Genetic implication of Fe-W mineralization at Ulsan mine, Southeastern Korea

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The Ulsan mine is located within the Cretaceous Gyeongsang volcano-sedimentary basin at the southeastern edge of the Korean peninsula. Distinct hydrothermal events resulted in calcic skarn and vein deposits in recrystallized limestone near a Tertiary epizonal granite stock. Skarn and ore mineralization developed as a result of multistage geochemical phenomena, which included silicate-oxide-sulfide metasomatism and subsequent hydrothermal alteration. The deposits of the Ulsan mine present a unique opportunity to document geochemically the complex evolution of a skarn-vein system that is related genetically to a low sulfidation system.

Isochemical contact metamorphism of an early skarnoid stage (stage I) is displayed by the presence of anhydrous Ca-Al-Mg skarn minerals at the contact between granite and recrystallized limestone. Following magnetite deposition in the main prograde skarn (stage II), the first deposition of arsenopyrite occurs intergrown with rammelsbergite-niccolite-gersdorffite-löllingite-native bismuth-bismuthinite-hexagonal pyrrhotite. These common sulfide assemblages are characterized by an overall low sulfidation state during the main skarn stage. Retrograde skarn (stage III) is characterized by minor scheelite impregnations in calcite and quartz with actinolite and chlorite. During latest stage III, Cu-Zn and polymetallic sulfide mineralization was introduced. The latest episode in the hydrothermal system (stage IV) is characterized by Zn-Pb-Ag mineralization in siderite-quartz veins. Decreasing As contents in arsenopyrite from stages II to IV indicate a decrease in temperature and/or sulfur fugacity with time. The various skarn forming events and ore minerals from various stages are interpreted to have resulted from an evolutionary trend from hypersaline magmatic fluids during prograde skarn formation associated with Fe-As(-Ni) mineralization to low-salinity and low-temperature fluids during the retrograde skarn formation associated with W-Cu-Zn mineralization. As the influence of magmatic-derived fluids waned, surficial fluids descended to deeper levels along fractures, resulting in siderite-quartz deposition associated with Zn-Pb-Ag mineralization. These results demonstrate that the Ulsan deposit is likely a skarn deposit that is genetically related to a low sulfidation porphyry system.

Based on results of arsenopyrite geothermometry and the fluid-inclusion data, the evolutionary trend from hypersaline magmatic fluids associated with Fe mineralization to low-salinity, lower-temperature ore-forming fluids related to W-Cu-Zn and Zn-Pb-Ag mineralization suggests an influx into the waning hydrothermal system of meteoric water at deep levels along fractures. The relationship between homogenization temperature and salinity suggests a complex history of simple cooling, dilution and local CO_2 effervescence. Decreasing As contents of arsenopyrite indicates a decrease in sulfur fugacity or temperature (or both) over all the stages of sulfide mineralization. Fe mineralization began above 464 ℃ from a fluid containing greater than 45 equiv. wt.% NaCl. Considered to have a genetic relation to felsic magmatism, i.e., the Gadae-Ri granite pluton, the nature of Fe-W and polymetallic mineralization at the Ulsan deposit may be regarded as having been formed at high temperatures and shallow depths (0.5 kbar). The formation of Ulsan skarn deposit may be due to its proximal position to a magma source, which is genetically related to a low-sufidation porphyry system.

Key words: skarn, low sulfidation porphry system, Fe-W mineralization

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