Pressure dependence on carbon isotope fractionation between diamond and iron carbide melt

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Stable isotope fractionation has been thought to be less affected by pressure until recently. In this study we present data on the pressure dependence of carbon isotope fractionation between diamond and iron carbide melt. Carbon, the fourth most abundant element in the solar system, is believed to be an important light element constituent in the Earth's core. The high carbon content of CI chondrites (3.2 wt.%) compared to bulk earth estimates, the presence of graphite/diamond and metal carbides in iron meteorites, the high solubility of carbon into iron melts in the Fe-C system suggests the plausible presence of carbon in the Earth's core. However, the distribution of carbon isotopes in the core is still not well understood. We carried out experimental studies in the Fe-C system and present the results on the equilibrium carbon isotope fractionation between graphite/diamond and iron carbide melt at varying pressures between 5GPa and 15 GPa and at temperature range of 1200 to 2100 ºC. Our previous results have shown that the iron carbide melt will preferentially gather 12C than 13C, which is temperature dependent (Satish-Kumar et al., 2011), consistent with the recent theoretical calculations of Horita and Polyakov (2014). The pressure dependence of this fractionation trend between iron carbide melt and graphite/diamond is examined in this study. Based on the preliminary results, we infer that pressure dependence is also important factor to consider when carbon cycle is considered in the core-mantle interface. It is anticipated that the combined pressure-temperature dependent fractionation of carbon isotopes between iron carbide melt and graphite/diamond is an effective mechanism that created a "12C enriched core" with large scale differences in the distribution of the carbon isotopes in the metallic core and bulk silicate Earth during the accretion and differentiation of early Earth. Our findings also have implications on the deep carbon cycle of the Earth, where the light carbon from the core might have transported to the mantle and crust through deep mantle plumes.
References: Horita, J. and Polyakov, V.B., 2014 PNAS doi/10.1073/pnas.1401782112; Satish-Kumar et al. 2011 Earth and Planetary Science Letters, 310, 340-348

Keywords: Carbon isotope fractionation, Diamond, Iron carbide melt

