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Geology, Mineralogy and Geochemistry of the Shinyemi Iron Deposit, Korea: Implications for a Genetic Model

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1 Introduction

The Shinyemi iron deposit, one of the biggest Fe deposits in South Korea, is proximal polymetallic deposits along the contact between the Cambro- Ordovician Makgol formation of the Joseon Supergroup and the Cretaceous granitoid. According to spatial location of the ore bodies, it can be divided by eastern Pb-Zn-Mo orebody and western Fe-Mo orebody. In recent boring data, these Shinyemi granitoid was intruded along gentle slope of Makgol carbonates and proximal iron orebody formed at both upper and lower part of the subvolcanic intrusives. The lower (eastern) orebody was transformed from the proximal Fe skarn at the bottom to a transitional Zn-Cu-Mo skarn at the top. On the other hand, the upper (western) orebody exhibits predominant Fe-mineralization with brecciation. The aims of this study are to present and document characteristics of related igneous rocks and to discuss the evolution of skarn and ore formation model in the Shinyemi polymetallic mineralogical deposits.

2 Shinyemi Granitoid

The Shinyemi granitoid is mainly composed of fine-grained biotite granite, aplite, quartz porphyry, and rhyolitic breccia, implying very shallow emplacement. The age of quartz porphyry is ca. 75~78Ma (Sato et al., 1981) and biotite granite is 75Ma (Yang, 1991).

As results of whole rock analysis of the Shinyemi granitoid, the major, trace, and REE geochemisty suggests that these granitoid represents highly evolved intrusions, calc-alkaline, peraluminous to metaluminous I-type intrusions, generated in a volcanic arc setting, e.g., 72.07～77.32 wt. % SiO_2, $(La/Yb)_N$ = 8.2~12.0, and Rb/Sr and K/Rb ratios of 0.68~3.57 and 208.3～346.3. In productive discriminant diagram about commodities (Meinert, 1982), the Shinyemi granitoid which shows Mo-related characteristics corresponds with molybdenite as by-product. However, it is different that the main ore mineral of the Shinyemi deposit is magnetite.

Aleksandrov (1998) suggests although acidic igneous rocks provide limited Fe, leucocratic melts, the post-magmatic changes in the femic minerals of the main intrusions stimulate the supply of iron into the hydrothermal solution.

3 Skarnification

The Shinyemi skarn deposit comprises various exoskarns (e.g., magnesian and calcic skarns) and endoskarns/skarnoids. Endoskarns/skarnoids recognized by residue of the Shinyemi granitoid formed simple mineral assemblages with fine garnet, clinopyroxene, and plagioclase. Magnesian skarn assemblages consist of olivine, clinopyroxene, monticellite, clinohumite, serpentine, talc, amphibole, phlogopite, Mg-rich chlorite, and lots of magnetite, whereby clinopyroxene, garnet, vesuvianite, epidote, amphibole, phlogopite, Fe-rich chlorite and a little magnetite assemblages characterized calcic skarns.

The Fe orebodies are closely associated with the magnesian skarn such as the massive skarn, layered skarn, vein skarn and breccia skarn. In the layered skarn, magnetite layers within the magnesian skarn alternate with olivine, clinohumite layers, whereby magnetites occurred with calcic skarn and magnesian skarn mineral in the massive skarn. The breccia skarn shows angular, rounded and milled breccias in the upper orebody.

At least four paragenetic stages of skarn formation and ore position have been recognized by mineral assemblages and textures: prograde stage-I, prograde stage-II, retrograde stage-Ⅲ and vein stage-Ⅳ. The massive and layered skarns characterize the prograde stage-I. The

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prograde stage-I formed mineral assemblage olivine, monticellite, clinopyroxene (Di_{70-100}, Hd_{0-21}, Jo_{0-9}) in magnesian skarn. Olivine occurred that early one was Fo = 89.1~98.5 mole% and latter one was Fo = 74.4~87.7% (Seo et al., 2007). Clinopyroxene (Di_{35-97} Hd_{1-61} Jo_{2-12}), garnet (Gr_{41-86} Ad_{11-56} Pry_{3-5}) was formed in calcic skarn.

The breccias and vein skarns characterize the prograde stage-II as repetitive addition of eruptive hydrothermal fluid. Clinopyroxene, garnet, magnetite and small amount of quartz, calcite, and molybdenite are dominate mineral of breccias skarn, vein skarn. In case of clinopyroxenes, those one inside the breccias, which is enriched in Mg composition (Di_{72-100} Hd_{0-25} Jo_{0-3}), conforms to the prograde stage-I and therefore it must be early skarn stage mineral. On the other hand, those one in the latter vein skarn is enriched in Fe and Mn composition (Di_{20-58} Hd_{37-74} Jo_{4-11}).

At retrograde stage-III, it formed that hydrous mineral like clinohumite, vesuvianite, serpentine, amphibole, and phlogopite. These cut or replace the anhydrous minerals which form in early skarn stage. The retrograde stage is associated with the later stage of rhyolitic intrusion and felsite-related Mo-Zn mineralization was subsequently overprinted on the prograde stage-I skarns and iron orebodies. Vein stage-Ⅳ is similar with retrograde stage-III, but consists of more sulfide mineral than retrograde stage-III.

Based on skarn assemblages and the occurrence of magnesian/calcic skarns, the early stage prograde skarns formed at relatively high temperature (~450° to 600°C), low CO_2 fugacity (X_{CO2} < 0.1) and shallow depth (~0.5 kbar), whereas the later retrograde skarn with Mo-Zn mineralization formed at lower temperatures (~300° to 400°C).

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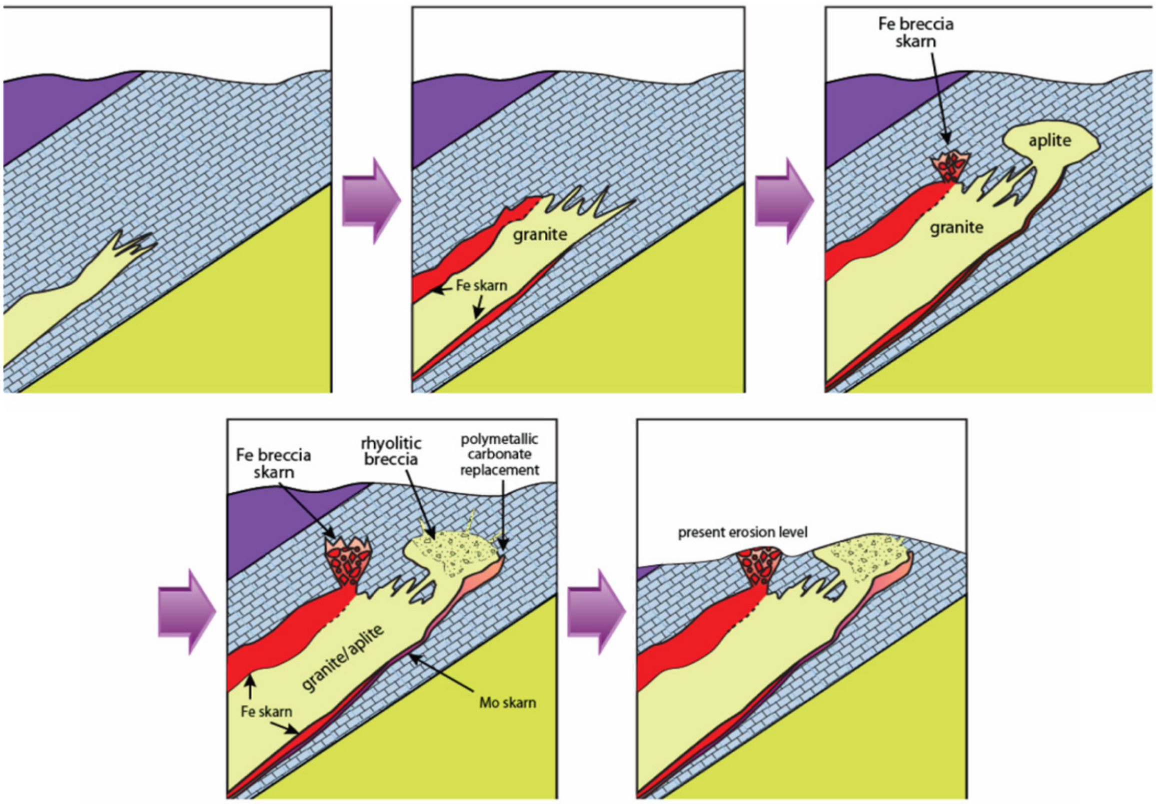

Fig.1 Genetic model showing the temporal-spatial distributions of the Shinyemi deposit.