SULFATES ON MARS LAYERED TERRAINS: OMEGA HIGH RESOLUTION CAMPAIGN CONFIRMS LOW RESOLUTION IDENTIFICATIONS. Aline Gendrin[1,2], Nicolas Mangold[2], Jean-Pierre Bibring[1], Yves Langevin[1], Brigitte Gondet[1], François Poulet[1], Guillaume Bonello[1], Cathy Quantin[3], John Mustard[4], Ray Arvidson[5], Stéphane LeMouélic[6], and the OMEGA team, [1]Institut d'Astrophysique Spatiale, Bâtiment 121, 91405 Orsay Campus, France, [2]IDES, Bâtiment 509, 91405 Orsay Campus, France, [3]LST, Bâtiment géode , 69100 Villeurbanne, France, [4]Geological Sciences, Brown University, Providence, Rhode Island 02912, USA, [5]Earth and Planetary Sciences, Washington University, St Louis, Missouri 63130, USA, [6]Planétologie, Université de Nantes, France.

Introduction: OMEGA, the imaging spectrometer onboard Mars Express, is the first orbital instrument able to identify sulfates associated to layered deposits in Terra Meridiani and Valles Marineris [1]. Though layered deposits have been priority science targets since their identification, distinct signatures of sulfates had not been recognized until now [2,3]. This is due to the wavelengths range covered and to OMEGA excellent spatial resolution (300 m to 4 km/pixel).

Since September 2004, OMEGA has started a high resolution campaign which allows the observation at high resolution (~300 m /pixel) of sulfate rich areas already mapped at lower resolution (2-4 km/pixel). The spatial location of sulfate identifications at lower and higher resolution match very well. Here, we report on the sulfate identification by OMEGA, and we present some examples of areas observed at high resolution, and compare the mineralogy mapped at high and low resolution.

Data processing: OMEGA [4] spectra cover the 0.35-5.1 µm wavelength range with 3 detector: VNIR (Visible and Near Infrared, 96 spectral channels) covers the 0.35 to 1.0 µm wavelength range, with a spectral sampling of 0.007 µm; SWIR (Short Wavelength InfraRed, 128 spectral channels) covers the 0.9 to 2.7 µm wavelength range with a spectral sampling of 0.015 µm; LWIR (Long Wavelength InfraRed, 128 spectral channels) covers the 2.5 to 5.1 µm wavelength range with a spectral sampling of 0.02 µm. After one year of observations, OMEGA has observed more than 50% of the Martian surface. The elliptical orbit adopted by Mars Express allows OMEGA to acquire observations at both high (300 m/pixel) and medium (4 km/pixel) spatial resolution. Areas have been covered both at higher and lower resolution, which allows us to have both the general geological context, and to obtain insights in the mineralogy present on the ground from the high resolution observations.

We correct OMEGA spectra from the atmospheric contribution using a scaled transmission atmospheric spectrum [2]. This correction assumes that the additive contribution due to the presence of aerosols in the Martian atmosphere is negligible. The atmospheric spectrum is obtained on the flanks of Olympus Mons, ratioing average spectra at the top and at the bottom of the volcano. This approach assumes that the mineralogy is the same in these two locations. The good results obtained with this method, visible through the absence of an atmospheric residual at 2 µm, show that the aerosols have a minimal impact on the spectra acquired during the first year of observations.

The presence of water ice in the atmosphere in the later observations (from September 2004) makes the atmospheric correction more difficult. A similar technique is adopted to remove the water ice contribution, using a transmission spectrum of water ice, and the excellent agreement between the mapping obtained with clear-atmosphere spectra shows that the technique is appropriate.

Method: Hydrated sulfates are identified through the use of band ratios [1]. Fig 1 presents some example identifications of sulfate rich material. They are compared to their best match in a spectral library. The first spectral type identified exhibits two broad absorption bands at 1.6 and 2.1 µm and a narrow shallow absorption at 2.4 µm. This spectral type is best matched by a spectrum of kieserite. The second spectral type has five absorption bands at 1.4, 1.75, 1.9, 2.2 (this absorption has a double shape) and 2.4 µm, which best match the spectral characteristics of calcium sulfate, likely gypsum. The third spectral type presents plateaus starting at 1.4, 1.9 and 2.4 µm which best match spectra of polyhydrated sulfates.

We then perform a detailed spectral study of the identified sulfate rich areas. We isolate in the dataset spectra which sample the spectral diversity of the dataset. We then group spectra sufficiently similar to one of the selected spectra, which means that the angle between the spectra is below a defined threshold [5].

Results: We identify sulfate deposits inside Valles Marineris and in the etched terrain in Terra Meridiani [6]. Kieserite is identified in Candor, Melas, Hebes, Juventae, Ius, Eos and Capri Chasma, Aram Chaos, and Terra Meridiani. Gypsum is identified inside Iani Chaos and Juventae Chasma. Polyhydrated sulfates are identified inside Candor, Melas, Ophir, Hebes, Ius and Capri Chasma, and Terra Meridiani.

It is interesting to compare results obtained at low (~2 km /pixel) and high (~300 m/pixel) resolution. Essentially, the high resolution campaign confirms the nature and location of the hydrated sulfate minerals identified. The much better spatial grouping that we obtain at higher spatial resolution reinforces the confidence that we had in the sulfate detection and identification. Some areas are detected which were not previously mapped as sulfate rich, for example in Hebes chasma. Futhermore the high resolution observations allow a more precise mapping of the deposits on the surface for correlations with other data sets (e.g. imaging).

Sulfate detections at high and low resolution in Melas Chasma are presented in fig. 2 and 3. The high resolution confirms that even isolated pixels identified at low resolution were reliable detections.

References: [1] Gendrin et al., submitted. [2] Bibring et al. (1989), Science. [3] Murchie et al. (2000), *Icarus* **147**, 444-471. [4] Bibring et al. (2004), ESA SP-1240. [5] Kruse et al. (1993), *Rem. Sens. of Envir.* **44**, p. 145-163. [6] Arvidson et al., this issue.

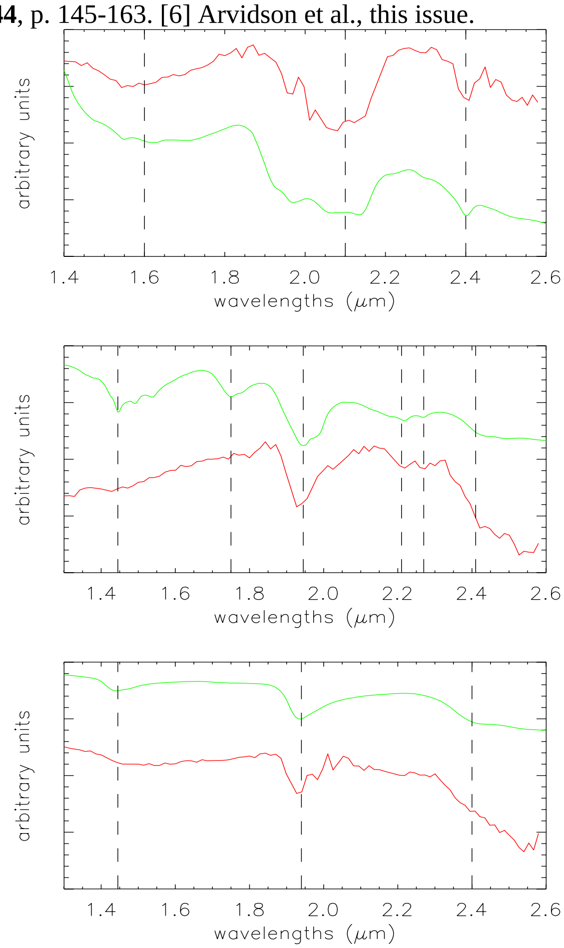

Fig 1 : Spectral ratios corresponding to a detection of kieserite (top), calcium sulfate, likely gypsum (middle), polyhydrated sulfate (bottom). Spectra of a spectral library are represented in green (from top to bottom: kieserite, gypsum and epsomite), and spectral ratio obtained from OMEGA data in red.

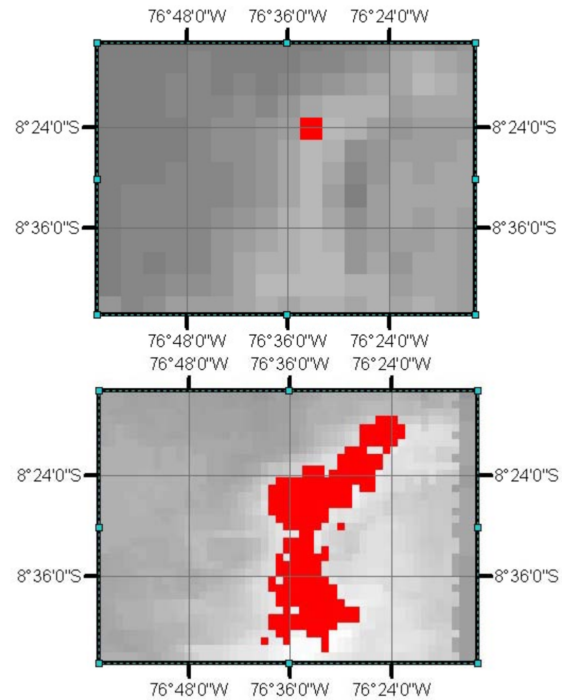

Fig 2 : Tentative detection of kieserite at lower resolution (isolated pixel), which is confirmed at higher resolution by the grouping obtained in our identification. The higher spatial resolution improves the band depth of the detected mineral, which allows the identification and mapping of an extended area of kieserite.

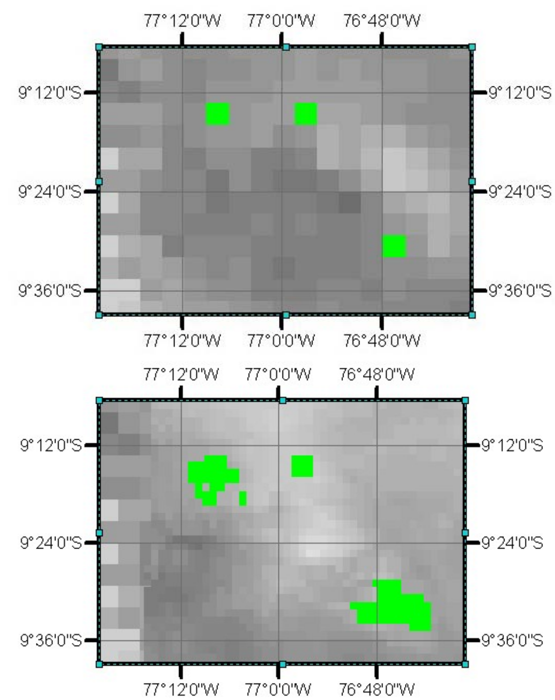

Fig 3 : Tentative detection of polyhydrated sulfates at lower resolution (3 isolated pixels), which is confirmed at higher resolution by the grouping obtained in our identifications.