SULFATES, FERRIC OXIDES AND Al-OH BEARING MINERALS IN ARAM CHAOS: COMPARISON OF OMEGA AND CRISM DATA.

M. Massé[1], O. Bourgeois[1], S. Le Mouélic[1], L. Le Deit[1], C. Verpoorter[1], J.-Ph. Combe[2], C. Sotin[1,3], J.-P. Bibring[4], B. Gondet[4],Y. Langevin[4] and the OMEGA Team. [1]Laboratoire de Planétologie et Géodynamique, UMR 6112, CNRS, Université de Nantes, 2 chemin de la Houssinière, BP 92208, 44322 Nantes Cedex 3, France (marion.masse@univ-nantes.fr), [2] Bear Fight Center, Box 667, Winthrop WA 98862, USA, [3]Jet Propulsion Laboratory, M/S 183-303, 4800 Oak Grove Drive, Pasadena, CA 91109, USA, [4]Institut d'Astrophysique Spatiale, Bâtiment 121, 91405 Orsay Campus, France.

Introduction: Aram Chaos is a 280 km wide Martian crater centered at 2.5°N, 338.5°E. This depression is connected to the Ares Vallis outflow channel by a gorge 15 km wide and 2.5 km deep, which cuts across the eastern wall of the crater. Previous studies have shown that this crater is filled by chaotic terrains, overlain by a presently dome-shaped, layered, 900 m thick formation (*Figure 1*), displaying spectral signatures of ferric oxides and sulfates on TES and OMEGA data [1,2,3,4,5]. In a previous study [6,11], we described the mineralogical composition, the structure and the morphology of this crater fill using various kinds of data: OMEGA, MOLA, MOC, TES, THEMIS, CTX and HiRISE. The aim of the present work is to refine these results and to compare them with newly acquired, high resolution, hyperspectral data from the Mars Reconnaissance Orbiter Compact Reconnaissance Imaging Spectrometer for Mars (CRISM).

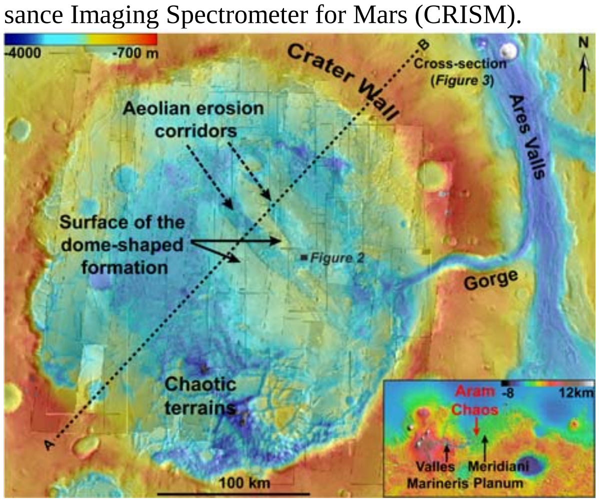

Figure 1: Morphological map of Aram Chaos (superimposition of a MOLA DTM on a mosaic of visible THEMIS images). The box indicates the location of Aram Chaos on a MOLA topographic map of Mars.

Methodology: The mineralogical composition of Aram Chaos was investigated from data acquired by the OMEGA imaging spectrometer, which collects 352 spectral channels from 0.38 to 5.2 µm at a spatial resolution ranging from 300 m to 4 km [7]. These data are compared with data from the CRISM imaging spectrometer, which collects 544 wavelengths from 0.36 to 3.9 µm at a spatial resolution ranging from 15 to 19 m/pixel [8]. We computed maps of various spectral parameters, which we integrated into a Geographic Information System (GIS) containing also high-resolution images from different instruments such as MOLA, MOC, THEMIS, CTX and HiRISE.

Sulfates and ferric oxides detected by OMEGA: Our previous study, based on OMEGA data, revealed that the floor of Aram Chaos is made of chaotic terrains, the composition of which remains unclear because they are covered by dust. A sulfate-rich formation, presently dome-shaped and layered, seems to have been emplaced unconformably on these chaotic terrains (*Figures 1 and 3*). The surface of this formation is partially covered by dust and displays wind erosion landforms (*Figure 3*). After its emplacement, this formation has been grooved down to various depths by large aeolian erosion corridors (*Figures 1 and 3*). On the floor of these corridors, strong spectral signatures of ferric oxides (possibly hematite and/or goethite and ferrihydrite and/or schwertmannite) are identified and correspond to large sheets of dark dunes. These dunes cover some outcrops of a bright, layered, cohesive material, which displays, in addition to ferric oxides, a monohydrated sulfate signature (kieserite or szomolnokite). The borders of the corridors are steep linear cliffs where the bright, layered, sulfate-rich material crops out (*Figure 3*). These cliffs are also partially covered by dark debris fans, which originate from the bright formation itself, and feed the dark sand sheets (*Figure 3*). We therefore infer that the dark ferric oxide sand sheets and debris fans are erosional products of the bright formation. However, due to the relatively low spatial resolution of OMEGA, it is not possible to analyse the exact composition of these cliffs.

Sulfates and ferric oxides confirmed by CRISM: New CRISM data on the dome-shaped formation are consistent with the results of our previous study. On the corridor floors, CRISM images display also a strong ferric oxide signature on the dark dunes, and a monohydrated sulfate signature that correlates well with the bright outcrops. According to the shape of the 2.4 µm band, CRISM data favour kieserite and therefore, enable us to discriminate between the two monohydrated sulfates suggested by OMEGA. Moreover, with the better resolution of CRISM images, it is possible to observe this mineralogy with both ferric oxides and sulfates, on the bright corridor cliffs.

Al-OH minerals (phyllosilicates?): On two CRISM cubes (FRT 7FA4 and HRL 646A), an additional absorption band centered at 2.23 µm is detected on some very localized areas of the corridor floors (*Figure 2*), in association with sulfate and ferric oxide signatures. Carefull re-examination of OMEGA data on these areas shows that this band is also present, but with a detection level very close to the noise level (*Figure 2c*). The detection of this feature on several OMEGA and CRISM cubes, exactly at the same locations (*Figure 2a and b*), confirms that this band is not an artifact but a real mineralogical signature. The comparison with high-resolution images shows that this spectral feature is always found at the base of the dome-shaped formation, at the boundary with the underlying chaotic terrains. Systematic investigation of this feature on OMEGA data, which have a wider spatial extent, confirms this stratigraphic position, on the whole Aram Chaos area *(Figure 3).*

The absorption band centered at 2.23 µm can be attributed to the presence of Al-OH or SiO [9]. However, the absorption band near 2.2 µm, due to the presence of SiO, is commonly wider than the 2.2 µm Aram Chaos absorption band. This new signature is therefore most probably correlated to Al-OH minerals.

The accurate mineralogical identification is still in progress but this signature could be attributed, for exemple, to an Al-OH phyllosilicate such as montmorillonite, as was suggested on Mawth Vallis [10].

Conclusion: CRISM data confirm the conclusions made with OMEGA data. The dome-shaped formation is composed of a bright, layered material, which contains both sulfates (kieserite) and ferric oxides. The erosion of these rocks induces ferric oxides accumulations in the form of dark dunes on topographic lows.

CRISM data allowed the detection of a new layer at the bottom of this dome-shaped formation (*Figure 3*). This layer contains an Al-OH mineral, which can possibly belong to the phyllosilicate family.

References: [1] Christensen P. R. et al. (2001) *JGR, 106*, 873-885. [2] Catling D. C. and Moore J. M. (2003) *Icarus, 144,* 21-26. [3] Glotch T. D. and Christensen P. R. (2005) *JGR, 110,* E09006. [4] Oosthoek et al. (2007) *LPSC XXXVIII,* Abstract #1577. [5] Noe Dobrea E.Z. et al. (2007) *Icarus*, *193*, 516-534. [6] Massé M. et al. (2008) *LPSC XXXIX,* Abstract #1391. [7] Bibring J.-P. et al. (2004) *Eur. Space Agency Spec. Publ. 1240*, *37*. [8] Murchie S. et al. (2007), *JGR*, *112*, E05S03, doi:10.1029/2006JE002682. [9] Hunt G.R. and Salisbury J.W. (1973), *Modern Geology*, vol.4, p. 85-106. [10] Loizeau et al. (2007), *JGR*, *112*, E08S08, doi :10.1029/2006JE002877. [11] Massé et al. (2008), *JGR*, accepted.

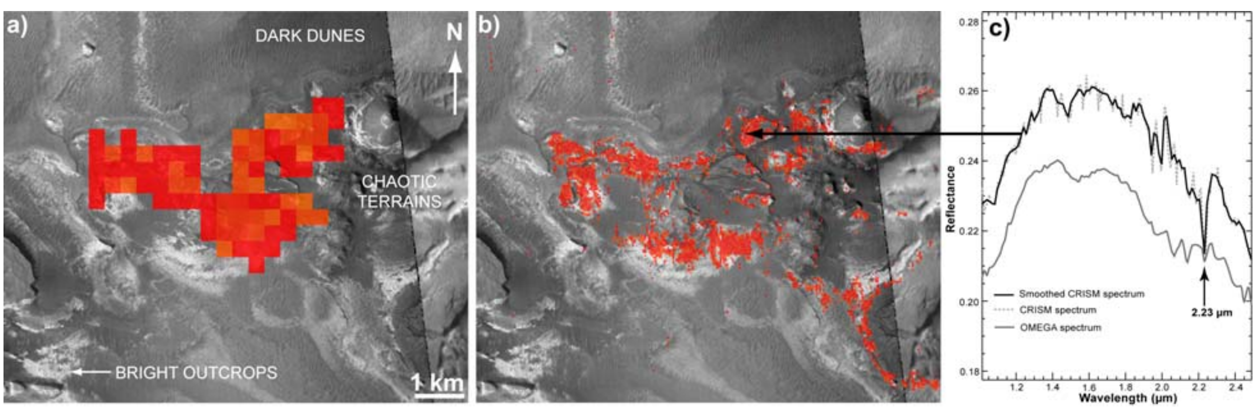

Figure 2: Map of a spectral criterion (location on Figure 1) corresponding to the 2.23 µm band depth computed on a) OMEGA data and b) CRISM data. This map is superimposed on a CTX image c) Comparison between an OMEGA and a CRISM spectrum acquired at the same place.

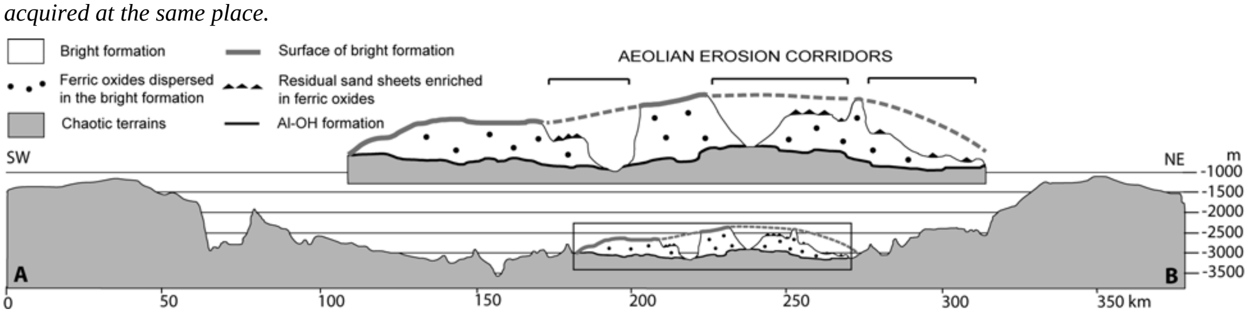

Figure 3: Interpretative cross-section of Aram Chaos (location on Figure 1), vertical exaggeration: x12.5.