ASTROBIOLOGY, GEOLOGY & HABITABILITY FIELD STUDIES SUPPORTING MARS RESEARCH

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Summary

We conducted a series of field research campaigns in the extreme environment of the Utah desert relevant to habitability and astrobiology research in Mars environments, and in order to help in the interpretation of Mars missions measurements from orbit (MEX, MRO) or from the surface (MER, MSL).

Keywords: astrobiology, geology, minerals, habitability, life detection, field analog research, Earth-Mars, organics

Extreme Terrestrial Analogue Environments

Extreme environments on Earth often provide similar terrain conditions to sites on the Moon and Mars. In order to maximize scientific return it becomes more important to rehearse mission operations in the field and through simulations. EuroGeoMars 2009 and EuroMoonMars 2010-2013 were an example of a Moon-Mars field research campaign dedicated to the demonstration of astrobiology instruments and a specific methodology of comprehensive measurements from selected sampling sites. Special emphasis was given to sample collection and pre-screening using in-situ portable instruments. In this paper we describe the protocol, in-situ and post-analysis of the astrobiology research campaign at MDRS. Other EuroMoonMars campaigns conducted in 2010-2012 looked at the mineralogy and environment conditions, and the geology context for habitability.

Results from EuroGeoMars & EuroMoonMars

We deployed at Mars Desert Research station, near Hanksville Utah, a suite of instruments and techniques [0-2, 9-11] including sample collection, context imaging from remote to local and microscale, drilling, spectrometers and Polymerase Chain Reaction PCR. We analyzed how geological and geochemical evolution affected local parameters (mineralogy, organics content, environment variations) and therefore the habitability and the signature of organics and biota.

Among the important findings of these field research campaigns are the diversity in the composition of soil samples even when collected in close proximity, the low abundances of detectable polycyclic aromatic hydrocarbons and amino acids and the presence of biota of all three domains of life with significant heterogeneity. An extraordinary variety of putative extremophiles, mainly Bacteria but also Archaea and Eukarya was observed [3,4,9]. A dominant factor in measurable bacterial abundance seems to be soil porosity and lower clay-sized particle content [6-8]. We discuss the protocol for sterile sampling, contamination issues, and the diagnostics of biodiversity via PCR and DGGE analysis in soils and rocks samples [10, 11].

The campaign in 2012 looked in particular at the correlation between minerals, topography and organic contents in selected sampling sites (Fig.1).

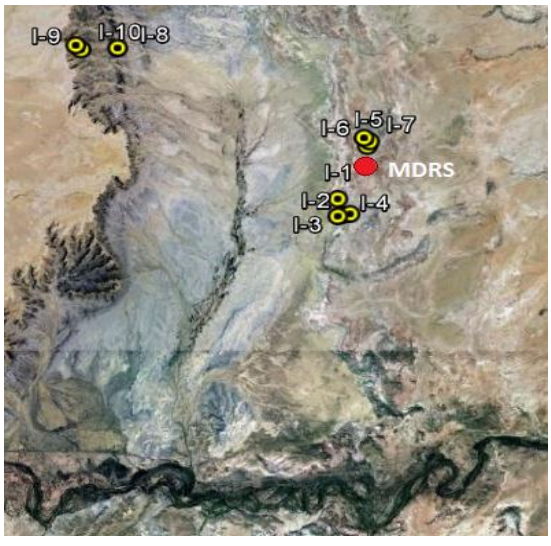

Fig. 1: Sampling areas for EuroMoonMars 2012 campaign near MDRS Utah, in Brushy Basin (right) and Bluegate Shale Membe (top left). Samples were taken at 0, 25 and 50 cm depth.

Fourier Transform-IR spectroscopy of soil samples
The samples IR absorbance was measured with a Fourier Interferometer We used the Compressed Alkali metal Halide pellet method. We performed 1) an Initial screening: simple comparative method using standard minerals to identify the mineralogy of a sample, 2) a study of Peak absorbance frequencies correlated to known minerals using previous studies and spectral libraries. This allowed to model the absorbance form a mixture of known minerals (Fig. 2).

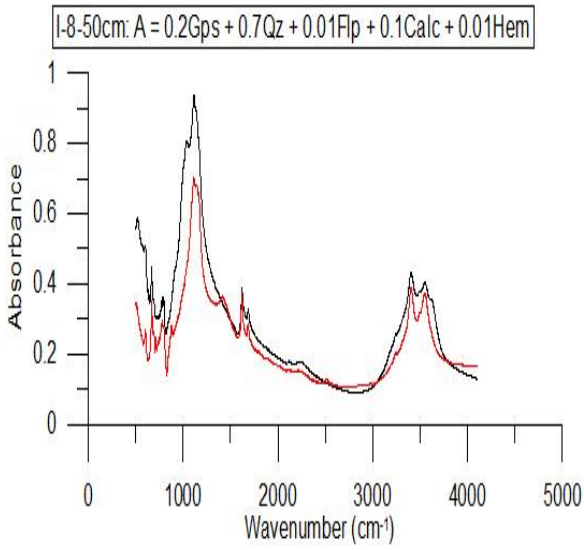

Fig. 2: FT-IR transmission spectroscopy of a MDRS sample compared to the absorbance due to a linear mixture of Gypsum, Quartz, Feldspar, Calcite and Hematite. [13]

The mineralogy measured in the samples includes: Quartz, Gypsum, Illite, Montmorrilonite, Albite, K-Feldspar, Calcite. There is more gypsum and feldspars in Blue Gate Shale than in Brushy Basin. Some possible peaks indicate: Nontronite/pyrophyllite/Water. Most clays occur in the Canyon (Montmorrillonite) and Brushy (Illite) samples. This mineralogy has equivalent in Mars sites investigated from orbit and in-situ by rovers (MER and MSL).

We have been comparing the 2009 campaign published results [0-9] to new measurements from 2010-2012 campaigns relevant to the geology context, mineralogy, habitability conditions, and detection of organics and signs of life.

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