Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SIT040-P01 Room:Convention Hall Time:May 23 10:30-13:00

Melting experiments of the Martian mantle and origin of shergottite

Yoko Nagayo[1*], Kyoko Matsukage[1]

[1]Ehime University, GRC

The basaltic and olivine-phyric meteorites from the Martian surface, shergottites, are known to differ from the Earth's basalts in chemistry. The parent magma of Martian basalts are estimated to be enriched in Fe and depleted in Al. Basaltic rocks are generally considered to originate from liquid part of the mantle material which suffered partial melting. Therefore, these chemical variations in shergottites indicate that the Martian mantle also has Fe-rich and Al-poor composition. Melting experiments on Fe rich mantle have been performed at 1.5-3.0 GPa by Bertka and Holloway (1994) and at 3.0-10 GPa by Draper and his coworkers (e.g., Draper et al., 2001; Wasserman et al., 2001; Agee and Draper, 2004). Parent magmas of shergottite, however, could not be produced by partial melting in this pressure range (Agee and Draper, 2004). Here, we point out that the solidus temperature reported by Borg and Draper (2004) is higher than that by Bertka and Holloway (1994). The difference is more than 150 ^{0}C at 3.0GPa, although the chemical composition of starting materials was almost same in the both studies. In this study, we performed melting experiments of Fe-rich Martian mantle between 1.0 and 5.0GPa in more reliable experimental conditions, and discussed the origin of shergottite magma.

The DW Martian mantle composition model which is suggested by Dreibus and Wanke (1985) is used as our starting material in the system SiO_2-TiO_2-Al_2O_3-Cr_2O_3-FeO-MgO-CaO-Na_2O. We reduced the synthesized starting material in a gas mixing furnace, oxygen fugacity at QFM, 1000 ^{0}C for 5 h. Pt/Re double capsules are used for all our experiments for reduction of Fe-loss from the sample. We used multi-anvil apparatus for the experiments at 5.0 GPa and piston-cylinder apparatus (Takahashi lab. in Tokyo Tec.) at 1.0 and 2.5 GPa. The experimental conditions are 1300- 1700 ^{0}C in temperature and 1-24 h in duration. We used SEM-EDS to analyze the chemical composition and to identify the mineral phases. We also calculated the degree of melting with image-editing software.

In our experiments, the solidus temperature at 5.0 GPa is around 1500 ^{0}C and liquidus temperature is 1750 ^{0}C, which indicates that the solidus and liquidus temperature of this study is about 100 ^{0}C lower than Agee and Draper (2004). At 2.5 and 1.0 GPa, solidus temperature is approximately 1400 and 1300 ^{0}C respectively which is a little higher than Bertka and Holloway (1994). Phase relation shows a good agreement with Bertka and Holloway (1994), Agee and Draper (2004) except for spinel stability field that is wider in our experiment up to 1400 ^{0}C. The chemical composition of partial melt from our experiments has low in Si content and high in Mg/(Mg + Fe) atomic ratio, compared to the calculated data of the parent shergottite magma by previous studies (e. g., McSween et al., 1988; Schwandt et al., 2001; Harvey et al., 1993). In Al and Ca contents, parent shergottite magma is comparable with the partial melts of DW mantle from our experiments at 2.5 and 5.0 GPa, which is lowest pressure condition of garnet stability field in Martian mantle. Consequently, we estimate that the primitive magma of Mars could be generated between at 2.5 and 5.0 GPa where 200-400km deep in the Martian mantle if the DW mantle is a host material of basaltic shergottites.

Keywords: Mars, mantle, shergottite, partial melting, high pressure and temperature experiments