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SELENIUM

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Selenium and Tellurium

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In 2011, the average U.S. dealers' price for commercial-grade selenium and the average European price for tellurium increased from those of 2010. Estimated global consumption for both metals also increased, while estimated global production declined. One copper refinery in Texas reported domestic production of primary refined selenium and tellurium. Domestic production of selenium and tellurium remained nearly unchanged in 2010.

Except for two new mines in China, which began production in 2010, selenium and tellurium were recovered as byproducts of nonferrous metal mining, mostly from the anode slimes produced during the electrolytic refining of copper. Selenium and tellurium were also recovered as byproducts from gold, lead, nickel, platinum, and zinc mining.

In a 2006 survey of 56 worldwide electrolytic copper refiners, 52 and 45 plants, respectively, reported selenium and tellurium in their anode slimes. The selenium-containing slimes averaged 7% selenium by weight, with a few containing as much as 25% selenium. Tellurium concentrations in tellurium-bearing slimes averaged 2% (Moats and others, 2007, p. 202–241).

Selenium and tellurium can also be recovered economically from industrial scrap and chemical process residues. Obsolete and damaged photoreceptor drums from plain paper copy machines have been shipped by manufacturers to refineries for recovery of selenium and tellurium metal. With a shift to organic photoreceptors, the supply of obsolete selenium- and tellurium-bearing drums has declined in recent years and now appears to be nearly exhausted.

Production

ASARCO LLC's (Tucson, AZ) copper refinery in Amarillo, TX, was the only U.S. producer of refined selenium and tellurium. One copper refinery produced and exported semirefined material containing 90% selenium plus tellurium for toll-refining in Asia, and one U.S. refinery generated selenium- and tellurium-containing slimes that were exported for processing. A copper refiner that had exported selenium- and tellurium-containing slimes recovered from imported anode, closed in mid-2010. Most of the selenium and tellurium contained in domestic anode slimes came from copper ores in Arizona and Utah. Domestic production of refined selenium and tellurium remained relatively unchanged in 2010.

With the higher price of tellurium that prevailed during 2007–11, tellurium was increasingly viewed as a valuable byproduct. This, and the rising price of gold, helped stimulate exploration for gold-telluride ores, including some early stage projects in the Western United States and Mexico.

Consumption

Selenium.—In 2011, world consumption of selenium was estimated to be greater than that in 2010. Selenium consumption by the glass industry increased owing to increased glass production. The estimated global distribution of consumption of selenium by application was metallurgy, 40%; glass manufacturing, 25%; agriculture, 10%; chemicals and pigments, 10%; electronics, 10%; and other, 5% (Selenium Tellurium Development Association, 2012).

The main use for selenium in metallurgical end uses was for the production of electrolytic manganese in China, where selenium dioxide (SeO_2) was substituted for sulfur dioxide to reduce the power required to operate electrolytic cells. In 2011, demand for selenium by electrolytic manganese metal producers in China decreased slightly compared with that in 2010 owing to decreased consumption of electrolytic manganese metal by steel producers. About 2 kilograms (kg) of SeO_2 was used per metric ton of electrolytic manganese metal produced.

Metallurgical-grade selenium was also used as an additive to cast iron, copper, lead, and steel alloys to improve machinability and casting and forming properties. In the United States, selenium-bismuth-copper alloys were substituted for lead-containing alloys in plumbing fixtures in response to requirements of the Safe Drinking Water Act Amendments of 1996 (Public Law 104–182) to reduce lead in potable water supplies. In lead-acid storage batteries, small amounts, about 0.02% by weight, of selenium were added to low-antimony lead alloys used in the support grids to improve the casting and mechanical properties of the alloy.

Selenium was used to decolorize the green tint caused by iron impurities in container glass and other soda-lime silica glass. It was also used as a colorant in art and other glass, such as architectural plate and automobile glass, to reduce solar heat transmission through the glass.

Selenium, an essential micronutrient for animal and human health, was added to fertilizer used to grow crops for animal and human consumption. This practice was more common outside the United States, in countries with selenium-poor soils, such as Australia and China.

Chemical and pigment uses of selenium include industrial and pharmaceutical applications. Selenium's principal pharmaceutical use was in shampoo to control dandruff and dermatitis and as an antifungal agent. Cadmium sulfoselenide compounds were used as pigments in ceramics, glazes, paints, and plastics, but because of the relatively high cost and the toxicity of cadmium-based pigments, their use was generally restricted to applications where they were uniquely suited. In addition, selenium was used in catalysts to enhance selective oxidation in plating solutions to improve appearance and durability, in blasting caps and gun bluing, in digital x-ray detectors, and in zinc selenide for infrared windows in carbon dioxide lasers.

Selenium was also used in the production of thin-film photovoltaic (PV) cells. Three major types of thin-film PV cells were in commercial production—amorphous silicon and thin-silicon, cadmium telluride (CdTe), and copper indium gallium diselenide (CIGS). Conventional silicon-based cells remained the dominant PV technology. While production of thin-film PV cells increased in 2011, their share of production decreased to an estimated 11% of the total market. The major reason for the decrease in market share was that the cost of producing conventional silicon-based solar cells plummeted, so they were produced instead of the thin-film solar cells. Also the economic problems in Europe reduced the demand for solar cells, which led to an oversupply of all types of solar cells. Several companies, however, announced plans to expand production of nonsilicon-based solar cells within the next several years. In 2011, production of thin-film PV reached about 3,700 megawatts (MW). Of this, 1,900 MW was CdTe solar cells and 700 MW was CIGS solar cells. Recent advancements in CIGS thin film technology have reduced production costs, improved performance, and reduced the environmental impact of production. Solar Frontier K.K. (Tokyo, Japan) was the leading producer of CIGS solar cells in 2011 (Shiao, 2012).

Tellurium.—World consumption of tellurium was estimated to have increased slightly in 2011. The leading use for tellurium was high-purity tellurium in alloys for electronics applications, such as thermal imaging, thermoelectric, phase-change memory, and photoelectric devices. An increase in consumption in the first half of 2011 in these applications was partially offset by lower consumption in the second half of 2011 owing to declining solar cell demand and decreased demand for thermoelectrics in China. In addition to economic problems in Europe, the ending of some tax rebates in Europe for solar cells and the availability of cheaper conventional silicon-based cells led to a surplus of solar cells in the market.

The estimated global distribution of consumption of tellurium by application was 40% in solar cell, 30% in thermoelectrics, 15% in metallurgy, 5% in rubber formulation, and 10% in other (Selenium Tellurium Development Association, 2012).

First Solar Inc. (Phoenix, AZ) was the global leader in CdTe production, with plants in Arizona and Ohio in the United States and in Germany and Malaysia, and Abound Solar Inc. (Fort Collins, CO) had production facilities in Longmont, CO. By yearend, both companies had reduced production owing to the surplus of solar cells in the market. Other manufacturers that were planning to produce CdTe solar cells included Calyxo GmbH (Bitterfeld-Wolfen, Germany); PrimeStar Solar Inc. (Arvada, CO), which was purchased by General Electric Co. in April 2011; and Solexant Corp. (San Jose, CA) (Shiao, 2012).

In 2011, companies were investigating ways to reduce cost and material demand. CdTe modules with an 11% efficiency and layers 3 micrometers (μm) thick, would require approximately 100 metric tons (t) of tellurium per gigawatt (GW). However, continuing investment in technology has the potential to increase the efficiency to 15% and reduce the thickness to 0.67 μm and would require only 13 t of tellurium per GW (U.S. Department of Energy, 2011, p. 37).

5N Plus Inc. (Saint-Laurent, Quebec, Canada) was the principal supplier of high-purity cadmium and tellurium to the thin-film industry. The company signed long-term contracts with many of the thin-film producers and had solar-cell recycling facilities in Malaysia and the United States (Shiao, 2012).

Mercury-cadmium-telluride was used in thermal-imaging devices to convert the raw image into a crisp picture on the screen, for infrared sensors, and for heat-seeking missiles. Semiconducting bismuth telluride was used in thermoelectric cooling devices employed in electronics and consumer products. These devices consist of a series of couples of semiconducting materials which, when connected to a direct current, cause one side of the thermo element to cool while the other side heats. Thermoelectric coolers were used in electronics and military applications, such as the cooling of infrared detectors, integrated circuits, laser diodes, and medical instrumentation. In China, these devices were used in refrigerators, water dispensers, and other home appliances. The devices were also used in high-end automobile car seats to cool seats on hot days. Lower production rates in the Chinese home appliance industry in the latter part of 2011 caused consumption of tellurium in China to be slightly lower than 2010 (Metals Pages, 2011a).

In metallurgy, tellurium was used in steel as a free-machining additive, in copper to improve machinability while not reducing conductivity, in lead to improve resistance to vibration and fatigue, in cast iron to help control the depth of chill, and in malleable iron as a carbide stabilizer. Consumption in metallurgical applications continued to decline owing to increasing tellurium prices that encouraged many steel and nonferrous metals producers to reduce consumption and find substitutes for tellurium.

Consumption in chemical, catalysts, and other uses continued to declined owing to increasing tellurium prices. Tellurium was used as a vulcanizing agent and as an accelerator in the processing of rubber and in catalysts for synthetic fiber production. Other applications included the use of tellurium in blasting caps and as a pigment to produce blue and brown colors in ceramics and glass.

Prices

The Platts Metals Week annual average New York dealer price for selenium was $66.35 per pound in 2011, 75% higher than the annual average price in 2010. The price began the year at about $50 per pound and rose to $75 per pound by late March because of increased demand from manganese producers in China. The price started to drop in late May and by mid-September, had declined to $60 per pound because demand fell when several Chinese manganese plants closed owing to a lack of power supplies and failed environmental inspections. With the restart of some of the manganese plants, the selenium price rose to $68 per pound by the end of September where it remained for the rest of the year (Metal-Pages, 2011d, e).

The Metal-Pages published Rotterdam 99.99%-pure tellurium price, averaged $349.35 per kilogram in 2011, a 58% increase from the 2010 price. The price range began the year at $265 to $300 per kilogram and, owing to increased demand from solar cell manufacturers, steadily increased until it reached a price range of $420 to $440 per kilogram on April 26. The price range started to decrease in the end of May, and by yearend the price range had declined to $220 to $300 per kilogram (Metal Bulletin, 2011; Metal-Pages, 2011b, c).

Foreign Trade

Exports of selenium materials in 2011 increased by 57% compared with those of 2010. In descending order, China, Japan, the Republic of Korea, Hong Kong, Germany, Canada, and Australia accounted for 85% of selenium exports in 2011 (table 2). The annual average value of exports in 2011 of $18.39 per kilogram was higher than the $17.41 per kilogram in 2010.

In 2011, imports of selenium (SeO_2 and selenium unwrought and waste and scrap) increased by 25% to 601 t from 2010 imports (table 3). Japan, Belgium, China, the Philippines, Germany, Canada, and Mexico, in descending order, accounted for 89% of the imports of selenium metal and SeO_2 into the United States in 2011.

In 2011, tellurium exports declined to 39 t from 59 t in 2010. The main destinations were, in descending order, China, Belgium, Canada, Germany, and Hong Kong, which accounted for 94% of total tellurium exports (table 4). The average value of exports of tellurium in 2011 was $186.88 per kilogram, which was higher than the 2010 value of $91.44 per kilogram.

Imports of unwrought tellurium and tellurium waste and scrap increased by 70% in 2011 compared with imports in 2010. The leading suppliers, in descending order, Canada, China, the Philippines, and Belgium, accounted for 97% of the total imports of tellurium metal into the United States (table 5). The average value of imports in 2011 was $184.31 per kilogram of tellurium, which was 15% lower than that in 2010.

World Review

Global selenium and tellurium output cannot be easily determined because not all companies or countries report production and because trade in scrap and semirefined products may be included in trade data.

In 2011, refinery production of selenium, based on data from a few countries, decreased by 10% to 1,980 t (table 6), principally owing to lower production in Canada and Japan. Average world production was estimated to be about 3,000 to 3,500 metric tons per year (t/yr) of selenium and 500 to 550 t/yr of tellurium. Based on global copper refinery data (Moats and others, 2007, p. 202–241), the U.S. Geological Survey estimated that copper anode slimes in 2006 contained 4,600 t and 1,200 t, respectively, of selenium and tellurium.

China.—In 2011, China was the leading consumer of selenium, accounting for about 40% to 50% of world consumption, as well as a significant producer. China still depended, however, on imports for most of its selenium needs and imported 1,560 t of selenium products in 2011, a slight decrease compared with 2010 imports (Metal-Pages, 2012).

Apollo Solar Energy, Inc. (Chengdu, Sichuan Province) started two mines where the principal product was tellurium. Production from these mines was expected to supply 60% to 70% of the company's needs for tellurium to produce solar cells. The indicated and inferred resources for the Dashuigou project in the Sichuan Province were 30,200 t of ore grading 1.09% tellurium and containing 328 t of tellurium, and the resources for the Majiagou project in Shimian County, Sichuan Province, were 13,400 t of ore grading 3.26% tellurium and containing 437 t of tellurium. In addition to suppling its own solar cell production, the company entered into a contract with First Solar to supply CdTe material (Metal-Pages, 2009; Apollo Solar Energy, Inc., 2011, p. 15).

Japan.—Production of selenium and tellurium dropped because of lower grades and the fall in copper production following the Tohoku earthquake in March. The major producers of selenium and tellurium were Kisan Kinzoku Chemicals Co., Ltd., Mitsubishi Materials Corp., Mitsui Metal Mining and Smelting Co., Ltd., Nippon Rare Metals, Inc., Pan Pacific Copper Co., Ltd., Shinko Chemicals Co., Ltd., and Sumitomo Metal Mining Co., Ltd. (Roskill's Letters from Japan, 2011; 2012).

Mexico.—Southern Copper Corp. (Phoenix, AZ) operated the La Caridad precious metals plant in the State of Sonora, which had a design capacity of 342 kilograms of selenium per day. Production in 2011 likely increased owing to higher production of refined copper (Southern Copper Corp., 2012, p. 32).

Peru.—Southern Copper produced selenium at its Ilo refinery in southern Peru. In 2011, selenium production was 56,000 kg, down by 5% compared with that of 2010 (Southern Copper Corp., 2012, p. 41).

Outlook

The supply of selenium and tellurium is directly affected by the production of the principal product from which it is derived—copper—and to a lesser extent, by the production of gold, lead, nickel, or zinc produced from sulfide ores. Since global refined production of copper was projected to increase, production of selenium and tellurium also were expected to increase in 2012. Increased recovery rates at copper refineries could increase selenium and tellurium supply, and longer term investments in gold-telluride deposits and other sources of tellurium, such as the tellurium mines in China, could boost the global growth rate for tellurium production above the growth in copper concentrate production. Although increased environmental regulation and prices have encouraged the recycling of electronic scrap, recovery of selenium and tellurium has been declining during the past several years owing to the reduction in available scrap selenium- and tellurium-based copier drums. However, many high-grade tellurium producers and users were recovering much of the manufacturing scrap from the production of consumable goods. Also, solar-cell recycling plants have been built in the United States and around the world that would capture selenium and tellurium from CIGS and CdTe cells.

Demand from China for selenium was expected to decrease owing to decreased demand from the electrolytic manganese metal industry. Global demand for selenium from glass manufacturing will probably increase, as there are few substitutes for this application, and solar cell production was expected to decline in 2012.

In 2012, tellurium consumption was expected to decrease, chiefly owing to decreased electronics and solar-cell production. As the technologies for these uses, especially solar cells and thermoelectronics, continue to advance, manufacturers likely will find ways to reduce unit consumption through efficiency, recycling, and thrifting. Consumption for metallurgical alloying and chemicals was expected to decrease, assuming the price of tellurium continues to remain high; producers of low-value products were expected to find substitutes.

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TABLE 1

SALIENT SELENIUM AND TELLURIUM STATISTICS[1]

(Kilograms, contained metal, unless otherwise specified)

	2007	2008	2009	2010	2011
Selenium:					
United States:					
Production, primary refined	W	W	W	W	W
Exports	592,000	562,000	618,000	919,000	1,440,000
Imports for consumption	544,000	519,000	263,000	480,000	601,000
Dealers' price, average, commercial grade,[2] dollars per pound	33.08	32.29	23.07	37.83	66.35
World, refinery production	2,240,000 r	2,240,000 r	2,240,000 r	2,210,000 r	1,980,000 e
Tellurium, United States:					
Production, primary refined	W	W	W	W	W
Exports	15,100	50,000	8,700 r	59,000	38,600
Imports for consumption	43,700 r	102,000 r	84,000 r	41,600 r	70,800
Price, commercial grade,[3] dollars per kilogram	110.00	175.00	130.00	221.25	349.35

[e]Estimated. [r]Revised. W Withheld to avoid disclosing company proprietary data.

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

[2]Source: Platts Metals Week.

[3]For 2007–08, average yearend price published by Mining Journal for United Kingdom lump and powder, 99.95% tellurium. On September 14, 2009, this price was discontinued. For 2009, the price was the average September 14 price published by Mining Journal for United Kingdom lump and powder, 99.95% tellurium. The 2010–11 price was 99.99% tellurium IWH Rotterdam annual average price as reported by Metal-Pages.com.

TABLE 2
U.S. EXPORTS OF SELENIUM[1]

Country	2010		2011	
	Quantity (kilograms, contained Se)	Value	Quantity (kilograms, contained Se)	Value
Argentina	6,960	$108,000	--	--
Australia	99,800	2,060,000	131,000	$2,410,000
Belgium	502	7,780	31,900	312,000
Bolivia	--	--	1,130	13,300
Canada	26,900	783,000	147,000	4,140,000
Chile	--	--	4,760	73,700
China	101,000	1,530,000	211,000	3,270,000
Colombia	8,680	99,100	13,500	186,000
Dominican Republic	--	--	1,000	15,600
Ecuador	--	--	2,210	35,100
France	263	4,070	166	2,580
Germany	212,000	3,290,000	159,000	2,870,000
Hong Kong	160,000	3,280,000	168,000	3,400,000
India	5,500	85,300	612	9,500
Indonesia	18,500	287,000	22,800	354,000
Israel	750	11,600	979	15,200
Japan	72,600	1,130,000	210,000	3,950,000
Korea, Republic of	106,000	1,890,000	202,000	3,540,000
Malaysia	--	--	2,310	35,900
Mexico	36,100	569,000	62,600	971,000
Netherlands	120	3,110	136	3,240
Panama	--	--	2,610	40,500
Peru	6,490	99,100	3,360	51,500
Philippines	2,370	40,400	--	--
Singapore	15,600	121,000	19,200	152,000
South Africa	11,800	167,000	9,480	126,000
Sweden	--	--	94	7,330
Taiwan	8,220	133,000	5,640	87,400
United Kingdom	1,950	41,000	5,960	92,400
Venezuela	15,800	246,000	21,000	327,000
Vietnam	924	14,300	1,910	29,700
Total	919,000	16,000,000	1,440,000	26,500,000

-- Zero.

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

Source: U.S. Census Bureau.

TABLE 3
U.S. IMPORTS FOR CONSUMPTION OF SELENIUM[1]

	2010		2011	
Class and country	Quantity (kilograms, contained Se)	Value	Quantity (kilograms, contained Se)	Value
Selenium:				
Australia	--	--	4,000	$209,000
Belgium	89,200	$7,110,000	105,000	14,600,000
Canada	38,200	2,810,000	47,500	5,170,000
China	96,400	4,580,000	86,000	12,200,000
Germany	47,100	3,660,000	54,700	7,100,000
Hong Kong	2,000	148,000	--	--
India	5	7,250	5	7,250
Italy	--	--	5,000	835,000
Japan	59,400	4,550,000	118,000	10,300,000
Korea, Republic of	6,000	429,000	2,500	264,000
Mexico	38,700	2,500,000	45,700	5,330,000
Netherlands	1	6,550	--	--
Norway	--	--	31,300	1,100,000
Papua New Guinea	--	--	64	8,550
Peru	--	--	4,370	343,000
Philippines	72,500	6,660,000	67,500	9,680,000
United Kingdom	21,400	1,640,000	17,000	2,500,000
Total	471,000	34,100,000	589,000	69,700,000
Selenium dioxide:[2]				
China	6,290	401,000	10,100	542,000
Germany	1,620	159,000	976	141,000
Japan	1,260	65,800	1,480	75,000
Total	9,170	626,000	12,500	758,000
Grand total	480,000	34,700,000	601,000	70,400,000

-- Zero.

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

[2]Selenium content calculated as 71% of gross weight of material.

Source: U.S. Census Bureau.

TABLE 4
U.S. EXPORTS OF TELLURIUM[1]

Country	2010 Quantity (kilograms, contained Te)	2010 Value	2011 Quantity (kilograms, contained Te)	2011 Value
Australia	489	$73,400	--	--
Austria	--	--	3	$3,670
Bangladesh	--	--	140	11,000
Belgium	6,540	1,340,000	4,320	684,000
Brazil	90	14,400	191	55,300
Canada	906	833,000	3,300	1,320,000
China	25,800	1,850,000	24,800	3,610,000
Costa Rica	--	--	794	53,000
France	243	121,000	24	33,700
Germany	746	245,000	2,240	1,070,000
Hong Kong	1,930	289,000	1,610	124,000
Japan	48	9,020	46	11,400
Korea, Republic of	10	10,600	20	21,800
Mexico	29	5,230	--	--
Philippines	6,320	185,000	911	169,000
Taiwan	--	--	166	45,200
United Kingdom	15,900	423,000	--	--
Total	59,000	5,400,000	38,600	7,210,000

-- Zero.

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

Source: U.S. Census Bureau.

TABLE 5
U.S. IMPORTS FOR CONSUMPTION OF TELLURIUM[1]

Country	2010 Quantity (kilograms, contained Te)	2010 Value	2011 Quantity (kilograms, contained Te)	2011 Value
Belgium	2,050	$440,000	3,080	$765,000
Canada	26,900	6,100,000	46,400	4,830,000
Chile	--	--	888	345,000
China	4,050	1,150,000	10,700	3,930,000
Germany	33	11,900	6	7,290
Hong Kong	--	--	80	30,800
Japan	31	28,200	60	119,000
Philippines	7,520	1,090,000	8,380	2,630,000
Russia	680	156,000	--	--
Ukraine	3	11,000	273	35,100
United Kingdom	331	49,400	980	367,000
Total	41,600	9,040,000	70,800	13,100,000

-- Zero.

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

Source: U.S. Census Bureau.

TABLE 6

SELENIUM: WORLD REFINERY PRODUCTION, BY COUNTRY[1, 2]

(Kilograms, contained selenium)

Country[3]	2007	2008	2009	2010	2011[e]
Belgium[e]	200,000	200,000	200,000	200,000	200,000
Canada[4]	144,000	156,000	173,000	97,000 [r, e]	35,000 [p]
Chile[e]	70,000	78,000	90,000	90,000	90,000
Finland[e]	60,000 [5]	64,730 [5]	65,000	60,000	60,000
Germany[e]	650,000	650,000	650,000	650,000	650,000
India[e, 6]	14,000	14,000	15,000	15,000	16,000
Japan	830,400 [r]	785,800 [r]	739,000 [r]	803,600 [r]	630,000
Peru	60,000 [r]	60,000 [r, e]	61,000 [r]	59,000 [r]	59,000 [p]
Philippines[e]	65,000	65,000	65,000	65,000	65,000
Russia[e]	120,000	130,000	140,000	140,000	145,000
Serbia	7,500 [e]	16,827 [r]	19,075 [r]	10,592 [r]	10,600
Sweden[e]	20,000	20,000	20,000	20,000	20,000
United States	W	W	W	W	W
Total	2,240,000 [r]	2,240,000 [r]	2,240,000 [r]	2,210,000 [r]	1,980,000

[e]Estimated. [p]Preliminary. [r]Revised. W Withheld to avoid disclosing company proprietary data; not included in total.

[1]World totals and estimated data have been rounded to no more than three significant digits; may not add to totals shown.

[2]Insofar as possible, data relate to refinery output only; thus, countries that produced selenium contained in copper ores, copper concentrates, blister copper, and (or) refinery residues but did not recover refined selenium from these materials indigenously were excluded to avoid double counting. Table includes data available through June 7, 2012.

[3]In addition to the countries listed, Australia, China, Iran, Kazakhstan, Mexico, Poland, and Uzbekistan produced refined selenium, but output is not reported, and available information is inadequate for formulation of reliable estimates output levels. Australia is known to produce selenium in intermediate metallurgical products and has facilities to produce elemental selenium. In addition to having facilities for processing imported anode slimes for the recovery of selenium and precious metals, the United States has facilities for processing selenium scrap.

[4]Excludes selenium intermediates exported for refining.

[5]Reported figure.

[6]Data are for Indian fiscal year beginning April 1 of year stated.

TABLE 7

TELLURIUM: ESTIMATED WORLD REFINERY PRODUCTION, BY COUNTRY[1, 2]

(Kilograms, contained tellurium)

Country[3]	2007	2008	2009	2010	2011
Canada[4]	14,000 [5]	19,000	16,000	8,000	6,000 [p]
Japan	41,000 [5]	46,500	49,200	47,000 [r]	40,000
Peru	35,000 [5]	28,000 [5]	7,000 [r, 5]	-- [r, p]	--
Russia	34,000	34,000	34,000	34,000	34,000
United States	W	W	W	W	W

[p]Preliminary. [r]Revised. W Withheld to avoid disclosing company proprietary data. -- Zero.

[1]Estimated data are rounded to no more than three significant digits.

[2]Insofar as possible, data relate to refinery output only; thus, countries that produced tellurium contained in copper ores, copper concentrates, blister copper, and (or) refinery residues but did not recover refined tellurium are excluded to avoid double counting. Table is not totaled because of exclusion of data from major world producers.

[3]Australia, Belgium, Chile, China, Colombia, Germany, Mexico, the Philippines, Poland, and some countries of the Commonwealth of Independent States, including Kazakhstan, are known to produce refined tellurium, but output is not reported; available information is inadequate for formulation of reliable estimates of output levels.

[4]Excludes tellurium intermediates exported for refining.

[5]Reported figure.