INVESTIGATION OF MULTIPLE BASALTIC VOLCANISM EVENTS IN THE FLOOR OF THE WOLF CRATER COMPLEX. H. Moitra[1], S. Pathak[1], S. Gupta[1] and S. Bhattacharya[1,2]. [1]Department of Geology and Geophysics, Indian Institute of Technology Kharagpur, India; [2]Space Applications Centre, Indian Space Research Organisation, Ahmedabad, India. (*himelamoitra@gmail.com)

Introduction: The Wolf crater complex (16.573°W, 22.904°S) is located in the central part of Mare Nubium in the lunar southern hemisphere [1]. The central depression in this complex has been divided into two overlapping craters, the larger crater in the north (diameter ~ 25 km) being called Wolf and the southern part being named Wolf B (diameter ~ 15 km) (Fig. 1). This work is focused on identifying multiple episodes of basaltic volcanism that cover the crater floors of craters Wolf and Wolf B that form the central depression in this complex. As the rim of this crater complex tapers to a very thin strip on the western corner, there might be a possibility that the mare basalt on the floor of the Wolf crater complex was deposited from the basalt flows of Mare Nubium that surround this complex, embaying on its edges (Fig. 2). The following work also investigates this possibility.

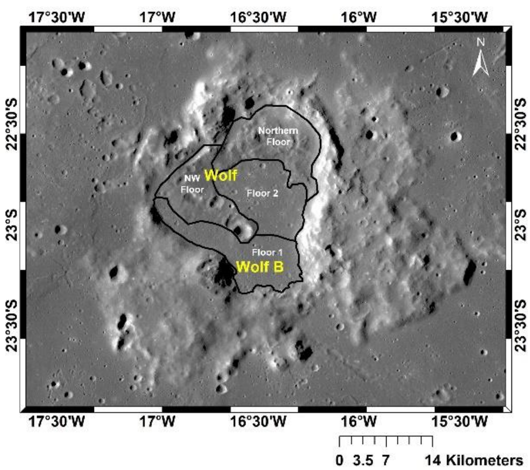

Figure 1: Wolf crater complex comprising of craters Wolf and Wolf B and the four parts in which the central depression has been divided for analysis.

Datasets used: For this work, visible to near-infrared reflectance spectral data collected by the Moon Mineralogy Mapper (M^3) instrument onboard the Chandrayaan-1 mission have been used [2, 3]. FeO content maps generated by [4] from reflectance data of the Mineral mapper instrument onboard the JAXA's Kaguya/Selene mission have been used for estimating FeO abundance. Topographic map has been produced from the high-resolution SLDEM (NASA's Lunar Orbiter and Laser Atlimeter Digital Elevation Model Coregistered with Kaguya's SELENE Data) data [5] to analyze the elevation variation.

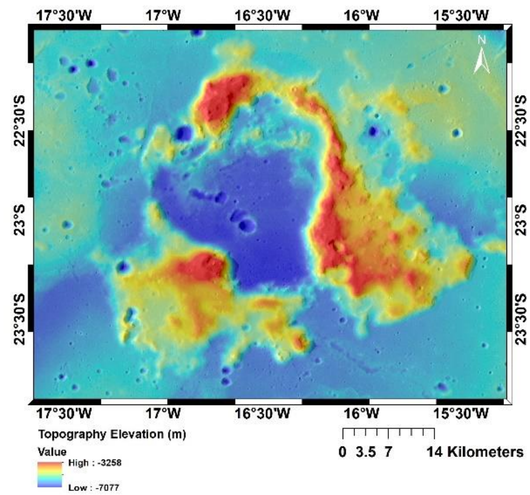

Figure 2: The topographic elevation map of the Wolf crater region derived from SLDEM data.

Results and Discussion: For this study, the crater floor has been divided into four parts based on topography and FeO content (Fig. 1, 2, and 3). The central depression shows three different levels of topographic elevation, successively decreasing from north to south and forming a terrace-like structure. The southernmost part with the lowest level of elevation has been termed 'floor 1'; the next higher level of terrace to the north of floor 1 consists of the parts 'northwestern floor' and 'floor 2'. The northernmost part of the crater floor, bearing the highest elevation, is termed the 'northern floor'. This part of the crater floor is only partially covered by basalt flows, whereas the three other parts are completely filled with basalt flows. The FeO map in the northwestern floor region shows a substantially higher FeO content of the mare basalts in this part (maximum value as high as 18.8 wt. %), as compared to the rest of the crater floor where the highest FeO content varies between 15.5 to 16.5 wt. % (Fig. 3), thus prompting the authors to identify it separately from the 'floor 2' part at the same elevation level.

Using the M^3 reflectance spectral data, regions of interest (ROIs) with dual absorptions at 1000 nm and 2000 nm were identified from each of the four parts, and band parameter analysis was performed on the spectra from these ROIs using methods previously used by [6] and [7]. These band parameters were then used to estimate the pyroxene compositions by end-member proportion calculations based on different empirical formulae suggested by [8]. Ternary plots of the enstatite-ferrosilitewollastonite end-member calculations from the pyroxene spectra from each of the four parts are given in Fig. 4. As can be seen from the plots, the pyroxenes in the northern and northwestern floors have similar compositions, whereas the pyroxenes in the 'floor 1' and 'floor 2' parts are less Ca-rich (<25 wt.% Wollastonite). Also, 'floor 1' pyroxenes are more Fe-rich than 'floor 2' pyroxenes. Therefore, it indicates that the basalt flows in the 'floor 1' and 'floor 2' parts of the crater floor are distinct from each other as well as from those in the northern and northwestern floor parts.

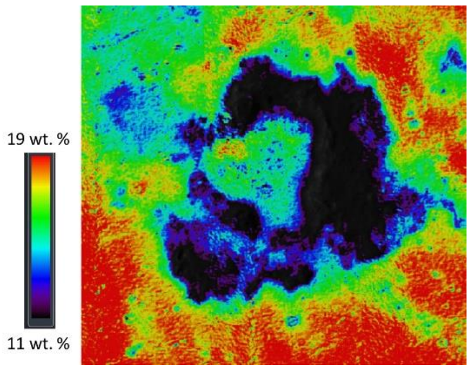

Figure 3: FeO abundance map of the study area.

Crater size-frequency distribution (CSFD) has also been conducted to estimate the ages of these parts in order to identify temporal differences in the basalt flows, except for the northwestern floor that is almost entirely covered by overlapping craters which makes it difficult to apply the CSFD in this part. The CSFD results suggest that the northern floor has an age of about 2.8 Ga, the 'floor 2' region gives an age of about 2.4 Ga, and the 'floor 1' region gives an age of about 2.0 Ga, making it the youngest of the three. On comparison with the ages of the surrounding basalt flows in Mare Nubium as given by [9] (Fig. 5), it can be seen that ages of the regions 'floor 1' and 'floor 2' are much younger than the youngest ages of the surrounding mare units (ranging from 2.8 to 3.7 Ga) [9]. Although the northern floor region does show an age comparable to the age of the youngest surrounding mare unit (2.8 Ga), the basalt flows in the northern floor, and the concerned mare unit are well-separated spatially and possibly signify two spatially distinct contemporaneous volcanic events. As can be seen in Fig. 2, the tappered rim on the western corner of this complex has a topographic high that might have acted as a barrier to the surrounding mare flows from entering the central part of the complex.

Conclusion: Thus, based on the FeO content, pyroxene composition and CSFD ages, it can be inferred that at least four different mare basalt units are present in the central depression or crater floor of the Wolf crater complex that are distinct from the surrounding mare basaltic units.

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References: [1] Greenhagen B. T. et al. (2017) LPSC XXXXVIII, Abstract# 2597), [2] Goswami and Annadurai, 2009; Curr. Sci., 96(4), 486-961. [3] Green et al. 2011, JGR, Vol. 116, E00G19. [4] Lemelin et al. (2019) PSS, 165, 230-243. [5] Barker et al. 2016, Icarus, 273, 346-355. [6] Chauhan et al. (2018) Moon, Meteoritics & Planet. Sci., 53, 2583–2595. [7] Pathak et al. (2021) Icarus, 360, 114374. [8] Gaffey et al. (2002) Asteroids III, 183-204. [9] Heisinger et al. (2011) GSA Special papers, 477, 1-51.

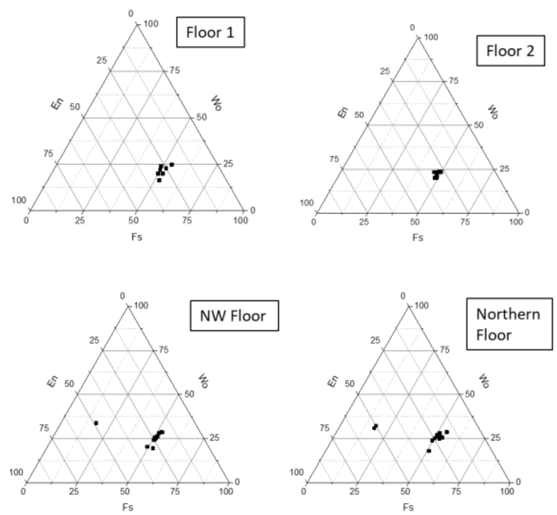

Figure 4: Ternary plot (En-Fs-Wo) for pyroxene compositions identified in the different parts of the crater floor.

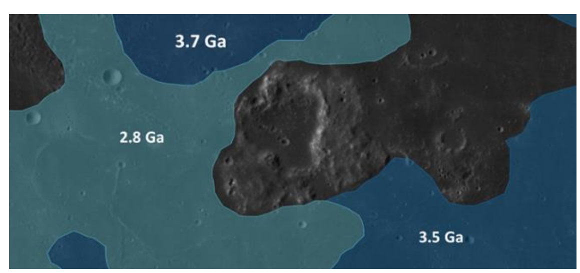

Figure 5: Ages of the mare basaltic units surrounding the Wolf crater complex given by Heisinger et al. (2011).