

SCG009-02

Room:301A

Time:May 23 14:45-15:00

X-ray diffraction studies on the structure of aluminosilicate melt under pressure

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The physical properties of silicate magma, such as density and viscosity, are important to understand migration of magma within the planetary interior as well as evolution of magma ocean. As these properties are related to the structure of magma, the structural studies of silicate magma at high pressures are fundamental to understand the magma related processes within the planetary interior. Therefore, we studied the structure of aluminosilicate melts at high pressures. Here we report the results of X-ray diffraction analysis on $\text{Ca}_3\text{Al}_2\text{Si}_6\text{O}_{18}$, $\text{Mg}_3\text{Al}_2\text{Si}_6\text{O}_{18}$, and $\text{NaAlSi}_2\text{O}_6$ composition melts up to 7 GPa.

Static structure of aluminosilicate melts under pressure has been studied by in situ x-ray diffraction experiments using synchrotron radiation at Photon Factory, KEK, Japan. X-ray diffraction patterns were acquired just above the melting temperature to about 7 GPa by energy-dispersive x-ray diffraction method and were analyzed by Fourier method.

Radial distribution functions of aluminosilicate melts show the increase of T-O distance as pressure increases. The T-O distance is an indicator of the coordination number of the network-forming cation, Si and Al. The higher the coordination number is, the longer the T-O distance is. In these melts, it is expected that the coordination number of Al increases in these pressure range. The first sharp diffraction peak (FSDP) of interference function shifts higher Q-side with increasing pressure, indicating the shrinkage of intermediate range structure in these melts.

The changes in the structure are related strongly to density and viscosity in these melts. These results are important to understand how these properties changes with pressure.