American Mineralogist, Volume 108, pages 1132–1148, 2023

Pyrite geochemistry in a porphyry-skarn Cu (Au) system and implications for ore formation and prospecting: Perspective from Xinqiao deposit, Eastern China

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ABSTRACT

Stratabound ore has been recognized as an end-member of porphyry copper systems, but pyrite chemistry has not been widely applied to linking stratabound ore with the related porphyry and skarn system. Stratabound ore is commonly developed around porphyry-skarn systems in eastern China, and is characterized by abundant colloform pyrite; however the origin of the colloform pyrite has been contentious. Xinqiao deposit is ideal for study of pyrite geology and geochemistry with the aim of elucidating formation of the stratabound ore and to decipher the evolution of pyrite compositions in a porphyry-skarn environment. The colloform pyrite paragenesis and S isotopes indicate that it formed during early skarn mineralization, based on its occurrence in stockwork veins cutting skarn minerals, and that it is replaced by later hypogene sulfides; the $\delta^{34}S$ of colloform pyrite (average 6.12‰) is close to the $\delta^{34}S$ value of both porphyry- (average 5.06‰) and skarn-type pyrite (average 4.65‰). The colloform texture formed as an aggregate of nanometer- or micrometer-sized (<0.2 µm) pyrite cubes produced by rapid crystallization from a high-f_{S_2}, low-temperature, and supersaturated fluid. Supersaturation of the fluid was probably produced by rapid decompression that triggered fluid boiling and cooling when the magmatic-hydrothermal fluid (derived from Cretaceous magma) flowed along the Devonian-Carboniferous unconformity. Subsequently, the colloform pyrite was replaced by later stage pyrite with distinctive trace elements (Co, Ni, and Se), indicating that the stratabound ore at Xinqiao formed from multiple pulses of magmatic-hydrothermal fluids derived from an Early Cretaceous stock.

Co, Ni, and Se enrichment in porphyry- and proximal skarn-type pyrite suggests they formed at relatively high temperature, whereas the colloform pyrite shows trace element contents (Cu, Pb, Zn, Ag, and Bi) similar to those in distal skarn pyrite, suggesting that they may have formed in the same fluid environment. The trace element variations in pyrite from stratabound, skarn and porphyry ore probably resulted from decreasing fluid temperature and increasing pH away from the source. Our data, combined with previous studies, show that Co and Ni in pyrite increase toward porphyry and skarn ore, whereas As, Sb, Pb, Ag, and Bi are enriched in pyrite in distal stratabound ore, which extends for 1–2 km away from the intrusion. A plot of As/Se vs. Co discriminates the three ore types that occur associated with porphyry-skarn Cu systems in the Middle and Lower Yangtze belt (MLYB). These results indicate pyrite chemistry can be effective in discriminating the genesis of different deposit types related to porphyry-skarn systems and can potentially be used as a vectoring tool during exploration in the MLYB and elsewhere.

Keywords: Colloform pyrite, stratabound ore, pyrite geochemistry, porphyry-skarn deposit, the Middle-Lower Yangtze River metallogenic belt