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Laboratory activities in support to the Ma_MISS experiment onboard the ExoMars2020 rover

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Abstract

Laboratory measurements were performed on different minerals and rocks that can be considered as Mars analogues with the aim of characterizing the scientific performance of the Ma_MISS (Mars Multispectral Imager for Subsurface Studies) instrument and built a spectroscopic database of Martian analogues.

1. Introduction

The main scientific objectives of the ESA mission ExoMars2020 are searching for signs of past and/or present life on Mars and characterizing the subsurface geochemical environment as a function of depth. The Rosalind Franklyn rover [1] payload consists of a suite of nine instruments that will provide information about the geological and geochemical environment of the surface and subsurface of selected landing site (i.e. Oxia Planum) [3].

Remote sensing measurements performed by OMEGA and CRISM suggest that the exposed rocks on the surface of Oxia Planum experienced an intense aqueous alteration [2]. The widespread presence of Fe-/Mg-phyllosilicates, and more generally, the presence of OH-bearing silicates confirm the interaction between water and the parent rocks. In this framework, we perform several spectroscopic measurements of minerals (Fe, Mg and Al clays, sulphates, zeolites, hydroxides), rocks, and perchlorate salts.

2. The Ma_MISS instrument

Ma_MISS is the Visible and Near Infrared miniaturized spectrometer hosted in the drill system of the ExoMars2020 rover that will characterize the mineralogy and stratigraphy of the excavated borehole wall at different depths (<2 m) [4]. Ma_MISS with a spectral range of 0.5–2.3 µm, a spectral resolution of about 20 nm in the IR, a SNR~100, and a spatial resolution of 120 µm will accomplish the following scientific objectives: (1) determine the composition of the subsurface materials; (2) map the distribution of the subsurface H_2O and hydrated phases; (3) characterize important optical and physical properties of the materials (e.g., grain size); (4) produce a stratigraphic column that will provide information on the subsurface geology. Ma_MISS will operate periodically during pauses in drilling activity and will produce hyperspectral images of the drill's borehole (Fig.1).

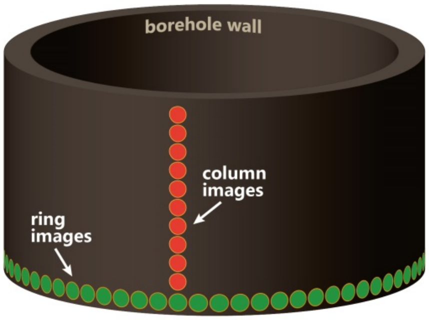

Fig. 1: Representation of a "column image" (red dots) and a "ring image" (green dots) acquired during a vertical translation and 360° rotation of the drill tip, respectively.

3. Experimental setup

The characterization of the scientific performances of the Ma_MISS instrument was made using the laboratory model (breadboard, Fig. 2 [5], [6]) at the Institute for Space Astrophysics and Planetology – INAF. The Ma_MISS breadboard includes the 5 W light source, the optical fibres and the Optical Head with the dual task of focusing the light on the target and recollecting the scattered light. However, it does not include the integrated spectrometer and is therefore coupled with a laboratory spectrometer (FieldSpec 4).

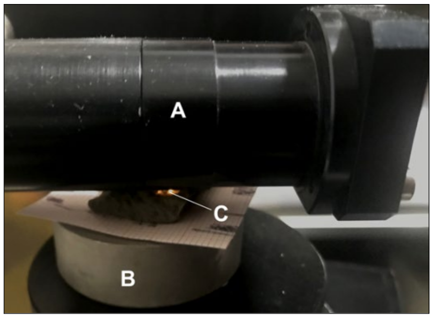

Fig. 2: Ma_MISS breadboard setup. A: Ma_MISS tip; B: sample holder; C: Ma_MISS illumination spot on a sample.

4. Martian analogue measurements

Several measurements have been performed on samples with different nature and texture to test the scientific performance of the Ma_MISS instrument.
The spectra collected on micro-stratified samples (Fig. 3) and on samples with porphyritic texture [6] was used to test the capability of the instrument to distinguish different components in natural rocks and in sedimentary sequences that show micro layering.

Fig. 3: Micro-layered samples composed of ground rocks and single minerals with different grain sizes.

Spectroscopic measurements made on single minerals chosen based on the mineralogy detected by OMEGA and CRISM in Oxia Planum area will allow us to build a spectral database useful for the interpretation of the scientific data. Moreover, the selected minerals allow us to test the instrument with both dark and bright samples. The measurements on powdered Martian analogues will be useful to investigate the variation of spectral parameters (i.e. reflectance and spectral slope) with the grain sizes. We are also conducting a field research campaign to retrieve Martian analogues [7].

5. Summary

Laboratory investigations have been performed using the breadboard model (coupled with a FieldSpec Pro) on mineral at different grain sizes, mineral mixtures and layered/stratified rocks. Mineral mixtures and mm-sized layered rocks can simulate stratigraphy of excavation inside regolith or mounds and outcrops of sedimentary origin. Analyses of layered rocks showed that spectral/mineralogical differences are discernible for millimetre-sized layering. The spectra acquired on samples with different grain sizes are in good agreement with the corresponding spectra acquired with a different setup.
Analyses of mineral mixtures at different grain sizes showed that the spectral/mineralogical diversity among the endmember components increases as the grain size exceeds the 120 μm-instrument spot.
Spectroscopic analysis performed on Martian analogues shows that the Ma_MISS instrument has spectral range, resolution, and imaging capabilities suitable for the characterization of subsurface environments.
Measurements of these type of samples can be also used to develop the operational strategies that Ma_MISS will adopt during the scientific phase of the mission.

Acknowledgements

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References

[1]Vago J.L. et al. (2017): Astrobiology, 17, 6, 7.
[2]Quantin C. et al (2016) #2863, 47th LPSC, Houston, TX.
[3]Carter J. et al. al (2016) #2064, 47th LPSC, Houston, TX.
[4]De Sanctis M.C. et al. (2017): Astrobiology, 17, 6, 7.
[5]De Angelis S. et al. (2014): PSS, 101, 89-107.
[6]De Angelis S. et al. (2017): PSS, 144, 1-15.
[7]Frigeri A. et al. (2019): This conference.