



2011 Minerals Yearbook

CADMIUM

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In 2011, global primary production of cadmium, excluding U.S. production, was 22,200 metric tons (t) (tables 1, 5). Most of the world's primary cadmium was produced in Asia—specifically China, Japan, and the Republic of Korea. Global secondary cadmium production was estimated to account for about 25% of all cadmium metal production. Most secondary cadmium metal was produced from nickel-cadmium (NiCd) battery recycling.

In 2011, net exports of cadmium metal (including alloys, powders, and waste and scrap) totaled 50,000 t, down from 85,000 t in 2010 and 539,000 t in 2009. Cadmium was primarily exported to China (71%), Israel (11%), and the Republic of Korea (7%) (table 3). Australia (27%), the Republic of Korea (19%), and Canada (14%) supplied the bulk of the corresponding imports (table 4). The annual average New York dealer price of cadmium metal in 2011 decreased by 29% from that of 2010 to \$2.76 per kilogram (\$1.25 per pound).

Leading consumers of refined cadmium were, in descending order of quantity, China, Belgium, and Japan. NiCd battery production continued to be the leading end use for cadmium, accounting for the majority of global cadmium consumption. Other significant end uses for cadmium included alloys, anticorrosive coatings, pigments, polyvinylchloride stabilizers, and semiconducting compounds for solar cells. The percentage of cadmium consumed globally for NiCd battery production has been increasing, while the percentages for the other traditional end uses of cadmium—specifically, coatings, pigments, and stabilizers—have gradually decreased during the past few decades because of environmental and health concerns. The NiCd battery market was concentrated in Asia. Cadmium metal is sold in several shapes and forms, which have different uses. Slabs or sticks are commonly consumed for alloys; balls and spheres for plating; and flakes, powder, or sticks for chemicals and pigments.

Production

Mine production.—Data on domestic mine production of cadmium were not collected by the U.S. Geological Survey (USGS) as data on the recoverable cadmium content of zinc concentrates, the principal source of primary cadmium, were not available. The cadmium content of typical zinc ores ranges from 0.2% to 0.3%. Sphalerite (ZnS), the most economically significant zinc mineral, is commonly impure; cadmium often substitutes for zinc in the crystal lattice. In 2011, zinc-concentrate-producing States were Alaska, Idaho, Missouri, and Tennessee. Concentrates from Alaska, Idaho, and Missouri were exported for processing, while concentrates from Tennessee were smelted and refined domestically.

Metal production.—Domestic metal production data were collected by the USGS from a voluntary survey on production

of cadmium metal and compounds. In 2011, cadmium metal was produced at one primary and two secondary smelters.

Primary.—The Clarksville refinery [owned and operated by Nyrstar NV (Balen, Belgium)] was an electrolytic zinc refinery located along the Cumberland River, 80 kilometers (km) northwest of Nashville, TN. The refinery's main products were Special High Grade Zinc and galvanizing alloy. Byproducts included cadmium metal, intermediate copper cementate, sulfuric acid, and synthetic gypsum. Zinc concentrates were sourced from Nyrstar's Tennessee Valley zinc mines and from imports.

Secondary.—The International Metals Reclamation Co. (INMETCO), owned by Horsehead Holding Corp. (Monaca, PA), produced secondary cadmium metal (ingot and shot) at its metals recovery facility in Ellwood City, PA. The cadmium recovery plant processed large industrial and portable consumer NiCd batteries through eight retort furnaces to recover cadmium. Spent NiCd batteries were secured from the Rechargeable Battery Recycling Corp. (Atlanta, GA) and through INMETCO's own collection programs. The bulk of the cadmium metal produced was sold back to battery manufacturers.

On a smaller scale, Toxco Inc.'s (Anaheim, CA) recycling operations in Lancaster, OH, also recovered cadmium ingots from NiCd batteries.

Consumption

Coatings and plating.—The amount of cadmium consumed domestically for corrosion-resistant coatings and plating decreased during the past several decades as cadmium-plated parts were phased out of motor vehicles by the automotive industry. However, cadmium coatings were still used by the aerospace industry and military for some critical applications where coating substitution may compromise operational safety; the metal was commonly used to plate fasteners in aircraft landing gear and parachutes owing to a combination of properties not present in other anticorrosive coatings.

Nickel-cadmium batteries.—NiCd batteries were used to power portable consumer electronics (commonly power tools) and provide emergency backup power for industrial applications and aircraft electrical systems.

Leading NiCd battery manufacturers were BYD Co., Ltd. (China), Panasonic Corp. (Japan), and Sanyo Electric Co., Ltd. (Japan). NiCd batteries had been favored for use in less expensive consumer appliances and electronics owing to their cost advantage over other battery chemistries. However, lithium-ion (Li-ion) batteries have begun to replace NiCd batteries in some low-cost electronics, as the manufacturing cost of Li-ion batteries has been decreasing, while the electrical storage capacity has been increasing. In 1994, a Li-ion battery

with a capacity of 1,100 milliampere-hours cost more than \$10 to manufacture. By 2001, a Li-ion battery of 1,900 milliampere-hours cost \$2 to manufacture. Though Li-ion battery production costs have continued to decline, in 2011, NiCd batteries still cost about one-half as much to produce as Li-ion batteries, but Li-ion batteries had a longer operating life. Despite the lower relative cost, global sales of NiCd batteries have reportedly declined from 1.42 billion cells in 1997 to 770 million cells in 2010 (Prentice, 2011).

Industrial-sized NiCd batteries potentially could be used to store energy produced by certain on-grid solar or wind systems. Excess energy generated during periods of low electricity demand could be stored in a battery storage system, from which it would be later dispatched during periods of high electricity demand. NiCd may be a favored battery chemistry for this use owing to its stability in offshore and harsh weather environments.

Pigments.—Cadmium pigments are inorganic and based on cadmium sulfide, which is golden yellow in color. The replacement of zinc or mercury for cadmium and the replacement of selenium for sulfur forms the spectrum of cadmium pigments that range from bright yellow to maroon. Cadmium pigments are predominantly used to color plastics that are processed at high temperatures, as the pigments are able to withstand the elevated temperatures without degrading.

Solar cells.—Cadmium telluride (CdTe) flexible thin-film solar cells were an alternative to traditional crystalline silicon solar cells and were suitable for commercial rooftop applications and large-scale, ground-mounted utility systems. In 2010 (latest data available), 1,437 megawatts of CdTe solar cells were produced globally, a 41% increase from that of 2009. CdTe solar cells were the second leading type of solar cell produced, following crystalline silicon solar cells and ahead of thin-film silicon solar cells. More than one-half of the solar cells produced in 2010 were manufactured in China and Taiwan. Other leading producers included Europe, Japan, and the United States (Roskill's Letters from Japan, 2011c).

Prices

The 2011 average New York dealer price for 99.95%-minimum-purity cadmium, as published by Platts Metals Week, was \$2.76 per kilogram (\$1.25 per pound), 29% less than the average price in 2010. In 2011, cadmium prices continued to trend downward from a monthly average peak price of \$4.52 in April 2010. In January 2011, the average monthly New York dealer price decreased from that of December 2010 to \$3.23 per kilogram (\$1.46 per pound), the highest average monthly price in 2011, and then generally decreased during the remainder of 2011, ending at an average of \$2.54 per kilogram (\$1.15 per pound) in December.

World Industry Structure

In 2011, most of the world's refined cadmium was produced in Asia, specifically China, Japan, and the Republic of Korea, followed by Central Europe and Eurasia, North America, and Western Europe.

Global secondary cadmium production was thought to have accounted for approximately one-quarter of all cadmium metal produced. Most secondary metal was recovered at NiCd battery recycling facilities in Asia, Europe, and the United States. In Japan, NiCd battery recyclers included Kansai Catalyst Co., Ltd., Mitsui Mining and Smelting Co., Ltd., and Toho Zinc Co., Ltd. In Europe, NiCd battery recycling took place at Accurec GmbH's facility in Germany, Saft AB's plant in Sweden, and Societe Nouvelle D'Affinage des Metaux's two recycling facilities in France.

World Review

European Union.—In early March, the European Union Council of Ministers approved additional restrictions on the use of cadmium under the Registration, Evaluation, Authorisation, and Restriction of Chemicals legislation (commonly known as REACH). The new laws ban the sale in the European Union of brazing fillers, jewelry, and polyvinyl chloride (PVC) that contain more than 0.01% cadmium by weight. Exceptions to the rule include brazing fillers used for defense purposes and recycled plastics manufactured from PVC waste (American Metal Market, 2011a).

Australia.—Nyrstar's Hobart zinc smelter in Tasmania produced cadmium metal from cadmium-bearing zinc concentrates sourced from zinc-lead mines in Australia. Most of the cadmium metal produced domestically was exported; a small amount was consumed in the country by specialized electroplating industries.

Sun Metals Corp. Pty. Ltd.'s (a subsidiary of Korea Zinc Co., Ltd.) zinc refinery near Townsville, northern Queensland, had the capacity to produce 1,000 metric tons per year (t/yr) of cadmium cake (containing 75% to 80% cadmium). Sun Metals was thought to have exported most of the cadmium cake to Korea Zinc's Onsan zinc-lead refinery in the Republic of Korea, where it was refined into metal (Park, undated, p. 5).

Belgium.—Belgium was a significant consumer of refined cadmium. Floridienne Chimie S.A. accounted for most of Belgian consumption for the production of cadmium compounds (carbonate, nitrate, and oxide) and powder, which were then exported to downstream consumers. It was estimated that the company consumed 4,800 to 7,200 t/yr of refined cadmium (Metal Bulletin, 2009).

Brazil.—Votorantim Metais' (Sao Paulo, a unit of Grupo Votorantim) Juiz de Fora zinc smelter in Minas Gerais was the sole producer of refined cadmium in Brazil.

Canada.—Teck Resources Ltd. (Vancouver, British Columbia) produced approximately 1,000 t/yr of refined cadmium at its metallurgical complex at Trail, British Columbia. Refined zinc and lead metal were the main products produced at Trail along with a number of byproducts that included cadmium. The cadmium plant at Trail was constructed in 1991 to handle the increased cadmium contained in zinc concentrates from the Red Dog Mine in Alaska and can produce up to 1,400 t/yr of refined cadmium. Cadmium metal products included balls, billets, and sticks, which were mostly consumed by NiCd battery manufacturers, and continuously cast cadmium sheet. Cadmium

sheet is commonly used to shield radiation measurement and control devices from slow neutrons. Teck also produced cadmium chemicals. HudBay Minerals Inc.'s (Winnipeg, Manitoba) copper smelting and zinc refining operations in Flin Flon, Manitoba, also produced byproduct cadmium metal.

China.—China was the world's leading producer and consumer of refined cadmium. Though estimated production of cadmium fell slightly, imports of unwrought cadmium into China increased by 53% to 7,260 t in 2011 from that of 2010. Major import sources included the Republic of Korea (41%), Kazakhstan (16%), Japan (9%), Peru (6%), Russia (6%), and Mexico (5%) (Metal-Pages, 2012a).

India.—Hindustan Zinc Ltd. (HZL, Udaipur) produced cadmium metal in the form of sticks at its Chanderiya lead-zinc smelter complex, Debari zinc smelter, and Vizag zinc smelter. During the fiscal year ending March 31, 2011, HZL produced 493 t of cadmium. HZL's cadmium metal production capacity was 833 t/yr—Chanderiya, 460 t/yr; Debari, 235 t/yr; and Vizag, 138 t/yr. During its next fiscal year, HZL planned to begin producing higher grades of refined cadmium. High-purity cadmium was typically used for nuclear shielding applications (Hindustan Zinc Ltd., 2011, p. 52, 100).

Binani Zinc Ltd. also produced cadmium at its zinc plant in Binanipuram. During the fiscal year ending March 31, 2011, Binani Zinc produced 67 t of cadmium. Production capacity was 80 t/yr (Binani Zinc Ltd., 2011, p. 24).

Japan.—Cadmium production in Japan decreased by 18% in 2011 from that of 2010 as several cadmium-producing zinc refineries were temporarily closed after the Tohoku earthquake that took place in March (Metal Bulletin, 2011).

In July, Sumitomo Metal Mining Co., Ltd. (Tokyo) announced that the company would begin using recycled zinc oxide materials instead of zinc concentrates as feedstock at its Harima zinc-lead smelter beginning in April 2012. Consequently, the smelter would no longer produce electrolytic lead and sulfuric acid. The change in raw material will also result in a 50% decrease in cadmium production (Roskill's Letters from Japan, 2011a; Sumitomo Metal Mining Co., Ltd., 2011).

According to Japan's Ministry of Economy, Trade, and Industry, Japanese production of portable NiCd batteries totaled 92.8 million units in the first half of 2011, a 17% decrease from that of the same period of 2010. However, the average value of the NiCd battery during this period increased by 5% compared with that in the first half of 2010, unlike the average value of all other rechargeable battery types, which decreased (Roskill's Letters from Japan, 2011b).

Korea, Republic of.—Korea Zinc (Seoul) was one of the leading suppliers of cadmium metal to China. Production capacity of refined cadmium at the company's Onsan zinc-lead refinery in Kyoung Nam Province was approximately 3,000 t/yr. Cadmium sticks were also produced at Young Poong Corp.'s (Seoul) Sukpo zinc refinery. In January 2010, the company announced that it had expanded its cadmium production capacity by approximately 75% to 1,400 t/yr (Metal Bulletin, 2010).

Mexico.—Refined cadmium balls and sticks were produced at Industrias Peñoles S.A. de C.V.'s Met-Mex metallurgical complex in Torreon. About 60% of the zinc concentrates processed at

Met-Mex originated from Industrias Peñoles' mines. During the first three quarters of 2011, 600 t of cadmium was produced at Met-Mex, which is the same amount produced in the same period of 2010. Grupo México S.A.B. de C.V. also produced cadmium ingots, mini-jumbos, spheres, and sticks at its electrolytic zinc refinery in San Luis Potosi. Cadmium-bearing zinc concentrates treated at San Luis Potosi were sourced from Grupo México's mines, principally the Charcas zinc mine. In 2011, Grupo México produced 600 t of refined cadmium at the San Luis Potosi refinery, unchanged from the amount produced in 2010 (Industrias Peñoles S.A. de C.V., 2012; Southern Copper Corp., 2012, p. 58).

Peru.—Cadmium metal was produced at Votorantim's Cajamarquilla zinc refinery. Production in 2011 totaled 572 t, a 60% increase from that of 2010 (Metal-Pages, 2012b).

Poland.—Huta Cynko produced 500 to 550 t/yr of cadmium at its zinc smelter (HCM) in Miasteczko. HCM was one of the few remaining zinc smelters that employed Imperial Smelting Process technology, which used bulk lead and zinc concentrates as feed material. HCM sourced most of its cadmium-containing concentrates from Xstrata's McArthur River Mine in Australia (American Metal Market, 2011b).

Russia.—Cadmium metal in Russia was produced at Chelyabinsk Zinc Plant OJSC's (Chelyabinsk) zinc refinery and Ural Mining and Metallurgy Co.'s (Sverdlovsk) Electro zinc lead-zinc refinery.

Outlook

Concern over cadmium's toxicity has spurred various legislation, especially in the European Union, to restrict the use of cadmium in most of its applications. However, cadmium-containing residues will continue to be produced as a byproduct from zinc smelting, regardless of cadmium demand. If the applications and markets for cadmium continue to decline, excess byproduct cadmium may need to be permanently stockpiled and managed, similar to the situation that the U.S. Government faces with mercury.

However, demand for cadmium may increase owing to increased usage in some industrial applications for NiCd batteries. NiCd batteries power some battery electric vehicles in circulation and are also used in a limited number of hybrid electric vehicles. NiCd batteries have been used to support various renewable energy installations owing to their long service life, low maintenance, and stability in harsh weather environments. NiCd batteries were also used as a buffer in transportable, renewable hybrid-power systems developed to generate electricity in remote locations and underdeveloped regions.

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TABLE 1
SALIENT CADMIUM STATISTICS¹

		2007	2008	2009	2010	2011
United States:						
Production of metal ²	metric tons	735	777	633	637	W
Shipments of metal by producers	do.	692	774	737	563	W
Exports of metal, alloys, scrap	do.	424	421	661	306	271
Imports for consumption, metal, alloys, and scrap	do.	316	197	122	221	211
Apparent consumption of metal	do.	594	528	199	477	W
Price, average, New York dealer ³	dollars per pound	3.45	2.69	1.30	1.77	1.25
Do. ³	dollars per kilogram	7.61	5.92	2.87	3.90	2.76
World, refinery production	metric tons	18,700 ^r	21,800 ^r	20,200 ^r	22,800 ^r	22,200 ^c

^cEstimated. ^rRevised. Do., do. Ditto. W Withheld to avoid disclosing company proprietary data.

¹Data are rounded to no more than three significant digits, except prices.

²Primary and secondary cadmium metal. Includes equivalent metal content of cadmium sponge used directly in production of compounds.

³Price for 1- to 5-short ton lots of metal having a minimum purity of 99.95% (Platts Metals Week).

TABLE 2
SUPPLY AND APPARENT CONSUMPTION OF CADMIUM METAL¹

(Metric tons)

	2007	2008	2009	2010	2011
Producer stocks, January 1 ²	74	107	132	27	W
Production	735	777	633	637	W
Imports for consumption, metal, alloys, and scrap	316	197	122	221	211
Total supply	1,130	1,080	887	885	W
Exports of metal, alloys, scrap	424	421	661	306	271
Producer stocks, December 31 ²	107	132	27	102	W
Consumption, apparent ³	594	528	199	477	W

W Withheld to avoid disclosing company proprietary data.

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

²Beginning stocks may not equal ending stocks of the prior year owing to inventory adjustments.

³Total supply minus exports and yearend stocks.

TABLE 3
U.S. EXPORTS OF CADMIUM PRODUCTS, BY COUNTRY AND TYPE¹

	2010		2011	
	Quantity (kilograms)	Value	Quantity (kilograms)	Value
Cadmium (Cd) metal: ²				
Brazil	--	--	5,960	\$69,200
Canada	28,900	\$145,000	11,600	81,700
China	122,000	350,000	192,000	443,000
Germany	23,600	292,000	114	158,000
Hong Kong	19,200	10,800	3,060	13,400
Israel	53,600	342,000	29,200	128,000
Korea, Republic of	38,500	99,400	19,500	32,700
Mexico	897	21,300	6,230	51,400
Singapore	--	--	2,040	8,270
Sweden	15,000	56,200	--	--
United Kingdom	--	--	901	34,100
Other	4,510 ^r	199,000 ^r	411	58,200
Total	306,000	1,520,000	271,000	1,080,000
Of which:				
Unwrought and powder	75,300	571,000	62,900	223,000
Waste and scrap	--	--	4,700	64,400
Other	231,000	945,000	204,000	790,000
Cadmium sulfide, gross weight:				
Germany	9,990	5,200	40,500	21,000
Italy	--	--	18,900	9,830
Mexico	30,800	16,000	--	--
Switzerland	6,140	3,190	--	--
United Kingdom	--	--	12,100	6,300
Total	46,900	24,400	71,500	37,200
Total, calculated Cd content	36,500	XX	55,600	XX
Cadmium pigments:				
Argentina	60,100	123,000	--	--
Belgium	--	--	7,980	57,600
Brazil	9,030	99,200	73,100	638,000
Canada	316,000	2,350,000	309,000	2,020,000
Chile	--	--	2,350	9,260
China	36,300	158,000	175	9,440
Colombia	2,110	13,400	198	10,900
Dominican Republic	3,520	20,100	--	--
Ecuador	--	--	4,340	68,000
France	5,350	42,500	--	--
Germany	3,460	17,800	4,560	230,000
Guatemala	96,300	172,000	40,000	77,900
Hong Kong	2,330	10,700	--	--
India	--	--	3,320	44,900
Israel	13,000	117,000	901	9,620
Italy	2,560	16,200	--	--
Jamaica	12,800	26,700	883	25,600
Mexico	1,430,000	4,660,000	988,000	3,610,000
New Zealand	9,320	9,270	--	--
Russia	--	--	9,180	162,000
Switzerland	11,300	669,000	--	--
Taiwan	3,430	15,000	1,010	35,300
Trinidad and Tobago	14,300	25,500	34,200	100,000
United Arab Emirates	--	--	14,400	14,400
United Kingdom	6,120	21,300	127	3,050
Other	10,300	129,000	6,270	119,000
Total	2,050,000	8,700,000	1,500,000	7,250,000

^rRevised. XX Not applicable. -- Zero.

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

²Includes exports of unwrought cadmium, other cadmium, and waste and scrap.

Source: U.S. Census Bureau.

TABLE 4
U.S. IMPORTS OF CADMIUM PRODUCTS, BY COUNTRY AND TYPE¹

	2010		2011	
	Quantity (kilograms)	Value	Quantity (kilograms)	Value
Cadmium (Cd) metal:²				
Australia	34,000	\$135,000	56,000	\$235,000
Austria	--	--	39	2,490
Belgium	16,600	365,000	20,300	480,000
Canada	7,530	612,000	30,000	849,000
China	15,500	136,000	1,510	12,500
France	--	--	96	16,800
Germany	66,300	315,000	10,100	28,100
India	125	11,600	--	--
Japan	28	19,500	20	30,500
Korea, Republic of	--	--	40,600	119,000
Mexico	60,000	236,000	20,000	52,800
Norway	20,000	1,040,000	--	--
Peru	--	--	10,000	34,400
Russia	30	9,300	--	--
United Kingdom	1,270	37,400	21,900	169,000
Total	221,000	2,910,000	211,000	2,030,000
Of which:				
Unwrought and powder	216,000	2,400,000	201,000	1,240,000
Waste and scrap	59	6,120	23	3,600
Other	4,910	509,000	9,140	786,000
Cadmium oxide:				
Belgium	201,000	1,750,000	97,500	930,000
India	540	13,000	--	--
Total	202,000	1,770,000	97,500	930,000
Total, calculated Cd content	177,000	XX	85,400	XX
Cadmium sulfide, gross weight:				
Canada	140,000	611,000	149,000	696,000
China	--	--	22	5,100
Germany	122	32,400	20,400	34,900
India	830	17,100	1,560	19,400
Russia	115,000	2,730,000	59,000	2,090,000
United Kingdom	2	4,200	5	14,700
Total	255,000	3,400,000	230,000	2,870,000
Total, calculated Cd content	199,000	XX	179,000	XX
Cadmium pigments:				
Belgium	850	12,600	1,050	15,500
Brazil	9,790	250,000	11,700	360,000
Canada	2,540	53,700	2,750	35,400
China	--	--	900	24,000
Colombia	9,000	24,800	--	--
France	--	--	100	6,490
Germany	110,000	759,000	232,000	1,280,000
India	--	--	1,510	69,000
Japan	58	11,300	1,500	71,600
Netherlands	892	5,840	--	--
Sweden	1	3,460	--	--
Taiwan	--	--	1,460	14,200
United Kingdom	99,400	1,730,000	90,000	1,650,000
Total	232,000	2,850,000	343,000	3,530,000

XX Not applicable. -- Zero.

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

²Includes imports of unwrought cadmium, other cadmium, and waste and scrap.

Source: U.S. Census Bureau.

TABLE 5
CADMIUM: WORLD REFINERY PRODUCTION, BY COUNTRY^{1,2}

(Metric tons)

Country	2007	2008	2009	2010	2011 ^c
Argentina	35	38	36	32 ^r	30
Australia	351	350	370	350	390
Brazil	200	200	200	200	200
Bulgaria	459	460	420	420 ^r	420
Canada ³	1,388	1,409	1,299	1,300	1,767 ^{p,4}
China ^c	4,210	6,960	7,050 ^r	7,200	7,000
Germany ^c	475 ^r	420	278	290 ^r	300
India	580 ^r	599	610	620	630
Italy ^c	10	10	10	10	10
Japan	1,939 ^r	2,126 ^r	1,824	2,142 ^r	1,755 ⁴
Kazakhstan	1,300 ^r	1,100 ^r	1,300 ^r	1,400 ^r	1,400
Korea, North ^c	200	200	200	200	200
Korea, Republic of	2,846	3,090	2,500	4,166 ^r	4,000
Mexico	1,617	1,550	1,210	1,483	1,480
Netherlands	495	530	490	560 ^r	570
Norway	269	178	249	300	309
Peru	347	371	289 ^r	357 ^r	572 ⁴
Poland	421	603	534	451 ^r	450
Russia	810	800	700	700 ^r	700
Ukraine ^c	-- ^r	-- ^r	-- ^r	-- ^r	--
United States ³	735	777	633	637	W
Total	18,700 ^r	21,800 ^r	20,200 ^r	22,800 ^r	22,200

^cEstimated. ^pPreliminary. ^rRevised. W Withheld to avoid disclosing company proprietary data, not included in total. -- Zero.

¹This table gives unwrought production from ores, concentrates, flue dusts, and other materials of both domestic and imported origin. Sources generally do not indicate if secondary metal (recovered from scrap) is included or not, where known, this has been indicated by a footnote. This table includes data available through May 18, 2012.

²World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

³Includes secondary.

⁴Reported figure.