

**NEAR-INFRARED SPECTRAL CHARACTERIZATION OF H2020/PTAL MINERAL SAMPLES.** C. Lantz<sup>1</sup>, F. Poulet<sup>1</sup>, D. Loizeau<sup>1</sup>, M. Veneranda<sup>2</sup>, H. Dypvik<sup>3</sup>, F. Rull Perez<sup>2</sup>, L. Riu<sup>4</sup>, C. Pilorget<sup>1</sup>, J. Carter<sup>1</sup>, and S.C. Werner<sup>3</sup>, <sup>1</sup>Institut d'Astrophysique Spatiale, CNRS/Univ. Paris-Sud, France (Bât. 121, 91405 Orsay Cedex; cate-line.lantz@ias.u-psud.fr), <sup>2</sup>Department of Condensed Matter Physics, Univ. of Valladolid, Spain, <sup>3</sup>Department of Geosciences, Univ. of Oslo, Norway, <sup>4</sup>Institute of Space and Astronautical Science, Sagami-hara, Japan.

**Introduction:** The PTAL project [1] aims at building and exploiting a database [2], the *Planetary Terrestrial Analogues Library*, in order to characterize the mineralogical evolution of terrestrial bodies, starting with Mars. A total of 94 natural Earth rocks have been collected on selected locations around the world to get the best analogues for martian geology. The PTAL samples collect a variety of igneous rocks from different plutonic and volcanic origin and composition, associated to different environments and level of aqueous alteration. Samples of sedimentary units of different origin and composition are also present.

Each sample is first characterized with XRD and thin section observation (Oslo University). Then, NIR (Paris-Sud University) and Raman (Valladolid University) spectroscopies are used. The samples will be finally analyzed by LIBS (Toulouse University) providing the elemental composition. These techniques are similar to the instruments on board current and forthcoming martian missions (Fig. 1). Such combined analysis [3] — with techniques that have never been brought together to Mars surface yet — will give the opportunity to prepare and understand ExoMars/ESA and Mars2020/NASA observations.

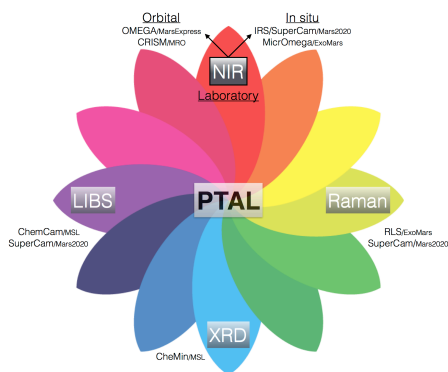


Figure 1: Overview of project PTAL.

**Techniques:** We will focus here on the Near-Infrared analysis made with a FTNIR spectrometer (Perkin Elmer Spectrum 100) that mimics spectral characterization of IRS/Mars2020 (a point spectrometer performing NIR observations in the range 1.3-2.6  $\mu\text{m}$  with spots of  $\sim 500 \mu\text{m}$  [4]). Spectra are acquired on crushed samples (powder with grain size  $< 100$

$\mu\text{m}$ ). Thus one obtains homogeneous sample for which the spectral information provided by the setup is sufficient to characterize it. The exact same protocol is followed for each measurement.

**Results:** The diversity of the PTAL samples is well revealed by the huge diversity of spectra from the NIR observations (Fig. 2 and 3). The detected minerals are representative of various formation, alteration and geochemical environments. The major diagnostic features observed are primary silicates like Olivine or Pyroxene with low and/or high Calcium content; altered silicates detected with vibrational features associated to OH and/or H<sub>2</sub>O and/or metal-OH features; Zeolites; Carbonates.

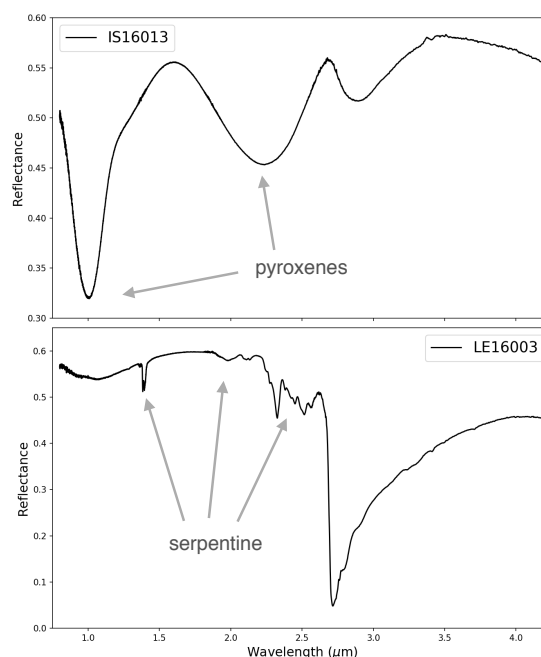


Figure 2: Examples of two end-member samples: one of the least altered (top) and one of the most altered (bottom). The first one shows only anhydrous silicates (not counting the hydration band at 2.7  $\mu\text{m}$ ). The second one shows clear serpentine features.

Following the methodology developed for Mars surface remote study, we started to apply a radiative transfer modeling [5] to a few samples. The obtained compositional results are remarkably consistent with

those from XRD and Raman techniques (Fig. 4 and Tab. 1).

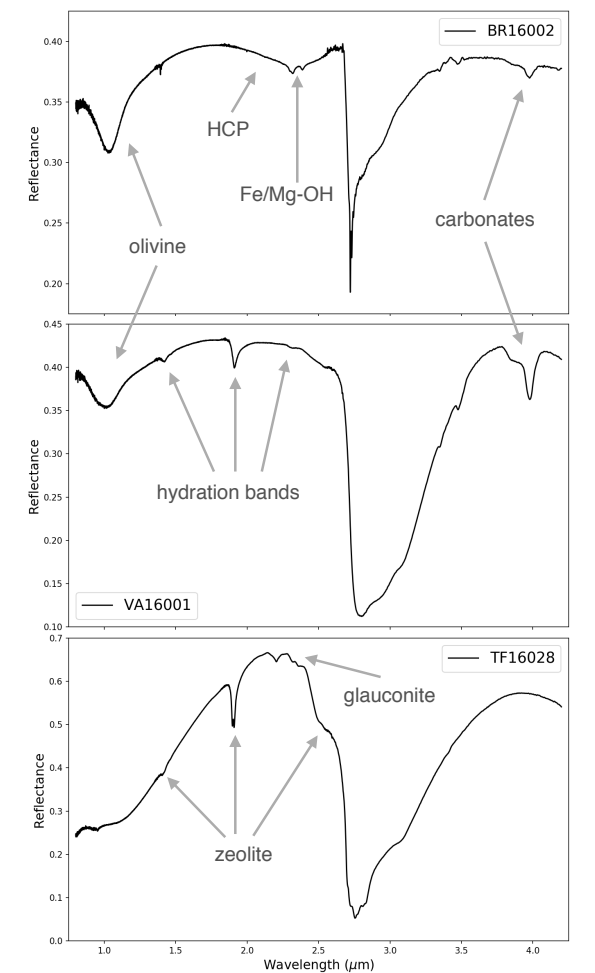


Figure 3: Examples of samples with different alteration features.

**Application to Mars space missions:** The analysis of the PTAL samples will also support the study of the forthcoming space missions landing sites. The Mars2020 mission will bring, on the mast of the rover, the IR, Raman, and LIBS techniques in Jezero Crater. This landing site presents Fe-olivine, Mg-phyllsilicates, and carbonates [6] possibly formed in situ and/or transported by fluvial activities. The ExoMars mission will bring a laboratory equipped with IR and Raman techniques (among others) to the Oxia Planum landing site. Based on remote sensing data, this site seems to be composed of Mg/Fe vermiculite phases. The origin of these low temperature phases are not well understood [7] so that any terrestrial analogue of similar composition could help to decipher their origin(s). We review the full PTAL collection to identify potential analogues. The team will also perform measurements with a flight spare of MicrOmega/ExoMars (0.9-3.5

μm) for better comparison with both missions instrumentation. ExoMars will also have an IR mast spectrometer, ISEM [8]. As part of the PTAL project, comparison of our samples with actual orbital data will be also performed.

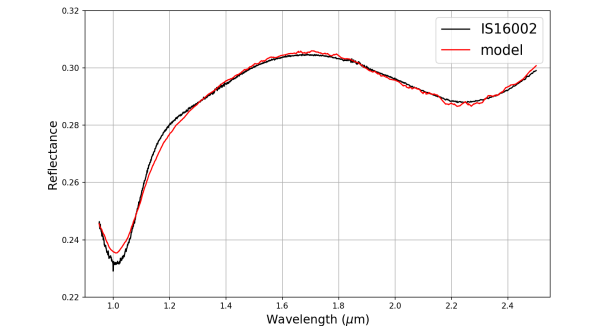


Figure 4: An example of spectral modeling on a sample composed only of anhydrous silicates. Based on NIR interpretation, one can say this sample is made of pyroxene. The use of the model allows to give a better identification and amount of materials. In this case, we found a mix of HCP and LCP among others as follows: 35% diopside, 33% augite, 30% labradorite, and 2% ilmenite which is consistent with XRD and Raman measurements, both in terms of pyroxene content and phases.

XRD	Raman	NIR	model
pyroxene +	diopside +	pyroxenes	diopside +
	augite +		augite +
plagioclase +	labradorite +		labradorite +
forsterite	olivine -		
	ilmenite -		ilmenite -
	hematite -		

Table 1: Example (same as in Fig. 4) of mineral composition using different techniques. The ‘+’ and ‘-’ give a raw estimation of relative abundance.

**References:** [1] Werner et al. (2018) *Second International Mars Sample Return*, No. 2071, 6060. [2] Veneranda et al. (2018) *Second International Mars Sample Return*, No. 2071, 6069. [3] Lantz et al. (2018) *Second International Mars Sample Return*, No. 2071, 6090 [4] Wiens et al. (2016) *LPSC*, No. 1903, 1322. [5] Poulet et al. (2009) *Icarus*, Vol. 201, 69-83. [6] Brown et al. (2018) *LPSC*, No. 2083, 1761. [7] Quantin-Nataf et al. (2018) *LPSC*, No. 2083, 2562. [8] Korabiev et al. (2017) *Astrobiology*, Vol. 17, 542-564

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