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The metal content of molybdenum-mineralizing fluids

L. Lerchbaumer and A. Audétat
Bayerisches Geoinstitut, Bayreuth, Germany (linda.lerchbaumer@uni-bayreuth.de)

Molybdenum can be found in porphyry-type systems as well as in hydrothermal veins and breccias associated with granite systems. Up to now our knowledge on the metal content of fluids forming molybdenum ore deposits has been very limited. The only data available so far are from the porphyry Mo deposit at Questa, New Mexico, and from the Cave Peak porphyry Mo-Nb deposit in Texas.

We have studied early, intermediate-density fluid inclusions in quartz crystals from miarolitic cavities in the Drammen and Glitrevann granites (Norway) and the Treasure Mountain Dome (Colorado/USA) to obtain more information about the bulk composition of magmatic-hydrothermal fluids exsolved from these plutons. The Treasure Mountain Dome contains weak Mo mineralization and is an apophysis of the Alma Batholith that produced also the famous Climax and Henderson porphyry Mo deposits; the Glitrevann granite hosts a sub-economic Mo stockwork, and the Drammen Granite contains numerous vein-type Mo mineralizations.

As a preliminary result, based on analyses of fluid inclusions using optical microscopy, microthermometry, Raman spectroscopy, and LA-ICP-MS we conclude that the primordial fluid of the Drammen granite was of high acidity and carried certain amounts of metals at conditions of 650°C and 1.3-1.5 kbar. The total elemental budget is: 3 wt% Na, 1.8 wt% K, 0.5 wt% S, 0.4 wt% Fe, 0.3 wt% Cu, 0.2 wt% Mn, 40 ppm Mo, 800 ppm Zn, 600 ppm Rb, 300 ppm Cs, 180 ppm Pb, 150 ppm As, 40 ppm W, 15 ppm Bi, and minor amounts of Ag, Sn, and Ce. Striking is the fact, that all the metal concentrations show little variability except the one of Cu.

In view of recent studies (Lerchbaumer & Audétat, 2011) showing that the Cu-values in quartz-hosted fluid inclusions are not always representative of the primary fluid and in fact can be too high, we want to check if this could be the case for the Cu-values measured in the samples from Norway and Colorado. The alteration of the original Cu-concentrations stems from post-entrapment diffusion of Cu+ through the host quartz into the fluid inclusions. The trigger for this process is the changing pH of the outer fluid due to rock-buffered cooling: As this fluid gets more and more basic, the increasing concentration gradient promotes the loss of H+ from existing fluid inclusions and the corresponding uptake of Cu+. In order to experimentally reconstruct this process we will put a well characterized trail of fluid inclusions from the Drammen granite into a gold capsule together with its original, acidic fluid (known from analyses mentioned above) and subject it to its forming conditions in rapid quench autoclaves.

In the case of fluid inclusions with a diffusively altered elemental composition, the pH-difference between the fluid inclusions and the outer fluid would reverse the diffusion process and would lead to quite diminished concentrations of Cu after the run. Such a result would finally indicate that these Mo-mineralizing fluids hardly transported any Cu.

Lerchbaumer L. & Audétat A. (2011): Preferential partitioning of copper into the vapor phase: An artifact? Mineralogical Magazine 75 (3), 1302.