Density of hydrous MORB at high pressure and stability of the melt at the base of upper mantle

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1. Introduction

Density of silicate melt is an important physical property to solve dynamics of planetary interiors. Therefore, the density has been determined for many silicate melts, such as MORB and peridotite. Density of hydrous silicate melts, however, has not been measured experimentally so far. In previous works, Ohtani et al. (2004) reported that a certain amount of water can be transported and stored in the transition zone. Recent studies on seismic tomography show the existence of a low velocity zone at the base of the upper mantle which is considered to be caused by dehydration melting of hydrous plume. In this study, density of hydrous MORB melt has been measured using the sink-float method and the gravitational stability of hydrous MORB melt at the base of the upper mantle was discussed.

2. Experimental procedure

Experiments were performed with an MA-8 type multianvil apparatus. Density of dry MORB melt has been reported by Ohtani et al.(2001). In this study, we used the hydrous MORB with the composition exactly the same as that of dry MORB except water to consider the effect of water on density of the MORB melt. Density was measured using the sink-float method with a diamond density marker enclosed in the sample. Experimental conditions were 14.0-18.2 GPa and 2200-2300C.

3. Results and discussion

The diamond marker was neutrally buoyant at 16.8GPa and 2300C, which implies that the density of hydrous MORB melt with 2wt% water is 3.55(0.08)g/cm3 in the condition. From the zero pressure density and pressure derivative of isothermal bulk modulus(K'=5.0), the isothermal bulk modulus of the hydrous MORB melt was calculated to be K=13.8(2.2)GPa.

The compression curve of the hydrous MORB melt containing 2wt%H2O at the condition of 1650C was calculated ignoring the effect of temperature on K and K'. Density relation among hydrous MORB melt and PREM at 1650C showed that hydrous MORB melt can exist stably at the base of the upper mantle.