Exceptional mobility of Cu and Ag inferred from experiments with rhyolitic melt inclusions in quartz

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Quantification of abundances of metallic elements in magmas using melt inclusion approach helps to understand metal partitioning during crystallization and degassing, and the role of different melts in contributing to economic mineralization. The outstanding question is whether inherently metal-enriched (fertile) magmas exist in nature and originate metal-bearing fluids, or whether occurrence of mineralization is governed by other factors. The existing discrepancy in the results obtained from unheated and reheated inclusions of felsic melts in quartz warranted this study which tests the possibility of metals being introduced into high-Si melt inclusions during experimental heating.

Heating experiments with quartz-hosted melt inclusions (MI) from the Taupo rhyolites were performed in a muffle furnace at different conditions [1]. Quenched MI were subsequently analysed for 30 elements by LA-ICPMS and compared with unheated inclusions and matrix glasses.

Diffusion into melt inclusions is noted for Cu and Ag only (increase by 2-3 orders of magnitude), but diffusion out of melt inclusions is recorded for Cu only. Absolute concentrations of Cu and Ag and Cu/Ag vary among heated melt inclusions within the same grain. No obvious correlation exists between Cu-Ag abundances and 1) inclusions sizes, 2) inclusions position in quartz (e.g., core-rim). We infer that diffusion is determined by specific ("volatile") properties of the Cu and Ag ions rather than a control from structural characteristics of quartz. Thus, phenomenal volatility of Cu and Ag can be accounted for when interpreting the results of other melt inclusion studies that showed metal enrichment in heated (remelted) melt inclusions compared to unheated inclusions from the same samples.

Our heating stage experiments and in situ analyses show strong Cu partitioning into aqueous saline fluids. Deagassing can account for Cu loss from the Taupo rhyolite magma during eruption, and thus low Cu content in the matrix glass (1.7 ppm). On the other hand, the melt trapped as inclusions appears to be undegassed (up to 7-8 wt% H_2O), and thus the original Cu should be at least 25 ppm (based on a model Cu/Zn = 0.55), not 2.8 ppm as measured in unheated melt inclusions. The phenomenon of Cu diffusion out of melt inclusions suggests the possibility of re-equilibration of quartz-hosted melt inclusion with continuously Cu-degassing magma during its ascent and eruption.

References

[1] Kamenetsky V.S. and Danyushevsky L.V. (2005) *Am. Mineral.* **90,** 1674-1678.