

# ZINC

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In 1998, domestic zinc mine production, expressed in zinc content of ore, increased by nearly 20% from that of 1997 mainly because of increased production at the Red Dog Mine in Alaska (table 1). Estimated from the recoverable content and the annual average U.S. price, the value of zinc mine production was about \$819 million. Zinc was extracted from 20 mines in 7 States by 8 mining companies (tables 2 and 3). For the eighth consecutive year, Alaska was the leading zinc mining State, followed by, in descending order, Tennessee, New York, and Missouri. In 1998, as in every year since the opening of the Red Dog Mine in 1989, U.S. mine production greatly exceeded smelter capacity (table 6), necessitating exports of concentrate. About one-third of all exports, supplied entirely by the Red Dog Mine, was trucked to the Trail smelter in Canada, with the remaining two-thirds, supplied by Red Dog and other domestic mines, going mainly to Asian markets (table 14). In 1998, zinc metal production by the three primary smelters (table 6), mostly from domestic concentrate, increased by about 3% (table 4).

In 1998, apparent consumption of refined zinc increased by 2%. Of the total refined zinc metal consumed in the United States, about one-half was used in galvanized products, followed by use in zinc-base alloys and in brass and bronze (table 11). Zinc compounds and dust were used principally by the agricultural, chemical, paint, and rubber industries.

The average U.S. producer price for 1998, based on the London Metal Exchange (LME) daily cash price plus premium, declined by more than 20%.

Although world mine production remained essentially unchanged in 1998, zinc metal production increased by nearly 5%. The largest producers of zinc concentrate, in order of magnitude, were China, Australia, Canada, Peru, and the United States (table 17). The largest producer of zinc metal was China, followed by Canada, Japan, the Republic of Korea, Spain, and the United States (table 18). In 1998, total world reserves amounted to about 190 million metric tons (Mt) of contained zinc.

## Legislation and Government Programs

A U.S. Supreme Court ruling on June 25, 1998, that dealt with universal statutory retroactivity may help ASARCO Incorporated avert a potentially massive Superfund cleanup cost sought by the Federal Government, the State of Idaho, and the Coeur d'Alene Tribe through the U.S. District Court in Idaho. Asarco claimed that the Superfund law is unconstitutional when applied to activities that had taken place well before the law was enacted in 1980. At the District Court, it was seeking

a partial summary judgment that would release Asarco from nearly \$1 billion in cleanup costs in the Coeur d'Alene area in Idaho's Silver Valley, which was once the center of U.S. silver mining (American Metal Market, 1998b).

A million-dollar land exchange between Kennecott Greens Creek Mining Co. and the U.S. Department of Agriculture took place in August 1998. Greens Creek received subsurface rights to more than 3,000 hectares (ha) of land immediately adjacent to its mine on Admiralty Island, AK, in exchange for about 76 ha of private holdings for inclusion in the Tongass National Forest in Alaska. Under the agreement, the United States retained surface rights and was to receive royalties from mineral sales from the exchanged land. Upon completion of mining operations and reclamation, all the land currently owned or yet to be acquired will revert to the U.S. Government. Greens Creek is a joint venture between Kennecott Minerals Co. (70.3%) and Hecla Mining Co. (29.7%) (American Metal Market, 1998a).

## Production

**Mine Production.**—Alaska produced more than one-half of the total U.S. production of zinc concentrate, most of which was supplied by the Red Dog Mine, 145 kilometers (km) northeast of Kotzebue. The mine was owned by NANA Regional Corp. and leased to Cominco Alaska Inc., a subsidiary of Cominco Ltd. of Canada. During 1998, the amount of ore milled and the metal content of the ore increased by 30% and 5.4%, respectively. Production of concentrate was 798,800 metric tons (t), a 31% increase from that of 1997. Although icy conditions delayed shipments of concentrate until the first week of July, Cominco Alaska shipped a record amount, 760,000 t, of concentrate in 1998. The record output was the result of the Production Rate Increase (PRI) project that was completed in the second quarter of 1998 and achieved full capacity in September 1998. With the completion of the PRI project, annual production was expected to exceed 900,000 t of zinc concentrate and 150,000 t of lead concentrate in 1999 (Cominco Ltd., February 4, 1999, Cominco Ltd. reports fourth quarter and annual results for 1998, news release, accessed April 26, 1999, at URL <http://www.cominco.com/news-info/NEWS/99archive/99-001-C.html>). New mineralization, of yet unknown quantity, was discovered below the Paalaaq deposit. Because of low zinc prices in 1998, annual profit declined to \$60 million from \$102 million in 1997, despite a 11% reduction in unit operating cost (Cominco Ltd., [no date], Operations, Red Dog Mine, accessed April 26, 1999, at URL <http://www.cominco.com/Ops/reddog/reddog.html>).

The second half of 1998 proved to be a troubled period for Savage Zinc Inc., the wholly owned subsidiary of Australian-based Savage Resources Ltd. First, the strike by 211 union members at the Gordonsville Mine in Tennessee that began on August 3 over health care for retired workers, pensions, and use of contractors continued until nearly the end of 1998.

Although production continued by salaried employees, output at the Gordonsville Mine was well below capacity. The shortfall was offset by outside purchases of concentrates and a temporary increase in production at Savage Zinc's Clinch Valley Mine, also in Tennessee. Consequently, according to Savage Zinc officials, the strike did not have a great impact on production at the company's nearby 105,000-ton-per-year (t/yr) Clarksville, TN, refinery, which itself underwent a scheduled 14-day maintenance shutdown of the roaster. The period of reduced production at the Gordonsville Mine was used for repairs and the digging of shafts to zinc deposits; both activities had been contracted out to outside mining companies, one of the reasons for the strike. After 2 months, production at Clinch Valley was suspended because of the low zinc price. Then, in addition to problems caused by strike, Savage Resources became the target of a hostile takeover by Pasminco Ltd. of Australia (Mining Journal, 1998l).

The combined production at Zinc Corporation of America's (ZCA) two mines was slightly lower than in 1997 owing to an ice storm in the beginning of 1998. New discoveries at the Balmat Mine, NY, increased ZCA's reserves by about 1 Mt. The Balmat beneficiation plant also processed the ore from the nearby Pierrepont Mine. Zinc concentrates, together with recycled zinc, were processed at ZCA's 146,000-t/yr refinery at Monaca, PA. More than two-thirds of the refinery's feed came from scrap, including electric arc furnace (EAF) dust from nearby steelworks. According to a spokesman for ZCA's parent company, Horsehead Resources Development Co., the supply of EAF dust was expected to grow by about one-third in the United States by 2015. EAF dust contains up to 25% zinc (Metal Bulletin, 1998m).

Asarco completed the sale of its Missouri lead-zinc operation to the Doe Run Co. for a sum in excess of \$55 million and royalty interest in the properties. The operation consisted of the Sweetwater and the West Fork underground mines and the Glover lead smelter and refinery complex (Metal Bulletin, 1998b). Production of zinc in concentrate at Asarco's four zinc mines near Knoxville, TN, increased by 9.2% compared with that of 1997 (ASARCO Incorporated, [no date], 1998 annual report, accessed May 5, 1999, at URL <http://www.asarco.com/AnnualReport98/metals.html>).

Exploratory drilling in the vicinity of the Montana Tunnels Mine in Montana continued in 1998. The property, located in Jefferson County and owned by Pegasus Gold Corp., a subsidiary of Canada's Pegasus Gold Inc., comprised 3,490 ha. Because of the new drilling, the proven and probable reserves that reportedly amounted to 17.6 Mt grading 0.2% lead, 0.6% zinc, 0.55 gram per ton (g/t) gold, and 10.63 g/t silver at the end of 1997 should increase (Mining Record, 1998b).

Rio Algom Mining Corp. of Canada bought the remaining 50% interest in the Crandon Mining Co. from Exxon Minerals Co. and created a new subsidiary, Nicolet Minerals Co. With

this purchase, Rio Algom became the sole owner of the zinc-copper deposit near Rhinelander-Crandon, WI. The deposit reportedly comprised 30 Mt grading 9.4% zinc, 0.4% copper, and small amounts of lead (Mining Journal, 1998n). The ore body is about 2 km long and 60 meters (m) wide. The originally scheduled opening of the mine, set for the second half of 1998, proved to be too optimistic. The delayed opening further fueled the controversy surrounding this project. The proposed mine, located at the headwaters of the Wolf River, would require constant pumping of underground water to keep the shafts dry and safe for mining. Opponents of the project have claimed that this drawdown effect may deplete the underground water reservoir for several square kilometers, eventually altering flow to surface wetlands, lakes, streams, and wells. Despite the opposition, Rio Algom was optimistic that "one of the better zinc resources remaining in the United States" will be used. At full capacity, the underground mine is expected to produce about 2 million metric tons per year (Mt/yr) of ore yielding between 200,000 t/yr and 300,000 t/yr of zinc concentrate and about 20,000 t/yr of combined copper-lead concentrate (Al Gedicks, Wisconsin Stewardship Network, [no date], Update—The Exxon/Rio Algom Mine controversy, accessed March 17, 1998, at URL <http://www.wsn.org/crandon/SOCIMAGN2.html>).

**Smelter and Refinery Production.**—The \$400 million expansion of the Clarksville smelter, announced at the beginning of May by Savage Resources and approved by the board of directors in September 1998, was expected to begin in April 1999. Under the expansion, smelting capacity was to increase to 300,000 t, slightly higher than originally planned in 1997. The near tripling of capacity would have allowed Savage Zinc to supply about one-quarter of U.S. zinc consumption by 2001. Savage Zinc believed that it had a market, mostly in galvanizing, of about 1 Mt, within an overnight deliverable distance from the smelter (Metal Bulletin, 1998j). Before any work could begin, Savage Resources had to fight a takeover attempt by Pasminco, submitted on October 20, 1998. By the beginning of 1999, the takeover was completed, and the smelter expansion was shelved. With the ownership of the Clarksville smelter, Pasminco gained additional capacity to process concentrates from its future Century Mine in Australia and established a foothold in North America (Metal Bulletin, 1998i).

Kvaerner Metals Corp. was awarded a \$148 million contract by CalEnergy Minerals LLC for the design and construction of a plant for the recovery of zinc from geothermal brines. CalEnergy operated geothermal plants in Imperial Valley, CA, and decided that extraction of zinc from brines could provide additional income. The new technology used a number of proven technologies but links them in a novel way. Brine that has been used for power generation will first pass through an ion-exchange plant instead of being pumped directly to reinjection wells. Through reverse osmosis, this plant will then produce a zinc concentrate solution that will go through solvent extraction and electrowinning to produce zinc cathodes for remelting in a casting facility. The operation, the commissioning of which should begin by the middle of 2000, was expected to yield about 30,000 t/yr of zinc (Mining

Journal, 1998k).

**Secondary Production.**—IMCO Recycling Inc., based in Irving, TX, acquired the privately owned U.S. Zinc Corp. for \$72 million. U.S. Zinc operated five production facilities in Illinois, Tennessee, and Texas, with a total capacity of about 100,000 t of scrap. With the new acquisition, IMCO became the world's largest zinc recycler and the second largest supplier of zinc oxide and zinc dust (American Metal Market, 1998c).

Metal Recovery Technologies Inc. was getting ready to begin commercial dezincing operations in its East Chicago, IN, plant. The \$3 million upgrade was reportedly completed in October, and full production was to start in February 1999. By using the new technology for which the company was issued a patent in July, the plant will have capacity to process about 115,000 t of galvanized steel scrap yielding 2,600 to 2,700 t/yr of 99.8% pure zinc powder. The most likely users of the zinc powder will be the spray galvanizing and paint industries (Metal Bulletin, 1998f).

**Exploration.**—Grayd Resource Corp. of Canada continued successful exploration in the Bonnifield District, 88 km south of Fairbanks, AK. In 1997, Grayd completed 3,935 m of diamond drilling in 37 holes in the Fosters Creek zone of the Dry Creek property. Four holes intersected mineralization containing 7% to 16% zinc, plus copper, gold, lead, and silver. The 1998 drilling program began in May, and by yearend, 3,600 m had been drilled. All holes drilled in 1998 intersected massive sulfide mineralization containing an average of about 6% zinc. In June, Grayd also began drilling on the nearby Anderson Mountain property, 29 km southwest of Dry Creek (Northern Miner, 1998e).

## Consumption

Of the major consuming regions of the world, Asia, which used 41% of refined zinc metal, was the largest; Europe was second with 32%, and the Americas, third with 25%. The United States was by far the largest individual consuming country, followed by China and Japan (American Metal Market, 1999).

Most of the increase in zinc consumption in the United States was in hot dip galvanizing; this was the result of an increased use of galvanized steel in residential framing and an expected future increase in galvanized steel roofing. Despite the recent growth in construction-related galvanizing lines, the capacity of steelworks serving automotive and consumer durable markets remained in first place, totaling about 16 Mt compared with 10 Mt for construction and related markets. The growing market for sport utility vehicles should increase zinc consumption because most of the up to 20 kilograms (kg) of zinc typically used per vehicle was for coating steel.

## Stocks

The stock levels in Western countries, with the exception of producer stocks, continued to fall in 1998 (table 1). The largest decline was registered by LME stocks, which fell by about 35%, to 317,100 t, in December. Consumer stocks, representing much lower quantities, fell by 30%, to 141,000 t; producer

stocks increased by about 16%, to 310,000 t.

## Prices

At the beginning of the year, experts forecasted a price increase enticed by the accelerating decline of LME stocks, lower Chinese exports, and a reduction in exports of concentrates from the Red Dog Mine caused by severe arctic weather in Alaska during the past winter. In addition, demand conditions remained buoyant in Europe and North America, mainly owing to the commissioning of new galvanizing capacities spurred by increased demand for galvanized steel. Contrary to the usual stock-price relation, however, zinc prices, as well as inventories, fell in 1998. The LME price was 22% lower in 1998 than that of 1997, and the average monthly price for North American Special High Grade zinc declined by 10% between January and December. The price fluctuated between the high of 54.38 cents per pound in April and the low of 47.91 cents in October.

## World Review

After a decline in 1997, Western mine production increased by 1.7% in 1998. Declines in Canada and Europe were more than offset by rises in Australia and the United States. The 20% increase of mine output in the United States was due mainly to increased production at the Red Dog Mine. With the opening of the Pillara Mine, Australian output rose by 2%, to 1.059 Mt, despite shortfalls at the Elura and Rosebery Mines and closure of the Woodlawn Mine. European production declined by 6% as the increase in Swedish output was more than outweighed by declines in production from the Galmoy Mine in Ireland, the suspension of operations at the Los Frailes Mine in Spain, and the closure of the Bleikvassli and the Grong Mines in Norway. South American output declined by 1% owing to the closure of the Vazante operations in Brazil, the suspension of operations at the El Toqui in Chile, and delayed shipments from Peru caused by the effects of El Niño. African mine production increased at the Hajjar Mine in Morocco and the reopened of the Bougrine Mine in Tunisia (table 17).

Production of refined zinc also rose in 1998, as a result of expansion at Cominco Ltd.'s Trail and Noranda Inc.'s Valleyfield refineries in Canada, the expansion of Korea Zinc Co. Ltd.'s Onsan plant, and the increase of mainly secondary production in Germany.

**Australia.**—Pasminco made an unsolicited cash offer for Savage Resources, another Australian mining company with interests in zinc, copper, gold, and coal. The offer, formally made on October 20, was for \$0.53 per share—42% more than the share price before takeover speculation began. Savage Resources resisted the attempted takeover by urging its shareholders to reject the \$279 million takeover offer, calling it opportunistic, timed to take advantage of low zinc prices. According to Savage Resources, the offer valued its 105,000-t/yr Clarksville zinc refinery significantly below the cost for a new smelter of the same capacity. In addition to its refinery, Savage Resources, through its Savage Zinc subsidiary, also owned two nearby zinc mines producing about 2 Mt of ore

containing more than 60,000 t of zinc (Platt's Metals Week, 1998b).

Production of zinc metal by Pasminco in fiscal year 1998 (ending June 30) was 518,961 t, slightly less than that of fiscal year 1997. The reason for the decline was a 5% decrease of production at the Hobart smelter caused by commissioning of new equipment and a smaller decline at the Port Pirie facility caused by the commissioning of a new lead refinery that adversely affected the affiliated zinc smelter (Mining Journal, 1998m). In addition to these smelters, Pasminco also operated the Cockle Creek smelter in New South Wales. Most of the concentrate for its three smelters was supplied by Pasminco's Broken Hill, Elura, and Potosi Mines in New South Wales and the Rosebery Mine in Tasmania. Broken Hill, the largest of these three mines, produced 326,556 t of zinc in concentrate in fiscal year 1998. It had 23.7 Mt of proven and probable reserves grading 8.1% zinc, 5.2% lead, and 51 g/t silver (Pasminco Ltd., [no date], 1998 annual report, accessed July 23, 1999, at URL

[http://www.pasminco.com.au/index.rsp?link\\_id=8.99](http://www.pasminco.com.au/index.rsp?link_id=8.99).

Continuing decline of output from the remaining mines, caused by depleting reserves, will be supplemented by the Century Mine in Queensland (Mining Journal, 1998e). Century, one of the world's largest zinc resources, contains about 118 Mt grading 10.2% zinc, 1.5% lead, and 36 g/t silver (Mining Journal, 1998l). Stripping operations began in May 1998, and mining was expected to start in August 1999. The Century open pit mine should be one of the world's largest zinc mines, producing 450,000 t/yr of zinc in concentrate.

Perth-based Western Metals Ltd. successfully reopened its underground Pillara (formerly Blendevale) Mine and processing plant in June 1998. Projected annual production of 170,000 t of zinc and 62,000 t of lead in concentrate, was based on proven reserves of 10.6 Mt at a grade of 8.1% zinc and 2.5% lead, and a mining rate of 2.4 Mt/yr. Pillara will replace the nearly exhausted Cadjebut Mine, whose concentrator will also supplement the new processing plant at Pillara. The main reason to keep the Cadjebut processing facilities, however, was the recent discovery of the Kutata deposit (previously known as Prices Creek) containing an estimated 2 Mt of ore grading 10.4% zinc, just 5 km from the plant (Metal Bulletin, 1997). To strengthen its zinc interest, Western Metals also secured a 98% interest in Aberfoyle Ltd., whose main assets included the Gunpowder property in Queensland and the Hellyer underground mine in Tasmania. Western Metals expected to produce 280,000 t of zinc during fiscal year 1999 from the Lennard Shelf operations (Goongewa, Kapok, and Pillara) in the Kimberley region of Western Australia, the newly acquired Hellyer Mine, and the future Gunpowder Mine (Mining Journal, 1998h). About 60% of Western's total output will be shipped to three of Korea Zinc's smelters—Onsan, Republic of South Korea, Big River in Sauget, IL, and a future smelter in Townsville, Queensland, Australia (American Metal Market, 1998d).

Australia's MIM Holdings Ltd. decided to proceed with the \$174 million development of the George Fisher deposit in Queensland. By mid-2000, it was expected to reach full production of 2.5 Mt/yr of ore, yielding 170,000 t of zinc in

concentrate and 100,000 t of lead and 150 t of silver in lead concentrate. The George Fisher Mine will replace the nearby Hilton and Mount Isa Mines, which will be depleted within the next 5 years. Ore from the new mine will be trucked to the Mount Isa concentrator, which is to be upgraded at a cost of \$40 million. The George Fisher Mine was said to have reserves of 24 Mt grading 9.1% zinc, 5.6% lead, and 128 g/t silver (Platt's Metals Week, 1998a). The reserves are contained in only 2 of the 11 known ore bodies and further resources of at least 70 Mt could be identified (Mining Journal, 1997). Although the annual production of zinc in concentrate at the Mount Isa Mine declined by 15% in 1998, the profitability of the operation increased by nearly 200% largely as a result of the cost reduction and productivity improvements. The McArthur River Mine in Northern Territory, 70% owned by MIM, improved production and profitability by 26% and 350%, respectively (Metal Bulletin, 1998g).

Denehurst Ltd.'s Woodlawn Mine in New South Wales was closed in March 1998 owing to depletion. It produced about 42,000 t of zinc, 9,400 t of lead, and 6,600 t of copper in concentrates, as well as some 14.5 t of silver and 48 kg of gold in 1998 (Metal Bulletin, 1998a).

**Canada.**—In the Canadian portions of the Appalachian Orogenic Belt, two important zinc-lead-copper volcanic massive sulfide mineralizations have been identified—Buchans, Newfoundland, and Bathurst, New Brunswick. The Buchans deposit amounts to 16.2 Mt grading 14.51% zinc, 7.56% lead, 1.33% copper, 126 g/t silver, and 1.37 g/t gold. At Bathurst, more than 30 deposits contained 250 Mt of ore of variable grading. Out of these 30, deposits only 2 were mined in 1998—Brunswick No. 12 and Heath Steele, both owned by Noranda Inc.

Brunswick No. 12, the larger of the two deposits, reportedly contained about 134 Mt grading 8.87% zinc, 3.6% lead, 0.3% copper, and 100 g/t silver. Production averaged about 250,000 t/yr of zinc in concentrate. The Heath Steele Mine reportedly contained more than 33 Mt grading 6.3% zinc, 2.5% lead, 0.7% copper, 60 g/t silver, and 0.62 g/t gold (Northern Miner, 1999). The ore from Heath Steele was trucked to the concentrator located at the site of the former Matagami Lake Mine. The same concentrator will be used for the future Bell Allard zinc-copper mine, which was expected to begin operation in mid-1999, less than a year before the Heath Steele Mine was expected to be depleted. Bell Allard was said to contain reserves of 3.2 Mt grading 13.8% zinc, 1.5% copper, and small amounts of silver and gold (International Lead and Zinc Study Group, 1996).

The Kidd Creek mineralization near Timmins, Ontario, was one of the premier zinc-copper deposits in Canada, reportedly containing proven and probable reserves of 32 Mt grading 5.67% zinc, 2.3% copper, and 62 g/t silver (Falconbridge Ltd., [no date], Kidd Creek at a glance, accessed April 26, 1999, at URL <http://www.falconbridge.com/bus/kidd.html>). Production at the Kidd Creek Mine was disrupted in 1998 when the movement of a large rock wedge caused water seepage into one of the pits. Falconbridge Ltd., majority owner of the mine, proposed to extend mining operations to the 2,500-m level. If approved, then the additional 7.14 Mt of reserves grading

6.93% zinc, 2% copper, and 48 g/t silver would extend the mine's life by 13 years, more than offsetting the loss of 1.7 Mt of reserves caused by the wedge movement. The construction could begin at the end of 1999, with production to come in 2004. Without the new addition, Kidd Creek's production would decline from the current (1998) 2.2 Mt of ore to about 0.8 Mt after 2005 (Metal Bulletin, 1998e).

Cominco's Canadian properties included the Polaris and the Sullivan Mines. Polaris, the world's most northerly based metal mine, located only 100 km from the North Pole on Little Cornwallis Island, the Northwest Territories, has been in operation since 1982. The underground mine, facilities, and related exploration properties are owned by Cominco (77.5%), the operator of the joint venture, and by Teck Corp. of Canada (22.5%). Recovery from the last remaining part of the ore body—the abutment pillar—was better than expected, resulting in a 15% increase of production and a \$23 million profit. Increased output in 1998 at the Sullivan Mine in Kimberley, British Columbia, compensated for decreasing ore grade. Because of reserves depletion, the Sullivan Mine is scheduled to cease production in 2001. Anticipating the closure of the Polaris and Sullivan Mines, Cominco had been preparing two replacement mines: the Sa Dena Hes and the Kudz Ze Kayah. The Sa Dena Hes Mine, 45 km north of Watson Lake, Yukon Territory, was jointly owned by Cominco and Teck. The underground mine ceased operation in November 1992 owing to low zinc prices. The minable proven and probable reserves on the property, covering about 5,600 ha, were estimated to be 1.3 Mt grading 10.1% zinc, 2.3% lead, and 43 g/t silver (Cominco Ltd., [no date], 1998 ore reserves + mineral resources, accessed July 8, 1999, at URL <http://www.cominco.com/EXPLORE/Oreaser.html>). Cominco's wholly owned Kudz Ze Kayah property, about 110 km southeast of Ross River, Yukon Territory, received its final environmental report in 1998. During the year, another deposit was discovered in the vicinity of Kudz Ze Kayah. The newly discovered deposit was estimated to contain minable reserves of 11.3 Mt grading 5.89% zinc, 1.52% lead, 0.93% copper, 133 g/t silver, and 1.34 g/t gold (Cominco Ltd., [no date], 1998 ore reserves + mineral resources, accessed July 8, 1999, at URL <http://www.cominco.com/EXPLORE/Oreaser.html>). Cominco also operated the Trail metallurgical complex in southwestern British Columbia. The 1998 production of 274,300 t of refined zinc was nearly 7% higher than that of 1997. Cominco's foreign interests in Peru include 82% ownership of the Cajamarquilla smelter-refinery, 13% ownership of Sociedad Minera Al Brocal S.A., and part ownership of the Bongara deposit.

The Faro area mining complex in the Anvil Mountain Range, Yukon Territory, consists of five deposits, all of which were owned by Anvil Range Mining Corp.—Faro, Grizzly, Grum, Swim, and Vangorda. The first two are depleted. Grum's proven and probable reserves at the end of 1996 was 21 Mt grading 4.28% zinc and 2.61% lead (Mining Journal, 1998c). Because of low zinc prices, the open pit operation was suspended in January 1998, preventing about 130,000 t of zinc in concentrate from reaching the market. The Grizzly deposit, which lies too deep for surface mining, was in an advanced

stage of exploration. The Swim deposit had not been developed by the end of 1998.

To conserve cash, Kit Resources Ltd. withdrew from purchasing the Izok Lake polymetallic property from Inmet Mining Corp. The Izok Lake deposit, in the Bathurst Inlet region of Canada's Northwest Territories, reportedly has proven and probable resources of 16.5 Mt grading 11.4% zinc, 2.2% copper, 1.1% lead, and 60 g/t silver (Northern Miner, 1998h). Despite the cancellation, Kit continued to seek financing for the project in hopes of making a new deal with Inmet. Because the mine could not operate as a stand-alone operation, owing to high transportation costs, Kit negotiated with Echo Bay Mines Ltd. to use its Lupin Mine processing facility and infrastructure for possible processing and shipment of Izok Lake concentrate.

In November 1998, Inmet Mining suspended milling operations at its Winston Lake Mine, near Schreiber on the northern shore of Lake Superior, Ontario, to develop the lower Pick Lake deposit. Reserves at the Lower Pick ore body, which in spring 1998 were estimated to contain 1.2 Mt grading nearly 16% zinc, proved, however, to be less than expected before the work began, and the development was abandoned (Northern Miner, 1998g).

In February 1998, Boliden Ltd. acquired the assets of Vancouver-based Westmin Resources Ltd. for about \$360 million, including the Myra Falls underground polymetallic zinc-copper mine on Vancouver Island, British Columbia. Because of poor ground conditions in the Battle and the Gap zones, Boliden decided to suspend operations in mid-December, probably until April 1999. Milling continued at 50% capacity to process stockpiled ore and to crush the waste rock for backfill. The suspension will allow Boliden to devote the mine's resources to carry out stoping and to rehabilitate and develop an access route, as well as to carry out maintenance work originally scheduled for early 1999 (Northern Miner, 1998f). At the end of 1996, minable reserves stood at 9.1 Mt grading 6.6% zinc, 1.5% copper, 28.6 g/t silver, and 1.4 g/t gold (Northern Miner, 1998b).

Atna Resources Ltd. and its new partner Boliden (through purchase of Westmin) announced a 17.5% increase of mineral resources at the Wolverine project, located in southeastern Yukon Territory. Resources reportedly amount to 6.2 Mt grading 12.66% zinc, 1.55% lead, 1.33% copper, 371 g/t silver, and small amounts of gold (Northern Miner, 1998a). Most of the tonnage (5.9 Mt) is in the main Lynx and Wolverine lenses.

In late 1997, Atna Resources reportedly intersected 25 m of massive sulfide mineralization grading 6.9% zinc, 2.8% lead, and 139 g/t silver on the Wolf property in southern Yukon Territory. According to an agreement with Cominco, the owner of the property, Atna can earn a 49% interest in the property by spending \$1 million for exploration (including 4,000 m of drilling) in 4 years and can increase its interest to 80% by spending an additional \$1 million. The company has committed to spend a minimum of \$150,000 for exploration in 1998 (Mining Record, 1998a).

Hudson Bay Mining and Smelting Co. Ltd., subsidiary of Minorco Inc., has reportedly discovered new reserves close to its mining operations centered in Flin Flon in northern

Manitoba. At the present rate of production (83,500 t of zinc in concentrate), the new discovery could extend mine life beyond the previously expected closure date of 2004. At the end of 1996, Hudson Bay reported reserves of 24.1 Mt grading 3.21% zinc and 1.45% copper, as well as measured, indicated, and inferred resources amounting to 16.9 Mt grading 5.1% zinc and 1.6% copper (Mining Journal, 1998j).

Foran Mining Ltd. of Canada will launch a drilling program on the McIlvenna Bay volcanogenic massive sulfide deposit in northeastern Saskatchewan, Canada, west of the historic Flin Flon camp. The main lens was estimated to contain a geological resource of about 13 Mt grading 5% zinc and 1.3% copper. Exploratory drilling on the nearby Thompson Bay property reportedly found a copper-zinc horizon 0.5 to 1.3 m wide and more than 800 m long grading 12% zinc (Northern Miner, 1998d).

**China.**—In the past, regulatory framework was widely regarded as the main hindrance to foreign investment in Chinese mining industry. Beginning with the 1997 amendment of the Mining Law of 1986, however, China enacted numerous changes that make foreign investment attractive to the international mining community. One of the changes involved separating ownership, which remained vested in the state, from rights for exploration and mining that can be acquired by domestic or, with certain reservation, foreign private parties. Foreign investment in mining was classified according to the type of mineral. The four categories are encouraged, permitted, restricted, and prohibited. Zinc was placed in the “encouraged” category. In addition, new Ministry of Land and Resources was created, entrusting it with the sole control over all mineral resources (Guanxi, 1998). When the reform is completed, the Government will retain control over only about 3,000 large- and medium-sized state-owned enterprises in diverse sectors, including the mineral industry.

Because of the weak zinc market in 1998, several major Chinese zinc producers decided to proceed with maintenance work ahead of schedule and to keep the smelters closed for longer periods of time than necessary. Consequently, expansion of mine production was slowed to about 1% in 1998, affecting mainly smaller mines, which were producing about 70% of all Chinese zinc ore. An additional consequence of the weak market was lower exports of zinc metal, which permitted buildup of strategic reserves that had been depleted in 1997 when China exported about 380,000 t of zinc (Metal Bulletin, 1998c).

**India.**—Hindustan Zinc Ltd. (HZL), the largest zinc producer in India, planned to build a new zinc smelter with an annual capacity of between 60,000 and 100,000 t. In 1998, India’s zinc production capacity was 180,000 t of primary zinc and about 50,000 t of secondary zinc. According to Government estimates, zinc consumption in India was expected to increase from 214,000 t in 1996 to 284,000 t by 2002, and to 380,000 t by 2007. The new smelter, India’s fifth, was expected to come on-stream in 2002. Feed for the new smelter would come from HZL’s Rampura-Agucha Mine in Rajasthan State, which increased production of ore from 3,000 to 4,500 metric tons per day (t/d) in 1998 (Minerals & Metals Review, 1997).

Binani Industries Ltd. planned to double the capacity of its existing smelter near Cochin to 60,000 t and to build a new lead-zinc smelter in Gujarat with an annual capacity of 100,000 t of zinc. Both projects were expected to be finished in 5 years. In 1998, most of the feed for Cochin was imported, mainly from Australia, through Western Metals (Metal Bulletin, 1998d).

**Ireland.**—At the end of January, a few months after production began at the underground Galmoy lead-zinc mine in County Kilkenny, a dispute between miners and Arcon International Resources plc forced the mine to suspend operations. The conflict was resolved on May 11 when both parties agreed to a 4-year contract covering basic pay, productivity-based incentives, working conditions, and some additional benefits. Arcon planned to produce about 150,000 t of concentrate at a zinc to lead ratio of 12 to 1 in 1998 (Metal Bulletin, 1998k). Modifications to the mill and processing plant in September allowed higher production, partially offsetting the \$2.4 million loss caused by the 14-week strike (Mining Journal, 1998i). Exploration since 1995 has increased the Galmoy Mine’s resources and reserves by more than 60% to about 10 Mt, thus extending the mine’s anticipated life from 10 to 15 years. The average grade of the additional reserves was nearly 15.5% zinc equivalent compared with about 13.5% for the original ore bodies (Mining Journal, 1998d).

Minorco Lisheen Ltd., a joint venture between Minorco SA and Ivernia West plc, chose Kvaerner Cementation Ltd. of Ireland to construct a lead-zinc concentrator, in addition to the previously awarded contract for development of underground facilities at the Lisheen Mine in County Tipperary. The \$49 million concentrator will have a capacity of 1.5 Mt/yr of ore and should be completed by late 1999 (Northern Miner, 1998i). About 70% of the future output had already been sold under long-term contracts, with the remaining 30% to be sold on the spot market.

The 19-month dispute between Tara Mines Ltd., a subsidiary of Finland’s Outokumpu Oy, and the workers at the Tara Mine was settled in February 1998. Although the actual terms of the agreement are not known, the company wanted a 14% reduction of cost and 25% increase of production, and workers wanted enhanced benefits. Because of the dispute, ore production in 1998 declined from 2.5 to 2.15 Mt (Metal Bulletin, 1998l).

**Kazakhstan.**—In October 1996, the Aktsionernoye Obshchestvo Kaztsink was created to unite Kazakhstan’s largest nonferrous producers. By the end of 1998, Kaztsink, in which Switzerland’s Glencore International AG held 62.4% interest and the Kazakh Government held a 23% interest, consisted of the Leninogorsk Integrated Metallurgical Combine, the Tekeli Mining and Beneficiation Plant, the Ust-Kamenogorsk Metallurgical Combine, and the Zyryanovsk Mining and Beneficiation Plant. In 1998, the mining capacity of Kaztsink was about 6 Mt of ore, and the smelter capacity stood at about 320,000 t/yr. The planned capacity increase of the Zyryanovsk concentrator by 1.3 Mt at a cost of \$16 million was to coincide with the expansion of the Maleyevsk open pit mine from 0.55 to 1.5 Mt by the end of 1999; the latter will cost an additional \$65 million, most of it supplied by Glencore

(Interfax-M&CN, 1998). Glencore also invested \$1.3 million on stripping and capital improvements at Tekeli. These improvements will bring the Tekeli's current production of about 360,000 t/yr of ore closer to the design capacity of 850,000 t/yr of ore and 29,600 t/yr of contained zinc in concentrate.

**Mexico.**—With an output of 50,750 t 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 1998. It was followed by the Bismark Mine (48,800 t) in Chihuahua State, owned by Industrias Peñoles S.A., Mexico's leading base metal producer, and IMMSA's San Martín Mine (44,700 t) in Zacatecas State. The next largest mines, the Real de Angeles and the Santa Bárbara, produced more than 30,000 t; production at the majority of Mexican zinc mines averaged around 20,000 t.

The Industrias Peñoles' Francisco I. Madero Mine in Zacatecas, now under construction, had reserves of 30 Mt grading 5.2% zinc and 1.1% lead. At full capacity, the mine will process ore at an annual rate of 3 Mt, with a production of about 100,000 t of zinc in concentrate. When full production is reached in 2002, it will be the largest zinc mine in Mexico.

Production at the Tizapa Mine, which increased by 14% in 1998, should further increase in coming years if the recently discovered additional reserves are mined. Prior to discovery of the additional reserves, the reserves amounted to 3.7 Mt grading 8.5% zinc, 1.3% lead, 250 g/t silver, and small amounts of gold (Flores, 1999). The Tizapa Mine, southwest of Mexico City, was owned by Industrias Peñoles (51%) and Dowa Mining Co. Ltd. of Japan (49%).

**Namibia.**—A joint venture of the United Kingdom's Reunion Mining plc (60%) and South Africa's Anglo American Corp. (40%) planned to build an integrated mining and refining operation producing about 150,000 t/yr of zinc metal from the Skorpion deposit in southwestern Namibia. Reserves were estimated to be 17.5 Mt grading 10.4% zinc in the proven category and 2 Mt at 7.6% in the probable category, giving a total of 19.5 Mt at 10.1% zinc. Mining would be from an open pit to a maximum depth of 180 m with a waste-to-ore ratio of 2.3 to 1 (Mining Journal, 1998o).

The protracted impasse over the ownership structure of the Rosh Pinah lead-zinc mine in southern Namibia was finally resolved. The agreement provided each partner, South Africa's Iron & Steel Corp. (Isacor) and PE Minerals Co., the Namibian minerals rights holder, with 50% equity in Rosh Pinah Zinc Corp. (Pty) Ltd., the new owner of the mine. Isacor will continue to operate the mine and will pay an undisclosed royalty to PE Minerals. The designed annual capacity of 50,000 t of contained lead and zinc in concentrate, should be reached by mid-1999. Ore reserves, grading from 6% to 7% zinc and from 1% to 2% lead, will be sufficient for another 10 years but could be extended with the development of additional reserves (Mining Journal, 1999b).

**Peru.**—Mining was one of the most important industries in Peru. It produced from 10% to 11% of Peru's gross domestic product and between 45% and 50% of its exports. By the end of 1998, about 97% of Peru's mining was in private hands (Phelps, 1999). The last big company to be privatized was the

Empresa Minera del Centro del Peru S.A. (Centromin).

The largest of Centromin's few remaining assets was the zinc-lead mine in Cerro de Pasco, now known by its sale name, Paragsha S.A., 200 km northeast of Lima. Glencore and Doe Run reportedly expressed interest in the mining complex, which comprised underground and open pit mines and two concentrators. The minimum base price was expected to be \$60 million plus an investment commitment of \$70 million within 5 years. The mine produced 210,309 t of zinc in concentrate, 72,488 t of lead in concentrate, and 227 t of silver in 1998 (Metal Bulletin, 1999b). Reserves amounted to 26 Mt grading 8.41% zinc, 2.92% lead, and 132 g/t silver (Metal Bulletin, 1999a). The main detriment for future mining was that the higher grade ore was situated below the town, which would have to be relocated. Because Cerro de Pasco is a long-standing mining community of about 90,000 inhabitants who were wholly dependent on mining, it will, in all likelihood, accept relocation.

One of the most significant sales in 1998, was that of the Antamina deposit. The original \$20 million purchase in July 1996 was made by Rio Algom, Ltd. and Inmet Mining, but the latter subsequently withdrew because its share of the total development cost was too large. Consequently, Inmet sold its stake to Noranda and Teck for \$70 million plus a 3.33% net-proceeds royalty. By yearend, Rio Algom and Noranda each held a 37.5% share of Compañía Minera Antamina, the Peruvian company that owned the project, and Teck held the remaining 25%. Located in the Andes, 380 km northeast of Lima, Antamina contained a minable resource of 500 Mt grading 1.2% copper, 1% zinc, 0.03% molybdenum, and 12 g/t silver amenable for open pit mining (Mining Journal, 1998b). Ore from the pit will pass, via a tunnel, to a 70,000-t/d concentrator comprising a single grinding mill, three ball mills, copper and zinc flotation cells, and a molybdenum and bismuth circuit. Concentrates will be trucked 360 km to port facilities to be built at Huarney.

Compañía San Ignacio de Morococha S.A. (Simsa), Peru's third largest zinc producer, produced about 800,000 t of ore at a cost of \$44.90 per ton at its San Vicente Mine in 1998. Proven and probable reserves were reported to be 6 Mt grading 9% zinc and 1% lead. To replenish reserves, Simsa invested \$2.5 million on exploration in the surrounding area (Platt's Metals Week, 1998c).

The annual capacity of the Cajamarquilla zinc smelter, 30 km from Lima, was expanded by 20,000 t, to 120,000 t, in May 1998. Work on doubling the present capacity, at a cost of \$350 million, was to start in 1999. The expansion, to be finished by the end of 2000, will include the addition of another roaster and acid plant, improvements to the leach purification section, and the construction of a new melting plant and cell house. The smelter was owned by Cominco (82%) and Marubeni Corp. of Japan (17%); the remaining 1% was held by the employees. In 1998, Cajamarquilla produced 113,000 t of zinc, 9.75% more than was produced in 1997 (Mining Journal, 1999a).

**South Africa.**—During 1998, extensive corporate restructuring took place in the mineral industry of South Africa. This restructuring involved the dismantling of Gold Fields of South Africa Ltd. and the merger of Anglo American

with Minorco, its 45.6% owned Luxembourg-based associate. Anglo American plc (AA), the newly merged company, was to be listed on the London stock market in 1999. Its zinc assets will include controlling interest in the Gamsberg deposit and the Black Mountain polymetallic mine in South Africa, and the Lisheen Mine in Ireland. In addition, AA planned to build a 200,000-t/yr smelter at the future Gamsberg mine site or elsewhere in the Northern Cape Province. Although Black Mountain was a mature operation, producing about 35,000 t/yr of zinc in concentrate, Gamsberg, only 22 km away, was not developed. It had an estimated reserve of 90 Mt grading 6.34% zinc. Although the development of the Gamsberg deposit was not an issue, market analysts believed that the local zinc concentrate production could not support a third smelter because all the existing mines in South Africa will likely be exhausted by 2005. In addition to an existing 105,000-t/yr smelter in Echo Springs, near Johannesburg, a new 250,000-t/yr smelter near Port Elizabeth was already in the final stages of acquiring all the necessary construction permits (Mining Journal, 1998a).

According to United Kingdom-based Billiton Holding Ltd. (40%) and South Africa's Industrial Development Corp. (35.5%), the remaining partners in the construction of the 250,000-t/yr Eastern Cape refinery, the originally planned 2003 production start for the estimated \$600 million project was now expected to be delayed. The project was part of a Government initiative to create employment opportunities in an area of high unemployment near Port Elizabeth. The refinery, mostly using imported concentrates, will be situated at a new deep-water port in Coega, east of Port Elizabeth (American Metal Market, 1998e).

**Spain.**—On April 24, a 50-m section of the tailings dam wall ruptured at Boliden's Los Frailes Mine in southern Spain, releasing nearly 7 million cubic meters of acidic water containing copper, iron, lead, sulfur, and zinc into the nearby Agrio River and vicinity. The probable cause of the dam failure that closed the mine for the rest of the year was the slippage along a shear zone, 15 to 20 m below the surface. By yearend, the cost for the cleanup and rehabilitation was \$17 million. Exploitation of the Los Frailes deposit, containing 46 Mt grading 3.8% zinc, 2.2% lead, 0.3% copper, and 60 g/t silver at the time of discovery in 1988, began in 1997 following the depletion of the nearby Aznalcollar deposit (Mining Journal, 1998p).

**Tunisia.**—The Bougrine zinc and lead mine resumed production in May and had reached full capacity of 50,000 t of zinc and 6,000 t of lead in concentrate by July, according to its new owner, Breakwater Resources Ltd. of Canada. The grades for zinc and lead averaged 9.06% and 1.71%, respectively. Future annual production was expected to average 88,000 t of zinc and 12,000 t of lead (Mining Journal, 1998f). Proven and probable reserves were estimated to be about 2.8 Mt, grading 12.2% zinc and 2.4% lead (Northern Miner, 1998c).

## Outlook

According to the International Lead and Zinc Study Group, world mine output is expected to increase annually by about 5%

in 1999 and 2000. This increase is expected to come from the opening of the Lisheen Mine in Ireland, reopening of the Pillara and opening Century Mines in Australia, the reopening of the Bougrine Mine in Tunisia, and increased production at the Galmoy Mine in Ireland and the Red Dog Mine in Alaska (Mining Journal, 1998g). By the time Red Dog and Century reach optimum capacity in 2001, they will be contributing the equivalent of 15% of current Western production (Mining Journal, 1998r). In addition, a number of smaller mines are scheduled to open in Africa, Asia, and South America. In later years, Peru's position as the fourth-largest zinc producer will be consolidated with the opening of the Antamina Mine. This increase of world production of zinc will be offset by the probable closing of numerous smaller mines, mainly in Australia (Broken Hill and Mount Isa), Canada (Flin Flon, Heath Steele, Isle Dieu, Matagami, Myra Falls, Polaris, Ruttan, Selbaie, Sullivan), and other countries. Beyond 2000, the concentrate production is less encouraging. Rising demand will outpace current levels of committed capacity by 2002. Current exploitable reserves are equivalent to 10 to 15 years of consumption. If new deposits are not found, then concentrate deficit will gradually develop, conceivably reaching a shortfall of 500,000 t by 2005 (Mining Journal, 1999c).

Output of refined metal is expected to grow by about 2% in 1999 and by 15% during the next 3 years (Mining Journal, 1998g). This increase in production is expected to come from expansion and debottlenecking at Cajamarquilla in Peru, Kokkola in Finland, Onsan in Korea, and Valleyfield in Quebec, and by use of a planned new smelter in Townsville, Australia. Some additional metal production will come from increased recovery of secondary zinc. The zinc content of EAF dust worldwide amounts to about 700,000 t/yr, of which only about 250,000 t is currently (1998) recovered. With the present technology, recycling of dust becomes profitable only if it contains more than 20% zinc. Recovery of the 350,000 t of zinc used in batteries is virtually nonexistent. Because of the long life cycle of many zinc-containing products, calculating the exact recovery rate of zinc is difficult. The amount of end-of-life zinc is estimated to be around 2.1 Mt, of which only about 1.4 Mt was recovered in 1998. The recovery rate of this old scrap could be increased with improved technology, mainly for recycling of EAF dust. Some of the other zinc-containing products will remain difficult to recycle owing to the low concentration of zinc in them (Metal Bulletin, 1998h).

Galvanizing will remain the primary driver for growth for the foreseeable future. It accounts for almost 50% of Western consumption compared with about 36% in 1967. This growth was caused by increased use of galvanizing in the automotive and construction industries. Usage in these sectors is expected to grow, particularly in developing countries where per capita consumption remains very low—0.6 kg in China, for example, compared with 4.8 kg in North America (Mining Journal, 1998r).

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

TABLE 1  
SALIENT ZINC STATISTICS 1/

(Metric tons unless otherwise specified)

	1994	1995	1996	1997	1998
<b>United States:</b>					
<b>Production:</b>					
Domestic ores, contained zinc	598,000	644,000	628,000	632,000	755,000
Domestic ores, recoverable zinc	570,000	614,000	600,000 r/	605,000	722,000
Value, recoverable zinc thousands	\$619,000	\$756,000	\$615,000 r/	\$860,000	\$819,000
<b>Refined zinc:</b>					
From domestic ores	201,000	223,000	214,000	195,000	192,000
From foreign ores	15,600	8,840	11,400	31,700	41,900
From scrap	139,000	131,000	140,000	140,000 r/	134,000
Total	356,000	363,000	366,000	367,000	368,000
Secondary zinc 2/	222,000	222,000	238,000 r/	234,000 r/	291,000
<b>Exports:</b>					
Ores and concentrates (zinc content)	389,000	424,000	425,000	461,000	552,000
Slab zinc	6,310	3,080	1,970	3,630	2,330
Rolled zinc	6,680	5,180	5,020	9,110	9,920
<b>Imports for consumption:</b>					
Ores and concentrates (zinc content)	27,400	10,300	15,100	49,600	46,300
Refined (Slab) zinc	793,000	856,000	827,000	876,000	879,000
Rolled zinc	475	332	16,900	19,200	16,900
<b>Stocks of slab zinc, December 31:</b>					
Producer	5,210	7,120	11,100	9,360	9,150
Consumer	64,600	64,400	59,700 r/	60,400 r/	69,900
Merchant	9,930 r/	6,440 r/	4,800 r/	34,000 r/	13,300
Total	79,700 r/	78,000 r/	75,600 r/	104,000 r/	92,400
Government stockpile	286,000	272,000	257,000	225,000	199,000
<b>Consumption:</b>					
<b>Refined zinc:</b>					
Reported	843,000	917,000	788,000	672,000	647,000
Apparent 3/	1,180,000	1,230,000	1,210,000	1,260,000 r/	1,280,000
All classes 4/	1,400,000	1,460,000	1,450,000	1,490,000 r/	1,580,000
Price: Special High Grade, cents per pound	49.26	55.83	51.11	64.56	51.43
<b>World:</b>					
<b>Production:</b>					
Mine thousand metric tons	7,050	7,280 r/	7,480 r/	7,530 r/	7,540 e/
Smelter do.	7,330 r/	7,440 r/	7,580 r/	7,850 r/	8,230 e/
Price: London Metal Exchange, cents per pound	45.26	46.82	46.50	59.70	46.45

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  
MINE PRODUCTION OF RECOVERABLE ZINC  
IN THE UNITED STATES, BY STATE 1/

(Metric tons)

State	1997	1998
Alaska 2/	376,000	487,000
Missouri	41,300	49,200
Montana	21,500	24,900
Other 3/	165,000	162,000
Total	605,000	722,000

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, New York, and Tennessee.

TABLE 3  
LEADING ZINC-PRODUCING MINES IN THE UNITED STATES IN 1998, IN ORDER OF OUTPUT

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

1/ Includes Brushy Creek Mill.

TABLE 4  
REFINED ZINC PRODUCED IN THE UNITED STATES 1/

(Metric tons)

	1997	1998
Primary:		
From domestic ores	195,000	192,000
From foreign ores	31,700	41,900
Total	226,000 r/	234,000
Secondary	140,000 r/	134,000
Grand total (excludes zinc recovered by remelting)	367,000	368,000

r/ Revised.

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	1997	1998
Special High	110,000	91,900
Continuous Galvanizing	101,000	105,000
Other 2/	156,000	171,000
Total	367,000	368,000

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

2/ Includes Controlled Lead, High, 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	1997	1998
Electrolytic:		
Big River Zinc Corp., Sauget, IL	82,000	85,000
Pasminco Ltd., Clarksville, TN	100,000	105,000
Electrothermic:		
Zinc Corporation of America, Monaca, PA 1/	146,000	155,000
Total	328,000	345,000

1/ Includes secondary capacity.

TABLE 7  
STOCKS AND CONSUMPTION OF NEW AND OLD ZINC SCRAP IN THE UNITED STATES IN 1998, BY TYPE OF SCRAP 1/

(Metric tons, zinc content)

Type of scrap	Stocks, January 1	Receipts	Consumption			Stocks, December 31
			New scrap	Old scrap	Total	
Diecastings	W	7,520	--	7,710	7,710	W
Flue dust	113	W	W	W	W	129
Galvanizer's dross	W	W	W	--	W	W
Old zinc 2/	W	208	--	186	186	W
Remelt die-cast slab	W	W	--	W	W	W
Remelt zinc 3/	475	W	W	--	W	580
Skimmings and ashes 4/	4,880	42,100	41,900	--	41,900	5,010
Other 5/	5,440 r/	182,000	122,000	60,600	182,000	5,190
Total	10,900 r/	232,000	164,000	68,500	232,000	10,900

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 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, fragmented diecastings, and steelmaking dust.

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

(Metric tons)

Products	1997	1998
Redistilled slab zinc	140,000 r/	134,000
Other zinc metal products 2/	3,240 r/	6,310
Zinc in chemical products	78,300	102,000
Zinc dust	24,700	19,600

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)

	1997	1998
<b>Type of scrap:</b>		
<b>New scrap:</b>		
Zinc-base	107,000	159,000
Copper-base	179,000 r/	184,000
Magnesium-base	331	331 e/
<b>Total</b>	<b>286,000</b>	<b>344,000</b>
<b>Old scrap:</b>		
Zinc-base	71,900	65,800
Copper-base	16,900 r/	15,700
Aluminum-base	695	718
Magnesium-base	186	186 e/
<b>Total</b>	<b>89,700 r/</b>	<b>82,400</b>
<b>Grand total</b>	<b>376,000 r/</b>	<b>427,000</b>
<b>Form of recovery:</b>		
<b>Metal:</b>		
Slab zinc	140,000 r/	134,000
Zinc dust	24,700	19,600
<b>Total</b>	<b>166,000 r/</b>	<b>154,000</b>
<b>In brass and bronze</b>	<b>129,000 r/</b>	<b>164,000</b>
<b>In chemical products:</b>		
Zinc oxide (lead free)	47,900	64,200
Zinc sulfate	20,300	12,400
Zinc chloride	W	W
Miscellaneous 2/	12,700 r/	31,700
<b>Total</b>	<b>210,000 r/</b>	<b>273,000</b>
<b>Grand total</b>	<b>376,000 r/</b>	<b>427,000</b>

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous."

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

2/ Includes electrogalvanizing anodes and zinc content of slab made from remelt die-cast slab.

TABLE 10  
U.S. CONSUMPTION OF ZINC 1/

(Metric tons)

	1997 r/	1998
Refined zinc, apparent	1,260,000	1,290,000
Ores and concentrates (zinc content)	1,010	1,020
Secondary (zinc content) 2/	234,000	291,000
<b>Total</b>	<b>1,490,000</b>	<b>1,580,000</b>

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 1998, BY INDUSTRY USE AND GRADE 1/

(Metric tons)

Industry use	Special High Grade	High Grade	Prime Western	Remelt and other grades	Total
Galvanizing	105,000	54,300	109,000	51,500	320,000
Zinc-base alloys	122,000	--	--	W	122,000
Brass and bronze	39,000	W	21,200	W	60,300
Other	64,800	18,500	61,000	258	145,000
Total	331,000	72,800	192,000	51,700	647,000

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  
ZINC CONTAINED IN PIGMENTS AND COMPOUNDS PRODUCED  
AND SHIPPED IN THE UNITED STATES 1/ 2/

(Metric tons)

	1997		1998	
	Production	Shipments	Production	Shipments
Zinc oxide	129,000	128,000	138,000	138,000
Zinc sulfate	22,300 r/	23,700	14,400	14,600

r/ Revised.

1/ Excludes leaded zinc oxide, lithopone, and zinc chloride.

2/ Data are rounded to three significant digits.

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

(Metric tons)

	1997	1998
Ceramics	5,670	6,070
Chemicals	27,100	26,200
Paints	5,610	7,130
Rubber	84,600	93,500
Other 3/	4,950	5,360
Total	128,000	138,000

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: 1997-49,900 and 1998-47,100; distribution cannot be distinguished by industry.

3/ Includes agriculture and photocopying.

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

	1997		1998	
	Quantity (metric tons, zinc content)	Value (thousands)	Quantity (metric tons, zinc content)	Value (thousands)
Belgium	94,100	\$81,800	117,000	\$56,000
Canada	179,000	125,000	179,000	71,400
Germany	32,800	25,100	33,000	14,600
Japan	79,000	44,700	60,400	31,500
Korea, Republic of	20,200	15,600	69,800	30,000
Netherlands	25,300	19,500	33,400	14,800
Russia	--	--	10,000	3,890
Spain	18	27	24,900	10,800
United Kingdom	24,100	11,300	20,900	12,200
Other	6,860	3,290	3,310	2,870
Total	461,000	326,000	552,000	248,000

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/

	1997		1998	
	Quantity (metric tons, gross weight)	Value (thousands)	Quantity (metric tons, gross weight)	Value (thousands)
Zinc chloride	2,780	\$1,880	1,940	\$1,290
Zinc compounds, n.s.p.f.	1,470	5,490	305	1,170
Zinc oxide	6,700	11,600	6,210	11,300
Zinc sulfate	5,800	3,360	4,380	2,780

1/ Data are rounded to three significant digits.

Source: Bureau of the Census.

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

	1997		1998	
	Quantity (metric tons, gross weight)	Value (thousands)	Quantity (metric tons, gross weight)	Value (thousands)
Lithopone	1,240	\$1,330	1,120	\$1,400
Zinc chloride	2,110	1,570	1,570	1,520
Zinc compounds, n.s.p.f.	-- r/	-- r/	4	7
Zinc oxide	62,400	72,700	58,900	60,100
Zinc sulfate	7,090	4,000	10,400	5,940
Zinc sulfide	-- r/	-- r/	--	--

r/ Revised.

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	1994	1995	1996	1997	1998 e/
Algeria	5,700	7,174	5,912	6,000 e/	6,000
Argentina	26,933	32,104	31,093	33,357 r/	35,560 3/
Australia	995,000	937,000	1,071,000	1,036,000	1,059,000 3/
Bolivia	100,742	146,131	145,092	154,491 r/	152,110 3/
Bosnia and Herzegovina e/	300	300	300	300	300
Brazil	177,565	188,472	117,343	152,636 r/	152,600
Bulgaria	29,000	26,000	19,800	20,000 e/	20,000
Burma	1,316	721	572	467 r/	490
Canada	1,010,712	1,121,172	1,222,388 r/	1,076,385 r/	1,057,011 3/
Chile	31,038	35,403	36,004	33,934	15,943 3/
China e/	990,300	1,011,000	1,120,000	1,200,000	1,100,000
Colombia e/	-- r/	-- r/	-- r/	-- r/	--
Congo (Kinshasa) e/ 4/	100	--	--	--	--
Czech Republic e/	100	--	--	--	--
Ecuador e/	100	100	100	100	100
Finland	16,916	16,385	26,294 r/	30,800	30,000
France e/	1,000	--	--	--	--
Georgia e/	1,000	700	500	500	500
Greece	17,200	14,500 e/	13,602	17,800 e/	20,700
Honduras	23,600 r/	27,100 r/	37,000 r/	39,500 r/	39,000 3/
India	147,300	154,500	148,200	142,000	143,000
Iran	72,900	145,100	75,600	77,000 r/	80,000
Ireland	195,000 e/	184,118	164,168	194,796	182,000
Italy	13,902	15,140	11,055 r/	8,470 r/	8,000
Japan	100,653	95,274	79,709	71,569	67,670 3/
Kazakhstan	190,000	225,000	225,000	225,000 e/	225,000
Korea, North e/	210,000	210,000	210,000	210,000	200,000
Korea, Republic of	7,122	7,747	8,384	8,992	10,488 3/
Macedonia e/	15,000	15,000	15,017 3/	15,000	8,000
Mexico	381,689	363,658	377,599	379,252	395,391 3/
Morocco	76,800	79,947	79,662	89,248	108,000
Namibia	33,414	30,209	35,873	40,519	37,000
Norway	30,117	18,985	17,182	9,000 r/	8,000
Peru	690,017	692,290 r/	760,563	865,267	868,958 3/
Poland	151,000	154,500	159,000	155,000 e/	155,000
Romania	35,357	34,730	32,082	29,366	30,000
Russia	147,000	131,000	126,000	121,000 e/	115,000
Saudi Arabia e/	500	500	500	619 r/ 3/	600
Serbia and Montenegro	1,609	3,195	5,500	5,000 e/	7,000
Slovakia e/	2,800	2,800	2,800	2,800	2,800
South Africa	76,361	70,241	76,853	71,062	70,000
Spain	150,425	172,469	140,100	171,800	128,100 3/
Sweden	159,858	167,090	160,325	155,400 r/	164,711 3/
Thailand e/	55,000	16,200 r/	21,700 r/	11,700 r/	23,400
Tunisia	13,000	44,244	31,920	2,967	31,368 3/
Turkey 5/	26,300 e/	9,118	14,921 r/	12,500 r/ e/	13,000
United States	598,000	644,000	628,000	632,000	755,000 3/
Uzbekistan e/	30,000	15,000	12,000	-- r/ 6/	-- 6/
Vietnam e/	11,900 r/	14,000 r/	16,000 r/	18,000 r/	18,000
Total	7,050,000	7,280,000 r/	7,480,000 r/	7,530,000 r/	7,540,000

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, 1999.

3/ Reported figure.

4/ Formerly Zaire.

5/ Content in ore hoisted.

6/ Mining operations appear to have been sharply curtailed or to have ceased.



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

(Metric tons)

Country	1994	1995	1996	1997	1998 e/
Algeria, primary and secondary e/	30,000	30,000	25,000	29,300 r/ 3/	29,300
Argentina:					
Primary	35,214	35,767	36,392	38,672 r/	38,677 p/
Secondary e/	2,800	2,800	2,900	3,100 r/	3,100 p/
Total	38,014	38,567	39,292	41,772 r/	41,777 p/
Australia:					
Primary 4/	323,000	320,000	326,000	307,000	312,000 3/
Secondary e/	4,975 3/	4,500	4,500	10,000	10,000
Total e/	327,975 3/	325,000	331,000	317,000	322,000
Belgium, primary and secondary	306,200	301,100	234,400	244,000 e/	250,000
Brazil:					
Primary	187,000 e/	198,976	186,339 r/	185,701 r/	185,700
Secondary e/	7,000	7,000	7,000	7,000	7,000
Total	194,000	205,976	193,339 r/	192,701 r/	192,700
Bulgaria, primary and secondary	64,005	68,796	68,018	70,420	70,000
Canada, primary	690,965	720,346	715,553	703,798 r/	743,170 3/
China, primary and secondary e/	1,000,000	1,080,000	1,180,000	1,400,000	1,500,000
Congo (Kinshasa), primary e/ 5/	1,000	--	--	--	--
Czech Republic, secondary e/	1,000	1,000	1,000	1,000	1,000
Finland, primary	173,200 e/	176,600	176,300	175,300 r/	176,000
France, primary and secondary e/	306,000	300,000	324,300 3/	346,000 r/	321,000
Germany, primary and secondary	359,878	322,460	327,015	251,700	334,000
India:					
Primary	156,400	146,500	143,600	159,000 e/	171,900 3/
Secondary e/	24,000	24,000	24,000	24,000	25,000
Total e/	180,000	171,000	168,000	183,000	196,900
Italy, primary and secondary	203,600	180,400	269,000	227,700	235,000
Japan:					
Primary	571,880	573,912	500,674	500,603	513,916 3/
Secondary	141,154	137,139	141,593	149,605 r/	138,892 3/
Total	713,034	711,051	642,267	650,208 r/	652,808 3/
Kazakhstan, primary and secondary	172,400 r/	169,200 r/	190,000 r/	170,000 e/	241,000 3/
Korea, North, primary e/	200,000	200,000	200,000	200,000	200,000
Korea, Republic of, primary	271,110	279,335	286,526	335,488	390,079 3/
Macedonia, primary and secondary	24,205	21,335	20,000 e/	20,000 e/	20,000
Mexico, primary	209,200	222,748	221,736	231,444	230,000
Netherlands, primary 6/	212,600	206,300	207,100	201,100	218,700 3/
Norway, primary	131,921	121,576	134,900	137,400	138,000
Peru, primary	182,000	158,987	173,139	171,691 r/	174,654 3/
Poland, primary and secondary	154,400	162,700	163,100	165,000 e/	165,000
Portugal, primary e/	4,200	4,000	3,600	3,600	36,000
Romania, primary and secondary	18,500	29,300	27,800	25,000 e/	25,000
Russia, primary and secondary e/	138,000	166,000	172,000	189,000 r/	196,000
Serbia and Montenegro, primary and secondary	3,895	5,976	29,954	29,454	30,000
Slovakia, secondary e/	1,000	1,000	1,000	1,000	1,000
Slovenia, primary and secondary e/	2,500	2,500	2,000	--	--
South Africa, primary	93,850	98,782	101,100 r/	108,100 r/	110,000
Spain, primary and secondary	294,700	358,000	360,800	364,200	370,000
Thailand, primary	58,513	46,398	59,738	72,036 r/	75,000
Turkey, primary	18,567	17,050	22,392	35,000 r/	35,000
Ukraine, secondary e/	14,000	5,000	2,000	2,000	--
United Kingdom, primary and secondary	101,300	105,998	96,867	107,704 r/	100,000
United States:					
Primary	217,000	232,000	226,000	226,000	234,000 3/
Secondary	139,000	131,000	140,000	140,000	134,000 3/
Total	356,000	363,000	366,000	367,000	368,000 3/
Uzbekistan, primary e/	70,000	70,000	40,000	50,000 r/	40,000
Vietnam, primary e/	-- r/	-- r/	-- r/	-- r/	--
Grand total	7,330,000 r/	7,440,000 r/	7,580,000 r/	7,850,000 r/	8,230,000
Of which:					
Primary	3,810,000 r/	3,830,000 r/	3,760,000 r/	3,840,000 r/	4,020,000

See footnotes at end of table.

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

(Metric tons)

Country	1994	1995	1996	1997	1998 e/
Grand total--Continued:					
Of which--Continued:					
Secondary	335,000 r/	313,000 r/	324,000 r/	338,000 r/	320,000
Undifferentiated	3,190,000 r/	3,300,000 r/	3,490,000 r/	3,670,000 r/	3,890,000

e/ Estimated. p/ Preliminary. 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, 1999.

3/ Reported figure.

4/ Excludes zinc dust.

5/ Formerly Zaire.

6/ Sales.