IRON ORE

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Iron ore is essential to the economy and national security of the United States. As the basic raw material from which iron and steel are made, its supply is critical to any industrial country. Scrap is used as a supplement in steelmaking but is limited as a major feed material because the supply of high-quality scrap is limited. In 1998, the steel industry accounted for more than 98% of iron ore consumption. Domestically, production fell slightly, and shipments increased by less than 1%. Internationally, iron ore production levels also fell.

Production

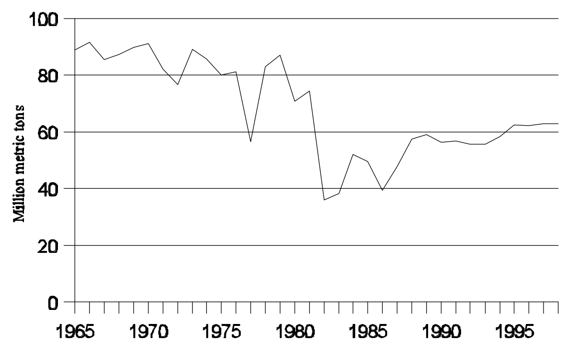
On the basis of data for January through midyear, it appeared that 1998 iron ore production would surpass that of 1997, a highly productive year. Domestic steel shipments had risen by more than 4% compared with the same period in 1997. For the year, however, steel shipments fell by more than 3%; in the last 2 months of the year, they fell below 7 million metric tons per month for the first time since December 1995. This was counter to steel demand, which was almost 6% higher than that of 1997. A large part of the increase in steel demand, however, was satisfied by imports. Net imports of steel mill products in 1998 were 43% greater than those of 1997. The deepening Asian financial crisis had curtailed steel demand there and elsewhere, and steel producers, particularly in Asia, began shipping much of their low-priced steel to the U.S. market. After averaging about 22% from 1990 through 1997, imported steel satisfied 30% of demand in 1998 and, at its peak in November, took nearly 37% of the total steel market. The decline in domestic shipments created by the surge in imports was compounded by the 54-day strike at General Motors Corp., a major steel consumer. Despite all this, iron ore production in 1998 fell by less than 1%.

U.S. iron ore production in 1998 was 62.9 million tons (figure 1). The nine taconite mining operations in Michigan and Minnesota accounted for virtually all domestic iron ore production. Seven of these operations were on the Mesabi Iron Range in northeastern Minnesota: EVTAC Mining LLC (formerly Eveleth Mines), Hibbing Taconite Co., Inland Steel Mining Co., LTV Steel Mining Co., National Steel Pellet Co., Northshore Mining Co., and the US Steel Group of USX Corp. (Minntac). The two taconite operations on the Marquette Iron Range in the Upper Peninsula of Michigan were the Empire and the Tilden Mines.

U.S. production data for iron ore are developed by the U.S. Geological Survey (USGS) from two separate, voluntary surveys of domestic operations. The annual "Iron Ore" survey (1066-A) provided 100% of total production shown in tables 1 through 4. This information is supplemented by employment data, mine inspection reports, and information from consumers. The American Iron Ore Association (AIOA) provided data on

FIGURE 1

U.S. IRON ORE PRODUCTION



ore shipments from loading docks on the upper Great Lakes, as well as receipts at transfer docks and furnace yards nationwide. The dock and steel plant data were compiled jointly by AIOA and the American Iron and Steel Institute (AISI).

Iron ore was produced by 12 companies; 4 other companies did not produce, but shipped iron ore from stockpiles. The nine taconite producers in Michigan and Minnesota accounted for 98.9% of domestic production. The 12 producing companies operated 12 mining operations, 10 iron ore concentration plants, and 10 pelletizing plants. Of the two iron ore producers that did not produce pellets, one produced iron ore as a byproduct of gold mining, and the other produced direct-shipping ore, which requires minimal processing. Of the 12 mining operations, 11 were open pit and 1 was underground. Virtually all ore was concentrated before shipment, and 98.7% was pelletized. In 1998, combined United States and Canadian production represented 10% of the world output of usable ore in terms of metal content. Trends in world mine production since 1994 are shown on a country basis in table 17.

Domestic iron ore supply (production minus exports) satisfied 72% of domestic demand in 1998, compared with an average of 70% from 1990 through 1998. Domestic iron ore production, at 62.9 million tons, decreased by less than 1% from that of 1997. In 1998, 10 mines produced ore for the iron and steel industry, and 2 produced ore mainly for cement plants. In terms of tons of usable ore produced per worker-hour, productivity in the Lake Superior District increased slightly. In 1998, an average of 3.4 tons of crude ore was mined for each ton of usable ore produced, a 2.3% increase compared with that of 1997. Low-grade ores of the taconite type mined in Michigan and Minnesota accounted for 99.5% of total usable ore production. U.S. production of pellets totaled 62.1 million tons. The average Fe content of usable ore produced was 63.1%. Fluxed pellets' share of total pellet production continued to grow rapidly, rising to 61.0% in 1998 from 39.0% in 1994.

Two production milestones were reached in 1998, when the Marquette Iron Range on the upper peninsula of Michigan produced its 400 millionth ton of pellets, and the Northshore Mining of the Mesabi Iron Range in Northeastern Minnesota, produced its 250 millionth ton of pellets (Skillings Mining Review, 1998b, c).

Michigan.—Michigan accounted for 24.3% of the output of usable ore in 1998. All the State's production was from the Empire and the Tilden Mines near Ishpeming, Marquette County, and nearly all was pelletized. Both mining ventures were managed by subsidiaries of Cleveland-Cliffs Inc.

Following the closure of the Algoma Ore Division of Algoma Steel Inc., the Tilden Mine, which is 45% owned by Algoma Steel, made modifications to its processing plant. The $10.9 million project, which affected the crushing, grinding, and filtering areas of the plant, activated idled production capacity, raising it from 6.8 million tons in 1998 to an expected 7.7 million tons in 1999 (Cleveland-Cliffs Inc., oral commun., 1999).

Minnesota.—Minnesota produced 75.1% of the national output of usable ore in 1998. All the State's production came from open pit mines on the Mesabi Range.

The Inland Steel Co. of Chicago, owner of Inland Steel Mining, Virginia, MN, was purchased by Ispat International NV, of Rotterdam, the Netherlands. The $1.4 billion acquisition was completed on July 16, 1998, and made Ispat the seventh largest steel company in the world (Skillings Mining Review, 1998a).

LTV and Minntac reduced production during the year as the result of the Asian financial crisis (Kirk, 1998a).

Missouri.—Pea Ridge Iron Ore Co. produced iron oxide powder at its mining complex near Sullivan. The company has the only active underground iron mine in the country. In January 1991, the company ceased pellet production and began concentrating on specialty iron oxide products, which had formerly been coproducts. Pea Ridge installed a new high-temperature calciner to produce various high-purity iron oxide products (Skillings, 1999).

Consumption

Data on consumption and stocks of iron ore and iron ore agglomerates (pellets and sinter) at iron and steel plants were provided by the AIOA. Data on consumption of iron ore for nonsteel end uses were compiled from information gathered from USGS surveys. In 1998, virtually all iron ore (98.3%) was consumed by the steel industry. Reported consumption of iron ore for manufacture of animal feed, ballast, cement, ferrites, heavy-medium materials, pigments, and other nonsteel products was 1.3 million tons. Iron ore consumption fell by 1.6%, pig iron production decreased by 2.8%, and crude steel production increased by 0.2%. Iron ore consumption fell in relation to crude steel production as the result of the increased use of scrap in steelmaking and higher levels of imports of pig iron and direct-reduced iron (DRI).

Minimills continued to gain market share at the expense of the integrated mills. The electric arc furnace's (EAF) share of crude steel production rose from 37.4% in 1990 to 44.6% in 1998. New capacity, either under construction or contemplated with financing in place, will bring the EAF share to 50% by 2001 (Shultz, 1999).

The number of blast furnaces in operation during the year ranged from 36 to 39. Consumption of iron ore and all types of iron ore agglomerates reported to the AISI by integrated producers of iron and steel totaled 74.6 million tons. This included 62.9 million tons of pellets; 10.8 million tons of sinter, briquettes, etc.; and 0.8 million tons of natural coarse ore. Of the ore consumed, 82.5% was of domestic origin, 9.3% came from Canada, and 8.2% came from other countries. Other materials consumed in sintering plants included mill scale, flue dust, limestone and dolomite, slag and slag scrap, and coke breeze. Other iron-bearing materials charged to blast furnaces included mill scale, slag scrap and steel-furnace slag.

The four consumption numbers in this annual review are listed in tables 1, 6, 7, and 8. The following explains why more than one consumption number is used and how each of them is derived. The first consumption number (78.2 million tons in 1998) is in table 1 and is the sum of the quantity of ore consumed by form as reported by the AISI (74.6 million metric tons in 1998) (American Iron and Steel Institute, 1999, table 32) and the quantities of ore consumed in direct reduced iron production and ore consumed in nonsteel uses, as reported to the USGS; the AISI number is reported in thousands of short tons and is converted to thousands of metric tons. The second consumption number (70 million metric tons in 1998) is in table 6 and is the quantity of ore consumed at U.S. iron and steel plants by originating area, as reported by the AIOA; the number has been converted from thousands of long tons, as it appears in the AIOA annual report, to thousands of metric tons (American Iron Ore Association, 1999, p. 46). The third consumption number (74.6 million tons in 1998) is in table 7 and is the quantity of ore consumed in U.S. iron and steel plants by type of ore as reported by the AISI; the number has been converted from thousand short tons, as it is listed in the AISI annual report, to thousand metric tons (American Iron and Steel Institute, 1999, table 32). The fourth consumption number (72 million tons in 1998) is in table 8 and is the sum of the AIOA number for consumption at United States iron and steel plants (70 million metric tons), the AIOA number for consumption of iron ore in the United States steel furnaces (American Iron Ore Association, 1999, p. 46) and two other numbers; these are the quantities of ore consumed in direct reduced iron production (761,000 tons in 1998) and nonsteel uses (1.28 million tons in 1998) as reported to the USGS. In summary, iron ore consumption for steelmaking is calculated by the AIOA and the AISI using different methods. To obtain total domestic iron ore consumption, iron ore consumption for other end uses must be added to AIOA and AISI reported consumption, thereby generating four consumption numbers.

Prices

Most iron ore prices are negotiated between buyer and seller. Currently, about 60% of domestic ore is produced by captive mines (mines producing for company-owned blast furnaces) and, therefore, does not reach the open market. The average free-on-board mine value of usable ore shipped in 1998 was $30.39 per ton, somewhat higher than that of 1997. This average value should approximate the average commercial selling price less the cost of mine-to-market transportation.

International iron ore prices rose in 1998, following record levels of output in1997 for many iron ore producers. The price for fine ores for fiscal year (April 1-March 31) 1998 in the Japanese market was 29.92 cents per 1% Fe per long ton unit, up 2.8% compared with that of the previous year (Duisenberg, 1999, p. 70-73). The price for lump ore was settled at 38.79 cents per 1% Fe per long ton unit, an increase of 2.9% compared with that of 1997. The lump ore to fine ores premium widened to 8.87 cents per 1% Fe per long ton unit. There were similar price percentage increases in Europe. Over the long term, however, iron ore prices have declined. The price of Carajás fines, a grade of ore produced by Companhia Vale do Rio Doce (CVRD) and sold to Europe, when denominated in U.S. dollars and adjusted for inflation using the U.S. Consumer Price Index for All Urban Consumers, fell by 53.2% between 1990 and 1998.

Transportation

Almost no iron ore is consumed near where it is produced, requiring most ores to be transported, often great distances. Nearly all iron ore leaves the mine by rail, after which much of it is transferred to ships. In the United States, a much larger proportion of ore is moved by water than in other countries because of the proximity of the mines to the Great Lakes, which offer low-cost transportation. No taconite mine is more than about 160 kilometers from Lake Superior or Lake Michigan, and most are much closer. In 1998, 94.8% of all domestic ore produced was transported on the Great Lakes and constituted 46.5% of U.S.-flag cargoes, more than twice that of stone and gypsum, the next largest dry bulk material category shipped. Including transshipments, U.S.-flag carriers moved 56.9 million tons of iron ore in 1998, a decrease of 0.9% compared with that of the 1997-98 season.

Published ocean freight rates fell sharply during the year (Duisenberg, 1999, p. 76-77). The average representative spot iron ore freight rate from Brazil to Western Europe in U.S. dollars per metric ton for cargos of 100,000 to150,000 per deadweight cargo ton (dwt), dropped from $6.19 in 1997 to $4.53 in 1998. The rate for Brazil to Japan for cargos of 120,000 to 160,000 dwt decreased from $10.70 to $6.46. The rates for Australia to Western Europe for cargos of 120,000 to 160,000 dwt dropped from an average of $7.54 to $6.03. The Canada-to-Europe rate for cargos of 80,000 to 125,000 dwt fell from $5.49 to $3.98.

Transportation costs are a major part of the overall cost of iron ore production. When buyer and seller agree on a price, that price includes the cost of some transportation. Most of the costs involve moving usable ore, which is the final product of a mining operation as opposed to crude ore, which is ore as mined in its natural state. In Australia and Brazil, the dominant leading iron ore exporters, ore is mined and processed and then sent by rail several hundreds of kilometers to ports, with the cost of rail transportation and transfer charges being part of the price of the ore. All producers are striving to reduce transportation costs. In their efforts to reduce transportation costs, three iron ore producers in the United States have found ways to reduce the costs of transporting crude ore from the pits to the processing plants. In 1994, LTV installed a super pocket, a device for transferring ore from its trucks to its trains (Kirk, 1995, p. 421).

The first super pocket cost $5.6 million, and LTV recovered the cost in about 2 years. It was successful enough for LTV to build another super pocket in April 1996. Again, LTV recovered the cost in about 2 years (Northshore Mining Co, oral commun., 1999).

Most recently, Northshore and Minntac invested in equipment that would reduce pit-to-plant transportation costs. Northshore purchased 5 new 205-ton ore-hauling trucks at a cost of $8.6 million to replace a fleet of 14 side-dump trucks that had been in use for more than 30 years (Kirk, 1998b). The old trucks carried only 100 tons each and, because of their age, were unavailable about 30% of the time. The five new trucks could haul the same quantity of crude ore as the 14 old ones with only about 5% down time. Crude ore production costs were expected to be cut by 22 cents per ton.

Minntac also changed its method of moving crude ore from the pit to the plant (Hyppa, 1999). After having moved more than1 billion tons of crude ore by rail during a 30-year period, Minntac planners foresaw a major decrease in train productivity rates beginning about 1996. Because of deeper pits and corresponding longer haul distances, production rates were expected to decrease by 25% by 1996 and to continue to decrease afterwards. Minntac's solution was to convert crude ore transportation from rail to truck. This involved converting Minntac's primary crusher crude ore pockets to receive ore from trucks rather than rail cars. Phase I of the project called for converting the eastern half of Minntac's west pit to truck crude ore haulage, a process that was completed in late 1996 at a cost of $25.3 million. It included the purchase of seven 240-ton trucks. Phase II, a $22.8 million project, involved the conversion from rail to trucks in the east pit, the purchase of five 240-ton trucks, and the conversion of another primary crusher crude ore pocket. The first truckload of crude from the east pit was in January 1998. The results included an increase in truck crude ore volume of more than 1 million tons per year and a reduction of 19 employees.

Foreign Trade

U.S. exports of iron ore were 5.3% lower than those of 1997 (tables 9 through 15). Almost all exports consisted of pellets shipped via the Great Lakes to Canadian steel companies that are partners in U.S. taconite projects in Michigan and Minnesota. U.S. imports of iron ore at 17.0 million tons were 8.6% lower than those of 1997. Net imports, which averaged

11.5 million tons from 1989 through 1998, were 11.0 million tons in 1998. This was equivalent to 14.7% of U.S. ore consumption. Canada's share of U.S. imports was 50.1%; Brazil's was 35.2%.

World Review

Production.—World iron ore production was 1,020 million tons, a 5% decrease compared with that of 1997 (table 17). Although iron ore production was widely distributed, occurring in about 50 countries, the bulk of world production came from just a few countries. The five largest producers, in decreasing order of production of gross weight of ore, were China, Brazil, Australia, India, and Russia. These countries accounted for about 70% of world production. China was the largest producer in gross weight of ore produced, but because its ore was of such low grade, the country's output ranked well below Australia's and Brazil's output in Fe content. Of the largest producing countries, India experienced the highest growth rate at 8%.

Consumption.—World steel production at 775 million tons was 3% lower than that of 1997. For the third consecutive year, China was the largest steel producer at 114.3 million tons. The combined production of the three largest steel-producing nations, China, Japan, and the United States, accounted for 39.4% of world production. Among the top 10 producing countries, only China experienced a major (5%) increase in production. World pig iron production fell by 1.5% to 537.7 million tons.

In 1998, DRI production (37.1 million tons) continued to increase, but grew by only 2.5%, the lowest rate since 1982. If not for the new capacity that came online in 1998, the increase would have been even smaller. The capacity increase was the result of plants that were completed during the year in India, Mexico, the United States, and Venezuela. Mexico overtook Venezuela as the world's leading DRI producer, followed by India. Venezuela fell to third place.

Trade.—In 1998, 91.2% of world iron ore production was exported, up from 85.5% in 1997. At 458.3 million tons, world exports decreased by 2.5%. Seaborne ore shipments totaled 418 million tons, accounting for 91.2% of exports. Among the major exporting countries, only Brazilian exports increased during the year. Australia was the leading exporter of iron ore, shipping 144.6 million tons to world markets, followed by Brazil, which exported 143.2 million tons and India which, exported 32.2 million tons. Australia's chief export customers were Japan (44.5%), China (19.6%), the Republic of Korea (13.1%), and Western Europe (16.0%). Brazil's primary export customers were Japan (18.3%) and Germany (16.4%).

Japan, as usual, was the leading importer, accounting for 26.7% of world iron ore imports. The next largest was China, which took 11.5% of total world imports, followed by Germany at 10.0%, and the Republic of Korea at 7.4%.

Australia.—The Broken Hill Proprietary Company Limited (BHP) suspended most of the development of Ore Body 18, a satellite deposit of its Mount Whaleback Mine in the Mount Newman range in Western Australia's Pilbara region. The two pits that comprise Ore Body 18 contain Brockman-type ore that was supposed to provide 4 million to 5 million tons per year of lump and fines. Some civil works associated with the development, such as the installation of power lines, will continue. The reason for the suspension was low Asian demand. BHP said future development will be determined by market requirements. To partially offset the loss of production, BHP has decided to increase the capacity of the Mount Whaleback Mine by upgrading the beneficiation plant from 4.5 million tons per year to 6 million tons per year.

The capacity expansion project of the Nelson Point facilities at Port Hedland, which included a third car dumper, upgrades to the crushing and screening plant, new conveyors, and other infrastructure, was completed in August. The simultaneous purchase of new locomotives and ore cars will allow for the additional tonnage to be shipped from the Newman and the expanded Yandi Mines. The port capacity was increased to more than 70 million tons per year (Broken Hill Proprietary Company Limited, 1998, written commun., Metal Bulletin, 1998b).

In September, BHP decided to mine below the water table at Ore Body 23, but delayed the mining until reserves were delineated and an assessment was made on the environmental impact. The mine site is approximately 13 kilometers northeast of Newman Township and is close to the Fortescue River. Reserves reportedly total about 125 million tons and will be extracted during a 4-year period at a rate of about 2 million to 4 million tons per year. Mining began at the site in July 1992 (TEX Report, 1998c; The Broken Hill Proprietary Company Limited, written commun. 1998).

Environmental approval was given for BHP to develop the 'C' deposit (Marra Mamba) and the Brockman detrital deposit. Mining of the 'C' deposit was expected to begin at a rate of 2 million tons per year and increase to 15 million tons per year, depending on market conditions. Mining of the Brockman Detrital Deposit is expected to start at 2 million tons per year and increase to 6 million tons per year. Discussions with the Native Title claimants for the area continued through 1998 (Metal Bulletin, 1998b; TEX Report, 1998d).

The Western Australia Government approved the request from Hamersley Iron Pty. Ltd. to extend its Brockman Mine, located 50 kilometers northwest of Hamersley's main mine at Mount Tom Price in the Pilbara region. Developed to extend the life of the Mount Tom Price Mine, the Brockman began operation in June 1992. At the Brockman extension, mining began in October 1998 at a rate of 2 million tons per year. The mine life was projected to be about 5 years. In a significant departure from its usual practice and contrary to the trend elsewhere in Western Australia iron ore producers, Hamersley staff will operate the Brockman extension.

The Brockman Mine is linked to the Mount Tom Price and Paraburdoo to Dampier rail line by a 50-kilometer rail spur. The Brockman Mine has been providing ore at the rate of about 4 million tons per year from the No. 2 detrital deposit, which was depleted in August. Detrital iron deposits occur where natural weathering processes have eroded preexisting iron ore bodies and deposited ore fragments in hollows or traps in low-lying areas. The new mining area, the Brockman extension, is an adjacent bedded ore body. Exploratory drilling in the

Brockman area has indicated promising additional reserves (Metal Bulletin, 1998k; Hamersley Iron Pty. Ltd., written commun., 1999; Rio Tinto, April 28, 1999, Brockman extension, Iron ore group projects, Iron ore group, Operational review, Annual report and accounts, accessed May 11, 1999, at URL http://www.riotinto.com/ok.html).

Hamersley decided late in the year to proceed with a trial mining operation at Nammuldi near its Brockman Mine. Initial mining will be for bulk samples for evaluation for potential customers. Nammuldi reportedly has mineral resources of 300 million tons of Marra Mamba-type ore grading 60.3% Fe. This type of ore was being blended with other ores, but Hamersley intended to sell the Nammuldi lump and fines as a stand-alone ore for specific markets. Marra Mamba-type ore is softer than the more commonly exploited Brockman-type ore. It has a lower phosphorus content, but the Fe content is also lower, with the high-grade Marra Mamba ore averaging around 62.5% Fe, compared to 64% Fe for the Brockman ore mined at Mount Tom Price. Hamersley was already mining Marra Mamba ore at Marandoo. Nammuldi, and two Marra Mamba deposits, Homestead and Silvergrass make up the larger Homestead prospect, which was regarded as providing an important future production base for Hamersley, having a mineral resource of 600 million tons grading more than 62% Fe. Ore from Nammuldi will be processed through the existing plant at Brockman, so that the initial capital outlay will be minimal and not needed for additional infrastructure (Metal Bulletin, 1998e; Mining Journal Interactive, January 11, 1999, Mining week—Nammuldi approval, from e-mail, editorial@mining- journal.com).

The construction of the Yandicoogina Mine, which began in late 1997, was nearly complete by the end of 1998. The initial production rate was planned to be 9 million tons per year, rising to 15 million tons per year according to market demand. The ore body is a channel iron deposit, an infilled meandering old river channel more than 80 kilometers long, 500 meters wide, and 45 meters thick. Hamersley has tenure over more than 50 kilometers of the channel.

The additional production at Yandicoogina necessitated an expansion program at Rio Tinto's Parker Point and East Intercourse Island terminals at Port Dampier. Dredging at Parker Point was expected to enable the terminal to handle vessels 190,000 dwt rather than the current maximum of 150,000 dwt. Two reclaimers will be replaced, and the two stockpile lines will be extended to increase stockpile capacity from 1.2 million to 1.6 million tons. The new reclaimers will increase the ship loading rate by 50% to 9,000 tons per hour. At the East Intercourse Island terminal, the size of the vessel that can be handled will be left unchanged at 240,000 dwt. Hamersley will add a parking bay, increase stockpile capacity, and add a reclaimer (Rio Tinto, April 28, 1999, Yandicoogina, Iron ore group projects, Iron Ore Group, Operational Review, Annual Report and Accounts, accessed May 11, 1999, at URL http://www.riotinto.com/ok.html; Rio Tinto, April 28, 1999, Overview, Iron Ore Group Projects, Iron Ore Group, Operational Review, Annual Report and Accounts, accessed May 11, 1999, at URL http://www.riotinto.com/ok. html; Metal Bulletin, 1998f).

Rio Tinto, Hamersley's owner, entered a joint venture with Orissa Mining Corp. in 1995 to conduct a prefeasibility study of two iron ore deposits, known as Gandhamardan and Malangtoli, in the Keonjar-Singhbum region of the State of Orissa, India. The joint venture, known as RTOML, was expected to spend $18 million to explore the viability of $1 billion exploration project in the Indian State of Orissa (TEX Report, 1998f). The first phase of the study was completed during the year, and work had begun on the second phase, which was expected to be completed in 1999. Elsewhere, Rio Tinto was involved in the investigation of other greenfield iron ore prospects, including a major bedded hematite deposit at Simandou in eastern Guinea. The company is also studying the feasibility of increasing production from the Corumba Mine in Brazil (Hamersley Iron Pty. Ltd., written commun., 1999; Rio Tinto, April 28, 1999, Orissa, Iron Ore Group projects, Iron Ore Group, Operational Review, Annual report and accounts, accessed May 11, 1999, at URL http://www.riotinto.com/ok. html).

Hancock Prospecting Pty. Ltd., a Western Australia-based company, entered into an agreement with Iscor Ltd., the South African iron ore producer and steelmaker, to perform a feasibility study on the Hope Downs iron ore deposits in the Pilbara region of Western Australia. Hancock, which holds the exploration and development rights to the Hope Downs tenements holds numerous iron ore tenements elsewhere in Western Australia and received royalties from current major iron ore producers in the State. Iscor would retain a participation interest of about 40% in the project and be the manager (Engineering and Mining Journal, 1998).

Brazil.—CVRD completed several expansion projects and was working on and planning others. In the Northern System, the company was involved in expanding parts of all three components: the mines at Carajás, the port at Ponta da Madeira Marine Terminal near Sao Luis in the State of Maranhao, and the railroad that links them. Because the haulage distance increased as the pits at the N4E and N4W deposits at Carajás were deepened, CVRD installed in-pit crushers and conveyor belt systems to replace haul trucks.

The company installed a conveyor system that links the N4W Mine to the N4E Mine and to its beneficiation plant. CVRD expected the system to yield a significant reduction in transportation costs. The Carajás beneficiation plant's production capacity was increased to almost 52 million tons per year. CVRD commenced operation of the N5 Mine in 1998 (TEX Report, 1998b).

CVRD completed a 3-year $52-million expansion of its storage yards, screening equipment, and loading conveyers at Ponta da Madeira. The port's stockpile capacity was increased from 2.5 million to 3.7 million tons. Also at Ponta da Madeira, CVRD is planning to build a 6-million-ton-per-year $350 million pellet plant, which will use ore from Carajás. The plant, which was expected to begin operation by the end of 2001 or early in 2002 to produce primarily pellets for the direct reduction market. This will be CVRD's first pellet plant in its Northern System (Metal Bulletin, 1998c).

The company was considering investing approximately $44 million in 1999 to increase the capacity of the Carajás Railroad.

The funds would be used to construct new spur tracks and turn-outs to increase the capacity to as much as 55 million tons annually without construction of a second line of track. The expansion will include the purchase of locomotives and rail cars.

Activities in CVRD's Southern System involved the completion of a pellet plant, improvements to the Vitória-Minas Railroad, and plans to greatly expand the production capacity of one mine and to develop several others. In November, Companhia Coreano-Brasileira de Pelotizaçã (Kobrasco), the 50-50 joint venture pellet plant between CVRD and Pohang Iron and Steel Co. of the Republic of Korea, began operations. The 4-million-ton-per-year plant was the seventh to be built at the Tubarão-Praia Mole marine terminal complex near the Port of Vitória in the State of Espírito Santo. Two of the plants were wholly owned by CVRD; the others are joint ventures between CVRD and other companies.

In October 1997, CVRD completed a 35-kilometer track extension in the State of Minas Gerais enhancing rail access to certain of its Southern System iron ore mines. In January 1998, the company completed a further 34-kilometer enhancement to this line.

CVRD is planning a major expansion of the Brucutu Mine in the state of Minas Gerais. The $243-million project, which will include building a beneficiation plant, will proceed in three stages. The first stage, with an investment of $82 million, will hike production to 6 million tons per year by July 2000. The output from this stage will be 3.4 million tons per year of pellet feed and 2.6 million tons per year of sinter feed; the pellet feed will supply the Tubarao pellet plants. The second stage, with an investment of $85 million, would raise capacity to 12 million tons per year by July 2003. A third stage, with a further investment of $80 million, would increase output to 24 million tons per year by 2008. The production capacity increase will offset the decrease in production in CVRD's other mines in Minas Gerais (Kepp, 1998a; Metal Bulletin, 1998d; Companhia Vale do Rio Doce, written commun., 1998).

In a joint-venture between Minas da Serra Geral S.A. and Kawasaki Steel Corporation, a Japanese steelmaker, CVRD agreed to develop a new mining area named Ouro Fino. The proposed mine is close to the Capanema Mine, which began operations in 1982 and was scheduled to close in 2002, when its reserves will be depleted. At its peak, the mine produced 10 million tons per year. Production from Ouro Fino was expected to offset the decrease in production at the Capanema. Other mine development plans included the Bau Mine, which CVRD expected to open in early 1999. Bau was expected to produce 2 million tons per year of fines and 1 million tons per year of lump ore; it is being developed to boost CVRD's production of lump ore. CVRD also planned to begin mining the Dois Irmaos deposit at Barao de Cocais near the Itabira mines in Minas Gerais. The site contains hematite and itabirite deposits (Kepp, 1998b; TEX Report, 1998e; Companhia Vale do Rio Doce, written commun.1999).

Subsequent to its recent privatization and restructuring, CVRD had a profit of $851 million, a record high for CVRD or any private company in Brazil (Companhia Vale do Rio Doce, 1998; Companhia Vale do Rio Doce, written commun., 1999). The restructuring enabled CVRD to reduce its iron ore production costs by 23% (Kepp, Michael, July 29, 1998, CVRD cuts costs 23%, AMM Online—Steel News, accessed September 8, 1999, at URL http://www.amm.com/SUBSCRIB/1999/ inside/90622stl.htm). When CVRD was a state-owned firm, three separate divisions handled its iron ore production, its railways, and its ports. Under the current structure, CVRD's mine, railway, and port operations have been consolidated into one division. The restructuring allowed CVRD to reduce its 15,000-person workforce by 4,500 employees.

Ferteco Mineração S.A.'s efforts in 1998 were directed toward the construction of port facilities at Septiba, in the Bay of Septiba, about 90 kilometers west of Rio de Janeiro. The facilities, scheduled to begin operation in mid-1999, were to enable Ferteco to load 20 to 25 million tons of ore per year. Ferteco has long needed this port. The company's two mines, the Fabrica and the Feijão, in the State of Minas Gerais, currently send their production to CVRD's port of Tubarão for export. The Fabrica is directly connected to the CVRD railroad, but the Feijão is not. Shipping Feijão ore to Tubarão is expensive because of the long distance (800 kilometers) and because the ore must be unloaded, stockpiled, and reloaded at the transfer point where the MRS Logistica wide gauge railroad connects the Feijão to CVRD's narrow gauge railroad.

Ferteco leased the port for 25 years and has agreed to proceed with a $100-million project provided that the government dredge the access channel to allow vessels of as much as 180,000 dwt to load. A second phase of dredging would enable vessels of 230,000 dwt to load. Ferteco also bought about 17% of the MRS railroad after it was privatized. The company is having car dumpers, stacker/reclaimers, and screening and ship loading equipment installed. The total Ferteco investment in the railroad and port projects will exceed $200 million. Ferteco will benefit from the port in three ways. First, the route from the mines to the port will be shorter, second, the ore will not have to be transferred, and third, the company will be able to move more ore per train. Trains currently are made up of 80 cars, which carry an average of 5,000 tons. Once the port is operational, trains with as many as 120 rail cars will haul 12,000 tons of ore 530 kilometers from the Feijão Mine, and 450 kilometers from the Fábrica Mine to Septiba. Ferteco will continue to ship about 10 million tons per year, mainly from the Fabrica Mine, to Tubarão even after the new port at Septiba is fully operational (The TEX Report, 1998a; Ferteco Mineração S.A., Railroads and Ports, MRS Railroad and the port of Septiba: Ferteco homepage, accessed May 22, 1998 at URL http://www.ferteco.com.br/english/por.htm).

Minerações Brasileiras Reunidas S.A. (MBR) was in the midst of an expansion that will increase its ability to produce and ship iron ore. The company must develop mines to offset the decrease in capacity when it closes some of its mines and to increase its overall capacity from the 27 million tons per year in 1998 to 32 million tons per year. A number of improvements were made to the beneficiation plant at the Pico Mine that enabled MBR to produce a record level of 818,000 tons of iron ore in November. This increased the production capacity to more than 9 million tons per year from 8.5 million tons per year in 1997. When Pico's hematite reserves are depleted in 2006, the mine will be used as a source of itabirite ore for sinter and pellet feed. The mine's itabirite reserves were expected to last until 2020.

The Águas Claras and the Mutuca Mines were scheduled for closure in the next few years. The beneficiation plant at the Mutuca Mine will continue to operate after the mine is closed and will treat ore from the Capão Xavier and the Tamanduá Mines. The plant was modified to increase its capacity. The Capão Xavier Mine was expected to begin producing in 1999 at a rate of 1 million tons per year, and its ore will partly replace blast furnace ore from the Pico Mine. Stripping of overburden and the construction of a new electric energy substation and distribution lines at the Tamanduá Complex continued throughout the year.

At the Guaiba Island Terminal, $3 million was invested in improvements and additions to increase the ore storage capacity from 1.5 million to 3 million tons. MBR also received ISO 9002 recertification at the Águas Claras, the Mutuca, the Pico, and the Tamanduá Mines, the Guaiba Island Terminal, and the Rio de Janeiro office (Metal Bulletin, 1998i, j; Minerações Brasileiras Reunidas S.A., 1998, p. 16).

Canada.—Three mining operations in the Labrador Trough area Labrador and northern Quebec accounted for 99% of Canadian iron ore production—the Iron Ore Company of Canada (IOC), Quebec Cartier Mining Co., and Wabush Mines. Canadian production—42.9 million tons remained at the level reached in 1997 (Michel Miron, Senior Advisor, International and Domestic Market Policy Division, Natural Resources, Canada, written commun. June 15, 1999).

The Board of IOC approved a C$344 million capital spending program that includes the reactivation of the pellet plant at Sept-Iles on the Saint Lawrence River in Quebec and upgrading equipment at the mine near Labrador City, Province of Newfoundland. The program also included additional rail equipment and upgrading of the company's hydroelectric power facility, which supplies the Sept-Iles operation. Generating capacity would be increased from 18 megawatts to 65 megawatts. IOC operated an open pit iron ore mine, concentrator, and pellet plant at Carol Lake near Labrador City and has port facilities and an idle pellet plant at Sept-Iles. A 420-kilometer railway linked the two sites. A primary component of the capital spending was being directed towards the reopening of the Sept-Iles pellet plant, which last operated between 1972 and 1981. The plant was to be redesigned, and commissioning will be timed to coincide with an expected recovery in the international steel industry. The expansion was expected to lift IOC's production capacity of pellets to 17 million tons per year from the present capacity of 12.5 million tons per year. The redesigned plant was also expected to contribute towards majority owner North Ltd.'s target of reducing average production costs at IOC by $5 per ton. Since North's acquisition of a majority ownership interest in IOC, a flotation plant at Carol Lake has been brought on-stream for the production of low-silica pellets suitable for the blast furnace and direct reduction markets (Iron Ore Company of Canada, written commun., 1999; North Ltd., November 16, 1998, IOC's $360 million expansion program, press release, accessed November 19, 1998, at URL: http://www.north.com.au/news-releases/rel-1998111600.html).

In March, Mitsubishi Corporation elected to exercise its option to acquire a further 3.2% of IOC as agreed in an option provided to Mitsubishi when North purchased a majority interest in IOC in April 1997. The changed shareholding of IOC was: North, 56.1%; Mitsubishi, 25.0%; Dofasco Inc., 6.9%; and Labrador Iron Ore Royalty Fund, 12.0% (North Ltd., March 13, 1998, North announce IOC shareholder adjustment, media release, accessed on June 28, 1998, at URL http://www.north.com.au/news-release/rel-1998031300.html).

Late in the year, Wabush Mines, Wabush, Newfoundland, commissioned a screening plant at its pellet production facility to reduce the fines that are generated in the initial handling of pellets. The facility and loading docks are on the north shore of the Saint Lawrence River at Pointe Noire, Quebec. Several of Wabush's customers have installed pulverized coal-injection and oxygen-enrichment systems in their blast furnaces to reduce the quantity of coke used. These systems require a high degree of permeability in the blast furnace. Screening the pellets before they are shipped reduces the quantity of fines that would otherwise reduce the permeability of furnace burdens (Metal Bulletin, 1998m).

As announced in 1997, Algoma closed its iron ore operation in Wawa, Ontario, in June (Cleveland-Cliffs Inc., 1999, oral commun.).

India.—The Indian Government was planning to sell as much as 49% of its 99% equity position in the country's largest iron ore producer, Kudremukh Iron Ore Co. Ltd. (Metal Bulletin, 1998g).

A memorandum of understanding was signed among the Steel Authority of India Ltd. (Sail), Indian Railways, the state government of Madhya Pradesh, and the National Mineral Development Corp. (NMDC) to build a broad-gauge rail line (Metal Bulletin, 1998l). The line was expected to link the existing iron ore mine at Dalli Rajhara, which served the Bhilai steel mill, to a new mining complex at Rowghat, which reportedly has reserves of 750 million tons. The cost of the new line will be entirely borne by Sail, and, in return, Sail will have freight concessions on the ore moved on the line. Sail has been trying to secure a rail link to the reserves for several years. The agreement was brought about because the Dalli Rajhara reserves have become depleted and the Bhilai mill has needed more ore to feed its expansion program. The rail line will go further, linking Rowghat with Jagdalpur, where some NMDC mines are situated. It is expected that the mines will take 4 years to develop and the rail line will take 5 years to complete.

Rio Tinto and Orissa Mining were conducting a prefeasibility study of two iron ore deposits in India (See Australia).

Iran.—The National Iranian Steel Co. awarded a $115 million contract to a consortium led by Voest-Alpine Industrieanlagenbau, for the construction of two iron ore beneficiation plants near its principal iron ore mine at Choghart. The Choghart Mine in Yazd Province served the Isfahan steelworks. The plants were expected to begin production in 2000 at a capacity of 3.3 million tons per year (Metal Bulletin, 1998h; Mining Journal, 1998a).

Norway.—Australian Bulk Minerals (ABM) decided to exercise its option to take over the state-owned Sydvaranger Mine at Björnevatn and pellet plant near Kikenes in northern Norway. In 1996, the Norwegian Parliament voted to close Sydvaranger, the world's most northerly iron ore mine. To remain in operation, the mine would have had to convert from open pit to underground mining, requiring further Government subsidies. The mine had been operating at a loss since the mid-1970's. ABM planned to increase production from the 1-million-ton-per-year rate to the 1.5-million-ton-per-year rate produced in recent years to 2.5 million tons per year. The company would also concentrate on the low-cost blast furnace pellet market, rather than the specialty markets that Sydvaranger had developed. ABM was the company that restarted the Savage River iron ore pelletizing operation in Tasmania in 1997 (Metal Bulletin, 1996, 1998a).

***South Africa*.**—Iscor Mining was in the midst of a program to increase the company's capacity to produce and ship iron ore. Among other things, the program involved increasing the work week at the Sishen Mine from 6 to 7 days a week. After negotiations with several labor unions, Sishen began operating under the new schedule in November. The goal was to raise the production capacity to 27 million tons per year and eventually to 32 million tons per year. The program also involved increasing the capacity of the Iscor-Saldanha Bay railroad. The rail line operator was spending $28 million on improvements to the 861-kilometer line. The port at Saldanha was part of the program as well, where improvements were made to the iron ore export infrastructure, including the railway car dumper (Mining Journal, 1998b; Iscor Mining, 1998, written commun.).

Also at Saldanha, Iscor Ltd. and Industrial Development Corp., in a 50-50 joint venture, were constructing a hot coil production plant with an annual production capacity of 1.2 million tons, a Midrex Process DRI plant with an annual production capacity of 800,000 tons, a Corex Process plant with an annual production capacity of 650,000 tons, and a new unloading berth for imported pellets. The DRI plant will receive 1.2 million tons per year of iron ore; the Corex plant, 1 million tons per year. The feedstock for the DRI plant will consist of 2.0 million tons per year of lump ore from Sishen and 400,000 tons per year of pellets from Brazil (Iscor Mining, 1999, Iron Ore, Report of the Managing Director, Mining, accessed June 10, 1999, at URL http://www.iscorltd.co.za/annual%20report/fr_mdrepming.htm).

The Associated Manganese Mines of South Africa Limited (Assmang) produced 5.1 million tons of iron ore in 1998. Assmang was in the first stages of developing the extended iron ore mining area immediately south of the current Beeshoek operation (The Associated Manganese Mines of South Africa Limited, 1998).

***Sweden.*—**Most of Luossavaara Kiirunavaara AB's (LKAB) efforts during the year centered on reducing costs by improving its rail transportation system. The company also increased pellet production capacity and mine automation. Rail transportation system improvements involved upgrading the rail lines and purchasing new rolling stock. Upgrading the rail lines from an axle load of 25 tons to 30 tons will allow LKAB to increase the payload of each rail car from 80 tons to 100 tons. The upgrade should allow the payload per train to increase from the current (1998) 4,100 tons to 6,800 tons. This means that 8 or 9 trains per day to Narvik could carry the same cargo that currently requires 12 or 13 trains. Banverket, Sweden's national rail administration began work to increase the bearing capacity of the southern section, Malmberget-Luleå, of the Ore Line from 25 tons per axle to 30 tons per axle (Luossavaara Kiirunavaara AB, June 11, 1998, LKAB invests in new locomotives and ore cars, press release, June 11, 1998. accessed May 27, 1999, at URL http://www.lkab.se/english/news/pressreleases/980611Locomotives_OreCars.html).

Jernbaneverket, Norway's national rail administration, and LKAB reached an agreement concerning the upgrading of the Ofoten Line, which runs from the Swedish-Norwegian border to Narvik. Narvik is the Norwegian port from which LKAB exported much of its iron ore. Jernbaneverket will assume the role of general contractor for the project, the purpose of which is to upgrade the line to 30 tons of axle pressure (Luossavaara Kiirunavaara AB, August 25, 1998, Upgrading of the Ofoten Line press release, accessed November 24, 1998 at URL http://www.lkab.se/english/news/pressreleases/980624_30tonnes.html).

LKAB assumed control of the ore rail system in 1996 through the formation of Malmtrafik i Kiruna AB, its subsidiary transportation company (Kirk, 1997, p. 470). The result was a nearly 30% reduction in rail transport costs from 1996 through 1998. LKAB expects to realize more cost savings after the southern circuit of the Ore Railway is upgraded (Luossavaara Kiirunavaara AB, 1998, p. 6).

The other part of improving LKAB's rail transportation system involved purchasing new rolling stock. The purchases were timed to coincide with the upgrade of the rail system. The LKAB Board of Directors approved an investment of $140 million to purchase 9 locomotives and 209 ore cars. The locomotives were ordered from Adtranz, a Swedish manufacturer. The first engine, which will be delivered in August 2000, will undergo extensive trials during a 1-year period (LKAB Press release, LKAB purchases new ore train locomotives from Adtranz: September 15, 1998, accessed September 23, 1998 at URL http://www.lkab.se/english/news/pressreleases/980915_new_locomotives.html). Because the locomotives in use in 1998 were almost 40 years old, they required considerable maintenance. The new locomotives will be equipped with asynchronous motors, which will facilitate electric braking with regeneration (Luossavaara Kiirunavaara AB, June 11, 1998, LKAB invests in new locomotives and ore cars, press release, accessed May 27, 1999 at URL http://www.lkab.se/english/news/pressreleases/980611Locomotives_OreCars.html). Five of the ore cars ordered for testing will be delivered in 1999. Once the tests have been completed, the rest of the cars will be delivered so as to be ready to be used on the Malmbanan, the Ore Railway (Luossavaara Kiirunavaara AB, 1998, p. 25).

LKAB's newest pelletizing plant, which has been in operation at Kiruna since 1995, reached a capacity of 4.3 million tons per year, compared with the initial estimate of 4 million tons per year. The company expected production to reach 5 million tons per year through the addition of higher capacity magnetic separators and a fifth balling drum (Luossavaara Kiirunavaara AB, March 10, 1998, LKAB invests in mine automation and increased pelletizing capacity in Kiruna, press release, accessed June 4, 1999, at URL http://www.lkab.se/english/news/press releases/980310Automation.htm).

A new generation of drilling rigs was introduced in the Kiruna and Malmberget Mines. These machines have been designed for remote-control operation so that one operator can run several rigs at once without having to be anywhere near them. This remote control technology has become so reliable, it can be implemented throughout the entire mine. The large-scale use of remote-control loaders and drilling rigs required the expansion of mine infrastructure for the transmission of video signals and other data to a central control room at the 775-meter level of the mine.

The centralized remote control of the drilling rigs means that the night shift can be used for drilling. Formerly, drilling was prohibited during the shift for safety reasons because blasting was done during the night shift. Having an additional shift when drilling can be done is expected to lead to greater productivity.

The company signed a new energy agreement with its electricity supplier guaranteeing LKAB long-term electricity deliveries at a predetermined price.

Another project involved waste rock disposal. LKAB was experimenting with pumping the waste rock directly to a dumping site rather than moving it with trucks and hoists as it was being done in 1998. The company built a pilot plant at Malmberget to test the process (Luossavaara Kiirunavaara AB, 1998, p. 28).

LKAB began the implementation of a quality management system based on ISO 9001:2000 during the year (Luossavaara Kiirunavaara AB, 1998, p. 2).

In March, the company began mining hematite at the Malmberget Mine after a hiatus of 25 years. Mining was made economically feasible by the use of new technology (Luossavaara Kiirunavaara AB, written commun., 1999).

Outlook

The domestic iron ore industry is totally dependent on the steel industry for sales. This dependence is not expected to change in the near future. Because of this relationship, the reader is referred to the outlook section in the Iron and Steel chapter of the USGS 1998 Minerals Yearbook. For the near term, growth of the U.S. iron ore industry is tied to the growth of the integrated steelworks along the Great Lakes. Significant expansion in the domestic iron ore industry may be possible if one or more of the direct-reduction processes prove to be economic for existing and potential Great Lakes producers. If this occurs, the industry can supply the rapidly expanding minimill sector of the U.S. steel industry. Steel products require lower residual alloy content than can be readily achieved with scrap. This indicates a role for imported DRI in the coastal regions of the United States and domestically produced DRI further inland where cheaper power is available. No matter how spectacular DRI growth is during the next decade, it will not be able to replace more than a fraction of the world's blast furnace production because of technological restrictions. The blast furnace is expected to remain the mainstay of the iron and steel industries in most developed countries during the next 25 years.

Based on recent growth rates in Asia, additional iron ore production capacity will be needed. As in the United States, much of the increase in consumption of iron in Asia will be from newly constructed minimills, but unlike the United States, where the consumption of iron ore in blast furnaces is declining, much of the additional ore needed will go to feed blast furnaces. Because iron ore prices have not risen substantially and industry observers see no reason to believe that they soon will, future increases in supply will probably not come from greenfield operations. Supply increases would come instead from low-cost brownfield expansions by existing producers in the major supplier countries such as Australia and Brazil. Most of the recent growth in iron ore consumption has come from Asia, particularly China, the Republic of Korea, and Taiwan.

Through the end of 1999 and into 2000, the iron ore market is expected to see some growth as the effects of the Asian financial crisis are alleviated. World consumption of steel products is likely to total 698.8 million tons in 1999, less than 1% increase from that of 1998 and reach 719.0 million tons in 2000.

Beyond 2000, iron ore demand should continue to increase, and most of that increase should be accounted for by Asia. The IISI is predicting that world consumption will be 763 million tons in 2005. Australia, because of its proximity to Asia, may be best positioned to satisfy that additional demand. Demand for DRI will continue to grow, fueled by demand from the EAF steelmakers.

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

TABLE 1
SALIENT IRON ORE STATISTICS 1/

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

	1994	1995	1996	1997	1998
United States:					
Iron ore (usable, less than 5% manganese): 2/					
Production	58,454	62,501	62,083	62,971	62,931
Shipments	57,600 r/	61,100	62,200	62,800	63,200
Value	$1,410,000	$1,730,000	$1,770,000	$1,890,000	$1,970,000
Average value at mines, dollars per ton	$24.49 r/	$28.32	$28.48	$30.06	$31.14
Exports	4,980	5,270 r/	6,260	6,340 r/	6,000
Value	$163,000	$184,000	$232,000	$235,000	$245,000
Imports for consumption	17,500	17,600	18,400	18,600	17,000
Value	$499,000	$491,000	$556,000	$551,000 r/	$521,000
Consumption (iron ore and agglomerates)	80,200	83,100	79,600	79,500	78,200
Stocks, December 31:					
At mines, plants and loading docks 3/	2,790	4,240	4,650	4,860	6,020
At receiving docks 4/	2,230	2,140	2,260 r/	2,890 r/	4,080
At consuming plants	16,300	17,100	18,800	20,200	20,500
Total 5/	21,300	23,500	25,700	27,900	30,600
World: Production 6/	991,858 r/	1,030,993 r/	1,017,824 r/	1,072,254 r/	1,020,935 e/

e/ Estimated. r/ Revised.
1/ Data are rounded to three significant digits, except "Production;" may not add to totals shown.
2/ Direct-shipping ore, concentrates, agglomerates, and byproduct ore.
3/ Excludes byproduct ore.
4/ Transfer and/or receiving docks of Lower Lake ports.
5/ Sum of stocks at mines, consuming plants, and U.S. docks.
6/ Gross weight.

TABLE 2
EMPLOYMENT AT IRON ORE MINES AND BENEFICIATING PLANTS, QUANTITY AND TENOR OF ORE PRODUCED, AND AVERAGE OUTPUT PER WORKER-HOUR IN THE UNITED STATES IN 1998, BY DISTRICT AND STATE 1/

			Production (thousand metric tons)				Average per worker-hour (metric tons)		
District and State	Average number of employees	Worker-hours (thousands)	Crude ore	Usable ore	Iron contained (in usable ore)	Iron content, natural (percent)	Crude ore	Usable ore	Iron contained
Lake Superior:									
Michigan	1,770	3,680	45,600	15,300	9,480	61.9	12.39	4.16	2.57
Minnesota	5,410	11,300	167,000	47,300	30,000	63.5	14.76	4.17	2.65
Total or average	7,190	15,000	213,000	62,600	39,500	63.1	14.18	4.17	2.63
Other States 2/	107	211	514	327	205	62.8	2.44	1.55	0.97
Grand total or average	7,290	15,200	213,000	62,900	39,700	63.1	14.02	4.13	2.61

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Includes California, Missouri, New Mexico, South Dakota, Texas, and Utah.

TABLE 3
CRUDE IRON ORE MINED IN THE UNITED STATES IN 1998, BY DISTRICT, STATE, AND MINING METHOD 1/ 2/

(Thousand metric tons unless otherwise specified and exclusive of ore containing 5% or more manganese)

District and State	Number of mines	Open pit	Underground	Total quantity
Lake Superior:				
Michigan	2	45,600	--	45,600
Minnesota	8	167,000	--	167,000
Total	10	213,000	--	213,000
Other States:				
Missouri	1	--	456	456
Other 3/	1	58	--	58
Total	2	58	456	514
Grand total	12	213,000	456	213,000

1/ Excludes byproduct ore.
2/ Data are rounded to three significant digits; may not add to totals shown.
3/ Includes California, New Mexico, South Dakota, Texas, and Utah.

TABLE 4
USABLE IRON ORE PRODUCED IN THE UNITED STATES IN 1998, BY DISTRICT, STATE, AND TYPE OF PRODUCT 1/

(Thousand metric tons and exclusive of ore containing 5% or more manganese)

District and State	Direct shipping ore	Concentrates	Agglomerates 2/	Total quantity
Lake Superior:				
Michigan	68	--	15,200	15,300
Minnesota	399	22	46,900	47,300
Total	467	22	62,100	62,600
Other States:				
Missouri	7	245	16	268
Other 3/	58	--	--	58
Total	65	245	16	327
Grand total	532	267	62,100	62,900

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Data may include pellet chips and screenings.
3/ Includes California, New Mexico, South Dakota, Texas, and Utah.

TABLE 5
SHIPMENTS OF USABLE IRON ORE FROM MINES IN THE UNITED STATES IN 1998 1/ 2/

(Exclusive of ore containing 5% or more manganese)

	Gross weight of ore shipped (thousand metric tons)					
District and State	Direct shipping ore	Concentrates	Agglomerates	Total	Average iron content, natural (percent)	Value (thousands)
Lake Superior:						
Michigan	52	--	15,600	15,600	62.0	W
Minnesota	377	58	46,800	47,200	63.2	$1,470,000
Total reportable or average	429	58	62,400	62,900	62.9	1,470,000
Other States:						
Missouri	6	239	16	261	70.3	W
Other 3/	93	29	--	122	46.3	1,540
Total reportable or average 3/	99	268	16	383	62.6	--
Total withheld	--	--	--	--	--	496,000
Grand total or average	529	326	62,400	63,200	62.9	1,970,000

W Withheld to avoid disclosing company proprietary data; included in "Total withheld."
1/ Includes byproduct ore.
2/ Data are rounded to three significant digits; may not add to totals shown.
3/ Includes California, New Mexico, South Dakota, Texas, and Utah.

TABLE 6
CONSUMPTION OF IRON ORE AT U.S. IRON AND STEEL PLANTS 1/ 2/

(Thousand metric tons)

	Iron ore originating areas					
	U.S. ores		Canadian ores			
Year	Great Lakes	Other U.S.	Great Lakes	Other Canada	Foreign ores	Total
1997	58,700	--	714	6,070	6,330 r/	71,800
1998	57,700	1	725	5,810	5,740	70,000

r/ Revised.
1/ Excludes dust, mill scale, and other revert iron-bearing materials added to sinter.
2/ Data are rounded to three significant digits; may not add to totals shown.

Source: American Iron Ore Association.

TABLE 7
CONSUMPTION OF IRON ORE AT U.S. IRON
AND STEEL PLANTS, BY TYPE OF PRODUCT 1/ 2/

(Thousand metric tons)

Type of product	1997	1998
Blast furnaces:		
Direct-shipping ore	1,540	786
Pellets	64,400	62,800
Sinter 3/	11,300	10,600
Total	77,300	74,300
Steelmaking furnaces:		
Direct-shipping ore	80	67
Pellets	32	18
Sinter 3/	126	191
Total	238	276
Grand total	77,500	74,600

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Includes agglomerates.
3/ Includes briquettes, nodules, and other.

Source: American Iron and Steel Institute.

TABLE 8
U.S. CONSUMPTION OF IRON ORE , BY END USE 1/ 2/

(Thousand metric tons and exclusive of ore containing 5% ore more manganese)

Year	Blast furnaces	Steel furnaces	Sintering plants 3/	Miscella-neous 4/	Subtotal integrated iron and steel plants 5/	Direct-reduced iron for steelmaking 6/	Nonsteel end uses 7/	Total
1997	64,900	86	6,660	146	71,800	752	1,280 r/	73,800
1998	63,500	101	6,330	48	70,000	761	1,280	72,000

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Includes agglomerates.
3/ Excludes dust, mill scale, and other revert iron-bearing materials.
4/ Sold to nonreporting companies or used for purposes not listed.
5/ Data from American Iron Ore Association.
6/ U.S. Geological Survey estimates based on production reports compiled by Midrex Corp.
7/ Includes iron ore consumed in production of cement and iron ore shipped for use in manufacturing paint, ferrites, heavy media, cattle feed, refractory and weighing materials, and for use in lead smelting. Data from U.S. Geological Survey surveys.

TABLE 9
U.S. EXPORTS OF IRON ORE,
BY COUNTRY OF DESTINATION 1/ 2/

(Thousand metric tons and thousand dollars)

Country	1997 Quantity	1997 Value	1998 Quantity	1998 Value
Canada	6,340	235,000	5,990	244,000
Mexico	1	141	2	191
Other	4 r/	431 r/	13	1,130
Total	6,340 r/	235,000	6,000	245,000

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

Source: Bureau of the Census.

TABLE 10
U.S. EXPORTS OF IRON ORE, BY TYPE OF PRODUCT 1/ 2/

Type of product	1997 Quantity (thousand metric tons)	1997 Value (thousand dollars)	1997 Unit value 3/ (dollars per ton)	1998 Quantity (thousand metric tons)	1998 Value (thousand dollars)	1998 Unit value 3/ (dollars per ton)
Concentrates	23	595	26.32	28	620	22.14
Coarse ores	--	--	--	1	51	51.00
Fine ores	14	490	35.00	27	1,090	40.52
Pellets	6,300	234,000	37.11	5,910	242,000	40.95
Briquettes	(4/)	39	NA	--	--	NA
Other agglomerates	2	111	48.33	27	680	25.19
Roasted pyrites	4	270	72.54	9	446	49.56
Total	6,340 r/	235,000	37.09 5/	6,000	245,000	40.80 5/

r/ Revised. NA Not available.
1/ Data may not add to totals shown.
2/ Includes agglomerates.
3/ Unit values shown are calculated from unrounded data.
4/ Less than 1/2 unit.
5/ Weighted average calculated from unrounded data by dividing total value by total tonnage.

Source: Bureau of the Census.

TABLE 11
U.S. IMPORTS OF IRON ORE, BY COUNTRY AND TYPE OF PRODUCT 1/ 2/

Country and type of product	1997 Quantity (thousand metric tons)	1997 Value (thousand dollars)	1997 Unit value 3/ (dollars per metric ton)	1998 Quantity (thousand metric tons)	1998 Value (thousand dollars)	1998 Unit value 3/ (dollars per metric ton)
Australia	742	6,200	8.36	807	6,850	8.49
Brazil	4,970 r/	129,000 r/	25.97 r/	5,980	169,000	28.22
Canada	10,000 r/	318,000 r/	31.68 r/	8,520	286,000	33.56
Chile	228	4,110	18.04	48	1,230	25.67
Peru	252	3,020	11.96	126	1,710 r/	13.60
Sweden	149 r/	5,790 r/	38.84 r/	276	10,500	38.20
Venezuela	2,090	80,600	38.64	1,000 r/	39,400 r/	39.33 r/
Other	107 r/	3,950 r/	36.92 r/	196	6,880	35.11
Total	18,600	551,000 r/	29.66 r/	17,000 r/	521,000 r/	30.75 r/
Concentrates	1,610 r/	27,400 r/	17.00 r/	1,360 r/	23,400 r/	17.20 r/
Coarse ores	1,350 r/	51,400 r/	38.14 r/	465	15,100 r/	94.89 r/
Fine ores	2,990 r/	49,300 r/	16.52 r/	3,180	56,400	17.74
Pellets	11,800 r/	402,000 r/	34.10 r/	11,100	397,000 r/	35.89
Briquettes	--	--	--	159 r/	9,180 r/	57.72 r/
Other agglomerates	843 r/	20,500 r/	24.34 r/	715 r/	19,600 r/	27.37 r/
Roasted pyrites	11	551	50.82 r/	7	368 r/	52.57 r/
Total	18,600	551,000 r/	29.66 r/ 4/	17,000 r/	521,000 r/	30.75 4/

r/ Revised.
1/ Data are rounded to three significant digits, except prices; may not add to totals shown.
2/ Includes agglomerates.
3/ Unit values shown are calculated from unrounded data.
4/ Weighted average calculated from unrounded data by dividing total value by total tonnage.

Source: Bureau of the Census.

TABLE 12
U.S. IMPORTS OF IRON ORE IN 1998, BY COUNTRY AND TYPE OF PRODUCT 1/ 2/

(Thousand metric tons)

Country of origin	Concentrates	Coarse ores	Fine ores	Pellets	Other agglomerates 3/	Roasted pyrites	Total
Australia	131	--	676	--	--	--	807
Brazil	273	147	2,330	2,820	416	--	5,980
Canada	900	5	--	7,450	167 r/	--	8,520
Chile	--	16	32	--	--	--	48
Norway	--	--	--	97	--	--	97
Peru	--	(4/)	--	7	119	(4/)	126
Sweden	58	--	22	197	--	--	277
Venezuela	--	240	94	508	159 r/	--	1,000 r/
Other	--	58	21	--	13	7	99
Total	1,360	465	3,180	11,100	874 r/	7	17,000 r/

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Includes agglomerates.
3/ Includes briquettes.
4/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 13
AVERAGE UNIT VALUE FOR SELECTED IMPORTS OF IRON ORE
IN 1998 1/

Type of product	Country of origin	Average unit value 2/ (dollars per metric ton gross weight)
Concentrates	Brazil	16.17
Do.	Canada	17.01
Coarse ores	Venezuela	30.45
Fine ores	Australia	8.19
Do.	Brazil	19.44
Pellets	Brazil	35.35
Do.	Canada	35.85
Do.	Venezuela	37.82

1/ Includes agglomerates.
2/ Weighted averages of individual Customs values.

Source: Bureau of the Census.

TABLE 14
U.S. IMPORTS OF IRON ORE, BY CUSTOMS DISTRICT 1/ 2/

(Thousand metric tons and thousand dollars)

Customs district	1997		1998	
	Quantity	Value	Quantity	Value
Baltimore	4,320 r/	101,000 r/	4,370	104,000
Charleston	815	29,600	763	28,600
Chicago	2,780	62,000	1,700	41,700
Cleveland	662	20,000	1,220	37,500
Detroit	2,220	80,600	1,800	68,100
Houston-Galveston	67	2,030	124	2,750
Mobile	4,390	152,000	3,990	142,000
New Orleans	1,400	33,000	2,750	88,500
Philadelphia	1,900	70,200	179	6,380
Other	37	888	64	1,790
Total	18,600	551,000 r/	17,000	521,000

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

Source: Bureau of the Census.

TABLE 15
U.S. IMPORTS OF PELLETS, BY COUNTRY 1/

(Thousand metric tons and thousand dollars)

Country	1997		1998	
	Quantity	Value	Quantity	Value
Brazil	1,660	61,000	2,820	99,600
Canada	8,840	297,000	7,450	267,000
Norway	92	3,590	97	3,760
Peru	54	649	7	99
Sweden	4	297	197	7,770
Venezuela	924	35,400	508	19,200
Total	11,600	398,000	11,100	397,000

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

Source: Bureau of the Census.

TABLE 16
SELECTED PRICES FOR IRON ORE IN THE JAPANESE MARKET

(F.o.b. shipping port basis. U.S. cents per dry long ton of iron, unless otherwise specified)

Country and producer	Ore types	April 1-March 31 Fiscal year 1997	Fiscal year 1998
Australia:			
Hamersley Iron Pty. Ltd. and Mount Newman Mining Co. Pty. Ltd.	Lump ore	37.68	38.79
Do.	Fines	29.10 r/	29.92
Robe River Iron Associates	do.	23.85	24.52
Savage River Mines Ltd.	Pellets	47.09 r/	48.41
Brazil:			
Companhia Nipo-Brasileira de Pelotizacao (Nibrasco)	do.	49.76	51.15
Companhia Vale do Rio Doce (Carajas)	Fines	26.58	27.32
Companhia Vale do Rio Doce (Itabira)	do.	28.07	28.90
Do.	Fines	26.08	26.82
Mineracoes Brasileiras Reunidas S.A.	Lump ore	27.45	28.71
Do.	do.	26.59	27.34
Samarco Mineracâo S.A.	Pellet feed	21.91	22.53
Canada:			
Iron Ore Company of Canada (Carol Lake)	Concentrates	25.30	26.01
Chile:			
Minera del Pacifico S.A. (El Algarrobo)	Pellets	46.37	47.67
Minera del Pacifico S.A. (El Romeral)	Fines	20.20	20.77
India:			
Minerals and Metals Trading Corp. (Bailadila)	Lump ore	36.33	37.40
Do.	Fines	27.93	28.72
Peru:			
Empresa Minera del Hierro del Peru S.A.	Pellet feed	19.83	20.39
South Africa, Republic of: 1/			
South African Iron and Steel Industrial Corp. Ltd.	Lump ore	30.50	31.40
Do.	Fines	22.13	22.75

r/ Revised.
1/ Price per dry metric ton unit.

Source: Trust Fund Project on Iron Ore Information, Iron Ore 1998.

TABLE 17

IRON ORE, IRON ORE CONCENTRATES, AND IRON ORE AGGLOMERATES: WORLD PRODUCTION, BY COUNTRY 1/

(Thousand metric tons)

	Gross weight 2/					Metal content 3/				
Country 4/	1994	1995	1996	1997	1998 e/	1994	1995	1996	1997	1998 e/
Algeria	2,047	2,202	2,245	2,250 e/	2,000	1,000 e/	1,100	1,100	1,100 e/	1,000
Argentina e/	80 r/	1 r/	-- r/	-- r/	--	28 5/	(6/) 5/	-- r/	-- r/	--
Australia	128,493	142,936	147,100	157,766	153,456 5/	80,900 e/	88,653	93,000	97,901 r/	96,250 5/
Austria	1,655	--	1,853	1,800 r/ e/	1,600	520 e/	660 e/	504	490 r/ e/	420
Azerbaijan e/	200	150	150	NA	NA	110	83	83	NA	NA
Bolivia	3	-- e/	--	--	--	2	-- e/	--	--	--
Bosnia and Herzegovina e/	200	150	150	150	150	70	52	50	50	50
Brazil	177,331 r/	183,839 r/	174,157 r/	185,128 r/	195,310 5/	103,227	112,793 r/	112,000 r/	122,184 r/	128,905 5/
Bulgaria	462	483	497	479 r/	450	290	290	320	320 e/	320
Canada 7/	37,703	36,628	36,030	37,277 r/	38,875 p/	24,235	23,416	23,034 e/	23,857 r/	24,880 p/
Chile	8,341	8,432	9,082	8,738	9,112 p/	5,167	5,233	5,275	5,437	5,540 p/
China e/	240,200	249,350	249,550	268,000 r/	210,000	72,050	75,000	75,000	80,400 r/	63,000
Colombia	610	734	550	640 r/	670 p/	317	382 e/	286 e/	333 r/ e/	348
Egypt	3,870	2,042	2,429	2,700 r/	2,700	2,100 e/	1,237 e/	1,700 e/	1,800 r/ e/	1,800
France e/	2,418 5/	1,496 5/	1,464 5/	525 r/	300	706	432	430	150 r/	85
Germany	146	69 r/	100	201 r/	200	21	18	15 e/	28 e/	28
Greece e/ 8/	1,990	1,970	1,990	NA	NA	810	800	810	NA	NA
Guatemala e/	3	3	3	3	4	2	2	2	2	2
India	60,473	65,173	66,657	69,400 r/	75,000	37,368	41,710	42,660	44,400 r/	48,000
Indonesia e/	335 5/	340	335	345 5/	345	194	197	194	200	200
Iran 9/	8,690	9,080	9,850 r/	12,750 r/	12,800	4,300	4,500	4,800 r/	6,300 r/	6,300
Japan	3	3	4 r/	4 r/	4	1	1	2 r/	2 r/	2
Kazakhstan	10,521	14,900	13,200	13,700 e/	8,693	5,700 e/	8,200 e/	7,200	7,500 e/	5,100
Korea, North e/	11,000	11,000	11,000	10,000	10,000	4,900	5,100	5,100	4,700	4,700
Korea, Republic of	191	184	221	296	328 5/	107	103	124	166	133 5/
Macedonia e/	15	15	15	15	15	9	9	9	9	9
Malaysia	243	202	325	269	380	148	123	208	172	243
Mauritania	11,440	11,330	11,400	11,700 r/	11,400	7,000 e/	7,000 e/	7,000 e/	7,000 r/ e/	7,000
Mexico 10/	9,194 r/	9,375 r/	10,182 r/	10,466 r/	10,557 5/	5,516	5,625 r/	6,109 r/	6,280 r/	6,334 5/
Morocco	64	47	12 r/	12 r/	6 5/	39	32	8 r/	8 r/	3
New Zealand 11/	2,080	2,362	2,334	2,478 r/	2,000	600 e/	900 e/	800 e/	800 e/	700
Nigeria e/	400 r/	168 r/	100 r/	50 r/	50	200 r/	65 r/	50 r/	25 r/	25
Norway	2,364	2,012	1,705	1,700 r/	1,600	1,532	1,348	1,023	1,100 r/	1,000
Peru	7,430	6,235	4,364	4,439	4,439 5/	4,830 r/	3,948	2,916	2,966	2,966 5/
Portugal 12/	14	15	19	18 e/	16	5	5	7	7 e/	7
Romania e/	951	570	670	650	650	198 5/	147 5/	175 5/	170	170
Russia	73,300	75,900	69,600	70,800 e/	72,343	40,200	41,700	39,600	38,900 e/	39,700
Serbia and Montenegro e/	32 5/	110 r/ 5/	110 r/	110 r/	100	10	34 r/ 5/	34 r/	34 r/	31
Slovakia e/	870	820	850 5/	850	800	230	225	240	240	220
South Africa 13/	30,489	31,946	30,830	33,225 r/	32,948 5/	18,903	19,806	19,115 e/	20,600 r/ e/	20,400
Spain 14/	2,082	2,307	1,269	-- r/	--	992	1,073	588	-- r/	--
Sweden	19,663	19,058	20,273	21,893	20,930 5/	12,587	12,211	12,975 e/	13,912 e/	13,186 5/

See footnotes at end of table.

TABLE 17--Continued

IRON ORE, IRON ORE CONCENTRATES, AND IRON ORE AGGLOMERATES: WORLD PRODUCTION, BY COUNTRY 1/

(Thousand metric tons)

	Gross weight 2/					Metal content 3/				
Country 4/	1994	1995	1996	1997	1998 e/	1994	1995	1996	1997	1998 e/
Thailand	143	34	86	44 r/	91 5/	78 e/	17 e/	43 e/	22 e/	46
Tunisia	288	224	239 e/	252	220 5/	129	122	130	137 e/	119 5/
Turkey e/	5,755 5/	4,931 5/	6,404	6,321 r/	6,500	3,148	2,754 5/	3,500	3,500	3,600
Ukraine	51,300	50,400	47,600	53,000 e/	50,659	28,200	27,700	26,200	29,200 e/	27,900
United Kingdom	1	1	1	1	1	(6/)	(6/)	(6/) e/	(6/) e/	(6/)
United States	58,454	62,501	62,083	62,971	62,931 5/	36,762	39,577	39,243	40,022	39,724 5/
Venezuela	18,318	18,954	18,412	18,359	19,932 5/	9,489	9,818	9,537	9,510	10,365 5/
Zimbabwe e/	4 5/	311 5/	324	479 r/ 5/	372 5/	3	160	160	230 r/	180
Total	991,858 r/	1,030,993 r/	1,017,824 r/	1,072,254 r/	1,020,935	514,935 r/	544,363 r/	543,358 r/	572,163 r/	560,991

e/ Estimated. p/ Preliminary. r/ Revised. NA Not available.

1/ Table includes data available through July 16, 1999.

2/ Insofar as availability of sources permit, gross weight in this table represent the nonduplicative sum of marketable direct-shipping iron ores, iron ore concentrates, and iron agglomerates produced from imported iron ores have been excluded under the assumption that the ore from which such materials are produced has been credited as marketable ore in the country where it was mined.

3/ Data represent actual reported weight of contained metal or are calculated from reported metal content. Estimated figures are based on latest available iron content reported, except for the following countries for which grades are U.S. Geological Survey estimates: Azerbaijan, Kazakhstan, North Korea, and Ukraine.

4/ In addition to the countries listed, Cuba and Vietnam may also produce iron ore, but definitive information on output levels, if any, is not available.

5/ Reported figure.

6/ Less than 500 tons.

7/ Series represented gross weight and metal content of usable iron ore (including byproduct ore) actually produced, natural weight.

8/ Nickeliferous iron ore.

9/ Data are for year beginning March 21 of that stated.

10/ Gross weight calculated from reported iron content based on grade of 60% Fe.

11/ Concentrates from titaniferous magnetite beach sands.

12/ Includes manganiferous iron ore.

13/ Includes magnetite ore as follows, in thousand metric tons: 1994--3,460; 1995--2,325; 1996--2,070; 1997-98--NA.

14/ Includes byproduct ore.

TABLE 18
IRON ORE: WORLD PELLETIZING CAPACITY,
BY CONTINENT AND COUNTRY IN 1998

	Rated capacity (million metric tons gross weight)
North America:	
Canada	27.3
Mexico	13.7
United States	65.9
Total 1/	106.9
South America:	
Argentina	2.0
Brazil	41.5
Chile	4.4
Peru	3.4
Venezuela	9.9
Total 1/	61.3
Europe:	
Belgium	0.7
Netherlands	3.8
Norway	1.4
Russia	34.0
Sweden	16.4
Turkey	1.0
Ukraine	32.0
Total 1/	89.3
Africa:	
Liberia	3.0
South Africa	0.6
Total 1/	3.6
Asia:	
Bahrain	4.0
China	20.0
India	8.5
Iran	9.0
Japan	3.0
Kazakhstan	8.4
Total 1/	52.9
Oceania: Australia	4.0
World total 1/	318.0

1/ Data may not add to totals shown because of independent rounding.

Sources: International Iron and Steel Institute, Brussels, Belgium; United Nations Commission on Trade and Development; Trust Fund Project on Iron Ore Information; U.S. Geological Survey.