MINERAL COMPOSITIONS OF THE BRIGHT RAYED CRATERS AND LUNAR FAR-SIDE CRUST REVEALED BY THE CONTINUOUS VIS-NIR SPECTRA BY SPECTRAL PROFILER ON SELENE/KAGUYA.

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Introduction: The Spectral Profiler (hereafter we write SP) is a visible and near infrared spectrometer onboard SELENE/KAGUYA satellite. It covers 500-2600 nm in wavelength with spectral resolutions of 6-8 nm and high SNRs of ~2300@810-860 nm, accompanying three detectors (VIS: 513-1010 nm, NIR1: 884-1676 nm and NIR2: 1702-2588 nm). SP data include very critical information to identify the mineralogical compositions of the lunar surface with unprecedented accuracy.

By its nominal mission for about 1 year, the SP data accumulated so far amount to more than 4500 polar orbits at the end of November, 2008. We obtained the global set of continuous spectra of the lunar surface. The observed points by SP are every 500 m along the tracks and the gaps across the tracks are less than a several kilometers on average, which definitely contributes to the completion of the global mapping of the mineral distribution [1].

Based on the SP spectral data we are conducting a preliminary survey to collect compositional information of the lunar highland crust on the far-side. We try to deduce possible thermal events of the crust.

Methods (Analysis of SP data): To clarify the global variation of the composition of the lunar highland crust, we targeted small-medium sized (9-23 km in cavity diameter) craters accompanying distinctive bright rays. The craters with the rays generally suggest they are fresh (<1 Ga) and we can retrieve the spectral signatures easily with less error. The craters should be small enough to obtain sufficient numbers of sampling. The number of the craters to satisfy the criteria amounts to 22 in total on the far-side and they distributed comparatively ubiquitously. We investigated the spectral features for all these craters using SP data and checked its change, too, connecting with the observed spots: cavity floor, inner wall (within the cavity), ejecta blanket, ray, mixture of ray and the backgrounds.

For quantitative comparison, we derived the following 3 parameters representing the spectral features (ex. [2]): continuum slope, wavelength position and the depth of 1 micron absorption band for each of the spectrum observed by SP. Each of the parameters is controlled by both composition and/or maturity, and provides us with mineralogical clues. We also conduct Modified Gaussian Modeling (called MGM) [3] for the representative spectrum for more accurate estimate to make sure our interpretation.

The spectrum of relative reflectance for the wavelength shorter than 2.1 micron are used here, following Matsunaga et al. (2008) [4], where the values are adjusted to keep the consistency with the Apollo 62231 sample [5] (For detailed procedures of calibration and derivation, see [4]).

Results: First, we found the inner walls always have the lower slopes of the continuum compared with other areas such as cavity floor, ejecta blanket, and the ray/background. The inner wall within the cavity always shows the higher reflectance by far, too. The band depths are also the deepest. These three facts clearly indicate the surface material of the inner wall is the freshest. The weathering seems the least on the inner walls.

Second, we found that the trend of the shape of the spectrum around the bright rayed craters could be categorized into two types: One type is spectrum which shows no significant compositional difference around the craters and could be explained only by difference of the degree of weathering. Another type is spectrum which shows significant difference of composition as well as weathering between the spectra within the cavity and ejecta around the cavity. The former type (Fig.1, 2) seems to be a majority. Only several craters are classified in the latter type (Giordano Bruno, Ryder, and a few unnamed craters).

Third, the spectra of the crater floors show some common features regardless of the above categories. They show very deep, sharp and symmetric absorption centered around 0.95-0.97 micron. It also accompanies asymmetric, distinctive absorption band around 1.2-1.25 micron without exception. We certify these facts by conducting MGM deconvolution for the representative spectrum (Fig. 3).

Discussion & Summary: We could explain the fact of the inner wall being the freshest by introducing the idea of slumping along the slope of the surface. If the regolith on the crater inner wall goes down along the slope to the floor, it keeps the wall always fresh.

The effect of resurfacing or gardening works for anti-weathering at the tilted surfaces such as the inner walls of the crater cavity.

As for the common spectra observed on the cavity floors, the composition seems to be pyroxene and comparatively rich in Calcium, judging from the wavelength position of the band minimum longer than ~0.95 micron. Since the crater diameter is limited in the range of 9-23 km now, the excavated depth would be only a few kilometers, so this composition may represent the shallower part of the highland crust. One interpretation is the shock melt could show such a composition. Our result could represent very local heating event after the formation of the crust (see [6]). Another possibility is the composition might be an outcome of the last stage of solidification of magma ocean.

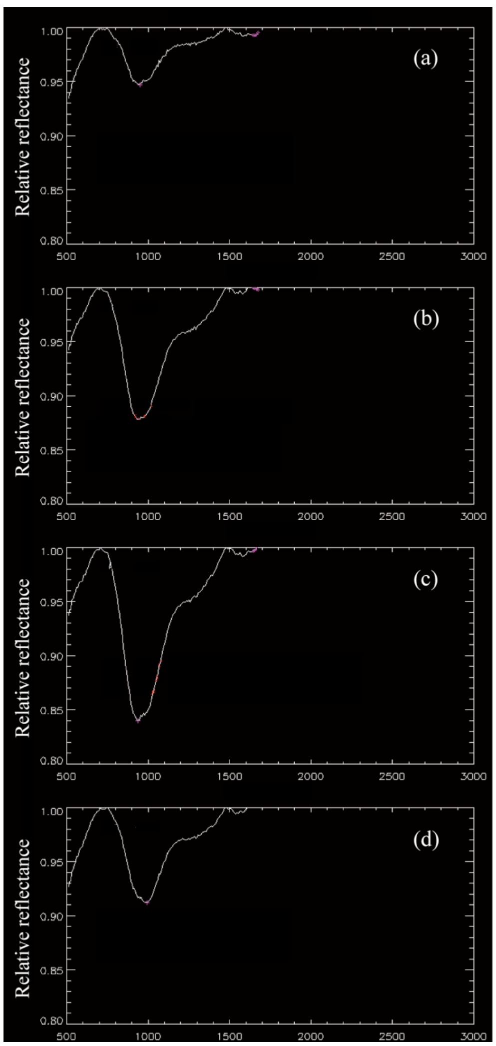

Figure 1. Representative spectrum of each spots around the bright rayed craters on the Moon: (a) Ray/background, (b) Ejecta blanket, (c) Inner wall, and (d) Cavity floor. Here picked-up crater is about 9 km in diameter locating eastward of Lents C (unnamed crater). Each spectrum is relative reflectance where the continuum is removed.

Lastly, a big question is what makes the difference between the two types described above. Is it connected to the location? Any boundary zone? Or due to the difference of the effectiveness of weathering which depend on the composition if there is? We will work on this problem.

References: [1] P. Lucey et al. (2006) *New Views of the Moon*, 83-202, [2] D. T. Blewett et al. (2005) *J. Geophys. Res.*, *110*, doi:10.1029/2004JE002380, [3] R. L. Klima and C. M. Pieters (2008) *LPSXXXIX*, 1756-1757, [4] T. Matsunaga et al. (2008) *Geophys. Res. Lett. 35*, doi:10.1029/2008GL035868, [5] S. Tompkins and C. M. Pieters (1999) *Meteorit. Planet. Sci.*, *34*, 25-41, [6] H. Takeda et al. (2008) *LPS XL*, *in this volume*.

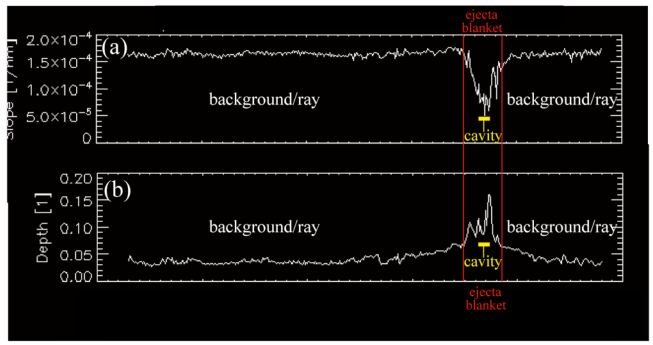

Figure 2. Comparison of spectral parameters: (a) Slope of the continuum and (b) Maximum band depth. The horizontal axis corresponds to the observational footprint of SP, which intersects the center of bright rayed crater of Fig.1.

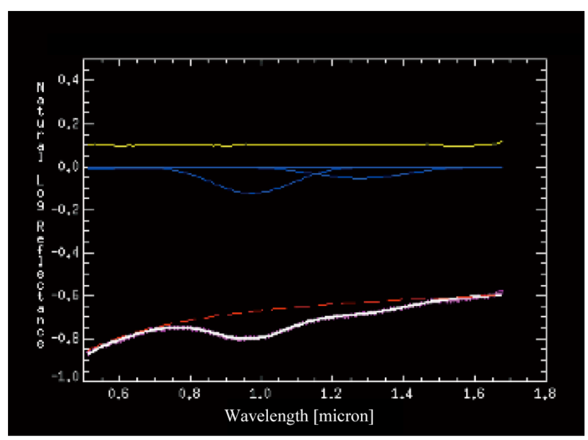

Figure 3. MGM-derived absorption bands for (d) in Fig 1. The band center is 0.97 micron.