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Compositional estimation of the lunar highland crust derived by the SELENE spectral data

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Global distribution of rocks of extremely high plagioclase abundance (approaching 100 vol%; called purest anorthosite (PAN)) was reported using an unambiguous plagioclase absorption band around 1250 nm found by the SELENE Multiband Imager (MI). The estimated plagioclase abundance is significantly higher than previous estimates of 82 to 92 vol%, providing a valuable constraint on models for lunar magma ocean evolution. Further study using continuous reflectance spectra derived by the SELENE Spectral Profiler (SP) revealed a global and common distribution of the PAN over the entire lunar surface, supporting the high abundance of PAN rocks within the upper crust.

In this study, we investigated a vertical compositional (modal abundance and/or mineral composition) trend of the PAN rocks within the crust using their reflectance spectra derived from SP and MI. Knowing the compositional trend of the lunar upper crust may enable us to understand the mechanism of the lunar crustal growth.

All of the SP data observed throughout SELENE mission periods were used in this study. The absorption depth at each wavelength was calculated after a linear continuum was removed. Spectra with the deepest absorption depth, around 1250 nm, which is caused by a minor amount of ferric Fe (in the order of 0.1 wt% FeO) contained in the plagioclase, were selected to detect the PAN rocks. To estimate modal abundance of each spectrum we used correlation of the absorption depth ratio of mafic minerals to plagioclase (900nm/1250 nm) to the crater diameter. Original burial depth of each outcrop was estimated from a crater scaling law using the crater diameter of each outcrop observed in MI data.

Results indicate that the majority of the derived absorption depth (strength) ratios (900/1250 nm) of the detected high plagioclase abundance anorthosite rock spectra appear to form a trend which increases as their estimated original burial depths increase within the crust (the trend is observed up to 30 km of the original burial depth).

Although understanding the actual cause of this trend requires further studies, such a trend may indicate a decrease in the mafic mineral abundance within the already very mafic-poor rock and/or an increase in the ferric Fe content of plagioclase with depth.

Keywords: SELENE, lunar exploration, highland crust, magma ocean