月南極-エイトケン盆地の衝突溶融物から推定する月内部組成

Compositional estimation of the lunar interior based on the mineralogy of impact melt pool of South Pole-Aitken basin

*大竹 真紀子[1]、上本 季更[2]、春山 純一[1]、中村 良介[3]、松永 恒雄[4]、山本 聡[4]、横田 康弘[5]、石原 吉明[1]、岩田 隆浩[1]
*Makiko Ohtake[1], Kisara Uemoto[2], Junichi Haruyama[1], Ryosuke Nakamura[3], Tsuneo Matsunaga[4], Satoru Yamamoto[4], Yasuhiro Yokota[5], Yoshiaki Ishihara[1], Takahiro Iwata[1]

1.宇宙航空研究開発機構 宇宙科学研究本部、2.東京大学、3.産業総合研究所、4.国立環境研究所、5.つくば惑星研究会
1.Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, 2.Tokyo Univ., 3.National Institute of Advanced Industrial Science and Technology, 4.National Institute for Environmental Studies, 5.Tsukuba Planetary Study Group

The South Pole-Aitken (SPA) basin is the largest basin (2400 x 2050 km) that is clearly identified on the Moon. The basin impact is very large, so it has been suggested that most of the crustal material within the SPA was excavated, and it is likely that the mantle materials have been exposed within the basin. However, the mineralogy of the SPA basin was not well known previously because it is one of the oldest basins (pre-Nectarian in age), and its surface has become obscured by intensive cratering and mixing since its formation. Therefore, it is very important to investigate the mineralogy and composition of the impact melt pool and to evaluate if the impact melt pool had undergone magmatic differentiation to acquire rare direct information of the lunar interior (possibly mantle) composition. In this study, we used a mineralogical map based on high-spatial-resolution reflectance spectra using the SELENE (Kaguya) Multiband Imager (MI). We investigated not only the mineralogy but also the layer thickness, distributions, chemical abundance, and stratigraphy within the central area of the basin.

As the results, we classified the rock types for six units as, 1) LCP-dominant unit (L1) located around the central depression, 2) HCP-dominant unit (H1) located within the depression, 3) HCP-dominant unit (H2) with relatively deeper spectral absorption at 1050 nm than the 950 and 1000 nm and tends to have longer wavelengths in the band center than the H2 unit, 4) an LCP-dominant unit (L2) observed at the central peaks of the large craters, which formed after the SPA basin impact, 5) the HCP-dominant unit (MB) having even longer wavelengths in the band center and higher iron content than H1 and L2 units, 6) plagioclase dominant rock (An). HCP-dominant rock types (H1 and H2) have the largest coverage in the central depression. Based on the crater wall and floor observation on the L1 unit, it is clear that the H1 unit extends under the L1 unit. The L1 thickness is estimated to be 100 to 500 m based on the estimated excavation depth of the observed craters. Based on the crater central peak observation of the H1 unit, the LCP-dominant L2 unit underlays the H1 unit, and the H1 thickness is from 6.5 to 6.9 km. Similarly, H1 extends under the H2 unit and is up to 2 km thick. The thickness of L2 is at least 8 km thick, based on the diameters of the smallest and largest craters that have central peaks of the red layer. As a result, columnar sections of the area are determined as L2> H1> (L1/H2) from bottom to top.

We interpreted the L1 unit as mantle material ejected by an SPA formed impact event based on its spectra, thickness, and chemical composition. We also interpreted the H1 and L2 units as the impact melt of the SPA basin that had undergone magmatic differentiation because this layer is larger and thicker than the normal mare basalt observed on the Moon. In addition, the average FeO abundance is 2 wt.% lower than that of mare basalt.

Hurwitz and Kring (2014) studies SPA impact melt differentiation and derived estimated stratigraphy

considering the different lunar bulk composition (different impact melt composition) and mantle overturn. Stratigraphy of our observation (lower LCP layer of at least 8 km and upper HCP layer of 6~7 km) is matched to the stratigraphy of a post-overturn model in their study, which estimated relatively thick olivine layer (~30 km)> LCP layer (12 km)> HCP layer (5 km) from bottom to top in the differentiated column. This suggest that the composition of the SPA impact melt indicates the lunar upper mantle after the mantle overturn. In other words, the SPA impact event occurred after the LMO cumulate overturn. This is possibly direct evidence that the mantle overturn occurred early in the history of the Moon.

キーワード：月、内部、組成、鉱物、衝突溶融物
Keywords: Moon, interior, composition, mineralogy, impact melt