Core formation in the Earth: Constraints from metal silicate partitioning of Copper.

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The estimated CI- and Mg-normalized abundance of Cu in the Earth's mantle is very similar to that of Ni and Co (McDonough, 2001). This is remarkable as the geochemical properties of Cu are very different from those of Ni and Co. At one bar Cu is less siderophile but more chalcophile than Ni and its condensation temperature is below those of Ni and Co. A better understanding of the behavior of Cu during core formation will be particularly useful for estimating the influence of sulfides in extracting siderophile and chalcophile elements from the Earth's mantle during core formation. The complex dependence of Ni and Co metal/silicate partition coefficients on pressure and temperature (Kegler et al. 2008) has demonstrated that a large number of experiments at various temperatures and pressures may be required to estimate the behavior of Cu during core formation. We therefore begun a systematic study of the metal - silicate partition behavior of Cu as function of p, T, silicate composition, and FeCu-alloy composition as well as variable C and S contents.

Piston cylinder experiments (BGI Bayreuth, Universität Münster) were performed at pressures between 0.5 and 2.5 GPa and temperatures between 1350 and 1600 °C. All experiments were made in capsules made of an Fe97Cu3 alloy, except for experiments at T $>$ 1500 °C. In these experiments graphite capsules were used. This allows the investigation of the influence of C on the partitioning of Cu. Basaltic silicate was used as silicate starting material in all experiments. The first results at 1.5 GPa show a strong negative T-dependence of $D^{met/sil}$ Cu , i.e. increasing lithophility with higher temperature. The observed T-dependence is in good agreement with the T-dependence at ambient pressure described by Holzheid & Lodders (2001). No significant influence of carbon on partitioning behavior seems to exist. Isothermal experiments (1450°C) show that the $D^{met/sil}$ Cu values slightly decrease with increasing pressure.

Using our p- and T-dependences for extrapolation of $D^{met/sil}$ Cu values along the peridotite liquidus, a pressure of approx. 25 GPa (at about 3000 °C) would be required to produce the core/mantle ratio of Cu. This is inconsistent to findings for other siderophile elements (e.g., Kegler et al. 2008) and might point to more complex scenarios to explain the Cu abundances in the Earth mantle.

Literature: McDonough W F (2001) The Composition of the Earth. In: Teisseyre R, Majewski E (eds) Earthquake Thermodynamics and Phase Transformations in the Earth's Interior. Academic Press, San Diego, pp 3–23

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