THE EXOMARS 2020 MARS ORGANIC MOLECULE ANALYZER (MOMA) INSTRUMENT'S ROLE IN THE SEARCH FOR MARTIAN BIOSIGNATURES.

C. Freissinet[1,2] V. T. Pinnick[1], A. Buch[3], F. Raulin[4], C. Szopa[2], R. D. Arevalo[1], F. Stalport[4], R. M. Danell[1], S. Siljeström[5], W. B. Brinckerhoff[1], W. Goetz[6], F. Goesmann[6]. [1]NASA GSFC, Greenbelt, MD, USA caroline.freissinet@nasa.gov [2]LATMOS, UVSQ/UPMC/CNRS, Guyancourt, France, [3]LGPM, CentraleSupelec, Chatenay-Malabry, France. [4]LISA, UPEC/UPD/CNRS/IPSL, Créteil, France, [5]SP Technical Research Institute of Sweden, Stockholm, Sweden, [6]MPS, Göttingen, Germany.

Introduction: The detection of reduced organic compounds in the martian near-surface with the Sample Analysis at Mars (SAM) instrument onboard Curiosity [1] was a significant step towards understanding the presence and diversity of prebiotic or biotic molecular signatures on Mars. However, Curiosity sampled only the first few cm of the subsurface, where organics are prone to degradation due to oxidation and radiation [2]. The Mars Organic Molecule Analyzer (MOMA) investigation on the ExoMars rover will investigate the molecular composition of samples acquired from depths of up to two meters below the martian surface, accessing the best windows of preservation of intact molecules. The clay-rich rock exposures accessible in Oxia Planum, the preferred landing zone, will provide an excellent opportunity to sample ancient material for organics analysis. MOMA incorporates both pyrolysis or derivatization gas chromatography/mass spectrometry (pyr/der-GCMS) [3] and laser desorption mass spectrometry (LDMS) [4] modes of operation, and is designed to work in concert with the other instruments in the rover's Pasteur Payload, particularly with the Raman Laser Spectrometer [5] and MicrOmega [6] that will analyze common drill samples presented on a carousel. With two analytical modes and versatility in the methods, MOMA will not only detect compounds over a wide range of molecular weight, volatility, and mineralogical association [7], but also investigate their origin, exogenous or indigenous, abiotic or biological.

MOMA and the possible biosignatures: After molecular identification, MOMA will investigate the abiotic or biotic origin of those molecules in different ways. Firstly, the LDMS mode, where the molecules are desorbed and ionized directly from the powdered samples with a pulsed UV laser (266 nm, 1 ns duration) at Mars ambient pressure, will investigate compounds of low to moderate volatilities such as carboxylic acids, aromatic species, chained aliphatics and macromolecular organics. The analysis of ions with *m/z* up to 1000 will allow not only the investigation and identification of specific molecules of interest, but also agnostic biosignatures such as repetitive patterns in the mass spectra. Tandem mass spectrometry (*i.e.*, MS/MS) and ion isolation/excitation (*e.g.*, *via* SWIFT techniques) enable the enrichment and structural characterization of organics and potential biosignatures.

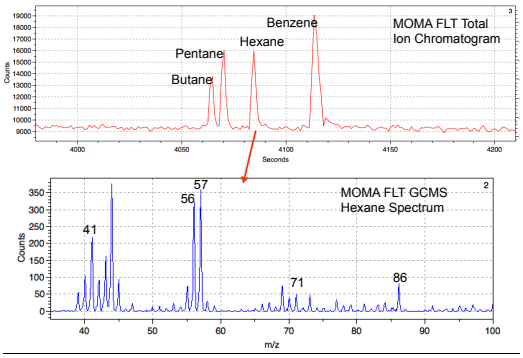

Fig. 1: Flight MOMA GCMS total ion chromatogram (top) shows nominal detection of hydrocarbons in He. The hexane GC peak is sampled with multiple EI spectra such as shown (bottom) with its characteristic fragmentation pattern.

The GCMS mode is designed to separate discrete molecules from a complex initial mixture, for a better identification and quantification of each. Because of the intrinsic constraints of the GCMS technique, the molecules need to either be volatile to be analyzed, or made more volatile or less polar using a chemical reaction with derivatization reagents [2]. Pyr/der-GCMS may detect a progression to a subset of more complex organic structures (carboxylic acids, amino acids) in the martian subsurface, a potential indicator of a biological role in the synthesis of these molecules. Alternatively, an abiotic distribution of molecules would show a preference toward simpler structures. Notably, one of the derivatizating reagents, dimethylformamide dimethyl acetal (DMF-DMA), is utilized to make the organic molecules more volatile while maintaining their chiral center. A further analysis on an enantioselective GC column, such as the Chirasil-Dex present on MOMA, will allow the determination of a potential enantiomeric excess, or homochirality, suggestive of a biological origin of the chiral molecules.

With these versatile capabilities and dual modes of analysis, MOMA will be able to further constrain the nature and origin of organic compounds on Mars to elucidate possible past or present biosignatures.

References: [1] Freissinet, C. *et al.* (2015), JGR [2] Buch, A. *et al.* (2017) this meeting [3] Pinnick, V. T. *et al.* (2017) this meeting [4] Pavlov, A.A. *et al.* (2012) GRL [5] Rull, F. *et al.* (2013) LPS 44, 3110 [6] Pilorget, C. *et al.* (2012) 3rd Conf. Early Mars, 7006 [7] Goesmann, F. et al. (2017) Astrobiology, Submitted.