PLANETARY TERRESTRIAL ANALOGUES LIIBRARY (PTAL): A NOVEL MULTI-ANALYTICAL DATABASE TO SUPPORT EXOMARS AND MARS2020 MISSIONS. M. Veneranda[1], J. Saiz[1], J.A. Manrique[1], G. Lopez-Reyes[1], J. Medina[1], D. Loizeau[2], C Lantz[2], F. Poulet[2], A.M Krzesinska[3], H. Dypvik[3], S.C. Werner[3], F. Rull[1], [1]University of Valladolid (marco.veneranda.87@gmail.com), [2]University of Paris-Sud, [3]University of Oslo.

Introduction: The aim of the PTAL project is to create a multi-analytical database of Terrestrial analogue samples that have been collected on the basis of their congruence to well-known Martian geological and environmental contexts. As a whole, the multi analytical data will provide a comprehensive view of the geochemical and mineralogical composition of the over 100 analogue materials. The PTAL platform will also give access to data collected from artificial samples that have been altered in the laboratory under controlled physical-chemical conditions (gas pressures, aqueous salinity, temperature etc.) to reproduce putative alteration processes occurred on Mars. The PTAL website will also implement a novel functionality that will allow future users to request physical access to analogues and synthesized materials. In this way, it will offer the opportunity to combine the data contained in the PTAL library with further analysis in the laboratory.

Being in the latest stage of its development, the PTAL platform is expected to be released to public at the end of 2021.

Further information about the project and related publications can be found at the PTAL official webpage (https://ptal.eu/), which can be directly accessed through the QR code provided in Figure 01.

Figure 01: PTAL QR code

Analytical data: PTAL terrestrial analogues were analyzed by a combination of complementary analytical techniques. XRD analyses of powdered samples and petrological observation of thin sections were first carried out to gather a reliable overview of samples' mineralogy. Then, LIBS, IR and Raman spectrometers were used to collect additional elemental and molecular data, these being the key analytical tools onboard NASA/Perseverance and ESA/Rosalind Franklin rovers that will soon operate on Mars. In this case, standard laboratory Raman and FTIR systems were used to characterize all PTAL samples under optimal analytical conditions. In addition to these, the RLS ExoMars Simulator, the MicrOmega-Flight Spare Model (FS) and the ChemCam-FS were employed to gather LIBS, Raman and NIR spectra (respectively) qualitatively comparable to those that will soon collected on Mars. In total, the PTAL platform provides access to 1 diffractogram, 1 NIR spectrum [1], 1 MicrOmega datacube and 1 LIBS spectrum per sample. Regarding Raman analysis, between 4 and 10 spectra per sample are included, providing a total of 577 Raman data [2].

In addition to those, during 2021 additional Raman analysis of selected samples will be carried out with a stan-off Raman system which was recently assembled to emulate the remote Raman analysis the SuperCam instrument will soon perform on Mars.

Spectral tools: The PTAL platform will facilitate direct access to the SpectPro software. Developed in the framework of the ExoMars/ESA project, SpectPro will provide the scientific community with the set of functions necessary for a refined interpretation of the spectroscopic data included in the database. Further information about the functionalities of this software are provided elsewhere [3]

Case of study, Otago samples: Raman: Among the PTAL analogues, the samples collected from Otago chlorite schists formation, New Zealand were included for being representative of the vermiculitic phyllosilicate units (high in Fe^{2+}) detected at Oxia Planum, the landing site selected for the ExoMars mission [4].

Raman: As resumed ion Table 01, the detailed interpretation of Raman data proved that samples OT-0001 and OT-0002 are mainly composed of feldspar and quartz primary phases (Figure 02). However, minor anatase and epidote minerals were also detected in both samples together with clear spectroscopic features of phyllosilicates. Regarding sample OT-0003, both microRaman and RLS ExoMars Simulator analysis were able to detect feldspar, quartz and phyllosilicate phases. In addition to those, hornblende and epidote were found. The mineralogical composition of sample OT-0004 is very similar to the abovementioned analogue materials. In this case however, amorphous carbon was additionally detected. To conclude, OT-0005 also provided clear Raman signals of amorphous carbon, together with feldspar, anatase, phyllosilicate, quartz and epidote.

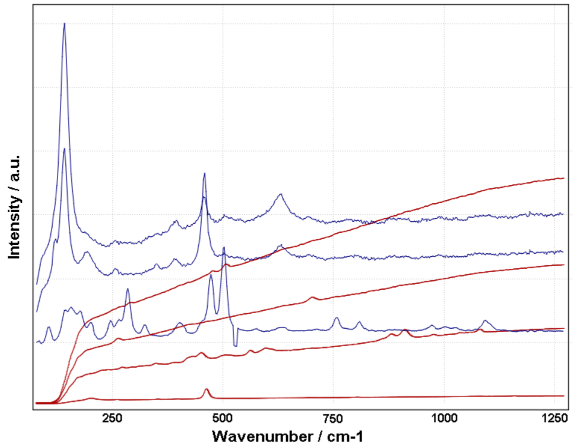

Figure 02: Representative Raman spectra collected from sample OT-001 by means of the laboratory spectrometer (red) and the RLS ExoMars Simulator (blue)

NIR: Complementary to Raman results, NIR spectra evidenced the presence of alteration products in form of phyllosilicates, zeolite and potentially iron oxide minerals. As presented in Figure 03, the presence of a strong spectral slope up to 1.8 µm, a strong 1.9 µm band, a strong drop after 2.2 µm with two bands at 2.25 and 2.33 µm suggested the presence of mixed-layer chlorite-smectite, rich in Fe/Mg.

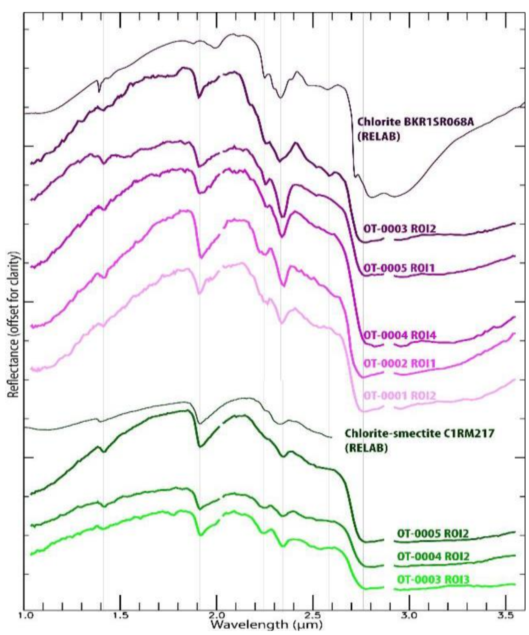

Figure 03: Selection of local averages of MicrOmega spectra from Otago rock samples compared with reference spectra of chlorite and chlorite-smectite.

The results were finally compared to XRD results, this being the reference technique for the mineralogical characterization of geological samples. The detailed XRD characterization of these samples is presented in a company abstract [4]. As can be seen in the resume Table 01, the combination of Raman and NIR analysis enabled the detection of all main mineral compounds, while achieving the detection of minor phases that were below the detection limit of the diffractometer.

Table 01:Summary of Raman, NIR and XRD results gathered from OT analogue samples

Sample / mineral	OT-001	OT-002	OT-003	OT-004	OT-005
feldspar	x o	x o	x o		x o
quartz	x o	x o	x o		x o
phyllosilicates	x ◊ o	x ◊ o	x ◊ o	x ◊ o	x ◊ o
zeolite		◊		◊	
iron-oxides				◊	
anatase	x	x			x
hornblende			x	x	
epidote	x	x	x	x	x
carbon				x	

x = Raman ◊ = NIR O = XRD

These results highlight the complementarity between the two spectroscopic techniques that play a key role in the fulfilment of the ExoMars mission objective. Once remote Raman spectra are collected, their combination with ChemCam-FS LIBS results will also provide insights into the potential scientific outcome of the SuperCam multi-analytical suite onboard the Mars 2020 Perseverance rover.

As such, the PTAL database could be an extremely useful tool for the scientific community working in the field of space exploration and, more in detail, for the researchers involved in the scientific exploitation of the spectroscopic data gathered by Mars2020 and ExoMars rovers.

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