EPSC Abstracts
Vol. 13, EPSC-DPS2019-1753-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Analogue Rock Sample Observation with MicrOmega, within the H2020/PTAL Project

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Abstract

The Planetary Terrestrial Analogues Library (PTAL) project aims to help characterizing the mineralogical evolution of terrestrial bodies through the collection of a set of analogue rock samples and their analysis through visible, XRD, IR and Raman spectroscopy, and LIBS. We describe here the implementation and validation of a specific bench dedicated to measurements using MicrOmega, an imaging microscope IR spectrometer.

1. Introduction

The PTAL project [1] aims to build and exploit an Earth analogues database [2], the Planetary Terrestrial Analogues Library, to help characterizing the mineralogical evolution of terrestrial bodies, with a special focus on the Martian analogue altered products. Within this project, a set of 94 natural Earth rock samples have been collected, of igneous, metamorphic, sedimentary or impact origin. The rocks suffered different conditions and levels of alteration or weathering. Those samples are characterized with thin section observations and XRD analysis, IR spectroscopy, Raman spectroscopy and LIBS.

The sample analysis is performed with commercial and space instruments. IR spectroscopy is performed using 1) a spare model of the MicrOmega space instrument, a microscope IR spectral imager [Bibring et al.], 2) a commercial IR point spectrometer mainly dedicated to the rock powders [3]. Models of the MicrOmega instrument have already been flown on the Mascot module of the Hayabusa-2 mission to the asteroid Ruygu [4], and been selected to the internal laboratory of the ExoMars rover to be launched in 2020 to the surface of Mars [5].

2. Development of a PTAL/ MicrOmega laboratory setup

The MicrOmega instrument that is used within the PTAL project is the spare model of the ExoMars project. It has a total field of view of 5 mm x 5 mm, with resolution of 20 µm/pixel in the focal plane. Its capabilities enables the identification of different crystals or grains of different mineralogy in the samples [6]. To work in optimal conditions for the observations and to ensure the protection of the MicrOmega flight spare, a complex set-up has been developed (Fig. 1).

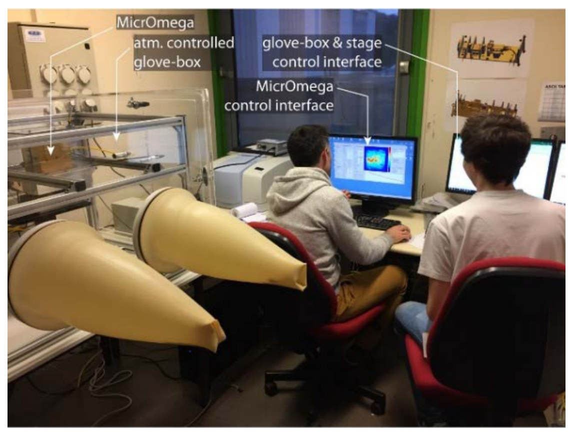

Figure 1: A view of the PTAL/MicrOmega bench during use.

The MicrOmega instrument better works at cold temperatures in a clean environment. Those requirements drove to the conception of a dedicated con-trolled chamber, saturated with dry air (pure nitrogen) to limit dust contamination and avoid frost on the instrument and samples. An actively cooled support for MicrOmega helps the instrument to regulate its temperature. Samples are introduced through an airlock in the main chamber.

A moving stage inside the chamber brings the samples around to the MicrOmega field of view and enables precise positioning. The platform at the top of the stage, can be cooled down to lower the temperature of the samples themselves and this way reduce undesired thermal emission.

3. Sample preparation

"Bulk" sub-samples from the PTAL rock collection have been prepared to use the imaging capabilities of MicrOmega. The focal plane is just 7 mm below the base of MicrOmega, implying constraints on the geometry of the samples that can be presented to the instrument. As the samples are cooled down from below, the samples should be only a few mm thick so the top surface is also cooled down. The ideal sample geometry is a sample with a flat base and a thickness of a few mm only: samples can be patches of sand or powder, or sections of bulk rock.

4. Laboratory bench validation

Fig. 2 shows an example of an altered impact breccia where millimeters and sub-millimeters grains of different mineralogy were identified after observation in the PTAL/MicrOmega set-up. Displayed spectra show identification of pyroxene (blue), strongly hydrated carbonates (red) and phyllosilicates (green). Those minerals were not all identified from the spectrum of the rock powder made from the same sample (black). Automatization of the setup allowed to complete the spectroscopic characterization of 10 samples in less than 6 hours.

5. PTAL/MicrOmega in the context of surface missions on Mars

ESA and NASA recently recommended/selected landing sites for their 2020 missions ExoMars and Mars2020, respectively Oxia Planum and Jezero Crater. Orbital IR spectroscopy has already been crucial in the identification and selection of those sites, where water alteration has played a prominent role. The mission target-rocks have compositional similarities with samples in the PTAL collection.

The IR spectrometers on board the rovers will be present at multiple stages of the surface operations and will be crucial to understand the geologic history of each landing site, and in particular the context of the water alteration of the rocks. The aid of this PTAL/MicrOmega laboratory set-up will take place with the use of the PTAL database to better interpret the *in situ* data, but will also give the opportunity to study additional terrestrial analogues, to recreate possible mineral mixtures and martian-like conditions to verify interpretations of the in situ data, and to confront results from different analysis techniques used in space to better prepare ExoMars or Mars2020 operations.

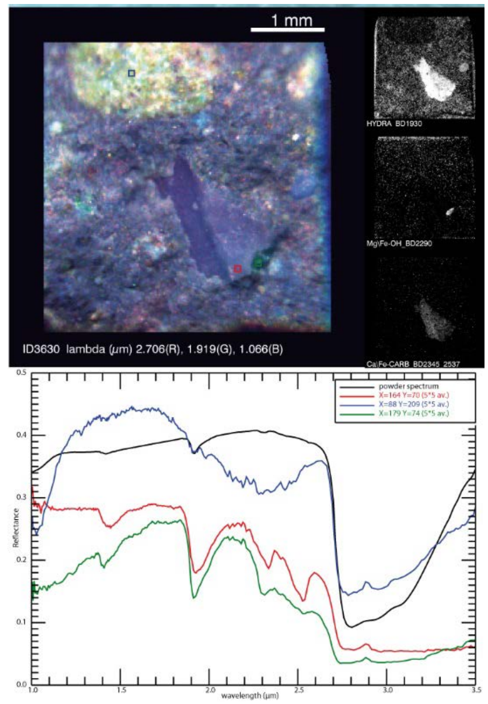

Figure 1: *Example of sample characterization using MicrOmega/PTAL facilities. Top: IR composite image from MicrOmega and maps of different hydrated mineral spectral features; bottom: spectra taken from the colored squares above, and spectrum of the rock powder from the same sample.*

Acknowledgements

We are grateful for the whole team that developed the MicrOmega instrument. This project is financed through the European Research Council in the H2020-COMPET-2015 program (grant 687302).

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