PHYLLOSILICATES RICH TERRAINS IN MAWRTH VALLIS REGION, MARS, AS SEEN BY OMEGA AND HRSC/MARS EXPRESS. D. Loizeau[1], N. Mangold[1], F. Poulet[2], J.-P. Bibring[2], A. Gendrin[2], C. Gomez[2], Y. Langevin[2], B. Gondet[2], V. Ansan[1], P. Masson[1], G. Neukum[3], and the OMEGA and HRSC teams, [1]IDES, Bât. 509, Université Paris XI, 91405 Orsay cedex, France, [2]Institut d'Astrophysique Spatiale, Bâtiment 121, Université Paris XI, 91405 Orsay cedex, France, [3]Institut für Geologische Wissenschaften, Freie Universität Berlin, Germany. (Contact: loizeau@geol.u-psud.fr)

Introduction: The Mawrth Vallis region (20° to 28°N and 17° to 22°W) shows large outcrops of bright, very finely layered deposits, interpreted as sedimentary rocks[1]. These deposits are located on noachian plateaus on each side of the outflow valley[2]. The results provided by OMEGA and HRSC aboard Mars Express has enabled us to study the mineralogy and geomorphology of the Mawrth Vallis region. Studying the geology of these ancient outcrops will help us to understand the past local environment.

Phyllosilicates detection: OMEGA (Observatoire pour la Minéralogie, l'Eau, les Glaces et l'Activité) is an hyper-spectral imaging spectrometer aboard Mars Express: we have been analysing its spectra between 1.0 and 2.7 µm to retrieve spectral features of hydrated minerals in the Mawrth Vallis area. Large deposits of phyllosilicates have detected in the Mawrth Vallis region[3]. We identified a strong band centred at ~1.9 µm, due to interlayer bounded water molecules, associated to a weaker ~1.4 µm band and to another band centred around either 2.2 µm or 2.3 µm. These latter bands are due respectively to Al-OH vibrations or Fe-OH and Mg-OH vibrations[4]. They reveal the presence of montmorillonite minerals and Fe-rich smectites respectively when compared to laboratory spectra (Figure 1). These types of phyllosilicates are generally due to the alteration of igneous rocks by liquid water on Earth[5].

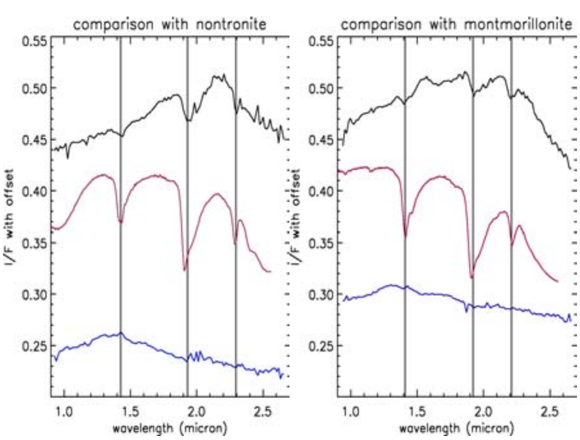

Figure 1: Smectites spectra as identified by OMEGA in Mawrth Vallis region. Left: From bottom to top: OMEGA reference spectrum in blue; laboratory spectrum of nontronite in red (Fe-smectites); ratio of 6 OMEGA spectra over the reference spectrum. Right: idem for a comparison with montmorillonite.

Geomorphology of the phyllosilicates rich surfaces: HRSC (High Resolution Stereo Camera) offers a full cover of Mawrth Vallis region at a high resolution, up to 14m/pixel. It enables to study the geomorphology of all the hydrated outcrops of the region. Figure 2 shows the distribution of the surfaces rich in phyllosilicates as revealed by OMEGA on top of the full visible cover provided by HRSC. The hydrated regions correspond exclusively to very bright terrains, displaying high erosion features: numerous mesas, the absence of the surrounding pyroxene-rich dark mantle, and a lack of small craters. This would indicate quite recent erosion. Most of the outcrops are located on the plateaus surrounding Mawrth Vallis, except one deposit in an eroded basin on the floor of the valley.

Several MOC (Mars Orbiter Camera) visible images, with a resolution of ~3m/pixel, reveal that the hydrated surfaces are outcrops of thin bright layered deposits, different of lava flows, an example is shown Figure 3. Therefore, the phyllosilicates are associated to terrains interpreted as sedimentary rocks[1].

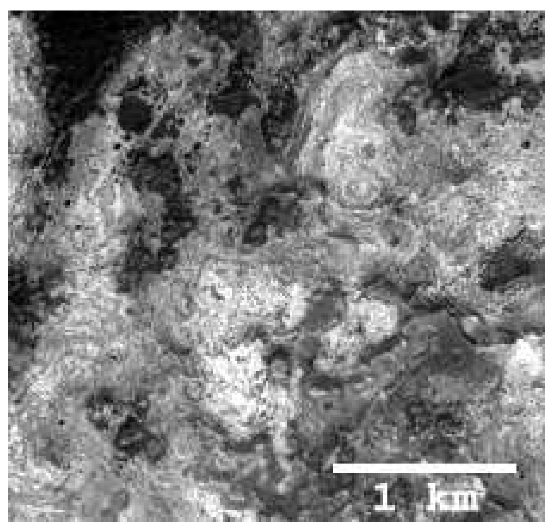

Figure 3: MOC image of a bright eroded outcrop, rich in phyllosilicates, displaying small mesas, surrounded by a pyroxene-rich dark mantle. The image shows several very thin layered deposits (E14_00606, 19.49°W, 25.14°N).

As OMEGA detects minerals only on the top micrometer of the surface, one can wonder if the phyllosilicates are only surfacial or are a bulk component of the deposits. Conditions to form phyllosilicates do not occur today on Mars surface, hence, the detected phyllosilicates cannot have been formed recently[6]. As they appear only on recent and very eroded surfaces, these phyllosilicates are really a bulk component of the sedimentary rocks, brought out by erosion.

THEMIS, the Thermal Emission Imaging System, gives more physical details about the hydrated surfaces of Mawrth Vallis: on infrared images taken by night, they appear uniformly warmer than the rest of the plateaus, revealing a higher thermal inertia than the surrounding pyroxene-rich mantle. This indicates, with the lack of small craters, that the hydrated surfaces are recent outcrops of a relatively highly indurated unit, rich in phyllosilicates. One can also notice that a few bright outcrops (especially at the west of Mawrth Vallis mouth) do not show phyllosilicates features on OMEGA data, they are actually simultaneously cooler on THEMIS night time images: a thin local dust cover could be present which would mask any spectral signature, as confirmed by OMEGA.

Extension of the phyllosilicates rich unit: The outcrops rich in phyllosilicates detected by OMEGA are spread all over the plateaus surrounding Mawrth Vallis, over a region of ~300 km x ~400 km. The altitudes of the outcrops go from –3,300 m, near Mawrth Vallis mouth and in the small basin on its floor, to –2,000 m on the top of the plateaus.

Thickness of the unit. An idea of a minimum thickness of the unit is reachable. Phyllosilicates are seen on the eroded ejectas of a crater ~20 km in width, and would indicate that these phyllosilicates have been excavated from a few hundreds of metres in depth. This could be a minimum indication of the depth of the unit.

The hydrated outcrop in the basin on Mawrth Vallis floor also shows polygonal structures, with a minimum width of 100 m. It has been shown that the crack depth is a third of the crack spacing[7]. The phyllosilicates rich unit should then be at least a few tens of metres deep at this place.

We can also suppose that these outcrops emerge of a single unit, rich in phyllosilicates. Checking the horizontality of the phyllosilicates rich layers is impossible so far and the volume of this unit remains very unconstrained. In any case, such a unit would suppose a very important volume of altered rocks.

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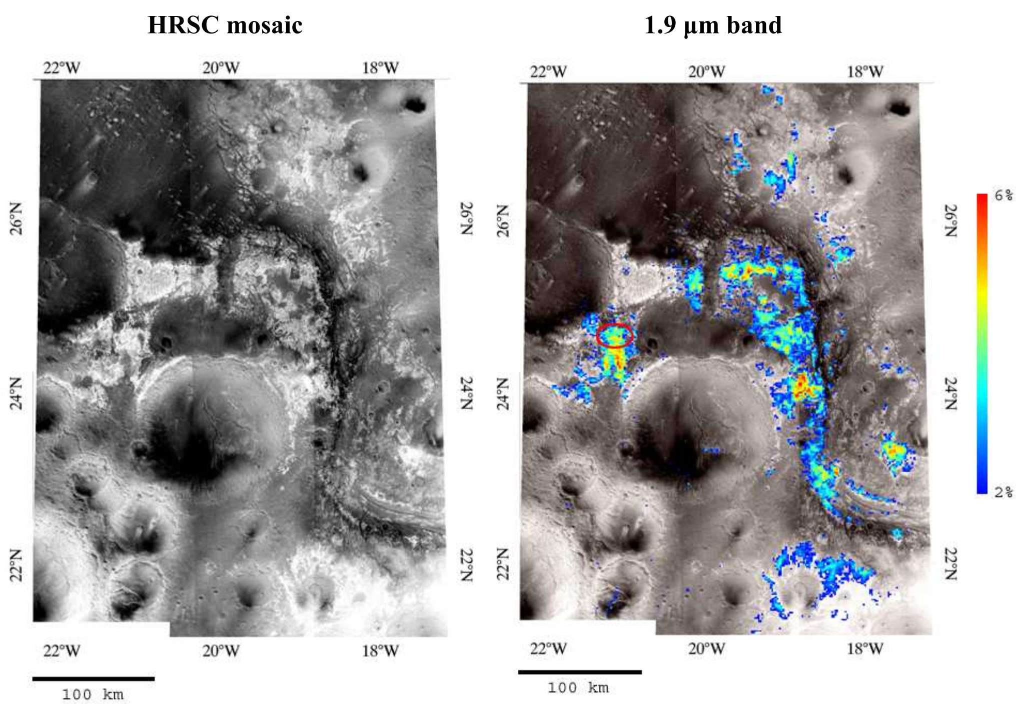

Figure 2: Maps of Mawrth Vallis region (mosaic of HRSC nadir images). The color code in the right image indicates in percent the spectral criterion calculated for the 1.9 µm band, with a band centre at 1.93 µm, and the continuum at 1.81 and 2.14 µm. Surfaces delimited by the 1.9 µm band display simultaneously another band either at 2.2 µm (similar to montmorillonite, limited by a red contour on the western part for the main area) or at 2.3 µm (Fe-smectites).