**STUDY OF PHYLLOSILICATES AND CARBONATES FROM THE CAPRI CHASMA REGION OF VALLES MARINERIS ON MARS BASED ON MARS RECONNAISSANCE ORBITER-COMPACT RECONNAISSANCE IMAGING SPECTROMETER FOR MARS (MRO-CRISM) OBSERVATIONS.** N. Jain*, S. Bhattacharya, P. Chauhan, and Ajai, Space Applications Centre (ISRO), Ahmedabad, Gujarat, India (nirmala@sac.isro.gov.in/ Fax: +91-079-26915825).

**Introduction:** Phyllosilicates and Carbonates are the minerals which explain about presence of neutral to alkaline environment of planet Mars in its past. The Capri Chasma canyon is situated at the outlet [1] of Valles Marineris. As it is low lying area, the chances of presence of liquid water is there in the form of lake or river in Martian past. Such area is mainly important for the formation of aqueous minerals by alteration processes. Therefore it is the most promising region for the study of aqueous minerals such as carbonates and phyllosilicates on Mars. Carbonates require water in their process of formation [2]. In order to understand the Martian environment it is essential to know the formation processes of carbonates. Phyllosilicates are the altered product of volcanic material [3]. In the present study the absorption features of phyllosilicates (illite) and carbonates (ankerite and manganocalcite) have been obtained. Therefore, the occurrences of these minerals at the Capri Chasma on Mars provide a strong evidence of its past watery environment.

**Datasets and methodology:** MRO CRISM reflectance data from visible to near infrared region has been used for the study of Martian minerals. For regional geological and geomorphological interpretation, CTX images along with the CRISM data have been used.
Various processing methods were applied to the CRISM data including: Ratio of spectral rich pixels and flat pixels has been taken to enhance the spectral signature of minerals. Spectral Analyst technique in which unknown spectra of the minerals from the study area on Mars were compared with the known spectra of minerals from the standard CRISM spectral library.

**Observed geomorphology at the Study Area:** This area shows the Interior Layer Deposits (ILDs) at the plateau area, mass wasting within these layer deposits, dust cover at most of the places. The study area also shows the chaotic terrain and impression of impact crater. The chaotic terrain indicates that a large amount of fluid flowed through the region, which probably was water. Therefore it is assumed that the exposures of the ILDs found in this region may be caused by these massive fluid flows or by impact crater.

**Observed mineralogy at the Study Area:** Promising origin of sulfates has been reported by [1] by using CRISM hyperspectral data in their previous study. We have used other CRISM hyperspectral images from previous study [1] for the analysis of phyllosilicate and carbonates deposits in Capri Chasma. In the present study the rocks in study area are enriched in deposits of phyllosilicate (illite) and carbonates (ankerite and manganocalcite). These minerals are found at many locations at ILDs of the plateau and at the top of the plateau. Olivine is found to occur along with phyllosilicate (illite) and carbonates (ankerite, manganocalcite).

**Results:** Aqueous minerals from Capri Chasma region on Mars have been examined using the hyperspectral data acquired by CRISM within 1.0 µm to 2.6 µm wavelength range with high spatial resolution (18m/pixel). The minerals such as phyllosilicates (illite) and carbonates (ankerite and manganocalcite) are observed.

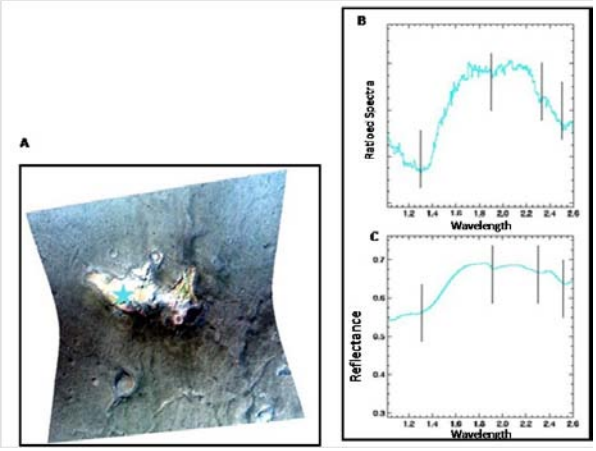


Figure 1: A- FRT0000C114_07 shows location of ankeirte (cyan) B- Spectral signature of ankerite (cyan) from Capri Chasma C- Spectral signature of ANKERITE LACB01B (cyan) from CRISM spectral library.

Figure 1 A Shows location of ankerite (carbonate) on CRISM image FRT0000C114 (cyan in colour). Figure 1 B is the ratio spectrum which shows absorption features of ankerite at 1.93 µm, 2.33 µm and 2.52 µm on plateau area. Presence of 1.35 µm band gives hint towards the mixture of phyllosilicate deposits in above spectra. Figure 1 C shows the spectra of ANKERITE LACB01B from CRISM library spectra. On Earth ankerite [(Ca(MgFe)(CO3)2)] is iron-rich carbonate mineral generally associated with iron ores. Therefore the spectroscopic study of this mineral will help to understand its formation process on Mars.

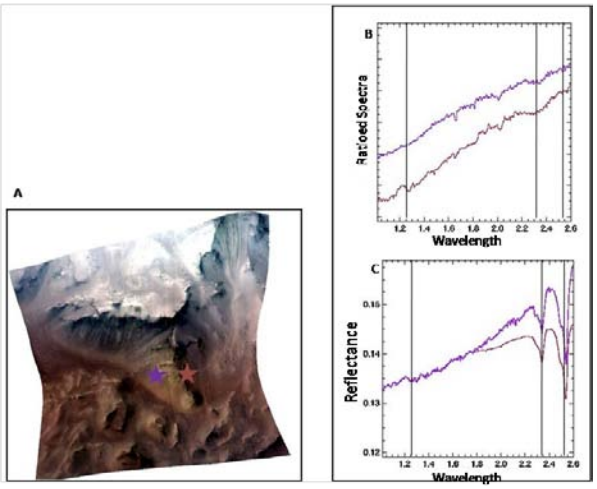


Figure 2: A- FRT00008112 shows locations of manganocalcitee (purple and maroon) B- Spectral signatures of manganocalcitee from Capri Chasma C- Spectral signatures of MANGANOCALCITEE LACB13B (maroon) and MANGANOCALCITEE CBCB13 (purple) from CRISM spectral library.

Figure 2 A and B show the spectral signatures of manganocalcite (carbonate), purple and maroon in colour on CRISM image FRT00008112 and ratio spectras of similar mineral respectively. Figure 2 C shows the spectral signature of manganocalcite from CRISM spectral library (MANGANOCALCITE LACB13B and MANGANOCALCITE LACB13B). Spectral signatures at 1.14 µm, 2.33 µm and 2.54 µm are found in spectra which are in purple colour and are important absorption bands in manganocalcite whereas absorption feature at 2.31 µm is found in other spectra which shows possibility of mixture of phyllosilicate with carbonate. Mangnocalcite ((Ca,Mn)CO3) is a pink calcite occurring in metamorphic rocks on Earth

Figure 3 A shows the location of illite (Coral in colour) and ankerite (Aquamarine in colour) on CRISM FRT0000A0F0.

Figure 3 B and C shows ratio spectra of both the minerals and spectral signature of similar minerals form CRISM spectral library (ILLITE LAIL01 and ANKERITE CACB01) respectively. Spectra of illite shows absorption band at 1.41 µm, 1.82 µm, 2.21 µm and 2.35 µm whereas the absorption band at 2.52 µm shows the mixture of serpentine or hydrated silica .

The absorption band at 2.23 µm, 2.33 µm and 2.52 µm are also found in spectra of ankerite in the study area. Absorption band at 1.35 µm indicates possible mixture of phyllosilicates with spectral signature of ankerite.

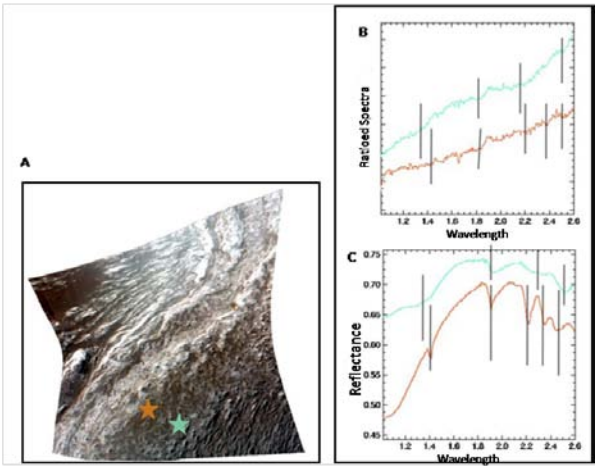


Figure 3: A- FRT0000A0F0 shows locations of ankerite (coral) and illite (aquamarine) B- Spectral signatures of ankerite (coral) and illite (aquamarine) from Capri Chasma C- Spectral signatures of ILLITE LAIL01 (coral) and ANKERITE CACB01 (aquamarine) from CRISM spectral library.

**Conclusions:** The hyperspectral imager CRISM on the MRO spacecraft played a significant role in understanding the mineralogy of the surface of planet Mars with its high spectral and spatial resolution quality. Spectroscopic study of Capri Chasma area within Valles Marineris confirms the presence of phyllosilicates and carbonates. With the help of these minerals we conclude that: 1) the presence of these aqueous minerals implies that water played an important role during their formation period, 2) the study area mainly shows geomorphological features such as plateau, impact crater and layer deposits. The presence of carbonates at top of plateau area and at the outcrop of layer deposits shows that carbonates could have been formed at the time of weathering of the plateau area in the presence of large amount of water, 3) similarly deposits of phyllosilicates are also found at outcrop of layer deposits of plateau area. Presence of these alkaline minerals makes Capri Chasma as promising region for the study of aqueous minerals for future studies.

**References:** [1] Flahaut J. et al. 2010, Icarus 207, 175–185. [2] Ralph et al. 2006. [3] Nancy et al. 2009, Journal of Geophysical Research, 114, Vol. 114, E00D10, doi: 10.1029/2008JE003301.