ZINC

By Jozef Plachy

In 1997, domestic zinc mine production, expressed in zinc content of ore, increased by less than 1% from the previous year. Based on the recoverable content and the average annual U.S. price, the value of zinc mine production was about $860 million. Zinc was extracted from 20 mines in 7 States by 8 mining companies. *(See tables 2 and 3.)* For the seventh consecutive year, Alaska was the leading zinc mining State, followed by Tennessee, New York, and Missouri. As in every year since the opening of the Red Dog Mine in Alaska, U.S. mine production greatly exceeded smelter capacity, necessitating exports of concentrate. About 39% of all exports, supplied entirely by the Red Dog Mine, was trucked to the Trail smelter in Canada. The imbalance between concentrate production and smelter capacity is expected to be partially reduced by planned capacity increase at the Clarksville smelter in Tennessee. In 1997, zinc metal production by the three primary smelters from domestic and a small amount of imported concentrate was about the same as in 1996. *(See table 4.)*

Apparent consumption of refined zinc in 1997 increased by nearly 6%. Part of that increase was provided by a 6% increase in imports of refined zinc, mostly from Canada. Of the total refined zinc metal consumed in the United States, more than one-half was used in galvanized products, followed by use in zinc-based alloys and in brass and bronze. Zinc compounds and dust were used principally by the agricultural, chemical, paint, and rubber industries.

The average U.S. producer prices for 1997, which are based on the London Metal Exchange (LME) daily cash price plus premium, increased by about 26%.

While world mine production remained essentially unchanged in 1997, zinc metal production increased by about 2%. The largest producers of zinc concentrate, in order of magnitude, were China, Canada, Australia, Peru, and the United States. The largest producer of zinc metal, primary and secondary combined, was China, followed by Canada, Japan, the United States, and Spain. Total world reserves in 1997 amounted to about 190 million tons of contained zinc.

Legislation and Government Programs

The Defense Logistics Agency (DLA) is authorized (Public Law 102-484) to sell 45,000 metric tons (50,000 short tons) of zinc per fiscal year from the National Defense Stockpile (NDS) as long as the sale does not cause undue disruption of the zinc market. The disagreement between the DLA and the American Zinc Association over what constitutes the zinc market for the stockpiled zinc, 90% of which is either high grade or prime western grade, was settled at the end of 1996 by the General Accounting Office's decision that the market is the total U.S. zinc market. The only remaining question to resolve was about the manner of sale. At a Chicago, IL, meeting on October 24, 1997, DLA and industry representatives agreed to split the sales between the sealed-bid and negotiated formats. The amounts of zinc sold under each format remained undecided until the Congressionally imposed floor price on sales of zinc from NDS expired on October 1. With the beginning of the new fiscal year, the DLA began offering zinc on a long-term basis in a negotiated-bid format with only a small portion, about 1,000 tons per month, set aside for spot sales.

Environmental issues related to technical start-up problems and procedural matters at Cominco Alaska Inc.'s Red Dog Mine, were settled with the U.S. Environmental Protection Agency out of court. Under the terms of settlement, Cominco had to pay a fine of $1.7 million and install groundwater and permafrost monitoring equipment, erect a fish protection barrier, and prepare an aquatic life study.

Production

Mine Production.—Alaska produced more than one-half of the total U.S. output of zinc concentrate, most of which was supplied by the largest zinc mine in the United States—Red Dog. Some of the results of Alaska's 13% increase in exploration expenditures in 1997 include the discovery of new zinc deposits. The largest is the massive sulfide mineralization at Red Mountain, 90 kilometers southwest of Fairbanks in central Alaska, discovered by Vancouver-based Grayd Resources. Ventures Resource Corp. announced the preliminary results of drilling on its Lead Creek deposit in east central Alaska, confirming the presence of lead, zinc, and silver (Ventures Resource Corporation, press release, December 8, 1997, accessed February 18, 1998, at URL http://www.venturesresource.com). Teck Corp. and Sumitomo Metal Mining Arizona Inc. (SMM) reached a basic agreement to continue exploration of the lead-zinc deposit in the Stone Boy area near Fairbanks. Prior to the agreement, SMM had completed a total of 11,000 meters of diamond drilling. Teck may earn a 40% interest in the property upon expenditure of $28 million for ongoing drilling, environmental studies, and preparation of a feasibility study.

Cominco Ltd. remained one of the largest zinc producers in the world despite a small decrease in ore production at the Red Dog Mine, 145 kilometers northeast of Kotzebue. The mine is owned by NANA Regional Corp. and leased to Cominco Alaska Inc., a subsidiary of Cominco Ltd. Because of higher ore grade and improved milling efficiency, annual production of zinc concentrate increased by 22,400 tons to 609,600 tons in 1997, despite decreased ore output. By the third quarter of 1998, when a $104-million expansion project is expected to be completed, production of concentrate should reach an annual rate of more than 900,000 tons. Exploration in 1997 extended the new Paalaaq deposit, presently estimated to be 13 million tons grading 15% zinc (Cominco Ltd., 1998).

The Greens Creek Mine, a polymetallic underground zinc-lead-silver-gold mine on Admiralty Island, 24 kilometers west of Juneau, reopened in July 1996. The full production rate of 45,000 tons of concentrate per year was reached at the beginning of 1997, when grinding, flotation, and gravity circuits were completed. In the

process of becoming a major zinc producer, the Greens Creek operation became 1 of the top 25 silver-producing mines in the United States. The joint venture of Kennecott Greens Creek Mining Co. (70.3%) and Hecla Mining Co. (29.7%) spent about $4 million on exploration in 1997, extending the existing high-grade Southwest zone at Greens Creek. More exploration will take place as soon as a land exchange with the U.S. Forest Service is completed in the first half of 1998. At present, the total known reserves amount to 7.9 million tons grading 13.4% zinc, 4.9% lead, 660 grams per ton silver, and 5.5 grams per ton gold (International Lead and Zinc Study Group, 1996).

In 1997, ASARCO Incorporated operated a marginal mine in Colorado (Leadville), two small mines in Missouri (Sweetwater and West Fork), and three mines in Tennessee (Coy, Immel, and Young). After the closing and subsequent reopening of the Leadville Mine at the end of 1996, full production was not achieved until February 1997. Despite the slow start, 1997 production at Leadville increased by nearly 30% to 10,705 tons of zinc in concentrate. Production at Asarco's two Missouri mines declined by 52%, mainly owing to an 80% decrease in zinc production at the Sweetwater Mine. During the 42-day strike at the Tennessee mines, only the Coy Mine remained in operation. Consequently, combined production of Asarco's Tennessee mines in 1997 declined by 21% to 47,582 tons of zinc in concentrate. The company's mineral reserves at the end of 1997 were highest at Sweetwater, albeit of low zinc grade, but containing enough lead and silver to make the operation profitable. Mineral reserves at all of its Tennessee mines amounted to a total of 6.1 million tons, with an average grade of 3.1% zinc (ASARCO Incorporated, Asarco annual report, 1997, accessed April 23, 1998, at URL http://www.asarco.com).

Expansion of the Lucky Friday Mine in Idaho, owned and operated by Hecla Mining Co., continued on schedule. In May, the company's board of directors approved a $16 million development of an area known as Gold Hunter. The cost for development was relatively low, because the basic infrastructure to handle the additional ore was already in place. During 1997, development of the expansion area included driving about 1,200 meters of preproduction development drift and constructing a ventilation raise to connect the 1,500-meter level with the 1,200-meter level. Improvements at the mill included expanding the storage area for concentrate, increasing the filtration and zinc flotation capacity, and completing several minor infrastructure improvements. About one-fourth of 1997 production came from the expansion area, although it was diluted with low-grade material from development excavations. By the end of 1998, up to 90% of production, which is expected to double in 1998, is expected to come from the new deposit (Mining Record, 1997).

After the closure of the Jefferson City Mine in 1996, Savage Zinc Inc., the wholly owned subsidiary of Australia-based Savage Resources Ltd., operated only two mines in Tennessee: Clinch Valley and Gordonsville. Consequently, the total ore production declined by nearly 9% to 2.1 million tons, yielding 94,500 tons of concentrate containing 63.6% zinc. Production at the Gordonsville Mine was affected by the introduction of a new underground hauling method, needed to access the new Horseshoe Bend mineralization, about 8 kilometers north of the Gordonsville shaft. Combined reserves at the Gordonsville and Clinch Valley Mines increased by 11% owing to a successful drilling program, most notably at the Gordonsville Mine. Total reserves at the end of the fiscal year (June 30, 1997) stood at 28.1 million tons grading 3.1% zinc (Savage Resources Limited, 1998).

Domestic mine production data were collected from a voluntary survey on lode-mine production by the USGS. All the major zinc-producing mines responded to this survey. (*See tables 1-3.)*

The development of the Crandon/Rhinelander zinc-copper deposit in Wisconsin by Nicolet Minerals Co. (formerly Crandon Mining Co.), a wholly owned subsidiary of Rio Algom Mining Corp., hinged on acquiring some remaining permits from the State Government and local authorities. Public discussions regarding construction of a proposed 61-kilometer treated-wastewater pipeline and a tailings pond continued in 1997. The location of a future mine near the headwaters of the Wolf River aroused local opponents, who feared pollution of underground water. The main ore body reportedly contains about 30 million tons of recoverable ore at grades of 9.4% zinc and 0.4% copper, with small amounts of lead and precious metals (Mining Journal, 1998b). Development of the deposit would include building a mill with an ore processing capacity of 2 million tons per year, producing between 200,000 and 300,000 tons of zinc concentrate and about 20,000 tons combined copper-lead concentrate per year (Metal Bulletin, 1996).

A new deposit near Palmer Mountain, 250 kilometers northwest of Spokane, WA, was discovered by Canada's Yamana Resources Inc. During exploratory drillings in 1997, Yamana encountered multiple layers of volcanogenic massive sulfides ranging in metal content between 1.7% and 6.3% zinc, plus copper and silver (Mining Journal, 1997a).

Additional zinc production is expected to be derived from two closed mines that are slated to be reopened. The New Burgin Mine, 112 kilometers southwest of Salt Lake City, UT, is being developed by Tintic Utah Metals LLC (Limited Liability Company), jointly owned by Chief Consolidated Mining Co. (75%) and the Korea Zinc Co. Ltd. (25%). The former underground mine contains 1.5 million tons of reserves grading 6.7% zinc, 21% lead, and 468 grams of silver per ton of ore (Mining Record, 1996). The second prospective mine, Pend Oreille, near Metaline Falls, WA, was closed in 1977 by Bunker Hill Co. The mine, acquired by Cominco in 1997, contains 5.9 million tons of reserves grading 7.4% zinc (Derkey, 1997).

Smelter and Refinery Production.—Savage Zinc spent $750,000 for rebricking the roaster, upgrading the pipes in the acid plant, and maintaining the boiler at its Clarksville, TN, smelter in 1997. It also approved the expenditure of $7.6 million for a feasibility study on expanding the annual capacity from 105,000 tons to about 275,000 tons.

The major constraint on such a sizable expansion is the availability of feed. Partial help could come from the planned 10% increase of output at its Gordonsville Mine, based on expansion of proven and probable reserves to 24 million tons grading 3.1% zinc. Additional concentrate may result from the company's exploration effort at the Columbia vein system in western Kentucky. About 80% of the holes drilled in 1997 intersected potential economic zinc grades. Despite the planned and hoped for increase of production by Savage's mines and additional domestic concentrate supplied by Asarco's mines, a large portion of the feed required for the smelter will have to be imported. In 1997, the total feed amounted to 150,583 tons of concentrate, of which only about 60% came from Savage's Tennessee mines.

Despite the temporary shutdown of the Clarksville operation, Savage's zinc metal production increased by 3% to 108,552 tons. In addition, 359 tons of cadmium and 15.6 tons of germanium was sold

in 1997 (Savage Resources Limited, 1998).

The domestic primary zinc production by three smelters, located in Clarksville, TN, Monaca, PA, and Sauget, IL, were reported in their Annual Reports or/and submitted to USGS or American Bureau of Metal Statistics. The secondary data were derived by the USGS from a combined secondary producer and consumer survey that included data from monthly and annual respondents. Of the 19 companies to which a survey request was sent, 11 responded, representing about three-fourth of secondary production. The remaining one-fourth was estimated from prior year data.

Secondary Production.—Recovery of zinc from electric arc furnace (EAF) dust and galvanizing scrap is becoming more widespread as new technologies are being developed. The discovery of the Waelz process to treat iron-bearing EAF dust and oxide has not only reduced airborne particles in the vicinity of steelworks, but simultaneously has helped to increase production of secondary zinc. Zinc production from EAF dust and oxide increased three times faster than primary zinc production during the period 1984-96 (Christiansen, 1997). The EAF dust, along with coke breeze and/or anthracite is heated in the Waelz kiln to vaporize zinc. After cooling, leaching, and dewatering, the resulting oxide, containing up to 70% zinc, can be briqueted and used directly in the furnace or calcined for use in electrothermic zinc smelting. For electrolytic zinc plants, secondary zinc oxide feed eliminates the problem of converting the iron content of zinc concentrate into jarosite, which poses disposal problems (Metal Bulletin, 1997c).

Zinc may also be recovered from galvanized scrap prior to steelmaking. One of the newest technologies was developed by Metal Recovery Technologies (MRT) in conjunction with the U.S. Department of Energy and its Argonne National Laboratory, which provided $5.46 million of financial help. According to MRT, its dezincing process could provide energy savings of 50 trillion British thermal units, save the U.S. iron and steel industry $140 million in raw materials, reduce the foreign exchange deficit, and eliminate zinc from waste streams. MRT's East Chicago, IN, plant began operating its first commercial degalvanizing line in March 1997. During its trial operation, MRT fell short of its planned production of 250 tons of zinc and 9,750 tons of high-grade steel scrap from 10,000 tons of galvanized steel scrap. Further financial help for commercial startup of the East Chicago plant will depend on additional private-sector financing, which in turn will depend upon on securing an arrangement with General Motors Corp. to supply coated steel for the dezincing process (Metal Bulletin, 1997g).

Consumption

In the United States about 30% of flat rolled steel is said to be galvanized. Shipments of galvanized sheet grew by an average of nearly 7% per year during the period 1981-86, with electrogalvanized sheets showing the most impressive rise at about 14% per year over the same period. In the automotive sector, the largest consumer of galvanized steel, hot dip galvanizing (HDG) accounts for 65% and electrogalvanizing for 35% of consumption (Metal Bulletin, 1997d). While in the past there has been a strong growth in the automotive sector, the building market is now the fastest growing end-use market, using mostly premium galvanized products, such as galvalume (45% Zn and 55% Al). These positive developments have led to a number of new galvanizing lines. U.S. Steel is to add a 600,000-ton HDG and galvalume lines at its two plants, one in Fairfield, AL, and the other, Pro-Tec Coating Co., in Leipsic, OH (Gill, 1997). Nucor Corp. is to install a 350,000 to 450,000-ton-per-year HDG line at its Berkeley, SC, flat product minimill (Metal Bulletin, 1997i). California Steel Industries will add a new 160,000-ton line at a cost of $62 million by 1998 at the company's Fontana facility (CRU Monitor, 1997). Last year, Worthington Industries Inc. of Columbus, OH, announced plans to build a 450,000-ton HDG line with Rouge Steel in Michigan (Metal Bulletin, 1997j), and in April 1997, it started up its 363,000-ton HDG line in Delta, OH. BHP Coated Steel is adding a 150,000-ton galvanized steel line at its Kalama, WA, plant. Other companies planning to add galvanizing lines include National Steel Corp., Steel Dynamics Inc., and AK Steel Corp.

Stocks

The imbalance between world supply and demand continued to be offset by the drawing down of stocks. At the start of 1995, the total world inventory was close to 1.7 million tons, equivalent to about 15 weeks of consumption; by the beginning of 1997, stocks amounted to 0.9 million tons, or about 8 weeks of consumption. While producer, consumer, and merchant stocks remained about the same (*See Table 1.)*, LME stocks declined from 506,800 tons at the beginning of 1997 to 379,500 tons by the end of August. Because of increased Chinese exports, LME stocks of zinc metal rebounded to 491,600 tons by yearend. According to industry experts, the zinc market should remain in a substantial deficit during 1998, if Chinese exports are lower than 1997 exports of 0.5 million tons. Reported U.S. stocks amounted to 88,900 tons by yearend.

Prices

Prices traditionally respond to supply and demand. The price of zinc metal is more responsive when stocks decline to approximately a 6-week supply. At the beginning of the year, the LME price for 1 pound of zinc metal was 49.3 cents. When the stocks reached their lowest level in August, the price increased to 75 cents; by yearend, it dropped to 50 cents, mainly due to large Chinese exports. The average LME price for 1997 was 59.70 cents per pound or $1,316 per ton of zinc metal. The average monthly U.S. price for 1 pound of zinc went from 55.17 cents in January to 79.15 cents in August and eventually declined to 54.24 cents by yearend. With its increased production and significant export capability, China has become the most important and largely unpredictable factor affecting the price of zinc. The average 1997 U.S. price for North American Special High Grade was 64.56 cents per pound of zinc, a 26% increase over that of 1996. While supply and demand have the greatest effect on price, other factors influence the final price of zinc. One of these factors is the treatment charge for production of zinc metal—periodically the topic of negotiations between mining and smelting companies.

World Review

Demand for zinc metal in 1997 grew by 2.8% worldwide. In the industrialized countries, consumption totaled 6.37 million tons and globally 7.74 million tons. Global output of refined zinc metal rose by 2.5% to 7.74 million tons, principally because of increased production in China and industrialized countries. Demand in the

industrialized countries exceeded production by 806,000 tons in 1997. However, supply to the industrialized countries was boosted by a substantial surge in net exports of refined metal from several countries, principally China, resulting in a surplus of supply over demand for the year.

After increases in 1995 and 1996, global and industrial countries' zinc mine production contracted slightly in 1997. With the continued privatization of Peru's Centromin, 85% of mine production of industrial countries was supplied by private companies. Regional shares of industrial countries' mine production in 1997 were as follows: North America, 21.5%; Latin America, 20%; Australia, 16%; and Europe, 12%. During 1997, about 350,000 tons of additional mining capacity was added, mostly by opening new mines (48%) and, to a lesser degree, by expanding production at existing mines (29%) and by reopening previously closed mines (23%). The 25 largest Western producers accounted for about one-fourth of Western production. The largest producers were the two Canadian-based companies, Cominco Ltd. and Noranda Inc., followed by two Australian producers, Pasminco Mining Ltd. and MIM Holdings Ltd. By 2000, Cominco and Pasminco are likely to have a more substantial impact on concentrate production, owing to expansion of the Red Dog Mine and opening of the Century Mine, respectively.

Anticipated oversupply of zinc concentrate at the beginning of 1997 turned into a shortage by yearend. With the closure of Anvil Range Mining Corp.'s Faro Mine in the Yukon Territory, about 130,000 tons of zinc in concentrate was lost. Additional shortfall was caused by cancellation of the reopening of Cominco Ltd.'s Sa Dena Hes lead-zinc mine in the Yukon Territory, temporary closure of Cambior's Gongague Langlois Mine in Quebec, and reduced production at Noranda's Bathurst Mine in New Brunswick. A significant shortfall in concentrate was averted in 1997 by the addition of 353,000 tons of production capacity, 60% of which occurred in Australia and Canada. An additional 480,000 tons of concentrate production is anticipated in 1998.

The eight countries listed below, together with the United States, accounted for more than three-fourths of the total world production of zinc in concentrate.

Australia.—Over the next 5 years, a number of Australian mines are to close, including Hilton, Mount Isa, Scuddle, Thalanga, and Woodlawn. However, production from new mines, such as Cannington, Century, George Fisher, Dugald River, Kapok, and Pillara (formerly Blendevale), and expansion of the Elura and Rosebery Mines will replace lost production and will increase mine production by about 50% by 2002 (Metal Bulletin, 1997a). By 2000, Australia's share of world zinc production should increase to 29%, from 14% in 1997.

Pasminco Mining Ltd. owns and operates three underground mines in Australia: Broken Hill and Elura in New South Wales and Rosebery in Tasmania. It also operates the Potosi open pit mine near Broken Hill and, intermittently, the small Beltana open pit mine in South Australia. In the fiscal year ending June 1997, Pasminco produced 317,000 tons of zinc in concentrate and 524,000 tons of zinc metal in four smelters (Cockle Creek, Hobart, and Port Pirie in Australia, and Budel in the Netherlands). Pasminco's already high mine output should rise dramatically with development of the Century deposit, which began in May 1997. When in full production, output of the Century Mine, in Queensland's Gulf of Carpentaria region, should reach 780,000 tons of concentrate containing 450,000 tons of zinc, making it the world's largest open pit zinc operation. The total proven and probable reserves at Century amount to 98.5 million tons grading 11.6% zinc, 1.7% lead, and 43 grams of silver per ton of ore (Mining Journal, 1997e).

Western Metals Ltd. has decided to proceed with the $73.5 million development of its Pillara Mine in the Lennard Shelf area of Western Australia, 50 kilometers northwest of the Cadjebut Mine. Pillara has reserves of 10.6 million tons grading 8.1% zinc and 2.5% lead, which will be mined and processed in a new plant designed to treat 1.5 million tons of ore per year. The mine is expected to produce 165,000 tons of concentrate per year containing 102,000 tons of zinc for at least 8 years (Platt's Metals Week, 1997e). Production was expected to start in July 1998. Concentrate will be trucked 260 kilometers to a 400,000-ton-capacity storage facility at the port of Derby. Most of Western Metals' production in 1997 came from the newly commissioned Goongewa Mine, supplemented by the nearly depleted Cadjebut Mine. A small amount of ore was supplied by the Kapok Mine, which became fully operational in September 1997. Resources at Kapok are estimated at 4.1 million tons grading 9.1% zinc and 7.1% lead (Platt's Metals Week, 1997d).

Opening of BHP Minerals' Cannington Mine near Cloncurry, northwest Queensland, will add 110,000 tons to Australia's zinc production. Construction of the underground lead-zinc-silver mine commenced in early 1996 and partial production began in November 1997. When in full production, at the beginning of 1998, it will treat 1.5 million tons of ore. The total resources are estimated at more than 47 million tons, of which almost 34 million tons is in the southern zone, where measured reserves are 11 million tons grading 14% lead, 5.2% zinc, and 653 grams of silver per ton of ore (Metal Bulletin Monthly, 1997).

Australian smelter output is relatively low, around 330,000 tons, compared with metal-in-concentrate production of 1.1 million tons. This deficiency will be alleviated by the new smelter being built by Korea Zinc Co. Ltd.'s subsidiary, Sun Metals Corp. Construction of the electrolytic smelter-refinery in Townsville, north Queensland, began in 1997; it will cost about $500 million. Commissioning is to start in 1999, and by 2000 it should reach its designed annual capacity of 170,000 tons. The plant has been designed so that output can be doubled in the second stage. Most of the required feed is expected to be sourced from northwest Queensland mines, including Cannington, Mount Isa, and Thalanga. The remaining feed will be brought in from other Australian mines and imported from overseas through the port of Townsville.

Canada.—The value of metal production in Canada declined by 2.7% from $8.1 billion in 1996 to $7.9 billion in 1997, according to figures released by Natural Resources Canada. Due to higher zinc prices, the overall value of zinc production grew to almost $1.3 billion, an increase of 15.4% over 1996, although production volumes declined by 12.5%. The decrease in output was primarily due to the closure of the Faro Mine. An anticipated increase in zinc production in 1998 was expected to come from the Pick Lake Mine in Ontario, which began production in late 1997, and the Caribou-Restigouche Mine in New Brunswick. By 1999, the 120,000-ton-capacity Bell Allard Mine in Quebec should begin operation (Minerals and Metals Sector, Natural Resources Canada, 1998).

Zinc is Cominco Ltd.'s largest single source of revenue, representing 48% of the total. This share should increase with the $104 million expansion program at the Red Dog Mine, in Alaska, which will raise annual output to more than 900,000 tons by 1999. In 1997, Red Dog contributed more than one-half of the concentrates

treated at Cominco's integrated lead and zinc smelter in Trail, BC. The remaining feed was made up by the wholly owned Sullivan Mine and the 77.5%-owned Polaris Mine, both in Canada. After 87 years of operation, the Sullivan Mine at Kimberley, BC, is in the last 5 years of its life. Production in 1997 amounted to 1.6 million tons of ore and about 192,800 tons of concentrate containing 52.3% zinc. The Polaris Mine on Little Cornwallis Island, Northwest Territories, jointly owned with Teck Corp., produced 1 million tons of ore and about 152,700 tons of concentrate containing 63% zinc. Cominco's foreign interests include 82% ownership of the Cajamarquilla smelter-refinery and 13% ownership of Sociedad Minera El Brocal S.A., in Peru. Despite improvements at the Trail smelter that raised the capacity by 18,000 tons, to 290,000 tons per year, production of zinc declined by 5.5% to 256,900 tons in 1997 (Cominco Ltd., 1998). About 77% of Trail's production of zinc was sold in North America, with 66% going to steel mills.

Noranda Inc. ceased operations at Matagami, Quebec, in December 1997 owing to the exhaustion of reserves at the Isle Dieu and Norita East zinc-copper mines; this resulted in the loss of 50,000 tons per year of contained zinc. As a replacement, the nearby Bell Allard zinc-copper deposit is being developed at a cost of $84 million, but will not be in production until early 1999. It has reserves of 3.2 million tons grading 13.8% zinc, 1.5% copper, and small amounts of silver and gold (International Lead and Zinc Study Group, 1996). In October 1997, Noranda reopened the 28,000-ton-per-year-capacity Gallen zinc mine near Rouyn-Noranda, Quebec. Canadian Electrolytic Zinc (CEZinc), Noranda's zinc smelter-refinery in Valleyfield, Quebec, invested $32 million to increase the capacity by nearly 9% to 250,000 tons per year. Expansion was accomplished by improving other departments to match the capacity of the tankhouse. Most of the zinc concentrate for the smelter was supplied by five Noranda-controlled mines in Canada with a total production of about 500,000 tons of concentrate. CEZinc currently is working on a process to reduce the amount of iron in waste; it involves filtering, washing, and chemical stabilization of jarosite.

One of the most active Canadian miners in 1997 was Toronto-based Breakwater Resources Ltd. It reopened the Caribou open pit lead-zinc mine in New Brunswick in July 1997, which had been closed since 1990. The Caribou mill will also process ore from Breakwater's newly developed Restigouche underground lead-zinc mine, opened at the same time. Total reserves at both adjoining mines amount to 14.6 million tons grading 8% zinc, 3.7% lead, and some copper, gold and silver (International Lead and Zinc Study Group, 1996). Breakwater also purchased the assets of Société Minière de Bougrine for $19.3 million, including the Bougrine Mine in Tunisia, which reportedly has proven and probable reserves of 4 million tons grading 12.2% zinc and 2.4% lead, sufficient for 7 years of operation. Breakwater plans to spend $7 million to ensure annual production of 400,000 tons of zinc concentrate. In Chile, Breakwater acquired the El Toqui mining complex from Barrick Gold Corp. for $6 million (Metal Bulletin, 1997b).

Anvil Range Mining Corp. spent most of 1997 trying to resume operation of its Faro Mine in Yukon Territory. The mine ceased operation in 1996, but continued milling stockpiled ore until March 1997. By the time financing was secured and full-scale operation began in mid-November, the price for zinc was already declining, and the mine was forced to close at the end of December. Faro reportedly has proven and probable reserves of 45.8 million metric tons grading 8.34% zinc and lead, 52.6 grams per ton silver, and 0.7 gram per ton gold (Mining Journal, 1997b).

Cambior Inc. resumed operations in July at the Gonzague Langlois zinc-copper mine near Lebel-sur-Quévillon. Production was suspended in late 1996 because of weak zinc markets and higher mining dilution.

China.—Estimated Chinese production of zinc in concentrate rose by 7% to 1.2 million tons in 1997, while zinc metal production increased by 18% to 1.4 million tons, mainly due to increased capacity and better capacity utilization.

On January 1, 1997, new amendments to the Mineral Resources Law became effective. They strengthened the state's ownership of China's mineral resources, but at the same time they bestowed more responsibility for exploration and mining on local governments. Some of the provincial capitals and coastal cities can now approve projects valued at up to $30 million; anything higher must be approved by some of the regulatory agencies of the Government. This decentralization is reflected in the increasing share of zinc output by local companies that operated outside of China National Nonferrous Metals Industry Corp. Their share of production went from 55% in 1992 to 70% of total zinc concentrate output in 1997. The amendments also allowed private enterprises and Sino-foreign joint ventures to participate in exploration, but only under the supervision of the Government.

In an effort to take advantage of these developments, Canadian Marshall Minerals Corp. has signed a letter of intent with China Nonferrous Metals Industry's Xien Corp. to develop the Qian Dong Shan lead and zinc mine. The mine, located 300 kilometers west of Xian in Shaanxi Province, has estimated resources of 25 million tons grading 7.5% to 8% zinc, 1.6% to 2% lead, and 45 grams per ton silver (Metal Bulletin, 1997f).

The Chinese State Tariff Commission abolished export duties on 14 commodities beginning January 1, 1997, including refined zinc and zinc scrap. Export duty on zinc concentrate was lowered to 10%. With the elimination of the 5% export duty, exports of zinc metal increased to 534,000 tons in 1997, an increase of 327,000 tons from 1996. China's annual trade in mineral products amounted to about $40 billion, accounting for 20% of the total trade value.

Zhuzhou smelter in Hunan Province increased zinc production from 150,000 tons in 1996 to 230,000 tons in 1997 in order to take advantage of higher zinc prices. More than one-half of the zinc metal was exported, mainly to Asian countries. Zhuzhou obtained its zinc concentrates from more than 60 different domestic mines, and stockpiled about a 3-month supply of concentrates.

The Chinese smelting capacity of 1.45 million tons in 1997 is planned to increase to about 1.58 million tons by 2000. Domestic mine supply will probably fall short of required feed for the rising smelter production, necessitating increased imports of zinc concentrate (Metal Bulletin, 1997k).

Ireland.—The Tara Mine at Navan, operated by Tara Mines Ltd. and owned by Outokumpu Oy of Finland, milled 2.15 million tons of ore grading 8% zinc and 2.45% lead. It produced 287,000 tons of concentrate containing 160,700 tons of zinc. Total proven and probable reserves reportedly amounted to 16.4 million tons grading 8.1% zinc and 2.5% lead. There are said to be additional resources totaling 20.3 million tons grading 6.8% zinc and 2.1% lead (Dhonau, 1998). While the Tara underground mine in County Meath has been in operation since 1977, the Galmoy Mine began operation in 1997 and the Lisheen Mine is expected to commence operation in the fall of 1999.

After spending $120 million for development, the first shipment of zinc concentrate left the underground Galmoy Mine in County Kilkenny in March, and by yearend it treated some 0.4 million tons of ore, yielding about 59,000 tons of zinc in concentrate. Galmoy is owned by Arcon International Resources plc of Ireland and operated by its subsidiary Arcon Mines Ltd. It is designed to produce 650,000 tons per year of ore, yielding about 65,000 tons of zinc over a mine life of at least 13 years. Concentrate is shipped through the New Ross port to European smelters on a long-term contract. Based on recent discoveries, minable reserves reportedly exceed 8 million tons grading 12.7% zinc (Dhonau, 1998).

Development commenced on the Lisheen zinc-lead mine, County Tipperary, in September 1997. The development of the mine, jointly owned by Ivernia West plc and Minorco SA and operated by Minorco Lisheen Ltd., is expected to cost about $266 million. Planned annual production should reach 1.5 million tons by 2000, resulting in 230,000 tons of zinc concentrate. The delineated mining reserve has been increased in 1997 to 18.9 million tons grading 12.75% zinc and 2.2% lead (Dhonau, 1998).

Kazakstan.—After restructuring in 1997, the Aktsionernoye Obshchestvo Kaztsink is to be composed of the Leninogorsk mining and smelting enterprise and the Ust-Kamenogorsk base metal smelter, but not the Ziryanovsk mining and processing enterprise, as originally intended. Late in 1997, the small Tekeli mining and beneficiation complex in the Taldy-Kurgan region of eastern Kazakstan was added to Kaztsink. The Tekeli complex consists of the Koksyu and Tekeli lead-zinc mines and two beneficiation plants with a combined annual capacity of 29,600 tons. The Leninogorsk enterprise reportedly has the annual capacity to mine 3.9 million tons of polymetallic ore, process 4.36 million tons of ore, and produce some 106,500 tons of zinc metal. Ore for the Leninogorsk smelter comes from Leninogorsk's four mines (Chekmar, Leninogorsk, Ridder, and Tishinsk) and other smaller independent local mines. Ust-Kamenogorsk enterprise reportedly has the capacity to produce 145,900 tons of refined lead, 215,000 tons of zinc metal, and 43,700 tons of copper (Mining Journal, 1997c). With production of 71,500 tons of zinc in 1997, the smelter operated well below its capacity. Kaztsink also has mining rights to the Maleyev, Ridder-Sokol, and Tishinsk mineral deposits. Maleyev was already producing small amounts of ore in 1997, but needs about a $40 million investment to reach planned production of 80,000 tons to 100,000 tons of zinc concentrate. Some foreign companies, including Glencore International AG of Switzerland and Asturiana de Zinc S.A. of Spain, expressed interest in forming a joint venture with Kaztsink. Funds from selling shares would help Kaztsink to develop not only the Maleyev Mine but help push production above the planned level of 225,000 tons in 1998.

The Kazak Government has identified priority investment areas which include the development of the Artemyevsk lead-zinc deposit at a cost of $70 million.

Mexico.—Production of most metals increased, including a 10% increase of zinc production. Mexico has in recent years opened the mining sector to foreign and domestic investment. It is estimated that about $1 billion was invested in the mining industry in 1997, of which approximately 70% was for new project development and 30% for exploration. The Consejo de Recursos Minerales (Mineral Resources Council) has set up a computer database of potentially attractive properties for investment. Cámara Minera de México (Chamber of Mines of Mexico) is helping the private mining sector by establishing clear and fair environmental laws, lobbying for elimination of the asset tax during the preproduction period, and amending classification of roadways and allowable weight of trucks (Flores, 1998).

With an output of 49,100 tons of contained zinc, the Charcas Mine in San Luis Potosí State, owned by Industrial Minera Mexico S.A. (IMMSA), was Mexico's largest zinc producer in 1997. It was followed by IMMSA's San Martín Mine in Zacatecas State. Total production of IMMSA in 1997 was 288,371 tons of concentrate containing 161,914 tons of zinc.

The third largest mine, the Bismark Mine in Chihuahua State, was owned by Mexico's leading base metal producer, Industrias Peñoles S.A. Peñoles produced about 125,000 tons of zinc in concentrate, accounting for about 17% of its sales. It also completed exploratory work on the Francisco I. Madero polymetallic deposit in Zacatecas, where reserves of some 30 million tons grading 5.2% zinc are said to have been outlined. Commercial production of 3 million tons per year was expected to start in 1999. Peñoles (51%), Dowa Mining Co. (39%), and Sumitomo Corp. (10%), have established a joint company—Minas Peñoles S.A. de CV—to develop the lead-zinc deposit at Rey de Plata in the State of Guerrero following the completion of the feasibility study. Current plans call for commercial mining to begin in 2000 at a rate of 1,100 tons of ore per day. The Rey de Plata deposit is 70 kilometers southeast of the currently operating Tizapa Mine owned by the same three mining companies. Ore output at Tizapa is to increase by 60% to 1,600 tons per day. Tizapa reserves amount to 3.7 million tons grading 8.5% zinc, plus lead, silver, and gold. Peñoles currently processes 71% of the zinc it mines; this figure is expected to rise to about 85% by 2000.

Additional large mines operating in Mexico included San Francisco del Oro in Chihuahua State (33,500 tons), Real de Angeles in Zacatecas State (33,400 tons), and Santa Bárbara and Naica, both in Chihuahua.

Industrias Peñoles S.A., through its wholly owned subsidiary Met-Mex Peñoles, is also Mexico's largest producer of refined lead and zinc. It is planning to expand production at its Torreón smelter in Coahuila State to 220,000 tons per year of zinc from its current output of 130,000 tons. Construction will start in early 1998 and is expected to be finished by 2000 (Platt's Metals Week, 1997c). In addition to lead and zinc, the Torreón facility also recovers ammonium sulfate, antimony, bismuth, cadmium, sulfur dioxide, and sulfuric acid. IMMSA operates the second refinery in San Luis Potosí, with a capacity of 115,000 tons. In 1997, it produced 101,901 tons of zinc.

Peru.—A stable political environment and improved prices encouraged an increase in mine production, which grew about 14% to 865,267 tons of contained zinc in 1997. This represented 11% of world concentrate output, although Peru produced only 2% of global refined metal. Most of the increase of concentrate production was due to a 365% rise in output at the Iscayacruz Mine in Oyen.

Production at the Iscaycruz Mine was suspended in November, when Empresa Minera Iscaycruz S.A. failed to secure a permit for a new tailings pond. After a short interruption, production returned to a normal rate of 125,000 tons of zinc in concentrate for a total of 86,076 tons in 1997. The mine reportedly has proven and probable reserves of 2.7 million tons grading 21.4% zinc and 2.2% lead. The company is jointly owned by four companies with Glencore International of Switzerland holding a 45% interest.

Privatization of Empresa Minera del Centro del Peru S.A.

(Centromin) continued in 1997 with the sale of three mining complexes (Mahr Túnel, Yauliyacu, and Yauricocha) and the La Oroya smelter. In April, the Yauliyacu mining complex was bought by Compañía Minera Casapalca S.A. of Peru, through its majority owned subsidiary Cía Minera Yuracmayo. Yauliyacu reportedly contains 7.3 million tons of proven and probable reserves grading 3.7% zinc, 1.9% lead, 0.45% copper, and 285 grams of silver per ton of ore and has a concentrator capable of treating nearly 1 million tons per year of ore (Platt's Metals Week, 1997b). In September, the Mahr Túnel complex was purchased for $128 million by Peru's Compañía Minera Volcán S.A. Mahr Túnel consists of two polymetallic mines (Andaychagua and San Cristobál) with a total production of more than 1 million tons per year of ore containing about 37,000 tons of zinc, plus lead, copper, and silver (Mining Journal, 1997d). This new acquisition will increase Volcán's annual production by about 15,000 tons to about 170,000 tons of contained zinc, making it the largest private producer of zinc in Peru. The Yauricocha Mine was bought by Cía Minera San Ignacio de Morococha S.A. in December 1997. Yauricocha reportedly contains 2.8 million tons of ore grading 5.3% zinc, 2.8% lead, and 1.1% copper (Metal Bulletin, 1997h). Centromin plans to complete its piecemeal privatization program by the end of 1998. One of Centromin's major assets yet to be sold consists of the Cerro de Pasco underground and open pit mine and two concentrator plants. In 1997, it produced 192,582 tons of zinc in concentrate. Proven and probable reserves are said to amount to 58 million tons (Mining Journal, 1997e).

Cominco Peru, a subsidiary of Cominco Ltd., entered into a joint venture with Solitaro Resources, a 57.6% owned subsidiary of Canada's Crown Resources Corp., to develop the Bongará deposit in northern Peru, consisting of the Florida Canyon and Florcita ore bodies. The agreement allows Cominco to earn up to a 60% interest in the project by spending $27.5 million on further exploration and development over the next 4 years. Seven holes at Florida Canyon intersected zinc mineralization with grades as high as 16.3% zinc and 6.2% lead. Zinc content at Florcita was typically 4% to 6%, but some intervals ran as high as 11.2% zinc (Whyte, 1997).

Inmet Mining Corp. and Rio Algom Ltd., both from Canada, acquired the Antamina copper-zinc project from Centromin in 1996. During 1997, after additional delineation drilling, a feasibility study was being prepared. According to preliminary estimates, minable reserves, amenable to open pit mining, amounted to 500 million tons grading 1% zinc and 1.2% copper (Rio Algom Ltd., Exploration & Development, accessed March 27, 1998, at URL http://www.rioalgom.com). The proposed mine could produce about 385,000 tons of concentrate beginning in 2001. The main drawback is the cost of development, which is estimated at $2.2 billion.

After Industrias Peñoles of Mexico backed out of the deal, the Doe Run Company, subsidiary of the Renco Group, acquired a controlling interest in the La Oroya polymetallic smelter-refinery for $246 million. Metal Oroya, as the complex had been renamed after the purchase, has an annual capacity of 91,000 tons of lead, 70,000 tons of zinc, 66,500 tons of copper, plus silver and gold (Metal Bulletin, 1997e). The purchase was expedited by the guaranteed 10-year environmental program financed by the Peruvian Government. The first stage of capacity, an increase to 120,000 tons per year of zinc, was well under way at yearend; the second stage, a $311 million project, to expand annual production to 240,000 tons, was approved in 1997 and should be completed by 2000.

The board of directors of Cajamarquilla, the largest refinery in Peru, located 25 kilometers east of Lima, approved a $300 million expansion that will double the annual output to 240,000 tons by the first quarter of 2000. Prior to expansion, revamping the leaching and roasting processes was expected to raise the annual capacity to 120,000 tons by 1998. About 35% of its output is sold to local consumers and 50% of the remaining production is sold to neighboring countries. The board of directors is hoping that annual per capita zinc consumption in Latin America will increase from about 0.5 kilogram to closer to 3.5 kilograms as in developed industrialized countries. Cajamarquilla is 81.6% owned by Cominco Ltd. of Canada, 16.7% by Marubeni Corp. of Japan, and 1.7% by its employees (Platt's Metals Week, 1997a).

Zinc Corp. PLC of the United Kingdom, through its Peruvian subsidiary Zinc Corp. del Peru S.A., signed an agreement with Compañía Minera San Valentin S.A. to build the first commercial-scale Warner plant at San Valentin's zinc mine. The new process is expected to increase metal recovery to about 90% while reducing soil pollution and virtually eliminating gas emissions (Mining Magazine, 1997).

Spain.—In 1995, Navan Resources of Ireland acquired the Aguas Teñidas deposit containing 18 million tons of zinc-copper ore grading 6% zinc. It was followed by Navan's purchase of Almagrera SA in 1997 for $7.9 million. The latest acquisition, only 21 kilometers from the first one, includes two working mines, a beneficiation plant, and a sulfuric acid plant. Output of both mines totaled 750,000 tons of ore, of which 450,000 tons was supplied by the Sotiel Mine and 300,000 tons by the Migollas Mine, resulting in 15,065 tons of zinc in concentrate in 1997. The concentrate also contains copper and lead. Concurrent with the development of Aguas Teñidas, the milling and beneficiation plant at Sotiel is being modified and expanded to allow processing of Aguas Teñidas ore when production begins in 1999 (Espi, 1998). By 2002, Navan will be mining over 1.4 million tons of ore annually, which should yield about 35,000 tons of zinc and more than 10,000 tons of copper.

The Los Frailes Mine, operated by Sweden's Boliden Ltd.'s subsidiary Boliden Apirsa SL, has reserves of 47 million tons of complex sulfides containing 3.82% zinc and 0.36% copper. The open pit mine is only 1 kilometer from Boliden's depleted Aznalcóllar Mine in southern Spain. After 3 years of construction, costing $100 million, it reached its designed annual production of 4 million tons of ore by December 1997. It was expected to yield between 230,000 tons and 240,000 tons of concentrate containing approximately 48% zinc plus copper, lead, and silver per year (Espi, 1998).

One of the oldest mines in Spain is Reocin in northern Spain. The mine, owned by Asturiana de Zinc, has been working continuously, both underground and opencast, since 1956. Production is about 1.1 million tons of ore, yielding 88,658 tons of zinc in concentrate.

Outlook

According to the International Lead and Zinc Study Group, zinc mine production is expected to increase by 8.7% to 7.9 million tons, while metal output is to increase by only 4.9% to 7.95 million tons in 1998. World zinc consumption is projected to rise by 2.4% to 7.93 million tons in 1998 (Metal Bulletin, 1997l). A surplus may arise if the financial crisis in some of the South East Asian countries spreads to other countries. The Asian region accounted for 30% of

global zinc demand in 1997, with the countries worst affected by the crisis accounting for only 7% in 1997. Western mine production is to increase by about 5.8% in 1998 due to increased production at the Galmoy Mine in Ireland, the Red Dog Mine in the United States, and the reopening of the Bougrine Mine in Tunisia. Future increases are to come from opening of the Lisheen Mine in Ireland, the Pillara Mine in Australia, and increased production at the Red Dog Mine. Western production of refined metal is to increase by 15.5% over the next 3 years as a result of expansion (Valleyfield in Canada, Cajamarquilla in Peru, Onsan in Korea, and Kokkola in Finland) and construction of a new facility (Townsville in Australia).

Continuous galvanizing remains the major market for zinc in the United States. Several new continuous galvanizing projects have been announced, totaling 4 million tons of steel, needing an additional 115,000 tons of zinc (Mining Journal, 1998a). Most of the additional zinc will come from the expanded Savage smelter in Clarksville, TN, augmented with imports, mostly from Canada and Mexico.

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[1]Prior to January 1996, published by the U.S. Bureau of Mines.

TABLE 1
SALIENT ZINC STATISTICS 1/

(Metric tons unless otherwise specified)

		1993	1994	1995	1996	1997
United States:						
Production:						
Domestic ores, contained zinc		513,000	598,000	644,000	628,000	632,000
Domestic ores, recoverable zinc		488,000	570,000	614,000	598,000 r/	605,000
Value, recoverable zinc	thousands	$497,000	$619,000	$756,000	$674,000 r/	$860,000
Refined zinc:						
From domestic ores		214,000	201,000	223,000	214,000	195,000
From foreign ores		26,000	15,600	8,840	11,400	31,700
From scrap		141,000	139,000	131,000	140,000	140,000
Total		382,000	356,000	363,000	366,000	367,000
Secondary zinc 2/		217,000	222,000	222,000	237,000 r/	228,000
Exports:						
Ores and concentrates (zinc content)		311,000	389,000	424,000	425,000	461,000
Slab zinc		1,410	6,310	3,080	1,970	3,630
Rolled zinc		6,600	6,680	5,180	5,020	9,110
Imports for consumption:						
Ores and concentrates (zinc content)		33,100	27,400	10,300	15,100	49,600
Refined (slab) zinc		724,000	793,000	856,000	827,000	876,000
Rolled zinc		135	475	332	16,900	19,200
Stocks of slab zinc, December 31:						
Producer		4,970	5,210	7,120	11,100	9,360
Consumer		61,600	64,600	64,400	58,400	61,000
Merchant		24,500 r/	23,900 r/	20,400 r/	18,800 r/	18,500
Total		91,000 r/	93,700 r/	92,000 r/	88,300 r/	88,900
Government stockpile		326,000	286,000	272,000	257,000	225,000
Consumption:						
Refined zinc:						
Reported		828,000	843,000	917,000	788,000	672,000
Apparent 3/		1,110,000 r/	1,180,000	1,230,000	1,210,000	1,280,000
All classes 4/		1,340,000	1,400,000	1,460,000	1,450,000	1,510,000
Price: Special High Grade, cents per pound		46.15	49.26	55.83	51.11	64.56
World:						
Production:						
Mine	thousand metric tons	6,910	7,050 r/	7,290 r/	7,490 r/	7,460 e/
Smelter	do.	7,360 r/	7,410 r/	7,450 r/	7,560 r/	7,740 e/
Price: London Metal Exchange, cents per pound		43.64	45.26	46.82	46.50	59.70

e/ Estimated. r/ Revised.

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

2/ Zinc in metal products and compounds derived directly from scrap; refined secondary zinc is listed separately in the table.

3/ Domestic production plus net imports, plus or minus stock changes.

4/ Apparent consumption of refined zinc plus reported consumption of zinc in metal products and compounds derived directly from ore, concentrate, or scrap.

TABLE 2
UNITED STATES, BY STATE 1/

(Metric tons)

State	1996	1997
Alaska 2/	331,000	376,000
Montana	19,400	21,500
Other 3/	248,000 r/	207,000
Total	598,000 r/	605,000

r/ Revised.

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

2/ Data in part based on publicly available information.

3/ Includes production from Colorado, Idaho, Illinois, Missouri, New York, and Tennessee.

TABLE 3
LEADING ZINC PRODUCING MINES IN THE UNITED STATES IN 1997, IN ORDER OF OUTPUT

Rank	Mine	County and State	Operator	Source of zinc
1	Red Dog	Northwest Arctic, AK	Cominco Alaska Inc.	Zinc ore.
2	Greens Creek	Southeastern, AK	Kennecott Mining Co.	Do.
3	Balmat	St. Lawrence, NY	Zinc Corporation of America	Do.
4	Elmwood-Gordonsville	Smith, TN	Savage Zinc Inc.	Do.
5	Young	Jefferson, TN	ASARCO Incorporated	Do.
6	Montana Tunnels	Jefferson, MT	Montana Tunnels Mining Inc.	Do.
7	Pierrepont	St. Lawrence, NY	Zinc Corporation of America	Do.
8	Cumberland	Smith, TN	Savage Zinc Inc.	Do.
9	Casteel 1/	Iron, MO	The Doe Run Co.	Lead ore.
10	Buick	do.	do.	Do.
11	Immel	Knox, TN	ASARCO Incorporated	Zinc ore.
12	Clinch Valley	Grainger, TN	Savage Zinc Inc.	Do.
13	Leadville Unit	Lake, CO	ASARCO Incorporated	Do.
14	Coy	Jefferson, TN	do.	Do.
15	Fletcher	Reynolds, MO	The Doe Run Co.	Lead-zinc ore.
16	West Fork	do.	ASARCO Incorporated	Do.
17	Viburnum No. 29	Washington, MO	The Doe Run Co.	Do.
18	Sweetwater	Reynolds, MO	ASARCO Incorporated	Do.
19	Lucky Friday	Shoshone, ID	Hecla Mining Co.	Do.
20	Viburnum No. 28	Iron, MO	The Doe Run Co.	Do.

1/ Includes Brushy Creek Mill.

TABLE 4
REFINED ZINC PRODUCED IN THE UNITED STATES 1/

(Metric tons)

	1996	1997
Primary:		
From domestic ores	214,000	195,000
From foreign ores	11,400	31,700
Total	226,000	227,000
Secondary	140,000	140,000
Grand total (excludes zinc recovered by remelting)	366,000	367,000

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

TABLE 5
REFINED ZINC PRODUCED IN THE UNITED STATES, BY GRADE 1/

(Metric tons)

Grade	1996	1997
Special High	111,000	110,000
Continuous Galvanizing	88,500	101,000
Other 2/	167,000	156,000
Total	366,000	367,000

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Includes High, Controlled Lead, and Prime Western grades.

TABLE 6
SLAB ZINC CAPACITY OF PRIMARY ZINC PLANTS IN THE UNITED STATES, BY TYPE OF PLANT AND COMPANY

(Metric tons)

Type of plant and company	Slab zinc capacity 1996	1997
Electrolytic:		
Big River Zinc Corp., Sauget, IL	82,000	82,000
Savage Zinc, Inc., Clarksville, TN	100,000	100,000
Electrothermic:		
Zinc Corp. of America, Monaca, PA 1/	146,000	146,000
Total operating capacity	328,000	328,000

1/ Includes secondary capacity.

TABLE 7
STOCKS AND CONSUMPTION OF NEW AND OLD ZINC SCRAP IN THE UNITED STATES IN 1997, BY TYPE OF SCRAP 1/

(Metric tons, zinc content)

Type of scrap	Stocks, Jan. 1	Receipts	Consumption: New scrap	Consumption: Old scrap	Consumption: Total	Stocks, Dec. 31
Diecastings	W	3,590	--	3,720	3,720	W
Flue dust	W	11,700	6,220	6,220	12,400	W
Galvanizer's dross	W	24,300	23,100	--	23,100	W
Old zinc 2/	W	W	--	W	W	W
Remelt die-cast slab	W	W	--	W	W	W
Remelt zinc 3/	24	W	W	--	W	W
Skimmings and ashes 4/	4,050	W	26,400	--	26,400	W
Other 5/	4,430	143,000	54,000	64,300	118,000	6,730
Total	8,500	182,000	110,000	74,300	184,000	6,730

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 engraver's plates and rod and die scrap.
3/ Includes new clippings.
4/ Includes sal skimmings and die-cast skimmings.
5/ Includes chemical residues and solutions, electrogalvanizing anodes, fragmentized diecastings, and steelmaking dust.

TABLE 8
PRODUCTION OF ZINC PRODUCTS FROM ZINC-BASE SCRAP IN THE UNITED STATES 1/

(Metric tons)

Products	1996	1997
Redistilled slab zinc	140,000	140,000
Other zinc metal products 2/	4,450	3,280
Zinc in chemical products	82,500	78,300
Zinc dust	24,500 r/	24,700

r/ Revised.
1/ Data are rounded to three significant digits.
2/ Includes electrogalvanizing anodes, remelt die-cast slab, and other metal alloys.

TABLE 9
ZINC RECOVERED FROM SCRAP PROCESSED IN THE UNITED STATES, BY TYPE OF SCRAP AND FORM OF RECOVERY 1/

(Metric tons)

	1996	1997
Type of scrap:		
New scrap:		
Zinc-base	110,000	107,000
Copper-base	156,000 r/	178,000
Magnesium-base	331	331 e/
Total	266,000 r/	286,000
Old scrap:		
Zinc-base	88,100	71,900
Copper-base	24,100 r/	15,900
Aluminum-base	821 r/	695
Magnesium-base	186	186 e/
Total	113,000 r/	88,800
Grand total	379,000	374,000
Form of recovery:		
Metal:		
Slab zinc	140,000	140,000
Zinc dust	24,500 r/	24,700
Total	165,000 r/	165,000
In brass and bronze	131,000 r/	128,000
In chemical products:		
Zinc oxide (lead free)	47,100	47,900
Zinc sulfate	27,300	20,300
Zinc chloride	2,730	W
Miscellaneous 2/	5,570 r/	13,400
Total	214,000 r/	209,000
Grand total	379,000	374,000

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Includes electrogalvanizing anodes, zinc content of slab made from remelt die-cast slab and other metal alloys.

TABLE 10
U.S. CONSUMPTION OF ZINC 1/

(Metric tons)

	1996	1997
Refined zinc, apparent	1,210,000	1,280,000
Ores and concentrates (zinc content)	1,670	1,020
Secondary (zinc content) 2/	237,000 r/	228,000
Total	1,450,000	1,510,000

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Excludes secondary slab zinc and remelt zinc.

TABLE 11
U.S. REPORTED CONSUMPTION OF ZINC IN 1997, BY INDUSTRY USE AND GRADE 1/

(Metric tons)

Industry use	Special High Grade	High Grade	Prime Western	Remelt and other grades	Total
Galvanizing	99,900	64,900	125,000	57,000	347,000
Zinc-base alloys	107,000	W	W	W	107,000
Brass and bronze	42,700	W	W	W	76,800
Other	69,500	23,800	81,600	271	141,000
Total	319,000	88,700	207,000	57,200	672,000

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.

TABLE 12
PRODUCED AND SHIPPED IN THE UNITED STATES 2/

(Metric tons)

	1996		1997	
	Production	Shipments	Production	Shipments
Zinc chloride	2,730	2,770	W	W
Zinc oxide	125,000	128,000	129,000	128,000
Zinc sulfate	30,000	29,200 r/	22,400	23,700

r/ Revised. W Withheld to avoid disclosing company proprietary data.
1/ Excludes leaded zinc oxide and lithopone.
2/ Data are rounded to three significant digits.

TABLE 13
REPORTED SHIPMENTS OF ZINC CONTAINED
IN ZINC OXIDE, BY INDUSTRY 1/ 2/

(Metric tons)

	1996	1997
Ceramics	4,950	5,670
Chemicals	26,200	27,100
Paints	5,430	5,610
Rubber	86,400	84,600
Other 3/	5,010	4,950
Total	128,000	128,000

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ In addition, zinc contained in zinc oxide was imported as follows: 1996-45,034 and 1997-49,939; distribution cannot be distinguished by industry.
3/ Includes agriculture and photocopying.

TABLE 14
U.S. EXPORTS OF ZINC ORES AND CONCENTRATES, BY COUNTRY 1/

	1996		1997	
	Quantity (metric tons, zinc content)	Value (thousands)	Quantity (metric tons, zinc content)	Value (thousands)
Belgium	61,100	$40,000	94,100	$81,800
Canada	178,000	64,900	179,000	125,000
China	9,140	4,380	--	--
Germany	--	--	32,800	25,100
Japan	47,300	20,000	79,000	44,700
Korea, Republic of	46,100	22,000	20,200	15,600
Netherlands	60,200	28,800	25,300	19,500
Spain	19,800	5,630	18	27
United Kingdom	2,230	2,570	24,100	11,300
Other	1,210 r/	1,440 r/	6,860	3,290
Total	425,000	190,000	461,000	326,000

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

Source: Bureau of the Census.

TABLE 15
U.S. EXPORTS OF ZINC COMPOUNDS 1/

	1996		1997	
	Quantity (metric tons, gross weight)	Value (thousands)	Quantity (metric tons, gross weight)	Value (thousands)
Lithopone	319	$2,040	49	$292
Zinc chloride	1,470	1,230	2,780	1,880
Zinc compounds, n.s.p.f.	1,250	4,670	1,470	5,490
Zinc oxide	5,770	9,430	6,700	11,600
Zinc sulfate	5,230	2,970	5,800	3,360
Zinc sulfide	112	1,410	162	188

1/ Data are rounded to three significant digits.

Source: Bureau of the Census.

TABLE 16
U.S. IMPORTS FOR CONSUMPTION OF ZINC COMPOUNDS 1/

	1996		1997	
	Quantity (metric tons, gross weight)	Value (thousands)	Quantity (metric tons, gross weight)	Value (thousands)
Lithopone	1,080	$1,030	1,240	$1,330
Zinc chloride	2,420	2,140	2,110	1,570
Zinc compounds, n.s.p.f.	1,190	1,280	294	686
Zinc oxide	56,300	57,500	62,400	72,700
Zinc sulfate	4,050	2,840	7,090	4,000
Zinc sulfide	517	4,240	449	3,050

1/ Data are rounded to three significant digits.

Source: Bureau of the Census.

TABLE 17
ZINC: WORLD MINE PRODUCTION (CONTENT OF CONCENTRATE AND DIRECT SHIPPING ORE UNLESS NOTED), BY COUNTRY 1/ 2/

(Metric tons)

Country	1993	1994	1995	1996	1997 e/
Algeria	6,800 r/	5,700 r/	7,174 r/	5,912 r/	6,000
Argentina	31,395	26,933	32,104	31,093 r/	31,100
Australia	1,010,000	995,000	937,000	1,071,000	1,036,000 3/
Austria e/	20,014 3/	--	--	--	--
Bolivia	122,638	100,742	146,131	145,092 r/	146,000
Bosnia and Herzegovina e/	350	300	300	300	800
Brazil	171,800	177,565 r/	188,472 r/	117,343 r/	120,000
Bulgaria	30,000 r/	29,000 r/	26,000 r/	19,800	20,000
Burma	850	1,316	721	572 r/	400
Canada	1,004,367 r/	1,010,712 r/	1,121,172	1,235,274	1,060,000 3/
Chile	29,435	31,038	35,403 r/	36,004 r/	33,934 3/
China e/	775,000	990,000	1,010,000	1,120,000 r/	1,200,000
Colombia	279	275	275 e/	275	275
Congo (Kinshasa) e/ 4/	6,830 r/	100 r/	--	--	--
Czech Republic e/	1,500	100	--	--	--
Ecuador e/	33 r/ 3/	100	100	100	100
Finland	22,529	16,916	16,385 r/	25,700 r/	30,800 3/
France e/	13,834 3/	1,000	--	--	--
Georgia e/	1,500	1,000	700	500	500
Greece	24,854 r/	17,200 r/	14,500 r/ e/	13,602 r/	17,800
Honduras	18,256	16,697	26,213	25,325	25,500
India	156,300	147,300	154,500	148,200	142,000 3/
Iran	77,000	72,900	145,100	75,600	75,000
Ireland	193,700	195,000 e/	184,118	164,168	194,796 3/
Italy	7,404 r/	13,902 r/	15,140 r/	14,000 r/	11,800
Japan	118,599	100,653	95,274	79,709	71,569 3/
Kazakstan e/	250,000	190,000	225,000	225,000	225,000
Korea, North e/	210,000	210,000	210,000	210,000	210,000
Korea, Republic of	13,808	7,122	7,747	8,384	8,992 3/
Macedonia e/	15,000 r/	15,000 r/	15,000 r/	15,017 r/ 3/	15,000
Mexico	369,697	381,689	363,658	377,599	379,252 3/
Morocco	65,378 r/	76,800 r/	79,947	79,662	89,248 3/
Namibia	28,380	33,414	30,209	35,873 r/	40,519 3/
Norway	27,469 r/	30,117 r/	18,995 r/	17,182 r/	17,000
Peru	664,045	690,017	692,250	760,563	865,267 3/
Poland	150,900	151,000	154,500	159,000 r/	155,000
Romania	28,017	35,357	34,730 r/	32,082 r/	29,366 3/
Russia	154,000 r/	147,000 r/	131,000 r/	126,000 r/	121,000
Saudi Arabia e/	542 r/ 3/	500 r/	500 r/	500 r/	500
Serbia and Montenegro	1,910 r/	1,609	3,195	5,500 r/	5,000
Slovakia e/	2,900 r/	2,800 r/	2,800 r/	2,800 r/	2,800
South Africa	77,096	76,361	70,241 r/	76,853	71,062 3/
Spain	169,892	150,425	172,469	140,100 r/	171,800 3/
Sweden	168,617	159,858	167,090 r/	160,325 r/	150,000
Thailand e/	70,000	55,000 r/	21,000 r/	28,500 r/	14,000
Tunisia	1,350 r/	13,000 r/	44,244	31,920	2,967 3/
Turkey e/ 5/	20,500 r/	26,300 r/	9,120 r/	12,000 r/	12,000
United States	513,000	598,000	644,000	628,000 3/	632,000 3/
Uzebekistan e/	35,000	30,000	15,000	12,000	3,000
Vietnam e/	15,000	15,000	15,000	15,000	15,000
Zambia 6/	16,704	--	--	--	--
Total	6,910,000	7,050,000 r/	7,290,000 r/	7,490,000 r/	7,460,000

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/ Table includes data available through July 1, 1998.

3/ Reported figure.

4/ Formerly Zaire.

5/ Content in ore hoisted.

6/ Data are for years beginning April 1 of that stated. Content of ore milled. Mine closed June 1994.

TABLE 18
ZINC: WORLD SMELTER PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country	1993	1994	1995	1996	1997 e/
Algeria, primary and secondary e/	33,400 r/	30,000 r/	30,000 r/	25,000 r/	25,000
Argentina:					
Primary	31,070 r/	35,214 r/	35,767 r/	36,392 r/	36,400
Secondary e/	2,500 r/	2,800 r/	2,800 r/	2,900 r/	2,800
Total	33,570 r/	38,014 r/	38,567 r/	39,292 r/	39,200
Australia:					
Primary 3/	316,000	323,000	320,000	326,000	307,000 4/
Secondary e/	4,500	4,975 4/	4,500	4,500	10,000
Total e/	321,000	327,975 4/	325,000	331,000	317,000
Austria, primary and secondary	6,838	--	--	--	--
Belgium, primary and secondary	299,600	306,200	301,100	234,400 r/	244,000
Brazil:					
Primary	187,550 r/	187,000 r/ e/	198,976 r/	177,466 r/	178,000
Secondary e/	7,200 4/	7,000	7,000	7,000	7,000
Total	194,750 r/	194,300 r/	205,976 r/	184,466 r/	185,000
Bulgaria, primary and secondary	54,039	64,005 r/	68,796 r/	68,018 r/	70,420 4/
Canada, primary	659,881	690,965	720,346	715,553	701,000 4/
China, primary and secondary e/	857,000	1,010,000	1,080,000	1,180,000 r/	1,400,000
Congo (Kinshasa), primary e/ 5/	4,150	1,000	--	--	--
Czech Republic, secondary e/	1,070 4/	1,000	1,000	1,000	1,000
Finland, primary	170,934	173,000 e/	176,600	176,300 r/	176,000 4/
France, primary and secondary e/	310,000	306,000 r/	300,000 r/	324,300 r/ 4/	317,200 4/
Germany, primary and secondary	380,948	359,878	322,460 r/	327,015 r/	251,700 4/
Hungary, secondary	1,000 e/	--	--	--	--
India:					
Primary	141,700	156,400	146,500	143,600	159,000
Secondary e/	24,000 r/	24,000 r/	24,000 r/	24,000 r/	24,000
Total e/	166,000 r/	180,000 r/	171,000 r/	168,000 r/	183,000
Italy, primary and secondary	182,000 r/	203,600 r/	180,400 r/	269,000 r/	227,700 4/
Japan:					
Primary	609,272 r/	571,880 r/	573,912 r/	500,674 r/	500,603 4/
Secondary	135,297 r/	141,154 r/	137,139 r/	141,593 r/	149,475 4/
Total	744,569 r/	713,034 r/	711,051 r/	642,267 r/	650,078 4/
Kazakstan, primary and secondary	263,000 r/	238,000 r/	168,300	168,500	170,000
Korea, North, primary e/	200,000	200,000	200,000	200,000	200,000
Korea, Republic of, primary	272,000 e/	271,110	279,335	286,526	335,488 4/
Macedonia, primary and secondary	22,611 r/	24,205 r/	21,335 r/	20,000 r/ e/	20,000
Mexico, primary	209,900	209,200	222,748	221,736	231,444 4/
Netherlands, primary 6/	206,700	212,600	206,300	207,100 r/	201,100 4/
Norway, primary	129,192	131,921	121,576	134,900 r/	137,400 4/
Peru, primary	157,000	182,000	158,987	173,139 r/	166,105 4/
Poland, primary and secondary	149,107 r/	154,400 r/	162,700 r/	163,100 r/	165,000
Portugal, primary e/	3,500	4,200	4,000 r/	3,600 r/	3,600
Romania, primary and secondary	14,100	18,500	29,300 r/	27,800 r/	25,000
Russia: e/					
Primary	170,000 r/	110,000 r/	135,000 r/	140,000 r/	155,000
Secondary	33,000 r/	27,800 r/	31,000 r/	32,000 r/	30,000
Total	203,000 r/	138,000 r/	166,000 r/	172,000 r/	185,000
Serbia and Montenegro, primary and secondary	6,985	3,895	5,976	29,954 r/	29,454 4/
Slovakia, secondary e/	1,000	1,000	1,000	1,000	1,000
Slovenia, primary and secondary e/	2,500	2,500	2,500	2,000	2,150
South Africa, primary	96,154	93,850	98,782	101,000 r/	108,000 4/
Spain, primary and secondary	341,600	294,700	358,000	360,800 r/	364,200 4/
Thailand, primary	65,000 e/	58,513	46,398	59,738 r/	60,000
Turkey, primary	18,500	18,567	17,050	22,392 r/	32,000 4/
Ukraine, secondary e/	15,000	14,000 r/	5,000	2,000	2,000

See footnotes at end of table.

TABLE 18
ZINC: WORLD SMELTER PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country	1993	1994	1995	1996	1997 e/
United Kingdom, primary and secondary	102,391	101,300	105,998	96,867	108,000
United States:					
Primary	240,000	217,000	232,000	226,000	227,000 4/
Secondary	141,000	139,000	131,000	140,000	140,000 4/
Total	382,000	356,000	363,000	366,000	367,000 4/
Uzbekistan, primary e/	65,000	70,000	70,000	40,000	35,000
Vietnam, primary e/	10,000	10,000	10,000	10,000	10,000
Zambia, primary 7/	3,450 r/	--	--	--	--
Grand total	7,360,000 r/	7,410,000 r/	7,450,000 r/	7,560,000 r/	7,740,000
Of which:					
Primary	3,970,000 r/	3,930,000 r/	3,970,000 r/	3,900,000 r/	3,960,000
Secondary	366,000 r/	363,000 r/	344,000 r/	356,000 r/	368,000
Undifferentiated	3,030,000 r/	3,120,000 r/	3,130,000 r/	3,300,000 r/	3,420,000

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/ Wherever possible, detailed information on raw material source of output (primary--directly from ores, and secondary--from scrap) has been provided. In cases where raw material source is unreported and insufficient data are available to estimate the distribution of the total, that total has been left undifferentiated (primary and secondary). To the extent possible, this table reflects metal production at the first measurable stage of metal output. Table includes data available through July 1, 1998.

3/ Excludes zinc dust.

4/ Reported figure.

5/ Formerly Zaire.

6/ Sales.

7/ Data are for years beginning April 1 of that stated. Imperial smelter production ceased in March 1993. Electrolytic production was suspended January 1991 to March 1993 and ceased in January 1994.