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DIRECTORATE OF INTELLIGENCE

The Soviet Manganese Industry: Past Performance and Future Prospects [redacted] 25X1

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Summary

The USSR is the world's largest producer of manganese ore, but most of its high-grade ore is being depleted. Soviet manganese ores, which have a lower metal content than those normally mined in the West, could be completely exhausted at the two major mining areas of Chiatura and Nikopol in nine and 20 years, respectively, leaving only even lower grade ores that are much more expensive to process. The large Bolshoy Tokmak deposit, which the Soviets are just beginning to develop, consists almost entirely of low-grade ores. [redacted] 25X1

The Soviets are the second largest exporter of manganese. But reduced exports in 1983 and 1984 probably reflect increased need at home for the little remaining high-quality ore and reduced Western demand. Exports to the West were last reported in 1978. Although still largely dependent on the USSR, some East European countries have become more dependent on imported Western manganese to supplement supplies of low-grade Soviet ore. [redacted] 25X1 [redacted] 25X1

The poor quality of Soviet ore has contributed to ferroalloy production problems. The average manganese content of ferromanganese in the USSR is only two-thirds that used in the West. In order to improve the quality of their manganese ferroalloys, the Soviets ordered six Japanese electric furnaces in 1977 and started buying high-grade ore from the West in 1983 for the first time in over two decades. We believe that the Soviets started importing ore because the furnaces require high-grade ore that the Soviets cannot readily obtain from domestic reserves. [redacted] 25X1

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This memorandum was prepared by [redacted] Office of Soviet Analysis, with contributions by [redacted] Office of Global Issues, and [redacted] Office of Imagery Analysis. Comments and queries are welcome and may be directed to the Chief, Economic Performance Division, SOVA, [redacted] 25X1 25X1 25X1

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Although Soviet demand for manganese may level off because of slow growth in steel production and modernization of the industry, manganese will remain an essential ingredient in steelmaking. If the USSR is to avoid sole reliance on its low-grade ore, it will continue to have to import high-grade ore from the West or obtain Western technology to develop production from seabed nodules. The Soviets have been conducting exploration, developing their own seabed mining capability, and attempting to buy Western technology and equipment for deep-sea mining. Although interest in this technology may be driven by several factors, including military, we believe the USSR primarily is interested in future extraction of minerals from the nodules. The manganese ore extracted from nodules is of poorer quality than that available from many international suppliers, but it is superior to most domestic ores. 25X1

Any dependence on the West, however, is apt to remain small because the Soviets probably can get by using their domestically produced ore for the next 15 to 20 years for most applications. New beneficiation techniques and methods for lowering the amount of manganese necessary for steel production may alleviate some of the problems associated with using low-grade ores. 25X1

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Major Producing Areas

The USSR is the world's largest producer of manganese and accounted for about 36 percent of global output in 1983 (see table 1).[1] According to Soviet statistics, annual output of manganese concentrate grew from 6.8 million tons in 1970 to about 9.9 million tons in 1983 (see table 2). During the 1970s, manganese concentrate production in the USSR grew at an average annual rate of about 3.5 percent, reaching a peak of over 10 million tons in 1979. However, production since then has stagnated. The Nikopol mining district in the Ukraine and the Chiatura Basin in the Georgian SSR are the principal manganese mining regions, accounting for over 90 percent of total Soviet production (see figure 1). Other areas with some manganese production include Kazakhstan and the northern Urals. In addition, a large manganese deposit is under development near Bolshoy Tokmak in the Ukraine. 25X1

Nikopol Mining District

The Nikopol mining district is the world's largest producer of manganese ore. According to Soviet estimates, this district contained about 1,000 million tons of proved and probable crude ore reserves in 1971. However, we estimate that,

[1] This comparison is based on metal content rather than the amount of manganese ore mined. According to the US Bureau of Mines, the term "ore" is ambiguous because some of the material reported as ore actually is concentrate or sinter. We believe that most of the material reported as ore in Soviet reference sources probably has been concentrated. 25X1

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Table 1

Leading Producers of Manganese, 1983

	Thousand tons metal content
USSR	2,976
South Africa	1,225
Brazil	1,000
Gabon	945
Australia	741
China	530
India	530

Source: US Department of the Interior, Bureau of Mines, Mineral Facts and Problems, 1985 Edition, forthcoming.

Table 2

USSR: Production of Manganese

Thousand tons

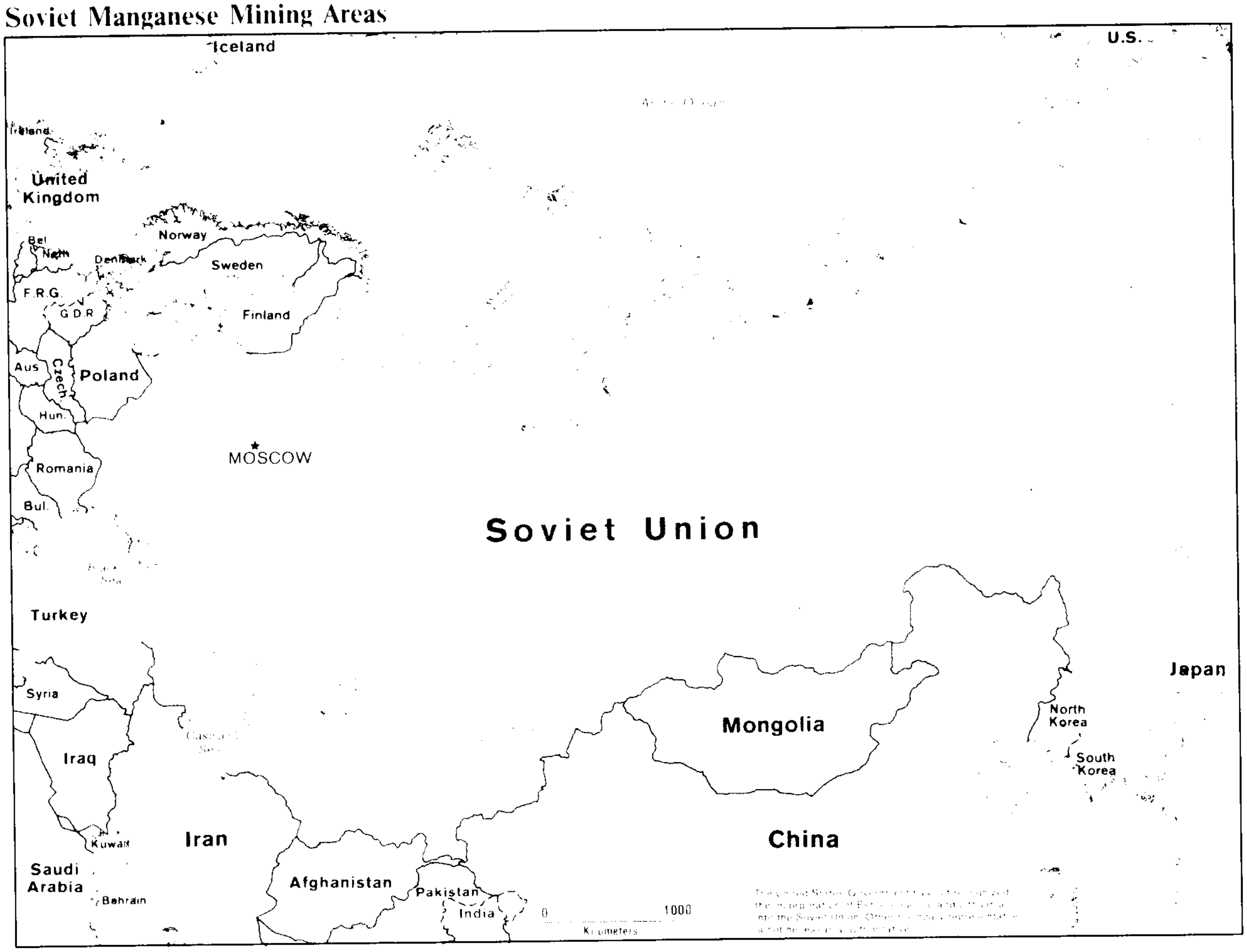
	Concentrate[a]	Metal Content	Metal Content of Concentrate (percent)
1970	6,841	2,446	36
1975	8,459	2,951	35
1980	9,750	3,040	31
1981	9,150	2,761	30
1982	9,821	2,957	30
1983	9,876	2,976	30

[a] Although the Soviets present these data as manganese ore production, we believe that the data more closely reflect the Western definition of manganese concentrate.

Source: Narodnoye khozyaystvo SSSR v 1983 g., p. 154.

Figure 1

Soviet Manganese Mining Areas



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[redacted]

as of 1 January 1985, Nikopol deposits contained only 680 million tons of recoverable crude ore.[2] Recent Soviet references to the Nikopol deposits suggest that the high-grade oxide ores there are being depleted. [redacted] 25X1
300 million tons of the remaining reserves consist of oxide ores. At the current rate of production, we estimate that the reserves at Nikopol will last 44 years; if only oxide ores were mined, these relatively high-grade reserves could be depleted in as little as 20 years. [redacted] 25X1

The Soviets report that the manganese content of the ore at Nikopol ranges from 12 to 30 percent. According to a Western study, some of this ore can be used to make standard ferromanganese after upgrading, but this product would be expensive to produce in the West because of the extensive concentrating and sintering steps that must be taken. It also is high in impurities. [redacted] Nikopol ore is sent to six concentration plants in the area. [redacted] 25X1 25X1

<u>Chiatura Basin</u>

The Chiatura basin is one of the oldest manganese ore-producing regions in the world but is now in decline. The Soviets reported crude ore reserves of 218 million tons at Chiatura in 1971, but we estimate that, as of 1 January 1985, recoverable crude ore reserves amounted to about 75 million tons. At the current rate of production, the basin could be

[2] This estimate was determined by subtracting from published Soviet reserve figures of 1 January 1971 all crude ore mined since that time. Ore production was estimated by using published concentrate production figures and applying historic concentrate-to-ore production ratios. [redacted] 25X1

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depleted in about nine years. The depletion of high-grade ore at Chiatura is so severe that the Soviets are now using secondary recovery methods. [redacted] the Soviets 25X1 approached a US firm in 1978 about the possible purchase of a turnkey facility for the recovery of manganese ore by enrichment of tailings. [redacted] 25X1

The average grade of the ore currently being worked is only about 30 percent manganese, and the overall average grade of the remaining ore is about 24 percent. Although Chiatura ore rarely was enriched in the past, five concentration plants now operate in the region, [redacted] In addition to 25X1 declining ore grade, an Australian geologist who made some studies at Chiatura in 1982 noted that the Soviets may be running into metallurgical problems with this ore in the production of manganese alloys because the ore contains impurities such as tungsten and phosphorus. [redacted] 25X1

Kazakhstan

The Dzhezdy mining area in Kazakhstan is the major supplier of manganese for the region's metallurgical industries. Minor amounts of ore may also be produced at mines in the Karazhal region of the Karaganda Oblast. These deposits are low in phosphorus and sulfur, making them well suited for ferroalloy production. However, a Western study reports that the average manganese content of the ore at Dzhezdy is only 11 to 17 percent, resulting in a relatively high cost for concentrate. Soviet literature has reported that capacity is being added in Kazakhstan--a new mining enterprise has been completed at

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Dzhezdy, and a new mine is under development at Ushkatin. The ore mined in Kazakhstan is beneficiated at a plant in Dzhezdy. [redacted] 25X1

Northern Urals

Manganese deposits in the northern Urals are numerous but relatively minor. The small amounts of ore mined probably are shipped to Nikopol for concentration. According to the Soviets, most of the oxide ores have been extracted and lower grade carbonate ores--with an average grade of only 21 percent--are left. The Soviets report that beneficiation tests of these ores show the possibility of obtaining quality manganese concentrates for the production of manganese alloys, but demand by the Urals steel industry is now being met with supplies from other mining regions. [redacted] 25X1

Bolshoy Tokmak

The Soviets plan to make Bolshoy Tokmak in the Ukraine the base of a new ferromanganese production center. It is the largest known manganese deposit in the USSR, and the Soviets estimate its reserves at over 1,100 million tons. [redacted] 25X1
[redacted] 96 percent of the deposit consists of carbonate 25X1
ores with an average manganese content of 24.5 percent and 4 percent are oxide ores with 34.3 percent manganese. [redacted] 25X1
[redacted] an open-pit mine began production in 1980 (see figure 2). The Soviets also plan to develop five underground mines at Bolshoy Tokmak, each with a capacity of 1.5 to 2 million tons per year. [redacted] 25X1

[redacted] 25X1

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Manganese Alloys

About one-half of all manganese ore is processed into alloys (see inset). Ferromanganese and silicomanganese are the principal manganese alloys used in the steel industry. The Soviets have 10 specialized ferroalloy plants, but most manganese alloys probably are produced at four of the plants--the Nikopol and Zaporozh'ye Ferroalloy Plants in the Nikopol Basin, the Zestafoni Ferroalloy Plant in the Chiatura Basin, and the Yermak Ferroalloy Plant in northeastern Kazakhstan. [redacted] 25X1
[redacted] the chief of the Soviet ferroalloy 25X1
directorate reported in late 1984 that the USSR annually produces 1 million tons of standard ferromanganese and 1.4 million tons of silicomanganese. [redacted] 25X1

Much of the ferromanganese produced in the USSR does not meet Western standards. Low-quality ore and a high percentage of impurities result in an average manganese content of ferromanganese in the USSR of only 52 percent, compared to 78 percent in the West. The use of low-grade ferromanganese introduces inefficiency into the steel process. The Soviets must use 30 to 40 percent more of their low-grade ferromanganese, and more scrap must be added in the steelmaking furnace, which results in heat loss and greater waste. [redacted] 25X1

As part of a continuing effort to modernize their industry, the Soviets ordered six Japanese electric furnaces--each with an annual capacity of 120,000 tons--in 1977 for the production of

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The Mission of Manganese

From 90 to 95 percent of all manganese produced is used in metallurgy, primarily for steelmaking, with the remaining amount going to the battery and chemical industries. In fact, no satisfactory substitute has been found for the metallurgical uses of manganese. In the steel industry, manganese is used as a smelting aid in the blast furnace and in the manufacture of ferroalloys (see figure 3). Manganese added to the blast furnace charge can be in virtually any form or grade, such as ore, sinter, slag, scrap, and manganiferous iron ore. It serves as a desulfurizer and deoxidizer, and it increases refractory lining life. The International Iron and Steel Institute estimates that about 45 percent of total managanese metal consumed from all sources is used in the blast furnace. 25X1

Manganese is also used as an alloying agent in the form of ferromanganese and silicomanganese to enhance toughness, hardness, wear resistance, and overall strength of steels. Ferroalloys are added to steel either in the furnace at the end of the steelmaking process, or after the metal has been tapped from the furnace into the ladle. The manganese content of most steels range between 0.5 and 1.5 percent. However, certain wear-resistant steels used in such applications as railroad tracks and mining and crushing equipment contain about 10 to 14 percent manganese. 25X1

We estimate that the Soviets use 44 to 53 kilograms of manganese concentrate per ton of crude steel produced, considerably higher than in other steel-producing countries. The Soviets consume larger amounts of manganese because their iron ores are low in manganese, they make greater use of high-manganese steels, and the coke they use in steel production is usually high in sulfur. 25X1

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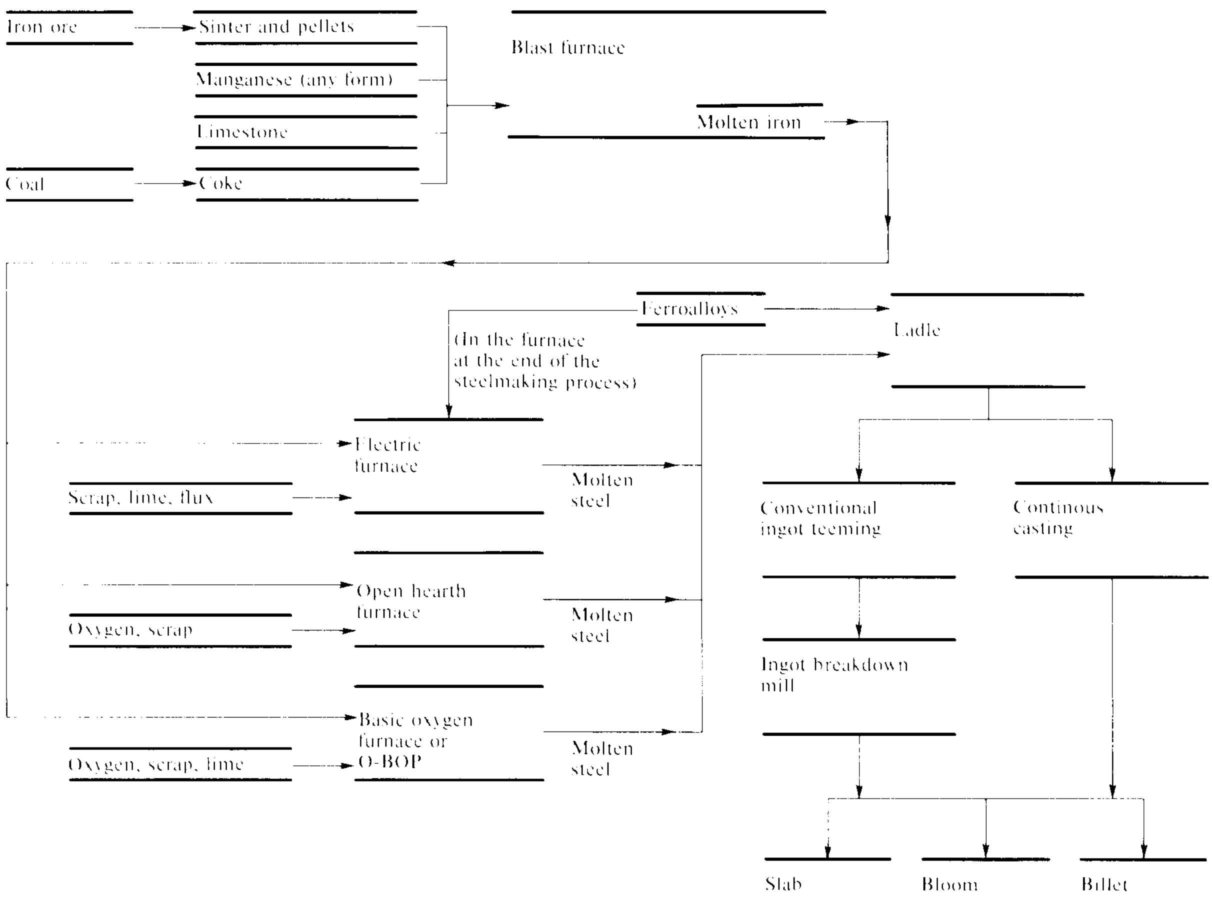
Figure 3
Manganese Use in Steelmaking



[redacted]

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ferroalloys. [redacted] four of these 25X1 furnaces were supplied to the Nikopol Ferroalloy Plant and the other two will go to Zestafoni. [redacted] two of 25X1 the furnaces were installed at Nikopol by mid-1983 (see figure 4).[3] Some East European countries, particularly East Germany, have contributed funds for the construction of the furnaces and will be receiving some portion of the ferroalloy output as repayment. [redacted] 25X1

Turnaround in Trade

The USSR is the world's second largest exporter of manganese concentrate, most of which originates in the Chiatura Basin. In 1984 the Soviets exported 1.1 million tons of concentrate or about 10 percent of their total production--all to East European countries (see table 3). According to Soviet data, the USSR last exported manganese concentrate to the West in 1978. [redacted] 25X1 [redacted] the USSR terminated manganese and some other 25X1 metals exports to the West after a speech by Leonid Brezhnev in late 1978 that identified national shortages in metallurgy and energy. [redacted] 25X1

3 Output from these two furnaces was presumably included in production figures given by the chief of the Soviet ferroalloy directorate in late 1984. Annual output of manganese alloys could increase by about 600,000 tons when the other four furnaces are installed and the two newly-operating furnaces reach design capacity, unless the Soviets retire some older equipment. [redacted] 25X1

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Table 3

USSR: Exports of Manganese Concentrate[a]

Thousand tons

	1970	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Total	1,228	1,411	1,342	1,352	1,186	1,317	1,255	1,194	1,144	1,079	1,081
Communist countries:											
Bulgaria	80	126	127	108	78	103	125	117	77	81	74
Czechoslovakia	153	341	356	320	373	423	397	372	346	295	300
East Germany	175	179	185	186	170	182	135	130	107	85	68
North Korea	21	20	20	11	21	21	29	15	28	20	21
Poland	365	484	482	502	446	518	490	493	535	539	549
Yugoslavia	31	30	26	34	17	27	36	38	31	32	35
West	403	195	89	115	19	0	0	0	0	0	0
Unspecified	0	36	57	76	62	43	43	29	20	27	34

[a] Although the Soviets report exports of manganese ore, we believe the product exported is actually concentrate. 25X1

Source: Vneshnyaya torgovlya SSSR (annual issues).

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Decreasing Western demand for low-grade Soviet manganese is probably a more likely explanation for the drop in trade. Western steel producers prefer higher grade ore that is readily available from Gabon, South Africa, Brazil, and Australia. The terminating of exports to the West did not cost the USSR an important source of hard currency. In 1978 the price of high-quality manganese ore was only about $66 per ton, and with the exception of the years 1980 and 1981, the price has remained stagnant over the last decade. [redacted] 25X1

The USSR traditionally has been largely self-sufficient in manganese, with only small amounts imported from Hungary. In 1983, however, the Soviets made their first appearance in over two decades as buyers in the open market by purchasing 200,000 tons of high-grade manganese ore from Gabon and Australia. The Soviets bought a total of 300,000 to 350,000 tons of high-grade ore from free market countries in 1984 and probably will purchase 345,000 tons in 1985. [redacted] 25X1

Although a number of reasons may be behind the Soviets' appearance in the open market for high-grade manganese ore, we believe that they are importing Western ore for use in the Japanese-built ferromanganese furnaces. These furnaces reportedly require high-grade manganese ore that the Soviets cannot readily obtain from domestic reserves. Moreover, imports began during the year when the two new furnaces were installed at Nikopol. [redacted] 25X1

[redacted] 25X1

The USSR may also be importing ore to increase domestic stockpiles. We do not know whether the Soviets stockpile more manganese ore than needed to maintain concentrate and ferroalloy operations. [redacted] ore storage areas at some production areas, and the Soviets may be stockpiling ore while waiting for the installation of the remaining Japanese ferromanganese furnaces. [redacted] 25X1 25X1

It is unlikely that the Soviets emerged as importers of high-grade ore to take advantage of low prices during a time of decreased demand. Any short-term cost advantage from using low-priced ore would be more than offset by higher production costs if the Soviets returned to total dependence on low-grade domestic ore. [redacted] changing the percentage of manganese in the ferroalloy mix necessitates a complete reprogramming of the production operation, which is both costly and time consuming. [redacted] 25X1 25X1

We also do not believe that the USSR entered the manganese market because of inability to meet both domestic and East European ore requirements. Hard currency shortages forced some East European countries to cut back on Western manganese imports in the early 1980s and turn to the USSR to make up the difference. But some of the countries having hard currency problems, such as Romania and Poland, are again purchasing manganese ore from the West largely on a countertrade basis. [redacted] 25X1

[redacted] 25X1

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The Seabed Mining Option

The Soviets have had a longstanding interest in locating and analyzing ocean-bottom mineral deposits, especially manganese nodules (see inset). They first reported the recovery of nodules in 1957 from the Pacific Ocean. Subsequent surveys in the Indian, Pacific, and Atlantic Oceans, as well as in Soviet coastal waters, have provided increasing information on the location, composition, and origin of the nodules. [redacted] 25X1

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we believe that the Soviets have not yet developed the technology needed for the collection of the nodules. This judgment is supported by the attempts that Moscow has made to buy a submersible nodule-mining vehicle, an oceanographic camera system, and a seabed miner built on a drillship hull from Western companies. [redacted] 25X1

We believe that the Soviets are interested in seabed mining technology to obtain minerals from the nodules, probably because of their need for higher grade manganese ore. Manganese ore extracted from nodules is of poorer quality than that available from many international suppliers, but it is superior to most domestic reserves. The USSR's interest in manganese nodule

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Seabed Mining of Manganese Nodules

Manganese nodules consist mainly of manganese and iron oxide, but they also contain copper, nickel, cobalt, aluminum, titanium, lead, vanadium, molybdenum, zinc, and chromium. Of most economic interest are nickel (used primarily in steel production), copper (widely used in electrical equipment), cobalt (used in the electrical and aerospace industries), and manganese. 25X1

Deposits of these small, dark brown, irregularly shaped nodules are normally found at depths of 4,000 to 6,000 meters. The distribution of nodules is uneven, but the largest deposits are thought to be in the Clarion-Clipperton zone, an area of the Pacific Ocean that extends from central America to south of Hawaii. Nodules from prime sites in this area contain an average of 25 percent manganese, 1.5 percent nickel, 1.2 percent copper, and 0.25 percent cobalt. 25X1

Many Western countries, including the United States, Japan, the United Kingdom, Canada, and West Germany, have been actively involved in studying the potential of commercial seabed mining. However, development has been slowed by continuing legal, economic, and technical questions. 25X1

The Law of the Sea (LOS) treaty, signed by over 100 nations in 1982, formed a regulatory agency and outlined some controversial conditions for seabed mining. The treaty, however, has not been signed by the United States and several other Western countries. It is unclear what will happen when claims filed with the regulatory agency conflict with mining rights claimed outside the LOS framework. 25X1

Economic questions also hamper the development of seabed mining. A recent US Bureau of Mines study estimates that a four-metal mining project that processes 3 million tons of nodules annually would require an estimated $2-billion capital investment and operating expenses of $150 per dry ton and would yield a rate of return after taxes of 6.6 percent. Most Western investors would require a rate of return of about 20 percent before undertaking such a risky venture. We do not have any direct cost comparisons for land-based versus seabed mining of manganese ore.[5] 25X1

The markets for metals produced from the seabed are fairly uncertain, but the technology for mining and processing is even

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less clear. Four major components are involved--a mining system, a mother ship to provide the focus of mining operations, ore transporters, and processing plants. The weakest link in the chain is the mining system. Systems that include either self-propelled or towed collection apparatus with lifting devices attached to a continuous line bucket have been tested on a pilot basis. [redacted] 25X1

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[redacted] 25X1

mining could also be driven by several other factors:

- o A desire to prevent other countries from cornering the market in manganese nodule mining. [redacted] 25X1

[redacted] 25X1

- o National pride because the United States and Japan have developed and tested prototype systems for manganese nodule mining.
- o A desire to obtain Western seabed technology for military applications.[6] [redacted] 25X1

The Soviets probably are over 20 years away from full-scale seabed mining operations. In addition to the technological barriers, some workable, legal framework for mining the seabed needs to be established.[7] The Soviets almost certainly will depend on Western equipment and technology, particularly for the mining phase of the operation. Although the processing of manganese nodules is similar to that used in land-based

6 The technology involved in mining operations at depths down to 6,000 meters is directly applicable to deep-ocean military activities such as the implantation and retrieval of weapons and antisubmarine warfare sensors. Because of possible military applications, the Soviets have been unable to obtain Western seabed mining equipment and technology. [redacted] 25X1

[redacted] 25X1

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7 As a pioneer investor, the USSR is guaranteed a mine site on the seabed under the LOS treaty. [redacted] 25X1
the Soviets have staked a claim in the Clarion-Clipperton region in the Pacific, but most of the area claimed by the Soviets overlaps claims of other countries. [redacted] 25X1

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operations, major environmental problems will likely arise from processing manganese ore containing high concentrations of barium and other toxic materials. Because the nodules also contain high percentages of nickel and copper--undesirable in ferromanganese production--the nodules must undergo a meticulous cleaning and separating operation. [redacted] 25X1

If the Soviets obtain the technology and undertake seabed mining operations, the effect on international metals markets could be dramatic. According to Western studies, an annual 3-million-ton operation might not only yield 500,000 tons of manganese ore, but also an estimated 40,000 tons of nickel and 7,000 tons of cobalt. Some of the nickel and cobalt probably would be sold on the international market in direct competition with cobalt from Zaire and nickel from Cuba. [redacted] 25X1

Outlook

The USSR will almost certainly continue to rely on its vast low-grade reserves for the bulk of its manganese requirements. To have higher quality manganese available for use in ferroalloy and steel production, the Soviets could continue importing from Western countries or initiate costly deep-sea mining activities. Additionally, the Soviets may improve their manganese enrichment technology to be able to produce higher quality alloys from their own ore. The sources chosen undoubtedly will depend on the future demand for manganese ore in the USSR. The two factors that most affect the demand for manganese are the level of steel production and the amount of

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manganese used to produce a unit of steel. 25X1

Slowdown in Manganese Demand

A Western study of the world steel outlook reports that the use of steel has been steadily declining because of substitution of alternative materials and conservation. The Soviet press also reports that similar substitution--through use of other structural materials such as plastics, aluminum, glass, and reinforced concrete--is currently taking place in the USSR. As the quality of structural materials improves and their manufacturing costs decline, we foresee continuation of the substitution trend. But conservation of steel--despite the priority Soviet officials are giving to saving metals--is making little headway and is not likely to substantially reduce demand in the future. 25X1

A Western econometric study estimates that--allowing for substitution and conservation--Soviet crude steel production will only grow at an annual rate of about 1 percent in 1986-90 and at less than 1 percent in the 1990s, similar to projections of Western steel output. This compares to average annual production increases in the USSR of 2.1 percent in 1971-80 and 0.9 percent in 1981-84. 25X1

In addition to slow growth in steel production, we expect that the amount of manganese used to produce a unit of steel in the USSR will drop, but manganese will remain an essential ingredient in Soviet steelmaking. Such a decline in manganese

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consumption occurred in the West during the 1960s when open-hearth furnaces and Thomas and Bessemer converters were replaced by basic oxygen and electric furnaces. As the Soviet steel industry continues to modernize, through the use of newer steelmaking techniques such as external desulfurization and combined-blowing converters and expanded use of continuous casting, it may realize some of these same savings.[8] [redacted] 25X1

Domestic Production

Despite the poor quality of their ore, the Soviets will almost certainly continue to rely on domestic, land-based production of manganese as their primary source for the next 15 to 20 years. The main source probably will be the remaining oxide ores at the Nikopol and Chiatura Basins. Secondary recovery of oxide ores, which is now taking place at Chiatura, probably will not occur at Nikopol. The Nikopol mining area is being extensively reclaimed to return the land to agricultural use. No large, unexploited deposits of oxide ores are left in the USSR, but some oxide ores may remain in small deposits that can be mined for use in local steel plants. [redacted] 25X1

Large deposits of lower grade carbonate ores remain at Nikopol and Chiatura and make up the bulk of the reserves at Bolshoy Tokmak. The Soviets are currently mining some carbonate ores at Nikopol and at the new mine at Bolshoy Tokmak. Although

[8] According to a US trade journal, the industrialized countries' weighted average manganese metal content fell from 6.1 kilograms per ton of steel produced in 1981 to 5.5 kilograms in 1983. [redacted] 25X1

[redacted] 25X1

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relatively abundant, carbonate ores are harder and more expensive to process than oxide ores, and carbon dioxide gas is given off when the ores are used to make ferroalloys in an electric furnace. A buildup of too much gas pressure can blow out the sides of the furnace. Carbonate ores can be sintered to remove the carbon dioxide, but this is an energy- and capital-intensive operation. 25X1

New beneficiation techniques and methods for lowering the amount of manganese necessary for steel production may help reduce the impact of using low-grade Soviet ore. Research currently is being conducted in these areas in the West, and we believe the USSR also is examining improved beneficiation techniques. According to the Soviet press, a small experimental plant for chemical enrichment of manganese ore went into operation at Nikopol in 1982, but the use of effective new beneficiation techniques on a large scale probably will not occur for several years. 25X1

Continued Trade

We believe that the Soviets will increase their imports of high-quality manganese ore from the West by approximately 4 percent per year for the foreseeable future. First, the Soviets appear to have committed themselves to imports for use in new ferromanganese furnaces despite their traditional philosophy of self-sufficiency. Second, if the Soviets grow more dependent on carbonate ores, they may need to mix them with higher grade

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imported ore. Mexico, for example, currently sinters its carbonate ores and then blends them with higher grade ores. In addition, the Soviets may choose to reduce exports to Eastern Europe to preserve their dwindling supplies of oxide ores. 25X1

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Glossary

Beneficiation — Enrichment of ore for smelting by drying, flotation, or magnetic separation.

Concentrate — Ore that has been enriched by removing waste.

Ferroalloy — A substance composed of iron and one or more other chemical elements used as an agent for introducing these elements into molten metal. It is added to effect changes in the mechanical or physical properties of steel.

Ferromanganese — A ferroalloy that is classified primarily on the basis of manganese metal and carbon content into standard or high-carbon, medium-carbon, and low-carbon grades. Standard ferromanganese is the most commonly used manganese alloy. The standard ferromanganese used in the West contains 74 to 82 percent manganese and 7.5 percent carbon.

Manganese nodules — Spherical masses of minerals, mainly composed of iron and manganese, that cover extensive areas of the ocean floor. These vary in size from extremely small to some 6 inches in diameter and may prove a useful source of minerals.

Manganese Ore — The US Bureau of Mines uses the term manganese ore for those ores containing 35 percent or more manganese. Oxide and carbonate ores are the most common commercial ores. Oxide ores include pyrolusite (MnO_3), psilomelane ($MnO*MnO_2*2H_2O$), and manganite ($Mn_2O_3*H_2O$). Rhodochrosite ($MnCO_3$) is the principal carbonate ore.

Metal content — The amount of pure metal contained in ore or concentrate.

Silicomanganese — A commonly used ferroalloy that normally contains 65 to 68 percent manganese, 1.5 to 3 percent carbon, and 16 to 32 percent silicon.

Sinter — A mass of fine particles that has been heated for a prolonged time below the melting point.

Tailings — Waste remaining after mining or concentration or beneficiation of ores

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