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Effect of Carbon and Hydrogen on Melting and Magma properties at High Pressure

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CO2 and H2O are important components in the Earth's mantle. These species have strong effects on melting and melt properties such as density and viscosity under the mantle conditions. We studied the effect of CO2 and H2O on melting relations of the mantle materials up to 30 GPa. The experiments revealed that the solidus temperature in the peridotite-CO2 system is comparable with that of the wet solidus of peridotite in the deep upper mantle, whereas it is lower than the wet solidus under the transition zone and lower mantle conditions. Thus, the fluid enriched in CO2 is likely to be formed under the transition zone and lower mantle conditions, whereas hydrous fluid can be formed more easily under the upper mantle conditions.
The density of the volatile rich magmas is controlled by the partial molar volume of the volatile components in magmas. We have determined the partial molar volume of H2O and CO2 in magmas at high pressure up to about 20 GPa by a sink-float experiment using a diamond density marker and the X-ray absorption method. Our measurements revealed that the CO2 component dissolved in magmas is less compressible compared to the H2O component at high pressure. These compression behaviors of CO2 and H2O components in magmas indicate that CO2 reduces the magma density more effectively compared to H2O, and density crossover at the base of the upper mantle between volatile-rich magmas and surrounding peridotite mantle is less likely if the volatile is CO2 enriched in compositions, since CO2 can reduce the magma density effectively even at high pressure of the base of the upper mantle. The CO2 rich melts formed in the upper mantle, transition zone and lower mantle can be buoyant and can move upwards.

Keywords: carbon, hydrogen, melting, magma, density, fluid