

The effect of melt composition on the activity coefficients and partitioning of silver

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Constraining the activity of trace components in silicate melts allows for predictions of partitioning behavior and volatility in natural igneous systems. In this study we measure the activity coefficient of the element Ag in silicate melt and its partitioning behavior between molten Fe metal and silicate melt.

Silver solubility experiments were carried out to explore the effect of melt composition on the activity coefficient of silver ($\gamma_{\text{AgO}_{0.5}}$) in silicate melt. A series of 21 experiments were done in graphite capsules at 1500 and 1650 °C and 1.5 GPa in the CaO - MgO - Al₂O₃ - SiO₂ system. A complementary set of 33 experiments investigating the partitioning behavior of Ag between silicate melt and molten Fe was also carried out at temperatures between 1560 and 1900 °C and 1.5 GPa in the CaO - MgO - FeO - Al₂O₃ - SiO₂ ± Na₂O system. To investigate the effect the presence of carbon in molten Fe metal has on partitioning, experiments were done in graphite capsules as well as capsules of MgO and SiO₂.

Based on the results of the solubility experiments we measured a variation in $\gamma_{\text{AgO}_{0.5}}$ of over an order of magnitude, ranging from 1320 to 19600, over the investigated range of melt composition. Although $\gamma_{\text{AgO}_{0.5}}$ shows no simple dependence on any particular oxide component, a strong direct correlation with the optical basicity [1] of the silicate melt is observed. Converting the solubility results to partition coefficients at infinite dilution in Fe metal using the relationship of Borisov et al. [2] yields a range in apparent $D_{\text{Met/Sil}}$ of 2.44 - 18.7 at an $f\text{O}_2$ of $\Delta\text{IW} -2$. These results are in excellent agreement with partitioning experiments run in carbon free systems.

The measured $D_{\text{Met/Sil}}$ values from partitioning experiments done in graphite capsules are approximately 0.5 log units lower than those determined by solubility and in carbon free systems. This is attributed to the presence of carbon in the molten Fe metal, which significantly increases the γ_{Ag} in the metal phase.

[1] Duffy (1993) *Geochim. Cosmochim. Acta* **57**, 3961-3970.

[2] Borisov et al. (1994) *Geochim. Cosmochim. Acta* **58**, 705-716.