Europlanet TA Scientific Report

PROJECT LEADER

Project number: 20-EPN2-015
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TA Facility visited: Rio Tinto, CAB-CISC, Spain
Date of TNA visit: Dr. Marco Ferrari / Simone de Angelis (Italy): 10-17 July but in the field 11-16 th (6 days) (10th and 17th travelling going and back)

COLLABORATOR

Name: Simone De Angelis **e-mail: simone.deangelis@inaf.it**
Home Institution: **ISTITUTO DI ASTROFISICA E PLANETOLOGIA SPAZIALI-INAF** **VIA DEL FOSSO DEL CAVALIERE, 100 - 00133 ROMA**

Project Title: **IN-SITU MEASUREMENT AND SAMPLING OF BIOSIGNATURE-HOSTING PRODUCTS IN SUPPORT OF ORGANICS DETECTION IN THE CONTEXT OF EXOMARS/2022**

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

This project aims at sampling and performing a wide set of VIS-NIR field measurements of weathering products (e.g., sulfates, clays), rocks with hydrothermal origin, and deposits showing evidence of biosignatures. To achieve this goal, during our visit we performed 195 measurement spots with the FieldSpec 4 portable spectrometer in the range of 0.35-2.5 µm and collected 47 samples in different forms. Among all the collected samples, 3 of them are consistent rock blocks. This is because they will be used as a test for the laboratory model of the Ma_MISS instrument that will be able to drill them and perform the spectroscopic measurements in the borehole wall.

This campaign will also allow us to confirm the capability of the Ma_MISS instrument to detect spectral signatures of organics in geological samples containing biosignatures. With the spectroscopic data obtained in the field and the laboratory on the collected samples, we will build a spectral database that will be useful to the scientific community.

These activities on terrestrial analogs have proven useful for understanding life in extreme conditions and how these can be preserved in the form of biological signatures and detected by the scientific instruments that will be on board future missions to Mars.

In addition, this work helps in acquiring crucial preparation for the exploitation and interpretation of the scientific data that the Ma_MISS instrument will provide during the active phase of the mission.

Full Scientific Report on the outcome of your TNA visit

INTRODUCTION: The selected landing site of the ExoMars mission (Oxia Planum) [1] shows mineralogical and morphological hints that it could be characterized by a hydrothermal history and by a long duration of aqueous superficial activity [2; 3]. These factors are consistent with conditions favorable to life development. In this framework, we conducted a field campaign in the Rio Tinto area [4; 5] where we performed a set of VIS-NIR measurements using our portable spectrometer both on biosignature-bearing rocks and alteration hydrated products. In addition, for each analyzed mineral/rock on-field, we collected a representative sample that we will measure with the Ma_MISS instrument laboratory model. This work will provide crucial preparation for the exploitation and interpretation of the scientific data that the Ma_MISS instrument will acquire during the active phase of the mission. Moreover, this activity may be relevant to the present and future Mars missions.

FIELD ACTIVITY: During our field trip to the Rio Tinto area, we visited the following locations:

Day 1 (11 July 22) Rio Tinto origin
Day 2 (12 July 22) Berrocal/Casa de los Sordos
Day 3 (13 July 22) Rabin Fools/Rio Tinto origin
Day 4 (14 July 22) Pequeño Grand Canyon
Day 5 (15 July 22) Peña de Hierro Output
Day 6 (16 July 22) Pequeño Grand Canyon

During this campaign, we performed several spectral measurements on different types of rocks/sediments like acidic altered outcrops, mining waste sediments, and various types of salts and sulphatic encrustations.

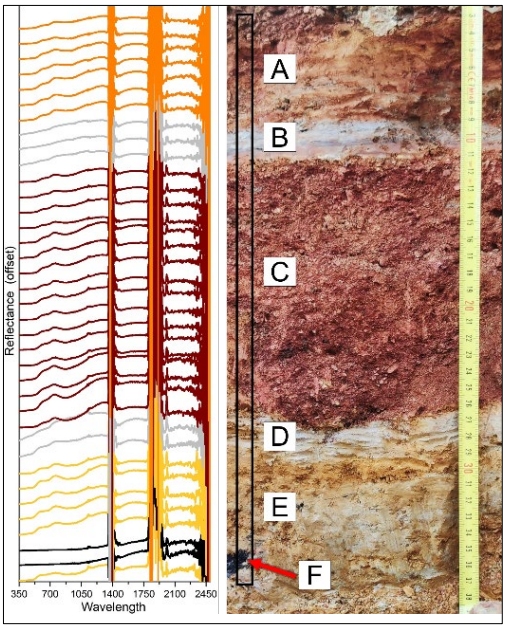

Fig.1 *VIS-NIR spectra acquired throughout the layers of the fluvial terrace at Rabin Fools:* ***Left****) All the 37 spectra collected across the stratigraphy, spectra color groups correspond to different sedimentary layers.* ***Right)*** *Image of the stratigraphy. The black rectangle indicates the zone where the spectra are collected by step of 1 cm, the red arrow indicates the organic-rich black spot in the stratigraphy.*

Figure 1 shows an example of spectral measurements collected along the stratigraphy of a fluvial terrace in Rabin Fools. The purpose of this acquisition is to simulate a Ma_MISS instrument scan through the subsurface stratigraphy. In this case, VIS-NIR measurements were collected with a vertical step of 1 cm going from the top to the bottom. The collected data highlight 6 different groups of spectra corresponding to the 5 different layers (A, B, C, D, and E) and the organic-rich zone (F) corresponding to the black spot in the image of the stratigraphy. Even if the spectra collected in the field were using solar radiation as a light source, they do not allow an easy identification of the hydration bands at 1400 and 1900 nm. In fact, they are compromised by the extremely variable content of atmospheric water. However, it is possible to attribute a compositional variability to the different layers due to their mineralogical diversity and hydration state. Fig. 2 shows the representative spectra of the single layers in the 350-1150 nm range. It can be seen that the layers exhibit a different level of reflectance, and different iron contents even in terms of the ratio between the different oxides. The data collected in the near-infrared range (Fig. 3) show that even in this range the individual layers exhibit clear compositional differences. Almost all layers show a band at about 2200 nm with varying depth except for layer “F”, which, on the contrary, shows a deep band at about 2360 nm and no band near 2200 nm. The spectral

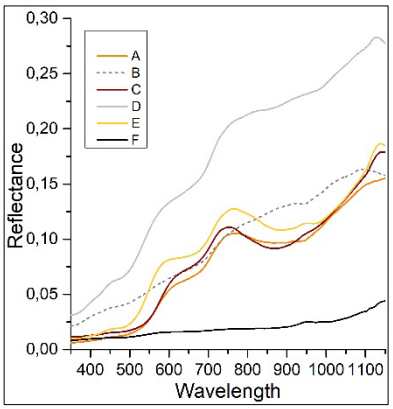

Fig.2 *Spectral types identified in the stratigraphy in the range 350-1150 nm.*

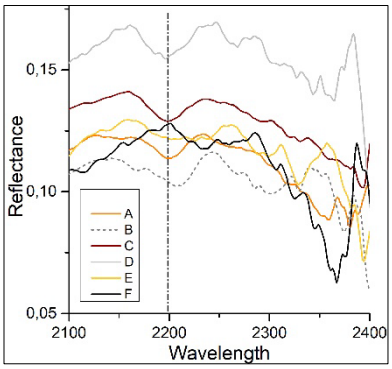

Fig.3 *Spectral types identified in the stratigraphy in the range 2100-2400 nm.*

feature at 2200 nm may be related to the acid alteration mechanisms that distinguished the rock formations present at Rabin Fools. In fact, the 2200 nm spectral band may be related to the occurrence of alteration products such as Al-bearing clays or hydroxylated Fe-bearing sulfates, or hydrated silica. The 2360 nm spectral feature present in layer F, on the other hand, can be attributed to the presence of C-H type bonds that distinguish organic compounds. The strong slope in the visible range also confirms the richness of organics in layer F (Fig. 2). The spectral data obtained during the measurement campaign carried out in the Rio Tinto area will be compared with measurements made in the laboratory on the respective collected samples. This further phase of investigation will improve our understanding of the mineralogy and alteration processes that have occurred on the rocks and soils of the studied area. Further work will be undertaken on some selected samples where drilling tests and spectroscopic measurements will be made using the laboratory model of the Ma_MISS instrument.

All the collected data and the associated sample information will be made available to the whole scientific community within one year since this field activity.

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

- EPSC 2022 oral presentation: In-situ measurement and sampling of Martian analogues in the Rio Tinto area in support of the Ma_MISS scientific activity. Marco Ferrari et al. EPSC2022-153 scheduled at Session TP17 - Planetary field analogues for Space Research.
- Publication of the Rio Tinto field campaign results on the special issue "Terrestrial Field Analogues for Planetary Exploration" of the Frontiers in Astronomy and Space Sciences journal.

- 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: dd-mm-yy 10/07/22 Arrived: dd-mm-yy 11/07/22	dd-mm-yy 11/07/22	2	6	0	dd-mm-yy 16/07/22	Departed: dd-mm-yy 17/07/2022 Arrived: dd-mm-yy 17/07/2022

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

Host Name	
Host Signature	GOMEZ GOMEZ FELIPE - DNI 02617123E Firmado digitalmente por GOMEZ GOMEZ FELIPE - DNI 02617123E Fecha: 2022.09.26 10:22:04 +02'00'
Date	

- Project Leader confirmation

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Project Leader Name	**Marco Ferrari**
Project Leader Signature	
Date	**26/09/2022**