EUROGEOMARS FIELD CAMPAIGN: SAMPLE ANALYSIS OF ORGANIC MATTER & MINERALS

P. Ehrenfreund[3,4*], B.H. Foing[1*], C. Stoker[2*], J. Zavaleta[2*], R. Quinn[2], D. Blake[2], Z. Martins[5], M. Sephton[5], L. Becker[6], G. Orzechowska[7], C. van Sluis[8], L. Boche-Sauvan[1*], C. Gross[9*], C. Thiel[10*], L. Wendt[9*], P. Sarrazin[11*], P. Mahapatra[1], S. Direito[12], W. Roling[12] and the Eurogeomars MDRS Team
[1]ESA-ESTEC & ILEWG, SRE-S, Noordwijk, NL, [2]NASA Ames Research Center, Moffett Field, CA, USA, [3]Space Policy Institute, Washington DC, USA, [4]Leiden Institute of Chemistry, NL, [5]Dept. of Earth Science and Engineering, Imperial College London, UK, [6]John Hopkins University, MD Baltimore, USA, [7]Jet Propulsion Laboratory, Pasadena, USA, [8]Delft University, Department of Biotechnology, Delft, NL, [9]Freie Universitaet Berlin, Institute for Geological Sciences, Berlin, D, [10]Max Planck Institute for Biophysical Chemistry, Goettingen, D, [11]InXitu Inc. Mountain View, USA, [12]VU University Amsterdam, NL, *EuroGeoMars crew

Abstract: A strategic search for life on Mars requires a thorough interdisciplinary preparation phase that includes the optimization of sample analysis techniques, instrument development and calibration and extensive terrestrial field tests at Mars analog sites. In this paper, we report on the results of chemical, physical and astrobiological measurements of samples collected during the EuroGeoMars campaign at Utah Mars Desert Research Station (MDRS) in February 2009 (see Figure 1).

EuroGeoMars MDRS campaign: The goal of the EuroGeoMars campaign (from 24 January to 28 February 2009) sponsored by ESA, NASA and ILEWG [1] was to demonstrate instruments from the ExoGeoLab pilot project [2], support the interpretation of ongoing planetary missions, validate a procedure for Martian surface in-situ and return science, and study human performance aspects [3]. Several science and exploration instruments were either brought from Europe or by US collaborators.

Geology: drilling equipment, Ground Penetrating Radar (GPR), Raman Spectrometer, Visible Near Infrared Spectrometer (VIS/NIR), Magnetic Susceptibility Meter (all lent by NASA-Ames), X-ray Diffractometer/X-ray Fluorescence Meter (XRD/XRF) (by inXitu Co), sampling collection and curation, scientific and HDTV cameras for field and lab studies (lent by ESTEC ExoGeoLab), installation of geochemical lab

Engineering supporting projects: Rover (lent by Carnegie Mellon Univ.); Enhanced Cyborg field reporting capability, Mars navigation experiment preparation; Visualization tests for rover, camera system and image data for outreach

Biology: Polymerase Chain Reaction (PCR) lab from ESTEC ExoGeoLab project; Adenosine Tri-Phosphate (ATP) Meter (NASA Ames), Microscope (MDRS)

The crew geologists first characterized the local surface and close sub-surface environment in the vicinity of the MDRS site, before moving on to sample extraction and analysis. Satellite and aerial photography was used to investigate the overall morphology and geological environment. Further reconnaissance included sample-extraction EVAs at sites of geochemical and astrobiological significance. Characterization of larger-scale geological features was conducted in-situ (for example using GPR to investigate the close sub-surface). Results from these sorties allowed us to selected sites for surface and sub-surface sampling [5].

Figure 1: Stratification of sampling sites in Dakota sandstone and Morrison formation near MDRS station

The sample collection/extraction step involved standard geological tools such as rock drills and scoops. Samples were returned to the MDRS for analysis. The MDRS Crew investigated those soil samples in the laboratory with microscopes (Fig. 2), Terra XRD/XRF (X-ray diffraction/X-ray fluorescence) from InXitu Inc., a Raman InPhotonics (LAS-750-300 Class3b embedded Diode Laser, 785 nm wavelength) instrument and a visible/near infrared reflectance spectrometer.

Selected soil properties including pH value and elemental composition of Ca, K, P, Mg, and nitrate were measured in-situ using colorimetric chemical reactions (LaMotte Soil Testing System). Salt concentrations were estimated with a conductivity probe.

Biological material was investigated with Polymerase Chain Reaction PCR DNA analysis [6].

We describe the in-situ results of the astrobiological, physical and chemical properties of soil samples as well as post-analysis data of a variety of soil samples including elemental composition, salt concentrations as well as carbon and amino acid abundances. Figure 2 shows the samples site and a microscopic image of a white sandstone layer collected in close vicinity to MDRS.

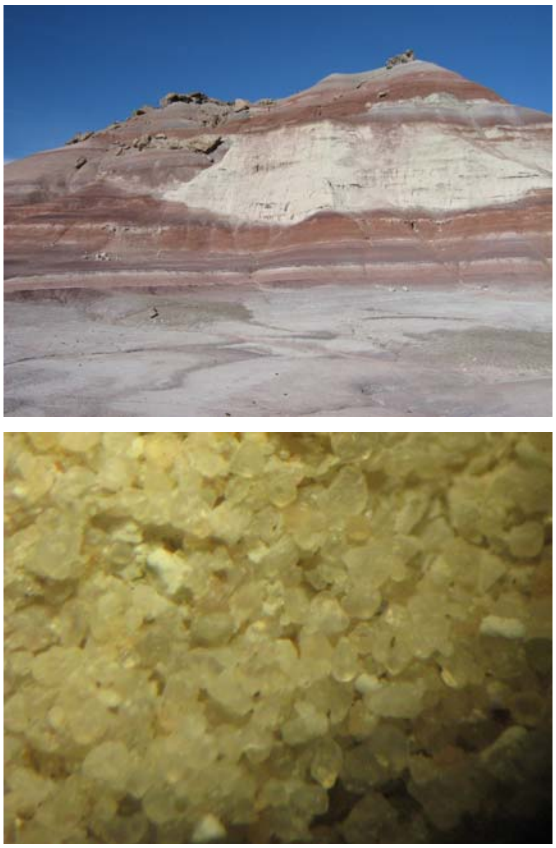

Figure 2 (a & b): White, well sorted sandstone (microscopic image below) part of a white channel-fill like lense in the Brushy basin member (Morrison formation context image above). This lense contains crossbedding structures. The elemental composition has been determined with XRD to contain Ca, Ti and Mn and little Fe.

Post-analysis techniques included Laser desorption mass spectrometry, (see Figure 3). This allowed the quantitative measurements of macromolecular carbon in the samples, with detections of Polycyclic Aromatic Hydrocarbons (PAHs) and kerogens.

The oxydation properties were measured with a miniaturised sensor developed in the frame of ExoMars Mars Oxydation Instrument (MOI).

The presence and characteristics of organics was then correlated with the elemental, mineral, oxidation and environment properties of the samples.

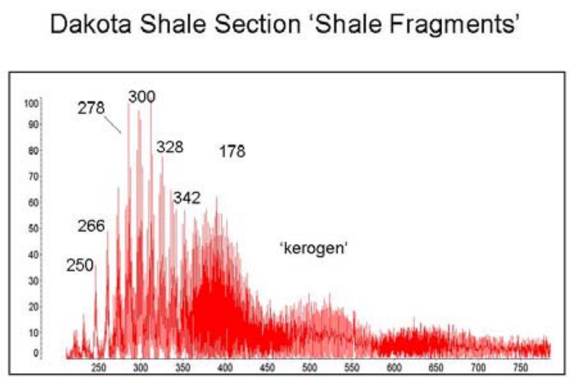

Figure 3. Laser desorption mass spectra of desert soil sample from the Dakota Shale section showing the presence of macromolecular carbon.

The presented field studies validate procedures for Martian surface in-situ and return science, provide limits to exobiological models and support current and planned space missions that search for biosignatures on Mars.

References:

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