Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)


SIT06-21 Room:303 Time:May 25 09:15-09:30

# Liquidus phase relations in MgO-FeO-SiO2 system at high pressure: Implications for the solidification of magma ocean

MORISHITA, Akira[1*] ; NOMURA, Ryuichi[2] ; HIROSE, Kei[2]

[1]Department of Earth and Planetary Sciences, Graduate School of Science and Engineering, [2]Earth-life Science Institute, Tokyo Institute of Technology

Seismological observations show the presence of large anomalies in the lowermost mantle such as LLSVP and ULVZ, both of which should be denser than surrounding mantle and thus gravitationally stable. The origins of such anomalies are still under debate, but they could be related to a basal magma ocean (BMO) that may have formed in early history of the Earth; the LLSVP represents iron-rich solids crystallized from the evolved BMO, and the ULVZ is a residual melt left after extensive solidification of the BMO.

Here we performed high-pressure melting experiments on the MgO-FeO-$SiO_2$ ternary system in a laser-heated diamond-anvil cell (DAC). Chemical and textural characterization of recovered samples were made using dual beam scanning microprobe (FIB + FE-SEM) (Versa 3D) and field-emission-type electron probe microanalyzer (FE-EPMA). The cross section of the sample showed a round portion with non-stoichiometric composition at the center (the hottest part), which represents quenched partial melt. And, such quenched melt was surrounded by a layer of solid phase(s) of (Mg,Fe)$SiO_3$ bridgmanite, (Mg,Fe)O ferropericlase, and SiO2 stishovite. Together with previous theoretical calculations of eutectic melt compositions in MgO-$SiO_2$ binary system and experimental results on FeO-$SiO_2$ and $(Mg,Fe)_2SiO_4$ systems, the liquidus phase relations in the MgO-FeO-$SiO_2$ ternary system were determined at 36 GPa. We also estimated those at 135 GPa considering the increase in iron content in bridgmanite with increasing pressure.

These results indicate that residual melt of the BMO should have evolved toward iron-rich and silica-poor with solidification. Fractional crystallization in the BMO leads to a very small fraction of residual melt that is strongly enriched in FeO, which is very dense in the lowermost mantle. The knowledge of chemical evolution of the BMO help understand the nature of the LLSVP and the ULVZ.

Keywords: magma ocean, mantle evolution