COMPOSITIONAL ANALYSIS OF YOUNG MARE BASALTS IN THE PROCELLARUM KREEP TERRANE USING KAGUYA DATA. Shinsuke Kato[1], Tomokatsu Morota[1], Yasushi Yamaguchi[1], Sei-ichiro Watanabe[1], Hisashi Otake[2], Makiko Ohtake[2], Tokuhiro Nimura[3], [1]Graduate School of Environmental Studies, Nagoya University (katou.shinsuke@h.mbox.nagoya-u.ac.jp), [2]Japan Aerospace Exploration Agency, [3]Japan Spaceguard Association.

Introduction: Mare basalts provide insights into the composition and thermal history of the lunar mantle. According to crater counting analysis with recently updated remote sensing data, the model ages of mare basalts suggest a first peak of volcanic activity during 3.2–3.8 Ga and a second peak at ~2 Ga [1, 2]. To understand the mechanism for causing the second peak and its magma source is important to constrain the thermal evolution of the Moon. We have reassessed the correlation between the titanium contents and the eruption ages of mare basalt units using the compositional and chronological data updated by SELENE (Kaguya) [3]. As a result, we found that there is a rapid increase in mean titanium content near 2.3 Ga (Figure 1), suggesting that the magma source of the mare basalts changed at this particular age in the Procellarum KREEP Terrane (PKT). In this study, we designate mare volcanism before 2.3 Ga as the Phase-1 volcanism and that after 2.3 Ga as the Phase-2 volcanism. The Phase-2 volcanism occurred mainly in the PKT (Figure 1b).

To understand the magma source transition at 2.3 Ga, reconstructing the history of the volcanic activity in the PKT is fundamental. In this study, we focused on the central region of the PKT and make new geological map of this region. Then, we performed spectral analysis of mare basalts to investigate mineral compositions of mare basalts.

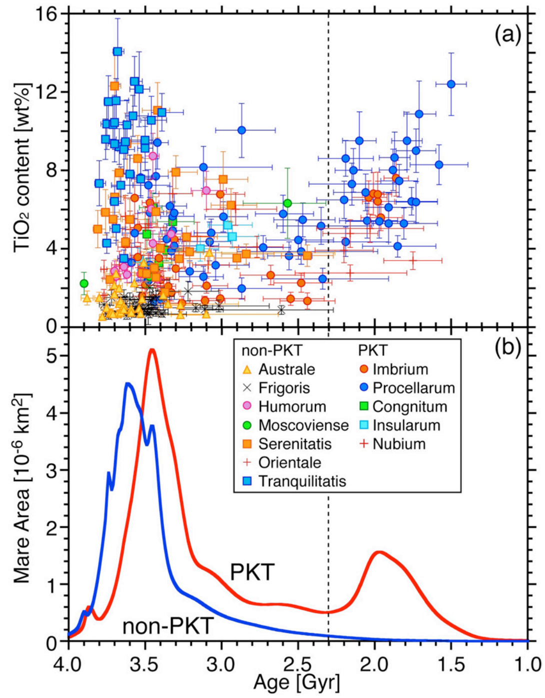

Figure 1. (a) Temporal variation in the titanium contents of mare basalts. The solid curve is averaged titanium contents. (b) Total mare basalt area with time in the PKT and outside the PKT. Model ages of mare basalts are derived by previous studies [1, 2, 4, 5, 6, 7, 8, 9, 10]

Methods: We made geological map of the central region of the PKT using KAGYA Multiband Imager (MI) data and digital terrain model (DTM) derived from KAGUYA Terrain Camera data and investigated mineral compositions of mare basalts using KAGYA Spectral Profiler (SP) data.

Geological map of the central region of the PKT. We calculated absorption depths of 950, 1050 and 1250 nm reflectance data from MI to divide highland and mare regions in the central region of the PKT. Also, topographic roughness was calculated from DTM to identify highland regions. We performed principal component analysis for MI 8 band reflectance data to identify each mare basalt unit.

Spectral analysis of mare basalts. The modified Gaussian model (MGM) [11, 12] is generally used for deconvoluting an observed spectrum into individual mineral components. However, it is difficult to fit the spectrum of complicatedly mixed material such as mare basalts by the MGM because each mineral has multiple absorptions. Nimura [13] improved the MGM by obtaining the relations between chemical compositions of minerals (the ratio of Fe/(Fe+Mg) in olivine and the ratios of Ca/(Ca+Fe+Mg) and Fe/(Ca+Fe+Mg) in pyroxene) and absorption band parameters (center, width and strength ratio of Gaussian curves). This method was applied to the spectra of asteroids [13]. In this study, we applied this method to the spectra of mare basalts obtained by KAGUYA. To avoid the effect of the space weathering spectra of fresh crater wall were used. We used GEKKO system [14] to choose spectral data.

Results and Discussion: Figure 2f shows the result of geologic classification of the central region of the PKT. The basalt unit boundary can be clearly identified from the result of principal component analysis (Figure 2e). In the altitude map (Fig 2c), the circular

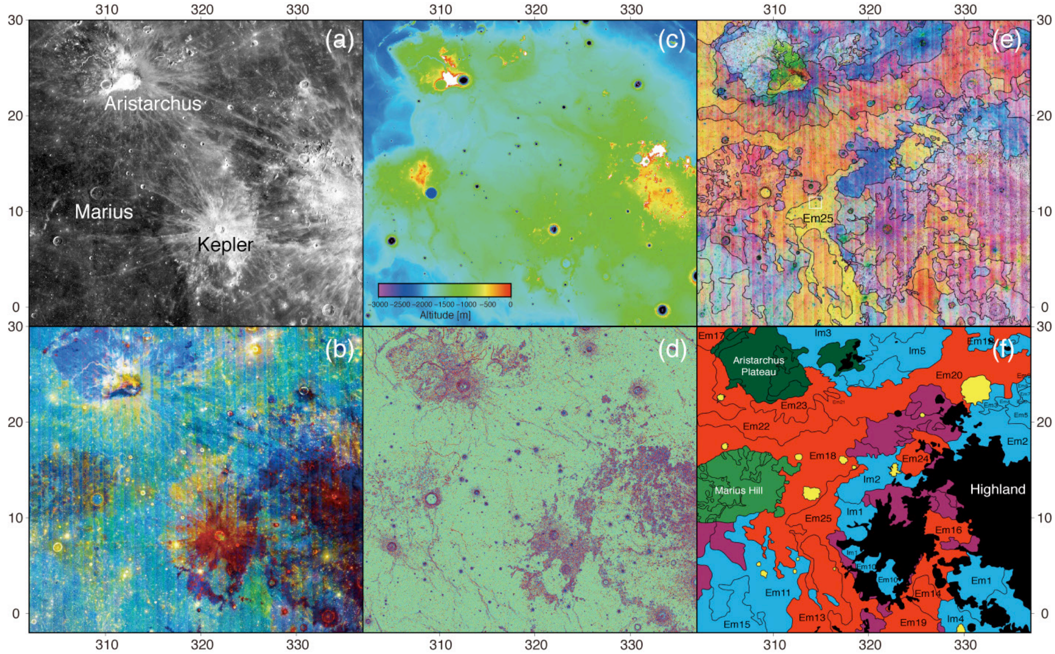

Figure 2. Maps in the central region of the PKT. (a) KAGUYA TC image. (b) Absorption depth map. (c) DTM map. (d) Roughness. (e) RGB map of principal component 2, 3 and 6. (f) Geological map (Red: Phase-2 units, Blue: Phase-1 units, Violet: unclassified basalt units, Green: other volcanic features, Black: highland, Yellow : crater ejecta). Names of basalt units represents formation period (Imbrian : Im, Eratosthenian : Em)

feature like a plateau exists in the center of the PKT, which the scale is ~1000 km horizontal and ~500 m vertical. Phase-2 mare basalt units seem to erupt from the center of the plateau.

Figure 3 shows an example of MGM fitting to a spectrum of a fresh crater on the unit Em25 located in Oceanus Procellarum. As a preliminary result, PKT Phase-2 mare basalts (Em18 and Em25) tend to be relatively olivine rich compared with Phase-1 mare basalts in Mare Tranquillitatis and the PKT.

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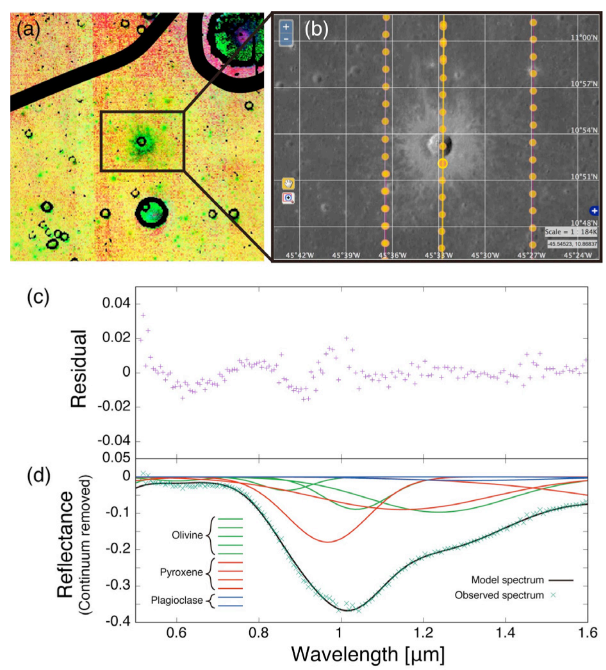

Figure 3. Example of MGM fitting. (a) Expanded map of white square in Fig. 2e. (b) Example of crater with GEKKO. (c) Residual and (d) result of MGM fitting.