COMPOSITIONAL AND MORPHOLOGICAL STUDY OF RUTHERFURD CRATER.

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Introduction: Rutherfurd (60.9° S, 12.1° W) is a Copernican-aged lunar impact crater located in the highland region on the nearside of the Moon's surface [1]. It has an average diameter of the crater is 48 km and is located entirely located within the southern rim of a Nectarian-aged Clavius crater [2]. Rutherfurd forms the larger member in an arcing chain of craters of decreasing size that curves across the floor of Clavius. The craters in this chain do not appear to be the same age, so this formation is most likely random in nature.

The concentration of OH/H_2O has been detected from the floor of Clavius [3], furthermore, the presence of water coincides with the asymmetric distribution of ejecta from the Rutherfurd crater rather than being connected to Clavius [4].

Datasets used: The Moon Mineralogy Mapper (M^3) is a NASA-supported guest instrument on ISRO's Chandrayaan-1 lunar remote sensing mission. With 86 spectral channels and 140 m/pixel spatial resolution, the M^3 push broom spectrometer can detect highly diagnostic mineral absorption bands in the visible to near-infrared (0.42-3.0 µm) regions. The M^3 datasets were acquired from the PDS Geosciences Node where the data is in the public domain [5].

NASA's Lunar Reconnaissance Orbiter (LRO) Wide Angle Camera (WAC) and Narrow Angle Camera (NAC) images are used for the morphological study. Calibrated NAC images were acquired from PILOT (Planetary Image Locate Tool), a web-based search tool for the Unified Planetary Coordinate (UPC) database of the PDS developed by the USGS Astrogeology Science Centre and the NASA PDS Imaging Node.

Methodology: The composition of the interior of the crater was studied from the normal and continuum reflectance spectra, as the continuum removal aids in the characterization of 1- and 2-µm bands [5]. The minimum Noise Fraction (MNF) gives the spectral diversity of the crater. Using the Environment for Image Processing (ENVI) software, georeferencing, mosaicking, and spectral sample collection were carried out.

Mapping of the physical features was carried out using characteristics such as relative elevation, structural complexity, albedo, and surface roughness as well as obvious geological boundaries [7]. Utilizing LROC NAC images, the features are examined and mapped in ArcGIS software and a high-resolution map was generated of various morphological features of the crater.

Results and discussion: The spectral graphs are used to do the compositional analysis because each mineral has distinct absorption bands. From the absorption spectra, we can get information about the moon's geological evolution from knowledge of the minerals present, their origin, and other cues. The spectral diversity of the crater can be observed from the MNF. The MNF method reduces data dimension by removing noise from data. The MNF combination (R: 6, G:8, and B:7) findings revealed the crater's spectral variety. The crater's spectral diversity was shown by the MNF combination (R: 6, G: 8, and B: 7) observations. The ejecta of Rutherfurd can be seen in dark pink color in the north-west direction and yellowish.

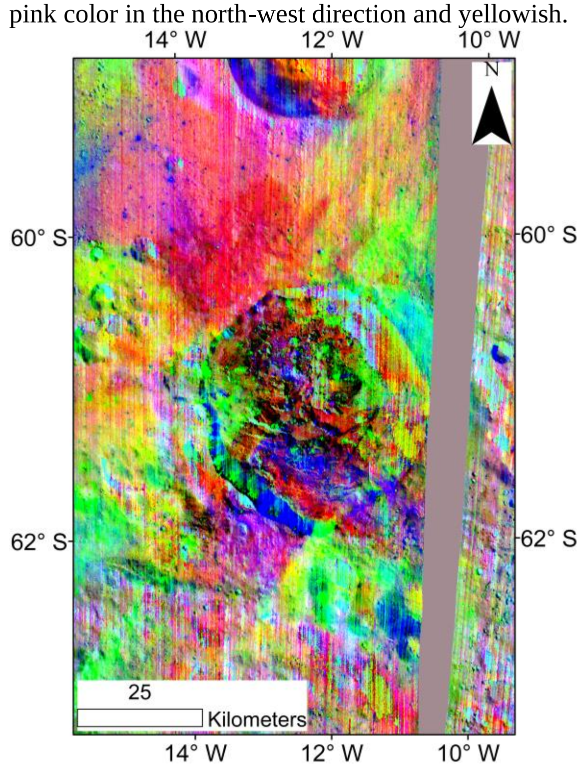

Figure 1: Minimum Noise Fraction with R: 6, G: 8, B: 7 generated from the M^3 data.

Based on the compositional analysis, the crater is rich in High Calcium (HCP) and Low Calcium Pyroxene (LCP). Pyroxenes feature two diagnostic absorption bands at around 1000 and 2000 nm, and as the iron or calcium concentration rises, the band center shifts to longer wavelengths [8]. The highest absorption of low-Ca pyroxene is at 940-980 nm and around 2000 nm[8,9]. The interior of the crater has a composition that is different from the surrounding region. There is an abundance of HCP present within the crater. The HCP spectra can be found in the prominent central peak, isolated mounds and crater walls. The presence of HCP indicates a dominant gabbroic composition in these areas. Spectra of Low Ca-Pyroxene are found in the southern rim of the crater.

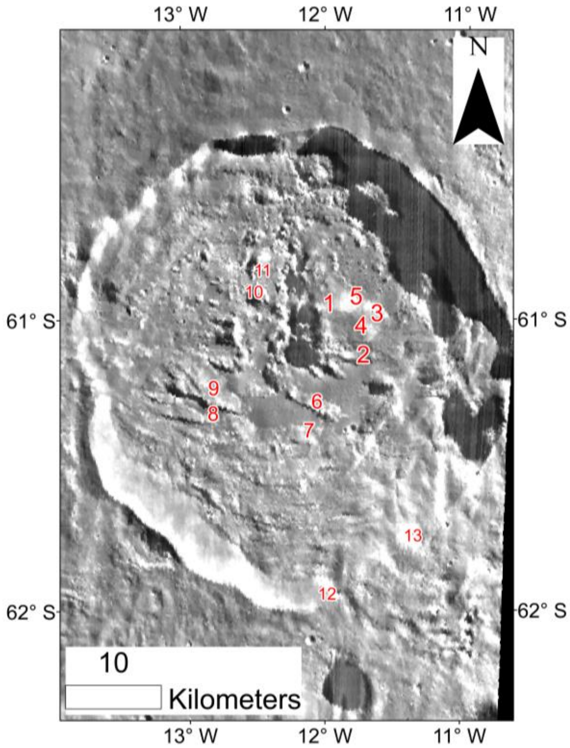

Figure 2: Rutherfurd crater mosaic generated from M^3 data with the locations of areas of the spectral collection.

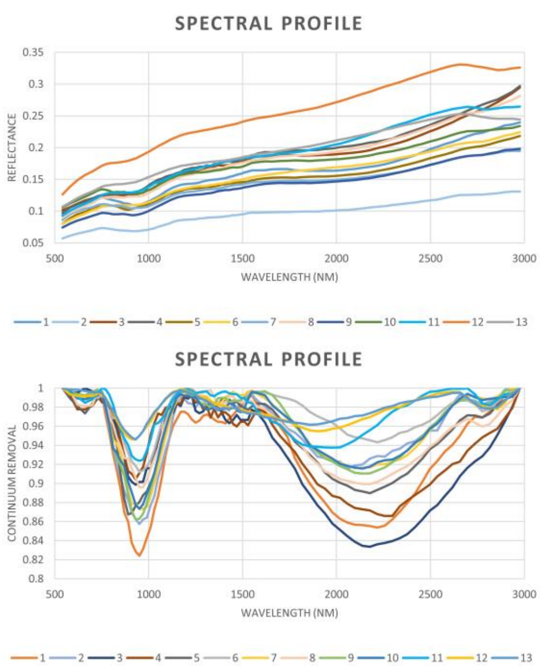

Figure 3: Spectra of LCP and HCP collected from Rutherfurd crater.

The morphological features of the crater consist of impact melt, a prominent central peak, crater floor, cooling cracks etc. Rutherfurd is roughly circular in shape, the northern outer ramparts have a series of radiating ridges on the floor of Clavius. Rutherfurd's rim is higher above the surface along its south and east sides because it sits on top of Clavius' inner wall. The floor is irregular in shape, and there is a central peak somewhat offset to the northeast. Using NAC data, a morphological map of all the features presented has been created at a scale of 1:25,000 in ArcGIS.

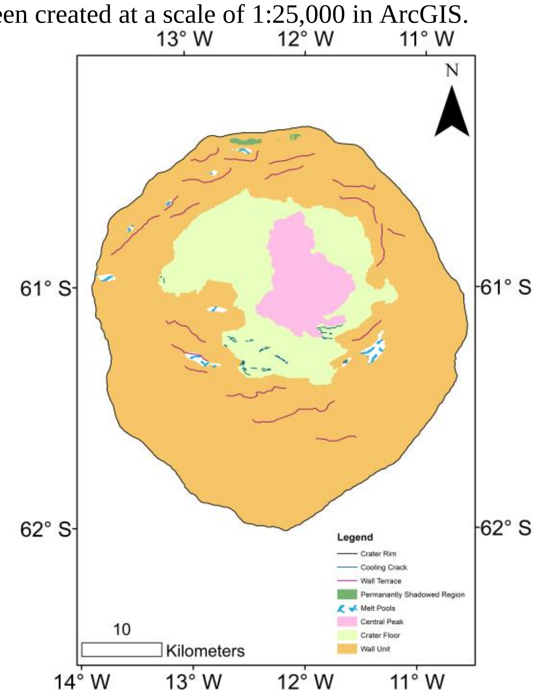

Figure 4: ArcGIS software was used to create a morphological map from high-resolution NAC images.

References: **[1]** Andersson L. E. & Whitaker, E. A. (1982) *NASA Catalogue of Lunar Nomenclature*, 1097, 147. **[2]** Fortezzo, C. M., et al. (2020) Release of the digital unified global geologic map of the Moon at 1: 5,000,000-Scale. *53rd Proc. LPSC* No. 2326, p. 2760. **[3]** Honniball, C.I. et al. (2020) Molecular water detected on the sunlit Moon by SOFIA. *Nat. Astron. 5*, 121–127. **[4]** Schultz, P. H., & Li, S. (2022) Origin of Water Signatures Within Clavius and Other Impact Craters on the Moon. *53rd Proc. LPSC* No. 2678, p. 2876. **[5]** Pieters, C. M. et al. (2009) *Curr. Sci.* 96(4) 1–6. **[6]** Thaker A. D. et al. (2020) *Planet. Space Sci*. 184, 104856. **[7]** Burns, R. G. (1970) *Amer. Mineral*. 55, 1608–1632. **[8]** Klima, R. L. et al. (2007) Spectroscopy of synthetic Mg-Fe pyroxenes I: Spin-allowed and spin-forbidden crystal field bands in the visible and near-infrared. *Meteorit. Planet. Sci.* 42(2), 235–253. **[9]** Klima, R. L. et al. 2011. Near-infrared spectra of clinopyroxenes: Effects of calcium content and crystal structure. *Meteorit. Planet. Sci.* 46(3), 379-395.