EVALUATING LUNAR EJECTA MATURITY ACROSS WAVELENGTHS CAN PROVIDE NEW INSIGHT INTO RELATIVE AGES

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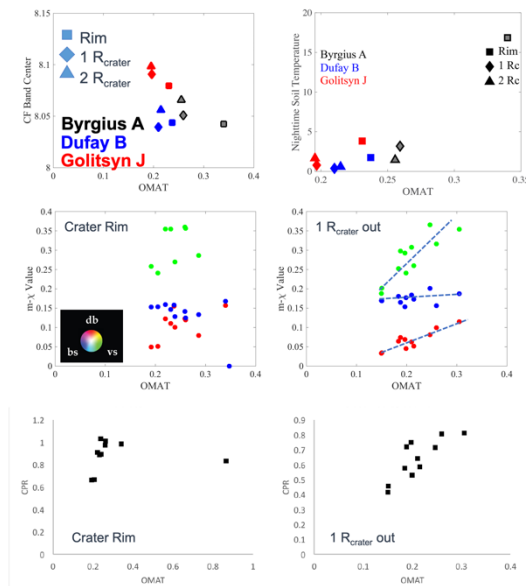
Figure 1. Various maturity parameters plotted as function of optical maturity (OMAT) of the ejecta blankets. Specific maturity indices show distinct trends with age (e..g, radar (middle, bottom). Trends in the thermal data (top) are murkier, but still promising.

Introduction: The physical evolution of the lunar surface with exposure to the space environment (particularly impacts) is termed "maturation", can take place over relatively short timescales, and has been attributed to the amount of glass and agglutinate content within the lunar soil [e.g., 1-8], the amount of trapped solar wind nitrogen [9], solar wind sputtering and vapor deposition [10-11], and/or the amount of sub-microscopic iron (SMFe) in the material. Studies show that the abundance of these glasses and agglutinates increases with age of the soil and can account for large portions of a given mature soil [e.g., 2,4,9,14]. Changes in physical properties of the lunar soil are quantified in terms of specific maturity indices (e.g., Optical maturity (OMAT) [13]), and thus soils are generally classified on the basis of one or more of these specific indices [3]. Though sampling maturity effects from different processes and on different time- and depth-scales, comparisons indicate that maturity of the soil can be tracked across wavelengths [14], which is a powerful tool when examining the surface evolution of the Moon. Data from the LRO and Kaguya missions (coupled with Clementine OMAT) provide new ways to examine lunar surface maturity and degradation of ejecta blankets around craters.

Initial Discussion Current analysis focuses on radar, thermal, visible, and UV wavelengths, and comparisons suggest that the maturity of the soil can be tracked across wavelengths. The methods for representing those maturities were OMAT, Lunar Reconnaissance Orbiter Camera (LROC), Diviner, and Minature Radio Frequency (Mini-RF). 36 craters have been identified, all of which are classified as "Copernican" or "Eratosthenian" in age. In a preliminary comparison [14], three craters: Byrgius A (young), Dufay B (intermediate), and Golitsyn J (old) were surveyed using different maturity methods to look for correlations of maturity as a function of wavelength. After reviewing these three craters, the conclusion was that maturity can be tracked across wavelengths but a more detailed comparison was necessary. Additional work, specifically using Mini-RF Radar data, Diviner lunar radiometer data, and LROC UV color data show that this comparison can be extended to multiple craters (Fig. 1), where trends begin appearing when specific maturity indices (e.g., surface roughness or scattering (CPR or m-χ), Christiansen Feature band center, soil temperature) are compared against ejecta soil maturity (OMAT).

Because we are using multiple datasets to understand how maturity indicators manifest across wavelength, it is important to examine each dataset individually and as a whole. By utilizing multiple datasets at multiple wavelengths, we hope to provide a more comprehensive understanding of maturation and degradation of craters on the lunar surface. Further, more detailed comparisons are necessary to fully understand specifics of correlating maturity trends. However, preliminary results suggest that these correlations can provide a powerful tool when examining the surface evolution of the Moon and determining relative ages between features.

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