Selenium and Tellurium

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One copper refinery in Texas reported domestic production of primary selenium and tellurium. One producer exported semirefined selenium for toll-refining in Asia, and two other companies generated selenium-containing slimes, which were exported for processing. In 2004, the price for both selenium and tellurium increased as demand for the metals increased and domestic production of primary selenium and tellurium decreased in 2004. Selenium and tellurium, rare elements widely distributed within the Earth's crust, do not occur in concentrations high enough to justify mining solely for their content. They are recovered as byproducts of nonferrous metal mining, mostly from the anode slimes associated with electrolytic refining of copper. Electrolytic refining utilizes a sulfate-base electrolyte for its role in absorbing copper ions on the cathode. This type of electrolyte does not dissolve precious and other base metals, allowing them to accumulate along with refractory components at the bottom of the electrolytic cell. The quantities of metals present in the slimes, such as bismuth, gold, selenium, silver, and tellurium, are dependent on their initial content in the anode material and, therefore, on the ores from which the copper concentrate originated.

Slimes resulting from primary copper metal refining can have average selenium concentrations of 10% and in a few cases as high as 40%. Tellurium concentrations are generally lower, 5% being the maximum (Weerts, 2002). Selenium and tellurium can also be recovered economically from industrial scrap and chemical process residues. Manufacturers recycle obsolete and damaged photoreceptor drums from copy machines that are shipped to refineries for recovery of selenium and tellurium metal.

Legislation and Government Programs

The U.S. Environmental Protection Agency (EPA) proposed revised water quality criterion for selenium pollutants. The new criterion was based on concentration in fish tissue rather than concentration in water. The proposal was aimed at improving the methodologies of the regulations and was favored by most industries. Opponents feared that the proposed regulation would relax the standards for selenium pollution. Contaminants have been linked to coal fire utilities, copper mines, phosphate mines, and agriculture industries (in decreasing order of estimated environmental impact) (U.S. Environmental Protection Agency, 2004; Leavenworth, 2004§[1]).

Production

In the United States, only one domestic copper refinery recovered refined selenium, ASARCO Incorporated (Asarco), Amarillo, TX. Another domestic producer exported semirefined selenium (90% selenium content) for toll-refining in Asia. Two other companies generated selenium-containing slimes, but did not produce selenium. Selenium-containing slimes from these refineries were exported for processing. Most of the selenium and tellurium mined in the United States in 2004 came from Arizona and Utah. It was estimated that, with the higher prices, domestic producers reduced their inventories of selenium material. Domestic production of refined selenium was estimated to have decreased in 2004 compared with that of 2003.

Most domestic selenium is produced as commercial-grade metal, averaging a minimum of 99.5% selenium, and is available in various forms. This commercial-grade selenium is also further refined to make minimum 99.999% selenium for use in thermoelectric applications.

Data on the production of tellurium were not readily available. The world's leading producers, Asarco in the United States and n.v. Umicore s.a. in Belgium, do not publish production figures. Asarco produced commercial-grade tellurium at its refinery complex in Amarillo mainly from copper anode slimes but also from lead refinery skimmings. Asarco also produced tellurium, selenium, and compounds of these metals in high-purity form for specialty applications at its Globe plant in Denver, CO. Domestic production of refined tellurium was estimated to have decreased in 2004 compared with that of 2003. Secondary tellurium was not produced domestically, but some scrap was exported for recycling. Production data reported to the U.S. Geological Survey are treated as company proprietary information.

Consumption

The global consumption of selenium during 2004 was estimated to have been about 2,700 metric tons. The USGS estimated that the global end-use demand in 2004 was as follows: glass, 35%; chemicals and pigments, 24%; metallurgy, 23%; electronics, 10%; and other uses, 8%. Global consumption was estimated to have increased in 2004 owing mostly to China's increase in consumption. Domestic consumption is thought to have decreased in 2004.

In 2004, global tellurium demand was estimated to be about 220 t. Domestically, about 40% of the tellurium was used in metallurgical uses as an alloying element to improve the properties of iron and steel, and 8% was used as an additive to nonferrous metals. Other domestic uses included catalysts and chemicals (24%), photoreceptors and thermoelectric devices (22%), and digital video discs (DVDs) and other minor uses (6%).

Selenium.—In glass manufacturing, selenium is used to decolorize the green tint caused by iron impurities in glass

[1]References that include a section mark (§) are found in the Internet References Cited section.

containers and other soda-lime silica glass. It is also used in art and other glass (such as that used in traffic lights to produce a ruby red color) and in architectural plate glass to reduce solar heat transmission through the glass.

More than one-half of the metallurgical selenium is used as an additive to cast iron, copper, lead, and steel alloys. In these applications, it improves machinability and casting and forming properties.

The use of selenium as an alloy with bismuth to substitute for lead in plumbing increased slightly during 2004 in response to requirements of the Safe Drinking Water Act Amendments of 1996 (Public Law 104-182). The Act requires that no lead be contained in any fixtures, fluxes, pipes, and solders used for the installation or repair of facilities that provide water for human consumption after August 1998.

The addition of a small amount, about 0.02% by weight, of selenium to low-antimony lead alloys used to support the grid of lead-acid batteries improves the casting and mechanical properties of the alloy. Other uses comprise about 9% of the selenium market.

Although it is a diminishing end-use market, electronics accounted for 10% of selenium use. Photoreceptors on the drums of plain-paper copiers had been the leading single application for selenium during the 1970s and 1980s. Organic photoreceptor compounds (OPCs) have replaced these high-purity selenium compounds. OPCs are free of the environmental concerns involved with the disposal of selenium compounds and reportedly offer better performance and lower costs at lower printing speeds. In 2004, selenium was used to make replacement parts for older copiers. While use in photoreceptors has been declining, other electronic uses for selenium, including rectifier and photoelectric applications, have been growing.

Chemical and pigment uses of selenium, which account for approximately 24% of use, include industrial and pharmaceutical applications. Dietary supplements for livestock and humans are a small portion of this category. Selenium added to fertilizer was the larger portion of this category where it was used in growing animal feed. This practice is more common outside the United States, especially in countries with selenium-poor soils. Selenium's principal pharmaceutical use is in shampoo to control dermatitis and dandruff and as an antifungal agent.

Cadmium sulfoselenide compounds are used as pigments in ceramics, glazes, paints, and plastics. Selenium in pigments has good heat stability, reacts well to moisture, and is resistant to ultraviolet or chemical exposure. It can be used to produce a wide range of red, orange, and maroon colors, but because of the relatively high cost and the toxicity of cadmium-base pigments, their use is generally restricted.

Additionally, selenium is used in catalysts to enhance selective oxidation; in plating solutions, where it improves appearance and durability; in blasting caps and gun bluing; in coating digital x-ray detectors; and in zinc selenide for infrared windows in carbon dioxide lasers (Amalgamet Canada, 2003§). In addition, China used selenium dioxide (SeO_2) to increase yields in the electrolytic production of manganese (Selenium-Tellurium Development Association, Inc., 2002§). Using this method requires about a kilogram of selenium per metric ton of manganese (Metal-Pages, 2004b§).

Tellurium.—World demand for tellurium is believed to have increased in 2004. The leading use for tellurium was as a metallurgical alloying element. Approximately 48% of the market demand for tellurium was as an alloy 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.

Chemical and catalyst usage made up about 24% of the domestic market with tellurium being used as a vulcanizing agent and accelerator in the processing of rubber and as a component of catalysts for synthetic fiber production. Electrical uses, such as photoreceptor and thermoelectric applications, accounted for about 22% of tellurium demand. Other uses, including use as an ingredient in blasting caps and as a pigment to produce blue and brown colors in glass and ceramics, were about 6% of consumption.

Tellurium catalysts are used chiefly for the oxidation of organic compounds but are also used in chlorination, halogenation, and hydrogenation reactions. Tellurium dioxide is used as a curing and accelerating agent in rubber compounds.

Consumption of tellurium in electronics applications was estimated to have increased in 2004. High-purity tellurium is used in electronics applications, such as photoelectric and thermoelectric devices. Thermal imaging devices use mercury-cadmium telluride, which assists in converting a raw image into a crisp picture on the screen. Semiconducting bismuth telluride is 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 thermoelement to cool while the other side generates heat.

Thermoelectric coolers are most commonly used in military and electronics applications, such as the cooling of infrared detectors, integrated circuits, laser diodes, and medical instrumentation. Their application in consumer products, such as portable food-and-beverage coolers or automobile car seat cooling systems, continued to increase. Demand for solar cells increased in 2004 and with this the consumption of tellurium and to a lesser extent selenium. Several companies announced plans to expand production of solar cells within the next couple of years.

Prices

Platts Metals Week's average New York dealer price for selenium was $24.89 per pound in 2004. The price range, which had risen sharply in 2003, began the year at $9.00 to $10.50 per pound and steadily rose throughout the year to end the year at $36.00 to $40.00 per pound. The continued increases in demand from China caused the rapid price change.

The United Kingdom price for lump and powder 99.95% tellurium, as published in Mining Journal, started the year at an average of $10.00 per pound. Similar to the selenium price in the past 2 years, the tellurium price increased rapidly. By the end of November, the price reached $22.50 per pound. Demand increases from China and solar cell manufacturers outside of China caused a supply shortfall and led to the price increases.

Trade

The export of selenium material in 2004 decreased by 36% compared with that of 2003. Reduced production and the export in 2003 by producers and consumers of most inventories to Southeast Asia left less material available for trade in 2004. In 2003, the Philippines was the leading recipient of selenium metal, scrap, and waste from the United States, accounting for almost 71% of these U.S. exports; despite an 86% year-on-year decrease in U.S. exports to the Philippines in 2004, that country remained a top destination for selenium products (table 2).

In 2004, imports of SeO_2 unwrought waste and scrap increased by 12% to 412 t compared with 2003 imports (table 3). In 2004, the United States had net imports of 253 t of selenium (including the selenium content of SeO_2) compared with 118 t in 2003. Belgium, Canada, the Philippines, and Germany (in order of decreasing quantity) accounted for 85% of the imports of selenium metal and SeO_2 into the United States in 2004.

Imports of unwrought tellurium and tellurium waste and scrap, on a gross weight basis, increased by 28% during the year (table 4). The leading suppliers were Germany, Canada, Belgium, and the United Kingdom (in order of decreasing quantity) accounting for 88% of the total imports of tellurium metal into the United States. In 2004, tellurium exports decreased by 40% compared with those of 2003. The main destinations of exports in 2004 were to Japan, the Philippines, Spain, and Canada (in descending order); these countries account for more than 84% of total exports.

World Review

World refinery production of primary selenium (excluding U.S. production) decreased by about 9% to 1,330 t (table 5). Japanese output, which accounted for approximately 45% of the world total, decreased by 18% to 599 t. Belgium, Canada, and Japan represented more than 77% of the total world refinery production of selenium and tellurium. About 250 t of secondary selenium is produced worldwide each year.

Global selenium output cannot be easily determined because not all companies report production and because of the trade in semirefined production. Only about 20 of the approximately 80 copper refineries in operation around the world reported recovery of selenium, and less than one-half of that number reported tellurium refining (Selenium-Tellurium Development Association, Inc., 2002).

The driving force behind the worldwide supply shortages in 2004 was demand increases for selenium in China. At yearend, there was little to no selenium being sold on the spot market. Long-term contracts and China's recent purchases had exhausted inventories and committed new production (Mining Journal, 2005a).

Canada.—Yukon Zinc Corporation (Vancouver, British Columbia, Canada) was developing the Wolverine zinc-copper-lead-silver-gold deposit in British Columbia. Once commissioned, the project had the potential to produce 344,000 kilograms per year of selenium for the first 3 years. This would represent more than 25% of 2004 world refinery production. The precious- and base-metal project was planned to be completed by the end of 2007 (Yukon Zinc Corporation, 2005§).

China.—Selenium production in China declined in 2004 as Chinese copper producers reduced the amount of copper concentrates that they imported in 2004. Imported copper concentrates were a main source of China's selenium (Metal-Pages, 2004a§).

China consumed much of the world's production of selenium. In mid-2003, China started importing large quantities of selenium, which led to tight global supplies and soaring prices. The significant increase in consumption has been linked to the increased production of manganese needed by the Chinese steel industry (Metal-Pages, 2004c§). As the Chinese economy continued to expand, demand for building materials grew. Production of selenium-containing products, especially glass, increased. Also, China's soil is very poor in selenium content. To correct this, Chinese fertilizers and animal feed use selenium additives to ensure adequate selenium intake in the diets of Chinese livestock and people (Metal-Pages, 2004e§). By the end of 2004, however, Chinese demand growth had slowed. Increased power costs and higher selenium prices caused some manganese producers to cut back or shut down, and others started to substitute sodium dioxide or sulfur dioxide for SeO_2 (Metal-Pages, 2004f§, 2005a§).

Higher prices reportedly encouraged the Chinese glass industry to start to collect dust and wastes from production to recover secondary selenium (Metal-Pages, 2004e§).

Japan.—Four of the major producers of selenium in Japan were Mitsubishi Materials Corporation; Nippon Mining & Metals Co., Ltd.; Shinko Kagaku Kogyo Co., Ltd.; and Sumitomo Metal Mining Co., Ltd. In 2004, selenium and tellurium production in Japan decreased by 17% and 32%, respectively, owing to a 6% drop in copper ore production and lower selenium content of copper ore. Approximately 47% of Japanese production of selenium was exported directly to China in 2004 (Roskill's Letter from Japan, 2005b). Other destinations for Japanese selenium were Hong Kong, India, and the United Kingdom, in descending order of quantity. During 2004, stocks for selenium fell by 13%, and stocks of tellurium fell by 72% (Roskill's Letter from Japan, 2005a).

Russia.—In 2004, the Russian copper refiner Uralelektromed JSC increased production of selenium by almost 6% and tellurium by 52%. Much of the increases were credited to the extraction of selenium and tellurium from semifinished products (Metal-Pages, 2005b§). The company has also announced that it planned to increase production in 2005 to 87 t of selenium (Metal-Pages, 2005c§).

Current Research and Technology

Selenium's antioxidant and curative properties have been demonstrated to assist with a number of human health problems. The use of selenium as a dietary supplement has been shown to have a positive effect on the following health problems: acquired immune deficiency syndrome (AIDS), Alzheimer's disease, arthritis, asthma, cancer, cardiovascular diseases, pancreatitis, reproduction, thyroid function, and viral infections (Oldfield, 2003). A Cornell University study, however, indicated that selenium could promote type 2 diabetes (Lang, 2004§). Research was ongoing into the role of selenium in reducing the risk of skin cancer from exposures to ultraviolet radiation. There have also been many new promising studies on the possibility of selenium reducing the risk of prostate cancer. The quantity of selenium required for individual medical doses is relatively small and not likely to significantly impact demand. Some countries, however, add selenium to fertilizers to increase the low selenium content of soils. This use requires much larger amounts of selenium than using selenium as a dietary supplement (Oldfield, 2003).

During 2004, several companies received clearance from the U.S. Department of Agriculture Food and Drug Administration (FDA) for amorphous selenium flat-panel detector systems to be used in radiological facilities. The new systems will allow the radiological images to be instantaneously available and in digital format (Analogic Corporation, 2004; Hologic Inc., 2004; Siemens Medical Solutions, 2005). Other new research for the use of selenium and tellurium included the construction of smaller, more flexible, more powerful and lighter solar cells. New technology for nonvolatile memory for computers that utilizes antimony and tellurium phase changing material has been developed by Koninklijke Philips Electronics (Blau, 2005§).

Outlook

The supply of selenium and tellurium are directly affected by the supply of the main product from which it is derived, copper, and to a lesser extent, by the supply of lead, nickel, or zinc where production is from a sulfide ore. Selenium and tellurium prices are often inversely related to the supply of copper. For example, as a byproduct of copper refining, selenium prices typically fall during periods of high copper production. In 2003 and 2004, however, the driving force behind the increased price was short supply brought on by large demand growth, as the production of anode copper grew only marginally. Since selenium and tellurium price has no influence on copper producers, an increase in demand will not cause a jump in the production of copper and its byproducts.

In 2005, domestic refined copper production was expected to fall because of an extended strike and the bankruptcy filing by Asarco, the main domestic producer of selenium and tellurium. In 2006, domestic copper mine and refinery production in the United States were expected to recover to 2003 levels, and world copper production was expected to increase during 2005 and 2006. This in turn could result in increases in the global production of selenium and tellurium. Many selenium and tellurium producers were investigating ways to increase production. However, many of the newer copper mines have a lower selenium and tellurium content than the older mines. Also, with Asarco production not coming back online until 2006, domestic production of selenium and tellurium were estimated to be lower in 2005 than in 2003 and 2004. In addition, though the production of copper anodes was projected to grow in 2005 and 2006, an increasing share of the refined copper will come from the leaching and electrowinning of copper ores, a process that does not provide for the recovery of contained selenium and tellurium. This will continue to constrain the future supply of selenium and tellurium.

Chinese demand for selenium is expected to remain relatively unchanged as the growth in demand by the glass industry, the leading consumer of selenium, counters reduced demand from manganese producers, unless the high price of selenium results in substitution. The glass industry has had a problem in absorbing the higher cost of production owing to the price of selenium materials (Metal-Pages, 2004d§). An increase in demand from plastics and chemical companies in India could further increase demand for selenium (Mining Journal, 2005b).

As with the Chinese manganese industry, demand for selenium in photoreceptors is likely to continue to decline as the cost of substituting organic compounds decreases. Promising prostate cancer research and other health benefits may eventually lead to increased consumption of the metal. Dosages taken directly for human consumption will not induce large increases in demand for the metal because only minute quantities are necessary for effective therapy. Nevertheless, there could be a relatively large consumption increase if selenium is increasingly applied to the soil for crops to be consumed by humans or livestock.

Tellurium supply and demand had remained in fairly close balance for a decade. However, in 2004, demand had outstripped supply, causing the price to climb rapidly. In 2005, tellurium consumption was estimated to have further increased, chiefly from the solar cell manufacturers, as production remained relatively unchanged, extending the supply shortfall and encouraging higher prices.

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TABLE 1
SALIENT SELENIUM AND TELLURIUM STATISTICS[1]

(Kilograms, contained metal, and dollars per pound)

	2000	2001	2002	2003	2004
Selenium:					
United States:					
Production, primary refined	W	W	W	W	W
Shipments to consumers	W	W	W	W	W
Exports	82,100	41,200	86,700	249,000 r	160,000
Imports for consumption	476,000	483,000	422,000	367,000	412,000
Apparent consumption, metal	W	W	W	W	W
Dealers' price, average, commercial grade[2]	$3.84	$3.80	$4.27	$5.68	$24.89
World, refinery production	1,460,000	1,460,000	1,410,000 r	1,470,000 r	1,330,000 e
Tellurium, United States:					
Imports for consumption	52,300	28,000	28,100	48,900	62,800
Price at yearend, commercial grade[r, 3]	$5.00	$7.00	$7.00	$10.00	$22.50

[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. Calculated from published price ranges.
[3]Average yearend price published by Mining Journal for United Kingdom lump and powder, 99.95% tellurium.

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

	2003		2004	
Country	Quantity (kilograms, contained Se)	Value	Quantity (kilograms, contained Se)	Value
Aruba	210	$3,240	--	--
Australia	13,800	207,000	22,800	$497,000
Belgium	18,700	290,000	--	--
Brazil	--	--	1,660	21,000
Canada	5,940 r	168,000 r	1,570	46,600
China	4,900	50,900	4,930	13,300
Colombia	100	8,330	1,630	13,500
Costa Rica	1,750	26,100	2,030	31,400
El Salvador	500 r	7,070 r	3,400	52,700
Finland	--	--	3,750	88,000
France	619	9,580	--	--
Germany	302	4,680	23,900	669,000
Hong Kong	2,290	21,000	7,570	117,000
Italy	--	--	1,070	16,500
Japan	978	20,800	3,850	78,500
Korea, Republic of	2,030	23,900	440	5,400
Malaysia	--	--	2,450	38,000
Mexico	9,030	97,700	26,700	415,000
Netherlands	--	--	7,750	120,000
Philippines	177,000	1,400,000	25,200	390,000
Singapore	5,230	58,600	10,500	72,500
Taiwan	--	--	40	4,360
Thailand	--	--	4,100	38,800
United Kingdom	--	--	1,900	50,300
Venezuela	5,550	51,000	2,300	35,600
Total	249,000 r	2,450,000 r	160,000	2,810,000

[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	2003 Quantity (kilograms, contained Se)	2003 Value	2004 Quantity (kilograms, contained Se)	2004 Value
Selenium:				
Belgium	69,600	$837,000	160,000	$7,310,000
Canada	119,000	1,700,000	90,100	3,280,000
Czech Republic	--	--	1,050	46,800
Germany	23,100	317,000	15,700	688,000
India	11,200	335,000	17,000	314,000
Japan	4,610	139,000	3,550	178,000
Korea, Republic of	20,500	196,000	500	28,100
Mexico	--	--	12,300	172,000
Netherlands	--	--	6,070	271,000
New Zealand	907	6,000	--	--
Peru	-- r	-- r	960	26,500
Philippines	102,000	856,000	79,700	2,880,000
Russia	--	--	14	8,100
Serbia and Montenegro	--	--	231	14,700
United Kingdom	2,230	24,800	14,700	734,000
Total	353,000	4,410,000	402,000	16,000,000
Selenium dioxide:[2]				
Germany	11,100	131,000	6,880	221,000
India	2,840	31,400	2,130	40,100
Japan	354	2,820	1,190	27,300
Spain	213	3,760	71	4,330
Total	14,500	169,000	10,300	293,000
Grand total	367,000	4,580,000	412,000	16,200,000

[r]Revised. -- Zero.

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

[2]Totals revised to 71% of original quantities and values.

Source: U.S. Census Bureau.

TABLE 4

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

Class and country	2003 Quantity (kilograms, contained Te)	2003 Value	2004 Quantity (kilograms, contained Te)	2004 Value
Belgium	17,500	$305,000	15,100	$461,000
Canada	8,170	650,000	15,800	1,280,000
China	190	64,800	115	30,500
Germany	15,700	297,000	16,400	232,000
India	--	--	695	32,100
Japan	12	22,600	126	80,600
Philippines	4,230	137,000	6,430	272,000
Russia	--	--	1	3,620
Ukraine	11	43,700	2	7,570
United Kingdom	3,050	88,600	8,120	222,000
Total	48,900	1,610,000	62,800	2,620,000

-- 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

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

(Kilograms, contained selenium)

Country[3]	2000	2001	2002	2003	2004[e]
Belgium[e]	200,000	200,000	200,000	200,000	200,000
Canada[4]	350,000	238,000	175,000 r	253,000 r	230,000
Chile[e]	40,000	40,000	40,000	40,000	40,000
Finland	36,300	38,900	39,237 r	39,500	39,800
Germany[e]	100,000	100,000	100,000	100,000	100,000
India[e, 5]	11,500	11,500	11,500	12,000	12,000
Japan	612,316	730,895	752,099	733,973 r	599,200 6
Peru	23,100 r	16,100 r	20,600 r	20,600 r, e	20,600
Philippines[e]	40,000	40,000	40,000	40,000	40,000
Serbia and Montenegro	20,000 e	20,000 e	15,000	10,000 r	10,000
Sweden[e]	20,000	20,000	20,000	20,000	20,000
United States	W	W	W	W	W
Zambia[7]	9,820	--	--	--	--
Total	1,460,000	1,460,000 r	1,410,000 r	1,470,000 r	1,330,000

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

[1]World totals, U.S. data, and estimated data have been rounded to 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 May 27, 2005.

[3]In addition to the countries listed, Australia and some countries of the Commonwealth of Independent States, including Kazakhstan, Russia, and Uzbekistan, produced refined selenium, but output is not reported, and available information is inadequate for formulation of reliable estimates of output levels. Australia is known to produce selenium in intermediate metallurgical products and has facilities to produce elemental selenium. In addition to having facilites for processing imported anode simes for the recovery of selenium and precious metals, the United Kingdom has facilities for processing selenium scrap.

[4]Excludes selenium intermediates exported for refining.

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

[6]Reported figure.

[7]Data are for year beginning April 1 of year stated. Gross weight, purity unknown.

TABLE 6

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

(Kilograms, contained tellurium)

Country[3]	2000	2001	2002	2003	2004[e]
Canada[4]	53,000	51,000	39,000 r	40,000 r	40,000
Japan	35,687	39,008	28,656	33,154 r	32,703 5
Peru	22,020 r	19,105 r	21,600 r	22,000 r	20,000
United States	W	W	W	W	W

[e]Estimated. [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, notably the Commonwealth of Independent States and the United States. Table includes data available through May 27, 2005.

[3]In addition to the countries listed, Australia, Belgium, Chile, Germany, the Philippines, and some countries of the Commonwealth of Independent States, including Kazakhstan and Russia, 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.