

# SILVER

By Henry E. Hilliard

In 1997, domestic mine production of silver increased for the third consecutive year. About 76 mines in 16 States reported production of silver with an estimated value of \$338 million. Nevada was the largest domestic silver producer, followed by Alaska, Arizona, and Idaho. Precious metal ores accounted for about one-half of domestic silver production; the other one-half was recovered as a byproduct from copper, lead, and zinc ores. There were 22 principal refiners of commercial-grade silver with an estimated output of approximately 3,600 metric tons. (There are 32,151 troy ounces in a metric ton.) About 30 fabricators accounted for more than 90% of the silver consumed in arts and industry. The remainder was consumed mostly by small companies and artisans. Aesthetic uses of silver for decorative articles, jewelry, tableware, and coinage were overshadowed by industrial uses. Industrial uses include photographic materials, electrical and electronic products, brazing alloys, dental amalgam, bearings, and catalysts.

Global mine production of silver increased for the fourth consecutive year. The 8% increase, to 16,400 tons, was 200 tons above the 1990 record, when mine production reached 16,200 tons. The world's largest silver producer, Mexico, increased output to 2,679 tons. In the United States, total production increased 38% to 2,150 tons, owing to increased production from two large silver mines in Idaho and several smaller mines reporting silver production for the first time in several years. The United States moved into second place ahead of Peru for the first time since 1992. European silver production was essentially unchanged in 1997, while production in Central America and South America increased by about 7%, primarily owing to growth in Mexico and Peru (Metals & Minerals Latin America, 1998). Global recycling of silver from old scrap materials increased only marginally in 1997 to about 4,740 tons. The United States was the largest silver recycler at about 1,360 tons, followed by Japan at about 500 tons. In the United States, photographic scrap was estimated to have generated 1,000 tons of silver, the largest part coming from spent fixer solution and from x-ray and graphic arts wastes (Silver Institute, 1998).

The steady draw-down of above-ground silver stocks to meet total demand that began in 1991 continued in 1997. Despite the excess of demand over supply, the average price for silver in 1997, at \$4.89 per troy ounce, was the lowest since 1993. With above-ground stocks of silver at the lowest level in recent years and the reentry of investors and speculators on a large scale, volatility was a major market factor. U.S. Government stocks of silver dropped nearly 1,870 tons to a level of 1,930 tons. U.S. industrial consumption, an estimated 5,000 tons, was up 435 tons from 1996 consumption. This was the highest U.S. industrial consumption since 1996, although it was still below the historic high of 6,100 tons in 1973. Photography, the largest end use category, accounted for about 53% of total domestic consumption.

Electrical and electronic products, including batteries, was the second largest end use category with about 19%, followed by jewelry and silverplate at about 9%.

Silver finds a variety of industrial uses due to its unique chemical and physical properties. The photographic and electronic industries were in the forefront of demand. Photographic emulsions contain silver bromide and silver chloride and may contain up to 10 weight-percent hexagonal silver iodide. Their primary sensitivity to light is amplified up to  $10^{11}$  times when the emulsions are developed. A high degree of purity is required of the silver halides, the gelatin, and any other ingredient used in photography. Silver's high electrical and thermal conductivity and superior oxidation resistance makes it the element of choice with respect to electrical contacts. Silver batteries include silver oxide-potassium hydroxide-zinc secondary (rechargeable) batteries and silver oxide-potassium hydroxide-zinc and silver chloride-seawater-magnesium primary batteries. Silver oxide-potassium hydroxide-zinc primary batteries have been used as watch batteries and as remotely activated batteries. The silver chloride-seawater-magnesium primary batteries have been used in torpedoes.

## Legislation and Government Programs

**Environmental Regulations.**—On July 16, the Environmental Protection Agency (EPA) signed its final new standards for ozone and particulate matter. The new standards for particulate matter called for regulation of particles 2.5 micrometers or smaller in concentrations of 15 micrograms per cubic meter annually and 65 micrograms per cubic meter daily. The new standards were scheduled to take effect between 2000 and 2002. EPA's current standards call for regulation of particulates of 10 micrometers or smaller in concentrations of 50 micrograms per cubic meter annually and 150 micrograms per cubic meter daily. This was the first update in 20 years for ozone and 10 years for particulate matter. The metal mining industry strongly opposed the tighter standards on the amounts of allowable ozone and soot particles, saying it was concerned with the science and cost of implementing the standards. EPA maintained that the new rules will be implemented in a cost-effective way.

In June, Idaho's Congressional delegation introduced legislation (S. 774, H.R. 1691) that was aimed at resolving historic mining problems in the Coeur d'Alene Basin. The legislation called for reducing discharges from old mines, capping or removing mine tailings, improving fish and wildlife habitat, and stabilizing river banks. The plan for cleanup would be drafted by a 14-member Citizens Advisory Commission composed of private citizens, county representatives, the Coeur d'Alene Indian tribe, Federal and State agencies, and one representative for the region's mining companies. The Coeur d'Alene mining district

has produced more than \$4.8 billion in silver and other metals and minerals since 1884 (Mining Week, 1997).

**United States Mint.**—Sales of Proof Silver American Eagles reached 482,610 units in fiscal year 1997, compared to 466,995 for fiscal year 1996. Sales of Uncirculated Silver American Eagles rebounded 16% from 1996 to 135,444 kilograms as prices rose from July lows. In 1997, the Mint began acting on reforms enacted by the Congress that limited the number and size of commemorative coin programs. Between 1994 and 1996, Congress approved programs with authorized mintages averaging 4.3 million coins per program. Under the reforms, the average authorized mintages for 1997 through 1999 has fallen to 430,000 coins. On September 28, 1996, a law was enacted that mandated several provisions for reforming the U.S. Mint commemorative coin programs. Public law 104-208, "Omnibus Consolidated Appropriations for fiscal year 1997," required that the Mint withhold surcharges from commemorative coin program beneficiaries until all production and marketing costs are recovered and until the beneficiaries have raised other monies from private sources equal to the maximum amount of surcharges that could be generated from their coin program (United States Mint, 1998).

Silver reserves are classified by the U.S. Mint as reserves if in bar form. Silver reserves are reported at the lower of cost or market value. Absent historical cost records to determine the acquisition cost of the silver over the decades, the reserves are valued at the rates stated in U.S. Code Title 31, sections 5116 and 5117 (statutory rates) which is \$1.292929 per troy ounce. An offsetting custodial liability is also reported for these assets. As of September 30, 1997, the market value for silver was \$5.17 per troy ounce. Silver inventories consisted of 483,605.52 kilograms of silver with a statutory value of \$20,102,486 and a market value of \$80,383,247. On September 30, 1996, silver inventories consisted of 401,520.76 kilograms of silver with a statutory value of \$16,690,392 and a market value of \$62,995,799 (United States Mint, 1998). The changes in number of silver fine troy ounces between the years is due to the use of silver in the Mint's numismatic operations. In addition, the silver inventory increased as a result of receiving silver from the Defense Logistics Agency.

## Production

Silver was produced from precious-metal ores at 46 lode mines and from base metal ores at 30 lode mines. In 1997, 14 mines each produced more than 30 tons of silver; their aggregated production equaled about 80% of total domestic production. Probably fewer than 10 placer operations recovered silver in 1997, and the quantity recovered was less than 1% of total domestic production. Total domestic mine production was 2,150 tons.

Silver production rose to 28,000 kilograms in the first quarter at the Sunshine Mine in Idaho, nearly doubling the 17,200 kilograms produced in first quarter 1996. The mine produced more silver than in any quarter since June 1991, when production was curtailed because of low silver prices. Total silver production for the year was more than 124,000 kilograms. The increased production was due to the development of the West Chance section of the mine. West Chance, discovered in 1992, provided most of the mine's production in 1997; it also increased Sunshine

Mining's total silver reserves to 1.08 million kilograms, with 404,400 kilograms coming from West Chance (Mining Engineering, 1997).

In May 1997, Hecla Mining Co.'s Board of Directors approved the expenditures necessary to double silver production at the Lucky Friday Mine in northern Idaho. Approval was also given to the final mine design and engineering plans for development and production into the expansion area known as the Gold Hunter deposit. The underground expansion area is located about 153 meters northwest of the Lucky Friday vein currently being mined. The Gold Hunter deposit's main vein has nearly twice the silver grade and twice the width of the Lucky Friday vein. According to Hecla officials, the Gold Hunter deposit was expected to push Lucky Friday annual silver production to more than 124,400 kilograms by 1998. The mine produced 59,100 kilograms of silver in 1996. Hecla's mining plan called for ore from the Gold Hunter deposit to be transported underground from the expansion area to the Lucky Friday shaft with rubber-tired vehicles. The mining method will be primarily overhand cut-and-fill combined with some underhand cut-and-fill. Access to the ore will be through an underground ramp system. Potential resources at Gold Hunter reportedly were estimated at 1,560 tons or more of silver. Total proven and probable reserves at Lucky Friday, including the expansion area, reportedly are 575,400 kilograms of silver (Hecla Mining Co., 1997).

A number of revitalized operations that had been mothballed owing to poor metal prices contributed to U.S. production in 1997. Kennecott and Hecla's Greens Creek polymetallic mine in Alaska, placed on standby in 1993 and reopened in 1996, reached full operating capacity in 1997. On a slightly smaller scale, the Coeur and Galena Mines in the historic Coeur d'Alene silver mining district of Idaho were reopened by Silver Valley Mines after a 3-year closure, to produce 105,600 kilograms of silver in 1997. The largest silver producer in the country in 1997 was Echo Bay's McCoy/Cove Mine, which is primarily a gold mine. Production at this mine reached nearly 343,000 kilograms of silver in 1997 (Silver Institute, 1998). However, scale-backs were planned at this high-cost gold operation that will likely lead to a significant decline in byproduct silver in 1998.

## Consumption

Global demand for refined silver grew 6% in 1997 to an estimated 24,900 tons (Engineering & Mining Journal, 1998). The driving force behind the increase was a 3% increase in world demand in the photographic industry in 1997 to nearly 7,230 tons and a combined 12% growth in the electrical and electronics sectors. The increase in demand by the photo industry was driven primarily by increased demand for color films and prints by amateur photographers, particularly in India and China.

In the United States, industrial demand for refined silver was estimated at about 5,000 tons, an increase of about 6% over demand in 1996. The electrical and electronics sectors were two of the better performers with electronics accounting for most of the growth. Industrial demand was driven by the development of new technologies and products that rely on the electrical and thermal conductivity properties of silver. Silver, in the form of powder and paste, was being used to make multilayer ceramic

capacitors, shielding, and contacts. Also, silver in the form of wire, strips, and plating solutions was required for the production of other products such as precision resistors and tantalum slug capacitors. These, in turn, were used in the production of mobile phones, pagers, integrated circuits, and other devices containing electrical components.

Another important industrial consuming sector was the catalyst industry. Most silver catalysts are used in the manufacture of ethylene oxide. Ethylene oxide was used in the manufacture of polyester and other plastics. Owing to the deposition of impurities, catalysts become poisoned and must be replaced. Replacement demand can be quite high, with 70% to 75% of all catalysts in use replaced each year.

## Prices

For centuries, the price of silver has been coupled with the price of gold, but the demonetization of both metals in much of the world has weakened the link. Through most of 1996 the price of silver was adversely affected by the poor performance of gold. However, toward the end of 1996 the price of silver began to deviate from the price of gold, owing to investors' and speculators' adoption of distinctly different positions in the two markets. This decoupling process continued into 1997 and although, at times, the gold market continued to influence the price of silver, the trend in the metals' prices indicated that a total decoupling was in the making.

In the first 2 months of 1997, the price of gold fell by 2%. Initially, the price of silver followed gold down to a 2-year low of \$4.65 per troy ounce on January 6. The price then began to rebound, rising by 14% over the next 6 weeks to reach \$5.32 on March 3. The higher price proved to be unsustainable as technical selling entered the market and silver prices dropped to \$4.64 on April 29. Early in July gold fell to \$315, a 12-year low. Subsequently, silver fell to \$4.21 on July 17, its low for the year. On October 27, the Dow Jones Industrial Average dropped more than 500 points, Asian equity markets were in turmoil, and gold fell to a 12-year low at \$308 per ounce. Silver, surprisingly, held its ground, closing above \$4.60. After the U.S. Thanksgiving holiday, gold fell below \$300 while silver climbed above \$5.30. By the first of December, the price of silver had increased \$0.53 to \$5.83 as above-ground stocks of silver declined to the lowest level in many years. The price of silver reached its high for the year on December 24 at \$6.24 (a 9-year high), closing out the year at \$5.95 per ounce; the price ratio to gold was 48:1. Gold continued its downward spiral, falling to an 18-year low at \$282 on January 5, 1998.

## Foreign Trade

U.S. imports of silver in ore and concentrates, dore, and refined bullion in 1997 totaled 2,540 tons, with a value of \$439 million. Mexico (41%), Canada (38%) and Peru (11%) were the major foreign sources of imports. U.S. exports of silver in ore and concentrates, refined silver bullion, and dore in 1997 totaled 3,080 tons, with a value of \$510 million. For the first time since 1980, the United States was a net exporter of silver.

## World Review

**Canada.**—In the early 1970's, Canada was the world's largest silver producer, but by 1976-77 production in Mexico exceeded production in Canada. By 1990, production in the United States and Peru also exceeded production in Canada leaving Canada in the fourth position. Despite having no primary silver mines, Canada has maintained the number four position through the 1990's. The source of Canada's silver is about evenly distributed between copper, gold, and lead-zinc mining. Production declined slightly to 1,220 tons in 1997 from 1,310 in 1996. Gold production in Canada increased significantly in 1997. However, zinc production declined by more than 10% and copper production was down by about 5%, offsetting what would have been a parallel increase in silver production. Prime Resources' Eskay Creek gold mine, Canada's largest silver producer, produced about 366 tons in 1997 (Silver Institute, 1998).

**Chile.**—Chile was the fifth largest silver producer in 1997. Chilean production was 843 tons, a 7% decrease from 902 tons in 1996. A large portion of the silver produced from ores and concentrates in Chile was generated by copper mines. The next largest source was gold ores, followed by primary silver mines and then lead/zinc mines. Production was expected to increase significantly in 1998 when CIA. Miner Mangos de Or begins production at the Chimberos silver deposit. CIA. Miner Mangos de Or is jointly owned by Placer Dome and TVX Gold of Canada. The Chimberos project is only about 25 kilometers away from the joint venture's La Coipa gold/silver mine. Production from the new mine was anticipated in the third quarter of 1998. Work will first focus on a pit located 4,225 meters above sea level, with mining operations moving down to 4,020 meters. Mining will then cease at La Coipa and its facilities will be used to process ore from Chimberos. Chimberos reportedly has reserves of 4.8 million tons of ore grading 305 grams of silver per ton of ore and was expected to yield 1,100 tons of silver (Metal Bulletin, 1997). The life of Chimberos will be very short, a little more than 1 year, after which mining at La Coipa will be resumed. Silver production at La Coipa was 320 tons in 1997, down from 421 tons in 1996.

**Mexico.**—Mexico continued to be the world's leading silver producer with about 2,680 tons, up 6% from 2,530 tons in 1996. The growth in Mexico's mine production was driven by primary silver mine output, which contributed more than 150 tons to 1997 production levels. Also adding to the growth in mine production, despite falling gold prices, Mexico's gold mining sector performed well in 1997, resulting in a parallel increase in silver production from that source. Industriales Peñoles S.A. de C.V. was Mexico's largest silver producer. The company operated the Torres Mine (148 tons) in Guanajuato, the Proaño operation (635 tons) near Fresnillo in Zacatecas, and La Ciénega project (306 tons) in Durango. Empresas Frisco S.A. de C.V., Grupo México S.A. de C.V., and Luismin S.A. de C.V. were the largest producers after Peñoles. These four companies accounted for more than 75% of Mexican production.

**Peru.**—Peru, the world's third largest silver producer, produced 2,080 tons of silver in 1997—a 6% increase from 1,970 tons in 1996. Cia. de Minas Buenaventura S.A. remained as the largest private producer, with a mine output of 311 tons (Compañía de

Minas Buenaventura, Annual report, accessed May 11, 1998, at URL <http://www.alignet.com/buenaventura>). Cia. de Minas Orcopampa, the Buenaventura subsidiary working a gold and silver mine near Arequipa, reported a production of 1,080 kilograms of gold and 93 tons of silver. Cia. de Minas Arcata S.A. remained as the second largest private silver producer in Peru, reporting a production of 191 tons. The underground Quiruvilca Mine, located in northern Peru, reported mine production of 88.4 tons of silver (Pan American Silver Corp., 1998). The operation was previously owned by Corporacion Minera Nor Peru, Asarco's local subsidiary, which was transferred to Pan American Silver of Canada in 1995. Other notable producers included Cia. Minera Santa Rita S.A., 84 tons; Cia. Minera Milpo S.A., 98 tons; Cia. Minera Atacocha S.A., 68 tons; Soc. Minera S.A., 74 tons; Cia. Minera Huaron S.A., 96 tons; and Cia. Minera Yauli S.A., 67 tons.

### Current Research and Technology

**Silver Selected for Use in Superconductor.**—Trials of a 200-horsepower electric motor and a 50-meter superconducting transmission line using high-strength, high-temperature superconductor wire, have been successfully completed. The wire is made by first drawing down silver tubes packed with superconducting oxides to diameters of a fraction of a millimeter, then bundling dozens of the tubes together. The bundles are crushed into tape that is flexible, strong, and superconducting. Silver was selected as the jacketing material because it does not react with the oxides. As a result, it can be mixed with oxides to form a highly conductive “cement” between particles. This is beneficial because studies have shown that the greatest amount of current flows in the superconducting oxides where they touch the silver. The crystal structure of silver is also important in the manufacture of the superconducting material, which is a combination of oxides of copper, barium, and rare earths. At the temperature the metals are oxidized, the silver jacket allows oxygen to be pumped into the metals, converting them into superconducting oxides. Then, when the wires are cooled to the 196 °C operating temperature, the silver blocks the loss of oxygen (Advanced Materials & Processes, 1997).

**High-Performance Silver Recovery Apparatus.**—An apparatus at Kennedy Space Center recovers silver from liquid waste produced during the development of photographic and radiographic film. According to the inventors, this apparatus recovers a greater portion of silver from the waste stream than does previously available silver-recovery equipment. In this apparatus, dissolved silver is removed from the waste stream by exchanging silver ions for iron ions in sacrificial cartridges in treatment cells, while particulate silver is removed by filtering. The system includes several treatment cells in series; a “lead” (farthest upstream) cell followed by a “lag” cell followed by a tailing or “polishing” stage that comprises a duel cell plus a single cell. When the concentration of silver in the lead-cell cartridge reaches the maximum allowable, this cartridge is removed to harvest the silver, the cartridge from the lag cell is moved to the lead position, and a fresh cartridge is placed in the lag cell. The apparatus treats as much as 15 gallons (about 166 liters) of waste per day, recovering more than 99.9% of the silver. The

concentration of silver in the effluent is no more than 5 parts per million, low enough to be sent to a sewage treatment plant (NASA Tech Briefs, 1997b).

**Silver Used in Windshields.**—Silver is the major material in a transparent metallic coating used for the first time in the windshield glass of some motor vehicles, giving the glass the ability to reflect solar energy away from passengers and to serve as an AM/FM radio antenna. The windshields are produced by PPG Industries Inc., Pittsburgh, PA, at a plant in Evansville, IN, which uses vacuum sputtering to apply the coatings. Coatings are applied to the windshields in nine layers of metals and metal oxides, each only 1,500 angstroms thick. The layers stop about 60% of all the energy from the sun, but, in compliance with federal regulations, passes more than 70% of the sun's visible light. By serving as the AM/FM antenna, the windshield eliminates the need for a conventional exterior antenna and its copper connectors (American Metal Market, 1997).

**Low-Resistance Contacts in Semiconductors Made from Silver.**—Silver-zinc contacts on p-doped semiconductor electronic devices have been found to exhibit electrical resistivities as low as  $10^{-4}$  ohms per square centimeter. The contacts are formed by deposition of a combination of silver and zinc on indium phosphide surfaces, then sintering. Unlike the fabrication of contacts from other materials, the sintering step in the fabrication of silver-zinc contacts does not cause so much interdiffusion of metal and semiconductor material as to degrade or destroy the underlying devices (NASA Tech Briefs, 1997a).

### Outlook

Despite the economic downturn in Asia and the threat of digital or silverless photography, industrial demand for silver will likely rise in the near term. A number of relatively new applications have been growing rapidly. Although the new uses are currently insignificant, they have the potential of growing to large consuming industries in the near future. An example of one of these new uses is the use of silver in glass coatings where a thin layer of silver is applied by vacuum sputtering. (See Current Research and Technology section.) Digital (silverless) photography, which was predicted to cut deeply into the use of silver in this industry appears to be losing much of its appeal, at least for amateur photography. The disadvantages of poor resolution and very expensive equipment will prevent digital imaging from affecting silver-based amateur photography in the near-term. In the next decade, as resolution improves and equipment costs become more competitive, digital imaging may replace some conventional photography, particularly in commercial industries, but is not likely to significantly affect silver usage. Demand for silver has nearly doubled in the last decade, while supply has risen only slightly. This has caused the known above-ground stocks to fall to record low levels, a condition that will probably result in higher prices for silver.

### References Cited

- Advanced Materials & Processes, 1997, Silver selected to jacket high-strength superconductor: Advanced Materials & Processes, v. 151, no. 4, April, p. 8.
- American Metal Market, 1997, GM planning to use silver in windshields: American Metal Market, v. 105, no. 103, May 29, p. 5.

Engineering & Mining Journal, 1998, Silver: Engineering & Mining Journal, v. 199, no. 3, March, p. 63.

Hecla Mining Co., 1997, Hecla directors approve Lucky Friday expansion plan: Coeur d'Alene, ID, Hecla Mining Co. news release, May 12, 2 p.

Metal Bulletin, 1997, Placer, TVX turn to Chilean silver as gold languishes: Metal Bulletin, no. 8226, November 6, p. 7.

Metals & Minerals Latin America, 1998, Latin America leads mining growth: Metals & Minerals Latin America, June, p. 10.

Mining Engineering, 1997, Sunshine Mining increases production at its Idaho mine: Mining Engineering, v.49, no. 5, May, p. 23.

Mining Week, 1997, Idaho delegation introduces clean-up bills for historic Coeur d'Alene Basin problems: Mining Week, v. 3, no. 21, June 2, p. 1.

NASA Tech Briefs, 1997a, Ag/Zn contacts on shallow-junction p-doped InP devices: NASA Tech Briefs, v. 21, no. 6, June, p. 45.

———1997b, High-performance silver-recovery apparatus: NASA Tech Briefs, v. 21, no. 4, April, p. 59.

Pan American Silver Corp., 1998, 1997 annual report: Vancouver, BC, Pan American Silver Corp., 44 p.

Silver Institute, 1998, World silver survey, 1998: Washington, DC, Silver Institute, 64 p.

United States Mint, 1998, 1997 annual report: Washington, DC, United States Mint, 46 p.

## SOURCES OF INFORMATION

### U.S. Geological Survey Publications

Silver. Ch. in Mineral Commodity Summaries, annual.<sup>1</sup>

Silver. Ch. in Minerals Yearbook, annual.<sup>1</sup>

Silver. Ch. in United States mineral resources, U.S. Geological Survey Professional Paper 820, 1973.

Precious Metals. Mineral Industry Surveys, monthly.<sup>1</sup>

### Other

Silver. Ch. in Mineral facts and problems, U.S. Bureau of Mines Bulletin 675, 1985.

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<sup>1</sup>Prior to January 1996, published by the U.S. Bureau of Mines.

TABLE 1  
SALIENT SILVER STATISTICS 1/

		1993	1994	1995	1996	1997
United States:						
Mine production	metric tons	1,640	1,490	1,560	1,570	2,150
Value	thousands	\$227,000	\$253,000	\$259,000	\$262,000 r/	\$338,000
Refinery production:						
Domestic and foreign ores and concentrates	metric tons	1,790	1,810	NA	NA	2,200
Scrap (old and new)	do.	2,020	1,700	NA	NA	1,360
Exports: Refined	do.	705	868	2,810	2,900	2,980
Imports for consumption: Refined	do.	2,180	2,060	2,630	2,580	2,120
Stocks, December 31:						
Industry	do.	735	929	NA	NA	395
Futures exchanges	do.	10,500	10,400	6,290	4,550	3,430
Department of the Treasury	do.	912	882	520	402	484
National Defense Stockpile	do.	1,850	1,670	1,450	1,450	1,220
Price, average per troy ounce 2/		\$4.30	\$5.29	\$5.15	\$5.19	\$4.89
Employment, mine and mill workers 3/		1,100	1,000	1,200	1,400	1,550
World: Mine production	metric tons	14,100 r/	14,200	14,900 r/	15,200	16,400 e/

e/ Estimated. r/ Revised. NA Not available.

1/ Data are rounded to three significant digits, except prices.

2/ Price data are Annual Handy & Harman quotations published in Platt's Metals Week.

3/ Employment data are from Mine Safety and Health Administration.

TABLE 2  
MINE PRODUCTION OF SILVER IN THE UNITED STATES, BY STATE 1/

(Kilograms)

State	1996	1997
Arizona	189,000 r/	190,000
California	21,600	22,500
Colorado	7,430	W
Idaho	234,000 r/	341,000
Nevada	594,000 r/	866,000
South Dakota	5,090 r/	4,410
Washington	--	1,810
Other States 2/	517,000	722,000
Total	1,570,000	2,150,000

r/ Revised. W Withheld to avoid disclosing company proprietary data; included with "Other States."

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Includes Alaska, Illinois, Missouri, Montana, New Mexico, New York, South Carolina, Tennessee, Utah, Wisconsin, and State indicated by symbol "W."

TABLE 3  
LEADING SILVER-PRODUCING MINES IN THE UNITED STATES IN 1997, IN ORDER OF OUTPUT 1/

Rank	Mine	County and State	Operator	Source of silver
1	McCoy/Cove	Lander, NV	Echo Bay Mines	Gold ore.
2	Greens Creek	Southeastern Alaska, AK	Kennecott Minerals	Zinc ore.
3	Rochester	Pershing, NV	Coeur Rochester Inc.	Gold ore.
4	Bingham Canyon	Salt Lake, UT	Kennecott Utah Copper	Copper ore.
5	Red Dog	NW Arctic, AK	Cominco Alaska Inc.	Lead-zinc ore.
6	Sunshine	Shoshone, ID	Sunshine Mining and Refining Co.	Silver ore.
7	Candelaria	Mineral, NV	Kinross Delamar Mining Co.	Gold ore.
8	Coeur	Shoshone, ID	ASARCO Incorporated	Silver ore.
9	Mission Unit 2/	Pima, AZ	do.	Copper ore.
10	Lucky Friday	Shoshone, ID	Hecla Mining Co.	Lead-zinc ore.
11	Morenci	Greenlee, AZ	Phelps Dodge Corp.	Copper ore.
12	Galena	Shoshone, ID	ASARCO Incorporated	Silver ore.
13	Kinross Delamar	Owyhee, ID	Kinross Delamar Mining Co.	Gold ore.
14	Denton-Rawhide	Mineral, NV	Kennecott Rawhide Mining Co.	Do.
15	Montana Tunnels	Jefferson, MT	Pegasus Gold Inc.	Zinc ore.
16	Sierrita	Pima, AZ	Cyprus Amax Minerals Co.	Copper ore.
17	Continental	Silver Bow, MT	Montana Resources Inc.	Do.
18	Bagdad	Yavapai, AZ	Cyprus Amax Minerals Co.	Do.
19	Twin Creeks	Humboldt, NV	Newmont Gold Co.	Gold ore.
20	Hycroft	do.	Hycroft Resources & Development /Granges Inc.	Do.
21	Ray Unit	Pinal, AZ	ASARCO Incorporated	Copper ore.
22	San Manuel	do.	BHP Copper Co.	Do.
23	Casteel 3/	Iron, MO	The Doe Run Co.	Lead-zinc ore.
24	Chino	Grant, NM	Phelps Dodge Corp.	Copper ore.
25	Goldstrike	Eureka, NV	Barrick Gold Corp.	Gold ore.
26	Bullfrog	Nye, NV	do.	Do.
27	Flambeau	Rusk, WI	Kennecott Minerals	Copper ore.
28	Robinson Operations	White Pine, NV	Nevada Mining Co.	Do.
29	Round Mountain	Nye, NV	Round Mountain Gold Corp.	Gold ore.
30	Hayden Hill	Lassen, CA	Lassen Gold Mining Inc.	Do.
31	Buick	Iron, MO	The Doe Run Co.	Lead-zinc ore.

1/ The mines on this list accounted for 95% of U.S. mine production in 1997.

2/ Includes Eisenhower, Mission, Pima, and San Xavier Mines.

3/ Includes Brushy Creek Mill.

TABLE 4  
U.S. EXPORTS OF SILVER, BY COUNTRY 1/ 2/

Year and country	Ore and concentrates 3/		Dore and precipitates		Refined bullion		Total		Waste and scrap	
	Quantity (kilograms, contained silver)	Value (thousands)	Quantity (kilograms, contained silver)	Value (thousands)	Quantity (kilograms, contained silver)	Value (thousands)	Quantity (kilograms, contained silver)	Value (thousands)	Quantity (kilograms, gross weight)	Value (thousands)
1996	1,520	\$316	43,300	\$8,030	2,900,000	\$536,000	2,950,000	\$544,000	1,280,000	\$236,000
1997:										
Belgium	--	--	--	--	18,000	3,010	18,000	3,010	111,000	23,500
Brazil	--	--	1,480	269	--	--	1,480	269	67	9
Canada	29,800	4,010	--	--	28,100	4,380	57,900	8,390	404,000	55,700
China	--	--	8,040	1,670	--	--	8,040	1,670	64,800	8,460
France	--	--	--	--	--	--	--	--	6,110	915
Germany	--	--	--	--	60	14	60	14	40,700	16,100
Hong Kong	--	--	--	--	24,800	4,130	24,800	4,130	7,370	1,300
India	--	--	--	--	39,700	6,780	39,700	6,780	701	91
Italy	--	--	--	--	--	--	--	--	20,300	2,740
Japan	--	--	867	317	188,000	29,300	188,000	29,700	244,000	31,100
Korea, Republic of	--	--	--	--	17,000	2,570	17,000	2,570	964	4,380
Netherlands	--	--	--	--	18,400	2,700	18,400	2,700	168	22
Mexico	80	14	--	--	--	--	80	14	2,000	263
Peru	--	--	--	--	3,980	716	3,980	716	--	--
Sweden	--	--	--	--	--	--	--	--	37,800	5,860
Switzerland	--	--	2,390	377	165,000	26,000	167,000	26,400	--	--
Taiwan	--	--	47,700	11,800	17	4	47,700	11,800	671	123
Trinidad and Tobago	--	--	--	--	--	--	--	--	1,400	249
United Arab Emirates	--	--	--	--	521,000	78,200	521,000	78,200	--	--
United Kingdom	4,430	816	4,480	1,160	1,950,000	329,000	1,950,000	331,000	80,200	57,400
Uruguay	--	--	--	--	12,500	1,960	12,500	1,960	37	5
Other	695	110	549	82	537	114	1,780	306	2,220	327
Total	35,000	4,950	65,500	15,700	2,980,000	489,000	3,080,000	510,000	1,020,000	209,000

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Bullion also moves in both directions between U.S. markets and foreign stocks on deposit in the Federal Reserve Bank. Monetary silver excluded.

3/ Includes base metal ores, concentrates, and matte imported for refining.

Source: Bureau of the Census.



TABLE 5  
U.S. IMPORTS FOR CONSUMPTION OF SILVER, BY COUNTRY 1/ 2/

Year and country	Ore and concentrates 3/		Dore and precipitates		Refined bullion		Total		Waste and scrap	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	(kilograms, contained silver)	(thousands)	(kilograms, contained silver)	(thousands)	(kilograms, contained silver)	(thousands)	(kilograms, contained silver)	(thousands)	(kilograms, gross weight)	(thousands)
1996	153,000	\$25,500	281,000	\$96,300	2,580,000	\$441,000	3,010,000	\$562,000	1,810,000	\$52,500
1997:										
Argentina	--	--	--	--	--	--	--	--	302	189
Australia	1,130	142	--	--	16	2	1,140	144	162	517
Brazil	--	--	--	--	--	--	--	--	100	127
Canada	207	57	38,800	6,220	914,000	147,000	953,000	154,000	289,000	11,400
Chile	1,540	646	227,000	71,400	18,900	3,090	247,000	75,200	4,950	2,870
China	--	--	--	--	--	--	--	--	134	1,810
Colombia	--	--	729	108	--	--	729	108	--	--
Dominican Republic	--	--	--	--	--	--	--	--	3,580	953
Estonia	--	--	--	--	--	--	--	--	156	545
Germany	--	--	(4/)	2	6	13	6	15	337,000	1,900
Honduras	--	--	--	--	--	--	--	--	1,340	2
Ireland	--	--	--	--	--	--	--	--	142	1,600
Italy	--	--	526	233	--	--	526	233	3	86
Japan	--	--	--	--	180	23	180	23	384	792
Korea, Republic of	--	--	--	--	--	--	--	--	1,240	3,150
Malaysia	--	--	--	--	--	--	--	--	283,000	18,700
Mexico	138,000	21,500	7,030	1,130	895,000	141,000	1,040,000	164,000	23,600	8,660
Netherlands	--	--	--	--	--	--	--	--	57,900	296
Nicaragua	--	--	769	122	--	--	769	122	--	--
Panama	--	--	10	1	278	48	288	49	1,710	2
Papua New Guinea	--	--	--	--	--	--	--	--	9,430	290
Peru	--	--	8,840	1,340	276,000	43,000	285,000	44,300	18	947
Philippines	--	--	--	--	--	--	--	--	104,000	1,250
Poland	--	--	--	--	9,970	1,420	9,970	1,420	11	2
Portugal	--	--	--	--	--	--	--	--	63,800	225
Russia	--	--	--	--	--	--	--	--	10,500	531
South Africa	--	--	1,080	67	--	--	1,080	67	30,200	601
Switzerland	--	--	--	--	605	97	605	97	607	92
Taiwan	--	--	--	--	--	--	--	--	35,400	126
United Kingdom	--	--	--	--	183	38	183	38	269,000	17,100
Other	--	--	333	77	446	70	779	147	1,190	1,310
Total	141,000	22,300	285,000	80,700	2,120,000	336,000	2,540,000	439,000	1,530,000	76,100

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Bullion also moves in both directions between U.S. markets and foreign stocks on deposit in the Federal Reserve Bank. Monetary silver excluded.

3/ Includes base metal ores, concentrates, and matte imported for refining.

4/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 6  
SILVER: WORLD MINE PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country	1993	1994	1995	1996	1997 e/
Algeria e/	2 r/	2 r/	2 r/	2 r/	2
Argentina	43	38	48	50 r/	50
Australia	1,092	1,045	939	1,013 r/	1,106 3/
Austria e/	--	2	2	1	--
Bolivia	333	352	425	384 r/	390
Brazil 4/	108	50	50	48 r/	49
Bulgaria e/	35	30	35	30 r/	25
Burma	2	6	4	4	2
Canada (shipments)	896	768 r/	1,285 r/	1,309 r/	1,222 3/
Chile	970	983	1,041 r/	1,047 r/	1,091 3/
China e/	840	810	910	1,140 r/	1,300
Colombia 5/	7	6	6	6 r/	4 3/
Congo (Kinshasa) e/ 6/	18	12	1 r/	1 r/	1
Costa Rica e/	(7/)	(7/) 3/	(7/)	(7/)	(7/)
Croatia e/	1	1	--	--	--
Czech Republic e/	1	(7/)	--	--	--
Dominican Republic	1	9 r/	21	17 r/	12 3/
Ecuador e/	(7/)	(7/)	(7/)	1 r/ 3/	2 3/
Fiji	1	1	2	2	2
Finland 8/	16 r/	26	26 r/	33 r/	32
France	1 r/	1	1	2 r/ e/	2
Ghana e/	2	2	3	2 r/	2
Greece	54 r/	45	33	17 r/	35
Honduras	24	25	25 e/	29	30
India	51	50	38	36 r/	35
Indonesia	90	107	183	185 e/	190
Iran e/	60	60	60	60	60
Ireland	13	17	14	15 r/	13 3/
Italy 9/	9 r/	12 r/	14 r/	9 r/	10
Japan	137	134 r/	100	85	87 3/
Kazakstan e/ 5/	500	506 r/	489 3/	480	500
Korea, North e/	50	50	50	50	50
Korea, Republic of 5/	215	257	299	254	268 3/
Macedonia e/	10	10	10	10	10
Malaysia	14	13	11	10	10 3/
Mali e/	(7/)	(7/)	(7/)	(7/)	(7/)
Mexico	2,136 r/	2,215 r/	2,324 r/	2,528 r/	2,679 3/
Morocco	309	328	204 r/	200 r/	261 3/
Namibia	72	62	69 r/	42	34 3/
New Zealand	26	28	28	29 r/	30
Nicaragua e/	2 3/	2	2	3 r/	6
Panama e/	(7/)	(7/)	(7/)	1 r/ 3/	2 3/
Papua New Guinea	96	78 r/	68 r/	58 r/	50
Peru	1,671 r/	1,768 r/	1,929 r/	1,970 r/	2,077 3/
Philippines	28	30	27	25 r/	20 3/
Poland	767	1,064	1,001	935 r/	1,000
Portugal	36	32	39	36 r/ e/	34
Romania e/	70	70 3/	60	60	60
Russia e/	800	800	700	700	700
Saudi Arabia	18	17	17 r/ e/	17	17
Serbia and Montenegro	25	18	31	69 r/	38
Solomon Islands	(7/)	(7/) r/	(7/) r/ e/	(7/) r/ e/	(7/)
South Africa	192	196	174	167	153 3/
Spain	158	136	102	66 r/	66
Sweden	255	276	268	272 r/	280
Tunisia e/	1	3 r/	4 r/	3 r/	1
Turkey e/	103	65	65	70 r/	70
United States	1,640	1,490	1,560	1,570	2,150 3/
Uzbekistan e/	60	65	65	70	70

See footnotes at end of table.

TABLE 6--Continued  
 SILVER: WORLD MINE PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country 3/	1993	1994	1995	1996	1997 e/
Zambia 10/	16	12	8	10 r/ e/	8
Zimbabwe	12	11	16	10 r/	10
Total	14,100 r/	14,200	14,900 r/	15,200	16,400

e/ Estimated. r/ Revised.

1/ World totals, U.S. data, and estimated data are rounded to three significant digits; may not add to totals shown.

2/ Recoverable content of ores and concentrates produced unless otherwise specified. Table includes data available through August 13, 1998.

3/ Reported figure.

4/ Includes the following quantities, in kilograms, identified as secondary silver: 1993--42,500; 1994--30,000; 1995--35,000; 1996--38,000 (revised); and 1997--38,500 (estimated).

5/ Smelter and/or refinery production.

6/ Formerly Zaire.

7/ Less than 1/2 unit.

8/ Metal content.

9/ Includes production from imported ores.

10/ Year beginning April 1 of that stated.