**ANALOGUE ROCK SAMPLES OBSERVATIONS WITH MICROMEGA, WITHIN THE H2020/PTAL PROJECT.**

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**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 natural Earth rock samples have been collected, compelling a variety of igneous and sedimentary rocks with variable compositions and levels of alteration. Those samples are characterized with thin section observations and XRD analysis (Oslo University, Norway), IR spectroscopy (Paris-Sud University, France), Raman spectroscopy (Valladolid University, Spain) and LIBS (Paul Sabatier University, France).

The sample analysis is performed with commercial and space instruments. This abstract focuses on the IR spectroscopy analysis that 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].

We here describe the implementation of a specific bench dedicated to automatic measurements using MicrOmega. A validation campaign of this setup confirming performances compliant with the objectives is also presented.

**MicrOmega:** The MicrOmega instrument that is used within the PTAL project is the sparemodel 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]. Identifying grains of different mineralogy can constrain the alteration history of the sample, but also participate to the selection of the Raman targets within this sample, onboard the ExoMars rover.

**Development of a MicrOmega/PTAL laboratory setup:** 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).

The MicrOmega instrument better works at cold temperatures in a clean environment. Those requirements drove to the conception of a dedicated controlled chamber, saturated with dry air (pure nitrogen) to limit dust contamination and avoid frost on the instrument and samples. An actively cooled support (~ -30°C) for MicrOmega helps the instrument to regulate its temperature.

A moving stage inside the chamber brings the samples around to the MicrOmega field of view. The platform at the top of the stage, where the samples are set, can be cooled down (~ -15°C) to lower the temperature of the samples themselves and this way reduce undesired thermal emission. The moving stage moves with enough accuracy so that it is possible to map automatically entire flat surfaces of samples by combining contiguous spectral cubes of 5 x 5 mm².

Samples are introduced through an airlock in the main chamber/glovebox to avoid bringing humidity inside the chamber, and are manipulated through gloves from the outside.

Fluids, cooling, heating, commands and data are controlled through a common command interface.

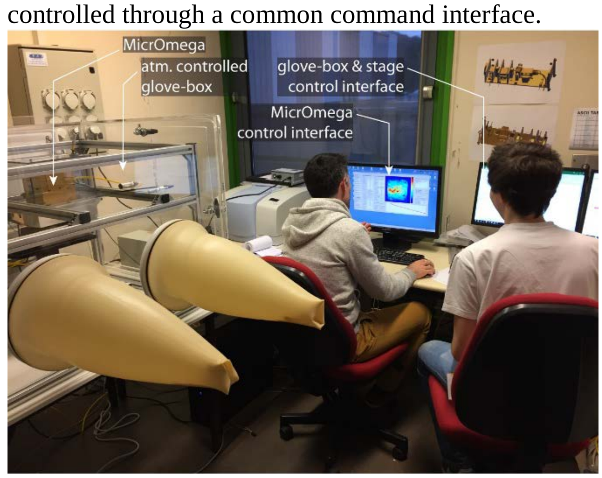


*Figure 1. A view of the PTAL/MicrOmega bench during use.*

**Sample preparation:** The PTAL rock collection includes a large set of samples (94 samples) of igneous, metamorphic, sedimentary or impact origin. The samples suffered alteration/weathering in near surface and deeper positions, resembling minerals reported elsewhere in the solar system and on Mars. Those rock samples were sub-sampled to be observed as "bulk" samples, 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.

**PTAL/MicrOmega bench validation:** We performed a validation campaign of the setup using about 10 samples of various albedos, compositions, and surface states. Fig. 2 shows an example of an altered impact breccia where millimeters and sub-millimeters grains of different mineralogy where 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.

**PTAL/MicrOmega in the context of surface missions on Mars:** ESA and NASA recently recommended or selected landing sites for their 2020 missions ExoMars and Mars2020. Both missions will land on geologic units where water alteration has played a prominent role, respectively in Oxia Planum and Jezero Crater, where different phyllosilicates and carbonates have been identified. The mission target-rocks have compositional similarities with samples in the PTAL collection.

IR spectroscopy has already been crucial in the identification and selection of those sites from the orbit. The IR spectrometers on board the rovers (ISEM and SuperCam on the masts of the ExoMars and Mars2020 rovers, Ma-MISS in the drill and MicrOmega in the internal laboratory of the ExoMars rover) 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 also by giving the opportunity to study additional terrestrial analogues, or to recreate possible mineral mixtures and martian-like conditions to verify interpretations of the *in situ* data.

In addition, having the opportunity to study in the lab the same characterized samples with MicrOmega and Raman and LIBS instruments is a great chance to confront results from these different techniques used in space to better prepare ExoMars or Mars2020 operations.

**References:** [1] Werner et al. (2018) *Second International Mars Sample Return, No. 2071*, 6060. [2] Veneranda et al. (2018) *2nd Int. Mars Sample Return, No. 2071*, 6069. [3] Lantz et al. (2019) *this conference* [4] Bibring et al. (2017) *Space Science Reviews 208*, 401-412. [5] Bibring et al. (2017) *Astrobiology 17*, 621-626. [6] Pilorget and Bibring (2014) *PSS 99*, 7-18.

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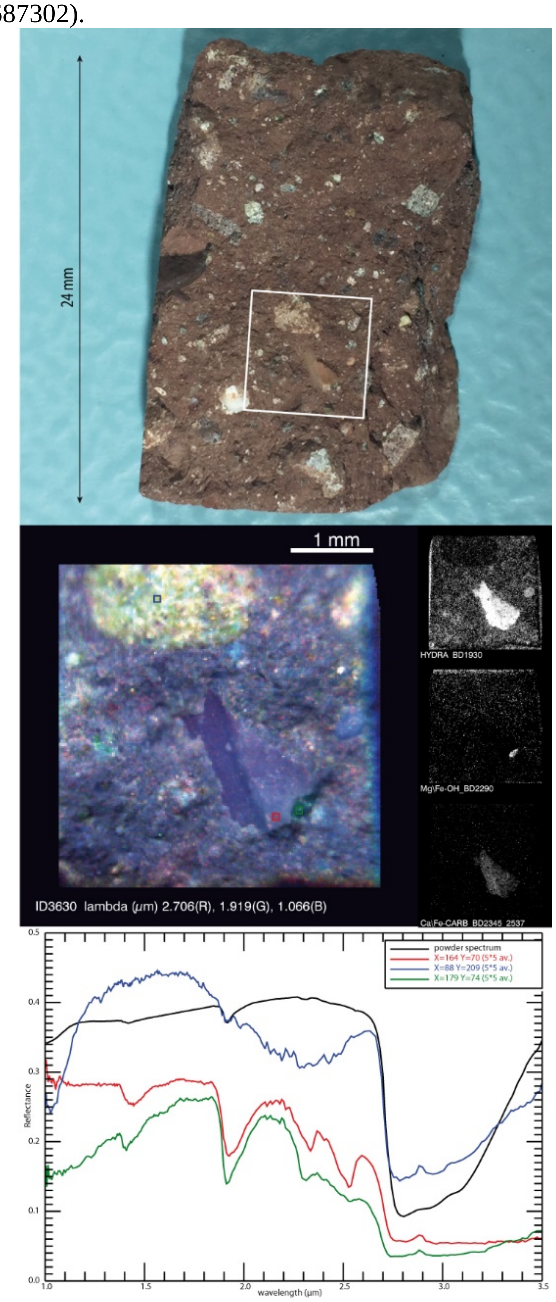


*Figure 2. Example of sample characterization using MicrOmega/PTAL facilities. Top: picture of the rock surface; middle: IR composite image from MicrOmega and maps of different hydrated mineral spectral features; bottom: spectra taken from the colored squares above, and spectrum of the rock powder from the same sample.*