# Europlanet TA Report

| Infrastructure short name | Installation ID | Installation short name |
|---|---|---|
| DPSF | TA2-4 | CSS |

## PROJECT LEADER – APPLICANT 1

| | | |
|---|---|---|
| **Project number:** 11276 **/ 17-EPN3-042** | | |
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## CO - APPLICANT

| | | |
|---|---|---|
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*How did you hear about us?*

| | | |
|---|---|---|
| Website | Advertising email | **X** Colleague |
| Other | | |

**HOST / COLLABORATORS –** This information is required for reporting.

| Name: | Affiliation: |
|---|---|
| Assimo Maris | Department of Chemistry "Giacomo Ciamician"<br>University of Bologna |
| Camilla Calabrese | University of Basque Country UPV/EHU<br>Facultad de Ciencia y Tecnología |
| | |
| **Start Date of visit** | 30/01/2018 |
| **Finish Date of visit:** | 05/02/2018 |
| **No. of days:** | 5 |

| | |
|---|---|
| Please do not include travel days, this is lab/field access only | |
| **Host laboratory:** | Institut de Planétologie et Astrophysique de Grenoble (IPAG) |
| | |
| **Will be Reimbursed** | Yes |

# Project Title

Spectroscopic Investigation of Terrestrial Analogues of Mars By Simulating Different Environmental Conditions

# Project number

17-EPN3-042

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


The samples, collected close to the Dallol volcano in the Danakil Depression (TA1), were analyzed exploiting the TA2 – Spectro-Gonio Radiometers at IPAG. In particular, 4 different soil samples were studied immediately after the campaign: white halite from salt plain, yellow sulfur from hydrothermal source (crater), yellow halite with red crust of Fe hydrothermal source (volcanic arc), and yellow-green halite from hydrothermal source (hydrothermal chimney).

Firstly, spectra were collected with the new SHADOWS goniometer for all the samples before and after desiccation (spectral range λ=0.4-4 µm, incidence angle $\theta_i$=0°, emergence angle $\theta_e$=30°), including the internal side of the fragment if remarkable differences were noted. The samples were located in an open cell and kept at 1.5°C.

In order to better characterize the surface of the yellow halite with red crust, a Bidirectional Reflectance Distribution Function (BRDF) was also recorded in the same spectral range on both sides of the fragment (λ=0.4-4 µm, $\theta_i$= 0°/20°/40°, $\theta_e$ from -60° to +60°). Moreover, for the outside part, a spectrum with the SHINE goniometer coupled to the SERAC environmental cell was recorded under vacuum at 20°C and 80°C (λ=0.5-2.6 µm, $\theta_i$=0°, $\theta_e$=30°).

Finally, low temperature spectra and a room condition BRDF were carried out on the white halite from salt plain using the SHINE instrument coupled to the CarboN-IR environmental cell in the λ=0.5-2.6 µm spectral range. Reflection properties were studied at: (i) T=[-135°C, 15°C], $\theta_i$=0°, $\theta_e$ =30° and (ii) T=25°C, $\theta_i$=0°, $\theta_e$ =[-50°, +60°], respectively.

All spectra were collected using the following parameters: azimuth φ=0°, and angular/spectral/temperature samplings of $\Delta\theta_e$=10°, Δλ=0.02 µm, ΔT=25°C.


**Full Scientific Report on the outcome of your TNA visit** (Approx. 1 page)

Four samples were collected close the Dallol volcano in the Danakil Depression (TA1, 21-28/01/2018), namely: Sample 1 - White halite from salt plain; Sample 2 - Yellow sulfur from hydrothermal source (crater); Sample 3 - Yellow halite with red crust of Fe hydrothermal source (volcanic arc); Sample 5 - Yellow-green halite from hydrothermal source (hydrothermal chimney). The samples were analyzed from 30/01/2018 to 05/02/2018 at

the Institut de Planétologie et Astrophysique de Grenoble (IPAG) using two homemade spectro-gonio radiometers, SHINE and SHADOWS.

Preliminary mid infrared absorption spectra of all samples were recorded in 400-4000 $cm^{-1}$ frequency range using a commercial FT-IR spectrometer working under vacuum. About 10 mg of material were ground from the desiccated sample, mixed to about 290 mg of KBr and pressed to obtain a pellet which was then analyzed. According to the environmental natural conditions, the obtained spectra of all samples show strong features corresponding to the stretching (2.9 µm) and bending (6.2 µm) vibrational normal modes of liquid water.

VNIR reflectance spectra of all the samples were recorded using the new micro Spectro-photometer with cHanging Angles for Detection Of Weak Signals (SHADOWS) located in a dark cold room. Portions of about 2x2 cm dimension were cut from each of the original samples and measured both before and after desiccation. The samples were located in an open cell and kept at 1.5°C. The spectra were recorded in the λ=0.4-4 µm wavelength range using a step of Δλ=0.020 µm. A fixed illumination/observation geometry was used, with incidence angle $\theta_i$=0° and the emergence angle $\theta_e$=30°. The spotlight on the sample is about 6 mm diameter and the detector collection diameter is 2 cm.

Based on the reflectance properties and grain of the samples, sample 3 (yellow halite) was selected for Bidirectional Reflectance Distribution Function (BRDF) study with the SHADOWS instrument. The spectra were recorded in the λ=0.4-4 µm wavelength range using a step of Δλ=0.02 µm. The azimuth angle was fixed at φ=0°, whereas three incidence angles (θi=0°, 20°, 40°) were explored varying the emergence angle $\theta_e$ from -60° to $\theta_e$=60° with a step $\Delta\theta_e$=10°, resulting in 36 spectra. Both the outside red part and the inside yellow part of the desiccated sample were analyzed.

Based on the reflectance properties and grain sizes of the samples, the outside red part of sample 3 (yellow halite) was chosen to be analyzed with the Spectro-pHotometer with variable INcidence and Emergence (SHINE) coupled to the SERAC cell which allows for experiments at high temperatures. The spectra were recorded in the λ=0.5-2.6 µm wavelength range using a step of Δλ=0.02 µm. A fixed illumination/observation geometry was used, at incidence angle $\theta_i$=0° and emergence angle $\theta_e$=30°. The diameter of the spotlight on the sample is 20 cm and the detector collection diameter is 2 cm. The first spectrum was recorded under primary vacuum (p=1 mbar) at temperature of 20°C. Then the temperature was increased to 80°C and 10 spectra were recorded iteratively. At the end of the procedure both a water condensation and a mineral deposit were formed on the sapphire window of the cell. A final spectrum was recorded after cleaning the window.

The reflection properties of sample 1 (white halite) were characterized with the SHINE instrument coupled to the CarboN-IR cell. A preliminary spectrum was recorded in the λ=0.5-4.0 µm wavelength range using a step of Δλ=0.02 µm and an open cell at 13°C. A fixed illumination/observation geometry was used, at incidence angle $\theta_i$=0° and emergence angle $\theta_e$=30°. The VNIR spectrum shows strong features of water and, above 2.6 µm appears saturated by the water absorption. In the subsequent experiments the spectra were then collected in the λ=0.5-2.6 µm wavelength range using a step of Δλ=0.02 µm. First spectra were recorded with the closed cell at room pressure (p=1 atm, T=16°C) and under primary vacuum (T=10°C p=0.4-0.6 mbar). Then the behavior of the sample at low temperatures was investigated from T=-135°C to T=+15°C using a step ΔT=25°, resulting in seven collected spectra ($\theta_i$=0°, $\theta_e$=30°). The samples were kept under a carbon dioxide pressure of p=7 mbar to mimic Mars environment. In the last experiment an open cell at room conditions (p=1 atm, T=25°C) was employed for a BRDF experiment exploring the effect of the emergence angle at $\theta_e$(°C) = -50, -30, -20, -10, 10, 20, 30, 40, 50, and 60°, whereas the azimuth and incident angles were fixed at φ=0°, $\theta_i$=40°, respectively.

Additional work is required for the interpretation of the different spectral features, and their angular and temperature variations, recorded in these series of experiments.

## **Publications arising/planned** (include conference abstracts etc.)

- Astro-Winter Modeling Meeting, 15-16 February 2018, Bologna IT
  Abstract Title: Visible and near-infrared spectroscopy of terrestrial analogues of Mars by spectro-gonio radiometer measurements.
  Authors: Assimo Maris,* Camilla Calabrese, Sonia Melandri, Barbara Cavalazzi, Bernard Schmitt, Pierre Beck, Olivier Brissaud, Sandra Potin.
- Life on Earth and beyond: emergence, survivability, and impact on the environment - COST Action ORIGINS, 19-24 March 2018, Bertinoro IT
  Abstract Title: Investigation of Terrestrial Analogues of Mars By Simulating Different Environmental Conditions.
  Authors:Assimo Maris,* Camilla Calabrese, Sonia Melandri, Barbara Cavalazzi, Bernard Schmitt, Pierre Beck, Olivier Brissaud.

Depending on the results of the analysis of the data recorded during the TNA visit, a manuscript could be written and submitted for publication.

The recorded data will be uploaded to the SSHADE database infrastructure and made public within one year.

## Host approval

The two managers of the facility, Bernard Schmitt (CNRS/IPAG), and Pierre Beck (UJF/IPAG), approve the report and agree that it is an accurate account of the research performed during the visit of the Cold Surface Spectroscopy facility (DPSF/CSS/TA2-4).

**Annex 1**

| ***Access provider short name*** | ***Short name of infrastructure*** | ***Installation*** | | ***Installation Country code*** |
|---|---|---|---|---|
| | | ***ID*** | ***Short name*** | |
| INTA | PFA | TA1-1 | Rio Tinto | ES |
| IRSPS | PFA | TA1-2 | Ibn Battuta | IT |
| Matis | PFA | TA1-3 | Iceland | IS |
| INTA | PFA | TA1-4 | Tirez Lake | ES |
| IRSPS | PFA | TA1-5 | Danakil | IT |
| DLR | DPSF | TA2-1 | PEL | DE |
| MUG | DPSF | TA2-2 | IMRF | AT |
| AU | DPSF | TA2-3 | PEF | DK |
| CNRS | DPSF | TA2-4 | CSS | FR |
| UJF | DPSF | TA2-4(8) | CSS – 3rd party | FR |
| VUA | DPSF | TA2-5 | HPHT | NL |
| OU | DPSF | TA2-6 | LMC | GB |
| NHM | DPSF | TA2-7 | PMCF | GB |
| VUA | DAFS | TA3-1 | GGIF | NL |
| CNRS | DAFS | TA3-2 | HNIF | FR |
| CNRS | DAFS | TA3-3 | SRIF | FR |
| OU | DAFS | TA3-4 | HS50L | GB |
| OU | DAFS | TA3-5 | LFS | GB |
| OU | DAFS | TA3-6 | CSSIA | GB |
| WWM | DAFS | TA3-7 | RNTSI | DE |
| CNRS | DAFS | TA3-8 | IPF | FR |