal, and stainless steel scrap trade, chromium apparent consumption in Japan was 538,000 t.

Nippon Denko and NKK Materials produced ferrochromium at plants in Toyama; and Shunan Denko, at a plant in Shunan. All produced high-carbon ferrochromium; however, only NKK produced low-carbon ferrochromium.

Doida (2002) reported that the Japanese stainless steel industry is restructuring and rationalizing to improve value added and production cost. Three companies produced 104,311 t of ferrochromium in 2001. Since 1993 Japanese traders and the consumers with whom they are associated have invested in ferrochromium production capacity expansions in South Africa, while production in Japan had declined and plants have closed.

Kazakhstan.—Kazchrome reported that metal-from-slag recovery plants were operating at the Aktyubinsk ferroalloy plant, and that the Aksu ferroalloy plant was installing such equipment. The Aktyubinsk ferroalloy plant installed an electrical power generation plant and a furnace-gas processing plant (TEX Report, 2001d).

Korea, Republic of.—Nippon Denko (Japan) made a joint-venture agreement with Korea Plating Industry Association of South Korea to recover chromic oxide in South Korea. The plant was to be constructed in the Kyonggi-Do area at a cost of about $0.8 million and was to be completed in 2002. Nippon Denko was to supply technical expertise and conduct operations. The Korea Plating Industry Association represents about 300 members. South Korean platers' cost to manage waste was 10% of turnover compared with cost of from 2% to 3% in Japan (TEX Report, 2002k).

The Republic of Korea reported ferrochromium imports to have been 217,755 t in 2001; 249,406 t in 2000 (TEX Report, 2002m).

Norway.—Elkem produced high-carbon ferrochromium containing 60% to 65% chromium from two, 35-megavolt-ampere, closed furnaces at its ferrochromium plant in Rana. Annual production capacity was 160,000 t. Elkem planned to discontinue ferrochromium production and convert the plant to the production of another material (Ryan's Notes, 2001b).

Russia.—Eurasia Mining Plc reported that it found chromite at a concentration of 141 kilograms of chromite concentrate per cubic meter of sample along with platinum at the rate of 311 milligrams per cubic meter at its Vissim area property in the Urals along the Martian River near Soloviev Hill. The mineralized zone was estimated to be 4.5 meters thick, between 400 meters (m) and 500 m wide and covered by a thin layer of cobbles. Eurasia is studying the feasibility of extracting the minerals (Mining Journal, 2001).

The Republic of Karelia reported one chromite ore project and one prospect. The project, the Karelmet Open Joint Stock Company, planned to develop the Aganozerskoe chromite deposit in the Pudozh District. The Shaloserskaya prospect is also in the Pudozh District, on the east bank of Lake Onega near Pudozh. The deposit was found to have two distinct zones; one of 6% to 14.5% chromic oxide content and the other of 15% to 24% chromic oxide content.

Chelyabinsk Electrometallurgical Integrated Plant produced low-carbon ferrochromium with an annual production capacity of 144,000 t. Chelyabinsk produced 140,000 t of ferrochromium in 2000 (Ryan's Notes, 2001c). Serov Ferroalloy Plant planned to build a sintering plant for its ferrochromium smelter. Tulachermet reported production of 650 t of chromium metal from a capacity of 1,000 t/yr. Polema reported production of about 600 t of chromium metal from a capacity of 900 t/yr.

Severonickel Combine, a subsidiary of RAO Norilsk Nickel, continued development of the Sopcheozero chromite deposits. Norilsk sought a partner to develop the chromite ore mine and a ferrochromium smelter (Ryan's Notes, 2000).

South Africa.—The Minerals Bureau reported that from a reserve base of 5,500 Mt of chromite ore in 2000, South Africa produced 6,662,000 t of chromite ore, from which it produced 2,574,000 t of ferrochromium and other products. South Africa exported 1,090,000 t of chromite ore and 2,119,000 t of ferrochromium in 2000 (Armitage, 2001). Based on chromite ore production and chromite ore and ferrochromium trade, South African chromium apparent consumption in 2000 was 512,000 t. The Minerals Bureau reported chromite ore production in 2001 of 5,502,010 t and sales of 5,529,028 t. Three percent was sold locally; the remaining 97% was exported (South African Minerals Bureau Report, 2002).

The South African rand declined in value relative to the U.S. dollar. The rand moved from 7.5609 rand/dollar in January 2001 to 11.9925 rand/dollar in December. The exchange rate peaked at 13.4714 rand/dollar in mid-December (Antweiler, 2002§[1]). This exchange rate change was thought to be at least partly responsible for the low price of chromium materials. Eskom, the South African power utility, withdrew preferential power tariffs for ferrochromium producers. Spoornet, the South African rail service, increased tariffs.

South African Chrome and Alloys Limited (SA Chrome) started construction of a ferrochromium plant that comprised two closed furnaces with combined ferrochromium production capacity of 235,000 t/yr. The plant is at Boshoek near Brits in North West Province. The plant was built above a 13.6-Mt chromite ore reserve held by SA Chrome and adjacent to reserves held by the Bafokeng Nation, a co-owner of SA Chrome. The mine, which is 40 km from the plant, extracts chromite ore from the LG6 seam. The smelter will use a blend of LG6 and UG2 ore. Chromite byproduct of platinum mining of the UG2 seam is available 8 km from the plant. The ownership structure of SA Chrome was as follows: Industrial Development Corp. (24.5%), Bafokeng Nation (22.5%), ThyssenKrupp Metallurgie GmbH (15.6%), Bateman Titaco, and Outokumpu. The plant will use Outokumpu technology to pelletize, preheat, and smelt 520,000 t of chromite ore in two 54- megavolt-ampere furnaces to produce 235,000 t/yr of ferrochromium. The plant was to be completed and production started in 2002 (McConnachie, 2001).

ASA Metals (Pty.) Ltd. (ASA) operated a 33-megavolt-ampere furnace near Burgersfort, Northern Province. ASA had a ferrochromium production capacity of 60,000 t/yr. ASA got its chromite ore from Dilokong Mine. ASA planned a second furnace that would double their production capacity.

Associated Manganese Mines of South Africa Ltd. (Assmang) completed construction of a fourth furnace and associated pelletizing and preheating line designed by Outokumpu and built at a cost of 375 million rand (about 87 million U.S. dollars). The new furnace has an electrical power capacity of 54 megavolt-amperes and a ferrochromium production capacity of 175,000 t/yr. The pelletizing operation is capable of turning out 350,000 t/yr of pellets. The smelter is supplied chromite ore by the Dwarsrivier chromite ore mine in Mpumalanga Province about 150 km from the plant. The Dwarsrivier mine had a reserve of 20 Mt and reserve base of 100 Mt. The mine was designed to produce 1 Mt/y run-of-mine chromite ore, which could be increased to 1.25 Mt/yr. The mine started operation in 2000 as an opencast mine; however, as mining continues, surface mining will be shifted to underground. It was developed at a cost of 190 million rand (about 23 million U.S. dollars) (TEX Report, 2001e; Gwillim, 2002§; Anglovaal Mining Limited, undated§).

Columbus Stainless (Columbus), Middelburg, Mpumalanga Province, changed ownership structure. Acerinox (Spain) purchased 64% of Columbus. Columbus' raw steel production capacity is 500,000 t/yr. In addition to the production facilities in Middelburg, Acerinox holds stainless steel production plants in Spain and the United States.

Hernic (Pty.) Ltd. (Hernic) operated a chromite mine and a ferrochromium smelter at Brits, North West Province. The plant's ferrochromium production capacity was 260,000 t/yr of high-carbon ferrochromium. The plant consisted of two 37-megavolt-ampere furnaces utilizing pelletized chromite ore feed and one 54-megavolt-ampere furnace utilizing pelletized and preheated chromite ore feed of Outokumpu design. Hernic planned to add a second smelter of comparable capacity once ore supplies were secured.

Samancor Ltd. (Samancor), a subsidiary of BHP Billiton, operated chromite mines and five ferrochromium smelters: Bathlako, Ruighoek, North West Province; Ferrometals, Witbank, and Tubastse, Steelpoort, Mpumalanga Province; and Palmeit, Krugersdorp, Gauteng Province. Samancor closed the Palmiet plant late in the year. Samancor reported 2001 fiscal year ferrochromium production of 908,000 t. BHP Billiton reported chromite ore production in calendar year 2001 to have been 2.577 Mt compared with 1.819 Mt in 2000 (BHP Billiton, 2001a-c).

Xstrata S.A. (Pty.) Ltd. (Xstrata) operated chromite mines and four ferrochromium smelters: one in Lydenburg, Mpumalanga Province; one in Wonderkop, North West Province; and two in Rustenburg, North West Province. Xstrata produced 2,228,000 t of chromite ore in 2001 from a capacity of 3,840,000 t, down 10.4% compared with that of 2000. Fiscal year chromite ore production and capacity by mine broke down as follows: Kroondal Mine, 1,050,000 t in 2001; 824,685 t in 2000; 1,320,000 t/yr capacity; Watervaal East Mine, 98,700 t in 2001; 579,386 t in 2000; 600,000 t/yr capacity; Watervaal West Mine, no production in 2001 or 2000, 720,000 t/yr capacity; and Thorncliffe Mine, 1,080,000 t in 2001; 1,083,364 t in 2000; 1,200,000 t/yr capacity. Xstrata's ferrochromium production capacity was 1.304 Mt/yr: Lydenburg, 380,000 t/yr-furnace plus

[1]References that include a section twist (§) are found in the Internet References Cited section.

24,000 t metal-from-slag recovery; Rustenburg, 395,000 t/yr-furnace plus 25,000 t metal-from-slag recovery; and Wonderkop, 460,000 t/yr-furnace plus 20,000 t metal-from-slag recovery (TEX Report, 2001c). Xstrata leased two of its furnaces at Rustenburg to Anglo American Platinum. Xstrata reported 2001 calendar year ferrochromium production of 806,600 t.

Samancor and Xstrata formed an equally owned joint venture to develop chromite ore mining and ferrochromium production in the Rustenburg area of the western belt of the Bushveld Complex. The joint venture used chromite ore reserves owned by Samancor that are accessible via Xstrata's Kroondal mine. The joint venture added two 45-megavolt-ampere, semiopen furnaces, pelletizing and prereduction designed by Outokumpu, and metal-from-slag recovery to the Wonderkop plant at a cost of about $40 million. The new production equipment added 180,000 t/yr of ferrochromium to the plant's annual production capacity. The new furnaces were brought into production at a cost of about $32 million.

Sweden.—The Swedish agency for civil emergency planning reported its intent to sell 6,530 t of high-carbon ferrochromium held in the Swedish stockpile.

Taiwan.—Taiwan reported imports of ferrochromium to have been 346,641 t high carbon and 11,117 t low carbon in 2001 (TEX Report, 2002n). Taiwan reported stainless steel scrap imports of 317,150 t in 2001 (TEX Report, 2002o).

Turkey.—Turkey produced chromite ore, chromium chemicals, and ferrochromium. Eti Elektrometalurji produced low-carbon ferrochromium at Antalya. Eti Krom A.S. produced high-carbon ferrochromium at Elazig.

Zimbabwe.—Zimbabwe produced chromite ore and ferrochromium. Maranatha Ferrochrome (Pvt.) Ltd. (Maranatha) produced high-carbon ferrochromium at Eiffel Flats near Kadoma in Mashonaland West Province from two furnaces with a combined production capacity of 30,000 t/yr. Zimasco reported production of about 213,000 t of high-carbon ferrochromium in 2001 from its plant at Que Que. Zimbabwe Alloys suspended low-carbon ferrochromium production. It converted one furnace to high-carbon ferrochromium production and planned to convert two others. Zimbabwe Alloys reported production of 34,957 t of ferrochromium in 2001 and recovery of ferrochromium from slag of about 10,000 t in 2001; 12,141 t in 2000; and 13,842 t in 1999.

Environment

The International Chromium Development Association published an overview of legislation affecting health and safety, and detailing the environmental effects of chromium and its compounds. The document reported fact-based risks for human health and the environment. The report found that impacts on human health and the environment from chromium is chemical-species specific. The document also reported health risk by industry sector; described health, safety and environmental programs; and described regulatory bodies and obligations (International Chromium Development Association, 2001).

Current Research and Technology

Mineral Processing and Industrial Applications.—Industry conducts research to develop new, more efficient processes and to improve the efficiency of currently used processes. The Council for Mineral Technology (Mintek) of South Africa conducts Government-sponsored, commercially sponsored, and cosponsored research and development on chromite ore and ferrochromium.

Chromium-bearing slag.—Mintek supplied a metal-from-slag recovery plant with a capacity to process 100 t per hour of slag to Vagön Alloys (Sweden) (Mintek, 2002a§).

Stainless Steel.—Mintek studied the recovery of metal from stainless steel plant dust. They processed 465 t of dust produced by Columbus Stainless to get 234 t of metal and 149 t of slag. The chromium units in the dust reported to the metal fraction were 93.8%. The remainder in the slag was trivalent (Mintek, 2002b§).

Outlook

The outlook for chromium consumption in the United States and the rest of the world is about the same as that for stainless steel, which is the major end use for chromium worldwide. Thus, stainless steel industry performance largely determines chromium industry demand worldwide. (See the following section on stainless steel.)

The trend to supply chromium in the form of ferrochromium by countries that mine chromite ore is expected to continue. With new efficient ferrochromium production facilities and excess capacity in chromite-producing countries, ferrochromium capacity and production are expected to diminish in countries that produce ferrochromium but not chromite ore, and in countries with small, less efficient producers. Further vertical integration of the chromium industry is expected as chromite-producing countries expand ferrochromium or stainless steel production capacity.

In Keegan's (2001) review of the chromium industry, she described the following: the geology of chromium and reported reserves and reserve base; world production and trade; chromite mining; metallurgical applications indicating distribution of use among alloys; ferrochromium processing techniques; products, and production and capacity by country; chromium chemical processing, products, and production capacity; chromium chemical, refractory, and foundry applications; and provided chromite ore and ferrochromium prices.

Chromite Ore.—Chromite ore production capacity is in balance with average consumption. Consumption capacity by ferrochromium plants, however, exceeds production capacity, which can lead to short supply when demand surges, thus preventing ferrochromium producers from meeting a surge in demand. To improve chromite ore availability and to stabilize feed material price, ferrochromium producers invest in chromite-ore-producing mines. Indeed, most chromite ore is produced under vertically integrated mine-smelter or mine-plant ownership. In 2001, world chromite production declined by 16% compared with that of 2000.

Ferrochromium.—Ferrochromium production is electrical energy intensive. Charge-grade ferrochromium requires 2,900 to 4,100 kilowatt-hours of electrical energy per ton of product, with efficiency varying with ore grade, operating conditions, and production process. Thus, ferrochromium plant location reflects a cost balance between raw materials and electrical energy supply. In 2001, world ferrochromium production declined 20% compared with that of 2000.

Jones (2001) reported that ferrochromium producers face five major production costs: chromite ore, electrical energy supply, labor, transportation, and coke supply. Of these, chromite ore and electrical energy supply typically account for about 50% of production cost. Increasing labor cost motivates the movement of ferrochromium plants to low-labor-cost areas and investment in mechanization; the availability of capital for investment makes that possible. Deregulation of electrical energy cost in Europe will result in more uniform energy cost there. Basic oxygen furnace (BOF) steelmaking has been the major demand for coke. The decline in BOF steelmaking and environmental concerns related to coke manufacture has resulted in reduced coke production and the closure of coke furnaces. A satisfactory substitute for coke in the manufacture of ferrochromium has not been found. Transportation cost motivates the movement of ferrochromium plants nearer to mines because the producer must move in excess of 2 units of chromite ore per unit of ferrochromium product.

Low-carbon ferrochromium consumption has been declining and was expected to continue declining. Technological changes in the consuming industry permit the substitution of high-carbon ferrochromium for low-carbon ferrochromium. The substitution is desirable because low-carbon ferrochromium production is more expensive than high-carbon ferrochromium production. Low-carbon ferrochromium production dropped from 792,738 t in 1988 to 413,079 t in 2001; an annual compound growth rate of 0.95 over the time period. Chelyabinsk, Russia, and Aktyubinsk, Kazakhstan, are the major low-carbon ferrochromium-producing centers. Low-carbon ferrochromium is also produced in China and India and supplied by the National Defense Stockpile (Platts Metals Week, 2001a).

Stainless Steel.—Stainless steel demand is expected to grow in the long term. Short-term demand fluctuation can exceed long-term demand growth. In 2001, world stainless steel production declined by 2.7% compared with that of 2000.

Plummer (2001) reported on the state of the world stainless steel industry. He reported that Asia accounted for 45% of stainless steel consumption. The major stainless steel producers are Japan, Korea, and Taiwan. However, China has a great impact on the market because it imports stainless steel, it has growth potential, and it has started producing its own stainless steel products. In the Western World, per capita stainless steel demand rose 75% from 2.9 kilograms per capita in 1985 to 5.9 kilograms per capita in 2000.

Pariser (2002) reported on chromium end uses. He identified building and construction, electrical machinery, non-electrical machinery, transportation equipment, and unallocated metal goods, as the end uses of stainless steel, alloy steel, nickel base alloys, cast alloys, and other uses of ferrochromium. He found that stainless steel accounted for 73.2% of chromium units; alloy steel, 21.5%; nickel-base alloys, 1.4%; cast alloys, 3.2%; and other uses, 0.7%.

Terörde (2001) reported stainless steel is fully recyclable and, therefore, meets the performance potential of environment-conscious consumers. Stainless steel is reusable, the highest level of recycling. The recyclable nature of stainless steel means that it need not contribute to environmental waste. The reusable character of stainless steel contributes to the sustainability of its use. Since the 1970s, in-plant generated stainless steel scrap has declined from accounting for the largest share of raw material supply to now accounting for only 14% to 15% of melt shop feed material. Improved steelmaking technologies result in a larger share of the mill feed reporting to product instead of scrap. Externally generated scrap is the scrap commodity sought as a raw material supply. Externally generated scrap accounts for about 36% of melt shop feed for the production of austenitic grades, up from 26% in 1990. In magnitude, that is 5.4 Mt of externally generated stainless steel scrap consumed in 2001. Consumption of externally generated stainless steel scrap varies among regions of the world with the United States leading at 55% followed by Europe at 38%, and Asia at 27% to 35%. Stainless steel scrap is desirable to stainless steel producers because the cost of chromium and nickel contained in the scrap is less than that of primary supply.

Chromium Chemicals.—In 2001, major producing countries where large plants (capacity in excess of 100,000 t/yr of sodium dichromate) operate, included Kazakhstan, Russia, the United Kingdom, and the United States. Moderate-sized production facilities were located in China, Japan, Romania, South Africa, and Turkey. Small-scale local producers operated in China and India.

Chromium Metal.—Major chromium metal producers include Russia and the United States (by the electrolytic process) and China, France, Russia, and the United Kingdom (by the aluminothermic process).

Lofthouse (2001) reviewed the chromium metal industry. From 1990 to 2000, world annual chromium metal consumption (excluding China and the former Soviet Union) increased from about 16,000 to 22,500 t, while the number of producers decreased and production capacity per plant increased. Annual consumption dipped to 13,500 t in 1992. The aerospace industry is the major source of demand for chromium metal in the form of superalloys, which are manufactured and consumed mostly in North America and Europe. The major producer changes in the 1990 through 2000 time period were the closure of Murex (United Kingdom), Shieldalloy Metal Alloys (United States), and Tosoh (Japan), while London and Scandinavian Metallurgical (United Kingdom) and Delachaux (France) increased their production capacity. In the post-Soviet Union world environment, Russia became a major world supplier of chromium metal. Russian exports of chromium grew from nil to exceed those of the major world exporters (China, France, and United Kingdom) for part of the time period.

The two major chromium metal production processes are electrolytic and aluminothermic; aluminothermic, which has been used longer, accounts for largest share of production, and appears to be increasing its share of the world production. The electrolytic process requires ferrochromium as a feed material; the aluminothermic process requires a special grade of chromic oxide. There is abundant supply of ferrochromium; however,

chromium-metal-grade chromic oxide production and capacity are limited.

World chromium metal demand has been increasing by about 1,000 t/yr. Chromium metal production was estimated at 22,000 t in 2001; 21,000 t in 2000; and 20,000 t in 1999. The trend was expected to continue. The major end use industries were aerospace, gas turbine, and petrochemical (TEX Report, 2001a).

Newman (2001) reported that demand increased for superalloys from 1998 through 2000. The source of that demand was industrial gas turbines and land-based turbines in addition to strong aerospace demand.

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TABLE 1
SALIENT CHROMIUM STATISTICS 1/

(Metric tons, contained chromium, unless otherwise specified)

	1997	1998	1999	2000	2001
World production:					
Chromite ore (mine) 2/	4,090,000 r/	4,090,000 r/	4,240,000 r/	4,380,000 r/	3,650,000 e/
Ferrochromium (smelter) 3/	2,750,000 r/	2,710,000	2,850,000 r/	3,260,000 r/	2,670,000 e/
Stainless steel 4/	2,840,000 r/	2,780,000 r/	2,970,000 r/	3,240,000 r/	3,150,000 e/
U.S. supply:					
Components of U.S. supply:					
Domestic mines	--	--	--	--	--
Secondary	120,000	104,000	118,000	139,000	122,000
Imports:					
Chromite ore	96,600	117,000	85,000	86,200	62,000
Chromium chemicals	6,430	9,070	10,400	12,500	12,800
Chromium ferroalloys	237,000	249,000	371,000	344,000	156,000
Chromium metal	9,800	9,520	9,030	9,930 r/	8,190
Stocks, January 1:					
Government	1,070,000	1,020,000	928,000	909,000	825,000
Industry 5/	74,400 r/	64,000 r/	59,700 r/	14,500 r/	15,600
Total	1,610,000	1,570,000	1,580,000	1,520,000	1,200,000
Distribution of U.S. supply:					
Exports:					
Chromite ore	5,890	39,900	37,200	44,600	20,000
Chromium chemicals	16,700	17,500	17,300	16,400	8,050
Chromium ferroalloys and metal	7,710	5,000	5,790	25,400	9,840
Stocks, December 31:					
Government	1,020,000	928,000	909,000	825,000	816,000 e/
Industry 5/	71,300 r/	59,700 r/	54,500 r/	15,600 r/	16,600
Total	1,120,000	1,050,000	1,020,000	927,000 r/	870,000 e/
Apparent consumption	489,000	524,000	558,000	589,000	332,000 e/
Reported production: 6/					
Chromium ferroalloy and metal net production:					
Gross weight	60,700	W	W	W	W
Chromium content	40,900	W	W	W	W
Net shipments	56,300	W	W	W	W
Reported consumption:					
Chromite ore and concentrates (gross weight)	350,000	269,000	W	W	W
Chromite ore average Cr_2O_3 (percentage)	45	45	45	45	45
Chromium ferroalloys (gross weight) 7/	385,000	345,000 r/	398,000 r/	384,000 r/	332,000
Chromium ferroalloys (contained chromium) 7/	220,000	195,000 r/	220,000 r/	215,000 r/	190,000
Chromium metal (gross weight)	4,970	4,670	4,690	4,980	5,880
Stocks, December 31 (gross weight):					
Government:					
Chromite ore	1,090,000	885,000	820,000	636,000	636,000 e/
Chromium ferroalloys	1,020,000	974,000	973,000	919,000	906,000 e/
Chromium metal	7,720	7,720	7,720	7,550	7,430 e/
Industry, producer 8/	10,900	W	W	W	W
Industry, consumer:					
Chromite ore 9/	175,000	159,000	130,000	W	W
Chromium ferroalloys 10/	16,700	17,300	24,900 r/	26,400 r/	27,800
Chromium metal	227	195	245	191	210
Prices, average annual:					
Chromite ore, per ton gross weight 11/	$73	$68	$63	NA	NA
Ferrochromium, per pound chromium content 12/	$0.480	$0.467	$0.366	$0.414	$0.324
Standard chromium metal, per pound gross weight 13/	$5.20	$4.73	$4.43	$4.43	$4.24
Vacuum chromium metal, per pound gross weight 13/	$5.39	$5.38	$5.38	$5.42	$5.43
Value of trade: 14/					
Exports thousands	$107,000	$102,000	$92,500	$110,000	$89,400
Imports do.	$450,000	$421,000	$420,000	$427,000	$239,000
Net exports 15/ do.	-$343,000	-$319,000	-$327,000	-$317,000	-$149,000

See footnotes the at end of table.

TABLE 1--Continued
SALIENT CHROMIUM STATISTICS 1/

(Metric tons, contained chromium, unless otherwise specified)

		1997	1998	1999	2000	2001
Stainless steel (gross weight):						
Production 16/		2,160,000	2,010,000	2,190,000	2,190,000	1,820,000 e/
Shipments 17/		1,880,000	1,850,000	1,890,000	1,930,000	NA
Exports		199,000	206,000	216,000	264,000	249,000
Imports		774,000	862,000	941,000	989,000	761,000
Scrap:						
Receipts		705,000	610,000	694,000	817,000	720,000
Consumption		1,140,000	1,040,000	1,140,000	1,220,000	1,080,000
Exports		370,000	298,000	260,000	468,000	438,000
Imports		64,100	57,200	66,100	56,200	42,300
Value of trade:						
Exports	thousands	$653,000	$622,000	$628,000	$782,000	$752,000
Imports	do.	$1,720,000	$1,680,000	$1,560,000	$2,010,000	$1,430,000
Scrap exports	do.	$231,000	$176,000	$151,000	$310,000	$270,000
Scrap imports	do.	$33,700	$21,600	$27,700	$35,500	$24,100
Net exports 15/ 18/	do.	-$870,000	-$903,000	-$811,000	-$955,000	-$433,000

e/ Estimated. r/ Revised. NA Not available. W Withheld to avoid disclosing company proprietary data. -- Zero.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Calculated assuming chromite ore to average 44% Cr_2O_3, which is 68.42% chromium.
3/ Calculated assuming chromium content of ferrochromium to average 57%.
4/ Calculated assuming chromium content of stainless steel to average 17%.
5/ Includes consumer stocks of chromium ferroalloys and metal and other chromium-containing materials; chromium chemical and refractory producer stocks of chromite ore before 2000; and chromium ferroalloy and metal producer stocks of chromite ore, chromium ferroalloys, and chromium metal before 1998.
6/ Includes chromium ferroalloys and metal and other chromium materials in the United States.
7/ Chromium ferroalloy and other chromium-containing materials excluding chromium metal.
8/ Chromium ferroalloy and metal producer stocks of chromium ferroalloys and metal.
9/ Chemical, chromium ferroalloy and metal, and refractory producer stocks of chromite ore.
10/ Consumer stocks of chromium ferroalloys and metal and other chromium-containing materials.
11/ Time-weighted average price of South African chromite ore, as reported in Platts Metals Week.
12/ Time-weighted average price of imported high-carbon chromium that contains 50% to 55% chromium, as reported in Platts Metals Week.
13/ Time-weighted average price of electrolytic chromium metal, as reported in American Metal Market.
14/ Includes chromite ore and chromium ferroalloys, metal, and chemicals.
15/ Data indicate that imports are greater than exports.
16/ Data on stainless steel production from American Iron and Steel Institute Annual Reports and quarterly production of stainless and heat-resisting raw steel.
17/ Data on stainless steel shipments from American Iron and Steel Institute Annual Reports.
18/ Includes stainless steel and stainless steel scrap.

TABLE 2
PRINCIPAL U.S. PRODUCERS OF CHROMIUM PRODUCTS IN 2001, BY INDUSTRY

Industry and company	URL address	Plant
Metallurgical:		
Eramet Marietta Inc.	NA	Marietta, OH.
JMC (USA) Inc.	NA	Research Triangle Park, NC.
Refractory:		
National Refractories and Minerals Corp.	http://www.nrmc.com	Moss Landing, CA, and Columbiana, OH.
RHI Refractories America Inc.	http://www.rhiamerica.com	Womelsdorf, PA.
Chemical:		
Elementis Chromium LP	http://www.elementis.com	Corpus Christi, TX.
Occidental Chemical Corp.	http://www.oxychem.com	Castle Hayne, NC.

TABLE 3
U.S. REPORTED CONSUMPTION AND STOCKS OF CHROMIUM PRODUCTS 1/

(Metric tons)

	2000		2001	
	Gross weight	Chromium content	Gross weight	Chromium content
Consumption by end use:				
Alloy uses:				
Iron alloys, steel:				
Carbon steel	12,600 r/	7,410	8,250	4,890
High-strength low-alloy steel	19,400	10,200	18,500	9,960
Stainless and heat-resisting steel	290,000	162,000	255,000	146,000
Full alloy steel	27,700	17,000	18,200	10,600
Electrical steel	W	W	W	W
Tool steel	3,060	1,860	5,640	3,390
Superalloys	9,000 r/	6,990	10,300	8,090
Other alloys 2/	26,300 r/	14,300	21,100	12,000
Other uses not reported above	W	W	W	W
Total	389,000 r/	220,000 r/	338,000	196,000
Consumption by material:				
Low-carbon ferrochromium	35,500 r/	24,100	35,600	23,600
High-carbon ferrochromium	299,000	174,000	249,000	149,000
Ferrochromium silicon	47,100 r/	16,000	45,100	16,600
Chromium metal	4,980	4,960	5,880	5,880
Chromite ore	989	309	1,020	332
Chromium-aluminum alloy	1,170	809	682	383
Other chromium materials	503 r/	241	612	252
Total	389,000 r/	220,000 r/	338,000	196,000
Consumer stocks:				
Low-carbon ferrochromium	2,160	1,470	2,000	1,330
High-carbon ferrochromium	23,300	13,500	24,200	14,400
Ferrochromium silicon	713	242	1,340	492
Chromium metal	191	191	210	210
Chromite ore	83	25	66	22
Chromium-aluminum alloy	58	40	72	40
Other chromium materials	118 r/	56	123	51
Total	26,600	15,600	28,000	16,600

r/ Revised. W Withheld to avoid disclosing company proprietary data; included in "Total."
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Includes cast irons, welding and alloy hard-facing rods and materials, wear- and corrosion-resistant alloys, and aluminum, copper, magnetic, nickel, and other alloys.

TABLE 4
U.S. GOVERNMENT STOCKPILE YEAREND INVENTORIES AND CHANGE FOR CHROMIUM-CONTAINING MATERIALS 1/ 2/

(Metric tons, gross weight)

Material	2000	2001 e/	Change	
			Quantity	Percentage 3/
Chromite ore:				
Chemical	203,000	203,000	--	--
Metallurgical	193,000	193,000	--	--
Refractory	241,000	241,000	--	--
Chromium ferroalloys:				
Ferrochromium-silicon	34,200	31,600	-2,630	-8
High-carbon ferrochromium	615,000	615,000	--	--
Low-carbon ferrochromium	270,000	259,000	-10,900	-4
Chromium metal:				
Aluminothermic	2,500	2,370	-125	-5
Electrolytic	5,050	5,050	--	--

e/ Estimated. -- Zero.
1/ Includes specification- and nonspecification-grade materials.
2/ Data are rounded to no more than three significant digits.
3/ Quantity change as a percentage of stocks in 2000.

Source: Defense Logistics Agency, Defense National Stockpile Center.

TABLE 5
TIME-VALUE RELATIONS FOR CHROMITE ORE, FERROCHROMIUM, AND CHROMIUM METAL 1/ 2/

(Annual average value, dollars per metric ton)

Material	2000		2001	
	Contained chromium	Gross weight	Contained chromium	Gross weight
Chromite ore:				
Not more than 40% chromic oxide	841	210	1,910	471
More than 40%, but less than 46% chromic oxide	178	56	209	66
46% or more chromic oxide	191	62	176	58
Average 3/	198	64	187	61
Ferrochromium:				
Not more than 3% carbon:				
Not more than 0.5% carbon	1,540 r/	1,000 r/	2,180	1,490
More than 0.5%, but not more than 3% carbon	1,090 r/	707 r/	993	622
Average 3/	1,470	956	2,050	1,390
More than 3%, but not more than 4% carbon	--	--	1,500	1,020
More than 4% carbon	710	409	579	335
Average 3/	797	466	709	415
Chromium metal	XX	5,980	XX	6,170

r/ Revised. XX Not applicable. -- Zero.
1/ Based on Customs value of chromium contained in imported material.
2/ Data are rounded to no more than three significant digits; may not add to totals shown.
3/ Mass-weighted average.

TABLE 6
PRICE QUOTATIONS FOR CHROMIUM MATERIALS
AT BEGINNING AND END OF 2001 1/

Material	January	December	Year average 2/
Cents per pound of chromium:			
High-carbon ferrochromium:			
Imported:			
50% to 55% chromium	$39.00-$41.00	$28.25-$29.25	$32.38
60% to 65% chromium	35.00-37.00	27.00-29.00	31.10
Low-carbon ferrochromium:			
Imported:			
0.05% carbon	59-63	60-65	62
0.10% carbon	43-47	56-60	51
Cents per pound of product:			
Chromium metal (domestic):			
Electrolytic, standard	435-445	380-400	424
Electrolytic, vacuum	520-565	520-565	543

1/ The source for ferrochromium prices is Platts Metals Week and the source for chromium metal prices is American Metal Market.
2/ Time-weighted average.

TABLE 7
U.S. EXPORTS OF CHROMIUM MATERIALS, BY TYPE 1/

HTSUSA 2/	Type	2000 Quantity (kilograms)	2000 Value (thousands)	2001 Quantity (kilograms)	2001 Value (thousands)	Principal destinations, 2001
2610.00.0000	Chromite ore and concentrate, gross weight	138,000,000	10,200	61,000,000	6,680	Sweden (88%); Mexico (5%); Canada (3%); Japan (3%).
	Metal and alloys:					
8112.20.0000	Chromium metal, gross weight 3/	1,260,000	13,100	1,040,000	10,700	Japan (58%); Germany (17%); Canada (11%); Australia (6%); Belgium (2%); Mexico (2%).
	Chromium ferroalloys:					
7202.41.0000	High-carbon ferrochromium, gross weight 4/	33,500,000	17,500	8,390,000	6,260	Netherlands (61%); Canada (22%); Mexico (16%); Brazil (1%).
7202.41.0000	High-carbon ferrochromium, contained weight 4/	22,200,000	--	3,380,000	--	
7202.49.0000	Low-carbon ferrochromium, gross weight 5/	1,570,000	2,180	7,880,000	6,160	Netherlands (77%); Canada (8%); Mexico (7%); Brazil (5%); United Kingdom (1%).
7202.49.0000	Low-carbon ferrochromium, contained weight 5/	945,000	--	5,400,000	--	
7202.50.0000	Ferrochromium-silicon, gross weight	2,700,000	1,490	85,500	92	Canada (49%); Mexico (40%); United Kingdom (10%); France (2%).
7202.50.0000	Ferrochromium-silicon, contained weight	946,000	--	26,600	--	
	Total ferroalloys, gross weight	37,700,000	21,200	16,400,000	12,500	
	Total ferroalloys, contained weight	24,100,000	--	8,800,000	--	
	Chemicals, gross weight:					
	Chromium oxides:					
2819.10.0000	Chromium trioxide	11,600,000	22,800	10,700,000	26,600	Canada (33%); New Zealand (10%); Australia (9%); Brazil (8%); Japan (8%); Mexico (8%); Hong Kong (5%); Germany (4%); Taiwan (4%); Korea, Republic of (3%); Thailand (2%); South Africa (1%).
2819.90.0000	Other	5,170,000	20,300	2,730,000	10,300	Canada (34%); Germany (18%); Belgium (11%); China (9%); Israel (3%); Japan (3%); Taiwan (3%); United Kingdom (3%); Australia (2%); Korea, Republic of (2%); Mexico (2%); Philippines (2%); Indonesia (1%).
2833.23.0000	Chromium sulfates	23,500	32	13,100	200	United Kingdom (72%); Chile (18%); Hong Kong (10%).
	Salts of oxometallic or peroxometallic acids:					
2841.20.0000	Zinc and lead chromate	287,000	620	158,000	416	Canada (70%); Chile (16%); Mexico (12%); Belgium (2%).
2841.30.0000	Sodium dichromate	19,400,000	14,400	16,300,000	16,600	Canada (30%); Mexico (23%); Thailand (13%); Colombia (5%); Panama (5%); Peru (5%); Hong Kong (3%); Indonesia (3%); San Salvador (3%); Taiwan (3%); Brazil (2%); Philippines (2%).
2841.40.0000	Potassium dichromate	95,400	144	18,600	44	Canada (33%); Japan (25%); New Zealand (24%); Korea, Republic of (14%); Brazil (1%); India (1%).
2841.50.0000	Other chromates, dichromates, and peroxochromates	639,000	2,140	562,000	1,650	Korea, Republic of (49%); Canada (30%); Malaysia (5%); Mexico (5%); United Kingdom (5%); Saudi Arabia (3%); Japan (1%).
3206.20.0000	Pigments and preparations, gross weight	1,040,000	5,340	771,000	3,710	Canada (32%); Mexico (31%); Sweden (5%); Brazil (4%); Nigeria (4%); Venezuela (4%); Costa Rica (3%); Germany (2%); Guyana (2%); Trinidad and Tobago (2%); Korea, Republic of (1%); Philippines (1%).

-- 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 of America code.
3/ Articles thereof and waste and scrap.
4/ More than 4% carbon.
5/ Not more than 4% carbon.

Source: U.S. Census Bureau.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF CHROMITE ORE, BY COUNTRY 1/

Country	Not more than 40% Cr_2O_3 (HTSUSA 2/ 2610.00.0020)			More than 40% but less than 46% Cr_2O_3 (HTSUSA 2/ 2610.00.0040)			46% or more Cr_2O_3 (HTSUSA 2/ 2610.00.0060)			Total		
	Gross weight (metric tons)	Cr_2O_3 content (metric tons)	Value 3/ (thou-sands)	Gross weight (metric tons)	Cr_2O_3 content (metric tons)	Value 3/ (thou-sands)	Gross weight (metric tons)	Cr_2O_3 content (metric tons)	Value 3/ (thou-sands)	Gross weight (metric tons)	Cr_2O_3 content (metric tons)	Value 3/ (thou-sands)
2000:												
Canada	1,130	440	$541	68	29	$36	86	43	$14	1,290	512	$592
Italy	--	--	--	--	--	--	32	15	6	32	15	6
Philippines	3,390	1,210	409	--	--	--	--	--	--	3,390	1,210	409
South Africa	--	--	--	33,100	15,100	1,810	230,000	109,000	14,300	263,000	124,000 r/	16,100
Total	4,520	1,650	950	33,100	15,100	1,840	230,000	109,000	14,300	268,000	126,000	17,100
2001:												
Canada	1,600	575	751	--	--	--	87	45	52	1,680	620	803
Italy	--	--	--	--	--	--	20	10	4	20	10	4
South Africa	--	--	--	3,100	1,430	204	184,000	88,400	10,500	187,000	89,800	10,700
Turkey	--	--	--	--	--	--	306	168	70	306	168	70
Total	1,600	575	751	3,100	1,430	204	184,000	88,600	10,600	189,000	90,600	11,600

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 of America code.

3/ Customs import value generally represents a value in the foreign country and therefore excludes U.S. import duties, freight, insurance, and other charges incurred in bringing the merchandise to the United States.

Source: U.S. Census Bureau.

TABLE 9
U.S. IMPORTS FOR CONSUMPTION OF FERROCHROMIUM, BY COUNTRY 1/

Country	Not more than 0.5% carbon (HTSUSA 2/ 7202.49.5090)			More than 0.5% carbon, but not more than 3% carbon (HTSUSA 2/ 7202.49.5010)			More than 3% carbon, but not more than 4% carbon (HTSUSA 2/ 7202.49.1000)			More than 4% carbon (HTSUSA 2/ 7202.41.0000)			Total (all grades)		
	Gross weight (metric tons)	Chromium content (metric tons)	Value (thou-sands)	Gross weight (metric tons)	Chromium content (metric tons)	Value (thou-sands)	Gross weight (metric tons)	Chromium content (metric tons)	Value (thou-sands)	Gross weight (metric tons)	Chromium content (metric tons)	Value (thou-sands)	Gross weight (metric tons)	Chromium content (metric tons)	Value (thou-sands)
2000:															
Brazil	40	25	$90	--	--	--	--	--	--	--	--	--	40	25	$90
China	159	111	236	60	42	$73	--	--	--	192	126	$147	411	279	456
Croatia	--	--	--	--	--	--	--	--	--	8,450	5,300	3,630	8,450	5,300	3,630
Georgia	130	91	213	--	--	--	--	--	--	--	--	--	130	91	213
Germany	7,520	5,090	14,400	23	16	74	--	--	--	--	--	--	7,540	5,110	14,500
India	--	--	--	--	--	--	--	--	--	3,850	2,260	1,610	3,850	2,260	1,610
Japan	1,940	1,330	4,320	114	79	266	--	--	--	--	--	--	2,060	1,410	4,590
Kazakhstan	4,620	3,210	3,300	1,850	1,300	1,250	--	--	--	131,000	89,900	60,500	138,000	94,400	65,000
Russia	32,200	20,300	24,700	2,690	1,840	1,890	--	--	--	7,040	4,630	4,110	41,900	26,700	30,700
South Africa	451	293	662	2,960	1,680	1,760	--	--	--	260,000	131,000	91,700	264,000	133,000	94,100
Sweden	39	28	87	133	95	282	--	--	--	--	--	--	172	123	369
Turkey	2,960	2,140	2,190	--	--	--	--	--	--	45,800	28,400	20,500	48,800	30,500	22,700
United Kingdom	23	16	23	--	--	--	--	--	--	--	--	--	23	16	23
Zimbabwe	220	148	145	1,320	881	877	--	--	--	60,400	36,800	29,500	61,900	37,800	30,500
Total	50,300	32,700	50,400	9,150	5,930	6,470	--	--	--	517,000	298,000	212,000	577,000	337,000	269,000
2001:															
Brazil	20	12	45	--	--	--	--	--	--	--	--	--	20	12	45
Canada	4	3	13	--	--	--	--	--	--	--	--	--	4	3	$13
China	20	14	25	--	--	--	--	--	--	103	68	78	123	81	103
France	3	2	4	--	--	--	--	--	--	--	--	--	3	2	4
Germany	7,240	5,090	14,200	--	--	--	--	--	--	--	--	--	7,240	5,090	14,200
Japan	2,520	1,600	5,350	--	--	--	--	--	--	20	14	42	2,540	1,620	5,390
Kazakhstan	--	--		500	345	275	--	--	--	61,400	42,100	21,100	61,900	42,500	21,400
Mexico	19	12	40	--	--	--	--	--	--	--	--	--	19	12	40
Russia	6,440	4,450	5,100	--	--	--	20	13	$20	20	14	12	6,480	4,480	5,140
South Africa	933	582	919	1,720	1,040	1,000	--	--	--	138,000	72,100	42,900	140,000	73,700	44,900
Sweden	38	28	72	76	55	152	--	--	--	38	28	78	152	110	302
United Kingdom	--	--	--	--	--	--	--	--	--	20	14	20	20	14	20
Zimbabwe	--	--	--	--	--	--	--	--	--	37,200	22,400	14,900	37,200	22,400	14,900
Total	17,200	11,800	25,700	2,290	1,440	1,430	20	13	20	236,000	137,000	79,200	256,000	150,000	106,000

-- 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 of America code.

Source: U.S. Census Bureau.

TABLE 10
U.S. IMPORTS FOR CONSUMPTION OF CHROMIUM MATERIALS, BY TYPE 1/

HTSUSA 2/	Type	2000 Quantity (kilograms)	2000 Value (thousands)	2001 Quantity (kilograms)	2001 Value (thousands)	Principal sources, 2001
	Metals and alloys:					
	Chromium metal:					
8112.20.3000	Waste and scrap, gross weight	40,700	$598	42,600	$163	China (79%); Japan (10%); Korea, Republic of (9%); Germany (2%).
8112.20.6000	Other than waste and scrap, gross weight	9,890,000 r/	58,800	8,150,000	49,900	France (29%); United Kingdom (25%); Russia (21%); China (12%); Kazakhstan (10%); Germany (1%); Pakistan (1%).
7202.50.0000	Ferrochromium-silicon, gross weight	20,700,000	10,300	14,600,000	5,910	Kazakhstan (77%); South Africa (19%); Zimbabwe (4%).
7202.50.0000	Ferrochromium-silicon, contained weight	7,670,000	--	6,110,000	--	
	Chemicals (gross weight):					
	Chromium oxides and hydroxides:					
2819.10.0000	Chromium trioxide	8,030,000	13,700	10,500,000	17,200	Kazakhstan (57%); China (16%); Turkey (14%); United Kingdom (6%); Italy (3%); Russia (1%); South Africa (1%).
2819.90.0000	Other	3,220,000	12,100	2,820,000	10,500	Japan (31%); China (22%); Germany (22%); United Kingdom (13%); Colombia (4%); Belgium (1%); France (1%); Italy (1%); Netherlands (1%); Poland (1%); Russia (1%).
2833.23.0000	Sulfates of chromium	239,000	227	155,000	151	United Kingdom (37%); Argentina (26%); Mexico (23%); Italy (14%).
	Salts of oxometallic or peroxometallic acids:					
2841.20.0000	Chromates of lead and zinc	289,000	563	111,000	224	Norway (68%); China (20%); Japan (8%); Colombia (2%); Germany (2%).
2841.30.0000	Sodium dichromate	16,900,000	10,500	14,800,000	7,760	United Kingdom (98%); China (1%); South Africa (1%).
2841.40.0000	Potassium dichromate	205,000	392	152,000	322	United Kingdom (60%); Kazakhstan (26%); Netherlands (13%).
2841.50.0000	Other chromates and dichromates; peroxochromates	56,900	183	110,000	291	Korea, Republic of (82%); United Kingdom (12%); Austria (4%); India (2%).
2849.90.2000	Chromium carbide	182,000	2,010	267,000	2,900	China (45%); Germany (19%); Japan (17%); Canada (11%); United Kingdom (7%); Israel (1%).
	Pigments and preparations based on chromium (gross weight):					
3206.20.0010	Chrome yellow	7,000,000	18,700	5,870,000	16,300	Canada (69%); Mexico (11%); China (7%); Korea, Republic of (7%); Hungary (2%); Colombia (1%); Germany (1%); Japan (1%).
3206.20.0020	Molybdenum orange	1,620,000	7,110	1,120,000	5,050	Canada (90%); Colombia (4%); Mexico (3%); Germany (1%); Phillipines (1%).
3206.20.0030	Zinc yellow	19,000	21	128,000	98	China (62%); Czech Republic (16%); Brazil (12%); Portugal (10%).
3206.20.0030	Other	1,530,000	6,290	1,390,000	4,100	China (47%); France (41%); Germany (6%); Czech Republic (3%); Japan (2%); Poland (1%).

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 of America code.

Source: U.S. Census Bureau.

TABLE 11
PRINCIPAL WORLD CHROMITE ORE PRODUCERS, 2001

Country 1/	Company
Albania	Albkrom (Government owned).
Australia	Consolidated Minerals Limited
	Pilbara Chromite Pty. Ltd.
Brazil	Cia. de Ferro Ligas da Bahia S.A.
	Elkem ASA (Norway).
	Mineracão Vila Nova Ltda.
	Magnesita S.A.
China	Huazang Smelter.
	Shashen.
	Xizang Kangjinla.
	Tibet Minerals Development Co., Ltd.
	Luobosa Mine.
	Xinjiang Karamay Gold Mine.
	Xinjiang Nonferrous Metals Industry Co.
Finland	Outokumpu Oy.
	Outokumpu Steel Oy.
	Outokumpu Chrome Oy.
India	Ferro Alloys Corp. Ltd.
	Indian Metals and Ferroalloys Ltd.
	Indian Charge Chrome Ltd.
	Misrilall Mines Ltd.
	Mysore Mineral Ltd.
	Orissa Mining Corporation Ltd.
	The Tata Iron and Steel Co. Ltd.
Indonesia	PT. Palabim Mining-PT. Bituminusa.
Iran	Faryab Mining Co.
Kazakhstan	Donskoy Ore Dressing Complex.
Madagascar	Kraomita Malagasy.
Oman	Oman Chromite Company SAOG.
Philippines	Benguet Corporation.
	Heritage Resources & Mining Corporation.
	Krominco Inc.
	Velore Mining Corporation.
Russia	Saranov Complex.
South Africa	ASA Metals (Pty.) Ltd.
	African Mining and Trust Co. Ltd.
	Rustenburg Minerals Development Co. (Pty.) Ltd.
	Zeerust Chrome Mine Ltd.
	Bafokeng Chrome Holdings.
South Africa--Continued	Bayer AG (Germany).
	Bayer (Pty.) Ltd.
	Canadian Gold S.A. (Pty.) Ltd.
	Goudini Chrome (Pty.) Ltd.
	Hernic Ferrochrome (Pty.) Ltd.
	National Manganese Mines (Pty.) Ltd.
	Pilanesberg Chrome (Pty.) Ltd.
	Rooderand Chrome Mine (Pty.) Ltd.
	South Africa Chrome and Alloys Ltd.
	Chromden Mine.
	Horizon Chrome Mine.
	Samancor.
	Eastern Chrome Mines.
	Western Chrome Mines.
	Vereeniging Refractories Ltd.
	Bophuthatswana Chrome Co. (Pty.) Ltd.
	Marico Chrome Corp. (Pty.) Ltd.
	Xstrata A.G. (Switzerland).
	Xstrata S.A. (Pty.) Ltd.
	Chromecorp (Pty.) Ltd.
	Consolidated Metallurgical Industries Ltd.
Sudan	Advanced Mining Works Co. Ltd.
Turkey	Aycan Madencilik Ltd. Sti.
	Bilfer Madencilik A.S.
	Cevher Madencilik ve Ticaret A.S.
	Dedeman Madencilik Sanayi ve Ticaret A.S.
	Eti Holdings.
	Pinarbasi Madencilik Sanayi ve Ticaret Ltd.
	Tekfen Dis. Ticaret A.S.
	Tevfik Refik Bayoglu Madencilik.
	Tut. Gen. Ticaret Ltd. Sti.
	Türk Maadin A.S.
United Arab Emirates	Derkek Raphael & Co.
	Dewent Mining Ltd.
Zimbabwe	Maranatha Ferrochrome (Pvt.) Ltd.
	Amble Mining Co.
	Zimasco (Pvt.) Ltd.
	Zimbabwe Alloys Ltd.

1/ Other chromite-producing countries included Burma, Cuba, Pakistan, and Vietnam.

TABLE 12
PRINCIPAL WORLD FERROCHROMIUM PRODUCERS, 2001

Country 1/	Company
Albania	Darfo Albania.
Brazil	Cia. de Ferro Ligas da Bahia S.A.
	Acesita S.A.
Chile	Carbomet Industrial S.A.
China	Dandong Ferroalloy Plant.
	Emei Ferroalloy (Group) Co. Ltd.
	Gansu Huazang Metallurgical Group Co. Ltd.
	Hanzhong Ferroalloy Works (Government owned).
	Hengshang Iron & Steel
	Hunan Ferroalloy (Government owned).
	Hunan Lengshuijiang Electrochemical Works.
	Jiangyin Ferroalloy Factory (Government owned).
	Jilin Dongfeng Ferroalloy Works.
	Jilin Ferroalloy Group Co. Ltd.
	Jilin Huinan Ferroally Works.
	Jinzhou Ferroalloy (Group) Co. Ltd.
	Liaoyang Ferroalloy Group Corp.
	Mengzang Ferroalloy Co. Ltd.
	Nanjing Ferroalloy Plant (Government owned).
	Ningjin Metal Smelting Co. Ltd.
	Northwest Ferroalloy Works.
	Qinghai Datong Ferroalloy Works.
	Qingzang Ferroalloy Co. Ltd.
	Quinhai Sanchuan Ferroalloy Co. Ltd.
	Taonan Ferroalloy Works.
	Urad Zhongqi Ferrochrome Group Corp.
	Xibei Ferroalloy Works (Government owned).
	Zhejiang Hengshan Ferroalloy Works.
Croatia	Dalmacija Ferro-Alloys Works.
Finland	Outokumpu Oy.
	Outokumpu Steel Oy.
	Outokumpu Chrome Oy.
Germany	Elektrowerk Weisweiler GmbH.
India	Andhra Ferro Alloys Limited.
	Baroda Ferro-Alloys.
	Deepak Ferro Alloys Ltd.
	Ferro Alloys Corp. Ltd.
	Charge Chrome Plant.
	Ferro-Alloys Unit.
	GMR Vasavi Industries Ltd.
	IMFA Group
	Indian Metals and Ferroalloys Ltd.
	Indian Charge Chrome Ltd.
	Industrial Development Corp.
	Ispat Alloys Ltd.
	Jindal Strips Ltd.
	Ferro Alloys Division.
	Nav Chrome Limited.
	Nava Bharat Ferro Alloys Ltd.
India--Continued	Sree Sarada Alloys Ltd.
	The India Thermit Corp. Ltd.
	The Tata Iron and Steel Co. Ltd.
	VBC Ferro Alloys Ltd.
	Visvesvaraya Iron & Steel Ltd.
Iran	Faryab Mining Co.
	Abadan Ferroalloys Refinery.
Italy	Darfo S.p.A.
	Fornileghe S.p.A.
	Mineralsider S.p.A.
Japan	Nippon Denko Co., Ltd.
	NKK Corp.
	NKK Materials Co. Ltd.
	Showa Denko K.K.
	Shunan Denko K.K.
Kazakhstan	Aksusky Ferroalloy Plant.
	Aktyubinsk Ferroalloy Plant.
Norway	Elkem ASA.
Poland	Huta "Laziska" Ferroalloy Plant.
Russia	Chelyabinsk Electrometallurgical Integrated Plant.
	Klutchevsk Ferroalloy Plant.
	Metall Joint Venture.
	Serov Ferroalloys Plant.
Slovakia	Oravske Ferozliatinarske Zavody.
Slovenia	Tovarna Dusika Ruse-Metalurgija d.d.
South Africa	ASA Metals (Pty.) Ltd.
	Associated Manganese Mines of South Africa Ltd.
	Feralloys Ltd.
	Hernic Ferrochrome (Pty.) Ltd.
	Samancor.
	Batlhako Ferrochrome Ltd.
	Ferrometals Division.
	Middelburg Ferrochrome Division.
	Palmiet Ferrochrome Division.
	Tubatse Ferrochrome Division.
	Xstrata A.G. (Switzerland).
	Xstrata S.A. (Pty.) Ltd.
	Chromecorp (Pty.) Ltd.
	Consolidated Metallurgical Industries Ltd.
	Lydenburg Works.
	Rustenburg Works.
Sweden	Vargön Alloys AB.
Turkey	Eti Holdings.
	Eti Elektromatalurji.
	Eti Krom A.S.
United States	Eramet Marietta Inc.
Zimbabwe	Maranatha Ferrochrome (Pvt.) Ltd.
	Zimasco (Pvt.) Ltd.
	Zimbabwe Alloys Ltd.

1/ Other ferrochromium-producing countries include Spain and Taiwan.

TABLE 13
CHROMITE: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons, gross weight)

Country 3/	1997	1998	1999	2000	2001
Afghanistan 4/	3,102	3,409	4,318	5,345	5,000 e/
Albania 5/	106,304	102,189	71,434	63,000 r/	129,700
Australia	31,000	80,000 r/	70,000 r/	90,000 r/	11,800
Brazil 6/	300,734 r/	554,813 r/	457,851 r/	600,011 r/	420,000 e/
Burma e/	3,299 7/	4,059 7/	3,200	3,000	3,000
China e/	66,500 r/	59,500 r/	64,500 r/	84,369 r/	113,000
Cuba	44,100 r/	46,000 r/	52,000 r/	56,300 r/	50,000 e/
Finland	588,856 r/	498,075 r/	597,438 r/	628,414 r/	575,126
Greece	12,020 8/	4,432 r/ 4/	2,273 r/ 4/	-- r/ 4/	-- 4/
India	1,363,049	1,311,310	1,472,766 r/	1,946,910 r/	1,677,924
Indonesia (sand, dry basis)	2,156	4,700 e/	6,355	1,000 r/	1,000 e/
Iran	168,984	211,555 r/	254,685 r/	153,000 r/	104,905
Kazakhstan	1,795,900 r/	1,602,700	2,405,600 r/	2,606,600 r/	2,045,800
Macedonia	5,000	5,000	5,000	5,000 e/	5,000 e/
Madagascar	139,700	104,300	-- r/	118,750 r/	51,900 e/
Oman	18,000	28,684	26,004 r/	15,216 r/	30,150
Pakistan	51,000 r/	77,500 r/	58,000 r/	119,490 r/	64,000 e/
Philippines	87,500	53,871	19,566	861 r/	1,932
Russia e/	151,000 r/	150,000 r/	115,100 r/	92,000 r/	69,926
South Africa	6,162,000	6,480,000	6,817,050	6,620,754	5,502,010
Sudan e/	30,500	30,500 r/	48,000 r/	28,500 r/	20,500
Turkey	1,702,633	1,404,470	770,352	545,725 r/	389,759
United Arab Emirates e/	61,000 7/	76,886 7/	60,000	30,000 r/	10,000
Vietnam	51,000	59,000 r/	58,500 r/	60,000 r/	60,000 e/
Zimbabwe	640,254 r/	635,528 r/	642,868 r/	652,133 r/	780,150
Total	13,600,000 r/	13,600,000 r/	14,100,000	14,500,000 r/	12,100,000

e/ Estimated. r/ Revised. -- Zero.

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

2/ Table includes data available through June 25, 2002.

3/ Figures for all countries represent marketable output unless otherwise noted.

4/ Gross weight estimated assuming an average grade of 44% Cr_2O_3.

5/ Direct shipping plus concentrate production.

6/ Average Cr_2O_3 content was as follows: 1997--39.3% (revised); 1998--47.6% (revised); 1999--49.3% (revised); 2000--46% (revised); and 2001--46%.

7/ Reported figure.

8/ Run-of-mine.

TABLE 14
FERROCHROMIUM: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons, gross weight)

Country	1997	1998	1999	2000	2001
Albania	31,144	30,252	28,120	9,900	19,500 e/
Brazil 3/	74,485	72,507	90,784	142,522 r/	105,000 e/
China e/	480,000	424,000	400,000	450,000	450,000
Croatia	24,231	11,771 r/	--	15,753	361
Finland	236,652	230,906	256,290	260,600	236,710
Germany	25,856	20,879	16,960	21,600 r/	19,308
India 4/	286,973	345,125	312,140 r/	376,693 r/	267,395
Iran	11,450	13,745	13,680	11,505 r/	8,430
Italy	11,295	11,487	-- r/	-- r/	-- e/
Japan 3/	186,432	142,931	119,777	130,074	111,167
Kazakhstan	600,000	535,000	731,563 r/	799,762 r/	761,900
Macedonia	460	--	--	--	-- e/
Norway	145,124	174,678	159,714	153,500 r/	82,600
Poland	6,200	4,200	-- r/	-- r/	-- e/
Romania	950	873	--	--	-- e/
Russia	247,000 e/	203,000	249,000	274,000	210,600
Slovakia	11,394	11,715	6,986	17,702 r/	5,968
Slovenia	9,232	10,621	560	-- r/	-- e/
South Africa 5/	1,939,500	2,025,300	2,155,202	2,574,000 r/	1,992,773
Spain	490	1,145	935	905 r/	-- e/
Sweden	101,842	123,958	113,140	135,841 r/	109,198
Turkey	108,320	110,175	99,105 r/	97,240 r/	50,735
United States 6/	60,700	W	W	W	W
Zimbabwe	233,386	246,782	244,379	246,324	249,841
Total	4,830,000	4,750,000	5,000,000 r/	5,720,000 r/	4,680,000

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

1/ World totals, U.S. data, 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 21, 2002.

3/ Includes high- and low-carbon ferrochromium.

4/ Includes ferrochrome and charge chrome.

5/ Includes high- and low-carbon ferrochromium and ferrochromium-silicon.

6/ Includes high- and low-carbon ferrochromium, ferrochromium-silicon, chromium metal, and other chromium materials.

TABLE 15
WORLD CHROMIUM ANNUAL PRODUCTION CAPACITY OF CHROMITE ORE, FERROCHROMIUM, CHROMIUM METAL, CHROMIUM CHEMICALS, AND STAINLESS STEEL IN 2001 1/

(Thousand metric tons, contained chromium)

Country	Ore	Ferro-chromium	Metal	Chemicals	Stainless steel
Afghanistan	2	--	--	--	--
Albania	48	22	--	--	--
Argentina	--	--	--	9	--
Australia	27	--	--	--	--
Austria	--	--	--	--	8
Bangladesh	--	--	--	--	3
Belgium	--	--	--	--	123
Brazil	135	78	--	--	65
Burma	1	--	--	--	--
Canada	--	--	--	--	39
China	48	272	6	87	64
Croatia	--	17	--	--	--
Cuba	17	--	--	--	7
Czech Republic	--	--	--	--	5
Egypt	--	--	--	--	3
Finland	189	139	--	--	109
France	--	--	7	--	204
Germany	--	17	1	--	272
Greece	4	--	--	--	--
India	586	196	(2/)	8	122
Indonesia	2	--	--	--	--
Iran	77	9	--	2	--
Italy	--	--	--	--	221
Japan	--	97	1	17	672
Kazakhstan	903	512	2	28	--
Korea, Republic of	--	--	--	--	269
Macedonia	2	--	--	5	--
Madagascar	42	--	--	--	--
Norway	--	106	--	--	--
Oman	9	--	--	--	--
Pakistan	36	--	--	3	--
Philippines	26	--	--	--	--
Poland	--	--	--	5	--
Romania	--	--	--	9	--
Russia	46	180	16	35	38
Slovakia	--	10	--	--	--
Slovenia	--	--	--	--	12
South Africa	2,060	1,470	--	23	92
Spain	--	--	--	--	204
Sudan	14	--	--	--	--
Sweden	--	86	--	--	138
Taiwan	--	--	--	--	231
Turkey	466	69	--	14	54
Ukraine	--	--	--	--	33
United Arab Emirates	23	--	--	--	--
United Kingdom	--	--	7	44	92
United States	--	20	3	58	374
Vietnam	16	--	--	--	--
Zimbabwe	214	221	--	--	--
Total	4,990	3,520	43	347	3,450

-- Zero.

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

2/ Less than 1/2 unit.