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Spectral measurements of Terrestrial Mars Analogues: support for the ExoMars – Ma_Miss instrument

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Introduction

The Ma_Miss (Mars Multispectral Imager for Subsurface Studies) instrument onboard of ExoMars 2018 mission to Mars will investigate the Martian subsoil down to a depth of 2 meters [1]. Ma_Miss is a miniaturized spectrometer, completely integrated within the drilling system of the ExoMars Pasteur rover; it will acquire spectra in the range 0.4 – 2.2 μm, from the excavated borehole wall. The spectroscopic investigation of the subsurface materials will give us precious information about mineralogical, petrologic and geological processes, and will give insights about materials that have not been modified by surface processes such as erosion, weathering or oxidation. Spectroscopic measurements have been performed on Terrestrial Mars Analogues with the Ma_Miss laboratory model (*breadboard*). Moreover spectroscopic investigation of different sets of Terrestrial Mars Analogues is being carried on with different laboratory setups, as a support for the ExoMars – Ma_Miss instrument.

1. The Ma_Miss instrument

The spectrometer will be completely integrated within the rover drilling system [2]. A 5W lamp and an optical fibre bundle provide the illumination of the target; the Optical Head has the twin task of focusing the light on the target (1 mm spot) and of collecting the scattered light from the target (100 μm spot). A single optical fibre then carries the light to the spectrometer. The optical fibers system is hosted within the driller, and thanks to four 50-cm extension rods a 2-m depth can be reached. A sapphire window is the interface between the Optical Head and the target. This window is characterized by a high transparency and hardness. The focal distance is less than 1 mm. The instrument can operate in two main different modes: it can acquire spectra during the translation movement of the drill, thus obtaining a *column* image, or it can acquire spectra during the rotational movement of the drill, acquiring a *ring* image. A picture of the laboratory setup of the breadboard is in fig.1; the breadboard consists of the optical subsystems (Optical Head, Sapphire Window) and the illumination system (illumination bundle and signal fiber). It must be coupled with another spectrometer: here we used the FieldSpec Pro spectrophotometer [3].

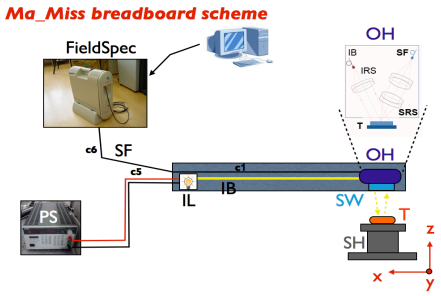

Figure 1: Picture of Ma_Miss BreadBoard lab setup.

1.1 Spectroscopy with the Ma_Miss BreadBoard

We started to perform spectroscopic measurements with the instrument breadboard on several sets of rock samples (Terrestrial Mars Analogues). The samples sets include igneous rocks, sedimentary rocks and Martian meteorites. In fig.2 we can see the spectrum of a Martian meteorite (Chassigny) acquired with the Ma_Miss breadboard and with the FieldSpec alone setup. Though the spectral shape is the same in both acquisitions, the difference in the spectral contrast is probably due to differences in the illumination conditions (5W for the Ma_Miss lamp against 80W for the FieldSpec lamp) and spatial resolution (FieldSpec, 6 mm; Ma_Miss, 100 μm).

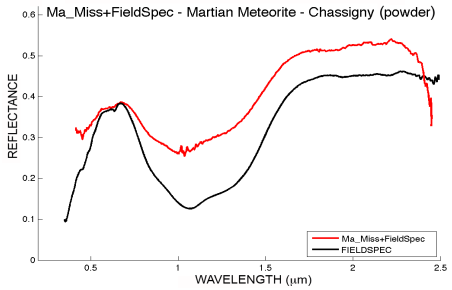

Figure 2: VNIR reflectance spectrum of Martian meteorite Chassigny (powder). Red: acquisition with Ma_Miss BreadBoard; black: acquisition with the FieldSpec setup.

2. Spectral characterization of Mars Analogues

An activity of reflectance spectroscopic measurements is being carried on, with the aim of support the development of the Ma_Miss instrument, and of build a lab spectral library that can be useful to the interpretation of ExoMars data. Many sets of rock samples, including igneous and sedimentary rocks, have been analyzed with a laboratory spectrophotometer (FieldSpec [3]). Here we report a series of analyses performed on volcanic lava samples from Aeolian Islands Arc (Sicily, Italy). The volcanics here analyzed, are most classified as basaltic andesites, HKCA porphyritic basalts, basalts and andesites [4]. The modal mineralogy constitutes principally of plagioclase, clinopyroxene, olivine and orthopyroxene, with accessory magnetite. A tool has been developed in LabView for the spectra analysis. The computing is performed in natural log reflectance and wavenumber. First of all, each spectrum is corrected for baseline: a definitive model of the continuum profile, that is due to multiple scatterings, reflections and other absorptions, does not still exist, thus there is no unique way to choose the correct baseline. Many authors use different types of lines for the continuum modeling, such as a straight line in energy domain, a polynomial or a Gaussian, or even a segment line [5,6,7]: here we use a 2^{nd} or 3^{rd} order polynomial, which is found fitting several points along the spectrum. The baseline is then subtracted from the spectrum; all spectra are characterized by a broad band in the 1.0-1.4 μm range, while the 2-μm band is very weak and flattened. Following the MGM model of Sunshine et al. [5] these bands have been fitted with 2-3 modified Gaussians. Each Gaussian represents a specific absorption process which is parameterized by: depth, position and width. Another parameter that is taken into account is the continuum mean slope: it is computed taking the slope of a line intersecting two points, generally around 0.76 μm and 2.0 μm, that typically represent local maxima. The continuum slope can give information about the sample grain size from fine powder to rock' slab and/or variation of roughness. The band at 1.2 μm is also analyzed; it appears as a shoulder of the wide 1-μm band, and can be related to the presence of plagioclase or mafic material like high-Ca pyroxene or olivine. The mean slopes of the band shoulders are also useful parameter.

3. Summary and Conclusions

The breadboard of the Ma_Miss instrument, a miniaturized VNIR spectrometer that will be onboard the Drill of the ExoMars 2018 mission Pasteur Rover, has been tested in laboratory; reflectance spectroscopy has been performed with the laboratory model. Spectroscopic measurements on Mars analogues are being carried on with a different lab setup (FieldSpec), with the aim of build a support spectral library. Many spectral parameters are taken into account in order to characterize the spectra and to get information.

Acknowledgements

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References

[1] Coradini, A. et al., Adv. Sp. Res.,28-8, p.1203-08, 2001.

[2] Preti, G. et al: IAC-11.A3.5.7, 2011.

[3] Coradini, A. et al:, IAU Symposium 229, 7-12-05, Rio de Janeiro, Brazil, 2005.

[4] Laiolo M. and Cigolini C., Bull Volcanol., 68:653-670, 2006

[5] Mc Cord, T.B., et al., JGR, 86, B11, 10883-892, 1981

[6] Sunshine, J.M., et al., JGR, 95, B5, 6955-6966, 1990

[7] Clenet, H., et al., Icarus 213, 404-422, 2011