HIGH RESOLUTION MORPHOMETRY AND MINERALOGY OF THE SHALBATANA PALEOLACUSTRINE DEPOSITS (MARS) USING MRO HiRISE AND CRISM DATA. G. Di Achille[1], C. Popa[1], S. Silvestro[2], J. Wray[3], F. G. Carrozzo[4], F. Esposito[1], [1]Istituto Nazionale di Astrofisica, Osservatorio Astronomico di Capodimonte, Napoli, Italy (diachille@na.astro.it), [2]SETI Institute, Carl Sagan Center, Mountain View, CA, USA, [3]Georgia Institute of Technology, Atlanta, GA, USA, [4]Istituto di Astrofisica e Planetologia Spaziali, Istituto Nazionale di Astrofisica, Roma, Italy.

Introduction: The Shalbatana paleolake is among the best preserved examples of ancient martian lacustrine environments from the geomorphologic point of view [1, 2]. Sedimentologic and morphometric analyses and the topographic correlation of deltaic deposits, strandlines, and terraces suggest that the lake water table covered an area of about 195 km^2 for a total volume of 29 km^3 with a maximum depth of about 200 m [1, 2]. However, spectral data from the Observatoire pour la Minéralogie, l'Eau, la Glace et l'Activité (OMEGA) [3] were of insufficient resolution to support the straightforward geologic evidence also from a mineralogic point of view.

Here, we report on the analysis of data recently acquired by the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) [4] over the Shalbatana paleolake. The latter data show that there is an enrichment of hydrated minerals associated to the exposed lacustrine beds. Particularly, the spectral signature of the lacustrine deposits suggests the presence of a mixture of Fe, Mg, and Al-phyllosilicates, polyhydrated sulfates and secondarily opal. Besides the spectral analysis, the overall morphometry of the lacustrine deposits is also investigated using high resolution topography derived from High Resolution Imaging Science Experiment (HiRISE) images [4]. Collectively, these results add further support to the overall geological evidence [1, 2] for the occurrence of a large body of standing water at this site during the Hesperian (~3.5 Gyr ago).

Morphometry and Mineralogy: The 1 meter/pixel digital elevation model from HiRISE images of the main Gilbert delta shows a clear break in slope (Figure 1) at the elevation of the strandlines zone suggested by [1, 2] based on the the interpretation of the visible images. Moreover, the topography across the strandlines zone (see AB in Figure 1) is matching closely that of strandlines in ancient terrestrial deltaic deposits (see Figure 7 in [6] for comparison).

The mineral composition of the lake sediments and surrounding geologic settings was inferred via NIR spectral analysis using MRO-CRISM orbits. The spectral water related response in the area is divided into two main assemblages: the first affected the top stratigraphic beds of the Shalbatana Vallis eastern wall. This alteration is dominated by Fe and Mg smectites

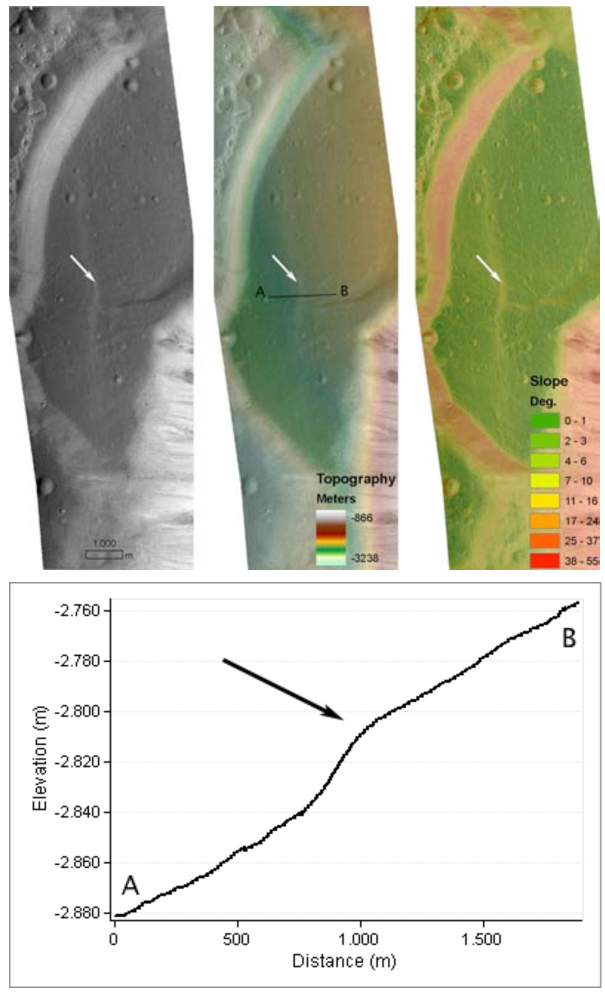

Figure 1 – (top) HiRISE image, DEM, and slope map of the main Gilbert delta deposit described in [1, 2]; white arrows mark the strandlines zone. (bottom) Topographic profile of the strandlines zone (compare with terrestrial analogs in Figure 7 of [6])

as suggested by the presence of the 1.4, 1.9, and 2.3 μm bands in CRISM spectra (Figure 2). This alteration event was likely due to the interaction between water and pyroxene enriched rocks producing in situ alteration of rocks related to geological processes occurring prio to the Shalbatana Vallis formation.

The second spectral assemblage is related to the subsequent hydrologic event that produced the fan delta, feeding the resulting lake with sediments eroded

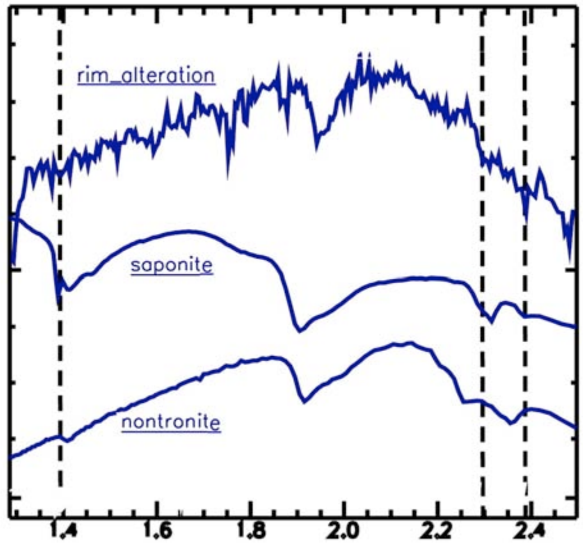

Figure 2 - CRISM ratio (offset for clarity) showing the spectrum of rocks of the top Shalbatana Vallis wall compared to spectral libraries of smectites

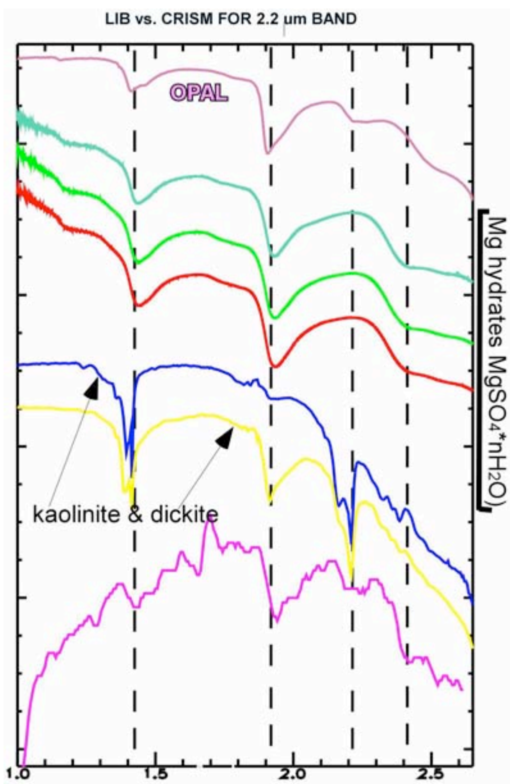

Figure 3 - In magenta the CRISM ratio (offset for clarity) showing details of the spectrum characterized by the 1.4, 1.9, and 2.2 bands compared to ratios from spectral libraries. Hydrated sulfates are good canditates for the features observed. Hydrated opal and Al-rich phyllosilicates also share some common spectral features

from the top of stratigraphical record of the eastern wall and deposited at the channel floor, in typical lake bed sediments. Figure 3 shows (in magenta) significant spectral features associated with the water related mineral phases within the lacustrine deposits exposed by erosion in the deepest part of the basin.

The lake bed sediments present a complex mineralogy consistent with the presence of smectites as well as Al-rich phyllosilicate alteration probably resulting from preexisting feldspars. Other spectral signatures point to mineral composition probably related to the cements and have characteristic spectral signatures of Ca and/or Mg sulfates that convolve spectrally with bands related to the allochthonous smectites, Al-rich phyllosilicates and other terrigenous (unaltered) sediment. The latter sediments dominate the fan delta deposit making it NIR featureless.

Conclusions: CRISM data and topography derived from HiRISE images confirm the presence of a lake in Shalbatana Vallis during the Hesperian (~3.5 Gyr ago). More interestingly, the lacustrine deposits show evidence for both phyllosilicates and sulfate minerals, suggesting the occurrence of mineral assemblages found only in a few other locations on Mars (e.g. [7]). As suggested by [7] the presence of sulfate related spectral signatures could be entirely related to direct water precipitation during the final evaporation of the lake in a sabkha-like environment.

References: [1] Di Achille G. et al. (2007) *JGR, 112*. [2] Di Achille G. et al. (2009) *GRL, 90*. [3] Bibring J. P. et al. (2006) *Science, 312*. [4] Murchie S. L. et al. (2009), *JGR*, *114*. [5] McEwen et al. (2007) *JGR, 112*. [6] Irwin R. P. and Zimbelman J. R (2012) *JGR, 117*. [7] Wray J. J. et al. (2011), *JGR, 116*.

Acknowledgments. We are grateful to the CRISM Team for the special targeting and successfully acquisition of the spectral data. We thank A. P. Rossi for an earlier version of HiRISE digital elevation model obtained using the Ames Stereo Pipeline.