Goldschmidt2017 Abstract

Chalcophile element partitioning between Mss and sulfide-melt: predictions from lattice strain

DUANE J. SMYTHE[1*], BERNARD J WOOD[1] AND
FRANCESCA J. MIROLO[1]

[1]University of Oxford, Department of Earth Sciences, Oxford UK. duane.smythe@earth.ox.ac.uk (* presenting author), bernie.wood@earth.ox.ac.uk, francesca.mirolo@earth.ox.ac.uk.

The evolution of sulfide melts in magmatic systems is a main control on the distribution of chalcophile elements in planetary bodies, their concentrations in the Earths crust as well as the formation of magmatic ore deposits. On cooling, monosulfide solid solution (Mss) is the first phase to crystalize from a sulfide melt. A detailed knowledge of chalcophile element partitioning between Mss and sulfide melt is therefore required to understand their behaviour during igneous processes.

Previous studies have primarily focused on the partitioning of Ni, Cu, Au and the platinum group elements [1,2] with relatively few exceptions [3]. We have investigated Mss/sulfide melt partitioning of 25 major and trace elements at temperatures between 900 and 1050°C, over a range of compositions in the FeS-NiS-Cu_2S system. Experiments were done at one atmosphere in evacuated silica tubes and at 1.5 GPa using a piston-cylinder apparatus.

With the exception of Fe, S, Mo and possibly Ga, all elements are found to be moderately to highly incompatible in Mss. Furthermore, as Ag is over an order of magnitude more incompatible than Cu, the Cu/Ag ratio of fractionating silicate melts should, as observed by [4], decline sharply as sulfide liquid is replaced by Mss.

We have found the partitioning of cations included in this study to vary systematically with charge and ionic radius and conform to predictions based on the elastic modulus [5]. This also holds true for partitioning of S and O, as well as Se and Te, on the anion sublattice. Previous work has shown that there are clear correlations between cation partition coefficients and the oxygen content of the sulfide melt [2]. These results enable the data to be extrapolated in fO_2-fS_2 space.

[1] Li et al. (1996) Geochim. Cosmochi. Acta 60, 1231-1238. [2] Mungall et al. (2005) Geochim. Cosmochim. Acta 69, 4349-4360. [3] Liu and Brenan (2015) Geochim. Cosmochim. Acta 159, 139-161. [4] Jenner et al. (2015) Geochem. Geophys. Geosyst. 16, 1490-1507. [5] Blundy and Wood (1994) Nature 372, 452-454.