MINERALOGICAL AND GEOMORPHOLOGICAL CHARACTERIZATION OF A MARTIAN CRATER IN NORTHERN MERIDIANI PLANUM TERRAINS. Beatrice Baschetti[1,2], Francesca Altieri[2], Cristian Carli[2], Alessandro Frigeri[2], Maria Sgavetti[3], [1]Sapienza University of Rome, Department of Physics, p.le Aldo Moro 2, 00185 Rome, e-mail address: beatricebaschetti@gmail.com, [2]INAF/IAPS, via del Fosso del Cavaliere 100, 00133 Rome, [3]Department of Chemistry, Life Sciences and Environmental Sustainability, Università degli Studi di Parma, Viale delle Scienze 157/A, 43121 Parma.

Introduction: the region of Meridiani Planum on Mars is a relatively plain area located at the equator of the planet, approximately ranging from 350°E to 10°E. The oldest exposed geological unit corresponds to cratered Noachian-aged terrains extensively dissected by channels and valley networks [1]. A series of younger terrains were then emplaced in some parts, likely during Late Noachian/Early Hesperian epochs [2].

Meridiani Planum shows signs of a variegate and complex history of aqueous activity in many locations. In addition to the evidence provided by the numerous valley networks, data from OMEGA and CRISM orbital spectrometers have revealed the presence of Fe/Mg phyllosilicates and sulfates throughout the area [3]. These hydrated minerals usually form by alteration in aqueous environments. Older, Noachian-aged areas are generally characterized by the presence of Fe/Mg phyllosilicates, while younger capping units may display both phyllosilicates and sulfates.

Regional differences in mineralogy and hydration imply that the aqueous conditions probably varied during emplacement and/or alteration of Meridiani terrains. Any advance towards a better understanding of the aqueous processes that left their imprint on the area could provide new insight on Mars' past climate and habitability. Noachian terrains are of particular interest, as they date back to a period which is largely recognized as the most suitable for hosting habitable conditions on Mars.

Mineralogical and morphological investigation: We selected a 20-km-wide crater (Figure 1) in the northern part of Meridiani Planum to investigate both its mineralogical and geomorphological characteristics using CRISM, HiRISE and CTX instruments onboard Mars Reconnaissance Orbiter. The combination of the observations from these three different types of instruments provide a powerful tool set for surface characterization.

The mineralogical composition of the terrains inside the crater is retrieved using infrared data from CRISM spectrometer, in the range 1.0-2.6 μm. This information is then integrated with HiRISE high-resolution camera data to identify different morphologies within the crater's area. Additionally, images from CTX camera are used to provide surrounding context. The crater, centered at 359.96°E, 2.45°N is embedded within the exposed Noachian-aged terrains and surrounded to the south and east by younger terrains, which overlie part of its ejecta.

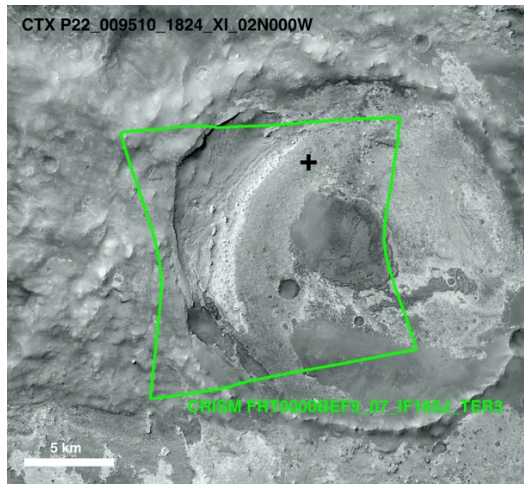

Figure 1: CTX image of the region of interest. The green lines trace CRISM footprint, showing the coverage of the spectral data analyzed.

Results: the results of the spectral analysis are compatible with the presence of the mineral group of Fe/Mg-rich smectite clays (e.g. nontronite and saponite) in a wide area within the crater's interior. The remaining terrains are mainly composed of pyroxene-bearing material mixed with dust. Generally, areas with pyroxenes have a darker appearance than the surroundings and dunes of a fine-grained material are frequently observed.

Spectra of smectites obtained from CRISM show absorption features near 1.4, 1.9, and 2.3 μm, with additional combination tones near 2.4 μm, and sometimes 2.5 μm. The exact position of some bands depend on the relative proportions of Fe and Mg: for example, the 2.3 μm band shifts to shorter wavelengths as Fe is exchanged for Mg [4].

We identify two distinct spectral classes for the smectites (Figure 2): the first class (red) is compatible with laboratory spectra of Fe-rich smectites, like for example nontronite, while the second class (green) appears consistent with the spectra of more Mg-rich smectites, such as saponite. The position and shape of the 2.3, 2.4 and 2.5 μm features are slightly different for the two classes, figure 3 shows these absorption bands for both CRISM and laboratory spectra.

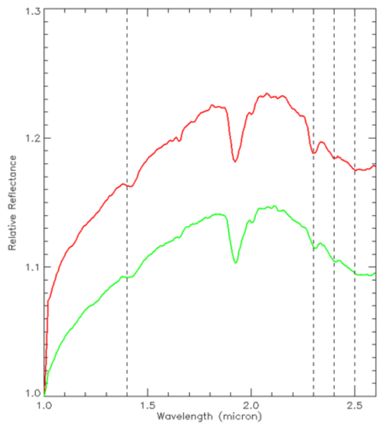

Figure 2: averaged spectra obtained for the areas which show the presence of Fe/Mg smectites: red is from predominantly Fe-rich smectite areas, green is from Mg-rich areas.

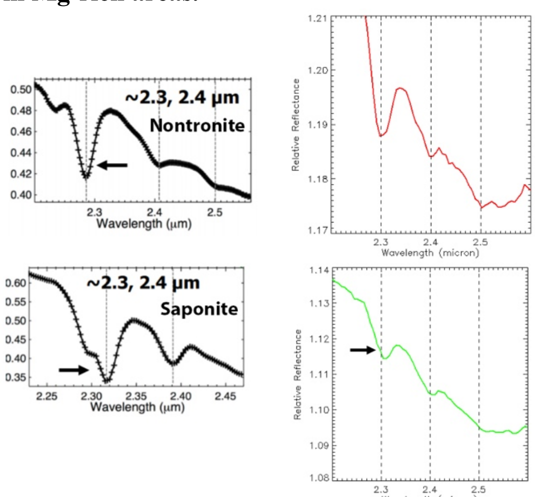

Figure 3: (left) Laboratory spectra of Nontronite (Fe-rich smectite) and Saponite (Mg-rich smectite). (right) Absorption details of the spectra from Figure 2.

Fe-rich smectites tend to be concentrated in limited areas of the crater, mostly close to its southern border. Further investigation is needed on this point to clarify the reasons of this specific distribution.

Terrains which retain signs of hydration show an interesting variety of morphologies, however, a common feature is that they all show polygonal fracture patterns to some extent (Figure 4).

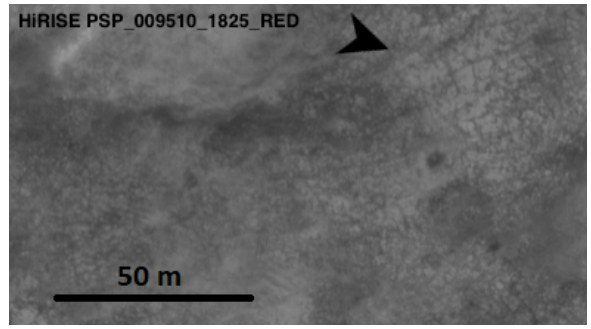

Figure 4: Cracking patterns on the crater's hydrated terrains as observed with HiRISE. Approximate location is marked by a plus sign in figure 1.

Discussion: A possible explanation for the cracking patterns observed on the crater's hydrated terrains is related to desiccation. Desiccation is caused by water evaporation or migration: as a result of the water loss, the terrain shrinks and cracks.

Cracks which may be related to desiccation are found in various Martian terrains, showing a regional preference for sedimentary environments. These features, observed in association with hydrated phases, such as Fe/Mg smectites, are potential markers for lacustrine conditions [5]. The Noachian geologic setting, in association with terrains that show evidence of past aqueous activity, reinforces this hypothesis.

Noachian paleo-lakes are a top-priority setting for astrobiological research as they might have been a suitable environment to support and preserve traces of microbial life [6]. Nevertheless, a different origin for these features it is not ruled out and further investigation is required.

Conclusions: Phyllosilicates detected in the northern Noachian-aged terrains of Meridiani Planum, in association with polygonal fracture patterns, could be related with the existence of ancient paleo-lake environments, making it an interesting spot for the astrobiological research.

Previous studies on the region of Meridiani Planum, majorly focused on the younger capping terrains laying south of the crater examined. The results obtained here are a worthwhile starting point for a better understanding of the evolutionary history of Meridiani Planum's oldest terrains.

Acknowledgments: Featured camera images were obtained from the Planetary Data System (PDS).

References: [1] Williams et al. (2017) *GRL, 44,* 1669-1678. [2] Hynek et al. (2002) *JGR, 107,* 5088. [3] Flahaut et al. (2015) *Icarus, 248*, 269-288. [4] Viviano-Beck et al. (2014) *JGR, 119,* 1403-1431. [5] El-Maarry et al. (2014) *Icarus, 241*, 248-268. [6] Vago et al. (2017) *Astrobiology, 17,* 471-510.