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Core-mantle fractionation of carbon in Earth and Mars: The effects of sulfur

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ABSTRACT

Constraining carbon (C) fractionation between silicate magma ocean (MO) and core-forming alloy liquid during early differentiation is essential to understand the origin and early distribution of C between reservoirs such as the crust-atmosphere, mantle, and core of Earth and other terrestrial planets. Yet experimental data at high pressure (P)-temperature (T) on the effect of other light elements such as sulfur (S) in alloy liquid on alloy-silicate partitioning of C and C solubility in Fe-alloy compositions relevant for core formation is lacking. Here we have performed multi-anvil experiments at 6–13 GPa and 1800–2000 °C to examine the effects of S and Ni on the solubility limit of C in Fe-rich alloy liquid as well as partitioning behavior of C between alloy liquid and silicate melt ($D_C^{\text{alloy/silicate}}$). The results show that C solubility in the alloy liquid as well as $D_C^{\text{alloy/silicate}}$ decreases with increasing in S content in the alloy liquid. Empirical regression on C solubility in alloy liquid using our new experimental data and previous experiments demonstrates that C solubility significantly increases with increasing temperature, whereas unlike in S-poor or S-free alloy compositions, there is no discernible effect of Ni on C solubility in S-rich alloy liquid.

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