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RESULTS OF THE END TO END MOMA (MARS ORGANIC MOLECULE ANALYSER) CAMPAIGN WITH THE GC-MS ENGINEERING TEST UNIT (ETU)

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Introduction:

The Mars Organic Molecule Analyzer (MOMA) aboard the Rosalind Franklin rover will be a key analytical tool in providing chemical (molecular) information from the solid samples collected by the rover, with a particular focus on the characterization of the organic content. The core of the MOMA instrument is a UV laser desorption / ionization ion trap mass spectrometer (LDI-ITMS) and a gas chromatograph-mass spectrometer (GC-MS), with on-board derivatization capabilities. These last ones will provide the unique capability to characterize a broad range of compounds, including volatile or non-volatile species, and chiral analysis. In a subset of GC-MS analyses, selected samples are subjected to in situ derivatization, consisting of the reaction of the sample components with specific reactants (MTBSTFA [1], DMF-DMA [2], TMAH [3]), which increase the volatility of complex organic species. In order to test our MOMA instrumentation suite, and especially the GCMS coupling, a series of tests have been carried out with our GCMS Engineering Test Unit (ETU) similar to the flight model.

The End to End MOMA-ETU:

Coupling campaigns has been done at NASA Goddard Space Flight Center with the Engineering Test Unit (ETU) MOMA-Gas Chromatograph (French) and the MOMA-Mass Spectrometer (USA). The MOMA instrument is composed of a pyrolysis oven, two injection traps (Tenax® GR) and a gas chromatogram (four columns) coupled to a mass spectrometer. The end-to-end tests have been done with three different samples : i) standard samples of chiral (amino acids) and non-chiral compounds ii) JSC-Mars-1 which is known to be one Martian analog (Martian dust) and to contain plenty of organic compounds and ii) Murchison meteorite representing the interplanetary material reaching the surface of Mars and containing organic compounds.

Experiments and results:

The results demonstrate the current status of the end-to-end performance of the gas chromatography-mass

spectrometry mode. We show that from a technical point of view the MOMA instrument is working as expected. From a chemical point of view we have shown that three of the four MOMA sample preparation methods tested here (DMF-DMA, thermochemolysis with TMAH, and Pyrolysis) work efficiently under MOMA like operational conditions. For example, we have compared the JSC-Mars-1 pyrolysis results with a commercial Pyrolyzer (Frontier)-GC-MS (GC-trace – ISQ ThermoFisher) and with ETU Pyr-GC-MS. Considering the ETU constraints (Pyrolysis and column temperature), our results showed that we have recovered the same compounds both from the commercial GCMS and the ETU Pyr-GC-MS.

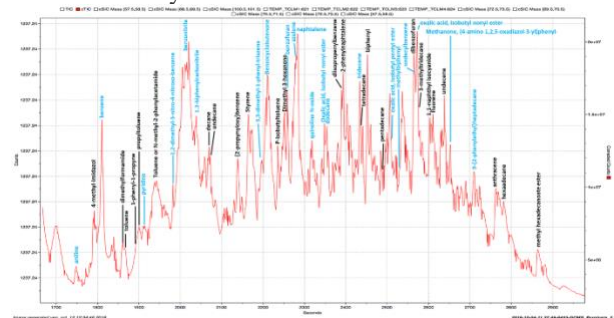


Figure 1 : chromatogram obtained from a ETU Pyr-GC-MS run after pyrolysis at 520°C with 49 mg of JSC-Mars-1.

Additionally, we have demonstrated chiral and isomeric separation with both one standard sample and organics extracted from JSC-Mars-1 Mars analogue samples.

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