

MARS ORGANIC MOLECULE ANALYZER (MOMA) FIELD TEST AS PART OF THE AMASE 2010 SVALBARD EXPEDITION. W. Goetz¹, H. Steininger¹, E. Steinmetz¹, M. Bierwirth¹, F. Goesmann¹, C. Philippot², B. Lustrent², C. Szopa², Arnaud Buch³, H. Amundsen⁴, M. Fogel⁴, and A. Steele⁴, ¹Max Planck Institute for Solar System Research (MPS), Max-Planck-Straße 2, 37191 Katlenburg-Lindau, Germany, goetz@mps.mpg.de; ²LATMOS, 11 Boulevard D'Alembert, 78280 Guyancourt, France.; ³LPGM, Ecole Centrale Paris, Grande voie des vignes, 92295 Chatenay-Malabry, France; ⁴Geophysical Laboratory, Carnegie Institution of Washington, Washington DC, USA.

Introduction: The ESA-lead Mars rover ExoMars (launch in 2018) will carry a suite of instruments (MOMA, Life-Marker-Chip) that will search for and constrain the identity of organic material in the Martian soil. In this abstract we report early field tests of a MOMA (Mars Organic Molecule Analyzer) breadboard model during the Arctic Mars Analogue Svalbard Expedition 2010 (AMASE) [1].

Instrumentation: A MOMA breadboard for field studies was deployed in several areas on Svalbard during the AMASE 2010 expedition. The breadboard consisted of a power supply, an oven for Differential Thermal Analysis (DTA, up to 600 °C) of soil material and two types of gas-chromatographs (GC) for separation and analysis of different types of gas mixtures (Figure 1). The breadboard did not include a mass spectrometer (MS). Thus the components of the gas mixture cannot be identified from in-field acquired data.



Figure 1 MOMA field equipment deployed at Knorringfjellet, Svalbard, with power supply (left) and one GC (middle).

Test site: The equipment (Figure 1) was deployed in the Knorringfjellet region in central Svalbard. This region is dominated by Jurassic shales which generally contain 1-4 wt% (occasionally up to 12 wt%) organic carbon [2]. Sample collection is documented in Figures 2-3. Figure 4 is a close-up view of the sample analyzed.



Figure 2 Knorringfjellet, Svalbard. The sampling location is marked by a red arrow in the image of the site (credit: K. O. Storvik) and by a red circle in the satellite image of Svalbard (376 km wide, credit: Google Earth).



Figure 3 Close-up of the sampling location (marked in red, ~30 cm across).



Figure 4 Close-up view of the sample, (a) as collected (image is ~40 mm wide, thus individual shale flakes are ~5 mm across), (b) after grinding in an agate mortar, and (c) after heating to ~ 600 °C in the MOMA oven.

Experiments and discussion: The full (DTA/GC) in-field measurement protocol involved the following consecutive steps: (1) The oven (containing the sample) was closed. (2) The GC column was preheated to 50 °C. (3) The oven was heated to ~600 °C within ~70 sec. (4) Gases released during heating of the sample were directed to a Peltier-cooled GC injection trap (about -10 °C) by the means of a steady helium flow. (5) When reaching its set point (~600 °C) the oven heating was switched off and the GC injection trap was heated to ~250 °C within ~10 s, causing a sudden release of the collected volatiles into the GC column. (6) The GC injection trap was switched off and the GC column was heated steadily to ~180 °C at a heating rate of ~10 °C/min. When only DTA was attempted, the protocol consisted only of steps (1) and (3), with step (3) being repeated three times.

During the AMASE-2010 field work DTA/GC data were acquired successfully, and will be presented during the conference. Here we present DTA results (Figures 5-6) backed up by GC/MS data (Figure 7) that were acquired by an independent commercial setup (composed of Pyrola 2000 pyrolysis unit, Varian 3800 GC with MXT-5 column and Varian 4000 ion trap MS with internal ionization). Figure 5 plots the heating rate for three successive heating cycles. The heating rate of the first cycle is smallest (as expected) due to irreversible chemical decomposition and release of volatiles. The corresponding DTA data (Figure 6) reveal two broad (partially overlapping) endothermic peaks (~340 °C, ~460 °C). Some oil shales reported in the literature have similar DTA features in that temperature range (300-500°C) [3, 4]. GC-MS data (Figure 7) confirm the high abundance and diversity of organic material in the Knorringfjellet sample.

Conclusions: The AMASE-2010 expedition to Svalbard has been an excellent opportunity to test an early breadboard of the MOMA instrument (part of the ExoMars-2018 science payload). The field work included in-situ characterization of organic-rich shales. An improved version of the MOMA breadboard shall be deployed during AMASE-2011.

References: [1] Steele, A. et al. (2010), P12a-06, AGU-FM, San Francisco. [2] Dypvik, H. (1985), *Sedim. Geol.* 41, 235-248. [3] Kok, M. V. et al. (2001), *Thermochim. Acta*, 371, 111-119. [4] Kok, M. V. et al. (2004), *J. Thermal Analysis and Calor.*, 76, 247-254.

Acknowledgements: This work is funded by DLR (FKZ 50QX1001), ESA PRODEX, and NASA ASTEP. We thank the entire AMASE 2010 team, and in particular O. Hammer and H. A. Nakram, for this remarkable expedition. Special thanks go to the tech-

nical teams of MPS, LISA and LATMOS for their excellent support.

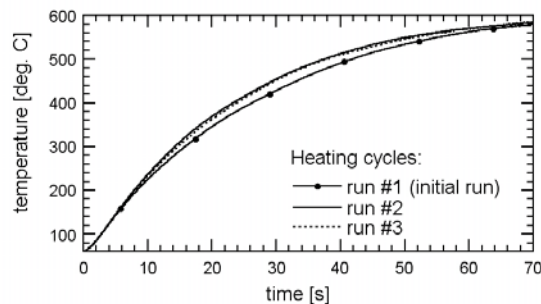


Figure 5 Heating of the Knorringfjellet sample.

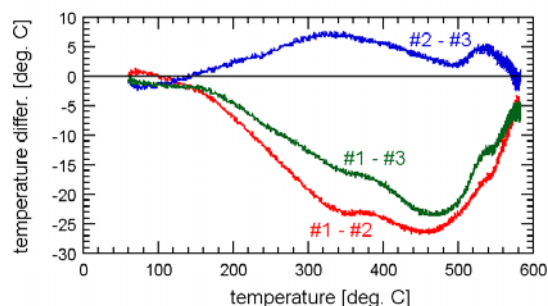


Figure 6 Differential Thermal Analysis (DTA) of the Knorringfjellet sample. Data obtained by differencing the time-series of Figure 5.

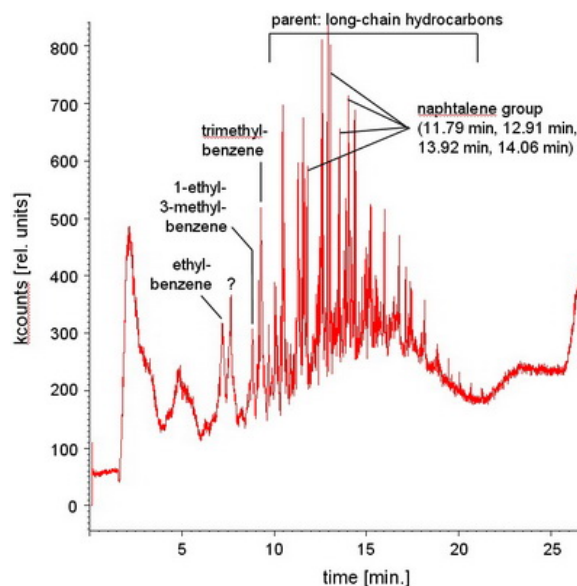


Figure 7 Gas chromatogram of the Knorringfjellet sample (GC), as acquired by a commercial GC-MS. Some of the peaks identified are labeled. The plot documents the high abundance of organic compounds in the rock sample. The first peak (retention time < 5 min) represents the carrier gas (He). The late increase in signal (> 25 min) is caused by bake-out of the column (heating to 325 C).