CHARACTERIZING CLAY-RICH TERRAINS IN OXIA PLANUM AND NORTH XANTHE TERRA: AN UPDATED OVERVIEW OF THE INFRARED SIGNATURES. J. Brossier*, F. Altieri, M.C. De Sanctis, A. Frigeri, M. Ferrari, S. De Angelis, A. Apuzzo, and the Ma_MISS team. Institute for Space Astrophysics and Planetology IAPS, National Institute of Astrophysics INAF, Rome, Italy (jeremy.brossier@inaf.it).

Introduction – ExoMars rover mission is expected to deliver the "*Rosalind Franklin*" rover to explore Oxia Planum, a region straddling between Arabia Terra and Chryse Planitia (335.5E, 18.2N). Oxia Planum shows evidences of a long-lasting aqueous activity [1–4], where near-infrared data reveal widespread outcrops of recently exhumed clay-rich deposits (Fig. 1). ExoMars rover will explore these outcrops to search for signs of life on the planet, as biosignatures might be preserved therein [5]. Here, we also focus on clay-bearing outcrops detected in north Xanthe Terra (313E, 13N) [6], a region that has already been suggested for several rover missions (Fig. 2). Clays detected at Oxia Planum and north Xanthe Terra are among those found all over circum-Chryse Planitia [7], a flat lowland region and bottom end of many outflow channels.

Like in Oxia Planum, several morphological features indicate a fluvio-deltaic and lacustrine history in north Xanthe Terra [8–10], particularly the Sabrina and Hypanis valley systems. Despite a possible detection of Fe,Mg-rich clays at the fan deltas, no detailed spectral survey has been done in the entire area. An in-depth analysis of these outcrops is essential to better determine possible mineral phase(s) and search for changes in the clay mineralogy related to differences in formation and weathering conditions. We examine near-infrared data, notably the absorptions centered in the 1.0–2.6 µm spectral range, to better constrain the clay mineralogy.

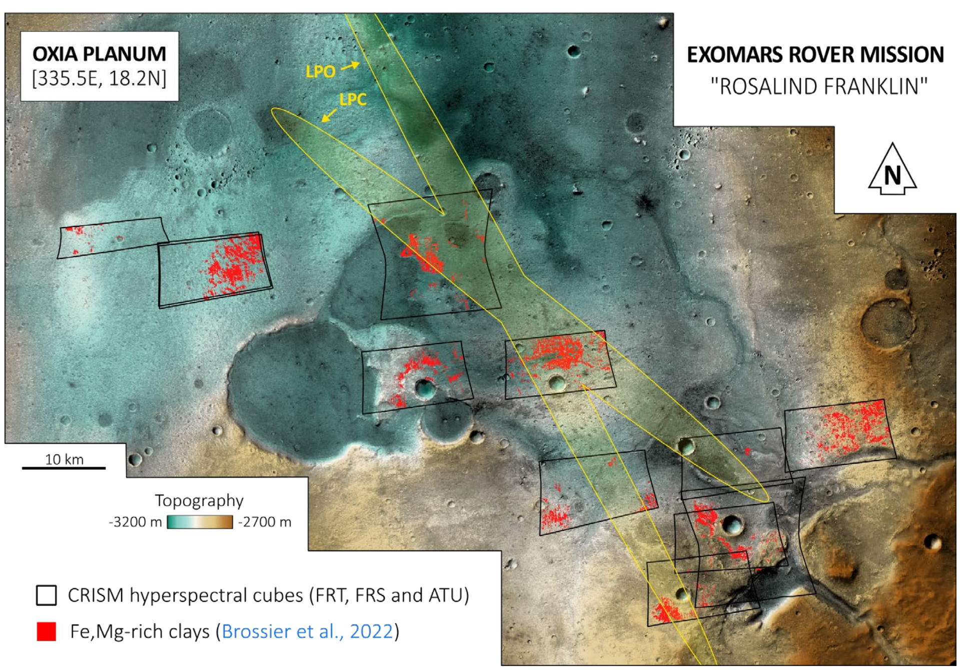

Figure 1 (right) – Oxia Planum, the landing site for the ExoMars rover mission. CTX mosaic overlain by the colorized topography..

Data & Methods – Spectral signatures of the clay outcrops are obtained from data gathered by the CRISM instrument [11], with spatial resolutions from 20 to 40 m·px^{-1} and a spectral resolution of 6.6 nm. We used several CRISM cubes acquired in the infrared spectral range (1–4 µm), targeting the two regions. They are first pre-processed with the CAT ENVI toolkit for atmospheric and photometric corrections. Corrected cubes are then denoised to reduce noise and residual atmospheric contributions, and to finally emphasize mineralogical absorptions in the "*ratioed*" spectrum. Once the cubes are corrected and denoised, we define our regions of interest (ROIs) to outline the clays. We calculate band depths at 1.9 and 2.3 µm [12] to select pixels with strong absorptions and map the ROIs for each cube.

Results – We retrieve the band centers for all pixels composing the ROIs within the three absorptions of interest (1.4, 2.3, and 2.4 µm), after continuum removal to emphasize the absorptions. The band centers do not strongly vary for the three absorptions, with average values being 1.410, 2.305 and 2.397 µm, respectively. Overall, these values are quite similar at Oxia Planum and Xanthe Terra [4,6]. Moreover, Oxia's catchment has large outcrops with various absorptions implying a different clay mineralogy [4].

Discussion – CRISM cubes reveal several absorptions in the 1.1–2.6 µm range. Paired absorptions near 1.4 and 1.9 µm are common to hydrated minerals, while an absorption near 2.3 µm indicates a (Fe,Mg)-OH vibration. Clays in Oxia Planum and Xanthe Terra are consistent with Fe,Mg-rich clays, combining absorptions

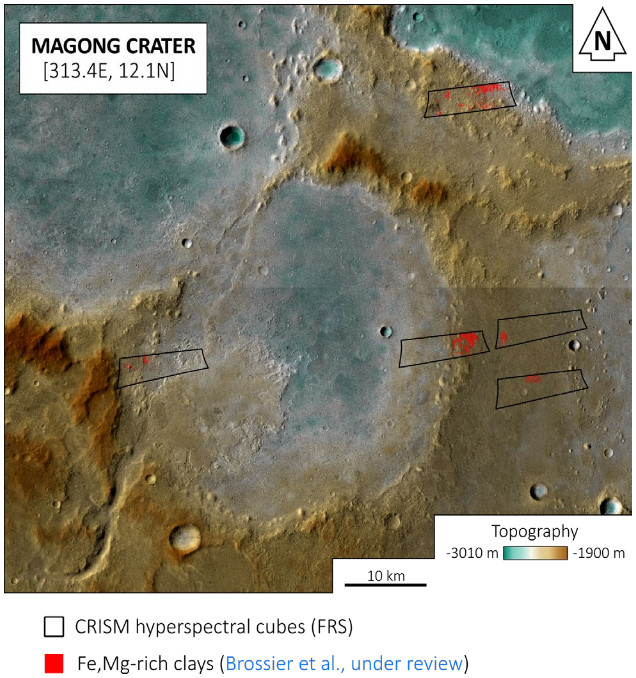

Figure 2 (left) – Magong crater and Sabrina's delta in north Xanthe Terra, a reference site for Oxia Planum.

at 1.41, 1.92, 2.30–2.31 µm and weaker overtones near 2.39–2.40 µm. Martian Fe,Mg-rich clays generally show spectral variability in these absorptions, from Fe-rich (nontronites) to Mg-rich (saponites) compositional phases. For instance, nontronites display typical absorptions near 2.28–2.29 µm and at 2.40 µm, while saponites have absorptions near 2.31–2.32 µm and at 2.39 µm. Nevertheless, intermediate band centers obtained for the mapped outcrops rather correlate with Fe-rich saponites and vermiculites. Band centers within these absorptions vary very little throughout the two regions. Exact positions therein depend on the relative abundance of iron and magnesium in the clay structure, and also the oxidation state of iron.

Interestingly, Oxia's catchment reveals the presence of Fe,Mg-rich clays with a narrow absorption near 2.29 µm, characteristic of nontronites. They are found together with Al-rich phases, having a single absorption at 2.21 µm (e.g., montmorillonites), and doublet absorptions at 2.17–2.21 µm (e.g., kaolinites), as previously reported in the vicinity of Mawrth Vallis and west Arabia Terra [e.g., 13].

We also find an additional, shallow absorption centered near 2.5 µm, suggesting the presence of carbonates or other smectites together with the Fe,Mg-rich clays in Oxia Planum [3,4] and north Xanthe Terra [6]. Coprecipitation of clays and carbonates throughout the outcrops further strengthens the exobiological potential of these regions in the sedimentary rocks.

Conclusions – We provide a detailed analysis of the clay-bearing outcrops found in Oxia Planum and north Xanthe Terra, in order to compare them with terrestrial analogs [4,6]. We reported the exact positions of the 1.4, 2.3 and 2.4 µm absorption bands, and searched for possible variations in these band centers. Furthermore, we also mapped the "*clearest*" exposures of clays in the two regions, in context with the morphology and topography. In both regions, the clays are consistent with either Fe-bearing saponites or vermiculites (associated with a hydrobiotite component). We only observe subtle variations between the different targeted outcrops, implying a relatively homogeneous distribution of the mineral assemblage, with very little changes in iron and magnesium content. Nonetheless, Xanthe's outcrops generally show weaker signatures relative to most outcrops in Oxia Planum, likely due to significant dust cover in north Xanthe Terra attenuating the clay spectral signatures.

Our new findings allow for further investigations regarding the ExoMars rover mission and eventual future landing missions. Further ongoing geologic analyses in Oxia Planum and north Xanthe Terra at a regional scale [15,16] should undoubtedly provide new insights on the geological history and stratigraphy of the two regions. Mineralogical and morphological similarities seen therein imply that both regions may share a common depositional and weathering history.

Acknowledgements – This work is fully funded and supported by the Italian Space Agency (ASI) [Grant ASI-INAF n. 2017–48–H.0]. We are greatly thankful to the European Space Agency (ESA) and Russian Space Agency ROSCOSMOS for the ExoMars project.

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