

Carbon isotope fractionation during carbonated mantle melting: Implications for deep carbon cycle

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Carbon, the fourth most cosmic abundant element in the solar system, has a key role in the melting phase relations and redox conditions of mantle rocks and can move within the mantle as carbonate-rich melts and volatiles (Dasgupta et al., 2013; Stagno et al., 2013). Carbonate carbon and organic carbon, the two solid forms of carbon in the surface of the Earth, is recycled to the mantle by subduction processes. The mass balance between the surface and mantle carbon inventories has been a topic of hot debate (Dasgupta et al., 2013), where the carbon isotopic composition serves as an efficient tool to understand the carbon cycle, both in the shallow and deep Earth environments. Recently, the presence of light carbon isotope-bearing diamonds was considered to provide evidence for deep cycling of surface carbon of the organic matter origin (Walter et al., 2011), however recent experimental results in the Fe-C system suggests an alternate possibility of light carbon can exist in the core (Satish-Kumar et al., 2011). Therefore, it is essential to understand the carbon isotope fractionation processes taking place in the mantle during carbonated mantle melting conditions in order to clearly interpret the movement of carbon in the deep Earth. Here, we present results on experimental determination of partitioning of carbon isotopes at high-pressure and high-temperature conditions, analogous to melting of carbonated mantle in the presence of graphite/diamond, and discuss the carbon mobility in the mantle.

High-pressure experiments were performed in the Mg-Si-C-O system using a Kawai type multi-anvil high-pressure apparatus at the Institute for Study of the Earths Interior, Okayama University, Misasa, Japan. Starting materials comprise of natural enstatite, synthetic magnesite, San Carlos olivine and pure graphite, that were mixed in the molar ratio 3:2:1:3. This mixture is assumed as simplified carbonated harzburgite in a upper mantle, with excess carbon. Experiments were carried out at pressures of 5 and 10 GPa at varying temperature conditions between 1100 C and 1800 C. Retrieved samples from HPHT experimental runs were mounted in epoxy and cut into two halves where one half was used for petrographic observations and the other half for carbon isotope measurements. Run products were mechanically and/or chemically separated and carbon isotope measurements were carried out using a conventional gas source isotope ratio mass spectrometer (IRMS).

Preliminary results indicate that runs at 5 GPa and above 1500 C have melted and the chemical composition of the melt varied widely, such as C-rich melt or Si-rich melt. Carbon isotope results show considerable partitioning between graphite/diamond and carbonate melt at temperatures and pressures corresponding to upper mantle conditions. We discuss the carbon isotope systematics during melting of carbonated mantle and implications for deep carbon cycle based on our experimental results.

References: Dasgupta et al., (2013) *Nature*, doi:10.1038/nature11731; Satish-Kumar et al., (2011) *Earth Planet. Sci. Lett.* 310, 340-348; Stagno et al., (2013) *Nature*, doi:10.1038/nature11679; Walter et al., (2011) *Science*, 334, 54-57

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