CHARACTERIZING GEOMORPHIC AND MINERALOGICAL FEATURES IN THE ERIDANIA BASIN AND THEIR IMPLICATIONS FOR THE GEOLOGIC HISTORY OF MARS. D. E. Chapline[1] and M. R. Salvatore[2], [1]Department of Geology, Pomona College, Claremont, CA, deca2018@pomona.edu. [2]Department of Astronomy and Planetary Science, Northern Arizona University.

Introduction: The Eridania basin on Mars is a network of highly degraded impact basins that covers more than one million km^2 [1] (**Fig. 1**). It is believed that water from the Eridania basin carved Ma'adim Vallis, one of the longest outflow channels on the Martian surface, in a single overflow event [1]. Ergo, the basin holds great importance for understanding the hydrological and fluvial history of the planet. Despite being heavily modified by subsequent geologic processes, evidence of Eridania's lacustrine origin is still prominent in the area, suggesting a long history of modification by water.

Previous research has helped to characterize the basin's stratigraphy and mineralogy [2-5]. Mineralogical analyses of various stratigraphic sections within the basin demonstrate that there is evidence for multiple stages of hydrologic activity [4,5]. Notably, [5] identified that chloride salt precipitation and acidic surface alteration followed clay formation, indicating a dynamic lake environment that increased in salinity as evaporation increased over time. However, many questions remain unanswered concerning the geologic history of the Eridania basin, especially in regards to its unique mineralogy and the duration of lacustrine activity in the area. Our research has attempted to elucidate this geologic history and provide new clues surrounding ancient martian hydrology and habitability.

Methods: Publicly available orbital data were analyzed using the Java Mission-planning and Analysis for Remote Sensing (JMARS) software [6]. Surface mineralogy was investigated using spectral parameter maps from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM [7]). Daytime and nighttime infrared mosaics from the Thermal Emission Imaging System (THEMIS [8]) instrument were used to differentiate between different surface units. High-resolution visible images from the Context Camera (CTX [9]) and the High-Resolution Imaging Science Experiment (HiRISE [10]) were utilized to provide context for different spectral and thermophysical units, as well as to identify different geologic formations. Topographic data used in this study were derived from the blended Mars Orbiter Laser Altimeter (MOLA [11]) and High-Resolution Stereo Camera (HRSC [12]) instruments. Where necessary, raw data were acquired through the NASA Planetary Data System (PDS), processed, and examined using the ENVI and Davinci image processing software packages.

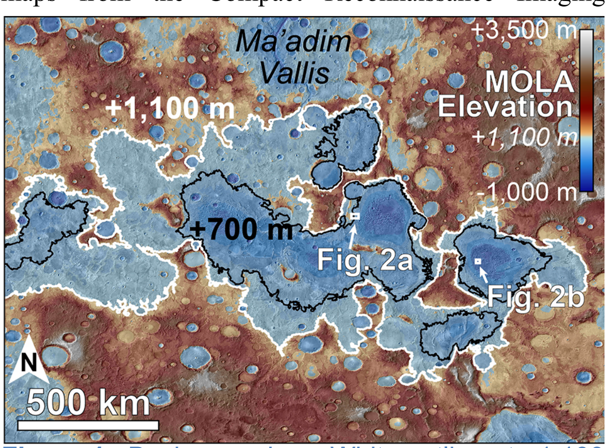

Figure 1. Basin overview. White outline at +1,100 m shows the greatest extent of the paleolake before breaching Ma'adim Vallis. Black outline at +700 m shows paleolake outline when water had retreated to individual sub-basins.

Mineralogy: Evidence for both Fe/Mg-OH and Al-OH spectral absorption features are observed in bright geologic units along the basin floor and within chaos blocks throughout the different sub-basins. These units are also associated with higher nighttime temperatures (implying higher thermal inertia) and are extensively fractured, primarily occurring as the highest exposed units on chaos blocks. This suggests that these minerals were present before the development of the chaos terrain. Therefore, if any surface waters originated from the subsurface and were liberated through chaos formation, that water was not likely involved in the formation of the observed alteration units widespread throughout the basin. It is possible, however, that water in the basin rapidly drained into the subsurface via the chaos terrain, but this theory has not been thoroughly investigated.

Bright clay-bearing units are omnipresent inside the limits of the basin, but do not appear outside of the basin. This is consistent with the clay units being a result of water alteration in a lake environment. Development of phyllosilicate units most likely implies that the surface conditions in the basin were relatively warm and wet compared to present conditions, but this is difficult to ascertain the duration of such conditions with any certainty. It is not clear whether these clays were created through *in situ* alteration, replacing the basement rock of the basin floor, or whether they were pre-altered before deposition.

Geomorphology: Geomorphic features consistent with the presence of a long-lived paleolake exist along the margins of the Eridania Basin. Features that are possibly indicative of ancient shorelines include terracing, stacked beach ridges, strandlines, and sediment benches, which are prominently observed on the rims of Eridania's sub-basins [13,14]. Topographic profiles of the sub-basins reveal that floor deposits slope gently downward toward the center [1]. This is inconsistent with volcanic overprinting, as the profile would instead show a flat basin floor or an upward slope toward the breach where the flow entered the basin [1]. Alleged terracing, beach cliffs, and concentric ridges are present in local elevation profiles across sub-basin margins. In our study, we identified these morphologies in many locations along the sub-basin margins as well as the smaller indicators, like spits, bars and a contrast in texture and across the contacts [14]. We interpreted these features as strong evidence of long-lived lacustrine activity.

One unique feature of the basin which appears at various locations along the margins of the individual sub-basins are flatiron morphologies and erosional patterns. They appear within the sub-basins and in line with other shoreline features, like the curvilinear, stacked ridges (**Fig. 2**). Their proximity to coastal features, as well as their shape and orientation, could suggest that they were created through erosion as water withdrew to the subsurface. However, there is no conclusive evidence to support this and more investigation is needed.

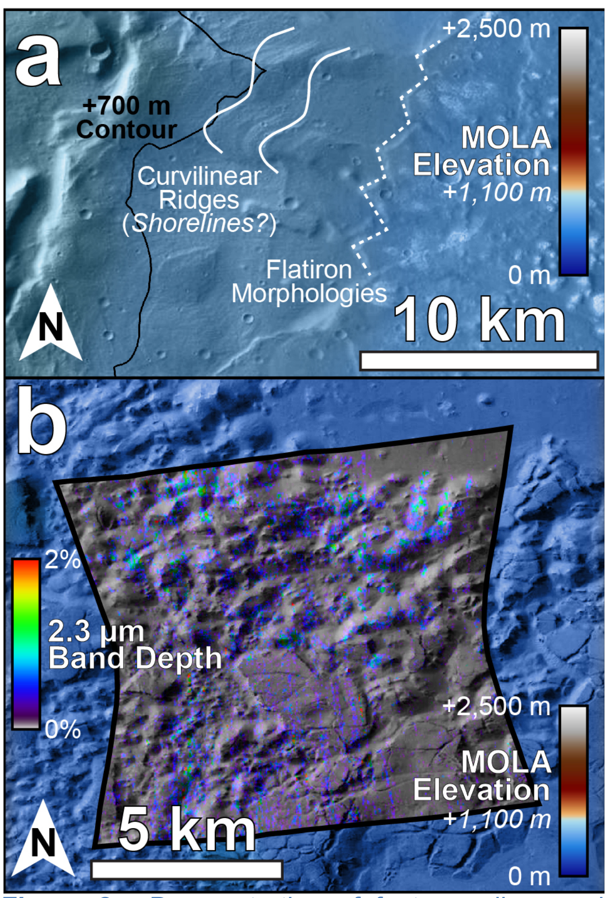

Figure 2. Demonstration of features discussed above. (a) Flatiron and potential shoreline morphologies. (b) CRISM image FRT00009764 showing the strength of the Fe/Mg-OH absorption in chaos blocks in eastern Eridania basin.

It is unclear why shoreline morphologies are clearly present at certain locations and not at others. Perhaps the elevation and topographic features of different locations along the basin's margin affected the magnitude and intensity of fluvial activity, thus resulting in differing geomorphology. It could also be caused by unequal degradation and erosion of the basin margins post hydrologic activity.

Outstanding Questions: *Principal source of water for the basin*. An estimated 114,000 cubic kilometers of water was delivered from Eridania to carve Ma'adim Vallis during the overflow event [1]. Precipitation has been suggested to significantly contribute to the basin's water supply, however a lack of major tributaries indicates that surface runoff alone would not have been sufficient to supply a large enough volume of water. It is possible that volcanism or impact activity could have created water outflow from the cryosphere. As well, it is also reasonable to suggest that disturbance in the subsurface due to the nearby growth of Tharsis could have risen the regional water table [4]. Understanding when and how water was introduced into the basin will be key to determining its climatic history and potential habitability.

Sink for water drainage. We interpreted the flatiron features on the basin floor as indicative of rapid drainage. While a significant amount of water was required to carve Ma'adim Vallis, there is evidence of multiple lake levels throughout the basin's history [4,5] and it is believed that small paleolakes inhabited individual basins later in Eridania's history. The possibility of water returning to the subsurface via chaos terrain should be investigated.

Development of hydrated minerals. Was the basement rock of the basin floor altered *in situ* with clays replacing the parent rock, or was pre-altered lake sediment deposited on the basin floor to create the observed bright, hydrated units?

Preservation of shoreline morphologies. Why do some areas of the basin margin demonstrate stronger evidence of preserved shoreline deposits and others do not?

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