MINERALOGICAL ANALYSIS OF HESPARIAN-AGED REGIONS OF IUS CHASMA, MELAS CHASMA AND CAPRI CHASMA OF VALLES MARINERIS. Adnan Ahmad[1] , Himanshu Chaudhary[1] and Archana M. Nair[1*], [1]Earth System Science and Engineering Division, Department of Civil Engineering, Indian Institute of Technology Guwahati, Assam, India (*e-mail: nair.archana@iitg.ac.in).

Introduction: Valles Marineris is located in the western hemisphere of Mars, which is 4000 Km long and 7 Km deep (Fig 1). Valles Marineris comprises many Chasmata with 7 interconnected Chasmata (Ius Chasma, Melas Chasma, Copartes Chasma, Capri Chasma, Ophir Chasma, Candor Chasma, Eos Chasma), 1 closed Chasma (Hebes Chasma), 2 directly opens up to the Northern Martian plains (Echus Chasma and Juventae Chasma) and 2 are connected to others from the east by chaotic terrains (Ganges Chasma) and via west from Noctis Labyrinthus (Tithonium Chasma) [1,2].

Valles Marineris may have been formed during the early to late Hesperian period following the accumulation of the thick lavas and other multiple processes likely led to its current geometry [3]. The Chasma is characterised by large Interior Layer Deposits (ILD) and uneven terrain [4]. [5] also observed a significant number of gullies on the canyon walls, created by the escape of water or ice through the wall rocks.

Several researchers have studied the secondary mineralogy of the various Chasmata of the Valles Marineris [1,4,5]. In this particular study, we carried out a comparative study based on mineralogical analysis across the Hesperian aged region of three Chasmata that are connected, namely Ius Chasma, Melas Chasma and Capri Chasma.

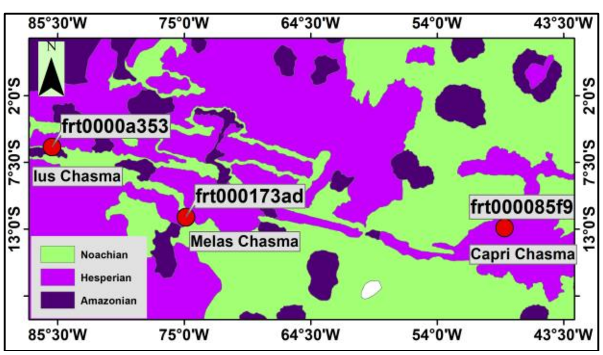


Figure 1 Geologic time scale of Valles Marineris with marked CRISM images product Id and locations.

Methodology: Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) onboard MRO (Mars Reconnaissance Orbiter) dataset has been used to carry out the mineralogical analysis. CRISM datasets have a spectral resolution of 6.55 nm, which covers an EM range from 362 to 3920 nm. It acquired data with the spatial sampling of 18.4 m/pixel from 300 km altitude [6].

In the present study, the MTRDR product is used. It is derived from processing CRISM radiance at sensor datasets through a number of standard spatial, renderings, and spectral corrections. The summary product and browse product are obtained from the MTRDR product using MTRDR using CRISM Analysis Tools (CAT), which is available as a plugin to ENVI software [7]. Consequently, the spectra were extracted from the potential regions. Further, spectra are ratioed with spectrally flat spectra from the same detector column to enhance the absorption features and reduce noise in the spectra. The wavelength region beyond 3 µm is avoided due to overlapping reflectance and thermal emission from the surface, which reduces the signal-to-noise ratio and results in a loss of spectrum information.

Furthermore, the majority of the minerals that comprise rocks exhibit diagnostic absorption in the wavelength range of 0.5 to 2.6 µm [8,9]. Therefore, in this study 0.8–2.6 µm wavelength region has been used for the spectral characterisation. The extracted spectra were then matched with the MICA library reference spectra for mineral identification.

Results and Discussion: This study focuses on the mineralogical analysis of different regions in Valles Marineris (Ius, Melas, and Capri) of the Hesperian age. Several browse products, such as CHL, PHY, MAF, HYD, HYS, PFM, were used to study the spatial distribution of minerals. The results of these browse products show well-distributed mafic, hydrated as well as clay minerals over the study region (Fig. 2, 3 and 4).

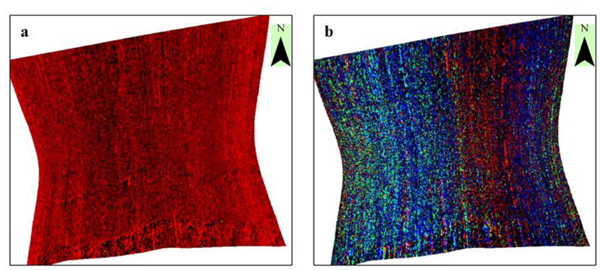


Figure 2 (a) MAF (b) PAL browse products of Hesperian-aged Ius Chasma.

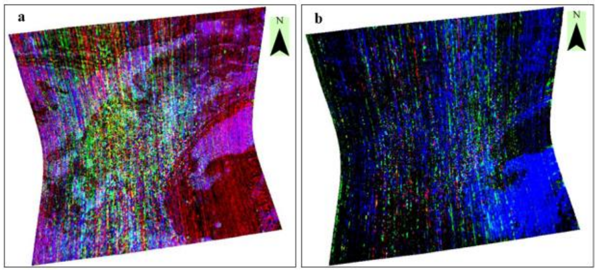


Figure 3 (a) MAF (b) PHY browse products of Hesperian-aged Melas Chasma.

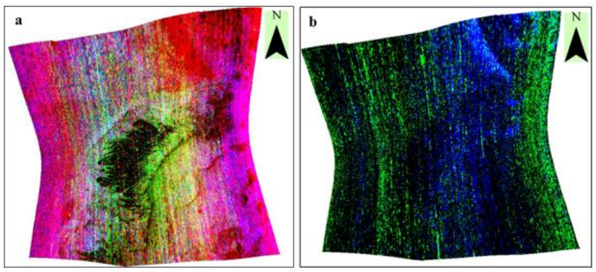
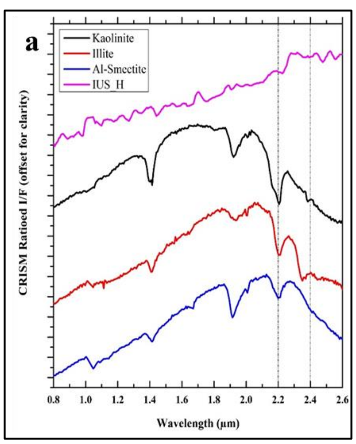
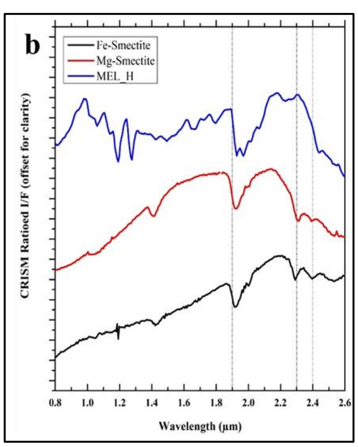


Figure 4 (a) MAF (b) PHY browse products of Hesperian-aged Capri Chasma.





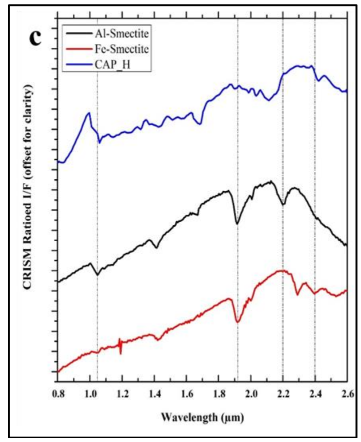


Figure 5 CRISM ratioed I/F target spectra plotted with reference to MICA library spectra for (a) Ius, (b) Melas and (c) Capri Chasmata region.

The Ius Chasma spectra exhibit absorption features near 1.9 µm and 2.2 µm, matched with Kaolinite, Al-Smectite and Illite minerals (Fig 5a). The Melas Chasma spectra exhibit absorption features near 1.9 µm and 2.3 µm, which matched with Fe-Smectite and Mg-Smectite (Fig. 5b). The Capri Chasma spectral absorption feature nearly matched with Al-Smectite and Fe-Smectite (Fig 5c).

Conclusions: We studied Hesperian-aged three different regions of Valles Marineris (namely Ius Chasma, Melas Chasma and Capri Chasma) using browse products and spectral analysis. Ius Chasma region shows the presence of clay minerals, i.e., Kaolinite, Al-Smectite and Illite. Melas Chasma shows the presence of Fe-Smectite and Mg-Smectite minerals, whereas the Capri Chasma shows the presence of Al-Smectite and Fe-smectite. The different clay minerals have been identified in these three Chasmata. Therefore, during their evolutionary phases, these Chasmata may have been subjected to various processes such as weathering or hydrothermal activity. Moreover, the presence of clay and hydrated minerals indicates that water played a significant role in the formation of the Valles Marineris valley networks.

References:

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