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Zone Refining in an Epithermal Setting: A Gold Liberation Mechanism at the Klaza Deposit, Yukon

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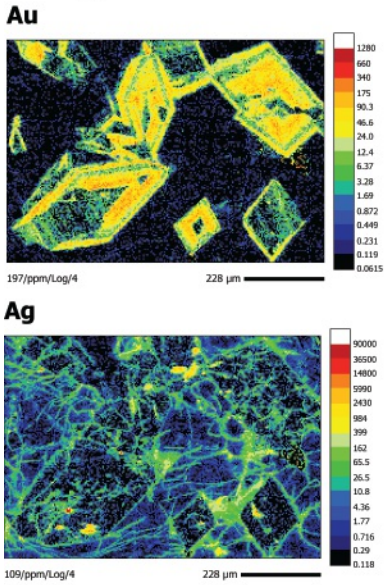
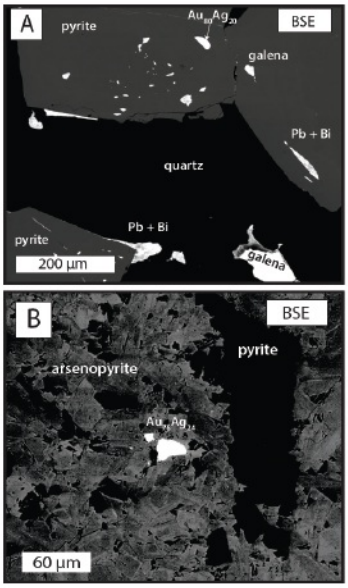
Gold mineralization in hydrothermal systems has long been considered to be a primary process; however, recent advances in analytical methods have highlighted the importance of secondary processes. The zone refining model proposed here discusses the role of secondary Au enrichment via its liberation from primary sulfides by hydrothermal fluids. The model is supported by a case study on the Klaza intermediate sulfidation epithermal deposit (Yukon) using evidence from empirical approaches: drill core logging, optical microscopy, SEM-EDS, CL, LA-ICP-MS element mapping of sulfides (pyrite, arsenopyrite, and sphalerite), and data-driven approaches (unsupervised machine learning workflows derived from the LA data). Integrated petrography and SEM-EDS studies reveal electrum as secondary inclusions in pyrite and arsenopyrite, whereas grains lacking such inclusions display primary As-zonation and banding. LA-ICP-MS element maps reveal that (1) primary zones in arsenopyrite have elevated Au-Sb (Au = 46 to 400 ppm) and (2) elevated Cu-Pb-Ag-Sb-Bi-Ba along fractures in all mapped sulfide grains. These data, combined with the data-driven approach (feature maps constructed with a combination of K-means clustering and principal component analysis), supports a model whereby coupled-dissolution-precipitation (CDP) processes destroyed the primary zonation in pyrite and arsenopyrite which released lattice-bound impurities which then re-precipitated as high-fineness electrum and Bi-Pb-Ag sulfides. This secondary process, which produces relatively pure secondary pyrite and arsenopyrite and upgrades metals (e.g., Au-Ag-Bi-Pb-Cu), constitutes zone refining and is considered an important and relevant mechanism for locally producing gold enrichment.

LA-ICP-MS Element Maps of Arsenopyrite



BSE images of electrum inclusions in pyrite and arsenopyrite



Model depicting hydrothermal evolution of Klaza epithermal system based on paragenetic work

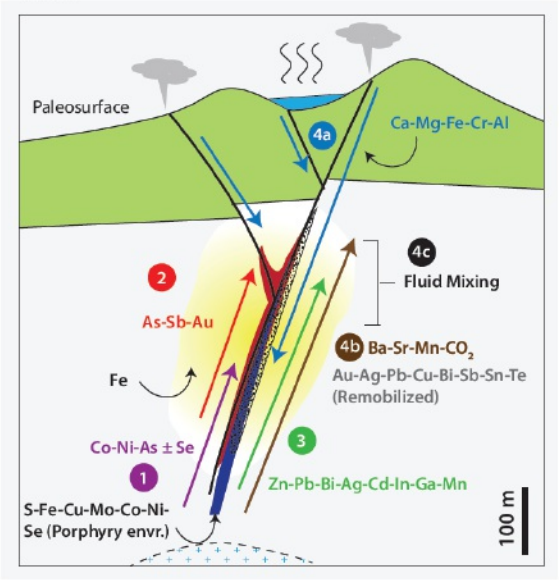


Figure 1

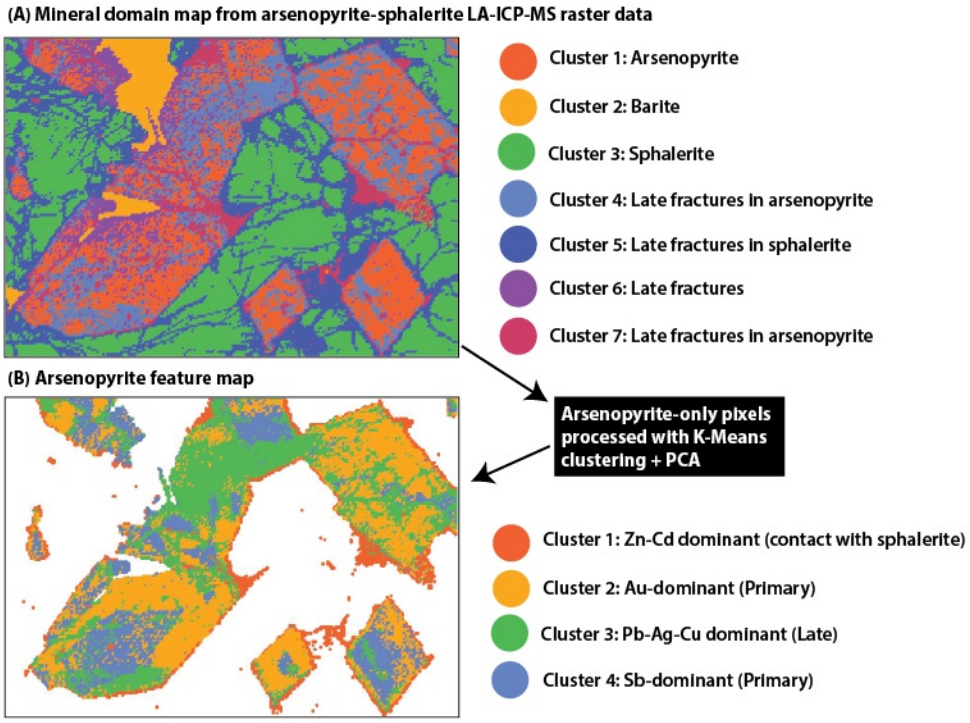


Figure 2