

ZINC

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In 2000, domestic zinc mine production, expressed in zinc content of ore, increased by nearly 2% from that of 1999, mainly due to increased production in Alaska and Missouri (table 1). On the basis of recoverable content and annual average U.S. price, the value of zinc mine production was estimated to be about \$1 billion. Zinc was extracted from 19 mines in 6 States by 8 companies (tables 2, 3). For the 10th consecutive year, Alaska was the leading zinc mining State, followed by, in descending order, Tennessee, Missouri, and New York. In 2000, 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. More than one-third of exports, which were supplied entirely by the Red Dog Mine, was trucked to the Trail smelter in Canada; the remaining two-thirds went mainly to Asian markets (table 14). Primary zinc metal production by the three primary smelters decreased by more than 5% in 2000 (tables 4, 6).

Apparent consumption of refined zinc metal in 2000 decreased nearly 2%, owing to the slowdown of the economy. Of the total refined zinc metal consumed in the United States, about one-half was used for galvanizing, followed by use in zinc-based 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 refined zinc in 2000, which was based on the London Metal Exchange (LME) daily cash price plus premium, increased by about 5% to \$1.13 per kilogram (51.15 cents per pound).

World production of zinc concentrate by 41 countries increased by about 9% in 2000, to more than 8.7 million metric tons (Mt). The largest producers were, in decreasing order of magnitude, China, Australia, Canada, Peru, and the United States (table 17). World smelter production increased by nearly 6%, to about 9 Mt. The largest producer of zinc metal was

China, followed by Canada, Japan, Australia, the Republic of Korea, Spain, and the United States (table 18).

Legislation and Government Programs

In January 19, 2000, the U.S. Environmental Protection Agency (EPA) finalized the Clean Water Act (CWA) establishing national, technology-based effluent limitations and pretreatment standards for waste water discharges associated with the operation and maintenance of new and existing hazardous and nonhazardous landfills regulated under the Resource Conservation and Recovery Act (RCRA). Because of an insufficient amount of contained biologically degradable organic material in the leachate of inorganic landfills, EPA concluded that the alternative technology of chlorination and use of granular activated carbon is as effective and economically achievable as the biological treatment of nonhazardous landfills containing biodegradable material. The proposed CWA limits zinc in nonhazardous landfills to a monthly average of 0.11 milligram per liter (mg/L) and a daily maximum limit of 0.20 mg/L. EPA estimated that the final CWA should remove about 400 metric tons per year (t/yr) of pollutants at an estimated annual cost of \$7.6 million (U.S. Environmental Protection Agency, 2000).

In 1998, the U.S. Geological Survey conducted a study to determine how much copper, gold, lead, silver, and zinc is undiscovered in the United States not more than 1 kilometer (km) below the Earth's surface. These commodities were chosen because they are the most valuable metals, after iron and aluminum, and because they usually occur together in nature. Partially based on the 1973 study by Wedow and others (1973), the estimate of the amount of zinc in undiscovered deposits ranged from greater than 130 Mt at a 90% probability to greater than 290 Mt at a 10% probability. Nearly 40% of the zinc was

Zinc in the 20th Century

By the beginning of the 20th century, the United States was the leading world zinc metal producer, a position held for most of the next 70 years. Mostly zinc sulfide (sphalerite) ore was crushed, washed, and subjected to gravity separation. About 65% of zinc metal was produced in Missouri, with smaller quantities produced in Colorado and New Jersey (from non-sulfide ore). In 1900, domestic production of zinc metal reached about 112,400 metric tons, 18% of which was exported. Consumption reached 90,200 t, about 50% of which was used in galvanizing, 26% was used in brass, and 17% was used to produce sheet metal.

During the next 100 years, new beneficiation processes, mainly flotation, increased zinc metal recovery up to 87%. Advancements in retort smelting and the introduction of

electrolytic processing increased efficiency of zinc metal production while reducing air pollution. Increasingly stringent environmental laws, however, made the building of new domestic smelters more costly. Consequently, by 2000, the United States had only three primary smelters producing 228,000 tons of zinc metal. With another 143,000 tons of secondary zinc, U.S. production accounted for only about one-fourth of its consumption. The remaining zinc for U.S. consumption was imported, mainly from Canada. The United States was the second largest consumer of zinc in the world, with a cumulative total use of 1.32 million tons of zinc metal. Of that total, about 57% was used in galvanizing; 17%, in zinc-based alloys; and 13%, in brass and bronze.

thought to be contained in the Mississippi Valley-type deposits, followed by sedimentary-exhalative deposits (31%), volcanogenic massive sulfide deposits (15%), and other deposits (14%) (U.S. Geological Survey, 1998). During the past 20 years, sedimentary-exhalative deposits have grown in importance because they usually occur in well-defined areas and are characterized by large tonnages and high grade, allowing for the development of large-capacity mines. These deposits, unfortunately, are usually fine-grained and metallurgically difficult to treat.

Production

Mine Production.—The Red Dog area in Alaska is considered the most significant zinc district in the world. Accordingly, Cominco Ltd. spent 36% of its total exploration expenditure (\$33 million) in this area in 2000. Most of the drilling was carried out to delineate the Anarraaq deposit, which was discovered in 1999, 10 km northwest of Red Dog. The deposit is estimated to contain 17.2 Mt of inferred resources grading 15.8% zinc, 4.8% lead, and 71 grams per ton (g/t) silver. Together, the five deposits at Red Dog—Anarraaq, Aqqaluk, Main Zone, Paalaaq, and Qanaiyaq—have total resources of 148 Mt grading 16.6% zinc, 4.5% lead, and 85 g/t silver (Cominco Ltd., 2001).

In February 2000, Cominco Alaska Inc., subsidiary of Cominco Ltd. of Canada, began a \$90 million Mill Optimization Project (MOP) designed to bring the mill at the Red Dog Mine up to its full operational potential. The project will include an upgrade of existing water treatment capacity, a new large-capacity zinc thickener, a major addition to flotation capacity and backup power generation, and enlargement of fuel storage capacity. These improvements will allow Cominco Alaska to produce 1.1 million metric tons per year (Mt/yr) of zinc concentrate, at a 87% recovery rate by the second half of 2001. Comparable figures for 2000 were 959,800 t of concentrate, containing 55.3% zinc, and average mill recovery rate of 83%. Increased production at the Red Dog Mine will partly compensate for planned closures of Cominco's Polaris and Sullivan mines in Canada (Platt's Metals Week, 2000c).

In September, Cominco approved the reopening of the Pend Oreille zinc-lead mine in Washington State, near Metaline Falls north of Spokane near the British Columbia (BC) border and about 50 km south of Cominco's Trail smelter in BC, Canada. The \$70 million project should be finished by September 2002 and is expected to produce 84,000 t/yr of zinc concentrate and 13,000 t/yr of lead concentrate for at least 10 years (Cominco News, 2001). In 1995, when Cominco acquired the property from Resource Finance Corp. (RFC), it contained reserves of 5.3 Mt grading 7.3% zinc and 1.3% lead (Platt's Metals Week, 2000f). The first recorded shipment of ore from the Pend Oreille property dates back to 1906. Production was sporadic until 1930 when a 300-ton-per-day (t/d) flotation mill was built on-site. The mill was later expanded, and in 1951 the existing 2,400-t/d mill was built. The Bunker Hill Co., which had acquired the project from the mine founder, Pend Oreille Mines & Metals Inc., in 1974, closed the mine in 1977, following a labor dispute at its electrolytic plant in Idaho. Pintlar Corp., a wholly owned subsidiary of Gulf Resources & Chemical Co., acquired Pend Oreille and optioned the property to RFC in 1988. In 1996, Cominco bought RFC, including the Pend

Oreille Mine (Northern Miner, 2000a). During 2000, an extensive drilling program outlined a 2-Mt resource at Washington Rock, 2 km southwest of the existing mine (Cominco Ltd., 2001).

Grupo Mexico S.A. de C.V. announced in December that it has completed the organization of a new, U.S.-based mining and minerals subsidiary, which will operate under the name of Americas Mining Group (AMG). The reorganization was triggered by the acquisition of ASARCO Inc. in November 1999. AMG includes not only Grupo's interest in Asarco, but also Southern Peru Copper Corp. and Grupo Minero Mexico. It will also include separate purchasing and sales offices. The new subsidiary will be staffed by personnel from the existing Grupo Mexico units and will be headquartered in Phoenix, AZ. After the merger with Asarco, Grupo Mexico became a diversified mining and transportation company that ranks internationally as the fifth largest zinc producer. Its zinc interest includes three zinc mines in Tennessee (Coy, Immel, and Young) (ASARCO Inc. News, 2000).

Zinc concentrate production at Doe Run Resources Corp.'s Missouri mining complex was reduced following production changes prompted by events primarily in the lead market. After closing its West Fork and Viburnum mills in May, Doe Run began shipping ore from West Fork to the Fletcher mill and put the Viburnum #29 Mine on care and maintenance and reduced production at the Viburnum #28 Mine. Because of the closure of the Viburnum mill, ore from the Casteel Mine was transported to the Buick mill. Before all these changes, Doe Run's Missouri complex produced about 52,000 t of zinc in concentrate and about 338,000 t of lead in concentrate in 1999 (CRU International Ltd., 2000c).

Exploration.—Cypress Development Corp. has completed the third phase of exploration at the Gunman zinc oxide property in northeastern Nevada. Results of drilling indicated grades of up to 20% zinc and 171 g/t silver. Since the results far exceeded the company's expectations, a fourth phase of drilling was being planned (Mining Journal, 2000f).

In January 2001, Denver-based Summo Minerals Corp. received all assays from an 18-hole drilling program completed by yearend 2000 at the Doctor Mine zinc property in Colorado. The dominant zinc mineral in the intercepts appeared to be smithsonite, and the drilling was interpreted by geologists as a zone of mineralization averaging 15 meters (m) deep, 53 m wide, and 152 m long, with a zinc content of up to 20.7% (Mining Journal, 2001).

Consumption

Since 1993, world consumption of zinc increased every year. It continued in 2000, when world consumption, at 8.8 Mt, was more than 5% higher than 1999. In comparison, the average increase between 1996 and 1998 was only about 1.6%. Slowing worldwide consumption was partially caused by a nearly 2% decline in U.S. consumption in 2000. Because of this decline, the United States was surpassed by China as the world's largest consumer of refined zinc metal. In 2000, the United States consumed 1.32 Mt of zinc, or about 15% of world consumption. Despite falling to second place in consumption, the United States still plays an important role in world zinc markets. Any weakening of U.S. economy would not only decrease consumption of zinc on the domestic market but it could

threaten the fragile economies of some Asian countries who are disproportionately dependent on exports to the United States.

According to the International Lead and Zinc Study Group, despite growing worldwide demand for zinc in 2000, production exceeded consumption by about 130,000 t, compared with a small deficit in 1999. In the Western countries, the zinc metal deficit in 2000 amounted to 815,000 t. This deficit was more than offset by imports, mainly from China, which alone exported 561,000 t of zinc metal (International Lead and Zinc Study Group, 2001a, c).

Stocks

Producers, consumers, merchants, the LME, and the U.S. Government maintain stocks of zinc metal. The surplus production of 130,000 t in 2000, had little effect on these stocks. After several consecutive years of market deficit, the draw down of LME stocks continued in 2000; by the end of December it fell to 195,000 t from 291,000 t at the beginning of 2000. The only stocks that increased in 2000 were in consumers' and merchants' warehouses. By the beginning of 2001, the overproduction of zinc metal during the previous year began to show in expanding stocks at all levels, except at the U.S. Government stockpile (International Lead and Zinc Study Group, 2001b).

Prices

Zinc concentrate production cost in the Western world's major mining countries in 2000 ranged between 29 cents per pound of contained zinc in Ireland to 39.5 cents per pound in the United States (Roskill Information Services Ltd., 2001, p. 49). In comparison with 1999, the average zinc metal cost increased by an estimated 10%, owing to higher concentrate treatment charges and reduced byproduct credits. These higher charges at smelters, plus increased fuel prices, have more than offset a continuing decline in mining and labor costs in many countries (Mining Journal, 2000h). The increase in zinc metal production cost, however, had no effect on zinc metal prices. From a level which was already hard to justify against declining stocks, zinc prices dropped further as worries over the probability of a world economic slowdown increased. In the United States, the composite price for North American Special High Grade zinc declined by nearly 9% from January to December 2000. The decline in price intensified during the past 4 months when the U.S. economy began slowing down. From September 2000, when the price reached 60.04 cents per pound, the highest for the year, it declined to 52.57 cents per pound by the end of December.

World Review

Australia.—The Australian Bureau of Agricultural and Resource Economics (ABARE) reported an 11% increase in the gross value of Australia's mine production in fiscal year (FY) 2000 (ended June 30). Increased investment in mining operations and exploration prior to FY 1998, as well as rising commodity prices and an upturn in global economic growth, contributed to an increase in production of almost all minerals. Substantial increases in production are forecast for the next fiscal year; one of the largest increases (nearly 20%) is expected

to be in the production of zinc in concentrate. Increased production will be reflected in increased metals and minerals exports, which are anticipated to rise in FY 2001 by 13%. New capital investment fell by about 40% in FY 2000, and is forecast to fall a further 6% in FY 2001. There was a similar decline in exploration expenditures, which could have been the result of cost-cutting measures by producers uncertain of the long-term price outlook. According to ABARE, the medium-term outlook (for the next 5 years) for the mining industry is not promising. Export earnings are expected to be placed under downward pressure by the steady appreciation of the Australian dollar from its current historic low (U.S. Embassy, 2000).

The Premier of Queensland officially opened Pasmaenco Ltd.'s Century zinc mine on April 4, 10 years after the first exploration drill-holes intersected significant mineralization. The Century deposit, which is 250 km from Mount Isa in the most northern part of Queensland, now supports the world's largest zinc mine. The final development cost was \$498 million, about 10% below budget. The first 10,000 t of zinc concentrate, produced from the development ore, was shipped to Pasmaenco's Budel smelter in the Netherlands in December 1999. By mid-April 2000, 100,000 t of high-grade concentrate was shipped to the Budel smelter. Shipments to other customers began in May. At full output, Century will produce 500,000 t/yr of zinc in concentrate (Platt's Metals Week, 2000e). The concentrate will be pumped through the 304-km-long pipeline to the Gulf of Carpentaria. From there, about one-half of the concentrate will be shipped to the Budel smelter and the rest to various smelters, mostly in Asia.

At the same time as the Century Mine is reaching full capacity, preparations are underway to close its century-old zinc mining operations at Pasmaenco's Broken Hill area in New South Wales. As a prelude to the impending closure in 2006, 52 jobs will be eliminated by the end of April 2000, reducing the number of miners to less than 600 for the first time since the mine opened (American Metal Market, 2000b).

Western Metals Ltd. will spend \$6.7 million to expand the Pillara mining complex, in the Kimberley region of Western Australia. Western Metals' overall zinc production will likely remain the same because the increased production at Pillara will be offset by the closure of the Hallyer zinc-lead mine and pending closure of the aging concentrator at Cadjebut. The expansion of the Pillara concentrator from 1.5 Mt/yr to 2.4 Mt/yr of ore processing capacity is expected to reduce the annual cost of beneficiation by some \$3.2 million. In addition, Western Metals expects ore from the deeper deposit to have a much higher grade, so that contained metal output is likely to rise substantially. Samples from greater depth showed mineralization as high as 12% zinc, compared with the current 8.4%. Production at the Pillara Mine is to rise by 20% to 1.8 Mt/yr of ore; the remaining 0.6 Mt of ore, needed for the expanded concentrator, will be trucked in from the nearby Western Metals' Kapok Mine (Metal Bulletin, 2000o).

Work on the George Fisher project in Australia continued in 2000 with upgrading of the existing lead-zinc concentrator. Capacity of Mount Isa, 22 km south of George Fisher, was expanded to 2.5 Mt/yr, and its regrinding, cleaning, and thickening processes were upgraded. During testing, recoveries reached 73.4% for zinc and 78.8% for lead. Limited production from the George Fisher Mine began at the end of 2000, 6 months ahead of schedule. At full capacity, the mine will

produce 170,000 t/yr of zinc in concentrate (Mining Journal, 2000e).

Kagara Zinc Ltd. of Australia has secured a second expansion deal for its Mount Garnet zinc project in northern Queensland. The company signed an agreement with Lachlan Resources NL to acquire 100% interest in the Balcooma project 120 km southwest of Mount Garnet and 230 km northwest of Townsville, where Korea Zinc Co. Ltd.'s new zinc smelter/refinery is located. The new acquisition included the high-grade Surveyor 1 zinc-lead deposit, which Kagara immediately incorporated into its current development plans for Mount Garnet. About 87% of the 659,000 t of resource was classified in the measured category and contained 16.7% zinc, 6.7% lead, 1% copper, 142 g/t silver, and 1 g/t gold. The deposit will initially be mined as an open pit, with the ore being trucked to nearby Mount Garnet for processing. The cash payment for Balcooma was \$3 million plus a convertible loan note valued also at \$3 million. If converted, Lachlan would own a 15% stake in Kagara. Kagara also negotiated an option to acquire a 100% interest in the nearby Muldiva property from a consortium that includes Barramundi Gold Ltd. and a number of prospectors. Muldiva comprises three exploration licenses covering 330 square kilometers (km²), about 100 km north of Mount Garnet. At the beginning of the year, when Kagara bought a 75% interest in the Mount Garnet project, it also acquired a 75% interest in the nearby King Vol deposit from Perilya Ltd. (Mining Journal, 2000g). At this stage, Kagara intends to treat about 500,000 t of ore from Mount Garnet and Balcooma and produce about 40,000 t of zinc in concentrate to be trucked to the Townsville plant.

According to Sun Metals Corp., subsidiary of Korea Zinc Co. Ltd., the Townsville smelter/refinery in Australia achieved its nameplate capacity of 170,000 t by yearend 2000, despite only having opened in November 1999. Planned expansion, which would double the capacity, will depend on the availability of inexpensive power and on high price for zinc. Because the main market for Sun Metals' zinc is Southeast Asia, where the economy has not yet fully recovered, expansion is unlikely to take place for at least 5 years. Sun Metals sources its concentrates from four mines, the Century, Mount Isa, and Pillara Mines in Australia and the Red Dog Mine in Alaska (Metal Bulletin, 2000l).

Brazil.—Brazilian zinc producer, Cia Paraibuna de Metais, is planning a \$100 million expansion of its Juiz de Fora smelter that would more than double zinc production over the next 3 years. The first step, which has already begun, is the debottlenecking project that will increase production from the current 77,000 t/yr to 86,000 t/yr. The major part of the expansion, to reach 170,000 t/yr of refined zinc, involves building of two new power plants of 50 and 40 megawatt capacity. A \$1.77 million feasibility study is already underway. On completion of the feasibility study, the Brazilian Government will offer a tender for the construction of the two powerplants. Production at Cia Mineraria de Metais' Tres Maria, the second of two Brazilian smelters, is also to increase from 120,000 t/yr to 160,000 t/yr by 2002. Although three new galvanizing plants will come on-stream in 2001, the anticipated increase of domestic consumption may not be enough to absorb the increased output of both refineries. Consequently, some of the refined zinc will probably be exported (Metal Bulletin, 2000j).

Canada.—In June 2000, Expatriate Resources Ltd. of Vancouver acquired 100% of Cominco Ltd.'s interest in some 2,800 mineral claims in the Finlayson Lake volcanogenic belt in southeast Yukon Territory, including the Kudz Ze Kayah polymetallic deposit. The purchase cost \$1 million in cash and \$10 million in convertible debentures is to be repaid over 4 years, with \$1 million payable in each of the first 3 years and the remainder due on the fourth anniversary of the purchase (Northern Miner, 2000c). In addition to the claims, the purchase included Cominco's water license for development of Kudz Ze Kayah, the surface lease for an access road, and an agreement with indigenous local groups. The purchase allows Expatriate to combine these newly acquired deposits with its 60%-owned Wolverine deposit, to form a single exploration and development project. Expatriate has solved the processing problems associated with the high selenium content of its Wolverine deposit simply by commingling the ore with that of the nearby Kudz Ze Kayah deposit. The two deposits contain an overall resource of 19.2 Mt grading 8% zinc, 1.6% lead, and 1.05% copper, plus gold and silver. Average annual production is anticipated to be about 87,000 t of contained zinc, 13,000 t of lead, and 10,500 t of copper, as well as 1,200 kilograms (kg) of gold and 180 t of silver over the life of the project. The prefeasibility study calls for the upper part of the Kudz Ze Kayah deposit to be mined by an open pit method at the rate of 3,000 t/d. The Wolverine deposit will be developed as a 1,250-t/d underground mine, with the ore trucked 35 km to a processing facility at Kudz Ze Kayah. The concentrate will be trucked 700 km to Skagway, AK, for shipment to smelters in Asia and eastern Canada (Northern Miner, 2000d).

Noranda Inc. of Canada suspended operations at its newly opened Bell-Allard zinc underground mine and mill for a period between February 24 and April 6. The mine, near Matagami, Quebec, was closed because a hoisting skip malfunctioned and damaged the mine's underground shaft compartment. No one was injured in the incident. Operation of Noranda's refinery at Valleyfield was not affected, because sufficient stocks of concentrate existed at the plant. The mine began operation at the start of 2000, reaching 65% of its 2,000 t/d capacity before the accident (Mining Journal, 2000b).

Noranda uncovered a zinc-rich massive sulfide zone during initial exploration in Perseverance, Quebec, near its Bell-Allard zinc mine. Samples from the site's 10 drill holes contained between 13.5% and 25.5% zinc, in addition to 11.8 g/t to 47.1 g/t silver and traces of copper. The Perseverance project is a joint venture between Toronto-based Noranda, which holds a 90% interest, and Societe de Development de la Baie James (SDBJ), which has an option to acquire 10% interest in the mine after completing a positive feasibility study. SDBJ has the option of converting its 10% interest in the mine to a 2% net smelter royalty, leaving Noranda with 100% interest in the mining operations (American Metal Market, 2000a).

Cambior Inc. continued its downsizing by completing the sale of its Bouchard-Hebert and Langlois zinc mines in the Abitibi region of northwestern Quebec to Breakwater Resources Ltd. for \$48 million. The transaction, which took place in April 2000, effectively took Cambior out of the zinc business. At the same time, the acquisition gave Breakwater an additional output of copper, gold, and zinc. In addition to copper, Bouchard-Hebert produced a total of 39,100 t of zinc in 1999 and had reserves of 5.3 Mt grading 4.73% zinc. During the same year,

Langlois produced 31,700 t of zinc in concentrate and had reserves of 5.6 Mt grading 9.45% zinc (Platt's Metals Week, 2000b). Together with other Breakwater mines, the company hoped to produce about 226,000 t of zinc concentrate in 2000 and 258,000 t in 2001 (Metal Bulletin, 2000b). However, by early December, Breakwater suspended operations at its Langlois zinc mine, owing to problems with the main ore transportation system. Together with low metal prices and high treatment charges, the problems made the operation of the mine uneconomic. Immediately after closing the mine, Breakwater began developing a plan to optimize the life of the mine. The new plan should be completed early in 2001, and the company may begin production by the first quarter of 2002 (Metal Bulletin, 2000c). Since 1995, Breakwater's zinc production expanded more than six-fold, making it the world's eighth largest producer of zinc.

Falconbridge Ltd. of Canada approved deepening of the Kidd Creek Mine at Timmins, Ontario. The mine will be extended by 1,000 m to 3,100 m below the surface at a cost of \$430 million. During the first stage, the mine will be extended to 2,700 m. It will involve sinking of a new shaft, installation of a new ventilation, a refrigeration system, and purchase of new underground equipment. Stage one, which should be completed by 2004, would give Falconbridge access to a part of the mine that contains 16 Mt of ore grading 5.74% zinc, 2.82% copper, and 58 g/t silver. Stage two is to begin in 2010. The reserve estimate for that part was 11 Mt of ore grading 5.3% zinc, 2.2% copper, and 100 g/t silver (Mining Engineering, 2000).

Major zinc producer, Billiton Metals Canada Inc., subsidiary of London-based Billiton plc, first agreed but later withdrew from participation in the development of the Howards Pass zinc project (owned by Copper Ridge Explorations Inc.), which straddles the border between the Yukon Territory and the Northwest Territories in Canada. The major attraction of the Howards Pass property is that it is believed to be one of the largest undeveloped zinc deposits in the world, with resources estimated at 110 Mt grading 7.7% zinc, plus lead, cadmium, and silver. Lack of infrastructure and metallurgy pose challenges for development (Metal Bulletin, 2000a). Original prefeasibility evaluation indicated that Howards Pass could not be mined economically, owing to the above mentioned lack of infrastructure and the high cost of traditional milling and smelting. Like many shale-hosted exhalative deposits, Howards Pass has a fine-grained mineralization that requires long grinding times and large mills. In addition, the mineralization is graphite-rich, which harms recoveries in conventional flotation. Copper Ridge hopes to overcome these difficulties by producing bulk zinc, lead, cadmium, and silver concentrate in a mill circuit, comprising gyratory crushing, semiautogenous grinding, and flotation. Concentrates would be transported south by a slurry pipeline to a pressure leaching, purification, and electrowinning plant at the Robert Campbell Highway, near Frances Lake, or possibly Watson Lake. Annual production is estimated at 350,000 t to 500,000 t of zinc metal, depending on the grade of ore mined (Northern Miner, 2000b).

China.—London-based Billiton plc, formed an "Incorporated Contractual Joint Venture" (ICJV) with Chinese Lanping Nonferrous Metals Co. (LNMC) to develop the Lanping zinc deposit in China. Billiton, through its wholly owned Billiton China BV, eventually will hold 65% of the ICJV. LNMC, is 51%-owned by Yunnan Metallurgy Group, which is wholly

owned by the provincial government. Thus, the agreement represented the first commercial joint venture between the Chinese provincial government and an international mining company in which a foreign company has taken a majority stake in a mineral project in China. The Lanping deposit is in Yunnan Province, western China, near the border with Burma. It is described as one of the world's largest undeveloped zinc mineralization, measuring 200 Mt at a grade in excess of 10% zinc. A feasibility study should be completed at the end of 2001. The project could involve a capital investment of about \$500 million. When developed, the Lanping facility is expected to produce between 250,000 t and 270,000 t of zinc metal per year (Mining Journal, 2000d).

Congo.—Zinc Corp. of South Africa (Zincor) restated its interest to exercise its option to join America Mineral Fields International Inc. (AMFI) in redevelopment of the historic Kipushi Mine in Congo (Kinshasa). Zincor can earn up to a 50% interest in the proposed joint venture by matching AMFI's expenditures on the project. The joint venture will include a formal agreement with La Générale des Carrières et des Mines, the Congolese mining corporation that owns the Kipushi Mine. The agreement will cover equity ownership, project finance, and dividend distribution. Pending the outcome of a feasibility study and approval by the board of directors, the project could commence once the Congolese Government grants approval. The Kipushi Mine operated from 1925 until 1993, when it was placed on care and maintenance. The mine has measured and indicated resources of 17 Mt grading 16.7% zinc and 2.32% copper. Zincor is a wholly owned subsidiary of Iscor Ltd., the South African iron, steel, and mining group (American Metal Market, 2000d). With minimal initial expenditure, the Kipushi Mine could produce as much as 30,000 t/yr of contained zinc in concentrate, beginning in the first half of 2001. Concentrate would be transported by rail for processing at Zincor's 115,000 t/yr zinc refinery at Springs, South Africa, near Johannesburg (Platt's Metals Week, 2000h).

Ireland.—In 2000, Tara Mines Ltd., subsidiary of Finnish base metal producer Outokumpu Oy, had to resolve two strikes at its Tara Mine at Navan, northwest of Dublin. After a 7-month-long labor dispute, the first strike ended in February, with a Government brokered deal that included an agreement on miners' bonuses and pay, extended shift schedules with increased shift premium payments, and the use of contract workers. Because of the vagueness of the agreement concerning contract workers, a new 2-week strike erupted in November. The new agreement provided for a new training program for 60 workers at the mine and allowed for the interim use of contract workers until the end of August 2001 (Platt's Metals Week, 2000i). Following the successful resolution of the first strike, Outokumpu Oy of Finland approved a mine-life extension of its Tara Mine. At the annual production level of 200,000 t of concentrate, the \$43 million extension will add at least 8 years to Tara's mine life. Production from the new southwest extension, measuring 10 Mt and averaging 9% zinc and 2% lead, should start in 2001, and it is anticipated that full capacity will be achieved by 2004 (Mining Journal, 2000i).

The Galmoy zinc-lead mine in County Kilkenny, owned by Arcon International Resources plc, has begun using a three-stage flotation process that reduced by 75% the amount of material that had to be put back through the regrind circuit. Arcon also has doubled the capacity of its acid leach process,

reducing the magnesium content of the concentrate to 0.44% MgO and improved recoveries to about 87%. The original reserve had been increased through exploration from 6 Mt to 8 Mt grading 11.5% zinc and 1% lead (Metal Bulletin, 2000e).

By the second half of 2000, the Lisheen zinc-lead mine reached full production capacity of 330,000 t/yr of zinc and 40,000 t/yr of lead in concentrate. The mine, 160 km southwest of Dublin in County Tipperary, is jointly owned by Ivernia West plc and Minorco SA (Platt's Metals Week, 2000d). The Lisheen Mine is the third largest zinc mine in Ireland, following Tara and Galmoy. By yearend 2000, these mines reached a combined annual production of about 700,000 t of zinc concentrate, making Ireland one of the world's major zinc producers. Lisheen's proven reserves of 18.9 Mt grading 12.8% zinc and 2.2% lead are in 3- to 7-m-thick seams in two adjacent ore bodies: Main and Derryville. Concentrates, which are described as low in iron with normal levels of cadmium, cobalt, and nickel, are trucked 110 km to Cork where sheds and shiploading facilities have been leased (Metal Bulletin Monthly, 2000).

Kazakhstan.—According to CRU International Ltd. (2000a), the zinc industry of Kazakhstan continues to expand. The expansion of Kaztsink's Maleevsk Mine was completed in July at a cost of \$65 million. Increased production at the Maleevsk Mine has offset the closure of the Zyryanovsk Mine. Reserves at Maleevsk are estimated at 36.7 Mt grading 7.7% zinc, 2.6% copper, 1.2% lead, and some gold and silver. An additional contribution will come from the Tishin Mine, where an investment of \$6 million should raise production to 1.4 Mt of ore in 2001 (CRU International Ltd., 2000b). Kaztsink's self-sufficiency increased to 71% in 2000 from 54% in 1999; complete self-sufficiency should be achieved by 2001. Slab zinc production in 2000 increased to 262,570 t. At Leninogorsk, which produced about 40% of the company's slab zinc in 2000, Kaztsink proposed to expand capacity by 20% through various new investments. It also planned to increase output at its Ust-Kemenogorsk smelter from 144,200 t/yr in 2000 to 156,000 t/yr in 2001 (CRU International Ltd., 2001).

The biggest contribution to the expanding zinc industry is to come from the Shaimerden oxide-silicate deposit in the Kustanai region of Kazakhstan. The Irish company, Ennex International Ltd., through its subsidiary Zinc Corp of Kazakhstan owns 95% of the project and already concluded a feasibility study. The operation, which will be technically similar to that of Skorpion in Namibia, is to produce 100,000 t/yr of zinc metal over a 6 to 10 year period. Resources are 4.3 Mt grading 21% zinc. The cost of development is estimated to be about \$250 million and should result in an exceptionally low operating cost of about 21 cents per pound (Roskill, 2001, p. 115).

Mexico.—During 2000, Industrias Peñoles S.A. de C.V. twice increased the capacity of its Torreón metallurgical complex: early in the year it went from 130,000 t/yr to 160,000 t/yr, and in December it increased to 220,000 t/yr because of increased domestic demand, mainly for zinc alloys due to growth in the construction and automobile sectors (Metal Bulletin, 2000m). Additional zinc concentrate for this expanding production came from increased output at existing mines and, later, two new mines: the Rey de Plata and the Francisco I. Madero. In early October, Mexico's Industrias Peñoles S.A. de C.V. opened its new zinc mine in the coastal

state of Guerrero, potentially raising its annual zinc production by 12%. The Rey de Plata Mine is expected to produce 20,000 t/yr of zinc in concentrate by 2001, making it the fifth largest zinc mine in Mexico. The mine is owned 51% by Peñoles, 39% by Dowa Mining Co. Ltd. of Japan, and 10% by Sumitomo Corp., a major Japanese trading company. The Rey de Plata Mine, in Tehuixtla, will create 465 new jobs directly and about 1,000 indirect employment opportunities (American Metal Market, 2000c). The Francisco I. Madero Mine is to produce 96,000 t/yr of zinc concentrate by 2001 (Platt's Metals Week, 2000g).

Namibia.—Anglo American plc is to spend \$454 million developing the Skorpion zinc mine and refinery in southern Namibia. The Skorpion Mine is expected to produce about 150,000 t/yr of zinc in concentrate by 2003 over a mine life of at least 15 years. The Skorpion deposit contains reserves of 21.4 Mt grading 10.6% zinc, minable by conventional open pit method. The ore is unusual in that it consists mainly of zinc silicates and zinc carbonates, rather than the more typical zinc sulfide (sphalerite). Accordingly, a special metallurgical process has been developed, consisting of a direct acid leaching of the ore, solid-liquid separation, solvent extraction, and electrowinning to produce special high-grade zinc. When at full capacity, the cost of production should be around \$0.20 and \$0.23 per pound, making Skorpion one of the lowest cost producers in the world (Miningweb, September 7, 2000, Anglo gives green light to \$454 million zinc venture, accessed September 7, 2000, at URL [http://www.mips1.net/422567CB004ED3BF/\(UNID\)/DMKY-4NXM9G](http://www.mips1.net/422567CB004ED3BF/(UNID)/DMKY-4NXM9G)).

Peru.—Rio Algom of Canada, Ltd. agreed to a friendly takeover by Billiton plc on August 25. The main incentive for the purchase lies in Rio Algom's 33.75% share in the Antamina copper-zinc project in Peru. The project is already 52% complete and engineering work is 95% finished. Annual production in the first 10 years is expected to be 270,000 t of copper and 160,000 t of zinc (Mining Journal, 2000c). The massive Antamina copper-zinc deposit in Peru is larger than previously believed. Based on new drill results, combined proven and probable reserves increased in volume by 13%, in addition to slightly higher zinc and silver grades. Proven reserves now stand at 313 Mt grading 1.3% copper, 1.06% zinc, 0.03% molybdenum, and 14.13 g/t silver. Probable reserves amount to 246 Mt grading 1.15% copper, 0.99% zinc, 0.028% molybdenum, and 13.71 g/t silver. Antamina is operated by Compañía Minera Antamina, which is now owned by Noranda Inc. (33.75%), Billiton plc (33.75%), Teck Corp. (22.5%), and Mitsubishi Corp. (10%). The project is slated to become the world's third largest zinc producer. Construction is on schedule for full production to begin in late 2001 (Northern Miner, 2000e).

Compañía Minera Volcán S.A., presently Peru's largest privately owned zinc producer, added about 30,000 t of high-grade zinc concentrate to its current production by purchasing the neighboring Chungar and Vinchos Mines for \$24 million. The purchase also included the supply of hydroelectric generating capacity, 382 hectare (ha) of land from the majority owners of the Chungar Mine, and 5,700 ha of exploration property from the owners of the Vinchos Mine. The latter property is near Volcán's Paragsha Mine. Over the past 3 years, Volcán has risen from relative obscurity to the largest zinc producer in Peru by purchasing the Mahr Tunel Mine from the

Government and later buying the Paragsha (formerly Cerro de Pasco) Mine from Centromin (Empresa Minera del Centro del Peru S.A.) (Metal Bulletin, 2000n). Volcán is also planning a \$70 million investment over the next 5 years to increase production at its recently purchased Paragsha Mine (Metal Bulletin, 2000k).

Portugal.—Canadian zinc producer EuroZinc Mining Corp. received the final feasibility study for the Aljustrel polymetallic project in southern Portugal in June 2000. The study called for an underground operation producing about 1.6 Mt of ore, with potential for an increase to 2 Mt. The mine was expected to produce 65,800 t of zinc 15,400 t of lead, and 34 t/yr of silver during the first 9 years and 13,600 t/yr of copper in the following 2 years. Aljustrel was estimated to contain proven and probable reserves of 13.8 Mt grading 5.3% zinc, 1.77% lead, 0.26% copper, and 63 g/t silver. EuroZinc received a \$32 million incentive package from the Portuguese Government towards the \$75 million that will be required for the development of the mine. A smaller part of the financing will be used for restarting the production at the Moinho Mine where underground infrastructure is in excellent condition. The proceeds from Moinho production will be used to supplement financing for the Feitais deposit, development of which will take about 2 years. The mine was closed in mid-1999 because of low zinc prices and inefficient mining and milling methods. Recent discoveries and modifications to the milling process should enable profitable mining when the mine is scheduled to reopen in 2001. EuroZinc will earn up to 75% interest from the Government-owned Empresa de Desenvolvimento de Minerio mining company by advancing the project to the production stage (Mining Journal, 2000a).

South Africa.—In September 2000, the board of directors of Anglo American plc approved the development of its Skorpion (Namibia) and Gamsberg (South Africa) zinc projects. The Gamsberg project is expected to produce 300,000 t/yr of refined zinc from 6 Mt/yr of ore containing 6% zinc (Platt's Metals Week, 2000a). Construction may begin in January 2001 and is expected to be completed within 3 years. The Gamsberg Mine project, near Aggeneys in the Northern Cape, will contain an open pit mine 4.5 km² and 540 m deep. The mining site will also include a concentrator, two waste rock dumps, and one tailings dam (Metal Bulletin, 2000f).

Spain.—The future of Boliden Ltd.'s Los Frailes zinc mine is in doubt after the Canadian company has decided not to develop pit #3, although it will proceed with developing pit #2. The development of pit #3 would involve stripping back overburden at an additional cost of \$26 million, before any revenues are generated from pit #2. Because Boliden does not have the financial resources nor the ability to borrow the necessary funds, its Spanish subsidiary, Boliden Apirsa S.L., has filed a Spanish equivalent of Chapter 11 bankruptcy protection. It would allow Apirsa to preserve assets, pay creditors, and ensure that operations at Los Frailes will continue until the completion of pit #2, planned for October 2001. Apirsa has been incurring significant financial losses since resumption of operations in 1999 after a rupture in the mine's tailings dam (Metal Bulletin, 2000d).

Navan Mining plc (formerly Navan Resources plc) of the United Kingdom has more than doubled its zinc production at its new Aguas Teñidas Mine. By the end of 2000, production rate reached 600,000 t/yr of zinc ore grading 8.7%. During the

year, existence of a westward extension of resource was discovered, increasing the overall resource by 10% to 15%, and probably extending the life of the mine beyond the anticipated 15 years. Crushed ore is transported 28 km by road to the Almagrera processing plant (Metal Bulletin, 2000g).

Thailand.—Union Minière SA of Belgium has purchased a 33% interest in Thai zinc producer Padaeng Industry Co. Ltd. The infusion of investment helped Tak smelter, Thailand's sole zinc smelter, to expand production to 101,000 t/yr in 2000 from 95,400 t/yr in 1999. Nearly three-fourths of production was sold on the domestic market; the remaining one-quarter was exported. Domestic consumption of zinc is expected to grow by 5.6% in 2001 and by about 30% in the next few years (Metal Bulletin, 2000h).

In mid-2000, Padaeng signed an agreement on zinc mining and processing with the Government of Laos, covering a 12 km² area near Kaiso, north of Vientiane, Laos. Ore from the planned mine will be blended with silicate ore from Padaeng's Mae Sod Mine in Thailand, to produce an even higher quality concentrate for its 106,000-t Tak smelter (Metal Bulletin, 2000i).

Outlook

According to the CEO of Cominco, the zinc industry is ripe for a wave of consolidation comparable to aluminum and copper industries during the past 2 years. The main benefit of mergers would be the ability of a small number of producers to manage resources and capital more effectively, avoiding wasteful investment in unprofitable projects. Even this consolidation may not be enough to improve the low profitability of the zinc industry, which earned a 0.7% return on equity between 1990 and 1999, compared with a 10.3% return for copper producers. Zinc metal prices have been falling 2.3% in real terms for the past 30 years (Platts Metals Week, 2001). Zinc prices most likely will continue to decline in 2001 because zinc production is forecast to increase by 4.6% to 9.34 Mt, while consumption is expected to increase by only 0.2% to 8.83 Mt (Metal Bulletin, 2001).

In contrast to other base metals, there is virtually no mine-site smelting of zinc concentrates, and the volume of zinc concentrates moving either within or across borders is large. Asia and Europe accounted for 72% of world zinc metal production and only 41% of mine production in 2000. America and Australia, on the other hand, accounted for 56% of world mine production and only 26% of metal production in 2000. Although there was significant integration of zinc mining and smelting within a few large companies in the past, it did not increase in the late 20th century. This pattern could begin to change with construction of Skorpion and Shaimerden mining and refining complexes in Namibia and Kazakhstan, respectively.

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TABLE 1
SALIENT ZINC STATISTICS 1/

(Metric tons, unless otherwise specified)

	1996	1997	1998	1999	2000
United States:					
Production:					
Domestic ores, contained zinc	628,000	632,000	755,000	813,000 r/	829,000
Domestic ores, recoverable zinc	586,000	592,000	709,000	771,000 r/	786,000
Value, recoverable zinc thousands	\$660,000 r/	\$843,000 r/	\$804,000 r/	\$909,000 r/	\$1,020,000
Refined zinc:					
From domestic ores	214,000	195,000	192,000	180,000	137,000
From foreign ores	11,400	31,700	41,900	61,100	90,900
From scrap	140,000	140,000	134,000	131,000	143,000
Total	366,000	367,000 r/	368,000	371,000	371,000
Secondary zinc 2/	238,000	234,000	292,000	267,000	290,000
Exports:					
Ores and concentrates (zinc content)	425,000	461,000	552,000	531,000	523,000
Slab zinc	1,970	3,630	2,330	1,880	2,770
Rolled zinc	5,020	9,110	9,920	3,870	3,530
Imports for consumption:					
Ores and concentrates (zinc content)	15,100	49,600	46,300	74,600	52,800
Refined (slab) zinc	827,000	876,000	879,000	966,000	915,000
Rolled zinc	16,900	19,200	16,900	22,600	9,380
Stocks of slab zinc, December 31:					
Producer	11,100	9,360	9,060	9,960	7,890
Consumer	59,700	60,400	45,400	64,400	58,300
Merchant	4,800	18,500	13,300	9,690	10,500
Total	75,600	88,200	67,700	84,100	76,600
Government stockpile	258,000 r/	225,000	199,000	177,000	138,000
Consumption:					
Refined zinc:					
Reported	788,000	672,000	647,000	614,000	640,000
Apparent 3/	1,210,000	1,260,000	1,290,000	1,340,000	1,330,000
All classes 4/	1,450,000	1,490,000	1,580,000	1,610,000	1,620,000
Price, special high grade cents per pound	51.11	64.56	51.43	53.48	55.61
World:					
Production:					
Mine thousand metric tons	7,480	7,530 r/	7,690 r/	8,040	8,730 e/
Smelter do.	7,610 r/	7,920 r/	8,160 r/	8,570 r/	9,050 e/
Price, London Metal Exchange cents per pound	46.50	59.70	46.45	48.80	51.15

e/ Estimated. r/ Revised.

1/ Data are rounded to no more than 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	1999	2000
Alaska 2/	563,000	574,000
Missouri	48,700	51,800
Montana	22,200	16,600
Other 3/	137,000 r/	143,000
Total	771,000 r/	786,000

r/ Revised.

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

2/ Data based, in part, on publicly available information.

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

TABLE 3
LEADING ZINC PRODUCING MINES IN THE UNITED STATES IN 2000, 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 1/	Juneau, AK	Kennecott Greens Creek Mining Co.	Zinc ore.
3	Balmat	St. Lawrence, NY	Zinc Corp. of America	Do.
4	Gordonsville	Smith, TN	Pasminco Ltd.	Do.
5	Young	Jefferson, TN	ASARCO Inc.	Do.
6	Montana Tunnels	Jefferson, MT	Apollo Gold Co.	Do.
7	Brushy Creek	Reynolds, MO	Doe Run Resources Corp.	Lead ore.
8	Pierrepoint	St. Lawrence, NY	Zinc Corp. of America	Zinc ore.
9	Immel	Knox, TN	ASARCO Inc.	Do.
10	Buick	Iron, MO	Doe Run Resources Corp.	Lead ore.
11	West Fork	Reynolds, MO	do.	Do.
12	Casteel	Iron, MO	do.	Do.
13	Cumberland	Smith, TN	Pasminco Ltd.	Zinc ore.
14	Coy	Jefferson, TN	ASARCO Inc.	Do.
15	Fletcher	Reynolds, MO	Doe Run Resources Corp.	Lead ore.
16	Clinch Valley	Grainger, TN	Pasminco Ltd.	Zinc ore.

1/ Updated to reflect locality name change.

TABLE 4
REFINED ZINC PRODUCED IN THE UNITED STATES 1/

(Metric tons)

	1999	2000
Primary:		
From domestic ores	180,000	137,000
From foreign ores	61,100	90,900
Total	241,000	228,000
Secondary	131,000	143,000
Grand total (excludes zinc recovered by remelting)	371,000	371,000

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

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

(Metric tons)

Grade	1999	2000
Special High	93,400	82,200
Continuous Galvanizing	103,000	93,200
Other 2/	175,000	195,000
Total	371,000	371,000

1/ Data are rounded to no more than 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	1999	2000
Electrolytic:		
Big River Zinc Corp., Sauget, IL	95,000	100,000
Pasminco Ltd. Clarksville, TN	115,000	115,000
Electrothermic:		
Zinc Corporation of America, Monaca, PA 1/	155,000	155,000
Total	365,000	370,000

1/ Includes secondary capacity.

TABLE 7
STOCKS AND CONSUMPTION OF NEW AND OLD ZINC SCRAP IN THE UNITED STATES IN 2000, 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	W	--	W	W	191
Flue dust	756	W	W	W	W	187
Galvanizer's dross	2,830	41,000	41,000	--	41,000	2,830
Old zinc 2/	72	305	--	308	308	69
Remelt die-cast slab	W	W	--	W	W	38
Remelt zinc 3/	177	W	W	--	W	744
Skimmings and ashes 4/	413	27,500	27,100	--	27,100	810
Other 5/	1,040 r/	161,000	104,000	58,200	162,000	133
Total	5,290 r/	230,000	172,000	58,500	230,000	5,000

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

1/ Data are rounded to no more than 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 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	1999	2000
Redistilled slab zinc	131,000	143,000
Other zinc metal products 2/	4,950	5,130
Zinc in chemical products	94,300	63,500
Zinc dust	3,010	3,770

1/ Data are rounded to no more than 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)

	1999	2000
Type of scrap:		
New scrap:		
Zinc-base	128,000	167,000
Copper-base	192,000	201,000
Magnesium-base	428 r/	430 e/
Total	321,000	369,000
Old scrap:		
Zinc-base	62,300	56,100
Copper-base	14,800 r/	9,850
Aluminum-base	696 r/	630
Magnesium-base	304 r/	300 e/
Total	78,100 r/	66,900
Grand total	399,000 r/	436,000
Form of recovery:		
Metal:		
Slab zinc	131,000	143,000
Zinc dust	3,010	3,770
Total	134,000	146,000

See footnotes at end of table.

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

(Metric tons)

	1999	2000
Form of recovery--Continued:		
In brass and bronze	165,000 r/	233,000
In chemical products:		
Zinc oxide (lead free)	35,900	23,100
Zinc sulfate	34,400	32,800
Zinc chloride	W	W
Miscellaneous 2/	29,600	13,800
Total	265,000 r/	302,000
Grand total	399,000 r/	449,000

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

1/ Data are rounded to no more than 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)

	1999	2000
Refined zinc, apparent	1,340,000	1,330,000
Ores and concentrates (zinc content)	986	225
Secondary (zinc content) 2/	267,000	290,000
Total	1,610,000	1,620,000

1/ Data are rounded to no more than 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 2000, BY INDUSTRY USE AND GRADE 1/

(Metric tons)

Industry use	Special high grade	High grade	Prime Western	Remelt and other grades	Total
Galvanizing	116,000	35,400	101,000	41,300	293,000
Zinc-base alloys	117,000	W	W	W	123,000
Brass and bronze	41,700	W	23,500	W	82,800
Other	57,200	25,200	82,400	231	XX
Total	332,000	60,600	206,000	41,500	640,000

W Withheld to avoid disclosing company proprietary data; included with "Other" and in "Total."

XX Not applicable.

1/ Data are rounded to no more than 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)

	1999		2000	
	Production	Shipments	Production	Shipments
Zinc oxide	114,000	116,000	102,000	101,000
Zinc sulfate	35,400	33,700	33,000	38,700

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

2/ Data are rounded to no more than three significant digits.

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

(Metric tons)

	1999	2000
Ceramics	5,100	4,320
Chemicals	23,300	20,200
Paints	5,610	4,600
Rubber	76,600	67,500
Other 3/	5,020	4,790
Total	116,000	101,000

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

2/ In addition, zinc contained in zinc oxide was imported as follows: 1999--65,203 and 2000--71,013; distribution cannot be distinguished by industry.

3/ Includes agriculture and photocopying.

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

	1999		2000	
	Quantity (metric tons, zinc content)	Value (thousands)	Quantity (metric tons, zinc content)	Value (thousands)
Australia	24,400	\$10,800	24,400	\$11,000
Belgium	219,000	96,100	202,000	97,000
Canada	61,000	83,400	49,900	65,700
Germany	32,700	14,600	28,100	14,700
Italy	1,300	1,250	6,840	2,990
Japan	123,000	69,300	108,000	51,500
Korea, Republic of	51,000	23,900	73,900	37,100
Mexico	5,080	2,160	1,990	1,070
Netherlands	7 r/	8 r/	--	--
Saudi Arabia	28	46	68	139
Spain	76	43	--	--
United Kingdom	14,100	14,700	28,400	16,400
Other	46 r/	140 r/	155	269
Total	531,000	317,000	523,000	298,000

r/ Revised. -- Zero.

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

Source: U.S. Census Bureau.

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

	1999		2000	
	Quantity (metric tons, gross weight)	Value (thousands)	Quantity (metric tons, gross weight)	Value (thousands)
Zinc chloride	3,200	\$2,140	3,290	\$2,440
Zinc compounds, n.s.p.f.	864	3,280	5,240	17,600
Zinc oxide	7,260	11,700	7,080	12,400
Zinc sulfate	4,750	2,940	6,950	22,800

1/ Data are rounded to no more than three significant digits.

Source: U.S. Census Bureau.

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

	1999		2000	
	Quantity (metric tons, gross weight)	Value (thousands)	Quantity (metric tons, gross weight)	Value (thousands)
Lithopone	1,180	\$1,070	1,380	\$1,150
Zinc chloride	1,650	1,520	1,110	1,240
Zinc compounds, n.s.p.f.	34	32	19	21
Zinc hydrosulfite	100	239	174	361
Zinc oxide	65,200	66,600	71,000	74,200
Zinc sulfate	10,500	6,350	13,700	6,800

1/ Data are rounded to no more than three significant digits.

Source: U.S. Census Bureau.

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

(Metric tons)

Country	1996	1997	1998	1999	2000 e/
Algeria	5,912	3,960	25,465 r/	42,306 r/	38,303 3/
Argentina	31,093	33,357	35,560	34,195 r/	35,000
Australia	1,071,000	1,036,000	1,059,000	1,163,000	1,420,000 3/
Bolivia	145,092	154,491	152,110	146,316 r/	150,000
Bosnia and Herzegovina e/	300	300	300	300	300
Brazil	117,343	152,636	87,474	96,500	96,500
Bulgaria e/	19,800 3/	20,000	17,000	11,000 r/	11,000
Burma	572	467	474	279	220
Canada	1,222,388	1,076,385	1,061,645	963,321 r/	935,686 p/
Chile	36,004	33,934	15,943	32,263	33,000
China	1,120,000 e/	1,200,000 e/	1,273,000	1,476,000 r/	1,710,000
Ecuador e/	100	100	100	100	100
Finland	26,294	30,800	30,700 r/ e/	20,000 r/ e/	16,200 3/
Georgia e/	500	200	200	200	200
Greece	13,602	17,800 e/	29,100	18,900	16,900 3/
Honduras	37,000	39,500	36,639	40,996	41,000
India	148,200	142,000	143,000	145,000 e/	144,000
Iran	76,300	76,500	82,000	80,000 e/	80,000
Ireland	164,168	194,796	182,000	226,000	262,900 3/
Italy	11,055	8,470	2,500 e/	-- e/	--
Japan	79,709	71,569	67,670	64,263 r/	63,547 3/
Kazakhstan	225,000	224,051	224,300	288,300	325,000 3/
Korea, North e/	210,000	210,000	200,000	190,000	190,000
Korea, Republic of	8,384	8,992	10,488 r/	9,832 r/	9,500
Macedonia	15,017	15,800 r/	14,328 r/	8,000 r/ e/	12,200 3/
Mexico	377,599	379,252	395,391	360,000 e/	392,791 3/
Morocco	79,662	89,248	112,000	115,000 e/	130,000
Namibia	35,873	39,658	42,142	34,639 r/	37,800 3/
Norway	8,591 r/	7,900 r/	-- r/	-- r/	--
Peru	760,563	865,267	868,958	899,457	910,303 p/
Poland	159,000	158,300	157,900 r/	155,000 r/ e/	155,000
Romania	32,082	29,366	30,000 e/	26,536 r/	27,455 3/
Russia	126,000	121,000 e/	115,000 e/	132,000	136,000 3/
Saudi Arabia	500 e/	619	3,550 r/	3,161 r/	3,000
Serbia and Montenegro	12,000	13,000	14,000	1,000 r/ e/	2,500
South Africa	76,853	71,062	69,630	69,733	62,703 3/
Spain	140,100	171,800	128,100	110,000	200,000
Sweden	160,325	155,400	164,711	175,000 e/	176,200 3/
Thailand	19,000 r/	15,000 r/	25,000 r/	24,000 r/	21,000
Tunisia	31,920	2,967	31,368	49,066 r/	41,247 3/
Turkey 4/	14,921	11,255 r/	6,000 r/ e/	1,500 r/ e/	1,000
United States	628,000	632,000	755,000	813,000 r/	829,000 3/
Uzbekistan	12,000 e/	-- 5/	-- 5/	-- 5/	-- 5/
Vietnam e/	16,000	16,000 r/	18,000	18,000 r/	16,000
Total	7,480,000	7,530,000 r/	7,690,000 r/	8,040,000	8,730,000

See footnotes at end of table.

TABLE 17--Continued

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

e/ Estimated. p/ Preliminary. r/ Revised. -- Zero.

1/ World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

2/ Table includes data available through July 01, 2001.

3/ Reported figure.

4/ Content in ore hoisted.

5/ 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	1996	1997	1998	1999	2000 e/
Algeria, primary and secondary e/	30,000	29,300	31,000	34,000	34,000
Argentina:					
Primary	36,392	38,672	38,677	40,224 r/	40,000
Secondary e/	2,900	3,100	3,100 3/	3,220 r/ 3/	3,000
Total	39,292	41,772	41,777	43,444 r/	43,000
Australia:					
Primary 4/	326,000	307,000	312,000	338,000	490,000 3/
Secondary e/	4,500	10,000	10,000	10,000	10,000
Total e/	331,000	317,000	322,000	348,000	500,000
Belgium, primary and secondary	234,400	243,600 r/	205,000	232,400	251,700 3/
Brazil:					
Primary	186,339	185,701	176,806 r/	187,010 r/	194,000
Secondary e/	7,000	7,000	7,000	7,000	7,000
Total	193,339	192,701	183,806 r/	194,010 r/	201,000
Bulgaria, primary and secondary	68,018	70,420	72,755	84,000 e/	85,000
Canada, primary	715,553	703,798	745,131	776,927 r/	787,527 p/
China, primary and secondary e/	1,180,000	1,430,000	1,490,000	1,700,000 r/	1,920,000
Czech Republic, secondary e/	1,000	1,000	1,000	1,000	1,000
Finland, primary	176,300	175,300	199,000	225,200	223,000 3/
France, primary and secondary e/	324,300 3/	346,000	321,000	330,000 r/	348,000
Germany, primary and secondary	327,015	251,700	334,000 e/	330,000 e/	325,000
India:					
Primary	143,600	159,000 e/	171,900	175,000 e/	176,000 3/
Secondary e/	24,000	24,000	25,000	25,000	25,000
Total e/	168,000	183,000	197,000	200,000	201,000
Italy, primary and secondary	269,000	227,700	231,600	152,800	168,000
Japan:					
Primary	500,674	500,603	513,916	524,979 r/	541,704 3/
Secondary	141,593	149,605	138,771	158,637 r/	158,806 3/
Total	642,267	650,208	652,687	683,616 r/	700,510 3/
Kazakhstan, primary and secondary	190,000	188,996	240,728 r/	249,327 r/	260,000
Korea, North, primary e/	200,000	200,000	180,000	180,000	180,000
Korea, Republic of, primary	286,526	335,488	390,260	430,108	473,897 3/
Macedonia, primary and secondary e/	38,000	53,000	57,000	48,000 3/	45,000
Mexico, primary	221,736	231,444	230,325	218,913 r/	230,000
Netherlands, primary 5/	207,100	201,100	218,700	220,000 e/	215,000 3/
Norway, primary	134,900	137,400	128,000 e/	132,600 r/	125,800 3/
Peru, primary	173,139	171,691	174,654	196,978 r/	199,813 p/
Poland, primary and secondary	163,100	171,000	175,000 e/	178,000	175,000
Portugal, primary e/	3,600	3,600	3,600	3,600 r/	3,600
Romania, primary and secondary	28,162	30,226	29,427	25,000 e/	25,000
Russia, primary and secondary e/	172,000	189,000	192,000	221,000 r/	230,000
Serbia and Montenegro, primary and secondary	29,954	29,454	14,000 e/	683 r/	8,291 3/
Slovakia, secondary e/	1,000	1,000	1,000	1,000	1,000
Slovenia, primary and secondary e/	2,000	--	--	--	--
South Africa, primary	101,100	108,500	107,400	114,000 e/	115,000
Spain, primary and secondary	360,800	364,200	360,000 e/	375,000 e/	385,000
Thailand, primary	59,738	72,035 r/	75,904	75,639	77,525 3/
Turkey, primary	22,392	37,074	35,716 r/	27,000 e/	25,000

See footnotes at end of table.

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

(Metric tons)

Country	1996	1997	1998	1999	2000 e/
Ukraine, secondary e/	2,000	2,000	--	--	--
United Kingdom, primary and secondary	96,867	107,704	99,600 r/	132,800 r/	96,600 3/
United States:					
Primary	226,000	226,000	234,000	241,000	228,000 3/
Secondary	140,000	140,000	134,000	131,000	143,000 3/
Total	366,000	367,000	368,000	371,000	371,000 3/
Uzbekistan, primary e/	45,000	53,000	52,000	27,000	18,000
Grand total	7,610,000 r/	7,920,000 r/	8,160,000 r/	8,570,000 r/	9,050,000
Of which:					
Primary	3,770,000 r/	3,850,000 r/	3,990,000 r/	4,130,000 r/	4,340,000
Secondary	324,000	338,000	320,000	337,000 r/	348,000
Undifferentiated	3,520,000	3,740,000	3,850,000	4,100,000	4,360,000

e/ Estimated. p/ Preliminary. r/ Revised. -- Zero.

1/ World totals, U.S. data, and estimated data are rounded to no more than 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, 2001.

3/ Reported figure.

4/ Excludes zinc dust.

5/ Sales.