



2016 Minerals Yearbook

ZINC [ADVANCE RELEASE]

ZINC

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In 2016, U.S. mine production of recoverable zinc was 778,000 metric tons (t), a slight decrease from that revised of 2015 (table 1). The value of domestic mine production was approximately \$1.74 billion. Alaska continued as the dominant zinc-producing State. Other zinc-producing States included Idaho, Missouri, Tennessee, and Washington. The United States exported 77% of its zinc mine production (597,000 t of zinc in concentrate) to foreign smelters for processing. Leading destinations for domestic exports of zinc contained in concentrates were Canada (35%), the Republic of Korea (17%), Spain (15%), and Australia (8%) (table 6). Regionally, 35% of exports were sent to North America, 32% to Europe, 24% to Asia, 8% to Australia and Oceania, and less than 1% to Central America and South America. Imports for consumption of zinc contained in concentrates were significantly less than exports as the only domestic primary zinc smelter mostly consumed domestically produced zinc concentrates (table 1).

Estimated total U.S. refined zinc production in 2016 decreased by 27% to 126,000 t, owing to a decrease in mine production in Tennessee and Horsehead Holding LLC's idled secondary zinc production plant (table 1). Imports for consumption of refined zinc in 2016 decreased by 7% to 713,000 t (table 1) and were sourced primarily from Canada (71%), Mexico (12%), Peru (9%), and Australia (4%). Domestic exports of refined zinc increased over 250%, or by 34,200 t, to 46,900 t in 2016 (table 1). Apparent consumption of refined zinc decreased by 15% from that of the prior year to 792,000 t (table 1). Most reported refined zinc consumption was for galvanizing, and other major end uses were brass and bronze and zinc-base alloys (table 5). Global zinc mine production decreased by 7% to 12.6 million metric tons (Mt), and zinc metal production decreased slightly to 13.8 Mt (tables 9, 10). According to data from the International Lead and Zinc Study Group (ILZSG), global zinc metal consumption increased by 4% to 13.9 Mt in 2016 (International Lead and Zinc Study Group, 2017c, p. 44, 47).

Legislation and Government Programs

A U.S. Government stockpile of refined zinc has been maintained since 1967 for national defense purposes. Public Law 102-484, signed in 1992, authorized the disposal of the entire inventory of zinc from the National Defense Stockpile (NDS). Sales of zinc from the NDS, however, were suspended in August 2008 owing to concerns regarding domestic availability and access to various raw materials. The Defense Logistics Agency Strategic Materials relisted zinc on the Annual Materials Plan-Disposals/Sales (AMP) for fiscal year 2016 (October 1, 2015, through September 30, 2016). The AMP ceiling quantity for zinc in fiscal year 2017 was 7,250 t, which represented the maximum quantity of zinc that could be sold from the NDS during the fiscal year. At yearend 2016,

the reported inventory of zinc remained at 7,250 t (Defense Logistics Agency Strategic Materials, 2016).

In February 2015, the Office of the United States Trade Representative asked the World Trade Organization to organize a panel to consider its allegation that China subsidized its domestic businesses in several markets, including galvanized steel, by providing free and discounted services, and cash grants, to enterprises that met export performance criteria (Metal Bulletin, 2015; Office of the United States Trade Representative, 2015). In April 2016, China agreed to eliminate its export subsidies, including those for galvanized steel (Office of the United States Trade Representative, 2016).

On November 14, the U.S. Department of Commerce (DOC) initiated an anti-circumvention inquiry on imports of cold-rolled and corrosion-resistant steel from Vietnam in response to requests from United States-based steel producers AK Steel Corp. (West Chester, OH), ArcelorMittal USA LLC (East Chicago, IN), California Steel Industries (Fontana, CA), Nucor Corp. (Charlotte, NC), Steel Dynamics Inc. (Fort Wayne, IN), and United States Steel Corp. (Pittsburgh, PA). The United States producers asserted that steel mills in Vietnam toll-processed hot-rolled steel from China into cold-rolled and corrosion-resistant steel for export to the United States to avoid the antidumping and countervailing duties imposed on imports of these steel products from China. The United States companies claimed that since Vietnam cannot produce hot-rolled steel, the cost of manufacturing value-added steel (cold-rolled and corrosion-resistant) products in Vietnam is small compared to the total export value. United States imports for consumption of zinc-coated (hot-dipped and electrogalvanized) steel from Vietnam increased notably beginning in December 2015 after the DOC announced in November 2015 that it had preliminarily determined countervailable subsidies were provided to producers and exporters of corrosion-resistant steel in China (Cowden, 2016; Schier, 2016; U.S. Department of Commerce, International Trade Administration, Enforcement and Compliance, 2016).

Production

Mine.—In 2016, zinc was produced in five States: Alaska, Idaho, Missouri, Tennessee, and Washington (table 3). Domestic mine production of recoverable zinc in 2016 was 778,000 t, slightly less from that of 2015 (table 1).

Alaska.—Teck Alaska Inc. (a subsidiary of Teck Resources Ltd., Canada) operated the open pit Red Dog zinc-lead mine in the Northwest Arctic Borough, the leading zinc-producing mine in the United States (table 3). The Red Dog property consists of several sedimentary-exhalative lead-zinc sulfide ore bodies and was leased and operated under an agreement with NANA Regional Corp. Inc. (Kotzebue, AK), an Alaska Native-owned corporation. Teck reported that zinc in concentrate

production at Red Dog increased by 3% to 583,000 t in 2016 from 567,000 t in 2015 owing to increased mill throughput, with softer ores processed. Approximately 30% of the zinc concentrates produced at Red Dog were refined at Teck's metallurgical complex at Trail, British Columbia, Canada. The remaining concentrates were exported to Asia and Europe. Most of Red Dog's concentrates were sold through long-term contracts, with the balance sold on the spot market. Reported reserves at yearend 2016 contained 6.33 Mt of recoverable zinc metal, and mine life was expected to extend to 2031. Teck projected that zinc production at Red Dog would decrease in the next few years, ranging from 545,000 to 565,000 t in 2017 and from 500,000 to 525,000 metric tons per year (t/yr) from 2018 through 2020 (Teck Resources Ltd., 2017a, p. 36–38, 45).

Hecla Mining Co.'s (Coeur d'Alene, ID) underground Greens Creek Mine recovered metals from a polymetallic (gold-lead-silver-zinc) massive sulfide deposit on Admiralty Island in the Tongass National Forest near Juneau. The mine produced bulk zinc-lead, lead, and zinc concentrates and a gravity concentrate that was upgraded into gold and silver dore by a third-party processor. Hecla reported that zinc in concentrate production decreased by 7% from that of 2015 to 52,400 t. Reported yearend reserves at Greens Creek contained 523,000 t of zinc, and mine life was expected to extend to 2026 (Hecla Mining Co., 2017, p. 31–34, 58–59).

Idaho.—Hecla operated the Lucky Friday Mine, an underground silver-lead-zinc mine in the Coeur d'Alene mining district in northern Idaho, which produced silver-lead concentrate and zinc concentrate. In 2016, reported zinc production increased by approximately 2,400 t from that of 2015 to 9,790 t. The increase in production resulted from an increase in the average zinc ore grade. All concentrates were sent to Teck's metallurgical facility in Trail for processing. Reported reserves, at yearend, contained 140,000 t of zinc, and mine life was expected to extend for 22 years (Hecla Mining Co., 2017, p. 35–39, 62–63).

Missouri.—Doe Run Resources Corp. (St. Louis, MO) operated a series of production shafts along the Viburnum Trend within the Mississippi Valley-type (MVT) lead-zinc-copper ore bodies in southeast Missouri. In 2016, Doe Run processed ore from the Brushy Creek, Buick, Fletcher, Sweetwater, and Viburnum (#29 and #35) Mines at four mills to produce primarily lead concentrates and, to a lesser extent, zinc and copper concentrates.

New York.—In October, Star Mountain Resources Inc. (Littleton, CO) announced entry into a definitive agreement with HudBay Minerals Inc. (Canada) and Northern Zinc LLC (Carson City, NV) to purchase their interests in Balmat Holding Corp., including the operating subsidiary, St. Lawrence Zinc Co. LLC, and its mining operations in the Balmat zinc mining district in St. Lawrence County. HudBay Minerals owned Balmat, and Northern Zinc held an exclusive purchase option with HudBay to acquire Balmat. HudBay placed the Balmat zinc mine on care-and-maintenance status in August 2008 owing to low zinc prices. Balmat's previous capacity was 60,000 t/yr of zinc in concentrate (Lavigne, 2015; Star Mountain Resources Inc., 2015). The company continued its drilling exploration in 2016 (Star Mountain Resources Inc., 2016). In December, Star

Mountain Resources sold Balmat Holding Corp. to Titan Mining Corp. (Canada). Titan Mining planned to restart production in mid-2017 (OTC Markets, 2017; Augusta Group, undated).

Tennessee.—Nyrstar NV (Belgium) owned and operated the East Tennessee and Middle Tennessee zinc mine complexes that recovered ore from MVT zinc deposits. The two mine complexes produced zinc concentrates, of which Middle Tennessee concentrates contained recoverable amounts of gallium and germanium. In December 2015, Nyrstar placed the Middle Tennessee mines on care-and-maintenance status to reduce costs in its mining segment as zinc prices in the fourth quarter fell below the operating costs of the mines. Zinc in concentrate production at the East Tennessee mine complex (the Coy Mine, Immel Mine, and Young Mine and mill) decreased slightly from that of 2015 to 62,000 t. The Middle Tennessee mine complex (the Cumberland Mine, Elmwood Mine, and Gordonsville Mine and mill) commenced actions to restart operations in September, and ore production was to commence in 2017 (Nyrstar NV, 2017a). Concentrates were sent to Nyrstar's Clarksville, TN, zinc refinery for processing (Nyrstar NV, 2016, p. 18, 23).

Washington.—In December 2014, Teck reopened the underground Pend Oreille Mine and began shipping lead and zinc concentrates to its nearby metallurgical facility in Trail for processing. Pend Oreille is a carbonate-hosted zinc-lead ore body near Metaline Falls in northeast Washington State. The mine opened in 2004 and was placed on care-and-maintenance status in February 2009 owing to low zinc prices (Teck Resources Ltd., 2014). Zinc in concentrate production at Pend Oreille was 34,100 t in 2016 compared with 30,700 t in 2015. Teck projected zinc production would increase to between 35,000 and 40,000 t in 2017. Reported reserves at yearend contained 56,700 t of zinc, and there was potential to extend the mine life to at least 2020 (Teck Resources Ltd., 2017a, p. 39, 45; 2017b, p. 22).

Smelter.—In 2016, refined zinc was mainly produced in Tennessee (Nyrstar's Clarksville zinc refinery). A smaller quantity of zinc metal was produced by U.S. Zinc Corp.'s (owned by Votorantim Metais, Brazil) zinc recycling operation in Houston, TX. Refined zinc production in 2016 decreased by 27% from that of 2015 to 126,000 t, owing to a decline in secondary production (table 1).

Nyrstar's Clarksville electrolytic zinc refinery was the only primary zinc smelter in the United States. Clarksville mostly treated zinc concentrate from Nyrstar's East and Middle Tennessee Mines, but also imported zinc concentrates and domestically sourced secondary crude zinc oxide. Refined zinc production at Clarksville in 2016 decreased by 10% from that of 2015 to 111,000 t, owing to processing lower grade zinc concentrates following the suspension of the Middle Tennessee zinc mine complex (Nyrstar NV, 2017a). Clarksville produced Special High Grade (SHG) and Continuous Galvanizing Grade (CGG) zinc. Byproducts included cadmium metal, copper cementate, copper sulfate, germanium leach product, synthetic gypsum, and sulfuric acid (Nyrstar NV, 2016, p. 9–10, 18).

Horsehead's solvent extraction–electrowinning (SX–EW) zinc refinery in Mooresboro, NC, began operating in May 2014. The plant produced SHG and CGG zinc in addition to

Prime Western-grade (PW) zinc from secondary materials, sourced mostly from the company's four electric arc furnace (EAF) dust recycling operations in Barnwell, SC; Calumet, IL; Palmerton, PA; and Rockwood, TN. On January 22, Horsehead announced it temporarily idled its Mooresboro, NC, secondary zinc production plant owing to the company's low liquidity and low zinc prices. The company filed for Chapter 11 bankruptcy protection on February 2 (Business Wire, 2016; Metal Bulletin, 2016). In September, the U.S. Bankruptcy Court for the District of Delaware approved Horsehead Holding LLC's bankruptcy exit plan, eliminating most of the company's debt and transferring Horsehead from public to private ownership. The company declared a plan to repair and restart its Mooresboro secondary zinc production plant, although a timeline was not specified (Dent, 2016a, b; Matyi, 2016).

U.S. Zinc produced PW zinc and zinc dust at its zinc recycling facility in Houston, TX. Feed materials were mainly top dross from continuous galvanizers and bottom dross and skimmings from general galvanizers. U.S. Zinc also produced zinc oxide at two recycling facilities in Tennessee (U.S. Zinc Corp., undated).

Consumption

Changes in zinc consumption follow trends in industrial production or, more generally, economic growth. Domestic apparent consumption of zinc in 2016 was 792,000 t, a 15% decrease from apparent consumption in 2015 (table 1).

According to reported data, most of the zinc consumed domestically in 2016 was for the production of galvanized (zinc-coated) steel (table 5). Galvanized steel is used extensively in the automotive and construction industries. Most of the zinc consumed domestically for galvanizing was at continuous galvanizing plants. An estimated 46 continuous galvanizing plants were operated by 18 companies in the United States, and leading producers of galvanized sheet included AK Steel Corp., ArcelorMittal USA LLC, Nucor Corp., Steel Dynamics, and United States Steel Corp. The balance of zinc consumed for galvanizing was at general galvanizing plants that treat fabricated steel shapes (for example, structural beams or fasteners). There were about 180 general galvanizing plants operated by 80 companies in the United States in 2016, of which the leading included AZZ Inc. (Fort Worth, TX), Valmont Industries Inc. (Omaha, NE), and Voigt & Schweitzer LLC (Columbus, OH).

Other major end uses of zinc included brass and bronze, chemicals, semimanufactures, and zinc-base alloys. Leading zinc chemicals, by production volume, included zinc oxide, which is used extensively in the tire manufacturing industry as an activator in the vulcanization process, and zinc sulfate, which is used as a micronutrient additive in animal feed and fertilizers. Leading zinc oxide producers included U.S. Zinc and Zinc Oxide LLC (Dickson, TN). U.S. Zinc used zinc dross and skimmings to produce up to 78,000 t/yr of zinc oxide at its two plants in Clarksville, TN, and Millington, TN (U.S. Zinc Corp., 2016). Zinc Oxide used zinc metal and secondary zinc materials at its 40,000-t/yr zinc oxide plant in Dickson, TN (Zinc Oxide LLC, undated). Zinc semimanufactures included mainly zinc sheet, also known as rolled zinc, which is used in architectural applications and for the production of the U.S. 1-cent coin.

Zinc-base alloys were mainly produced by about 15 companies and predominantly used to make die-cast parts for applications such as automotive parts, builders and household hardware, electronics, home appliances, medical instruments, office equipment, power tools, and zippers.

Stocks

Reported producer and consumer stocks of zinc in the United States decreased by 4% to 83,600 t in 2016. Global London Metal Exchange Ltd. (LME) warehouses held 427,850 t of zinc at the end of 2016, an 8% decrease from the yearend 2015 stock level, and the Shanghai Futures Exchange (SHFE) held 153,000 t of zinc, a 24% decrease (47,000 t) from that of 2015. In the United States, LME stocks of zinc were mostly held in warehouses in New Orleans, LA. At yearend 2016, LME warehouses in New Orleans, LA, held 380,125 t of zinc, or 89% of global LME stocks, a 4% increase from the 365,750 t held at yearend 2015 (International Lead and Zinc Study Group, 2017c, p. 55).

Aside from the United States, China was the only other country known to hold a Government stockpile of zinc. China's State Reserve Bureau (SRB) manages its stockpile, which contained 254,000 t of zinc at yearend 2016, unchanged from the stock level at yearend 2015 (International Lead and Zinc Study Group, 2017c, p. 55).

Prices

The annual average LME cash price for SHG zinc in 2016 increased by 8% from that of 2015 to \$2,090.34 per metric ton (94.82 cents per pound) (table 1). Prices steadily increased throughout the year. Prices averaged \$1,511.88 per metric ton (68.58 cents per pound) in January and rose to \$2,671.34 per metric ton (121.17 cents per pound) in December. The increase in price was coincident with increased investor interest and an increasing refined zinc production-to-consumption deficit; the latter supported by several significant mine closures and production cutbacks. The annual average Platts North American price for SHG zinc in 2016, which was based on the LME cash price plus a regional North American premium, was 101.37 cents per pound, 6% more than that in 2015 (table 1). Despite the increase in price, monthly average North American SHG premiums decreased steadily during the year, averaging about 6.53 cents per pound in January and decreasing to 6.02 cents per pound in December. Decreasing premiums are generally indicative of an increasing supply of zinc in a regional market.

World Review

Mine Production.—Global zinc mine production in 2016 decreased by 7% from that of the prior year to 12.6 Mt. China (38% share of global production), Peru (11%), and Australia (8%) continued to be the three leading producers of zinc in concentrate in 2016. The United States was the fourth-ranked producer, accounting for 6% of global zinc mine production. Zinc mine production decreased significantly in Australia (757,000-t decrease), India (140,000-t decrease), and Ireland (87,300-t decrease). Partially offsetting these decreases were

production increases in Canada (45,200-t increase), China (51,100-t increase), and Bolivia (47,800-t increase) (table 9).

There were several mine closures, suspensions, and production cutbacks in 2016. In October 2015, Glencore plc (Switzerland) announced a plan to reduce its global zinc mine production rate by 500,000 t/yr of contained zinc, equivalent to about one-third of its production (Glencore plc, 2015). In November, Glencore plc placed its Black Star zinc mine in Australia on care-and-maintenance status as a result of a depletion of reserves (Glencore plc, 2016). In May, Consolidated Tin Mines (Australia) closed its Mount Garnet Mine in Australia after reopening in the fourth quarter of 2015 pending additional funding. In January, Volcan Compañía Minera (Peru) suspended production at its Cerro do Pasco mining unit in Peru. Offsetting these closures were several additions totaling 169,000 t/yr of zinc mine capacity: most notably, the opening of Nevsun Resources Ltd.'s (Canada) 85,000-t/yr Bisha Mine in Eritrea and Trafigura Group Pte. Ptd.'s (Netherlands) 58,000-t/yr Aguas Teñidas Mine in Spain (International Lead and Zinc Study Group, 2017b, p. 36–37).

In January 2016, Nyrstar NV (Belgium) formally launched the divestment process of the majority of its Latin America mining operations (Nyrstar, 2017a; 2017b, p. 12). In June, the El Toqui Mine in Chile was sold to Laguna Gold Ltd. (Australia). In September, the company sold the El Mochito Mine in Honduras to Ascendant Resources Inc. (Canada). In both of these sales, the new owners agreed to sell 100% of the zinc concentrate production to Nyrstar; El Toqui's agreement was for a 4-year period, and El Mochito's agreement was for a 10-year period. In December, Nyrstar sold the Contonga Mine in Peru and its various mineral claims in Quebec, Canada, to subsidiaries of Glencore plc (Switzerland). Also in December, the Coricancha Mine in Peru was sold to Great Panther Silver Ltd. (Canada) (Nyrstar 2017b, p. 12).

Metal Production.—Global zinc metal production decreased slightly in 2016 from that of the prior year to 13.8 Mt. China (46% share of global production), the Republic of Korea (7%), Canada (5%), India (5%), and Japan (4%) were the leading producers of refined zinc metal in 2016. Production increased most significantly in China (210,000 t) and the Republic of Korea (77,800 t); offsetting these increases were notable production decreases in India (210,000 t) and the United States (46,000 t) (table 10). Global zinc smelter production capacity increased by 40,000 t/yr in 2016 as a result of Boliden AB's (Sweden) project to expand its Odda, Norway, refinery. There were no zinc smelter openings in the year (Boliden AB, 2017a, p. 4, 23; International Lead and Zinc Study Group, 2017b, p. 41–42).

Metal Consumption.—According to the International Lead and Zinc Study Group (2017c), global zinc metal consumption increased slightly from that of 2015 to 13.9 Mt. Notable increases in Australia, China, India, and the Republic of Korea more than offset reported decreases in Belgium, Peru, South Africa, Taiwan, and the United States. The leading consumer of zinc was China, accounting for 48% of global consumption. Other significant consumers included, in decreasing order of consumption, the United States, India, the Republic of Korea, Germany, Japan, and Belgium. Collectively, these countries account for 25% of global consumption. ILZSG's data indicated zinc metal consumption

exceeded production by 268,000 t in 2016 (International Lead and Zinc Study Group, 2017c, p. 46–47, 52).

Australia.—Zinc mine production in Australia decreased by 44% in 2016 compared with that of 2015, mainly as a result of several mine closures (table 9). In October, Glencore moved the Mount Isa Mines' Black Star open pit zinc mine to a care-and-maintenance phase after mining out the existing reserves. The mine operated for 13 years and had a zinc production capacity of 43,000 t/yr (Glencore, 2016). In May, Consolidated Tin Mines (Australia) closed its Mount Garnet Mine, after reopening in the fourth quarter of 2015, until additional funding could be secured. The mine had a zinc production capacity of 25,000 t/yr (International Lead and Zinc Study Group, 2017b, p. 37).

Canada.—Zinc mine production in Canada was 322,000 t in 2016, 16% more than in 2015 (table 9). Production increased in 2016, owing mostly to an increase in zinc production at Glencore's Kidd Creek Mine and Matagami mill and also to record production at Trevali's Caribou Mine (Glencore plc, 2017, p. 65; Trevali Mining Corporation, 2017). This increased production offset the closure of Yukon Zinc Corp.'s Wolverine Mine and Nyrstar's Myra Falls Mine (Nyrstar NV, 2015; 2016, p. 12, 23; Yukon Zinc Corp., 2015).

China.—Zinc mine production in China increased slightly in 2016 from that of 2015 to 4.8 Mt (table 9) and took place predominantly in the Nei Mongol Autonomous Region and Hunan and Yunnan Provinces, where combined production accounted for approximately one-half of China's zinc in concentrate production in 2016. According to Beijing Antaika Information Development Co. Ltd. (Antaika), increases in the zinc price and decreases in smelter treatment changes resulted in considerable mine profit, which stimulated an increase in output. As a result of the increase in mine production, China's net imports of zinc in concentrate decreased by 38% in 2016 to about 2 Mt. About one-half of China's zinc concentrate imports (gross weight) were sourced from Australia and Peru (Beijing Antaika Information Development Co. Ltd., 2017a, p. 12–20; 2017b, p. 9–13; Global Trade Information Services Inc., 2017).

Zinc metal production increased slightly in 2016 from that of 2015 to 6.3 Mt (table 10). Antaika reported that zinc smelters operated at stable production rates in 2016. Hunan, Shaanxi, and Yunnan were the three leading zinc-metal-producing Provinces in China and accounted for slightly over one-half of the country's zinc metal production in 2016. Domestic smelter production capacity in China remained relatively unchanged compared with increases in 2015 (Beijing Antaika Information Development Co. Ltd., 2017a, p. 14–15).

China's zinc consumption increased in 2016 from that of 2015 coinciding with higher utilization rates in the country's automotive, construction, and galvanization sectors. ILZSG reported a 9% increase in zinc consumption in 2016 compared with a slight decrease in 2015 (Beijing Antaika Information Development Co. Ltd., 2017b, p. 10–12; International Lead and Zinc Study Group, 2017c, p. 47).

Finland.—After decreasing in 2015, zinc mine production increased significantly in Finland in 2016 owing to the rampup and first full year of production at Terrafame Ltd.'s mine located in Sotkamo. The mine produced 22,600 t of zinc during its first full year (Terrafame Ltd., 2017). Zinc smelter production

decreased by 5% in 2016 (table 10) owing to disruptions in production, including a fire in the cell house, and lower recovery levels at Boliden's Kokkola smelter (Boliden AB, 2017a, p. 39; 2017b, p. 10).

Honduras.—Zinc mine production decreased by 37% in Honduras in 2016. In September, Nyrstar NV sold the El Mochito Mine, the only zinc mine in Honduras, to Ascendant Resources, Inc. (Canada) in December. The new owners agreed to sell 100% of the zinc concentrate production to Nyrstar for a 10-year period. Production in 2016 for the El Mochito Mine was affected by safety incidents and Nyrstar's divestment process (Nyrstar NV, 2017b, p. 4, 12). Ascendant announced plans to implement optimization programs focused on opportunities to increase mine production, and full mine operations resumed in February 2017 (Ascendant Resources Inc., 2017a, b).

India.—Zinc mine and metal production decreased in India in 2016 primarily owing to Hindustan Zinc Ltd.'s (HZL's) (a joint venture predominantly between Vedanta Ltd. and the Government of India) continued plan to transition the Rampura Agucha Mine from an open pit to an underground operation. The decrease in Rampura Agucha's production was partially offset by production at HZL's underground mines, especially Sindesar Khurd and Kayad. As an open pit mine, Rampura Agucha's ore production capacity was 6.15 million metric tons per year (Mt/yr). HZL planned to operate both the open pit and underground mine until the fiscal year ending March 31, 2020, maintaining an average production rate of about 5.0 Mt/yr of ore. Once Rampura Agucha became solely an underground mine, ore production capacity would decrease to 3.75 Mt/yr (Hindustan Zinc Ltd., 2016a, p. 28, 31–32; 2016b).

Ireland.—Zinc mine production in Ireland decreased by 37% in 2016 from that of 2015 to 149,000 t of contained zinc (table 9) mostly as a result of the closure of Vedanta's Lisheen Mine owing to reserve depletion. Mining activities and concentrate production at Lisheen stopped in late 2015 (PR Newswire, 2016). Boliden's Tara Mine was the only zinc-producing mine in Ireland in 2016 (CRU International Ltd., 2017).

Peru.—Zinc mine production in Peru decreased by 6% in 2016 from that of 2015 (table 9) as a result of decreased production at the Antamina copper-zinc mine [a joint venture among BHP Billiton plc (33.75%), Glencore plc (33.75%), Teck (22.5%), and Mitsubishi Corp. (10%)], and suspensions of production at Glencore's Iscaycruz Mine and Volcan's (Peru) Cerro do Pasco mining unit (Ministry of Energy and Mines of Peru, 2017, p. 58). Zinc production decreased by 12% at Antamina in 2016 to 195,000 t primarily as a result of a decrease in the amount of copper-zinc ore processed. In 2018 to 2020, zinc production at Antamina was projected to increase as mining was expected to take place in an area of higher zinc ore grades resulting in an increased proportion of copper-zinc ore mined. Copper and zinc production at Antamina can vary significantly from year to year owing to the geology of the deposit and the proportion of copper to copper-zinc ore produced (Teck Resources Ltd., 2017a, p. 20–22).

In October 2015, Glencore announced plans to reduce its zinc mine production by 500,000 t/yr in response to low lead and zinc prices. The suspension of the Iscaycruz Mine was included in this reduction, and the mine remained suspended throughout

2016 (Glencore plc, 2015, 2017). Operations at Volcan's Cerro de Pasco mining unit were temporarily suspended from November 2015 to November 2016 (Volcan Compañía Minera S.A.A., 2017, p. 67).

Spain.—Zinc mine production increased by an estimated 53% in 2016 compared with that in 2015 (table 9) mostly as a result of increased production at the Aguas Teñidas Mine [a joint venture between Trafigura (50%) and Mubadala Investment Co. (50%)]. The mine, located in Valdelamusa, had a zinc production capacity of 58,000 t/yr for the majority of 2016. The company completed work to double zinc capacity to 116,000 t/yr in the fourth quarter of 2016 (International Lead and Zinc Study Group, 2017b, p. 36; Trafigura Group Pte. Ltd., 2017, p. 32).

Outlook

ILZSG forecast global zinc consumption in 2017 to increase by 3% from that in 2016 to 14.3 Mt primarily owing to continued demand in China and India. In Europe, consumption was projected to remain flat. On the supply side, ILZSG forecast global zinc mine production to increase by 7% to 13.7 Mt as a result of recovered production output at India's Rampura Agucha Mine and increased output at Peru's Antamina Mine. Metal production is forecasted to increase by 3% to 14.1 Mt in 2017 owing to an increase in China and a recovery of India's mine production. Overall, zinc metal consumption is expected to exceed production by 226,000 t in 2017 despite the expected increase in zinc mine supply (International Lead and Zinc Study Group, 2017a).

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TABLE 1
 SALIENT ZINC STATISTICS¹

(Metric tons, unless otherwise specified)

	2012	2013	2014	2015	2016
United States:					
Production:					
Domestic ores:					
Contained zinc	738,000	784,000	831,000 ^r	825,000	805,000
Recoverable zinc:					
Quantity	713,000	758,000	803,000	797,000	778,000
Value	\$1,510,000	\$1,600,000	\$1,900,000	\$1,680,000	\$1,740,000
thousands					
Refined zinc:					
At primary smelters	114,000	106,000	110,000	124,000	111,000
At secondary smelters ^c	147,000	127,000	70,000	48,300	15,000
Total	261,000	233,000	180,000	172,000	126,000
Exports:					
Ores and concentrates, zinc content	591,000	669,000	644,000	708,000 ^r	597,000
Refined zinc	14,200	11,500	19,800	12,700	46,900
Imports for consumption:					
Ores and concentrates, zinc content	6,140	2,370 ^r	2	22	60
Refined zinc	655,000	713,000	805,000	771,000	713,000
Reported stocks of refined zinc, December 31:					
Producer and consumer	74,200	73,600 ^r	88,000 ^r	86,700 ^r	83,600
Government stockpile	7,250	7,250	7,250	7,250	7,250
Consumption, refined zinc:					
Reported	380,000	414,000	403,000	433,000	462,000
Apparent ²	902,000	935,000	965,000	931,000	792,000
Price:³					
North American	95.76	95.57	107.12	95.54	101.37
cents per pound					
London Metal Exchange, cash	88.35	86.64	98.05	87.64	94.82
do.					
World, production:					
Mine	13,300 ^r	13,700 ^r	13,600 ^r	13,500 ^r	12,600
thousand metric tons					
Smelter	12,600	13,000	13,400 ^r	13,900	13,800
do.					

^cEstimated. ^rRevised. do. Ditto.

¹Table includes data available through September 28, 2017. Data are rounded to no more than three significant digits, except prices; may not add to totals shown.

²Smelter production plus imports for consumption minus domestic imports.

³Special High Grade. Source: Platts Metals Week.

TABLE 2
MINE PRODUCTION OF RECOVERABLE ZINC
IN THE UNITED STATES, BY STATE¹

(Metric tons)

State	2015	2016
Alaska	629,000	658,000
Other ²	168,000	120,000
Total	797,000	778,000

^rRevised.

¹Table includes data available through September 28, 2017. Data are rounded to no more than three significant digits; may not add to totals shown.

²Includes production from Idaho, Missouri, Tennessee, and Washington.

TABLE 3
LEADING ZINC-PRODUCING MINES IN THE UNITED STATES IN 2016, IN ORDER OF OUTPUT¹

Rank	Mine	County and State ²	Operator	Source of zinc
1	Red Dog	Northern Region, AK	Teck Alaska Inc.	Zinc-lead ore.
2	East Tennessee Zinc Complex ³	Jefferson and Knox, TN	Nyrstar Tennessee Mines - Strawberry Plains LLC	Zinc ore.
3	Greens Creek	Southeastern Region, AK	Hecla Mining Co.	Zinc-silver ore.
4	Pend Oreille	Pend Oreille, WA	Teck American Inc.	Zinc-lead ore.
5	Lucky Friday	Shoshone, ID	Hecla Mining Co.	Silver ore.
6	Brushy Creek	Reynolds, MO	Doe Run Resources Corp.	Lead ore.
7	Viburnum (#29 and #35)	Washington and Iron, MO	do.	Do.
8	Sweetwater	Reynolds, MO	do.	Do.
9	Fletcher	do.	do.	Do.
10	Buick	Iron, MO	do.	Do.

Do., do. Ditto.

¹The mines on this list accounted for 100% of recoverable U.S. zinc mine production in 2016.

²For Alaska, mines are located by geographic region, as delineated by the Alaska Division of Geological & Geophysical Surveys in its Special Report 67, Alaska's mineral industry 2013—Exploration activity.

³Includes the Coy, Immel, and Young Mines.

TABLE 4
ZINC RECOVERED FROM SCRAP PROCESSED IN THE UNITED
STATES, BY TYPE OF SCRAP¹

(Metric tons)

Type of scrap	2015	2016
New scrap:		
Zinc-base	53,200	52,400
Copper-base	91,500	82,200
Magnesium-base	297 ^r	373
Total	145,000	135,000
Old scrap:		
Zinc-base	45,700	22,900
Copper-base	6,670	5,910
Aluminum-base	389 ^r	403
Magnesium-base	9 ^r	9
Total	52,800 ^r	29,300
Grand total	198,000	164,000

^rRevised.

¹Table includes data available through September 28, 2017. Data are rounded to no more than three significant digits; may not add to totals shown.

TABLE 5
U.S. REPORTED CONSUMPTION OF ZINC IN 2016, BY INDUSTRY USE AND GRADE¹

(Metric tons)

Industry use	Special	High	Continuous	Controlled	Prime	Remelt	Total
	High Grade	Grade	Galvanizing Grade	Lead Grade	Western	and other grades	
Galvanizing	81,400	67,800	227,000	--	21,100	318	397,000
Zinc-base alloys	26,800	82	--	--	--	--	26,900
Brass and bronze	23,700	10,200	--	--	98	19	34,000
Other	4,190	--	--	--	--	--	4,190
Total	136,000	78,200	227,000	--	21,100	337	462,000

-- Zero.

¹Table includes data available through September 28, 2017. Data are rounded to no more than three significant digits; may not add to totals shown.

TABLE 6
U.S. EXPORTS OF ZINC ORES AND CONCENTRATES, BY COUNTRY OR LOCALITY¹

	2015		2016	
	Quantity (metric tons, zinc content)	Value (thousands)	Quantity (metric tons, zinc content)	Value (thousands)
Australia	66,500	\$79,300	47,800	\$78,100
Belgium	52,900	67,100	26,800	40,600
Canada	224,000 ^r	309,000 ^r	209,000	347,000
China	1,350	737	6,440	11,000
Dominican Republic	--	--	2	8
El Salvador	17	46	48	141
Finland	26,800	56,000	30,700	43,500
Germany	26,100	41,000	30,600	45,700
Italy	40,400	47,700	16,500	23,500
Japan	63,000	94,600	38,100	59,400
Korea, Republic of	120,000	144,000	102,000	159,000
Mexico	130 ^r	101 ^r	75	81
Norway	3,970	5,250	--	--
Panama	6	22	6	23
Spain	82,300	141,000	88,800	130,000
Trinidad and Tobago	--	--	1	3
Venezuela	10	38	--	--
Total	708,000 ^r	986,000 ^r	597,000	938,000

^rRevised. -- Zero.

¹Table includes data available through September 28, 2017. Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 7
U.S. EXPORTS OF ZINC COMPOUNDS¹

	2015		2016	
	Quantity (metric tons, gross weight)	Value (thousands)	Quantity (metric tons, gross weight)	Value (thousands)
Chromates of zinc or of lead	24	\$713	25	\$644
Lithopone	1,040	7,200	1,260	7,160
Zinc chloride	419	657	856	1,130
Zinc oxide	21,800	28,900	55,300	56,300
Zinc sulfate	726	751	588	850
Zinc sulfide	780	14,100	1,040	14,500

¹Table includes data available through September 28, 2017. Data are rounded to no more than three significant digits.

Source: U.S. Census Bureau.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF ZINC COMPOUNDS¹

	2015		2016	
	Quantity (metric tons, gross weight)	Value (thousands)	Quantity (metric tons, gross weight)	Value (thousands)
Chromates of zinc or of lead	128	\$2,220	220	\$539
Lithopone	1,200 ^r	1,610 ^r	2,670	6,310
Zinc chloride	154	1,150	137	1,290
Zinc oxide	116,000	250,000	123,000	239,000
Zinc sulfate	89,000	68,100	79,900	60,400
Zinc sulfide	2,460	8,050	579	1,600

^rRevised.

¹Table includes data available through September 28, 2017. Data are rounded to no more than three significant digits.

Source: U.S. Census Bureau.

TABLE 9
ZINC: WORLD MINE PRODUCTION, BY COUNTRY OR LOCALITY¹

(Metric tons, zinc content of concentrate and direct shipping ore unless otherwise specified)

Country or locality	2012	2013	2014	2015	2016 ^p
Argentina	39,602	39,424	28,038 ^r	30,498 ^r	30,000 ^e
Armenia ²	7,370 ^r	9,050 ^r	8,460 ^r	6,500 ^{r,e}	4,100
Australia	1,520,484 ^r	1,525,515 ^r	1,475,166 ^r	1,721,871 ^r	965,309
Bolivia	389,911	407,332	448,970 ^r	442,154 ^r	490,000 ^e
Bosnia and Herzegovina ^c	7,400 ^r	9,200 ^r	8,000 ^r	7,000	8,000
Brazil	164,258 ³	152,147 ³	169,766 ³	160,000 ^e	160,000 ^e
Bulgaria	8,995 ³	11,992 ³	11,299 ^r	10,783 ^r	10,000 ^e
Burkina Faso	--	32,215 ³	65,000 ³	62,000 ²	65,000 ^e
Burma	10,000 ^e	4,800 ^r	6,100 ^r	10,000	10,000
Canada	641,134	426,545	352,125	276,519	321,757
Chile	26,762	29,759	45,094	48,071	46,000 ^e
China	4,860,000 ^r	5,190,000 ^r	5,120,000 ^r	4,750,000 ^r	4,800,000
Congo (Kinshasa)	10,572 ^r	12,114 ^r	12,737 ^r	12,675	11,650
Eritrea	--	--	--	--	40,900 ^e
Finland	52,303	40,956	43,000 ^{r,e}	25,000 ^{r,e}	45,852
Greece	22,585 ^r	22,262 ^{r,2}	22,658 ^{r,2}	14,936 ^{r,2}	18,000 ²
Guatemala	--	1,221	13,394	14,810	15,000
Honduras	25,603	25,223	29,509	22,992	14,579
India	758,000	793,000	706,000	822,000 ^r	682,000
Iran ^c	140,000	130,000	150,000 ^r	168,210 ^r	130,000
Ireland	337,500	326,700	282,600	236,300	149,000
Kazakhstan	369,700	361,500	345,200	342,500 ^r	340,000 ^e
Korea, North	35,000	36,000	32,000	26,000	30,000
Korea, Republic of ²	1,430	1,750	1,918 ^r	2,070	1,825
Kosovo	3,818	4,983	5,500 ^r	3,986	4,640
Laos	1,600 ²	1,500 ²	--	--	--
Macedonia ²	28,000 ^r	31,000 ^r	32,000	29,000	25,000 ^e
Mexico	660,349	642,542	659,878	677,000 ^{r,e}	670,000 ^e
Mongolia ²	59,600	52,100	46,600	44,800	50,100
Montenegro ^c	9,200 ^r	9,200 ^r	14,400 ^r	14,100 ^r	14,000
Morocco	45,800 ²	47,600 ^{r,2}	45,000 ^{r,2}	53,260 ^{r,2}	50,000 ^e
Namibia	194,380 ²	184,109 ²	172,783	123,672	129,856
Nigeria	13,800	7,000	7,000 ^{r,e}	14,200 ^{r,e}	17,000 ^e
Pakistan	10,000 ^e	5,000 ^e	--	--	--
Peru	1,280,949 ^r	1,350,874 ^r	1,315,215 ^r	1,421,218 ^r	1,334,327
Philippines	19,559	16,730	--	--	--
Poland	57,700	58,200	70,000 ^r	65,000 ^r	62,000 ^e
Portugal	30,006	53,382	67,378	61,921	69,527
Russia ⁴	179,800	248,300 ^r	273,000 ^{r,e}	250,000 ^{r,e}	230,000 ^e
Saudi Arabia	11,200	18,300	17,400	18,400	9,000
Serbia ^c	5,000	5,000	5,000	5,000	5,000
South Africa	37,034	30,145	26,141	29,040	26,695
Spain	28,634	30,428	26,756	41,765	64,000 ^e
Sweden	188,391	176,578	221,882	246,889	257,335
Tajikistan ^c	20,000	20,000	30,000	40,000	40,000
Thailand	31,000	30,000	39,140	34,738	34,500
Turkey	209,000 ^{r,3}	200,000 ³	212,000 ^{r,e}	174,000 ^{r,e,3}	200,000 ^e
United States	738,000	784,000	831,000 ^r	825,000	805,000
Uzbekistan ^c	20,000 ^r	40,000 ^r	50,000 ^r	50,000 ^r	50,000
Vietnam ^c	30,000	20,000	17,000 ^r	17,000 ^r	20,000
Total	13,300,000 ^r	13,700,000 ^r	13,600,000 ^r	13,500,000 ^r	12,600,000

See footnotes at end of table.

TABLE 9—Continued
ZINC: WORLD MINE PRODUCTION, BY COUNTRY OR LOCALITY¹

(Metric tons, zinc content of concentrate and direct shipping ore unless otherwise specified)

^eEstimated. ^pPreliminary. ^rRevised. -- Zero.

¹Table includes data available through May 15, 2017. All data are reported unless otherwise noted. Totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Data derived from reported production of zinc concentrates.

³Estimated based on reported exports of zinc ores and concentrates.

⁴May not include production from some small-scale mining operations.

Sources: British Geological Survey; Bulgarian Association of the Metallurgical Industry; Chamber of Mines (Namibia); Chilean Copper Commission; China Nonferrous Metals Industry Association; Company reports; Department of Industry and Science (Australia); Department of Mineral Resources (South Africa); Department of Statistics of Kazakhstan; Geological Survey of Finland; International Lead and Zinc Study Group; Istanbul Minerals & Metals Exporters' Association; Korea Institute of Geoscience and Minerals Resources; Lao Department of Mines; Mineral Resources Authority of Mongolia; Mines and Geosciences Bureau (Philippines); Ministry of Energy and Mines (Peru); Ministry of Energy, Mines, Water, and the Environment (Morocco); Ministry of Industry, Energy, and Tourism (Spain); Ministry of Mines (Democratic Republic of the Congo); Ministry of Natural Resources and Ecology (Russia); National Department of Mineral Production (Brazil); National Institute of Statistics and Census (Argentina); National Institute of Statistics and Geography (Mexico); National Statistical Service of the Republic of Armenia; Natural Resources Canada; Polish Geological Institute; U.S. Geological Survey.

TABLE 10
ZINC: WORLD SMELTER PRODUCTION, BY COUNTRY OR LOCALITY^{1,2}

(Metric tons, zinc content)

Country or locality	2012	2013	2014	2015	2016 ^p
Algeria, primary ^c	8,090 ^r	6,980 ^r	3,980 ^r	7,090 ^r	5,000
Argentina, primary	37,797	36,712	29,122	30,000 ^c	-- ^c
Australia, primary	498,259	498,291	481,573	489,030 ^r	464,176
Belgium, primary	250,000	252,000	262,000	260,000	236,000
Brazil, primary	245,526 ^r	245,417	246,120	230,000 ^c	240,000 ^c
Bulgaria, primary	73,558	75,830	76,293 ^r	75,100	75,000 ^c
Canada, primary	648,619	651,638	649,217	683,118	691,389
China:					
Primary	4,770,000	5,160,000	5,610,000	5,910,000	6,110,000 ^c
Secondary	120,000	150,000	170,000	180,000	189,000 ^c
Total	4,890,000 ^r	5,310,000 ^r	5,780,000 ^r	6,090,000 ^r	6,300,000
Finland, primary	314,742	311,686	302,024	305,717	290,599
France, primary	161,000	152,000	171,000	169,000	149,000
Germany, primary and secondary	169,400	162,000	168,000	169,000 ^c	170,000 ^c
India:					
Primary	703,495	768,834	705,707	821,617	611,814
Secondary	25,505	19,166	18,293	16,383	16,189
Total	729,000 ^r	788,000 ^r	724,000 ^r	838,000 ^r	628,000
Iran, primary and secondary	148,000 ^r	140,000	145,000 ^r	138,000 ^r	120,000 ^c
Italy, primary	100,000 ^c	111,000	138,100	139,200	140,000 ^c
Japan:					
Primary	459,322	470,573	458,481	457,786	438,650
Secondary	111,990	116,718	124,540	108,833	95,129
Total	571,000 ^r	587,000 ^r	583,000 ^r	567,000 ^r	534,000
Kazakhstan, primary and secondary	319,847 ^r	320,150	324,946	323,848 ^r	325,000 ^c
Korea, North, primary and secondary ^c	35,000	35,000	30,000	20,000	20,000
Korea, Republic of, primary	876,550	885,804	900,943	934,949	1,012,763
Mexico, primary	323,569	322,781	320,924	326,642	321,159
Namibia, primary	144,508	124,924 ^r	117,783 ^r	71,691 ^r	75,559
Netherlands, primary	257,000	275,000	290,000	291,000	283,000
Norway, primary	152,647	143,444	165,600	162,878	170,541
Peru, primary	319,280	346,362	336,454	335,422	341,518
Poland, primary	138,300	146,300	154,000 ^{r, c}	161,000 ^{r, c}	155,000 ^c
Russia, primary and secondary	250,000	216,260	223,311 ^r	229,602	247,303
Spain, primary	489,455	490,488	491,331	493,765 ^r	500,000 ^c
Thailand, primary	97,000	78,000	70,100	74,121	72,813
United States:					
Primary	114,000	106,000	110,000	124,000	111,000
Secondary	147,000	127,000	70,000	48,000	15,000
Total	261,000	233,000	180,000	172,000	126,000
Uzbekistan, primary	61,100	54,000	66,000	73,000	85,000
Vietnam, primary ^c	18,000	12,000	12,000	10,000	10,000
Grand total	12,600,000	13,000,000	13,400,000 ^r	13,900,000	13,800,000
Of which:					
Primary	11,300,000 ^r	11,700,000 ^r	12,200,000 ^r	12,600,000 ^r	12,600,000
Secondary	405,000 ^r	413,000 ^r	383,000 ^r	353,000 ^r	315,000
Undifferentiated	922,000 ^r	873,000 ^r	891,000 ^r	880,000 ^r	882,000

^cEstimated. ^pPreliminary. ^rRevised. -- Zero.

¹Table includes data available through May 15, 2017. All data are reported unless otherwise noted. Totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Wherever 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.

Sources: Bulgarian Association of the Metallurgical Industry; Chamber of Mines of Namibia; China Nonferrous Metals Industry Association; Company reports; Department of Statistics (Kazakhstan); Federal Institute for Geosciences and Natural Resources (Germany); Indian Bureau of Mines; International Lead and Zinc Study Group; Ministry of Economy, Trade, and Industry (Japan); Ministry of Energy and Mines (Namibia); Ministry of Energy and Mines (Peru); Ministry of Natural Resources and Ecology (Russia); National Department of Mineral Production (Brazil); National Institute of Statistics and Census (Argentina); Natural Resources Canada; Office of the Chief Economist (Australia); Polish Geological Institute; U.S. Geological Survey.