The effect of water and redox state on melting at the top of the lower mantle

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There are various igneous activities in the Earth. On the surface of the Earth, for example, igneous activities occur in island arcs, mid-ocean ridges, hot spots and petit spots. However, not only on the surface, but also in the interior, melting phenomena are also suggested at the top of the asthenosphere [e.g., Barazangi & Isacks, 1971 *JGR*; Schmerr, 2012 *Science*] and the bottom of the upper mantle [e.g., Bercovici & Karato, 2003 *Nature*; Song *et al.*, 2004 *Nature*]. In this study, we focused on the melting of hydrous peridotite at the top of the lower mantle because seismological observation indicates the low velocity anomaly [Schmandt *et al.*, 2014 *Science*; Liu *et al.*, 2016 *GRL*; Liu *et al.*, 2018 *EPSL*]. The low-velocity region is expected to be caused by mantle melting due to dehydration decomposition of ringwoodite to bridgmanite and ferro-periclase with a downward flow.

Here, we performed melting experiments of peridotite with 2.0 wt. % H_2O at 26 GPa and 1600 ˚C - 2000 ˚C. As a starting material, two peridotite samples were synthesized: one was Fe_2O_3-bearing sample and the other was FeO-bearing. The samples were sealed by gold capsules. Recovered product of reductive sample (= FeO-bearing) from 2000 ˚C and 26 GPa showed a partial melting texture. This indicates that mantle melting can be occurred under this experimental condition. On the other hand, there are no melting texture of recovered sample of Fe_2O_3 system from 2000 ˚C and 26 GPa. In short, the materials constituting the lower mantle melts in the reduced state but not in the oxidized state. It is reported that ferric iron occupies a majority in the redox state at the top of the lower mantle [McCammon, 1997 *Nature* ; Frost *et al.*, 2004 *Nature*]. Thus, it is considered that melting phenomenon may or may not occur due to the regional difference of redox state. At 2000 ˚C, compared to bridgmanite in this study, the composition of melt was SiO_2- and Al_2O_3-poor and MgO- and CaO-rich. Although the FeO component concentrated in the melt, this behavior is closer to the tendency of the anhydrous melting experiments (2400 ˚C or more) [Ito & Takahashi, 1987 *Nature*; Trønnes & Frost, 2002 *EPSL*] than the hydrous system (~1400 ˚C) [Kawamoto, 2004 *PEPI*] because of the small amount of water. We calculated the density and compressibility of the magma based on the obtained melt composition. Comparing with seismological model, this melt is lighter than the lower mantle rock. This implies that a small amount of water (2.0 wt. %) can cause a light melt at the top of lower mantle and form the seismological low velocity zone.

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