Suspension-Driven Transport of Noble Metals in Hydrothermal Fluids

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The transport of noble metals (Au, Ag) by metal-rich melts in hydrothermal ore systems has been increasingly documented over the past decade. This challenges the traditional view that ligands (e.g., chloride- and bisulfide-bearing) are the only effective metal carriers in hydrothermal solutions. Nonetheless, the conditions under which soluble and non-soluble metal transport coexist—and whether metal-rich melts can be physically mobilized by hydrothermal fluids—remain uncertain. Here we present evidence for the suspension-like transport of nano- to micron-sized sulfide-sulfosalt melts within hydrothermal fluids at temperatures below 400 °C. These melts crystallize into irregular, bleb-shaped polymineral inclusions composed of Ag sulfosalts, electrum, and base metal sulfides. Polymineral inclusions range from 5 nm to 40 µm, and are cogenetic with liquid + vapor fluid inclusions hosted in quartz. Numerical modeling using fluidization and settling dynamics demonstrates that hydrothermal fluids can mechanically carry these metal-rich nano- to micromelts at flow rates below 0.1 m/s. The chemical consistency between the nano- and micron-scale inclusions supports a model in which nanomelt precursors coalesce during episodic transport (or upon precipitation), contributing significantly to the formation of high-grade noble metal deposits.