GLOBAL DISTRIBUTION TREND OF PUREST ANORTHOSITE ON THE MOON REVEALED BY SELENE SPECTRAL PROFILER

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INTRODUCTION

The studies using the spectral data obtained by Multi-band Imager (MI) and Spectral Profiler (SP) onboard the Japanese lunar explorer SELENE/Kaguya revealed the existence of the purest anorthosite (PAN) over the entire Moon [1, 2]. In order to understand the formation and the evolution of the lunar crust based on the PAN sites, we need to investigate the global distribution trend of the PAN sites on the Moon. Therefore, we did the intensive global survey, which uses the same algorithm to find the global distribution of the olivine-rich exposures [3], to find the PAN sites from all the SP data. We also examined their modes of occurrence of each PAN site based on the close-up images obtained by the MI and Terrain Camera (TC) onboard on SELENE [1, 4]. Here, we describe the global distribution trend of the PAN sites based on the result of this new survey.

RESULTS

SP has obtained continuous spectral reflectance data for about 70 million points (0.5 by 0.5 km footprint) on the Moon in the wavelength $\lambda = 0.5$-$2.6\,\mu$m and a spectral resolution of 6-8 nm during the mission from November 2007 to June 2009 [e.g., 5, 6]. Analyzing the 70 million spectral data with the global survey algorithm used in [3], we identified more than 500 observational points, which show a clear plagioclase band around $1.25\,\mu$m as shown in Fig. 1. We consider that these spectra indicate the existence of the purest anorthosite (PAN)(> 98 vol. percent) [1,2].

Most of the PAN points appear to be grouped into many local sites on the Moon. Our survey identified the classical anorthosite-rich sites [e.g., 7] in the near side of the Moon: e.g., Grimaldi, Humorum, Nectaris, and Crisium basins. On the other hand, there is no definitive PAN exposure in the Procellarum KREEP Terranes (PKT). As for the Feldspathic Highland Terrain (FHT), many PAN sites are found in and around large impact basins. Fig. 2 shows the locations of the PAN sites around FHT region. We can see that the PAN sites are

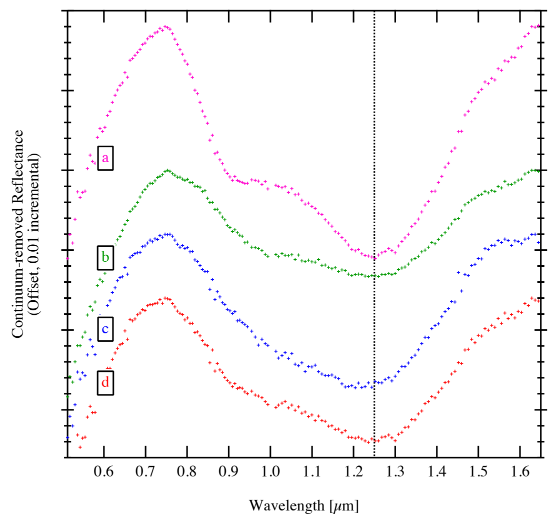

Figure 1: The continuum-removed reflectance spectra measured at SP points in (a) Orientale, (b) Hertzsprung, (c) Plaskett, and (d) Shackleton. All spectra have been vertically offset for clarity, and the thick intervals of the vertical axes are 0.01.

located around the large impact basins: e.g. (A) Orientale, (B) Hertzsprung, (C) Korolev, (D) Freundlich-Sharonov, (E) Dirichlet-Jackson, (F) Grimaldi, and (G) Mendel-Rydberg basins. Some of these basins have been considered as anorthosite-rich areas based on their very low FeO values [e.g., 7]. Around the South Pole-Aitken (SPA) basin, we found the PAN sites in the rim region: e.g., (H) Aitken, (I) Chebyshev, and (J) Thomson craters (Fig. 2). Our survey did not identify definitive PAN exposures in the center of the SPA basin.

At local scales, the PAN exposures are found in km-sized fresh craters or sloped walls of the peaks. Fig. 3 show the close-up images of the PAN sites on the inner ring of Hertzsprung basin (1.0°N, 124.3°W) and the central peaks of Plaskett crater (82.1°N, 174.3°E). (The close-up images shown here are obtained by the MI and TC). The PAN spectra are found near the rim of a 3 km-sized crater on the inner ring of Hertzsprung basin and the sloped area of the central peak of the Plaskett crater. These suggest that the impacts that formed these craters exposed the PAN materials from beneath the surface.

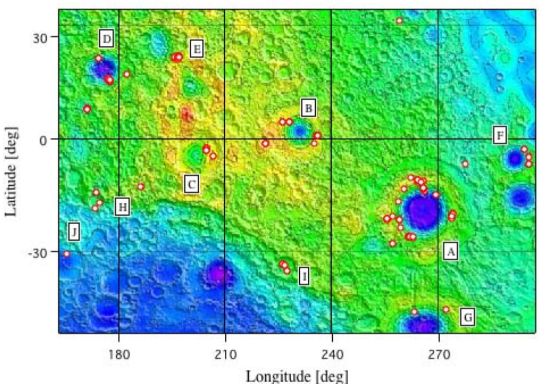

Figure 2: The location of PAN sites around Feldspathic Highlands Terrane (FHT) region. The background map is the total lunar crustal thickness [in km] (crustal materials and mare basalt fills) map based on SELENE gravity and a topographic model, which was obtained by SELENE [see 8].

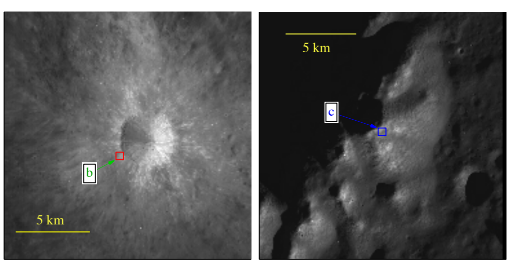

Figure 3: The close-up images of the PAN sites in the inner ring of Hertzsprung basin (left) and at the central peak of Plaskett crater (right). The spectra at ‘b’ and ‘c’ are shown in Fig. 1.

We also found many PAN sites at higher latitudes (> 70°N or < 70°S): e.g., Drygalski, Schrödinger, Shackleton, Anaxagoras, Schwarzschild, Plaskett, and Rozhdestvenskiy. Shackleton crater, which is located at the lunar south pole, was considered as a possible water-ice reservoir [e.g., 4]. We identified 26 PAN spectra in this crater. Fig. 4 shows the close-up image of the Shackleton crater. The Shackleton crater might be a good target site for a sample return mission as well as a future site for a Moon-based telescope [e.g., 9].

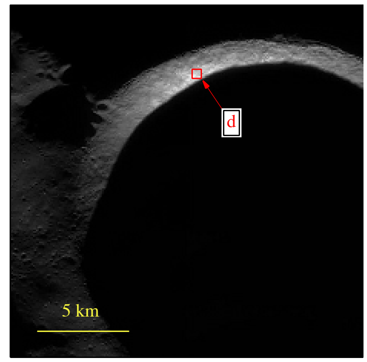

Figure 4: The close-up image of the Shackleton crater. The spectrum at ‘d’ is shown in Fig. 1.

SUMMARY

The PAN sites are widely distributed over the highland regions, while there is no definitive PAN exposure in the SPA and PKT. The PAN sites are found on the peak rings or the central peaks of the large impact basins, suggesting that the PAN rocks come from deeper layers below the surface [7]. Recent exposure events are important for the identification of PAN by spectral remote-sensing [10], because space weathering and development of soil easily obscures PAN spectra. Therefore, PAN materials widely extend below the lunar surface except for the center region of the PKT and SPA basin, but several, different scale impacts excavated and exposed the PAN materials to the surface.

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