



# 2010 Minerals Yearbook

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## CHROMIUM

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In 2010, the U.S. chromium supply (measured in contained chromium) was 144,000 metric tons (t) from recycled stainless steel scrap, 499,000 t from imports, and 136,000 t from Government and industry stocks. Supply distribution was 274,000 t to exports, 122,000 t to Government and industry stocks, and 383,000 t to apparent consumption. Chromium apparent consumption increased by 140% compared with that of 2009.

## Legislation and Government Programs

The Defense Logistics Agency, DLA Strategic Materials (DLA) disposed of chromium materials under its fiscal year 2010 (October 1, 2009, through September 30, 2010) Annual Materials Plan (AMP) and announced the fiscal year 2011 plan. The DLA's fiscal year 2011 AMP set maximum disposal goals for chromium materials at 90,700 t of chromium ferroalloys and 454 t of chromium metal (Defense Logistics Agency, DLA Strategic Materials, 2011).

## Production

Industrial Minerals Corp. Ltd. (Australia) (IMC) continued construction on the Oregon Heavy Minerals Project (OHMP) to recover chromite from paleo-beach placer (heavy-mineral sand) deposits in Coos County, OR. IMC reported proved and probable ore reserves of 8.26 million metric tons (Mt) at an average grade of 7.41% chromic oxide ( $\text{Cr}_2\text{O}_3$ ). IMC planned to mine ore and reclaim dry tailings concurrently in the same pit. Run-of-mine ore would be stockpiled at the mine site before being transported about 30 kilometers to the mineral separation plant. Dry tailings would be returned for mine reclamation. At the mineral separation plant, ore sand would first pass through wet spirals that separate constituent minerals by density. The ore, which consists of the heavy minerals chromite, garnet, high-iron ilmenite, and zircon, would then be separated from gangue material via a dry process comprising electrostatic, magnetic, and density separators. IMC planned to start commercial production in 2011 under the name Oregon Resources Corp. Oregon Resources planned to produce 63,000 metric tons per year (t/yr) of foundry-grade chromite, which differs from traditional foundry-grade chromite sand because of its origin—beach sands (Drew and others, 2010, p. 29–39; Industrial Minerals Corp. Ltd., 2011, p. 12–24).

Elementis Chromium [a subsidiary of Elementis plc (United Kingdom)] produced sodium dichromate from chromite ore at Castle Haynes, NC.

The stainless steel industry is the leading consumer of chromium materials. AK Steel Corp., Allegheny Technologies Inc., and North American Steel Co. were the leading U.S. stainless steel producers in 2010. The U.S. stainless steel industry produced more than 2 million metric tons per year

(Mt/yr) of stainless steel and imports and exports stainless steel mill products and scrap, which account for a significant amount of chromium in U.S. trade.

## Consumption

Domestic data for chromium materials were developed by the U.S. Geological Survey (USGS) by means of the monthly “Chromite Ores and Chromium Products” and “Consolidated Consumers” consumer surveys. Stainless and heat-resisting steel producers are the leading chromium consumers, and high-carbon ferrochromium is the leading chromium-containing material consumed.

Roberts (2010, p. 40–48) observed that chromite sand has traditionally been commonly used as a facing sand on manganese steel castings or for large castings or thick sections; however, it is also used as a molding sand and in a wide range of ferrous and nonferrous castings.

The U.S. Department of Energy (2011, p. 30) reported that iron-chromium batteries may play an essential role in clean energy generation and distribution by storing energy generated in excess of immediate demand for later use.

## Technology

Chromite ore is a combination of chromite minerals and gangue minerals that are separated through the beneficiation process after mining. Chromite mineral is the chromium-rich component of a complex family of spinel group oxide minerals comprising aluminum, chromium, magnesium, and (or) iron in solid solution. The chromium-rich components are magnesium chromite ( $\text{MgCr}_2\text{O}_4$ ) and iron chromite ( $\text{FeCr}_2\text{O}_4$ ). Gangue minerals comprise one or more silicate minerals. Gangue minerals affect the performance of chromite products, because beneficiation does not completely separate them from chromite ore. Metamorphosis of ore can result in the  $\text{Cr}_2\text{O}_3$  reporting to the gangue minerals stream (tailings) during beneficiation (Greico, 2010).

Mineral beneficiation of chromite ore from South Africa and Zimbabwe is the exploitation of physical properties, such as density and chemical, magnetic, and surface characteristics, to produce concentrates. Current chromite ore beneficiation practice is to separate chromite ore from gangue minerals via dense media separation or gravity separation, which take advantage of the higher density of chromite minerals [4.3 to 4.5 grams per cubic centimeter ( $\text{g}/\text{cm}^3$ )] compared to that of silicates (the gangue minerals) (2.6 to 4.0  $\text{g}/\text{cm}^3$ ). New methods will be required to process lower grade or mineralogically more complex chromite ore deposits. Future beneficiation may incorporate preconcentration, sensor-based sorting, or higher density cut points of dense media separation (McKenzie, 2010).

Cookson (2010) compared ferrochromium process technologies, capital equipment costs, power requirements, reductant and ore consumption, and production costs for the ChromeRed, ChromeRed plus DCF SAF, direct current furnace (DCF), Outotec, and submerged arc furnace (SAF) processes for a greenfield ferrochromium plant to be constructed in 2 years, which would produce 252,000 metric tons per year (t/yr), and consume South African MG1 chromite ore comprised of 70% concentrate, 20% lumpy, and 10% chip. Such a plant would cost \$450 million to \$500 million to construct, consume 2,070 to 3,080 kilowatt-hours (kWh) of electricity per ton of ferrochromium, require 1.95 to 2.06 t of chromite ore per ton of ferrochromium, and cost 46.36 to 59.40 cents per pound of chromium produced. DCF SAF and ChromeRed had the lowest capital cost at \$454 million. ChromeRed had the lowest power consumption at 2,250 kilowatt-hours per metric ton and the lowest production cost at 46.36 cents per pound of contained chromium.

### Prices

Market forces and the U.S. dollar-South African rand exchange rate affected the price of ferrochromium (Davidson, 2010). Exchange rate change accounted for about 31% of the ferrochromium price increase in 2010 from that of 2009 (Pacific Exchange Rate Service, 2011).

### World Industry Structure

The geographic distribution of mineral production has changed during the past 150 years. Europe, along with the United States, accounted for nearly all of mineral production in the mid-19th century, but together now account for less than one-fifth of world mineral production. The world share of mineral production from the United States and Europe had been decreasing while the share from Australia, Canada, China, Commonwealth of Independent States (CIS), and a number of developing countries has been increasing. While minerals and metals are not being mined to extinction, mineral scarcity will likely become an issue in coming decades. The displacement of Western countries by developing countries as the leading mineral producers has major geopolitical implications, because Europe is dependent on foreign supplies to satisfy its industrial demand. It was of concern that scarce-minerals markets could be transformed from equal-access competitive bidding markets to markets where trade is conducted by long-term supply agreements between major corporations with heavy government involvement, resulting in a politicized mineral supply (Kooroshy and others, 2010, p. 42, 89–93).

**Chromite Ore.**—Dutta (2010) reported that India, like China, Germany, and the United States, classifies chromite ore as a strategic raw material. India has been restricting the export of chromite ore. The United States stockpiled chromite ore, which is currently being sold. China is investing in South Africa and Zimbabwe to gain access to ore supplies and is discouraging ferrochromium export via export duty. The European strategy emphasizes conservation and recycling. South Africa, the leading exporter of chromite ore, has threatened to restrict

chromite ore exports by imposing export duties to encourage domestic vertical integration.

The chromium industry relationship between China and South Africa was observed by Xstrata plc to be complementary for chromite ore and competitive for ferrochromium. The complementary nature of the chromite ore industry between China and South Africa resulted from the fact that China consumed much more chromite ore than it could produce, while South Africa produced much more chromite ore than it consumed. The competitive nature of the ferrochromium industry between China and South Africa resulted from the fact that both China and South Africa produced ferrochromium. China's ferrochromium industry is not a threat to that of South Africa because South Africa is a lower cost producer (Xstrata plc, 2010). China, as the leading consumer of chromium materials, and South Africa, as the leading producer of chromium materials, were expected to reach an accommodation through trade and investment.

**Chromium Chemicals.**—Major chromium chemical producers were China, Kazakhstan, Russia, South Africa, and the United States. Daijian (2010) reported that world annual production capacity of chromium chemicals was 1 Mt sodium dichromate equivalent. China had the leading capacity at 40% followed by Kazakhstan, 15%; the United States, 10%; Russia, 7%; South Africa, 6%; and India and Turkey, 5% each. China's chromium chemical production industry was down to 14 chromium chemical producers in 12 Provinces from more than 70 producers historically. China planned to consolidate production further to about 4 plants producing 50,000 to 100,000 t/yr during the next 5 years, improve environmental quality, and prohibit any new chromium chemical enterprises. China produced about 35,000 t-sodium dichromate equivalent in 2010. Daijian anticipated that chromium chemical consumption in China would reach 500,000 t/yr by 2020.

**Stainless Steel.**—International Stainless Steel Forum (2011) reported 31.1 Mt of world stainless steel production in 2010, a 27% increase compared with that of 2009. A review of stainless steel life cycle in 51 countries from 2000 through 2005 found the amount of stainless steel in use had increased by 30%. During the same time period, China accounted for almost one-half of world stainless steel production growth; global stainless steel recycling rate increased from 66% to 70%; the amount of stainless steel landfilled was unchanged; and the amount of stainless steel lost to other steel alloys increased from 9% to 12%. China was estimated to begin major discard flows in 2015 (Reck and others, 2010).

**Ferrochromium.**—Grigorieva (2010) reported that the volume of international ferrochromium trade decreased from 2008 to 2009 while China lost and the CIS gained market share. World stainless steel production declined; however, not as much as crude steel production. In 2009, the CIS produced about 1.4 Mt of ferrochromium and consumed about 200,000 t, leaving the balance for export. CIS ferrochromium producers had conveniently located, large, integrated plants producing quality products with low production costs. The CIS ferrochromium industry included SC Feral SRL (Tulcea, Romania); Chelyabinsk Electrometallurgical Integrated

Plant (Chelyabinsk, Russia), which consumed chromite ore from CML (Australia) and JSC Kongor-Khrome (near Salekhard, Yamalo-Nenets Autonomous Region, Russia) (RFA International, LP, 2008); and Eurasian Natural Resources Corp. (ENRC) (United Kingdom), which produced ferrochromium in Kazakhstan at Aktobe Ferroalloy Plant, Aksu Ferroalloy Plant, and Serov Ferroalloy Plant, and chromite ore at Donskoy Ore Mining and Processing Plant.

Hobbs (2010) found that ferrochromium and stainless steel output fully recovered in 2010 from the global 2008–09 recession, and that the grade mix of stainless steel produced had shifted to 56% chromium-nickel, 28% chromium, and 16% chromium-manganese in 2010 from 72% chromium-nickel, 23% chromium, 5% chromium-manganese in 2001. In other words, chromium-nickel stainless steel lost market share mainly to chromium-manganese stainless steel. Chinese ferrochromium consumption drove the 2010 chromium market recovery and China was expected to be the leading consumer along with India in the foreseeable future.

## World Review

**European Union.**—The European Union (EU) produced chromite ore, chromium metal and ferroalloys, and stainless steel. The EU was the third leading stainless steel producing area after China and Asia (excluding China). The leading stainless steel producers in the EU were Acerinox, S.A., Aperam S.A. (a wholly owned subsidiary of ArcelorMittal), ThyssenKrupp AG, and Outokumpu Oyj.

Stainless steel production has shifted from Europe to Asia, where the world's leading three producers, Tangshan Iron and Steel Co. (Taigang), Pohang Iron and Steel Co. Ltd. (POSCO), and Yieh United Steel Corp. (Yusco) were located. In addition, 13 of the top 20 stainless long products manufacturers were Asian. Chinese companies announced their expansion plans, and Chinese officials said that they were building now for demand in 5 to 10 years. By contrast, stainless producers in Europe and Japan operated at low capacity utilization and low profitability because demand was low. For China's competitors, the biggest concerns were that its lower cost and increasingly high-quality products will take over their export markets (Metal Bulletin Weekly, 2010b, p. 27).

The European Commission (EC) identified 14 of 41 raw materials and metals (relative to other materials and metals) as critical to the EU based on the geopolitical framework in which they are produced and consumed. The EC based criticality on importance to the EU economy and supply risk. Supply risk was based on environmental risk, concentration of production, recycling, and substitution. The EC was concerned that there would be inadequate supply to meet emerging-technology demand. Chromium was determined to be of highest economic importance, low supply risk, and low environmental country risk. The emerging technologies affecting demand for chromium were identified as seawater desalination and marine technologies. In addition to increasing demand resulting from the emerging technologies identified above, raw material and metal demand was expected to increase as the world economy grows. The EC recommended periodic critical raw material assessments; improvement of raw materials statistical

information; EU policies that improved access to primary raw materials resources including land access, trade, and investment; encourage recycling; substitution; and efficient use (European Commission, 2010a, p. 37–43; b, p. 5, 6, 12–14, 19, 23, 34–39, 43, 47).

The European Chemicals Agency proposed four chromium compounds—ammonium dichromate, potassium chromate and dichromate, and sodium chromate—for public consultation as 'substances of very high concern' as part of its Registration, Evaluation, Authorization and Restriction of Chemical Substances legislation. Sodium chromate was used in the production of other chromium compounds, potassium chromate was used in metals coating, ammonium dichromate was used in the treatment of metals, and potassium dichromate was used in the manufacture of chromium metal. The chromium compounds were proposed for consultation by the Danish, French, and German governments (Metal Bulletin Daily, 2010c, p. 3).

**Albania.**—ACR Albanian Chrome [a subsidiary of DCM DECOMetal GmbH (Austria)] produced ferrochromium for export at its Elbasan smelter using chromite ore from Bulqiza Mine. ACR planned to upgrade the Bulqiza Mine and Elbasan smelter and renovate the ferrochromium smelter at Burrel. ACR would increase its ferrochromium production capacity to 72,000 t/yr from the current 36,000 t/yr with the addition of a third furnace at Burrel (Metal Bulletin Daily, 2010b; SBB Daily Briefing, 2010).

**Australia.**—The Government of Western Australia reported chromite ore sales by calendar year in contained  $\text{Cr}_2\text{O}_3$ : 2010, 73,618 t- $\text{Cr}_2\text{O}_3$ ; 2009, 72,813 t- $\text{Cr}_2\text{O}_3$  (Government of Western Australia, 2011, p. 20).

Weld Range Metals Ltd. started a study to determine the feasibility of exploiting 63.5 Mt of inferred mineral resource containing 4% chromium, 38.1% iron, and 0.38% nickel in Western Australia. Weld Range planned to mine 600,000 t/yr of ore to produce 310,000 t/yr of refined iron-chromium-nickel alloy starting in 2015 subject to affirmative feasibility and completion of capital raising (Weld Range Metals Ltd., 2010).

**Brazil.**—Brazil produced chromite ore, ferrochromium, and stainless steel. Brazil reported 2009 chromite ore production of 365,210 t (140,786 t  $\text{Cr}_2\text{O}_3$ -content), exports of 75,334 t, and imports of 11,953 t. Brazil produced from chromite ore reserves of 3.824 Mt  $\text{Cr}_2\text{O}_3$ -content, mostly in Bahia State. In 2009, Brazil produced 131,048 t of chromium ferroalloys, exported 5,063 t, and imported 6,030 t (Ramos, 2010).

**Canada.**—Cliffs Natural Resources Inc. (United States) (2011, p. 3, 5) reported that its chromite ore resources in Ontario were in the prefeasibility stage of development. Having completed the acquisition of Freewest Resources Canada Inc. and Spider Resources, Inc. Cliffs owned 100% of the Black Thor and Black Label properties and 74% of the Big Daddy property in 2010. Cliffs planned to produce from 1 to 2 Mt/yr of chromite ore out of which it would produce from 400,000 to 800,000 t/yr of ferrochromium.

**China.**—China produced chromite ore, chromium chemicals and metal, ferrochromium, and stainless steel. In 2010, China was the leading producer of stainless steel, which made it the leading market for ferrochromium. China also produced a small amount of chromite ore and a moderate amount of

ferrochromium, mostly from imported chromite ore. China imported 6.76 Mt of chromite ore and 2.2 Mt of ferrochromium. China's chromium apparent consumption was 3.2 Mt (about 15% of world production). The Stainless Steel Council of China Special Steel Enterprise Association reported stainless steel production of 11.26 Mt in 2010, and the stainless branch of the China Metal Trade Association reported 14 Mt (Metal Bulletin Daily, 2011).

At yearend 2008 (the latest year for which data were available), China had chromite ore reserves of 1.98 Mt distributed among Gansu, Inner Mongolia, Tibet, and Xinjiang. China's annual chromite ore production has been between 220,000 t and 250,000 t. From 2002 through 2009, world chromium ore imports increased to 9.89 Mt, a growth rate of 220%, while China's imports increased to 6.76 Mt, a growth rate of 493%. In 2009, China accounted for 68% of global chromite ore trade. Since 2006, Oman, South Africa, and Turkey have increased their share of the Chinese market, and India and the rest of the world share has decreased. In 2009, China produced 1.81 Mt of ferrochromium from 70 plants whose total capacity was 3.2 Mt. Production was 600,000 t from Sichuan, 370,000 t from Shanxi, and 370,000 t from Inner Mongolia. From 2006 through 2009, China ferrochromium production has grown at an average annual rate of 26.6%. China imported 2.16 Mt of high-carbon ferrochromium in 2009 reaching a growth rate of 191% since 2006 (Hailiang, 2010).

Eurasian Natural Resources Corp. PLC (ENRC) (United Kingdom) reported production of 28,000 t of ferrochromium at its Tuoli plant in 2010 (Eurasian Natural Resources Corp. PLC, 2011, p. 22, 46).

Chinese mining companies have been securing raw material resources outside China. China Minmetals, Sinosteel, and Jiuquan Iron and Steel, which are entirely parastatal companies, have made joint-venture agreements with South African companies to produce chromium raw materials needed by China's steel industry. Some industry analysts expressed concern that China's expansion into raw material resource production could, in the long term, undermine the free market system that has provided raw materials, and lead to uncertain access to strategic minerals through the politicization of the mining industry in mineral-producing countries. Limited supply of critical raw material resources could cause increased chances for conflict (Burgess, 2010; Campbell, 2010; Pariser, 2010, p. 3).

Bielski (2010) anticipated that China's steel compound growth rate would be 7.9% after 2010 from 17.1% during the 2000–10 time period (stainless steel, 8.3% after 2010 from 35.8%). Increased urbanization in China was expected to lead to stainless steel production in 2020 of 25 Mt resulting in domestically produced raw material supply becoming exceptionally tight, and security of supply becoming an issue. Raw material growth in developed markets was constrained by limited exploration during the past 20 to 30 years, environmental costs, power and infrastructure limitations, skilled labor shortages, and rising fiscal and trade duties and taxes. China needed to accelerate its raw materials supply capacity investments, increase scrap supply, and find materials substitutes.

Based on gross domestic product, China's economy increased fourfold since 1998. In 2010, China displaced Japan as the second leading economy. Since 1992, China has become the world's leading national consumer of many raw materials and must make up the gap between domestic production and consumption through imports, making China increasingly import dependent and at risk of potential severe raw materials shortage that could interrupt its economic development. While most national economies experienced negative metal consumption growth in 2009 resulting from the recession that followed the banking crisis of 2008, China's economy reached record import levels for selected metal commodities and showed double digit year-on-year consumption growth. While China has increased domestic steel consumption, mostly for its domestic construction industry, it did so based on only 20% domestically produced iron ore. As China's raw materials import dependence has increased, so has its overseas foreign direct investment, a large portion of which is in the resource sector. From 2008 to 2009, China moved from 13th to 6th ranked by foreign direct investment outward flows, and China holds the world's largest national currency reserves, with which it can invest. Wath (2010) expected Australia and Africa to receive greater investment attention from China.

Wenzhang (2010) anticipated China's crude steel production would increase until about 2012–13, at which time China's per capita income would reach about \$5,000 per person. Historically, it has been at this point that crude steel production peaked in the economies of France, Germany, Japan, and the United States. In 2012, China's crude steel production would be 680 Mt; consumption would be 650 Mt.

The leading stainless steel producers in China were Baoshan Iron and Steel (Group) Corp. (Baosteel) [Baogang Group], Lianzhong Stainless Steel Corp., Shanghai Krupp Stainless Co., Ltd., Tangshan Iron and Steel Co. (Taigang) (Hebei Iron and Steel Group Co.), and Zhangjiang Pohang Stainless Steel Co., Ltd. China's stainless steel melting capacity could reach 23 Mt/yr by 2015 at which time consumption was expected to be 14 Mt/yr necessitating China's finding export markets for the excess production so that it could keep its stainless mills running at a reasonable rate (Metal Bulletin Weekly, 2010a, p. 25–26).

Shiguo (2010) reported that China planned to renovate its ferroalloy industry. In 2009, with 20% of world population, China accounted for 44% of iron and steel production and more than 60% of world ferroalloy production. As China's per capita income moved from \$1,000 to about \$4,000 in 2009, ferroalloy demand increased. It is China's goal to consolidate ferroalloy production into higher efficiency, less polluting, rationally located ferroalloy plants. The current goal is computer controlled, semiclosed furnaces with electrical capacity of 25,000 kilovolt-ampere or greater that consume less energy and raw materials per unit of production.

**Finland.**—Finland produced chromite ore (Kemi Mine), ferrochromium (Tornio Works), and stainless steel (Tornio Works). Outokumpu produced 0.598 Mt of marketable chromite ore from 1.3 Mt of run-of-mine ore and 0.238 Mt of ferrochromium compared with 0.247 Mt of chromite ore from 0.9 Mt of run-of-mine ore and 0.123 Mt of ferrochromium in 2009. The company reported proven reserves of chromite ore at

36 Mt graded at 26% Cr<sub>2</sub>O<sub>3</sub>, and indicated resources of chromite ore at 13 Mt graded at 30% Cr<sub>2</sub>O<sub>3</sub>, and inferred resources of chromite ore at 74 Mt graded at 29% Cr<sub>2</sub>O<sub>3</sub> (Outokumpu Oyj, 2011, p. 37).

Best available technology applied to ferrochromium and stainless steel integrated plant production improved profitability, reduced CO<sub>2</sub> emissions, and provided clean and safe working conditions at Outokumpu's Tornio works. The use of preheated pellets reduced power consumption for ferrochromium production to 3,470 kWh per ton of ferrochromium produced (Kauppi, 2010).

**Germany.**—Elektrowerke Weisweiler GmbH [owned by Ruukki Group (Finland)] produced 17,994 t of ferrochromium in 2010 compared with 14,074 t in 2009 from a production capacity of 30,000 t/yr (Ruukki Group plc, 2011, p. 5, 12).

German industry relies on imported raw materials supply, which emerging technologies will convert into high-tech, cutting edge products. Chromium was among 15 vulnerable raw materials for German manufacturing industry. Thirty-two emerging technologies were analyzed for their impact on these vulnerable materials. German economic development depends on secure supply of stably priced raw materials (Angerer and others, 2009, p. 1, 2, 9–13).

**India.**—India produced chromite ore, chromium chemicals, ferrochromium, and stainless steel. India exported lumpy and friable chromite ore and chromite ore concentrates. India reported that 22 mines collectively produced 3.98 Mt of chromite ore in fiscal year 2008–09 (April 1, 2008, through March 31, 2009) compared with 4.87 Mt from 20 mines in fiscal year 2007–08, from chromite ore reserves of 53.9 Mt as of January 4, 2010. India reported chromite ore exports of 1.90 Mt in fiscal year 2008–09, compared with 0.907 Mt in fiscal year 2007–08 (Indian Bureau of Mines, 2010a, c). From an installed production capacity of 1.30 Mt/yr, India produced 0.817 Mt of ferrochromium in fiscal year 2008–09 compared with 0.949 Mt in fiscal year 2007–08. India exported 492 Mt of ferrochromium in fiscal year 2008–09 compared with 483 Mt in fiscal year 2007–08 (Indian Bureau of Mines, 2010b). The Geological Survey of India described many chromite ore deposits that it had explored (Geological Survey of India, 2010).

The leading Indian chromite ore and (or) ferrochromium producers were Balasore Alloys Ltd., Ferro Alloys and Minerals Division of Tata Steel Ltd., Ferro Alloys Corp., IDCOL Ferrochrome and Alloys Ltd., IMFA Group, JSL Ltd., Orissa Mining Corp. Ltd., Pradhan Industries Public, Rohit Ferro-Tech Ltd., and VISA Steel Ltd.

**Kazakhstan.**—In 2009, Donskoy produced 3.333 Mt of chromite ore from 225.8 Mt of reserves and operated two 700,000-t/yr beneficiation and pelletizing plants; the Aktobe ferrochromium plant produced 300,000 t of high-carbon ferrochromium, 26,000 t of medium-carbon ferrochromium, and 17,000 t of low-carbon ferrochromium; and the Aksu ferrochromium plant produced 686,000 t of high-carbon ferrochromium, and 52,000 t of ferrochromiumsilicon (Vulis, 2010).

ENRC produced chromite ore at Donskoy Mining Complex from production capacity of 3.5 Mt/yr. ENRC reported salable chromite ore production of 3.574 Mt in 2010 compared with

3.398 Mt in 2009 (of which Serov accounted for 65,000 t) and 3.629 Mt in 2008 (of which Serov accounted for 77,000 t). ENRC produced ferrochromium at Aksu, Aktobe, Serov Ferroalloy Plant JSC (Russia), and Tuoli (China) plants. ENRC reported ferrochromium production of 1.44 Mt in 2010, compared with 1.161 Mt in 2009 and 1.196 Mt in 2008, typically with 69% chromium content, of which in 2009, 105,000 t at Serov Ferroalloy Plant JSC (Russia) and 28,000 t at Tuoli (China). At Aktobe, where ENRC operated a gas-fired electrical powerplant, ENRC started construction of four new direct current furnaces with collective ferrochromium production capacity of 440,000 t/yr at an estimated cost of \$750 million. The new production capacity was to replace a portion of the old production capacity, which was to be retired. For Donskoy GOK, ENRC reported Joint Ore Reserves Committee (JORC) compliant chromite ore reserves of 225.8 Mt at 41.5% Cr<sub>2</sub>O<sub>3</sub> and resources of 322.2 Mt at 49.2% Cr<sub>2</sub>O<sub>3</sub> as of December 31, 2009 (Eurasian Natural Resources Corp. PLC, 2010, p. 21–22, 115–119; 2011, p. 22, 46).

Mechel OAO (Russia) owned Oriel Resources (United Kingdom), which produced chromite ore at Voskhod Mine. Mechel reported JORC and NI 43–101 compliant proven (0.9 Mt) plus probable (17.4 Mt) chromite ore reserves at an average grade of 42.2% Cr<sub>2</sub>O<sub>3</sub> as of December 2010 (Mechel OAO, 2010, p. 110).

**Nigeria.**—Chromite ore from the Anka area, Zamfara State, of Nigeria was characterized and beneficiated using magnetic separation. Beneficiated chromite ore was found to contain 48% Cr<sub>2</sub>O<sub>3</sub> with chromium-to-iron ration of 6.2:1. Abubakre and others (2007) found that the chromite ore was successfully upgraded to meet specifications for metallurgical use by conventional ore dressing methods. Rhodium Ltd., an indigenous prospecting and development company, investigated the Dambagudu Chromite Deposit, which is near Talata-Mafara, Zamfara State (Rhodium Ltd., undated).

**Oman.**—Al Tamman Trading Establishment LLC (a wholly owned subsidiary of Muscat Overseas Group) operated two chromite mines—Al Ram Chromite and Wadi Rajmi Chromite projects. Al Ram produced about 12,000 metric tons per month (t/mo) at an average grade of 38% Cr<sub>2</sub>O<sub>3</sub> and Wadi Rajmi produced 5,000 t/mo, 32% Cr<sub>2</sub>O<sub>3</sub> (Al Tamman Trading Establishment LLC, 2010). Muscat Overseas Group formed a joint-venture agreement with Indsil Group (Indsil Energy & Electrochemicals Ltd. and Indsil Hydro Power & Manganese Ltd.) to build a plant in Oman with ferrochromium production capacity of 75,000 t/yr (Indsil Group, 2010). Hatton FZE reported chromite ore production of about 480,000 t/yr from the Somail region (Hatton FZE, undated). Northern Minerals Co. LLC reported chromite ore production in the Batinah and Dakhiliya Regions (Northern Minerals Co. LLC, undated).

**Russia.**—Russia produced chromite ore, chromium chemicals and metal, ferrochromium, and stainless steel. ENRC produced chromite ore at Saranovskaya Mine 'Rudnaya' JSC and ferrochromium at Serov Ferroalloy Plant JSC. ENRC reported Saranovskaya chromite ore production of 65,000 t in 2009 compared with 77,000 t in 2008 and Serov ferrochromium production of 105,000 t in 2009 (Eurasian Natural Resources Corp. PLC, 2010, p. 21).

Mechel acquired the Tikhvin Ferroalloy Smelting Plant Closed Joint-Stock Co. through the acquisition of Oriol Resources plc (United Kingdom) in 2008. Mechel produced 455,800 t of ferrochromium in 2010 compared with 400,700 t in 2009 at 4 plants—Chelyabinsk Electro-Metallurgical Plant OAO (211,600 t compared with 207,700 t), Chelyabinsk region; Serov Ferroalloys Plant OAO (167,500 t compared with 92,700 t), Sverdlovsk region; Tikhvin Ferroalloy Plant ZAO (72,100 t compared with 95,200 t), Leningrad region; and Klyuchevsk Ferroalloys Plant OAO (4,600 t compared with 5,100 t), Sverdlovsk region (Mechel OAO, 2010, p. 52, 108; 2011, p. 111).

**South Africa.**—South Africa was a leading chromite ore and ferrochromium producing country and produced chromium chemicals and stainless steel. Among issues confronting the South African chromium industry were electrical power generation and logistics. Leading producers of chromite ore and (or) ferrochromium in South Africa were African Rainbow Minerals Ltd., ASA Metals (Pty.) Ltd., Assore Ltd., Chromex Mining plc, Hernic Ferrochrome (Pty.) Ltd., International Ferro Metals Ltd., Lanxess (Pty.) Ltd., Merafe Resources Ltd., Samancor Chrome Ltd., Tata Steel Ltd., and Xstrata plc.

South Africa's Council for Mineral Technology (Mintek) conducted Government- and commercial-sponsored research and development on chromite ore and ferrochromium. Mintek developed mine-specific processes for chromite ore beneficiation, developed platinum recovery process applied to chromite ore tailings, developed furnace controller technology for ferrochromium-producing furnaces, and developed stainless steel dust recycling technology. Mintek reported a furnace-control and optimization system for an 80 megavoltampere furnace at Kazchrome's Aksu ferroalloy plant in Kazakhstan (Mintek, 2010).

Platinum-group minerals (PGM) are found in the Merensky and UG2 reefs; however, the UG2 reef contains substantially more chromite. After the extraction of PGM, chromite is left in the tailings. PGM mining of the UG2 reef has increased, because mining is less costly and better technologies are available to treat the chromite-rich ore. Increased demand for chromite for export and as a low-cost chromite to supplement mined chromite for smelting, now that pelletizing and sintering technologies for chromite fines are common, have made these tailings useable. Machingawuta (2010) reported that acceptance of ferrochromium containing less than 50% chromium also contributes to UG2 tailings processing, because those tailings produce ferrochromium containing 49.5% chromium. Aiken (2010) reported that UG2 chromite contains 10% to 25% Cr<sub>2</sub>O<sub>3</sub>, which can be beneficiated to 40% to 42% Cr<sub>2</sub>O<sub>3</sub> after extraction of PGM. UG2 platinum reserves are about 1.3 billion metric tons held by Anglo American Platinum (51%), Impala Platinum (25%), Lonmin Platinum (20%), and Aquarius Platinum Ltd. (4%). Aiken estimated chromite ore production from UG2 tailings to be 3 Mt/yr with 1.4 Mt in the building phase, and an additional 1.3 Mt possible in 2012–13. Aquarius Platinum, GB Mining, and Sylvania South Africa operated a chromite tailings retreatment plant (CTRP) adjacent to Aquarius' Kroondal (platinum) Mine where chromite mine tailings were treated to recover platinum. Aquarius restarted production at its Everest

(platinum) Mine where it processed UG2 tailings in its Spiral Retreatment Plant (SRP). SRP chromite production capacity was 200,000 t/yr at a grade of 40% Cr<sub>2</sub>O<sub>3</sub> (Aquarius Platinum Ltd., 2010, p. 10, 25, 82). Lonmin Platinum planned chromite recovery from UG2 platinum tailings in a joint venture with Xstrata-Merafe and ChromTech (Metal Bulletin Daily, 2010d, p. 3).

As result of the commodity boom that started circa 2004, AMCOL found the supply of wet bulk chromite it used to make foundry sand difficult to maintain, so it acquired controlling interest in Batlhako Mining Ltd. (Ruighoek Mine) in 2009 and acquired the remaining interest in 2010. AMCOL found that by carefully milling run-of-mine LG6 chromite ore followed by dry separation and classification, it could get 70% yield of a low silicate product with size range of 25 to 70 American Foundry Society (AFS) while reducing power and water use (Castanga and Howden, 2010). AMCOL International Corp. (United States) had purchased 53% interest in the Ruighoek Chrome Project from Pacific Niugini Ltd. [formerly Chrome Corp. Ltd. (Australia)] in 2009. AMCOL purchased the remaining 47% in 2010. AMCOL reported that production of ferrous castings for automobile and industrial equipment in China and the United States, AMCOL's two largest markets, rebounded in 2010. In 2010, AMCOL started up a new chromite ore processing plant to produce foundry sand (AMCOL International Corp., 2011, p. 4; Pacific Niugini Ltd., undated). AMCOL reported that basic to neutral pH, broad sieve distribution, high melting point, high thermal conductivity, low thermal expansion, and wettability resistance to molten steel were among the unique combination of chromite sand properties that produce a better surface finish and reduced the likelihood of casting defects (AMCOL, undated).

Marico Chrome Corp., a 50–50 joint venture between Vereenging Refractories and Samancor Chrome SA, produced refractory and metallurgical chromite ore from the Marico chromite deposit of the Bushveld Complex at the rate of 40,000 t/yr from a run-of-mine reserve of 9 Mt, where Marico has been producing metallurgical- and refractory-grade chromite ore since 1956 from the LG6, MG, and UG2 layers. Refractory-grade ore contained up to 49% Cr<sub>2</sub>O<sub>3</sub>, less than 1% silicon dioxide, and a chromium-to-iron ratio of 2:1. Refractory characteristics of chromite were identified as high melting temperature, moderate thermal expansion, neutral chemical behavior, and high corrosion resistance (McEwan, 2010; McEwan and others, 2011).

Ruukki Group entered the chromium industry through acquisition of chromite ore mining resources and ferrochromium production facilities in South Africa [Mogale Alloys (Pty.) Ltd., a South African producer of ferrochromium and other ferroalloys] and Zimbabwe after Kermas Group became its largest shareholder in 2008. Kermas Group, as of February 2006, operated as a subsidiary of Kluchevsky Ferroalloy Plant OAO and was based in the United Kingdom, manufactured ferrochromium and chromium chemicals in Russia, ferrochromium in Germany, and chromite ore in Turkey (Bloomberg Businessweek, undated). Ruukki acquired Chromex Mining plc (United Kingdom), which produced chromite ore from the Stellite Mine and was developing the Mecklenburg

Mine in South Africa and held interest in Waylox Mining (Pvt) Ltd. in Zimbabwe (Ruukki Group plc, 2011, p. 4–5, 9–10). Ruukki planned to add two DC arc furnaces at Mogale Alloys that would double ferrochromium production capacity to 280,000 t/yr (Metal Bulletin Weekly, 2010c, p. 7).

Tharisa Minerals (Pty.) Ltd. reported reserves of about 74 Mt of chromite ore and planned to produce at a rate of 5.5 Mt/yr from an open pit that would yield 1.6 Mt/yr of chromite ore concentrate. Tharisa reported that it would double chromite ore concentrate production to 0.42 Mt (Clark, 2008; 2009).

**Sweden.**—Sweden produced ferrochromium and stainless steel. Vargön Alloys AB, a Yildirim Group (Turkey) company, produced ferrochromium from a ferrochromium production capacity of about 220,000 t/yr. Vargön suspended ferrochromium deliveries after heavy snowfall caused roof collapses at its production and warehouse facilities (Metal Bulletin Daily, 2010d, p. 1).

**Turkey.**—Turkey produced chromite ore, chromium chemicals, and ferrochromium. Eti Krom Inc., a Yildirim Group company, produced chromite ore and high-carbon ferrochromium. Eti Krom's ferrochromium production capacity was 50,000 t/yr. Eti Krom planned to complete renovation of two furnaces that would add 100,000 t/yr to its production capacity (Eti Krom Inc., 2010). Harsh winter conditions and heavy snowfall in Turkey interrupted train service between Elazig, the location of Eti Krom's smelter and near to its chromite ore mines, and the ports of Iskenderun and Mersin, causing Eti Krom to declare force majeure.

Eti Elektrometalurji A.S. produced chromite ore and high- and low-carbon ferrochromium near Antalya from a production capacity of 13,000 t/yr low-carbon ferrochromium and 10,000 t/yr high-carbon ferrochromium (Eti Elektrometalurji A.Ş., undated). Türk Maadin Sirketi A.Ş. (TMS) [a subsidiary of Ruukki Group plc (Finland)] acquired Intermetal Madencilik ve Ticaret A.Ş. TMS produced 54,917 t of chromite in 2010 compared with 25,774 t in 2009 (Ruukki Group plc, 2011, p. 12, 46).

Çevikler Mermer San. ve Tic. Ltd. Şti., Dedeman Madencilik Sanayi ve Ticaret AS, and Eti Krom Inc. were the leading chromite ore producers with Eti Krom producing about 1 Mt/yr and the other two producing about 0.3 Mt/yr each (Metal-Pages, 2008). Çevikler Group reported that it mined chromite ore via its subsidiary Çevikler Mermer San. ve Tic. Ltd. Şti., which it exported with chromite ore from other producers. Çevikler mined chromite ore in the Pınarbasi District of Kayseri Province (Çevikler Group, undated). Eti Krom reported that it operated 79 mines, mostly in Elazig Province but also in Adana, Diyarbakir, Hatay, Kayseri, Malatya, and Mugla Provinces from proven plus probable reserves of 250 Mt (Eti Krom Inc., undated).

**Zimbabwe.**—Zimbabwe's ferrochromium industry comprised Maranatha Ferrochrome (Private) Ltd., Olikan Ferro Alloys (Private) Ltd., Zimasco (Private) Ltd., and Zimbabwe Alloys. Chromite ore for these smelters was supplied by Caesar, Darwendale, Inyala, Lalapanzi, Mapanzure, Ngezi, Fhonda-Mumo, Southridge, Sutton, United, and Vanad Mines, and Inyala and Sutton heavy-media separation plants. Chromite ore graded between 40% and 55% Cr<sub>2</sub>O<sub>3</sub> with chromium-to-iron ratio of 2.0 to more than 3.3. Zimasco produced high-carbon

ferrochromium from a capacity of 220,000 t/yr; Zimbabwe Alloys, 146,000 t/yr of high-carbon ferrochromium, 29,200 t/yr of ferrochromium-silicon, and 40,200 t/yr of low-carbon ferrochromium; and other producers, 55,000 t/yr of high-carbon ferrochromium, yielding a collective 490,000 t/yr of chromium ferroalloys. Planned expansions were expected to bring chromium ferroalloy production capacity to 588,000 t/yr in Zimbabwe.

Zimasco (Private) Ltd., a vertically integrated ferrochromium producer co-owned by Sinosteel (China), China-Africa Development Fund (China), and ZCE Finance (SFV) (Mauritius), produced at Kwekwe from a high-carbon ferrochromium production capacity of 180,000 t/yr from six furnaces, one of which was not operational. Zimasco was supplied with chromite ore from its mines and other mines along the Great Dyke of Zimbabwe. Zimasco planned to increase its ferrochromium production capacity (Metal-Pages, 2010).

Maranatha Ferrochrome (Private) Ltd. produced high-carbon ferrochromium at Eiffel Flats near Kadoma in Mashonaland West Province. RioZim Ltd. (a subsidiary of Rio Tinto) planned a joint venture with Maranatha to produce 30,000 t/yr of ferrochromium based on chromite holdings in the Darwendale area (Njini, 2010). RioZim Ltd. (2011, p. 12) explored for JORC compliant resources and planned to set up a chromite ore concentration operation.

## Outlook

After the 2008 financial crisis that put the chromium industry into recession in 2009, 2010 was a year of recovery. World chromite ore, ferrochromium, and stainless steel production decreased from 2008 to 2009; and then increased from 2009 to 2010 with 2010 production of ferrochromium and stainless steel exceeding that of 2008, leading to the expectation that chromite ore production would continue to increase.

Agnello (2010) reported that foundry-grade chromite, which accounted for 3% of global chromite ore consumption, was used as core and molding sands, initially used in manganese steel casting, and has moved to the manufacture of alloy and carbon steel castings and nonferrous metal castings. Since 1970, about 70% of foundry capacity in developed countries closed, resulting in a shift of casting to Southeast Asia and developing countries. Refractory-grade chromite is used more in shaped-refractory (80%) than in monolithic products. Magnesite-chromite refractories are preferred in nonferrous metallurgy (such as copper, lead, and zinc refining); however, the cement, lime, and glass industries have moved away from using magnesite-chromite bricks because of environmental considerations associated with the disposal of used refractories. About 850,000 t of sodium dichromate was produced in 2008 from about 1.25 to 1.3 Mt of chromite ore. The sodium dichromate was converted to chromium oxide (34%), chromic acid (29%), chromium sulfate (23%), and other chemicals (14%). Agnello forecast of chromium sulfate production, which is used in leather manufacturing, to increase between 1% and 1.5%; chromic acid, which is used in metal finishing and to preserve wood, to increase between 3% and 3.5%, and chromium oxides, which are used in alloy, ceramic, and pigment manufacture, to increase between 2% and 3%.



Historically, three events outside of the chromium industry (the dissolution of the Soviet Union, the economic growth of China, and the world financial crisis in 2008–09) have had significant impacts on the chromium industry, making industry analysts and company planners sensitive to the potential for such events.

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TABLE 1  
SALIENT CHROMIUM STATISTICS<sup>1</sup>

		2006	2007	2008	2009	2010
World, production, contained chromium:						
Chromite ore (mine) <sup>2</sup>	metric tons	6,080,000	7,030,000 <sup>r</sup>	7,390,000 <sup>r</sup>	6,000,000 <sup>r</sup>	7,290,000
Ferrochromium (smelter) <sup>3</sup>	do.	4,180,000 <sup>r</sup>	4,790,000 <sup>r</sup>	4,590,000	4,000,000 <sup>r</sup>	4,960,000
Stainless steel <sup>4</sup>	do.	4,820,000	4,730,000	4,410,000	4,180,000	5,300,000
U.S. supply:						
Components of U.S. supply, contained chromium:						
Domestic mines	do.	--	--	--	--	--
Secondary <sup>5</sup>	do.	179,000	162,000	146,000	141,000	144,000
Imports:						
Chromite ore <sup>2</sup>	do.	53,800	46,400	64,300	23,000	43,900
Chromium chemicals	do.	12,100	10,600	18,000	10,600	5,120
Chromium ferroalloys	do.	265,000	259,000	307,000	140,000	305,000
Chromium metal	do.	10,900	11,700	13,100	7,570	13,000
Stainless steel mill products and scrap	do.	179,000	158,000	157,000	91,800	133,000
Stocks, January 1:						
Government	do.	375,000	253,000 <sup>6</sup>	115,000	155,000 <sup>7</sup>	129,000
Industry <sup>8</sup>	do.	8,520	9,620	9,940	7,290	6,820
Total	do.	1,080,000	910,000	831,000	576,000	779,000
Distribution of U.S. supply, contained chromium:						
Exports:						
Chromite ore <sup>2</sup>	do.	17,400	12,000	2,280	743	1,390
Chromium chemicals	do.	16,700	21,000	22,600	13,500	21,600
Chromium ferroalloys and metal	do.	22,300	27,000	11,300	2,900	4,850
Stainless steel mill products and scrap	do.	156,000	231,000	250,000	263,000	246,000
Stocks, December 31:						
Government	do.	272,000 <sup>6</sup>	115,000	105,000 <sup>9</sup>	129,000	115,000
Industry <sup>8</sup>	do.	9,620	9,940	7,290	6,820 <sup>r</sup>	7,300
Total	do.	493,000	416,000	399,000	416,000	396,000
Production, reported, chromium ferroalloy and metal net production <sup>10</sup>		W	W	W	W	--
Consumption:						
Apparent, contained chromium	do.	589,000	493,000	432,000	160,000	383,000
Reported:						
Chromite ore and concentrates, gross weight	do.	W	W	W	W	W
Chromium ferroalloys <sup>11</sup>						
Gross weight	do.	429,000 <sup>r</sup>	469,000 <sup>r</sup>	427,000	383,000 <sup>r</sup>	434,000
Contained chromium	do.	252,000 <sup>r</sup>	275,000 <sup>r</sup>	251,000	224,000 <sup>r</sup>	248,000
Chromium metal, gross weight	do.	6,160	5,410	4,740	4,190 <sup>r</sup>	4,540
Stocks, December 31, gross weight:						
Government: <sup>6</sup>						
Chromite ore	do.	1,160	--	--	--	--
Chromium ferroalloys	do.	373,000	155,000	140,000 <sup>9</sup>	175,000	154,000
Chromium metal	do.	5,290 <sup>r</sup>	4,970	4,820	4,670	4,670
Industry:						
Producer <sup>12</sup>	do.	W	W	W	W	W
Consumer:						
Chromium ferroalloys <sup>13</sup>	do.	15,500	16,300	11,700	11,400	11,500
Chromium metal	do.	220	221	235	160	284
Other	do.	231	216	272 <sup>r</sup>	263	243
Prices, average annual:						
Chromite ore <sup>14</sup>	dollars per metric ton	119	244	346	159 <sup>r</sup>	208
Ferrochromium, chromium content <sup>15</sup>	dollars per pound	0.695	1.048	1.748	0.806	1.261
Electrolytic chromium metal, gross weight <sup>16</sup>	do.	4.50	NA	NA	NA	NA
Aluminothermic chromium metal, gross weight <sup>17</sup>	do.	2.94	3.66	5.30	4.08	5.23

See footnotes at end of table.

TABLE 1—Continued  
SALIENT CHROMIUM STATISTICS<sup>1</sup>

		2006	2007	2008	2009	2010
Value of trade: <sup>18</sup>						
Exports	thousands	\$121,000	\$150,000	\$149,000	\$86,600	\$131,000
Imports	do.	\$529,000	\$699,000	\$1,430,000	\$444,000	\$1,010,000
Net imports <sup>19</sup>	do.	\$408,000	\$548,000	\$1,280,000	\$358,000	\$883,000
Stainless steel:						
Production:						
Gross weight <sup>20</sup>	metric tons	2,460,000	2,170,000	1,930,000	1,620,000	2,200,000
Contained chromium <sup>21</sup>	do.	419,000	360,000	324,000	276,000	383,000
Average grade, dimensionless <sup>22</sup>		0.1705	0.1656	0.1684	0.1703	0.1738
Shipments, gross weight <sup>23</sup>	do.	1,890,000	1,700,000	1,380,000	1,200,000	1,510,000
Exports, gross weight	do.	410,000	476,000	471,000	414,000	508,000
Imports, gross weight	do.	872,000	809,000	783,000	416,000	585,000
Scrap, gross weight:						
Receipts	do.	1,050,000	953,000	858,000	832,000	846,000
Consumption	do.	1,500,000	1,430,000	1,330,000	1,260,000	1,280,000
Exports	do.	506,000	882,000	1,000,000	1,130,000	937,000
Imports	do.	180,000	118,000	140,000	124,000	195,000
Value of trade:						
Exports	thousands	\$1,580,000	\$2,110,000	\$2,300,000	\$1,450,000	\$2,120,000
Imports	do.	\$3,210,000	\$4,300,000	\$4,040,000	\$1,710,000	\$2,400,000
Scrap exports	do.	\$716,000	\$1,620,000	\$1,190,000	\$777,000	\$936,000
Scrap imports	do.	\$209,000	\$198,000	\$217,000	\$138,000	\$305,000
Net exports <sup>19, 24</sup>	do.	-\$1,130,000	-\$770,000	-\$773,000	\$384,000	\$346,000

<sup>1</sup>Revised. do. Ditto. NA Not available. W Withheld to avoid disclosing company proprietary data. -- Zero.

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

<sup>2</sup>Calculated assuming chromite ore to average 44% Cr<sub>2</sub>O<sub>3</sub>, which is 68.42% chromium.

<sup>3</sup>Calculated assuming chromium content of ferrochromium to average 57% chromium.

<sup>4</sup>Calculated from American Iron and Steel Institute reported stainless steel production assuming chromium content of stainless steel to average 16.7% chromium.

<sup>5</sup>Calculated assuming chromium content of stainless steel to average 17% chromium.

<sup>6</sup>"Summary of Commodities" as reported by the Defense Logistics Agency, DLA Strategic Materials (formerly Defense National Stockpile Center) through 2006. "Inventory Material" as reported by DLA starting in 2007 except where noted otherwise.

<sup>7</sup>From January 1, 2009 to December 31, 2009, the DLA made an accounting adjustment to low-carbon ferrochromium stocks making them (the stocks for those months) incompatible for the purpose of computing stock change for that year. January stocks were estimated.

<sup>8</sup>Includes consumer stocks of chromium ferroalloys and metal and other chromium-containing materials.

<sup>9</sup>From January 1, 2008 to December 31, 2008, the DLA changed its high-carbon and low-carbon ferrochromium stocks accounting method making them (the stocks for those months) incompatible for the purpose of computing stock change for that year. December stocks were estimated based on monthly stock change excluding the accounting-change month.

<sup>10</sup>Includes chromium ferroalloys and metal and other chromium materials in the United States.

<sup>11</sup>Chromium ferroalloy, chromite ore, and other chromium-containing materials excluding chromium metal.

<sup>12</sup>Producer stocks of chromium ferroalloys and metal.

<sup>13</sup>Consumer stocks of high- and low-carbon ferrochromium and ferrochromium-silicon.

<sup>14</sup>Time-weighted average price of South African chromite ore that contains 44% Cr<sub>2</sub>O<sub>3</sub> f.o.b. South Africa as reported in Ryan's Notes in 2006. Annual average price of South African chromite ore that contains 44% Cr<sub>2</sub>O<sub>3</sub> f.o.b. South Africa as reported by Ryan's Notes after 2006.

<sup>15</sup>Time-weighted average U.S. price of imported high-carbon ferrochromium that contains 50% to 55% chromium as reported in Platts Metals Week.

<sup>16</sup>Time-weighted average U.S. price of domestically produced electrolytic chromium metal as reported by Ryan's Notes.

<sup>17</sup>Annual average U.S. price of imported aluminothermic chromium metal as reported by Ryan's Notes.

<sup>18</sup>Includes chromite ore and chromium ferroalloys, metal, and chemicals.

<sup>19</sup>Negative data indicate that imports are greater than exports.

<sup>20</sup>Source: American Iron and Steel Institute annual report of stainless and heat-resisting raw steel production and shipments.

<sup>21</sup>Estimated mass-weighted average of the mean chromium content of stainless steel production by grade. Uncertainty is approximately ± 0.01, owing to the range of chromium chemical specification limits by stainless steel grade.

<sup>22</sup>Ratio of estimated mass-weighted average chromium content of stainless steel production by grade to production. Expressed as a fraction. Source: American Iron and Steel Institute quarterly reports of stainless and heat-resisting raw steel production by grade.

<sup>23</sup>Source: American Iron and Steel Institute annual report of stainless and heat-resisting raw steel shipments.

<sup>24</sup>Includes stainless steel and stainless steel scrap.

TABLE 2  
U.S. REPORTED CONSUMPTION AND STOCKS OF CHROMIUM PRODUCTS<sup>1</sup>

(Metric tons)

	2009		2010		Change <sup>2</sup>	
	Gross weight	Chromium content	Gross weight	Chromium content	Quantity	Percentage
Consumption by end use:						
Alloy uses:						
Steel:						
Carbon steel	5,760	3,500	7,210	4,430	1,450	25
High-strength low-alloy steel	5,810	2,460 <sup>r</sup>	2,800	1,840	-3,010	-52
Stainless and heat-resisting steel	323,000	188,000	358,000	207,000	34,600	11
Full alloy steel	13,400	8,180 <sup>r</sup>	17,900	10,900	4,530	34
Unspecified steel <sup>3</sup>	26,900	16,800 <sup>r</sup>	27,800	17,400	821	3
Superalloys	8,630 <sup>r</sup>	6,820 <sup>r</sup>	9,390	7,480	762	9
Other alloys and uses <sup>4</sup>	3,110 <sup>r</sup>	2,000 <sup>r</sup>	4,690	3,180	1,580	51
Total	387,000 <sup>r</sup>	228,000 <sup>r</sup>	428,000	252,000	40,800	11
Consumption by material:						
Low-carbon ferrochromium	27,400 <sup>r</sup>	18,700 <sup>r</sup>	32,000	21,900	4,540	17
High-carbon ferrochromium	323,000	192,000	364,000	215,000	40,400	13
Ferrochromium silicon	(5)	(5)	(5)	W	W	W
Chromium metal	4,190 <sup>r</sup>	4,180 <sup>r</sup>	4,540	4,540	357	9
Chromium-aluminum alloy	355	219	371	256	16	4
Other chromium materials	31,700 <sup>r</sup>	12,900 <sup>r</sup>	27,100	10,700	-4,570	-14
Total	387,000 <sup>r</sup>	228,000 <sup>r</sup>	428,000	252,000	40,800	11
Consumer stocks:						
Low-carbon ferrochromium	1,790 <sup>r</sup>	1,220 <sup>r</sup>	1,810	1,240	19	1
High-carbon ferrochromium	8,580 <sup>r</sup>	5,090 <sup>r</sup>	9,210	5,450	634	7
Ferrochromium silicon	W	W	W	W	W	W
Chromium metal	149 <sup>r</sup>	149 <sup>r</sup>	284	283	135	91
Chromium-aluminum alloy	119	73	124	86	5	5
Other chromium materials	663 <sup>r</sup>	280 <sup>r</sup>	618	246	-45	-7
Total	11,300 <sup>r</sup>	6,820 <sup>r</sup>	12,000	7,300	749	7
National Defense Stockpile stocks: <sup>6,7</sup>						
Chromium ferroalloys: <sup>8</sup>						
High-carbon ferrochromium	113,000	80,800	95,400	68,100	-17,700	-16
Low-carbon ferrochromium	61,500	43,900 <sup>r</sup>	59,000	42,200	-2,450	-4
Chromium metal <sup>9</sup>	4,670	4,670	4,670	4,670	--	--

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; included in "Total." -- Zero.

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

<sup>2</sup>Change based on gross weight quantity of unrounded data of current year compared with that of previous year.

<sup>3</sup>Includes electrical, tool, and unspecified steel end uses.

<sup>4</sup>Includes cast irons, welding and alloy hard-facing rods and materials, wear- and corrosion-resistant alloys, and aluminum, copper, magnetic, nickel, and other alloys.

<sup>5</sup>Withheld to avoid disclosing company proprietary data; included in "Other chromium materials."

<sup>6</sup>The source for stockpile information is the Defense Logistics Agency, DLA Strategic Materials.

<sup>7</sup>The DLA data is based on the "Total Uncommitted Inventory" of stockpile material D-1 report.

<sup>8</sup>Chromium content estimated using 71.4% chromium.

<sup>9</sup>Chromium content estimated using 100% chromium.

TABLE 3  
VALUE OF IMPORTS AND U.S. PRICE QUOTATIONS FOR CHROMIUM MATERIALS<sup>1</sup>

Material	2009		2010		
	Contained chromium	Gross weight	Contained chromium	Gross weight	
Value: <sup>2,3</sup>					
Chromite ore:					
Not more than 40% chromic oxide	dollars per metric ton	2,030	344	XX	XX
More than 40% but less than 46% chromic oxide	do.	1,980	621	537	168
46% or more chromic oxide	do.	641	203	793	252
Average	do.	762	227	674	212
Ferrochromium:					
Not more than 0.5% carbon	do.	4,490	3,040	4,630	3,180
More than 0.5% but not more than 3% carbon	do.	3,360	2,030	3,660	2,240
More than 3% but not more than 4% carbon	do.	1,000	540	1,850	1,100
Average (not more than 4%)	do.	4,230	2,800	4,540	3,090
More than 4% carbon	do.	1,540	844	2,290	1,320
Average (all grades)	do.	2,090	1,190	2,560	1,500
Chromium metal <sup>4</sup>	do.	XX	9,900	XX	11,300
Price: <sup>5</sup>					
Chromite ore:					
Turkey					
36% to 38% Cr <sub>2</sub> O <sub>3</sub>	do.	976	247	1,340	339
40% to 42% Cr <sub>2</sub> O <sub>3</sub>	do.	823	231 <sup>r</sup>	1,270	357
44% Cr <sub>2</sub> O <sub>3</sub>	do.	814	245	XX	XX
South Africa					
39% Cr <sub>2</sub> O <sub>3</sub>	do.	578 <sup>r</sup>	154 <sup>r</sup>	777	208
44% Cr <sub>2</sub> O <sub>3</sub>	do.	527 <sup>r</sup>	159 <sup>r</sup>	690	208
High-carbon ferrochromium:					
49% to 51% chromium	cents per pound	80.90	XX	117	XX
60% to 65% chromium	do.	81.60 <sup>r</sup>	XX	126	XX
Low-carbon ferrochromium:					
0.05% carbon	do.	235 <sup>r</sup>	XX	240	XX
0.10% carbon	do.	207 <sup>r</sup>	XX	216	XX
0.15% carbon	do.	190 <sup>r</sup>	XX	200	XX
Chromium metal:					
Imported, aluminothermic	do.	XX	408	XX	523

<sup>r</sup>Revised. do. Ditto. XX Not applicable.

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

<sup>2</sup>Mass-weighted average based on customs value and weight of imported material.

<sup>3</sup>Reported by the U.S. Census Bureau.

<sup>4</sup>Average for all grades.

<sup>5</sup>Source: Ryan's Notes.

TABLE 4  
U.S. EXPORTS OF CHROMIUM MATERIALS, BY TYPE<sup>1</sup>

HTS <sup>2</sup> code	Type	2009		2010		Principal destinations in 2010 (Quantity in metric tons, value in thousands)
		Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	
2610.00.0000	Chromite ore and concentrate, gross weight	2,500	\$1,610	4,420	\$2,620	Canada (2,810, \$1,410); Mexico (1,390, \$906); Venezuela (78, \$57); Vietnam (31, \$7); Colombia (28, \$16); Thailand (26, \$74); Philippines (20, \$40); Taiwan (14, \$11); China (12, \$52); Ecuador (8, \$26); Belgium (3, \$8); Uruguay (1, \$3); Hong Kong (1, \$5); Spain (1, \$4).
Metal and alloys, gross weight:						
8112.21.0000	Unwrought chromium powders	213	4,570	291	6,570	Germany (67, \$1,830); Japan (55, \$1,020); Canada (44, \$693); Mexico (39, \$511); Taiwan (20, \$428); China (19, \$508).
8112.22.0000	Chromium metal waste and scrap	20	481	41	734	Taiwan (15, \$283); Japan (11, \$205); United Kingdom (7, \$53); Singapore (3, \$59); Malaysia (2, \$40); Philippines (2, \$38); Germany (1, \$49).
8112.29.0000	Chromium metal other than unwrought powders and waste and scrap	179	8,250	265	11,100	Japan (70, \$3,550); Canada (23, \$222); Hong Kong (22, \$787); Brazil (16, \$627); Laos (14, \$130); Singapore (12, \$758); Russia (10, \$271); United Kingdom (10, \$256); Germany (10, \$455); Taiwan (9, \$1,180); China (9, \$324); Czech Republic (7, \$82); Ireland (7, \$228).
Total chromium metal		411	13,300	597	18,400	
Chromium ferroalloys:						
7202.41.0000	High-carbon ferrochromium: <sup>3</sup>	3,200	4,270	6,530	7,810	Canada (2,980, \$3,480); Mexico (2,010, \$2,640); Brazil (756, \$702); Peru (200, \$192); India (114, \$100); Italy (99, \$160); Chile (87, \$187); Argentina (61, \$53); Taiwan (58, \$51); Colombia (57, \$52); New Zealand (44, \$75); Thailand (43, \$98); Philippines (27, \$24).
Gross weight		1,770	XX	3,150	XX	
Contained weight						
7202.49.0000	Low-carbon ferrochromium: <sup>4</sup>	1,560	2,440	2,490	4,820	Canada (1,860, \$3,490); Mexico (309, \$576); Brazil (118, \$268); Australia (64, \$94); Netherlands (41, \$96); Republic of Korea (41, \$104); Thailand (20, \$57); China (20, \$57); Peru (13, \$31); Colombia (8, \$31); India (3, \$3); Lebanon (1, \$8).
Gross weight		710	XX	1,060	XX	
Contained weight						
7202.50.0000	Ferrochromium-silicon:	19	109	106	225	Mexico (60, \$125); Canada (36, \$46); Brazil (9, \$49); Costa Rica (1, \$6).
Gross weight		6	XX	37	XX	
Contained weight						
Total chromium ferroalloys:						
Gross weight		4,780	6,820	9,130	12,900	
Contained weight		2,490	XX	4,250	XX	
Chemicals, gross weight:						
Chromium oxides:						
2819.10.0000	Chromium trioxide	10,100	18,600	14,700	30,700	Brazil (2,590, \$5,410); United Kingdom (1,760, \$2,870); China (1,750, \$4,590); Republic of Korea (1,110, \$2,180); India (1,100, \$1,810); France (791, \$1,690); Italy (518, \$1,020); Spain (493, \$829); Colombia (469, \$1,120); Indonesia (452, \$1,110); Belgium (435, \$1,070); Chile (367, \$628).

See footnotes at end of table.



TABLE 4—Continued  
U.S. EXPORTS OF CHROMIUM MATERIALS, BY TYPE<sup>1</sup>

HTS <sup>2</sup> code	Type	2009		2010		Principal destinations in 2010 (Quantity in metric tons, value in thousands)
		Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	
	Chemicals, gross weight—Continued:					
	Chromium oxides—Continued:					
2819.90.0000	Other	1,900	\$9,300	5,250	\$26,000	Belgium (1,160, \$4,500); Spain (1,050, \$3,310); United Kingdom (619, \$1,840); Canada (423, \$2,480); Brazil (308, \$1,240); China (270, \$1,180); South Africa (194, \$1,010); France (189, \$2,170).
	Total chromium oxides	12,000	27,900	19,900	56,700	
2833.29.4000	Chromium sulfates	16	114	60	306	Mexico (25, \$121); China (12, \$61); Taiwan (5, \$24); Congo (4, \$20); India (4, \$19); Singapore (3, \$21); Turkey (2, \$11); Argentina (2, \$10); Hong Kong (1, \$6); Venezuela (1, \$10).
	Salts of oxometallic or peroxometallic acids:					
2841.90.4500	Zinc and lead chromate	56	293	35	362	Guatemala (18, \$50); Jamaica (8, \$43); Norway (2, \$5); South Africa (2, \$229); Trinidad and Tobago (2, \$5); Costa Rica (2, \$10); Barbados (1, \$6); Brazil (1, \$4).
2841.30.0000	Sodium dichromate	19,700	20,200	29,400	27,500	Japan (15,500, \$14,500); Mexico (7,480, \$5,710); Canada (3,790, \$4,590).
2841.50.1000	Potassium dichromate	53	276	48	131	Brazil (24, \$52); Mexico (7, \$36); Germany (6, \$9); Taiwan (4, \$29); Angola (3, \$3); Republic of Korea (3, \$3).
2841.50.9100	Other	615	2,330	929	3,570	Republic of Korea (130, \$477); China (110, \$379); Vietnam (105, \$478); Canada (102, \$424); Thailand (84, \$343); Indonesia (64, \$105); India (55, \$93); Taiwan (47, \$120); Lithuania (38, \$171); Russia (37, \$59).
	Total salts	20,500	23,100	30,500	31,500	
3206.20.0000	Pigments and preparations, gross weight	1,220	13,800	2,540	8,640	Mexico (all).

<sup>1</sup>XX Not applicable.  
<sup>2</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>3</sup>Harmonized Tariff Schedule of the United States.

<sup>4</sup>More than 4% carbon.

<sup>5</sup>Not more than 4% carbon.



TABLE 5—Continued  
 U.S. IMPORTS FOR CONSUMPTION OF FERROCHROMIUM, BY COUNTRY<sup>1</sup>

Country	Not more than 0.5% carbon (HTS <sup>2</sup> code 7202.49.5090)		More than 0.5% carbon, but not more than 3% carbon (HTS <sup>2</sup> code 7202.49.5010)		More than 3% carbon, but not more than 4% carbon (HTS <sup>2</sup> code 7202.49.1000)		More than 4% carbon (HTS <sup>2</sup> code 7202.41.0000)		Total all grades		
	Gross weight (metric tons)	Cr content (metric tons)	Gross weight (metric tons)	Cr content (metric tons)	Gross weight (metric tons)	Cr content (metric tons)	Gross weight (metric tons)	Cr content (metric tons)	Gross weight (metric tons)	Cr content (metric tons)	Value (thousands)
United Kingdom	--	--	--	--	--	--	--	19	24	19	\$68
Zimbabwe	--	--	--	--	--	--	--	9,550	16,500	9,550	23,400
Total	49,900	34,300	2,370	1,450	1,170	697	454,000	261,000	507,000	297,000	763,000

2010—Continued:  
 Revised. -- Zero.

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

<sup>2</sup>Harmonized Tariff Schedule of the United States.

Source: U.S. Census Bureau.

TABLE 6  
U.S. IMPORTS FOR CONSUMPTION OF CHROMIUM MATERIALS, BY TYPE<sup>1</sup>

HTS <sup>2</sup> code	Type	2009			2010			Sources in 2010 (Quantity in metric tons, value in thousands)
		Quantity (metric tons)	Value <sup>3</sup> (thousands)	Quantity (metric tons)	Value <sup>3</sup> (thousands)			
Chromite ore:								
2610.00.0020	Not more than 40% Cr <sub>2</sub> O <sub>3</sub> :							
	Gross weight	10,300	\$3,540	--	--			
	Cr <sub>2</sub> O <sub>3</sub> content	2,560	XX	--	XX			
2610.00.0040	More than 40%, but less than 46% Cr <sub>2</sub> O <sub>3</sub> :							
	Gross weight	859	533	65,400	\$11,000	South Africa (all).		
	Cr <sub>2</sub> O <sub>3</sub> content	394	XX	29,900	XX			
2610.00.0060	46% or more Cr <sub>2</sub> O <sub>3</sub> :							
	Gross weight	66,100	13,400	73,700	18,600	South Africa (73,700, \$18,600); Russia (2, \$29).		
	Cr <sub>2</sub> O <sub>3</sub> content	30,600	XX	34,300	XX			
	Total chromite ore:							
	Gross weight	77,200	17,500	139,000	29,600			
	Cr <sub>2</sub> O <sub>3</sub> content	33,600	XX	64,100	XX			
Chromium ferroalloys:								
Ferrochromium:								
7202.49.5090	Not more than 0.5% carbon:							
	Gross weight	36,600	111,000	49,900	159,000	Russia (32,400, \$98,500); Germany (5,240, \$21,800); Kazakhstan (2,920, \$8,150); China (2,570, \$6,860); Japan (2,050, \$9,010);		
	Cr content	24,800	XX	34,300	XX	Turkey (1,700, \$5,450); Albania (1,370, \$3,280); South Africa (1,000, \$3,080); Belgium (500, \$2,020); Netherlands (81, \$298); Sweden (23, \$138).		
7202.49.5010	More than 0.5%, but less than 3% carbon:							
	Gross weight	2,110	4,290	2,370	5,320	South Africa (1,180, \$2,110); Russia (1,050, \$2,840); China (140, \$371).		
	Cr content	1,280	XX	1,450	XX			
7202.49.1000	More than 3%, but less than 4% carbon:							
	Gross weight	3,180	1,720	1,170	1,290	Russia (636, \$473); India (475, \$611); China (40, \$123); Belgium (20, \$79).		
	Cr content	1,720	XX	697	XX			
7202.41.0000	More than 4% carbon:							
	Gross weight	198,000	167,000	454,000	597,000	South Africa (243,000, \$250,000); Kazakhstan (112,000, \$194,000);		
	Cr content	109,000	XX	261,000	XX	Russia (33,500, \$53,300); Zimbabwe (16,500, \$23,400); India (13,300, \$18,900); Albania (11,600, \$16,700); Turkey (11,000, \$20,000);		
						Sweden (8,050, \$14,200); Romania (3,030, \$3,410); China (960, \$1,770); Finland (429, \$415); Latvia (200, \$375); Slovenia (100, \$139); Switzerland (96, \$124); Germany (50, \$176); United Kingdom (24, \$68); Brazil (19, \$49).		

See footnotes at end of table.

TABLE 6—Continued  
U.S. IMPORTS FOR CONSUMPTION OF CHROMIUM MATERIALS, BY TYPE<sup>1</sup>

HTS <sup>2</sup> code	Type	2009		2010		Sources in 2010 (Quantity in metric tons, value in thousands)
		Quantity (metric tons)	Value <sup>3</sup> (thousands)	Quantity (metric tons)	Value <sup>3</sup> (thousands)	
7202.50.0000	Ferrochromium-silicon:					
	Gross weight	7,560	\$9,140	17,000	\$28,200	Kazakhstan (all).
	Cr content	3,120	XX	7,210	XX	
	Total chromium ferroalloys:					
	Gross weight	248,000	294,000	524,000	791,000	
	Cr content	140,000	XX	305,000	XX	
	Chromium metal, gross weight:					
8112.21.1000	Unwrought chromium powders	635	6,410	1,860	22,800	China (978, \$13,000); United Kingdom (535, \$5,930); Russia (113, \$1,440); France (105, \$1,380); Spain (104, \$579); Japan (15, \$179); Germany (9, \$219); Romania (2, \$75).
8112.22.0000	Waste and scrap	107	797	544	2,260	Mexico (515, \$1,730); Germany (17, \$263); Singapore (12, \$266); Japan (1, \$4).
8112.29.0000	Other than waste and scrap	6,830	67,700	10,600	122,000	Russia (3,570, \$38,700); France (2,480, \$31,800); United Kingdom (2,430, \$28,800); China (2,060, \$21,000); Netherlands (41, \$338); Germany (31, \$1,070); Japan (11, \$330); Kazakhstan (5, \$358).
	Total chromium metal	7,570	74,900	13,000	148,000	
	Chemicals, gross weight:					
	Chromium oxides and hydroxides:					
2819.10.0000	Chromium trioxide	6,240	18,400	5,050	14,100	Turkey (3,090, \$7,930); Kazakhstan (1,100, \$2,870); South Africa (356, \$977); China (309, \$1,380); Canada (116, \$479); Japan (36, \$242); Germany (27, \$76); Colombia (14, \$77); Spain (4, \$27); France (2, \$12); Mexico (1, \$3).
2819.90.0000	Other	2,850	9,560	3,200	13,800	China (1,950, \$9,370); Canada (706, \$796); Germany (295, \$2,180); Kazakhstan (95, \$458); Colombia (90, \$586); India (20, \$66); France (19, \$114); Spain (11, \$56); United Kingdom (6, \$37); Republic of Korea (4, \$125); Japan (1, \$25); Finland (1, \$16).
	Total oxides	9,100	28,000	8,240	27,900	Turkey (all).
2833.29.4000	Sulfates of chromium	71	88	325	351	
	Salts of oxometallic or peroxometallic acids:					
2841.90.4500	Chromates of lead and zinc	32	101	168	701	China (81, \$316); Japan (57, \$216); Republic of Korea (21, \$101); France (9, \$51); Brazil (1, \$12).
2841.30.0000	Sodium dichromate	15,000	17,300	150	438	China (101, \$239); Colombia (44, \$191); Italy (4, \$8).
	Other chromates and dichromates:					
	Peroxo-chromates:					
2841.50.1000	Potassium dichromate	3	10	12	59	Colombia (9, \$31); India (2, \$13); Japan (1, \$11).
2841.50.9100	Other	239	711	439	1,530	Austria (321, \$1,160); Brazil (38, \$107); Canada (37, \$93); Colombia (17, \$57); Germany (16, \$30); France (5, \$49); Spain (3, \$13); China (2, \$15).
	Total salts	15,300	18,100	769	2,730	

See footnotes at end of table.

TABLE 6—Continued  
U.S. IMPORTS FOR CONSUMPTION OF CHROMIUM MATERIALS, BY TYPE<sup>1</sup>

HTS <sup>2</sup> code	Type	2009		2010		Sources in 2010 (Quantity in metric tons, value in thousands)
		Quantity (metric tons)	Value <sup>3</sup> (thousands)	Quantity (metric tons)	Value <sup>3</sup> (thousands)	
2849.90.2000	Chromium carbide	165	\$3,060	242	\$4,370	China (91, \$1,900); United Kingdom (56, \$635); Canada (45, \$846); Japan (37, \$466); Germany (11, \$416); Russia (1, \$10); Austria (1, \$103).
Total chromium chemicals		24,600	49,300	9,580	35,400	
Pigments and preparations based on chromium, gross weight:						
3206.20.0010	Chrome yellow	1,000	4,670	1,550	7,030	China (709, \$2,400); Canada (579, \$3,600); Colombia (130, \$434); Mexico (88, \$365); Germany (37, \$216); France (5, \$11).
3206.20.0020	Molybdenum orange	269	2,170	349	2,730	Canada (247, \$2,220); Mexico (50, \$293); United Kingdom (30, \$78); Colombia (10, \$49); Germany (6, \$29); China (3, \$18); Japan (2, \$12); Italy (2, \$18).
3206.20.0030	Zinc yellow	168	464	92	282	China (70, \$198); United Kingdom (12, \$31); Mexico (6, \$24); Italy (4, \$25).
3206.20.0050	Other	254	1,350	292	1,540	China (120, \$527); France (100, \$391); Germany (29, \$215); Poland (19, \$126); Japan (14, \$107); Canada (5, \$40); Netherlands (2, \$17); United Kingdom (1, \$96); India (1, \$14).
Total pigments		1,700	8,650	2,280	11,600	

XX Not applicable. -- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.<sup>2</sup>Harmonized Tariff Schedule of the United States.<sup>3</sup>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 into the United States.

TABLE 7  
 WORLD PRODUCTION CAPACITY OF CHROMITE ORE, FERROCHROMIUM,  
 CHROMIUM METAL, CHROMIUM CHEMICALS, AND STAINLESS STEEL IN 2010<sup>e,1</sup>

(Thousand metric tons of contained chromium)

Country	Production capacity				Stainless steel
	Ore	Ferrochromium	Metal	Chemicals	
Afghanistan	2	--	--	--	--
Albania	87	11	--	--	--
Argentina	--	--	--	13	--
Australia	78	--	--	--	--
Austria	--	--	--	--	10
Belgium	--	--	--	--	259
Brazil	193	123	--	--	84
China	60	1,260	6	70	1,960
Czech Republic	--	--	--	--	3
Finland	185	153	--	--	222
France	--	--	7	--	92
Germany	--	17	1	--	293
Greece	(2)	--	--	--	--
India	1,170	567	(2)	31	330
Iran	81	5	--	2	--
Italy	--	--	--	--	310
Japan	--	9	1	17	688
Kazakhstan	1,150	719	2	37	--
Korea, Republic of	--	--	--	--	389
Kosovo	1	--	--	--	--
Madagascar	40	--	--	--	--
Oman	259	--	--	--	--
Pakistan	97	--	--	3	--
Philippines	14	--	--	--	--
Poland	--	--	--	--	1
Russia	291	372	16	31	31
Slovenia	--	--	--	--	18
South Africa	3,270	1,880	--	23	124
Spain	--	--	--	--	212
Sudan	17	--	--	--	--
Sweden	--	71	--	--	116
Taiwan	--	--	--	--	292
Turkey	568	42	--	17	--
Ukraine	--	--	--	--	21
United Arab Emirates	10	--	--	--	--
United Kingdom	--	--	7	--	66
United States	--	--	--	38	420
Vietnam	31	--	--	--	--
Zimbabwe	215	128	--	--	--
Total	7,820	5,360	40	282	5,940

<sup>e</sup>Estimated. -- Zero.

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

<sup>2</sup>Less than ½ unit.

TABLE 8  
CHROMITE: WORLD PRODUCTION, BY COUNTRY<sup>1,2</sup>

(Metric tons, gross weight)

Country <sup>3</sup>	2006	2007	2008	2009	2010
Afghanistan <sup>4</sup>	7,273	6,491	6,491	6,000 <sup>e</sup>	6,000 <sup>e</sup>
Albania <sup>5</sup>	212,581	199,771	207,104	288,759 <sup>r</sup>	289,687
Australia	258,087	253,400	224,809	119,314	--
Brazil <sup>6</sup>	562,739	627,772	664,347 <sup>r</sup>	365,210 <sup>r</sup>	370,000 <sup>p</sup>
China <sup>e</sup>	200,000	200,000	200,000	200,000	200,000
Cuba	27,900	-- <sup>r</sup>	-- <sup>r</sup>	-- <sup>r</sup>	--
Finland	548,713	556,100	613,543	246,817	245,000
Greece <sup>4</sup>	1,500	1,400	1,400 <sup>e</sup>	1,400 <sup>e</sup>	1,400 <sup>e</sup>
India	3,600,400	3,320,000	3,900,000	3,760,000	3,800,000
Iran	244,603	185,760	268,586 <sup>r</sup>	255,129	250,000 <sup>e</sup>
Kazakhstan	3,366,078	3,687,200	3,552,000 <sup>r</sup>	3,544,000 <sup>r</sup>	3,829,000
Madagascar	132,335	122,260	84,000	60,000 <sup>e</sup>	105,000
Oman	70,500	407,822	859,748	636,482	801,856
Pakistan	199,000	323,100	320,000 <sup>e</sup>	90,000 <sup>r</sup>	257,000
Philippines	46,728	31,592	15,268	16,000 <sup>r,e</sup>	16,000 <sup>e</sup>
Russia	966,065	776,681	913,000	416,194	400,000 <sup>e</sup>
South Africa	7,418,326	9,646,958	9,682,640	7,560,938 <sup>r</sup>	10,871,095
Sudan	28,772	15,476	27,094 <sup>r</sup>	14,087 <sup>r</sup>	56,823
Turkey	1,059,901	1,678,932	1,885,712	1,573,993 <sup>r</sup>	1,700,000 <sup>e</sup>
United Arab Emirates	--	19,000	34,350	23,770	25,000
Vietnam	73,037	103,830	55,880	37,105	37,000 <sup>e</sup>
Zimbabwe	712,908	663,593	484,482	279,360	425,353
Total	19,700,000	22,800,000 <sup>r</sup>	24,000,000 <sup>r</sup>	19,500,000 <sup>r</sup>	23,700,000

<sup>e</sup>Estimated. <sup>p</sup>Preliminary. <sup>r</sup>Revised. -- Zero.

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

<sup>2</sup>Table includes data available through August 22, 2011.

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

<sup>4</sup>Gross weight estimated assuming an average grade of 44% chromic oxide (Cr<sub>2</sub>O<sub>3</sub>).

<sup>5</sup>Ore grade was 18% to 42% Cr<sub>2</sub>O<sub>3</sub>.

<sup>6</sup>Average chromic oxide (Cr<sub>2</sub>O<sub>3</sub>) content was as follows: 2006—40.6%; 2007—40.3%; 2008—42.5%; 2009—40.0%; and 2010—40.0% (estimated).



TABLE 9  
FERROCHROMIUM: WORLD PRODUCTION, BY COUNTRY<sup>1,2</sup>

(Metric tons, gross weight)

Country	2006	2007	2008	2009	2010
Albania	17,040	--	11,916	7,556	8,000 <sup>e</sup>
Brazil <sup>4</sup>	166,577	195,890	194,324 <sup>r</sup>	131,048 <sup>r</sup>	170,000 <sup>p</sup>
China <sup>e</sup>	1,000,000	1,300,000	1,500,000	1,810,000 <sup>r</sup>	2,000,000
Finland	243,350	241,760	233,550	123,310	125,000
Germany	26,710	22,030	26,960	13,667	20,000 <sup>e</sup>
India <sup>4</sup>	634,200	820,000	750,000	873,385 <sup>r</sup>	850,000
Iran <sup>e</sup>	7,000	8,000	8,000	8,000	8,000
Japan <sup>3</sup>	13,056	12,016	13,888	7,698 <sup>r</sup>	16,208
Kazakhstan	1,190,673 <sup>r</sup>	1,307,536	1,220,315	1,173,286 <sup>r</sup>	1,250,000 <sup>e</sup>
Romania	--	--	W	W	W
Russia <sup>e</sup>	600,000	570,000	490,000	378,000 <sup>5</sup>	414,000
Slovakia	19	--	--	--	--
South Africa <sup>6</sup>	3,030,000	3,551,983 <sup>r</sup>	3,268,659 <sup>r</sup>	2,346,131 <sup>r</sup>	3,607,132
Sweden	136,374	124,403	117,053	31,345	36,000
Turkey	67,975	69,730	79,840 <sup>r</sup>	41,028	60,000 <sup>e</sup>
United States <sup>7</sup>	W	W	W	W	W
Zimbabwe	200,673	187,327 <sup>r</sup>	145,430 <sup>r</sup>	72,223 <sup>r</sup>	150,000
Total	7,330,000 <sup>r</sup>	8,410,000 <sup>r</sup>	8,060,000	7,020,000 <sup>r</sup>	8,710,000

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

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

<sup>2</sup>Table includes data available through August 22, 2011.

<sup>3</sup>Includes high- and low-carbon ferrochromium.

<sup>4</sup>Reported on a fiscal year basis, which is from April 1 to March 31. Includes ferrochrome and charge chrome.

<sup>5</sup>Reported figure.

<sup>6</sup>Includes high- and low-carbon ferrochromium and ferrochromium-silicon.

<sup>7</sup>Includes chromium metal, high- and low-carbon ferrochromium, ferrochromium-silicon, and other chromium materials.