COMPOSITIONAL DIVERSITY WITHIN CLASS-1 LUNAR FLOOR-FRACTURED CRATER CARDANUS. Sumit Pathak[1]*, Ritwick Sen[1], Himela Moitra[1], Satadru Bhattacharya[1,2] and Saibal Gupta[1], [1]Department of Geology & Geophysics, Indian Institute of Technology, Kharagpur, WB - 721302, India. [2]Space Applications Centre, Indian Space Research Organisation, Ahmedabad-380015, India (*spathak.sac@gmail.com)

Introduction: The lunar floor-fractured craters (FFCs) are thought to be generated due to the magmatic intrusion beneath the crater floor subsequent to the impact event [1, 2]. In this study, an attempt has been made to infer the compositional variability within the Cardanus Crater, a class-1 lunar FFC, in a spatial context. Cardanus (13.27°N, 72.5°W) is located on the western flank of Oceanus Procellarum near Rima Cardanus south of the Kraft crater. It is an upper Imbrian-aged, nearly circular complex crater with a diameter of ~ 48 km. This crater has a nearly flat but fractured floor with prominent radial and concentric fractures with a central peak and some knobby structures. The ejecta material of the Glushko crater covered some parts of Cardanus towards the SW-NE trend. The compositional study of this floor-fractured crater provides insights into the mineralogical diversity of the region and constrains the lunar crustal stratigraphy and magmatic evolution [3, 4].

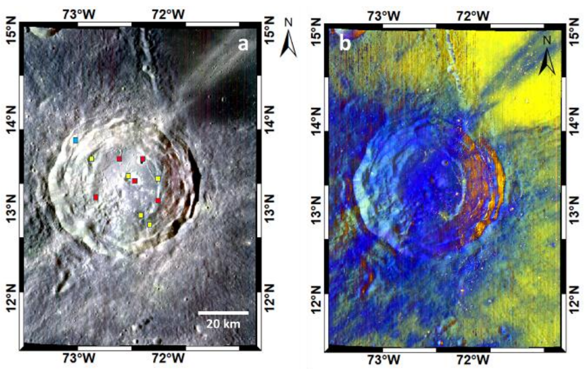

Figure 1: (a) M^3 FCC mosaic image of Cradanus crater; [Red box: HCPs, Yellow Box: LCPs and Cyan Box: Spinels] (b) IBD-mosaic of Cardanus crater generated using the method given by Mustard et al. 2011.

Dataset used and Methodology: For mineralogical analysis, the photometrically and thermally corrected level-2 hyperspectral data of Chandrayaan-1 Moon Mineralogy Mapper (M^3) instrument have been utilized [5, 6]. M^3 mapped the lunar surface in the spectral range of ~450-3000 nm at a spatial resolution of ~140 m. To depict the mineralogical diversity present within the study area, a false color composite (FCC) mosaic has been prepared by assigning the 930-nm, 1249-nm and 2137-nm spectral bands of M^3 in red, green and blue channel, respectively (Fig. 1a). To identify the abundance of mafic mineralogies within the studied region, an Integrated Band Depth (IBD) mosaic has been generated by assigning IBD-1000 nm, IBD-2000 nm, and 1578 nm albedo band of M^3 in red, green and blue channels, respectively (Fig. 1b) [7]. Later, using these reference maps, we derived the reflectance spectra from some target regions in the M^3 FCC mosaic to detect and map the various mineralogical constituents in the studied site (Fig. 2). The SLDEM (NASA's Lunar Orbiter and Laser Atlimeter Digital Elevation Model Coregistered with Kaguya's SELENE Data) datasets with ~60m/pixel ground resolution have been used for topographic analysis [8].

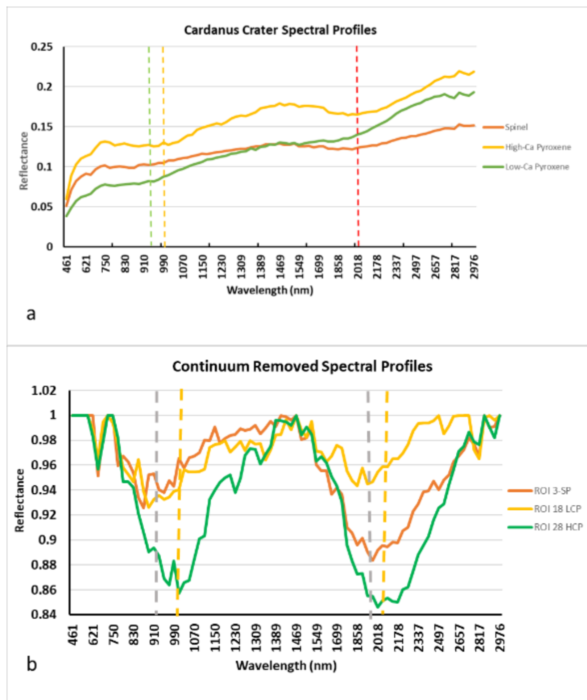

Figure 2: (a) Representative reflectance spectra and (b) corresponding continuum-removed spectra of various minerals that have been observed within crater Cardanus.

Results and Discussions: The spectroscopic analyses indicate that the central peak area is mainly composed of low-Ca pyroxene- (LCP) bearing lithologies along with a few scattered abundances of high-Ca pyroxene- (HCP) (Fig. 2a and 2b). The LCPs can be identified in the reflectance spectra by their dual absorptions near 930 nm and 2000 nm. However, the HCP-bearing mineralogies are characterized by dual absorptions near 1000 nm and 2000 nm in their reflectance spectra. The crater floor is mainly composed of LCP and HCP. The spectroscopic study further depicted that the crater wall is mainly composed of spinel, LCP and HCP. Exposures of spinel-bearing litho-units appear in lighter shades of yellow. The spinel-bearing mineralogies can be characterized by their relatively strong spectral absorption near 2000 nm as compared to a weak to non-existent (sometimes) absorption near 1000 nm (Fig. 2a and 2b). The IBD-mosaic shows the presence of ejecta blanket of Glushko crater over the central peak area, SW crater floor and NE rim have been draped by the regolith from ejecta ray radiating out of the Glushko crater emplaced on the lunar highlands. From the present study, it can be inferred that there is no indication of any late-stage pyroclastic activity in the crater floor or may be overlapped by the ejecta material of the Glushko crater.

The SLDEM topographic profile (Fig. 3a and 3b) shows that the crater has a steep wall with prominent wall terraces and slumps at some part of the inner flank. The crater floor is slightly uplifted, which could be due to the formation sill-type body beneath the floor. The floor is mostly flat but has scattered knobby structures on the SW. It has a prominent central peak but is slightly off-centric.

Conclusions: Cardanus is a class-1 lunar FFC with concentric and radial fractures. It has a prominent central peak and some knobby features on its floor. The inner flanks of the crater rim have terraced walls along with some slumps. The uplifted floor could be resulted from the deposition of a sill-body beneath the floor during the post-impact modification period (Fig. 3a and 3b). Later, this development triggered the ductile deformation on the floor and generated the fracture system. The mineralogical analysis of the central peak region with LCPs and HCPs suggests that the underneath crust could be ferroan anorthosite in composition [9] and these mineralogies are probably related to the mid-lower crustal mafic suite later excavated by the Cardanus-forming impact. However, the floor mineralogy indicates a mixture of pristine highland crustal composition and mid-crustal assemblages. The spinel-bearing lithologies on the NW crater wall could be pink spinel anorthosite in nature and hint towards a lower crustal composition previously excavated to/near the surface and subsequently recaptured by the Cardanus forming impact event [10-12]. Further, a detailed study is required to understand the stages of evolution of this studied crater.

Acknowledgements: All datasets used to generate the results were freely downloaded from the Lunar Orbiter Data Explorer archive (https://ode.rsl.wustl.edu/moon/index.aspx).

References: [1] Jozwiak et al. 2012, JGR, Vol. 117, E11005. [2] Jozwiak et al. 2015, ICARUS 248, 424-447. [3] Martinot et al., JGR, doi:10.1002/2017JE005435. [4] Pathak et al., 2021, Icarus, 360, 114374. [5] Goswami and Annadurai, 2009; Curr. Sci., 96(4), 486-961. [6] Green et al. 2011, JGR, Vol. 116, E00G19. [7] Mustard et al. (2011) JGR 116, E00G14. [8] Barker et al. 2016, Icarus, 273, 346-355. [9] Isaacson and Pieters, 2009, JGR: Planets, 114(9). [10] Smith et al. 2010, GRL, 37(18). [11] Cahill et al., 2009, JGR, VOL. 114, E09001. [12] Bhattacharya et al., 2015, ICARUS, 260, 167-173.

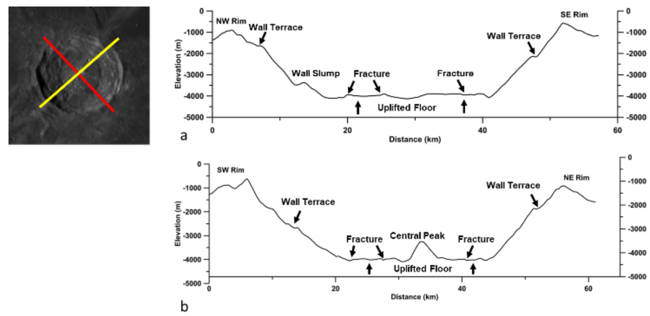

Figure 3: The figures show the (a) NW-SE and (b) SW-NE spatial profile of crater Cardanus derived from SLDEM data.