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MA_MISS AND TERRESTRIAL ANALOGUES FOR MARS

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Abstract

The MA_MISS instrument (Mars Multispectral Imager for Subsurface Studies) is a VIS-NIR spectrometer devoted to study the Martian subsoil within the ExoMars mission. This miniaturized spectrometer is integrated in drilling system of the ExoMars Pasteur Rover, and will investigate the Martian subsoil down to 2 m, in the spectral range 0.4 – 2.2 μm [1,2]. It will provide important information regarding the composition and mineralogy of the Martian subsoil, whose materials are expected to be less altered by erosion and other exogenous processes than surface rocks. With a view to doing laboratory spectroscopic measurements with the instrument breadboard, we performed preliminary laboratory measurements on Mars analogues using a spectrophotometer coupled with a goniometer.

1. The Experiment

MA_MISS miniaturized spectrometer is completely integrated within the ExoMars drill; it will produce multispectral imaging of the borehole walls excavated by the drilling system. The Optical Head of the instrument, which is protected from debris by a sapphire window, has two tasks: it is used to illuminate the borehole wall with an illuminating spot of 1 mm on the target, and to collect the scattered light from a 100 μm spot on the target. A box placed on the external wall of the Drill Box houses the spectrometer, the VNIR detector and the electronics. Optical fibers and an optical rotary joint are used in order to transmit the signals from the Optical Head to the spectrometer through the various elements of the drilling system. The spectrometer can produce *ring images*, by acquiring spectra during the drill rotation, or *column images*, by acquiring during the drill translation. The translation movement proceeds through steps that are equal to the observation spot. The collection of many adjacent ring images is useful in order to reconstruct a precise multispectral image of the borehole wall, thus obtaining information about the chemical composition, structure and mineralogy. Laboratory preliminary tests on the Optical Head have already been performed [2], analyzing reflectance spectra of representative minerals such as Olivine and Gypsum with a laboratory spectrometer, and also performing a drilling experiment, with MA_MISS integrated in the ExoMars Drill [2].

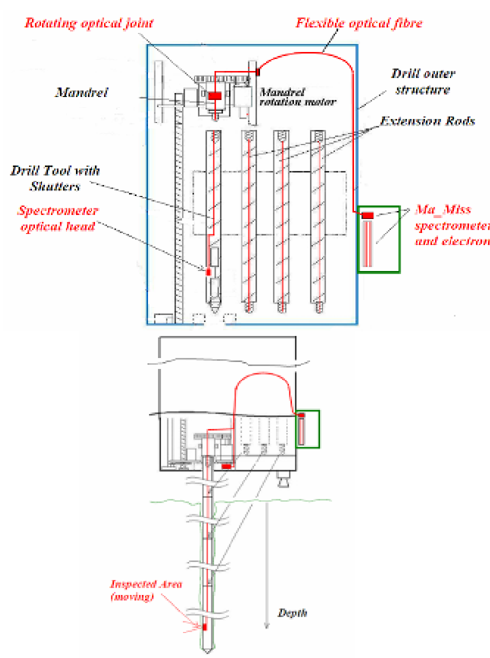

Figure 1: MA_MISS layout (in red) integrated in the Drill with the penetration system folded (upper) and deployed (lower) [4].

2. Analogues preliminary measurements

With the final goal of a dedicated measurement campaign in the laboratory with the MA_MISS breadboard, preliminary measurements have been performed on a terrestrial sample with a commercial spectrometer. The sample is a red micritic limestone, a carbonate rock that is typical of deep-sea environments. Sample powders have been previously prepared before of performing spectroscopic analyses; the powder has been sieved, in order to obtain samples with five different grain sizes in the range <100 μm – 800 μm. Reflectance spectra have been taken in the VIS and NIR range (0.35 – 2.5 μm) using a Fieldspec-Pro spectrophotometer coupled with a goniometer [3], with a 1 nm spectral sampling. It is possible to illuminate the sample (*i* = illumination angle) and to collect the emitted light at different angles (*e* = emission angle); here we configured the goniometer with *i* = 30° and e = 0°. The light source is a QTH lamp, producing a 0.5 cm^2 spot on the sample. Spectralon optical standards (LabSphere) have been used as white references. The reflectance spectra are in fig.2.

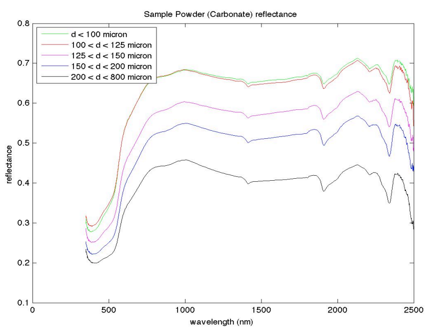

Figure 2: reflectance spectra of red micritic carbonate (powder).

6. Summary and Conclusions

The MA_MISS miniaturized imaging spectrometer, integrated within the drilling system of the ExoMars Pasteur Rover, will investigate the Martian subsoil down to 2 m; the spectrometer will acquire multispectral images of the borehole walls, thus obtaining precious information about the composition, structure and mineralogy of the less altered materials of the Martial subsoil. With a view to doing laboratory tests with the instrument breadboard on terrestrial analogues for Mars, several preliminary laboratory measurements have been performed with a terrestrial carbonate rock, using a spectrophotometer.

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