COMPOSITIONAL VARIATION OF THE LUNAR HIGLAND CRUST. M. Ohtake[1], H. Takeda[2], T. Morota[3], Y. Ishihara[4], T. Mastunaga[4], Y. Yokota[4], S. Yamamoto[4], J. Haruyama[1], Y. Ogawa[5], T. Hiroi[6], Y. Karouji[7] and K. Saiki[8], [1]Planetary Science Department, Japan Aerospace Exploration Agency, 3-1-1 Yoshinodai, Sagamihara, Kanagawa, 229-8510, Japan (ohtake.makiko@jaxa.jp), [2]The University of Tokyo, [3]Nagoya University, [4]National Institute for Environmental Studies, [5]The University of Aizu, [6]Brown University, [7]Japan Aerospace Exploration Agency, [8]Osaka University.

Introduction: A global distribution of rocks of very high plagioclase abundance (approaching 100 vol.%; purest anorthosite) has been detected at central peaks, crater walls, and ejecta using an unambiguous plagioclase absorption band recorded by the SELENE Multiband Imager (MI) and Spectral Imager (SP) [1][2]. The estimated plagioclase abundance is significantly higher than previous estimates of 82 to 92 vol.% [3], providing a valuable constraint on models of lunar magma ocean (LMO) evolution.

To understand the compositional variation of these high plagioclase abundance anorthosite rocks (spatial compositional variation on a scale from tens of meters to a global lunar surface with possible vertical compositional trends) is important for addressing the crustal generation mechanism because it is difficult to generate such monomineralic rocks by simple plagioclase flotation from a lunar magma ocean according to the general differentiation mechanism of magma [3][4].

Therefore, this study investigated spatial and vertical compositional (modal abundance) trends of these high plagioclase abundance anorthosite rock over the entire lunar surface within the uppermost mixing layer and the upper and lower crust by using continuous reflectance spectra derived by SP and multiband images derived by MI.

Method: We used MI images (nine bands with wavelength assignments of 415, 750, 900, 950, 1000, 1050, 1250, and 1550 nm and a spatial resolution of 20 m/pixel in the visible and 62 m/pixel in the near-infrared bands) of representative highland material (central peak and basin ring material) to investigate spatial compositional variation on a smaller scale (from tens of meters to several hundreds of kilometers) by observing band depth ratio between 950 nm (pyroxene band) and 1250 nm (plagioclase band).

To investigate global surface compositional variation, we used 26 million SP spectra after data screening to select data with a high signal-to-noise ratio and low correction errors. These spectra were binned into 1-degree intervals, with 30 km resolution at the equator.

We utilize a new algorithm, which uses correlation between mafic mineral (low-Ca pyroxene) abundance and absorption depth around 950 nm where a diagnostic absorption band of pyroxene exists, that determines modal abundance (mafic mineral abundance) to derive a high-spatial-resolution global surface map of mafic mineral abundance. We apply this new algorithm to the global data set obtained by the SP, which has spectral coverage from 500 to 2600 nm in 300 bands and a spatial resolution of 500 x 500 m.

The estimated error of our modal mineralogy estimation has an absolute error of ±1 vol.%. Presence of high-Ca pyroxene may cause small errors in estimating mafic mineral abundance. Therefore, this study discusses only highland areas with low HCP/LCP.

To investigate vertical compositional variations, we used the mafic mineral abundance data described above in and around major highland basins [5][6] to observe correlations between the distance from the basin center, which corresponds to an original depth before excavation, and concentrically averaged mafic mineral abundance of the basin interior and ejecta.

Results: The derived compositional variation up to several kilometers in scale at Jackson central peak and compositional variation up to several hundreds of kilometers at Orientale rings indicates relatively homogeneous composition (mafic abundance ranging from 0 to 3 vol.%) within these most extensive exposures of the upper highland crust, except for areas covered by impact melt, and cannot be expected to retain the original crustal composition [1].

The global surface mafic mineral abundance map indicates its dichotomic distribution having a lower mafic mineral abundance in the farside highlands than in the nearside, which is basically consistent with previous observations [7][8] though our map appears to display more detailed variation both spatially and compositionally and the lowest mafic mineral abundance location does not match exactly with that of the previous datasets.

The compositional variation within and around the basins indicates decreased mafic mineral abundance with original depth (increased mafic mineral abundance with increased distance from the basin center), indicating decreased mafic mineral abundance with depth in the crust in both the upper (< 30km) and lower crusts, possibly up to 60 km deep (Figs. 1 and 2; Freundlich-Sharonov, Kororev, and Dirchlet-Jackson Basins).

Discussion: The observed compositional homogeneity within the crust on a scale of tens of meters to several hundred of kilometers suggests the presence of the PAN (purest anorthosite) rocks within the highland crust as a vast rock body. The previously observed numerous exposures of the PAN outcrops [9][10] suggest abundant presence of the PAN rocks within the highland crust. This information further implies a vast

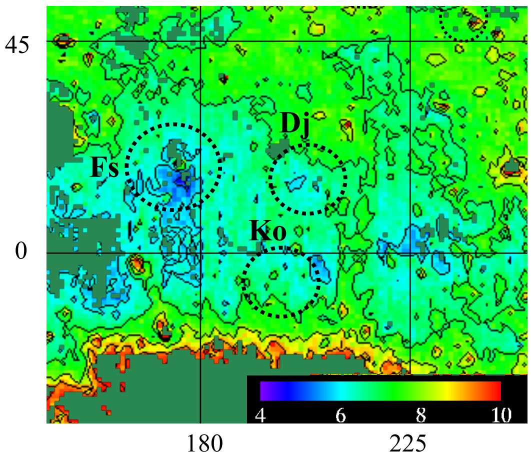

Fig. 1 Mafic mineral abundance map (vol.%) around the analyzed highland basins.

Dotted circles denote three highland basins (Freundlich-Sharonov, Kororev, and Dirichlet-Jackson) analyzed in this. Regions with greater than 11 vol.% of mafic mineral abundance and regions with high HCP/LCP ratios (exceeding 0.2) are indicated in sea green.

mechanism to generate this type of rock in the crust, which cannot be a minor component among the highland material.

The observed decrease of mafic mineral abundance with depth in the highland crust is inconsistent with the previous studies both in terms of the composition of the lower crust (more mafic-rich noritic composition has been suggested [11][12]) and compositional trend within the crust (increase of mafic mineral abundance with depth has been suggested [11][12]).

PAN rocks as widespread magma ocean flotation cumulates are problematic because of the apparent need for a mechanism to generate such cumulates in vast volume, though it may be generated by the most simple flotation mechanism from the magma ocean [13]. The results here indicate that very high plagioclase abundances occur over vast areas, which suggests need of further study of a new lunar magma ocean solidification (post-concentric) model such as [14] to explain our observation.

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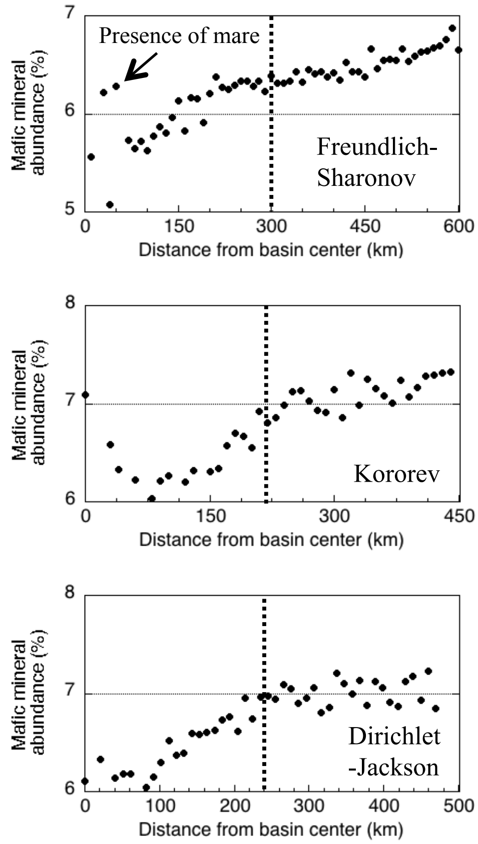

Fig. 2 Variation of mafic mineral abundance within and around highland basins.

Distance from basin center (x-axis) and averaged mafic mineral abundance (y-axis) are plotted. Dotted lines indicate locations of each basin rim. Data of up to one radius from the basin rim are presented here to observe the compositional trend in ejecta. Mafic mineral abundances increase from the center of the basin outward even in the ejecta region. This suggests decreasing mafic mineral abundance with depth, even in the lower crust.

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