Isotope geochemical evidences for sources of ore fluid in carbonate-hosted Zn-Pb-(Ag-Ge) metallogenic district, Northeast Yunnan, China

RUN-SHENG HAN AND BIN HU

Kunming University of Science and Technology, Southwest Institute of Geological Survey, Geological Survey Center for Non-ferrous Mineral Resources, Kunming 650093, P.R.C (*correspondence: hrs661@yahoo.com.cn)

The typical medium-to large-sized carbonate-hosted high-grade Zn-Pb-(Ag-Ge) deposits (exemplified as the Huize deposit, Zhaotong Maoping deposit etc.) in the well-known Sichuan-Yunnan-Guizhou Zn-Pb Polymetallic Metallogenic District are distributed mainly over northeast Yunnan. The deposits were controlled by the NE-extending Structural Zone.

The ore fluids containing Pb and Zn belong to the Na^{+}-K^{+}-Ca^{2+}-Cl^{-}-F^{-}type in these deposits. The isotope compositions and fluid inclusion features are similar. For the Huize deposit, the ore fluids are characterized by temperature at 164–221°C and salinity in 5–10.8 wt%NaCl [1]. The waters of fluid inclusions have δD values from -43.5‰ to -55.4‰ of calcite. The$\delta^{18}O_{V\text{-}SMOW}$ values of the ore fluids range from 17.09‰ to 18.56‰ of calcite and 17.80‰ to 23.14‰ for dolomite. $\delta^{13}C_{V\text{-}PDB}$ values range from -1.94‰ to -3.31‰ for calcite and -3.35‰ to 0.85‰ for ore-hosted dolomite; For the Maoping deposit, the ore fluids are characterized by temperatures of 180–218°C and salinity in 4.1 wt%–9.5wt% NaCl. The waters of fluid inclusions have δD values from -23‰ to -64‰. The $\delta^{18}O_{V\text{-}SMOW}$ values of the ore fluids range from 0.3‰ to 6.2‰ for galena, -9.0‰ to 3.4‰ for sphalerite, and -6.8‰ to -12.7‰ for pyrite. $\delta^{13}C_{V\text{-}PDB}$ values range from -1.1‰ to -3.7‰ for calcite and dolomite. These data better demonstrate that the ore-forming fluids were mainly derived from metamorphic water, magmatic hot fluid and hosted formation water, in relation to the metamorphism of the Kunyang Group in the basement, the magmatic hydrothermalism and sedimentation. On basis of field studies, The Zn-Pb-(Ag-Ge) doposits in Northeast Yunnan can be designated as deformed, carbonate-hosted, MVT-type deposits.

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[1] Han R S *et al.* (2007). *Ore Geology Reviews*, 31: 360-383.

Gold-rich sulfide melt inclusions in xenocrysts from a mid-crustal magma chamber, Mt. Milligan porphyry deposit, B.C., Canada

JACOB HANLEY[1] AND MARCEL GUILLONG[2]

[1]Dept. of Geology, St. Mary's University, Halifax, Canada, B3H3C3 (jacob.hanley@smu.ca)

[2]Dept. of Earth Sciences, ETH Zurich, Clausiusstrasse 25, Zürich, Switzerland CH-8092

Very coarse-grained amphibole xenocrysts (potassian magnesiohastingsite) hosted in an early monzonite stock at the Mount Milligan Cu-Au porphyry deposit, British Columbia, Canada contain coeval sulfide and silicate melt inclusions of primary origin. The sulfide melt inclusions have a bulk composition comparable to Cu-rich ISS. Late growth zones in the amphibole are devoid of sulfide inclusions and contain only low salinity, chalcopyrite-bearing fluid inclusions (average 7.4 wt% $NaCl_{eq.}$). Thermobarometry constrains the minimum conditions of sulfide entrapment (amphibole crystallization) to ~8 kbar and ~700°C. LA-ICP-MS analyses of 22 sulfide melt inclusions show that it was highly enriched in Au (50 ± 20 ppm, 1σ), Ag (140 ± 70 ppm, 1σ) and Ni (5000 ± 3000 ppm, 1σ). Ratios of Cu/Au (7500 ± 2500, 1σ) and Au/Ag (0.45 ± 0.24, 1σ) are identical to metal ratios in porphyry-stage veins, demonstrating that these metals were not fractionated from one another during suspected volatile exsolution, fluid-melt partitioning, and subsequent transport and precipitation of ore metals. The extremely Au-rich composition of the sulfide melt may reflect fractional crystallization of the sulfide liquid prior to entrapment in the amphibole. Both the xenocrysts and rare, high Mg, alkali basalt xenoliths hosted in the intrusions are depleted in Cr, Co, Ni and Cu, reflecting the sequestering of the base metals into a sulfide liquid in a mid-crustal magma chamber where amphibole and Cr-spinel were cumulus phases.

The results of this study show that a Cu-Au-rich sulfide melt coexisted with a amphibole-saturated alkalic basaltic liquid in mid-crustal magma chamber prior to the emplacement of the main intrusions and associated porphyry stage mineralization at Mt. Milligan. This sulfide melt appears to have destabilized with the appearance (exsolution) of a single-phase low salinity aqueous fluid. Identification and analysis of ore metals in sulfide melt inclusions in relatively common xenocryst phases may serve as a useful exploration tool for predicting the metal ratio of undiscovered Cu-Au porphyry deposits in the Canadian Cordillera.