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Primary fluid chemistry: the key driver of metal budgets and dispersion geochemistry in hydrothermal ore systems?

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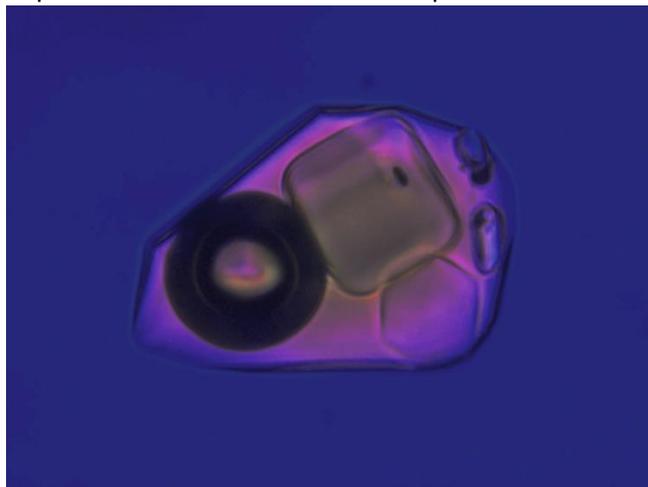
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It may seem obvious to suggest that fluid chemistry is a key driver of the metal endowment of hydrothermal systems and there are many instances in the literature of fluids in a given ore deposit type being assumed to contain elevated levels of the metals in which that ore type is enriched. However, many processes are involved in the final make-up of ore deposits and their associated alteration haloes, influenced by numerous intensive and extensive parameters. Thus, the links between the chemistry of an ore fluid exiting its source and the final product of its interactions within the ore-forming environment might be expected to be complex. It is only with the increasing analysis of paleo-orefluids by LA-ICP-MS that this paradigm can start to be addressed.

Here, we consider published and unpublished fluid chemical data derived from a variety of ore systems in order to assess the primary fluid compositional controls on their ore metal budgets and, for those elements that may not be deposited in the ores themselves, on their “exhaust” alteration zones. We conclude that, in general, ores do reflect the make-up of primary fluids which can be accounted for by near-quantitative precipitation of ore metals in the deposits themselves. Trace metals which are not deposited in the ore zone are transported out into the wider haloes and are incorporated in a range of



minerals. This process is still metasomatic in nature, with net addition to host rocks that may be typically depleted in such elements, thus producing the typical pathfinder element footprints with which we are familiar. The implication of this, at least for hypabyssal magmatic-hydrothermal systems, is that the chemical fingerprint of an orebody and its dispersion halo are controlled by the compositional characteristics of the magma source, and the partition coefficients extant when those fluids were separating from their parent melt.

Figure 1: Multiphase brine inclusion from the

Boyongan

porphyry Cu-Au system, Philippines. Sample courtesy of

Dave Braxton.

As has been previously argued, not only might the tenor of a hydrothermal system be controlled by fluid chemistry [1], so also may its total endowment in metals [2,3]. Thus, a better understanding of what

enriches fluids in metals is essential in order to be able to predict the location of ore deposits and potentially even their grade.

References:

[1] Audetat, A. et al. (2008) *Econ Geol* 107: 877-908

[2] Ulrich, T. et al. (1999) *Nature*

[3] Wilkinson, J.J. et al. (2009) *Science* 323: 764-767

