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Other Conference Item

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Publication date:
2009-06

Permanent link:
https://doi.org/10.3929/ethz-b-000162204

Originally published in:
Geochimica et Cosmochimica Acta 73(13, Supplement), https://doi.org/10.1016/j.gca.2009.05.015

Towards a numerical reconstruction of the Bingham Canyon magmatic-hydrothermal ore system

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Porphyry-type ore deposits develop within much larger magmatic-hydrothermal systems. Dissolved metals are transported in both vapour and liquid phases and precipitated in response to steep temperature and pressure gradients. The driving force for fluid flow in such systems are density variations caused by the thermal energy released by a magmatic intrusion. The amount of thermal energy is given by the intrusion's volume and temperature. From the initial temperature and pressure distribution in a given geometry and from additional constraints on magmatic fluid contributions, numerical simulation can be used to develop reconstructions of the spatial and temporal evolution of the magmatic-hydrothermal system.

At Bingham Canyon, petrography and fluid inclusion data from the mine area indicate that ore precipitation took place from a vapour-dominated magmatic fluid plume in a temperature interval from 350 to 425°C and at pressures of 14 to 21 MPa [1, 2]. First generic models [3] predict steep temperature-pressure gradients along with a spatial and temporal fluid evolution that closely resembles the fluid inclusion results. In an ongoing project to apply this hydrological simulation technique to an actual case study, we are compiling 3D geological, geomagnetic and structural data to construct a geological model of Bingham Canyon.

A suite of scenarios varying in deep subsurface geometry and large-scale permeability structure will be tested with these simulations, to match observational constraints of the timing sequence of intrusion and veining, the zoned distribution of Cu, Au and Mo ore grades, and the chemical and density characteristics of fluid inclusions.

[1] Redmond *et al*. (2004) *Geology* **32** 217-220. [2] Landwing *et al*. (2005) *Planetary Science Letters* **235**, 229-243. [3] Driesner & Geiger (2007). *Reviews in Mineralogy* **65**, 187-212.