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MANGANESE DEPOSITS OF KOREA*

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ABSTRACT. Deposits of many types are known in Korea, apparently none of notable size. They are found in the southeastern and central parts of South Korea and occur in Precambrian, Paleozoic, Mesozoic and Cenozoic rocks. Hydrothermal fissure filling deposits, hydrothermal replacement deposits, sedimentary deposits, and supergene epigenetic deposits are found. The hydrothermal deposits are associated with base-metal ores and also with gold-silver ores, which increase in tenor with depth as the manganese, usually in the form of rodochrosite, diminishes in tenor. Minor manganese oxide deposits associated with spilitization of andesite occur. One sedimentary bed of manganiferous rock intercalated into Precambrian dolostone ranges from 0.5 to 0.1 m in thickness over an outcrop length of 9 km; unfortunately the rock has been metamorphosed and contains a high percentage of silicates of no economic value as well as manganese carbonate.

INTRODUCTION

The manganese deposits of Korea (South Korea) are generally distributed in the southeastern and central parts of Korean peninsula. They occur in the pre-Cambrian, Paleozoic, Mesozoic, and Cenozoic rocks *(Fig. 1)*.

The manganese deposits of Korea can be classified genetically into:

1. Hydrothermal fissure filling deposits,
2. Hydrothermal replacement deposits,
3. Sedimentary deposits, and
4. Superficial deposits.

HYDROTHERMAL FISSURE FILLING DEPOSITS

There are two distinct types of hydrothermal fissure filling deposits. They are vein deposits and breccia-filling deposits.

Veins of the manganese ores are generally found in the Paleozoic dolostone and limestone, pre-Cambrian schists, Mesozoic andesite, granite, and sedimentary rocks, and Tertiary rhyolite. Manganese ore veins nearly always cut the general structures of the country rocks. The contact between the ore veins and their country rocks are generally sharp. The manganese ore veins are grouped as follows:

1. Veins of the manganese oxides only,
2. Veins of rhodochrosite with gold-silver ores,
3. Veins of rhodochrosite with base-metals, and
4. Veins of rhodonite only.

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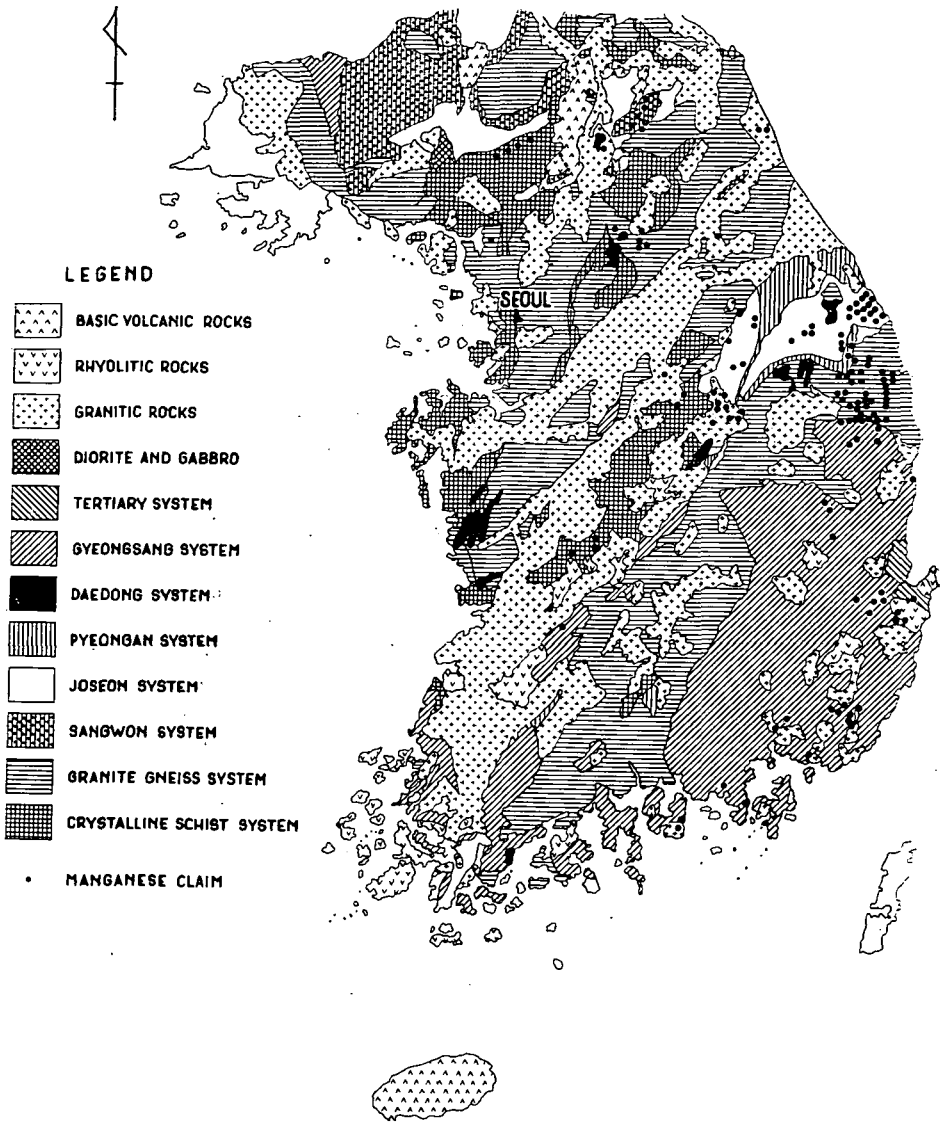
FIG.1. DISTRIBUTION MAP OF MANGANESE DEPOSITS OF SOUTH KOREA

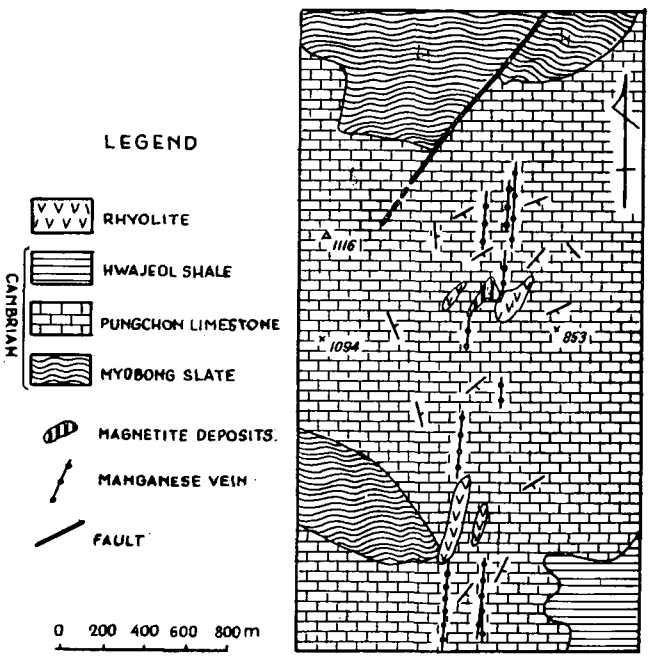


The manganese oxide veins of hydrothermal origin are generally found in the Mesozoic sedimentary rocks and Tertiary rhyolitic rocks. They are closely connected with the subvolcanic rocks in their genesis. Small-scale manganese oxide ores are also found in andesite. They are believed to have originated from spilitization of andesite.

The manganese carbonate veins were formed in close relation to granodiorite

or rhyolitic rock in their genesis. The manganese carbonate veins genetically connected with granodiorite generally accompany the gold-silver or base-metal ores. The manganese carbonate veins genetically connected with rhyolitic rocks frequently accompany the iron ores. The manganese carbonate veins in Dongnam Mine are associated with the magnetite ores of earlier replacement phase. They accompany the hematite ores in one and the same veins in places *(Fig. 2)*.

FIG. 2. GEOLOGIC MAP OF DONGNAM MINE, KOREA

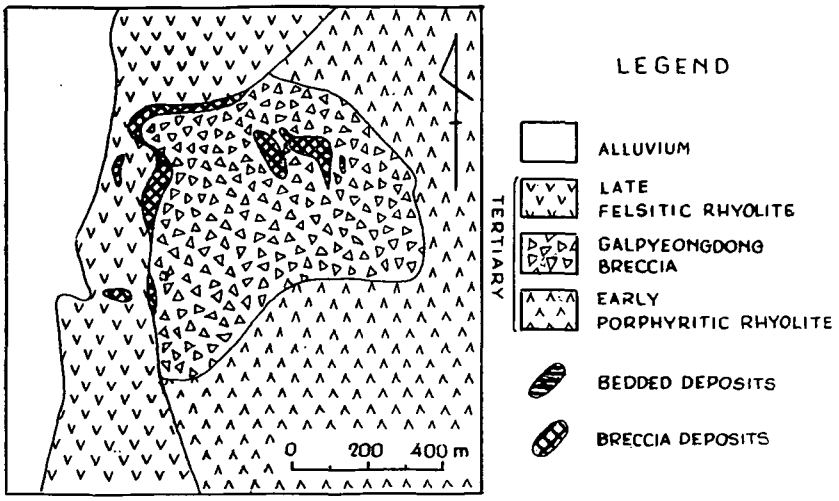


The manganese carbonate ores near the surface change gradually into gold-silver veins, or base-metal veins or replacement ore bodies with increasing depth. The outstanding example is observed in Yeonhwa Mine, where the large lead-zinc-copper deposits of vein and replacement characters were found below the rhodochrosite veins. Breccia-filling deposits are found in the Tertiary subvolcanic rhyolitic rocks *(Fig. 3)*. The rhyolitic rocks are throughly crushed along the contact with the country rocks. The highly porous interstices of the brecciated rhyolitic rocks are filled with the manganese oxide ores. The manganese oxides are also found in the fissures in rhyolite in the same area. It is uncertain whether the rhyolitic rocks were erupted in a submarine environment. Rhodonite veins in altered andesite are believed to have formed from the manganese and silica originating from spilitization of andesite.

HYDROTHERMAL REPLACEMENT DEPOSITS

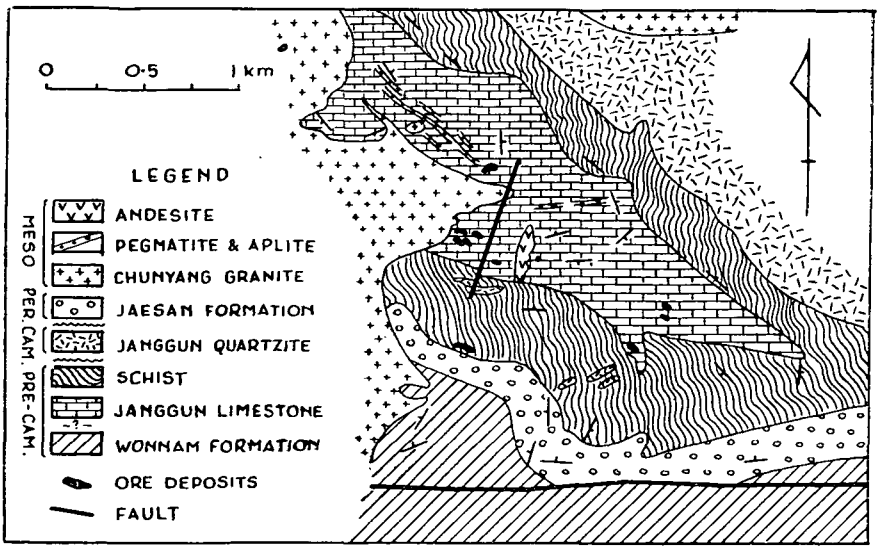
The manganese deposits of replacement type are not abundant but they are very important as the main source of the manganese ores in Korea. The typical deposits of this type are Janggun manganese deposits in which the manganese

FIG.3. GEOLOGIC MAP OF YEONGIL MANGANESE DEPOSITS, KOREA



carbonate ores were formed by replacement of dolostone and limestone *(Fig. 4)*. Dolostone is developed only around the manganese carbonate ore bodies. It is believed that the manganiferous solutions arose along faults and replaced the dolostone along the fissures and along the beds. The extent of replacement by rhodochrosite along the beds is not great. The manganese carbonate ores decrease gradually with depth and conversely the base-metal ores increase in their amount. Although small masses of andesite are found near the ore deposits, they have no connection with the formation of the manganese deposits. It is believed that andesite intruded

FIG. 4. GEOLOGIC MAP OF JANGGUN MINE, KOREA

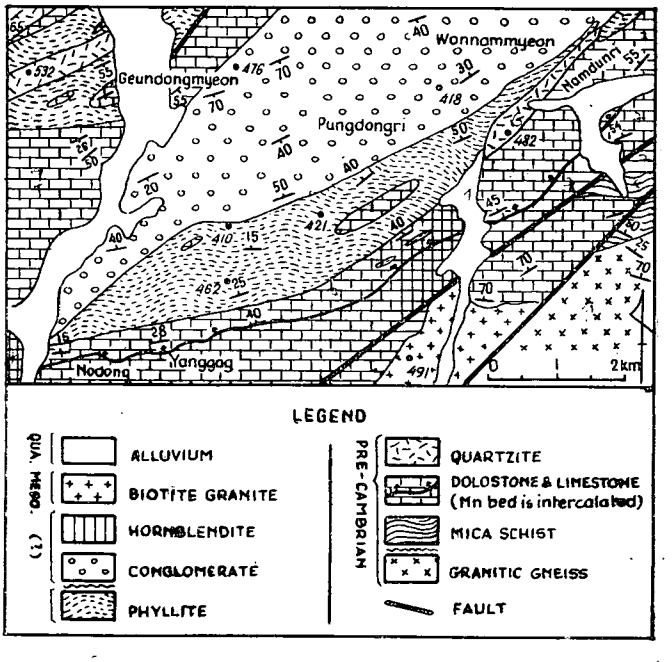


later than the manganese mineralization. The fact that the manganese ores are also found in the Permian schists in this area indicates that the manganese mineralization probably took place in the Mesozoic Period.

SEDIMENTARY DEPOSITS

Sedimentary manganese deposits in Korea are found in the pre-Cambrian and Paleozoic formations. The most important pre-Cambrian manganese formations are metamorphosed. They are mainly found in the central part of Korea. They occur in the dolostone and limestone or calcareous formations of the pre-Cambrian. The manganese formations in Gimhwa district are embedded in the thick dolostone having a strike of N40—70° E, and dip of 50—60° NW *(Fig. 5)*. The manganese formation ranges from 10 to 50 cm in thickness, and extends about 9 Km on the same horizon. The average grade of the ores is 20—30 % Mn. The ores are composed of rhodonite, rhodochrosite, manganoan dolomite and mangangarnet.

FIG. 5. GEOLOGIC MAP OF GIMHWA AREA, KOREA



The manganese formations in Gapyeong district occur in mica schists along the schistosity. The ores are composed of rhodonite and manganiferous pyroxene.

Only thin lenses of the manganese otides are embedded in the Paleozoic shale in Samcheog district. It is very interesting that the small-scaled recent manganese conglomerate formation is found on the terrace near the Tertiary manganese deposits.

SUPERFICIAL DEPOSITS

In the past, most of the manganese oxide ores in Korea were produced from the superficial oxidation deposits. Nearly all the manganese carbonate and silicate deposits primary in nature are deeply oxidized near the surface. Typical superficial manganese deposits are Janggun, Yeonhwa and Dongnam mines. Original manganese carbonates are oxidized to various manganese oxide minerals such as manganite, birnessite, pyrolusite, nsutite, cryptomelane, and psilomelane. The manganese oxide ores are found as residual concentration deposits or as the cavity-filling deposits formed from the descending manganese colloids.

AGES AND TYPES OF MINERALIZATION

Manganese mineralization in the pre-Cambrian is characterized by sedimentary deposits associated with dolostone and limestone. In the Paleozoic, manganese was deposited so little as to be non-economic. In the Mesozoic, the manganese oxide and carbonate veins or replacement deposits were formed as the result of igneous activity such as intrusion of granodiorite, and the manganese oxide and silicate deposits were formed from spillitization of the andesitic rocks. In the Tertiary, the manganese oxide and carbonate veins and breccia deposits were formed in close connection with rhyolitic subvolcanic activity. In the Recent, the small-scale manganese conglomerate formations were deposited in a fluvial basin.

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