CHARACTERIZATION OF THE OLIVINE/PLAGIOCLASE MINERALOGY AT COPERNICUS CRATER FROM MGM DECONVOLUTION OF M3 OBSERVATIONS. P. C. Pinet1,2, S. D. Chevrel1,2, Y. Daydou1,2, Université de Toulouse; UPS-OMP; IRAP; Toulouse, France. 2CNRS; IRAP; 14, avenue Edouard Belin, F-31400 Toulouse, France (patrick.pinet@irap.omp.eu).

Introduction: Recent observations from the multiband imager and the spectral profiler onboard the Japanese SELENE spacecraft and from the Moon Mapper (M3) imaging spectrometer onboard the Chandrayaan mission identified in a number of lunar regions (e.g., in crater central peaks) the unambiguous occurrence of a 1.2-1.25 μm spectral feature, indicative of a crystal field absorption consistent with Fe-bearing plagioclase feldspar in anorthosite [1, 2]. Olivine mineral detection has also been documented [e.g.,3,4,5]. Given the wealth of the M3 dataset, advanced hyperspectral processing appears needed to fully explore the existing variability involving plagioclase and mafic crystal field absorptions [e.g., 6], and to better constrain the lunar crust lithology and cratering process.

MGM background and testing: The principle of the Modified Gaussian Model is to deconvolve overlapping absorptions of mafic mineral spectra into their fundamental absorption components. Its specific interest is to directly account for electronic transition processes[e.g.,7]. The MGM approach is in essence able to achieve a direct detection and quantification of minerals which make up the observed surface. Spectra are modeled in the logarithm of reflectance space as a sum of modified Gaussian distributions superimposed on a baseline continuum. The resulting combinations of Gaussians can then be interpreted in terms of mineralogy. MGM can retrieve modal and/or chemical composition from an unknown spectrum in the case of simple mineralogies [8]. Several studies have shown the interest of the MGM approach for planetary surface characterization (e.g., [9,10]). However, reference studies rely on spectra acquired on controlled laboratory powder samples. More complex situations addressing mixed mineralogies (e.g., olivine and pyroxene(s) with plagioclase) and/or rock samples have been little explored and significant efforts have still to be made for improving our capability of spectroscopic modeling and interpretation when dealing with real world observations of unknown mafic rock lithologies.

Our goal here is to improve the capability of the MGM to realistically model complex mafic mineralogies when considering rock slab surfaces with coarse textures, involving plagioclase and mafic crystal field absorptions [e.g.,11]. MGM testing has been performed on slab spectra of Plg-rich rock samples from the igneous stratified Stillwater Complex [12] and on an hyperspectral cube produced on a core section from a drill in the oceanic crust (IODP Expedition 345) [13]. The composition is globally gabbroic, mostly composed of plg feldspar and cpx; ol and opx are also present, and their variations define a modal layering, with some ol-rich layers and other ones devoid of olivine. Based on these tests, our MGM approach can properly discern the mafic minerals contribution (ol, cpx, opx), including the detection of crystalline plg, in the spectra across a complex sample such as the studied core [13].

Data Analysis and Results: We now implement this hyperspectral strategy on M3 spectra with the objective of documenting the petrology at Copernicus crater through characterization of plagioclase and mafic crystal field absorptions, from exposed outcrops (e.g., central peaks, inner walls and rims). The present study has been made on a subset of the M3G20090416T122951_V01_RFL hyperspectral image (140m/pixel) acquired during the OP2A optical period. A systematic search for mineral assemblages [10] involving opx, cpx, ol and plg detects a prominent diverse mafic mineralogy with well-developed absorption features and the presence of surface patches across the crater floor and ejecta with almost featureless signatures possibly associated with impact melts. Distinct px-rich mineralogies are found but not discussed here, the focus being on the ol/pl detections. Ol and plg-bearing materials identified are only found in association with the crater structure (Fig. 1.a). For the ‘olivine-only’ detections (~950 pixels), the Mg number variation is determined and its distribution displayed (Fig. 1.b). A selection of four representative reflectance spectra associated with various ol and/or pl-rich mineralogy is shown (Fig. 1.c) with their corresponding MGM deconvolution results (see Figs. 1.d-g).

Interpretation: The present results touch on the complexity of impact melt-related processes and complement findings from [3,4,5,14] concerning olivine-bearing exposures found in the central peaks, north wall and scattered blocks on the crater floor. Based on Mg#, the ol composition is Fo 70-90. Two central peaks (Pk2 and Pk3) appear more homogeneous than the westernmost one. Both in the north wall and on the peaks, plg-bearing exposures are found, some in association with ol mineral, possibly rejuvenating the idea of a troctolitic horizon at shallow depths [15,16]. Plg-bearing exposures (~1050 pixels) are also found scattered across the northeastern floor, the inner and outer parts of the northeastern rim.

Figure 1. (1.a) Mapping of Ol/Plg-driven mineralogy, with four classes ranging from ol-rich, to ol-px mix, ol-plg, and plg-rich, with histogram (~1050 pixels) of plagioclase band-center distribution. (1.b) Mg # variation for ol-rich (‘olivine only’ detection) pixels (green: 0.65-0.75, red: 0.75-0.85, blue:0.85-0.95). (1.c) selection of four representative spectra with their pixel location and corresponding MGM deconvolutions: □ North wall ol-rich pixel (see Fig. 1.d), ◇PK2 central peak ol-rich pixel (see Fig. 1.e), △ North wall ol/plg-rich pixel (see Figs. 1.f and 1.g). ○ North wall plg-rich pixel (see Fig. 1.h). Continuum slope is handled by means of a second-order polynomial adjusted on the local maxima along the spectrum; MGM residuals ~ 0.003-0.007 rms.