PERU MERCURY INVENTORY 2006

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Conversion Factors

Multiply	By	To obtain
centimeter (cm)	0.3937	inch (in.)
gram (g)	0.03527	ounce, avoirdupois (oz)
kilogram (kg)	2.204	pounds
kilograms per year (kg/yr)	2.204	pounds per year
kilometer (km)	0.6214	mile (mi)
liter (L)	33.82	ounce, fluid (fl. oz)
meter (m)	3.281	foot (ft)
metric ton (t)	1.10231	short ton
metric ton per year (t/yr)	1.102	ton per year (ton/yr)
square kilometer (km^2)	247.1	acre

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$°F=(1.8\times°C)+32$

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Abstract

In 2004, a specific need for data on mercury use in South America was indicated by the United Nations Environmental Programme-Chemicals (UNEP-Chemicals) at a workshop on regional mercury pollution that took place in Buenos Aires, Argentina. Mercury has long been mined and used in South America for artisanal gold mining and imported for chlor-alkali production, dental amalgam, and other uses.

The U.S. Geological Survey (USGS) provides information on domestic and international mercury production, trade, prices, sources, and recycling in its annual Minerals Yearbook mercury chapter. Therefore, in response to UNEP-Chemicals, the USGS, in collaboration with the Economic Section of the U.S. Embassy, Lima, has herein compiled data on Peru's exports, imports, and byproduct production of mercury. Peru was selected for this inventory because it has a 2000-year history of mercury production and use, and continues today as an important source of mercury for the global market, as a byproduct from its gold mines. Peru is a regional distributor of imported mercury and user of mercury for artisanal gold mining and chlor-alkali production.

Peruvian customs data showed that 22 metric tons (t) of byproduct mercury was exported to the United States in 2006. Transshipped mercury was exported to Brazil (1 t), Colombia (1 t), and Guyana (1 t). Mercury was imported from the United States (54 t), Spain (19 t), and Kyrgyzstan (8 t) in 2006 and was used for artisanal gold mining, chlor-alkali production, dental amalgam, or transshipment to other countries in the region. Site visits and interviews provided information on the use and disposition of mercury for artisanal gold mining and other uses.

Peru also imports mercury-containing batteries, electronics and computers, fluorescent lamps, and thermometers. In 2006, Peru imported approximately 1,900 t of a wide variety of fluorescent lamps; however, the mercury contained in these lamps, a minimum of approximately 76 kilograms (kg), and in other products such as batteries and computer electronics is not recycled and may ultimately be released to the environment.

Introduction

Throughout history, mercury has been known and used for gold and silver processing. In Peru and many parts of the world, mercury is now used in batteries, chlor-alkali production, dental amalgam, fluorescent lights, switches, and thermometers. Much of the mercury contained in these end-of-use products can be recycled (Brooks and Matos, 2005); however, only a small amount of the mercury used for artisanal gold mining is recycled.

Mercury, the liquid metal, occurs naturally in a number of geologic environments, may be obtained as a byproduct from precious metals mining, or is found in trace amounts in coal. Much of this mercury may be used and recycled; however, mercury used for artisanal gold production and mercury released from coal-fired powerplants, broken fluorescent lamps, and other sources is not recovered and becomes a global environmental and human health concern.

In 2001, the Global Environment Facility allocated funding for studies related specifically to mercury use for artisanal gold mining in six countries from three continents. In order to focus awareness on human health issues, mercury releases, and regional mercury pollution, a United Nations Environmental Programme-Chemicals (UNEP-Chemicals) workshop took place in Buenos Aires, Argentina, in 2004. UNEP-Chemicals indicated a specific need for data and information on mercury production and use of mercury for artisanal gold mining in South America. Minimizing mercury contamination in the Amazon Basin was the theme of meetings held in Rio de Janeiro, Brazil, in December 2004 and in Lima, Peru, in February 2005. Sources of contamination, ecotoxicity, and human health issues were discussed by attendees from Bolivia, Brazil, Colombia, Ecuador, Peru, Suriname, and Venezuela. These meetings were sponsored by the Amazon Cooperation Treaty Organization (Brazil), the Andean Community (Peru), the Ministry of Environment (Brazil), and the Regional Environmental Program of the Department of State-U.S. Embassy, Brasilia, Brazil.

In 2006, Peru ranked first in gold production in Latin America and fifth in world gold production as well as being a world leader in silver, zinc, copper, and tin production. Therefore, because of environmental awareness and mercury stewardship on the part of Peru's major international mining companies, Peru became a leader in reduction of mercury emissions and byproduct mercury recovery from their large scale open-pit mines (Barrick Gold Corporation, 2005, p. 14). Byproduct mercury and calomel (Hg_2Cl_2), which is recovered from precious metals processing in Peru and elsewhere in South America, are exported to the United States for processing, and the mercury is resold into the world market, where it may be used for a variety of uses. Peru also imports mercury for artisanal mining, chlor-alkali production, and dental amalgam. Mercury is also imported as a component of batteries, electronics, fluorescent lamps, medical equipment, and thermometers.

The U.S. Embassy, Lima requested an in-country, field inventory of commodity mercury in Peru through the U.S. Department of State's Embassy Science Fellow Program. This was in response to the need for mercury information in the region indicated by UNEP-Chemicals at environmental meetings in Rio de Janiero and Lima, and Peru's leading role in gold mining, byproduct production of mercury, and widespread use of mercury for artisanal gold mining in Peru.

Ancient Use of Mercury

Mercury and the ore of mercury, cinnabar, were known to and used by ancient people in Asia, Europe, and South America. Geologically, mercury and cinnabar are well-known at Almaden, Spain; Huancavalica, Peru; Idrija, Slovenia; in the Yangtze belt, China; and other locations. Archaeologists have shown that mercury was used for gold amalgamation by the Romans, and cinnabar was used for funeral preparations and as a multi-use pigment.

Near Valencia, Spain, well-preserved human bones covered with powdered cinnabar were found in a tomb that dates to 5000 B.C. (Maravelaki-Kalaitzaki and Kallithrakas-Kontos, 2003). Mercury was found in a ceremonial cup in an Egyptian tomb that dates to 1600 B.C. and the Greeks retorted mercury from cinnabar in 300 B.C. Archaeologists have described an underground tomb in China that dates to 200 B.C. and it is described as having flowing rivers of mercury (China History Forum, 2006; Saiget, 2007). Roman villas were decorated with pigments made from powdered cinnabar, which was also used for makeup and, by A.D. 77, 4 to 5 t of mercury were imported annually from the mines in Spain for gold amalgamation. Roman slaves and criminals were sent to work, and subsequently to die, from the toxic mercury fumes released by firesetting (an ancient mining practice in which wood was burned at the face of the ore zone and water was poured on the face causing the rock to spall and crack) in the Spanish mercury mines (D'Itri and D'Itri, 1977, p. 6). In Central America, jade and shell fragments were found floating on a tiny, approximately 130-gram (g) pool of mercury in a closed container in a Mayan tomb in Belize that dates to A.D. 900-1000 (Pendergast, 1982).

Mercury was known in ancient Peru and used by the Moche (approximately 100 B.C.-A.D. 750) in northern Peru to amalgamate placer gold and for the production of gold artifacts (Kaufmann Doig, 1978,

p. 747; Larco Hoyle, 2001, p. 128). Mercury was recovered from drainages near the mercury occurrences at Huancavelica, and possibly from retorting cinnabar (Petersen, 1970, p. 55). Whether or not the ancient Andeans retorted cinnabar for mercury is controversial; however, retorts have been identified near the mines at Huancavelica (K. Brown, professor, Brigham Young University, written commun., May 9, 2003). Powdered cinnabar was used to decorate gold masks during the Formative Period (400-1000 B.C.) (De Lavalle, 1992, p. 39); as a mineral pigment used on murals (Muelle and Wells, 1939, p. 27; Brooks and others, 2006b); for painting warriors bodies and as a cosmetic for the elite Inca women (Brown, 2001, p. 477); and also for funeral preparations (Maravelaki-Kalaitzaki and Kallithrakas-Kontos, 2003; Jackson, 2004; J. Verano, Ph.D., anthropologist, Dumbarton Oaks, Washington, D.C., oral commun., December 12, 2005).

Approximately 20 mercury occurrences are known in Peru (Petersen, 1970, p. 55) and there are occurrences in southern Ecuador, near Cuenca and Azoguines (Truhan and others, 2005); however, the occurrences at Huancavelica are the largest and most well-known in the region and are the most likely source of mercury and cinnabar used in the ancient Andes. Only 15 kilometers (km) from the mine is Atalla, an archaeological site which was interpreted as an ancient cinnabar pigment production center (Burger and Matos, 2002, p. 10). As did the Romans, the Inca recognized the health hazards of mercury and that exposure to mercury and cinnabar during mining and retorting would cause the ancient miners "to shake and lose their senses" and, therefore, the use of mercury by the Inca declined (Larco Hoyle, 2001, p. 135).

Originally, Spain transported mercury from the mines at Almaden for mineral processing in the New World, and Spanish shipwrecks that still contain mercury are known in the Dominican Republic and in Colombia (Petersen, 1979, p. 851). However, upon re-discovery of the mercury occurrences at Huancavelica by the Europeans in the 1600s (Arana, 1901, p. 77), this regional source soon replaced imported Spanish mercury. Because of the combination of dangerous mining conditions, cold, working at 4,000 meters (m), and exposure to the toxic mercury fumes, Huancavelica was known as the "mina de la muerte" [the mine of death] (Brown, 2001, p. 468). Regardless, mercury's role was important for mineral processing in Spanish Colonial Peru and adding mercury, "el azogado" [azogue is an Arabic term for mercury that is commonly used in many parts of Latin America], was an essential step in silver recovery (Del Busto Duthurburu, 1996, p. 98).

Mercury from Huancavelica was also used in the "patio process" for silver processing in Chile, Bolivia, and Mexico. Salt, mercury, and vitriol (mixed copper and iron sulfates) were mixed with crushed silver ore that contained argentite (Ag_2S), cerargyrite (AgCl), or pyragyrite (Ag_3SbS_3), also known as the "dry ores," in a large open area, or patio, and at Potosí, Bolivia, the cold climate required that the patios be heated from below to speed silver production (Craddock, 1995, p. 216).

Mercury in Coal

Mercury and other metals such as arsenic are contained in trace amounts in coal, and mercury is released when the coal is burned in a coal-fired powerplant. The quantity of mercury contained in coal is typically small; however, the volume of coal that is burned yearly indicates that tons of mercury may be released and this is a concern for the environment and human health. For example, the thousands of coal-fired powerplants in the United States are estimated to release approximately 48 t of mercury annually (Gugliotta, 2004). Powerplants in coal-using nations such as China also contribute to global mercury releases; however, there is no recovery of this mercury.

Coal is widely distributed in Peru, and the number of coal basins may be as few as four (Petersen, 1978) to as many as fifteen (Alvarado, 1980, p. 401). The most recent compilation of maps, locations, formations, ages, rank, and reserves for 230 occurrences of coal in Peru is provided by Carrascal and others (2000, p. 44). Even though Peru has abundant coal, most of Peru's electric power is provided from hydroelectric sources, and Peru imports coal from Colombia, Indonesia, and Venezuela for power generation in southern Peru (Bowen, 2001).

The Goyllarisquizga Mine in northern Peru is perhaps the most well known occurrence because it supplied coking coal to the copper smelters at Cerro de Pasco. This coal mine was closed in the early 1970s, was then reopened, and then, due to declining production, closed again in the 1990s (Brooks and others, 2006a).

Because of global concern for mercury emissions related to coal-burning, the USGS initiated an inventory of the mercury and other trace element content of coal in the world market (Finkelman and others, 2001). Even though Peru is not one of the region's major coal-producing or coal-using nations, coal is available from several smaller mines such as Baños de Chimu, Cocobal, La Limeña, and La Victoria (Dunin-Borkowski, 1996, p. 148) and is used locally for calcining cement, cooking, or making coal briquettes. Analyses from these occurrences indicate that the mercury content of Peruvian coal is less than 1 part per million (ppm), and Peruvian coal does not appear to present any potential environmental or health problems (Brooks and others, 2006a).

Geology and Mining

Mercury is retorted from, or is found in association with, the sulfide mineral cinnabar. It is a scarce metal that is silvery and liquid at room temperature in elemental form. It averages 0.05 ppm in the Earth's crust. Mercury's chemical and physical properties, isotopes, and thermodynamic properties are given in DeVito and Brooks (2005).

Also known as azogue (Arabic) or llimpi (Quechua) in Andean Latin America, mercury occurs as a native metal or can be produced by retorting cinnabar. The more common ore of mercury, cinnabar, is dark red and soft, and may be associated with low-sulfidation epithermal mineral deposits worldwide; this is a type of hydrothermal mineral occurrence with a specific suite of minerals that forms at depths of less than 1 km and at temperatures of less than 300° C. Mercury ores may be found disseminated in fine-grained or brecciated volcanic rocks near volcanic centers, fossil hot springs, and intrusive rocks and may be any age from Silurian to Tertiary (Cox and Singer, 1986, p. 178).

Cinnabar is commonly mined by underground or open-pit methods from depths of less than 350 m. There are numerous mercury occurrences in Peru (Petersen, 1970, p. 55) and the most well known, the Santa Barbara Mine in Huancavelica, is now closed. Mercury miners at Huancavelica used the intensity of the color of the cinnabar, "…sangre seca, ley mas alta [if the ore is the color of dried blood, the grade is higher]," to indicate ore grade.

In general, mercury ores may contain from 0.1 to more than 2 percent mercury; however, most economic ores contain more than 1 percent mercury. The ore is crushed, screened, and then heated in a retort or furnace with limited ore beneficiation. Other specialized methods include leaching, dissolution, and electro-oxidation (Nowak and Singer, 1995, p. 232). Mercury occurrences, as cinnabar, are widespread and are known in Algeria, China, Italy, Kyrgyzstan, Mexico, Spain and the United States.

Since 1927, the common unit for measuring and pricing mercury has been the "flask," which was set to conform to the system used at Almaden, Spain (Meyers, 1951). One flask weighs 34.5 kg, and 1 t of mercury contains approximately 29 flasks. The flask itself is a screw-top, welded-steel container that is approximately the size of a 2-liter soft drink bottle. During the Spanish Colonial period, the Huancavelica mines produced over 48,000 t (1,470,000 flasks) of mercury with most of this coming from the Santa Barbara Mine (Yates and others, 1955, p. 11).

Byproduct Production of Mercury

In 2006, world mine production of mercury was 1,480 t, and China was the leading producer (1,100 t) followed by Kyrgyzstan (250 t), Russia (50 t), and Tajikistan (30 t) (Brooks, 2007). However, mercury may also be produced as a byproduct from the processing of copper (tennantite-tetrahedrite), gold (amalgam), lead-zinc (sphalerite), and silver (kongsbergite) ores (Rytuba, 2003). Of these occurrences,

most byproduct mercury is produced from epithermal gold-silver occurrences in a regional subduction setting, for example, in the western United States or the western part of South America.

At Barrick's Pierina gold mine, near Huaraz in northern Peru, and at Newmont's Yanacocha gold mine, near Cajamarca, also in northern Peru, the gold-silver ore, which also contains mercury, is milled and then leached with cyanide to remove the metals. In the zinc precipitation process (Merrill-Crowe process), mercury is also precipitated with the gold and silver, and some of these precipitates may contain in excess of 20 percent mercury (Washburn and Hill, 2003). A carbon-based extraction system is then used to recover the dissolved metals. The gold-silver-mercury amalgam, or Merrill-Crowe precipitate, is then sent to a large, on-site retort for step-heating, which will volatize and remove the mercury from the gold-silver ore. The volatized mercury cools, condenses, and then passes into a tank that is periodically tapped, and the mercury is drained into a 1 t container. The container sits in a larger, water-filled pan that will trap any droplets of mercury that may splash during tapping. The 1-t container itself has a 2-to 3-centimeter (cm) layer of water inside that keeps the mercury from volatizing at ambient temperatures. The byproduct mercury is then transferred to flasks for export only to the United States and the gold-silver concentrate moves on for further treatment in-plant.

A number of strictly enforced health and safety measures are in place at the on-site retorts, which are separate from other mine operations. The mercury flasks are drop-tested for security and measured for standard dimensions. After the flasks are filled, the mercury may then be chemically tagged, and the flask caps are double-sealed. The filled flasks are placed in a larger container, which has also been drop tested for security (fig. 1). That container is then bolted shut before dedicated shipment to the port in Callao, Peru, for export to mercury recyclers in the United States for processing. Mercury will volatize at room temperatures (Putman, 1972, p. 513), therefore, 1-2 cm of water on the retort-room floor keeps any splashed mercury droplets from volatizing. Gold rings, cameras, pens, and other metallic items are not permitted in the retort area. Workers and visitors must sign in and out, wear rubber boots, and use protective, disposable clothing. Visitors and workers are chemically "sniffed" before leaving the building, and workers submit to periodic blood and urine testing.

Figure 1. Security container with flasks of byproduct mercury before leaving Newmont Mining Corporation's Yanacocha mine, northern Peru. (Photograph permission of Newmont Mining Corporation)

The major mining companies operating in Peru recognize the environmental and human health issues associated with byproduct production of mercury and therefore export their mercury to the United States for treatment and recycling. However, after the mercury is processed in the United States, it may then be resold in the international metals market for a variety of purposes. That carefully safeguarded shipment of byproduct mercury that originally came from Peru may then be shipped to warehouses or importers in Europe, South America, or other destinations for artisanal gold mining or a variety of industrial uses (Fialka, 2006).

Another solution to the byproduct mercury problem is chemical stabilization of the mercury using sulfur to make artificial cinnabar. In collaboration with the U.S. Department of Energy's Brookhaven National Laboratories, Minera Yanacocha S.R.L., is researching ways to chemically stabilize or otherwise encapsulate the mercury (Ron Bradburn, process manager, Minera Yanacocha, S.R.L., written commun., June 1, 2005).

Peru is an important exporter of byproduct mercury from its precious metals mines to the United States, and according to the U.S. Geological Survey (USGS), 22 t (2006), 128 t (2005), 0 t (2004), 19 t (2003), 0 t (2002), 29 t (2001), and 11 t (2000) were exported to the United States for treatment and resale.

From 1994 to 2000, an average of 20 metric tons per year (t/yr) of byproduct mercury was produced by one mine in Peru, according to Peru's Corporación Financiera Internacional; however, the disposition of this mercury is unknown. Peruvian customs indicate that from 1993 to 2000, an average of 40 t/yr of mercury was imported for chlor-alkali production, medical uses, and artisanal gold mining (Carmen Mora Donayre, director, Ministerio de Industria, Turismo, y Negociones Commerciales Internacionales, written commun., September 6, 2001).

Mercury Uses in Peru

The chief uses of elemental mercury imported into Peru include artisanal gold mining, chlor-alkali production, and dental amalgam. Mercury imported for use in Peru may also be transshipped to other destinations in South America such as Colombia, Ecuador, or Guyana. Peru's domestic byproduct mercury is not used directly in Peru and is exported to the United States for processing and resale (Fialka, 2006).

Overview of Artisanal Gold Mining

Mercury has been used for artisanal gold mining in Peru at least since the time of the Moche (approximately 100 B.C.-A.D. 750), who lived along the northern coast of Peru (Larco Hoyle, 2001, p. 128). The widespread use of mercury for artisanal gold mining continues today in the Department of Piura in the northwest (Minas y Petroleo, 2006a); in southern coastal areas that include parts of the Departments of Ica, Arequipa, and Ayacucho (Canepa, 2005, p. 7); and the Departments of Puno and Madre de Dios in southeastern Peru (Kuramoto, 2001; Guerra, 2007). It is estimated that more than 200 t/yr of mercury are released annually through artisanal, or small-scale gold mining throughout Latin America (Viega, 1997).

In a review of all types of gold occurrences in Peru, Noble and Vidal (1994) outlined three areas of alluvial or artisanal gold production; these were, from north to south, Rio Huallaga, Maranon, and Madre de Dios; however, no production data were given. From 1990-1999, in increasing order of production, Costa Norte (La Libertad, Pataz), Costa Sur (Arequipa, Ica), Puno, and Madre de Dios produced a total of approximately 20 t/yr of gold, according to the Ministerio de Energía y Minas.

In 2001, approximately 17 percent of Peru's total gold production was from artisanal production of gold from vein and alluvial occurrences, and of that total, 70 percent was from Madre de Dios (Kuramoto, 2001). Other important areas include the Department of Puno, the southern coastal area, and the Department of La Libertad, and now, Piura. In 2004, artisanal gold mining accounted for 9 percent (14.8 t) of the gold produced in Peru (Gurmendi, 2004), and in 2005, the Ministry of Energy and Mines indicated that a minimum of 12,000 people working in the country's artisanal gold mining sector produced 15.8 t of gold (El Minero Artesanal, 2007).

The simplest method of amalgamation is with a wooden gold pan (batea), mercury, and the gold-bearing sediments. Either alluvial sources, or vein occurrences that have been processed, are washed directly until only the heavy minerals, including gold and "black sand" remain. Mercury is then added which amalgamates with only the gold. The gold-mercury amalgam may then be removed for further treatment, and the remaining material, which may still contain some gold, is treated with cyanide. The quality of the mercury, whether virgin (preferred) or recycled, is an important factor in gold recovery. At alluvial or placer gold occurrences, the sediments may be collected directly from the streams, or in some mining operations, front-end loaders may dump the sediments in grizzlies, and the gold-bearing sediments are then treated by hand once the larger stones are removed.

In vein or hard-rock mining areas, meter-sized crushing stones (quimbaletes) are used. The gold-bearing material is crushed by rocking the quimbalete, then washed, and the remaining muddy sediment is washed again to remove the light minerals. Mercury is added to amalgamate with the gold. The density of the amalgam causes it to sink to the bottom of the slurry. In the third method, gold-bearing material is put into a ball mill (molino á bolas), mercury is added to amalgamate with the gold, and the light materials are removed by washing. In all of these examples, the mercury-gold amalgam is then burned either in the open-air or in a retort, the mercury is partially to completely volatized, and the gold remains. If the open-air system is used, or if the mercury is retorted indoors, then mercury may be released directly to the surroundings (fig. 2). If a sealable retort is used, then a small amount of mercury may be captured from a condenser tube on the side of the retort (fig. 3). Regardless, significant mercury losses take place.

Figure 2. Unvented mercury retort for gold processing in a grocery store in Inambari, Madre de Dios, Peru (Photograph by William E. Brooks)

Figure 3. Sealable mercury retort at Mina Cabecera Santa Ynes, Huepethue, Madre de Dios, Peru. Tube on side helps to capture some of the volatized mercury fumes. (Photograph by William E. Brooks)

Each quimbalete operation will use 1-2 kg of mercury daily, and 800 g of mercury may be recovered with a loss of 200 to 1,200 g of mercury. Treatment of the amalgam in a closed retort results in approximately 10 percent recovery of the mercury with a 90 percent loss of mercury as toxic fumes when the gold is burned (Canepa, 2005, p. 50). The 10 percent that is recovered by this method must then be cleaned before reuse. At the gold-buying shops in the mining towns, the metal may once again be burned with a gas torch to remove any remaining impurities or mercury. Usually, but not always, there is a chimney from the retort in the gold shop that releases any fumes from this process to the outside (fig. 4A, B). Even though most chimneys vent to the outside, approximately 50 percent of the mercury released precipitates in the area surrounding the place where it is burned, and high levels of mercury have been found in the blood of people who live in or above the gold shops (fig. 2) (Kuramoto, 2001).

Figure 4A. Mercury retort with chimney, with B) chimney from inside gold shop to vent mercury fumes outside, Huepethue, Madre de Dios, Peru. (Photographs by William E. Brooks)

At the Huepethue mine site, a 1 g sample of amalgam, before retorting or burning, contained 312,000 ppm mercury. After the two-stage process of retorting and burning with the gas torch, a 1 g sample of gold contained 822 ppm mercury.

Then, at the gold shop, a final burning step helps the dealer gauge the purity of the gold, set a price and, most importantly, at all times the gold is visible to the dealer and to the miner. After the gold cools, the dealer weighs the gold and pays the miner. Because of safety and the threat of being robbed, only partial payment may go directly to the miner, and the dealer will transfer the balance of the payment to a bank or a gold office in the miner's hometown. The dore from the gold shop is then collected and transported to Lima for further processing and some mercury may be removed before the dore is sent to the United States for further refining and parting of the gold and silver (S. Gutierrez, general manager, Procesadora Sudamericana, oral commun., February 15, 2007).

The amount of artisanal gold produced is an important factor in estimating mercury use. To produce a given quantity of gold, two to three times as much mercury is used (Roskill Information Services, Ltd., 1990, p. 105; Sausa, 2007); therefore, 32 t of mercury, or more, may have been used to produce the 16 t of gold from Peru's artisanal mining sector in 2005. The price of the mercury is based on its origin; that is, virgin mercury from, or perceived to be from Almaden, Spain, is more costly. Recycled mercury, typically from the United States, is also used, but virgin Spanish mercury is preferred because miners believe that it gives better gold recovery. Some recycled mercury may be packaged in such a way as to imply Spanish origin and therefore receive a better price for the mercury. There is no information on the recovery rate of artisanal gold using virgin or recycled mercury. Regardless, after the mercury is used, very little is recovered or recycled. However, the mercury that is recovered may be cleaned using a variety of methods that include: electricity from 12-volt batteries; lemon juice; paper towels; soap; or toilet paper. After Spanish mercury, recycled mercury is a second choice for gold amalgamation; however, most of the mercury used for gold amalgamation, regardless of its origin, is released as mercury fumes during retorting or is otherwise lost to the environment and is not recycled.

In some cases, the miner will sell his mercury-gold concentrate obtained from the quimbalete or ball mill directly to a dealer. Virgin mercury is preferred for presumably better gold recovery; however, some dealers may sell low quality or recycled mercury to the miner, which will then result in incomplete recovery of the gold from the concentrate. The tailings from this transaction will then be sold and treated with cyanide for further gold recovery, and the miner receives no profit from the gold recovered from this later process.

Because of mercury losses, human health, and environmental concerns, and the reluctance of miners to let their gold leave their sight during retorting, communal, miner-operated retorts have been established as part of an international environmental program between Switzerland and Peru. Since 1993, the Swiss Agency for Development has been involved with environmental projects related to mining in Bolivia, Ecuador, and Peru. Even though hand-held retorts are relatively inexpensive, most miners do not like and rarely use them. Some miners think that retorts may turn the gold green, which will result in a lower price, or that the process is slower than traditional methods (del Carmen Piazza, 2001).

Because of these concerns, miner-run retorts with a traditional open-faced oven, so that the miner can see his gold during every step of retorting, have been built. Condenser tubes are installed and the mercury can then be recovered, recycled, and resold locally. Approximately 120 kilograms per year (kg/yr) of mercury can then be reused (Hruschka, 2007).

The Peruvian environmental organization, Proyecto GAMA (Gestíon Ambiental en la Minería Artesenal) and the Ministerio de Energía y Minas del Peru has also tried to reduce mercury releases by providing free retorts and reactivadores de mercurio [mercury reactivators]. The reactivador de mercurio is a small rubber cup with a cathode and anode that will attach to a 12-volt battery (fig. 5). The used mercury is placed in the rubber cup with 2-3 cm of water and the mercury may be cleaned by passing the electricity through the mercury and the mercury, now recycled, can then be reused. From 1996 to 2000, approximately 1,600 reactivadores were distributed in artisanal gold mining areas (Medina Cruz, 2001).

Figure 5. Mercury reactivator for cleaning and recycling mercury by using electricity from a 12 volt battery. (Photograph by William E. Brooks)

Environmental contamination caused by mercury releases related to artisanal gold mining has been addressed by government and other agencies in Peru. Mercury losses in Madre de Dios were researched by Galloso and others (1996) and the Ministerio de Energía y Minas (2005) has published a guide to the use of mercury that also addresses handling and transportation issues. As a part of the Swiss environmental program, designs for community retorts, mitigation of mercury releases, and health effects are described in a guidebook distributed in artisanal mining areas by Adrianzen (2005). Newspaper articles address governmental concern about widespread contamination caused by mercury used for artisanal gold mining (Diario Gestíon, 2007; Guerra, 2007).

From Piura, in the northwest, to Madre de Dios, in the southeast, artisanal gold mining is an important economic activity; however, there are health risks involved with using mercury and from the toxic fumes released from burning the gold-mercury amalgam. Children working in the artisanal mining areas are exposed to mercury on a daily basis, and the damage to their health and mental development is irreversible (Sausa, 2007). There are a minimum of 50,000 workers, many of whom are children, and the combination of malnutrition, exposure to mercury, time devoted to work, and, in some cases, altitude, are key factors in understanding why there is a high proportion of children with intellectual developmental difficulties in the artisanal mining communities (del Carmen Piazza, 2001).

Artisanal gold mining is a global activity, the processes are similar, and mercury is widely used. Therefore, The Global Mercury Project has published “Protocols for Environmental and Health Assessment of Mercury Released by Artisanal and Small-Scale Gold Miners” (Viega and Baker, 2004) and a “Manual for Training Artisanal and Small Scale Gold Miners” (Viega and others, 2006). The purpose of these books is to introduce cleaner and healthier artisanal gold mining and extraction technology. Chapters discuss gold ores, crushing, gravity methods, classical and home made retorts, amalgamation, use of cyanide, and the environmental and health effects of mercury exposure.

Piura

Even though the Department of Piura, in northwestern Peru, is considered one of the best locations for exploration and mining in Peru, it did not figure into 2005 Ministry of Energy and Mining statistics for

gold production nor did Kuramoto (2001) include Piura in her compilation of important artisanal gold producing regions. In the 1990s mining investments began flowing into Peru and one of these projects was Tambogrande in Piura. The Tambogrande project was different because it brought the possibility of large-scale, open-pit mining, which had previously only taken place in Andean Peru, to an established agricultural region. Conflict over the potential environmental affects ensued and the mining company left in 2003 (Wilson, 2004; De Echave, 2005; Guerra, 2007). However, conflict between artisanal mining and agriculture was just beginning.

Since 2001, artisanal mining has been growing in Piura. Some of the more well known locations include San Lorenzo, Las Lomas, and El Chira; however, there are many more. There are a minimum of 4,000 artisanal miners in the area and the regional government of Piura has established a census commission to establish the number of workers and families involved in mining (El Peruano, 2007).

Gold is worked mainly using quimbaletes and ball-mills—both processes use mercury. Approximately 4 kg of gold may be obtained from every 100 t of rock that is crushed using the quimbaletes and each kilogram may be worth as much as $21,000 (Obregon Rossi, 2007). The mercury comes either from Trujillo or from nearby Ecuador and sells for $60 to $75 (S/. 180 to 225) per kilogram. There is no recovery of the mercury, and the gold is burned in the open without the use of retorts (Minas y Petroleo, 2006a, p. 10).

Mining methods also include the use of cyanide and dynamite for blasting. Gold-bearing waste rock from the ball-mines and quimbaletes is purchased and transported for treatment with cyanide at cyanidation pits 20 to 40 km northwest of Tambogrande, or as far south as Nazca, for further gold recovery. The use of cyanide, mercury, and zinc and the fact that waste rock from the quimbaletes is left in the open, or put almost anywhere, and may drain these metals directly into the groundwater is a cause of intense concern to the agricultural community in Piura. Uncontrolled artisanal mining and the widespread use of mercury and cyanide has contaminated the rivers in the region, the San Lorenzo reservoir, and the water in the agricultural areas of Las Lomas and Tambogrande. Neither the miners nor the many underage children working in the region use any sort of protection when working with these toxic materials (Obregon Rossi, 2007).

Approximately 120 t of waste rock from the quimbaletes may be transported daily for processing with cyanide and from those 120 t, another 2.4 kg of gold may be obtained daily, with a yearly yield of 864 kg of gold (La Hora, 2007a; La Hora, 2007b). There are no data on the amount of gold recovered from the less efficient, mercury-only methods. There are locations where it is possible to obtain 5 g gold from a 30 kg load of rock and a gram of gold may be worth approximately $20 (S/. 45-60) to the mine owners. Laborers at the quimbaletes and at the mines may receive approximately $8 (S/. 20-25) per day compared with approximately $2.50 (S/. 8) for a day's work in the agricultural sector, and one former agricultural worker indicated that his daily wages had quadrupled.

La Libertad

Pataz—Artisanal mining in the Department of La Libertad is mainly near Pataz which is approximately 350 km east of Trujillo in northern Peru. Since pre-European contact, this has been one of Peru's major gold producing areas. Most gold is extracted from gold-quartz-pyrite veins that crop out for a distance of approximately 70 km and are associated with the Pataz batholith (Schreiber and others, 1990, p. 1328; Noble and Vidal, 1994). However, the Pataz gold mining area was not visited because it is within an area outlined by the U.S. Embassy as restricted because of coca production.

At Pataz, the gold-quartz-pyrite veins are of primary interest and adits follow the high-grade zones. The adits are dangerous (Warren Church, anthropologist, Columbia State University, written commun., December 14, 2006). Ore is extracted using hand drills and sledgehammers. Beneficiation of the ore includes sledgehammers and quimbaletes. Mercury is added to the crushed and washed material and then the amalgam is squeezed through a cloth and some mercury is recovered for reuse. The amalgam is then burned to remove any remaining mercury and the gold is then sold. The alluvial deposits, which are of less importance, are mainly along the Rio Maranon and Rio Cajas where the gold-bearing gravels shed from

the batholith are worked with shovels, gold pans, and mercury (Kuramoto, 2001). Cyanide and carbon treatment is also being used to recover gold in this area.

Trujillo (site visit)—In 1998, La Libertad was fourth in artisanal gold production, which was estimated to be 190 kg (Kuramoto, 2001). In Trujillo, at Inversiones Mineras Victoria S.A.C., the "El Español" brand of mercury is sold along with cyanide, zinc powder, and other mining supplies such as boots, dust masks, gloves, and hard-hats (Miguel Angel Rodriguez, owner, Jr. Bolivar 717, written commun., February 5, 2007). Many gold shops are nearby; however, these do not sell mercury or mining supplies. From gold production data, it is inferred that less than 1 t of mercury was released through artisanal mining in 1998. There were approximately 700 miners working in the Pataz area in 1998 (Kuramoto, 2001) and 11 years was the minimum age for children to work in the mines (Warren Church, anthropologist, Columbia State University, written commun., December 14, 2006); however, Juan Valdivia, Minister of Energy and Mines, indicates that children as young as 4-6 years are used as cheap labor or "helpers" in the broader artisanal mining sector (Guerra, 2007).

Madre de Dios

Huepethue (site visit)—Madre de Dios produces approximately 70 percent of Peru's artisanal gold (Kuramoto, 2001). At Huepethue, one of the most important artisanal mining centers in the jungle in the Department of Madre de Dios, mining takes place at an area locally referred to as "Las Quebradas." Other nearby mining areas include: Caychihue, Puerto Carlos, Puquiri, Laberinto, and other unnamed occurrences. Huepethue, which may or may not appear on maps, is approximately 15 hours by hazardous road, boat, and stream crossings from Cusco. When available, there is seasonal air service from Cusco to Huepethue.

Gold extraction methods used in Madre de Dios include channeling, dragging, sluicing, use of boats with suction hoses, and dredges. Bateas (gold pans) are used and one of the simpler methods used at Huepethue is the "balde" or pig-tail bucket. These buckets are filled with sediment and then the sediment is washed, sometimes by foot to concentrate the gold at the bottom of the bucket. Light materials are floated, gravel is removed by hand, and then mercury is added. "Chupaderas" or boats with divers using suction hoses are used in the rivers, especially at Laberinto. The gold-bearing sediments are brought to the surface using the suction hoses and mercury is added to the sediments to recover the gold. These artisanal methods are widely used; however, the presence and use of numerous dump trucks, excavators, and front-end loaders all indicate substantial investment in the area.

Sediments collected by the methods described above all rely first on gravity to separate gravel and light minerals from the nuggets, finer gold particles, and heavy mineral sands. The nuggets are extracted by hand and the finer gold particles are recovered by amalgamation. Because of the widespread use of mercury and environmental concerns, Galloso and others (1996) studied the dispersion of mercury in Rio Madre de Dios as well as studies near Caychihue, Puerto Carlos, Puquiri, and Huepethue. Madre de Dios was also included in a regional study of artisanal mining, environmental impact, occupational health, and child labor by Kuramoto (2001).

At Huepethue, gold is found in placer deposits that may be from 20 to 70 m thick in an area that may be 25 square kilometers or larger with 7,000 to 10,000 miners. The area has been mined for gold since Spanish Colonial time; however, it saw a resurgence of activity in 1977. At the site visit to Mina Cabecera Santa Ynes, trucks dumped gold-bearing sediments in a large grizzly at the top of a hill, gravels were removed, and the sediment was washed downhill in a ziz-zag sluice lined with carpet (fig. 6A, B). The carpets were recovered from the sluices and the gold was washed into a muddy settling pit from which the gold-bearing sediment was recovered. Mercury was then added, mixed by hand with the sediment, the amalgam was recovered, and was then placed into a small retort in a cabin (fig. 4A). The retort was bolted shut and the amalgam was heated for approximately 30 minutes. A small tube on the side of the retort condensed some of the mercury fumes in a water-filled cup for later cleaning and reuse. All mine staff left the cabin and it was locked while retorting took place; however, dark smoke indicated the release of mercury fumes. After the smoke cleared, the retort was opened and the smudgy brown gold

ingot was recovered. This ingot was allowed to cool, then broken with a hammer and burned again [refogado] to remove any remaining mercury (fig. 7A, B). The broken fragments are burned with a gas torch until glowing and, upon cooling, the beauty and attraction of the precious metal is compelling—this is an important, hands-on step because the price that the miner will be paid is based on the color of the gold, and the miner can then judge the quality of his metallurgy, the purity of the gold, and the price that he will receive (fig. 7B).

Figure 6A) Sluice and b) silvery, mercury-gold amalgam in gold pan (batea) in foreground at Mina Cabecera Santa Ynes, Huepethue, Madre de Dios, Peru. (Photographs by William E. Brooks)

Figure 7A. Gold immediately after being removed from the retort and 7B gold after being burned (refogado) to remove any mercury and improve the aesthetic appearance of the gold, Mina Cabecera Santa Ynes, Huepethue, Madre de Dios, Peru. (Photographs by William E. Brooks)

Figure 8. Widely used "El Español" brand of recycled mercury. (Photograph by William E. Brooks)

Mercury used in gold processing at Huepethue was bought locally and was labeled either "American Mercury" or "El Español" and prices varied between $50 and $60 (S/.150-180) per 1-kg bottle (fig. 8). Very little mercury was recovered in the cup at the retort. The amount of mercury used daily or monthly is dependant on ore grade; however, the miners indicated that they might use 500 g to 2 kg weekly at this mine alone.

Puno

The Department of Puno is in mountainous southeastern Peru near the border with Bolivia. Artisanal exploitation of gold-bearing quartz veins at 5,000 m in the Ananea-La Rinconada region of Puno was first described by Raimondi (1878). The gold-bearing quartz was crushed using quimbaletes and the ore was concentrated in bateas using glacial meltwater, a style used since pre-European contact (Petersen, 1970, p. 121).

Puno is the second most important artisanal mining area in Peru, with 17 percent of Peru's artisanal gold production, and Kuramoto (2001) estimates its production at 2.5 t/yr. However, Juan Valdivia, Minister of Energy and Mines, estimates that the San Antonio de Poto region of Puno, which includes Ananea, may produce as much as 50 t/yr of gold, mainly because of lack of controls in the area (Guerra, 2007). Puno is a center of artisanal mining and is also the location of a new open pit gold mine, Mina Arasi, which is projected to produce 4.5 t/yr (Minas y Petroleo, 2006b, p. 6).

Juliaca is the nearest town and is approximately 4 to 5 hours by rural, unsurfaced road from the mining areas. Artisanal gold mining, which dates back to the Colonial period, is especially difficult because of high altitude (5,000 m) and cold. Anywhere from 7,500 to 30,000 people live in the area, and dwellings are made of adobe, brick, and stone with corrugated roofs. Streets quickly turn to mud in the rain or snow, and there is no infrastructure for trash removal. Mining takes place in the Rio Ramis watershed, and the combination of mercury from mining activities and contamination from trash dumped in open areas contributes to concern for human health and water quality in downstream areas. After periods of high runoff, communities downstream indicate that they have underweight cattle and that children do not want to eat, are sick, and frequently vomit. In 2000, the University of Montana and the Universidad Nacional del Altiplano-Puno (Peru) were awarded a grant from the U.S. Department of State to initiate environmental studies related to mining and metal contamination in the Rio Ramis watershed. One of the objectives of the study was to assess metals pollution, specifically mercury, in Lake Titicaca owing to artisanal mining upstream. Analyses of water and soil samples indicated a high level of mercury contamination, and approximately 27 percent of the pejerrey and 75 percent of the carachi (important local food fish) from Lake Titicaca exceeded the fish tissue-based water quality criterion of 0.30 milligrams (mg) (Gammons and others, 2006, p. 637).

Site visits were made to Ananea and La Rinconada-Cerro Lunar de Oro; however, other nearby mining areas include Ancoccala, Carabaya La Aurifera, Lampa, Masiapo, San Antonio del Oro, and Yanahuaya.

Ananea

At Ananea, gold is obtained from 10-m thick, or more, glacial-derived alluvial deposits using high-pressure monitors, sluices, riffle boxes, and panning. There are some tunnels and shafts where mining is accomplished using shovels and wheelbarrows. Front-end loaders are also used, some of which work 24 hours. The front-end loaders and other heavy machinery indicate a substantial investment in gold mining in the region. At various times, the miners have been organized under the government agency Centromin and also as Minero Peru, Minería Los Andes, or Corporación Minera Ananea.

The amalgam from Ananea and La Rinconada-Cerro Lunar artisanal mining sites is brought to the gold shops in Ananea, where it is burned and the mercury fumes are vented to the outside of the shop. There is no recovery or recycling of the mercury in the field or in the gold shops. The gold price is fixed

daily depending on prices obtained on the Internet from New York or London. One local newspaper, "El Minero Artesanal" carries a chart with 30-day New York and London gold prices. Therefore, the gold price paid is a function of gold prices from the Internet, depending on the source of the gold, and a percentage for the dealer (for example, Ananea gold has silver and is generally 92.6 percent gold; however, Rinconada gold is typically 95 percent gold). The dore, approximately 20 to 25 kg per month, goes to Juliaca and from there, to Lima (H. Llacsa Bustinea, gold dealer, Ananea, oral commun., February 18, 2007).

At Ananea, the "El Español" brand of mercury sells for $40/kg (S/. 120) and another brand "American Mercury" sells for $30/kg (S/. 100). Another brand was available, also for $30; however, the bottle only carried the name "Corporación Reggiper, S.A."

La Rinconada-Cerro Lunar de Oro

These two adjacent artisanal mining communities are very near Ananea. Elevation here is approximately 5,000 m and the towns are located at the terminus of a glacier that also supplies water to the communities. The local Civil Defense Agency of Puno has recommended evacuation of the 3,000 or more miners in the area because of the possibility of hazards such as glacial release and landslides (El Comercio, 2006).

Gold is hosted in subhorizontal, 2 to 40 cm quartz veins that contain gold, pyrite, galena, tetrahedrite, and other minerals (Kuramoto, 2001). Adits and small tunnels follow the quartz veins, and the ore is extracted using picks, explosives, and sometimes, compressors. The ore is crushed and ground using quimbaletes, and it is at this step that mercury is added. There are approximately 1,000 quimbaletes in use, gold recovery is low, and mercury losses are high. Approximately 500 g of mercury are used to recover 10 to 20 g of gold. The mercury-gold amalgam is squeezed through a cloth in order to recover some of the mercury, which is then cleaned with cotton or toilet paper. The amalgam is then burned either in the homes of the miners or is taken to the gold shops in Ananea for burning and sale.

Chlor-Alkali Production

Quimpac S.A. is the sole producer of chlorine, caustic soda, and related products in Peru. These materials are used to bleach newspapers, for swimming pools, medicine, and other industrial uses. Quimpac production units are located in Callao, Huacho, Paramonga, and Otuma, with headquarters in Callao (Quimpac S.A., 2005). Mercury cell technology (DeNora 14H3/14TGL) is used by Quimpac with installed capacity of 45 t/yr of NaOH (Nelson Felipe, spokesman, Clorosur, written commun., December 6, 2004). In 1989, Roskill Information Services Ltd., (1990, p. 70) indicated that total mercury-cell capacity for Peru was 74 t. However, the current mercury capacity of the cells at the Quimpac facilities was not available (Isias Flit, advisor, Quimpac S.A., oral commun., February 14, 2007). During 2006, data from Peruvian customs indicate that approximately 2 t of replacement mercury were purchased from suppliers in Spain. And, as of February 2007, there were no immediate plans to change to non-mercury chlor-alkali production.

Dental Amalgam

Dentists have used amalgam, which contains mercury and other metals, since 1833 (Talbot, 1882). Modern amalgam contains mercury (50 percent), silver (34 to 38 percent), tin (12 to 14 percent), copper (1 to 2 percent) and zinc (0 to 1 percent) (Davis, 2003). Amalgam fillings may last from 2 to 20 years, depending on the size of the filling (Dr. John Mercantini, dentist, Reston, Va., oral commun., December 12, 2004). In the United States, amalgam is sold in pre-measured capsules that are opened in the dentist's office just before use, and the American Dental Association discourages the use of bulk mercury (American Dental Association, 2006). Approximately 30 t/yr of mercury is used in the United States and

used or discarded amalgam from collection devices in dental offices may be processed to recover the mercury and the silver (Lawrence, 1995). There are no data on the amount of mercury that is recycled from dental amalgam in the United States.

Site visits were made to dental supply stores in Lima, a dental clinic at the Universidad Cayetano Heredia in Lima, and to a dental office in Trujillo. Bulk mercury in 100-g plastic bottles is sold in the dental supply stores in the 200 block of Avenida Emancipación in Lima. Several gold shops are nearby. Mercury sold in the dental supply shops is triple-distilled, has a label indicating that it has U.S. Food and Drug Administration approval, is imported from the United States, and distributed by a Peruvian importer. The cost is approximately $7 (S/. 22) for the 100-g bottle, and no professional documentation is needed for purchase. The other metallic components for making dental amalgam are sold separately as a powder so that the dentist may make a custom amalgam at the dental office. A visit to other dental supply shops indicated that no chairside traps are sold with which to recover the discarded silver-mercury amalgam.

At the Universidad Cayetano Heredia, dentists use either bulk mercury or pre-measured amalgam capsules that are imported from Australia. There is no system to capture the unused or discarded silver-mercury amalgam. The discarded amalgam is either put into the trash or goes directly into the local sewage system from the chairside spitoon provided for the patient. In general, the use of amalgam, which is typically dark, is declining, and composite fillings that have a more natural color are preferred (Dra. Allison Chavez and Dr. Elar Ventura, dentists, oral commun., Clinica Dental de la Universidad Cayetano Heredia, Lima, January 30, 2007).

At the dental clinic in Trujillo, bulk mercury is commonly hand-mixed with silver-bearing powder for making amalgam. These fillings are inexpensive and generally cost $10; however, for aesthetic reasons given above, amalgam use is declining and most patients prefer composite restorations (Dr. Alex Rodriguez, dentist, Primavera Centro Odontológico, Trujillo, oral comm., February 5, 2007). Dr. Rodriguez was especially interested in this study because he had recently finished his thesis research on "The influence of low-temperature polishing on high-copper dental amalgam" at the Universidad Nacional de Trujillo.

Other Uses and Disposition of Imported Mercury-Containing Products

Mercury-containing products include batteries, computers and electronics, fluorescent lamps, and thermometers. Children's light-up toys and some toothbrushes may contain batteries as well, but specific data on the large quantity of toy and other battery-containing imports were not available. None of the mercury contained in these products is recycled and may ultimately be released to the environment.

Batteries

There are many sizes, shapes, and varieties of everyday-use batteries, and virtually all batteries contain some mercury. Mercury oxide is used in varying amounts, especially in "button" batteries; however, alkaline batteries generally have the lowest mercury content. Cadmium-mercury batteries have been widely used in watches, calculators, cameras, and hearing aids (Battery-Index, 2003; Mercury in Batteries, 2004). In the United States in 2004, mercury batteries imported from China were used in approximately 17 million light-up toys distributed in cereal boxes that were clearly marked "battery in toy contains mercury" (Spitzer, 2004). In Peru, inexpensive "button" batteries that were sometimes swallowed by children were blamed for blindness and other health problems (El Comercio, 2002; 2003).

"Button" batteries from China and Japan are routinely sold in multi-battery packs in stores, and replacement batteries for watches and hearing aids are sold on many street corners in Lima, Trujillo, and elsewhere and the used batteries are thrown into the trash. Recently, Supermercados Wong, S.A., a large supermarket chain in Lima, has placed battery recycling canisters outside its stores. At Colegio Roosevelt, a private high school in Lima, as part of an environmental studies project, students have collected batteries for recycling in collaboration with Supermercados Wong, S.A. (S. Kemme, teacher, Colegio Roosevelt,

Lima, written commun., February 24, 2007) (fig. 9). Batteries from Supermercados Wong, S.A., Colegio Roosevelt, and other sources are collected monthly by Teconec, S.A.C, an environmental consulting company; however, at present there are no battery recycling facilities in Peru, and Teconec, S.A.C. is researching storage or possible export of the batteries for recycling (Teconec, S.A.C., 2007; A. Knell, manager, Teconec, S.A.C., oral commun., February 22, 2007).

Figure 9. Battery collection for recycling, an environmental project by students at Colegio Roosevelt, Lima, Peru in collaboration with Supermercados Wong, S.A., a major grocery chain and Teconec, S.A.C., an environmental consulting firm in Lima, Peru. (Photograph courtesy of Sarah Kemme, instructor, Colegio Roosevelt, Lima, Peru)

In 2006, a minimum of 2,960 t of batteries of a wide variety of descriptions were imported into Peru. According to Environment Canada (2007), batteries may contain from 5 to 25 mg of mercury as mercury oxide. Given, an average battery weight of 5 g for all battery styles (Shenzhen Tech, 2007), a minimum of 5 mg of mercury per battery, and given a zero recycling rate for batteries, then a minimum of approximately 3 t of mercury will ultimately be released after the batteries imported in 2006 are put into the trash.

According to the Canadian Household Battery Industry, mercury in household batteries, especially the button cells, will be eliminated by 2011 (Recycling Product News, 2006). The Swiss company Batrec, which was founded in 1989, is Europe's leading recycler of mercury-containing materials and it processes more than 3,000 t/yr of batteries, sludges, and other materials (Beck, 2004). The Mercury Recycling Group, which is the largest recycler of mercury in the United Kingdom, has tripled its recycling capacity in response to European environmental legislation (Metal-Pages, 2004). Environmental legislation in Europe has resulted in the European Union Battery Directive which is expected to result in a $640 million market for recycled batteries (Vollrath, 2006).

Electronics and Computers

Electronics and computers may be recycled in order to recover the lead, mercury, and other metals that can be harmful if dumped in a landfill. However, the cost to recycle a computer is approximately $20 (S/. 60), and therefore, the recycling rate for the broad category of computers and electronics in the United States is less than 10 percent (Kessler, 2004). On its model MA6, Gateway Inc. includes a label indicating that the lamp in the display contains mercury and should be disposed of in accordance with local, state, and federal laws.

There is no recycling of computers in Peru. Used U.S. Embassy computers may be given to local schools. For the most part, used computers and electronics may be passed from one agency to local schools or refurbished and resold in the used computer district in Lima, the 400 to 500 block of Avenida Wilson. Used computers may also be resold so that the gold contained in the microprocessors may be recovered.

Fluorescent Lamps

In the United States, reclamation of mercury from spent fluorescent lamps and mercury-vapor lamps began in 1989. The startup recycling rate was 10 to 12 percent, and that rate had increased to about 20 percent by the end of 2000 and each lamp may contain from 10 to 20 mg of mercury (Zero Mercury Campaign, 2002; National Electrical Manufacturers Association, 2003; Environment Canada, 2007). Fluorescent lamp packages in the United States have an information panel that has the symbol for mercury "Hg" and a statement that the lamp contains mercury and should be disposed of in accordance with disposal laws. A website (http://www.lamprecycle.org) and a telephone number (1-800-435-4448) are provided for further information. The U.S. Embassy purchases fluorescent lamps from General Electric, Canada, in 36 unit boxes (F32T8-SP65-ECO). These lamps are marked as containing mercury; however, end-of-use lamps are not recycled and go into the trash.

Fluorescent lamps and the newer energy-saving compact fluorescent lamps (CFLs) are widely promoted and used in Peru and, in 2006, approximately 1,900 t of fluorescent lamps of all types were imported. A site visit to Ace Hardware in Lima (January 31, 2007) showed that this total included a wide variety of wattages (8 watts to 100 watts) and styles such as traditional tubes, CFLs, and circular lamps which were imported from Canada, China, Brazil, Germany, Hungary, Netherlands, and Thailand. Most, however, were made in China. Some of these lamp packages indicate that mercury is used in the lamps; however, most do not. These lamps are not recycled and end up in the trash (fig. 10) and, enroute to the landfill, are likely broken and mercury is released.

Given that approximately 1,900 t of mercury-containing fluorescent lamps were imported in 2006, an average lamp weight is 250 g, and each lamp contained 10 to 20 mg of mercury, then it is estimated that a minimum of 76 kg of mercury (using a minimum of 10 mg of mercury per lamp) was contained in the lamps. Since there is no recycling of fluorescent lamps in Peru, the approximately 76 kg of mercury contained in the 1,900 t of lamps imported in 2006 will be released to the environment when the lamps are ultimately broken.

In 2006, an estimated 150 million CFLs were sold in the United States and these energy-saving bulbs are widely used in Canada, the European Union, and Australia. The CFLs require less electricity than traditional lamps, and manufacturers argue that the CFLs reduce overall mercury in the atmosphere by reducing the amount of coal used, which by implication reduces mercury emissions from coal-fired power plants. The mercury content of these bulbs is approximately 3 to 5 mg, and some have as little as 1.2 mg (Von Ahn, 2007). However, since there is no recycling of CFLs or any other fluorescent lamps in Peru, ultimately the mercury from these energy-efficient lamps will be released when the bulbs are broken, either in, or enroute to, the landfills.

Figure 10. Discarded fluorescent lamp on the street, Trujillo, Peru. (Photograph by William E. Brooks)

Thermometers, Medical Equipment, and Vaccines

Digital fever thermometers are available in Peru, and mercury thermometers that sell for approximately $1 (S/. 3.0) are available in many drug stores. These thermometers were manufactured in China (fig. 11). A minimum of 14 t of thermometers were imported into Peru in 2006 and were used mainly for aquariums, medical use, and refrigeration. Some of these thermometers, if not recycled, may ultimately be broken releasing the mercury in the home, hospital, or to the environment.

Figure 11. Mercury thermometer bought in a drugstore in Lima, Peru. (Photograph by William E. Brooks)

Mercury-containing blood pressure devices are imported from Germany (Rudolf Riester GmbH & Co., http://www.riester.de) and are widely sold and used in Peru. Digital blood pressure measuring devices are available; however, the mercury blood pressure cuffs give more reliable readings and are preferred for office use (C. Estrada, nurse, U.S. Embassy, Lima, oral commun., February 22, 2007).

A mercury compound, timerosal, which is used as a preservative in some vaccines, reportedly is a suspected cause of autism in children. As in the United States, in Peru, the relationship between autism in children and mercury in vaccines remained controversial (Harris and O'Connor, 2005; Hightower, 2001). University studies and studies by the Ministry of Health (Peru) present contradictory findings on the health effects of the mercury compound timerosal in vaccines (Izaguirre, 2007; Martinez, 2007).

Mercury used in thermometers and in blood pressure devices may be recycled; however, at present, there is no collection or recycling of mercury-containing thermometers or medical equipment in Peru. In 2003, however, about 300 t of mercury-containing waste from a closed thermometer plant in India were shipped to the United States for recycling (Rai, 2003). The mercury used as a compound in the vaccine preservative, timerosal, is dissipative.

Prices

In the global market, mercury is commonly priced and shipped by the 34.5-kg flask, a unique measure that was established at Almaden, Spain, the world's oldest producer of mercury. Information on mercury prices in the global market was compiled from Platts Metals Week, and information on Peruvian import prices was obtained from the Superintendencia Nacional de Aduanas del Peru and from EQUIFAX, formerly known as INFOCORP, a Peruvian company that collects financial data for companies, banks, and individuals that is used for credit sales and loans.

In 2001, the price of mercury was approximately $155 per flask, then rose sharply to $850 per flask in spring 2005, and settled to approximately $600 per flask in 2006 (Platts Metals Week, 2006, p. 19) and early 2007 (Platts Metals Week, 2007, p. 19). The overall rise in mercury prices is in response to: 1) increased demand for mercury for artisanal gold mining in step with increased world gold prices, and, 2) the decline in the production of mercury-containing devices (except for CFLs and other types of fluorescent lamps) and subsequent decline in the supply of end-of-use mercury-containing devices from which mercury may be reclaimed and recycled (Brooks and Matos, 2005).

Virgin mercury is imported into Peru from Spain and Kyrgyzstan and this mercury is preferred for artisanal gold production. The Peruvian import price for this mercury is usually $20/kg or higher. Recycled or processed byproduct mercury is imported from Kyrgyzstan (Suerkulov, 2001), the United States, or other sources and the price is somewhat less than $20/kg. However, some of this recycled mercury may be packaged as to imply Spanish origin in order to obtain a higher price when the mercury is repackaged in 1-kg bottles for sale in the artisanal mining areas.

Byproduct mercury and mercury obtained from processing calomel is also transshipped from the United States, and then held in European warehouses for global distribution (Fialka, 2006). Minor amounts of mercury are also imported from Australia, Austria, Germany and the United States, for dental amalgam and medical uses.

In 2004, Platts Metals Week listed $365 per flask (or $11/kg) as the price for mercury in the United States. Peruvian import prices were from $2 to $8 per kg. In 2005, mercury sold for $555 per flask ($16 per kg) and import prices were from $2 to $28 per kg. In 2006, mercury sold for $600 per flask ($17 per kg), and import prices were from $1 to $22.20 per kg. For the first 3 months of 2007, mercury also sold for $600 ($17 per kg), and import prices were from $4 to $20 per kg. The uneven nature of import pricing, some of which is well below the international average price per kg of mercury, may be related to country of origin, hedging, whether or not the mercury was recycled or virgin, improper customs declarations, or other reasons.

In 2006, a $600, 34.5-kg flask (or approximately $17/kg) may easily be worth $2,100 or more when repackaged in 1-kg bottles and sold at $60 per kg for artisanal gold mining. Import prices in 2006 per kg of mercury range from a high of $24 for mercury from Almaden to a low of $1 for mercury processed in the United States.

In February 2007, in the artisanal mining areas of Huepethue (Madre de Dios) and Ananea (Puno), 1-kg bottles of mercury sold for approximately $40 to $60 (S/. 120-180) depending on the perceived origin of the mercury. Typically, "El Español," also called "Torito" because of the bullfight scene on the bottle, is the preferred brand and sells for as much as $60 (S/. 180) per kg. At some shops in artisanal mining areas, signs are posted that indicate that "good Spanish mercury" is sold. The name and label imply, and users commonly assume that "El Español" is "Spanish mercury;" however, based on distributor contact information on the bottle, Peruvian Customs data show that this is not mercury from Spain and this

mercury may either be recycled mercury from the United States or virgin or recycled mercury from Kyrgyzstan. Local newspapers, such as "El Minero Artesanal" carry advertisements for mining supplies, quimbaletes, and azogue.

A 100-g plastic bottle of triple-distilled mercury, marked as imported from the United States, and sold in one of the many dental supply stores in the 200 block of Av. Emancipación in Lima cost approximately $7 (S/. 22) in February 2007.

In artisanal mining areas in nearby Brazil, a kilogram of mercury may sell for as much as $250 (L. Fernandez, regional specialist, U.S. Environmental Protection Agency, Washington, D.C., oral commun., August 28, 2007).

Mercury Stocks

The Government of Peru maintains no stockpile of mercury (M. Yepez, economist, oral commun., U.S. Embassy, Lima, February 8, 2007); however, for comparison, 4,436 t of mercury are held by the Defense Logistics Agency (U.S. Department of Defense) and 1,206 t of mercury left from 1950s research on lithium isotopes for bomb production are held by the U.S. Department of Energy. Approximately 3,000 t of mercury is held in the cells of the remaining 9 mercury-cell chlor-alkali plants in the United States.

Mercury-cell technology is used by Quimpac S.A., a major supplier of chlorine and caustic soda; however, the amount of mercury in the cells, or stocks, was not available (Isias Flit, advisor, Quimpac S.A., oral commun., February 14, 2007). An unknown amount of mercury was on hand at dental supply shops, dentists' offices, and importers and suppliers of mercury for artisanal gold mining.

Other Mercury Releases and Uses

Cremation

Mercury fumes may be released from mercury-silver dental amalgam during cremation, and crematoriums in the United States may emit as much as 145 kg/yr of mercury (Chea, 2007). A study of mercury and the cremation process in the United Kingdom indicated that approximately 11 kg of mercury was released from one crematorium chimney in 1 year (Mills, 1990). A site visit to a funeral agency in Trujillo indicated that cremation was not commonly used in Peru; however, the deceased's family had the right to make the decision regarding removal of gold, platinum, or silver dental work from the deceased. During the time of the site visit, cremations were suspended because the fuel used gave an undesirable black smoke (Jorge Garcia, administrator, Cementerio de Miraflores, Trujillo, oral commun., February 5, 2007). Mercury released from amalgam during cremation was not a concern.

Fireworks

Studies in Stockholm, Sweden, in 1996 showed that airborne levels of mercury, cadmium, lead, and other metals were 4 to 5 times higher than normal after a fireworks display (Fireworks, 2007; U.S. Fireworks, 2007). Fireworks are made and sold in clandestine shops in Lima and in Juliaca. A fire at one of these shops in Lima in 2001 resulted in the deaths of 250 people (Stevenson, 2001). There is no information on the quantity of metals or metal compounds on hand that are used to color locally made fireworks.

Laboratories

School chemistry labs and other laboratories may have stocks of mercury on hand in thermometers, hygrometers, or in bulk. Releases of mercury from broken thermometers is a concern because mercury readily volatizes at room temperature (Putman, 1972, p. 513). For example, mercury from a Washington, D.C., high school lab was stolen and spread around the school which caused evacuation and closure of the school (Fahrenthold, 2003). An elementary school classroom in Leesburg, Va, was quarantined after grade school children were found playing with mercury (Chandler, 2007). There was no information available on the quantity of mercury held in high school and other labs in Peru.

Landfills

Site visits were made to landfills, landfill offices, and recycling centers in Lima and Trujillo. At the recycling center for Trujillo, at Km 571 Panamericana Norte, aluminum cans, cardboard, and plastic bottles were separated for recycling. At the Relima "Portillo Grande" landfill, near Lurín (south of Lima), from 1,500 to 2,000 t of waste are received per day from Lima. This is an arid area and this particular landfill has no impermeable plastic layers or a system to trap leachate or test groundwater (Craig and others, 2001, p. 116). Waste material is deposited directly on a clay layer that is estimated to be 70-meters thick. There is a medical waste area where, if identified, some mercury-containing waste material may be placed (Odilon Amado, manager, Relima, oral commun., February 15, 2007). A visit was also made to the Gerencia de Medio Ambiente (Municipalidad de Surco) in Lima, a recycling center where glass and plastic materials are recycled (Julio Dávalos, manager, Gerencia de Medio Ambiente, oral commun., February 15, 2007). In general, at the three sites visited, no provisions are made to remove or recycle mercury-containing materials such as amalgam, batteries, electronic waste, fluorescent lamps, thermometers, or toys.

Neon lights

Argon, neon, and mercury are used as fill to provide color in neon lighting, and out of 44 lamp styles listed on one website, 37 of these used argon/mercury fill (Depue, 2001; Lite Brite Neon, 2007). These lamps may last 25 years or longer. Neon lights are commonly used at restaurants and casinos in Lima; however, there is no information on the source, stock on hand, or amount of mercury used in these lamps.

Paint

A site visit to several hardware stores indicated that mercury-containing paints are not used. Mold and mildew, when present, are treated by sealants.

Conclusion

Mercury has been used for ancient and modern artisanal gold production in Peru, and today mercury is an important byproduct from Peru's large scale gold mines. Releases of mercury occur from artisanal gold mining and from broken fluorescent lamps, batteries, and dental amalgam that are put into the waste stream without reclamation or recycling of the mercury. Much of the mercury used for artisanal gold mining, chlor-alkali production, and the mercury contained in these mercury-containing products could be recycled. However, at present, there are no recycling facilities in place in Peru nor is there legislation in place, or pending, which would require tracking or recycling of mercury.

Peru is a world leader in precious metals production and has the potential to become a world leader in mercury stewardship. As Peru's byproduct mercury is transported and used internationally, its mercury-containing waste, with appropriate legislation, could also be sent to recycling centers worldwide for reclamation and recycling of the mercury.

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Tables (1-15)

Table 1. Salient Mercury Statistics[1]

[Metric tons unless otherwise specified; [e]Estimated; [r]Revised; NA not available or not applicable; --no data [Source: Superintendencia Nacional de Aduanas del Perú]

	2002	2003	2004	2005	2006
Peru:					
Primary production	--	--	--	--	--
Secondary production, mine byproduct	--	19	--	128	22
Imports for consumption	63	94	84	88	85
Exports	124	66	58	105	24
Industry stocks, yearend	NA	NA	NA	NA	NA
Industrial consumption	NA	NA	NA	NA	NA
Price, average, free market (dollars per flask)	140	140	365	555	670
World mine production[e]	1,490	1,370	1,890	1,680	1,480

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

[2]Stocks at consumers and dealers not available. Mine stocks withheld to avoid disclosing company proprietary data.

[3]Source: Platts Metals Week.

Table 2. Imports and Exports of Mercury, by Country

[Metric tons and thousand dollars; --no data; Source: Superintendencia Nacional de Aduanas del Peru]

	2002		2003		2004		2005		2006	
Country	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Imports:										
Algeria	--	--	--	--	21	156	4	113	2	45
Austria	--	--	--	--	--	--	--	--	(1)	1
Czech Republic	2	8	--	--	--	--	--	--	--	--
Germany	--	--	8	50	2	17	--	--	(1)	--
India	--	--	--	--	--	--	(1)	1	--	--
Japan	(1)	--	--	--	--	--	--	--	--	--
Kyrgyzstan	--	--	--	--	--	--	--	--	8	160
Mexico	--	--	(1)	3	--	--	--	--	(1)	--
Netherlands	9	38	2	11	--	--	--	--	2	38
Spain	30	147	44	270	16	124	21	469	19	342
United States	23	55	39	174	45	84	62	129	54	250
Total	64	248	93	508	84	381	87	712	85	836
Exports:										
Brazil	--	--	--	--	--	--	--	--	1	27
Columbia	--	--	--	--	--	--	3	17	1	4
Ecuador	--	--	--	--	--	--	--	--	--	--
Guyana	--	--	--	--	--	--	--	--	1	20
Spain	106	--	53	--	45	--	--	--	--	--
United States	18	13	13	10	12	86	102	1,385	22	209
Total	124	13	66	10	57	86	105	1,402	25	260

[1]Less than ½ unit.

Table 3. Imports of Mercury by Country of Origin

[Metric tons; Source: Superintendencia Nacional de Aduanas del Perú]

Use	Importer	Exporter	Country	Quantity	Value[1]
Artisanal Gold Mining:					
Recycled:	Mercantil S.A.	Millenium Chemical Inc.	Algeria	2	$44,000
	Mercantil S.A.	Millenium Chemical Inc.	United States	1	16,626
	Triveño Mercury Corporation	Bethlhem Apparatus Company, Inc.	United States	5	81,750
	Torres Rojas Aldo Orlando	Millenium Trading Inc.	United States	5	21,390
	J.H. Minerals	Millenium Trading Inc.	United States	3	10,350
	Torres Rojas Aldo Orlando	Millenium Trading Inc.	United States	4	17,250
	J.H. Minerals	Millenium Trading Inc.	United States	2	6,900
	Triveño Mercury Corporation	U.S. Chemical & Metal Company	United States	5	23,288
	Torres Rojas Aldo Orlando	Millenium Trading Inc.	United States	2	6,900
	J.H. Minerals	Millenium Trading Inc.	United States	2	6,900
	Triveño Mercury Corporation	NA	United States	2	6,533
	Torres Rojas Aldo Orlando	Millenium Trading Inc.	United States	2	3,892
	Triveño Mercury Corporation	NA	United States	3	7,050
	Torres Rojas Aldo Orlando	Millenium Trading Inc.	United States	2	2,949
	Triveño Mercury Corporation	U.S. Chemical & Metal Company	United States	3	5,920
	Triveño Mercury Corporation	U.S. Chemical & Metal Company	United States	10	17,760
	Triveño Mercury Corporation	NA	United States	3	4,472
Virgin:	M & M Trading S.R.L.	Minas de Almaden y Arrayanes S.A.	Spain	3	58,930
	M & M Trading S.R.L.	Minas de Almaden y Arrayanes S.A.	Spain	3	58,930
	M & M Trading S.R.L.	Minas de Almaden y Arrayanes S.A.	Spain	2	27,775
	M & M Trading S.R.L.	Minas de Almaden y Arrayanes S.A.	Spain	2	27,775
	M & M Trading S.R.L.	Minas de Almaden y Arrayanes S.A.	Spain	2	29,465
	M & M Trading S.R.L.	Minas de Almaden y Arrayanes S.A.	Spain	2	35,275
	M & M Trading S.R.L.	Minas de Almaden y Arrayanes S.A.	Spain	3	70,595
Recycled and Virgin:	Mercantil S.A.	Millenium Chemical Inc.	Kyrgystan	1	15,960
	Mercantil S.A.	Millenium Chemical Inc.	Kyrgystan	(2)	6,650
	Mercantil S.A.	Millenium Chemical Inc.	Kyrgystan	1	15,960
	Mercantil S.A.	Millenium Chemical Inc.	Kyrgystan	1	15,960
	Mercantil S.A.	Millenium Chemical Inc.	Kyrgystan	1	16,124
	Mercantil S.A.	Millenium Chemical Inc.	Kyrgystan	1	16,124
	Mercantil S.A.	Millenium Chemical Inc.	Kyrgystan	2	32,248
	Mercantil S.A.	Millenium Chemical Inc.	Kyrgystan	1	$16,124
	Mercantil S.A.	Millenium Chemical Inc.	Kyrgystan	2	32,248
	Mercantil S.A.	Millenium Chemical Inc.	Kyrgystan	1	16,124
Chlor-alkali production:	Kossodo S.A.C.	Productos Quimicos Monterrey, S.A.	Mexico	(2)	260
	Quimpac S.A.	NA	Netherlands	2	37,410
Dental:	Triveño Mercury Corporation	NA	United States	NA	NA
Medical:	Cimatec S.A.C.	Sigma-Aldrich Chemie GMBH	Austria	--	41
	Cimatec S.A.C.	Sigma-Aldrich Chemie GMBH	Austria	(2)	453
	Merck Peruana S.A.	Merck KGAA	Germany	--	58
	Merck Peruana S.A.	Merck KGAA	Germany	--	126
	Merck Peruana S.A.	Merck KGAA	Germany	(2)	230
Total				86	814,775

[1]Free on board.

[2]Less than ½ unit.

Table 4. Import Prices per Kilogram, 2004-2007

[Dollars and kilograms, unless otherwise specified; --no data; Source: EQUIFAX (formerly known as INFOCORP)].

Purchaser	Value[1]	Value[2]	Quantity	Dollars per kilogram (kg)[3]
2004:				
Mercantil S.A.	$156,639.92	$149,838	20,709	$7.56
M & M Trading S.R.L.	110,484.98	108,689	14,630	7.55
DFG Mercury Corporation del Peru E.I.R.L.	83,304.66	77,854	45,232	1.84
Quimpac, S.A.	29,289.99	27,999	3,450	8.48
2005:				
J & C Aurysur S.C.R.L.	286,535.00	284,022	12,765	22.44
M & M Trading S.R.L.	124,755.00	123,076	6,038	20.66
Mercantil S.A.	112,977.72	111,639	4,002	28.23
Triveño Mercury Corporation	112,623.53	105,845	61,306	1.83
Aurimetal E.I.R.L.	57,375.00	56,796	2,588	22.17
Corporación Reggiper S.A.	15,693.90	15,300	900	17.43
2006:				
M & M Trading S.R.L.	341,971.28	338,210	18,975	18.02
Mercantil S.A.	221,163.61	218,385	10592	20.88
Triveño Mercury Corporation	152,216.53	146,772	31,913	4.76
Torres Rojas Aldo Orlando	55,386.23	52,381	15,387	3.59
Quimpac, S.A.	38,311.15	37,410	1,725	22.20
J.H. Minerals E.I.R.L.	25,682.25	24,150	6,038	4.25
2007 (January-March):				
M & M Trading S.R.L.	89,325.00	88,395	5,175	17.26
Mercantil S.A.	22,211.31	21,945	1,139	19.50
Torres Rojas Aldo Orlando	20,289.87	19,458	4,865	4.17
J.H. Minerals E.I.R.L.	10,955.25	10,350	2,588	4.23

[1]Including cost, insurance, freight.

[2]Free on board.

[3]Rounded, based on value, including cost, insurance, and freight.

Table 5. Import Mercury Average Price 2004-2007

[Source: EQUIFAX (formerly known as INFOCORP)]

Year	Dollars per flask	Dollars per kilogram
2004	$365	$11
2005	555	16
2006	670	19
2007 (January-March)	600	17

Table 6. Exports of Mercury by Country of Destination

[Metric tons and dollars; Source: Superintendencia Nacional de Aduanas del Perú]

Country of Destination/Port	Exporter	Quantity	Value
Brazil/Rio De Janeiro	Triveño Mercury	(1)	$9,208
	Triveño Mercury	(1)	9,202
	Triveño Mercury	(1)	9,000
Colombia/Buenaventura	Triveño Mercury	1	4,000
Guyana/Georgetown	Triveño Mercury	1	20,000
United States/New York	Minera Yanacocha S.R.L.	6	53,654
	Minera Yanacocha S.R.L.	8	65,920
	Minera Yanacocha S.R.L.	8	89,413
Total		22	208,987

[1]Less than one half unit.

Table 7. Imports of Fluorescent Lamps by Country

[-- no data]

Country	Quantity, (metric tons)	C.I.F.[1] Total (thousands)
Imports:		
Argentina	(2)	5,280
Bolivia	--	3,462
Brazil	200	638,517
Canada	3	12,361
China	797	3,783,930
Columbia	42	96,817
Czech Republic	(2)	1,394
Denmark	(2)	65
France	31	210,348
Germany	26	218,478
Hungary	104	369,112
Indonesia	3	20,353
Italy	4	44,492
Japan	(2)	3,758
Mexico	3	5,677
Netherlands	38	205,894
Poland	441	1,418,770
Republic of Korea	1	9,677
Russia	(2)	404
Singapore	(2)	1,208
Spain	(2)	1,974
Switzerland	(2)	990
Taiwan	9	27,954
Thailand	175	901,006
United Kingdom	(2)	1,202
United States	20	115,522
Total	1,866	8,098,645

[1]Cost insurance freight.

[2]Less than ½ unit.

Table 8. Imports of Fluorescent Lamps by Company

[Metric tons and dollars; --no data. Source: Superintendencia Nacional de Aduanas del Perú]

Company	Quantity	Total value[1]
Philips Peruana S.A.	1,028	$5,417,983
GE Lighting Peru S.A.	247	1,231,363
Dekatec S.A.C.	44	290,928
Importaciones Megalo S.A.C.	101	105,054
Comercial Bella-Sur E.I.R.L.	53	90,021
Consorcio Comercial Lung S.A.C.	13	51,506
MHT Corporation E.I.R.L.	27	46,636
Celszen Representaciones S.A.C.	9	45,821
Fenix Trading Soc.Com.De Resp. Ltda.	22	36,507
Ferre Import S.A.C.	32	35,360
Koller S R Ltda.	16	35,233
C&K Importadores S.A.C.	9	35,156
Comercial Industrial Selva S.A.	12	34,648
Anna Import S.R.L.	28	30,616
Fahan S.A.C.	8	22,299
Representaciones Ferretera S.R.L.	8	20,445
Comercial Vilca S.A.	10	18,840
Southern Peru Copper Corporation	[2]	17,811
Sun Light S.A.C.	11	16,723
Corporacion E. Wong S.A.C.	3	16,469
J P & CIA E.I.R.L.	9	14,095
Importaciones Togen S.R.L.	15	13,347
Anicama Correa Daniel	14	13,185
Tech Pak S.A.	[2]	12,294
Homelight Peru S.A.C.	2	11,600
Peruvian Alliance SOC. Anonima Cerrada	1	10,889
Gulda Agro Selva S.A.C.	3	10,850
Representaciones RAE S.R.L.	4	10,452
Metropolis Import Export E.I.R.L.	7	10,157
J Y J Importaciones S.A.C.	5	9,970
Autorex Peruana S.A.	[2]	8,720
Sodimac Perú S.A.	1	7,387
Pulsar Import E.I.R.L.	5	7,335
Cruz Montesinos Ricardo Celestino	9	7,322
Minera Barrick Misquichilca S.A.	[2]	7,124
Invercom Yerat S.A.C.	5	7,019
H Y L Imports S.A.C.	4	6,659
Gonzales Caro Jimmy	8	6,342
La Piramide Importaciones S.R.L.	8	6,269
Perales Huancaruna S.A.C.	[2]	5,399
Sociedad Quimica Mercantil S.A.	[2]	5,382
Davisco S.A.	[2]	5,280
Logic Games Peru S.A.C	[2]	5,230
EGT Eximport E.I.R.L.	4	4,543
Schonimex S.A.C.	[2]	3,462
Corporacion Jose R. Lindley S.A.	[2]	3,373
Arrese Cavero Nancy Aida	1	2,973
Blitzkrieg S.A.C.	2	2,847
CP & C Comercial S.A.C.	2	2,257
Fajardo Esteves Cesar Augusto	[2]	2,116
Wing WA S.R.L.	2	2,016
Representaciones Martin S.R.L.	[2]	1,949
Mixtel S.A.C.	[2]	1,865
Pisconte Gutierrez Laura Evelyn	1	1,864

Table 8. Imports of Fluorescent Lamps by Company—Continued

Company	Quantity	Total value[1]
Pyetrex S.A.	(2)	1,671
Distribuidora Y Serv. Graf. Lch E.I.R.L.	(2)	1,659
NCR Del Perú S.A.	(2)	1,645
Grupo Fenix E.I.R.L.	1	1,639
Castillo Jimenez Fidencio	1	1,478
Industrias del Envase S.A.	(2)	1,451
Windows Business Import Export E.I.R.L.	1	1,413
Compania de Servicios cosmos S.A.	(2)	1,363
Fluor Daniel Sucursal del Perú	(2)	1,355
Variedades Yhelsin' S.R.L.	1	1,334
Quebecor World Perú S.A.	(2)	1,300
Lighting Camera S.A.	(2)	1,225
Hilite S.A.C.	(2)	1,224
Centro Papelero S.A.C.	(2)	1,175
Electro Daylum E.I.R.L.	1	1,115
Corporacion Fabril de Confecciones S.A.	(2)	1,047
Cía. Ind. Textil Credisa-Trutex S.A.	(2)	990
C.I. Grafinal del Perú S.A.C.	(2)	939
America Sam S.A.C.	(2)	925
Video Broadcast S.A.	(2)	883
Amalur Industrial S.A.	(2)	850
Banco Continental	(2)	835
Gloria S.A.	(2)	735
Lanatta Rivarola Fernando Alberto	(2)	696
Mullisaca Quispe Teresa	1	683
Hotelera Costa del Pacifico S.A.	(2)	679
Importaciones E L Figueroa S.R.L.	(2)	659
Laupa Ayquipa Lucio Eloy	(2)	638
Specchi Sociedad Anonima Cerrada	(2)	635
OHMLUX S.A.C.	(2)	569
Saxon Services del Perú S.A.	(2)	521
Ferreyros S.A.	(2)	513
Xerox del Perú S.A.	(2)	493
Peruplast S.A.	(2)	425
Obras Y Servicios Petroleros S.A.C.	(2)	424
Protecnia Amazon S.A.C.	(2)	413
Datacont S.A.C.	(2)	412
Importad y Exportadora Ferrochiang E.I.R.L.	(2)	405
Importaciones & Tecnologias S.R.L.	(2)	380
El Tumi Perú S.R.L.	(2)	370
Eesaperu S.A.C.	(2)	363
Chen Zhimin	(2)	316
Importaciones y Representaciones Medico Dental S.R.L.	(2)	291
Cia. Internacional del Café S.A.C.	(2)	285
Euro Motors S.A.	--	284
Cetres Post-Producciones S.A.	(2)	279
IBM del Perú S.A.C.	(2)	278
Valtri S.A.	(2)	276
Asea Brown Boveri S.A.	(2)	254
Universal de Desarrollos Electronicos Perú S.A.	(2)	251
Briggitte Import Export E.I.R.L.	(2)	250
EECOL Electric Perú S.A.C.	(2)	232
Biocon del Perú S.A.C.	(2)	228
Triton Trading S.R.L.	(2)	224
Dicom Ingenieros S.R.L.	(2)	208

Table 8. Imports of Fluorescent Lamps by Company—Continued

Company	Quantity	Total value[1]
Omega Perú S.A.	(2)	193
Unitex Global S.A.	(2)	175
Telvicom S.A.	(2)	173
G Y M S.A.	(2)	165
Petro Tech Peruana S.A.	(2)	161
Empresa Algodonera S.A.	(2)	157
Dimatic S.A.C	(2)	153
Química Suiza S.A.	--	151
Yap Inga Yandy	1	151
American Industrial Equipment S.A.C.	(2)	147
Exportimo S.A.C.	(2)	133
Siemens Building Technologies S.A.	(2)	116
Guillermo Li S.A.C.	(2)	114
Exclusive Import S.A.C.	(2)	111
Laura Janco Jesús Santos	(2)	107
Import & Export China Comercial Central S.A.C.	(2)	102
Topsa Productos Opticos S.A.	--	98
Merck Peruana S.A.	--	96
Country Home S.A.	(2)	90
BSH Electrodomesticos S.A.C.	(2)	83
World Casino Technology E.I.R.L.	(2)	68
Prelatura de Huari	(2)	68
Soc.Promotora de Import.Export.S.A.C.	(2)	67
Sweden Spare Parts S.A.C.	(2)	62
Corporación Cerámica S.A.	--	61
H.W.Kessel S.A.C.	(2)	60
Tecnología Digital Victoria Perú S.A.C.	--	52
Modular Mining Systems Sociedad Comercial de	--	51
Heidelberg Perú S.A.	(2)	46
Machines Los Andes Slots S.A.C.	(2)	42
Logicorp S.A.	--	37
Internacional Colección Cristina S.R.L.	--	32
San Fernando S.A.	--	32
Peru Office S.A.	--	31
Fashionlight S.A.C.	(2)	29
Tetra Pak S.A.	--	29
Servicios Electrónicos Integrales S.A.	(2)	29
Universidad Peruana Cayetano Heredia	--	25
Milano Sport S.A.C.	(2)	20
America Ret Maquinarias S.A.C.	(2)	19
Epson Perú S.A	(2)	18
Indio Feliz E.I.R.L	(2)	16
Evolution Games S.A.C.	--	16
Marmolería Gallos S.A.	(2)	15
Sony Sucursal del Peru	--	13
Senwest International S.R.L.	(2)	11
Atronic Perú S.A.	--	10
ZS Motor S S.A.C.	(2)	10
Millennium Game S.A.C.	(2)	8
Team Computer S.A.C	--	6
Turbogeneradores del Perú S.A.C.	--	3
Club de Leones de Iquitos	--	1
Total[3]	1,900	8,098,646

[1]Including cost, insurance, freight.

[2]Less than ½ unit.

3Data are rounded to no more than three significant digits; may not add to totals shown.

Table 9. Imports of Non-Electric Thermometers by Company

[Metric tons and dollars; --no data]

Company	Quantity	Total value[1]
Empressa Eléctrica de Piura S.A	1	$179,037
Asea Brown Boveri S.A.	(2)	70,629
Banco Internacional del Perú-Interbank	(2)	70,475
Industrial Control's S.A.C.	1	39,091
Petro Tech Peruana S.A.	(2)	35,663
Consultec y Servicios S.A.	1	33,513
Corporacíon Infarmasa S.A.	(2)	27,405
Emp Reg de Serv Público de Electricdad	(2)	21,004
Rash Perú S.A.C.	1	15,961
Importécnia S.A.	(2)	14,411
Josiel S.A.C.	1	12,787
Banco de Crédito del Perú	(2)	11,933
Ferreyros S.A.	(2)	11,684
Mitsui Maquinarias Perú S.A.	(2)	11,371
Energia del Sur S.A.	1	10,961
Valvulas	(2)	10,389
EPLI S.A.C.	(2)	10,099
Motores Diesel Andinos S.A.- Modasa	(2)	9,530
Controlmatic S.A.C.	(2)	8,770
Metso Minerals (Perú) S.A.	(2)	7,673
Sandvik del Perú S.A.	(2)	7,582
Duke Energy International Egenor S.A.-Egenor S.A.	(2)	7,269
Omega Perú S.A.	(2)	6,591
Logytec S.R.L.	(2)	6,459
Textil el Amazonas S.A.	(2)	6,113
Gobierno Regional Piura	--	5,866
Logindustrias S.R.L.	(2)	5,416
Industrias EKA del Perú S.A.	(2)	5,039
Tetra Pak S.A.	(2)	4,827
Termofix Sociedad Comercial de Responsabilidad Limitada	(2)	4,530
EMP Concesionaria de Elect de Ucayali S.A.	(2)	4,529
Importadora Andina E.I.R.L.	(2)	4,502
Construcciónes Electromecánicas Delcrosa S.A.	1	4,352
Noble Equipment & Services S.A.C.	(2)	3,591
Praxair Perú S.A.	(2)	3,458
Southern Peru Copper Corporation	(2)	3,439
Gloria S.A.	(2)	3,431
Prosemedic S.A.	(2)	3,346
Citibank N.A. Sucursal de Lima	(2)	3,344
Jose Luís López Aguirre S.A.	(2)	3,301
Venture Management Consultants Enterprises Peru S.R.L	(2)	3,244
Refinería la Pampilla S.A.	(2)	3,068
Complejo Agroindustrial Cartavio S.A.	(2)	3,041
Inversiones Interamericanas S.A.	(2)	3,007
M & M Repuestos y Servicios S.A.	(2)	2,994
Siemens Building Technologies S.A.	(2)	2,730
Filamentos Industriales S.A.	(2)	2,716
Higseg E.I.R.L.	(2)	2,571
Sullair del Pacifico S.A.C.	(2)	2,515
International Tool & Supply del Peru S.A.	(2)	2,266
Repuestos Nuevos S.A. (RENU S.A.)	(2)	2,111
Procesadora de Gas Parinas S.A.C.	(2)	2,110

Table 9. Imports of Non-Electric Thermometers by Company—Continued

Company	Quantity	Total value[1]
Edegel S.A.	(2)	2,087
AWS Consulting S.A.C.	(2)	2,079
Ferrier S.A.	(2)	2,064
Industria Textil Piura S.A.	(2)	1,968
Aparatos y Conecciónes a Gas S.A.	(2)	1,909
Pluspetrol Norte S.A.	(2)	1,908
San Fernando S.A.	(2)	1,893
G Y M S.A.	(2)	1,845
Serv y Representaciones Asociadas S.A.	(2)	1,834
A.B.Importaciones Industriales Sociedad	(2)	1,784
Science and Technology Training E.I.R.L.	(2)	1,774
Energotec S.A.C.	(2)	1,721
Arin S.A.	(2)	1,619
Generadores de Vapor y Equipos Afines S.A.	(2)	1,606
Guillermo Li S.A.C.	(2)	1,571
Eléctrica Optimización S.A.	(2)	1,553
Schlúmberger del Perú S.A.	(2)	1,539
Classic Chocolat Nelly E.I.R.L.	(2)	1,254
Fluor Daniel Sucursal del Peru	(2)	1,372
Aliaga Marro Milágros del Carmen	(2)	1,295
Lima Caucho S.A.	(2)	1,247
Gnio Comercial S.A.	(2)	1,197
Cia. Ind. Textil Credisa-Trutex S.A.	(2)	1,113
Promotores Eléctricos S.A.	(2)	1,107
Artículos Importados SRL	(2)	1,092
Thissen del Perú S.A.	(2)	1,089
Pluspetrol Perú Corporation S.A.	(2)	1,078
Masias Marrou Manuel Estuardo	(2)	1,058
Agrovet Market S.A	(2)	1,047
Diseños y Equipamientos S.A.C.	(2)	1,033
Compañía Cervecera Aambev Perú S.A.C.	(2)	986
Samy Import S.R.L.	(2)	954
Sunshine Export S.A.C	(2)	927
Nuñez Alarcón E.I.R.L.	(2)	905
3M Perú S.A.	(2)	895
Burns Philp Perú S.A.C.	(2)	889
V & Q Instrumentos y Maquinarias Industriales	(2)	869
Importaciónes Racing S.A.C.	(2)	792
Pathros Representaciones S.A.	(2)	771
Unión de Cerveza Peruana Backus y Johnston S.A.	(2)	749
Texgroup S.A.	(2)	740
Pesquera Carola S.A.C.	(2)	726
Fabricá de Cintas Arbona S.A.	(2)	666
A. Jaime Rojas Representaciónes Generales S.A.	(2)	651
Marco Peruana S.A.	(2)	617
Emerson Energy Systems del Perú S.A.C	(2)	617
Kossodo S.A.C.	(2)	613
Doe Run PerúS.R.L.	(2)	612
Importaciónes Gala Empresa Individual de Responsabilidad	(2)	580
I.C.C. Perú S.A.C.	(2)	562
Instrumentos y Sistemas E.I.R.L.	(2)	558
G.R Tech S.A	(2)	550
NPI Perú S.A.C.	(2)	546

Table 9. Imports of Non-Electric Thermometers by Company—Continued

Company	Quantity	Total value[1]
Mercantil Interamericana S.A.	(2)	533
Importaciónes Togen S.R.L.	(2)	510
Construcciónes Peruanas S.A.	(2)	488
Diveimport S.A.	(2)	482
Talleres Reunidos E.I.R.L.	(2)	474
Textiles Camones S.A.	(2)	439
Fundición Central S.A.	(2)	412
Corporación E. Wong S.A.C.	(2)	407
Motores y Maquinarias S.A.C.	(2)	405
York International S.R.L.	(2)	402
Sociedad Minera Cerro Verde S.A.	(2)	399
Consorcio Neshuya	(2)	379
Mercantil S.A.	(2)	351
Saeg Perú S.A.	(2)	349
Frigorífico de Hielo S.A.	(2)	347
Alicorp S.A.	(2)	340
Inchcape Motors Perú S.A.	(2)	320
Schmalbach-Lubeca Plast.Contai.D.Perú S.A.	(2)	316
J.A.O.R. Representaciónes E.I.R.L.	--	312
Minera Aurífera Retamas S.A.	(2)	309
Acuario Real S.R.L.	(2)	306
Servicios Petroleros y Anexos S.R.L.	(2)	302
Asensores S.A.	(2)	290
Fuel Injection Cano S.R.L.	(2)	284
Catalina Huanca Sociedad Minera S.A.C.	(2)	279
Automotriz General del Peru S.A.	(2)	268
Geotec S.A.	(2)	266
Cold International S.A.	(2)	265
A & A Representaciónes y Servicios S.R.L.	--	259
Petrex S.A.	(2)	258
M & M Appliance Parts S.R.L.	(2)	243
Bionet S.A.	(2)	233
Maquinaria Nacional S.A.	(2)	224
Brammertz Ingenieros S.A.	(2)	215
Mantenimento Industrial y Comercial S.A.C.	(2)	215
Imcetron S.R.L.	(2)	209
Robocon Servicios S.A.C.	(2)	208
Minera Yanacocha S.R.L.	--	201
Maersk Perú S.A. O ALCONSA	(2)	165
Tumi Contratistas Mineros S.A.C.	(2)	164
Química Service S.R.L.	--	160
Cafe Britt Perú S.A.C.	(2)	153
Igardi Herramientas S.A.	(2)	149
H Y S International S.A.	--	140
Granja Santa Rosa S.A.C.	(2)	124
Olivera Sulca Lourdes Gloria	(2)	115
Minas y Concentradoras S.A.	(2)	114
M I Overseas Limited Surcursal del Peru	(2)	112
Instruments Lab S.A.C.	(2)	108
General House de Comercio Industrial S.A.C.	(2)	105
Cemento Andino S.A.	(2)	98
Meg Energy S.A.C.	(2)	97

Table 9. Imports of Non-Electric Thermometers by Company—Continued

Company	Quantity	Total value[1]
Bradley MDH S.A.C.	(2)	97
Unión de Concreteras S.A	--	95
Tognetti S.A.	(2)	92
Saidel S.A.	(2)	89
MC Trade S.A.C.	(2)	84
Volvo Perú S.A.	(2)	80
Agrogenetica S.A.C.	(2)	80
Medicos Sin Fronteras Belgica	(2)	75
Liftoil S.A. Sucursal Perú	(2)	72
Inversiones Brencar E.I.R.L.	--	70
UNIMAQ S.A.	(2)	70
Sistemas Industriales y Tecnológicos S.A	(2)	57
Operaciones Arcos Dorados de Perú S.A.	(2)	57
Inst. Educac. Franklin Delano Roosevelt	(2)	53
Refrigeración Oscco E.I.R.L.	(2)	50
Tecnoimagen del Perú S.A.	--	49
La Madrid Gonzales Raul Guillermo	(2)	47
H.W.Kessel S.A.C.	--	42
Inversíones Avicolas S.A.	(2)	37
Alfa Laval S.A.	--	33
C & CC International S.A.C.	(2)	32
Glaxosmithkline Perú S.A.	(2)	32
MGM Consultores y Contratistas Generales S.A.	(2)	31
Agromotors E.I.R.L.	(2)	30
Ceyesa Ingeniería Electrica	(2)	28
Hewlett-Packard del Perú S.A.	--	26
Pacific Interproducts S.A.C.	(2)	23
Digital Peruana E.I.R.L.	(2)	17
Servimatic S.A.C.	(2)	16
Spena Fish Aquacultura S.R.L.	--	16
BSH Eletrodomesticos S.A.C.	(2)	14
Artiglas S.A.	(2)	11
Belnet Perú S.A.C.	--	11
Importaciones Dega Empresa Individual	(2)	10
Tecnología E Ingeñieria de Fluidos S.A.C.	--	10
G.W. Yichang & Cia S.A.	(2)	6
Química Suiza S.A.	--	5
Total[3]	14	828,950

[1]Including cost, insurance, freight.

[2]Less than ½ unit.

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

Table 10. Imports of Batteries, Manganese Dioxide, Alkaline

[Metric tons and dollars; Source: Superintendencia Nacional de Aduanas del Perú]

Country	Quantity	Value
Australia	(1)	$33
China	338	3,021,057
Germany	2	20,135
Indonesia	2	12,012
Japan	1	6,446
Korea, North	(1)	22
Korea, Republic of	(1)	1,262
Malaysia	1	25,285
Singapore	95	562,902
Spain	(1)	373
Switzerland	(1)	300
United States	69	562,218
Total[2]	509	4,212,045

[1]Less than ½ unit.

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

Table 11. Imports of Other Batteries, Manganese Dioxide, Alkaline

[Metric tons and dollars; --no data; Source: Superintendencia Nacional de Aduanas del Perú]

Country	Quantity	Value
Australia	--	$9
Belgium	--	19
China	7	91,831
Germany	(1)	1,132
Japan	(1)	765
Malaysia	(1)	4,502
Taiwan	(1)	771
United States	7	68,167
Total[2]	14	167,198

[1]Less than ½ unit.

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

Table 12. Imports of Other Batteries, Manganese Dioxide, Cylindrical

[Metric tons and dollars; Source: Superintendencia Nacional de Aduanas del Perú]

Country	Quantity[2]	Value
Brazil	248	$475,161
China	100	138,022
Columbia	1,477	2,594,745
India	37	37,552
Indonesia	412	1,094,244
Japan	124	138,320
Korea, Republic of	17	22,954
Total[1]	2,415	4,500,998

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

[2]Quantity is gross weight.

Table 13. Harmonized Tariff Codes for All Batteries

[Source: Superintendencia Nacional de Aduanas del Perú]

HTS Code	Description
8506101100	Pilas y baterias de pilas, electricas, de dioxido de magnaneso, alcalinas, cilindrica [Batteries, manganese dioxide, alkaline, cylindrical]
8506101200	Pilas y baterias de pilas, electricas, de dioxido de magnaneso, alcalinas, de "boton" [Batteries, manganese dioxide, alkaline, "button"]
8506101900	Las demas pilas y baterias de pilas, electricas, de dioxido de magnaneso, alcalinas [Other batteries, manganese dioxide, alkaline]
8506109100	Las demas pilas y baterias de pilas, electricas, de dioxido de magnaneso, cilindricas [Other batteries, manganese dioxide, cylindrical]
8506109200	Las demas pilas y baterias de pilas, electricas, de dioxido de magnaneso, de "boton" [Other batteries, manganese dioxide, "button"]
8506109900	Las demas pilas y baterias de pilas, electricas, de dioxido de magnaneso [Other batteries, manganese dioxide]
8506111000	Pilas secas de menos de 1.5v, de dioxido de manganeso [Dry batteries, less than 1.5v, manganese dioxide]
8506111001	Pilas secas de menos de 1.5v de dioxido de manganeso [Dry batteries, less than 1.5v, manganese dioxide]
8506112000	Pilas secas de 1.5v o mas, de dioxido [Dry batteries, more than 1.5v, manganese dioxide]
8506112001	Pilas secas de mas de 1.5v o mas de dioxido de manganeso [Dry batteries, more than 1.5v, manganese dioxide]
8506119000	Las demas pilas o baterias de pilas, de dioxido de manganeso [Other batteries, manganese dioxide]
8506119001	Las demas pilas o baterias de dioxido de manganeso [Other batteries, manganese dioxide]
8506121000	Pilas secas de menos de 1.5v, de oxido de mercurio [Dry batteries, less than 1.5v, mercury oxide]
8506122000	Pilas secas de mas de 1.5v, de oxido de mercurio [Dry batteries, more than 1.5v, mercury dioxide]
8506129000	Las demas pilas o baterias de pilas, de oxido de mercurio [Other batteries, mercury dioxide]
8506131000	Pilas secas de menos de 1.5v de oxido de plata [Dry batteries, less than 1.5v, silver oxide]
8506132000	Pilas secas de 1.5v o mas, de oxido de plata [Dry batteries, more than 1.5v, silver dioxide]
8506139000	La demas pilas o baterias de pilas, de oxido de plata [Other batteries, silver dioxide]
8506191000	Las demas pilas secas de menos de 1.5v [Other dry batteries, less than 1.5v]
8506191001	Pilas secas de menos de 1.5v [Dry batteries less than 1.5v]
8506192000	Las demas pilas secas de menos de 1.5v [Other dry batteries less than 1.5v]
8506192001	Pilas secas de 1.5v o mas [Dry batteries, more than 1.5v]
8506199000	Las demas baterias [Other batteries]
8506199001	Las demas pilas o baterias volumen exterior<= 300 cm^3 [Other batteries, exterior volume of < 300 cm^3]
8506201000	Pilas secas de menos de 1.5v, de volumen superior A 300 cm^3 [Dry batteries, less than 1.5v, exterior volume >300 cm^3]
8506201001	Pilas secas de menos de 1.5v volumen exterior > 300 cm^3 [Dry batteries, less than 1.5v, exterior volume of > 300 cm^3]

Table 13. Harmonized Tariff Codes for All Batteries—Continued

8506202000	Pilas secas de 1.5v o mas [Batteries, more than 1.5v]
8506202001	"Pilas secas de 1.5v o mas volumen ex [Dry batteries, more than 1.5v]
8506209000	Las demas pilas o baterias de pilas [Other batteries]
8506209001	Las demas pilas o baterias de volumen exterior>300 cm^3 [Other batteries, exterior volume of > 300 cm^3]
8506301000	Pilas y baterias de pilas, electricas, de oxido de mercurio, cilindricas [Batteries, mercury oxide, cylindrical]
8506302000	Pilas y baterias de pilas, electricas, de oxido de mercurio, de "boton" [Batteries, mercury oxide, "button"]
8506309000	Las demas pilas y baterias de pilas, electricas, de oxido de mercurio [Other batteries, mercury oxide]
8506401000	Pilas y baterias de pilas, electricas, de oxido de plata, cilidricas [Batteries, silver oxide, cylindrical]
8506402000	Pilas y baterias de pilas, electricas, de oxido de plata, "boton" [Batteries, silver oxide, "button"]
8506409000	Las demas pilas y baterias de pilas, electricas, de oxido de plata [Other batteries, silver oxide]
8506501000	Pilas y baterias de pilas, electricas, de litio, cilindricas [Batteries, lithium, cylindrical]
8506502000	Pilas y baterias de pilas, electricas, de litio, de "boton" [Batteries, lithium, "button"]
8506509000	Las demas pilas y baterias de pilas, electricas, de litio [Other batteries, lithium]
8506601000	Pilas y baterias de pilas, electricas, cinc, cilindricas [Batteries, zinc, cylindrical]
8506602000	Pilas y baterias de pilas, electricas, cinc, de "boton" [Batteries, zinc, "button"]
8506609000	Las demas pilas y baterias de pilas, elecricas, cinc [Other batteries, zinc]
8506801000	Las demas pilas y baterias de pilas, electricas, cilindricas [Other batteries, cylindrical]
8506802000	Las demas pilas y baterias de pilas, electricas, de "boton" [Other batteries, "button"]
8506809000	Las demas pilas y baterias de pilas, electricas [Other batteries]

Table 14. Imports of Batteries, Electrical

[Metric tons and dollars; --no data; Source: Superintendencia Nacional de Aduanas del Perú]

Country	Quantity	Value
Brazil	1	$6,424
France	1	281,899
Germany	--	49
Indonesia	16	59,998
Japan	(1)	169
Taiwan	--	2
United Kingdom	(1)	26
United States	(1)	11
Total	18	348,578

[1]Less than ½ unit.

Table 15. Imports of Batteries, Lithium, Cylindrical

[Metric tons and dollars; --no data]

Country	Quantity	Value
China	(1)	$5,104
France	(1)	13,871
Germany	(1)	1,061
Indonesia	(1)	391
Israel	(1)	1,518
Italy	--	79
Japan	2	43,206
Korea, Republic of	(1)	1,973
Phillapines	(1)	1,930
Singapore	(1)	536
Switzerland	--	26
Taiwan	(1)	86
United Kingdom	(1)	76,075
United States	3	101,044
Total[2]	5	246,900

[1]Less than ½ unit.

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