



2015 Minerals Yearbook

IRON ORE [ADVANCE RELEASE]

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In 2015, demand for domestic iron ore production decreased owing to increased consumption of imported steel products. As a result, several mines and facilities were idled. In the United States, the vertically integrated structure of iron and steel companies and long-term price contracts buffered iron ore producers from falling global prices; however, low-cost steel imports increased competition in the steel industry and reduced demand for iron ore domestically. U.S. iron ore production decreased by 18% to 46.1 million metric tons (Mt) of usable ore in 2015 from 56.1 Mt in 2014. The United States was the eighth-ranked world producer of iron ore by usable ore and iron content (fig. 1, table 10).

Overall, global iron ore production in 2015 was essentially unchanged from that in 2014; this was the first year production did not increase since 2001. Pig iron production, the primary end use of iron ore, decreased by 2% in 2015, the first decrease since 2009. Global iron ore production was 2.29 billion metric tons (Gt) of usable ore, containing an estimated 1.40 Gt of iron, a slight decrease from that of 2014. Global iron ore production, on a usable-ore basis, was led by Australia (817 Mt), Brazil (397 Mt), China (375 Mt), India (156 Mt), and Russia (101 Mt), which combined accounted for 81% of global production.

Raw steel production in China decreased by 21 Mt, the first decrease in many years, resulting in decreased demand for iron ore (American Iron and Steel Institute, 2015). This led to an oversupply of iron ore and prices declined sharply; however, low-cost, high-volume producers, such as Australia, Brazil, and India increased production, on a usable-ore basis, by 42 Mt, 11 Mt, and 27 Mt, respectively, in 2015.

Iron ore is the basic raw material for producing steel, an alloy critical to the economies of all industrialized nations. Two iron oxides—hematite (Fe_2O_3) and magnetite (Fe_3O_4)—are the primary iron ore minerals found in the United States. The principal form of iron ore mined in the United States contains hematite and magnetite in varying proportions, averaging 25% to 30% iron content (Fe), and occurs in hard, fine-grained, banded iron formations also known as taconite. Magnetite is the main iron oxide recovered during concentration, although hematite tailings have become an alternative source of primary iron.

In the United States, low-grade iron ore is concentrated to reach, on average, the 62.5% Fe or greater benchmark required globally for steel production. The concentrates can then be agglomerated using binders to create iron ore pellets, which can be more easily transported and more efficiently melted in blast furnaces. More than 98% of all domestic iron ore production is transformed into molten iron, also known as pig iron, in blast furnaces by removing residual oxygen. The pig iron then may be transferred to basic oxygen furnaces (BOFs) for the removal of residual carbon and conversion to steel.

Small-scale steel mills, also known as minimills, use electric arc furnaces (EAFs) to produce steel from iron metallics and recycled steel scrap. Iron metallics—cold pig iron, direct-reduced iron (DRI), hot-briquetted iron (HBI), and iron nuggets—are intermediate iron products that have become increasingly cost effective as supplements to lower grades of steel scrap when integrated into the EAF process. DRI, also known as sponge iron, is produced through solid-state reduction of iron ore to 90% to 94% Fe (about the same iron content as molten pig iron); however, DRI requires special handling owing to its high susceptibility to oxidation. HBI is a higher density, premium quality form of briquetted DRI with lower susceptibility to oxidation. Iron nuggets, also known as iron nodules, are the least reactive among iron metallics and are a premium grade of pig iron, with an average of 97% to 99% Fe and almost no gangue.

Iron ore also may be used for nonsteel applications including ballast, cement clinker production, coal washing, crushed road base material, fertilizer, heavy media separation, iron oxide pigments, ferrite magnets, oil and gas well drilling, radiation shielding, water treatment, and other specialty applications. These applications represent a relatively small portion of iron ore consumption. Some applications require costly beneficiation to create high-grade products. Data for these applications are not included in the U.S. Geological Survey's (USGS's) tables for domestic iron ore consumption, exports, imports, production, shipments, or stocks, unless otherwise noted. With the exception of iron oxide pigments and cement clinker, USGS surveys do not include production or consumption of iron ore for miscellaneous, nonsteel end uses.

This report includes information from surveys of domestic producers, government agency reports, company reports, and public information. Trade data in this report are from the U.S. Census Bureau. Labor statistics were based on data available from the Mine Safety and Health Administration. Percentages in the report were computed using unrounded data and were rounded to three significant digits.

Legislation and Government Programs

Regulations, legislative initiatives, and monitoring of environmental issues regarding iron ore production continued as previously reported, with no significant changes in 2016. The aspects of iron ore production under environmental consideration included, but are not limited to, cross-state air pollution, effects of sulfate discharge on wild rice and water quality standards, greenhouse gas emissions, hazardous air pollutants, mercury discharge, regional haze, selenium discharge, sulfur dioxide and nitrogen dioxide emissions, and water conductivity as a measure of dissolved minerals (Cliffs Natural Resources, Inc., 2016, p. 11–15).

The Trade Promotion Authority and the Trade Preferences Extension Act, including Trade Adjustment Assistance, were signed into law in June 2015. These laws were designed as tools to assist U.S. companies and workers that are disproportionately affected by unfair trade practices such as dumping of foreign goods, including iron and steel products (American Iron and Steel Institute, 2015; United States Steel Corp., 2015b).

The Congressional Steel Caucus, a bipartisan coalition of U.S. lawmakers that promotes the health and stability of the domestic steel industry and its workforce, met with representatives from major iron ore and steel producing companies in the United States as part of an annual hearing in Washington, DC. The companies attributed the recent rise in U.S. steel imports to reductions in iron ore and steel production in the United States that took place in response to the global oversupply of iron ore and falling prices for both commodities. Import quantities from China, the Republic of Korea, and Turkey were compared with those from the late 1990s, when a similar market situation resulted in the bankruptcies of United States steel producers (Caffarini, 2015).

Production

The USGS developed the U.S. iron ore data shown in tables 1 and 2 through an annual “Iron Ore” survey, which was sent to 15 mines and facilities that produce iron ore and iron metallics for steel production. This information was supplemented by company reports, employment data, mine inspection reports, and tax data. Steel plant data were compiled by the American Iron and Steel Institute. Information on the capacity, production, and reserves of individual operations in the United States can be found in table 3.

Louisiana.—Nucor Steel Louisiana, LLC’s 2.5-million-metric-ton-per-year (Mt/yr) DRI operation, which began production in St. James Parish in late December 2013, experienced a failure of equipment in November 2014 and was shut down through the first quarter of 2015. The company also shut down the plant from October 2015 through late January 2016 (Nucor Corp., 2016, p. 21).

Michigan.—In 2015, the Empire and Tilden Mines in Michigan, operated by Cliffs Natural Resources Inc., reported production of 10.8 Mt of pellets, 11% less than 12.1 Mt in 2014 (table 2). In February, Cliffs finalized an interim power agreement for its Michigan operations, cited as a key step to ensure the viability of its iron ore mines in the Upper Peninsula. The agreement was expected to reduce costs for the company. The Empire Mine was temporarily idled from late June through mid-October 2015 owing to lower tolling requirements from the Tilden Mine as a result of reduced demand. The partnership agreement used in operating the Empire Mine was set to expire at yearend 2016 following an extension in 2014 (Cliffs Natural Resources Inc., 2016, p. 33).

Minnesota.—In Minnesota, 10 iron ore facilities operated, including 6 colocated open pit mines, concentrators, and pellet facilities and 4 tailings reclamation operations. One DRI facility operated in Minnesota fed by one of the tailings reclamation operations. The Minnesota Executive Council reduced mineral royalty rates for iron ore mined on State lands. The rate was reduced by 19% for Hibbing Taconite Co. [a joint venture of ArcelorMittal USA, Cliffs, and United States

Steel Corp. (U.S. Steel)], ArcelorMittal’s Minorca Mine, and Cliffs’ Northshore Mining Co., retroactive to April 2015 through June 2016. Similar rate cuts were enacted for U.S. Steel’s Minntac Mine earlier in the year (Myers, 2015). In 2015, operations in Minnesota produced 32.8 Mt of pellets, 21% less than the 41.4 Mt produced in 2015. Overall production of salable iron products in the State decreased by 18% to 35.5 Mt in 2015 from 43.2 Mt in 2014 (table 2). Nonoperational deposits in Minnesota’s Mesabi Range, including the former LTV Corp.’s mine and the Buhl, Kinney, McKinley, and Sherman deposits, were estimated to contain approximately 1.5 Gt of high-grade iron ore. An additional 1 Gt of iron ore in tailings ponds and stockpiles were also considered economically recoverable (Minnesota Department of Natural Resources, 2013).

In 2015, the mines operated by Cliffs in Minnesota, which included the Hibbing, Northshore, and United Taconite Mines, reported production of 15.7 Mt, 13% less than the 18.1 Mt produced in 2014. In January, one of the four furnaces at Northshore was idled and the mine was idled completely in November. United Taconite was idled at the beginning of August. Both mines were idled owing to reduced iron ore demand by steel producers and were expected to be idle through at least the first quarter of 2016. The company expected to continue meeting customer demand using existing stocks. Cliffs terminated its pellet sale and purchase agreement with Essar Steel Algoma Inc., although Cliffs was considering a just-in-time iron ore supply arrangement with Essar Algoma (Cliffs Natural Resources Inc., 2016, p. 33–34).

In 2015, the mines operated by U.S. Steel, which included the Keetac (Keewatin Taconite) and Minntac (Mt. Iron) Mines, reported production of 14.1 Mt, 30% less than the 20.1 Mt produced in 2014. As a result of reduced steel production, the Keetac Mine was idled in May and production from the Minntac Mine was partially idled in June (United States Steel Corp., 2015c; 2016, p. 32).

Magnetation LLC announced that it would indefinitely idle its Plant 1 iron ore concentrate facility in Keewatin, MN, by the end of March 2015 and potentially idle Plant 2 in Bovey, MN, on or after January 31, 2016. The company cited low global iron ore prices and market uncertainty. Plant 1 was Magnetation’s highest cost and smallest operation, which had been scheduled to produce 350,000 metric tons (t) of iron ore concentrate in 2015. Plant 2, a 1.1-Mt/yr tailings reclamation operation, would be the second operation the company had to shut down within a 12-month period (Magnetation LLC, 2015a, b). Following a planned idling of Mesabi Nugget, LLC’s plant in Hoyt Lakes, MN, in the first quarter of 2015, the plant and its concentrates supplier, Mining Resources, LLC, were expected to remain idle for 24 months (Duluth News Tribune, 2015).

At yearend 2015, Essar Steel Minnesota Inc. and its parent company, Essar Global Fund Ltd., owners of a 7.7-Mt/yr iron ore facility under construction in Nashauk, accepted the State of Minnesota’s final offer for repayment of multiple State-funded loans. The company was expected to begin making payments in February 2016, repaying \$10 million to the State by the end of March 2016, and making quarterly payments, beginning in 2017, to satisfy the remainder of the \$66 million loan. The agreement also required the company to notify the State

of the repayment status to contractors and project vendors each quarter (State of Minnesota, 2015). The project had curtailed construction multiple times in recent years owing to a lack of funding, and no completion date had been set as of yearend 2015.

Utah.—Palladon Ventures Ltd. agreed to sell CML Metals Corp., an iron ore mine in Utah that was idled in October 2014, to Gilbert Development Corp. (Palladon Ventures Ltd., 2015).

Wisconsin.—Gogebic Taconite LLC formally notified Wisconsin's Department of Natural Resources that the company was withdrawing from its mining project in Ashland County, WI. The company withdrew from the proposed open pit iron ore mine following the completion of the company's environmental fieldwork owing to regulatory uncertainty and Federal requirements for mitigating wetlands (Bergquist, 2015).

Consumption

Iron ore is primarily consumed in the steelmaking process. It is estimated that producing 1 t of steel requires 0.4 t of coking coal, 0.3 t of steel scrap, and 1.3 t of iron ore pellets, as well as 6 million British thermal units of natural gas, using blast furnaces at normal operating conditions. In 2015, U.S. consumption of iron ore, by gross weight, reported to the American Iron and Steel Institute, totaled 38.5 Mt, including 32.1 Mt of pellets; 5.1 Mt of sinter, briquettes, nodules, and other products; and 1.3 Mt of direct-shipping ore (table 4).

Production of pig iron, the primary phase of steelmaking in which iron ore is consumed before raw steel is produced, decreased to 25.4 Mt in 2015, 13% less than the 29.4 Mt produced in 2014. Raw steel production by BOFs, which accounts for nearly all pig iron consumption, decreased to 29.4 Mt, 11% less than the 33.0 Mt produced in 2014, and accounted for 37% of total raw steel production in 2015, nearly the same as the prior year. Total raw steel production decreased to 78.8 Mt, 11% less than the 88.2 Mt produced in 2014 (American Iron and Steel Institute, 2016, p. 70, 75). Although imported iron ore supplemented domestically produced iron ore, the United States remained a net exporter with 7.5 Mt of exports and 4.6 Mt of imports, down from 12.1 Mt of exports and 5.1 Mt of imports in 2014 (tables 5, 6).

Transportation

Domestically, iron ore is transported from mines to rail stations by heavy hauling trucks and by rail to port facilities on the Great Lakes or to processing facilities in North America. From ports, ore is transported by ship across the Great Lakes and (or) through the St. Lawrence Seaway to the Atlantic Ocean. Bulk iron ore products are primarily transported by freighter across the Great Lakes owing to cost-effective transportation rates. Seasonal fluctuations in shipments, production, sales, and stocks of iron ore in Minnesota and Michigan from December through April were a result of the closing and reopening of the Soo Locks at Sault Ste. Marie, MI, as well as to frozen lake surfaces during winter months.

The Lake Carriers' Association called for the construction of a second heavy icebreaker to work with the U.S. Coast Guard's *Mackinaw* to keep Great Lakes shipping lanes open during the winter season as long as possible. Despite the Soo Locks

seasonal closure, some iron ore is shipped from Escanaba, MI, to steelmaking facilities in the Great Lakes basin later into the winter. When the locks reopen, lingering ice cover requires icebreaking ships and tugs to reestablish regular shipping lanes. Including the *Mackinaw*, the U.S. Coast Guard operates up to nine icebreakers on the Great Lakes, unless one is out of service for maintenance and (or) modernization (Lake Carriers' Association, 2015).

Prices

In 2015, the average unit value of iron ore in the United States was \$81.19 per metric ton, a 4% decrease from the revised \$84.43 per metric ton in 2014 (table 1). The average value of exported iron ore was \$81.28 per metric ton, a 26% decrease from \$109.25 in 2014. The average unit value of exports totaling more than 1,000 t to any single country ranged from \$35.00 to \$86.76 per metric ton (table 5). The average value of imported iron ore was \$100.03 per metric ton, a 24% decrease from \$131.40 in 2014. The average unit value of imports totaling more than 1,000 t from any single country ranged from \$54.86 to \$431.33 per metric ton (table 6).

The average monthly spot price of imported iron ore fines, 62% Fe, at the Port of Tianjin, China, fell from \$68.23 per metric ton in January to \$52.28 per metric ton in April, fluctuated between \$46.86 per ton and \$62.63 per ton through November, and then decreased to \$40.50 in December. In 2015, the lowest average monthly spot market price, \$40.50 per metric ton in December, was 41% lower than the lowest average monthly spot price of 2014, \$68.80 per metric ton in December. In 2015, the highest average monthly spot market price, \$68.23 per metric ton in January, was 47% lower than the highest average monthly spot price of 2014, \$128.12 per metric ton in January (Index Mundi, undated).

Foreign Trade

In 2015, U.S. exports were 7.5 Mt, a 38% decrease from 12.1 Mt in 2014. U.S. iron ore pellet exports accounted for 92% (6.9 Mt) of total exports. Steel companies in Canada received 82% of the iron ore exported from the United States, 9% went to China, and 7% to Mexico (tables 1, 5). Imports in 2014 were 4.6 Mt, a 12% decrease from 5.1 Mt in 2014. Canada and Brazil each accounted for 45% of imports to the United States (table 6).

World Industry Structure

Production.—World iron ore production in 2015 was 2.29 Gt by gross weight and 1.40 Gt by iron content, essentially unchanged from those in 2014. Australia remained the leading iron ore producer (817 Mt), followed by Brazil (397 Mt), China (375 Mt), India (156 Mt), and Russia (101 Mt) (fig. 1, table 10). Production data were revised for China in 2014, resulting in lower world production totals than previously reported. Historically, iron ore production in China was reported in terms of crude ore, ranging from 10% to 30% iron content, as opposed to usable ore, with averages ranging from 58% to 65% iron content. In this and future USGS minerals information publications, data were adjusted to reflect the reported figures for usable ore produced in China and to incorporate them into

the world total, removing crude ore, to provide a uniform basis for comparison of global iron ore production. China's iron ore production increased by 39 Mt on a usable-ore basis over the 5-year period from 2010 through 2014 (Tuck and others, 2017).

Consumption.—Crude steel and pig iron production are the major indicators of iron ore consumption, as well as iron metallics, although on a smaller scale. World consumption of iron ore was estimated to have decreased in 2015, as reflected by decreases in production of crude steel (by 3.0%, or 54.7 Mt), DRI (by 2.7%, or 1.98 Mt), and pig iron (by 2.7%, or 35.4 Mt) compared with those in 2014. China was the leading producer of pig iron and crude steel and the Middle East and North Africa region was the leading producer of DRI (American Iron and Steel Institute, 2016, p. 115–120; Midrex Technologies, Inc., 2016, p. 6).

Trade.—Global trade of iron ore rose to 1.40 Gt in 2015, a slight increase from 1.36 Gt in 2014. This continued the trend of year-on-year increases in trade during the past 12 years. Since 2002, China, Germany, Japan, and the Republic of Korea have accounted for more than two-thirds of global imports, with their combined share increasing to 87% in 2014 from 62% in 2002 and decreasing slightly to 85% in 2015. China's share more than tripled during this 12-year period to 68% from 21%. Australia was the leading exporter of iron ore (57%), followed by Brazil (26%) (United Nations Commodity Trade Statistics Database, undated).

Exploration.—Companies continued to expand current mines and facilities, to develop mines, and to investigate new deposits; however, reductions in price and increased availability of iron ore for global trade were expected to drastically reduce expenditures for new projects. The iron ore exploration expenditures in 2015 were estimated to be \$940 million, a decrease of nearly one-third from \$1.4 billion in 2014. Iron ore exploration expenditures, as a percentage of total exploration expenditures, were highest in Australia (28%), followed by Asia (9%), Europe (3%), Canada (3%), and Commonwealth of Independent States (1%). Africa was estimated to target iron ore in 4% of exploration projects by count (Wilburn and Karl, 2016, p. 30–51).

World Review

Australia.—Production of iron ore in Australia was 817 Mt, on a usable-ore basis, in 2015, 5.5% greater than the 774 Mt produced in 2014. On a year-on-year basis, iron ore production in Australia increased by 42 Mt in 2015, 91 Mt in 2014, 127 Mt in 2013, and 68 Mt in 2012. The three leading miners in Australia—BHP Billiton Ltd., Fortescue Metals Group Ltd., and Rio Tinto Group—were among the four leading iron ore producers in the world and accounted for the vast majority of iron ore produced in Australia.

BHP Billiton's iron ore production in Australia in fiscal year (FY) 2015, which ended June 30, increased to 218 Mt, from 159 Mt in FY 2014, mostly owing to the ramping up of the Jumblebar Mine in Western Australia. Production was expected to increase to 233 Mt in FY 2016 as operations were optimized and expansion projects were completed in preparation for a potential doubling of capacity to 290 Mt/yr (BHP Billiton Ltd., 2015, p. 83). Fortescue's production in FY 2015 increased to 165 Mt, from 140 Mt produced in FY 2014, and was expected to continue at 165 Mt/yr through FY 2016 (Fortescue Metals Group Ltd., 2015, p. 6, 25). Rio Tinto's share of production

at its operations in Australia in 2015 increased to 253 Mt, from 225 Mt in 2014. The company's Port of Pilbara and rail infrastructure project was completed in mid-2015, as well as the ramping up of multiple mines across the Pilbara region and the commissioning of the Yandicoogina project (Rio Tinto Group, 2016, p. 38–39, 215).

Brazil.—Production of iron ore in Brazil increased to 397 Mt in 2015, 3% greater than the 385 Mt produced in 2014. Vale S.A., the leading iron ore producer in Brazil, increased production in 2015 to 346 Mt, from 332 Mt in 2014. The company sold 276 Mt of fines and 46 Mt of pellets, an increase from 256 Mt of fines and 44 Mt of pellets in 2014 (Vale S.A., 2016, p. 29, 88). Anglo American plc increased production in 2015 to 9.2 Mt (wet basis) as the operation continued to be ramped up through mid-2016 (Anglo American plc, 2016, p. 60).

In early November, the Fundão Dam burst at the Samarco Mine in Minas Gerais State, resulting in casualties and flooding surrounding villages and areas. The dam's failure released approximately 60 million cubic meters of water and mine waste from the site's tailings ponds into the surrounding area and eventually the Rio Doce estuary and the southern Atlantic Ocean. Concerns regarding the environmental impact of the dam failure and loss of life prompted the Environment Minister of Brazil to file a lawsuit against the operators and to demand that the owners establish a \$5.2 billion fund to pay for environmental recovery and victim compensation (Guardian, The, 2015). The 30.5-Mt/yr pellet facility was a joint venture between BHP Billiton Ltd. and Vale S.A.

Canada.—Production of iron ore in Canada increased slightly in 2015 to 45.9 Mt from 44.2 Mt produced in 2014 (table 10). The Bloom Lake Group, several affiliates managing operations at Cliffs' Bloom Lake Mine in Quebec Province, began restructuring proceedings under the Government of Canada's Companies' Creditors Arrangement Act. Operations at the mine were suspended in late 2014. Cliffs was considering equity investors and sale options, which would terminate all the company's operations in Canada. Champion Iron Ltd. indicated it was considering purchasing the mine along with its rail assets (Topf, 2015).

U.S. Steel's transition plan with U.S. Steel Canada, as part of the latter's restructuring under Canada's Companies' Creditors Arrangement Act, was approved by the Ontario Superior Court of Justice. The agreement's approval was integral to separating the two companies (United States Steel Corp., 2015a).

China.—Production in China, on a usable-ore basis, decreased in 2015 to 375 Mt from 410 Mt in 2014. In November, the China Iron and Steel Association, a leading trade group for major iron ore and steel producers in the country, released an announcement denouncing a joint statement from nine iron and steel associations from the United States and Europe that alleged overcapacity and instability in the steel industry was largely a result of high rates of subsidized steel production in China entering the global seaborne trade market. The original statement expressed opposition to China receiving market-economy status from the World Trade Organization starting in December 2016. The China Iron and Steel Association indicated that the Government of China had attempted to resolve overcapacity, having reduced steel

production capacity by 77.8 Mt since 2011 (China Iron and Steel Association, 2015). Steel mills in China remained the leading consumers of iron ore in the world.

Guinea.—In May 2015, ArcelorMittal terminated an agreement to purchase shares in the Mount Nimba iron ore project in Guinea. The original agreement was contingent on the receiving permission from the Government of Guinea to ship iron ore into Liberia. That permission was not received by the established deadline (BHP Billiton, 2015, p. 86).

India.—Production in India increased in 2015 to 156 Mt from 129 Mt in 2014. NMDC Ltd., a state-owned iron ore miner in India, set a production target of 35 Mt for 2015 through 2016 and planned to increase production to 65 to 75 Mt by 2018 through 2019, and 100 Mt by 2021 through 2022. The company entered into a memorandum of understanding with India's Ministry of Steel regarding its plan for 2015 through 2016 (Kumar, 2015).

Outlook

During 2015, an estimated 110 Mt of new iron ore capacity was brought on stream, and 130 Mt of existing iron ore capacity was shut down (Rio Tinto Group, 2016, p. 38). Global consumption of iron ore was estimated to have declined slightly in 2015 and is expected to remain stable or decline slightly throughout the next decade owing to reduced economic growth rates in China and reduced large-scale infrastructure spending in Europe and North America. During the past 5 years, world production of iron ore has increased by 255 Mt, a 13% increase from 2011 to 2015 (table 10). In 2015, trade was at or near equilibrium (table 9) as new production entered the market and, owing to reductions in price, miners continued to reduce or idle production capacity. In 2015, some production capacity and mine expansion projects were completed. Others were halted indefinitely following the sustained decline in prices over the 5-year period. With two notable exceptions, the Roy Hill project in Australia and the S-11D project in Brazil, no major projects were known to be under development at yearend 2015.

From 2013 to 2015, an estimated 200 to 250 Mt of capacity was idled or operating at reduced rates. The effects were most pronounced for iron ore producers in countries where increased imports of low-cost steel from China reduced the demand for domestic iron ore for steel production. Junior miners in direct competition with dominant suppliers to China were also negatively affected. Major suppliers from Australia and Brazil are expected to continue to focus on cost savings and improving efficiencies to reduce unit cost. As these companies continue to invest in high-efficiency, high-quality, and low-cost operations, small-scale and high-cost miners are expected to idle additional operations as they become uneconomic.

From 2016 to 2020, companies are expected to bring more than 200 Mt of annual production capacity into the market. Production of iron ore is expected to decrease in China during the next decade as high-cost mines are phased out as part of industry optimization and efforts to reduce environmental pollution. Following a 3.0% decrease in 2015, global steel consumption was expected to decrease by 0.8% in 2016 and to increase slightly in 2017 (World Steel Association, 2016). Additional discussion of trends in the steel industry are provided

in the "Outlook" section in the Iron and Steel chapter of the 2015 USGS Minerals Yearbook, volume I, Metals and Minerals.

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TABLE 1
SALIENT IRON ORE STATISTICS¹

(Thousand metric tons, gross weight, and thousand dollars, unless otherwise specified)

	2011	2012	2013	2014	2015
Iron ore, usable:					
United States:					
Production	56,200	54,700	52,800	56,100	46,100
Shipments	56,900	53,900	53,400	55,000	43,500
Value:					
Minnesota: ²					
Cost of mining dollars per metric ton	12.27	13.31	13.57	13.62	11.67
Cost of beneficiation do.	31.02	30.78	32.66	34.49	29.75
Average value of production do.	85.67	92.75	87.42	85.88	69.44
United States:					
Reported value at mines ³	5,850,000	5,080,000	4,610,000	4,730,000	3,750,000
Average value at mines dollars per metric ton	104.10	116.48	87.42	84.43 ^r	81.19
Exports:					
Quantity	11,100	11,200	11,000	12,100	7,540
Value	1,330,000	1,440,000	1,480,000	1,320,000	612,000
Imports for consumption:					
Quantity	5,270	5,160	3,250	5,140	4,550
Value	841,000	759,000	426,000	676,000	455,000
Reported consumption, iron ore and agglomerates	45,700	46,900	44,200	44,400	38,500
Stocks, December 31	2,320	4,440	2,350	4,460	7,860
World, production	2,030,000	2,080,000 ^r	2,230,000	2,290,000 ^r	2,290,000 ^e
Iron metallics: ⁴					
United States:					
Production	386	404	469	1,950	1,450
Imports for consumption	1,850	2,760	2,360	2,390	2,100 ^e
Exports	3,910	533	265	1,110	20,200
World, production	73,600	73,500	75,400	74,600	72,600

^eEstimated. ^rRevised. do. Ditto.

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

²As reported in Minnesota Department of Revenue's annual Mining Tax Guide.

³Value for iron ore as reported by mines, which may refer to price or value of shipments or production as sold on the open market or within the company. In 2013, one company changed the reporting standard from the method used in prior years.

⁴Data for iron metallics may include cold pig iron, direct-reduced iron, hot-briquetted iron, iron nuggets, and solid sponge iron.

TABLE 2
EMPLOYMENT AND PRODUCTION STATISTICS FOR IRON OPERATIONS IN THE UNITED STATES IN 2015, BY STATE¹

(Thousand metric tons, unless otherwise specified)

State	Number of operations	Number of employees ²	Worker hours (thousands)	Crude ore	Saleable products			Shipments	Average iron content ⁴ (percent)
					Pellets	Iron ore, other ³	Iron metallics	Total	
Indiana	2	60	115	--	(5)	--	245 ⁶	245	62.2 ⁶
Louisiana	1	25	12	--	--	--	1,100 ⁶	1,100	XX
Michigan	2	1,100	2,250	35,900 ⁶	10,800 ⁶	--	--	10,800	62.5 ⁶
Minnesota	11	3,620	6,310	123,000	32,800	2,600	100 ⁶	35,500	62.2
Total or average	16	4,800	8,690	159,000	43,500	2,600	1,450	47,600	62.5

-- Zero. XX Not applicable.

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

²Does not include professional or clerical workers at mines, pelletizing plants, maintenance shops, or research lab workers.

³Includes other unspecified products not included in other categories; may include concentrates, direct-shipping ore, fines, flux, and pellet chips.

⁴Data for iron metallics (cold pig iron, direct-reduced iron, hot-briquetted iron, iron nuggets, and sponge iron) not included.

⁵Iron pellets were produced by Magnetation LLC. but were not included in production totals because they were not primary mine production.

⁶Data reported in or calculated from publicly available company annual reports or other publications.

TABLE 3
IRON OPERATIONS IN THE UNITED STATES IN 2015
(Million metric tons)

State and operation	County	Operator	Primary product	Status ¹	Capacity ²	Production ²	Reserves ³
Indiana:							
Iron Dynamics, Inc.	DeKalb	Steel Dynamics, Inc.	Hot-briquetted iron	Active	0.3	0.3	(4)
Reynolds Pellet Plant	White	Magnetation LLC	Iron ore pellets	do.	3.3	NA	(4)
Louisiana, Nucor Steel Louisiana LLC	St. James	Nucor Corp.	Direct-reduced iron	IT (6 months in 2015)	2.5	1.1	(4)
Michigan:							
Empire	Marquette	Cliffs Natural Resources Inc.	Iron ore pellets	IT (Jun.–Nov. 2015)	5.6	3.1	8.7
Tilden	do.	do.	do.	Active	8.1	7.7	400
Minnesota:							
Hibbing Taconite	St. Louis	do.	do.	Active	8.1	8.2	270
Keewatin Taconite	Itasca	United States Steel Corp.	do.	ID (May 2015)	5.4	1.7	350
Mesabi Chief Plant #1	do.	Magnetation LLC	Iron ore concentrates	ID (Feb. 2015)	0.4	0.3	3.6
Mesabi Chief Plant #2	do.	do.	do.	ID (Jan. 2016)	1.0	0.9	18
Mesabi Chief Plant #4	do.	do.	do.	Active	2.0	1.4	(5)
Mesabi Nugget Delaware LLC	St. Louis	Steel Dynamics, Inc.	Iron nuggets	IT (May 2015–May 2017)	0.4	NA	(4)
Mining Resources LLC	do.	do.	Iron ore concentrates	do.	1.0	--	NA
Minntac	do.	United States Steel Corp.	Iron ore pellets	RP (Jun.–Sep. 2015)	15	12	460
Minoreca	do.	ArcelorMittal S.A.	do.	Active	2.7	2.7	130
Northshore	St. Louis and Lake	Cliffs Natural Resources Inc.	do.	RP (Jan. 2015), IT (Nov. 2015)	6.1	4.4	830
United Taconite	St. Louis	do.	do.	IT (Aug. 2015)	5.4	3.2	470

do. Ditto. NA Not available. -- Zero.

¹ID, Idled indefinitely. IT, Idled temporarily. RP, Reduced production rate.

²As reported or calculated from data in company annual reports, oral communications, published online data, or U.S. Securities and Exchange Commission filings.

³Proven and probable reserves or equivalent, including those on owned and leased property, as reported by the company on the last publicly available date.

⁴Facility does not operate an independent mine and has no reserves.

⁵Magnetation LLC owned mineral rights for 1,400 million metric tons of unspecified iron ore equivalent resources or reserves as of April 2014.

TABLE 4
CONSUMPTION OF IRON ORE AT U.S. IRON
AND STEEL PLANTS, BY TYPE OF PRODUCT¹

(Thousand metric tons)

Type of product	2014	2015
Blast furnaces:		
Pellets	37,500	32,100
Sinter ²	5,360	4,920
Total	42,900	37,100
Steelmaking furnaces:		
Direct-shipping ore	1,320	1,320
Sinter ²	159	159
Total	1,470	1,470
Grand total	44,400	38,500

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

²Includes briquettes, nodules, and other forms.

Source: American Iron and Steel Institute.

TABLE 5
U.S. EXPORTS OF IRON ORE, BY COUNTRY AND TYPE OF PRODUCT^{1,2}

Country and type of product	2014			2015		
	Quantity (thousand metric tons)	Value (thousands)	Unit value ³ (dollars per metric ton)	Quantity (thousand metric tons)	Value (thousands)	Unit value ³ (dollars per metric ton)
Country:						
Belgium	51	\$5,130	100.51	36	\$1,970	54.72
Canada	8,630	1,030,000	119.33	6,210	539,000	86.76
China	1,690	151,000	89.23	689	27,400	39.80
Czech Republic	--	--	--	2	70	35.00
Germany	(4)	9	1.80	--	--	--
Hong Kong	(4)	22	4.40	--	--	--
Japan	122	13,000	106.29	36	2,900	80.44
Mexico	1,600	124,000	77.26	522	38,400	73.53
Philippines	--	--	--	39	2,600	66.59
United Kingdom	26	1,580	60.65	--	--	--
Other	1	223	223.00	1	183	183.00
Total	12,100	1,320,000	109.25	7,540	612,000	81.28
Type of product:						
Coarse ores	10	710	71.00	(4)	22	4.40
Concentrates	1,460	137,000	93.70	98	12,000	122.13
Fine ores	171	18,700	109.39	16	1,850	115.38
Other agglomerates	847	66,800	78.83	492	29,300	59.61
Pellets	9,630	1,100,000	114.30	6,930	569,000	82.14
Roasted pyrites	1	247	247.00	(4)	192	38.40
Total	12,100	1,320,000	109.25	7,540	612,000	81.28

-- Zero.

¹Data are rounded to no more than three significant digits, except "Unit value"; may not add to totals shown.

²Includes agglomerates.

³Weighted average calculated from unrounded data by dividing total value by total tonnage.

⁴Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 6
U.S. IMPORTS OF IRON ORE, BY COUNTRY AND TYPE OF PRODUCT^{1, 2}

Country and type of product	2014			2015		
	Quantity (thousand metric tons)	Value (thousands)	Unit value ³ (dollars per metric ton)	Quantity (thousand metric tons)	Value (thousands)	Unit value ³ (dollars per metric ton)
Country:						
Argentina	98	\$12,000	122.34	132	\$10,600	80.66
Brazil	1,780	225,000	126.73	2,050	159,000	77.59
Canada	2,860	395,000	138.34	2,040	257,000	126.01
Chile	70	8,640	123.40	105	7,890	75.12
China	(4)	24	4.80	1	67	67.00
Honduras	--	--	--	6	2,590	431.33
Luxembourg	28	3,200	114.25	--	--	--
Norway	(4)	72	14.40	(4)	50	10.00
Peru	35	4,150	118.63	22	1,210	54.86
South Africa	29	3,360	115.79	87	8,850	101.69
Sweden	154	18,000	116.79	85	6,420	75.58
United Kingdom	(4)	5	1.00	(4)	5	1.00
Venezuela	97	6,270	64.64	25	1,490	59.68
Other	(4)	18	3.60	(4)	7	1.40
Total	5,140	676,000	131.40	4,550	455,000	100.03
Type of product:						
Coarse ores	43	4,370	101.67	54	4,230	78.24
Concentrates	731	58,400	79.87	1,020	53,500	52.25
Fine ores	461	50,800	110.30	247	18,700	75.77
Other agglomerates	28	1,840	65.68	(4)	3	0.60
Pellets	3,880	560,000	144.38	3,220	379,000	117.45
Roasted pyrites	(4)	5	1.00	--	--	--
Total	5,143	675,774	131.40	4,550	455,115	100.03

-- Zero.

¹Data are rounded to no more than three significant digits, except "Unit value"; may not add to totals shown.

²Includes agglomerates.

³Weighted average calculated from unrounded data by dividing total value by total tonnage.

⁴Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 7
U.S. IMPORTS OF IRON ORE IN 2015, BY COUNTRY AND TYPE OF
PRODUCT^{1,2}

(Thousand metric tons)

Country of origin	Coarse	Concentrates	Fine ores	Pellets	Other	Total
Argentina	--	23	109	--	--	132
Brazil	--	454	--	1,590	--	2,050
Canada	10	401	30	1,600	(3)	2,040
Chile	21	65	18	--	--	105
China	--	1	--	--	--	1
Honduras	--	--	6	--	--	6
Norway	--	(3)	(3)	--	--	(3)
Peru	--	--	22	--	--	22
South Africa	(3)	79	--	8	--	87
Sweden	23	--	62	--	--	85
United Kingdom	--	--	(3)	--	--	(3)
Venezuela	--	--	--	25	--	25
Other	--	--	(3)	(3)	--	1
Total	54	1,020	247	3,220	(3)	4,550

-- Zero.

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

²Includes agglomerates.

³Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 8
U.S. IMPORTS OF IRON ORE, BY CUSTOMS DISTRICT^{1,2}

(Thousand metric tons and thousand dollars)

Customs district	2014		2015	
	Quantity	Value	Quantity	Value
Baltimore, MD	301	44,700	328	43,700
Buffalo, NY	(3)	30	(3)	69
Charleston, SC	(3)	44	(3)	16
Chicago, IL	987	78,100	976	48,000
Cleveland, OH	896	129,000	1,130	172,000
Columbia-Snake, OR	--	--	23	3,170
Detroit, MI	(3)	51	11	319
Great Falls, MT	--	--	1	158
Houston-Galveston, TX	49	6,080	44	3,480
Minneapolis, MN	(3)	37	2	120
Mobile, AL	247	30,200	17	2,870
New Orleans, LA	2,650	386,000	2,010	180,000
New York, NY	(3)	38	(3)	24
Pembina, ND	--	--	(3)	147
Philadelphia, PA	(3)	5	--	--
Seattle, WA	(3)	28	--	--
Tampa, FL	10	1,380	11	1,170
Washington, DC	(3)	8	--	--
Total	5,140	676,000	4,550	455,000

-- Zero.

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

²Includes agglomerates.

³Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 9
SALIENT IRON ORE STATISTICS FOR SELECTED COUNTRIES¹

(Million metric tons, gross weight)

Country	2014				2015				Reserves, yearend 2015	
	Production, usable ore	Calculated consumption ²	Exports	Imports	Production, usable ore	Calculated consumption ²	Exports	Imports	Crude ore	Iron content
Australia	774	8	755	3	817	7	810	3	54,000	24,000
Brazil	385	50	344	--	397	49	366	--	23,000	12,000
Canada	44	13	40	9	46	14	37	7	6,300	2,300
China	410	1,270	--	932	375 ^c	1,320	--	953	23,000	7,200
Germany	--	51	--	43	--	50	--	41	NA	NA
India	129	128	10	7	156	76	4	--	8,100	5,200
Iran	33	21	--	--	27	21	--	--	2,700	1,500
Japan	--	146	--	136	--	151	--	131	40	24
Kazakhstan	25	6	15	--	21	6	15	--	2,500	900
Korea, Republic of	1	86	--	74	1	84	--	--	NA	NA
Russia	102	102	23	10	101	100	21	8	25,000	14,000
South Africa	81	10	67	--	73	10	42	1	1,000	650
Sweden	27	5	24	--	25	6	20	--	3,500	2,200
Ukraine	68	39	41	3	67	45	--	--	6,500	2,300
United States	56	48	12	5	46	54	8	5	12,000	3,500
Other	152	202	81	145	130	257	54	156	18,000	9,500
Total	2,290	2,180	1,410	1,370	2,280	2,250	1,360	1,310	190,000	85,000

^cEstimated. NA Not available. -- Zero.

¹Data are rounded to no more than three significant digits except reserves, which are rounded to no more than two significant digits; may not add to totals shown.

²Based on pig iron production.

Sources: U.S. Geological Survey; company, country, and government reports.

TABLE 10
IRON ORE: WORLD PRODUCTION, BY COUNTRY^{1,2}

(Thousand metric tons)

Country	Gross weight					Iron content				
	2011	2012	2013	2014	2015 ^c	2011	2012	2013	2014	2015 ^c
Algeria	1,320	1,784	1,067	911	911	693	937	560	478	478
Australia	488,000	555,500	682,700	774,200	816,689 ³	277,000	336,000	413,000	468,000	486,000
Austria	2,210	2,140	2,320	2,300	1,190	1,379	1,339	1,452	1,438	743
Azerbaijan	214	207	141	115 ^r	120	134	129	88	72 ^r	75
Bosnia and Herzegovina	1,891	2,076	2,122	2,128	2,123 ³	1,180	1,300	1,330	1,330	1,330
Brazil	398,131	400,822	386,270	385,440 ^r	396,531 ³	265,000	258,000	246,000	250,000 ^r	257,000
Canada	35,705	38,892	42,063	44,196	45,954 ³	21,000	25,000	26,000	27,300	28,300
Chile	12,624	17,330	17,109	18,866	14,143 ³	7,750	9,430	9,090	10,150	7,870
China: ⁴										
Crude ore	1,340,000	1,330,000	1,450,000	1,510,000	1,380,000	XX	XX	XX	XX	XX
Usable ore	442,179	420,206	417,287	410,123	374,838 ³	274,000	261,000	259,000	254,000	232,000
Colombia	174	809	710	676	876 ³	109	506	444	423	548
Egypt	3,321	3,930	3,320	3,300	5,180	1,960	2,320	1,960	1,950	3,060
Greece ⁵	2,250	2,306	2,221	2,382	2,380	1,060	1,080	1,040	1,120	1,120
India ⁶	168,582	136,618	152,433	129,103	155,898 ³	104,000	84,000	94,000	80,000	96,000
Indonesia	4,475	4,800	4,000	3,013	3,160	2,750	2,950	2,460	1,850	1,940
Iran ⁶	44,335	36,000	38,000	33,000	27,450 ³	20,900	17,000	17,900	15,600	12,900
Kazakhstan	24,736	25,889	25,228	24,561	20,814 ³	14,100	14,800	14,400	14,100	11,900
Korea, North	2,508	2,412	3,054	3,212 ^r	3,200	1,460	1,400	1,770	1,860	1,860
Korea, Republic of	542	593	663	660	1,400 ³	303	332	371	369	783
Laos	43	316	1,459	1,853	1,100	26	196	561	712	548
Liberia	1,300	3,300	5,103	5,744	5,700	780	1,980	3,110	3,500	3,450
Malaysia	8,078	12,144	12,134 ^r	9,615 ^r	1,612 ³	5,050	7,590	7,580	6,010	1,010
Mauritania	11,400 ^r	11,170 ^r	13,038 ^r	13,244 ^r	11,296 ³	7,130 ^r	6,980 ^r	8,150 ^r	8,280 ^r	7,060
Mexico	12,806	14,915	18,840	16,628	13,462 ³	8,000	9,320	11,780	10,390	8,410
Mongolia	5,678	7,561	6,736	6,389	6,173 ³	3,630	4,760 ^c	4,120	3,890	3,840
Morocco	79	261	301	23 ^r	20	43	141	163	12 ^r	11
New Zealand ⁵	2,290 ^r	1,505 ^r	2,037 ^r	2,107 ^r	2,063 ³	1,430 ^r	941 ^r	1,270 ^r	1,320 ^r	1,290
Norway	6,723 ^r	7,745 ^r	9,549 ^r	10,542 ^r	10,500	4,200 ^r	4,840 ^r	5,970 ^r	6,590 ^r	6,560
Pakistan ⁶	430	412	193	329 ^r	293 ³	260	249	117	199 ^r	177 ³
Peru	10,626 ^r	10,132 ^r	10,126 ^r	10,731 ^r	10,908 ³	7,123 ^r	6,792 ^r	6,788 ^r	7,193 ^r	7,321 ³
Philippines	468	1,800	1,057	154 ^r	42 ³	293	1,150	793	103 ^r	28
Russia	103,607	104,010	102,156	102,019	100,985 ³	62,700	62,900	61,800	61,700	61,100
Sierra Leone	339	5,203	11,895	12,000	18,000 ³	195	2,992	6,840	6,900	10,400
South Africa	58,057	67,100	71,645	80,759	73,000 ³	36,500	42,900	45,700	51,500	46,400
Swaziland	80	1,032	1,259	603	--	50	645	787	377	--
Sweden	26,100 ^r	26,433 ^r	27,900 ^r	26,900 ^r	24,500 ³	16,300 ^r	16,500 ^r	17,400 ^r	16,800 ^r	15,300
Thailand	489	303 ^r	397 ^r	227 ^r	35	306 ^r	189 ^r	248 ^r	142 ^r	22
Tunisia	172	223	244	240	286	103	135	148	145	173
Turkey	6,661	8,102	8,589	7,789	5,491 ³	4,030	4,900	5,200	4,710	3,320
Ukraine	65,807	66,379	67,020	67,874	66,815 ³	39,800	40,200	40,500	41,100	40,400
United States	56,200 ^r	54,700	52,800 ^r	56,100 ^r	46,100 ³	35,200	34,500	33,300	35,400	28,800
Venezuela	17,037	15,124	16,800	18,000	11,394 ³	10,600	9,400	10,400	11,200	7,080
Vietnam	4,474 ^r	2,842 ^r	4,708 ^r	5,130 ^r	4,222 ³	2,371 ^r	1,506 ^r	2,495 ^r	2,719 ^r	2,238 ³
Other ^{c,7}	140	200	150	150	130	85	120	91	91	68
Total	2,030,000	2,080,000 ^r	2,230,000	2,290,000 ^r	2,290,000	1,240,000	1,280,000	1,370,000	1,410,000 ^r	1,400,000

^cEstimated. ^rRevised. XX Not applicable. -- Zero.

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

Includes data available through November 29, 2017.

²All data are for usable ore, unless otherwise noted, which represents total for all iron ore products used in steelmaking produced in the country, excluding agglomerates produced from imported iron ore. Iron content indicates either reported weight of contained iron ore or metal content as calculated based on surveyed and reported figures or estimates.

³Reported figure.

⁴Data for China are reported as both crude ore and usable ore, as opposed to only crude ore in prior reports. Crude ore is a preliminary form of usable ore and not representative of other values within this table, which are assumed or explicitly reported as usable ore. China's crude ore production is not included in "Total."

⁵Production includes alternative iron ore sources as follows: Greece (nickeliferous iron ore), Indonesia (iron sand, dry basis), and New Zealand (titaniferous magnetite beach sands).

TABLE 10—Continued
IRON ORE: WORLD PRODUCTION, BY COUNTRY^{1, 2}

(Thousand metric tons)

⁶Production is based on fiscal year, with starting dates as follows: India, April 1; Iran, March 21; and Pakistan, July 1.

⁷Includes the following countries for which inadequate information was available: Bhutan, Kenya, Nigeria, Portugal (manganiferous iron ore), Togo, and Uganda.



Figure 1. Global production of usable iron ore in 2015. Source: U.S. Geological Survey.