Partitioning of weakly siderophile elements during core formation

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A recent experimental study of metal-silicate partitioning during formation of the Earth's core[1] concluded that the mantle contents of the moderately and weakly siderophile elements W, V, Co, Ni, Ga and Si could be explained by high-pressure core segregation provided the oxygen fugacity of core-mantle equilibration increased during accretion of the Earth. It was proposed that this increase in oxygen fugacity was due to disproportionation of ferrous iron to ferric plus metal in the lower mantle. In this study we have explored the implications of the model by adding data on the weakly siderophile elements Nb, Cr and Ta and the chalcophile (volatile) elements Pb and Tl.

A range of bulk compositions with variable S and Fe contents were used as starting materials and experiments were performed at between 2 and 25 GPa. We find that partitioning of Nb between metal and silicate melt depends strongly on both pressure and temperature (as well as oxygen fugacity) while Cr partitioning is essentially pressure-independent. When considered in the context of accretion of the Earth, the data for these two elements are consistent with the model of progressive oxidation elucidated in reference [1]. Results for Pb, Tl and Ta are currently less well constrained, but we find that the short-lived radionuclide ^{205}Pb is both more siderophile and more chalcophile than its' daughter ^{205}Tl. These observations make it difficult to explain the current Pb/Tl ratios and Tl isotopic compositions of the silicate Earth without extensive volatile loss of Tl during planetary accretion.

[1] Wade, J., Wood, B.J. (2005) Core formation and the oxidation state of the Earth. *Earth Planet. Sci. Lett.* **236**, 78-95