**Geology and Mineralogy of the Interior Layered Deposits in Capri/Eos Chasma (Mars), based on CRISM and HiRiSE data.** J. Flahaut, C. Quantin and P. Allemand, Laboratoire des Sciences de la Terre, UMR CNRS 5570, Université Claude Bernard/Ecole Normale Supérieure de Lyon, 2 rue Raphaël Dubois, 696222 Villeurbanne Cedex, France. Jessica.flahaut@ens-lyon.fr; cathy.quantin@univ-lyon1.fr.

**Introduction**: Sulfates have been discovered by the Spectral Imager OMEGA, on board of Mars Express, at different locations on the planet Mars [1] . They are abundant in the Valles Marineris area, near the northern cap in Utopia Planitia and locally in plains as Terra Meridiani. They are strongly correlated to light-toned layered deposits in the equatorial area [1] . Capri Chasma, a small canyon located at the outlet of Valles Marineris, exhibits such deposits called Interior Layered Deposits (ILD). ILD were first observed on Mariner 9 images in 1971; they have been described as kilometers-thick deposits in the middle of Valles Marineris chasmata [2]. Even if they have been known for long, their morphology is not very well-constrained, and their origin and age is still unknown [3]. We present here a fine analysis of the ILD morphologies with HiRiSE pictures, and a fine scale mineralogical study obtained from CRISM data.

**Regional context:** Capri Chasma is located at the outlet of Valles Marineris, in the continuation of Coprates Chasma, and at the head theater of the outflow channels that are spreading over at the east, like Eos Chasma. This canyon extends over 650 by 350 km, the floor has an average elevation of -4000 m, and the surrounding plateaus are above +2000 m. ILD in Capri Chasma are mainly located in the center of the canyon where they formed 3 mesas of variable sizes. Their thickness is close to 3 km what gives them an altitude comparable to half the plateaus one. One of the major interest of Capri Chasma is that we observed the layered deposits associated with typical morphologies of outflow channels like catastrophic flow features and chaotic floors [4].

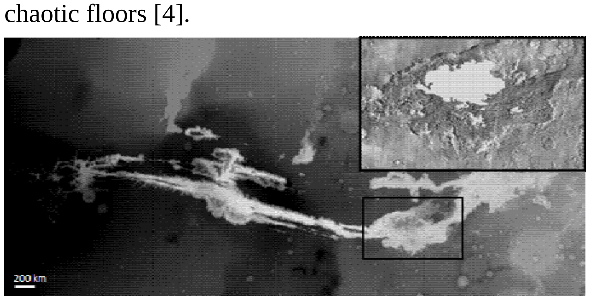


*Figure 1 :a- localisation of Capri Chasma (black box) on a topographic map of Valles Marineris (MOLA data). b- Zoom on Capri Chasma (Mosaic THEMIS_IR Day). Outline of the ILD have been mapped in gray with a GIS tool (Arcmap 9.1).*

**Datasets**: A Geographic Information System (GIS) was built to gather data from different Martian missions. Themis Visible and Infrared day and night data from the Mars Odyssey Spacecraft were used, in association with the MOC (Mars Orbiter Camera) data from the Mars Global Surveyor mission, and the HiRiSE (High Resolution Imaging Science Experiment) and CTX (Context Camera) data from the Mars Reconnaissance Orbiter mission. MOLA laser altimetry map of 300m per pixel was added to this image collection, providing topographic data. This whole combination of images offers a full spatial-coverage of the canyon. Hyperspectral and multispectral data from CRISM (The Compact Reconnaissance Imaging Spectrometer for Mars) on board of Mars Reconnaissance Orbiter were used to determine mineralogical composition. CRISM is provinding images at 544 different wavelengths (at 6,55 µm/channel) between 0,362 and 3,92 µm in hyperspectral mode, against 72 wavelengths in mulispectral mode. Spatial resolution are ranging from 18 to 40 m per pixel for hyperspectral data to 100 to 200m per pixel for multispectral ones. All the data have been corrected for atmospheric contribution and georeferenced . The atmosphere is removed using a ratio with a CRISM scene of Olympus Mons, scaled to the same column density of $CO_2$ as in [5, 6]. We processed mineralogical maps from atmospheric corrected CRISM data that we then projected over HiRiSE data.

**Morphological analysis:** ILD in Capri Chasma are formed of 3 mesas of 370*170, 60*50 and 60*20km. 3D models were built in Capri Chasma showing that the ILD are overlapping the chaotic floor. Flanks of the ILD show thick outcrops of massive light-toned material, while their flat top is covered with a dark thin capping layer. The outcrops of light-toned material were finely mapped at HiRiSE scale. They are mainly observed in the northern part of the main mesa. They form massive bright outcrops with a alveolus facies at full spatial resolution. Stratification is not obvious but may be visible in some location, as inside some small craters affecting the top of the ILD. One major impact crater, 30km wide, is digging into the major mesa (figure 2). The crater exposes lower albedo material in its bottom, stratigraphically under the light-toned outcrops. This lower albedo material exposes thinner layers. It seems made of coaser grains at high resolution, it also shows faulting. These low-albedo deposits have been observed in a few others locations in the canyon, always at lower elevation than the light-toned ones.

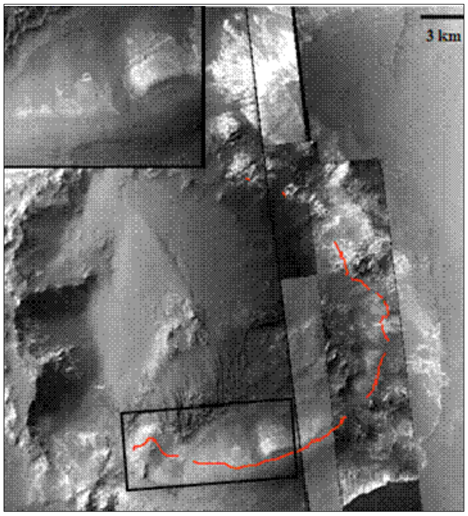


*Figure 2 :a- CTX and HiRiSE mosaic of the major impact crater showing lower albedo deposits below the light-toned deposits in the ILD. b- Zoom on layered, fractured, coarsed-grains, low-albedo material.*

**Spectral analysis:** 27 CRISM hyperspectral data are available in Capri Chasma. Among them only 13 are targeted above the ILD material. On these 13 cubes, we detected a remarkable spectral type with absorption bands at 2,1 and 2,4 µm and sometimes a weaker band around 1,6 µm. The combinaison of these three absorption features is diagnostic of monohydrated sulfates [1,7] . It is especially the shift of the bound water vibration from 1.9 to 2.1µm that is caracterizing the presence of a single water molecula in the sulfate structure [1].

The monohydrated sulfate signature is always associated with the light-toned material described previously. Most of the detections lie within the ILD mesa outcrops and one is located in the south west wall of Capri chasma, far from the ILD mesas. The counterpart material is light-toned but doesn't appear to form the bulk component of the wall and would be more surficial patches.

North of the ILD, spectra show a decrease around 1 µm that could indicate a mixing with ferric oxides, what OMEGA already observed in this part of the canyon [8].

We also used multispectral data to analyse accurate part of the spectrum. These data cover almost 60% of the canyon. We detected absorption features at 1,9 µm that we didn't detected on hyperspectral CRISM data. The 1.9 band is strongly spatially correlated to the mapping of the 2,4 µm band in several locations. The 1,9 and 2,4 absorption bands are diagnostic of polyhydrated sulfates [1,7].

The polyhydrated signatures are correlated to disctinct morphologies than the monohydrated ones. For the major impact crater, the bottom material has 1,9 and 2,4 µm absorption band, while the top material has strong 2,1 and 2,4 µm absorption bands .

**Conclusion:** Spectral data from CRISM reveal the presence of both monohydrated and polyhydrated sulfates in abundance in Capri Chasma. Comparison with HiRiSE data show that monohydrated sulfates are detected over massive bright outcrops of layered material. They seem to form the bulk component of the ILD. A underlying layer, with a lower albedo and coarser grains is observed in some locations, as the bottom layers exposed in the major impact crater emplaced on ILD. Its diagnostic absorption bands at 1,9 and 2,4 µm indicate that it is probably layers containing polyhydrated sulfates. The capping layer of the layered deposits does not have any diagnostic absorption band. These roughly-flat spectra could be explained by dust coverage. These results confirm the OMEGA discoveries with a higher spatial resolution, and add new localisations of sulfates in Capri Chasma. A plausible history for the spectral signatures and the morphologies is under construction, and ongoing results should be added to these preliminary conclusions at time conference [9].

**References:** [1] Gendrin A. & al. (2005) *Science*, 1587-1591. [2] Nedell S. S. & al. (1987) *Icarus*, 409-441. [3] Weitz C. & al. (2003) *JGR,* ROV 23-1/23-15. [4] Harrison K. P. & Chapman M. G. (2008) *Icarus*, 351-364. [5] Pelkey S. & al. (2007) *JGR*, 112, E08S14. [6] Mustard J. F. & al. (2008) *Nature*, 305-309. [7] Bishop. J. & al. (2008) *LPSC*, 2334. [8] Bibring J. P. & al. (2007) *Science*, 1206-1210. [9] Flahaut J. & al, *In prep.*

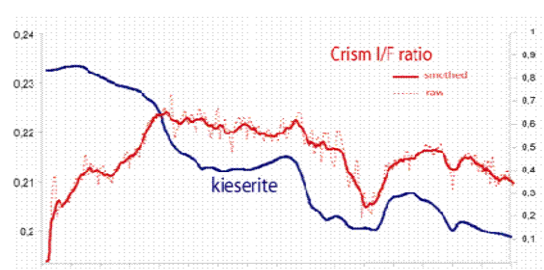


*Figure 3 : Red : spectrum acquired over light-toned depostis in Capri Capri, showing bands at 2,1 and 2,4 µm. Blue: spectrum of kieserite, a monohydrated sulfate, for comparison (from USGS spectral library).*