SPECTRAL ACQUISITIONS OF MIXTURES WITH MARTIAN SIMULANTS AND WATER ICE.
Planetologia sperimentale e di laboratorio – Strumentazione e simulazioni; Poster

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Introduction: On Mars, the North Polar Cap is made up mainly of water ice and in a minor content of dry ice. The variable percentage of dust into the polar layers causes variations in terms of composition and physical properties (e.g., dielectric constant). The different amount of lithic inclusions is probably due to climatic fluctuations originated by changes in orbital parameters [1].

The space spectrometer Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) onboard the NASA Mars Reconnaissance Orbiter (MRO) gives us information about composition of the Martian surface, even in the polar regions [2]. The spectra from the CRISM hyperspectral cubes in 400-4000 nm spectral range (spectral sampling of 6.55 nm/channel, spatial resolution of 18.4 m/px) on the polar layered deposits should be compared with spectral acquisitions of icy mixture taken in the laboratory. The main focus of this project is to retrieve the composition and the quantitative abundance of the dust included in the polar icy layers.

Simulant characterization: We have chosen three different Martian simulants commercially available: 1) Mars Global (MGS-1) High-Fidelity Martian Dirt Simulant which reproduces the average composition of the Red Planet [3]; 2) Mojave Mars Simulant MMS-1 [4] and 3) Enhanced Mars Simulant MMS-2 which both simulate the regolith composition found by the lander Phoenix [4].

We need a proper characterization of the simulants in order to know deeply their composition before mixing them with water ice and proceed with the spectral acquisition.

We have analyzed these materials using many instruments:

- Inductively Coupled Plasma Mass Spectroscopy: chemical analysis;
- X-ray powder diffractometry: mineralogical analysis;
- Mastersizer3000 Laser Diffraction Particle Size Analyzer: grain-size analysis;
- hyperspectral analysis in the VNIR-SWIR spectral range;
- SEM-EBS: confirmation of mineralogical composition of the coarse grains of MGS-1 simulant.

We have chosen to perform the first test with the MGS-1 simulant because, after all these analyses, it was confirmed to be the most similar to the main composition of the Red Planet [3]. In particular, we have used the finest component (0-32µm) since it is easier to obtain a homogeneous mixture.

Laboratory set-up: We used the Headwall Photonics Nano Hyperspec VNIR camera and the Micro Hyperspec SWIR camera for the hyperspectral acquisitions. Their accommodation stage was adapted to this type of experiment (Fig. 1). In particular, the sample was placed over a cold holder, whose temperature was controlled by a thermocouple. The spectral acquisition was performed under a nitrogen atmosphere to prevent any water-vapour condensation. The hyperspectral cameras acquired with their halogen filament lamp (150 W) in a dark room at room temperature (23.5°C).

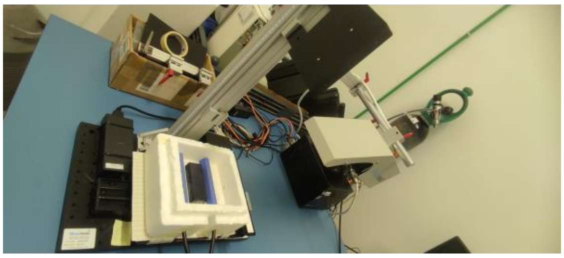

Figure 1. Set-up: hyperspectral camera and its accommodation for acquiring spectra of icy samples.

Icy mixtures: We have prepared multiple mixtures with different amounts of the Martian simulant, following the literature (e.g., [5]). We have mixed the finest particles (0-32 µm) of the simulant MGS-1 with the right quantity of deionized water. The sample has been prepared in order to have an extremely narrow thickness of the water/dust mixture. We have frozen it at -80°C, which is in the range of the polar temperatures during the Martian summer [6].

The resulting ice/dust slab (Fig. 2) have been acquired in the VNIR-SWIR spectral range, taking into account the effect of i) changes in dust/ice ratio; ii) temperature increase through time and iii) different freezing time and methods during the sample preparation.

We have also acquired some spectra of pure dry ice and dry ice mixed with simulant MGS-1, using the same set-up.

Figure 2. Icy slab of 30% Martian simulant MGS-1 and 70% water ice.

Results: As expected and reported by other authors using different set-ups (e.g., [7]) the SWIR spectra (1000-2500 nm) shows the 1500 nm and 2000 nm bands characteristic of the water ice becoming deeper with the decrease of dust content (Fig. 3).

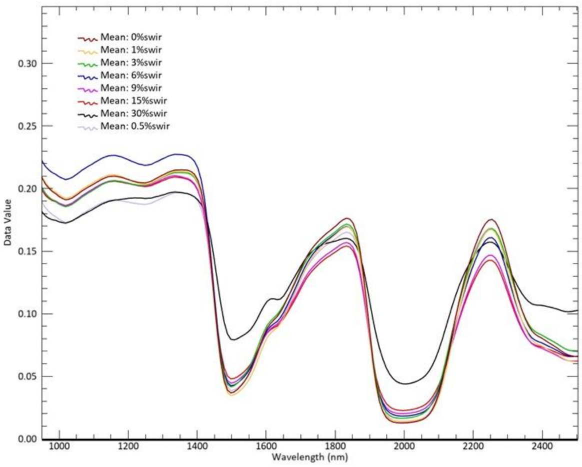

Figure 3. SWIR spectra of different concentrations of Martian simulants.

In the VNIR range (400-1000 nm), the spectra is mainly characterized by the 500 nm absorption band due to the contribution of the dust: with the increase of the amount of the inclusions in the ice slab the 500 nm band becomes deeper (Fig. 4).

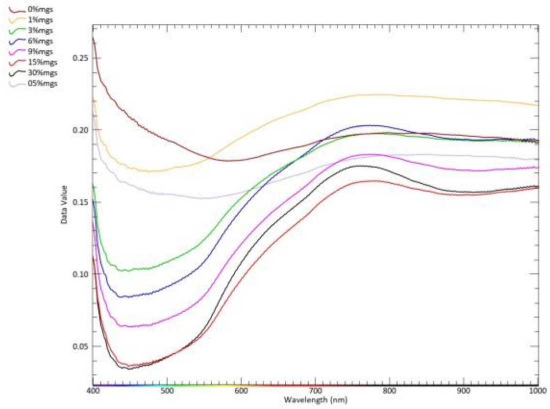

Figure 4. VNIR spectra of different concentrations of Martian simulants.

Moreover, the whole reflectance of the spectral signatures is affected by a general increase with the increasing of the icy slab temperature.

Conclusions: The described set-up is easy to build, indeed, this procedure is designed to be easily replicable. We show that the results are in line and comparable with what is found in literature. Moreover, we are able to study spectra of icy slabs instead of ice powder. This would be more sounding being the polar layers most probably formed by compact ice rather than a mixture of snow and dust. These first results are supportive of the analysis that we will plan. In the future, we will consider a wider grain-size range (e.g., 0-63 μm) of the Martian simulant for the icy mixture.

Finally, the spectra derived from this set-up will be compared with the ones from CRISM cubes on the northern polar regions to better understand the composition of the polar layers and try to quantify the amount of dust into the stratigraphic column.

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