POLAR EXPOSURE OF MG-SPINEL LITHOLOGY AT CABEUS CRATER: IMPLICATIONS FOR NEXTGEN LUNAR EXPLORATION MISSIONS. Garima Sodha and Deepak Dhingra, Department of Earth Sciences, Indian Institute of Technology Kanpur, UP 208016, INDIA. (garimasd@iitk.ac.in, ddhingra@iitk.ac.in)

Introduction: Global distribution of Mg-Spinel lithology on the Moon and the current understanding of its petrogenesis suggests that it is geographically widespread but generally occurs on small spatial scale within the lower lunar crust [1, 2, 3, 4]. Its current absence in the returned lunar sample collection hinders precise compositional and petrological characterization. As a result, the role of this new rock type in the lunar crustal evolution is poorly understood. A sample of this lithology is, therefore, essential and has been listed as high priority lunar samples in Planetary Science Decadal survey 2023-2032.

Here, we report the first Mg-spinel exposure from the lunar poles, at Cabeus crater (85º S, 35º W, 100 km), an Imbrium aged impact crater located ~ 100 km from the lunar south pole and hosting one of the highest resource potential permanently shadowed regions (PSR) on the Moon [5, 6]. Our finding makes Cabeus crater an even more interesting site that would enable collection of ground truth for Mg-Spinel lithology alongside investigating PSRs in the new era of human and robotic lunar exploration.

Data: We have used Moon Mineralogy Mapper (M^3) data from multiple optical periods (OP2A, OP2B, OP2C1) to study the mineralogy of Cabeus crater [7]. Although polar data has low signal-to-noise ratio, sunlit region has reasonable quality signal to evaluate the mineralogy of the surface. In addition, we have also utilized high-resolution imaging data from Lunar Reconnaissance Orbiter Narrow Angle Camera (LRO NAC) and SELENE Terrain Camera (TC) to understand the geologic context of the region [8, 9].

Results: In this work, we describe our detection of Mg-spinel lithology at Cabeus crater and discuss its potential as a ground truth site for Mg-Spinel, in addition to its relevance as an important PSR site.

1. Mg-Spinel Exposures at Cabeus Crater: The exposure of Mg-spinel is located on an elevated ridge on the sunlit, equator-facing northern wall of Cabeus crater. It has the typical spectral character of lunar Mg-Spinel bearing lithology indicated by the presence of a well-defined absorption band around 2-micron, absence of 1-micron, small spatial scale (~ 600 m), and a dominantly feldspathic host rock. The exposure is associated with a fresh crater and has been observed in multiple observations from M^3 (Fig. 1).

2. Spectral Comparison with other Mg-spinel Exposures: We have compared the spectral signatures of Cabeus exposure with few other Mg-Spinel exposures

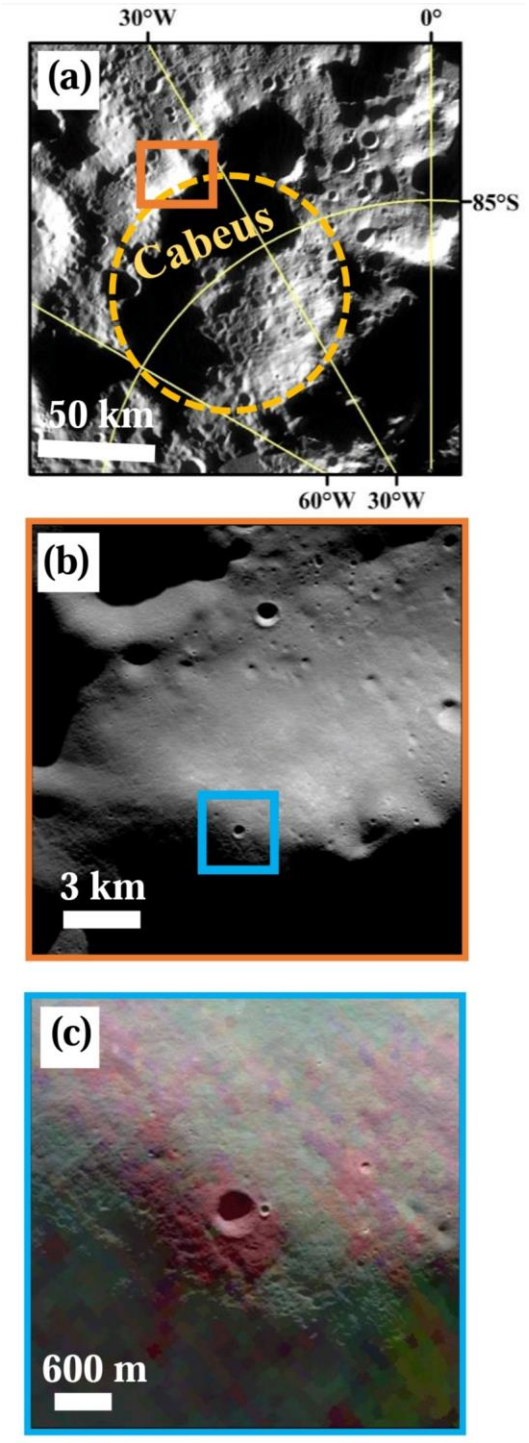

Figure 1. (a) Cabeus crater shown on LROC WAC **(b)** Fresh crater (blue box) exposing Mg-Spinel lithology on SELENE TC image **(c)** PCA color composite overlain on SELENE TC image highlighting Mg-spinel bearing material surrounding fresh crater.

on the Moon. Cabeus Mg-Spinel spectral character depicts striking similarities with Moscoviense spectra (Fig. 2) in terms of their relative band strength, shape, and long wavelength spectral slope [10].

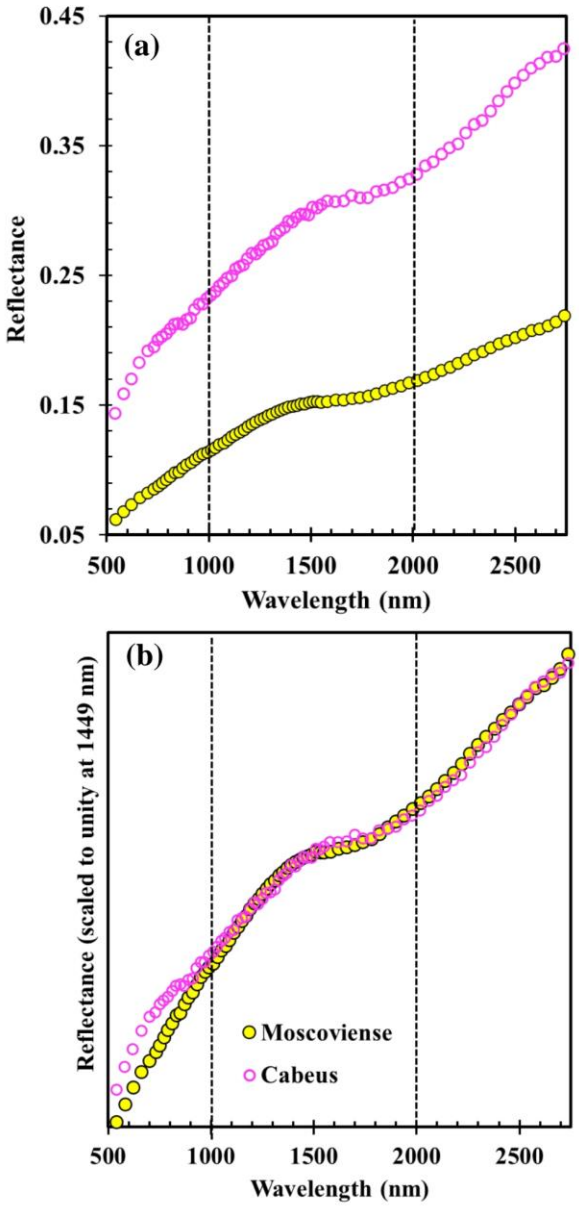

Figure 2. (a) Spectral signatures of Cabeus and Moscoviense Mg-Spinel lithology. **(b)** Spectra scaled to unity at 1449 nm for spectral comparison (modified after [3]).

3. Potential link to SPA Basin: Cabeus crater intersects the SPA basin inner ring and so the Mg-spinel bearing ridge may be remnant of the basin rings. Detection of Cabeus occurrence is a result of our comprehensive spectral survey along the SPA basin rings. Our survey hints at post-SPA origin of Cabeus exposure because a pre-SPA origin might have resulted in more pervasive exposures along the basin rings instead of scattered local exposure of lithology. An extensively fractured subsurface resulting from SPA impact might have created conditions favorable for the movement of magma and formation of Mg-Spinel. Therefore, the origin of Cabeus Mg-spinel may have been influenced by the SPA impact event although the small size of Mg-Spinel exposures always makes it challenging to provide a conclusive answer [3]. Ground truth from one or more of the Mg-Spinel locations, including at Cabeus, is therefore highly desirable and would enable better interpretations about this new rock type and its detailed geologic context.

Summary: We report the first polar Mg-Spinel exposure at Cabeus crater based on multiple observations from M^3 and spectral comparison with previously identified Mg-Spinel exposures, including the discovery site at Moscoviense basin. Geological association of potential remnants of SPA basin inner ring hints at a possible connection of Cabeus Mg-Spinel exposure to SPA basin. As part of a larger survey, post-SPA origin of Cabeus exposure is favored. Therefore, in the new era of human and robotic exploration of the Moon, finding this lithology in the polar region has great advantage from the perspective of collecting the crucial ground truth. Availability of the high-priority lunar samples in the proximity of polar region designates a special significance to Cabeus Mg-spinel occurrence.

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