Vapor as a medium for the transport of metals

Implications for ore deposit modeling

Other Conference Item**Author(s):**

Williams-Jones, Anthony E.; Heinrich, Christoph A. Migdisov, Artas A.

Publication date:

2005-05

Permanent link:

<https://doi.org/10.3929/ethz-b-000162589>

Rights / license:

Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International

Originally published in:

Geochimica et Cosmochimica Acta 69(10 / Supplement), <https://doi.org/10.1016/j.gca.2005.03.036>

Vapor as a medium for the transport of metals: Implications for ore deposit modeling

A.E. WILLIAMS-JONES¹, C.A. HEINRICH²
AND A.A. MIGDISOV¹

¹Department of Earth and Planetary Sciences, McGill
University, 3450 University St., Montreal, Q.C. H3A 2A7,
Canada

²Isotope Geochemistry and Mineral Resources, Department of
Earth Sciences, Swiss Federal Institute of Technology,
ETH Zentrum NO, 8092 Zürich, Switzerland

Despite increasing evidence to the contrary, most economic geologists still assume that hydrothermal ore deposits form exclusively from aqueous liquid. However, analyses of fluid inclusions in porphyry systems show that the vapor can contain ore-forming concentrations of metals, and that to varying degrees some metals, e.g., Cu, favor the vapor over the coexisting brine.

Although most partitioning experiments have shown that Cu, Zn, Ag, Au and Fe strongly favor the brine, recently reported experiments involving sulfur showed a preference of Cu for the vapor. The solubility of Cu, Ag, Au, and Sn in vapor has been investigated at sub-critical temperatures in the HCl-H₂O system, and that of Mo in pure water vapor. Models developed from these experiments, which assume that the dissolved species have the form, MeCl_m.nH₂O, predict metal concentrations in the vapor approaching those required by an ore fluid, but substantially lower than those measured in vapor-rich fluid inclusions from ore deposits. Metal solubility experiments in sulfur-bearing vapor are now in progress.

Considering that vapor is the dominant fluid in high level magmatic hydrothermal systems, and fluid inclusion and experimental evidence that Cu partitions preferentially into the vapor, we argue that vapor can be the principal agent of metal transport in some porphyry copper systems. We further argue that high sulfidation epithermal deposits closer to the earth's surface are also formed by this vapor. Early in the evolution of these latter systems the vapor condenses, producing acid-sulfate and vuggy silica alteration, and in some cases Cu-As-Au-Ag mineralization. In other cases, this mineralization is later, after the site of magmatic fluid exsolution has receded to greater depth. Vapor separating at this stage cools along a P-T path above the critical curve of the system, causing it to contract to a liquid from which precious metals subsequently deposit.

- [1] Taran Y.A., Bernard A., Gavilanes J.C., Africano F. (2001) *Appl. Geochem.* **15**, 337-346.
- [2] Taran Y.A., Bernard A., Gavilanes J.C., et al (2000), *JVGR* **108**, 245-264