PRODUCTION AND SPECTROSCOPIC INVESTIGATION OF MARTIAN ANALOG MIXTURES.

E. Bruschini[1], M. Ferrari[1], S. De Angelis[1], M. C. De Sanctis[1], F. Altieri[1], A. Pisello[2], J. Brossier[1], A. Frigeri[1], & the Ma_MISS team [1]Institute for Space Astrophysics and Planetology INAF, Rome, Italy (enrico.bruschini@inaf.it), [2]Dipartimento di Fisica e Geologia, Università degli Studi di di Perugia.

Introduction: Given the strong astrobiological implications, the exploration of Mars is a compelling ongoing scientific activity since many decades. Several space missions investigated the planet and are still scouting its surface through orbiters (hyperspectral imaging) and robotic rovers (mineralogy and spectroscopy). In particular, the in-situ exploration is revealing a complex mineralogical diversity exemplified by a wide range of magmatic and sedimentary rocks [1]. Very often, remotely and in-situ acquired data are characterized by a non-optimal signal-to-noise ratio making the interpretation of the results challenging and ambiguous. In order to correctly understand and interpret data from robotic rovers and orbiting spacecrafts it is of paramount importance to know exactly how the mineralogical complexity of the Martian surface affects its spectral properties. For this reason, we investigated in the laboratory the spectroscopic properties of synthetic Martian analog mixtures characterized by a high mineralogical complexity. We focused our efforts on two regions of Mars, namely the Jezero crater (JC) and the Gale crater (GC). In both sites the remote spectroscopic characterization from spacecrafts is coupled with a partial in-situ spectroscopic and mineralogical characterization carried out by robotic rovers (Perseverance and Curiosity respectively).

Materials and Methods: To produce our mixtures, we used a set of selected natural minerals and synthetic materials (glass) whose relative abundances were varied in such a way to represent different geologic scenarios (i.e. degree of aqueous alteration under a variety of conditions). The materials were ground and sieved to produce powders with grain sizes between 0 and 50 µm. The number of component for each mixture ranges between 4 and 5. In addition to multi-component mixtures we also produced binary mixtures to asses the spectral features of specific components. The starting materials and the produced mixtures were investigated by visible-near infrared (VNIR) reflectance spectroscopy in the spectral range 350-2500 nm. In addition we used a micro-Raman confocal system (µRS) to characterize the constituent materials. The VNIR spectra of our mixtures were compared with available spectroscopic data from the rovers and the abundance and type of end-members were adjusted in such a way to reproduce the absorption pattern observed by the rovers. We also explored the application of simple modeling approaches (linear mixing) to asses the spectral features of the mixtures

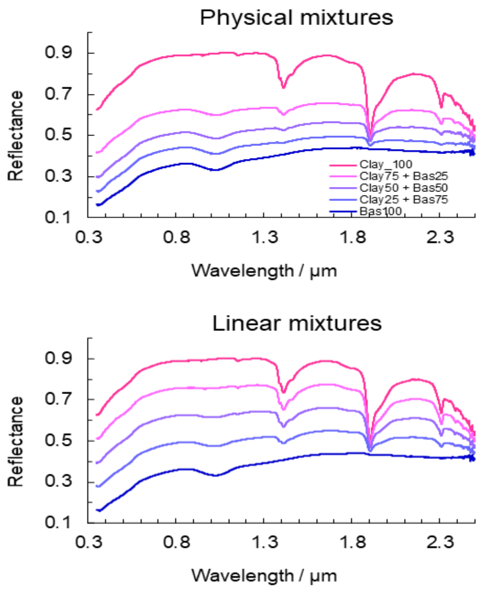

Figure 1. Binary mixture between clay (hectorite) and basalt. Top panel: physical mixtures in the proportion Clay:Basalt: 100:0, 75:25, 50:50, 25:75, 0:100. Bottom panel linear mixing model for the same mixtures.

Results:

Gale crater. The results for the Gale crater indicate that a large amount of alteration products in the mixtures are needed to reproduce the observed rover spectroscopic data while the mineralogy of the unaltered component of the rock matches those of basaltic rocks.

Jezero crater. The mineralogy of Jezero Crater is characterized by a high diversity which testifies a complex geologic history of the crater. In our initial test we reproduced the crater floor material [2] and compared our the result with those of the Perseverance rover. To reproduce the spectroscopic features of this unit we used a basaltic mineralogy which accounts for more than 80% (in weight) of the mixture while the alteration represent a small fraction of the mixtures. In particular or results indicate that clay component should be a minor component (few points %) of the mixtures.

Our study emphasizes the importance of the alteration products (clays, amorphous component, oxides and sulfates) in determining the VNIR spectroscopic features of the Martian surface and allow to put quantitative constrains on mineral type and abundance on Mars.

References:

[1] Bell et al. (2022) *Sci. Adv., 8(47),* abo4856.
[2] Goudge al. (2015) *JGR, Planets, 120(4),* 775-808.