GLOBAL ASSESSMENT OF PURE CRYSTALLINE PLAGIOCLASE ACROSS THE MOON: IMPLICATIONS FOR THE EVOLUTION OF THE PRIMARY CRUST.

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Introduction: The formation of the Moon's primary anorthositic crust is still an outstanding science question as two major hypotheses have been suggested. The impetus for the hypothesis of a lunar magma ocean came from the analyses of pristine Apollo samples [e.g. 1-2] and suggests that the lunar primary crust was formed by the crystallization and flotation of plagioclase in the late stages of a magma ocean. Serial magmatism models have also been suggested in which plagioclase crystallizes from several different plagioclase-rich diapirs and these models are based on the analyses of terrestrial anorthosites and lunar breccias and feldspathic meteorites[e.g. 3-5]. Thus, examining the local and global distribution of crystalline plagioclase across the lunar surface and estimating its compositional variations is significant for constraining the crustal formation processes In this work we combine the strength of identifying Fe-bearing minerals in near infrared (NIR) remote sensing data with the strength of determining plagioclase composition using remote thermal infrared observations [6] to characterize the distribution of pure crystalline anorthosite and determine the its composition in those anorthosites.

Results: Analysis of M^3 NIR observations confirmed that pure, crystalline plagioclase is widely distributed across the lunar surface. We identified spectrally pure, crystalline plagioclase in the walls and ejecta of simple craters and in the walls, floors, central peaks, and ejecta of complex craters; most in association with near- and far-side impact basins. All of these identifications are associated with regions of the highest crustal values (as modeled by Wieczorek et al. [7]) surrounding each impact basin.

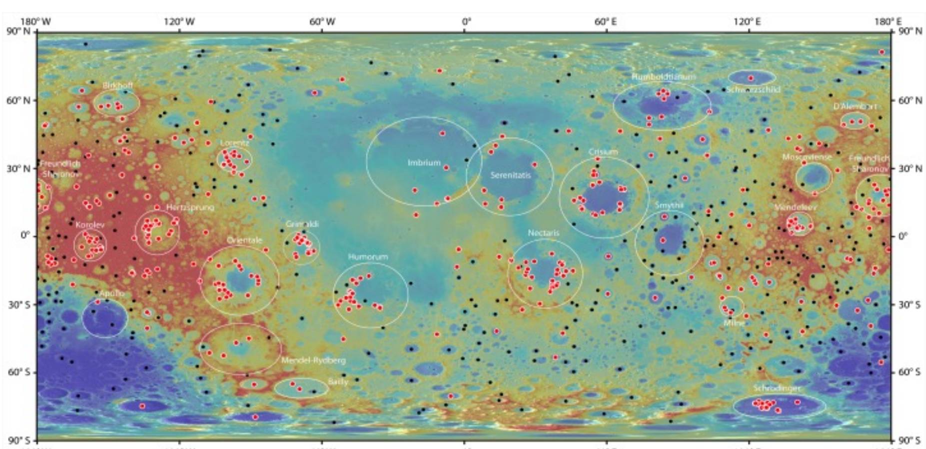

Figure 1. Red circles highlight M^3 identifications of pure crystalline plagioclase. The background image is the Lunar Orbiter Laser Altimeter (LOLA) topography overlain on a Lunar Reconnaissance Orbiter Camera (LROC) Wide Angle Camera (WAC) global mosaic.

To better understand the compositional variability of plagioclase globally distributed across the lunar highlands, estimated Diviner Christensen Feature (CF) values were analyzed. A single distribution of CF values is observed with a mean CF value of 7.91 ± 0.05 μm suggesting that the average composition of plagioclase identified in all of the highlands craters is similar. The mean Diviner CF value can be compared to the wavelength position (7.84 μm) of the CF of anorthite (An_{96}) measured under simulated lunar conditions to estimate the An# for the observed pure plagioclase units. The mean CF value measured by Diviner suggest the plagioclase composition across the highlands is relatively uniform in composition, highly calcic ($An_{\geq 96}$), and is consistent with plagioclase compositions found in the ferroan anorthosites (An_{94-98}) in the Apollo sample collection.

Conclusions: Our results confirm that spectrally pure anorthosite is widely distributed across the lunar surface and most exposures of the primary anorthositic crust are concentrated in regions of thicker crust surrounding impact basins on the lunar near- and far-sides. In addition, the scale of the impact basins and the global nature and distribution of pure plagioclase requires a coherent zone of anorthosite of similar composition in the lunar crust, thus supporting its formation from a single differentiation event like a magma ocean.

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