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SELENIUM AND TELLURIUM [ADVANCE RELEASE]

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Selenium and Tellurium

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In 2012, the average U.S. dealers' price for commercial-grade selenium and the average European price for tellurium decreased from those of 2011. Estimated global consumption and production for both metals also decreased. One copper refinery in Texas reported domestic production of primary refined selenium and tellurium. Domestic production of selenium and tellurium was estimated to have decreased 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 worldwide electrolytic copper refiners, 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

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 was estimated to have decreased in 2012 as compared to production in 2011.

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 and the decrease in the price of tellurium during 2012 have reduced interest in exploration for tellurium.

Consumption

Selenium.—In 2012, world consumption of selenium was estimated to have been lower than that in 2011. The global distribution of consumption of selenium by application was estimated as metallurgy, 40%; glass manufacturing, 25%; agriculture, 10%; chemicals and pigments, 10%; electronics, 10%; and other, 5%.

The main metallurgical end use for selenium 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 2012, demand for selenium by electrolytic manganese producers in China decreased compared with that in 2011 owing to decreased consumption of manganese by steel producers. About 1.2 to 2 kilograms of SeO_2 was used per metric ton of electrolytic manganese produced (Chao, 2012b).

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 the human population. 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 were 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, use of these pigments is limited to applications where cost is not the prevailing factor and human contact is limited, such as art pieces.

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). In 2012, conventional silicon-based cells remained the dominant PV technology and their PV market share increased to 89%. Production of thin-film PV cells decreased to about 11% of the PV market in 2012 because the cost of producing conventional silicon-based solar cells plummeted. In 2012, CIGS solar cells were only 19% of the thin-film PV market, with Japan-based Solar Frontier KK the leading CIGS producer (Mehta, 2013).

Tellurium.—World consumption of tellurium was estimated to have decreased in 2012 because of declining demand for solar cells and decreased demand for thermoelectrics in China. The estimated global distribution of consumption of tellurium by application was 40% in solar cells, 30% in thermoelectrics, 15% in metallurgy, 5% in rubber formulation, and 10% in other.

As with selenium, tellurium used in solar cells was estimated to have decreased in 2012 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 2012, many of the CdTe producers faced economic difficulties. Although First Solar Inc. (Phoenix, AZ), the global leader in CdTe production, with plants in Arizona and Ohio in the United States and in Germany and Malaysia, sold more solar cells in 2012 than in 2011, the company closed its plant in Germany and canceled plans for new plants in France and Vietnam. In 2012, Abound Solar Inc. (Fort Collins, CO) with production facilities in Longmont, CO, filed for Chapter 11 bankruptcy protection. Other companies, including Solexant Corp. (San Jose, CA) and General Electric's CdTe plant in Colorado, halted research on CdTe solar technology. In 2012, CdTe solar cells made up about 45% of the thin-film PV market (Cammell, 2012; First Solar Inc., 2013, p. 47; Mehta, 2013; Wesoff, 2013).

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 which, 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 in metallurgical applications continued to decline owing to increasing tellurium price volatility, which encouraged many steel and nonferrous metals producers to reduce consumption and find substitutes for tellurium.

Consumption in chemical, catalyst, and other uses continued to decline owing to increasing tellurium 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 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 $54 per pound in 2012, 18% lower than the annual average price in 2011. The price range began the year at $65 to $70 per pound and slowly declined through mid-July when the price dropped sharply to a range of $40 to $42 per pound by the beginning of August. The decline coincided with weak demand from Chinese manganese producers and a slowdown of China's economy. The price remained at this level before increasing to a range of $42 to $48 per pound in October, where it remained for the rest of the year (Chao, 2012d).

The Metal-Pages published Rotterdam 99.99%-pure tellurium price averaged $150 per kilogram in 2012, a 57% decrease from the 2011 price. The price range at the beginning of the year was $220 to $300 per kilogram but, owing to decreased demand from solar cell and thermoelectric manufacturers, it steadily decreased until reaching a price range of $90 to $130 per kilogram on August 14. The price range increased through late October, reaching $140 to $160 per kilogram, coinciding with an increase in consumption by China's thermoelectric producers. By yearend, however, the price range had declined to $105 to $130 per kilogram (Chao, 2012a, e, f).

Foreign Trade

Exports of selenium materials in 2012 decreased 29% to 952 metric tons (t) from exports in 2011. In descending order, the Republic of Korea, Hong Kong, Australia, China, Germany, Japan, Indonesia, and Mexico, accounted for 86% of selenium exports in 2012. The annual average value of exports in 2012 was $20.67 per kilogram, 13% higher than the 2011 annual average (table 2).

In 2012, imports of selenium unwrought metal, waste and scrap decreased by 25% to 440 t. Japan, China, Belgium, Germany, Mexico, the Philippines, and Canada, in descending order, accounted for 89% of the imports of selenium metal, waste, and scrap into the United States in 2012. The annual average value of imported selenium metal, waste, and scrap in 2012 was $111.79 per kilogram, 6% lower than the $118.38 per kilogram in 2011 (table 3).

There were only three countries that supplied the United States with SeO_2 in 2012, China, Germany, and Japan, in decreasing order, with China accounting for more than 75% of the imports. In 2012, imports of SeO_2 increased to 14 t, a 13% increase from 2011 imports. The annual average value of imports of SeO_2 was $96.49 per kilogram, a 59% increase compared with that of 2011.

In 2012, tellurium exports increased to 47 t, a 23% increase compared with exports in 2011. The main destinations were, in descending order, Hong Kong, China, the Philippines, Belgium, and Germany, all of which accounted for 94% of total tellurium exports. The average value of exports of tellurium in 2012 was $124.35 per kilogram, which was 33% less than the 2011 value (table 4).

Imports of unwrought tellurium and tellurium waste and scrap decreased by almost one-half in 2012 compared with imports in 2011. The leading suppliers, in descending order, Canada, the Philippines, and China, accounted for 95% of the total imports of tellurium metal into the United States. The average value of imports in 2012 was $242.26 per kilogram of tellurium, which was 31% higher than that in 2011 (table 5).

World Review

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

In 2012, based on available data from a few countries, refinery production of selenium decreased slightly to 2,240 t (table 6). Based on global copper refinery data (Moats and others, 2007, p. 202–241; 2013), the U.S. Geological Survey estimated that world production in 2012 was about 2,700 to 3,000 t of selenium and 550 to 600 t of tellurium. Some analysts thought that tellurium production in 2012 was 20% to 30% lower than production in 2011, due to the decreasing price and weak demand (Chao, 2012g).

China.—In 2012, China was the leading consumer of selenium, accounting for about 40% to 50% of world consumption. Despite being a significant producer of selenium, China depends on imports for most of its selenium needs and imported 1,610 t of selenium products in 2012, a 3% increase compared with 2011 imports. About 75% of China's selenium consumption was used in the production of manganese (Chao, 2012c, 2013).

In 2012, China's production of 99.99% minimum tellurium was about 175 t, a 44% decrease from the 315 t produced in 2011. About 50% of China's tellurium consumption was used in thermoelectric production and 40% was used in the production of CdTe solar cells (Chao, 2012f, g).

Jinwang Bismuth opened a new plant in Chenzhou in 2012. The new $79 million plant has a capacity of 4,000 metric tons per year (t/yr) of high-grade bismuth, 260 t/yr of silver, 200 t/yr of tellurium, and 10 t/yr of gold (Chao, 2012a).

Russia.—Ural Mining and Metallurgical Co. (UUMC) (Verkhnyaya Pyshma) announced plans to expand production at its Uralelektromed plant from 30 to 40 t/yr by mid-2013. The expansion was estimated to cost $3.02 million (105 million rubles) (Ural Mining and Metallurgical Co., 2013).

Sweden.—The Boliden Group's Kankberg gold and tellurium mine started up in March 2012. The underground mine had mineral reserves of 3.58 million metric tons, with a gold grade of 3.8 grams per metric ton (g/t) and a tellurium grade of 177 g/t. The mine expected to produce 1.15 t/yr of gold and 41 t/yr of tellurium through 2020 (Boliden Group, 2013, p. 43).

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 declining 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.

Demand from China for selenium was expected to increase owing to the cancellation of the 20% export duty on electrolytic manganese in 2013 (Chao, 2013). In 2013, the selenium consumption from solar manufacture was expected to remain about the same as that in 2012. However, global demand for selenium from glass manufacturing was expected to decline in 2013.

In 2013, tellurium consumption was expected to decrease, chiefly owing to decreased electronics and solar-cell production. Consumption for metallurgical alloying and chemicals was expected to decrease, assuming the price of tellurium continues to remain volatile; 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)

	2008	2009	2010	2011	2012
Selenium:					
United States:					
Production, primary refined	W	W	W	W	W
Exports	545,000 r	613,000 r	857,000 r	1,350,000 r	952,000
Imports for consumption	519,000	263,000	480,000	601,000	454,000
Dealers' price, average, commercial grade,[2] dollars per pound	32.29	23.07	37.83	66.35	54.47
World, refinery production	2,260,000 r	2,120,000 r	2,180,000 r	2,280,000 r	2,240,000 e
Tellurium, United States:					
Production, primary refined	W	W	W	W	W
Exports	50,000	8,700	59,000	38,600	47,400
Imports for consumption	102,000	84,000	41,600	70,800	36,100
Price, commercial grade,[3] dollars per kilogram	210.58 r	157.50 r	221.25	349.35	149.66

[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 2008, annual 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 December 31 price published by Metal-Pages.com for IWH Rotterdam, 99.99% tellurium. The 2010–12 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	2011 Quantity (kilograms, contained Se)	2011 Value	2012 Quantity (kilograms, contained Se)	2012 Value
Australia	131,000	$2,410,000	115,000	$3,400,000
Belgium	18,800 r	108,000 r	24,000	371,000
Bolivia	1,130	13,300	--	--
Canada	119,000 r	3,340,000 r	24,400	685,000
Chile	4,760	73,700	--	--
China	181,000 r	2,800,000 r	101,000	1,880,000
Colombia	10,500 r	140,000 r	3,770	41,200
Dominican Republic	397 r	6,150 r	1,340	20,800
Ecuador	2,210	35,100	--	--
France	166	2,580	610	9,450
Germany	159,000	2,870,000	93,400	2,570,000
Hong Kong	168,000	3,400,000	130,000	3,160,000
India	306 r	4,750 r	--	--
Indonesia	22,800	354,000	60,000	929,000
Israel	979	15,200	--	--
Japan	210,000	3,950,000	62,200	1,260,000
Korea, Republic of	201,000 r	3,530,000 r	202,000	3,130,000
Latvia	--	--	10,000	61,500
Malaysia	2,310	35,900	--	--
Mexico	45,600 r	707,000 r	53,700	832,000
Netherlands	136	3,240	--	--
Panama	2,610	40,500	2,270	35,200
Peru	3,360	51,500	12,700	196,000
Philippines	--	--	20,000	571,000
Singapore	19,200	152,000	1,810	22,700
South Africa	8,470 r	110,000 r	5,640	56,100
Sweden	94	7,330	53	4,070
Taiwan	5,640	87,400	22,200	345,000
Thailand	--	--	1,330	34,400
United Kingdom	5,960	92,400	--	--
Venezuela	21,000	327,000	4,590	71,100
Vietnam	1,910	29,700	--	--
Total	1,350,000 r	24,700,000 r	952,000	19,700,000

[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]

	2011		2012	
Class and country	Quantity (kilograms, contained Se)	Value	Quantity (kilograms, contained Se)	Value
Selenium:				
Australia	4,000	$209,000	3,990	$27,900
Belgium	105,000	14,600,000	63,700	8,240,000
Canada	47,500	5,170,000	34,200	3,030,000
China	86,000	12,200,000	69,800	9,120,000
Germany	54,700	7,100,000	48,100	5,920,000
India	5	7,250	--	--
Italy	5,000	835,000	--	--
Japan	118,000	10,300,000	90,400	9,560,000
Korea, Republic of	2,500	264,000	22,000	1,290,000
Mexico	45,700	5,330,000	47,800	5,470,000
Norway	31,300	1,100,000	--	--
Papua New Guinea	64	8,550	--	--
Peru	4,370	343,000	--	--
Philippines	67,500	9,680,000	39,700	5,420,000
United Kingdom	17,000	2,500,000	20,300	1,110,000
Total	589,000	69,700,000	440,000	49,200,000
Selenium dioxide:[2]				
China	10,100	542,000	10,800	1,040,000
Germany	978	141,000	1,680	206,000
Japan	1,480	75,000	1,630	115,000
Total	12,500	758,000	14,200	1,370,000
Grand total	601,000	70,400,000	454,000	50,600,000

-- 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	2011 Quantity (kilograms, contained Te)	2011 Value	2012 Quantity (kilograms, contained Te)	2012 Value
Australia	--	--	754	$459,000
Austria	3	$3,670	--	--
Bangladesh	140	11,000	--	--
Belgium	4,320	684,000	2,420	318,000
Brazil	191	55,300	442	64,000
Canada	3,300	1,320,000	948	201,000
China	24,800	3,610,000	3,970	480,000
Costa Rica	794	53,000	180	27,000
Denmark	--	--	12	5,530
France	24	33,700	25	34,600
Germany	2,240	1,070,000	1,540	421,000
Hong Kong	1,610	124,000	33,700	3,650,000
India	--	--	20	13,300
Japan	46	11,400	--	--
Jordan	--	--	40	6,000
Korea, Republic of	20	21,800	21	27,300
Philippines	911	169,000	2,960	118,000
Taiwan	166	45,200	336	66,600
United Kingdom	--	--	30	8,730
Total	38,600	7,210,000	47,400	5,900,000

-- 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	2011 Quantity (kilograms, contained Te)	2011 Value	2012 Quantity (kilograms, contained Te)	2012 Value
Belgium	3,080	$765,000	1,200	$287,000
Canada	46,400	4,830,000	22,000	4,370,000
Chile	888	345,000	--	--
China	10,700	3,930,000	5,760	1,950,000
France	--	--	25	34,400
Germany	6	7,290	19	16,500
Hong Kong	80	30,800	--	--
Japan	60	119,000	9	18,100
Malaysia	--	--	100	4,640
Philippines	8,380	2,630,000	6,480	1,970,000
Ukraine	273	35,100	--	--
United Kingdom	980	367,000	500	96,000
Total	70,800	13,100,000	36,100	8,740,000

-- 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]	2008	2009	2010	2011	2012
Belgium[e]	200,000	200,000	200,000	200,000	200,000
Canada[4]	191,000 r	131,000 r	97,000	128,000 r	144,000 p, e
Chile[e, 5]	78,000	90,000	90,000	90,000	70,000
Finland	64,730	59,040 r	73,130 r	85,663 r	92,769
Germany[e, 6]	650,000	600,000 r	650,000	700,000 r	650,000
India[e, 7]	14,000	15,000	15,000	16,000	16,000
Japan	754,000 r	709,000 r	750,000 r	750,000 r, e	755,000 e
Peru	60,000 e	61,000	59,000	54,000 r	50,000 e
Poland	82,000	73,000	79,000	80,000 e	80,000 e
Russia[e]	130,000	140,000	140,000	140,000 r	145,000
Serbia	16,827	19,075	10,592	12,947 r	13,200 e
Sweden[e]	20,000	20,000	20,000	20,000	20,000
United States	W	W	W	W	W
Total	2,260,000 r	2,120,000 r	2,180,000 r	2,280,000 r	2,240,000

[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. Includes data available through July 24, 2013.

[3]In addition to the countries listed, Australia, China, Iran, Kazakhstan, Mexico, the Philippines, and Uzbekistan produced refined selenium, but output is not reported; 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 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]In 2012, the noble metals plant at Ventanas faced protests against its emissions, and had to temporarily stop production for limited periods of time during the final quarter of 2012, and planned to continue to limit production during the first quarter of 2013.

[6]In 2011, RETORTE GmbH substantially increased its production capacity for high-purity selenium, but actual production appeared to decrease in 2012 (in response to decreased demand).

[7]Data are for India's fiscal year beginning April 1 of year stated.

TABLE 7
TELLURIUM: ESTIMATED WORLD REFINERY PRODUCTION, BY COUNTRY[1, 2, 3]

(Kilograms, contained tellurium)

Country[4]	2008	2009	2010	2011	2012
Canada[5]	20,000 r	16,000	8,000	9,000 r	11,000 p
Japan	46,500	49,200	47,000	40,000	45,000
Peru	28,000 6	7,000 6	--	--	--
Russia	34,000	34,000	34,000	34,000	35,000
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]Includes data available through July 24, 2013.

[3]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 were excluded to avoid double counting. Table is not totaled because of exclusion of data from major world producers.

[4]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.

[5]Excludes tellurium intermediates exported for refining.

[6]Reported figure.