GEOCHEMICAL RESULTS FROM EUROGEOMARS MDRS UTAH 2009 CAMPAIGN

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Introduction: We report on the geochemistry investigations that were accomplished during the EuroGeoMars Campaign at the MDRS station in Utah. This campaign, supported by ILEWG [2], ESA, NASA and partners, took place from from 24 January to 28 February 2009 (two rotations, crew 76 and 77), with the goal to demonstrate and test instruments for the ExoGeoLab pilot project [1]. These results support the interpretation of ongoing missions such as Mars-Express and can be used to validate procedures for in-situ Martian exploration and sample return [3-6]. specially designed for future space missions. Among these instruments were an integrated X-Ray Diffractometer/X-Ray Fluorescence meter (XRD/XRF, *InXitu Terra 158*), a VIS/NIR Spectrometer *(OceanOptics)* and a Raman Spectrometer *(InPhotonics).*

Geological setting: The MDRS station in Utah is surrounded by an early Jurassic to Late Cretaceous sedimentary succession consisting mainly of sands, clays and evaporites from aerial and lacustrine to fluvial facies. During the Jurassic, thick layers of volcanic ashes are emplaced within the siliciclastic deposits. The formations, which make up a large part of the Colorado Plateau are now exposed to subarid conditions. Changes in the amount of iron-oxides within the layers provide the outcrops with a great variety of colours. Common secondary products are smectites (swelling clays), gypsum, pyrite, salt efflorescence, calcic concretions and desert varnish. Additional geological findings are shell fossils, dinosaur bones and petrified wood. Many of these facets have been sampled and analyzed, in order to test the performance of the instruments under the working constraints (mainly in time and space) such as during a manned mission to Mars. Below we will summarize some of the geochemical results from various instruments.

Fig 1. Geological setting MDRS

XRD/XRF results:
The portable Terra XRD/XRF instrument provides a great possibility for quick and easy analysis of both chemical compounds and mineralogy. The accompanying software program JADE allows direct mineral interpretation. The sample preparation requires crushing and sieving, which is a fast procedure using the provided tools. Analysis on crystal samples revealed that evaporate crystals (gypsum, calcite, halite) are very easily identified. Samples from the Morrison and Dakota Formations mainly resulted in a clear pattern for quartz and a variety of clays. Clays were more difficult to interpret using the software program, as they come in great geochemical diversity. Clays that were commonly found are beidellite, montmorillonite (Mg), nontronite (Fe) and kaolinite, illite and vermiculite, most of which are smectites and bentites resulting from the weathering of volcanic ash. No correlation could be made between outcrop colour and clay content, which is rather a result of iron and magnesium content and the state of oxidation. Salt efflorescence and soils often showed a mix of sand, clays, evaporates (thenardite, gypsum, calcite) and pyrite.

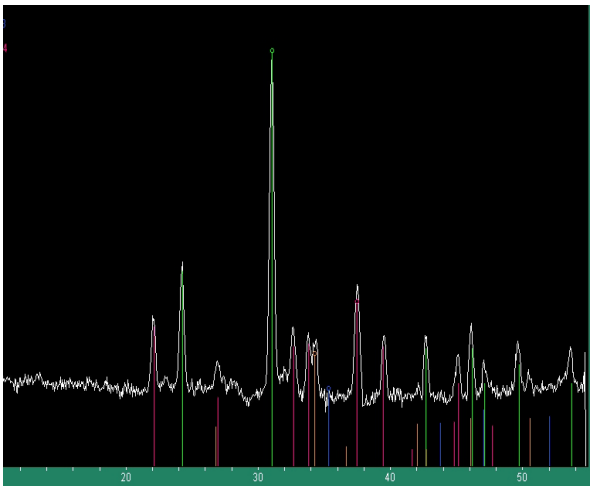

Fig 2. Jade interpretation XRD plot on a soil containing quartz (green), thenardite (pink), calcite.

Desert varnish, a black solid coating on weathering resistant rocks, was analyzed upon chemical compounds. We found a clear enrichment of Mg in the coating, compared to signal of the bulk rock (often sandstones). This enrichment in magnesium could be the result of microbial activity during aerial exposure.

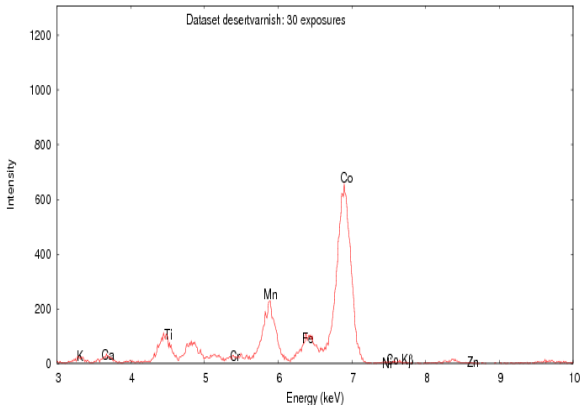

Fig 3. XRF plot of desert varnish giving elemental abundances.

Finally, we tested the element composition of petrified wood for different colours; blue, grey, and black. The XRF results showed slight differences in Ti, Mg and Fe contents. Petrified with a blue colour contained little Mg and Ti, black petrified wood had a high signal of Fe. From this we can conclude that the instrument is very sensitive and accurate.

Raman Spectrometer: The InPhotonics Raman spectrometer is an easy to use instrument consisting of a Class 3b embedded Diode laser, 785 nm Wavelength. The laser is attached to a glassfiber probe, which is to be pointed on the sample manually. This manual approach is often disturbed by small vibrations of the hand. Crew 77 developed a laser holder for better measurements. It is best to operate the instrument in dark conditions.

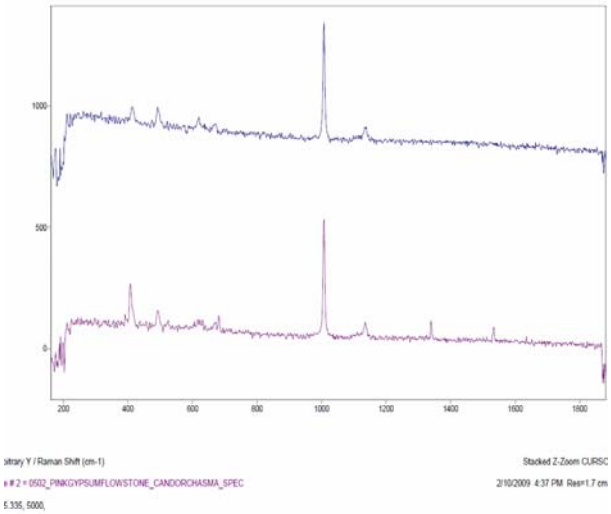

Fig 4. Raman spectrum for gypsum

Data handling: For all samples, the obtained geochemistry data, gps coordinates, field observations and geological context were gathered in one database, to provide a simple working space and a good overview.

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References:

[1] Foing, B.H. et al . (2009) LPI, 40, 2567; [2] ILEWG http://sci.esa.int/ilewg ; [3] Foing, B.H., Pletser, V., Boche-Sauvan L., E. Monaghan et al , Daily reports from MDRS (crew 76 and 77) on http://desert.marssociety.org/mdrs/fs08/. [4] Boche-Sauvan L., Pletser V. , Foing BH and EurGeoMars Team, EGU2009-13323; [5] S.T.M. Peters, A. Borst, L. Wendt, C. Gross, C. Stoker, J. Zhavaleta, P. Sarrazin, E. Slob, V. Pletser, B. Foing and the ExoGeoLab team & EuroGeoMars Team, EGU2009-13353; [6] C. Thiel, D. Wills, B. Foing, and the ExoGeoLab team, the EuroGeoMars Crew and Support Team, EGU2009-13414; [8] Peters S, Borst A & EuroGeoMars Team (2010) LPI, 41