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 demand. 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 about 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.

Trends in consumption were, for steelmaking, an increase in demand for refined grades of ferromanganese and, for dry cell batteries, further displacement of natural manganese dioxide by synthetic dioxide, principally electrolytic manganese dioxide (EMD).

For U.S. foreign trade in manganese materials, volumes for all main categories increased for exports and decreased for imports except for metal. Exports of ore again increased significantly to the highest level since 1984.

Prices decreased for metallurgical-grade ore and the main manganese ferroalloys. For ore, the decrease was in the range of 4% to 5%. The decrease in year-average price was about 4% for silicomanganese and 18% for medium-carbon ferromanganese.

The Government's stockpile disposal program was active for manganese materials; the larger disposals were of metallurgical-grade ore and ferromanganese (high- and medium-carbon grades). The Government's inventory of manganese was lowered by about 4% but remained nearly twice the annual domestic consumption.

Production of manganese ore was estimated to have declined about 5% as production decreased for most of the world's largest producers. *(See table 1.)* Unavailability of firm data for China continued to introduce uncertainty as to the final total. In manganese ferroalloys, an emphasis on production of refined ferromanganese was evident by developments in Brazil, the Republic of Korea, and South Africa. Significant progress was made by two joint ventures between Japanese and South African interests.

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

Legislation and Government Programs

On February 13, the Defense Logistics Agency (DLA) revised its proposed Annual Materials Plan (AMP) for fiscal year 1998 with respect to manganese by lowering the maximum sale quantity from 54,431 to 18,144 metric tons for natural battery-grade ore and from 362,874 to 226,796 tons for metallurgical-grade ore. Otherwise, the maximum fiscal year disposal authority for manganese materials remained the same as in the AMP for fiscal year 1997, in tons: 2,732 for synthetic manganese dioxide; 36,287 for chemical-grade ore; 45,359 for ferromanganese; and 1,814 for electrolytic manganese metal. The AMP for fiscal year 1998 became effective October 1.

During 1997, DLA issued a new solicitation of offers for electrolytic manganese metal and a solicitation that separated medium-carbon ferromanganese out of the existing solicitation for ferromanganese. DLA-ELECTROLYTIC MANGANESE METAL-001, which was issued May 1, offered for sale 1,053 tons of electrolytic metal and included a preference to domestic ferroalloy upgraders. In concurrent actions on June 20, DLA-FERROMANGANESE-001 was amended by deleting medium-carbon ferromanganese from it, and DLA-FERROMANGANESE-002 was issued, which offered 4,536 tons of medium-carbon ferromanganese for unrestricted sale. Subsequently, the offering of medium-carbon ferromanganese was amended on August 11 to reduce the quantity slightly to 4,165 tons and then suspended on December 18.

Disposals of manganese materials in 1997 announced by DLA totaled, in tons, natural battery-grade ore, 4,393; chemical-grade ore, 1,542; stockpile-grade metallurgical-grade ore, 162,724; nonstockpile-grade metallurgical-grade ore, 186; high-carbon ferromanganese, 27,246; medium-carbon ferromanganese, 9,092; silicomanganese, 183; and electrolytic metal, 481. All disposals (sales) were cash transactions.

Data on physical inventory of manganese materials reported by DLA indicated that changes in 1997 consisted, in tons, of decreases of 9,273 for natural battery-grade ore; 1,413 for chemical-grade ore; 109,587 for nonstockpile-grade metallurgical-grade ore; 28,894 for high-carbon ferromanganese; 2,127 for medium-carbon ferromanganese; 178 for silicomanganese; and 1,170 for electrolytic metal. The decrease for nonstockpile-grade metallurgical-grade ore related to a reclassification that also resulted in a net increase in inventory of 5,584 tons for stockpile-grade metallurgical-grade ore. The estimated manganese content of the manganese inventories being held by the Government at yearend was lowered 4% to somewhat more than 1.3 million tons. *(See table 2.)* Total inventory still remained about twice the current national apparent consumption.

Production

Ore and Concentrate.—The only production consisted 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.)* The source of electrical power for the Marietta plant was being changed, as Elkem Metals signed with Allegheny Power a 7-year agreement for supply of power. Subsequently Elkem Metals exercised its option to sell its remaining share of about 31% in the coal-fired plant that has been its main source of power (Elkem ASA, 1998). Elkem Metals once owned and operated the coal-fired plant now being completely turned over to American Municipal Power.

Consumption, Uses, and Stocks

Data relating to manganese end use and 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 about twice that for 1996 but still at a comparatively low level. Reported data for U.S. consumption of manganese ferroalloys and metal indicated a slight overall decline in unit consumption, as the rate of usage of silicomanganese apparently declined. (*See tables 4 and 5.*) The data appeared to support the expectation that the advent of thin slab casting of steel by electric furnace mills would increase demand for medium- and low-carbon grades of ferromanganese (Anderson, 1997). Relatively small quantities of manganese were used for alloying with nonferrous metals, chiefly in the aluminum industry as manganese-aluminum briquets that typically contained 75% or 85% manganese.

Domestic consumption of manganese ore advanced nearly 7% in 1997 to 510,000 tons and corresponding yearend stocks decreased to 275,000 tons. Because of the need to avoid disclosing proprietary data, these figures do not include relatively small quantities associated with ironmaking and cannot be disaggregated into end-use segments.

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 that consume it in the manufacture of dry cell batteries and manganese ferroalloys, metal, and chemicals. The collective consumption of these firms is believed to constitute that of the United States, exclusive of the steel industry. Full-year responses were obtained from all of these firms for 1997.

The ongoing trend in the battery industry for displacement of carbon-zinc cells by alkaline cells was reflected in restructuring of the Eveready Battery Co. Eveready was closing its last domestic plant for manufacture of carbon-zinc batteries, in which natural manganese dioxide is employed. Most of the carbon-zinc cells being produced were of the type in which the electrolyte contains zinc chloride rather than ammonium chloride (Leclanche cell) because mercury is more easily eliminated from cells with zinc chloride (Powers and MacArthur, 1998, p. 37). In alkaline cells, which employ EMD, major manufacturers were bringing out longer lasting versions of the smaller-sized cells popularly used in high-drain devices such as digital cameras and cell phones.

In November, Rayovac Corp., Madison, WI, made the transition from a private to a public company by completing an initial public offering of shares of its common stock. This was carried out under the Thomas H. Lee management, which, with affiliates, had acquired a controlling position in Rayovac in September 1996.

A proprietary process for recycling alkaline batteries that yields a byproduct zinc-manganese powder for use as a fertilizer micronutrient has been developed by Battery Conservation Technologies Inc. (BCTI) in Pecos, TX. Since September 1996, BCTI's pyrolysis, shredding, and separation process has been used to recycle 350 to 400 tons per month of a pre-existing inventory of about 7,100 tons of alkaline batteries (Curry and Hayton, 1997).

Prices

For 1997, with the price of manganese in metallurgical-grade ore taken as 1.0, the corresponding prices per manganese unit were approximately 2.5 for high-carbon ferromanganese, 2.6 for silicomanganese, 3.9 for medium-carbon ferromanganese, and 10 for manganese metal. These price factors are based on year-average prices such as discussed in the following, which for ferroalloys and metal were derived from prices listed in Platt's Metals Week.

Manganese Ore.—The average price, on the basis of cost, insurance, and freight (c.i.f.) U.S. ports, of metallurgical-grade ore containing 48% manganese was assessed as $2.44 per metric ton unit. 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 metric ton unit 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 1997 and 1996 can be expressed as 24.4 and 25.5 cents per kilogram, respectively. These values indicate a decrease of more than 4% in U.S. c.i.f. price or somewhat less than the decrease in free-on-board (f.o.b.) price in international markets.

The international benchmark price for metallurgical-grade ore was reduced approximately 5% early in March. At that time, amidst reports that Chinese ore consumers were calling for a price reduction from their suppliers, Japanese consumers came to agreement on price with their major Australian and South African sources. On an f.o.b. basis per metric ton unit for delivery during the annual contract year, the prices settled on were $2.08 for ore from Australia's Broken Hill Pty. Co. Ltd. (BHP) and $1.99 for ore from South Africas Samancor Ltd.

Manganese Ferroalloys.—For high-carbon ferromanganese and silicomanganese, the trend was for prices to rise in the first half of 1997 and afterwards to decline. For medium-carbon ferromanganese, the price trend was downward throughout the year, particularly in the latter half. These trends and the price information that follow pertain to quotations for U.S. imports, as public information on current prices for domestic product was not available. English units were the basis for price quotes in the United States.

For ferromanganese, the price range for the high-carbon grade containing 78% manganese, per long ton of alloy f.o.b. Pittsburgh or Chicago warehouse, began and ended the year at $480 to $500 and $475 to $495, respectively, for a net overall decrease of 1%. The average over the year for the middle of the price range was $491, which was about 8% less than that of 1996. For about 1 month at midyear, the price had ranged as high as $500 to $525. 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 45.5 to 47 and 37 to 41 at the beginning and end of the year, respectively, for a net overall decrease of about 16%. The middle of the price range averaged 43.1 cents for the year, which was about 18% less than that of 1996. Trade journal reports indicated that a cause of the price decline was failure of demand to develop as rapidly as anticipated from new steel mills.

For imported silicomanganese with 2% carbon, the price range, in cents per pound of alloy, f.o.b. Pittsburgh or Chicago warehouse, was 23.75 to 24.75 and 25.5 to 27.0 at the beginning and end of the year, respectively, for a net increase of about 8%. However, the average over the year of 27.0 for the middle of the price range was about 4% less than that for 1996. The price range was as high as 30 to 31 at midyear, when trade journal articles were reporting supply shortages.

Manganese Metal.—Trade journals indicated no change during the year for producer price; for bulk shipments of domestic material, per pound f.o.b. shipping point, American Metal Market listed a range of $1.15 to $1.17, while Platt's Metals Week and Ryans Notes listed $1.15. For its North American transaction price, Ryan's Notes indicated a downward trend giving a decrease of about 7% over the year and a price level that averaged about one-sixth less than producer list price.

Foreign Trade

In comparison with those of 1996, trade volumes for all main categories of manganese materials increased for exports and decreased for imports except for metal. *(See tables 6 and 7.)* In terms of manganese units contained, for all categories combined the increase in exports was about 91% and the decrease in imports was about 18%. The number of manganese units exported was the greatest since 1984. Also on the basis of content, the ratio, imports of ferroalloy plus metal divided by imports of ore plus dioxide, rose to 2.6:1, the greatest such ratio since 1994.

Among exports of ore, about 4% went to Canada and had a relatively high unit value; the remainder of the ore went elsewhere, virtually all apparently unprocessed material of metallurgical grade. Ore exports were the greatest since the large reshipments of 1984. Increased exports of ferromanganese resulted mainly from an increase of about one-fourth in exports of ferromanganese containing more than 2% carbon. Exports of metal advanced again and rose to the greatest quantity since 1988. Reexports of ore, ferromanganese, silicomanganese, and metal were, in tons, 0; 7,260; 5,535; and 112, respectively, all of which went to Canada except for small tonnages of silicomanganese and metal that went to Mexico.

Among imports, average manganese contents were comparatively low for ore and ferromanganese. An overall average percentage content of 43.7% for ore resulted from significant receipts of low-grade ore from Brazil and Mexico. For high-grade ore, an average percentage content of 48.4% was typical. Gabon again was the dominant ore source. For ferromanganese, the overall average percentage content of 77.4% was the smallest since at least 1982.

For silicomanganese, the import volume was about the same as the average for the past 5 years. By small margins, record amounts were received from Australia, Mexico, and Venezuela; for Australia and Venezuela, this was the second successive year of record amounts. Reported imports of spiegeleisen decreased 27% to 330 tons, all from South Africa at relatively high unit value.

Among imports of manganese chemicals, for manganese dioxide the volume of receipts was just slightly less than in 1996 and remained at a near-record level. These receipts included noticeable quantities from China for the first time. 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 decreased by about one-tenth, as the decrease in volume of imports of material in that class was about 23% for China and about 7% for Mexico. Receipts from China were 4,525 tons at a value of $1.7 million and from Mexico 18,194 tons at a value of $9.4 million.

The Generalized System of Preferences (GSP) program was allowed to expire on May 31, but in August, Congress approved its retroactive extension through June 30, 1998. Along with the

extension, reimbursement of duties paid during the period when the program temporarily was not in effect was approved also (Platts Metals Week, 1997). Categories of U.S. imports from developing countries that may have been affected included manganese dioxide, permanganate, and sulfate; low- and medium-carbon ferromanganese; silicomanganese; and manganese metal, other.

In June, the Office of the U.S. Trade Representative announced that, in the 1995 Annual Review of the GSP program, it was denying a petition of The Ferroalloys Association to remove duty-free treatment for manganese dioxide from South Africa (Office of the U.S. Trade Representative, 1997).

In July, the International Trade Administration announced the final results of its antidumping duty administrative review of silicomanganese from Brazil (U.S. Department of Commerce, 1997). These results applied to U.S. imports during June 17, 1994, through November 30, 1995, from the Ferro-Ligas Group (Cia. Paulista de Ferro-Ligas and Sibra Eletrosiderurgica Brasileira S.A. For such material, the cash deposit margin was raised to 88.87% from the 64.93% originally set in 1994.

World Review[1]

Leading producer countries among a relatively concentrated production of manganese ore are Australia, Brazil, China, Gabon, India, South Africa, and Ukraine. *(See table 8.)* Leading producer countries among a more widely distributed production of manganese ferroalloys have been Brazil, China, France, Japan, Norway, South Africa, and Ukraine. Annual world production of ferromanganese and silicomanganese, by country, is reported in the annual review for 1997 for Ferroalloys in the Mineral Industry Surveys series of the USGS and in the Ferroalloys chapter of the 1997 Minerals Yearbook.

Australia.—According to monthly production reports of BHP, manganese ore production at BHPs Groote Eylandt Mining Co. Pty. Ltd. (GEMCO) subsidiary advanced 7% to a total of 1,936,000 tons. This was the greatest output by GEMCO since the record year of 1989.

In manganese ferroalloys, a furnace upgrade was carried out in the second part of the year at Tasmanian Electro Metallurgical Co. Pty. Ltd. (TEMCO), a subsidiary of BHP (BHP Minerals Global Report, 1997b). This was to increase annual capacity at TEMCO by 11,000 tons for silicomanganese and to a total of 211,000 tons for the plant (BHP Minerals Global Report, 1997c). Late in the year, production of manganese ferroalloys at this plant was being linked with Japan Metals & Chemicals Co. Ltd. (JMC) and Mitsui & Co. Ltd. for marketing in Japan.

As a result of a review of its business portfolio, BHP signed a memorandum of understanding at midyear to sell the EMD plant of Australian Manganese Company Ltd. (AMCL), another BHP subsidiary. The buyer, South Africa's Delta Electrical Industries Ltd., would thereby acquire facilities at Newcastle, New South Wales, having an annual capacity for EMD of about 23,000 tons. BHP was to continue supplying ore to AMCL under a long-term agreement (BHP Minerals Global Report, 1997a).

In Western Australia for the second successive year, heavy rains and adverse weather conditions in the first part of the year significantly impeded the operations and shipping of Valiant Consolidated Ltd. in the Pilbara Manganese Province. Transport problems were to be lessened through construction of an all-weather road that was to be completed by late 1998. Mining by Valiant in the Woodie Woodie area had moved from the Mike Mine (closed in late 1996) to the Big Mack deposit. In the latter part of the year, however, operational and financial troubles resulted in suspension of mining and appointment of an administrator for the company.

Brazil.—Cia. Vale do Rio Doce (CVRD) was privatized in May with ownership going to a consortium composed mostly of Brazilian interests. Two of the larger resulting shareholders were a group of pension funds and a major steelmaker, Cia. Siderúrgica Nacional. CVRD subsequently was restructured into four main areas, of which the ores area included manganese activities. Production and sales of manganese ore by CVRD in 1997 both totaled 1,400,000 tons, which was a decrease of about 17% for production and an increase of about 19% for sales. For the Azul Mine in the Carajás region and the Urucum Mine in Mato Grosso do Sul State, output in tons and percentage change from 1997 (in parentheses) were 1,100,000 (-23%) and 300,000 (+15%), respectively. Exports accounted for about three-fifths of sales.

Manganese ore shipments by Indústria e Comércio de Minérios S.A. (ICOMI) from operations at Serra do Navio, Amapá Territory, totaled 311,000 tons. Destinations of the shipments, which were through Porto de Santana on the Amazon River, were, in tons, 111,000 to Europe; 101,000 to South America (including Brazil); 63,600 to Asia; and 35,000 to North America (Skillings Mining Review, 1998b). Shipments to Europe dropped by about one-third; increased shipments to North America largely offset the decrease in those to South America. This was the third successive year that overall shipments declined, in 1997 by about 15%, as four decades of mining at Serra do Navio were drawing to a close.

Following the restructuring of CVRD, the program for production of manganese ferroalloys being managed by Vale-Usiminas Participações (VUPSA) came under review. Several of the smaller plants of the former Paulista Group remained inoperative. At Sibra Eletrosiderúrgica Brasileira S.A., Bahia State, reduced production of high-carbon ferromanganese and silicomanganese and increased production of medium-carbon ferromanganese was planned. The decrease in silicomanganese production would result from converting two furnaces to production of silicon metal.

Also under VUPSA, annual capacity for production of EMD from local ores was being roughly doubled to 4,800 tons at the

[1]Discussions by country of the more significant developments during 1997 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 TEX Report (Tokyo). These items have not been acknowledged individually because the information they conveyed often was aggregated, possibly with that from other sources.

plant of Soc. Brasileira de Eletrolise, Conselheiro Lafaiete, Minas Gerais State.

Canada.—Effective June 23, the Government imposed a ban that prohibited importation and interprovincial trade, but not continued use, of the additive methylcyclopentadienyl manganese tricarbonyl (MMT), an octane-enhancer for gasoline. Subsequently, the Ethyl Corp. (U.S.), a supplier of MMT, filed a claim with the Canadian Department of Justice asserting that the Canadian Government had breached its obligations under the North American Free Trade Agreement. In addition, Canadian provinces sued the Government claiming that the ban contravened Canadian laws governing interprovincial trade (Chemical Engineering, 1997).

China.—Manganese ore had been imported at a record pace in the first part of the year but then slackened in the second half, resulting in a total of 1,320,000 tons, a decrease of about 17% from the 1996 record total.

Exports of manganese ferroalloys increased about 7% overall to 579,000 tons. Quantities exported, in tons, and percentage changes were 106,000 and -4% for high-carbon ferromanganese; 43,000 and -31% for medium- and low-carbon ferromanganese; and 431,000 and +18% for silicomanganese (The TEX Report, 1998). Exports of silicomanganese were depressed when in September the European Commission imposed a provisional antidumping duty of 19.6% on imports from China.

Exports of manganese metal in 1997 were 60,100 tons, an increase of about 32% from those in 1996. Of the 45,700 tons exported in 1996, 40% went to Japan and 36% went to the Netherlands.

Gabon.—Exports of manganese ore produced from the Moanda Mine of Compagnie Minière de l'Ogooué S.A. (COMILOG) totaled 1,995,000 tons, of which 1,931,000 tons was metallurgical-grade ore and 64,000 tons was battery-grade ore. Shipments were made in 64 cargoes via the port of Owendo (Skillings Mining Review, 1998a). Most of the 18,000-ton increase in exports was attributed to shipments of battery-grade ore (dioxide), which were about one-third greater than those of 1996.

France's ERAMET moved from largest (46%) to majority (61%) shareholder in COMILOG by acquiring the 15% share that had been held by South Africa's Gencor Ltd. The history of COMILOG's Moanda Mine was set forth in a series of three articles published in Skillings Mining Review. The first two articles described the origins and development of the mine and associated events up until the late 1970's, and certain later ones (Strong, 1997a, b). The third article gave the mine's recent history and described operations and equipment for mining, beneficiation, and shipping (Gautier, 1997).

Japan.—Overall imports of metallurgical-grade manganese ore decreased by about 5% to 1,109,000 tons. For ore containing more than 39% manganese, imports increased about 1% to 900,000 tons, 87% of which was from Australia and South Africa. Imports from South Africa rose by one-fourth to 414,000 tons, while those from Australia fell by about one-tenth to 367,000 tons. For ore containing no more than 39% manganese, imports dropped by one-fourth to 209,000 tons, the sources of which were Ghana (8%), India (45%), and South Africa (48%). Imports of ferruginous manganese ore nearly tripled to 238,000 tons, the largest total since 1990. Nearly all of these imports were from India (59%), Ghana (29%), and South Africa (11%).

Production of manganese ferroalloys increased almost 9% overall, mainly because of an increase of about one-sixth in production of high-carbon ferromanganese. Nippon Denko Co. Ltd. rationalized its production of manganese ferroalloys in the first part of the year. The startup of a new electric furnace at the Tokushima plant in southwestern Japan effectively shifted production of medium- and low-carbon ferromanganese from the Miyako plant in Iwate Prefecture, eastern Japan, which was closed. Annual capacity of the new furnace was 24,000 tons of refined ferromanganese, which was being produced using silicothermic technology. Citing high energy costs, JMC announced late in the year its decision to almost completely end production of ferroalloys as of the first part of 1998. In addition to its participation in the Advalloy joint venture for production of refined ferromanganese in South Africa, JMC was arranging to replace its own production of manganese ferroalloys with those produced in Australia and South Africa.

Overall imports of manganese ferroalloys increased slightly to 353,000 tons, with those of silicomanganese increasing 10% to 257,000 tons and those of ferromanganese (almost all high-carbon) decreasing 14% to 95,000 tons. China and Ukraine, the two leading sources of silicomanganese with shares of 32% and 24%, respectively, reversed their relative position. South Africa (57%) and China (32%) were the largest sources of ferromanganese.

Exports of manganese ferroalloys increased about one-fifth overall to 45,700 tons, nearly all of which consisted of ferromanganese containing less than 2% carbon (45,100 tons). Exports to the United States declined about one-sixth to 15,200 tons.

Production of manganese dioxide decreased slightly further, by 1%, to 57,900 tons, whereas exports rose about 3% to 32,800 tons.

Imports of unwrought manganese metal, including scrap, advanced a further 10% to 40,600 tons; China (64%), South Africa (33%), and the United States (2%) again were the sources for practically all metal imports.

Kazakstan.—In the first part of the year, Kazchrome Transnational Corp. acquired a 51% shareholding in the Kazmarganets beneficiation plant near Dzhezdy in the Dzhezkazgan region of central eastern Kazakstan, with the aim of reopening it. Kazchrome also planned to develop a source of ore for the plant by opening a mine in the Tur manganese field in the Karaganda region to the northeast (Interfax Mining & Metals Report, 1997). However, the future of these developments became uncertain when disputes arose late in the year between Kazakstani nationals and the Trans-World Group as to control of various mineral establishments in Kazakstan. These included those being managed by Kazchrome, which was controlled by Trans-World.

Also in the Dzhezkazgan-Karaganda region, a program of

rehabilitating the Zhairem mining complex was being furthered by investments of Switzerland's Nakosta AG. This complex, a producer of manganese and ferruginous manganese concentrates, was restarted in 1996 after having been virtually out of production for 2 years (Interfax Mining News, Nakosta allocates $16 million to mine in Kazakhstan, accessed February 23, 1998, at URL http://www.info-mine.com/interfax/news/ifoct17-97.html).

Korea, Republic of.—After midyear, Dongbu Corp. installed a new electric furnace and thereby increased its annual production capacity for medium- and low-carbon ferromanganese to 50,000 tons from 15,000 tons. This raised the overall capacity for manganese ferroalloys to 135,000 tons per year at Dongbu's plant east of Seoul at Donghae City, Kangwon Province.

Mexico.—Overall salable production by Cía. Minera Autlán (Autlán) increased moderately for most ores and ferroalloys. Data for 1997 output of ore products, in tons and percentage increases from 1996 (in parentheses), were manganese carbonates, 107,000 (4%); oxide nodules, 395,000 (9%); and manganese dioxide, manganous oxide, and other oxides, 32,000 (68%). Overall production of manganese ferroalloys increased by 7% to 174,000 tons. Production advanced 11% for medium-carbon ferromanganese and 13% for silicomanganese, but declined 15% for high-carbon ferromanganese.

South Africa.—According to preliminary data, ore production decreased by about 3% for metallurgical-grade ore, 40% for chemical-grade ore, and 4% overall. The proportion of total production that was metallurgical-grade ore increased to almost 99%. Within the production of metallurgical-grade ore, ore containing 30% to 40% manganese still accounted for 36% of the subtotal while the proportion for ore containing more than 48% manganese fell back to 54% from 58%. Production of ore containing 40% to 45% manganese increased more than 70% to 205,000 tons.

For fiscal years ending June 30, 1997, ore production by Samancor advanced nearly one-tenth to 2.3 million tons, while ore sales by The Associated Manganese Mines of South Africa Ltd. (Assmang) decreased to about one-half Samancor's output. The decline of about 13% at Assmang reflected a comparable decrease in sales volume of ferromanganese by its Feralloys Ltd. subsidiary and correspondingly reduced ore consumption. Samancor instituted a program to double the annual capacity of the sintering plant at its Mamatwan Mine to 1 million tons by early 1999. The history, development, geology, and mineralogy of the Kalahari and Postmasburg fields on which the manganese operations of Assmang and Samancor have been based was the subject of a book (Cairncross, Beukes, and Gutzmer, 1997).

The Advalloy and Cato Ridge Alloys (Pty) Ltd. joint ventures for production of refined manganese ferroalloys, for which Samancor and Assmang, respectively, were providing plant sites for their Japanese partners, progressed toward startup of commercial operations in the first part of 1998. Oxygen converting of high-carbon ferromanganese was common to both projects, but the technologies were not the same. Besides through the Advalloy venture, Samancor was achieving flexibility in marketing manganese ferroalloys through toll converting of ore into ferroalloy in China and elsewhere.

Ukraine.—Total ore output declined only marginally, as production by the Ordzhonikidze complex in the western part of the Nikopol' Basin was virtually unchanged at 1,890,000 tons, while that by the Marganets complex in the eastern part of the basin declined slightly to 1,150,000 tons. As in 1996, 62% of total production was accounted for by the Ordzhonikidze complex and 38% by the Marganets complex (Interfax Mining & Metals Report, 1998).

Current Research and Technology

The Geological Society of London published a special volume containing chapters by various authors that dealt with geochemical and mineralogical aspects of manganese deposits in land and marine settings (Nicholson, Hein, Bühn, and Dasgupta, 1997). Other reports of geologic investigations included those for deposits in Georgia (Kuleshov and Dombrovskaya, 1997a, b), India (Acharya, Rao, and Sahoo, 1997), South Africa (Gutzmer and Beukes, 1997a, b; Tsikos and Moore, 1997), Turkey (Öztürk, 1997; Öztürk and Hein, 1997), and Ukraine (Varentsov and others, 1997). Also reported on were investigations on the possible role of manganese dioxide in the world's nitrogen cycle (Luther and others, 1997) and microbial oxidation of divalent manganese (Tebo and others, 1997).

In research on manganese electrometallurgy, a process was proposed for treating manganiferous silver ores such as those that occur in the United States (Rutten, Sandwijk, and Van Weert, 1997). In a study of manganese electrodeposition from sulfate solutions, possible benefits from selenium and zinc were noted (Ilea and others, 1997).

In manganese pyrometallurgy, authors from the University of Missouri at Rolla presented a number of publications giving the results of their work on ferromanganese smelting (Li and Morris, 1997; Li and Robertson, 1997; Li, Robertson, and Morris, 1997). With application to oxygen steelmaking, an experimental investigation was made of the thermodynamics of slags that might be generated from the use of manganese ore (Morales and Fruehan, 1997).

Studies involving manganese compounds included investigation of manganese carbonate as a catalyst in making diamonds (Srikanth and others, 1997), evaluation of starting materials (for manganese, particularly the sulfate) in hydrothermal preparation of manganese-zinc ferrites (Dias and Buono, 1997), and development of a humidity sensor based on manganese tungstate (Qu and Meyer, 1997). In Israel, the aluminum-permanganate couple for electricity generation was studied (Licht, 1997).

The environmental and health issue of the paradoxical need for manganese in the diet versus the possibility of its producing a toxic effect was addressed by Greger and Malecki (1997).

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.

During 1985-96, U.S. apparent consumption of manganese generally has been within about plus or minus 10% of 670,000 tons of contained manganese. This largely has been a consequence of a reasonably comparable degree of variation in domestic steel production. During this period, manganese demand, which is presented as apparent consumption in table 1, has tended to increase at about the same rate as raw steel production. It may be that manganese apparent consumption has not tracked 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 and is believed to account for the higher-than-average manganese apparent consumption in 1996.

The October 1997 forecast of the International Iron and Steel Institute (IISI) (Gavaghan, 1997) implies that domestic steel output, the main determinant of manganese demand, is likely to be relatively steady throughout the remainder of the 1990's. This suggests U.S. apparent consumption of manganese will remain near 670,000 tons of contained manganese for the midterm. With U.S. steel demand having moved into record territory in 1997 and steel production having grown at an annual rate of about 1.4% during 1985-96, however, manganese apparent consumption could reach 770,000 tons of contained manganese by 2000. These outlooks for a range of 670,000 to 770,000 tons assume 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, the IISI forecast 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 areas such as China and Latin America. For the midterm, the global growth rate in demand for manganese could be somewhat less than that for steel if manganese unit consumption declines for countries whose steel industries are developing 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)

	1993	1994	1995	1996	1997
United States:					
Manganese ore (35% or more Mn):					
Exports	16	15	15	32	84
Imports for consumption	232	331	394	478	357
Consumption	389	449	486	478 2/	510 2/
Stocks, December 31: Consumers	302	269	309	319 2/	275 2/
Ferromanganese:					
Exports	18	11	11	10	12
Imports for consumption	347	336	310	374	304
Consumption	341	347	348	326	337
Stocks, December 31: Consumers and producers	30	36	33	27	21
Consumption, apparent, manganese 3/	696	694	676	776	NA
Ore price, dollars per metric ton unit, c.i.f. U.S. ports	2.60	2.40	2.40	2.55	2.44
World production of manganese ore	20,500 r/	18,000	23,300 r/	24,100 r/	22,700 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 1997 1/

(Metric tons, gross weight)

		Physical inventory, December 31				
		Uncommitted			Sold,	
Material	Disposal authority	Stockpile grade	Nonstockpile grade	Total	pending shipment	Grand total
Natural battery ore	111,000	93,900	16,800	111,000	11,800	122,000
Synthetic manganese dioxide	2,730	2,730	--	2,730	--	2,730
Chemical ore	148,000	148,000	81	148,000	--	148,000
Metallurgical ore	879,000	703,000	427,000	1,130,000	67,800	1,200,000
High-carbon ferromanganese	690,000	939,000	--	939,000	--	939,000
Medium-carbon ferromanganese	--	8,910	--	8,910	6,640	15,500
Silicomanganese	--	--	--	--	5	5
Electrolytic metal	8,560	8,560	--	8,560	--	8,560

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

Source: Defense Logistics Agency.

TABLE 3
DOMESTIC PRODUCERS OF MANGANESE PRODUCTS IN 1997

		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 1997 1/

(Metric tons, gross weight)

End use	Ferromanganese			Silico-manganese	Manganese metal
	High carbon	Medium and low carbon	Total		
Steel:					
Carbon	189,000	74,400	264,000	92,000	1,090
High-strength, low-alloy	18,500	4,390	22,900	6,060	(2/)
Stainless and heat-resisting	14,700	(2/)	14,700	5,780	1,200
Full alloy	21,100	5,100	26,200	24,900	(2/)
Unspecified 3/	386	310	696	328	489
Total	244,000	84,200	328,000	129,000	2,780
Cast irons	7,650	415	8,070	783	5
Superalloys	W	W	W	--	155
Alloys (excluding alloy steels and superalloys)	782	397	1,180	(4/)	19,200 5/
Miscellaneous and unspecified	--	W	W	(4/)	W
Total consumption	252,000	85,000	337,000	130,000 6/	22,100
Total manganese content 7/	197,000	68,000	265,000	85,700	22,100
Stocks, December 31, consumers and producers	10,700	10,500	21,200	8,960	3,600

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		1996	1997
Basis: Production of raw steel 2/ and steel castings	million tons	96.6	99.6
Ore 3/		--	--
Ferromanganese		2.56	3.47
Silicomanganese		.93	.86
Manganese metal		.04	.03
Total		3.54	3.47

e/ Estimated.
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	1996 Gross weight (metric tons)	1996 F.a.s. value (thousands)	1997 Gross weight (metric tons)	1997 F.a.s. value (thousands)
Ore and concentrates with 20% or more manganese:				
Belgium	3,410	$272	10,400	$832
Canada	5,800	1,140	3,410	904
Colombia	--	--	3,590	287
Israel	--	--	2,840	227
Italy	1,930	155	10,200	812
Netherlands	1,690	828	16,400	1,320
Norway	--	--	12,800	1,030
United Kingdom	(2/)	62	16,000	1,280
Other	18,800 3/	1,550 3/	8,650	703
Total	31,600	4,000	84,300	7,390
Ferromanganese, all grades:				
Canada	8,700	7,750	10,300	7,610
Egypt	--	--	611	605
Japan	--	--	250	383
Mexico	751	763	487	548
Other	341	334	112	132
Total	9,800	8,850	11,800	9,270
Silicomanganese:				
Canada	4,810	4,000	4,700	2,780
Mexico	306	277	553	337
Other	153	116	107	165
Total	5,270	4,390	5,360	3,290
Metal, including alloys and waste and scrap:				
Belgium	544	1,240	402	989
Canada	1,030	2,780	1,200	3,210
France	348	632	1,370	3,180
Japan	1,020	2,520	1,150	2,700
Netherlands	470	1,820	958	2,850
United Kingdom	1,100	1,570	1,730	2,870
Other	1,330 3/	3,890 3/	1,090	2,900
Total	5,840	14,500	7,890	18,700

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Less than 1/2 unit.
3/ Revised; unspecified group of countries differs from that in the 1996 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	1996 Gross weight (metric tons)	1996 Manganese content (metric tons)	1996 Customs value (thousands)	1997 Gross weight (metric tons)	1997 Manganese content (metric tons)	1997 Customs value (thousands)
Ore and concentrates with 20% or more manganese:						
All grades:						
Australia	96,000	48,900	$8,840	32,700	17,200	$3,090
Brazil	18,700	5,640	294	35,000	9,100	553
Gabon	277,000	140,000	27,300	208,000	99,500	22,200
Mexico	43,000	16,100	2,580	80,800	30,100	5,000
Morocco	18	9	5	70	37 2/	18
South Africa	43,500	20,800	3,430	--	--	--
Other	--	--	--	24	39	22
Total	478,000	231,000	42,400	357,000	156,000	30,900
More than 20%, but less than 47% manganese:						
Brazil	18,700	5,640	294	35,000	9,100	553
Gabon	--	--	--	816	386	764
Mexico	43,000	16,000	2,580	80,700	30,100	4,930
Total	61,700	21,700	2,870	116,000	39,500	6,250
47% or more manganese:						
Australia	96,000	48,900	8,840	32,700	17,200	3,090
Gabon	277,000	140,000	27,300	208,000	99,100	21,500
Mexico	20	14	7	120	75	66
Morocco	18	9	5	70	37 2/	18
South Africa	43,500	20,800	3,430	--	--	--
Other	--	--	--	24	39	22
Total	416,000	209,000	39,600	240,000	116,000	24,600
Ferromanganese:						
All grades:						
Australia	33,900	25,500	13,500	31,900	23,600	10,600
Brazil	36,400	27,700	17,100	39,100	29,900	16,600
China	11,700	9,440	9,310	7,760	6,300	6,330
France	97,600	76,800	46,600	65,200	50,700	27,500
Italy	5,630	5,050	9,110	4,940	4,370	7,060
Japan	27,100	21,900	22,400	13,700	11,100	10,200
Mexico	24,400	19,600	19,700	31,200	25,000	22,200
Norway	4,960	4,070	4,500	4,200	3,270	2,770
South Africa	132,000	103,000	63,800	103,000	78,800	44,500
Other	4	4	3	2,900	2,230	1,280
Total	374,000	293,000	206,000	304,000	235,000	149,000
1% or less carbon:						
Italy	5,630	5,050	9,110	4,810	4,270	6,930
Japan	2,480	2,070	2,880	4,060	3,310	3,610
Norway	1,160	961	1,330	343	164	250
South Africa	2,240	2,060	3,910	2,160	1,980	3,830
Other	24	21	42	298	246	322
Total	11,500	10,200	17,300	11,700	9,970	14,900
More than 1% to 2% or less carbon:						
Brazil	5,210	4,170	4,340	5,740	4,670	4,040
China	11,700	9,440	9,310	7,470	6,070	6,020
France	4,200	3,430	3,290	--	--	--
Japan	24,600	19,800	19,500	9,660	7,760	6,570
Mexico	24,400	19,600	19,700	31,200	25,000	22,200
Norway	3,740	3,060	3,110	3,850	3,100	2,520
South Africa	4,230	3,390	3,710	120	94	112
Other	--	--	--	264	221	238
Total	78,100	62,900	62,900	58,300	46,900	41,700
More than 2%, but not more than 4% carbon:						
Canada	--	--	--	101	40	13
China	--	--	--	7	6	12
Total	--	--	--	108	47	25

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	1996 Gross weight (metric tons)	1996 Manganese content (metric tons)	1996 Customs value (thousands)	1997 Gross weight (metric tons)	1997 Manganese content (metric tons)	1997 Customs value (thousands)
Ferromanganese--continued:						
More than 4% carbon:						
Australia	33,900	25,500	$13,500	31,900	23,600	$10,600
Brazil	31,200	23,600	12,700	33,300	25,300	12,500
France	93,400	73,400	43,300	65,200	50,700	27,500
South Africa	125,000	97,200	56,100	101,000	76,700	40,600
Other	62	49	70	2,660	2,070	1,160
Total	284,000	220,000	126,000	234,000	178,000	92,400
Silicomanganese:						
Argentina	7,490	4,870	4,910	4,520	2,940	1,950
Australia	50,300	33,700	29,200	50,700	34,300	23,400
France	20,900	13,800	11,100	12,300	7,930	6,450
Georgia	1,260	884	701	9,630	7,030	4,840
India	47,400	31,200	27,000	29,900	20,000	14,700
Kazakstan	10,200	6,370	4,820	--	--	--
Macedonia	11,000	7,460	4,910	4,300	2,930	2,370
Mexico	23,600	15,400	13,300	40,600	26,600	20,200
Norway	10,500	6,440	10,200	1,550	1,060	851
Romania	13,600	9,070	7,390	11,100	7,240	5,500
Russia	2,510	1,150	1,260	12,000	6,370	6,490
South Africa	93,900	63,300	54,600	87,400	58,700	42,900
Ukraine	--	--	--	7,490	5,660	4,360
Venezuela	24,500	15,600	13,800	25,700	16,900	12,300
Other	5,840 3/	3,850 3/	4,610 3/	8,810	5,600	5,470
Total	323,000	213,000	188,000	306,000	203,000	152,000
Metal:						
Unwrought:						
China	1,100	XX	1,800	3,260	XX	4,970
Russia	3	XX	33	484	XX	457
South Africa	8,480	XX	14,000	9,500	XX	15,800
Ukraine	524	XX	856	479	XX	774
Other	20 3/	XX	29 3/	299	XX	585
Total	10,100	XX	16,800	14,000	XX	22,600
Other:						
China	40	XX	60	262	XX	375
France	102	XX	964	110	XX	1,000
Germany	169	XX	452	14	XX	140
South Africa	335	XX	585	--	XX	--
United Kingdom	152	XX	369	(4/)	XX	2
Other	43 3/	XX	168 3/	78	XX	257
Total	841	XX	2,600	465	XX	1,780
Waste and scrap:						
Canada	207	XX	168	85	XX	51
China	--	XX	--	40	XX	77
Mexico	54	XX	49	47	XX	34
Other	68 3/	XX	60 3/	54	XX	55
Manganese dioxide:						
Australia	19,500	XX	27,400	18,700	XX	26,300
Belgium	976	XX	1,680	743	XX	1,240
China	34	XX	39	732	XX	871
Ireland	6,970	XX	9,730	5,910	XX	8,310
South Africa	801	XX	1,130	2,360	XX	3,280
Other	617 3/	XX	1,260 3/	353	XX	929
Total	28,900	XX	41,300	28,800	XX	40,900

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	1996			1997		
	Gross weight (metric tons)	Manganese content (metric tons)	Customs value (thousands)	Gross weight (metric tons)	Manganese content (metric tons)	Customs value (thousands)
Potassium permanganate:						
Czech Republic	631	XX	$1,190	630	XX	$1,240
Germany	181	XX	310	303	XX	537
India	181	XX	301	278	XX	490
Spain	420	XX	1,020	374	XX	866
Other	44 3/	XX	82 3/	90	XX	175
Total	1,460	XX	2,900	1,680	XX	3,310

XX Not applicable.
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 MnO2 content to Mn content).
3/ Revised; unspecified group of countries differs from that in the 1996 Annual Report.
4/ Less than 1/2 unit.

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				
		1993	1994	1995	1996	1997 e/
Australia 5/	37-53	2,092	1,920 e/	2,177	2,109	2,136 6/
Brazil 7/ 8/	30-50	1,837	2,199 r/	2,398 r/	2,506 r/	2,000
China e/ 9/	20-30	5,860	3,570	6,900	7,600 r/	7,000
Gabon 7/ 10/	45-53	1,290	1,436	1,930 r/	1,980 r/ e/	1,900
Ghana 7/	30-50	295	270	217 r/	266 r/ 11/	300
India 7/ 12/	10-54	1,655	1,632	1,764	1,797 r/	1,800
Kazakstan e/ 7/ (crude ore)	20-30	400	400	428	430	400
Mexico 7/ 13/	27-50	363	307	472 e/	485	534 6/
South Africa 7/ 10/	30-48+	2,507	2,851	3,199	3,240	3,112 6/
Ukraine 7/	30-35	3,800	2,979	3,200	3,070 r/	3,040 6/
Other 14/	XX	409 r/	453 r/	621 r/	593 r/	517
Total	XX	20,500 r/	18,000	23,300 r/	24,100 r/	22,700

Country 3/	Range percent Mn e/ 4/	Metal content e/				
		1993	1994	1995	1996	1997 e/
Australia 5/	37-53	1,043 6/	944	1,066 6/	1,023 6/	1,024 6/
Brazil 7/ 8/	30-50	716	858 r/	935 r/	977 r/	780
China 9/	20-30	1,170	714	1,380	1,520 r/	1,400
Gabon 7/ 10/	45-53	595	663	891 r/	915 r/	878
Ghana 7/	30-50	115	108	85 r/	101 r/	108
India 7/ 12/	10-54	628	620	670	680 r/	680
Kazakstan 7/ (crude ore)	20-30	98	98	105	106	98
Mexico 7/ 13/	27-50	135	112	174	173	193
South Africa 7/ 10/	30-48+	1,080	1,210	1,350	1,380 r/	1,320
Ukraine 7/	30-35	1,350	1,050	1,100	1,040 r/	1,030
Other 14/	XX	145 r/	149 r/	215 r/	203 r/	171
Total	XX	7,070 r/	6,520	7,980 r/	8,120 r/	7,680

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 18, 1998. 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/ Exports.

12/ Much of India's production grades below 35% Mn.

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

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