

The solubility of silver in magmatic fluids

Y. YIN^{1*} AND Z. ZAJACZ¹

¹University of Toronto, Department of Earth Sciences,
Toronto, ON, M5S 3B1, Canada
(*correspondence: yiwei.yin@mail.utoronto.ca)
(zajacz@es.utoronto.ca)

Silver is a common and economically important constituent of many magmatic-hydrothermal ore deposits, yet little is known about its geochemical behaviour during magma degassing. We performed experiments to determine the effect of various chemical components (NaCl, KCl, LiCl, CaCl₂, SO₂, H₂S) on the solubility and speciation of Ag in high-temperature, low-density fluids. The experiments were conducted at $T=900$ °C, $P=200$ MPa and oxygen fugacity (f_{O_2}) of 0.5 log units below Ni-NiO buffer in rapid-quench Molybdenum-Hafnium Carbide externally-heated pressure vessel assemblies. The volatile phase was sampled at run conditions by the entrapment of synthetic fluid inclusions in *in situ* fractured quartz chips. As capsule material, Au₉₇Ag₂Cu₁ alloy was used, which imposed an Ag activity of 0.005. In the NaCl-H₂O and NaCl-HCl-H₂O systems, the apparent Ag solubility exponentially increases as a function of total chloride concentration. In the mixed NaCl – HCl system at a fixed total Cl concentration of 1 m and varying NaCl/HCl ratios, the apparent solubility of Ag reaches a maximum (432 ± 123 µg/g) at equal NaCl and HCl concentration (0.5 m) and then decreases towards both end-members (1m for NaCl or HCl) following a parabolic function. The addition of H₂S has a moderate impact on Ag solubility, which is more apparent in the simultaneous presence of NaCl or KCl. Silver solubilities predicted using the HKF model and thermodynamic properties from Akinfiev and Zotov [1] for Ag-chloride and bisulfide complexes greatly underestimate the measured values. Model calculations suggest that Na₂AgCl₃ and NaAgCl₂ are the dominant complexes in S-free, chloride-bearing fluids with the additional presence of NaAg(HS)₂ and NaAg(HS)Cl in S-bearing fluids. Comparison of the measured Ag solubilities in high-temperature fluids to literature data on Ag solubilities in silicate melts suggests that Ag partitions only moderately into the magmatic volatile phase, except for chloride-rich fluids exsolving from felsic magmas.

[1] Akinfiev and Zotov (2001), *Geochemistry International* 39, 990-1006.