Viscosities of MORB melt at high pressure

Ryota Ando[1], Eiji Ohtani[2], Akio Suzuki[3], Tomoaki Kubo[1], Tadashi Kondo[4], Kenichi Funakoshi[5]

[1] Tohoku Univ, [2] Institute of Mineralogy, Petrology, and Economic Geology, Tohoku University, [3] Faculty of Science, Tohoku Univ., [4] Sci., Tohoku Univ., [5] JASRI

Recent study indicates that MORB (Mid Ocean Ridge Basalt) is related to activity of hot spot. Plume, which ascends from the deep mantle, takes in the old MORB and rises together with it. This MORB component can easily generate a large amount of basaltic melt, because MORB liquidus is lower than the solidus of peridotite within 10 GPa. (Takahashi et al. 1993, Yasuda et al., 1994) This mechanism is important both for the genesis of CFB (Continental Flood Basalt), and for the genesis of OIB (Ocean Island Basalt). (Takahashi et al., 1998, Hauri, 1996, Yasuda et al., 1994) If we want to know the activity of a hot spot, we have to investigate the physical properties of MORB melt at high pressure. Therefore we measured viscosity of MORB melt at high pressure.

Previous studies (Kushiro, 1976, Fujii and Kushiro, 1978, Scarfe, 1981, Iwasaki, 1997) measured viscosities of basaltic melts by quenching falling sphere method. Kushiro (1976), Fujii and Kushiro (1978) and Scarfe (1981) measured the viscosity of basaltic melt by a piston cylinder high pressure apparatus and indicated that at lower pressures than 2.0 GPa, the viscosity of the basaltic melt decreases isothermally with increasing pressure. While, Iwasaki (1997) measured viscosity of the basaltic melt by the multianvil high pressure apparatus and indicated that at higher pressure than 2.5 GPa, the viscosity of basaltic melt increases isothermally with increasing pressure. So he also claimed that the basaltic melt had the minimum value of viscosity about 2.5 GPa.

This result is very important because basaltic melt would have the depth where this melt can move most smoothly. But this result may be doubtful, because he used a diamond with an irregular shape but he did not consider this effect.

We measured the viscosity isothermally at 1600 ºC, from 2.5 GPa to 4.4 GPa, in order to investigate the pressure dependency of basaltic melts above 2.5 GPa.

We measured viscosities by using both falling sphere X-ray radiography method and quenching falling sphere method.

The falling sphere X-ray radiography method was performed at BL04B1, Spring-8, Japan, and MA-8 multianvil press system (SPEED1500) installed there was used as the high pressure apparatus.

Quenching falling sphere method was performed by the MA-8 multianvil press system installed at Tohoku University. We also used diamond grain which is not perfect sphere. However we made the correction the shape of diamonds by using liquid whose density and viscosity were known before the experiments.

MORB viscosity decreases to 3.4 GPa with increasing pressure and increases above 3.4 GPa with increasing pressure, Therefore MORB melt has a viscosity minimum at 3.4 GPa.