



# 2013 Minerals Yearbook

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## SELENIUM AND TELLURIUM [ADVANCE RELEASE]

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# SELENIUM AND TELLURIUM

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In 2013, domestic production of selenium and tellurium decreased. Only one copper refinery in Texas reported production of primary refined selenium and tellurium. U.S. consumption of selenium and tellurium also decreased in 2013, while the average U.S. dealers' price for commercial-grade selenium decreased to \$36 per pound from \$54 per pound in 2012, and the average price for tellurium decreased to \$112 per pound from \$150 per pound in 2012.

Except for two mines in China that began mining tellurium as a principal product in 2010, selenium and tellurium were recovered as byproducts of nonferrous metal mining, principally from the anode slimes produced during the electrolytic refining of copper. Selenium and tellurium were also recovered as byproducts from gold, lead, nickel, platinum-group metals, and zinc mining.

In a 2013 survey of 39 electrolytic copper refiners worldwide, 37 and 35 plants, respectively, reported selenium and tellurium in their anode slimes. The selenium-containing slimes averaged 8% selenium by weight, with a few containing as much as 20% selenium. Tellurium concentrations in tellurium-bearing slimes averaged 1% by weight (Moats and others, 2013).

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

The only U.S. producer of refined selenium and tellurium responded to an annual survey of production by the U.S. Geological Survey; however, to avoid disclosing company proprietary data, production data were withheld.

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. 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 decreased in 2013 compared with production in 2012.

With the higher prices of tellurium that prevailed from 2007 to 2011, 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. The decrease

in global consumption of tellurium and the decrease in the price of gold and tellurium during 2013, however, reduced interest in exploration for tellurium.

Pacific Rare Specialty Metals and Chemicals Inc. (PRM) (Cavite, Philippines) announced in August that it would end production of tellurium but would continue to produce selenium for internal needs only, such as the II-VI infrared optics business (Sparks, 2013). PRM's parent company, II-VI Inc. (Saxonburg, PA), cited reducing price volatility and solidifying internal needs of selenium for this decision.

## Consumption

**Selenium.**—In 2013, world consumption of selenium was estimated to have been lower than that in 2012. Global consumption of selenium by application was estimated, in descending order, as metallurgy, 40%; glass manufacturing, 25%; agriculture, 10%; chemicals and pigments, 10%; electronics, 10%; and other, 5% (Selenium Tellurium Development Association, 2010).

The main metallurgical end use for selenium was for the production of electrolytic manganese in China, where selenium dioxide ( $\text{SeO}_2$ ) was substituted for sulfur dioxide to reduce the power required to operate electrolytic cells. In 2013, demand for selenium by electrolytic manganese producers in China decreased compared with that in 2012 owing to decreased consumption of manganese by steel producers. About 1.2 to 2 kilograms of  $\text{SeO}_2$  was used per metric ton of electrolytic manganese produced (Chao, 2013a).

In other metallurgical applications, selenium was used with bismuth to substitute for lead as a free-machining agent in brass plumbing fixtures. The Safe Drinking Water Act Amendments of 1996 (Public Law 104-182) restrict the use of lead in any fixtures, fluxes, pipes, and solders used for the installation or repair of facilities that provide water for human consumption after August 1998. Metallurgical grade selenium was also used as an additive to cast iron, copper, lead, and steel alloys. In these applications, it improves machinability and casting and forming properties.

In the glass industry, 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 in art and other glass to produce a ruby red color and in architectural plate glass to reduce solar heat transmission through the glass.

Selenium is a micronutrient essential to human and animal health and, in areas with selenium-poor soils, selenium has been added to fertilizer and applied to acreage used to grow animal feed to increase selenium in the diet of animals and, in turn, the diet of humans. This practice is more common outside the United States, especially in countries with selenium-poor soils. Selenium's antioxidant and curative properties have been

alleged to have a positive effect in treating the following health problems: acquired immune deficiency syndrome (AIDS), Alzheimer's disease, arthritis, asthma, cancer, cardiovascular diseases, pancreatitis, reproductive problems, thyroid dysfunction, and viral infections.

Cadmium sulfoselenide compounds are used as pigments in ceramics, glazes, paints, and plastics. Selenium pigments have good heat stability, react well to moisture, and are resistant to ultraviolet or chemical exposure. These pigments produce a wide range of red, orange, and maroon colors, but because of the relatively high cost and the toxicity of cadmium-based pigments, their use is limited to applications where cost is not the prevailing factor and human contact is limited, such as art pieces.

In 2013, conventional crystalline silicon-based cells remained the dominant photovoltaic (PV) technology and their market share increased to 90%. Thin-film PV cells production decreased to about 9% of the PV market in 2013, the lowest level since 2006. Selenium was also used in the production of thin-film 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). In 2013, CdTe solar cells accounted for 39% of the thin-film PV market, or about 4% of the total PV cell market, with First Solar Inc. (Phoenix, AZ) accounting for a majority of production. CIGS made up 31% of the thin-film PV market, with Japan-based Solar Frontier KK the leading CIGS producer (Mehta, 2014).

**Tellurium.**—World consumption of tellurium was estimated to have decreased in 2013 because of decreased demand for thermoelectrics in China. In 2010, the Selenium Tellurium Development Association reported that the estimated global distribution of consumption of tellurium by application was in solar cells, 40%; thermoelectrics, 30%; metallurgy, 15%; rubber formulation, 5%; and other applications, 10% (Selenium Tellurium Development Association, 2010). However, U.S. imports for consumption increased in 2013.

As with selenium, tellurium used in solar cells was estimated to have decreased in 2013 because of the decreasing cost of conventional silicon-based cells. The trend toward reduced subsidies through government loans and tariffs continues to encourage the lower cost technology. During 2013, many of the CdTe producers recovered slightly from the economic effects of the expiration of government subsidies. First Solar, the global leader in CdTe thin-film PV cell production, had sales in 2013 that were about the same as those in 2012. The company completed construction of major solar powerplants in Australia, Chile, the Middle East, and the United States (First Solar Inc., 2014, p. 14–16).

Mercury-cadmium-telluride was used in thermal-imaging devices to convert the raw image into a crisp screen picture, 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 semiconducting material couples that, when connected to a direct current, cause one side of the thermo element to cool and the other side to heat. 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 automobiles to cool cup holders and seats.

In metallurgy, tellurium was used in steel as a free-machining additive, in copper to improve machinability without 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 estimates of chemical, catalyst, and other uses of tellurium remained stable, owing to decreasing price volatility. 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 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 \$36 per pound in 2013, 34% less than the annual average price in 2012. The price range began the year at \$42 to \$48 per pound and slowly decreased through mid-July when the price dropped sharply to a range of \$23 to \$28 per pound by the beginning of August 2013. The price peaked in late September, with a range of \$29 to \$33 per pound before returning to the August price range.

The Metal-Prices published Rotterdam 99.99%-pure tellurium price averaged \$112 per kilogram in 2013, a 25% decrease from the 2012 price. The price range at the beginning of 2013 was \$105 to \$130 per kilogram and slowly decreased throughout the year to a yearend range of \$80 to \$100 per kilogram. In July, a short-lived spike in the price range to \$120 to \$150 per kilogram was due to the start of trading of tellurium on China's Fanya Metal Exchange (Chao, 2013b, f, g).

### Foreign Trade

Exports of selenium materials in 2013 decreased by 32% to 648 kilograms of contained selenium from those in 2012. In descending order, the Republic of Korea, Hong Kong, Canada, Germany, Japan, Indonesia, Australia, and Mexico were the destinations for 88% of selenium exports in 2013. Based on unrounded data, the annual average value of exports in 2013 was \$20.06 per kilogram, 3% less than the 2012 annual average (table 2). Based on the low value, much of the material reported as selenium is unrefined metal, residues, and scrap.

In 2013, imports of selenium decreased by 4% to 442 kilograms of contained selenium. Japan, Belgium, China, Germany, Mexico, Canada, and the Philippines, in descending order, accounted for 85% of the imports of selenium into the United States in 2013. Based on unrounded data, the annual average value of imported selenium in 2013 was \$77.34 per kilogram, 21% less than 2012 (table 3).

Only three countries, China, Japan, and Germany, in decreasing order, supplied the United States with SeO<sub>2</sub> in 2013, with China accounting for more than 55% of the imports (table 3). In 2013, imports of SeO<sub>2</sub> decreased to 14 kilograms of

contained selenium, a 30% decrease from 2012 imports. Based on unrounded data, the annual average value of imports of SeO<sub>2</sub> was \$59.93 per kilogram, about a 13% decrease compared with that of 2012.

In 2013, tellurium exports decreased to 42 kilograms of contained tellurium, an 11% decrease compared with exports in 2012 (table 4). The main destinations were, in descending order, Canada, Germany, Mexico, and the Republic of Korea, which accounted for 96% of total tellurium exports. Imports of tellurium increased by almost 77% in 2013 compared with imports in 2012 (table 5). The leading suppliers, in descending order, China, Belgium, Canada, and the Philippines, accounted for 98% of the total imports of tellurium into the United States.

## World Review

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

**China.**—In 2013, China increased its imports of selenium and increased the number of countries it imported from to 21. Despite being a significant producer of selenium, China depended on imports for most of its selenium needs and imported 1,750 t of selenium products in 2013, a 9% increase compared with 2012 imports (Chao, 2014).

**Russia.**—In January, Ural Mining and Metallurgical Co. (UUMC) (Verkhnyaya Pyshma) announced the opening of the new tellurium production area at its Urালেktromed plant. Tellurium production was expected to increase by 30 metric tons per year (t/yr) to 40 t/yr. The expansion cost \$3.02 million (105 million rubles) (Ural Mining and Metallurgical Co., 2013).

## 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. 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 could boost the global rate of growth for tellurium production above the rate of 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 decreasing during the past several years owing to the reduction in available scrapped 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 and they could capture selenium and tellurium from CIGS and CdTe cells.

Global selenium consumption by solar manufacturers is expected to increase, while global demand for selenium by glass manufacturers is expected to decrease in 2014. Demand from China is expected to decrease further owing to reduced

demand for electrolytic manganese and a stagnant glass industry (Chao, 2013a, d, e).

In 2014, tellurium consumption is expected to decrease, chiefly owing to decreased production of electronics and solar cells, which could be offset by increased demand for stocks on the Fanya Metal Exchange. Consumption for metallurgical alloying and chemicals is expected to decrease, assuming the price of tellurium remains relatively volatile; producers of low-value products are expected to find substitutes.

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TABLE 1  
 SALIENT SELENIUM AND TELLURIUM STATISTICS<sup>1</sup>

(Kilograms, contained metal, unless otherwise specified)

	2009	2010	2011	2012	2013
<b>Selenium:</b>					
<b>United States:</b>					
Production, primary refined	W	W	W	W	W
Exports	613,000	857,000	1,350,000	952,000 <sup>r</sup>	648,000
Imports for consumption, total	263,000	480,000	601,000	460,000 <sup>r</sup>	442,000
Dealers' price, average, commercial grade, <sup>2</sup> dollars per pound	23.07	37.83	66.35	54.47	36.17
World, refinery production	2,160,000 <sup>r</sup>	2,150,000 <sup>r</sup>	2,170,000 <sup>r</sup>	2,110,000 <sup>r</sup>	2,170,000 <sup>e</sup>
<b>Tellurium, United States:</b>					
Production, primary refined	W	W	W	W	W
Exports	8,700	59,000	38,600	47,400	42,300
Imports for consumption	84,000	41,600	70,800	36,100	63,900
Price, commercial grade, <sup>3</sup> dollars per kilogram	157.50	221.25	349.35	149.66	111.95

<sup>e</sup>Estimated. <sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data.

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

<sup>2</sup>Source: Platts Metals Week.

<sup>3</sup>For 2009, the price was the average December 31 price published by Metal-Pages.com for IWH Rotterdam, 99.99% tellurium. For 2010–13, the price was the annual average price published by Metal-Pages.com for IWH Rotterdam, 99.99% tellurium.

TABLE 2  
U.S. EXPORTS OF SELENIUM<sup>1</sup>

Country	2012		2013	
	Quantity (kilograms, contained Se)	Value	Quantity (kilograms, contained Se)	Value
Australia	115,000	\$3,400,000	25,200	\$748,000
Belgium	24,000	371,000	--	--
Brazil	--	--	1,180	18,300
Canada	24,400	685,000	71,800	2,010,000
China	101,000	1,880,000	15,100	131,000
Colombia	3,770	41,200	--	--
Dominican Republic	1,340	20,800	--	--
Egypt	--	--	2,640	22,200
France	610	9,450	--	--
Germany	93,400	2,570,000	56,400	861,000
Gibraltar	--	--	1,460	5,170
Hong Kong	130,000	3,160,000	115,000	2,270,000
Indonesia	60,000	929,000	43,900	681,000
Israel	--	--	300	4,650
Japan	62,200	1,260,000	53,400	1,570,000
Korea, Republic of	202,000	3,130,000	206,000	3,760,000
Latvia	10,000	61,500	--	--
Mexico	53,700	832,000	20,500	353,000
Panama	2,270	35,200	--	--
Peru	12,700	196,000	1,530	23,600
Philippines	20,000	571,000	1,600	27,200
Singapore	1,810	22,700	--	--
South Africa	5,640	56,100	3,180	41,000
Sweden	53	4,070	--	--
Taiwan	22,200	345,000	18,600	289,000
Thailand	1,330	34,400	--	--
Venezuela	4,590	71,100	10,600	169,000
Total	952,000	19,700,000	648,000	13,000,000

-- Zero.

<sup>1</sup>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<sup>1</sup>

Class and country	2012		2013	
	Quantity (kilograms, contained Se)	Value	Quantity (kilograms, contained Se)	Value
<b>Selenium:</b>				
Australia	3,990	\$27,900	3,310	\$25,400
Belgium	63,700	8,240,000	70,800	6,100,000
Canada	34,200	3,030,000	28,600	2,000,000
China	69,800	9,120,000	64,300	4,870,000
Germany	48,100	5,920,000	45,000	4,060,000
Italy	--	--	2,480	74,200
Japan	90,400	9,560,000	90,700	5,980,000
Korea, Republic of	22,000	1,290,000	12,400	796,000
Mexico	47,800	5,470,000	36,300	2,650,000
Norway	--	--	18,100	1,360,000
Peru	--	--	240	12,600
Philippines	39,700	5,420,000	28,100	2,730,000
Spain	--	--	5	5,920
Thailand	--	--	1,200	63,600
United Kingdom	20,300	1,110,000	26,500	2,340,000
<b>Total</b>	<b>440,000</b>	<b>49,200,000</b>	<b>428,000</b>	<b>33,100,000</b>
<b>Selenium dioxide:<sup>2</sup></b>				
China	15,300 <sup>r</sup>	1,040,000	7,790	582,000
Germany	2,360 <sup>r</sup>	206,000	2,360	162,000
Japan	2,300 <sup>r</sup>	115,000	3,880	97,400
<b>Total</b>	<b>19,900<sup>r</sup></b>	<b>1,370,000</b>	<b>14,000</b>	<b>841,000</b>
<b>Grand total</b>	<b>460,000<sup>r</sup></b>	<b>50,600,000</b>	<b>442,000</b>	<b>33,900,000</b>

<sup>r</sup>Revised. -- Zero.

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

<sup>2</sup>Selenium content calculated as 71% of gross weight of material.

Source: U.S. Census Bureau.

TABLE 4  
U.S. EXPORTS OF TELLURIUM<sup>1</sup>

Country	2012		2013	
	Quantity (kilograms, contained Te)	Value	Quantity (kilograms, contained Te)	Value
Australia	754	\$459,000	369	\$29,200
Belgium	2,420	318,000	--	--
Brazil	442	64,000	118	16,300
Canada	948	201,000	34,300	1,220,000
China	3,970	480,000	481	79,500
Costa Rica	180	27,000	--	--
Denmark	12	5,530	--	--
France	25	34,600	--	--
Germany	1,540	421,000	2,590	768,000
Hong Kong	33,700	3,650,000	--	--
India	20	13,300	--	--
Japan	--	--	380	35,300
Jordan	40	6,000	242	36,300
Korea, Republic of	21	27,300	1,760	267,000
Mexico	--	--	1,910	201,000
Philippines	2,960	118,000	--	--
Switzerland	--	--	140	21,700
Taiwan	336	66,600	24	3,250
United Kingdom	30	8,730	--	--
Total	47,400	5,900,000	42,300	2,670,000

-- Zero.

<sup>1</sup>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<sup>1</sup>

Country	2012		2013	
	Quantity (kilograms, contained Te)	Value	Quantity (kilograms, contained Te)	Value
Belgium	1,200	\$287,000	17,900	\$907,000
Canada	22,000	4,370,000	13,700	1,260,000
China	5,760	1,950,000	21,200	3,220,000
France	25	34,400	--	--
Germany	19	16,500	32	26,200
Japan	9	18,100	263	55,400
Malaysia	100	4,640	--	--
Peru	--	--	979	92,000
Philippines	6,480	1,970,000	9,840	1,230,000
United Kingdom	500	96,000	--	--
Total	36,100	8,740,000	63,900	6,790,000

-- Zero.

<sup>1</sup>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<sup>1,2</sup>

(Kilograms, contained selenium)

Country <sup>3</sup>	2009	2010	2011	2012	2013 <sup>e</sup>
Belgium <sup>e</sup>	200,000	200,000	200,000	200,000	200,000
Canada <sup>4</sup>	173,000 <sup>r</sup>	79,000 <sup>r</sup>	35,000 <sup>r</sup>	144,000 <sup>r,e</sup>	159,000
Chile <sup>e,5</sup>	90,000	70,000 <sup>r</sup>	75,000 <sup>r</sup>	75,000 <sup>r</sup>	75,000
Finland	59,040	73,130	85,663	92,769	92,000
Germany <sup>e,6</sup>	600,000	650,000	700,000	650,000	700,000
India <sup>e,7</sup>	15,000	15,000	16,000	16,000	17,000
Japan	709,000	754,000 <sup>r</sup>	750,000	755,000 <sup>e</sup>	760,000
Peru	61,000	59,000	54,000	50,000 <sup>e</sup>	50,000
Poland	73,000	79,000	85,000 <sup>r,5</sup>	90,000 <sup>r,5</sup>	90,000
Russia <sup>e</sup>	140,000	140,000	140,000	145,000	150,000
Serbia	19,075	10,592	12,947	13,200 <sup>e</sup>	13,000
Sweden <sup>e</sup>	20,000	20,000	20,000	20,000	20,000
United States	W	W	W	W	W
Total	2,160,000 <sup>r</sup>	2,150,000 <sup>r</sup>	2,170,000 <sup>r</sup>	2,110,000 <sup>r</sup>	2,170,000

<sup>e</sup>Estimated. <sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; not included in total.

<sup>1</sup>Totals and estimated data have been rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>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. Includes data available through July 4, 2014.

<sup>3</sup>In addition to the countries listed, Australia, China, Iran, Kazakhstan, Mexico, the Philippines, and Uzbekistan produced refined selenium, but output was not reported; available information was inadequate for the 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 facilities for processing imported anode slimes for the recovery of selenium and precious metals, the United States has facilities for processing selenium scrap.

<sup>4</sup>Excludes selenium intermediates exported for refining.

<sup>5</sup>In 2012, the noble metals plant at Ventanas temporarily stopped production for limited periods of time during the fourth quarter of 2012, and planned to continue to limit production during the first quarter of 2013.

<sup>6</sup>In 2010, RETORTE GmbH substantially increased its production capacity for high-purity selenium, but actual production appeared to decrease in 2012 (in response to decreased demand).

<sup>7</sup>Data are for the fiscal year beginning April 1 of the year stated.

TABLE 7  
TELLURIUM: ESTIMATED WORLD REFINERY PRODUCTION, BY COUNTRY<sup>1,2,3</sup>

(Kilograms, contained tellurium)

Country <sup>4</sup>	2009	2010	2011	2012	2013
Canada <sup>5</sup>	16,000	8,000	6,000 <sup>r</sup>	11,000 <sup>r</sup>	12,000 <sup>p</sup>
Japan	49,200	47,000	40,000	45,000	48,000
Peru	7,000 <sup>6</sup>	--	--	--	--
Russia	34,000	34,000	34,000	35,000	35,000
United States	W	W	W	W	W

<sup>p</sup>Preliminary. <sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data. -- Zero.

<sup>1</sup>Estimated data are rounded to no more than three significant digits.

<sup>2</sup>Table includes data available through March 2, 2015.

<sup>3</sup>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.

<sup>4</sup>In addition to the countries listed, Australia, Belgium, Chile, China, Colombia, Germany, Kazakhstan, Mexico, the Philippines, Poland, and Sweden are known to produce refined tellurium, but output is not reported; available information is inadequate for formulation of reliable estimates of output levels.

<sup>5</sup>Excludes tellurium intermediates exported for refining.

<sup>6</sup>Reported figure.