LOCAL GLACIAL FEATURES ON EASTERN VALLES MARINERIS TROUGH WALL; IMPLICATIONS FOR GLACIAL PROCESSES ON LOW LATITUDINAL MARS.

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Introduction: The chances for the occurrences of large mass of ice in the Martian equatorial region were explained earlier using the morphological landforms of Valles Marineris region [1]. A recent study came up with the evidences for occurrences of unknown amount of subsurface ice in the mid latitudinal Mars [2]. The presence of ice on present Mars can be linked with the past fluvial processes. The liquid water which was once present on Mars must have solidified into ice as Mars lost its atmosphere.

Eastern Valles Marineris is a widely known low latitudinal region for occurrences of morphological features implying past aqueous processes on Mars [3]. The Eos Chaos is a least studied integral part of Eastern Valles Marineris trough system. The Eos Chaos consists of semi-circular troughs of various sizes. In order to understand the possible glacial evolution, the morphology of western part of the Eos Chaos is studied detail in this study.

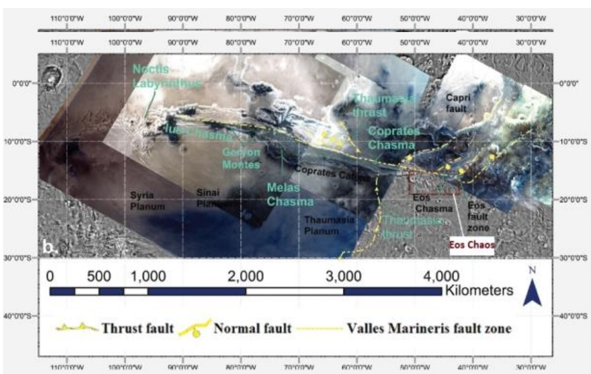

Figure 1. A mosaic of Valles Marineris, prepared using MCC images and Viking orbiter data. The area shown within the rectangle with brown dotted margin is Eos Chaos. The western semi-circular trough of this region is selected for this study

Data sets and methodology: Mars Colour Camera (MCC) images on board ISRO's Mars Orbital Mission (MOM1) are used as context image in this study. CTX (Context Camera) imageries, High Resolution Imaging Science Experiment (HiRISE) aboard NASA's Mars Reconnaissance Orbiter (MRO) mission along with Digital Elevation Model (DEM) derived out CTX stereo pairs were the other major tools used in this study. DEM is created using MarsSI web interface [4]. CTX image mosaic is used for identifying and mapping the morphological features and land forms of the study region.

Results and Observation: The sedimentary deposits of this region were previously reported as Amazonian smooth floor material (Avfs) [5]. There exist remnants of a major glacial tongue in the western Eos Chaos trough. A well-developed moraine surrounding the remnants of tongue shaped flow feature is a strong indication for glacial origin. The escarpment near the alcove of the glacial tongue consists of fine dark and light toned layers. The small viscous flows originating from these layers are interpreted as nascent stage of the glacial flow. An active flow, which can be defined as juvenile stage, with lobate terminal was also identified. Brain terrain [6], Lineated Valley Fill (LVF) [7] and pit cum knob structures [8] (Figure 2) in close proximity to the flow features also indicate the glacial origin of the flow features.

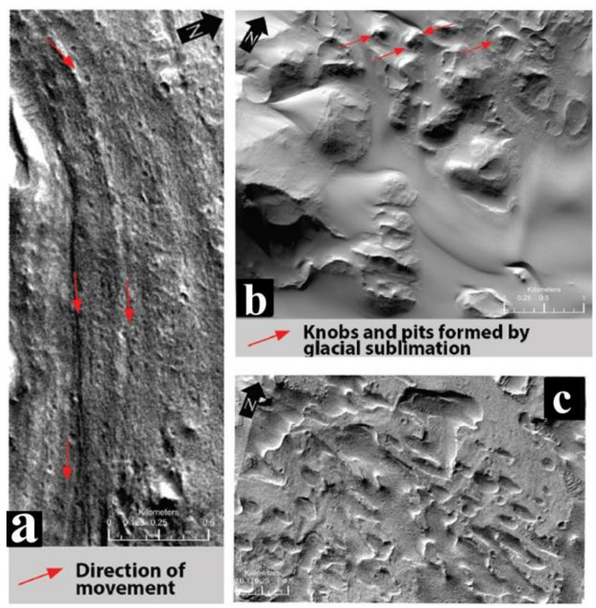

Figure 2. (a) Lineated Valley Fill (LVF) features identified from the study area. (b) Pit cum Knob structure implying glacial processes. (c) Brain terrain indicating subsurface sublimation of icy objects.

Channels of probable fluvial origin are also present in the study area. We observed small scale fault movements here and some of the channels were diverted by tectonic processes. This is an indication of past stream piracy on Mars. Various minerals indicating past aqueous processes are identified from the study area by analysing the CRISM hyper-spectral data from Eos Chaos region. Presence of a hydrous mineral zoisite, which indicates low-grade metamorphic processes was also reported [9].

The nascent lobate flows originates from the fine light toned layers of the Eos Chaos trough wall. The flow gradually develops to a juvenile stage. Most of the icy objects in the flow features do sublimate as the flow reaches a mature stage. A well developed moraine is left and preserved well. All the three stages of development of glacial flow have been identified from this region (Figure 3).

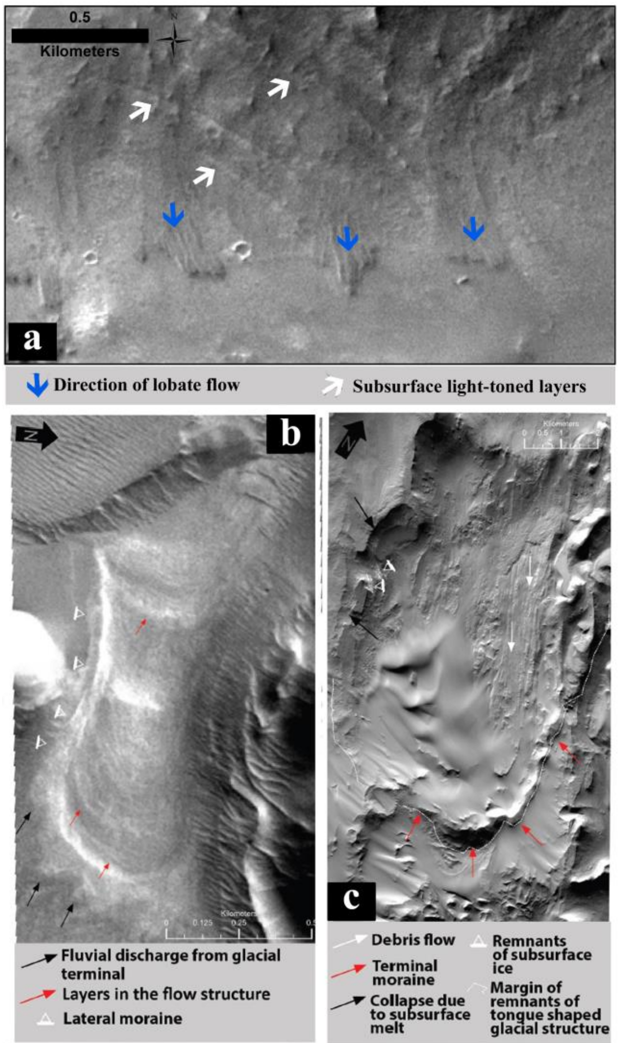

Figure 3. (a) Nascent flows originating from light toned layers of the trough wall. (b) A juvenile viscous flow observed on the study region. (c) A tongue shaped glacial skeleton with a well-developed moraine.

Conclusion: The origin of the ice in the subsurface environment may be from the past rain fall of Mars during the Noachian and Early Hesperian period [10]. With the gradual loss of atmosphere, the aquifers formed from the penetrated water must have solidified into ice. When exposed to the outer surface, after the tectonic rifting and formation of Valles Marineris, viscous flow of glaciers triggered. The existence of ice on present Martian surface is impossible as the exposed ice sublimates [11]. This instability causes the formation of tongue shaped skeletal structures with surrounding moraine. Remaining ice fragments, which were separated from the major flow feature, are covered by dust before complete melting and evaporation causes the formation of pit cum knob structure. The active glacial process hints an unknown volume of ice deposits beneath the surface, near to the Eos chaos region.

Apart from the landforms indicating past and recent glacial activity a number of morphological features which indicate aqueous processes are also identified from the study area. Water that carved channels on the trough wall and the water which caused the formation of glacial features of the region, probably have same origin.

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