Geology of the SLIM landing site on the Moon

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Introduction: Smart Lander for Investigating Moon (SLIM) is a Japanese technology demonstration mission to pinpoint landing within a hundred meters in radius, which will be launched in fiscal year 2021. The lander carries one small instrument (high-resolution Multiband Camera; see Saiki et al. in this conference) to derive the detailed mineralogy of the olivine-rich exposure to investigate a olivine bearing lithology for understanding their origin and investigating the composition of the lunar unsampled mantle or deep crustal material. To directly explore this unexplored lithology, one of the small fresh craters just outside of the Theophilus crater is selected as a landing site for the SLIM mission. In this study, we analyzed geology of Theophilus crater and the selected landing site.

Crater Theophilus (11.4°S, 26.4°E) is located in the immediate vicinity (northwest) of the Mare Nectaris on the Moon. It is on the ring of the Nectaris basin. Its diameter is 110 km, and it has a clear central peak at the center of the crater. Previous study revealed the central peak’s compositional diversity [1][2]. However, the origin of other lithologies and the relation of these rare geologic lithologies in this unique central peak are still not clear. In addition to their geological (mineralogical) diversity.

Data and Results: We used remote sensing reflectance spectra and spectral images obtained by the SELENE (Kaguya) Spectral Profiler (SP) and Multiband Imager (MI). Olivine-dominant lithology at the central peak have clear diagnostic absorption of olivine. Percentage of olivine among olivine and pyroxene of the olivine dominant lithology is estimated to be more than 70. The FeO abundance of the olivine-dominant lithology estimated ranges from 5 to 8 wt.%. Olivine-dominantlithology appears to be present as a basal lithology of the central peak blocks. Olivine dominantlithology is also observed as localized exposures at many small but fresh craters throughout the wall and ejecta region. These fresh craters commonly have a very clear olivine absorption feature, and the FeO abundance of these localized olivine exposures ranges up to 12 wt.%,which corresponds to a nearly pure olivine rock, if Mg# (Mg/(Mg+Fe) in mole per cent) of the olivine is assumed to be similar to the olivine-rich rock types (troctolite and dunite) among the Apollo samples.

Discussion: Based on the modal abundance, FeO abundance, distribution, and morphological information of the observed lithologies, we believe that the central peak of Theophilus crater mainly consists of olivine-dominant lithologies with lesser amounts of purest anorthosite (PAN) and Mg-spinel bearing lithologies. Distribution of Mg-spinel bearing lithology is limited in our datasets and they tend to have a relatively sharp vertical boundary with the adjacent lithology. Therefore, we interpret it is not presented as a laterally extensive unit before the formation of the Theophilus crater as suggested [1]. Observed olivine-rich composition comparable to dunite and a sharp boundary with the adjacent PAN lithology suggest that it is not a part of the continuous crustal material. Instead, it is probably mantle (or the lower part of the crustal) origin, which is excavated by the Nectaris basin forming impact as suggested by the global distribution of the olivine-rich sites [2], well before the formation of the Theophlius.

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