MINERALOGY AND IRON CONTENT OF THE LUNAR POLAR REGIONS USING THE KAGUYA SPECTRAL PROFILER AND THE LUNAR ORBITER LASER ALTIMETER.

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Introduction: Quantitative assessment of the mineralogical composition of the lunar surface using visible (VIS) and near-infrared (NIR) wavelengths can be obtained by comparing calibrated reflectance spectra to modeled spectra of known composition, and assigning the composition to the best spectral match using FeO as a constraint to ensure that the best spectral match is compositionally and physically plausible. However, in the polar regions, calibrated reflectance data had not been derived until recently, and the FeO abundances currently available have a coarse spatial resolution (~15 km per pixel). As a result, beside a few local studies [e.g., 1-4], most mineral analyses have been constrained to within 50° in latitude. The mineralogy of the polar regions, or ~44% of the lunar surface, is mostly unknown. Here we took a novel approach to derive the first mineral and FeO maps of the polar regions (50-90° in latitude) at 1 km per pixel.

Methods: We used of the newly available calibrated reflectance data from the Lunar Orbiter Laser Altimeter (LOLA) [5,6] along with reflectance ratio from the Kaguya Spectral Profiler (SP) [7,8] to derive the first high resolution FeO maps of the polar regions. These maps are in excellent agreement with the FeO abundances measured by the Lunar Propector Gamma-Ray Spectrometer [9] ($r = 0.96$, $\sigma = 5$ wt.%).

We used continuum-removed reflectance from SP (level 2B1) acquired during the North and South polar summers (orbits 2000-2999 and 4000-4999) and radiative transfer equations to model the mineral abundances of each spectrum, constrained by its FeO abundance. We used Hapke's radiative transfer equations and the optical constants of Lucey et al. [10] to model 118,818 spectra. This includes: 6601 mixtures of olivine, low-calcium pyroxene, high-calcium pyroxene and plagioclase, nine different amount of nanophase iron (0-0.7 wt.% [11]) and Britt-Pieters particles [12], two different grain sizes (17 and 200 µm), and a Mg-Number of 65. For each SP spectrum, we then identified the most similar modeled spectra that contains within ±5 wt.% FeO of the local FeO.

Results: Our preliminary results indicate that the FeO and mineral mapping methods are promising. The new FeO abundance maps allows to resolve details such as pyroclastic deposits and small geological units

with high FeO content. The mineral maps reveal that low-calcium pyroxene is widely abundant (especially in the South Pole-Aitken with up to ~40 wt.%). High-calcium pyroxene is much less abundant (up to ~10 wt.%) and especially concentrated in the center of the South Pole-Aitken basin, as found by [3]. We find exposures with ≥98 wt.% plagioclase on the rim of Shackleton crater consistent with the observations of Yamamoto et al. [2]. Next, in an effort to reduce the orbit-to-orbit noise resulting from the interpolation of the SP points into mineral maps, we will derive new versions of the mineral maps using data points from the nearly 7000 available SP orbits.
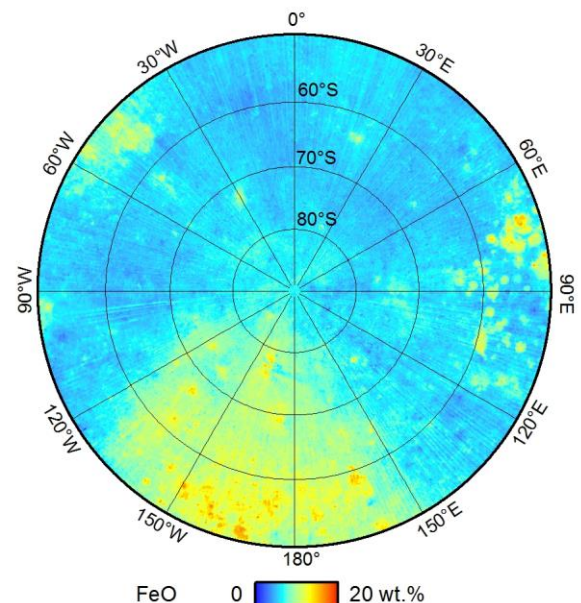

Figure 1. South polar map of FeO derived using Kaguya Spectral Profiler 955.5/752.8 nm reflectance ratio, and Lunar Orbiter Laser Altimeter 1064 nm reflectance data at 1km/pixel.

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