Europlanet TA Scientific Report

PROJECT LEADER

Project number: 21-EPN-FT1-024
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Project Title: Untangling rock-inhabiting microorganisms and their biosignatures from the Mars-like area of Puna Plateau, Argentinian Andes

Scientific Report Summary.

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

The hostile current conditions on the surface of Mars entail that, if any form of life exists or ever existed on the planet, it may have adopted survival strategies like those evolved by terrestrial microorganisms inhabiting extremely harsh regions. Here, one of the most common strategies observed is endolithic growth, defined as the colonization of the small interstices and cracks inside rocks where microorganisms can be protected from external hostile conditions. On the other hand, environments exhibiting a strong negative hydrological balance can be characterized by the sporadic presence of pools saturated in minerals. Here, microorganisms can induce carbonate precipitation along with the physicochemical factors occurring in these environments, causing the formation of sedimentary structures in which they can be trapped.

From an astrobiological perspective, several studies showed how the early Mars environment may have exhibited an overall desertic environment hosting localized water basins. Therefore, the possibility that microbial forms of life may have existed on Mars makes hypothetical endolithic habitats and evaporite deposits on the planet interesting targets for the search for tracks of past life. In this optic, the southern end of the Puna Plateau in the Argentinian Andes (Catamarca province, Argentina) may represent an excellent model to understand how putative microorganisms may be adapted to the early Martian environments and how to detect their signatures. For this reason, a sampling campaign was performed at the Laguna Negra Lake (Puna Plateau region) in April 2022, with the purpose to characterize different microbial habitats hosted in the site.

Full Scientific Report on the outcome of your TNA visit

We encourage you to add figures to your report, which should be approx. 1 page of text plus figures.

The environmental conditions experienced in some places in the Southern end of Puna Plateau in the Argentinian Andes (Catamarca province, Argentina) make the region an excellent terrestrial analog of the environments occurring on early Mars. The analogies with the early Martian environments are observed both in the evaporitic mineral-rich saline lakes present in the region and in the surrounding volcanic desertic areas. In this optic, the present campaign was conducted in the Laguna Negra (Fig. 1a and 1c), a high-altitude (4200 m amsl) hypersaline lake of Puna Plateau (-27.6318, -68.5409) and in its bordering desertic area, to characterize the microbial communities living in these environments and their biosignatures. In total, five sampling sites were chosen in the region, covering distinct possible substrates that might host microbial communities (Fig. 1b). For each sample reported below, six replicates in an area of about 9 m^2 were collected. All the samples were collected in sterile conditions.

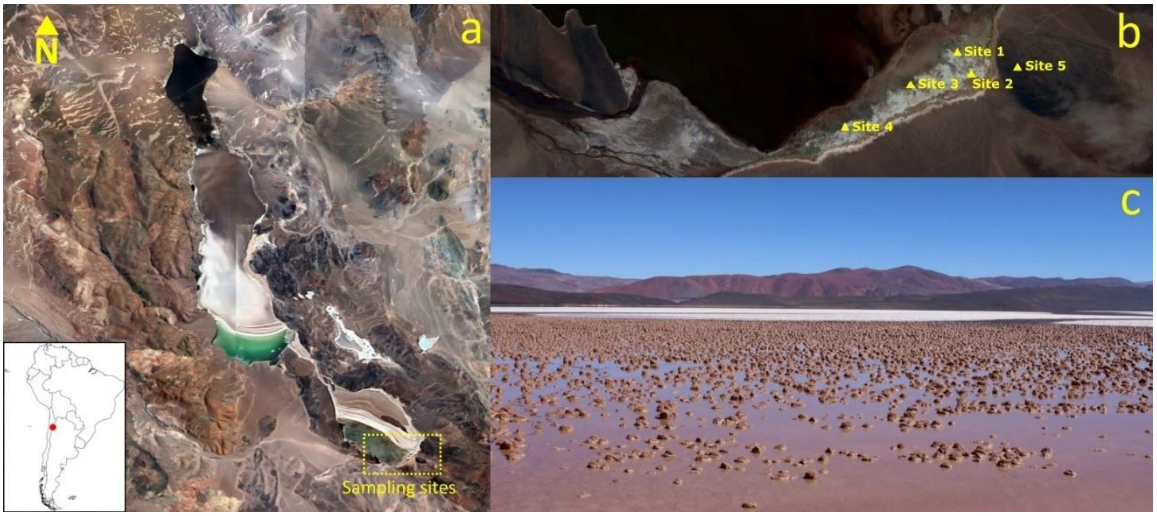


Figure 1. a) Laguna Negra area; b) samplins sites at Laguna Negra; c) picture of the Laguna Negra showing the oncoidal structures taken during the campaign**.**

Laguna Negra lake:

The Laguna Negra is characterized by the presence of a stromatolite belt bordering with a saline plain in the southern part of the lake. The stromatolite belt is characterized by an hypersaline, evaporitic environment, with a range of sedimentary deposits (carbonates, evaporites and siliciclastics). The main microbialite types are represented by laminar crusts (a few cm in thick), oncoids (microbialites with spherical laminated structures) and stromatolites in various shapes.
Therefore, such a geological setting required the selection of three distinct sampling sites, where different substrates were collected (Fig. 1b):

- Site 1:
  Saline crusts, in a total volume of 500 ml.

- Site 2:
  Oncoids (10 to 30 cm in diameter) (Fig. 2a); laminar crusts (5 to 10 cm in diameter) (Fig. 2b); pustular microbial mat (50 ml per replicate) (Fig. 2d)

- Site 3:
  Microbialites (5 to 15 cm in diameter) and surrounding pustular microbial mats (50 ml per replicate) (Fig. 2c)

- Site 4:
  Oncoids (10 to 15 cm in diameter).

Mountainside (Site 5):

The desertic area surrounding the Laguna Negra site is characterized by various volcanic substrates, mainly represented by basaltic, intermediater and ignimbrite rocks (Fig. 2e). Samples of both rocks were collected on the mountainside next to the lake to detect the presence of possible microbial endolithic communities.

Figure 2. a) oncoids; b) laminar crust; c) microbialite; d) microbial mat; e) ignimbrite.

In addition to the Laguna Negra area, other two sites were chosen for the sampling activity:

Volcano Antofagasta:

The volcano Antofagasta (Antofagasta de la Sierra, Catamarca) is in a high altitude (3300 m amsl) desertic area characterized by the presence of saline lakes. The geological setting of the area around the volcano, characterized by the massive presence of basaltic and ignimbrite rocks and clastic sedimentary rocks, the paucity of water and the high solar irradiation make the area another possible Martian analog site. To detect the presence of endolithic communities colonizing rock substrates and their signatures, a sampling campaign was conducted in the area. Therefore, three types of samples were collected in six replicates each: Ignimbrite rocks; Basaltic rocks; Conglomerates.
Furthermore, evaporitic rocks (six replicates, 3 to 5 cm in diameter) were collected in the lagoon close to the site.

Pomán Region:

The semiarid area between the Pomán and Chumbicha region (Catamarca, Argentina) is characterized by clastic sedimentary rocks that may represent an excellent substrate for hosting microbial endolithic communities adapted to the harsh conditions experienced in the area. For this reason, three sets of sedimentary rocks (six replicates each) were collected in the area (-28.7422, -66.3583) to characterize the possible communities within them.

All samples were stored in sterile conditions at -20°C at the Centro de Investigaciones en Ciencias de la Tierra (CICTERRA CONICET-UNC) (Cordoba, Argentina), and sent to the applicant's facility in Italy in frozen conditions. Raman spectroscopic, metagenomic, metabarcoding and metabolomic analyses on the described samples are currently ongoing.

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

To date, the preliminary results from the analyses on the collected samples have been presented at the European Planetary Science Congress 2022 (*Aureli, L., & Coleine, C. (2022, September). Untangling rock-inhabiting microorganisms and their biosignatures from the Mars-like area of Puna Plateau, Argentinian Andes. In European Planetary Science Congress (pp. EPSC2022-343*). Three distinct publications concerning Raman spectroscopic,

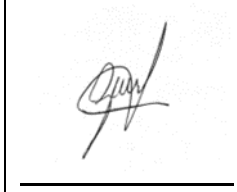
metabarcoding and metagenomic, and metabolomic results are planned to be published by the end of 2023.

- 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: 15-04-22 Arrived: 16-04-22	17-04-23	0	6	1	23-04-22	Departed: 29-04-22 Arrived: 30-04-22

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

Host Name	**Fernando Javier Gomez**
Host Signature	
Date	**18th January 2023**

- Project Leader confirmation

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Project Leader Name	Lorenzo Aureli
Project Leader Signature	
Date	18/01/23