Europlanet TA Scientific Report

PROJECT LEADER

Project number: 22-EPN3-088
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TA Facility visited: Medical University of Graz, Microbial Life detection facility, FELMI-ZFE – Austrian Centre for Electron Microscopy & Nanoanalysis of the Graz University of Technology

Project Title: Scrutining bio- and geo-signatures in support of the Raman interpretation of space missions data

Scientific Report Summary.
(plain text, no figures, maximum 250 words, to be included in database and published)

This project is devoted to investigate geo- and biosignatures that can be preserved in mineral assemblages formed in extreme aqueous terrestrial environments. Environments such as subaerial hot springs that could had existed on early Mars, and cold-seep marine environments that can develop in icy-moon oceans are particularly interesting for astrobiology. In order to achieve this goal, we use information obtained by Raman spectroscopy and SEM/EDX microscopy.

Raman spectroscopy is a recently incorporated analytical technique in the payload of several space missions: SHERLOC@Perseverance, Supercam@Perseverance, RLS@ExoMars and RAX@MMX. It is based on the scattering effect generated by the interaction of photons with the electron density of the chemical bond of a molecule. The position and width of the Raman bands give information on the structure, chemical and isotopic composition and crystallinity of mineral. Studying changes in Raman frequencies allows to evaluate the biological or inorganic origin of the sample. This methodology is relevant for the in-situ identification of geo- and bio-signatures in soil/rock samples collected during space missions.

Several bio-mediated minerals sampled from several hydrothermal and cold-seep areas were characterised by micro-Raman spectroscopy coupled with scanning electron microscopy (SEM/EDX). Obtained Raman spectrum was correlated with its texture in order to identify patterns that would allow us to assess the biological or inorganic origin. We observed Raman band shifting and width changes. These results should be complemented by further experimental work to determine the involvement of bio-mediation processes.

Full Scientific Report on the outcome of your TNA visit

The two main objectives of the project were: i) to characterise mineral phasess from extreme environments at microscale by analysing their related compositional and morphological features by coupled SEM/EDX (texture and chemistry) and Raman spectroscopy (bands position, intensity ratio, width and area), and ii) to determine features that might indicate biological mediation, which could be used in space exploration.

We selected eight natural rock samples collected from four Mars analogue sites and one for investigating icy-moon oceans. Before performing the characterisation of the samples described in Table 1, they were prepared to the size required by the instruments, and embedded in a resin when the compaction was low, e.g., samples A, B, C and D4.

Table 1. Location and the studied minerals of each samples.

Sample			Location	Geological setting	Studied minerals that are potentially biomediated	Planetary analogue
A	Clathrite		Hydrate Ridge (Cascadia Margin, Oregon)	Cold-seep in marine methane clathrate environment	Aragonite, calcite, dolomite, framboidal pyrite	Icy-moon ocean
B	Siliceous hot sping deposit		Krysuvic (Iceland)	Acid hydrothermal spring	Anatase	Mars
C	Gaylussite-rich stromatolite		Diamante Lake (Puna volcanic field, Argentina)	As-rich basic hydrothermal spring	Gaylussite	
D1	Travertine 1		Vega Verde Botijuela (Puna volcanic field, Argentina)	Basic hydrothermal spring	Calcite	
D2	Travertine 2				Calcite	
D3	Travertine 3				Calcite	
D4	Travertine 4				Calcite	
E	Basaltic tuff		Cerro Caliente (Deception Island, Antarctica)	CO2-rich geothermal site in permafrost	Aragonite, tricalcium phosphate	

Initial results show:

- Differences in the degree of crystallinity between travertine samples related to the distance to the fluid source. The presence of an additional lattice vibration band (not assigned yet) was detected in these samples, excepting in sample D4.
- We identified a phosphate mineral in the upper section of Cerro Caliente hydrothermal spring in addition to the main alteration minerals: e.g. smectites, oxides.

- Clathrite sample is composed of three carbonate mineral phases: aragonite, Mg-calcite and dolomite. The latter two are related to clathrate hydrates. A pattern related to the process of formation and dissociation of clathrate hydrates has been found.
- In case of the stromatolite sample from La Puna and the basaltic tuff sample from Cerro Caliente, the stretching band of both minerals, gaylussite and aragonite, shift from their respective value reported in the mineral database (RRUFF). Further experimental work are needed to investigate if these evidences are the result of biological mediation.

- Give details of any publications arising/planned (include conference abstracts etc)

One or two contributions to the EANA 2023, DPS-EPSC 2023 and/or EPSC 2024 conferences and at least one JCR article are expected.

- Host confirmation

Please can hosts fill in/check this table confirming the breakdown of time for this TA project:

Dates for travel to accommodation for TA visit (if physical visit by applicant)	Start Date of TA project at facility	Number of lab/field days spent on TA Visit pre-analytical preparation	Number of days in lab/field site for TA Visit	Number of days spent in lab for TA Visit data analysis	End Date of TA project at facility	Dates for travel home (if physical visit by applicant)
Departed: 16-04-23 Arrived: 16-04-23	17-04-23	0	10	0	28-04-23	Departed: 29-04-23 Arrived: 29-04-23

The host is required to approve the report agreeing it is an accurate account of the research performed.

Host Name	**Christine Moissl-Eichinger**
Host Signature	
Date	**06.06.2023**

- Project Leader confirmation

Do you give permission for the full version of this TA Scientific Report (in addition to the 250 word summary) to be published by Europlanet 2024 RI on its website and/or public reports? YES

Project Leader Name	**Ana de Dios Cubillas**
Project Leader Signature	
Date	**30-05-2023**