A COMPREHENSIVE STUDY ON CRUSTAL DICHOTOMY AND EXTENSIONAL TECTONICS IN AND AROUND VALLESMARINERIS, MARS

ISRO Project : ISRO/SSPO/MOM-AO/2016-17, 8th August 2016

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Introduction

- The Martian morphology is unique with several extreme topographical features including large volcanic provinces, long trough systems, impact craters, and ridge like structures that are unique among the entire solar system.
- Various theories for origin of Valles Marineris (regarded as longest and deepest system of canyons in the Solar System) (Figure 1) have been proposed which includes tectonic rifting of Martian surface.
- The present study focuses on the characterization of the lithospheric dichotomy as well as the extensional tectonics in and around Valles Marineris on Mars through a comprehensive approach by using high-resolution geophysical and geological data sets and associated models.

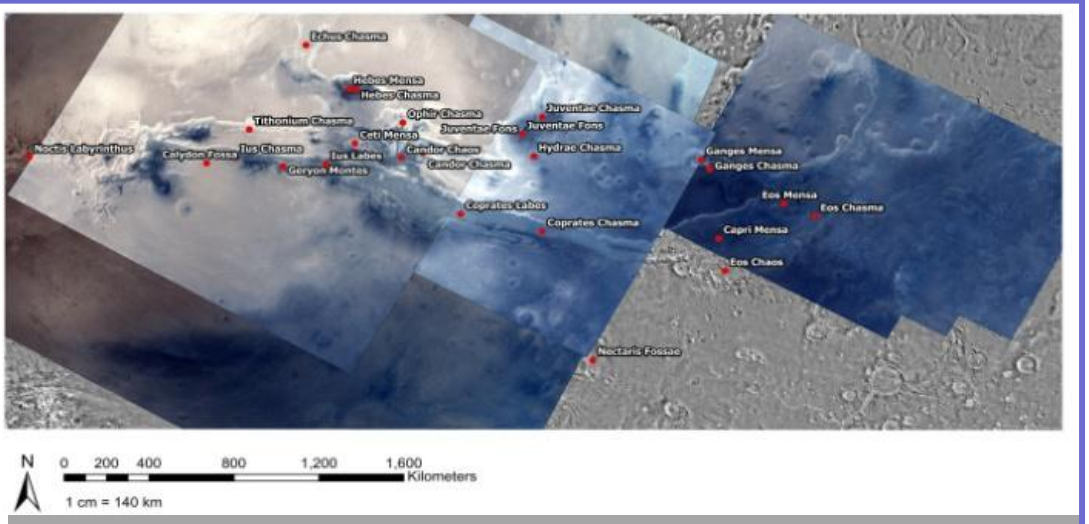

Figure 2:MCC-Viking mosaic showing corridors Valles Marineris selected for this study

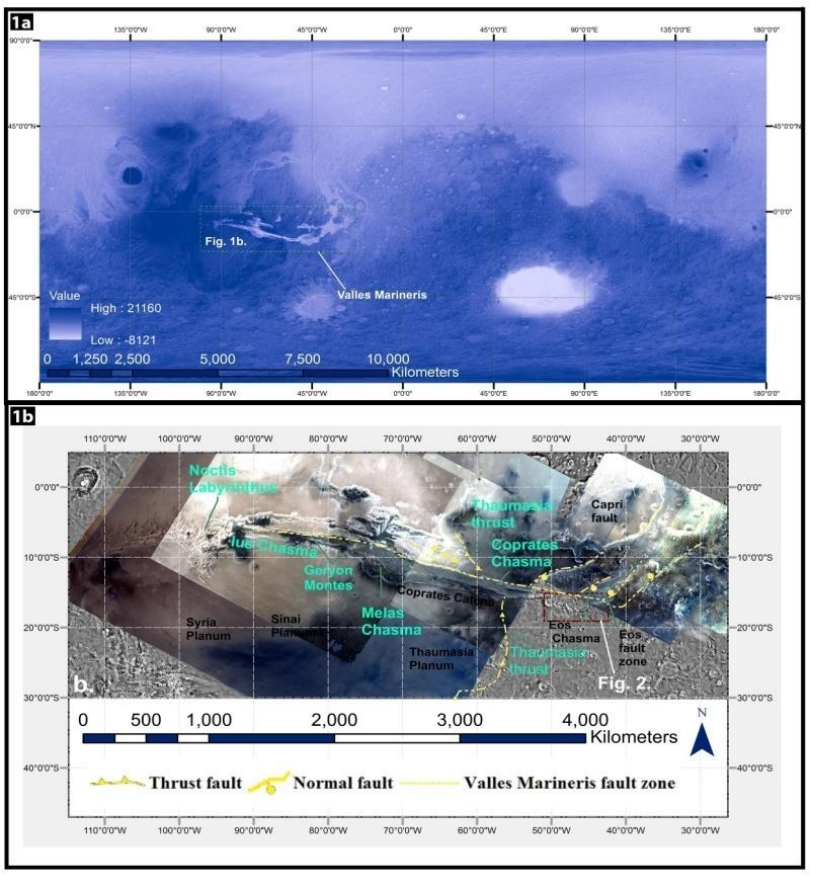

Figure 1:(a)Topographic image of Martian surface prepared from Mars Orbital Laser Altimeter (MOLA) of the Mars Global Surveyor (MGS). Valles Marineris Has been marked within the image. (b) Tectonic features descovered (Anyin 2012) are marked on the Minnaert topographically corrected (Misra et al., 2015)MCC-Viking mossaic.

Major objectives

- To understand the morphology and spectral features of different rocks and minerals over selected corridors of Valles Marineris using various data sets such as Mars Color Camera (MCC) on board ISRO's Mars Orbiter Mission (MOM 1), Context Camera (CTX), High Resolution Imaging Science Experiment (HiRISE) and Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) aboard NASA's MRO mission.
- To investigate the various tectonic and other geological activities operated over the selected corridors of Valles Marineris.

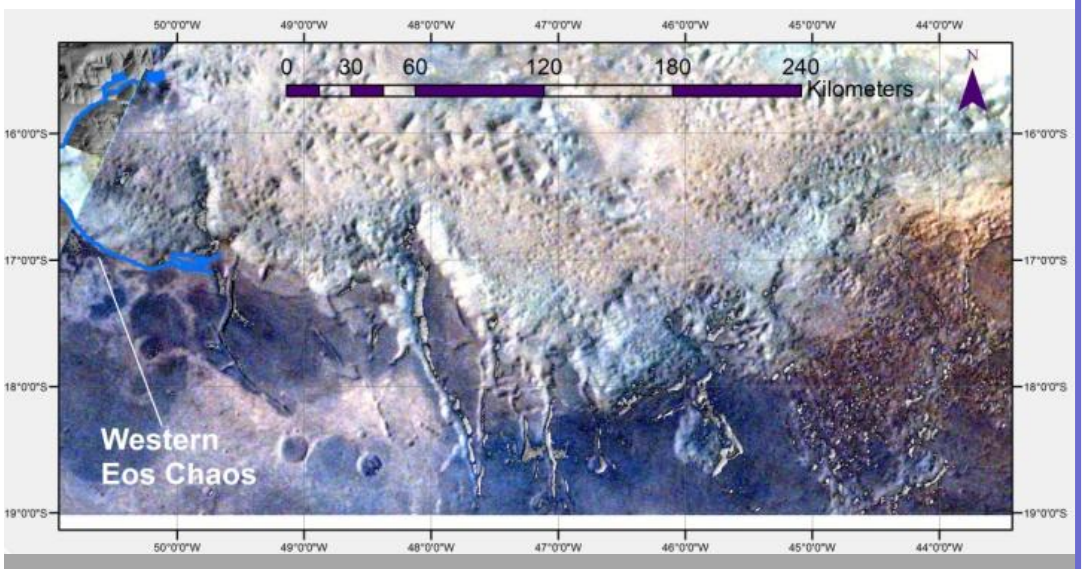

Figure 3:Structural and geological processes operated over the western Eos chaos has been studied in detail. This figure represents MCC-CTX mosaic of the study area.

Works done so far

- All the MCC images over Valles Marineris have been downloaded
- The tectonic features identified so far have been marked in the MCC-Viking image created.
- Various corridors of Valles Marineris have been selected for the study and marked in the MCC-Viking mosaic.
- Mosaic of Eos Chaos using CTX imageries has been created.
- The features identified have been mapped using Arc GIS 10.1
- CRISM hyperspectral (TRDR) data has been processed using CRISM Analysis Tool 7.2.1 extension of ENVI software.
- CRISM summary parameters and browse products (Viviano beck et al., 2014) have been used to understand compositional variations on the surface.
- Spectra collected from the area were matched with CRISM library spectra.

Results

- Various morphological features were identified on western Eos Chaos region.
- The morphology of the area indicates evidences for past aqueous, glacial and tectonic activities prevailed over Western Eos chaos trough system
- Evidences for present glacial activities have also been identified.

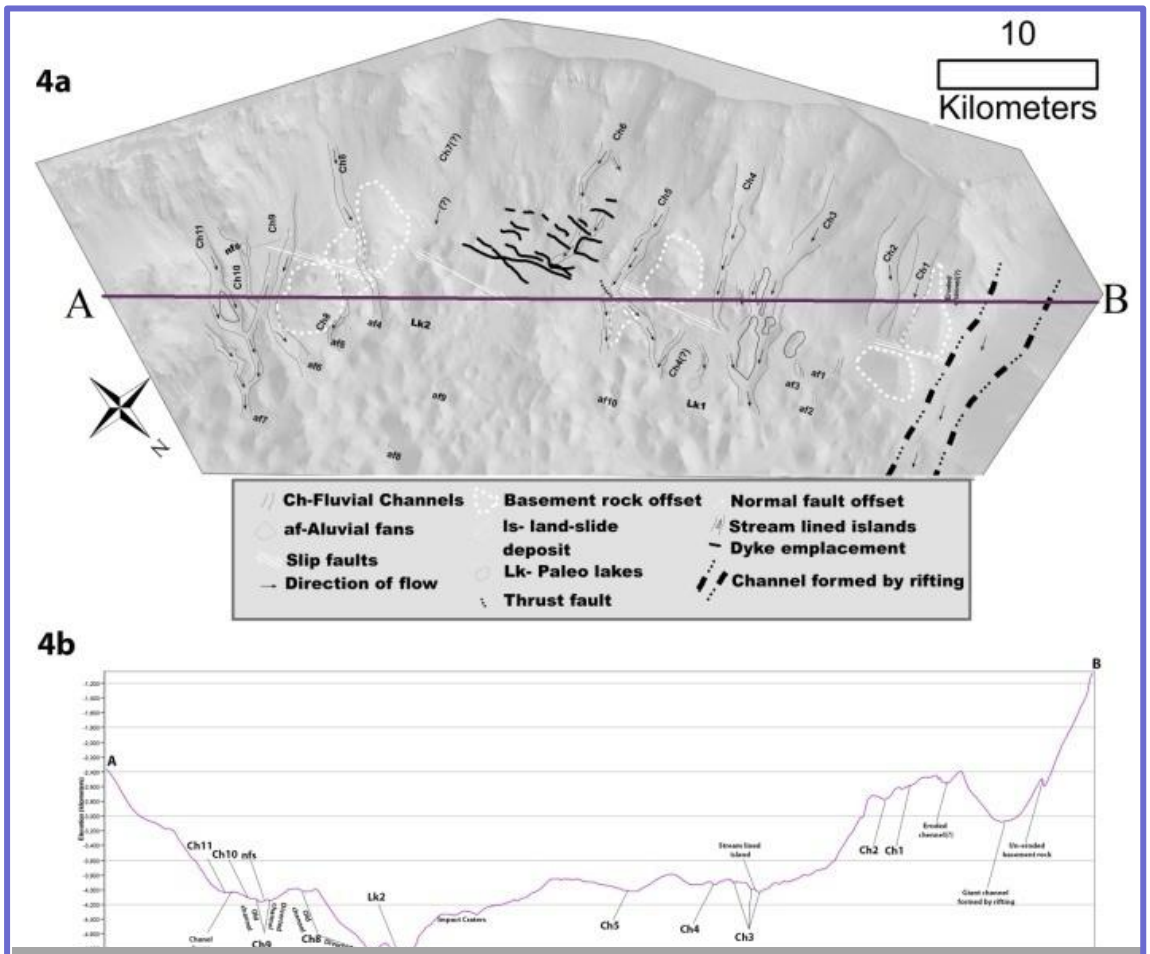

Figure 4:. (a) A map of fluvial features of south west part of the study area(Western Eos chaos) . Dykes and tectonic movements of the area which affected fluvial features have been marked. (b) A vertical profile of line AB of figure 4a. Various features have been marked.

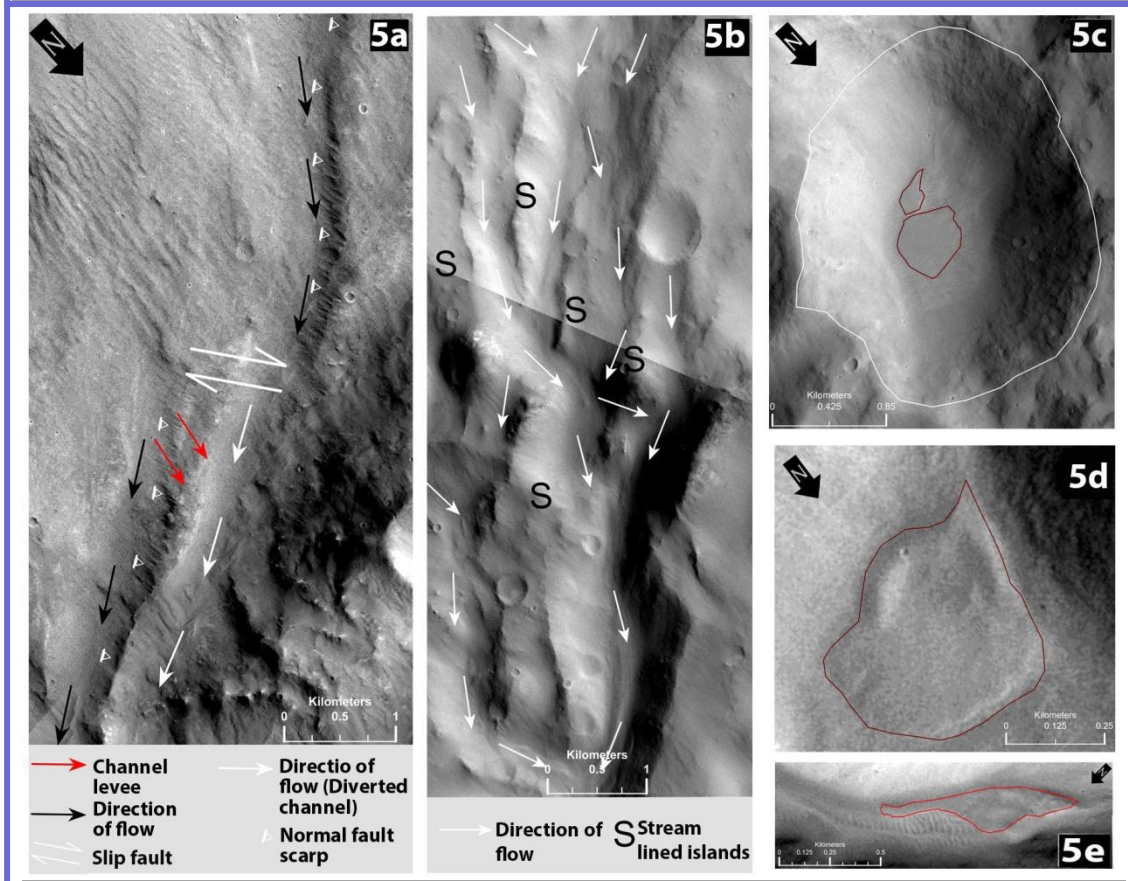

Figure 5: (a) Diverted channel and abandoned channel formed near normal fault scarp. Vertex of white triangles points the normal fault scarp. The normal fault scarp is offset by the slip fault movement. The channel was affected by the slip fault and resulted a new path of flow .White arrows show the direction of aqueous flow just before the fluvial activity ceased. The black arrows point the direction of flow through the channel before the slip fault occurred. The red arrows show the levee formed between the channels. The fan shaped (Figure 4b) deposits that can be seen at the mouth of both channel shed light to fluvial nature of the channels (b)Tributaries of channel (Ch3) and stream lined islands formed by them. Braided appearance of the channel can be noticed. White arrows points the direction of flow and letter's' represent streamlined islands. (c) A possible paleo lake. (d &e) Fan shaped deposit formed at the mouth of channels.

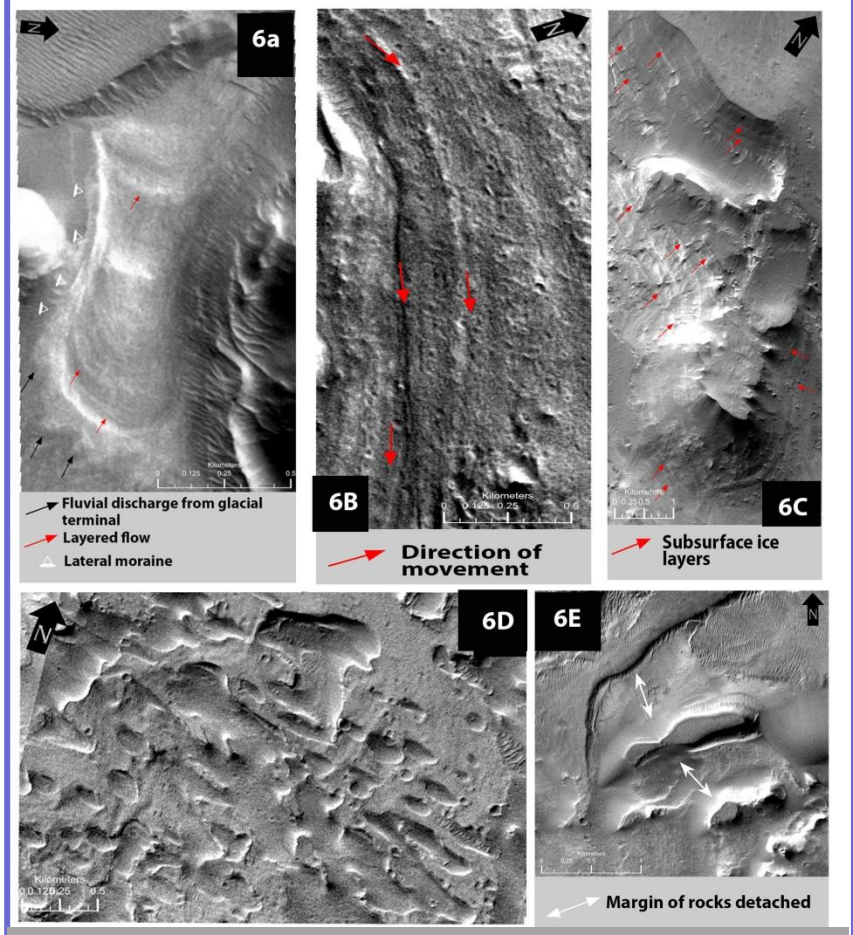

Figure 6: (a) A recent layered glacial flow. Some of the layers have been marked using red arrow. Black arrows indicate fluvial discharge from the glacial terminal. Vertex of the white triangle points lateral moraine. (b) Lineation on the surface formed by rock glacier movement. Direction of movement is shown using red arrows. (c) Distinct layering of the wall of western Eos chaos. Nature of layering is different from the other area of trough wall. Light toned layer may be subsurface ice material. (d) Surface of Western Eos chaos altered by subsurface glacial sublimation. (e) Double headed arrows point the margin of rock fragments formed by the collapse occurred after subsurface glacial melting. Light toned material present below the rock fragments may be remnants of ice.

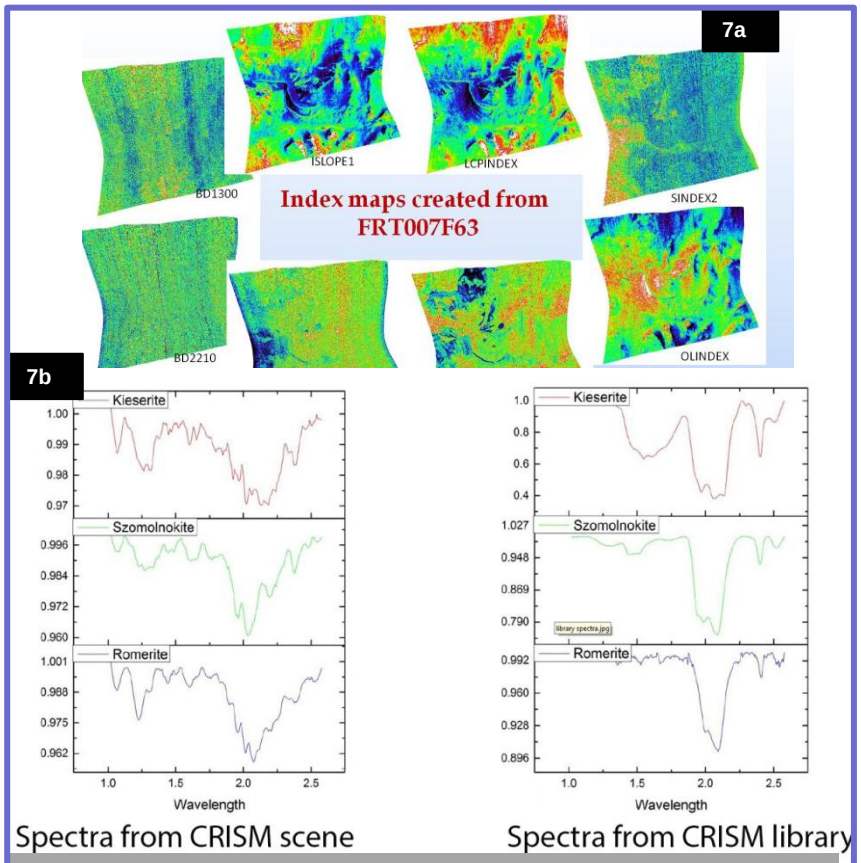

Figure 7. (a) Index maps used to understand spectral variation on surface.(b) Some of the hydrated sulfates identified from western Eos chaos

Publications

1. *Asif Iqbal Kakkassery, V. J. Rajesh-* ***Western Eos chaos on Mars: a potential site for future landing and returning samples****., 2nd International Mars Sample Return 2018 (LPI Contrib. No. 2071)*
2. *Asif Iqbal Kakkassery, V. J. Rajesh-* ***Detection of zoisite from Eos chaos – implication for hydrothermal alteration on mars.****, 49th Lunar and Planetary Science Conference 2018 (LPI Contrib. No. 2083)*
3. *Asif Iqbal Kakkassery, V. J. Rajesh-****Mineralogy and morphology of Eos chaos region in eastern Valles Marineris, Mars: implications for diverse geological processes****, space studies of the earth-moon system, planets, and small bodies of the solar system (b) mars science results (b4.1), 42nd cospar scientific assembly 2018.*
4. *Asif Iqbal Kakkassery, V. J. Rajesh-****Mineralogical and structural characteristics of Eos Chaos on Valles Marineris, Mars: Implications for aqueous and hydrothermal processes,*** *UGC SAP DRSII, Shear Zones and Crustal Blocks of southern India conference. University of Kerala, Thiruvananthapuram*
5. *Asif Iqbal Kakkassery, V.J. Rajesh-****Spectral and morphological mapping of western Eos chaos, Valles Marineris: implications for aqueous Processes on Mars*** *at 30th Kerala Science Congress ,Government Brennen college, Thalassery.*
6. *Presented a poster titled* ***A Study on Mineral Assemblages and Geomorphology of Eos Chaos Region of Valles Marineris, Mars*** *at the Brain Storming Session on Vision & Explorations for Planetary Sciences in Decades 2020-2060, organized by Physical Research Laboratory, Ahmedabad'.*