MANGANESE

By Thomas S. Jones

Manganese (Mn) is essential to iron and steel production by virtue of its sulfur-fixing, deoxidizing, and alloying properties. Steelmaking, including its ironmaking component, has accounted for most domestic manganese demand, presently in the range of 85% to 90% of the total. Among a variety of other uses, manganese is a key component of certain widely used aluminum alloys and is used in oxide form in dry cell batteries. The overall level and nature of manganese use in the United States is expected to remain much the same in the near and medium term. Currently, no practical approaches exist for replacing manganese by other materials or for basing U.S. raw material supply on domestic sources, either deposits or other accumulations.

Current ongoing trends in consumption were indicated to be, for steelmaking, some shifting from ferromanganese to silicomanganese and, for dry cell batteries, displacement of natural manganese dioxide by synthetic dioxide, principally electrolytic manganese dioxide (EMD).

U.S. foreign trade in manganese materials was active in 1996. Exports of ore increased significantly. Import volume was up for nearly all material categories, that for silicomanganese to a record high.

The price for metallurgical-grade ore rose (by about 7% on international markets) while prices fell for ferroalloys. January-to-December price decreases for U.S. imports were 14% for ferromanganese and 37% for silicomanganese.

The Government's stockpile disposal program was expanded for manganese to include ferromanganese, to which significant restrictions applied. The rate of disposal of manganese materials was nearly as great as in 1995. The majority of disposals was of ore.

Production of manganese ore was believed for most of the world's main producers to have been at about the same level as in 1995 or possibly even greater. *(See table 1.)* The final total will be more certain once data for China become available. Developments in foreign production of manganese ferroalloys included, in South Africa, establishment of joint ventures between Japanese and South African interests for production of refined and/or specialty grades of ferromanganese and silicomanganese and, in Iran and Saudi Arabia, the startup of new smelters.

Most data in this report are rounded by the U.S. Geological Survey to three significant digits. Table footnotes will indicate which statistics have been rounded.

Legislation and Government Programs

Stockpile.—The Defense Logistics Agency (DLA) modified its Annual Materials Plan (AMP) with respect to manganese by including synthetic manganese dioxide and ferromanganese. With this change, the maximum fiscal year disposal authority for manganese materials became, in metric tons, 54,431 for natural battery-grade ore; 2,732 for synthetic manganese dioxide; 36,287 for chemical-grade ore; 362,874 for metallurgical-grade ore; 45,359 for ferromanganese; and 1,814 for electrolytic manganese metal. These figures for the revised fiscal year 1996 AMP and also the fiscal year 1997 AMP were submitted to Congress on February 15. These AMP's became effective April 1 and October 1, respectively.

Disposals of ferromanganese were required to consist first of material not meeting the stockpile classification of Grade One, as stipulated in the National Defense Authorization Act for fiscal year 1996. This act was a part of Public Law 104-106 that became effective February 10. On August 28, DLA issued Solicitation of Offers DLA-FERROMANGANESE-001 for sale of manganese ferroalloys. Material being offered for sale during the remainder of fiscal year 1996 comprised 42,910 tons of high-carbon ferromanganese, 2,268 tons of medium-carbon ferromanganese, and 181 tons of silicomanganese. Material being offered for sale during fiscal year 1997 comprised 40,823 tons of high-carbon ferromanganese and 4,536 tons of medium-carbon ferromanganese. Many sale conditions were negotiable; long-term contracts for up to 5 years could be considered, and, as specified in Public Law 104-106, sale of high-carbon ferromanganese was restricted to domestic producers of manganese ferroalloys for remelting.

On November 27, DLA canceled Solicitation of Offers DLA-MET-101 for sale of electrolytic manganese metal, and stated that a new solicitation would be issued in 1997.

Disposals of manganese materials in 1996 announced by DLA totaled, in tons, natural battery-grade ore, 7,121; metallurgical-grade ore, 38,501; and electrolytic metal, 2,518. All disposals were cash transactions.

Data on physical inventory of manganese materials reported by DLA indicated that changes in 1996 consisted, in tons, of decreases of 131,298 for metallurgical-grade ore and 2,126 for electrolytic metal, and increases of 3,766 for natural battery-grade ore and 2,169 for high-carbon ferromanganese. The estimated manganese content of the manganese inventories being held by the Government at yearend was lowered 4.1% to somewhat less than 1.4 million tons. *(See table 2.)* Total inventory was still about twice current national apparent consumption.

Other.—The Government continued to encourage limited study of marine mineral resources, including manganese nodules, through enactment of two laws that became effective

October 19 (Public Law 104-312 and Public Law 104-325). Public Law 104-325 amended the Mining and Minerals Policy Act of 1970 by adding to it a Title II that directed the Secretary of the Interior to conduct a program of research on marine mineral resources. The Secretary also was directed to designate three centers for marine mineral research, the primary areas of concentration of which were to be continental shelf regions, deep seabed and near-shore environments of islands, and arctic and cold water regions, respectively. Public Law 104-312 stated that the amount to be made available for such research should not exceed $1.8 million for each fiscal after fiscal year 1996. Subsequently during 1996, Congress did not appropriate funds for this purpose.

The Mercury-Containing and Rechargeable Battery Management Act (Public Law 104-142, which became effective May 13) prohibited sale in the United States of alkaline manganese or carbon-zinc batteries into which mercury had been introduced intentionally. An exception was that alkaline-manganese button cells could contain up to 25 milligrams of mercury per cell. Title I of this act excluded rechargeable alkaline batteries from requirements imposed on other rechargeable batteries such as those employing nickel and cadmium, whose recycling or proper disposal was being encouraged.

U.S. exporters were required to provide the Drug Enforcement Administration (DEA) of the U.S. Department of Justice at least 15 days advance notice of shipments to Colombia of certain chemicals, including potassium permanganate, that might be diverted to illicit manufacture of cocaine (61 FR 13759-13760). This requirement became effective March 28 upon DEA's revoking of regular customer status for Colombian customers.

Production

Ore and Concentrate.—The only output consisted of shipments from stocks, no production, of a small amount of manganiferous material for use in coloring brick. This material was mined in Cherokee County, SC, and had a natural manganese content in the range of 5% to 15%. Shipments data were not published to avoid disclosing proprietary data.

Ferroalloys, Metal, and Synthetic Dioxide.—Production statistics for these materials were not published to avoid disclosing proprietary data. Elkem Metals Co. was the only domestic producer of manganese ferroalloys, which was at its Marietta, OH, plant. *(See table 3.)*

Pyron Corp. began production in March of its manganese sulfide plus, a powder metallurgy additive. This product resulted from process development at Pyron, which had manufacturing facilities at Niagara Falls, NY, and Greenback, TN. Pyron, a subsidiary of the Zemex Corp., had been the distributor of manganese sulfide manufactured by Elkem Metals. This business was sold in 1995 to Sweden's Höganäs AB, and production of the sulfide was then transferred to Sweden.

Late in the year, Kerr-McGee Chemical Corp. completed an expansion that brought the annual capacity of its EMD plant at Henderson, NV, to 25,900 tons (Kerr-McGee Corporation, 1997, p. 14).

Consumption, Uses, and Stocks

Data relating to manganese end use plus certain other information indicated that metallurgical applications accounted for most domestic manganese consumption, 85% to 90% of which has been for steelmaking. This is the typical usage pattern for most industrialized countries (Mining Magazine, 1990). Reported data for U.S. ore consumption indicated that unit consumption of manganese in ironmaking, which could not be published to avoid disclosing proprietary data, was roughly 4% below the comparatively low level for 1995. Reported data for U.S. consumption of manganese ferroalloys and metal indicated a decline of a similar extent for manganese unit consumption in steelmaking. These data continued to suggest some shifting from the use of ferromanganese to silicomanganese by steelmakers. (*See tables 4 and 5.*) Relatively small quantities of manganese were used for alloying with nonferrous metals, chiefly in the aluminum industry as manganese-aluminum briquets. Indications were that use of the recently introduced briquet containing 85% manganese was growing as opposed to use of the traditional briquet containing 75% manganese. A review of developments in the metallurgy of the ends of aluminum cans indicated that for the past three decades the ends have been fabricated from the Al-Mg-Mn alloy 5182 (McBride, Sanders, and Reavis, 1996).

Domestic consumption of manganese ore in 1996 was 478,000 tons and yearend stocks were 319,000 tons. Because of the need to avoid disclosing proprietary data, these figures cannot be disaggregated into end-use segment and also do not include relatively small quantities associated with ironmaking.

Comparatively small amounts of manganese were used domestically in animal feed, brick coloring, dry cell batteries, manganese chemicals, and plant fertilizers. These were among the many nonmetallurgical applications of manganese (Weiss, 1977; Harries-Rees, 1993; Major-Sosias, 1996). The source of manganese units for these applications was mainly manganese ore.

Data on domestic consumption of manganese ore, exclusive of that consumed within the steel industry, are collected by means of the "Manganese Ore and Products" survey. By means of this survey, approximately 15 firms were canvassed that process ore by such methods as grinding and roasting or consume it in the manufacture of dry cell batteries and manganese ferroalloys, metal, and chemicals. For this segment of ore consumption, the collective consumption of these firms is believed to constitute that of the United States except for negligible quantities consumed by other firms, if any. In 1996, full-year responses were obtained from all but three plants. The missing data were estimated on the basis of information received in prior years and data trends of other firms having similar business activities. The data reported were thus estimated to represent almost 97% of total consumption.

Further developments involving U.S. suppliers of manganese

materials for agricultural uses included the acquisition early in the year of the Pittsburg, KS, plant of AlliedSignal Inc. by the Inspec Group PLC of the United Kingdom. Manganese sulfate is produced at this plant. The acquisition was carried out by an Inspec subsidiary, Allco Chemical Corp. of Dallas, TX. Also as discussed in the World Review section of this report, TETRA Technologies Inc., with headquarters near Houston, TX, acquired Mexico's Industrias Sulfamex S.A. de C.V., also a producer of manganese sulfate.

The Ethyl Corp. reported that sales of its manganese-containing octane-enhancing additive, methylcyclopentadienyl manganese tricarbonyl (MMT, "HiTEC 3000"), increased in 1996. Ethyl had started selling MMT to the U.S. refining industry in December 1995. MMT was being manufactured for Ethyl under a long-term supply contract with Albemarle Corp., formerly a wholly owned subsidiary of Ethyl that had been spun off in February 1994 (Ethyl Corporation, 1997). Use of MMT continued to face opposition because of health concerns and objections of U.S. carmakers.

The trend continued in the battery industry for alkaline cells, in which EMD is used, to displace carbon-zinc cells, in which natural manganese dioxide is employed. The share of alkaline cells in the consumer market was reported to have risen to 80% in the United States and to be advancing from 40% to 60% in Japan (Powers and MacArthur, 1997, p. 3).

Among the largest battery companies with headquarters in the United States, Rayovac Corp., Madison, WI, and Duracell International Inc., Bethel, CT, underwent changes in ownership. As of September, an 80% share in Rayovac was acquired by Thomas H. Lee, a Boston-based investment firm, and its affiliates. A merger of Duracell and the Gillette Company was completed late in December. The Eveready Battery Co. adopted Energizer as its new trade name in the latter part of 1996.

A laboratory investigation demonstrated that existing processes used in the mining industry could be applied for recycling the components, particularly mercury, of high-mercury batteries. The study was conducted on batteries that were based on manganese and other metals and have military applications (Bowers and Beyke, 1996).

Prices

For 1996, with the price of manganese in metallurgical-grade ore taken as 1.0, the corresponding prices per manganese unit were approximately 2.6 for high-carbon ferromanganese, 2.3 for silicomanganese, 4.6 for medium-carbon ferromanganese, and 9.9 for manganese metal. These price factors are based on year-average prices such as discussed in the following.

Manganese Ore.—The midrange value for the average price, c.i.f. U.S. ports, of metallurgical-grade ore containing 48% manganese was assessed as $2.55 per metric ton unit (mtu). It is recognized that prices somewhat above or below this value applied, depending on ore quality, time of year, and nature of the transaction. The price of a metric ton of ore is obtained by multiplying the mtu price by the percentage manganese content of the ore. The ore market consists of a number of submarkets because of differences between ores according to such various end uses as ferroalloy production, blast furnace ironmaking, and battery manufacture.

Because the metric ton unit is 1% of a metric ton, i.e., 10 kilograms of contained manganese, the price of manganese in ore in 1996 and 1995 can be expressed as 25.5 and 24.0 cents per kilogram, respectively. These values indicate an increase of more than 6% in U.S. c.i.f. price or somewhat less than the increases in f.o.b. price in international markets.

The main price evolution in international markets for metallurgical-grade ore occurred shortly before the April 1 start of the Japanese 1996 fiscal year. Japanese consumers reached agreement at that time on f.o.b. prices per mtu for delivery during the annual contract year that were $2.19 for Australia's Broken Hill Pty. Co. Ltd. (BHP) and $2.09 for South Africa's Samancor Ltd., for price increases of 7.4% and 7.2%, respectively. At about the same time, Japanese customers agreed to an f.o.b. price of $2.14 per mtu for ore from Western Australia's Portman Mining Ltd., which constituted an increase of 9.7%.

Manganese Ferroalloys.—For the principal ferroalloys, the generally rising trend in prices that developed in 1995 was reversed in 1996. As a result, prices at yearend 1996 were at about the same level as at the start of 1995. The price information that follows refers to quotations for U.S. imports, as public information on current prices for domestic products were not available. English units also were the basis for price quotes in the United States as given in sources such as Platt's Metals Week.

Price trends were similar in 1996 for high-carbon and medium-carbon ferromanganese. For both grades, the middle of the price range was about 14% less at the end of the year than at the beginning. Generally also for both grades, the price drifted downward from January into June and then began to drop more rapidly at almost a steady rate. The price range for high-carbon ferromanganese containing 78% manganese, per long ton of alloy f.o.b. Pittsburgh or Chicago warehouse, began and ended the year at $560 to $575 and $480 to $500, respectively. The middle of the price range averaged $532 for the year, a further small increase of 2.5% above that of the preceding year. The price range for medium-carbon ferromanganese with a manganese content of 80% to 85% and a nominal carbon content of 1.5%, in cents per pound of manganese f.o.b. warehouse, was 54.5 to 56 and 46.5 to 48 at the beginning and end of the year, respectively. The middle of the price range averaged 52.8 for the year, which was 6.2% above that for 1995.

According to trade journal reports, the downward pressure on ferromanganese prices came at first from the availability of manganese units at lower prices in the form of silicomanganese and steel scrap and later on because of an oversupply situation coupled with a seasonal decline in steel production.

For silicomanganese, the middle of the price range fell 37% between the beginning and end of the year and averaged somewhat more than 10% less than in 1995. The price of silicomanganese fell more or less progressively through May at

a relatively rapid rate and thereafter relatively slowly. The price range for imported silicomanganese with 2% carbon, in cents per pound of alloy, f.o.b. Pittsburgh or Chicago warehouse, was 36.75 to 39.5 and 23.75 to 24.25 at the beginning and end of the year, respectively. The middle of the price range averaged 28.3 for the year. Trade journals cited oversupply from areas such as China and Eastern Europe as factors behind the decline in silicomanganese price.

Manganese Metal.—For the producer price for bulk shipments of domestic material, per pound f.o.b. shipping point, Platt's Metals Week listed $1.15 throughout the year. This was the same figure as given effective in October 1995, and implied a year-average price 4.6% greater than in 1995. American Metal Market, which had listed a range of $1.14 to $1.15 as of October 1995, indicated that the price was in-creased to $1.15 to $1.17 as of mid-February, or somewhat more than 1%. North American transaction prices as given by Ryan's Notes were roughly 12% less than producer price.

Foreign Trade

In terms of manganese units contained, the volume of trade in the principal manganese materials was the greatest of the 1990's so far. Principally because of a doubling of ore exports, the quantity of manganese exported increased about one-sixth to the greatest overall total since 1991. *(See table 6.)* The quantity of manganese imported increased about one-fifth, again to the greatest overall total since 1989 and with nearly all categories showing increases in volume. *(See table 7.)* Also on the basis of content, the ratio, ferroalloy plus metal imported divided by ore plus dioxide imported, decreased for the third consecutive year, to 2.1:1. This was again the lowest such ratio since 1989.

Among exports, unit values again indicated that about four-fifths of the ore was unprocessed material of metallurgical grade. About two-thirds of the ore with higher unit value went to Canada. Exports of ferromanganese containing more than 2% carbon, which were about one-third of total ferromanganese exports, were virtually unchanged, but those of other ferromanganese decreased about one-sixth. The modestly increased exports of metal again were the greatest since 1990. Reexports of ore, ferromanganese, silicomanganese, and metal were, in tons, 504; 3,776; 4,057; and 209, respectively; all went to Canada except for small amounts of ore and metal. Reexports of ore all had relatively high unit value.

Among imports, average manganese contents of 48.3% for ore and 78.4% for ferromanganese were at about the middle of the ranges for the past decade. For ore, Gabon was again the dominant source, about 60% of the total, of a one-fifth greater volume of imports. For ferromanganese, an increase also of about one-fifth in manganese imported was caused especially by a rise in imports of medium-carbon ferromanganese (particularly those from China and Japan) that reached a level surpassed only in 1988.

For silicomanganese, an increase of about 6% was enough to produce a record high import volume. Receipts from Australia, India, Kazakstan, and Venezuela were the most since at least 1970. Reported imports of spiegeleisen increased 74% to 455 tons, all from South Africa at relatively high unit value.

Among imports of manganese chemicals, receipts of a record quantity from Australia helped produce for manganese dioxide a volume again second only to that in 1994. Imports of dioxide appeared again to have been wholly synthetic material. Data for imports under the classification "Other sulfates" suggested that imports of manganese sulfate could have increased by about 40%, which was approximately the increase in volume for material in that class each from China and Mexico. Receipts from China were 5,875 tons at a value of $2.0 million and from Mexico 19,489 tons at a value of $9.2 million.

The Generalized System of Preferences (GSP) program was reauthorized effective October 1, 1996, through May 31, 1997, retroactive to August 1, 1995 (Platt's Metals Week, 1996). For the time period specified, preferential tariff treatment was restored, with certain exclusions, for U.S. imports from developing countries of manganese dioxide; permanganates; manganese sulfate; low- and medium-carbon ferromanganese; silicomanganese; and manganese metal, other.

World Review[1]

The prominent position attained by China in the world's manganese industry is indicated in the data for world production of ore and ferroalloys at the end of this report. *(See tables 8 and 9.)*

Australia.—Monthly production reports of BHP indicated that manganese ore production at BHP's Groote Eylandt Mining Co. Pty. Ltd. (GEMCO) subsidiary totaled 1,810,000 tons, or only 11,000 tons less than the corresponding total for 1995. In September, GEMCO marked the 30th anniversary of the beginning of shipments to customers in Japan, noting that it has maintained relations with certain of them ever since. BHP initiated a trial of toll processing of GEMCO ore into high-carbon ferromanganese at the Tokushima plant of Japan's Nippon Denko Co. Ltd., to be carried out during the Japanese fiscal year ending March 1997.

A recent investigation of samples from the Groote Eylandt deposit found that weathering has played a greater role in the evolution of the deposit than had been thought. Intense leaching and reprecipitation were believed to have led to complete replacement of the original sedimentary and diagenetic manganese minerals (Dammer, Chavis, and McDougall, 1996).

The Pilbara Manganese Project of Portman was sold to Valiant Manganese Pty. Ltd., a subsidiary of Valiant Consolidated Ltd. Besides Portman, Valiant was the other operator of a manganese mine in the Woodie Woodie area of Western Australia. The midyear sale included all of Portman's

[1]Discussions by country of the more significant developments during 1996 were based in a number of instances on news items in trade journals such as American Metal Market, Metal Bulletin (London), Platt's Metals Week, Ryan's Notes, and The TEX Report (Tokyo). These items have not been acknowledged individually because the information they conveyed often was aggregated, possibly with that from other sources.

manganese interests except stockpiled lump manganese ore, ownership of which did not pass to Valiant until the end of October.

Brazil.—Production of manganese ore by Cia. Vale do Rio Doce (CVRD) increased at both its Azul Mine in the Carajás region and its Urucum Mineraçao S.A. subsidiary in Mato Grosso do Sul State. Output in thousand tons and percentage change from 1995 (in parenthesis) were 1,421 (+12%), the second successive new record; and 260 (+26%); respectively. Of ore sales that totaled 1,179 thousand tons, 54% was to foreign markets (Cia. Vale do Rio Doce, 1997).

Manganese ore shipments by Indústria e Comércia de Minérios S.A. (ICOMI) from operations at Serra do Navio, Amapá Territory, totaled 366,000 tons. Destinations of the shipments, which were through Porto de Santana on the Amazon River, were, in tons, 167,000 to Europe, 115,000 to South America (including Brazil), 64,200 to Asia, and 18,800 to North America (Skillings Mining Review, 1997b). Shipments overall were about 7% less than in 1995, with decreased shipments to Europe moderated by increased shipments to Asia.

The history and geology of the Morro da Mina Mine near Conselheiro Lafaiete in Minas Gerais State, southeastern Brazil, and the production practices followed there were detailed (Strong, 1996). This mine was noted to be a relatively small but long-lived producer of manganese ore, having yielded 8.6 million tons of oxide ore and 3.4 million tons of manganese silicate-carbonate protore during 1902-95. The then U.S. Steel Corp. purchased the mine in 1920 and sold it in 1978.

Early in the year, Brazil's production of manganese ferroalloys was bolstered by the return to full capacity of operations at the plant of Eletrosiderúrgica Brasileira S.A. (Sibra). The Sibra plant, near Salvador in Bahia State, was being managed by Vale-Usiminas Participações, the equally owned company that CVRD and Usinas Siderúrgica de Minas Gerais S.A. formed in 1995. Brazil lost a relatively small amount of manganese ferroalloy production capacity, mostly ferromanganese, when the Caemi Group closed the plant of its subsidiary, Cia. Ferroligas do Amapá in the first part of the year. This plant, in operation only since 1990, was in the Porto de Santana area in northeastern Brazil and had an annual capacity for high-carbon ferromanganese of 23,000 tons. It was being fed with manganese ore from the affiliated operations of ICOMI's mine.

China.—Imports of manganese ore were reported to have advanced nearly one-fourth to a record 1,585,000 tons. In decreasing order of magnitude, the leading ore source countries were again Australia, Myanmar, Gabon, and South Africa, which together accounted for 93% of total imports (The TEX Report, 1997). The quality of ore being imported into China was generally superior to that of domestic sources. An example of the latter is the Chadian phosphorus-manganese deposit in Shaanxi Province, central China, in which the manganese content of the ores was in the range of 11% to 24% and whose geology and conditions of formation were investigated (Liu, Fan, and Ye, 1996).

China's substantial ferroalloy industry, which in 1995 had exported more than 600,000 tons of manganese ferroalloys, appeared to be giving greater emphasis to environmental concerns.

In the electrolytic industry, an export-oriented joint venture, JMC-Xinshao Co. Ltd., was formed between Chinese and Japanese interests for production of EMD at Shaoyang City, Hunan Province. The Chinese participants, the Hujiang State Exclusive Raw Materials Factory (703 Factory) and the Hunan Provincial Import & Export Corp., made up about two-thirds of the venture, mostly in terms of facilities. On the Japanese side, the major participant was Japan Metals & Chemicals Co. Ltd. (JMC), a producer of EMD in Japan, and the minor participant was Sumitomo Corp. The joint venture was formed in the first part of the year and was shipping samples by the end of the summer. Its annual capacity of 10,000 tons resulted from a combination of existing and new facilities.

China's exports of manganese metal were virtually the same in 1995 as in 1994, 50,000 tons. The majority of shipments continued to be to Japan and the Netherlands.

Gabon.—Exports of manganese ore produced from the Moanda Mine of Compagnie Minière de l'Ogooué S.A. (COMILOG) totaled 1,977,000 tons, of which 1,929,000 tons was metallurgical-grade ore and 48,100 tons was battery-grade ore. Shipments were made in 62 cargoes via the Port of Owendo (Skillings Mining Review, 1997a). Compared with the corresponding figures for 1995, exports were about 2% greater overall, about 4% greater for metallurgical-grade ore, and only about one-half as much for battery-grade ore.

In June, ERAMET, a French producer of nickel and high-speed steel, proceeded with its plan for increasing its shareholding in COMILOG from 17% to 46%. ERAMET thus became the largest shareholder in COMILOG and took over its management. Subsequently, ERAMET and COMILOG began a restudy of the feasibility of establishing a ferromanganese plant in Gabon, a possibility whose consideration dates back more than 20 years. The new study was of a plant near the Moanda Mine with annual capacity of 100,000 tons.

Georgia.—Privatization of Georgia's manganese industry moved ahead for the Zestafoni ferroalloys plant but not for the Chiatura Mine. The Government contracted with North Atlantic Resources Inc. of New York, NY, a consultancy, and the Russian-Georgian Bank of Reconstruction and Development of Tbilisi to manage the Zestafoni plant for a 10-year period. Shareholders selected a new board of directors for the plant in March, and the plant's furnaces were restarted in April.

Iran.—In the first half of the year, Navid Manganese commissioned a high-carbon ferromanganese plant near Esfahan in central western Iran. The plant's annual capacity of 30,000 tons was 10 times that of a nearby predecessor pilot plant, which was to be shut down later on. Ore for these operations initially was sourced from a mine near Qom to the north and west of Esfahan. Because the manganese content of this ore was only about 30%, consideration was being given to replacing it with higher-grade imported ore.

Japan.—Overall imports of metallurgical-grade manganese

ore decreased less than 1% to 1,169,000 tons. For ore containing more than 39% manganese, imports declined somewhat more than 5% to 889,000 tons, 84% of which was from Australia plus South Africa. Imports from South Africa fell by almost 30%. For ore containing no more than 39% manganese, imports rose by nearly 20% to 279,000 tons, virtually all of which was from India and South Africa. Imports of ferruginous manganese ore decreased about 4%, from 86,000 to 82,000 tons, virtually all of which was from Ghana (58%) and India (41%).

Within a production of manganese ferroalloys that only slightly exceeded that in 1995, production of refined ferromanganese and silicomanganese increased by roughly one-sixth. The Tokushima plant of Nippon Denko in Tokushima Prefecture, southwestern Japan, was being expanded into fully integrated production of manganese ferroalloys. Facilities were being installed so that low- and medium-carbon ferromanganese could be produced in addition to the existing production of high-carbon ferromanganese and silicomanganese. This plant also was involved in an international alliance whereby Australian manganese ore was being toll processed into high-carbon ferromanganese. As discussed under South Africa, Japanese companies participated in two joint ventures set up for production of refined manganese ferroalloys in South Africa.

Imports of manganese ferroalloys decreased, by about 6% overall to 344,000 tons, 10% for ferromanganese to 111,000 tons, and 3% for silicomanganese to 233,000 tons. Most imports of ferromanganese were high-carbon ferromanganese, of which South Africa (48%) and China (42%) were the main sources. For silicomanganese, the main sources were Ukraine (30%) and China (23%), receipts from Ukraine having increased by about one-fifth while those from China fell by about one-third.

Exports of manganese ferroalloys decreased 17% overall to 37,500 tons. Most of the total was accounted for by ferromanganese containing less than 2% carbon, 33,700 tons, of which exports to the United States, 21,600 tons, were about one-sixth greater than in 1995.

For EMD, production declined about 3% to 58,500 tons while exports were down roughly 9% to 32,000 tons. As discussed under China, Japanese firms entered into a joint venture for production of EMD in China.

Imports of unwrought manganese metal, including scrap, increased again (about 9%) to 36,800 tons, practically all of which was from China (60%), South Africa (36%), and the United States (3%), or nearly the same pattern for sources as in 1995.

Kazakstan.—The production program at the Ermak ferroalloy plant at Aqsu in northeastern Kazakstan was being structured so as to achieve for manganese ferroalloys, principally silicomanganese, an annual output in the range of 100,000 tons. Most of this output was to come from one of the plant's four melting shops. The Ermak plant, along with the Aktyubinsk ferroalloy plant and the Donskoy chromium mine, was part of the Kazchrome Transnational Corp. that had been established by Japan Chrome Corp. and later joined by the Trans-World Group.

Mexico.—Output levels for the ore products of Cía. Minera Autlán (Autlán) were relatively comparable to those in 1995. Data for salable production in 1996, in tons, were manganese carbonates plus ore from the Terrenates Mine, 103,000; oxide nodules, 363,000; and manganese dioxide plus manganous oxide, 19,000. Most of this production was from operations in the Molango District of Hidalgo State, where nodule production increased more than 3%. Supplemental quantities were produced from the Terrenates Mine in Chihuahua State. Autlán's salable production of manganese ferroalloys rose across the board, by 33% for high-carbon ferromanganese, 8% for medium-carbon ferromanganese, and 37% for silicomanganese.

In July, Sulfamex was acquired by TETRA Technologies. Sulfamex has a plant near Tampico, Veracruz State, for production of manganese sulfate and related products that are sold mostly to U.S. customers. Sulfamex' plant was capable of annually producing upwards of 20,000 tons of sulfate, on the basis of monohydrate.

Saudi Arabia.—Late in the year, the four 27-megavolt-ampere furnaces at the new plant of Gulf Ferro Alloys Co. (SABAYEK) were brought into operation, initially for production of silicomanganese, ferrosilicon, and silicon metal. As reported at the 1995 INFACON, one furnace at this plant was to be capable of producing either silicomanganese or ferromanganese and another either silicomanganese or ferrosilicon, for an overall annual capacity for silicomanganese of 30,000 tons (Al Mokrin, 1995). SABAYEK's plant is located in the Jubail Industrial City, which is near Saffaniyah on the Persian Gulf, south of Kuwait.

South Africa.—According to preliminary data, metallurgical-grade ore still accounted for more than 98% of manganese ore production, the balance being chemical-grade ore. Total ore production and production of metallurgical-grade ore were marginally greater than in 1995, while production of chemical-grade ore rose by more than one-fifth. Among categories comprising the production subtotal for metallurgical-grade ore, ore containing 30% to 40% manganese again accounted for 36% of the subtotal, while the portion of the subtotal accounted for by ore containing more than 48% manganese increased from 54% to 58%. Production of ore in this highest grade category advanced by 8%. Sales of manganese ore by The Associated Manganese Mines of South Africa Ltd. (Assmang) for the fiscal year ending June 30, 1996, were 1,320,000 tons, an increase of 11% over that for the prior fiscal year.

Wellbeloved and Glück (1996) reviewed the South African manganese ore industry and the extraction of manganese from South African ores via the production of manganese sulfate solutions. Geologists reported on the evolution of the mineralogy of the Kalahari manganese field (Gutzmer and Beukes, 1996b), continued to debate the origin of its extensive deposits (Beukes and Gutzmer, 1996; Cornell and Schütte, 1996), and described the deposits of the Postmasburg manganese field (Gutzmer and Beukes, 1996a).

Two joint ventures were established for the production of refined manganese ferroalloys. Each consisted of a major integrated South African manganese producer, a Japanese ferroalloy producer, and a Japanese trading company. ADVALLOY, formed at midyear, was composed of Samancor (50%), JMC (35%), and Mitsui & Co. Ltd. (15%). This joint venture projected annual production of about 75,000 tons of mostly medium- and low-carbon ferromanganese plus also ultra-low-carbon grades of ferromanganese and silicomanganese. Using high-carbon ferromanganese and silicomanganese supplied by Samancor, trial production was to begin late in 1997 and commercial production in 1998. To accomplish this, a 30-ton converter and two relatively small electric furnaces were to be installed at Samancor's manganese ferroalloy plant at Meyerton. In connection with this, Samancor acquired the Midland plant of Polifin Ltd., with the plan to convert this calcium carbide facility to production of as much as 120,000 tons annually of silicomanganese as a replacement for that being used in the ADVALLOY joint venture.

The second joint venture, established a few months later, was composed of Assmang's Feralloys Ltd. subsidiary (50%), Mizushima Ferro Alloy Co. Ltd. (40%), and Sumitomo (10%). Subsequently named Cato Ridge Alloys (Pty) Ltd., this joint venture was aimed at production of about 30,000 tons annually of low- and medium-carbon ferromanganese. Facilities being established at Feralloys were to begin operation early in 1998 using ore feed from Assmang.

Samancor started up its metal-from-slag plant in February. This plant began recovering metal for remelting from slag that has accumulated at the Meyerton plant from decades of manganese ferroalloy smelting. Byproduct barren slag for use as aggregate by the construction industry was being returned to a contractor operating in conjunction with Samancor.

A jigging process was replacing hand sorting for recovery of salable metal from low-grade alloy at the Witbank plant, Gauteng Province, of the Transalloys Division of Highveld Steel and Vanadium Corp. Ltd. This process, a joint venture between Mintek and Titaco Consolidated Investments, was being carried out intermittently on a toll treatment basis (Mintek Bulletin, 1996).

Spain.—Pechiney's sale of its 72% interest in Hidro-Nitro Española SA (HNE) to Ferroatlantica SL was completed in April. Ferroatlantica thus became Spain's only producer of manganese ferroalloys, and France's Pechiney completed its withdrawal from that industry. A producer of specialty manganese ferroalloys, HNE's typical annual output was 20,000 tons of silicomanganese, 5,000 tons of low-carbon ferromanganese, and 5,000 tons of ferromanganese powder for welding applications.

Ukraine.—In an assessment of the outlook for Ukraine's mining and metallurgical industries, the Minister of Industry projected that manganese ore output would remain less than one-half that just prior to the dissolution of the U.S.S.R. and decrease further within 15 years. He gave for manganese ore production (million tons) 6.9 in 1990, 3.2 in 1995, 3.3 in 2000, and 2.7 in 2010 (Mazur, 1996).

The 30th anniversary of the Nikopol' ferroalloy plant was commemorated in an issue of the Russian-language journal Stal' (Koval', 1996). Also described in this issue was technology developed at this plant for electrosilicothermic production of medium-carbon ferromanganese using manganiferous low-phosphorus slags and silicomanganese screenings (Gasik and others, 1996).

Current Research and Technology

The geochemistry of manganese was the subject of a book on the world's supergene deposits (Varentsov, 1996) and of a paper on the mechanism of sedimentation of carbonates in black shales (Calvert and Pedersen, 1996). The status of technology for mining marine nodules and crusts was reviewed (Chung, 1996).

Studies were conducted in Ghana on sulfuric acid leaching of Nsuta ore with the aim of increasing utilization of rejects from processing carbonate ore (Momade, 1996).

The kinetics of reactions involved in smelting manganese ore into ferromanganese was investigated for samples of ore from Australia and South Africa (Berg and Olsen, 1997). In India, a study was made of the possibility of using a calcium silicide treatment to reduce the phosphorus content of ferromanganese (Sen, Basu, and Gupta, 1996).

A phase diagram of the manganese-oxygen system was obtained using data from solution calorimetry employing molten lead borate as the solvent (Fritsch and Navrotsky, 1996).

Several approaches for preparing manganese-containing electrodes for use in lithium batteries were reported (Gao and Dahn, 1996; Liu, Farrington, Chaput, and Dunn, 1996; Manthiram, Dananjay, and Tsang, 1996). Development and performance were described for titanium anodes surfaced with a titanium-manganese alloy containing 16% manganese that were used to manufacture EMD at the Rustavi plant in Georgia (Trusov and Kryuchkova, 1996).

Progress in achieving a commercial process for electrodepositing zinc-manganese coatings on steel and their ability to provide enhanced corrosion resistance were reviewed (Wilcox and Petersen, 1996).

Also reviewed was the status of knowledge about the role of manganese in the photosynthetic oxidation of water to oxygen, a reaction critical to animal and plant life (Yachandra, Sauer, and Klein, 1996).

The potential for airborne manganese to produce neurological effects years after a relatively high-level exposure was explored in a study of former Chilean manganese miners, in whom it was possible to detect impaired motor performance (Hochberg and others, 1996). The possibility that adverse health effects would arise from low-level exposure to manganese from the use of MMT in gasoline was assessed. One study found it unlikely that Canadian usage represented a significant health risk (Egyed and Wood, 1996). The Environmental Protection Agency reviewed the issues associated with the U.S. situation, noting uncertainties resulting from lack of information (Davis and Elias, 1996).

Outlook

The trend of manganese demand, domestically and globally, will continue to follow closely that of steel production. Although some nonmetallurgical components of manganese demand may experience higher growth rates than for steel production, especially batteries, this will have only a minor effect on overall manganese demand.

For the past decade, U.S. apparent consumption of manganese has been within roughly plus or minus 10% of about 660,000 tons of contained manganese. This largely has been a consequence of a reasonably comparable degree of variation in domestic steel production during the same period. Manganese demand, which is presented as apparent consumption in table 1, generally has shown an increasing trend as has the level of activity in the steel industry. It may be that manganese apparent consumption has not traced steel production precisely because of the influence of unmeasured changes in stocks of manganese materials, such as those of importers. The effect of this may have outweighed changes in demand by steelmakers.

Forecasts of the International Iron and Steel Institute (IISI) and others that were publicized in 1996 suggest that domestic steel output, the main determinant of manganese demand, is likely to be relatively steady throughout the remainder of the 1990's. Accordingly, the midterm outlook for U.S. apparent consumption of manganese is to remain near 660,000 tons of contained manganese. This outlook for a stable manganese demand assumes no significant change in manganese unit consumption by U.S. steelmakers. The majority of U.S. demand for manganese units will be met by imports.

For the world, forecasts by IISI and others for world steel demand during the balance of the 1990's suggest an annual growth rate in the vicinity of 2%. Demand is foreseen to be relatively static in traditional industrialized countries and expected to grow the most in China, other Asian countries besides Japan, and Latin America. For the midterm, the global growth rate in demand for manganese seems likely to be somewhat less than that for steel because of an anticipated decline in manganese unit consumption in the steel industries of countries that are industrializing or restructuring.

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

TABLE 1
SALIENT MANGANESE STATISTICS 1/

(Thousand metric tons, gross weight)

	1992	1993	1994	1995	1996
United States:					
Manganese ore (35% or more Mn):					
Exports	13	16	15	15	32
Imports for consumption	247	232	331	394	478
Consumption	438	389	449	486	478 2/
Stocks, Dec. 31: Consumers	276	302	269	309	319 2/
Ferromanganese:					
Exports	13	18	11	11	10
Imports for consumption	304	347	336	310	374
Consumption	339	341	347	348	326
Stocks, Dec. 31: Consumers and producers	28	30	36	33	27
Consumption, apparent, manganese 3/	596	696	694	676	NA
Ore price, dollars per metric ton unit, c.i.f. U.S. ports	3.25	2.60	2.40	2.40	2.55
World production of manganese ore	21,800 r/	20,800 r/	18,000 r/	23,000 r/	22,300 e/

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

1/ Data are rounded to three significant digits, except prices.

2/ Exclusive of iron and steel plants.

3/ Thousand metric tons, manganese content. Based on estimates of average content for all significant components excepts imports, for which content is reported.

TABLE 2
U.S. GOVERNMENT DISPOSAL AUTHORITIES AND YEAREND
INVENTORIES FOR MANGANESE MATERIALS IN 1996 1/

(Metric tons, gross weight)

		Physical inventory, Dec. 31				
		Uncommitted			Sold,	
Material	Disposal authority	Stockpile grade	Nonstockpile grade	Total	pending shipment	Grand total
Natural battery ore	127,000	110,000	16,800	127,000	5,040	132,000
Synthetic manganese dioxide	2,730	2,730	--	2,730	--	2,730
Chemical ore	149,000	149,000	81	149,000	--	149,000
Metallurgical ore	1,040,000	741,000	392,000	1,130,000	165,000	1,300,000
High-carbon ferromanganese	727,000	968,000	--	968,000	--	968,000
Medium-carbon ferromanganese	--	17,700	--	17,700	--	17,700
Silicomanganese	--	183	--	183	--	183
Electrolytic metal	9,050	9,050	--	9,050	690	9,740

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

TABLE 3
DOMESTIC PRODUCERS OF MANGANESE PRODUCTS IN 1996

		Products 1/				
Company	Plant location	FeMn	SiMn	Mn	MnO2	Type of process
Chemetals Inc.	Baltimore, MD	--	--	--	X	Chemical.
Do.	New Johnsonville, TN	--	--	--	X	Electrolytic.
Elkem Metals Co.	Marietta, OH	X	X	X	--	Electric furnace and electrolytic.
Kerr-McGee Chemical Corp.	Hamilton, MS	--	--	X	--	Electrolytic.
Do.	Henderson, NV	--	--	--	X	Do.
Ralston Purina Co.:						
Eveready Battery Co.	Marietta, OH	--	--	--	X	Do.

1/ FeMn, ferromanganese; SiMn, silicomanganese; Mn, manganese metal; MnO2, synthetic manganese dioxide.

TABLE 4
U.S. CONSUMPTION, BY END USE, AND INDUSTRY STOCKS OF MANGANESE FERROALLOYS AND METAL IN 1996 1/

(Metric tons, gross weight)

End use	Ferromanganese			Silico-manganese	Manganese metal
	High carbon	Medium and low carbon	Total		
Steel:					
Carbon	189,000	68,000	257,000	93,500	1,900
Stainless and heat-resisting	13,100	(2/)	13,100	6,020	1,500
Full alloy	18,900	5,100	24,000	29,300	(2/)
High-strength, low-alloy	16,300	4,090	20,400	7,340	(2/)
Unspecified 3/	330	248	578	371	721
Total steel	238,000	77,400	315,000	137,000	4,110
Cast irons	8,530	488	9,020	797	--
Superalloys	W	W	W	--	125
Alloys (excluding alloy steels and superalloys)	761	383	1,140	(4/)	17,800 5/
Miscellaneous and unspecified	--	W	W	(4/)	W
Total consumption	247,000	78,300	326,000	137,000 6/	22,000
Total manganese content 7/	193,000	62,700	256,000	90,600	22,000
Stocks, Dec. 31:					
Consumers and producers	12,800	14,600	27,300	7,760	4,010

W Withheld to avoid disclosing company proprietary data; included with "Alloys (excluding alloy steels and superalloys)."
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Withheld to avoid disclosing company proprietary data; included with "Steel: Unspecified."
3/ Includes electrical and tool steel, and items indicated by (2/).
4/ Withheld to avoid disclosing company proprietary data.
5/ Approximately 85% of this combined total was for consumption in aluminum alloys.
6/ Internal evaluation indicates that silicomanganese consumption is considerably understated.
7/ Estimated based on typical percent manganese content.

TABLE 5
U.S. UNIT CONSUMPTION OF MANGANESE IN STEELMAKING 1/

(Kilograms per metric ton of raw steel unless otherwise specified)

Form used		1995	1996
Basis: Production of raw steel 2/ and steel castings	million tons	96.2 r/	96.6
Ore 3/		--	--
Ferromanganese		2.75 r/	2.56
Silicomanganese		0.89	0.93
Manganese metal		0.05	0.04
Total		3.69 r/	3.54

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ As ingots, continuous- or pressure-cast blooms, billets, slabs, etc.
3/ Containing 35% or more manganese.

TABLE 6
U.S. EXPORTS OF MANGANESE ORE, FERROALLOYS, AND METAL, BY COUNTRY 1/

Country	1995 Gross weight (metric tons)	1995 F.a.s. value (thousands)	1996 Gross weight (metric tons)	1996 F.a.s. value (thousands)
Ore and concentrates with 20% or more manganese:				
Belgium	1,410	$113	3,410	$272
Brazil	3,080	246	2,290	216
Canada	6,980	1,040	5,800	1,140
China	--	--	5,620	450
France	--	--	2,710	216
Japan	1,320	105	2,860	229
Sweden	234	19	3,380	270
Other	2,360 2/	224 2/	5,550	1,210
Total	15,400	1,750	31,600	4,000
Ferromanganese, all grades:				
Canada	8,950	8,110	8,700	7,750
Japan	514	523	--	--
Mexico	477	525	751	763
Other	1,080 2/	963 2/	341	334
Total	11,000	10,100	9,800	8,850
Silicomanganese:				
Canada	6,000	4,700	4,810	4,000
Luxembourg	1,200	496	--	--
Mexico	609	415	306	277
Other	34	41	153	116
Total	7,840	5,650	5,270	4,390
Metal, including alloys and waste and scrap:				
Belgium	55	139	544	1,240
Canada	1,600	3,930	1,030	2,780
Japan	893	2,170	1,020	2,520
Netherlands	928	1,920	470	1,820
United Kingdom	946	1,200	1,100	1,570
Other	1,220 2/	3,230 2/	1,680	4,520
Total	5,640	12,600	5,840	14,500

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Revised; unspecified group of countries differs from that in the 1995 Annual Report.

Source: Bureau of the Census.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF MANGANESE ORE, FERROALLOYS, METAL, AND SELECTED CHEMICALS, BY COUNTRY 1/

Country	1995 Gross weight (metric tons)	1995 Manganese content (metric tons)	1995 Customs value (thousands)	1996 Gross weight (metric tons)	1996 Manganese content (metric tons)	1996 Customs value (thousands)
Ore and concentrates with 20% or more manganese:						
All grades:						
Australia	60,200	31,600	$5,480	96,000	48,900	$8,840
Brazil	22,900	7,080	514	18,700	5,640	294
China	18,000	7,420	1,150	--	--	--
Gabon	204,000	104,000	20,500	277,000	140,000	27,300
Mexico	62,200	23,600	3,460	43,000	16,100	2,580
Morocco	71	37 2/	15	18	9	5
South Africa	26,000	13,100	2,200	43,500	20,800	3,430
Total	394,000	187,000	33,300	478,000	231,000	42,400
More than 20%, but less than 47% manganese:						
Brazil	21,100	6,130	337	18,700	5,640	294
China	9,500	3,150	617	--	--	--
Mexico	61,800	23,500	3,430	43,000	16,000	2,580
Total	92,400	32,700	4,380	61,700	21,700	2,870
47% or more manganese:						
Australia	60,200	31,600	5,480	96,000	48,900	8,840
Brazil	1,840	957	178	--	--	--
China	8,520	4,270	528	--	--	--
Gabon	204,000	104,000	20,500	277,000	140,000	27,300
Mexico	400	188	30	20	14	7
Morocco	71	37 2/	15	18	9	5
South Africa	26,000	13,100	2,200	43,500	20,800	3,430
Total	301,000	154,000	28,900	416,000	209,000	39,600
Ferromanganese:						
All grades:						
Australia	32,300	24,300	11,400	33,900	25,500	13,500
Brazil	18,300	14,000	8,140	36,400	27,700	17,100
China	--	--	--	11,700	9,440	9,310
France	89,600	69,400	38,800	97,600	76,800	46,600
Italy	5,400	4,840	8,450	5,630	5,050	9,110
Japan	11,500	9,330	8,220	27,100	21,900	22,400
Mexico	22,300	17,700	15,400	24,400	19,600	19,700
Norway	413	338	354	4,910	4,070	4,500
South Africa	129,000	101,000	58,100	132,000	103,000	63,800
Other	1,290 3/	1,080 3/	967 3/	4	4	3
Total	310,000	242,000	150,000	374,000	293,000	206,000
1% or less carbon:						
Italy	5,400	4,840	8,450	5,630	5,050	9,110
Japan	1,540	1,290	1,310	2,480	2,070	2,880
Norway	413	338	354	1,160	961	1,330
South Africa	1,900	1,730	3,250	2,240	2,060	3,910
Ukraine	1,240	1,050	937	--	--	--
Other	28	25	35	24	21	42
Total	10,500	9,270	14,300	11,500	10,200	17,300
More than 1% to 2% or less carbon:						
Brazil	1,650	1,320	1,320	5,210	4,170	4,340
China	--	--	--	11,700	9,440	9,310
France	2,750	2,240	2,150	4,200	3,430	3,290
Japan	10,000	8,040	6,910	24,600	19,800	19,500
Mexico	21,100	16,900	15,100	24,400	19,600	19,700
Norway	--	--	--	3,740	3,060	3,110
South Africa	7,940	6,340	6,350	4,230	3,390	3,710
Other	21	14	8	--	--	--
Total	43,400	34,900	31,800	78,100	62,900	62,900

See footnotes at end of table.

TABLE 7--Continued
U.S. IMPORTS FOR CONSUMPTION OF MANGANESE ORE, FERROALLOYS, METAL, AND SELECTED CHEMICALS, BY COUNTRY 1/

Country	1995 Gross weight (metric tons)	1995 Manganese content (metric tons)	1995 Customs value (thousands)	1996 Gross weight (metric tons)	1996 Manganese content (metric tons)	1996 Customs value (thousands)
Ferromanganese:						
More than 2%, but not more than 4% carbon:						
Mexico	1,200	762	$310	--	--	--
More than 4% carbon:						
Australia	32,300	24,300	11,400	33,900	25,500	$13,500
Brazil	16,600	12,700	6,790	31,200	23,600	12,700
France	86,800	67,200	36,700	93,400	73,400	43,300
South Africa	119,000	93,400	48,600	125,000	97,200	56,100
Other	18	14	16	62	49	70
Total	255,000	198,000	103,000	284,000	220,000	126,000
Silicomanganese:						
Argentina	9,510	6,180	4,550	7,490	4,870	4,910
Australia	46,300	30,800	23,600	50,300	33,700	29,200
France	21,500	13,600	11,100	20,900	13,800	11,100
Georgia	19,600	13,200	8,320	1,260	884	701
India	39,400	25,800	19,700	47,400	31,200	27,000
Kazakstan	1,000	662	643	10,200	6,370	4,820
Macedonia	--	--	--	11,000	7,460	4,910
Mexico	22,400	14,400	10,800	23,600	15,400	13,300
Norway	9,710	6,010	7,430	10,500	6,440	10,200
Romania	14,700	9,720	9,290	13,600	9,070	7,390
South Africa	99,700	66,300	52,900	93,900	63,300	54,600
Venezuela	18,000	11,900	9,880	24,500	15,600	13,800
Other	3,070 3/	1,910 3/	2,420 3/	8,350	5,000	5,860
Total	305,000	201,000	161,000	323,000	213,000	188,000
Metal:						
Unwrought:						
China	1,100 r/	XX	1,610 r/	1,100	XX	1,800
South Africa	9,120	XX	14,300	8,480	XX	14,000
Ukraine	--	XX	--	524	XX	856
Other	121 r/	XX	132 r/	23	XX	62
Total	10,300	XX	16,100	10,100	XX	16,800
Other:						
France	101	XX	953	102	XX	964
Germany	8	XX	41	169	XX	452
South Africa	--	XX	--	335	XX	585
United Kingdom	268	XX	647	152	XX	369
Other	24 3/	XX	48 3/	83	XX	228
Total	401	XX	1,690	841	XX	2,600
Waste and scrap:						
Canada	108	XX	130	207	XX	168
Other	38	XX	42	122	XX	109
Manganese dioxide:						
Australia	16,300	XX	22,900	19,500	XX	27,400
Belgium	1,030	XX	1,810	976	XX	1,680
Brazil	819	XX	1,110	254	XX	349
Ireland	8,070	XX	11,500	6,970	XX	9,730
South Africa	305	XX	416	801	XX	1,130
Other	289	XX	605	396	XX	954
Total	26,800	XX	38,300	28,900	XX	41,300
Potassium permanganate:						
China	284	XX	157	1	XX	1
Czech Republic	491	XX	886	631	XX	1,190
Germany	99	XX	186	181	XX	310
India	288	XX	456	181	XX	301
Spain	396	XX	831	420	XX	1,020
Other	338 3/	XX	414 3/	42	XX	81
Total	1,900	XX	2,930	1,460	XX	2,900

XX Not applicable. r/ Revised.

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

2/ Includes U.S. Geological Survey's conversion of part of reported data (from apparent MnO_2 content to Mn content).

3/ Revised; unspecified group of countries differs from that in the 1995 Annual Report.

Source: Bureau of the Census, adjusted by the U.S. Geological Survey.

TABLE 8
MANGANESE ORE: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Thousand metric tons)

Country 3/	Range percent Mn e/ 4/	Gross weight 1992	1993	1994	1995	1996 e/
Australia 5/	37-53	1,251	2,092	1,920 e/	2,177 r/	2,109 6/
Brazil 7/ 8/	30-50	1,703 r/	1,837	2,100 r/	2,105 r/	2,200
China e/ 9/	20-30	5,300	5,860	3,570	6,900 r/	6,000
Gabon 7/ 10/	45-53 r/	1,556	1,290	1,436	1,934 r/	2,000
Georgia e/ 7/	29-30	500 r/	300 r/	150 r/	100 r/	97
Ghana 7/	30-50	276	295	270	176	436 6/
India 7/ 11/	10-54	1,810	1,655	1,632	1,764 r/	1,740
Kazakstan e/ 7/ (crude ore)	20-30 r/	400 r/	400 r/	400 r/	428 r/	430
Mexico 7/ 12/	27-50	407	363	307	472 e/	485 6/
South Africa 7/ 10/	30-48 +	2,464	2,507	2,851	3,199	3,240 6/
Ukraine 7/	30-35	5,819	3,800	2,979	3,200	3,000
Other 13/	XX	280	376 r/	414 r/	563 r/	533
Total	XX	21,800 r/	20,800 r/	18,000 r/	23,000 r/	22,300

Country 3/	Range percent Mn e/ 4/	Metal content 1992	1993	1994	1995	1996 e/
Australia 5/	37-53	596	1,043	944 e/	1,066	1,023 6/
Brazil 7/ 8/	30-50	664 r/	716	819 r/	821 r/	858
China e/ 9/	20-30	1,060	1,170	714	1,380 r/	1,200
Gabon 7/ 10/	45-53 r/	718	595	663	893 r/	923
Georgia e/ 7/	29-30	148 r/	89 r/	44 r/	30 r/	29
Ghana 7/	30-50	106	115	108	69	174
India 7/ 11/	10-54	687	628	620	670 r/	659
Kazakstan e/ 7/ (crude ore)	20-30 r/	98 r/	98 r/	98 r/	105 r/	106
Mexico 7/ 12/	27-50	153	135	112	174	173 6/
South Africa 7/ 10/	30-48 +	1,080	1,080	1,210	1,350	1,381 6/
Ukraine 7/	30-35	1,850	1,350	1,050	1,100	1,020
Other 13/	XX	101	135	139 r/	200 r/	186
Total	XX	7,260 r/	7,150 r/	6,520 r/	7,860 r/	7,730

e/ Estimated. r/ Revised. XX Not applicable.

1/ World totals and estimated data are rounded to three significant digits; may not add to totals shown.

2/ Table includes data available through June 4, 1997. Data pertain to concentrates or comparable shipping product, except that in a few instances the best data available appear to be for crude ore, possibly after some upgrading.

3/ In addition to the countries listed, Burkina Faso, Cuba, Panama, and Sudan may have produced manganese ore and/or manganiferous ore, but available information is inadequate to make reliable estimates of output levels.

4/ May be average content of each year's production rather than for content of typical products.

5/ Metallurgical ore.

6/ Reported figure.

7/ Gross weight reported; metal content estimated and rounded to three significant digits.

8/ Production of beneficiated ore as reported in Sumário Mineral (Brasilia).

9/ Includes manganiferous ore.

10/ Calculated metal content includes allowance for assumed moisture content.

11/ Much of India's production grades below 35% Mn; average content was reported as approximately 38% Mn for fiscal years 1990-91 and 1991-92.

12/ Mostly oxide nodules; may include smaller quantities of direct-shipping carbonate and oxide ores for metallurgical and battery operations.

13/ Category represents the combined totals of Argentina (low-grade ore), Bolivia, Bosnia and Herzegovina, Botswana, Bulgaria, Burma (Myanmar), Chile, Colombia, Egypt, Greece, Hungary, Indonesia, Iran, Italy (from wastes), Japan (low-grade ore), Malaysia, Morocco, Namibia, Philippines, Romania, Thailand, Turkey, and Zambia.

TABLE 9
FERROMANGANESE AND SILICOMANGANESE: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Thousand metric tons, gross weight)

Country	1992					1993				
	Ferromanganese			Silico-manga-nese	Grand total	Ferromanganese			Silico-manga-nese	Grand total
	Blast furnace	Electric furnace	Total			Blast furnace	Electric furnace	Total		
Argentina	--	5	5	31	35	--	5	5	19	24
Australia e/	--	55	55	75	130	--	75	75	75	150
Belgium e/	--	25	25	--	25	--	25	25	--	25
Brazil	--	179	179	300	479	--	202	202	284	486
Chile	--	7	7	2	9	--	9	9	2	11
China e/	550	200	750	420	1,170	520	220	740	525	1,270
Croatia e/	--	10	10	15	25	--	10	10	40	50
Czechoslovakia e/ 3/ 4/	--	70	70	--	70	XX	XX	XX	XX	XX
Egypt e/	--	10	10	--	10	--	30	30	--	30
France 5/	280 e/	60	340	80	420	300	57	357	80	437
Georgia e/	--	100	100	50	150	--	100	100	50	150
Germany e/ 3/ 6/	130	30	160	--	160	100	20	120	--	120
India e/	--	198	198	93	291	--	137 7/	137 7/	85 7/	222 7/
Indonesia e/	--	--	--	--	--	--	10	10	--	10
Italy	--	17	17	50	67	--	17	17	50 e/	67
Japan	--	362	362	96	458	--	383	383	65	448
Kazakstan e/	--	--	--	--	--	--	--	--	--	--
Korea, North e/ 3/	--	70	70	--	70	--	70	70	--	70
Korea, Republic of	--	86	86	83	168	--	101	101	82	183
Mexico	--	79	79	51	130	--	70 e/	70 e/	55 e/	125 e/
Norway	--	203	203	213	416	--	226	226	219	445
Philippines e/	--	5	5	--	5	--	5	5	--	5
Poland	43	5	48	25 e/	73 e/	56	1	58	25 e/	83 e/
Romania e/	--	27	27	28	55	--	16	16	22	38
Russia e/	200	--	200	--	200	150	--	150	--	150
Slovakia e/	XX	XX	XX	XX	XX	--	22	22	12	34
South Africa	--	270	270	267	536	--	393	393	268	661
Spain e/	--	50	50	40	90	--	40	40	35	75
Taiwan	--	38	38	4	42	--	14	14	--	14
Thailand	--	1	1	4	5	--	(8/)	(8/)	2	2
Ukraine e/	50	250 r/	300 r/	1,100 r/	1,400 r/	40	140 r/	180 r/	735 r/	915 r/
United Kingdom	137	--	137	--	137	45	--	45	--	45
Venezuela e/	--	9	9	32	41	--	--	--	42	42
Zimbabwe	--	--	--	--	--	--	2	2	--	2
Total	1,390	2,420 r/	3,810 r/	3,060 r/	6,870 r/	1,210	2,400 r/	3,610 r/	2,770 r/	6,380 r/

See footnotes at end of table.

TABLE 9--Continued
FERROMANGANESE AND SILICOMANGANESE: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Thousand metric tons, gross weight)

Country	1994					1995				
	Ferromanganese			Silico-manganese	Grand total	Ferromanganese			Silico-manganese	Grand total
	Blast furnace	Electric furnace	Total			Blast furnace	Electric furnace	Total		
Argentina	--	8 r/	8 r/	29 r/	37 r/	--	6 r/	6 r/	27 r/	33 r/
Australia e/	--	100	100	100	200	--	110 r/	110 r/	100 r/	210
Belgium e/	--	25	25	--	25	--	25	25	--	25
Brazil	--	200	200	248	448	--	130 e/	130 e/	167 e/	297 e/
Chile	--	9 e/	9 e/	2	10 e/	--	9 e/	9 e/	2 e/	10 e/
China e/	567	350	917	657	1,570	400 r/	605 r/	1,010 r/	830 r/	1,840 r/
Croatia e/	--	10	10	30	40	--	10	10	30	40
Czechoslovakia e/ 3/ 4/	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
Egypt e/	--	35	35	--	35	--	35	35	--	35
France 5/	294	66	360	75 e/	435 e/	304 r/	100 r/	404 r/	80 e/	484 r/ e/
Georgia e/	--	10	10	40	50	--	5	5	25	30
Germany e/ 3/ 6/	--	20	20	--	20	--	20	20	--	20
India e/	--	150	150	140	290	--	150	150	120 r/	270 r/
Indonesia e/	--	10	10	--	10	--	14	14	7	21
Italy	--	16 e/	16 e/	40 e/	56 e/	--	16 e/	16 e/	40 e/	56 e/
Japan	--	345	345	69	414	--	347	347	65	412
Kazakstan e/	--	--	--	40	40	--	--	--	20	20
Korea, North e/ 3/	--	70	70	--	70	--	70	70	--	70
Korea, Republic of	--	120	120	89	209	--	119 e/	119 e/	98 e/	217 e/
Mexico	--	67 e/	67 e/	64 e/	131 e/	--	58	58	68	126
Norway	--	249	249	197	446	--	225 e/	225 e/	200 e/	425 e/
Philippines e/	--	5	5	--	5	--	5	5	--	5
Poland	66 r/	-- r/	66 r/	25 e/	91 r/ e/	46 r/	-- r/	46 r/	25 e/	71 r/ e/
Romania e/	--	31	31	35	67	--	28 7/	28 7/	57 7/	86 7/
Russia e/	55	--	55	--	55	55	--	55	1 r/	56 r/
Slovakia e/	--	25	25	12	37	--	25	25	12	37
South Africa	--	591	591	290	881	--	507 r/	507 r/	251 r/	758 r/
Spain e/	--	35	35	35	70	--	25	25	50 r/	75 r/
Taiwan	--	7	7	--	7	--	5 e/	5 e/	--	5 e/
Thailand	--	(8/)	(8/)	1	1	--	(8/) e/	(8/) e/	1 e/	1 e/
Ukraine e/	30	170 r/	200 r/	600 r/	800 r/	25 r/	170 r/	195 r/	600 r/	795 r/
United Kingdom	--	--	--	--	--	--	--	--	--	--
Venezuela e/	--	--	--	40	40	--	--	--	40	40
Zimbabwe	--	--	--	--	--	--	--	--	--	--
Total	1,010 r/	2,720 r/	3,740 r/	2,860 r/	6,590 r/	830 r/	2,820 r/	3,650 r/	2,910 r/	6,560 r/

See footnotes at end of table.

TABLE 9--Continued
FERROMANGANESE AND SILICOMANGANESE: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Thousand metric tons, gross weight)

	1996 e/				
	Ferromanganese				
Country	Blast furnace	Electric furnace	Total	Silico-manga-nese	Grand total
Argentina	--	6	6	28	34
Australia e/	--	110	110	95	205
Belgium e/	--	25	25	--	25
Brazil	--	160	160	210	370
Chile	--	9	9	2	10
China e/	400	550	950	800	1,750
Croatia e/	--	10	10	30	40
Czechoslovakia e/ 3/ 4/	XX	XX	XX	XX	XX
Egypt e/	--	35	35	--	35
France 5/	300	80	380	80	460
Georgia e/	--	5	5	15	20
Germany e/ 3/ 6/	--	20	20	--	20
India e/	--	150	150	120	270
Indonesia e/	--	14	14	7	21
Italy	--	16	16	50	66
Japan	--	343 7/	343 7/	76 7/	419 7/
Kazakstan e/	--	--	--	50	50
Korea, North e/ 3/	--	70	70	--	70
Korea, Republic of	--	126	126	83	209
Mexico	--	69 7/	69 7/	93 7/	162 7/
Norway	--	225	225	200	425
Philippines e/	--	--	--	--	--
Poland	45	--	45	25	70
Romania e/	--	20	20	79	99
Russia e/	55	--	55	--	55
Slovakia e/	--	25	25	12	37
South Africa	--	480	480	250	730
Spain e/	--	25	25	50	75
Taiwan	--	5	5	--	5
Thailand	--	(8/)	(8/)	1	1
Ukraine e/	30	190	220	650	870
United Kingdom	--	--	--	--	--
Venezuela e/	--	--	--	40	40
Zimbabwe	--	--	--	--	--
Total	830	2,770	3,600	3,040	6,640

e/ Estimated. Revised. XX Not applicable.
1/ Table includes data available through June 25, 1997.
2/ World totals and estimated data are rounded to three significant digits; may not add to totals shown.
3/ Data for ferromanganese includes silicomanganese, if any.
4/ Dissolved Dec. 31, 1992.
5/ Includes silicospiegeleisen, if any.
6/ Data for blast furnace ferromanganese includes spiegeleisen, if any.
7/ Reported figure.
8/ Less than 500 tons.