SEG 2024 Conference: Sustainable Mineral Exploration and Development

Factors for Classification of the Precious and Base-Metal Mineralization in Epithermal Deposits: Evidence from Apatite Chemistry in Ore-Related Igneous Activity

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Metal assemblages concentrated in epithermal deposits are related to Cl and S contents in hydrothermal fluids. The differences of Cl and S contents in hydrothermal fluids may reflect the difference of ore-related magma compositions. We estimated Cl and S contents exsolved from magmas by using apatite chemistry in the felsic rocks associated with the Miocene Kitano-o Au-Ag and Inaushi Cu-Pb-Zn deposits in northeastern Hokkaido, Japan.

The EPMA analysis indicated that Cl content in the apatite is 0.56–0.97 wt% in the Inaushi dacite, while it is 0.37–0.45 wt% in the Kitano-o rhyolite. Based on the partition coefficients between apatite and melt, the calculated maximum Cl contents in the Inaushi and Kitano-o melts are 1.48 wt% and 0.96 wt%, respectively. Both apatites contain ~100 ppm S, indicating <10 ppm of S in the Inaushi and Kitano-o melts.

We also traced the Cl in the melt during magmatic fractionation of the Inaushi dacite by using apatites of different crystallizing stages, which are determined by paragenetic sequence of apatite-hosting minerals. Maximum Cl content is 0.78 wt% during the early plagioclase crystallization and 0.97 wt% during the amphibole crystallization, and then it decreases to 0.87 wt% and 0.83 wt% during titanomagnetite and groundmass crystallization, respectively.

The significant difference of Cl content and similar small S content between the Inaushi dacitic and Kitano-o rhyolitic melts estimated by apatite chemistry suggest that the Cl content in the epithermal fluids for the Inaushi base-metal and Kitano-o precious metal mineralization was inherited from the those in the magmas associated with these deposits. At Inaushi, Cl content was estimated to have exsolved from melt during amphibole-titanomagnetite crystallization stages.