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. Here we present data on the pressure dependence of carbon isotope fractionation between diamond and iron carbide melt. We have conducted HP 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 ^{12}C than ^{13}C, which is temperature dependent (Satish-Kumar et al., 2011). This is 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 an 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 can create a "^{12}C 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