FLUVIO-LACUSTRINE ACTIVITY IN A CHLORIDE RICH TERRAIN AND ITS ASTROBIOLOGICAL IMPLICATIONS. Deepali Singh[1], Rishitosh K. Sinha[1], and Kinsuk Acharyya[1], [1]Physical Research Laboratory, Ahmedabad 380009, India (Email: deepalisingh@prl.res.in).

Introduction: Chlorides, on Mars, have been primarily reported within the inter-crater plains and topographic lows [1,2]. On Earth, evaporites often deposit within desiccating lakes, or playas, in semi-arid to arid environments, generally following the chemical divide proposed by [3]. Since chlorides have high solubility, they precipitate out at the end of the series and their presence indicates last hydrological activity within a region [4]. Hence, they may serve as important markers while reconstructing the geological history of an area on Mars and proposing the time frame until which the settings were conducive for life to have survived.

Study Area: The study area (Fig. 1) lies within the Terra Sirenum, to the south-west of the Tharsis extending from -139.15º to -138.66º in the east and -38.69º to -38.84º in the south. It is a topographic depression which has been identified as a chloride rich terrain by [1]. It has been previously dated as a part of Early Hesperian volcanic (eHv) unit by [5] and is surrounded by early Noachian and middle Noachian units on the eastern and southern sides respectively.

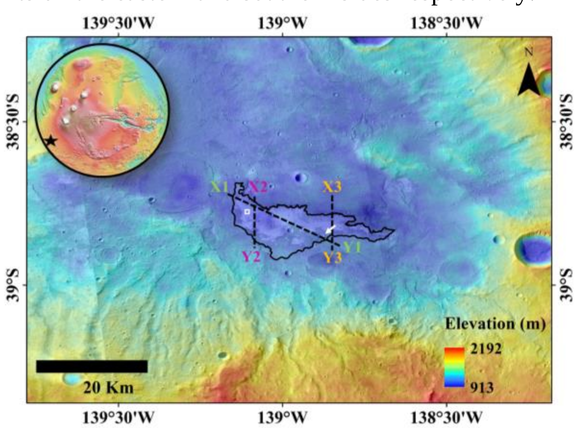

Fig. 1. Study area. *Inset within the figure shows the general location of the study area on Mars. The boundary of the study area is marked in black. Three cross-section profiles drawn across the study area are presented in Fig. 2. The basin is surrounded by channels on the southern and the eastern side. White arrow shows a crater through which profile X1Y1 crosses. White box depicts the location of the polygonal cracks shown in Fig. 3.*

Data set and Methods: We used THEMIS-IR Day (100 m/pix) [6] and HRSC and MOLA Blended DEM (200m/pix) [7] basemaps to demarcate the boundaries. ConTeXt Camera [8] (6m/pix) and High Resolution Imaging Science Experiment (HiRISE) (0.25m/pix) [9] datasets were used for morphological and morphometric analysis. We used Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) [10] for mineralogical analysis of the study area. All the datasets were downloaded from Planetary Data System (PDS) available at https://ode.rsl.wustl.edu/mars/.

Observations: *Basin Morphology.* The basin had a maximum depth of about 50m (Fig. 2) and encompassed a total area of about 153 square km. The basin floor is cracked into polygonal patterns of different sizes (Fig. 3). At some places, larger polygons were further fractured into even smaller ones, thereby giving them a size variation from ~4-15m. We observed white-toned deposits overlying the polygonal cracks. The deposits appear to have been cemented over the cracks. Similar deposits were also seen in discontinuous patches near the north-eastern boundary and in a channel westward of the study area.

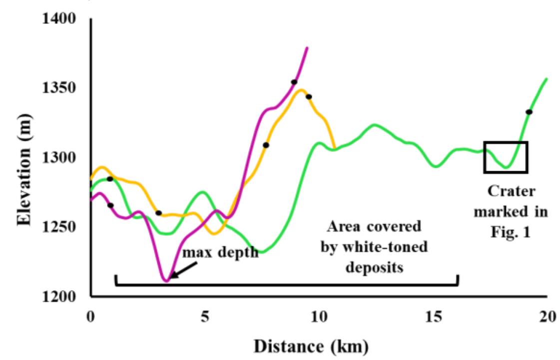

Fig 2. Cross-section profiles of the study area. *The profiles are color-coded as their corresponding labels in Fig. 1. The basin boundary is marked with a dot in the profiles.*

The basin was surrounded by two different types of channels on its eastern and southern sides (Fig.4). While the channels on the southern side of the basin possessed both U and V shapes and reached a maximum depth of about 90m, the channels on the eastern side were V-shaped and with a depth of about 50 m. The channels on the southern side had a Strahler order of 4, whereas channels on the eastern side reached a maximum Strahler order of 3 in some instances.

Basin Mineralogy. We observed an absorption band at 2.31 μm along with a water band near 1.9 μm and OH band near 1.4 μm indicating the presence of Mg-smectite (saponite) in the area. These signatures were observed near the north-eastern and southern side of the basin.

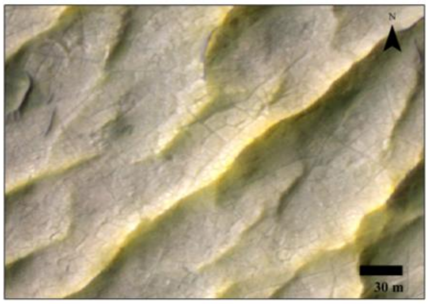

Fig. 3. Polygonal cracks observed within the basin. *The white-toned appear cemented over the polygons.*

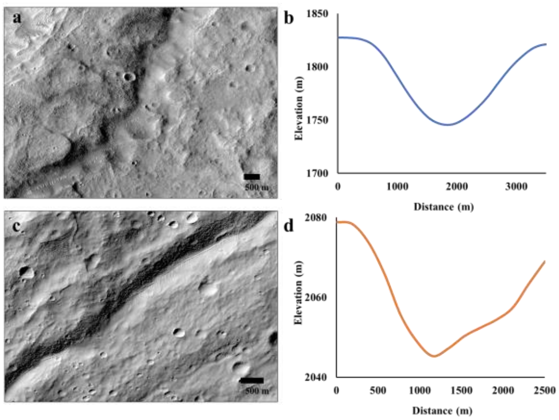

Fig. 4. The channels observed around the basin. *Fig. 4a shows a channel on the southern side and its cross-section is shown in 4b. Fig. 4c shows a channel on the eastern side and its cross-section is shown in 4d.*

We also observed a broad absorption feature near the 2.2 μm band in small patches distributed over the basin. The shape of this band indicates the presence of a mixture of Al-rich phyllosilicate with, possibly, hydrated silica. Spectro-morphological mapping of the De-Correlation stretched (DCS) [11] CRISM dataset showed that the chlorides were associated with the white-toned deposits. Even though the CRISM dataset was not available to cover the area of interest, based on similar textures and discontinuous patches observed through the CTX images, it is likely that chlorides also extend beyond the study marked in Fig. 5. The mineralogical diversity within the area indicates that the basin witnessed different geological environments.

Astrobiological potential of the basin: Properties of various minerals have been explored with reference to their biosignature preservation potential. Amongst them, clay minerals and hydrated silica have been considered widely popular choices given their astrobiological importance and extensive presence on the Martian surface [12,13].

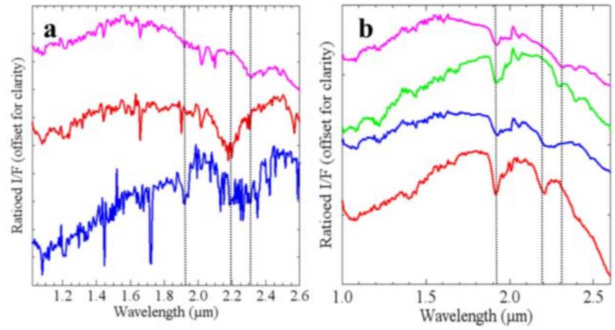

Fig. 5. Basin mineralogy. *Fig. 5a shows the spectral signatures collected from the basin. Fig. 5b depicts the spectra from the CRISM library. The colors of the spectra in 5b refer to the following: Pink- Mg-smectite, Green- Fe-smectite, Blue- Hydrated silica, Red- Montmorillonite. The colors of the spectra in 5a correspond to the respective minerals in 5b.*

However, evaporites such as chlorides and sulfates have shown the potential to provide harbor for microbes to survive and propagate in extreme environments, including providing moisture and protecting them from radiation [14]. It might be relevant if the proposed basin was a playa, and which was resourceful for potential life forms to adapt and survive for a longer duration when Mars started drying up.

Conclusion: Topographic depressions on Mars have the potential as paleolake basins and often show complex geological history due to their activation at different time periods through various sources. Though they have not been explored in much detail as compared to crater-hosted lakes, they too have the potential as paleolakes and present a strong case for exploration with respect to their astrobiological potential and water budgeting on Mars [15,16].

References: [1] Osterloo et al. (2008). *Sci.*, 319(5870), 1651-1654. [2] Osterloo et al. (2010*). JGR: Planets*, 115(E10). [3] Eugster, H. P., & Hardie, L. A. (1978). (pp. 237–293). *Springer*. [4] Leask, E. K., & Ehlmann, B. L. (2022). *AGU Advances*, 3(1). [5] Tanaka et al. (2014). *Planet Sp. Sci.* 95, 11-24. [6] Edwards (2011). *JGR: Planets*, 116 (E10). [7] Fergason et al. (2017). *Astrogeo. PDS Annex*., U.S.G.S. [8] Malin et al. (2007). *JGR: Planets*, 112 (E5). [9] McEwen et al. (2007). *JGR: Planets*, 112 (E5). [10] Murchie et al. (2007). *JGR: Planets*. 112(E5), 1–57. [11] Gillespie et al. (1986). *Remote Sens. Environ.*, 20, 209–235. [12] McMahon et al. (2018). *JGR: Planets*, 123(5), 1012-1040. [13] Singh et al. (2022). *Astrobiology*, 22(5), 579-597. [14] Davila et al. (2008). *JGR: Biogeosci.* 113 (1), 1–9. [15] Mukherjee et al. (2020). *Geomorphology*, 351, 106912. [16] Singh et al. (2022). *Icarus*, 372, 114757.