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# VNIR spectral analyses of powdered mixtures with ExoMars-Ma_Miss instrument

S. De Angelis (1), P. Manzari (1), M.C. De Sanctis (1), F.Altieri (1)
(1) Institute for Space Astrophysics and Planetology, IAPS-INAF, Rome Italy, (simone.deangelis@iaps.inaf.it)

## Introduction

Ma_Miss (Mars Multispectral Imager for Subsurface Studies) experiment onboard of ExoMars 2018 mission to Mars will study the Martian subsurface down to a depth of 2 meters [1]. Ma_Miss is a miniaturized spectrometer, integrated within the drilling system of the ExoMars rover; it will perform visible and near infrared spectroscopy in the 0.4 ‑ 2.2 μm range, acquiring signal from the excavated borehole wall. The spectroscopic characterization of the subsurface rocks will give us important information about mineralogy, petrology and geological processes; moreover it will give insights about materials that have not been altered by surface processes such as erosion, weathering or oxidation. Spectroscopic measurements have been performed on different types of rock/mineral mixtures with the Ma_Miss laboratory model (*breadboard*).

## 1. The Ma_Miss instrument

The miniaturized spectrometer will be integrated within the rover drill [2]. A 5W lamp and an optical fiber bundle provide the illumination of the target; the Optical Head focuses the light on the target (1 mm spot) and collects the scattered light from the target (about 100 μm spot, spatial resolution). An optical fiber carries the light to the spectrometer. The optical fibers system is hosted within the driller; a depth of 2 meters can be reached using four 50-cm extension rods. 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, between the window and the subsurface wall, is less than 1 mm. The breadboard (BB) consists of the optical main subsystems (Optical Head, Sapphire Window) and the illumination system (illumination bundle and signal fiber). In the laboratory it must be coupled with another spectrometer: here we used the FieldSpec Pro spectrophotometer [3]. Details on the instrument and on the laboratory BB setup are in [4].

## 2. Spectral measurements of rock mixtures

A set of powdered rock/mineral mixtures have been analyzed with the Ma_Miss breadboard instrument. Here we report about the results obtained on two different powder samples: (i) granite, and (ii) a mixture composed of alunite and a basaltic rock. The first mixture was produced starting from a granite piece: granite was composed by millimeter-sized crystals. The second mixture was produced starting from alunite crystals on a rock. Both powders have been grinded and sieved in four different grain sizes: d<100 μm, 100-200, 200-500 and 500-800 μm. Spectra have been acquired in several positions on each of the different samples. The high Ma_Miss spatial resolution (100 μm spot) will allow to obtaining spectra from different minerals, when measuring coarser grains: thus it allows to investigating in detail mineral mixtures with grain size exceeding about 100 μm.

*Granite*.
The spectra relative to the smallest grain size (d<100 μm, fig.1A) have been acquired on four different positions. They are very similar: the spectral shape is characterized by a red slope, typical of fine powder, and lacks remarkable absorptions except the one of $H_2O$ at 1.9 μm. The spectral behavior is dominated by quartz. Increasing the grain size of the powder with respect to the instrument spot, the spectral (and mineralogical) diversity becomes more evident (fig.1, panel B to D); the spectral slope also begins to vary among redder and bluer values, as the particle size increases. In fig.1 panel C, the spectrum of biotite appears (blue curve). In panel D the spectrum of feldspar (microcline) appears, characterized by blue slope (cyan curve). Other spectra are indicative of quartz; spectra blue and red in fig.1D could be attributed to biotite.

*Alunite – rock mixture*.

In the case of the mixture alunite/basaltic rock, the effects of spectral and mineralogical diversification become more evident as the grain size increases (fig.2). While spectra in fig.2A are very similar and with little shift in reflectance, spectra in fig.2D are characterized by different spectral shapes and reflectance values. Black, green and yellow curves (panel D) are indicative of the basaltic rock. Blue spectrum is characterized by Al-OH absorptions near 1.75-1.8, 2.2 μm, OH features near 1.3-1.5 μm and $H_2O$ near 1.9 μm.
In this case the effect of the presence of dark volcanic rock is to lower the overall reflectance, and to smooth the spectral features due to alunite. In some spots, only alunite grains can be present (fig.2D, blue spectrum), while in other spots a mixture of mineral and basalt can be observed: in this case there are no additional spectral features, but only a flattening of the spectrum.

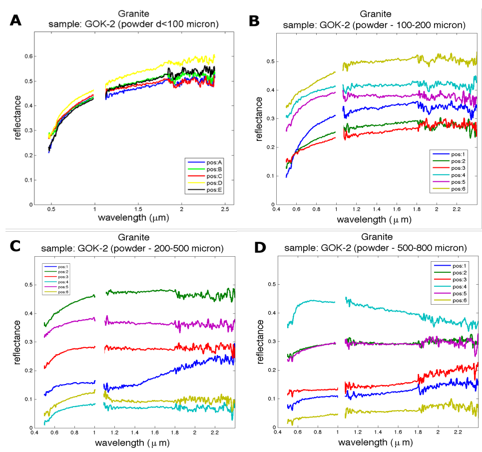


Figure 1: spectra of powdered granite, at four different grain sizes. Spectra in panels B,C,D are shifted in reflectance for clarity.

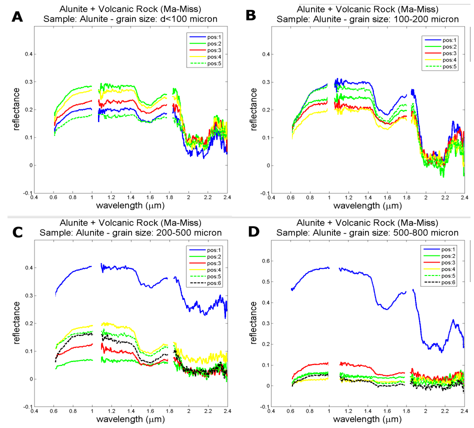


Figure 2: spectra of a powder mixture of alunite and basaltic rock, obtained at four different grain sizes.

## 3. Summary and Conclusions

The ExoMars/Ma_Miss miniaturized spectrometer will be integrated within the Rover Drill, and will perform VNIR spectroscopy of the subsurface rocks. Two different types of mineral/rock mixtures have been analyzed with the breadboard at INAF-IAPS laboratory. In both analyzed mixtures the spectral diversity gradually increases as the grain size exceeds the instrument spot of 100 μm (spatial resolution). The overall spectral slope also starts to become bluer as the dimension of grains increases. Thus it will be possible to investigate in detail mineral/rock mixtures with grain size (or texture) exceeding 100 μm.

## 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, Rio de Janeiro, Brazil, 2005.
[4] De Angelis S. et al, *Planetary and Space Science*, 101, 89–107, 2014