Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.6600

Genesis of volcanic-hosted Cu deposit at Wenyu in the southern Yunnan, China: evidenced from ore geology and in-situ C-O-S isotopes

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Magmas associated with subduction or post subduction of Paleo-Tethyan oceanic lithosphere have been suggested to be relatively reduced and thus barren for porphyry and epithermal copper mineralization. Recently, many hydrothermal vein-type copper deposits have been discovered in the Triassic volcanic arc that was located to the east of Changning–Menglian Paleo-Tethys suture zone in the southern Yunnan of China. In order to reveal the genesis of these copper veins, the large Wenyu copper deposit in the arc were studied. Wenyu copper veins crosscut the middle-late Triassic basaltic and andesitic lava and breccia. Cu minerals are dominated by chalcopyrite, bornite and tetrahedrite, with minor chalcocite and covellite. Three hydrothermal stages have been recognized, including stage 1 calcite-anhydrite veins and associated alteration, stage 2 K-feldspar veins, quartz veins and silicification, and stage 3 chlorite-epidote alteration.

In-situ C-O isotopes indicated that calcite was deposited from a H_2CO_3 dominant fluid with $\delta^{13}C$ value of -8 to -5‰ (PDB) and $\delta^{18}O$ value of 4‰ (SMOW) due to CO_2 degassing accompanied by a progressive decrease of temperature from 250º to 175 ºC. The inferred temperature is well consistent with the homogenization temperatures of fluid inclusions within carbonate, which further indicated hydrothermal process occurred at shallow depth. The calculated $\delta^{18}O_{H2O}$ values of fluids in equilibrium with the early quartz and late quartz are of 3.4‰ to 5.7‰ and -6.8‰ to -3.6‰, respectively. Fluids related to Wenyu copper mineralization were likely derived from magmatic fluid with increasing contribution from meteoric water from early to later. At Wenyu, different sulfide grains from the same sample or single grain have variable $\delta^{34}S_{sulfide}$ values (-20‰ to 0‰), whereas sulfates have nearly constant $\delta^{34}S_{sulfate}$ values (6‰ to 10‰). This would be attributed to the changes of fO_2 and pH during precipitation from oxidized magmatic-hydrothermal fluids, based on observations that sulfides replaced hydrothermal carbonate and anhydrite, and locally coexisted with magnetite.

The abundant base metal sulfides, relatively oxidized and neutral-alkaline magmatic fluids constrained from ore geology and stable isotopes, and ore precipitation under shallow depth and <300 ºC indicated that Wenyu copper deposit is an intermediate sulfidation deposit.