EVALUATION OF STRATIGRAPHY AT THE SOUTH POLE – AITKEN BASIN: FROM LOCAL TO REGIONAL.
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Introduction: The South Pole – Aitken Basin (SPA) is one of the largest and oldest impact basins on the Moon [1]. The current stratigraphy across SPA has arisen from the following general events and processes [2]: (1) formation of the crust and mantle (including crystallization of a magma ocean, overturn, the Mg-suite, etc.), (2) the SPA-forming impact (including excavation of crust/mantle and formation of large volumes of impact breccia and melt which may have pooled and differentiated), (3) continuous smaller impacts which have exposed and redistributed materials, (4) emplacement of mare basalts, and (5) continuous soil formation and alteration. Here, we investigate rock types across SPA in order to address science topics such as the pre-impact stratigraphy of the crust and mantle and the nature of the SPA-forming impact.

Since SPA is a vast, complex region, several subregions within SPA are being analyzed in detail to establish local stratigraphies. By comparing these subregions in spatial context, the larger regional stratigraphy can be addressed. A map showing the initial subregions discussed here is given in Fig. 1.

Methods: For this study, compositional information is extracted from Moon Mineralogy Mapper (M^3) spectra using spectral parameters that capture properties of both the 1 and 2 um absorption bands [3]. These include (1) estimated band centers (EBC1,2), which shift to longer wavelengths with increasing Fe/Ca/CPX content of the pyroxene component, (2) estimated band depths (EBD1,2), which are related to mafic abundance, but decrease with optical maturity, and (3) normalized continuum slopes (NCS1,2), which are sensitive to several properties including composition and optical maturity.

Spectral parameter images were derived from mosaics of M^3 data for each subregion. In order to evaluate the local mineralogy, we isolated the most "pristine" mafic and feldspathic exposures by identifying pixels with EBD1 values >0.15 and <0.05. We thus avoid materials that have undergone extensive mixing or space weathering. None of the subregions were found to exhibit feldspathic exposures.

The mafic areas identified by EB**D** are evaluated for pyroxene composition using EB**C**. Several distinct compositional units in each subregion are classified based on (1) geologic context (crater wall, central peak, etc.), and (2) band center (pyroxene composition). Each exposure typically includes 10s to 100s of mafic pixels. Mean spectra for each unit are calculated from all pixels comprising the unit.

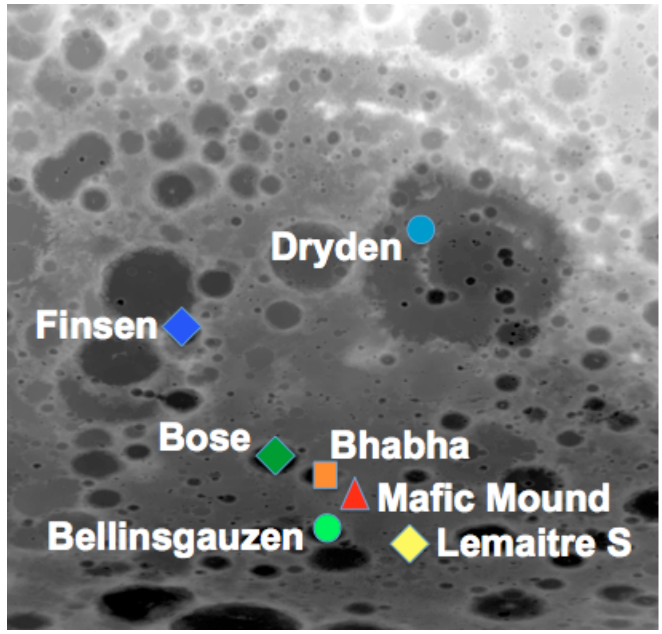

Fig. 1: LOLA topography for SPA (bright represents high elevations; dark represents low). Center locations of each subregion are shown by color symbols.

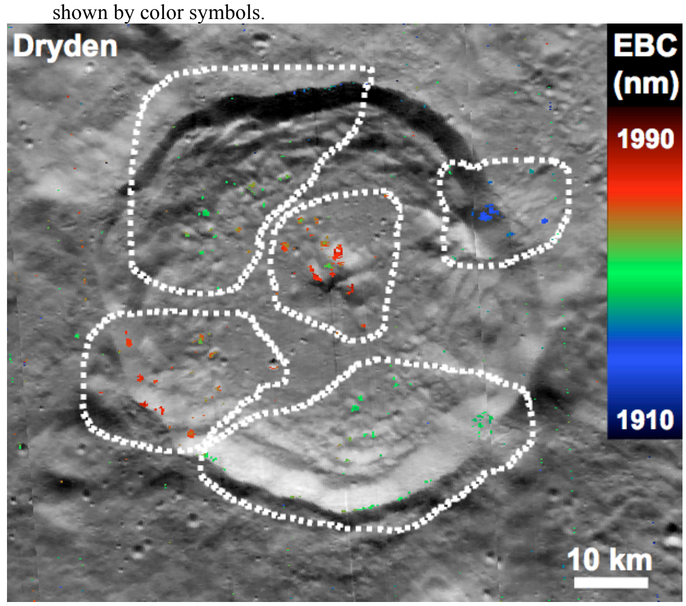

Fig. 2: M^3 2940 nm radiance image of Dryden. Pixels with EBD1>0.15 are displayed by band center using the EBC2 color legend. The white dotted lines show groupings of mafic pixels analyzed as single compositional units.

Results: *Dryden (51 km):* Example results for Dryden are given in Fig 2. Pristine mafic exposures occur on the central peak and walls of Dryden. These areas exhibit a range of relatively short-wavelength absorption bands (as seen in Fig. 3), implying a range of Mg-rich pyroxenes. The most Mg-rich pyroxenes occur on the NE wall, while the lower-Mg pyroxenes occur on the central peak and SE wall. Intermediate pyroxenes occur on the SE and NW walls. This distribution is not symmetric and might reflect an oblique impact into a stratified target with lower-Mg pyroxenes at depth.

Finsen (72 km): Pristine mafic exposures occur on Finsen's large central peak, walls, and in nearby Finsen C (25 km). The peak exhibits relatively short wavelength EBCs associated with Mg-rich pyroxene. The walls and Finsen C exhibit longer EBCs. This suggests a stratigraphy in which the more Mg-rich materials occur deeper (opposite to that of Dryden).

Bose (91 km): Although Bose's central peak is not covered in this data, mafic exposures are prevalent across the crater floor and in nearby Bose D (20 km). A small, fresh crater near the SW wall exhibits ejecta with strong absorption bands. In this ejecta, a "bull's-eye" pattern is observed in EBC, with relatively short-wavelength distal ejecta surrounding longer-wavelength proximal ejecta. Mafic exposures across the floor and walls of Bose are similar in EBC to the distal ejecta, while Bose D exhibits slightly longer EBCs.

Bhabha (70 km): In Bhabha, mafic exposures occur on the walls, central peak structure, and several areas across the crater floor (including a ~5 km crater). The floor and peak materials exhibit shorter-wavelength EBC values than the wall materials, suggesting a stratigraphy similar to that of Finsen.

Mafic Mound: In this slightly elevated region, strong mafic absorptions are exhibited by several craters (<~10 km). Most of these craters exhibit notably long-wavelength EBC values indicating the presence of more Fe-rich OPX or CPX. The southern-most crater exhibits somewhat shorter-wavelength EBC values.

Bellinsgauzen (63 km): Mafic exposures occur along the walls and floor of Bellinsgauzen, mostly associated with smaller craters. Most of these exposures exhibit relatively short wavelength EBCs, but several longer wavelength exposures are also present.

Summary: Band centers derived from average spectra of the local compositional units defined for each subregion are presented in Fig. 3, along with band centers for pure, synthetic pyroxenes [4,5]. The pyroxene compositions range from Mg-rich OPX (Dryden) to Fe-rich OPX and CPX (Mafic Mound).

Several stratigraphic trends are suggested from these analyses. Overall, Dryden exhibits much higher Mg than the other subregions. Although the central peaks of the three craters are somewhat similar in EBC, the implied stratigraphy of pyroxene compositions at Dryden is opposite to that observed at both Finsen and Bhabha. These differences may arise from Dryden's location within the Apollo Basin (524 km), which lies outside of the SPA transient cavity [6] and could reflect a separate environment or altered stratigraphy.

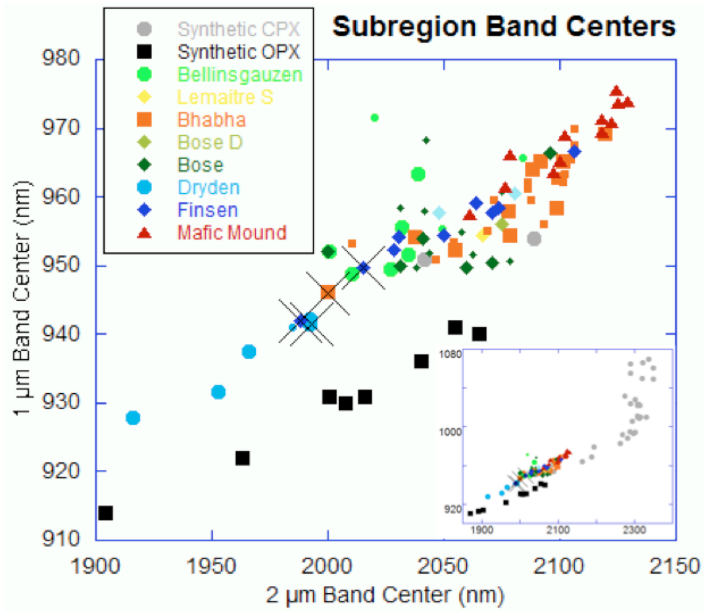

Fig. 3: Band center values derived from average spectra of the compositional units defined for each subregion. Large symbols represent units falling within the crater rim (where subregions are defined by a single crater). Large symbols with 'X' superimposed are central peaks. Small symbols represent units in the vicinity of each crater. Black and grey symbols represent the band centers of pure, synthetic pyroxenes. [4,5]. (inset) Subregion band centers plotted against the full range of synthetic pyroxene band centers.

The remainder of the subregions lie within the estimated SPA transient cavity [6]. The materials from the greatest depths (Finsen's and Bhabha's central peak, Bose, Bellinsgauzen) exhibit relatively Mg-rich pyroxene compositions (short-wavelength EBC values). Materials from shallower depths are more heterogeneous. Finsen's and Bhabha's walls as well as Mafic Mound exhibit relatively higher proportions of Fe-rich OPX and CPX (longer-wavelength EBC values). Lateral heterogeneity is apparent in near-surface materials and may be due to a variety of secondary processes: mare emplacements, cryptomare, intrusive emplacements, or ejecta deposition. We are investigating several additional subregions to clarify these relations.

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References: [1]Spudis, P. D. et al. (1994), *Science, 266,* 1848–1851. [2]Wilhelms, D. E. et al. (1997), *USGS.* [3]Moriarty, D. P. et al. (2013), *JGR,* 2310-2322. [4]Klima, R. L. et al. (2009), *MAPS,* 235-353. [5]Klima, R. L. et al. (2011), *MAPS,* 379-395. [6]Petro, N. E. and C. M. Pieters (2002), *LPS33,* 1848.