GLOBAL MAP PRODUCTS FROM THE KAGUYA MULTIBAND IMAGER AT 512 PPD: MINERALS, FEO, AND OMAT. M. Lemelin[1], P. G. Lucey[1], L. R. Gaddis[2], T. Hare[2], and M. Ohtake[3], [1]Hawaii Institute of Geophysics and Planetology, Department of Geology and Geophysics, University of Hawaii at Manoa, 1680 East-West Rd, POST 602, Honolulu, HI 96822, USA, mlemelin@hawaii.edu, [2]Astrogeology Science Center, United States Geological Survey, Flagstaff, AZ 86001, USA, [3]Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, Sagamihara, Kanagawa 252-5210, Japan.

Introduction: Data acquired by the Clementine UVVIS/NIR camera (415-2000 nm) in the 1990's at a spatial resolution of ~100 m/pixel has allowed to model the abundance of olivine, low-calcium pyroxene, clinopyroxene and plagioclase across the entire lunar surface [1]. This dataset has proven to be useful in a variety of studies regarding the composition of the lunar crust. However, the Clementine NIR dataset lacked a thorough photometric calibration, which might have introduced errors in mineralogical composition estimations. The Kaguya Multiband Imager recently acquired data in nine visible (415, 750, 900, 950, 1001 nm) and near-infrared (1000, 1050, 1250, and 1550 nm) spectral bands very similar to those acquired by Clementine [2]. The Kaguya Multiband Imager provides a spatial resolution of ~20m/pixel in the UVVIS, and ~60m/pixel in the NIR at the nominal altitude of 100 km [3], and its reflectance data have been corrected for the shading effects of topography, which drastically reduces the error in mineral abundance estimations. In this study we provide new global maps of olivine, low-calcium pyroxene, clinopyroxene, plagioclase, FeO and OMAT using data from the Kaguya Multiband Imager.

Methods and datasets: We determined the abundance of olivine, low-calcium pyroxene, clinopyroxene and plagioclase for the entire lunar surface at ~80 m/pixel (512 ppd) using 1°x1° mosaics of the Multiband Imager reflectance data corrected for the shading effects of topography (MAP level 02 [2]) and Hapke's radiative transfer equations. We constructed a spectral lookup table of the reflectance spectra of 6601 mixtures of olivine, low-calcium pyroxene, clinopyroxene and plagioclase, at 7 amounts of submicroscopic iron (SMFe), an Mg# (Mg/Mg+Fe) of 65, and a grain size of 17µm. We also modeled the reflectance spectra of these mixtures for a grain size of 200 µm for plagioclase to account for the band depth observed in the Multiband Imager data [4], for a total of 92,414 spectra. We compared the modeled spectra that contained ±2 wt% FeO of a given pixel [5], and assigned the composition to the best spectral match (in terms of correlation and absolute difference in continuum removed reflectance). We then validated the mineral abundances we obtained with global elemental maps from Lunar Prospector [6]. We also produced global maps of FeO using the algorithm of Lemelin et al. [5], and global maps of OMAT based on the algorithm of Lucey et al. [7]. However, the OMAT algorithm has been derived using reflectance data from Clementine at 750 and 950 nm, and cannot be directly used with Multiband Imager data. Therefore, we first computed the regression coefficients that should be applied to the Multiband Imager data at 750 (*r750*) and 950 (*r950*) nm in order to match the reflectance of Clementine at these bands ($r750_{corr}$, $r950_{corr}$):

$$r750_{corr} = (r750*1.51) + 0.020$$
$$r950_{corr} = (r950*1.38) + 0.022$$

Results: Figure 1 shows the global mineral maps for olivine, low-calcium pyroxene, clinopyroxene, and plagioclase we produced, within ±50° in latitude.

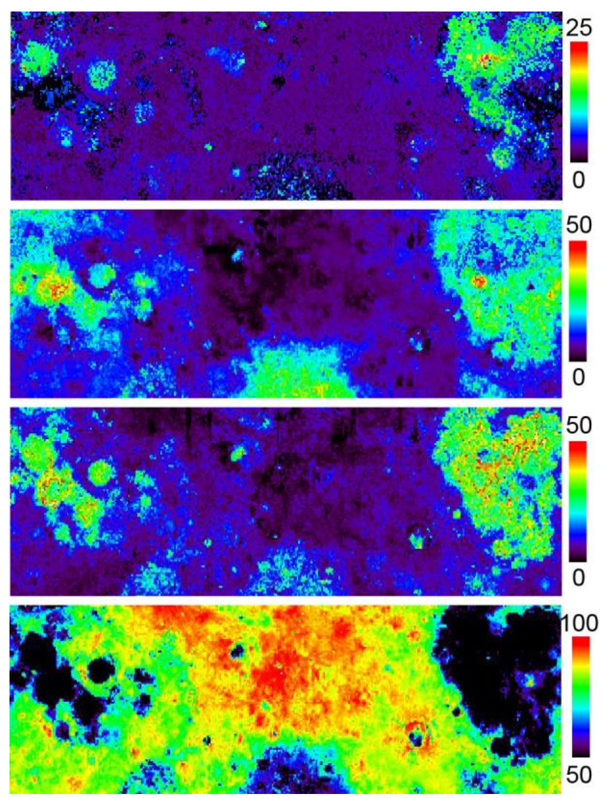

Figure 1. Global mineral maps produced using the Kaguya Multiband Imager data, from top to bottom: olivine, low-calcium pyroxene, clinopyroxene, and plagioclase. Abundances are shown in wt.%.

The mineral maps obtained using the Multiband Imager data shows some notable differences with the mineral maps obtained using Clementine data [1]. The Multiband Imager data suggests there is much more low-calcium pyroxene than what Clementine suggested, and that low-calcium pyroxene is by far the dominant mafic mineral found in the South Pole-Aitken basin. The data also suggests that Mare Serenitatis contains much more olivine than Mare Tranquilitatis, in agreement with Mare Serenitatis having excavated mantle material [8]. The highest olivine abundances (~25 wt.%) are found in the Procellarum KREEP Terrane. High abundances (~50 wt.%) of low-calcium pyroxene and clinopyroxene are also found in the Procellarum KREEP Terrane and in Mare Tranquilitatis. Plagioclase abundances are very high in the Feldspathic Highland Terrane, but mature surface should be analyzed with caution. Indeed, there is currently a mineral identification for every pixel in the Multiband imager data. However, mature surfaces exhibit subdued absorption bands, which can lead to an overestimation in plagioclase abundances, even though we included the presence of SMFe in our modeling. Therefore, the mineral maps presented herein should be interpreted with the aid of the OMAT map. Also, we provide global mineral maps for the complete range of latitudes, but the Multiband Image data has been better calibrated within ±50° in latitude [5], therefore caution should be taken when interpreting regions at higher latitudes.

These global high resolution maps will be valuable for a variety of studies. For example, Figure 2 shows the plagioclase and FeO abundance at Orientale. The mineral abundances were used by Lemelin et al. [9] to derive the composition of the lunar crust with depth, by extracting the composition on basins' innermost ring (such as the black outline shown in Figure 2).

Conclusion: These derived mineral maps, including global maps of FeO and OMAT, are available from the USGS at the Planetary Data System's Cartography and Imaging Sciences ("Imaging") Node Annex (see http://astrogeology.usgs.gov/pds/annex, [9]). The derived mineral maps are stored as 1°x1° mosaics, at a spatial resolution of ~60 m/pixel (512 ppd). These mosaics will be accompanied by near-global mosaics of the original 9-band Kaguya Multiband Imager map-projected (MAP) data at the same resolution.

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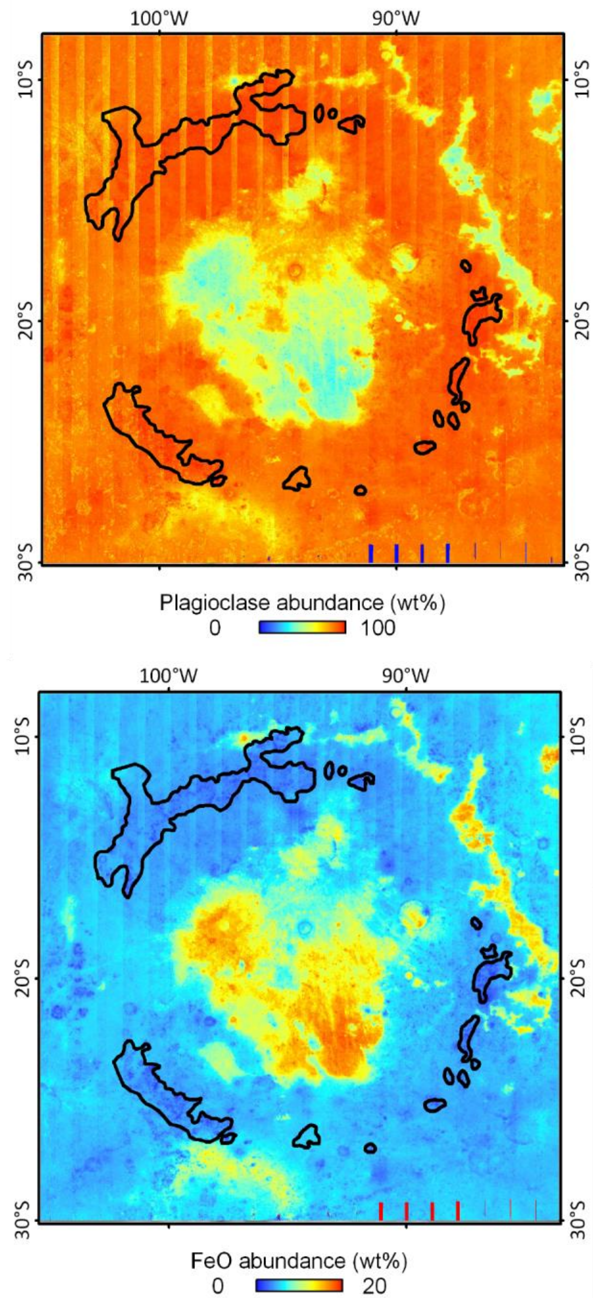

Figure 2. Plagioclase and FeO abundances shown at Orientale basin. The black outline shows the outline of Orientale's innermost ring used by Lemelin et al. (2016) to analyze the composition of the lunar crust with depth. Such detailed studies will be enabled by the availability of the high resolution maps presented herein.

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