GEOLOGICAL MAP OF MARE MOSCOVIENSE: A POTENTIAL LANDING SITE FOR FUTURE LUNAR MISSIONS.
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Introduction: Although we have almost 400 kg of lunar samples that were either brought back by the Apollo astronauts or were delivered in the form of lunar meteorites, new sets of lunar samples are required to expand our knowledge of the geological history and evolution of the Moon. This study presents Mare Moscoviense as a potential candidate landing site for future missions aside from the traverses previously proposed in Schrödinger basin [1,2]. The Moscoviense basin is a 450 km wide multi-ring impact crater with three distinguishable rings. It is located on the northern hemisphere of the lunar farside at 27°N, 148°E. Mare Moscoviense largely fills this impact structure with volcanic material of at presumably Eratosthenian age.

Data/Methods: Several studies [3-13] have used multispectral data and images to explore the Moon and gain knowledge of the origin of mare volcanism. Clementine [3, 4] and Kaguya [5-6] spectral data, have been used to examine compositional differences in lunar rocks and regolith. In this work, we use recent Lunar Reconnaissance Orbiter Camera datasets for Mare Moscoviense to generate a new geological map and examine possible landing locations for future missions. Within ArcGIS, we used Kaguya mineral maps [5], multispectral Clementine FeO and TiO_2 data [3], and LROC datasets [9] to define morphological and compositional geological units within Mare Moscoviense. Using digital terrain models [10], slope maps, and LRO Diviner rock abundances [8], we examined the topography and rock distributions inside Mare Moscoviense. We also derived absolute model ages from crater size-frequency distributions (CSFDs) for one of the prominent mare units and a light plains unit between two mare units.

Results: Inside Mare Moscoviense, at least three volcanic flows with different spectral compositions [9 and this work] were identified. By comparison of albedo contrast from LROC images and multispectral data, several geological units within Moscoviense basin were identified (***Fig. 1***). Two of these units are the prominent, dark unit *Em1* and the brighter unit *Em2* (***Fig. 1***). Both units differ in their multispectral compositions and filli large parts of the basin. The *Em2* unit gave an absolute model age of 3.0 Ga (***Fig. 2***). Beneath these younger units is a light plains unit of Imbrian to Nectarian age (*INp*; ***Fig. 1***). This unit differs in albedo, crater spatial density, and spectral composition from both afore mentioned units. The CSFD for the *INp* unit resulted in an absolute model age of at least 4.0 Ga (***Fig. 3***). The inner ring of Moscoviense is visible in the northeastern and southern part of the basin and consists of Nectarian plains and rugged mountain material (*NpNbr*; ***Fig. 1***). This unit is topographically higher than the units inside Moscoviense and also shows a different spectral composition than the mare units. The *NpNbr* unit is encompassed by an elevated terrace

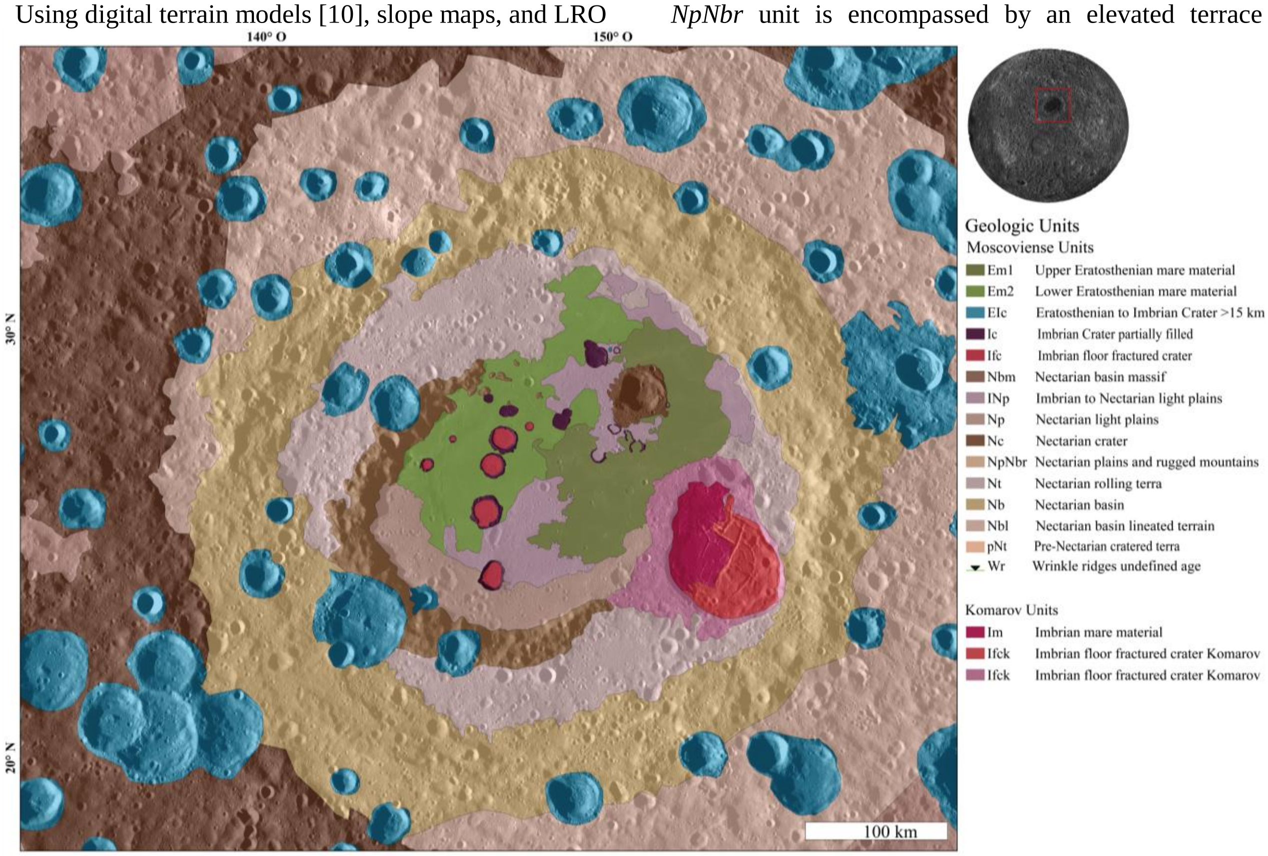

Figure 1: *Geological map of the Mare Moscoviense region in the northern hemisphere of the lunar farside.*

(*Nt*; ***Fig. 1***) containing blocks and rolling terra from the overlying second basin ring of Moscoviense crater (*Nbm*; ***Fig. 1***). Between the second and the third ring is an unit located consisting of several lineated features (*Nbl*; ***Fig. 1***). The *Nbl* unit also contains block and landslide material from the outermost basin ring of the Moscoviense basin (*Nb*; ***Fig. 1***). At the eastern margin of Moscoviense basin is a smaller impact crater named Komarov, which contains mare material of at presumably Imbrian age in the west (*Im*; ***Fig. 1***). In the eastern part of Komarov, the crater floor is characterized by large fractures (*Ifck*; ***Fig. 1***).

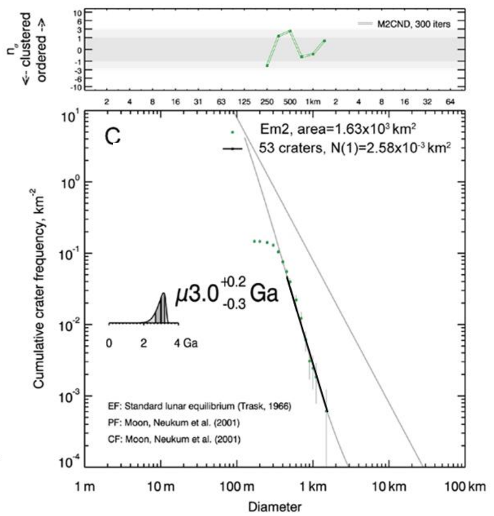

Figure. 1: *Crater size-frequency distribution and absolute model age for the western Eratosthenian mare unit Em2 of Mare Moscoviense.*

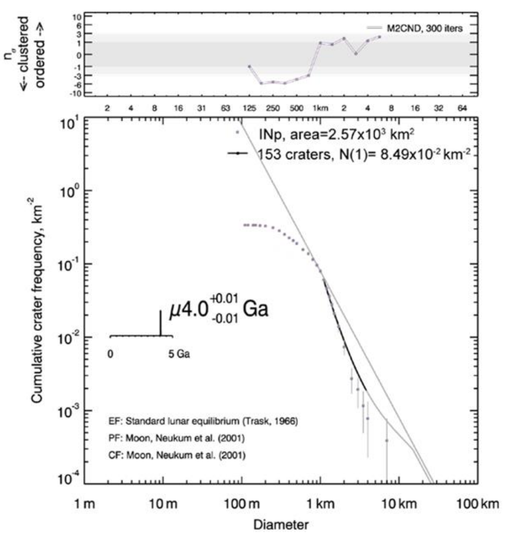

Figure. 2: *Crater size-frequency distribution and absolute model age for the southern Imbrian to Nectarian light plains unit INp of Mare Moscoviense.*

The slope map derived from the LROC WAC image digital elevation model indicates that the basin floor has in inclination angle between 3-12°. The rock abundance map of the study region indicates that the southeastern and eastern parts of the basin have the lowest abundances of rocks. The abundance for those parts are below a fraction of 0.05 % small rocks [8,14].

Discussion: With all the information gathered, there are several potential candidate spots as a possible landing site for future lunar missions. The southeastern and eastern volcanic flows show the lowest abundance of rocks compared to the other flows and are better suited as a landing site with a rock abundance below 0.05 %. Spectral data revealed that the eastern unit is covered by a mare unit with different mineralogic composition than the underlying older unit. The eastern flow provides also access to older impact craters, e.g. Titov a 25 km wide Nectarian crater, that may be related to the original basin floor (*Nc*; ***Fig. 1***). As shown in the geological map the eastern part of Mare Moscoviense gives access to several geological units in close proximity to a possible landing spot in vicinity to Titov. A landing site on the eastern flow provides access to at least two different mare units, ray material on one of the mare units, several wrinkle ridges and insights in the small scale mare volcanism on the lunar farside as shown by [12, 13, and this work].

Conclusion/Future work: Here we presented an updated geological map of Mare Moscoviense. At least three mare units inside Moscoviense basin were identified and two of them were dated so far. For future work we will provide several possible landing ellipses for the eastern part of Mare Moscoviense and work out a rover traverse for upcoming potential lander missions. The eastern part of Mare Moscoviense would be the most promising part for getting a better understanding in the timing of young mare volcanism and the examination of lunar cooling processes and the formation of wrinkle ridges.

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