Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.30359

Crystal defects control the mobility of gold in sulphides

DENIS FOUGEROUSE[1], STEVEN M. REDDY[2], DAVID W. SAXEY[1], WILLIAM D. A. RICKARD[2], NICOLAS THEBAUD[3] AND JOËL BRUGGER[4]

[1]Geoscience Atom Probe, John de Laeter Centre, Curtin University
[2]Curtin University
[3]The University of Western Australia
[4]Monash University

Gold hosted in sulphides represents a large proportion of the gold resource globally. Sulphide-hosted gold is refractory, meaning that its liberation requires a full destruction of the crystals. Yet, gold can be remobilised naturally during geological processes through fluid-rock interaction and deformation. The general driving force of the re-equilibration reaction is the minimisation of free energy from a distorted pyrite lattice due to the incorporation of impurities, as well as tectonic strain, to a pyrite closer to stoichiometric composition and strain-free. However, the mechanisms operating at the nanoscale for the remobilisation of gold in sulphides remains poorly understood. Here, we apply a multiscale characterisation workflow using electron backscattered diffraction (EBSD), nanoscale and time-of-flight secondary ion mass spectrometry (NanoSIMS and ToF-SIMS), and atom probe tomography (APT) on selected gold-bearing pyrite and arsenopyrite crystals from various ore deposits to determine the factors controlling the remobilisation of gold.

Three main mechanisms have been identified, including crystal-plastic deformation, fluid-mediated dissolution-reprecipitation and dislocation-mediated interfacial re-equilibration. In all cases, nanoscale data highlight the importance of crystal defects, in particular dislocations, for the mobility of gold. Dislocations have been documented to collect gold through their migration during crystal-plastic deformation. Dislocations can also be utilised as fast diffusion and/or fluid pathways for localised dissolution-reprecipitation reactions to occur and the extraction of gold from the sulphides. Finally, dislocations located at the interface between arsenic-gold-rich pyrite and arsenic-gold-poor pyrite, control mass transfer and the progression of the re-equilibration reaction. Collectively, these observations suggest that mineralogical processes such as fluid-mediated re-equilibration or chemical modification during recrystallisation are fundamentally controlled by dynamic crystal defects.