Oral | Symbol P (Space and Planetary Sciences) | P-PS Planetary Sciences

[P-PS23_2PM2]Lunar science and exploration

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Scientific data sets acquired by not only Japanese lunar mission SELENE (Kaguya), but also other countries' missions, have become new standardfor lunar science. Analyses of these data have been providing several new knowledge and changing some hypotheses into the truth of the Moon. In concurrence with these studies, some countries including Japan are planning future lunar missions. In this session, we will discuss scientific results based on newly acquired lunar data, strategy for future missions, and theoretical and experimental studies for lunar science.

4:00 PM - 4:15 PM

[PPS23-P09_PG]Experimental evidence for the deep high-Ti basalt magma in the lunar mantle

3-min talk in an oral session

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The existence of high seismic attenuation zone at the depths greater than about 800 km implies that the lower mantle of the Moon could be partially molten (Nakamura et al., 1973; 1974). There is a longstanding hypothesis that the last fraction of the lunar magma ocean crystallized into a layer of dense Ti-rich cumulates at the shallow depths (~ 100 km) early in the lunar history. It has been suggested that the cumulates subsequently sank into the deep interior of the moon because of its gravitational instability (e.g., Ringwood and Kesson, 1976). It is necessary to investigate the melting relations of the high-Ti basalt that may be erupted from the depths at high pressure (> 4 GPa).In this study, melting relations of Apollo 14 black glass (Delano, 1986), the most Ti-rich lunar ultramafic glasses, were experimentally determined at the pressure of 4 GPa and the temperature range from 1300 C to 1450 C. The high-pressure and high-temperature experiments were performed by using 3000 ton Kawai-type multi-anvil apparatus of Tohoku University. The samples were packed into graphite capsules and the experimental temperatures were measured by using W-Re thermocouples. The compositions of run products were analyzed by using FE-SEM (Field Emission Scanning Electron Microscopy). Our experiments depicted that the liquidus and solidus temperatures were determined to be 1450 C and 1325 C respectively at 4 GPa. The liquidus phase is garnet, and the first consuming phase is ilmenite. Estimated temperature profile of the Moon at depths of 700 km -1200 km are between 1100 C and 1400 C (e.g., Gagnepain-Beyneix et al., 2006). The densities of partial melts and total melt were calculated by using the partial molar volume of the oxide components at one atmosphere (Lange and Carmichael, 1987) and the Birch-Murnaghan equation of state (Sakamaki et al., 2010). The densities of the melts formed by partial and total melting of the Apollo 14 black glass were heavier than those of the lunar deep mantle. Crystal-liquid density crossover is inevitable at the depth around 800 km, the pressure corresponding to 4 GPa. Therefore, the high-Ti basalt magma can exist stably if the lunar temperature profile is close to the upper bound of the estimated lunar temperature profile, suggesting existence of the low-velocity

and low attenuation anomalies caused by chemical heterogeneities in the lunar deep mantle.