Mineralization Timing and Characteristics of the Heavy Sulfide Zone at the Grasberg Porphyry Cu-Au Deposit, Papua, Indonesia

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The Ertsberg-Grasberg district, Central Range of Papua, Indonesia, includes world-class porphyry and skarn Cu-Au deposits. A Cu-Au porphyry deposit hosted in the Grasberg Igneous Complex (GIC) was estimated at a total of 1,022 million tons of ore reserves at 1.01% Cu and 0.78 g/t Au. Porphyry mineralization is closely associated with the GIC, formed in the Pliocene. The GIC mainly consists of the Dalam (DI), Main Grasberg (MGI), and Kali Intrusions (KI). In addition, another mineralized zone, the Heavy Sulfide Zone (HSZ), is developed at a peripheral zone of porphyry Cu-Au mineralization; however, formation timing and characteristics of the HSZ have not been well examined. Therefore, we focus on the nature of mineralization characteristics at the HSZ to compare and understand mineralization conditions at the HSZ and GIC through petrography and trace elements in sulfide and sulfur isotope study.

Copper mineralization styles included in the HSZ are dissemination and veins. The dominant ore minerals in both types are chalcopyrite and bornite. Pyrrhotite, typically formed under low-sulfidation conditions, was observed with pyrite and chalcopyrite. Covellite, chalcocite, and digenite were precipitated along the fractures of pyrite, and native gold is present with covellite, suggesting that it was remobilized by cooling during mineralization (gold contents up to 73 ppm). The ore mineral assemblage observed in the HSZ was three stages. The first is porphyry copper mineralization formed at higher temperature and sulfur fugacity characterized by chalcopyrite and bornite. The second one is characterized by pyrrhotite and native gold under relatively low temperature and sulfur fugacity conditions. These two stages are considered to correspond to DI and MGI intrusion events. The third one is a retrograde cooling stage of mineralization by Cu-Fe sulfide and native gold. This stage is considered a later Cu mineralization stage (Kali intrusion-related) characterized by high Zn contents in sulfide.