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Organic matter on Mars – Inventory and implications

CAROLINE FREISSINET

LATMOS - CNRS

Presenting Author: caroline.freissinet@latmos.ipsl.fr

The ability to detect organic compounds in martian sedimentary rocks is a function of their initial abundance and entrainment as the rock formed as well as the extent of subsequent degradation during diagenesis, exhumation and exposure to the surface and near-surface radiation. Their detection then depends on the performance, flexibility, and robustness of operating instruments. The Sample Analysis at Mars (SAM) investigation on Curiosity rover and the Mars Organic Molecule Analyzer (MOMA) instrument on the upcoming ExoMars "Rosalind Franklin" rover are both analytical laboratories that seek to detect organic molecules and potential biomarkers in the martian near-surface.

SAM has been analyzing martian samples since 2012 and molecules were detected at various locations in Gale crater in the form of chlorinated and sulfurized organic compounds, long-chain hydrocarbons, derivatized molecules, and co-evolving CO and CO_2 at temperatures compatible with oxidation or decarboxylation of organics. The origins of the molecules detected on Mars so far remain unclear. Likewise, the exact nature of the precursor molecules is unclear; laboratory experiments are crucial. The ExoMars rover is designed to enhance the detection, in abundance and diversity, of organic molecules on Mars. The rover's sampling drill will reach as deep as two meters, accessing increasingly preserved materials. MOMA's complementary combination of laser desorption mass spectrometry (LD-MS) and gas chromatography MS (GC-MS) techniques seek to maximize the scientific return *via* with both detection of high molecular weight, non-volatile organics and patterns, and the identification of volatile and semi-volatile lower molecular weight molecules.

In situ investigations with SAM and MOMA provide significant progress towards mapping out taphonomic windows of preservation for chemically reduced organic compounds. Lessons learned will feed forward to planning of future experiments, increase our ability to select future landing sites in the search for traces of life, and select the best samples to return to Earth for more thorough analyses. Lessons learned will also feed forward future missions to explore the chemistry and potential biology of further bodies in the solar system such as Titan, Europa or Enceladus. New challenges are facing us in these detections as Mars and the icy bodies are worlds apart.