



Thematic session: Analysis of Extraterrestrial and analogue materials

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Abstract. The first Italian Space Agency Workshop on Astrobiology was held as virtual event on October 27-28, 2021. The workshop included a thematic session dedicated to “Analysis of extraterrestrial and analog materials” co-chaired by J.R. Brucato and B. Cavalazzi. We present here a summary of the presentations and discussions that took place during this session.

Key words. Astrobiology – Astromaterials – Planetary field analogues – Mars habitability – Biosignatures – in-situ measurements – Sample return – Planetary Protection

1. Introduction

The next-generation Mars Sample Return (MSR) missions planned by NASA and ESA are based on the following multi-mission concept: the NASA-led Mars 2020 Perseverance rover mission, the NASA-led Sample Return Lander (SRL) mission, the ESA-led Earth Return Orbiter (ERO) mission, and ground-based receiving and analysis facilities (SRF: Samples Receiving Facilities). Working Groups appointed by ESA and NASA are actively collaborating on a number of areas of critical importance to advance the state of science planning for the MSR Campaign.

Considering this perspective, the first on-line Italian Space Agency Workshop on Astrobiology (October 27-28, 2021) included a thematic session dedicated to “Analysis of extraterrestrial and analog materials” co-chaired

by J.R. Brucato and B. Cavalazzi. The Italian Space Agency Workshop on Astrobiology provided a venue for Italian astrobiologists to present the results of their work to the Italian scientific community, and an opportunity for researchers to exchange ideas, share experiences, discuss methodologies and technological advances, and inspire young planetary scientists. The objectives of the “Analysis of extraterrestrial and analog materials” thematic session was to define the position of the Italian Astrobiology Community relative to the interests of the international MSR Campaign.

2. Description

The session took place on Wednesday, October 28th with oral presentations and discussions related to astromaterial laboratory characteri-

zation and simulations of MSR missions, as well as the study of planetary field analogues (PFA) for space exploration. Chairpersons J.R. Brucato and B. Cavalazzi commenced the session with a brief introduction to astromaterials, and outlining the importance of receiving and curation facilities, and the role that PFA offer in learning about the possibilities of life both on Earth and other planetary bodies. This outline was followed by several presentations.

- **G. Poggiali** and co-authors illustrated the research activities at the INAF Astrobiology Laboratory in Arcetri including laboratory simulations of the synthesis and stability of biomarkers, prebiotic and biological molecules (i.e., iCOMs), and studies of their interaction with space-relevant mineral phases under realistic conditions (e.g. UV irradiation). The INAF Astrobiology Laboratory in Arcetri is also involved in astrobiology space mission instrument development and testing and in defining planetary protection protocols (Brucato et al. 2021).
- **B. Cavalazzi** and co-authors illustrated the research activities at the Astrobiology Laboratory at the Università di Bologna, which includes the study of planetary field analogues for space exploration, the geomicrobiological characterisation of biosignatures in modern and ancient extreme environments, and the analysis of Earth's oldest traces of life using high-resolution correlative microscopy approaches. This research is focussed on developing methods for life detection, with a particular focus on the search for fossilised life on Mars (Cavalazzi et al. 2021).
- **A. Frigeri** and co-authors presented the important role played by field research and analogue sites in our understanding of physical processes observed through remote observations of planetary bodies of our Solar System, and their primary importance in astrobiology for the understanding of factors influencing the presence and evolution of life. Secondly, they discussed the potential of developing an astrobiological field study bringing together experi-

enced Italian field geoscientists from different disciplines (e.g. geologists, geobiologists, geochemists, planetary geologists) into an interdisciplinary team. Such an approach would offer an opportunity for the Italian astrobiological community to develop an integrated and interdisciplinary research including the testing of instrument prototypes prior to the design of payloads for future robotic or human interplanetary exploration (Frigeri et al. 2021).

- **A. Lazzarini and M. Crucianelli** illustrated the analytical facilities available at the “Centro di Microscopie” of the University of L’Aquila, which includes the molecular and spectroscopic analytical techniques suitable for use in the characterization of samples brought to Earth by MSR missions (Lazzarini & Crucianelli 2021).
- **Palumbo** and co-authors illustrated the research activities at the Laboratory for Experimental Astrophysics at INAF Osservatorio Astrofisico di Catania, where samples are exposed to space conditions (e.g. high vacuum, low temperature, UV irradiation, ion bombardment) and spectroscopically analysed; extraterrestrial dust particles are also characterized (Palumbo et al. 2021).
- **Pondrelli** and co-authors demonstrated the importance in astrobiology of the close connection between biosignature identification and habitat reconstruction in a geological setting. They showed the importance of geological investigations as primary goals in remote and in situ planetary missions aimed at assessing the habitability potential of a specific planet or region, especially in the context of a sample return mission (Pondrelli et al. 2021).

Many ideas were introduced and discussed in this thematic session. These ideas can be summarised within four main issues:

1. the importance of laboratory activity for detecting biosignatures under space conditions and/or preserved as fossilised trace of life in natural samples;

2. the importance to have a curation facility in Italy, where characterized samples with astrobiological implications could be stored and made available for selected experiments;
 3. the importance of the role played by geology in the reconstruction of the environment or habitat and the use of terrestrial analogues as tools for the identification of sampling sites and area of interests for upcoming mission;
 4. the importance of terrestrial analogues to test instruments and prepare the next generation of planetary scientists with mission-relevant experiences.
2. Italy offers a number of extreme environments that could be used as field analogues, and experienced scientists would be able to give value to those field sites. The participants considered that, within the coming years, it will be of great importance to prepare a catalogue of Italian field sites with astrobiological potential and possibly to identify and characterize an Italian astrobiological analogue site suitable for testing instruments, training astronauts in preparation for extravehicular activity, training young scientists, and organise summer or winter schools and field classes in astrobiology.

3. Conclusions

It was clear from the presentations and discussions that:

1. Italy has many excellent research groups in astrobiology, astromaterials and astrochemistry, all of whom are involved in national and international research projects. In spite of this, there is not a clearly defined framework or network to which these groups may refer; this implies that a coordination role is missing.

References

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