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Mineral chemistry and fluid inclusions of enargite in the Lepanto high-sulfidation epithermal deposit, Mankayan Mineral District, Philippines

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Enargite (Cu_3AsS_4), a diagnostic ore mineral for high-sulfidation epithermal deposits, represents an important copper and gold resource. Enargite hosts critical elements such as Te, Sb, and Ge, either as solid solution or as inclusions. In the Mankayan Mineral District, Philippines, several events of enargite mineralization have been previously documented. Ages of alunite that are closely associated with the enargite mineralization range from 2.2 Ma [1] to 1.45 Ma[2]. In this study, we investigate how the chemical composition of enargite varies across different orebodies in Lepanto, and how it correlates to variations of temperature, salinity, and volatile composition of hydrothermal fluids.

Petrography revealed variable opacity of enargite crystals to near-infrared light. Tabular enargite commonly displays an opaque core overgrown by transparent rims. Trace element analysis revealed that enargite opacity positively correlates with Sn, Sb, and Fe content. Enargite from the Northwest orebody has the widest range of Sb contents, reaching up to 5.5 wt%, while that from the Lepanto Main and Florence orebodies has up to 2.0 wt% Sb. Enargite of the Florence and Lepanto Main orebodies is richer in Sn. Among the three orebodies, Ag content is the highest in the enargite from the Lepanto Main orebody, while Au is most abundant in that from the Northwest orebody.

Enargite-hosted liquid-rich aqueous fluid inclusions have homogenization temperatures between 205 and 240 ºC. Fluid salinity ranges from 2.5 to 6.7 wt% NaCl eq. Bulk-gas composition analysis of fluid inclusions in enargite of the three orebodies revealed that H_2O and CO_2 are the major volatile components. N_2/Ar ratios range from 2 to 120. Low N_2/Ar ratios correspond to higher H_2S and CO_2 contents. These signatures indicate meteoric water and magmatic fluid contributions.

Spatial variations of the above mentioned characteristics were also observed. Sn and Te contents of enargite increase from north to south in Lepanto Main and Northwest orebodies, while N_2/Ar ratios of fluid inclusions decrease southwards. This study provides insights on the spatial and time evolution of different mineralization events in an epithermal high-sulfidation system.

[1]Manalo et al. (2018) *Economic Geology* 113, 1609-1626.
[2]Arribas et al. (1995) *Geology* 23, 337-340.