

Status and Future of the North Korean Minerals Sector

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The minerals industry in the Democratic People's Republic of Korea (DPRK) is responsible for a significant part of North Korea's exports and accounted for 15.2 percent of exports in 2005. The DPRK holds most of the total known minerals deposits on the Korean peninsula and are estimated to be 30 times more than the deposits of the Republic of Korea (ROK). The minerals production sector in North Korea lacks modern equipment and suffers from electricity shortages. Equipment in many mines is decades old and includes some materials that date back to the Japanese colonial period. Due to its economic isolation, the DPRK is unlikely to develop these resources and increase production independently. The exception is uranium mines in the DPRK that have received significant resources from the Korean People's Army (KPA). These mines use modern equipment and transportation facilities, and their workers are accorded special status, receive preferential access to food, and other bonuses. Given its inability to redevelop the minerals sector domestically, exploitation of the DPRK's mineral resources through linkages with South Korean and overseas consumer markets is likely to be the most profitable way for the DPRK to develop its minerals sector. Chinese and South Korean firms have the most experience in investing in the mineral sector. Mineral sector development activities and Korean-Chinese business networks can be extremely beneficial in building relations with DPRK officials and acting as intermediaries for investors.

Current Status of North Korea's Mineral Sector

The mining industry is very important to the Democratic People's Republic of Korea (DPRK, North Korea). The mining subsector of the DPRK's economy accounted for 8.3 percent of North Korean GDP and 15.9 percent of export revenues in 2005. However, the minerals production sector in North Korea has been struggling because of poor central planning and a lack of modern technology and equipment, as well as shortages of electricity. For these reasons, North Korea needs to rebuild its production lines by obtaining proper equipment and technology.¹ Based on a study by Chung Woo Jin,² the exploitation of the DPRK's mineral resources through linkages with South Korean and overseas consumer markets is likely to be the most profitable method for the DPRK to develop its minerals sector. Strong markets for the DPRK's gold, silver, lead, iron ore, zinc, tungsten, copper, and other metallic minerals are likely to be found in the ROK. In addition, among the DPRK's non-metallic minerals,

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Table 1. Importance of the Mineral Sector in the DPRK Economy

Year	Total Exports US\$100m.	Mineral Exports US\$100m.	Comparison (%)
1998	6.4	0.8	12.3
1999	6.5	0.6	9.3
2000	7.1	0.6	8.5
2001	8.2	0.8	9.8
2002	10	1.1	11
2003	10.7	1.7	15.9
2004	6.6	0.6	9.1
2005	6.6	1	15.2

Source: Korea (ROK) Trade-Investment Promotion Agency (KOTRA), <http://www.globalwindow.org>

magnetite, flaky graphite, and limestone are valuable products.³ The DPRK's mineral resources are of considerable interest to the Chinese market, as transporting North Korean minerals to China is less expensive than Australian and Brazilian mineral resources.⁴

This paper describes and evaluates the DPRK's mineral sources in terms of importance, where they are found, and how they might be developed with financial input by overseas investors. This study proposes various methods of effectively engaging in mineral resources development and investment in the DPRK by analyzing the mineral industries of the DPRK and exploring possible investment projects in the DPRK mineral industry. The difficulties typically encountered in trade between the DPRK and foreign investors, possible solutions to those difficulties, and the economic effects of trade in minerals on the DPRK are studied as well.

Sources and Methods Used in this Paper

In order to prepare this paper, various methods have been used to gather facts and sources from the DPRK, China, and South Korea. First, DPRK internal documents related to natural resources in the DPRK and their exploration were collected from contacts in the border region of the DPRK and China. Second, some sources providing trade data and other documents were collected from representatives of Chinese state-owned corporations and medium-sized businesses, as well as North Korea-related economic research institutes in China. Third, statistical data and in-depth research papers were collected from South Korean energy-related institutes and government-owned research institutes in order to analyze and to assess DPRK natural resources from an objective viewpoint.

In addition, the author interviewed 11 North Korean defectors living in Seoul and Australia who have work experience in the minerals and coal mining industries of the DPRK (five were in mines in Hamgyeongbuk-do (province), two were in the coal industry in Pyongan-do and four were from iron manufacturing companies in Pyongan-do and Cheongjin-si (city) and the Nampo and Moonchon Refinery) as a key method to collect information on the current situation in the DPRK mining industry. Finally, the author's experience and knowledge (as a former North Korean assistant researcher in the DPRK Agricultural Research Center, with education including majoring in Earth Physics Geological Exploration at Cheongjin Mineral and Metal University), were used to compile this paper. As a geology student, the

author traveled and was involved in minerals exploration projects throughout the DPRK for three years.

Current Status of the DPRK Minerals Sector

Table 2 summarizes the known reserves of major natural resources in the DPRK, along with their value, if extracted, assuming 2005 resource prices.

Table 2. Major Natural Resources in the DPRK

Classification	Grade (%)	Unit	Deposits	Value (US\$, million)
Gold	Metal (Au,100)	1,000 tons	1.5	19,171
Silver	Metal (Ag, 100)	1,000 tons	4	745
Copper	Metal (Cu 100)	1,000 tons	2,155	2,044.9
Lead (Pb)	Metal (Pb 100)	1,000 tons	6,000	1,178.4
Zinc	Metal (Zn 100)	10 million tons	1.5	6,709.1
Iron	Fe 50	100 million tons	30	71,866.3
Tungsten	WO3 65	1,000 tons	250	219.4
Molybdenite	Mose 90	1,000 tons	2	8.2
Manganese	Mn 40	1,000 tons	200	6.5
Nickel	Ni 3	1,000 tons	15	3.6
Black lead	Various classes	1,000 tons	6,000	3,316.5
Limestone	Various classes	100 million tons	1,000	996,230.7
Kaolin	Various classes	1,000 tons	2,000	30.2
Talc	Various classes	1,000 tons	600	75
Asbestos	Various classes	1,000 tons	13	0.9
Fluorspar	Various classes	1,000 tons	500	12.5
Barite	Various classes	1,000 tons	2,100	163.6
Magnesite	MgO 45	100 million tons	35	126,000
Anthracitic	Various classes	100 million tons	117	767,138.9
Bituminous coal	Various classes	100 million tons	30	168,000
Total				2,162,927

Source: 2004 Korea (ROK) Resources Corporation (KORES) Report.

Key Regional Mines and Capacity of Extractive Infrastructure

There are more than 360 types of natural mineral resources in the DPRK, which are typically spread out across North Korea. Among them are 220 types of resources that are useful for economic purposes. The DPRK’s reserves of tungsten, molybdenite, black lead, barite, and fluorite place the DPRK among the world’s top-10 countries in terms of mineral reserves.⁵

The DPRK has vast mineral resources as well as abundant energy resources such as coal and uranium that play major roles in supplying power and industrial materials in North Korea.

Table 3 summarizes the ROK estimates of mineral resources in the DPRK by major mines. In this table, production data for North Korean mineral resources in 1990 have likely been understated, with production somewhat overstated after 1990. A reason for this is that North Korean natural resource production capacity reached

Table 3. Output of Major Metallic Ores in the DPRK

	Gold (tons)	Silver (tons)	Copper (1,000 tons)	Tungsten (tons)	Lead (Pb) (1,000 tons)	Zinc (1,000 tons)	Iron ore (1,000 tons)
1990	5	50	15	1000	80	230	8430
1992	5	50	16	1000	75	200	5747
1994	5	50	16	900	80	210	4586
1996	4.5	50	16	900	80	210	3440
1998	4.5	50	14	500	70	100	2890
2000	2	40	13	500	60	100	3793
2001	2	40	13	500	60	100	4208
2002	2	40	12	600	60	100	4078
2003	2	20	12	600	60	100	4579
2004	2	20	12	600	12	100	4580
2005	2	20	12	600	13	100	5000
2006	2	20	12	600	13	100	5000

Source: 2008 KORES Report.

its highest level in 1990, based on the author's experience and knowledge; however, it declined dramatically through 1999. This decrease in DPRK mining capacity was not well known to ROK analysts. As a result, the numbers in Table 3 are inaccurate reflections of true DPRK minerals production. According to the testimony of former North Korean miners (Mr. Kim, 57 years old with 30 years of mining experience, and six other interviewees) mining production in the DPRK declined dramatically from the early 1990s (from about 1993–1994) through 1999.⁶

Descriptions of key mines and output trends for each of several different key minerals are provided below:

Gold Mining

Gold ore is produced along with silver and copper ore in the DPRK.⁷ Gold and silver ore reserves total a few million tons of raw ore, according to a Korea Mining Corporation source, with gold ore reserves estimated at 2,000 tons⁸ as gold 100 percent and silver reserves at 3,000–5,000 tons as silver 100 percent.

Major gold mines in the DPRK are the Soosan Mine (Soosan-gun, Hwanghaebuk-do), the Holdong Mine (Yonsan-gun, Hwanghaebuk-do), the Daeyoo-dong Mine (Dongchang-gun, Pyonganbuk-do), the Woosan Mine (Woosan-gun, Pyonganbuk-do), the Sunghong Mine (Hoichang-gun, Pyongnam-go), the Sangnong Mine (Huhchong-gun, Hamgyeongnam-do), the Ongjin Gold Mine (Hwanghae-do), and the Kumkang Mine (Kumkang-gun, Kangwon-do).⁹ The total production from these seven major gold mines has not been officially reported; however, it is clear that the annual gold production capacity is approximately five tons in these major mines and the annual silver production is approximately 40 tons.¹⁰ In particular, the annual production capacity of the Woosan Gold Mine is about 1.5–1.8 tons according to private sources.¹¹ This mine's capacity is estimated to represent over 40 percent of the DPRK's gold production capacity. The gold ore deposits of the Woosan Gold Mine are estimated at 1,500 tons and represent almost 50 percent of North Korean total gold reserves.¹²

In terms of production technology in the gold mining industry, the DPRK has

been experiencing a shortage of technology and infrastructure. For example, the large mines described generally have 30-to-40-year-old (or older) production equipment, including some equipment inherited from the 1940's Japanese colonial period. As a result, the production capacity of these mines is likely similar to the 1940's era production capacity.¹³ As is widely known, the DPRK authorities have declared that all gold production in the country should belong to the Korean Workers Party assets that are controlled by Kim Jong Il's private assets manager, Department 39. Subsequently, no other organization has the authority to deal with and to produce gold in the DPRK.¹⁴ Increasingly cheaper strata in the previously mentioned gold mines have been worked due to the mines operational history of more than 50 years. The increasing depth of pits (tunnel depth) is making it more complicated and difficult to extract gold ore from these mines.¹⁵

Due to a decline in gold ore production, the DPRK authorities have contacted Chinese and Japanese entrepreneurs in an attempt to attract funds to invest in these major gold mines.¹⁶ That means that the KWP-Department 39 wishes to produce more gold ore to earn more hard currency to support the newly announced military leader, Kim Jong Un, by providing precious gifts such as Mercedes Benz cars, Swiss-made watches, and Cognac for his followers.¹⁷

The investment proposal made to overseas investors by the DPRK authorities is as follows: 1) Investors should invest at least US\$1 million in cash to produce gold ore (Holdong Gold Mine, Kumgang, and Woonsan Gold Mine). 2) The North Korean government will be the guarantor to protect the investor's funds. 3) Investors will have the authority to extract gold ore from the mine they invested in and export it to overseas locations for refining into gold bullion.¹⁸

The transportation infrastructure in gold mining regions utilizes trucks and freight trains as major carriers of ore from mines to refineries, with heavily-armed guards to protect shipments against potential robberies.¹⁹

Iron Ore

Table 4 summarizes the major iron ore mines in the DPRK, including their location, the reported size of their deposits, the reported grade of their ore bodies, and estimates of their output as of 2001. The overall size of deposits of iron ore in the DPRK are estimated at 3.5–4.0 billion tons (including ores of quality in the 22–50 percent Fe range) according to a Korea Mining Corporation (ROK) report,²⁰ and iron ore production in the DPRK peaked in 1985 (at 9.8 million tons, Fe 65 percent) but sharply declined to 2.89 million tons as of 1998.²¹ Major iron ore regions are the Musan, Lee-won, Bukchong, Hurchon areas (Hamgyeong-do), and Eunryul, Shinwon, and Jaeryong (in Hwanghe-do).²² Details of key mines and factories using iron ore are provided below.

Musan Iron Ore Mine

The reserves of the Musan Iron Ore Mine are estimated at 1.5–2.0 billion tons of magnetite (FeOFe_2O_3) containing iron at 23–30 percent (ibid, p. 16). The mines reserves are considered low-grade ore (average 25 percent); however, it is a strip mine and offers iron ore production at a low cost. There are three to four mineral veins in the Musan Iron Ore Mine. The first vein is 400 meters in width, 3,000 meters in

Table 4. Major Iron Ore Mines of DPRK

Area	Mine name	Location	Deposit	Grade	Others
East	Musan	Musan, Hamgyeongbuk-do	1.5 billion tons	25–35 %	8 million tons. (30%), 3 million tons (60%)
	Leewon	Leewon Hamgyeongnam-do	20 years operation	49%	
	Poongsan	Poongsan Ryangang-Do	120 million tons	45%	
	Hurchon	Hurchon Hamgyeongnam-do	150 million tons	48%	
	Danchon	Danchon Hamgyeongnam-do	100 million tons	45%	
	Janggang	Jagang-Do	unknown	50%	
West	Eunryul	Hwanghaenam-do	100 million tons	48%	Open mine 1.6 million tons
	Jaeryung	Hwanghaenam-do	100 million tons	50%	Open mine 500,000 ton
	Chondong	Gaecheon Pyongannam-do	50 million tons	50%	1 million tons
	Suhhaeri	Eunryul Hwanghaenam-do	unknown	55%	Under development
	Hahsung	Shinwon Hamgyeongnam-do	15 million tons	45%	Open mine 500,000 ton
	Duckhyun	Euijoo Pyonganbuk-do	unknown	50%	Iron & copper 500,000 tons
	Anark	Hwanghaenam-do	unknown	50%	Newly developed
	Songrim	Hwanghaebuk-do	unknown	55%	Newly developed
	Hwangjoo	Hwanghaebuk-do	unknown	55%	Newly developed
	Yonsan	Hwanghaebuk-do	unknown	55%	Newly developed
	Taetan	Hwanghaenam-do	unknown	55%	Newly developed
Gaecheon	Pyongannam-do	17.5 million tons	45–55%	Developed 1976	

Source: Industrial Bank of Korea (ROK), *The DPRK's Industry*, 2001.

length, and 1,000 meters deep. Another three veins are known to be similar in structure to the first; however, further details on those veins are not available.²³

In the mine, 28–30 percent iron ore is refined to an iron content of 60–65 percent through a dressing (separation of higher-grade ore products) procedure in the mine area. Ore produced from an open surface is sent to six ore separators in 25-ton and 50-ton heavy trucks (which were mostly imported from Sweden) then the ore is sent to

dressing plants by gravity separation methods at a location near the ore separator.²⁴

Using this refining method, the ore is produced as 60–65 percent powdered ore then, sent to the Kimchaek Iron-Manufacturing Plant in Cheongjin-si (97 km from the Musan Iron Ore Mine) by freight train and a steel pipeline that is two meters in diameter.²⁵ Unlike most regional one-way railway systems in the DPRK, the railway from the mine is a double line so that powdered ore can be carried out without any delay by freight train if the mine produces at its maximum capacity. The capacity to carry out powdered ore on the railway and pipe lines (which run a distance of 97 km from the Musan Iron Ore Mine to the Cheongjin Iron Manufacturer) was 6 million tons per year.²⁶

The Musan Iron Ore Mine production capacity is 3 million tons of 65 percent powdered ore. The mine produced 9.9 million tons of raw ore in 1985; however, after that production sharply declined to 2.89 million tons or 30 percent of the 1985 production. Iron ore production at the mine has reportedly been slowly increasing between late 2002 and 2009.²⁷

As an iron ore provider, the mine has been supplying its production to the Kimchaek Iron-Manufacturing Company. This iron-manufacturer's production capacity is 2.17 million tons that accounts for about 40 percent of the DPRK's iron production (5.42 million tons).²⁸ This manufacturer employed 20,000 workers when operating at peak output; its annual capacity is reported to be 2.4 million tons of pig iron, 2 million tons of steel, and 1.4 million tons of steel materials (rolled steel).²⁹

Eunryul Mine

The Eunryul Mine has iron ore in the form of limonite ($\text{Fe}(\text{OH})_n \text{H}_2\text{O}$) and is located in Eunryul-gun, Hwanghae-do. Deposits in this mine are estimated to total 200 million tons. Due to their high grade of iron ore (Fe 44 percent) and the convenience of transporting ore in ships (the Eunryul Mine is within 20 kms of Haejoo Port) the Eunryul Mine and the nearby Jaeryong Mine described below are likely destinations for overseas' investment funds.³⁰

Jaeryong Mine

This mine is located in Jaeryong-gun, Hwanghae-do. The Jaeryong Mine vein is similar to that in the Eunryul Mine. Both mines provide their production to the Hwanghae Iron-manufacturer.

Hwanghae Iron-Manufacturer

The two mines above provide their production to the Hwanghae Iron-Manufacturer. This factory's capacity to produce pig iron is approximately 1.14 million tons per year.³¹ This iron-manufacturer has more modernized and sophisticated facilities relative to the Kimchaek Iron-Manufacturer, but it does not operate continuously due to a shortage of iron ore supplies from the Jaeryong Mine and Eunryul Mine.³²

Hurchon Iron Ore Mine

The Hurchon Iron Ore Mine is located in Hurchon-gun, Hamgyeongnam-do. The

Table 5. Production Capacity of Major DPRK Iron Manufacturers
(10,000 tons per year, and fraction of total national capacity)

Name	Iron making (10,000tons)	Steel making (10,000tons)	Rolling (10,000tons)
Kimchaek Iron Manufacturer	216.7 (40%)	240 (40%)	147 (36.4%)
Hwanghae Iron Manufacturer	114.2 (21%)	144.5 (24.1%)	75 (18.6%)
Sungjin Iron Manufacturer	48 (8.9%)	72.6 (12.1%)	41.5 (10.3%)
Cheongjin Steel Manufacturer	96 (17.7%)		
4.13 Iron Manufacturer	51.6 (9.5%)		
September Iron Manufacturer	9.6 (1.8%)	9 (1.5%)	55 (13.6%)
Others	6 (1.1%)		
Total	542.1	600.2	403.7

Source: Industrial Bank of Korea (ROK), *The DPRK's Industry*, 2002.

Table 6. Supply Chains for Major Iron & Steel Manufacturers in the DPRK

Name	Major Products	Iron Ore	Power Plant	Supplies Products for
Kimchaek Iron Manufacturer	Pig iron, steels, rolled steel	Musan Iron Mine	Cheongjin Thermal Power Plant	Sungjin and Chunrima Steel Maker
Hwanghae Iron Manufacturer	Pig iron, steels, secondary metal products	Eunryul, Jaeryong mine	Pyongyang Thermal Power Plant	Steel sheet, Rail, shape steel
Chunrima Steel Manufacturer	General rolled steel, steel rope, secondary steel products	Chondong Mine and Geachon Mine	Pyongyang Thermal Power Plant	Construction, building materials
Cheongjin Steel Manufacturer	Secondary steel products alloy steel products structural steel		Cheongjin Thermal Power Plant	Machinery factories, exporting

Source: Ibid.

deposit is composed of reserves of hematite (Fe_2O_3), and the quality of iron ore is 44 percent.

North Korea is reluctant to export iron ore; however, it encourages iron ore manufacturers to export steel or pig iron production to China or South Korea.³³ Table 5 provides a summary of the production capacity (in units of ten thousand tons per year). Table 6 shows the supply chains, sources of ore, and electricity for major iron manufacturers in the DPRK.

Copper Mines

The North Korean authorities have been deliberately reluctant to reveal information about North Korea's copper mines and copper production capacity to outsiders,

including China and South Korea, due to the fact that copper is a significant component in the production of military equipment that includes copper cable, bullets, shells and missile-related materials.³⁴ Thus it is not easy to gather data related to North Korean copper mines and copper production. There are three major copper mines in the northern part of the DPRK: Hurchon Copper Mine, Hyesan Copper Mine, and Yongheong Copper Mine. Those mines are owned, controlled, and operated by the Korean People's Army as they provide strategic war industry supplies.³⁵ The information available on these mines is as follows.

Hyesan Youth Copper Mine

The Hyesan Youth Copper Mine is located in the Hyesan region of Ryanggang-do. The copper ore deposit for this mine is known to be 20 million tons, the mine's annual production capacity is 30,000 tons (of Copper 30 percent), and its employees number about 2,500. Copper ore from the mine is processed in a concentrator unit at the mine and the concentrated ore is carried by freight train to Danchon Refinery.³⁶ There are two copper mines in this region: Gapsan Copper Mine and Shinpa Copper Mine in Ryanggang-do.

Hurchon Copper Mine

The Hurchon Copper Mine is located in the Hurchon region of Hamgyeong-do. The known copper ore deposits for the mine are 15 million tons; gold and other rare minerals are also found in the deposit. The annual production capacity of the mine is 20,000 tons (copper 40 percent) and it employs 5,500 personnel. Copper ore is processed in a concentrator at the mine and is carried by trucks and freight trains to the Danchon Refinery.³⁷

Yongheong Copper Mine

The Yongheong Copper Mine is located in the Yongheong region of Hamgyeong-do. The known copper ore deposits are 12 million tons, and is associated with gold and rare minerals. The annual production capacity of the mine is 10,000 tons (copper 40 percent) and it employs 1,500 workers. Copper ore is concentrated in concentrator units at the mine and then carried by trucks and freight trains to the Danchon Refinery.³⁸

Tungsten and Molybdenite (Mannyun Mine)

The Mannyun Mine is located in Shinpyong-gun, Hwanghae-do. Tungsten reserves in this area are approximately 20 million tons (WO₃ 65 percent), accounting for half of North Korea's total reserves.³⁹ There are 10 veins of tungsten in the deposit (three to six meters in width and 1,800 meters long) of this mine. This mine also produces manganese ore and copper pyrite ore. The mine's ore separator's capacity is 1000 tons/day and the mine produces 500,000 tons of ore annually (measured as WO₃ 65 percent). The mine employs 3,500 workers and has eight work tunnels for mining.⁴⁰

Figure 1 shows the output of major non-metallic minerals in the DPRK over the period of 1990 through 2006. Major non-metallic mineral products include black lead (graphite), phosphate rock (mainly used as fertilizer), limestone used for cement,

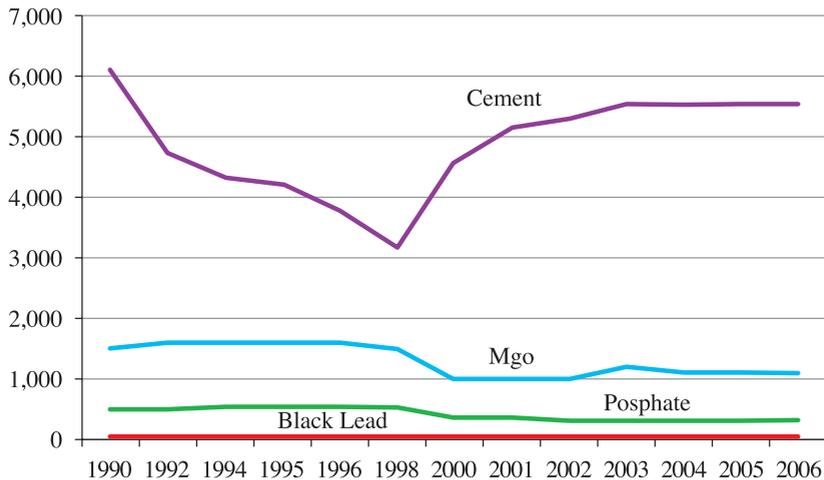


Figure 1. Output of Major Non-metallic Ores in the DPRK (Unit: 1,000 tons)

(Note that in this graph, “Cement” denotes tons of cement clinker.)

Source: 2005 KORES Report.

and magnesium oxide from magnesite. Major mines for each of these are discussed below.

Magnesium Oxide (Ore)

The DPRK’s reserves of the nonmetallic mineral magnesite are estimated at 3.5–4 billion tons (Mg 45 percent), and are mostly located in the Danchun area, Hamgyeong-do, which is the largest deposit in the world. In particular, as a strip mine and large scale mine, the deposit in the Baegumsan area is approximately 3.6 billion tons and is 7,660 meters length, and 7–100 meters in depth. North Korean production of magnesite as of 2005 was estimated at 1 million tons as concentrated ore.⁴¹

Ryongyang Mine

The Ryongyang Mine is located in Donsan-dong, Danchun City and is a subsidiary of the Danchun Regional Mining Group. The magnesite ore grade is MgO 30 percent, and the mine’s capacity to produce magnesium ore is 8 million tons per year, which after concentration of the ore (to 55–60 percent Mg), is 3 million tons. Mining operations use two methods: terrace strip mining and underground mining. Heavy trucks operate from inside the mine to transfer points outside of the mine tunnels and freight trains are used as major carriers to move ore from the mine area.⁴² A major ore separator was built within the mine in 1988 and the capacity of the separator is 8 million tons of ore per year.

The Ryongyang Mine is operating as a subsidiary of the Korea Magnesite Clinker Industry Group (KMCIG) that has three mines and three clinker manufacturers with 30,000 employees. In addition, the KMCIG operates four kilns for caustic calcined magnesite (CCM) and dead burned magnesite with a production capacity of 750,000 tons per year.⁴³

Double railways were built early in the 1990s as infrastructure for this mine. However, freight railways operating from the seaside (Danchon-si) to the mining sites are on steep slopes and alternative freight methods need to be considered to serve the mine.⁴⁴

Lead and Zinc Mines

Most lead and zinc deposits are found in Hamgyeong-do, Pyongan-do, and Hwanghae-do with reserves of approximately 600,000 tons (Pb 100 percent) and 15–20 million tons (Zn 100 percent). The national total output of lead and zinc are approximately 60,000 tons and 100,000 tons per year respectively.⁴⁵ Most zinc and lead ore are smelted at the Moonpyong Refinery (located in Moonchon-si, Kangwon-do).

Gumdock Mine

The Gumdock Mine is located in the Danchon area of Hamgyeong-do. As the largest zinc mine in the DPRK, this mine has a rich vein of ore 9 km in extent and deposits estimated at 8 million tons (Zn 100 percent) and represent half of the DPRK’s total deposits.⁴⁶

Energy Resources: Coal

Table 7 list the major coalfields in the DPRK, providing the type of coal mined and the estimated size of coal deposits for each.

Coal is recognized as a major strategic energy resource for the DPRK economy. It is an economic development engine as well as an industrial component for the operation of thermal power plants, factories, transportation systems, and households.⁴⁷ Approximately 70 percent of North Korea’s energy is provided by coal and coal mines have been recognized to have significant importance in resource development plans for the DPRK economy.⁴⁸ The DPRK has exported approximately two million tons of coal annually to China in exchange for strategic materials needed by North Korea or for US dollars (or other hard currencies) since 2004. For instance, coal produced

Table 7. Deposits in Major Coalfields of the DPRK (million tons)

Type of coal	Name of coalfield	Deposits of coal
Anthracitic	Northern Pyongan Coalfield	3,670
	Southern Pyongan Coalfield	1,260
	Kowon Coalfield (Kangwon-do)	320
	Others	6,490
	Sub-total	11,740
Brown Coal	Northern Hamgyeongbuk-do	1,910
	Southern Hamgyeongbuk-do	570
	Others	520
	Sub-total	3,000
Total		14,740

Source: Bank of Korea, 2008 *Bank of Korea Report*.

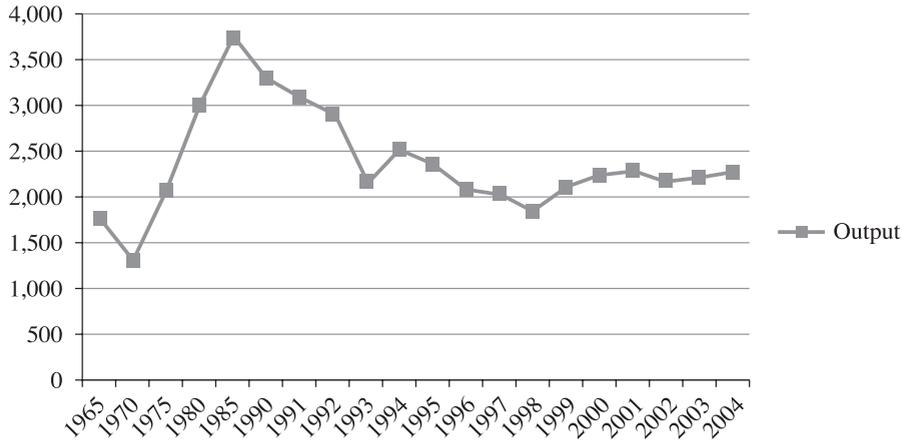


Figure 4. Output of Coal (10,000 tons)

Source: 2005 KORES Report.

in the Pyongan Regional Mines has been exported to Tienjin, Dalian and Chingdao cities in China from Nampo Port in the western DPRK.⁴⁹

The DPRK's coal deposits totaled approximately 14.7 billion tons, including 3 billion tons of lignite coal (soft coal) and 11.7 billion tons of anthracite coal (mostly in Pyongan-do and Hamgyeong-do). In terms of anthracite coal reserves in North Korea, major coal production areas are classified into two areas: the North Pyongan Coalfield (deposits of 3.7 billion tons) and the South Pyongan Coalfield (deposits of 1.23 billion tons). In terms of lignite coal reserves, major coalfields are divided into three areas: North Hamgyeong-do Coalfield, South Hamgyeong-do Coalfield, and Anjoo Coalfield (Pyongan-do). Coal deposits in these major coalfields are 1.88 billion tons, 480 million tons and 117 million tons, respectively.⁵⁰ Figure 4 shows ROK estimates of overall DPRK coal production from the 1960s through 2004.

Reportedly, the Anjoo Coalfield has produced coking coal (high heat content coal used as coking coal), which was exported to China in 2008. By contrast, South Korean research papers on the topic have so far denied the existence of coking-quality coal production at Anjoo.⁵¹ The annual nationwide coal production was 38.3 million tons in 1989; however, the production of coal declined sharply after 1990 and the annual coal production declined to 18.6 million tons in 1999. The nationwide coal production capacity is estimated to have been 53.50 million tons in 1986.⁵²

With regard to coal quality, the DPRK-produced anthracite coal from the Duckchon Coal Mine is reported by Chinese importing authorities and shipping sources to have the characteristics specified below. Coal of this type has recently been exported to Chinese thermal power plants in Tienjin and Dalian.⁵³ This coal is of superior quality in terms of caloric value than other coal produced by the DPRK.

Coal Specifications:

- Caloric value: 6,480 kcal/kg (min.)
- Fixed Carbon: 80.3 percent (max.)
- Ash content: 12.2 percent (max.)
- Volatile material: 6.1 percent (max.)

- Sulfur: 0.2 percent (max.)
 - Moisture (max): 6.0 percent (max.)
 - Size: 0-30 mm (100 percent min.)
- (Source: Invoice from DRPK exporting company, 2009).

There are currently several urgent problems that the DPRK coal industry must overcome. First, there is the depth of mining at existing sites that means that the expense and difficulty of draining underground water has increased with a subsequent decrease in the operational effectiveness of the mines. Second, a lack of power, transport equipment, mining technology and funding has hindered production. Third, there is a lack of attention to mine development, as opposed to the enforcement of impractical plans to promote short term coal production when new general managers or Workers Party executives are sent to oversee the mines. Fourth, the deterioration of mining equipment, replacement parts, and lack of mine support posts limits production. Fifth, the high rate of industrial accidents and the lack of new investments in the coal mining industry reduces output. Sixth, the lack of electricity for mine operations is a cause of low production due to the fact that most power plants rely on coal supplied by coal mines as energy sources that results in a vicious circle. The problems of lack of power is obviously linked to energy sources used to produce power in the DPRK.⁵⁴

Energy Source: Uranium Ore

The DPRK has been highly reluctant to reveal the extent of its uranium ore deposits and annual production capacity. According to private sources in China and DPRK business contacts, the DPRK's deposits of uranium ore amount to approximately 26 million tons. There are two major uranium ore mines in the DPRK, the Pyongsan Mine and the Woonggi Mine.⁵⁵

Pyongsan Uranium Mine

The Pyongsan Uranium Mine is located in Pyongsan-gun, Hwanghae-do and has been operating for 30 years under the control of the Korean People's Army. The uranium ore deposits in this area are estimated at 1.5 million tons and the mine's annual production capacity is 10,000 tons.⁵⁶ The mine has its own separator for the concentration of ore. All products are sent to the Yongbyon Nuclear Power Station under armed guard. Recently, a new facility for uranium extraction has been built in the Pyong-won area.⁵⁷

Woonggi Uranium Mine

The Woonggi Uranium Mine is located in Woonggi, Hamgyeongbuk-do and has operated for 35 years under the control of the KPA. The uranium ore deposits in this mine area are estimated at 10 million tons and its annual production capacity is 19,000 tons (private source). The mine has its own separator for the concentration of ore. All production is sent to the Yongbyon Nuclear Power Station under armed guard.⁵⁸ The mine's operation has been kept secret even from North Koreans due to the fact that the output from the mine is known to have been used for nuclear weapon development purposes. As a result, the workers and engineers in the mine have been restricted within the mine facilities even if they suffer from uranium related diseases.⁵⁹

Educational Institute for Uranium Mines

In the fields of geological exploration and engineering, the Kimchaek Engineering University, the Cheongjin Mining and Metal University, and the Sariwon Geology University have played major roles in staffing exploration activities to find additional uranium ore deposits. The Yongbyon Physics University and Leegwa University have played major roles in the areas of mining and ore separator operation within the mines as well as logistical operations, for security reasons.⁶⁰

Infrastructure and Facilities for the Mines

Unlike other mining industries in the DPRK, uranium mines have been the targets of heavy investment. The technically capable engineers and skilled workers receive preferential treatment in terms of food, salary, and social status. Funds invested in the mines have been used for mining equipment and facilities. In particular, specialized Swedish and Japanese trucks are utilized to support production activities instead of freight railway shipping of ore.⁶¹

Energy Source: Oil

Ascertaining if North Korea has petroleum deposits has been one of the critical issues in the geological exploration community in the DPRK as well as a factor for the central economy planning authorities. North Korean geologists and foreign engineers have found oil deposits during an East Sea seabed area exploration (near Tongchon, Kangwon) and in an West seabed area exploration (near Nampo) in 1985.⁶² The North Korean authorities have established a self-reliance policy for oil exploration and production since the 1960s. The DPRK set up an Oil Exploration Institute in Sookchon (near the West Sea) in 1968, with advanced Russian and Swedish exploration equipment to accelerate oil exploration within the West seabed area. In 1978, North Korea signed an agreement with China on oil exploration, under which the DPRK would receive support in the form of Chinese technology and equipment (oil drilling machines and oil prospecting ships) in the Balhaeman area (the Yellow Sea).⁶³

The latest activities related to oil exploitation in the DPRK in partnership with overseas investors include an agreement between Korea-Ireland Exploration (KOREX) and the Korean Oil Exploration Company (KOEC) on a production sharing contract (PSC) in the East Sea, based on a report by Channel Asia News on June 2, 2006.⁶⁴ KOREX was established as a subsidiary of the Irish company Aminex and the North Korean firm Chosun Energy (as a 50:50 shared company).

Suggested Strategies for Overseas Investors

The Most Fruitful Areas for Foreign Investment

The most opportune areas for foreign investment in the DPRK minerals sector are as described below:

- (1) The iron mines in the Musan and Eunryul areas have a great potential to produce significant benefits for overseas investors due to the fact that the DPRK's biggest

iron manufacturers, the Kimchaek and Hwanghae corporations, could be used to process iron from those mines. Subsequently the steel and pig iron products could be exported to provide returns on investment with low costs for transportation.

- (2) Gold and copper mines could be beneficial investment projects offering low transportation expenses. In recent years, DPRK authorities have proposed that overseas funds be provided to invest in gold mines and copper mines as stated above. Newly explored and developed mines such as the Sangnong, Gapsan, and Shinpa copper mines may be great opportunities for overseas investors.⁶⁵
- (3) Another possible mine for investment is the Danchon Magnesite Mine that could be developed to export products to China and the United States. In this case, it should be possible to cooperate with the authorities for a “win-win” strategic investment. According to private sources,⁶⁶ a DPRK company has made a deal with a Chinese trading company for the export of caustic calcined magnesia (MgO 90 percent, CaO 2.5 percent, SiO₂ 2.5 percent, Fe₂O 1.05 percent, LOI 3.5 percent, Size; 200 mesh 95 percent). In this deal, the selling price of the material FOB Heongnam port was US\$88 per metric ton.
- (4) Mining of limestone ore is another possible application of overseas investments, coupled with the construction of cement factories in the DPRK for the export of cement products to China and South Korea. In addition, with investments in the cement industry, overseas funds could be involved in State-owned Corporations (SOC) in the DPRK, as well as North Korean calcium fertilizer industries that provide products essential to helping the DPRK improve agricultural efficiency.⁶⁷
- (5) The coal mining industry could be an alternative investment for foreign investors, as the DPRK needs to increase the production of coal as a required energy source to drive the country’s economic engine. In this industry, the exploration and development of new coal mines would bring significant benefits to overseas investors.
- (6) Investing in zinc ore mines such as the Gumdock, Hyesan, and Ruckyayon mines has a potential for investors due to the fact that the DPRK has a sufficient existing capacity to refine the zinc ore. As a result, zinc ingots could be exported to provide a good return to investors.⁶⁸
- (7) Tungsten mines could be an alternative destination for investment due to the high price tungsten commands in the international market. The efficient transportation system and the huge deposits of tungsten ore at the Mannyun Mine are currently being further developed and expanded.⁶⁹
- (8) New exploitation of deposits of rare-earth elements such as titanium, indium, and cerium are another area in which the DPRK’s natural resources could be developed. Rare-earth element production has been dominated by Chinese mines in recent years. These mines account for only 30 percent of known global deposits, but represent 97 percent of global production.⁷⁰ North Korea is known to have reserves of these materials in the Kyung-sung and Hurchon areas. In particular, the Saen-gi-ryong area in Kyung-sung-gun is abundant in Kaolin (the raw material for ceramics) as well as includes some indium and cerium elements that are abundant in waste rocks from the Kaolinite mining process.⁷¹ the development of DPRK rare-earth resources for export would yield significant benefits due to the DPRK’s competitive labor costs relative to the costs of Chinese labor.⁷²

Feasible Strategies for Overseas Investors

Co-operating with South Korean firms would be beneficial for overseas investors in order to assist with the security of investment in the DPRK minerals sector and to build relationships with future consumers of mineral products. Investment by South

Korean firms in the DPRK mining industry and the experience in investment in mining trading and mineral resource development by Chinese firms in the DPRK represent valuable experience that overseas investors can learn from.⁷³ In addition, South Korean firms are likely to be willing buyers of minerals products from the DPRK.

Building sustainable relationships with DPRK authorities in mining departments and other officials is significant for hedging risks in the uncertain business environments that prevail in the DPRK. First, using the Korean-Chinese business network, for example trade between the DPRK and China via Chinese-Korean community channel, would be beneficial. These Chinese live in the DPRK and have played major roles in the trading business between the two countries since the 1980s. According to private sources, approximately 5,000 Chinese live in the DPRK (with Pyongyang home to about 2,000, and Hamgyeong-do, and Ryanggang-do home to another 3,000). These Chinese have knowledge of outside news and skills for trading between the two countries and could play major roles in promoting international business opportunities for overseas investors.⁷⁴

Alternative Strategies and Issues for Overseas Investors

Alternative strategies and special issues relating to investment by foreign companies in the DPRK's minerals sector are described below, including possible funding approaches for the development of the minerals sector, issues to consider when reviewing investment opportunities, approaches to making investments in the sector, and mining rights issues for foreign investors. A case study of an investment possibility in a molybdenite mine concludes this section.

Establishing Special Purpose Enterprises (SPEs) for Funding Development of the DPRK Mineral Sector

Due to the large amount of funds needed for investment in this sector, one approach for developing the mining businesses would be to establish SPEs and then issue company debentures or bonds to attract large amounts of investment funding. Individual and institutional investors would be interested in this business opportunity because the DPRK's mineral sector could generate significant benefits (return on investment) if the U.S. or South Korean governments could provide assurance for those investments similar to those that the ROK government has provided in assistance and assurance to Korean companies that invest in Kaesong and other joint ventures.⁷⁵ According to the South Korean government policy for investing in the DPRK, funding for ventures could be subsidized by the South Korean government on the basis of its contribution to North-South Korea economic cooperation. This means that more than 50 percent of investment funds could be provided in the form of government assistance. The U.S. and other governments could also provide such assistance for the overseas mineral exploration businesses.⁷⁶

Factors to Be Considered When Evaluating Potential Investments

There are five major issues that should be considered when overseas investors make decisions regarding investment in the DPRK's mineral sector: 1) The attributes of the deposit of mineral resources with respect to its possible development. 2) The

quality and cost of available labor. 3) The availability and status of infrastructure needed for mining, such as power plants, railways, roads, and ports. 4) The status of environmental regulations. 5) The political and economic stability of the country. In the case of the DPRK, in its current situation, the author believes that 1), 3), and 5) should be improved to allow safe investments in the mineral sector. Based on the experience of South Korean companies, the DPRK authorities seem to have principally considered three factors when overseas investors offer investment possibilities: 1) the scale of the investment 2) whether the investment will result in the transfer of mining technologies to the DPRK 3) whether the investment will support infrastructure development.

Possible Scenarios for Investment

Contracting for equipment supply in exchange for mineral products is an option that avoids the possible failure of large investments in the DPRK. Due to environmental concerns in developed nations that result in mine closures and a surplus of mining infrastructure, second-hand mining equipment and facilities could be assembled at low cost and exchanged for mineral resources in initial deals with the DPRK. Small amounts of funds could then be invested in DPRK mining operations in a gradual fashion if the deals proceed as expected.

Investing in operational mines and drawing on economic deposits of mineral resources reduces risk. Investing in new mine development with initial exploitation step requirements is a significantly more risky business when compared to the investment in existing mines. Investing in existing mines would be an appropriate strategy to reduce the possibility of investment failures in the DPRK. With regard to difficulties in the DPRK energy sector as they might affect the more than 20 mine development projects for overseas investors that have been identified by DPRK authorities,⁷⁷ energy supplies can be provided if investments in mining projects require energy supply upgrades.

Conclusion

The minerals industry in the DPRK represents a significant part of North Korean exports and account for 15.2 percent of exports in 2005. The DPRK holds the great bulk of the total known minerals deposits on the Korean peninsula that are estimated to be nearly 30 times those of South Korea. The minerals production sector in North Korea lacks modern equipment and suffers from electricity shortages. Equipment in many mines is decades old and include some materials that date back to the Japanese colonial period. The DPRK is unlikely to be able to develop these resources and increase production on its own due to its economic isolation. The exception is uranium mines in the DPRK that have received significant resources from the KPA, use equipment that is more modern, utilize specialized transportation facilities, and with workers that are accorded special status, receive preferential access to food, and other bonuses.

The exploitation of the DPRK's mineral resources through linkages with South Korean and overseas consumer markets is likely to be the most profitable way for the DPRK to develop its minerals sector due to the inability to redevelop the domestic

minerals sector. Chinese and South Korean firms have the most experience in investing in the mineral sector. Mineral sector development activities and Korean-Chinese business networks can be extremely beneficial in building relations with DPRK officials and acting as an intermediary for investors.

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