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2010 Minerals Yearbook

SELENIUM AND TELLURIUM

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Selenium and Tellurium

By Micheal W. George

Domestic survey data and tables were prepared by Hodan A. Fatah, statistical assistant, and the world production tables were prepared by Glenn J. Wallace, international data coordinator.

In 2010, the average U.S. dealers' prices for commercial-grade selenium and average European price for tellurium increased from those of yearend 2009. Estimated global consumption for both metals also increased. 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, as did estimates of global production.

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 were generally lower and 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. The supply of old drums, however, 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. One copper refiner, which generated selenium- and tellurium-containing slimes that were exported for processing, closed in mid-2010. This left only one other U.S. refinery that generated selenium- and tellurium-containing slimes that were exported for processing in 2010. Most of the selenium and tellurium contained in domestic anode slimes came from copper ores in Arizona and Utah. Domestic production of selenium and tellurium remained relatively unchanged in 2010.

With the higher price of tellurium that persisted during 2007–10 and projected increases in demand, tellurium was increasingly viewed as a valuable byproduct. This helped stimulate exploration for gold-telluride ores, including some early stage projects in the Western United States and Mexico.

Consumption

Selenium.—In 2010, world consumption of selenium was estimated to be higher than 2009 consumption owing to the global economic recovery. Selenium consumption in the glass industry increased because of increased glass production. The estimated global distribution of consumption of selenium by application was metallurgy, 30%; glass manufacturing, 30%; agriculture, 10%; chemicals and pigments, 10%; electronics, 10%; and other, 10%.

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 2010, demand for selenium by electrolytic manganese metal producers in China decreased compared with that in 2009 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 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 was used as an alloy with bismuth to substitute for lead 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, the addition of a small amount, about 0.02% by weight, of selenium to low-antimony lead alloys used in the support grids improves 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.

Additionally, 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.

Although conventional silicon-based cells remained the dominant photovoltaic (PV) technology, thin-film PV cells production continued to increase in 2010 to an estimated 14% of the total market share. 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). Several companies announced plans to expand production of nonsilicon-based solar cells within the next several years. Projections indicated that total thin-film capacity would reach 10 gigawatts (GW) by 2012, with a CdTe capacity of 2.47 GW and a CIGS capacity of 2.11 GW. Recent advancements in CIGS thin films have reduced production costs, improved performance, and reduced the environmental impact of production. In 2010, more than 40 companies were involved in the development of CIGS products; however, very few produced cells commercially (Mehta, 2010).

Tellurium.—World demand for tellurium was estimated to have increased in 2010. The leading use for tellurium was as a metallurgical alloying element. 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. Owing to recent higher tellurium prices, many steel and nonferrous metals producers have reduced consumption and found substitutes for tellurium.

Consumption in chemical, catalysts, and other uses declined owing to the recent increases in price. 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.

High-purity tellurium was used in alloys for electronics applications, such as thermal imaging, thermoelectric, phase-change memory, and photoelectric devices. Consumption of tellurium in these applications was estimated to have increase in 2010 because of the global economic recovery.

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 most commonly used in electronics and military applications, such as the cooling of infrared detectors, integrated circuits, laser diodes, and medical instrumentation. The devices were also used in high-end automobile car seats to cool seats on hot days. With the global economic recovery, tellurium consumption in thermoelectric consumer goods increased in 2010.

During 2010, the CdTe thin-film PV cell industry increased investments in research and capacity. First Solar Inc. (Phoenix, AZ), the global leader in CdTe production, had plants in Germany, Ohio, and, Malaysia. In 2010, estimated global production for First Solar rose to 1,300 megawatts (MW) of capacity, from 1,230 MW in 2009, owing to expansion at its plant in Malaysia. First Solar reported plans to expand production to 2,100 MW of capacity by 2012 owing to expansions in Germany and construction of new plants in France and Malaysia. Another CdTe manufacturer, Abound Solar Inc. (Fort Collins, CO), with production facilities in Longmont, CO, had a capacity of 200 MW. In December, the company received a $400 million loan guarantee from the U.S. Department of Energy and planned to build a new 640-MW plant in Tipton, ID. Other manufacturers that were planning to produce CdTe solar cells included Calyxo GmbH (Bitterfeld-Wolfen, Germany), PrimeStar Solar Inc. (Arvada, CO), and Solexant Corp. (San Jose, CA). 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 much of the thin-film industry and has set up solar-cell recycling facilities in Malaysia and the United States (Mehta, 2010; Metal-Pages, 2010a; Runyon, 2010; Wesoff, 2010).

Prices

The Platts Metals Week annual average New York dealer price for selenium was $37.83 per pound in 2010 and was 64% higher than the annual average price in 2009. The price started the year at about $30 per pound, where it remained for the first 2 months of 2010. The price increased to about $39 per pound in March before decreasing to $36 per pound in June. The price rose in September because of increased demand owning to glass and ceramics production in India, and finished the year at $49 per pound (Metal-Pages, 2010c, d).

Metal-Pages published a Rotterdam 99.99%-pure tellurium price, which averaged $221.25 per kilogram in 2010. The price range began the year at $145 to $170 per kilogram and steadily increased until it reached a price range of $230 to $250 per kilogram on May 11. The price range started to decrease in the beginning of July, and by the end of July, the price leveled off at $210 to $230 per kilogram. The price range increased to $220 to $250 per kilogram on October 12 before it jumped to $275 to $300 per kilogram on November 25. The price range decreased slightly on December 23 to $265 to $300 per kilogram.

Foreign Trade

Exports of selenium materials in 2010 increased by 49% compared with those of 2009. In descending order, Germany, Hong Kong, the Republic of Korea, China, Australia, and Japan accounted for 82% of selenium exports in 2010 (table 2). The annual average value of exports in 2010 of $17.41 per kilogram was higher than the $16.79 per kilogram in 2009.

In 2010, imports of selenium (SeO_2 and selenium unwrought and waste and scrap) increased by 82% to 480 metric tons (t) compared with 2009 imports (table 3). China, Belgium, the Philippines, Japan, Germany, Mexico, and Canada, in descending order, accounted for 94% of the imports of selenium metal and SeO_2 into the United States in 2010.

Imports of unwrought tellurium and tellurium waste and scrap decreased by 50% in 2010 compared with imports in 2009. The leading suppliers, in descending order, Canada, the Philippines, China, and Belgium, accounted for 97% of the total imports of tellurium metal into the United States (table 5). The average value of imports in 2010 was $217.14 per kilogram of tellurium, which was the alltime high.

In 2010, tellurium exports rose to 59 t, from 8 t in 2009. The main destinations were, in descending order, China, the United Kingdom, Belgium, the Philippines, Hong Kong, and Canada, which accounted for 97% of total tellurium exports (table 4). The average value of exports of tellurium in 2010 was $91.44 per kilogram, which was lower than the 2009 value of $148.33 per kilogram because of the export of low-value and low-grade tellurium material, such as waste and scrap, because of the higher price of tellurium.

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 selenium trade data.

In 2010, refinery production of selenium, based on data from a select few countries, decreased 3% to 2,120 t (table 6). Average world production was estimated to be about 3,000 to 3,500 metric tons per year (t/yr) of selenium and 450 to 500 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.

Belgium.—In 2010, Umicore Precious Metals Refining received 350,000 t/yr of mixed metal material to recycle. The company has a capacity to produce 600 t/yr of selenium and 150 t/yr of tellurium powder (Metal-Pages, 2010b).

Canada.—In 2010, the Canadian Government estimated selenium production to be 79 t, down by 40% compared with revised 2009 production. Tellurium production in Canada was 8 t, down by 50% from that of 2009 (Natural Resources Canada, 2011).

China.—In 2010, China was the leading consumer of selenium, with 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 1,570 t of selenium products in 2010, a slight increase compared with 2009 imports. China's consumption of selenium was estimated to be 1,500 to 2,000 t/yr, with electrolytic manganese production consuming about 1,000 t/yr and ceramics and glassmaking consuming 350 t/yr combined. In 2010, the country had about 500 t/yr of refined selenium capacity, but this was expected to increase to 600 t/yr when new production techniques were implemented (Roskill's Letters from Japan, 2010a, b; Metal-Pages, 2011).

Apollo Solar Energy, Inc. (Chengdu, Sichuan Province) started up two mines where the main 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 company announced that the indicated and inferred resources for the Dashuigou project were 30,200 t of ore grading 1.09% tellurium and containing 328 t of tellurium, and the Majiagou project resources were 13,400 t of ore grading 3.26% tellurium and containing 437 t of tellurium (Metal-Pages, 2009; Apollo Solar Energy, Inc., 2010, p. 18).

Japan.—The major producers of selenium and tellurium were 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. In 2010, selenium production was estimated to be 754 t, an increase of 5% compared with revised 2009 production. In 2010, stockpiles of selenium dropped to 40 t from 160 t in 2009. Most Japanese production of tellurium was as a byproduct of copper refining, and the majority was exported. Domestic consumption was dominated by Japanese steel industry (Roskill's Letters from Japan, 2010a, b; 2011).

Mexico.—Southern Copper Corp. (Phoenix, AZ) operated the La Caridad precious metals plant in the State of Sonora, which had a capacity to produce 342 kilograms per day of selenium. Production in 2010 likely declined owing to lower production of refined copper (Southern Copper Corp., 2011, p. 37).

Peru.—Southern Copper produced selenium at its Ilo refinery in the southern Peru. In 2010, selenium production was 59,000 kg, up by 5% compared with that of 2009 (Southern Copper Corp., 2011, p. 47).

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 was expected to increase in 2011. Increased recovery rates at copper refiners could increase selenium and tellurium supply, and longer term investments in gold-tellurium deposits and other sources of tellurium, such as the tellurium mines in China, could boost the global rate of tellurium production above the growth in copper 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 increase owing to increased demand from the electrolytic manganese metal industry. Global demand for selenium from glass and solar cell manufacturers will probably increase, as there are few substitutes in glass manufacturing, and the expansion of solar cell production was expected to continue.

In 2011, tellurium consumption was expected to increase, chiefly owing to increased 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 as the cost of tellurium continues to rise; 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)

	2006	2007	2008	2009	2010
Selenium:					
United States:					
Production, primary refined	W	W	W	W	W
Exports	204,000 r	592,000 r	562,000 r	618,000 r	919,000
Imports for consumption	409,000	544,000	519,000	263,000	480,000
Dealers' price, average, commercial grade,[2] dollars per pound	24.57	33.08	32.29	23.07	37.83
World, refinery production	2,090,000 r	2,200,000 r	2,180,000 r	2,190,000 r	2,120,000 e
Tellurium, United States:					
Production, primary refined	W	W	W	W	W
Exports	3,550	15,100	50,000	8,130	59,000
Imports for consumption	14,100	19,800	46,200	38,100	18,900
Price, commercial grade,[3] dollars per kilogram	60.00	110.00	175.00	130.00	221.25

[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 2006–08, 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 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	2009 Quantity (kilograms, contained Se)	2009 Value	2010 Quantity (kilograms, contained Se)	2010 Value
Argentina	5,540	$85,800	6,960	$108,000
Australia	93,200	1,440,000	99,800	2,060,000
Belgium	12,000	138,000	502	7,780
Canada	15,600 r	440,000	26,900	783,000
Chile	2,170	33,700	--	--
China	141,000	2,410,000	101,000	1,530,000
Colombia	3,970	67,500	8,680	99,100
Costa Rica	550	2,940	--	--
France	--	--	263	4,070
Germany	64,200	1,090,000	212,000	3,290,000
Hong Kong	151,000	2,650,000	160,000	3,280,000
India	--	--	5,500	85,300
Indonesia	3,470	51,900	18,500	287,000
Israel	--	--	750	11,600
Italy	245	3,800	--	--
Japan	2,530	39,300	72,600	1,130,000
Korea, Republic of	51,100	832,000	106,000	1,890,000
Malaysia	170	2,630	--	--
Mexico	10,400	172,000	36,100	569,000
Netherlands	--	--	120	3,110
Panama	1,680	26,000	--	--
Peru	841	13,000	6,490	99,100
Philippines	--	--	2,370	40,400
Singapore	6,120	44,800	15,600	121,000
South Africa	141	9,280	11,800	167,000
Sweden	38,700	626,000	--	--
Taiwan	--	--	8,220	133,000
United Kingdom	1,610	25,000	1,950	41,000
Venezuela	11,100	169,000	15,800	246,000
Vietnam	--	--	924	14,300
Total	618,000 r	10,400,000	919,000	16,000,000

[r]Revised. -- 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]

Class and country	2009 Quantity (kilograms, contained Se)	2009 Value	2010 Quantity (kilograms, contained Se)	2010 Value
Selenium:				
Belgium	39,100	$1,760,000	89,200	$7,110,000
Canada	43,000	1,950,000	38,200	2,810,000
China	18,000	1,090,000	96,400	4,580,000
Germany	43,900	2,320,000	47,100	3,660,000
Hong Kong	1	3,400	2,000	148,000
India	--	--	5	7,250
Japan	19,600	846,000	59,400	4,550,000
Korea, Republic of	--	--	6,000	429,000
Mexico	42,000	1,680,000	38,700	2,500,000
Netherlands	1,280	54,000	1	6,550
Peru	1,800	64,000	--	--
Philippines	35,600	2,080,000	72,500	6,660,000
United Kingdom	15,700	897,000	21,400	1,640,000
Total	260,000	12,700,000	471,000	34,100,000
Selenium dioxide:[2]				
China	--	--	6,290	401,000
Germany	3,230	197,000	1,620	159,000
Japan	193	12,700	1,260	65,800
Total	3,420	210,000	9,170	626,000
Grand total	263,000	13,000,000	480,000	34,700,000

-- 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	2009 Quantity (kilograms, contained Te)	2009 Value	2010 Quantity (kilograms, contained Te)	2010 Value
Australia	--	--	489	$73,400
Belgium	213	$32,000	6,540	1,340,000
Brazil	92	16,400	90	14,400
Canada	157	7,540	906	833,000
China	2,010	301,000	25,800	1,850,000
France	13	7,760	243	121,000
Germany	2,250	476,000	746	245,000
Hong Kong	1,880	161,000	1,930	289,000
India	95	13,100	--	--
Japan	--	--	48	9,020
Korea, Republic of	--	--	10	10,600
Mexico	--	--	29	5,230
Philippines	--	--	6,320	185,000
Taiwan	556	81,000	--	--
United Kingdom	878	110,000	15,900	423,000
Total	8,130	1,210,000	59,000	5,400,000

-- 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	2009 Quantity (kilograms, contained Te)	2009 Value	2010 Quantity (kilograms, contained Te)	2010 Value
Belgium	3,220	$227,000	2,050	$440,000
Canada	18,300	4,030,000	26,900	6,100,000
China	39,400	3,310,000	4,050	1,150,000
Germany	12	7,880	33	11,900
Japan	3,020	485,000	31	28,200
Kazakhstan	200	36,000	--	--
Korea, Republic of	500	198,000	--	--
Mexico	2,790	377,000	--	--
Netherlands	52	3,500	--	--
Phillippines	10,200	1,890,000	7,520	1,090,000
Russia	5,780	691,000	680	156,000
Ukraine	--	--	3	11,000
United Kingdom	390	69,000	331	49,400
Total	84,000	11,300,000	41,600	9,040,000

-- 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]	2006	2007	2008[e]	2009[e]	2010[e]
Belgium[e]	200,000	200,000	200,000	200,000	200,000
Canada[4]	106,000	144,000	156,000 [5]	173,000 [5]	79,000 [p]
Chile[e]	74,000	70,000	78,000	90,000 [r]	90,000
Finland[e]	62,000	60,000	64,730 [5]	65,000	60,000
Germany[e]	650,000 [r]	650,000 [r]	650,000 [r]	650,000 [r]	650,000
India[e, 6]	13,000	14,000	14,000	15,000	15,000
Japan	730,100	805,600	754,000 [5]	722,200 [r, 5]	753,300 [5]
Peru	49,800	45,000	45,000	45,000	45,000
Philippines[e]	65,000	65,000	65,000	65,000	65,000
Russia[e]	110,000	120,000	130,000	140,000	140,000
Serbia[e]	7,500	7,500	7,500	7,500	7,500
Sweden[e]	20,000	20,000	20,000	20,000	20,000
United States	W	W	W	W	W
Total	2,090,000 [r]	2,200,000 [r]	2,180,000 [r]	2,190,000 [r]	2,120,000

[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, 2011.

[3]In addition to the countries listed, Australia, China, Iran, Kazakhstan, Mexico, Poland, and Uzbekistan produced refined selenium, but output is not reported, 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: WORLD REFINERY PRODUCTION, BY COUNTRY[1, 2]

(Kilograms, contained tellurium)

Country[3]	2006	2007	2008[e]	2009[e]	2010[e]
Canada[4]	10,000	14,000	19,000	16,000	8,000 [p]
Japan	35,000	41,000	46,500 [r]	49,200 [r]	51,000
Peru	37,000	35,000	28,000	30,000	30,000
Russia[e]	34,000	34,000	34,000	34,000	34,000
United States	W	W	W	W	W

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

[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.