

SILVER

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In 1998, the average price of silver in was \$5.54 per troy ounce, the highest since 1996. World mine production, which had fallen steadily between 1990 and 1994, increased for the fourth consecutive year. Although showing a slight decline owing to a drop in silverware and jewelry manufacture in India and Asia, fabrication demand increased significantly in industrial and decorative uses, especially in photography. The photography and decorative sectors were the largest consumers of silver owing mainly to the metal's application in a wide variety of products, many of them domestic consumer products purchased worldwide. The significant increase in fabrication demand caused the gap between demand and the production of silver to widen further. Normally the gap would be filled by new mine production and scrap but is currently being filled mostly by destocking.

In 1998, domestic mine production of silver fell by 6% to 2,060 metric tons (t) from 2,180 t in 1997. Seventy six mines in 16 States reported production of silver with an estimated value of \$367 million. Nevada was the leading domestic silver producer; other large producers included 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. Estimated output of the 22 principal refiners of commercial-grade silver was approximately 3,600 t.

About 30 fabricators accounted for more than 90% of silver consumed in domestic arts and industrial applications. 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 included photographic materials, electrical and electronic products, brazing alloys, dental amalgam, bearings, and catalysts.

In 1998, global mine production of silver, as noted earlier, increased for the fourth consecutive year. The increase (to 16,400 t), was only 200 t below the 1990 record. The world's largest silver producer, Mexico, increased mine output to 2,686 t, more than 16% of the world's silver output. In 1998, Mexican silver supply included:

Refined	2,100 t
In copper bars	395 t
Mixed gold and silver	238 t
Concentrates	97 t
Copper anodes	8 t
Other	29 t

for a total of 2,868 t (numbers are rounded).

European silver production increased by about 3%, and

production in Central America and South America increased by about 7% owing primarily to growth in Chile and Mexico. Peru, the third leading producer in terms of mine production, reported a modest decline in production of 3.2%, falling to 1,934 t. Global recycling of silver from old scrap materials increased by 13% to about 5,940 t. The United States was the largest silver recycler at about 1,730 t, followed by Japan at about 908 t. In the United States, photographic scrap was estimated to have generated 1,000 t of silver, most of which came from spent fixer solution and from X-ray and graphic arts wastes (Silver Institute, 1999, p. 32).

In 1998, for the 10th consecutive year, global fabrication demand for silver exceeded supply, leading to reductions of above-ground stocks. World fabrication demand exceeded supply from mine production and the recycling of scrap by 3,260 t. Between 1990 and 1997, cumulative silver fabrication demand exceeded mine production by 68,400 t. The gap was filled by recycled silver scrap and draw-down of more than 31,100 t of silver bullion inventories (Silver Institute, 1999, p. 6).

Legislation and Government Programs

Sales of Proof Silver American Eagle bullion coins, the world's leading silver investment coin for many years, eased—119,765.1 kilograms (kg) in fiscal year 1998 versus 135,442.2 kg in fiscal year 1997. Sales of Uncirculated Sets, Proof Sets, and Silver Proof Sets increased by 6% to more than 4 million sets as numismatists responded to developments affecting these products. First, the 50 State Quarters Program was set to begin in 1999, so the 1998 sets were the last to include the eagle quarter reserve for the next 10 years. Second, 1998 was the final year for Premier Silver Proof Sets, and collectors bade farewell by driving sales up 70% to their highest point since the product debuted in 1992 (United States Mint, 1999, p. 7-10).

Silver reserves are classified by the U.S. Mint as reserves if in bar form. Silver reserves are reported at either cost or market value, whichever is lower. Without historical cost records to determine the acquisition cost of the silver over the decades, the reserves are valued at the rate stated in the 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, 1998, the market value for silver was \$5.39 per ounce. Silver inventories consisted of 582,242.08 kg of silver with a statutory value of \$24,210,407 and a market value of \$100,929,033. The changes in number of silver fine troy ounces from year to year is due to the use of silver in the Mint's numismatic operations. In

addition, the silver inventory may have increased as a result of receiving silver from the Defense Logistics Agency (United States Mint, 1999, p. 33-34).

Production

In 1998, silver was produced from precious-metal ores at 46 lode mines and from base metal ores at 30 lode mines. More than 30 t of silver was produced at each of 14 mines; their aggregated production equaled about 80% of total domestic production. Fewer than 10 placer operations recovered silver in 1998, and the quantity recovered was less than 1% of total domestic production of 2,060 t.

In 1998, silver production in Arizona totaled 211 t, all recovered as a byproduct of copper mining. Silver production in the Coeur d'Alene district of Idaho during 1998 increased to more than 400 t. The increase resulted from operations at Sunshine Mining and Refining Co., Sunshine Mine, Hecla Mining Co.'s Lucky Friday Mine, and Silver Valley Resources Corp.'s Galena Mine. Output from the Sunshine Mine was from the West Chance vein. Discovered in 1992, the vein provided most of the mine's production in 1997 (Mining Engineering, 1997). Production increased again in 1998 as the company completed development of the ore body. During substantially all 1998, the mine was operated at or near its rated capacity of 1,000 metric tons per day (t/d) of ore. Sunshine expected that most of the company's production during 1999 and 2000 could be from the West Chance section. The company produced about 181,000 kg of silver in 1998 (Sunshine Mining and Refining Co., 1999, p. 3-9).

In May 1997, Hecla'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 of the expansion area known as the Gold Hunter deposit located about 153 meters northwest of Lucky Friday. The Gold Hunter deposit's main vein has nearly twice the silver grade and twice the width of the Lucky Friday vein. The Gold Hunter deposit pushed Lucky Friday's annual silver production to more than 128,400 kg in 1998; the mine had produced 60,500 kg of silver in 1997 and 59,100 kg of silver in 1996 (Hecla Mining Co., 1999, p. 12). Hecla's mining plan called for ore from the Gold Hunter deposit to be transported underground from the expansion area to the Lucky Friday Mine. The principal mining method at the Lucky Friday Mine is ramp access, cut and fill. This method used rubber tired equipment to access the veins through ramps developed outside of the ore body. Once a cut was taken along the strike of the vein, it was backfilled with cemented tailings, and the next cut was accessed, either above or below, from the ramp system. Ore produced from the mine was processed in a 1,100 t/d conventional flotation mill. In 1998, ore was processed at the rate of approximately 1,037 t/d. The flotation process produced a silver-lead concentrate and a zinc concentrate. During 1998, approximately 94.6% of the silver was economically recovered. Probable resources at the Gold Hunter deposit were estimated by Hecla at 1,560 or more of silver. Total proven and probable reserves at Lucky Friday, including the Gold Hunter expansion area, reportedly are 575,400 kg of silver (Hecla Mining Co., 1999, p. 12).

In 1998, silver from domestic gold mines fell by more than 15%, to about 400,000 kg, owing mostly to weakened gold

prices that caused operators to cut output or suspend operations at a number of silver-bearing gold mines. In 1998, about 20% of domestic silver was produced from Echo Bay Minerals Co.'s McCoy/Cove gold-silver mine in Nevada. Output at McCoy/Cove, however, dropped by 15%, as a result of lower silver grades and the scaling back of operations owing to high operating costs. For the same reasons, reductions were recorded at the Denton-Rawhide Mine. The Aurora Mine, operated by Nevada Goldfields Corp. Inc., was placed on care-and-maintenance and Vista Gold Corp. suspended the Hycroft gold mine in December because of low prices. Nevada was the leading silver (and gold) producing State during 1998, with 36 mines reporting gold production and 30 mines producing silver. Domestic silver production from copper operations totaled about 308,000 kg, down by about 5% from that of 1997. Byproduct silver from lead-zinc mines increased by more than 13% to about 155,000 kg, owing mainly to expansions at the Red Dog Mine in Alaska.

Consumption

Silver has become predominantly an industrial metal with demand made up almost exclusively of four major components—industrial, photography, jewelry, and silverware. In 1998, U.S. consumption of silver, including scrap, was estimated to have been about 5,900 t, about 9% above that of 1997. Most of the increase was for use in electronic products. Demand for silver in electronics benefitted from increased use of silver in various forms of existing and new applications, such as multilayer ceramic capacitors, shielding, and keypad contacts. The increase might have been even larger if the price of palladium had not increased sharply. Possibly the largest single use of silver in electronics is in silver-palladium powders that are used to manufacture multilayer ceramic capacitors. As the price of palladium increased to more than \$300 per ounce, manufacturers began to substitute copper-nickel formulations for silver-palladium powders. In addition to multilayer ceramic capacitors, 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, which 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 being replaced each year. Very little of the silver used in these catalysts is lost so that when catalysts are recycled, the net impact in terms of demand is limited. Only when new catalysts are introduced is there an increase in silver demand. In 1998, U.S. manufacturers added 40 t of new catalysts to an estimated 310,000 kg of replacement catalyst (Silver Institute, 1999, p. 46).

Prices

The price of silver began 1998 at \$5.90 per ounce. On February 3, a U.S.-based investment company announced that it

had, over the previous 6 months, quietly purchased 4,034,127 kg of silver. The purchases had begun on July 25, 1997, when silver closed at \$4.32 per ounce. Prices soared the week after the announcement, breaking the \$7 per ounce barrier and reaching \$7.81 per ounce at the London fixing on February 6, the highest price since July 1988 (Platt's Metals Week, 1998b). The price increase was short lived; by mid-March it had fallen below \$6.00 per ounce. In early April, silver traded between \$6.00 per ounce and \$6.50 per ounce. In early May, the investment firm that triggered the price spike by purchasing more than 4 million kilograms of silver indicated that further purchases were unlikely. Market prices responded by falling to \$5.80 per ounce by the close of trade on May 12, down \$0.40 from the previous week and the lowest the market had been since January. Speculators entered the market and the decline in price accelerated, with the price plunging to \$5.08 by the first of June. The balance of the quarter was spent in a narrow range just above \$5.00 per ounce (Engineering & Mining Journal, 1999). Owing to a weakening worldwide economy, particularly in Asia, the price of silver in July and August remained at around \$5.00 to \$5.80 per ounce. The Asian economic crisis not only reduced the level of industrial demand in Asia, but with the slowed growth of the global economy, industrial demand for silver worldwide fell during the third quarter of 1998. Silver prices did not increase in the fourth quarter as Russia and other Commonwealth of Independent States countries were forced to increase exports, thereby adding to the silver supply. The price dropped below \$5.00 per ounce in October, trading between \$4.74 and \$5.14 per ounce. At yearend, the price was \$4.99 per ounce, a decline of about 16%.

On an annual average basis, the gold-to-silver price ratio fell to 53.04 in 1998, compared with 67.90 in 1997. The ratio was last below 60.0 in 1985 when it averaged 51.75 (Silver Institute, 1999, p. 12).

Foreign Trade

In 1998, U.S. importers imported 3,336 t of silver in ore and concentrates, doré, and refined bullion. The value of these imports was \$603 million, an increase of 31% compared with those of 1997. Mexico (46%), Canada (33%) and Peru (10%) were the major foreign sources of imports. U.S. exporters exported 2,500 t of silver in ore and concentrates, refined silver bullion, and doré. The value of these exports was \$516 million, a decrease of 19% compared with those of 1997 (tables 4-5).

World Review

Canada.—Despite having no primary silver mines, Canada has maintained its position as a major silver producer. The source of Canada's silver was about evenly distributed among copper, gold, and lead-zinc mining. Production declined slightly to 1,179 t in 1998 from 1,224 t in 1997. Prime Resources Group Inc.'s Eskay Creek Mine, Canada's largest silver producer, produced about 360 in 1999 (Silver Institute, 1999, p. 20).

Chile.—Chile was the world's fourth largest silver producer in 1998. Chilean mine production was 1,340 t, a 23% increase compared with 1,091 t mined in 1997. 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 increased significantly in 1998, when C. Miner Mangos de Or began production at the Chambers silver deposit; the mine produced 590 t of silver. C. Miner Mangos de Or was jointly owned by Placer Dome Inc. and TVX Gold Inc. of Canada. The Chambers project is only about 25 kilometers away from the joint venture's La Coipa gold-silver mine. Production from the new mine began in the third quarter of 1998. Work first focused on a pit located 4,225 meters (m) above sea level, with mining operations moving down to 4,020 m. Mining then ceased at La Coipa and its facilities were used to process ore from Chambers. Chambers reportedly has reserves of 4.8 million metric tons of ore grading 305 grams per ton of ore of silver and was expected to yield 1,100 t of silver (Metal Bulletin, 1997). The life of Chambers will be short, a little more than 1 year, after which mining at La Coipa will resume.

Europe.—Following a modest performance in 1997, silver production in Europe increased by about 3% in 1998 to 1,813 t. About 75% of Europe's silver production was a byproduct of copper mining, with Polish miner KGHM Polska Miedz, the second largest silver producer in the world, contributing nearly 1,100 t. Sweden produced 275 t, and Spain, 176 t, both less than in previous years owing to lower base-metal output (Mining Journal, 1999).

Mexico.—Mexico continued to be the world's leading silver producer with mine production of 2,686 t, essentially unchanged from that of 1997. Mexico's total silver output, however, was 2,868 t, about 6% more than output in 1997. More than one-half of Mexico's silver production was from primary mines. Lead and zinc mines were responsible for about 30%, with the remainder being produced by copper and gold mines. Industriales Peñoles S.A. de C.V. was Mexico's largest silver producer. The company operated the Torres Mine in Guanajuato, the Proaño operation near Fresnillo in Zacatecas, and La Ciénega project 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 Mexico's production.

Peru.—Peru, the world's third largest mine producer of silver in 1998, produced 1,934 t of silver—a 3.2% decrease from the 1,998 t produced in 1997. About one-third of Peru's silver was produced by primary silver mines. The remainder was produced as a byproduct of lead-zinc production. At the Buenaventura subsidiary, a working gold and silver mine near Arequipa, production through September 1998 was up slightly to 229 t. Production at the state-owned Centromin fell 48% to 168 t after selling off five mines. The Cerro de Pasco Mine had a 2% decrease in production to 102 t and Morococha's output fell 7% to 23.5 t (Platt's Metals Week, 1998a).

Current Research and Technology

Ceramic Grains that Can be Used to Clean up Waterways and Recover Metals Developed.—The U.S. Department of Energy's (DOE) Pacific Northwest National Laboratory (PNNL) developed a granular ceramic material that can be used to recover metals, including precious metals, from contaminated waters. The material, self-assembled monolayers on mesoporous support (SAMMS), integrated mesoporous

ceramic technology with a novel method for attaching monolayers to the pore surfaces of the ceramic material. The molecules in the monolayer can be custom designed to bind selectively with a range of metals including, mercury, lead, chromium, precious metals, and radionuclides. According to a staff scientist at PNNL, SAMMS can be used effectively in water, nonaqueous solutions, or gas-phase waste streams.

SAMMS may be produced in beads or powder form. Each grain of ceramic material ranges from 5 to 15 micrometers in diameter and contains a densely packed ordered array of cylindrical pores. Chemically tailored monolayers are hosted by the pores, with one end of the molecules binding strongly with the ceramic material and the free end available for binding the target metal species passing through the pore. According to PNNL, when SAMMS is released into water, it quickly binds with the targeted metal, reducing its concentration to a level that complies with drinking water standards. In Toxic Leaching Characteristic Tests (a regulatory benchmark that measures release under environmental conditions), PNNL researchers found that the bound metal contaminants remained in the material and did not leach into solution. If required, a strong acid can be used to strip the metals from the material, which is then ready for reuse. PNNL researchers believed that in addition to being able to clean up mercury-contaminated sites, SAMMS has applications in industry, particularly mining and metal finishing, where it could be used to clean process water and even recover precious metals from waste streams (Journal of Metals, 1998).

Silver Coats DNA Bridge to Form Wire Between Electrodes.—One of several hurdles blocking creation of functional nanometer-scale electronic devices is the difficulty of wiring the elements together and attaching them to electrodes. By using DNA as a construction tool, Israeli researchers have taken a step in overcoming this hurdle by using the molecular recognition characteristics of DNA. As the first step in device construction, they used DNA molecules to create a bridge between two electrodes and then used that bridge as a template to grow a conductive silver wire. The bridge was formed by attaching two oligonucleotides to two gold electrodes via disulfide metal bonds. The derivatized electrodes were then linked by a DNA molecule bearing two “sticky” ends complementary to the different oligonucleotides. Silver ions were localized along the DNA by exchanging them with sodium ions. The silver ion-exchanged DNA was subsequently reduced, yielding nanometer-sized silver clumps bound to the DNA skeleton. Drawing an analogy to photographic film processing, the aggregates were developed further by using an acidic solution of hydroquinone and silver ions under low-light conditions. The structure, size, and conduction properties of the metal wire were reproducible and dictated by the developing conditions. According to the research team, the wire diameters attained were well below the minimal dimensions accessible by standard, large-scale microelectronics technology.

Although the silver wires have some unusual properties—they can serve as a memory device, for example—they exhibit high resistivity and thus were not yet practical for circuit interconnects. The research team predicted that the optimization of growth conditions, metal selection, and post-growth heat treatments will serve to improve wire performance (Chemical & Engineering News, 1998).

Silver-Based Solder Developed.—A lead-free solder of tin, silver, and copper that is easy to use, strong and heat resistant was developed by the DOE’s Ames Laboratory, Ames, IA. The solder was developed in response to the environmental hazards caused by lead but has other advantages, including better heat resistance in high-heat conditions, such as under the hood of a car. Primary applications were expected to be in electronic circuit boards for sensors and automotive engine control computers (Advanced Materials & Processes, 1998).

New Printing Process Uses Silver-Coated Plates.—A new printing process that uses silver-coated plates offers high-quality images with virtually no preparation time. In the new process, called zero-processing platemaking, a digital image is projected by lasers directly onto a silver-coated plate. The laser beam heats the silver particles sufficiently to vaporize the organic matrix, allowing the silver to be vacuumed away and exposing a water-receptive layer which rejects printing ink. The plate is then placed directly into the printing press where it is inked for printing. The amount of silver used on this thermal ablation plate is about 1 gram per square meter (g/m^2), versus 4 g/m^2 for photographic film. The useful life of these silver plates ranges from 500,000 to more than 1 million impressions. Silver is the logical choice for this application because it results in a permanent image as fine as the focus of the laser. An important feature of the silver plate is its permanence; it has an infinite shelf life (Silver News, 1998).

Outlook

Global silver production is expected to increase by more than 2,000 t during the next 2 years as demand for the metal continues to grow, according to the Silver Institute. By 2001, worldwide silver production is expected to reach 18,400 t, compared with 16,400 t in 1998. Despite increased production, demand will continue to outstrip mine production, which will result in a significant reduction of above-ground stocks. Production increases can be expected to continue so long as prices remain above full production costs. Silver prices will continue to fluctuate wildly and to be affected by numerous factors, such as expectations for inflation, speculative activities, the relative exchange rate of the U.S. dollar, global and regional demand and production, political and economic conditions and production costs in major producing regions.

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TABLE 1
SALIENT SILVER STATISTICS 1/

		1994	1995	1996	1997	1998
United States:						
Mine production	metric tons	1,490	1,560	1,570	2,180 r/	2,060
Value	thousands	\$253,000	\$259,000	\$262,000	\$343,000 r/	\$367,000
Refinery production:						
Domestic and foreign ores and concentrates	metric tons	1,810	NA	NA	2,200	2,300
Scrap (old and new)	do.	1,700	NA	NA	1,360	1,700
Exports: Refined	do.	868	2,810	2,900	2,980	2,250
Imports for consumption: Refined	do.	2,060	2,630	2,580	2,120	2,800
Stocks, December 31:						
Industry	do.	929	NA	NA	395	400
Futures exchanges	do.	10,400	6,290	4,550	3,430	2,360
Department of the Treasury	do.	882	520	402	484	582
National Defense Stockpile	do.	1,670	1,450	1,450	1,220	1,030
Price, average per troy ounce 2/		\$5.29	\$5.15	\$5.19	\$4.89	\$5.54
Employment, mine and mill workers 3/		1,000	1,200	1,400	1,550	1,550
World: Mine production	metric tons	14,000 r/	14,800 r/	14,900 r/	16,000 r/	16,400 e/

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

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

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

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

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

(Kilograms)

State	1996	1997	1998
Arizona	189,000	190,000	211,000
California	21,600	23,100 r/	11,300
Colorado	7,430	W	W
Idaho	234,000	341,000	447,000
Nevada	596,000 r/	878,000 r/	670,000
South Dakota	5,090	4,410	1,960
Washington	--	1,810	622
Other 2/	517,000	743,000 r/	723,000
Total	1,570,000	2,180,000 r/	2,060,000

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

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

2/ Includes Alaska (1996-98), Colorado (withheld data in 1997 and 1998), Illinois (1996), Missouri (1996-98), Montana (1996-98), New Mexico (1996-1998), New York (1996-98), South Carolina (1996-98), Tennessee (1996-98), Utah (1996-98), and Wisconsin (1996 and 1997).

TABLE 3
LEADING SILVER-PRODUCING MINES IN THE UNITED STATES IN 1998, IN ORDER OF OUTPUT 1/

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

1/ The mines on this list accounted for 97% of U.S. mine production in 1998.

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

3/ Includes Brushy Creek Mill.

4/ Includes Betze-Post and Meikle operations.

5/ Acquired by Phelps Dodge Corp. in February 1998.

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

Year and country	Ore and concentrates 2/		Doré and precipitates		Refined bullion 3/		Total		Waste and scrap	
	Silver content (kilograms)	Value (thousands)	Silver content (kilograms)	Value (thousands)	Silver content (kilograms)	Value (thousands)	Silver content (kilograms)	Value (thousands)	Gross weight (kilograms)	Value (thousands)
1997	35,000	\$4,950	65,500	\$15,700	2,980,000	\$489,000	3,080,000	\$510,000	1,020,000	\$209,000
1998:										
Australia	--	--	210	86	1,560	259	1,770	345	--	--
Belgium	--	--	--	--	18,000	3,070	18,000	3,070	177,000	44,500
Brazil	--	--	1,420	300	--	--	1,420	300	--	--
Canada	5,690	1,320	--	--	15,100	2,250	20,800	3,570	474,000	64,800
China	--	--	11,700	2,710	--	--	11,700	2,710	92,400	12,100
France	--	--	--	--	68,600	15,700	68,600	15,700	103	13
Germany	--	--	--	--	10,800	2,300	10,800	2,300	117,000	34,800
Hong Kong	--	--	1,410	310	--	--	1,410	310	5,970	819
India	--	--	58,700	9,440	85,200	15,100	144,000	24,500	--	--
Italy	--	--	--	--	14,700	2,420	14,700	2,420	37,100	5,440
Japan	--	--	165	73	18,000	2,940	18,200	3,010	38,800	8,340
Mexico	202	36	7,960	1,510	4,160	713	12,300	2,260	3,780	516
Netherlands	610	110	--	--	--	--	610	110	307	40
Singapore	--	--	51	60	6,470	1,640	6,520	1,700	29	12
South Africa	--	--	--	--	--	--	--	--	3,180	548
Sweden	--	--	25	19	--	--	25	19	38,100	6,510
Switzerland	--	--	18,200	3,280	635	105	18,800	3,380	1,790	397
Taiwan	--	--	63,800	16,000	522	97	64,300	16,100	684	94
United Arab Emirates	--	--	--	--	111,000	19,200	111,000	19,200	--	--
United Kingdom	--	--	74,600	14,700	1,880,000	397,000	1,950,000	411,000	71,000	44,400
Uruguay	--	--	2,080	423	19,300	3,330	21,400	3,750	--	--
Other	35	11	844	186	286	55	1,170	252	1,310	363
Total	6,540	1,480	241,000	49,000	2,250,000	466,000	2,500,000	516,000	1,060,000	224,000

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

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

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

Source: Bureau of the Census.

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

Year and country	Ore and concentrates 2/		Doré and precipitates		Refined bullion 3/		Total		Waste and scrap	
	Silver content (kilograms)	Value (thousands)	Silver content (kilograms)	Value (thousands)	Silver content (kilograms)	Value (thousands)	Silver content (kilograms)	Value (thousands)	Gross weight (kilograms)	Value (thousands)
1997	141,000	\$22,300	285,000	\$80,800 r/	2,120,000	\$336,000	2,540,000	\$440,000	1,530,000	\$76,100
1998:										
Australia	--	--	--	--	425	77	425	77	11,800	3,300
Canada	734	111	7,800	1,380	1,080,000	198,000	1,090,000	200,000	357,000	42,000
Chile	477	97	241,000	39,000	25,300	4,490	267,000	43,600	2,530	968
Colombia	--	--	617	80	--	--	617	80	--	--
Costa Rica	--	--	260	51	--	--	260	51	5,760	336
Denmark	--	--	--	--	--	--	--	--	13,600	43
Dominican Republic	--	--	--	--	--	--	--	--	2,020	461
France	--	--	--	--	--	--	--	--	67,700	2,250
Germany	--	--	--	--	--	--	--	--	563,000	3,090
Indonesia	542	94	--	--	--	--	542	94	--	--
Ireland	--	--	--	--	--	--	--	--	272	3,250
Israel	--	--	--	--	--	--	--	--	22,200	81
Italy	--	--	--	--	--	--	--	--	32,300	666
Japan	--	--	--	--	475	55	475	55	71,500	996
Korea, Republic of	--	--	--	--	10,000	1,960	10,000	1,960	7,980	1,790
Malaysia	--	--	--	--	--	--	--	--	175,000	11,000
Mexico	182,000	32,900	66,300	12,100	1,280,000	229,000	1,520,000	274,000	5,460	13,200
Namibia	--	--	1,610	327	--	--	1,610	327	3,700	785
Netherlands	--	--	--	--	--	--	--	--	54,900	3,830
Nicaragua	--	--	1,870	336	--	--	1,870	336	--	--
Panama	--	--	--	--	508	76	508	76	17	3
Papua New Guinea	1,010	171	--	--	--	--	1,010	171	--	--
Peru	8,800	1,320	20,600	3,800	292,000	51,800	321,000	57,000	6,730	2,040
Philippines	--	--	--	--	--	--	--	--	103,000	1,660
Russia	2,220	2,180	--	--	15,000	2,090	17,200	4,260	28	281
Singapore	--	--	--	--	--	--	--	--	1,910	88
South Africa	--	--	--	--	--	--	--	--	91,400	2,540
Switzerland	--	--	--	--	--	--	--	--	1,170	161
Taiwan	--	--	--	--	--	--	--	--	41,800	100
United Arab Emirates	--	--	--	--	95,000	21,400	95,000	21,400	--	--
United Kingdom	--	--	--	--	470	75	470	75	161,000	2,060
Other	--	--	89	19	384	64	473	83	383	562
Total	196,000	36,900	340,000	57,100	2,800,000	509,000	3,330,000	603,000	1,800,000	97,500

r/ Revised.

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

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

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

Source: Bureau of the Census.

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

(Metric tons)

Country	1994	1995	1996	1997	1998 e/
Algeria e/	2	2	2	2	2
Argentina	38	48	50	52 r/ p/	51
Australia	1,045	939	1,013	1,106	1,469 3/
Austria e/	2	2	-- r/	--	--
Bolivia	352	425	384	387 r/	380
Brazil 4/	50	50	30 r/	27 r/	27
Bulgaria e/	30	35	30	25	25
Burma	6	4	4	2 r/	2
Canada	768	1,285	1,309	1,224 r/	1,179 3/
Chile	983	1,041	1,047	1,091	1,340 3/
China e/	810	910	1,140	1,300	1,400
Colombia 5/	6	1 r/	(6/) r/	(6/) r/	-- 3/
Congo (Kinshasa) e/ 7/	12	1	1	1 r/	1
Costa Rica e/	(6/) 3/	(6/)	(6/)	(6/)	--
Croatia e/	1	--	--	--	--
Czech Republic e/	(6/)	--	--	--	--
Dominican Republic	9	21	17	12	8
Ecuador	(6/) e/	(6/) e/	8 r/	2	2
Fiji	1	2	2 r/	3 r/ e/	2
Finland 8/	26	26	33	32 e/	32
France	1	1	2 e/	2 r/	2
Ghana e/	2	3	2	3 r/	4
Greece	45	33	17	45 r/	45
Honduras	25	25 e/	29	30 e/	47 3/
India	50	38	36	35 e/	34
Indonesia	107	183	185 e/	190 e/	190
Iran e/	60	60	60	60	60
Ireland	17	14	15	13	13
Italy 9/	12	14	9	10 e/	10
Japan	134	100	85	87 r/	94 3/
Kazakhstan e/	506	489	468 r/ 3/	465 r/	470
Korea, North e/	50	50	50	50	50
Korea, Republic of 5/	257	299	254	268	270
Macedonia e/	10	10	10	10	10
Malaysia	13	11	10	10	10
Mali e/	(6/)	(6/)	(6/)	1 r/	1
Mexico	2,215	2,324	2,528	2,679	2,686 3/
Morocco	328	204	200	261	260
Namibia	62	69	42	34	9
New Zealand	28	28	29	30 e/	25
Nicaragua e/	2	2	3	2 r/ 3/	2 3/
Panama	(6/) e/	(6/) e/	1	2	2
Papua New Guinea	78	68	58	50 e/	52
Peru	1,768	1,929	1,970	1,998 r/	1,934 3/
Philippines	30	27	25	20	13
Poland	1,064	1,001	935	1,000 e/	1,000
Portugal	32	39	36 e/	34 e/	32
Romania e/	70 3/	60	60	60	60
Russia e/	600 r/	600 r/	400 r/	400 r/	350
Saudi Arabia	17	17	17	17 r/	17
Serbia and Montenegro	18	31	69	38 e/	35
Solomon Islands e/	(6/) 3/	(6/)	(6/)	(6/)	1
South Africa	196	174	169 r/	144 r/	140
Spain	136	102	66	66 e/	65
Sweden	276	268	272	280 e/	275
Tajikistan	NA	NA	NA	NA	5 3/
Tunisia	3	4	3	1 e/	1
Turkey e/	65	70 r/	70	90 r/	90
United States	1,490	1,560	1,570	2,180 r/	2,060 3/
Uzbekistan e/	65	65	70	70	70

See footnotes at end of table.

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

(Metric tons)

Country	1994	1995	1996	1997	1998 e/
Zambia 10/	10 r/	9 r/	9 r/	7 r/	6
Zimbabwe	11	16	10	6 r/	6
Total	14,000 r/	14,800 r/	14,900 r/	16,000 r/	16,400

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

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, 1999.

3/ Reported figure.

4/ Includes the following quantities, in kilograms, identified as secondary silver: 1994--30,000; 1995--35,000; 1996--38,000; 1997--32,000 (revised); and 1998--32,000 (estimated).

5/ Smelter and/or refinery production.

6/ Less than 1/2 unit.

7/ Formerly Zaire.

8/ Metal content.

9/ Includes production from imported ores.

10/ Year beginning April 1 of that stated.