

High resolution lunar mineral maps using Kaguya Multiband Imager data

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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 [1,2] 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 17 microns. We also modeled the reflectance spectra of these mixtures for a grain size of 200 μ m 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].

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.

References: [1] Kodama S, Ohtake M, Yokota Y, Iwasaki A, Haruyama J, Matsunaga T, Nakamura R, Demura H, Hirata N, Sugihara T, Yamamoto Y. Space science reviews. 2010 Jul 1;154(1-4):79-102. [2] Ohtake, M. et al. (2008) EPS, 60, 257-264. [3] Haruyama, J. et al. (2008) EPS, 60, 243-255. [4] Ohtake, M. et al. (2009) Nature, 461, 236-241. [5] Lemelin, M. et al. (2015) JGR, 120, 869-887. [6] Prettyman et al. 2006. [7] Lucey, P.G. et al. (2000) JGR, 105(E8), 20,377-20,386. [8] Miljkovic, K. et al. (2015) EPSL, 409, 243-251.

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