TITLE: In-situ electrowinning of magmatic fluids

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Context

The great majority of base metals such as copper are extracted from the remaining of volcanic edifices, where magmatic fluids enriched the volcanic rocks over hundreds of thousands of years. Currently the metal-enriched rocks are extracted en-mass and treated before the metal can be finally extracted, a process with a significant environmental impact, which requires vast amount of energy.

Recent geophysical measurements, corroborated by geochemistry and numerical modeling highlight that active volcanic systems might be associated with hydrothermal systems at 1-2 km depth hosted in fractured rocks and containing salty fluids (at temperatures of up to 700 °C) and dissolved metals in significant concentrations. The extraction of these fluids and their ex-situ mining is difficult as decompression and cooling leads to metal precipitation of solutes and clogging of the well permeability.

Objectives and Methods

The target of this project is to assess the efficiency and feasibility of metal electrowinning and recovery from magmatic fluids in-situ (i.e. at depth of 1-2 km). We will first perform a series of laboratory experiments to simulate the selective deposition of metals from solutions similar to those encountered in magmatic environment. These experiments will also serve to quantify the energy efficiency of this process as function of various parameters such as concentration of the metals in the fluids, temperature and pressure. Once sufficient data will be acquired and if sufficient time will be available we will perform large-scale experiments in a natural environment (a system of flooded mine tunnels, where the dissolved metal represent an environmental threat).

Literature

- Afanasyev, A., Blundy, J., Melnik, O., Sparks, S., 2018. Formation of magmatic brine lenses via focussed fluid-flow beneath volcanoes. Earth and Planetary Science Letters 486, 119–128. doi:10.1016/j.epsl.2018.01.013
- Kouzmanov, K., Pokrovski, G.S., 2012. Hydrothermal controls on metal distribution in porphyry Cu (-Mo-Au) systems. Society of Economic Geologists, Special Publication 16, 573–618.
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Chuquicamata mine in Chile (courtesy of Dr M. Chiaradia), one of the largest copper mine in the world.

WEB sites

http://www.unige.ch/sciences/terre/en/research/petrology-and-volcanology/

https://gem.epfl.ch

Choice of orientation : GATO