MARS ORGANIC MOLECULE ANALYZER (MOMA): UPDATES ON LASER DESORPTION/IONIZATION MODE AND ANALOG SAMPLE STUDIES FOR THE EXOMARS ROVER MISSION

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INTRODUCTION

The Mars Organic Molecule Analyzer (MOMA), a linear ion trap (LIT)-based mass spectrometer (MS) investigation onboard the 2020 ExoMars rover mission, directly addresses the scientific objective to search for signs of past or present life on Mars. A wide range of organic compounds from drilled samples acquired from up to 2 m below the martian surface will be analyzed through both pyrolysis-gas chromatography mass spectrometry (pyt/GC-MS) and laser desorption/ionization mass spectrometry (LDI-MS) modes. MOMA will represent the first implementation of LDI on another planet. LDI-MS is capable of detecting both nonvolatile organic compounds and inorganic species indicative of host mineralogy. During Mars operations, an LDI survey mode provides broad molecular composition to guide selection of focused follow-on experiments, for detailed study of observed molecular features. Advanced LDI modes employ Stored Waveform Inverse Fourier Transform (SWIFT) for selected isolation and amplification and tandem mass spectrometry (MS/MS) for structural analysis which can support interpretation of the origin and processing of organics.

MOMA in ExoMars 2020 Rover (Rosalind Franklin Rover)

ExoMars Rover

ExoMars Analytical Laboratory Drawer

MOMA-MS Instrument

MOMA ETU

ExoMars status: The FM was delivered to the European Space Agency in mid-2018 for integration and testing, meeting all critical requirements during the Analytical Laboratory Drawer (ALD) thermal vacuum tests ahead of launch in July, 2020. The MOMA Testbed that will serve as the “clean” flight reference model is being integrated at NASA GSFC, and the MOMA engineering test unit (ETU) at GSFC has been refurbished to match flight characteristics for analog sample studies and continued support of operational strategy development.

Analog sample study in LDI mode

Landing site: Oxia Planum

Minerals

Chalk (CaCO3)

Calcite (CaCO3)

Narrow mass range isolation, 400-700Da

Yellowstone Green Streamer powder

Terrestrial organic rich analog samples

Conclusion: The MOMA LDI-MS mode of operation enable compositional and structural information to be derived from Martian samples in situ. Analog sample studies are a critical part for a successful scientific investigation on ExoMars mission. This work is continuing, targeting analyses of even broader types of minerals and organics, particularly phases related to the mineralogy at the ExoMars landing site in Oxia Planum.