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Arsenic in pyrite acts as a catalyst for dissolution-reprecipitation reaction and gold remobilization

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Abstract

In orogenic systems, pyrite hosts both free-native and lattice-bound gold. The processes governing gold habit, however, remain uncertain and subject to widespread debate. In this study, we employ micro-to-nanoscale trace element mapping alongside crystallographic characterization of gold-rich pyrite from the Kanowna Belle deposit (Western Australia) to probe the mechanisms influencing gold precipitation. Our examination reveals a complex chemical zoning in mineralized pyrite samples, characterized by an As-depleted core (As ≤2.5 wt%; Au ≤149 ppm) and rim (As ≤2.5 wt%; Au ≤264 ppm), separated by an As-Au-rich banded mantle (As ≤4.5 wt%; Au ≤2251 ppm). Pyrite structure in the mantle domain shows that low-angle boundaries mostly follow the shape of As-rich oscillatory zones. Gold in the pyrite mantle domain occurs as: (1) lattice-bound Au associated with As-rich oscillatory zoning; (2) gold micro-inclusions formed in equilibrium with arsenopyrite inclusions hosted within convoluted As-depleted pyrite domain; and (3) Au-filled late-stage fractures that crosscut the pyrite mantle. The shift in pyrite chemical composition from Au- and As-poor pyrite cores to Au- and As-rich mantles suggests that lattice-bound Au may have been integrated into As-rich zones via chemisorption during rapidly changing fluid conditions. Conversely, we propose that the gold inclusions hosted within the As-depleted convoluted domain form through a coupled dissolution re-precipitation process driven by fluid infiltration along low-angle boundaries. This study underscores the significance of linking arsenic distribution and crystallographic characteristics to comprehensively understand the controls on both gold form and distribution in gold deposits.

Keywords: Pyrite, arsenic, gold inclusion, low-angle boundary, EBSD