in situ measurement of viscosity and structure of basaltic melts at high pressure

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In this study, we investigated viscosity and structure of MORB melts by in situ measurement at high pressure and high temperature. The viscosity of basaltic melts were measured by X-ray radiography method from 0.8 to 4.4 GPa at 1873 K, and from 3.5 to 5.2 GPa at 2023 K. The structure of basaltic melts and glass were determined by the EDXD method (Energy-Dispersive X-ray diffraction method) from 1.1GPa to 4.7 GPa at liquidus tempreture for melts, from 1atm to 9.0 GPa for glasses.

Viscosity measurements were carried out at the BL04B1 beamline, which was combined with a Kawai-type multianvil apparatus (SPEED1500) and a CCD camera with YAG fluorescence screen. We observed the radiography image of Pt or Re sphere falling in the molten sample at high pressure and high temperature, and calculated the viscosity using Stokes' law by using the terminal velocity of the falling sphere.

Structure measurements were also carried out at the BL04B1 beamline combined with SPEED1500. Scattering X-ray was detected by Ge-SSD on the horizontal Gonio stage, which was combined with a multi channel pulse analyzer (MCA). We obtained the diffraction pattern at 2-theta angles of 4,6,8,10,12,14 degree. The effective Q ranged up to 12 A-1. In order to obtaine the static structure function S(Q), we employed the Monte Carlo intensity analysis method. We also obtained the pair distribution function g(r) by Fourier transformed of S(Q).

The viscosity of the MORB melt were decreasing with increasing pressure up to 2.5 GPa, which is consistent with the previous studies. However, it increases above 2.5 GPa with increasing pressure. These results imply that the structure of basaltic melts is changed around 2.5 GPa

This change was also observed by the structure measurements. Both first peak position of S(Q) and g(r) were abruptly changed from 1.6 GPa to 2.5 GPa, This change was due to the collapse of TO4 tetrahedron and would correspond to the change of viscosity trend around 2.5 GPa.