Metal transport in vapour-like magmatic fluids and porphyry-epithermal ore formation

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New formulations of metal solubility in low- and intermediate-density fluids based on experimental data [1-4], allow for the thermodynamic modelling of metal solubility and mineral precipitation during cooling and decompression of a magmatic high temperature volatile phase. Low- and intermediate-density fluids are the dominant volatile phases in magmatic-hydrothermal systems [5] and are most likely agents of metal transport to sites of ore deposition. These fluids are highly compressible; hence metal solubility is a function of fluid density. Moreover, these fluids are characterized by molecular/neutral compounds and there are no free electrons, which indicates that metal transport and wall-rock alteration are decoupled. Geochemical simulations were performed using GEM-Selektor v.3 [6] and metal mobility was modelled in the context of Cu-Au-Mo porphyry and Au-Ag epithermal ore formation. During cooling and decompression, gold solubility reaches a maximum between 320 and 500 °C, depending on the fluid density, whereas Mo and Ag concentrations decrease with decreasing temperature and pressure. These differences in metal solubility with changing temperature and pressure control metal ratios, metal zoning and the partitioning of metals upon fluid phase separation. The occurrence of a solubility maximum for gold indicates a potential for remobilization/redistribution of gold to shallower, and more distal environments at lower temperatures by vapour-like fluids. There is an overall strong compositional control on the Au/Mo ratio of the parental ore fluid, which can explain Au-Mo zoning in porphyry ore deposits and the formation of Au-rich and Mo-rich sub-types.

[1] Hurtig and Williams-Jones (2014), *Geochim Cosmochim Ac*, **127**, 305-325. [2] Hurtig and Williams-Jones (2014), *Geochim Cosmochim Ac*, **136**, 169-193. [3] Migdisov and Williams-Jones (2013), *Geochim Cosmochim Ac*, **104**, 123-135. [4] Migdisov et al. (2014), *Geochim Cosmochim Ac*, **129**, 33-53. [5] Weis et al. (2012), *Science*, **338**, 1613-1616. [6] Kulik et al. (2013), *Computat Geosci*, **17**, 1-24.