**Effect of pressure on trace element activity coefficients in metal-silicate systems**

Kelsey Prissel; Kevin Righter

The partitioning of trace elements between metal and silicate melts serves as the foundation for understanding the differentiation of a planetary body into a metallic core and silicate mantle. Element activity influences metal-silicate partitioning behavior. Activity coefficients are directly dependent on composition and temperature, and can be indirectly dependent on oxygen fugacity and pressure. Distinguishing the effect of pressure from other variables on the activity coefficients and partitioning is important for understanding the chemical evolution of different planetary bodies during differentiation. In this study, we investigated the influence of pressure on the activity coefficients of Cu, Mo, Pd, Pt, As, Sb, and Bi in Fe-Si metallic liquids. All of these elements exhibit moderate to high activity coefficients in Fe-Si liquids at low pressure, which significantly controls their metal-silicate partitioning behavior. Identifying whether this strong dependence persists at higher pressures is critical to modeling and understanding the chemical consequences of core formation. New experiments at 10 GPa were used to derive activity coefficients for these metals which can be compared to activity coefficients determined at 1 GPa.

Experiments were conducted at 10 GPa and 2373K using a 10/5 assembly in the 880-ton multi-anvil press at NASA Johnson Space Center. The standard 10/5 COMPRES assembly was slightly modified to accommodate a sample capsule machined from single-crystal MgO that minimizes melt percolation out of the sample volume during the experiment. Experiment starting materials were comprised of 70 wt.% Knippa basalt and 30 wt.% metal. The metal mixture (~85 wt.% Fe) was created by adding the elements of interest (Cu, Mo, Pd, Pt, As, Sb, Bi) to Fe metal powder. Varied amounts of Si metal (0-10 wt.% Si) were added to the metal-silicate mixtures to generate a systematic series of starting materials.

For each element, an epsilon interaction parameter in Fe-Si liquid was derived from the results of our 0-10 wt.% Si metal series. To investigate whether pressure influences the trace element activity coefficients in the 1-10 GPa pressure range, we compared our results at 10 GPa to those at 1-4 GPa [1-3]. Our results can also be directly compared to interaction parameters for Au, P, V, Mn, Ga, Zn, Cd, Sn, W, Pb, and Nb previously determined at 10 GPa and 2373K following the same methods [4]. Combined, this suite of interaction parameters will directly inform metal-silicate partitioning between 1 and 10 GPa, and assess whether these values can be extrapolated to modeling differentiation processes at pressures >10 GPa.

[1] Righter et al. (2018) GCA 232, 101-123

[2] Righter et al. (2019) MaPS 54, 1379-1394

[3] Steenstra et al. (2020) Icarus, 335, 113391

[4] Righter et al. (2020) Geochem. Persp. Let. 15, 44-49