

Co-segregation of Au and Low-Melting-Point Chalcophile Elements Along Low-angle Grain Boundaries in Pyrite During Plastic Deformation

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Plastic deformation-induced microstructures in pyrite, particularly low-angle grain boundaries (LAGBs), have been increasingly recognized as potential repositories for Au and low-melting-point chalcophile elements (LMCEs; e.g., Ag, Te, and Bi) in some hydrothermal gold deposits. However, their nanoscale behavior during the plastic deformation of pyrite remains enigmatic in epithermal gold systems. In this study, we systematically investigate the crystallography and geochemistry of pyrite from the Yongxin low-sulfidation epithermal gold deposit, China. Electron backscatter diffraction analyses show that Au- and LMCEs-bearing pyrite exhibits complex misorientation patterns and contains LAGBs. Atom probe tomography analyses reveal that Au and LMCEs are preferentially enriched along LAGBs, with significant depletion in adjacent regions. In the Y-Z projection plane, LAGBs display planar structures characterized by semi-parallel compositional bands enriched in Au and LMCEs. Additionally, quartz closely associated with pyrite shows grain orientation spread values typically below 2° and an average grain size of 8 µm. These findings collectively suggest that pyrite in the Yongxin deposit underwent significant plastic deformation via dislocation creep, during which Au and LMCEs gradually segregated into LAGBs through a dislocation-impurity pair diffusion mechanism. This study underscores the critical role of plastic deformation in element remobilization and re-enrichment, and identifies a previously unrecognized form of LMCEs. Furthermore, elemental segregation observed within microstructures implies that interpretations of micron-scale geochemical anomalies as mineral inclusions should be treated with caution.