

Present Status of Mineral Resources, Republic of Korea

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Abstract : South Korea has about 50 useful mineral commodities for the mineral resources, among 330 kinds of minerals described. In 1986, she exported 14 mineral commodities of silver, lead, tungsten, molybdenite, ceramic minerals, limestone and graphite etc...

And the component ratio of mining industry in the gross national production (GNP) of South Korea maintains 1.5% during last five years(1982 to 1986).

INTRODUCTION

Before the 20th century, mineral resources of Korea limited to a few minerals, chiefly gold, iron and the base metals, to local exploitation of ceramic minerals, and to the quarrying of building stone and small quantities of ornamental stone for carving.

With the beginning of this century, the contributive weight of mineral resources industry to the industrial economic growth of Korea is on the increase, compared with those of other natural resources industries as well as those of the advanced countries in the world.

Korea has about 50 useful mineral commodities for the mineral resources industry, among 330 kinds of minerals, except petroleum, platinum, diamond and mercury for lack of related basic and/or ultrabasic rocks in the country.

In 1986, South Korea exported 14 mineral resources of silver, lead, tungsten, molybdenite, ceramic minerals, limestone and graphite etc...

GENERAL GEOLOGY

Geology of Korea comprises all geological sequences from Early Precambrian to Recent-

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(Kobayashi, 1953 ;C.H. Cheong, 1956 H.Y. Lee, 1982, 1983), except for the great break extending from late Silurian to Early Carboniferous Periods in which no sedimentary formation is known to be deposited. South Korea is geologically bound to North Korea by the Chugaryeong Rift Valley of N-NE trend(Fig. 1).

On the basis of tectonics and geology, South Korea can be divided into four geological provinces(Fig. 2) and their major geology(Tab. 1) are summarized as follows ;

Gyeonggi Massif--Rocks of the Precambrian Yeoncheon System, as well as the

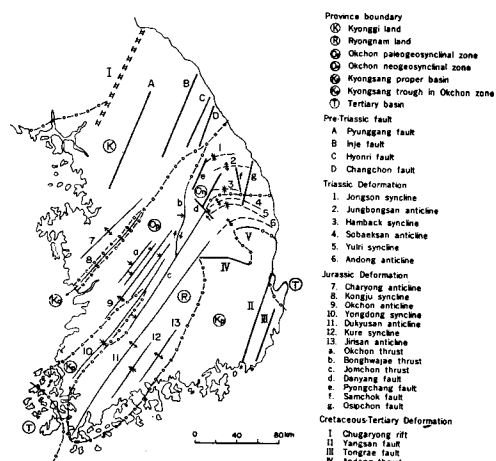


Fig. 1 Geological provinces and structural map of South Korea (After O.J.KIM et al., 1977)

Table 1 Generalized geological sequence in South Korea (after O. J. Kim, 1975)

Age	C. H. CHEONG (1956)		O. J. KIM (1973)	
	System	Series	System	Series
Cenozoic	Quaternary		Quaternary	Basalts
	Tertiary	Yonil Janggi	Tertiary	Yonil Janggi
Mesozoic	Cretaceous	Balkusa (Granite & porphyry) intrusion Silla Naktong	Kyongsang	Granites (Balkusa granites) Volcanics Silla Naktong
	Jurassic	Ryukyong Sonthyon Nokam Kobangsan Sadong Hongjom	Daedong	Granites (Daebo granites) Undifferentiated in S. Korea Granite ?
Palaeozoic	Triassic	Nokam		Nokam Granite ?
	Pyongan Permian Carboniferous	Kobangsan Sadong Hongjom	Pyongan	Kobangsan Sadong Hongjom
Proterozoic	Devonian	Chonsongri ?		Granite ?
	Silurian Ordovician Cambrian	Great limestone Yangduk Kuihyon Sadangwu Jikhyon	Chosun Okchon (late)	Lacking Great limestone Yangduk Kunjasan Hwanggangri Changri Munjuri Hyangsanri Kemyongsan Taebaksan Kosonri Kakhwasa Wonnam Kisong Pyonghae
Archeozoic			Yulri (middle)	Granite gneiss
		Granite gneiss	Ryongnam (early)	Chuncheon granite gneiss Yonchon Puchon

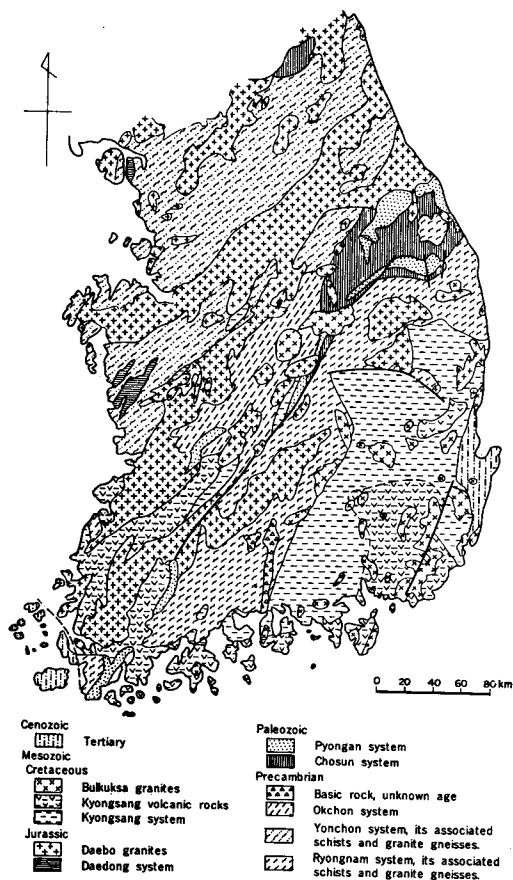


Fig. 2 Geological map of South Korea(after O.J.Kim, 1975)

younger Jangrak and Chunsong Groups and the associated granitic gneisses are widely distributed in the massif. The Mesozoic Daebo granite is widespread across the peninsula in the Sinian Direction (NE to SW).

Yeongnam Massif--The Precambrian Yeongnam and Yulri Systems, granite gneisses, and Mesozoic Daebo granite are widespread. The Daebo granite is aligned in the Sinian Direction, but not so clearly as in the Gyeonggi Massif.

Ogcheon Geosynclinal Zone--This zone is within the Gyeonggi - Yeongnam Massif. Paleozoic to Mesozoic sedimentary formations are distri-

buted in the northeastern neogeosynclinal zone, and Precambrian Ogcheon System is present in the southwestern paleogeosynclinal zone. The Jurassic Daebo and late Cretaceous Bulgugsa granites are scattered in both zones.

Gyeongsang Sedimentary Basin--Cretaceous terrestrial sedimentary formations and associated volcanic flows and tuffs are present, and the late Cretaceous and Paleogene Bulgugsa granite intrudes randomly into the sedimentary rocks in the basin.

Tertiary Basins--Neogene sedimentary formations and the associated basaltic flows and tuffs are present in the small tertiary basins and in Cheju Island of the south end of the peninsula. Granites also crop out there, and some has been dated as Paleogene granites.

MINERALIZATION

Metallogenesis of mineral resources of Korea can be treated in two folds; those related with acidic igneous rocks, and those of sedimentary and secondary origin.

Majority of hydrothermal deposits are embedded in Precambrian schists and gneisses as well as younger sedimentary formations up to Gyeongsang Formations. Nearly entire contact replacement deposits are in lenticular limestone layers in Precambrian formation as well as in Great Limestone Series of Cambro-Ordovician Periods.

Mineral deposits of Korea are divided into four metallogenic epochs and accompanied mineral commodities are as follows;

- (1) Precambrian--Sedimentary origin of hematite bearing quartz schist and crystalline graphite schist beds; also syngenetic, uranium and vanadium

bearing black shale in late Precambrian age(Fig. 7), magmatic segregation type of titaniferous magnetite deposits and nickel deposits of deuteric stage mineralization related to basic magma ; finally several occurrences of low grade cassiterite bearing pegmatite deposits(Fig. 3).

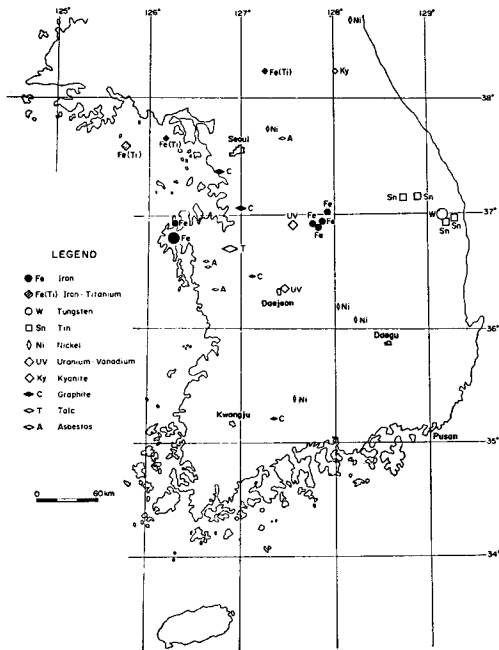


Fig. 3 Metallogenic map of South Korea Precambrian Epoch.
For figure 3 to 5, size of the symbols indicate relative size of the mineral deposits (after N.Y.Park, 1981)

- (2) Paleozoic---Two hematite beds ; one in Dongjom quartzite bed of Ordovician and the other in bed of Hongjom Series of upper Carboniferous. Sedimentary limonite beds occur in the upper horizon of Sadong Series of Permian age.
- (3) Jurassic to early Cretaceous---Hypothermal gold-silver veins related to Daebo granite are widely distributed and some occurrence of wolframite quartz veins are observed in and near the

Daebo granite batholith(Fig. 4).

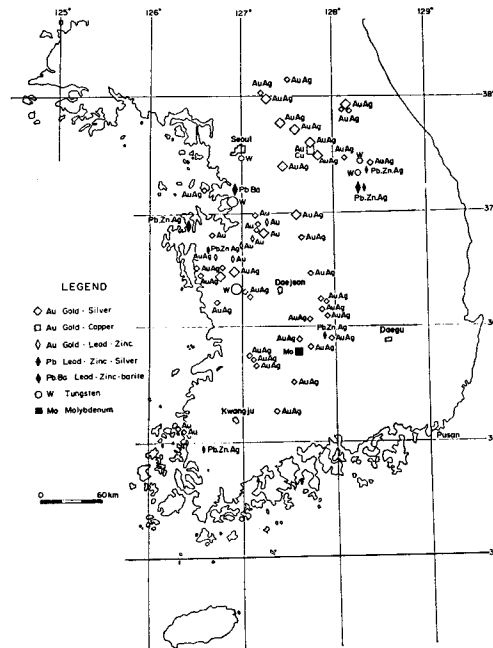


Fig. 4 Metallogenic map of South Korea Jurassic- Early Cretaceous Epoch (after N.Y.Park, 1981)

- (4) Late Cretaceous to early Tertiary---Strong and various kinds of mineralization provided by Bulgugsa granite magmatism. Replacement type of copper, lead-zinc, tungsten, iron and fluorite deposits, and breccia or porphyry type of copper deposits, vein type of gold-silver, copper, lead-zinc and tungsten-molybdenum deposits were formed in this epoch(Fig. 5).

MINERAL RESOURCES

The most important mineral resources in South Korea are tabulated in Table 2 and summarized as follows ;

- (1) Resources of metallic minerals---Gold, silver, copper, lead, zinc, iron, uranium, tungsten, molybdenum, tin, man-

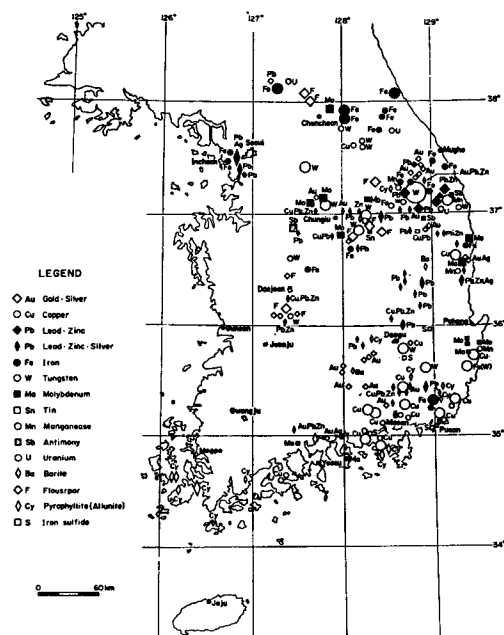


Fig. 5 Metallogenetic map of South Korea Cretaceous-Tertiary Epoch (after N.Y.Park, 1981)

ganese, bismuth and some rare metals.

- (2) Resources of non-metallic minerals---Graphite(both crystalline and amorphous), talc, limestone, dolomite, kaolin, pyrophyllite, feldspar, quartz, silica sand, mica, diatomite, asbestos, fluorite, barite, andalusite, and phosphate.
- (3) Resources of sub-metallic minerals---Arsenopyrite and stibnite associated with

sulfide minerals.

- (4) Resources of placer deposits---Monazite, zircon, ilmenite, garnet, magnetite and gold.
- (5) Resources of fossil fuel and nuclear energy---Anthracite and a little amount of lignite, and low grade uranium minerals.
- (6) Resources of construction materials---A great deal of building stones with high qualities which are produced mainly from granite complexes and partly from shales, sandstones and marbles in the whole country.

Especially, the coal-fields and uranium occurrences of South Korea are shown in Fig 6 and 7. The distribution of the coalfields are located in two different geologic units; the

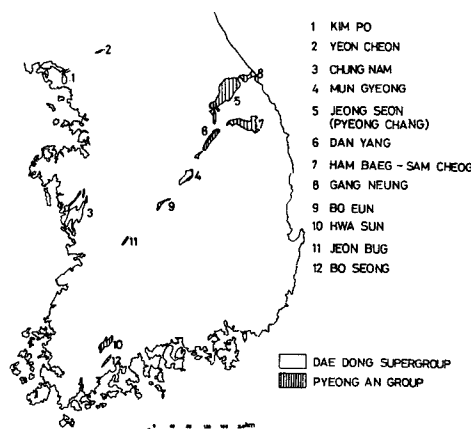


Fig. 6 Distribution of the Coalfields of Korea

Table 2 The Most Important Mineral Resources of Korea. the

RESOURCES	MINERALS and/or ROCKS
Metallic Mineral	Gold, Silver, Copper, Zinc, Lead, Iron, Manganese, Tungsten, Molybdenum, Tin, Bismuth and some Rare Metals.
Non-metallic Mineral	Graphite, Talc, Pyrophyllite, Feldspar, Kaoline, Limestone, Dolomite, Quartz, Silica Sand, Diatomite, Asbestos, Fluorite, Barite, Mica, Andalusite, Pyrite and Phosphate.
Sub-metallic Mineral	Arsenopyrite and Stibnite associated with Sulfide Minerals.
Placer Deposits	Monazite, Zircon, Ilmenite, Garnet, Magnetite and Gold.
Fossil Fuel and Nuclear Energy	Anthracite and a little amount of Lignite, and Low Grade Uranium Minerals.
Construction Materials	Building Stones from Granite, Shale, Sandstone and Marble.

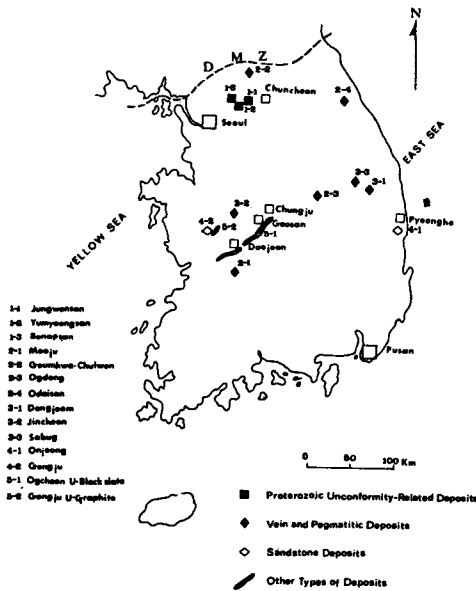


Fig. 7 Uranium occurrences of Korea (after J.H.KIM, 1986)

large-scaled coalfields are in Pyeong An Group and the other small ones are in Dae Dong Supergroup.

The uranium occurrences of the country are originated from four different types; (1) Proterozoic unconformity-related Deposits, (2) Vein and pegmatitic deposits, (3) Sandstone type deposits(Gongju and Onjeong deposits) and (4) Other types of deposits. Among above them, Ogyeung U-V-bearing black slate(Other Types of Deposits)and proterozoic unconformity-related deposits(Bonapsan, Jungwonsan and Yumyeongsan) had been prospected and reported as the low grade uranium reserves(116 million M/T, U_3O_8 0.039%).

PRESENT STATUS OF MINERAL RESOURCES

Reserves of Mineral Commodities

Thirty-nine mineral commodities are compiled their total ore reserves with average grades in Fig-8.

Eight mineral commodities(anthracite, limes-

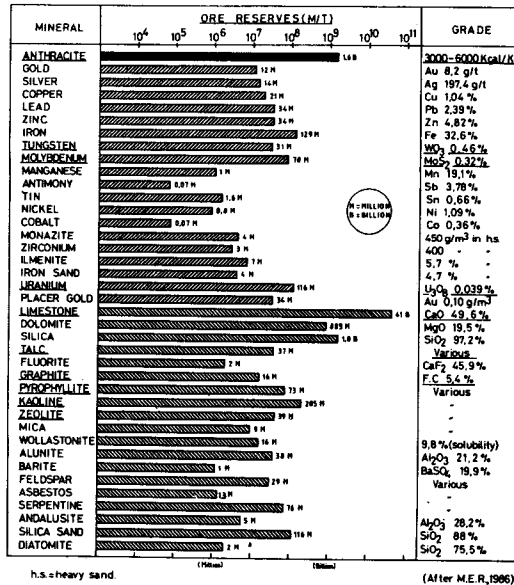


Fig. 8 Ore Reserves of Korea

tone, silica, iron, uranium, dolomite, kaolin and silica sand) have over 100 million M/T of total ore reserves, 10 to 100 million M/T are 16 mineral commodities(gold, silver, base metals, talc, and graphite etc.), and under 10 million M/T are 15 mineral commodities(tin, fluorite, ilmenite, mica, and monazite etc.).

Annual Production of Minerals

According to the statistical data from Ministry of Energy and Resources(M.E.R., 1987), South Korea has produced over 0.1 million metric tons of 8 metallic minerals and 15 non-metallic minerals during last 7 years(1980 to 1986, Tab 3).

The annual production of only 4 minerals-(gold, silver, graphite and limestone) are progressively increased because of the international metal price and/or internal demands. The other ones, however, are generally decreased.

Exportation of Mineral Commodities

During the last 5 years(1982 to 1986), South Korea has annully exported 14 mineral

Table 3 Annual production of minerals in Korea from 1980 to 1986.

Mineral	Year							
	1980	1981	1982	1983	1984	1985	1986	
METAL	Gold	1.3	1.3	1.7	2.2	2.5	2.4	4.6
	(Au 99.9%)	87	100	101	105	117	124	157
	Silver							
	(Ag 99.9%)							
	Copper	1,500	1,800	2,100	2,600	1,900	1,200	800
	(Cu 25%)							
	Lead	23,000	27,000	24,000	25,000	22,000	19,000	24,000
	(Pb 50%)							
	Zinc	0.11M	0.11M	0.12M	0.11M	0.10M	0.10M	0.10M
	(Zn 50%)							
Tungsten	4,900	4,900	4,400	4,500	4,900	4,700	4,400	
(WO ₃ 70%)								
Molybdenum	560	870	670	260	290	620	590	
(MoS ₂ 90%)								
Iron	0.62M	0.59M	0.62M	0.66M	0.63M	0.67M	0.58M	
(Fe 56%)								
NONMETAL	Graphite	60,600	38,700	27,000	33,300	58,600	71,500	97,200
	Talc	0.21M	0.17M	0.13M	0.17M	0.19M	0.19M	0.21M
	Asbestos	9,900	13,600	15,900	12,500	8,100	4,700	3,000
	Kaoline	0.58M	0.70M	0.63M	0.69M	0.72M	0.66M	0.85M
	Pyrophyllite	0.52M	0.40M	0.47M	0.46M	0.66M	0.74M	0.59M
	Limestone	28.0M	28.3M	30.7M	33.0M	33.5M	35.1M	38.1M
	Diatomite	25,100	42,200	55,300	56,000	48,500	53,600	54,800
	Silica	0.29M	0.55M	0.49M	0.84M	0.89M	0.87M	0.89M
	Feldspar	72,000	0.10M	85,000	0.11M	0.13M	0.15M	0.13M
	Fluorite	6,900	6,500	3,700	6,400	4,700	700	200
	Silica Sand	0.51M	0.59M	0.66M	0.64M	0.86M	1.10M	1.23M
	Mica	10,300	8,200	20,400	14,400	24,400	20,000	42,000
	Serpentine	0.27M	0.27M	0.27M	0.27M	0.37M	0.38M	0.32M
	Andalusite	82	86	33	289	209	42	-
	Anthracite	18.6M	19.9M	20.1M	19.9M	21.4M	22.5M	24.3M

Unit : Metric Ton. M : Million Tons.

(After N. E. R., 1986)

commodities(6 metallic minerals and 8 non-metallic minerals).

The exportation of mineral resources are decreased for metallic minerals and are generally increased for the non-metallic minerals (Tab.4 and Fig.9)

Present Condition of Mineral Support

The present condition of mineral support of South Korea are showed in Table-5.

In 1986, 14 mineral resources(5 metallic minerals and 9 non-metallic minerals) were self-support, 16 mineral resources were partial-support and 15 mineral resources with petroleum

depended on the whole-import in South Korea. these phenomena have been maintained for the recent 5 years in south Korea.

Finally, the component ratio of mining industry in the Gross National Production(GNP) of South Korea is dropped from 1.9% in 1961 to 1.5% during last 5 years(1982 to 1986). This decrease is caused by the rapid growth of other industries as well as the developed countries in the world.

CONCLUSION

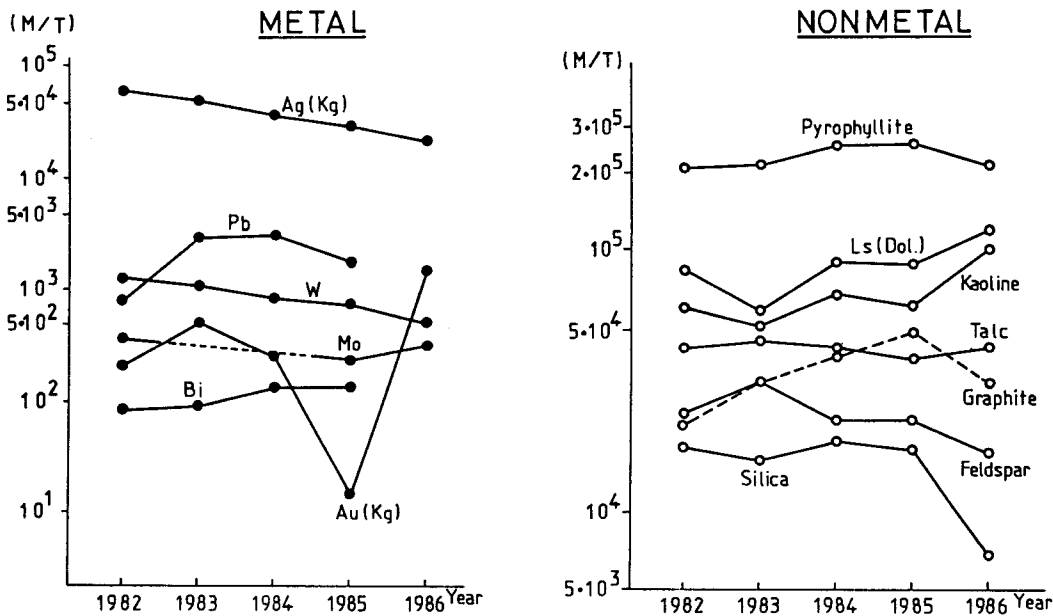
South Korea has about 50 useful mineral commodities for the mineral resources industry,

Table 4 Annual Exportation of Minerals in Korea from 1982 to 1986.

Mineral		Year	1982	1983	1984	1985	1986
METAL	Gold		208	599	251	15	1,413
	Silver		60,879	51,504	37,925	29,233	21,796
	Lead		800	2,850	3,000	1,700	-
	Tungsten		1,222	1,061	859	747	514
	Molybdenum		360	-	-	230	308
	Bismuth		83	92	136	139	-
NON METAL	Graphite		21,723	31,609	39,847	48,353	30,969
	Talc		41,836	45,898	40,650	37,987	42,486
	Pyrophyllite		207,929	213,228	252,288	251,374	203,769
	Feldspar		23,551	31,679	22,988	22,746	16,759
	Kaoline		60,302	52,283	68,406	60,338	101,176
	Limestone		83,500	59,565	92,045	89,100	117,000
	Silica		18,233	16,041	18,505	17,764	6,654
	Silica Sand		2,000	2,000	3,054	5,001	2,012

Unit : M/T (Gold and Silver : kg).

(After M. E. R., 1986)

**Fig. 9** Mineral Exportation of Korea

among 330 kinds of minerals described.

In 1986, she has exported 14 mineral commodities (amounting 45 million dollars) of silver, lead, tungsten, molybdenite, ceramic minerals, limestone and graphite etc... Especially, south Korea is one of the main tungsten and graphite producing country in the free world.

And the component ratio of mining industry in the gross national production (GNP) of South Korea is dropped from 1.9% in 1961 to 1.5% during last 5 years (1982 to 1986). This phenomenon is caused by the rapid growth of other industries in the country.

Table 5 The Present Condition of Mineral Support of South Korea in 1986.

CONDITION	No.	MINERAL
Self-Support	14	Metal (5) Silver, Molybdenite, Tungsten, Lead, Pyrite. Non-Metal (9) Amorphous graphite, Feldspar, Limestone, Silica Stone, Serpentine, Wollastonite, Zeolite, Pyrophyllite, Alunite.
Partial-Support	16	Metal (5) Gold(52%), Copper(0.2%), Lead(30%), Iron(5%), Ilmenite(27%). Non-Metal (11) Kaoline(88%), Silica Sand(86%), Asbestos(4%), Fluospar(0.7%), Crystalline graphite(16%), Mica(97%), Cyanite(3%), Barite(61%), Talc(80%), Diatomite(97%), Crystal quartz.
Whole-import	14	Metal (7) Manganese, Aluminium, Chrom, Zirconium, Antimony, Tin, Tantalum. Non-Metal (7) Phosphate, Sulfur, Magnesite, Uranium, Andalusite, Gypsum, Boron.

(Data from M. E. R., 1987)

REFERENCES

- Burke, K.(1960) - Ore mineral zones related to granite in South Korea. Geol.Surv. Korea. Bull., no. 4, pp. 141-147.
- Cheong, C.H.(1956) - Outline of the geology of Korea. Geol. Surv. Korea. Bull., no. 1, pp. 12-28(in Korean).
- Gallagher, D.(1963) - Mineral resources of Korea. Vol. I-IV, USOM/KOREA.
- Kim, J.H.(1977) - Metallogeny of Korea. J. Geol. Soc. Korea., Vol. 13, pp. 267-275.
- Kim, O.J.(1968) - Stratigraphy and tectonics of Ogcheon system in the area between Chungju and Mungyong. J. Korea. Inst. Mining Geol., vol. 1, pp. 35-46(in Korean).
- _____(1969) - Geology and tectonics of the mid-central region of south Korea. J. Korea. Inst. Mining Geol., Vol. 2, pp. 73-90 (in Korean).
- _____(1971a) - Study on the intrusive epochs of the Younger Granites and their bearings to orogenies in South Korea. J. Korea. Inst. Mining Geol., Vol. 4, pp. 1-10(in Korean).
- _____(1971b) - Metallogenic epochs and provinces of South Korea. J. Geol. Soc. Korea., Vol. 7, pp. 37-59.
- _____(1972) - Precambrian geology and structure of the central region of South Korea. J. Korea. Inst. Mining Geol., Vol. 5, pp. 231-240(in Korean).
- _____(1973) - The stratigraphy and geologic structure of the metamorphic complex in the northeastern area of the Gyeonggi massif. J. Korea. Inst. Mining Geol., Vol. 6, pp. 201-218.
- _____(1975) - Granites and tectonics of South Korea. J. Korea. Inst. Mining Geol., Vol. 8, pp. 223-230.
- _____, Lee, H.Y. and Lee, D.S.(1977) - Summary of the geology of south Korea. J. Korea. Inst. Mining Geol., Vol. 10, pp. 129-154.
- Kobayashi, T.(1953) - Geology of South Korea. University of Tokyo Press, Tokyo.
- Lee, H.Y.,(1982a) - Conodonts from the Hoedongri Formation (Silurian), Western Chongson Area, Kangwondo, South Korea. J. Nat. Acad. Sci. R.O.K. Nat. Acad. Sci. Nat. Sci. Ser., v.21, p.43-131(E-K).
- Lee, H.Y.,(1982b) - Conodonts from the Hoedongri Formation (Silurian), Kangwondo, South Korea. Third European Conodont Symposium(ECOS III), Abstracts, Lund, p.16.
- Lee, H.Y.,(1983) - Conodont biostratigraphy of

- the Hoedongri Formation (Silurian) in Western Chongson area, Kangwondo, south Korea, J. Nat. Sci. Res. Inst. Yonsei Univ. v.12, p.77-90.
- Lee, S.M.(1972) - Metamorphic facies and facies series in relation to the tectonics of south Korea. 24th Int. Geol. Congr., sec. 2, pp. 81-87.
- _____ (1974) - The tectonic setting of Korea with relation to plate tectonics. United Nations ESCAP, CCOP Tech, Bull., Vol. 8.
- Ministry of Energy and Resources (1987) Annual statistics on the mineral supply and demand of Republic of Korea in 1986.
- Park, B.K. and Kim, S.W.(1971) - Recent tectonism in the Korean Peninsula and sea floor spreading. J. Korea. Inst. Mining Geol., Vol. 4, no. 1, pp. 39-43.
- _____ and So, C.S.(1972) - The Ogcheon System in the central part of southern Korean Peninsula as an ancient island arc. J. Geol. Soc. Korea, Vol.8, no. 4(in Korean).
- Park, N.Y.(1981) - Geology and mineral deposits of Korea. Report of geological Survey of Japan, No. 261, pp. 93-106.

韓國의 鑛物資源 現況

要約: 韓國에는 330余種의 鑛物이 記載되었으며, 其中 50余種이 鑛物資源으로 產出되고 있다. 1986年度에는 銀, 鉛, 重石, 輝水鉛石, 窯業鑛物, 石灰石 및 黑鉛等 14種의 鑛產物을 輸出한 바 있다. 또한 最近 5年間(1982~1986) 國民總生産中 鑛業部門이 차지하는 比率은 1.5%를 지속하고 있다.