Metal silicate partitioning of Mo and W in a deep magma ocean

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The concentration of siderophile elements in the Earth's mantle is the end result of planetary accretion and core formation. These elements were partitioned between core-forming, iron-rich metallic phases and residual silicate mantle with their distribution controlled by a number of key variables including pressure (P), temperature (T), oxygen fugacity (fO_2) and the chemical compositions of the metallic and silicate phases (X). Core formation models are constrained by the results of partitioning experiments that yield an allowable P–T–X space compatible with the observed siderophile distribution of the mantle. Elements poorly affected by volatility have received the most attention as their mantle depletions are imputable to core formation only and as their bulk Earth contents are well constrained. In this framework, a great deal of effort has been dedicated to the study of highly refractory elements partitioning such as Mo and W (e.g. Walter and Thibault, 1995; Cottrell et al., 2009; Siebert et al., 2011; Wade et al., 2012; Righter et al., 2016; Shofner et al., 2016). However, thermodynamic expressions used to constrain the partitioning behavior of these elements are mainly established from large volume press experiments that do not cover the full range of potential P-T conditions for core-mantle equilibrium. In this work, we have extended metal–silicate partitioning measurements for Mo and W to 75 GPa and 4300 K, exceeding the liquidus temperatures for both metal and silicate (basalt or peridotite) and, therefore, achieving thermodynamic conditions directly comparable to those of the magma ocean. Additionally, the effect of sulfur on partitioning was investigated. We use the results to determine whether or not W and Mo partitioning are compatible with various models for core formation in Earth. For instance, scenarios of heterogeneous accretion proposing to account for Mo and W concentrations in the mantle by equilibration with S-rich metal towards the end of accretion will be discussed.