THE COMPOSITION OF MAFIC MOUND: AN UNUSUAL FEATURE WITHIN THE SOUTH POLE – AITKEN BASIN .
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Introduction: The vast, ancient South Pole - Aitken Basin (SPA) is a valuable lunar science target due to its size and age, providing clues to the evolution of the crust and mantle. From impact crater scaling laws, SPA likely excavated and/or melted lower crustal and mantle materials [1]. The resulting basin structure was then altered by billions of years of impacts and soil development.

The interior of SPA has been observed to be Fe-rich [2] and noritic in composition [3]. However, near the center of the basin lies a ~30-40 km-wide topographic high with a distinctly more gabbroic composition [3]. This feature is often referred to as "Mafic Mound." A context image for central SPA including Mafic Mound is givein in Fig. 1A. In this study, we analyze the pyroxene compositions of Mafic Mound materials in the context of pyroxenes from throughout SPA.

Methods: For this analysis, Moon Mineralogy Mapper [4] (M^3) data are used to evaluate the compositional diversity of SPA materials in spatial context. The analysis focuses on pyroxenes, which dominate spectral variations across the basin. The 1 µm and 2 µm absorption band centers are fundamentally linked to the Mg, Fe, and Ca content of pyroxenes [5-7]. These absorption band centers are used to characterize compositional differences in this analysis. Band center (and depth) values are measured using **p**arabola fits and a two-part **l**inear **c**ontinuum (PLC) [7]. M^3 mosaics of the Mafic Mound region are given in Figs. 1(b-c).

The SPA interior is generally enriched in pyroxene content compared to the highlands. For this analysis, only materials with 1 µm band depths greater than 0.15 (typically found in craters) are considered in order to focus on optically immature areas. PLC band center measurements for such areas from Mafic Mound and several additional locations in SPA are compared in Fig. 2a. Each individual crater is simply the most recent event in a string of complex processes including impact redistribution and soil development and may not be representative. However, by considering many craters, patterns can be identified and related to to the overall composition and geologic history of the region.

Results: As illustrated in Fig. 2a, SPA central peaks exhibit relatively short-wavelength absorption bands compared to other SPA materials, indicating a higher Mg abundance in pyroxenes. Mafic Mound and mare craters exhibit longer-wavelength band centers, indicating a higher Fe,Ca abundance in pyroxenes.

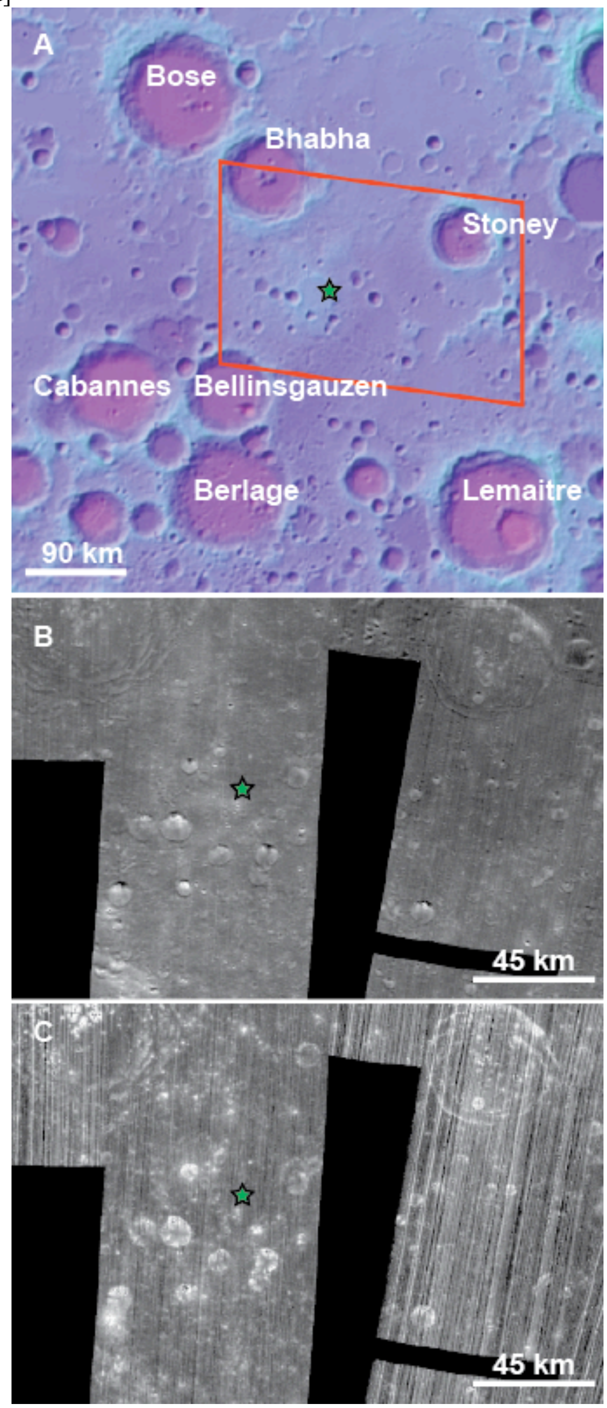

Fig. 1: (A) LROC[9] color shaded relief for the Mafic Mound region. The general area of Mafic Mound is indicated by the green star. The red box indicates the coverage of the M^3 region below. (B) Level 2 M^3 750 nm reflectance (with topography correction) for the region indicated in (A). (C) PLC-derived 1 µm band depth map (correlated with pyroxene abundance and optical maturity).

Walls/rims/floors of several large craters throughout

SPA exhibit intermediate band centers, overlapping both the central peak and Mafic Mound band centers.

The geologic setting of these areas provides general stratigraphic information about SPA. Mafic Mound craters are smaller than 10 km in diameter and exhibit a simple morphology. Therefore, they expose material from relatively shallow depths, probably less than 1 km[1]. In contrast, central peaks from many large SPA craters uplift material from greater depths – closer to ~5-10 km [8]. Other structures of these large craters (walls, rims, floors,. etc) generally represent material from shallower depths than central peaks [1,8]. While the complex regional geologic history must be considered in order to construct a detailed stratigraphic model, these results show that deep-seated SPA materials exhibit pyroxenes that are generally more Mg-rich than materials closer to the SPA surface.

Mafic Mound materials exhibit 2 µm band centers at wavelengths similar to to mare materials. This indicates pyroxene composition that is relatively Fe,Ca-rich. However, exposures at mare craters exhibit longer 1 µm bands than Mafic Mound materials (Fig. 2a). This difference is likely due to the presence of a 1.2 µm band in mare spectra seen in Fig. 2b [7]. In pyroxenes, the 1.2 µm band arises from the presence of Fe in the M1 crystallographic site [8], even thoughFe prefers the larger M2 crystallographic site. However, rapid cooling during crystallization can trap Fe in the M1 site [8]. Therefore, a stronger 1.2 µm band can indicate faster cooling (for pyroxenes of similar composition). Alternatively, the 1.2 µm band can be due to crystalline plagioclase which exhibits an absorption near 1.2 µm.

As seen in Fig. 2b, SPA mare spectra exhibit a significantly stronger 1.2 µm band than Mafic Mound spectra. However, the overall 1 µm and 2 µm band centers are similar. It follows that the Mafic Mound and mare pyroxenes are similar in pyroxene composition. However, Mafic Mound materials either cooled much quicker than the mare materials, and/or contain significantly less crystalline plagioclase.

Summary: Mafic Mound materials exhibit significantly longer-wavelength absorption bands than other non-mare materials within SPA, indicating a higher Fe,Ca content in pyroxenes. Mafic Mound pyroxenes appear compositionally similar to mare pyroxenes. However, significant differences were observed in the strength of a 1.2 µm between Mafic Mound and mare materials. This could be explained through two scenarios: (1)Mafic Mound materials were initially intrusive and cooled slowly enough to allow Fe in pyroxenes to partition completely into the M2 site. This weakens the 1.2 µm band compared to pyroxenes of extrusive, rapidly-cooled mare materials. (2)Mafic Mound materials are more gabbroic and contain significantly less crystalline plagioclase than SPA mare basalts.

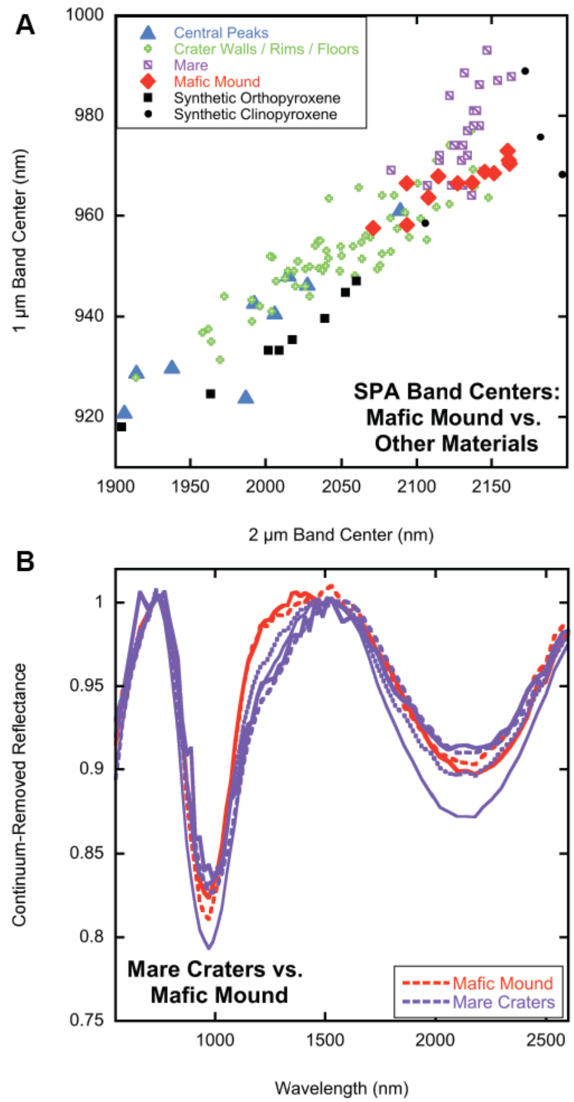

Fig. 2: (A) PLC-measured band centers for pyroxene-bearing exposures in Mafic Mound and several other context areas throughout SPA. The band center values are superimposed on values for several synthetic pure pyroxenes with a range in Fe, Mg, and Ca content[5-7]. In general, band centrs shift to longer wavelengths with increasing Fe and Ca content. (B) Example spectra for several craters within Mafic Mound, compared to spectra from fresh mare craters. Mafic Mound exhibits a much weaker 1.2 µm band than the mare craters.

Acknowledgements: This analysis is supported through NASA LASER (NNX12AI96G) and SSERVI (NNA13AB01A).

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