

**In situ detection of organic molecules on the martian surface with the Mars Organic Molecule Analyzer (MOMA) on ExoMars 2018** Xiang Li<sup>1</sup>, William B. Brinckerhoff<sup>2</sup>, Veronica T. Pinnick<sup>1</sup>, Friso H. W. van Amerom<sup>3</sup>, Ryan M. Danell<sup>4</sup>, Ricardo D. Arevalo, Jr.<sup>2</sup>, Stephanie Getty<sup>2</sup>, Paul R. Mahaffy<sup>2</sup>, and the MOMA Team, <sup>1</sup>Center for Research and Exploration in Space Science and Technology (CRESST), University of Maryland, Baltimore County, Baltimore, MD ([xiang.li@nasa.gov](mailto:xiang.li@nasa.gov)) <sup>2</sup>NASA Goddard Space Flight Center, 8800 Greenbelt Rd., Greenbelt, MD 20771, <sup>3</sup>MiniMass Consulting, St. Petersburg, FL, <sup>4</sup>Danell Consulting, Inc., Greenville, NC.

**Introduction:** The Mars Organic Molecule Analyzer (MOMA) investigation on the 2018 ExoMars rover will examine the chemical composition of samples acquired from depths of up to two meters below the martian surface, where organics may be protected from radiative and oxidative degradation [1,2]. The MOMA instrument is centered around a miniaturized linear ion trap (LIT) that facilitates two modes of operation: i) pyrolysis/gas chromatography mass spectrometry (pyr/GC-MS); and, ii) laser desorption/ionization mass spectrometry (LDI-MS) at ambient Mars pressures. The LIT also enables the structural characterization of complex molecules via complementary analytical capabilities, such as multi-frequency waveforms (i.e., SWIFT) and tandem mass spectrometry (MS/MS). When combined with the complement of instruments in the rover's Pasteur Payload, MOMA has the potential to reveal the presence of a wide range of organics preserved in a variety of mineralogical environments, and to begin to understand the structural character and potential origin of those compounds.

However, the pervasive presence of oxidative perchlorates across the martian surface provides a challenge to detecting organics via traditional in situ analytical techniques, such as evolved gas analysis (EGA) or pyr/GC-MS. The MOMA LDI-MS mode of operation, on the other hand, enables the detection and identification of fragile molecules that may otherwise decompose during sample heating. Using a high fidelity breadboard instrument, we show that via LDI-MS methods the MOMA instrument is capable of detecting  $\mu\text{g/g}$ -levels of organics in a suite of natural and synthetically-derived Mars analog samples, even in the presence of wt.-%-levels of perchlorate (e.g., Fig. 1 [3]). Spectra acquired from the commercial Thermo MALDI LTQXL serve as verification for the data presented here.

The data demonstrate that the LDI technique has distinct potential benefits for detecting trace amounts of organics in mineral matrices that mimic the martian surface environment. Coupling the LDI technique to a LIT mass analyzer also provides benefits for application to future Mars missions. The MOMA instrument on the ExoMars 2018 rover is therefore well matched to the mission goal of detection of organics in drilled samples, in support of the search for signs of life on Mars. In addition, the LDI technique has potential for

further development and use on future missions to Mars and other planets. For example, the small laser spot size used in LDI can provide precision point-by-point analysis, offering detailed information with high spatial resolution and, thus, temporal insights into even the most complex samples. Such precision in situ detection could be used to guide the sample selection for a Mars sample return mission.

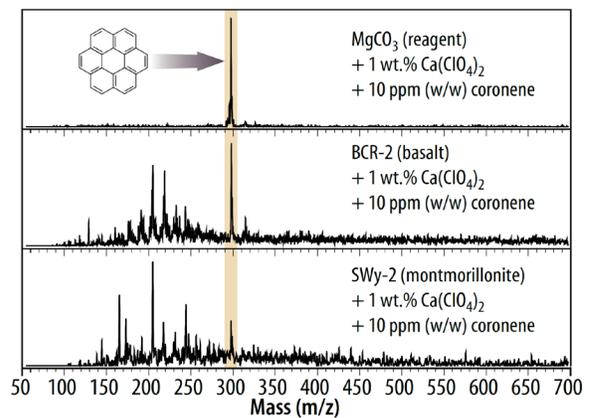


Fig. 1. Coronene is identified clearly via LDMS in a variety of mineral and rock matrices doped with organics, even in the presence of wt.-%-levels of perchlorate.

#### References:

- [1] Pavlov, A. A. et al. (2012) GRL 39, L13202.
- [2] Quinn, R. C. et al. (2013) Astrobiology 13, 515 - 520.
- [3] Li, X. et al. (2015) Astrobiology 15, 104 - 110