

THE MINERAL INDUSTRY OF

UKRAINE

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Although Ukraine is the largest country solely in Europe in land area, it only composes 0.4% of the world's land surface and contains 0.8% of the world's population. At the end of the 1980's, however, Ukraine mined about 5% of the world's output of mineral products (Gurskiy and Kalinin, 2000). Since the breakup of the Soviet Union, production in Ukraine's mineral sector has fallen precipitously. Based on the former importance of Ukraine's mineral industry, its successful functioning was considered to be critical for the country's economic renewal (Gurskiy and Kalinin, 2000).

Still, in 1999, Ukraine continued to be a major world producer of coal, ferroalloys, ilmenite, iron ore, manganese ore, and steel. The country had been a lesser producer of a number of other metallic mineral products that included alumina, aluminum, cadmium, germanium, secondary lead, magnesium, mercury, nickel, rutile, uranium ore, secondary zinc, zircon, and zirconium and a large number of industrial minerals that included dolomite, graphite, kaolin, limestone fluxes, potash, quartz, salt, soda ash, and a variety of building materials. Because of the large reduction in demand that followed the breakup of the Soviet Union, Ukraine sharply reduced or ceased its production of a number of these commodities.

In 1999, Ukraine's gross domestic product (GDP) decreased by 0.4% in constant prices, and industrial output increased by 4.3% compared with that of 1998 (Interfax Statistical Report, 2000a). This decline in GDP was one of the lowest rates since the breakup of the Soviet Union (Interfax Statistical Report, 2000b). Reported GDP statistics, however, understated the country's economic performance because possibly as much as 60% of Ukraine's actual GDP was produced in the informal "shadow economy" and was not reported in official Ukrainian statistics (World Bank Group, September 2000, Ukraine, accessed December 7, 2000, at URL <http://wbln0018.worldbank.org/ECA/eca.nsf/e858492deec02890852567d10014b15c18880e8e6aea334ac852567f0005bfb38?OpenDocument>).

In 1999, production increased in the ferrous metals sector by 6.2%; in the nonferrous metals sector, by 8.9%; and in the fuel sector, by 6.6% in comparison with that of 1998 (Interfax Statistical Report, 2000a). Production decreased in the construction materials sector by 0.6% in comparison with that of 1998. The ferrous metals sector produced 23.9%; the fuel sector, 11.4%; the construction materials sector, 3.1%; and the nonferrous metals sector, 2.1% of the total value of industrial output (Interfax Statistical Report, 2000a). The category "ferrous and nonferrous metals" accounted for slightly less than 40% of the total value of exports, and the category "fuel and energy" accounted for slightly more than 40% of the total value of imports (World Bank Group, September 12, 2000, Ukraine at a glance, accessed December 7, 2000, at URL http://www.worldbank.org/data/countrydata/aag/ukr_aag.pdf).

In 1999, Ukraine's metal mining and processing industry consisted of about 300 enterprises, which included 26 mining enterprises, 14 steel mills, 3 electric furnace ferroalloy plants, 7 pipe plants, 10 metal goods plants, 17 refractories plants, 20 nonferrous metallurgical plants, 16 coke chemical plants, and 35 secondary ferrous and nonferrous metals plants. As of yearend, more than 500,000 persons were employed by these facilities, which produced 26% of the total value of industrial output and provided almost 40% of the country's export earnings (Grishchenko and Gurov, 2000).

Ukraine's mineral industry was dominated by ferrous metals production. At the end of the Soviet period, Ukraine was the Soviet Union's leading iron ore producer and second-ranking steel producer (after Russia). It has the world's second-largest manganese reserves and had produced low-grade manganese ore at a rate that made it the world's leading producer in volume of output as late as 1992 (Jones, 1995).

Nonferrous metal production played a lesser but still significant role in the country's mineral industry. Ukraine was a large alumina producer with production centered at the Mykolayiv alumina refinery. Ukraine was the only major producer of titanium ore in the former Soviet Union (FSU) and recently had resumed domestic titanium sponge production at the Zaporizhzhya titanium-magnesium plant. Ukraine was making an effort to initiate gold mining and was seeking investors to develop some identified deposits. The country had also identified a copper deposit in the Volyn' region for which it was seeking investment (Interfax-M&CN, 1998).

In recent years, Ukraine had been exporting its steel products to world markets, where it needed to avoid trade sanctions against its exports. It also needed to increase its domestic market for its steel products and machinery, which had been a large consumer of its steel output. In the nonferrous metals sector, Ukraine was producing a large percentage of its output for export markets.

Although the country produced some oil and gas, Ukraine remained primarily a coal producer. Ukraine imported about 80% of its oil and natural gas requirements, practically all of which came from Russia. Ukraine had incurred huge debts for these fuel shipments that it had not been able to pay, thus resulting in strained relations with Russia and in Russia cutting off oil and gas supplies a number of times. A pipeline through Ukraine was part of the major transit route for Russian gas shipments to European markets, and Russia had accused Ukraine of illegally diverting gas from this pipeline (U.S. Energy Information Administration, August 2000, Ukraine—Oil, Country Analysis Briefs, accessed November 29, 2000 at URL <http://www.eia.doe.gov/emeu/cabs/ukraine.html>).

Despite the predominance of coal production, in 1998, about 40% of the country's electricity was generated by five nuclear

powerplants; coal provided fuel for about 27% of electricity generation, natural gas for about 21%, hydroelectric power for about 9%, and marzout (a fuel oil) for about 3% (Tulub and others, 2000). Ukraine also was dependent on Russia for nuclear fuel. Owing to lack of payments, Russia had curtailed nuclear fuel supplies to Ukraine, which resulted in the forced idling of nuclear reactors (U.S. Energy Information Administration, August 2000, Ukraine—Nuclear, Country Analysis Briefs, accessed on November 29, 2000 at URL <http://www.eia.doe.gov.emeu/cabs/ukraine.html>).

There was in place in Ukraine a very large metal-consuming sector, in the form of the FSU's second largest machine manufacturing and metal working industry, after Russia's. Ukraine, reflecting its former role in the Soviet machine-building industry, specialized in heavy machine manufacturing, generally producing equipment that required large quantities of steel to produce. Ukraine was noted for the production of metallurgical and mining excavation equipment (Kramatorsk); machinery used in electricity generation, such as turbines and generators (Kharkiv); transportation equipment [e.g., automobiles in Zaporizhzhya and Lutsk, heavy transport trucks in Kremenchug, and locomotives in Luhansk (the largest locomotive plant in the FSU)]; shipbuilding [Mykolayiv (three shipyards specializing in deep-sea vessels) and Kherson]; agricultural machinery (e.g., tractor engine production in Kharkiv and plants in Kharkiv and Dnipropetrovska); machine tools; and machinery for the food-processing industry (Levine and Bond, 1998).

In addition, about one-third of the Soviet Union's defense industrial capacity was in Ukraine; this included tank production; naval shipbuilding, such as aircraft carriers; electronics; aircraft components; and armaments. Also, there was a wide range of metal working activity, such as the ball-bearing plant in Lutsk, which supplied automobile, truck, tractor, and bus plants in Ukraine, Belarus, and Russia with needed inputs. This metal-consuming sector by and large was spatially coincident with the ferrous metals industry from which it derived most of its inputs (Levine and Bond, 1998).

The decrease in domestic demand by the metal-consuming industries, primarily machine manufacturing and defense industries, following the breakup of the Soviet Union resulted in domestic metal consumption falling from 13 million metric tons per year (Mt/yr) in 1990 to 5.2 Mt/yr in 1998. In 1999, for the first time since the dissolution of the Soviet Union, the total volume of machine manufacturing did not decrease, and in certain machine manufacturing sectors (metallurgical machinery, the aviation industry, ship building, tractors and other agricultural machinery) production increased. Correspondingly, the metal mining and processing sector experienced its best performance in the past 6 years (Grishchenko and Gurov, 2000).

Nevertheless, the metals sector was producing far below existing capacity. In 1999, the utilization of production capacity ranged between 30% and 70% (Grishchenko and Gurov, 2000). Despite its large production of mineral products, according to the Chief of the Ukrainian State Geology Committee, the mineral industry was in a difficult situation. It inherited from the FSU an industry characterized by intensive extraction methods, which were deficient in fully exploiting the economic value of deposits, and, in many cases, resulted in their premature

depletion. Also, deposits that were developed often were not of the highest quality and were not developed to compete economically on world markets. Furthermore, little attention was paid to exploring for precious and nonferrous metals (Uryadovyy Kuryer, 1998). Problems were compounded by more-difficult mining conditions. Many underground mines in the iron ore and coal mining sectors were operating at depths of more than 1,000 meters (Bundesanstalt fuer Geowissenschaften und Rohstoffe, 1996, p. 35-41; Gornyy Zhurnal, 1998).

Another factor holding back development in the mineral production sector was the extensive use of barter, which prevented enterprises from accumulating necessary capital for investing in equipment and technology that would improve their competitiveness. In an effort to improve economic performance in the mineral sector, Ukrainian metallurgical plants were to be discouraged from bartering in an experiment designed to stimulate production. According to a Presidential decree on reducing barter in the economy, the experiment would be conducted between January 1 and July 1, 1999. The benchmark by which levels of barter would be judged would be the average volume of barter deals between January and September 1998, and for enterprises with a long production cycle, it also would include barter conducted in 1997. The program included tax incentives to reduce barter and penalties for enterprises that did not comply (Interfax Mining and Metals Report, 1998c).

Since the Soviet era, labor productivity in the Ukrainian mineral sector had fallen in half because of more market-driven costs. Costs were increasing, particularly for transport. Also, with the end of Government subsidies and price controls, enterprise production costs had more than doubled. The situation regarding the condition of equipment and availability of spare parts was considered to be dire. Although Ukraine manufactured almost 40% of all mining equipment in the FSU, most of the equipment needed for mining and milling was manufactured abroad, and the industry lacked funds to purchase this equipment. Furthermore, the machinery manufactured in Ukraine and that purchased from other countries of the FSU was not state-of-the-art. Ukraine had created a program to retool its mining equipment manufacturing plants to produce equipment that used to be produced in other countries of the FSU and to produce new state-of-the-art machinery for domestic use and for export (Gornyy Zhurnal, 1998; Remkha, 1999).

The Government had formulated a plan for the development of the mining and metallurgical sector, which stressed the development of domestic and export markets and the closing of unprofitable enterprises. The thrust of the program was to increase enterprise profitability and the competitiveness of Ukrainian products (Gornyy Zhurnal, 1998). According to this program, which was passed in October 1998 by the Ukrainian Parliament (Verkhovna Rada), the Government was encouraged to develop a list of strategic enterprises with a view to improving Government management and for setting a procedure for their privatization. Also, the Parliament proposed amendments to a number of regulatory acts regarding energy and transport to make metals more competitive (Interfax Mining and Metals Report, 1998b).

Commodity Review

Aluminum

Production Status.—Ukraine's Mykolayiv refinery was among the world's largest alumina-producing plants with the capacity to produce about 1.2 Mt/yr of alumina and employing about 6,500 workers (Interfax-M&CN, 1998). Ukraine also produced a much smaller amount of alumina at the Zaporizhzhya aluminum smelter as feed for the smelter. Mykolayiv exported about 90% of its output, primarily to Russia and Tajikistan.

In 1999, the Zaporizhzhya aluminum smelter commissioned an aluminum rolled wire (katanki) shop with the capacity to produce 15,000 metric tons per year (t/yr) of rolled wire (Grishchenko and Gurov, 2000).

Production Development.—Following a series of planned upgrades, the Mykolayiv alumina refinery planned to sustain output at 1.3 Mt/yr (Interfax Mining and Metals Report, 1998b). Work was also underway to construct the first stage of an aluminum foil plant at Zaporizhzhya (Grishchenko and Gurov, 2000).

Coal

Reserves.—Ukraine reportedly possessed a reserve base of 46 billion metric tons (Gt) of coal, of which 10.1 Gt was considered to be extractable reserves. Of these extractable reserves, 10 Gt is composed of hard coals (Bundesanstalt fuer Geowissenschaften und Rohstoffe, 1996, p. 35). Hard coal reserves are in the Donets and Lviv-Volhynskiy basins (Bundesanstalt fuer Geowissenschaften und Rohstoffe, 1996, p. 30).

Production Status.—Coal production steadily declined from 1988 until 1997, when production began to rise. Although coal production increased in 1999, the industry's indebtedness also increased owing to an increase in outstanding payments and in the use of barter, which affected the industry's ability to invest in reequipping (Interfax Mining and Metals Report, 2000e).

Coking coal accounted for about 40% of total output. The quality of the coking coal mined, however, was decreasing, and coking coal reserves were being depleted (Bundesanstalt fuer Geowissenschaften und Rohstoffe, 1996, p. 35-41; Interfax Mining and Metals Report, 2000b). About 60% of the coal produced was consumed by powerplants and public utilities (Interfax Mining and Metals Report, 2000b).

More than 90% of Ukraine's coal production was from the Donets basin. Mines in the Donets basin were deep; the average mine depth is about 700 meters (m). A significant number of mines were more than 1,000 m deep. In all mines in the Donets basin, gas posed a serious danger, and the safety risks from gas and dust were increasing (Bundesanstalt fuer Geowissenschaften und Rohstoffe, 1996, p. 35-41). In Ukraine, 5.5 miners died in accidents for every 1 million metric tons (Mt) of coal produced (Interfax Mining and Metals Report, 1998a).

Approximately 80% of the coal mined from the Donets basin

required processing to be marketable, and this percentage was projected to increase to 90%. Coal-processing facilities often used outdated equipment and technology because a large number of the plants were more than 25 years old and some were more than 50 years old (Bundesanstalt fuer Geowissenschaften und Rohstoffe, 1996, p. 35-41).

Approximately 600,000 workers were employed in the coal mining sector. The average miner reportedly produced about 100 t/yr coal in comparison with Russia and Poland where an average miner produced 200 t/yr and 400 t/yr, respectively. Because coal miners in Ukraine were owed large sums in back wages, they often had shut down mines across the country (U.S. Energy Information Administration, August 2000, Ukraine—Coal, Country Analysis Briefs, accessed on November 29, 2000, at URL <http://www.eia.doe.gov/emeu/cabs/ukraine.html>).

Production Development.—The coal sector was facing problems at least as serious as those faced by the ferrous metals sector. The future of the coal industry would depend on it being fundamentally restructured to increase efficiency. A large number of mining operations were not economic and required subsidies. Owing to the depths of the mines and the high cost of mining coal in the Donets basin, the country faced a major problem in acquiring funds to renovate mines. A major goal was to restructure the coal mining industry to make it a cost-competitive producer by concentrating efforts to develop newer mines that could be profitably exploited by using modern technology and to close older uneconomic mines (Bundesanstalt fuer Geowissenschaften und Rohstoffe, 1996, p. 35-41).

As of the start of 1999, Ukraine had slated 29 coal mines for closure. In 1999, 20 mines were closed (Interfax Mining and Metals Report, 2000d). This was in accordance with plans to rank the country's mines according to their profitability. Coal mines were to be ranked in four groups on the basis of an assessment of how much state support they needed to operate. Mines in the least profitable fourth group would get state support only to reimburse the cost of their liquidation, mothballing, and social maintenance expenditures (Interfax Mining and Metals Report, 1999).

Plans for 2000 listed a total of 191 mines, of which 6 were put in the first category, 26 in the second, 122 in the third, and 35 in the fourth. The Coal Ministry originally wanted to consign about 70 mines to the fourth group. Plans called for closing 12 mines in 2000 and preparing to close the remaining 23 mines in the fourth category (Interfax Mining and Metals Report, 1999, 2000d).

Coal-bed methane was being considered as a potentially valuable source of energy. The coal mines in the Donets basin were venting more than 2.7 billion cubic meters per year (Gm^3/yr) of methane into the atmosphere. To use coal-bed methane would require conducting a significant amount of methodological work for studying the methane reserves, as well as for creating and putting into operation effective technologies for exploring for and extracting methane in coal deposits. Ukraine reportedly has the potential to produce 10 Gm^3/yr of coal-bed methane by 2005 from the first stage of a project

being planned in the western part of the Donets basin (Gurskiy and Kalinin, 2000).

Ferroalloys

Production Status.—Ukraine had three electric furnace ferroalloy plants—the Nikopol, Stakhanov, and Zaporizhzhya. The Nikopol plant was one of the world's largest ferroalloy plants. Ukraine had two plants, the Konstantinovka and the Kramatorsk, that produced blast furnace ferroalloys. These plants produced a variety of manganese ferroalloys and ferrosilicon (Mazur, 1966; Gasik, Ovcharuk, and Rogachev, 2000).

The total capacity of the three electric furnace ferroalloy plants composed between 44% and 48% of the total ferroalloy production capacity of the FSU. The Nikopol plant had 24 electric furnaces with the capacity to produce almost 1.5 Mt/yr of ferromanganese and silicomanganese. The Zaporizhzhya plant had 29 furnaces in operation with the capacity to produce 200,000 t/yr of ferrosilicon, 160,000 t/yr of silicomanganese, and 39,000 t/yr of refined manganese ferroalloys. The Stakhanov plant had eight electric furnaces in operation that produced all grades of ferrosilicon (Gasik, Ovcharuk, and Rogachev, 2000).

From 1990 to 1999, production of manganese and silicon ferroalloys decreased by 55.4%, although production of ferroalloys increased in 1999. In this 10-year period, Ukraine production of manganese metal fell by 90.7%; ferrosilicon, by 59%; silicomanganese, by 55%; and high-carbon ferromanganese, by 51.7%. Production of low-carbon ferromanganese, however, increased to 14,600 t in 1999 from 1,500 t in 1990. In 1999, production increased for all types of ferroalloys with the exception of blast furnace ferromanganese (Gasik, Ovcharuk, and Rogachev, 2000).

The largest decrease in electric furnace ferroalloy production during the period from 1990 to 1999 was at the Nikopol plant where output dropped by 60.3%, followed by the Stakhanov plant where output dropped by 50.4%, and the Zaporizhzhya plant where output dropped by 32%. At the Kramatorsk plant, output of blast furnace ferromanganese fell by 64.7% during this period. At the Konstantinovka plant in 1998, production of blast furnace ferromanganese practically ceased (Gasik, Ovcharuk, and Rogachev, 2000).

From 1994 to 1999, Ukraine's shipments of ferroalloys to domestic enterprises increased from 337,000 metric tons (t) to 439,000 t. Exports to countries outside the FSU varied during this period from a low of 355,000 t/yr to a high of 468,000 t/yr. In 1999, exports to countries outside the FSU totaled 398,000 t. In 1999, ferroalloy exports to countries of the FSU increased to 194,000 t compared with 176,000 t in 1998 (Gasik, Ovcharuk, and Rogachev, 2000).

Production Development.—Plans called for ferroalloy production to stabilize at about 1.55 Mt/yr. Excess production capacity was to be converted to producing ferroalloys not currently in production, such as ferrochrome, ferrotitanium, ferrovanadium, and other ferroalloys (Mazur, 1996). Exports to markets in Russia and Kazakhstan could decrease as these

countries increase their domestic production of high-carbon ferromanganese and silicomanganese (Gasik, Ovcharuk, and Rogachev, 2000).

Graphite

Reserves.—Ukraine has more than 50% of the FSU's graphite reserves. The largest quantity, which is in the Kirovgrad region, has been assessed at 7 Mt of reserves of graphite in 126 Mt of ore, of which 6.2 Mt in 97.2 Mt of ore was declared to be minable (Bundesanstalt fuer Geowissenschaften und Rohstoffe, 1996, p. 56).

Production Status.—The Zavalyevskiy graphite mining complex in Ukraine had the capacity to produce almost 50% of the FSU's graphite production. Graphite production in Ukraine had decreased by more than 80% since 1992 when Ukraine was producing one-third of the graphite in the FSU. As of 1997, it was producing about 22% of the FSU's graphite output (Troitsky Petrov, and Grishaev, 1998, p. 55).

Iron and Steel

Production Status.—In 1999, production of pig iron, crude steel, and rolled steel increased in comparison with the 1998 level of production. In 1999, Ukraine ranked seventh among world steel producers (U.S. Geological Survey, unpub. data). Production of steel in Ukraine had fallen to 26.8 Mt in 1999 from 50 Mt/yr in 1990. Production of finished rolled steel products had decreased to 19.3 Mt in 1999 from 38.6 Mt in 1990. From January through November 1999 compared with the same period in 1998, crude steel production reportedly increased by 32.2% at the Alchevsk plant, 16.9% at the Azovstal plant, 10% at the Dneprovsk plant in Dniprodzerzhynsk, 11% at the Il'yich plant, 65.2% at the Kirov plant, 17% at the Krivyy Rih plant, and 6.1% at the Yenakiyev plant. During this same period in 1999 compared with the same period in 1998, production reportedly decreased by 9.8% at the Dneprospetsstal plant, 2.5% at the Donetsk plant, and 23.6% at the Zaporizhzhya plant (Interfax Mining and Metals Report, 2000c).

National per capita production of steel in Ukraine decreased from 1,014 kilograms (kg) per person in 1990 to 477 kg per person in 1999. During the Soviet period, however, the intensity of metal usage was much higher than in advanced industrial countries. In 1999, Ukrainian per capita steel production was comparable to that of the other leading steel producing countries among the advanced industrial nations (Bulgakov, Drobnova, and Khudyakova, 2000). Unlike the advanced industrial nations, however, the decrease in usage in Ukraine had more to do with the decrease in production that occurred following the breakup of the Soviet Union than a dramatic improvement in the quality of Ukrainian steel. Also, Ukraine's machine manufacturing industries remained relatively inefficient consumers of steel, which kept Ukraine's steel industry producing at a higher level of output to satisfy domestic consumption needs than would be the case in countries with more efficient steel consumption (Dolzhenkov, 1999).

In the steel sector within the past decade, there was a loss of capacity to produce 12 Mt/yr of pig iron, 15 Mt/yr of crude steel, and 8 Mt/yr of finished rolled steel. In 1999, 33 blast furnaces out of an existing 50, 13 oxygen converter furnaces out of an existing 19, 31 open hearth furnaces out of an existing 56, and 52 rolling mills out of an existing 66 were in operation. In 1999, 17.5% of steel was produced by continuous casting (Grishchenko and Gurov, 2000). As a large integrated steelmaker, Ukraine was producing high- and low-carbon steels and low-alloy steels.

In 1997, Ukraine's steel industry employed 480,000 workers with an estimated average worker-hour-per-metric-ton production rate of 19.5 compared with 4.1 in Organization for Economic Cooperation and Development (OECD) countries. Energy intensity of steel production was two to three times higher than in OECD countries. With the fall in domestic consumption, as well as the fall in consumption in the FSU following the dissolution of the Soviet Union, Ukraine began to heavily depend on world export markets for selling its steel products (Organization for Economic Cooperation and Development, December 21, 1998, Co-operation between OECD and Russia and Ukraine in the steel sector, News Release, accessed September 29, 1999, at URL http://www.oecd.org/news_ane_events/release/nw98-126a.htm).

Production Development.—Following a meeting of the OECD's Steel Committee at OECD headquarters in Paris in November 1998 and an in-depth discussion of the steel sector in Russia and Ukraine, Committee members and observers reached agreement on a series of findings and recommendations. These included agreeing to consider ways of cooperating in the restructuring and environmental clean-up of these two countries' steel sectors, as well as in the promotion of sound business and marketing principles with regard to steel exports from these two countries (Organization for Economic Cooperation and Development, December 21, 1998, Co-operation between OECD and Russia and Ukraine in the steel sector, News Release, accessed September 29, 1999, at URL http://www.oecd.org/news_ane_events/release/nw98-126a.htm).

Owing to the fact that Ukrainian machine manufacturing industries were not efficient consumers of steel, Ukraine steel production would remain at a relatively high level to satisfy internal consumption needs. Ukraine, however, would have to improve the quality of its steel products to expand its export markets significantly (Dolzhenkov, 1999).

Iron Ore

Reserves.—Economic (balansovye) reserves classified according to the reserve system used in the Soviet Union were reportedly 32.9 Gt. Of these reserves, 67.2% were in the Krivyy Rih basin, which are Lake-Superior-District-type ores (Kornienko, 1999). Of total reserves, 2 Gt were considered rich ores suitable for being mined by underground methods (Mazur, 1996).

Production Status.—Since the dissolution of the Soviet Union, iron ore production in Ukraine has fallen by about 50%.

In 1999, Ukraine ranked seventh in the world in iron ore production, with iron ore production decreasing by about 6% compared with that of 1998. In 1999, iron ore production at the Krivbassruda production association increased by 10.6%; the Novokrivorozhskiy mining and beneficiation complex, by 9.2%; the Yuzhniy mining and beneficiation complex, by 2%; and the Inguletskiy mining and beneficiation association, by 1% compared with that of 1998. In 1999, iron ore production decreased at the Severnyy mining and beneficiation complex, by 34.1%; at the Poltaviskiy mining and beneficiation complex by 27.8%; and at the Tsentralnyy mining and beneficiation complex, by 1.8% compared with that of 1998 (Interfax Mining and Metals Report, 2000a).

The majority of open pits were mined at depths below 300 m, and the majority of underground mines operated at depths below 1,000 m (Kovalenko and others, 1998). The largest iron ore producers in 1999, which were all in the Krivoy Rog basin, were the Inguletskiy mining and beneficiation complex extracting 10.8 Mt of ore; the Yuzhniy mining and beneficiation complex, 7.9 Mt; the Poltaviskiy mining and beneficiation complex, 5.0 Mt; the Novokrivorozhskiy mining and beneficiation complex, 4.7 Mt; the Krivbassruda production association, 4.7 Mt; the Severnyy mining and beneficiation complex, 3.8 Mt; and the Tsentral'nyy mining and beneficiation complex, 3.7 Mt (Interfax Mining and Metals Report, 2000a).

Production Development.—A priority goal was to solve the problems associated with water in mines and to maintain the working capabilities of mines and open pits under conditions of decreased production. Products of Ukraine's iron ore mining and beneficiation enterprises were not meeting world-market standards in terms of iron content or percentages of harmful admixtures. A goal of the industry was to raise the quality of output by introducing state-of-the-art technologies for processing ores (Mazur, 1996).

Kaolin

Reserves.—Ukraine had 4 kaolin-producing regions with 20 deposits, of which 12 were under development. The Prosyantovskoye deposit in the Dnepropetrovsk region was one of the largest kaolin deposits in the FSU and had been producing about 50% of Ukraine's kaolin output. Of the total kaolin reserves, primary kaolin totaled 303 Mt, of which 141.3 Mt was under development, and secondary kaolin totaled 71.1 Mt, of which 53.9 Mt was under development (Bundesanstalt fuer Geowissenschaften und Rohstoffe, 1996, p. 57-60).

Production Status.—Since the dissolution of the Soviet Union, kaolin production has fallen by about 70%. Ukraine was producing more than 80% of the marketed kaolin in the FSU (Troitsky, Petrov, and Grishaev, 1998, p. 75). Uzbekistan had a huge stockpile of kaolin for which it was seeking markets and conceivably could challenge Ukraine as the FSU's major kaolin supplier. Primary kaolin was used mainly in the ceramics, detergent, paper, pharmaceuticals, rubber, and other industries, and secondary kaolin was used primarily as a fire-insulation

material. Feldspar concentrates and quartz sands are byproducts of kaolin production in Ukraine (Bundesanstalt fuer Geowissenschaften und Rohstoffe, 1996, p. 57). The Russian paper industry was the largest consumer of kaolin in the FSU (about 200,000 t/yr). Russia imported about 150,000 t/yr of kaolin from Ukraine (Troitsky, Petrov, and Grishaev, 1998, p. 75).

Manganese

Reserves.—Ukraine contains about 75% of the FSU's manganese reserves (Danil'yants, Zavertkii, and Kharchenko, 1999). The balansovye reserves of manganese ore in reserve categories A,B,C1 total about 2.2 Gt. These reserves are in the Nikopol basin. Within the Nikopol basin, the Bol'shoy Tokmak deposit accounted for 1,582 Mt; the Ordzhonikidze sector (West Nikopol), 310 Mt; and the Marganets (East Nikopol) sector, 280 Mt (U.S. Bureau of Mines, 1994). Three types of ores—oxide, carbonate, and mixed oxide-carbonate—occur. The average grade of the oxide ore is 27.1% manganese (Mn); the oxide-carbonate ore, 25.6% Mn; and the carbonate ore, 17% Mn. Since 1975, Ukraine has been mining oxide-carbonate and carbonate ores in addition to the richer oxide ores, which are being depleted. The carbonate ores are more difficult to process and are not as suitable for producing high-grade concentrate (Bundesanstalt fuer Geowissenschaften und Rohstoffe, 1996, p. 47-48; Postolovskiy, Kravchenko, and Prokopenko, 2000).

Production Status.—In 1999, Ukraine was the world's fourth largest producer of manganese ore by gross weight and sixth largest producer in terms of manganese content (U.S. Geological Survey, unpub. data). Ukraine, however, was producing only about one-fourth of the peak amount of manganese concentrate it produced in 1985. Ukraine had accounted for more than 85% of the manganese produced in the Soviet Union. Since the dissolution of the Soviet Union and the end of Soviet political and economic control in East Europe, the demand for manganese in this region, which was the primary consuming area, had fallen sharply. The country's manganese output was consumed domestically at ferroalloys plants and steel mills, but the output of these domestic industries had also fallen sharply.

In Ukraine, the Ordzhonikidze and Marganets mining and beneficiation complexes mined their respective sectors of the Nikopol basin. Both were public stock companies. At the Ordzhonikidze complex, eight open pit mines supplied ore to three beneficiation plants; there was also an agglomeration plant. Ordzhonikidze had a design capacity to produce 3.92 Mt/yr of manganese concentrate and an actual production capacity of 2.28 Mt/yr of concentrate. Its agglomeration plant had a design capacity and actual production capacity to produce 400,000 t/yr of agglomerate (Postolovskiy, Kravchenko, and Prokopenko, 2000).

The Marganets complex had five underground mines, two beneficiation plants, and a chemical beneficiation complex. Marganets had the capacity to produce between 1.1 and 1.2 Mt/yr of concentrate (Postolovskiy, Kravchenko, and Prokopenko, 2000).

Production Development.—Plans called for stabilizing production at current levels at the Marganets and the

Ordzhonikidze complexes and to put development on hold at the Tavricheskiy complex. Technology at existing enterprises was to be upgraded, and worn equipment at mines and processing plants was to be replaced (Gornyy Zhurnal, 1998). With the loss of markets in the FSU and Eastern Europe, Ukraine was having a difficult time finding new foreign markets for its ores. The high phosphorous content of the ores and their low grade compared with ores from other leading world producers, such as Australia and South Africa, made it difficult for Ukraine to compete in a number of world markets (Levine and Bond, 1998). The demand for manganese in the country's domestic ferrous metals industries and the country's success in increasing its ferrous metals production would affect the level of manganese production.

Titanium

Reserves.—Ukraine was the only country from the FSU with significant mining of titanium ore. Mine output supported sponge production at the Zaporizhzhya (formerly Zaporozh'ye) titanium-magnesium plant in Ukraine and pigment production at plants at Armyansk and Sumy on the Crimean Peninsula, as well as titanium-sponge-producing plants in Kazakhstan [Oskemen (formerly Ust'-Kamenogorsk)] and Russia (Berezniki).

Ukraine's titanium mine output came from two secondary placer fields. At the Irsha deposit, buried sands along the channel of the Irsha River (near Zhitomir) and sands in areas exposed to seasonal flooding began to be worked in 1951. The titanium-bearing horizons in the sands, which were 2 to 8 m in thickness at depths that ranged from 3 to 12 m, contained 1.2% to 4.8% ilmenite, and yielded a lower grade ilmenite concentrate (50% to 56% TiO₂) that served as a feedstock for pigment production. Unlike the Irsha deposits, the second major Ukrainian placer field, the Verkhnedneprovsk (Upper Dnieper), contains heavy-mineral sands that include ilmenite, rutile, and zircon; the largest output from this field came from the Malyshevskiy deposit. Lower grade ilmenite concentrates from Verkhnedneprovsk (50% to 56% TiO₂ content) were used in pigment production, and part of the higher grade concentrates (56% to 65% TiO₂) were directed toward sponge production. Another part of the higher grade concentrates was reported to be directed to ferrotitanium output at the Klyuchevsk ferroalloys plant in Russia. Rutile concentrates from this field find special uses in the production of welding-rod coatings, among other things (Levine, Gambogi, and Bond, 1995).

Production Status.—In 1999, Ukraine was estimated to be the world's third largest producer of ilmenite and rutile (U.S. Geological Survey, unpub. data). Titanium sponge production at Zaporizhzhya, which was the FSU's first titanium sponge plant, had ceased at the end of 1993 and was restarted in October 1998. Production capacity at Zaporizhzhya before it closed was close to 20,000 t/yr of titanium sponge; peak output of 18,000 t/yr was at the end of the 1980's. Zaporizhzhya's capacity after it reopened was 6,000 t/yr (Yegorov, 2000).

Mining at the Irsha field featured a combination of dredging, hydraulic operations, and shallow open pit workings depending upon the workability of the sands and their location relative to

the water table and the main river channel (Levine, Gambogi, and Bond, 1995).

Production Development.—The immediate obstacles to maintaining levels of titanium mine output in the country reflected a lack of capital for new mine development. The entire reserves at the “dredging fields” of the original deposits at Irsha were exhausted. Since the early 1970’s, mining had been shifting to new deposits with reserves that were only a fraction of those of the initial placers. The capital required to bring new deposits on-stream in the Irsha field; Stremigorodskiy, a residual placer (weathering crust), and Torchinskiy, an alluvial placer, were believed to be so large as to lie beyond the capacity of the Irsha Enterprise to develop without the assistance of outside investors (Levine, Gambogi, and Bond, 1995).

Unlike the situation at the Irsha fields, reserves at the Malyshevskiy deposit were thought to be adequate for roughly 15 more years. Considerable development potential existed in the eastern sector of the deposit (Levine, Gambogi, and Bond, 1995).

In October 1999, the Ukrainian Cabinet of Ministers confirmed the Complex Program for the Development of Nonferrous Metallurgy Until the Year 2010, which called for reequipping the titanium sponge plant between 2000 and 2010 and beginning production of titanium ingots between 2006 and 2010 (Yegorov, 2000).

Zirconium

In 1999, Ukraine was estimated to be the world’s third largest producer of zirconium concentrates (Hedrick, 2000). Zirconium was commercially mined as a coproduct from the Verkhnedneprovsk (Upper Dnieper) placer field from heavy mineral sands that include ilmenite, rutile, and zircon. Zirconium metal and compounds were commercially produced at plants in Ukraine. In general, for every 4 to 5 t of ilmenite extracted, about 1 t of zircon was produced. Ukraine was the only supplier of zircon in the FSU, although Russia produced some baddeleyite concentrate (O’Driscoll, 1998).

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TABLE 1
UKRAINE: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity	1995	1996	1997	1998	1999 e/
METALS					
Alumina e/	1,100,000	1,000,000	1,075,000	1,291,000 3/	1,230,000 3/
Aluminium, primary	98,000	90,000 e/	100,500	106,700	112,000 3/
Aluminum, secondary	NA	NA	NA	71,164 3/	106,806 3/
Cadmium, metal e/	15	25	25	25	25
Germanium e/	22	22	22	22	22
Iron and steel:					
Iron ore, marketable	50,400,000	47,600,000	53,000,000 e/	51,070,200 r/	47,769,100 3/
Metal:					
Pig iron	20,000,000	18,143,000	20,561,000	20,840,000	21,937,000 3/
Ferroalloys: e/					
Blast furnace:					
Ferromanganese	100,000 r/	100,000 r/	125,000 r/	112,400 r/ 3/	57,800 3/
Spiegeleisen	2,500	2,500	2,500	2,500	2,500
Electric furnace:					
Ferromanganese	170,000	170,000	160,000	179,025 3/	199,539 3/
Ferronickel	23,000 3/	8,300 3/	--	--	--
Ferrosilicon	300,000	250,000 r/	300,000	222,511 r/ 3/	243,600 3/
Silicomanganese	600,000	600,000	560,000	485,560 r/ 3/	498,905 3/
Other	25,000	25,000	25,000	20,000	25,000
Total	1,220,000 r/	1,160,000 r/	1,170,000 r/	1,022,000 r/	1,030,000
Steel:					
Crude	22,309,000	22,100,000	25,600,000	23,461,000 r/	26,757,000 3/
Finished	16,600,000	17,045,000	19,525,000	17,776,000	19,300,000 3/
Pipe	1,500,000 e/	2,001,300	1,844,300	1,519,300	1,175,000 3/
Lead, refined (secondary) e/	10,000	21,000	11,000	7,340 3/	9,903 3/
Magnesium, primary e/	10,000	10,000	10,000	5,040 3/	3 3/
Manganese:					
Marketable ore	3,200,000	3,070,000	3,040,000	2,217,000 r/ 3/	1,984,800 3/
Mn content e/	1,100,000	1,040,000	1,030,000	755,000	675,000
Metal	NA	NA	NA	NA	3,500 3/
Mercury e/	NA	NA	NA	6 3/	2 3/
Nickel, mine output, metal content e/	1,400	500	--	--	--
Silicon e/	1,400	1,000	1,000	1,000	1,000
Titanium:					
Ilmenite concentrate, 42% TiO ₂	359,000	NA	NA	507,435	536,542 3/
Rutile concentrate, 95% TiO ₂	112,000	50,000 e/	50,000 e/	49,000	49,500 3/
Metal, sponge e/	--	--	--	500	4,000
Zinc, metal, secondary e/	5,000	2,000	2,000	--	--
Zircon concentrates, zircon content e/	35,000 r/	NA	NA	47,000 r/	50,000
INDUSTRIAL MINERALS					
Cement	7,600,000	5,017,000	5,098,000	5,589,000	5,800,000 3/
Graphite e/	5,000 e/	5,000 e/	5,000 e/	5,104 3/	7,461 3/
Nitrogen, N content of ammonia	3,100,000	3,300,000	3,400,000 e/	3,300,000 e/	3,710,000
Potash, K ₂ O content	110,000	76,000 r/ e/	60,000	35,000 r/ e/	35,000
Salt e/	3,000,000	2,800,000	2,500,000	2,500,000	2,500,000
Sulfur, native	238,000	168,000	100,000 e/	96,949 3/	79,979 3/
MINERAL FUELS AND RELATED MATERIALS					
Coal	83,800,000	70,500,000	76,900,000	77,176,000 r/	81,659,000 3/
Coke	15,000,000 e/	14,800,000	15,000,000 r/ e/	13,956,700	14,787,200 3/
Natural gas thousand cubic meters	18,170,000	18,408,000	18,131,000	17,967,000 r/	18,092,100 3/
Petroleum:					
Crude:					
As reported gravimetric tons	4,100,000	4,097,100	4,131,200	3,894,800	3,791,000 3/
Converted e/ 42-gallon barrels	30,100,000	30,100,000	30,400,000	28,625,000	27,860,000
Refinery products	NA	13,477,000	12,833,000	13,510,000	13,500,000
Uranium concentrate, U content e/	500	500	500	500	500

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

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

2/ Table prepared by Richard M. Levine and formatted by Glenn J. Wallace, International Data Unit; includes data available through December 2000.

3/ Reported figure.

TABLE 2
UKRAINE: STRUCTURE OF THE MINERAL INDUSTRY IN 1999

(Metric tons unless otherwise specified)

Commodity	Major operating facilities	Location 1/	Annual capacity e/
Alumina	Mykolayiv refinery	Mykolayiv (Nikolayev)	1,200,000.
Do.	Zaporizhzhya (Dneprovsk) refinery	Zaporizhzhya (Zaporozhye)	245,000.
Aluminum, primary	Zaporizhzhya (Dneprovsk) smelter	do.	120,000.
Coal:			
Hard	Donets coal basin with about 225 mines produces more than 90% of Ukraine's coal	Donetska (Donetskaya), Dnipropetrovska (Dnepropetrovskaya) and Luhanska (Luganskaya) oblasts	130,000,000.
Do.	Lviv-Volynskiy basin produces remainder from 18 mines	Western Ukraine	6,000,000.
Brown	Dneprovskoye basin	Central Ukraine	7,000,000.
Ferroalloys	Nikopol ferroalloys plant	Nikopol	250,000 (ferromanganese).
Do.	do.	do.	1,200,000 (silicomanganese).
Do.	do.	do.	3,000,000 (manganese sinter).
Do.	Stakhanov plant	Luhansk	NA (ferrosilicon).
Do.	Zaporizhzhya plant	Zaporizhzhya	200,000 (ferrosilicon), 160,000 (silicomanganese), NA (ferrochrome), NA (ferromanganese), 40,000 (manganese metal).
Graphite	Zavalyevskiy graphite complex	Zavalyevskiy deposit	40,000.
Iron ore	Underground mining:		
Do.	Krivbassruda production association with 16 mines	Kryvyi Rih (Kryvoy Rog) basin	15,000,000.
Do.	Eksploataciynaya Mine of the Zaporizhzhskiy iron ore complex	do.	3,500,000.
Do.	Open pit mining: Yuzhniy, Novokrivorozhskiy, Tsentralnyy, Severnyy, Inguletskiy, Poltaviskiy and Kamysh-Burunskiy mining and beneficiation complexes	do.	90,000,000 (total).
Kaolin	Prosyankovskoye mining and beneficiation complex	Dnepropetrovsk region	NA.
Lead, secondary	Ukrtsink plant	Kostyantynivka (Konstantinovka)	70,000.
Magnesium	Zaporizhzhya plant	Zaporizhzhya	10,000.
Do.	Khlorvinil concern	Kalush	20,000.
Manganese ore, marketable	Ordzhonikidze, Marganets mining and beneficiation complexes	Nikopol basin	6,000,000 (total).
Do.	Tavrcheskiy mining and beneficiation complex (under development)	Bolshoy Tomak basin	
Mercury	Nikitovskiy mining and metallurgical complex	Donets basin	120.
Nickel	Pobuzhskiy mining and metallurgical complex, comprising three open pit mines and smelter	Pobuga region	7,000 (nickel in ferronickel).
Potash	Khlorvinil production association, Stebnik potash plant	Pricarpathian region	300,000 (K ₂ O).
Steel, crude	Alchevsk plant	Alchevsk (Kommunarsk)	4,500,000.
Do.	Azovstal plant	Mariupol	4,000,000.
Do.	Dneprospetsstal	Zaporizhzhya	1,400,000.
Do.	Dneprovsk plant	Dniprodzerzhynsk (Dneprodzerzhinsk)	3,850,000.
Do.	do.	Dnipropetrovsk (Dnepropetrovsk)	1,900,000.
Do.	Donetsk plant	Donetsk	1,300,000.
Do.	Yenakiyev plant	Yenakiyev (Yenakiyev)	3,100,000.
Do.	Ilyich plant	Mariupol	7,300,000.
Do.	Kirov plant	Makeyevka	4,000,000.
Do.	Kryvyi Rih plant	Kryvyi Rih	10,650,000.
Do.	Zaporizhzhya plant	Zaporizhzhya	2,300,000.
Sulfur	Sera production association	Rozdol mining complex mines, Rozdol, Soroks, Zhidachev Deposits. Yavorov complex mines. Nemirov and Yazov deposits in (Lvivska) (Lvovskaya) and Kyivska (Kievskaya) oblasts	1,500,000 (total).

See footnotes at end of table.

TABLE 2--Continued
 UKRAINE: STRUCTURE OF THE MINERAL INDUSTRY IN 1999

(Metric tons unless otherwise specified)

Commodity	Major operating facilities	Location 1/	Annual capacity e/
Titanium ore	Irshanskiy mining and beneficiation complex	Irsha River valley	600,000 (ilmenite concentrate, total for both enterprises).
Do.	Verkhnedneprovskiy mining and metallurgical complex	Verkhnedneprovsk region	60,000 (rutile concentrate).
Titanium, metal	Zaporizhzhya plant	Zaporizhzhya	6,000.
Uranium	Zheltye Vody complex	Northern part of Kryvyi Rih basin	NA.
Zinc, secondary	Ukrtsink plant	Kostyantynivka	25,000.
Zirconium ore	Verkhnedneprovskiy mining and metallurgical complex	Verkhnedneprovsk region	60,000 (zircon).
Zirconium, metal and compounds	Pridneprovskiy chemical plant	Dniprodzerzhyn'sk	NA.
Do.	Kharkiv physical-technical institute	Karkiv	NA.

e/ Estimated NA Not available.

1/ Old name or spelling, if applicable, given in parentheses.