



# 2010 Minerals Yearbook

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## CADMIUM [ADVANCE RELEASE]

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# CADMIUM

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In 2010, estimated cadmium metal production in the United States was 637 metric tons (t), about the same as the 633 t produced in 2009 (table 1). Apparent consumption of cadmium was 477 t, a 140% increase from that of 2009. Cadmium metal (including alloys, powders, and waste and scrap) was primarily exported to China (40%), Israel (18%), and the Republic of Korea (13%) (table 3). Germany (30%), Mexico (27%), and Australia (15%) supplied the bulk of the corresponding imports (table 4). The annual average New York dealer price of cadmium metal in 2010 increased by 36% from that of 2009 to \$3.90 per kilogram (\$1.77 per pound).

In 2010, global primary production of cadmium increased slightly to 21,100 t (table 5). Most of the world's primary cadmium was produced in Asia and the Pacific—specifically China, Japan, and the Republic of Korea—followed by Central Europe and Eurasia, North America, and Western Europe. 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.

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 of cadmium, accounting for the majority of global cadmium consumption. Other significant end uses of 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 because of environmental and health concerns. The NiCd battery market was concentrated in Asia. Cadmium metal is sold in several shapes and forms, which are used for different types of 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). Primary cadmium was generally recovered from zinc concentrates. 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 will often substitute for zinc in the crystal lattice. In 2010, zinc-concentrate-producing States were Alaska, Idaho, Missouri, and Tennessee.

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

of cadmium metal and compounds. In 2010, cadmium metal was produced at one primary and two secondary smelters.

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

**Secondary.**—The International Metals Reclamation Co. (INMETCO) produced secondary cadmium metal (ingot and shot) at its metals recovery facility in Ellwood City, PA. The company was established in 1978 to process stainless steel wastes and then expanded in December 1995 to recycle NiCd batteries. The cadmium recovery plant thermally recovered cadmium from both large industrial and portable consumer NiCd batteries in eight cadmium retort furnaces. The bulk of the cadmium metal produced was sold back to battery manufacturers. Chromium and nickel were also reclaimed in the recovery process as a ferrous remelt alloy for stainless steel production. In addition to NiCd batteries, INMETCO also processed alkaline, lithium, magnesium, nickel chloride, nickel iron, nickel metal hydride, and zinc carbon batteries.

Toxco Inc.'s (Anaheim, CA) recycling operations in Lancaster, OH, also produced secondary cadmium metal in the form of ingots. Cadmium was recovered from NiCd batteries in 12 cadmium retort furnaces. Nickel-iron cells were also produced during the recycling process.

## Consumption

**Coatings and plating.**—Cadmium coatings and plating can be applied to certain metals to prevent their corrosion. The amount of cadmium consumed domestically for 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 have a high number of charge-discharge cycles, high rate of energy discharge, and a wide operating temperature. They power portable consumer electronics (commonly power tools) and provide emergency backup power for industrial applications and aircraft electrical systems.

Domestically, NiCd batteries were thought to have been produced at six facilities operated by four battery manufacturing companies. Globally, leading NiCd battery manufacturers were BYD Co., Ltd. (Pingshan, Shenzhen Province, China), Panasonic Corp. (Japan), and Sanyo Electric Co., Ltd. (Japan). NiCd battery use in consumer electronics was thought to be declining owing partly to the preference for other rechargeable battery chemistries—particularly lithium ion (Li-ion) batteries, which have already replaced NiCd batteries in cellular telephones and laptops owing to their high energy density. However, NiCd batteries have a cost advantage compared with other battery chemistries and are still favored for use in less expensive consumer appliances and electronics.

Industrial-sized NiCd batteries potentially could be used to store energy produced by certain on-grid solar or wind systems. About 2% of the Nation's power was generated by solar cells and wind farms. If this percentage were to increase to more than 10%, mass energy storage may be required for load leveling. Excess energy 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 batteries may be a favored battery chemistry for this use owing to their stability in offshore and harsh weather environments.

**Pigments.**—Cadmium pigments are inorganic and based on cadmium sulfide, which is golden yellow in color. The increased replacement of zinc or mercury for cadmium and 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 higher temperatures, as the pigments are able to withstand the elevated temperatures without degrading.

**Solar cells.**—Cadmium telluride (CdTe) flexible thin-film solar cells are an alternative to traditional crystalline silicon solar cells and are practical for commercial rooftop applications and large-scale, ground-mounted utility systems. CdTe photovoltaic cells are potentially a safe, environmentally friendly application for cadmium; the cadmium would remain contained and recyclable. CdTe cells contain an average of 7 grams (g) of cadmium per square meter. This equates to 70 g of cadmium per kilowatt of electric power produced, assuming the cells are 10% efficient. Companies involved in developing CdTe thin-film technology within the United States included Ascentool, Inc., AVA Solar, Inc., Canrom Photovoltaics, Inc., China Nuvo Solar Energy, First Solar, Inc., Primestar Solar, Inc., Solar Fields LLC, and Zia Watt Solar (Ullal and von Roedern, 2007).

## Prices

Platts Metals Week publishes a weekly and monthly New York Dealer price for cadmium (minimum 99.95% purity) in dollars per pound. The 2010 average New York Dealer price for cadmium was \$3.90 per kilogram (\$1.77 per pound), 36% more than the average price in 2009. The average monthly New York dealer price in January was \$3.64 per kilogram (\$1.65 per pound). Average monthly prices reached a yearly high in April at \$4.52 per kilogram (\$2.05 per pound) and then generally decreased during the remainder of 2010, ending at \$3.57 per kilogram (\$1.62 per pound) in December.

## World Industry Structure

In 2010, most of the world's refined cadmium was produced in Asia and the Pacific, 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 a quarter of all cadmium metal production. Most secondary metal was produced 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

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

Sun Metals Corporation 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. Most of this consumption took place at Floridienne Chimie S.A.'s plant 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, accounting for almost 40% of global cadmium production.

**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 copper compounds, germanium dioxide, gold, indium, silver, and various sulfur products. The cadmium plant at Trail was constructed in 1991 to handle the increased cadmium input from the Red Dog Mine in Alaska and can produce up to 1,400 t/yr of refined cadmium. Cadmium metal products, which were mostly consumed by NiCd battery manufacturers, included balls, billets, and sticks. Teck also produced cadmium chemicals and continuously cast cadmium sheet. Cadmium sheet is commonly used to shield radiation measurement and control devices from slow neutrons. HudBay Minerals Inc.'s (Winnipeg, Manitoba) copper smelting and zinc refining operations in Flin Flon, Manitoba, also produced byproduct cadmium metal.

**India.**—Hindustan Zinc Ltd. (HZL, Udaipur) produced cadmium metal at its Chanderiya lead-zinc smelter complex, Debari zinc smelter, and Vizag zinc smelter in the form of sticks. During the financial year ending March 31, 2011, HZL's cadmium metal production capacity was 833 t/yr. Cadmium production capacity by plant was as follows—Chanderiya, 460 t/yr; Debari, 235 t/yr; and Vizag, 138 t/yr. HZL produced 493 t of cadmium during its 2010–11 financial period. During its next financial year, HZL planned to begin producing higher grades of refined cadmium. High-purity cadmium is 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. Production capacity was 65 t/yr of refined cadmium.

**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 leading smelter, the Onsan zinc-lead refinery in Kyoung Nam Province, was approximately 3,000 t/yr. Cadmium was also produced at Young Poong Corp.'s (Seoul) Sukpo zinc refinery in the form of sticks. Cadmium production capacity at Sukpo was 805 t/yr.

**Mexico.**—Refined cadmium in Mexico was produced mainly at Industrias Peñoles S.A. de C.V.'s Met-Mex metallurgical complex in Torreon (in the form of balls and sticks) and at Grupo Mexico S.A. de C.V.'s electrolytic zinc refinery in San Luis Potosi (in the form of ingots, mini-jumbos, spheres, and sticks). Cadmium-bearing zinc concentrates treated at San Luis Potosi were sourced from Grupo Mexico's mines, principally the Charcas zinc mine. About 60% of the zinc concentrates processed at Met-Mex originated from Industrias Peñoles' mines.

**Peru.**—Cadmium metal was produced at Votorantim's Cajamarquilla zinc refinery (430 t/yr of production capacity). Doe Run Peru's (Lima) La Oroya metallurgical operations also had the capacity to produce cadmium. However, operations at the smelter ceased in 2009 owing to environmental and financial problems.

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

## Outlook

Concern over cadmium's toxicity has spurred various legislative efforts, 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 the zinc smelting process, 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 now faces with mercury.

However, demand for cadmium may increase owing to several new market opportunities for NiCd batteries, particularly in industrial applications. NiCd batteries power some battery electric vehicles in circulation and are also used as a source of power 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 STATISTICS<sup>1,2</sup>

		2006	2007	2008	2009	2010
United States:						
Production of metal <sup>3,4</sup>	metric tons	723	735	777	633	637
Shipments of metal by producers <sup>4,5</sup>	do.	833	692	774	737	563
Exports of metal, alloys, scrap	do.	483	424	421	661	306
Imports for consumption, metal, alloys, and scrap	do.	180	316	197	122	221
Apparent consumption of metal	do.	530	594	528	199	477
Price, average, New York dealer <sup>6</sup>	dollars per pound	1.35	3.45	2.69	1.30	1.77
Do. <sup>6</sup>	dollars per kilogram	2.98	7.61	5.92	2.87	3.90
World, refinery production	metric tons	19,900	19,400	22,800 <sup>r</sup>	20,800 <sup>r</sup>	21,100 <sup>e</sup>

<sup>6</sup>Estimated. <sup>r</sup>Revised. Do., do. Ditto.

<sup>1</sup>Data are rounded to no more than three significant digits, except prices.

<sup>2</sup>Cadmium content.

<sup>3</sup>Primary and secondary cadmium metal. Includes equivalent metal content of cadmium sponge used directly in production of compounds.

<sup>4</sup>Partially estimated.

<sup>5</sup>Includes metal consumed at producer plants to make oxide and other cadmium compounds.

<sup>6</sup>Price 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 METAL<sup>1,2</sup>

(Metric tons)

	2006	2007	2008	2009	2010
Producer stocks, January 1 <sup>3</sup>	184	74	107	132	27
Production <sup>3</sup>	723	735	777	633	637
Imports for consumption, metal, alloys, and scrap	180	316	197	122	221
Total supply	1,090	1,130	1,100	887	885
Exports of metal, alloys, scrap	483	424	421	661	306
Producer stocks, December 31 <sup>3</sup>	74	107	132	27	102
Consumption, apparent <sup>4</sup>	530	594	528	199	477

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

<sup>2</sup>Excludes supply and apparent consumption of cadmium sulfide, cadmium telluride, and related cadmium chemicals.

<sup>3</sup>Partially estimated. Beginning stocks may not equal ending stocks of the prior year owing to inventory adjustments.

<sup>4</sup>Total supply minus exports and yearend stocks.

TABLE 3  
U.S. EXPORTS OF CADMIUM PRODUCTS, BY COUNTRY AND TYPE<sup>1</sup>

	2009		2010	
	Quantity (kilograms)	Value	Quantity (kilograms)	Value
<b>Cadmium (Cd) metal:</b> <sup>2</sup>				
Belgium	900	\$18,100	--	--
Canada	22,300	129,000	28,900	\$145,000
China	335,000	823,000	122,000	350,000
Germany	29,700	443,000	23,600	292,000
Hong Kong	116,000	64,800	19,200	10,800
Israel	17,000	69,300	53,600	342,000
Korea, Republic of	76,900	274,000	38,500	99,400
Netherlands	17,000	161,000	--	--
Pakistan	40,400	17,700	--	--
Sweden	--	--	15,000	56,200
United Kingdom	3,380	22,600	--	--
Other	2,870 <sup>f</sup>	102,000 <sup>f</sup>	5,410	221,000
Total	661,000	2,120,000	306,000	1,520,000
Of which:				
Unwrought and powder	276,000	1,270,000	75,300	571,000
Waste and scrap	137,000	319,000	--	--
Other	249,000	537,000	231,000	945,000
<b>Cadmium sulfide, gross weight:</b>				
Germany	--	--	9,990	5,200
Mexico	--	--	30,800	16,000
Switzerland	5,640	2,940	6,140	3,190
United Kingdom	10,600	5,510	--	--
Total	16,200	8,440	46,900	24,400
Total, calculated Cd content	12,600	XX	36,500	XX
<b>Cadmium pigments:</b>				
Argentina	--	--	60,100	123,000
Brazil	11,300	52,300	9,030	99,200
Canada	116,000	1,820,000	316,000	2,350,000
China	13,600	44,500	36,300	158,000
Colombia	5,840	44,100	2,110	13,400
Dominican Republic	6,180	41,600	3,520	20,100
France	--	--	5,350	42,500
Germany	3,260	44,100	3,460	17,800
Guatemala	96,300	156,000	96,300	172,000
Hong Kong	24,600	42,200	2,330	10,700
Israel	3,760	31,200	13,000	117,000
Italy	--	--	2,560	16,200
Jamaica	58,800	99,600	12,800	26,700
Mexico	904,000	3,580,000	1,430,000	4,660,000
New Zealand	--	--	9,320	9,270
Switzerland	10,800	1,090,000	11,300	669,000
Taiwan	--	--	3,430	15,000
Trinidad and Tobago	34,500	85,200	14,300	25,500
United Kingdom	211	4,480	6,120	21,300
Other	50,600 <sup>f</sup>	229,000 <sup>f</sup>	10,300	129,000
Total	1,340,000	7,360,000	2,050,000	8,700,000

<sup>f</sup>Revised. 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>Includes exports of other cadmium (Schedule B 8107.9000) and waste and scrap (Schedule B 8107.3000).

Source: U.S. Census Bureau.

TABLE 4  
U.S. IMPORTS OF CADMIUM PRODUCTS, BY COUNTRY AND TYPE<sup>1</sup>

	2009		2010	
	Quantity (kilograms)	Value	Quantity (kilograms)	Value
<b>Cadmium (Cd) metal:<sup>2</sup></b>				
Australia	38,000	\$121,000	34,000	\$135,000
Belgium	14,800	301,000	16,600	365,000
Canada	21,700	576,000	7,530	612,000
China	4,020	109,000	15,500	136,000
Germany	4,040	38,200	66,300	315,000
India	--	--	125	11,600
Japan	3	3,210	28	19,500
Mexico	11,500	25,500	60,000	236,000
Norway	--	--	20,000	1,040,000
Peru	24,000	63,000	--	--
Russia	--	--	30	9,300
United Kingdom	3,960	247,000	1,270	37,400
<b>Total</b>	<b>122,000</b>	<b>1,480,000</b>	<b>221,000</b>	<b>2,910,000</b>
Of which:				
Unwrought and powder	117,000	1,110,000	216,000	2,400,000
Waste and scrap	--	--	59	6,120
Other	4,940	371,000	4,910	509,000
<b>Cadmium oxide:</b>				
Belgium	115,000	760,000	201,000	1,750,000
India	--	--	540	13,000
Japan	240	19,800	--	--
Netherlands	5,230	50,000	--	--
United Kingdom	25	2,200	--	--
<b>Total</b>	<b>120,000</b>	<b>833,000</b>	<b>202,000</b>	<b>1,770,000</b>
<b>Total, calculated Cd content</b>	<b>105,000</b>	<b>XX</b>	<b>177,000</b>	<b>XX</b>
<b>Cadmium sulfide, gross weight:</b>				
Canada	55,900	446,000	140,000	611,000
Germany	--	--	122	32,400
India	--	--	830	17,100
Russia	74,000	1,960,000	115,000	2,730,000
United Kingdom	4,720	21,200	2	4,200
<b>Total</b>	<b>135,000</b>	<b>2,420,000</b>	<b>255,000</b>	<b>3,400,000</b>
<b>Total, calculated Cd content</b>	<b>105,000</b>	<b>XX</b>	<b>199,000</b>	<b>XX</b>
<b>Cadmium pigments:</b>				
Belgium	750	11,100	850	12,600
Brazil	1,990	51,300	9,790	250,000
Canada	2,770	36,500	2,540	53,700
China	2,000	8,800	--	--
Colombia	--	--	9,000	24,800
Germany	62,900	414,000	110,000	759,000
India	3	7,560	--	--
Japan	487	42,200	58	11,300
Netherlands	--	--	892	5,840
Sweden	--	--	1	3,460
United Kingdom	58,900	1,050,000	99,400	1,730,000
<b>Total</b>	<b>130,000</b>	<b>1,630,000</b>	<b>232,000</b>	<b>2,850,000</b>

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>Includes imports of other cadmium [Harmonized Tariff Schedule of the United States (HTS) 8107.90.00] and waste and scrap (HTS 8107.30.00).

Source: U.S. Census Bureau.

TABLE 5  
CADMIUM: WORLD REFINERY PRODUCTION, BY COUNTRY<sup>1,2</sup>

(Metric tons)

Country <sup>3</sup>	2006	2007	2008	2009	2010 <sup>e</sup>
Argentina	6	35	38	36 <sup>r</sup>	35
Australia	329	351	350	370	350
Brazil	141	200 <sup>e</sup>	200 <sup>e</sup>	200	200
Bulgaria	363	459	460 <sup>e</sup>	420 <sup>r</sup>	440
Canada <sup>4</sup>	2,090	1,388	1,409	1,299	1,300 <sup>e</sup>
China <sup>e</sup>	3,790	4,210	6,960 <sup>r</sup>	7,000 <sup>r</sup>	7,200
Germany <sup>e</sup>	640	400	420 <sup>r</sup>	278 <sup>r</sup>	400
India	457	583	599	610	620
Italy <sup>e</sup>	10	10	10	10	10
Japan	2,287	1,933	2,116	1,824	2,053 <sup>5</sup>
Kazakhstan	2,000	2,100	2,100 <sup>e</sup>	1,800	1,800
Korea, North <sup>e</sup>	200	200	200	200	200
Korea, Republic of	3,320	2,846	3,090	2,500 <sup>r</sup>	2,500
Mexico <sup>6</sup>	1,401	1,617	1,550	1,210	1,483 <sup>5</sup>
Netherlands	524	495	530	490	580
Norway	125	269	178	249	300 <sup>5</sup>
Peru	416	347	371	375	400 <sup>p</sup>
Poland	373	421	603	534 <sup>r</sup>	530
Russia	690	810	800	700	NA
Ukraine <sup>e</sup>	25	25	25	25	25
United States <sup>4</sup>	723	735	777	633	637 <sup>5</sup>
Total	19,900	19,400	22,800 <sup>r</sup>	20,800 <sup>r</sup>	21,100

<sup>e</sup>Estimated. <sup>p</sup>Preliminary. <sup>r</sup>Revised. NA Not available.

<sup>1</sup>This 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. Data derived in part from World Metal Statistics (published by World Bureau of Statistics, Ware, United Kingdom) and from Metal Statistics (published jointly by Metallgesellschaft AG of Frankfurt am Main, Germany, and World Bureau of Metal Statistics). Cadmium is found in ores, concentrates, and (or) flue dusts in several other countries, but these materials are exported for treatment elsewhere to recover cadmium metal; therefore, such output is not reported in this table to avoid double counting. This table includes data available through May 4, 2011.

<sup>2</sup>World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

<sup>3</sup>Romania, Thailand, and Uzbekistan may produce primary cadmium metal or oxide, but information is inadequate to make reliable estimates of output.

<sup>4</sup>Includes secondary.

<sup>5</sup>Reported figure.

<sup>6</sup>Excludes significant production of both cadmium oxide and cadmium contained in exported concentrates.