GEOLOGICAL STRUCTURE FROM ANORTHOSITE DISTRIBUTION OF THE LUNAR SOUTH POLE-AITKEN BASIN BASED ON DATA DERIVED FROM SELENE MULTIBAND IMAGER

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Introduction: SPA is one of the biggest basins (2500 km in diameter [1]) on the lunar far side. Previous studies have suggested that most of the crustal material of this basin was excavated and that the mantle materials have been exposed [2]. Therefore, most of the anorthosite composing the crust may have been excavated and ejected from the basin [1]. However, the basin formation process and consequent mineralogy of this basin are still unclear because of the degradation after the supposedly ancient SPA basin-generated impact. For example, [2] and [3] reported that the central part of the SPA basin contains anorthosite which is crustal material (Fig. 1). Additionally, Ishihara et al. (2009) estimated the anorthositic crust in the SPA basin to be 20 to 30 km thick based on data derived from the SELENE Relay satellite, its Main Orbiter transponder, and the Laser Altimeter [4]. These observations are apparently inconsistent with the theory of previous studies. In this study, we analyzed the geological structure of this large impact crater to understand the cause of this disagreement by investigating the distribution of anorthosite within the SPA basin and compared the results with topographic data.

Methods: Anorthosite has higher reflectance than rocks with more mafic-rich compositions. Therefore, we chose 54 areas to analyze by selecting higher reflectance locations (more than 80%) based on the Clementine 750 nm base map. We used the SELENE Multiband Imager (MI) to estimate the lunar mineralogy of these selected locations. MI is a high-resolution spectral imager with both visible and near-infrared coverages at spectral bands of 415, 750, 900, 950, 1000, 1050, 1250 and 1550 nm. In all MI images, spatial resolution is adjusted to 20 m x 20 m per pixel. At each location, the reflectance is derived by averaging an area corresponding to 6 x 6 pixels in the MI VIS to remove spatial variation. Mineral phases have diagnostic absorption features depending on the minerals. Plagioclase has an absorption band at around 1250 nm; olivine, at around 1050 nm; and pyroxene, at around 1000 nm. These minerals are the three commonest minerals on the Moon. We detected a peak shoulder at around 1250 nm compared to the line between 1050 nm to 1550 nm to select anorthosite spectra. Locations without this peak shoulder are categorized as others.

We made a color-composite image (Fig. 2-2) in which red is assigned to a continuum-removed absorption depth at 950 nm; green, to that at 1050 nm; and blue, to that at 1250 nm. We also used topographic data derived from the SELENE Laser Altimeter (LALT) to compare the mineralogy with topography [5]. Its spatial resolution is finer than 0.5 degrees. We identified rings within the SPA basin based on the topographic features.

Results: We identified four rings from the LALT data (rings 1 through 4 in Fig. 1). The area within ring 4 is smooth compared to the other areas. We found anorthosite in 16 locations both on and outside of ring 2 (Fig. 1) (and within the SPA basin). In addition to these 16 locations, three locations were recognized in the northwest area between ring 3 and ring 4 in Fig. 1. We illustrate an example of one of the anorthosite locations in Fig. 2. Anorthosite is present in the blue area in the color-composite image. Figure 3 depicts reflectance spectra of the presented location. In this example, anorthosite was detected at location 1, 2 and 3.

Discussion: The boundary (ring 2 in Fig. 1) derived from topographic data matched the presence of the anorthosite distribution derived from mineralogical data. This suggests that ring 2 corresponds to a transient cavity within which crustal material is excavated.

The fact that the elevation difference among the exposed anorthosite locations within ring 3 (Fig. 1) is about 2 km may suggest that these three locations are remnants of crust within the SPA basin because if the origin of the detected anorthosite is fractionated impact melt, it would be difficult to generate an elevation difference as much as great as observed. Although ring 4 is the innermost ring, it is possible that impact melt filled only this ring.

References: [1] Spudis P.D. et al. (1994) *Science*, 266, 1848-1851. [2] Pieters C.M. et al. (2001) *JGR*, 106, 28,001-28,022. [3] Ohtake M. et al. (2009) *Nature*, 461, 236-401. [4] Ishihara et al. (2009) *GRL*.36, L19202, 4 [5] Araki et al. (2009) *Science, 323, 5916, 897-900*

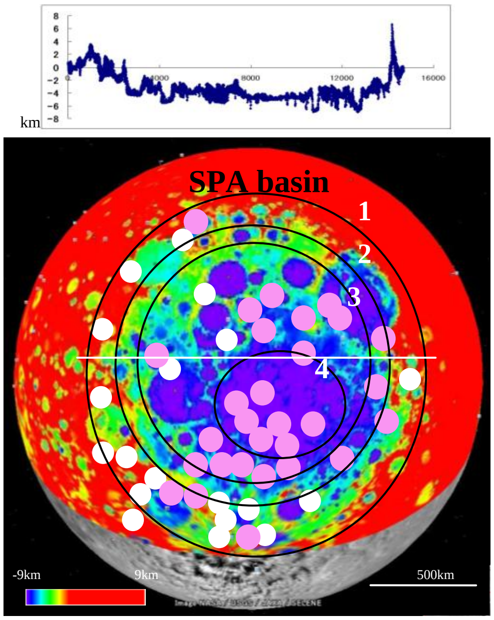

Fig. 1. Distribution of the craters analyzed in this study. Elevation map is from the *LALT data.* Ring 1 is the rim of SPA. Rings 2 to 4 are derived from topographic data. White dots indicate locations where anorthosite (>90 vol.% plagioclase) was found. Pink circles indicate locations where anorthosite (>90 vol.%plagioclase) was not found.

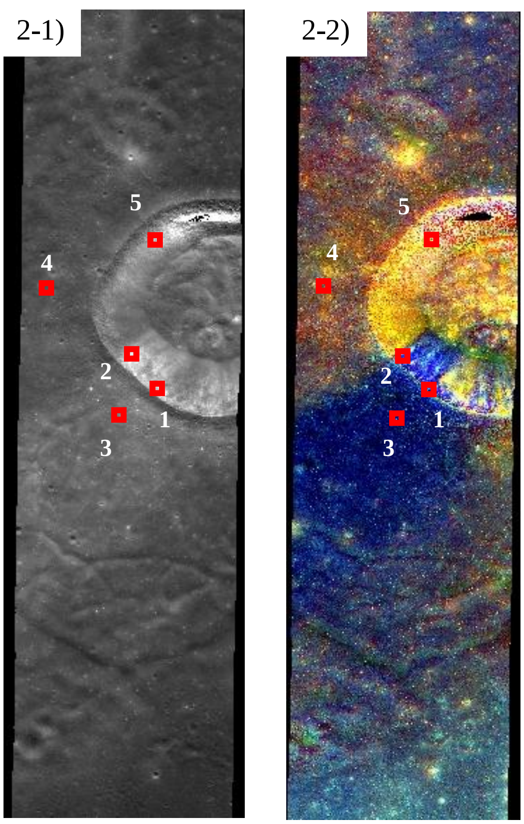

Figure 2. 2-1) Multiband Imager 750 nm image of Poincare NE.
2-2) Color-composite image of Poincare NE. Red, green, and blue are assigned to a continuum-removed absorption depth at 950, 1050, and 1250 nm. These approximately indicate the relative strengths of pyroxene, olivine, and plagioclase absorptions, respectively.
Reflectance spectra of red squares is presented in Fig. 3.
Squares 1, 2 and 3 indicate locates anorthosite was found.
Squares 4 and 5 indicate locations it was not found.

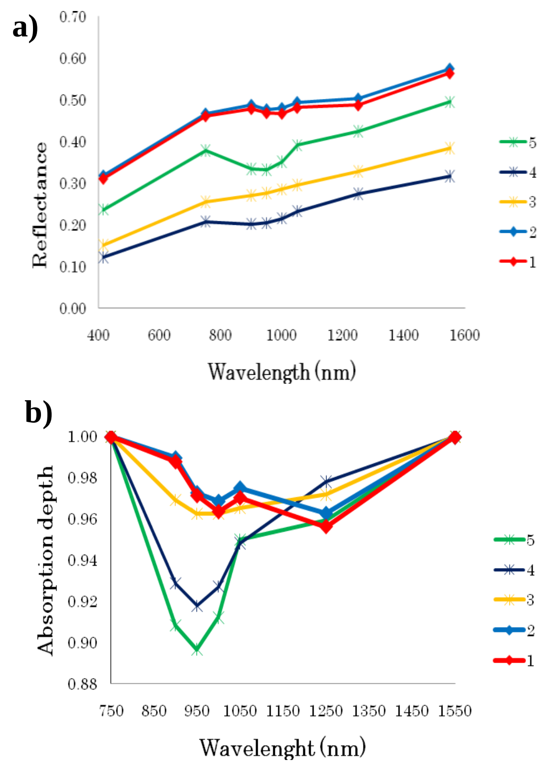

Fig. 3. Reflectance spectrum of each location in North crater of the PoincareNE. a) Representative reflectance spectra of Poincare NE crater.
b) Absorption after continuum removal. Spectra 1 and 2 indicate maximum absorption at about 1250 nm, indicating anorthosite composition.
Graphs of red (1), blue (2) and yellow (3) in both profiles indicate that anorthosite is present. Other color graphs (4 and 5) indicate that it is not present.
At each location, the reflectance is given by averaging an area corresponding to 6 x 6 pixels in the MI VIS to remove spatial variations.