Optimization of organic matter detection using MOMA-like procedures

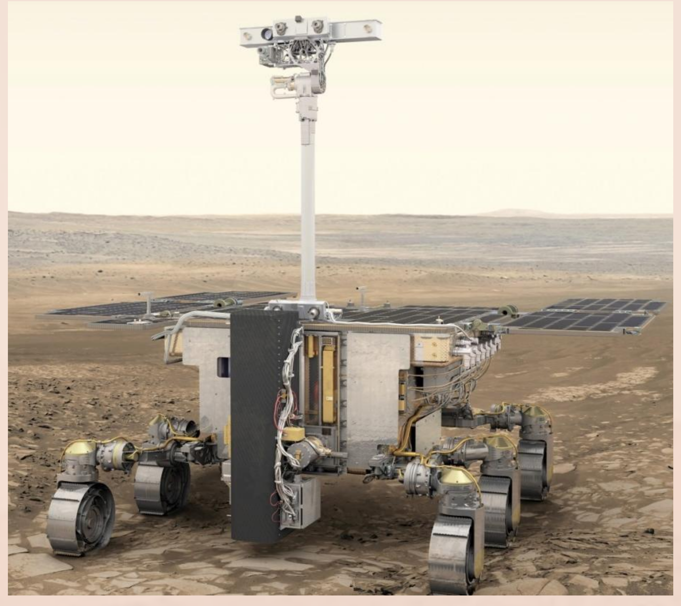
Couderc O.[1,3,4], Bouhier B.[1], Azémard C.[1], Cottin H.[1], Stalport F.[2]

[1] Univ Paris Est Creteil and Université Paris Cité, CNRS, LISA, F-94010 Créteil, France, [2] Université Paris Cité and Univ Paris Est Creteil, CNRS, LISA, F-75013 Paris, France,
[3] Centre national d'études spatiales (CNES), Paris, France, [4] Académie Spatiale Ile-de-France, UPEC, France

Introduction

The Rosalind Franklin (ExoMars mission) rover's main objective is to search for **potential biosignatures** at the **Mars surface**, using a drill and an appropriated instrumental payload [1].

In particular, the **Mars Organic Molecule Analyzer (MOMA)** was designed to separate, detect and identify **organic molecules** such as specific life-relevant organic compounds (amino acids, carboxylic acids, nucleobases…). MOMA has two operational modes based on laser desorption or **gas chromatography** (GC), both coupled with **mass spectrometry** (MS) [2].



ExoMars mission's rover Rosalind Franklin

The organic molecules in the samples collected by the rover must be volatilized before being separated by GC and identified by MS. To do so, the samples can be either pyrolyzed or **chemically derivatized** thanks to agents (**MTBSTFA**, DMF-DMA, TMAH) aboard the rover.

To test the MOMA capacity, and its complementarity with the other instruments, in the detection of organic matter, we studied **analog samples** from a set of sample selected by the ExoMars scientific team.

Material and method

- Laboratory **GC-MS** setup coupled with a **pyrolizer**.

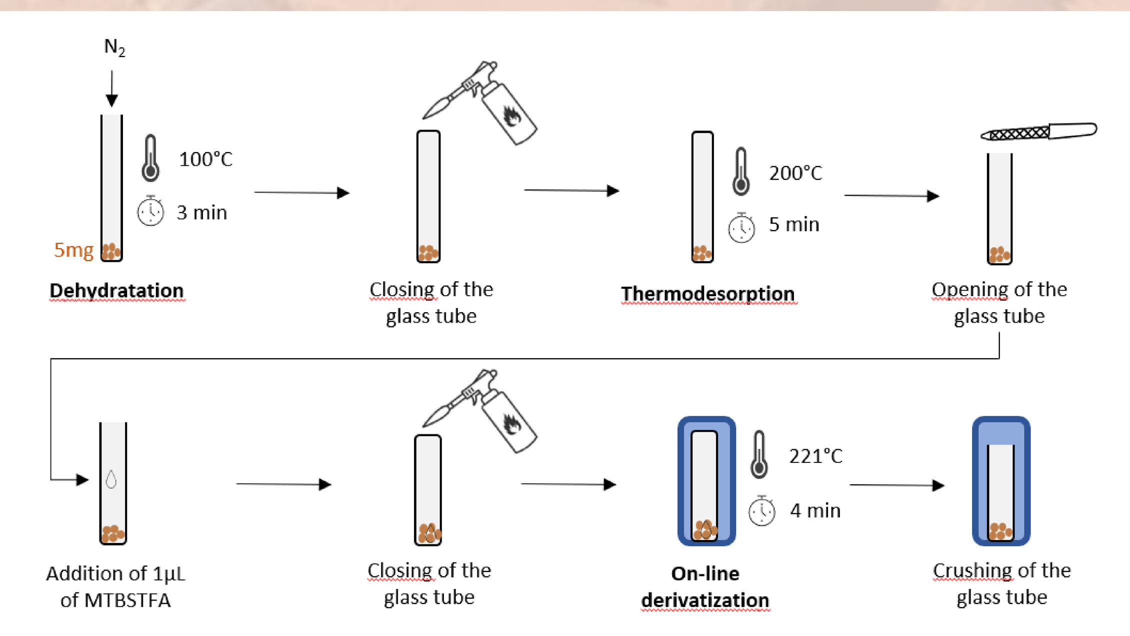


Diagram of the on-line sample preparation and derivatization protocol

- Reproduction of the **MOMA hardware constraints** : available time, temperature range, sample-to-agent ratio...
- **On-line** sample **preparation** and **derivatization** (MTBSTFA).

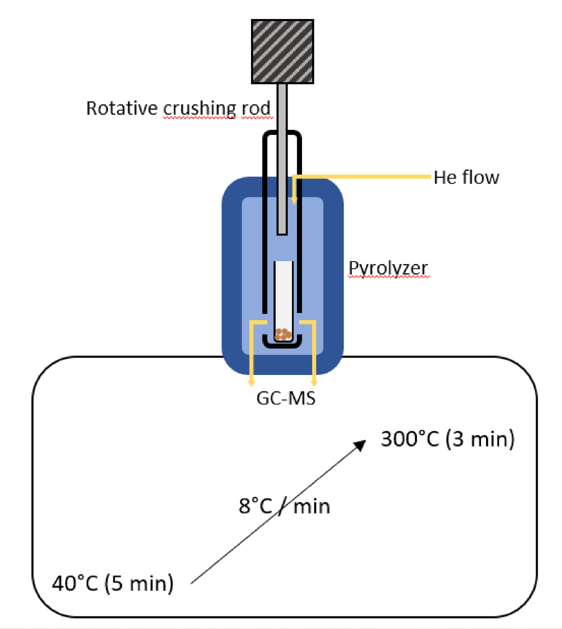
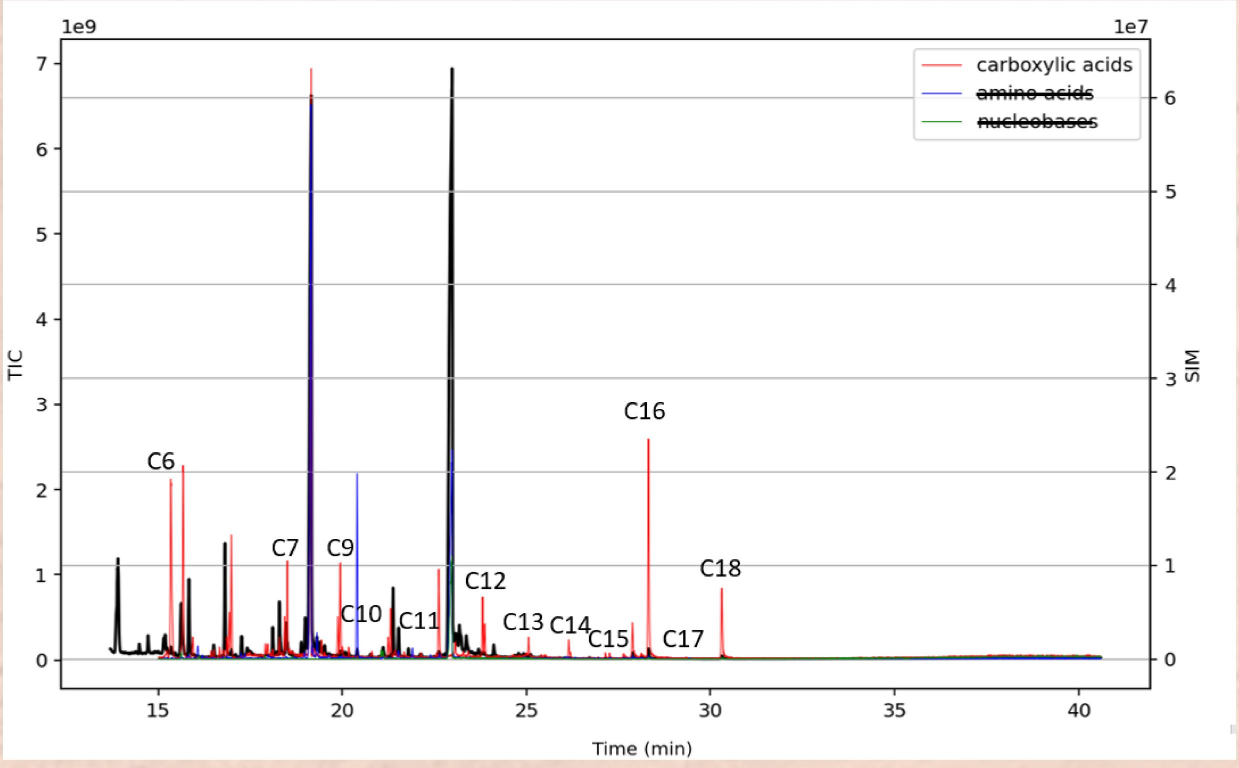


Diagram of the GC-MS-pyrolyzer setup

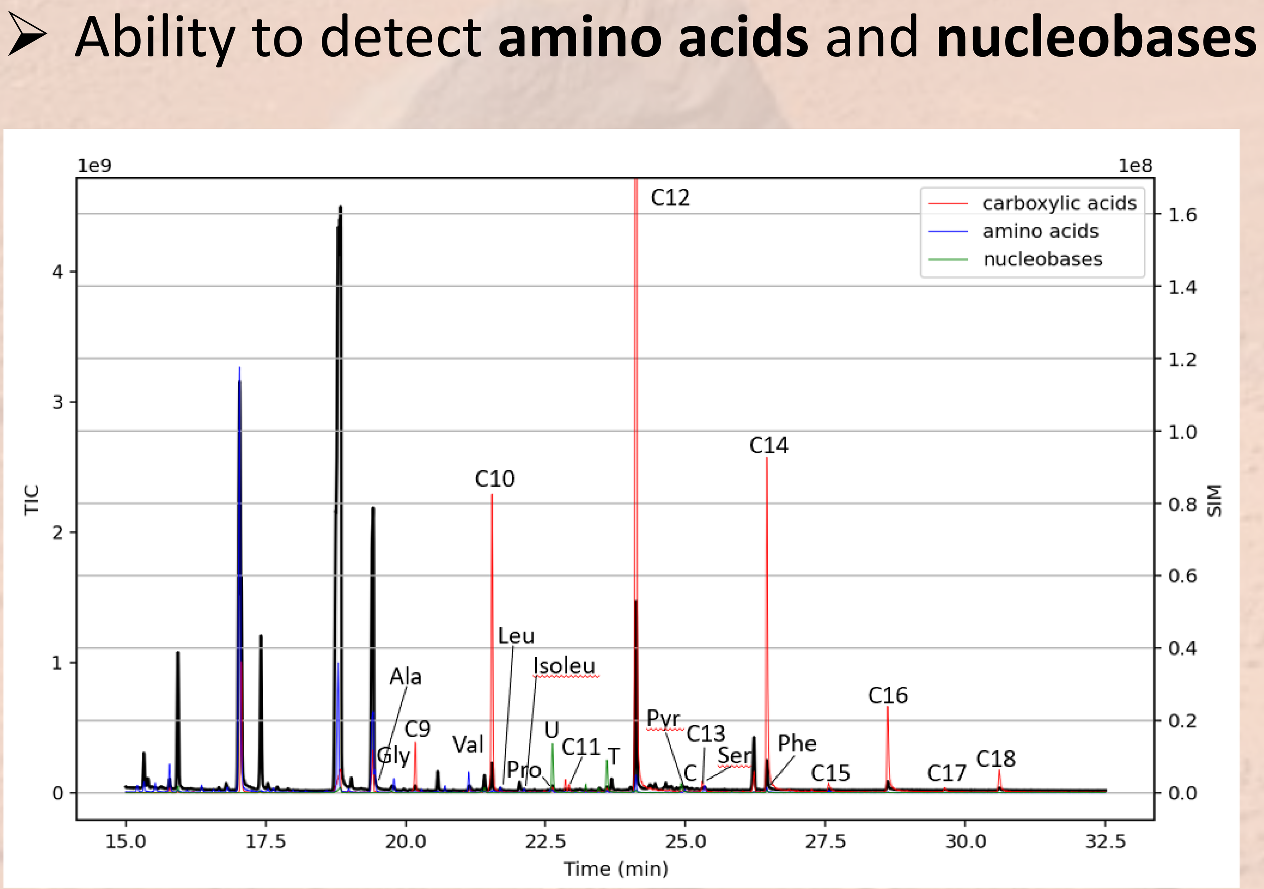
- 14 **analog samples** : both **natural** (from the Arctic, Mauritania, Atacama desert…) and **synthetic** doped, whose composition was initially unkown.

Results

- Ability to detect a **wide variety** of life-relevant **organic molecules**, including **carboxylic acids**, in most samples (e.g., Mauritania sample).
- Ability to detect **amino acids** and **nucleobases** in a few samples (e.g., Arctic sample).



Chromatogram of proterozoic mudstone with MISS (Mauritania)



Chromatogram of Lost Hammer Spring sediments (Arctic)

- Detection of fewer interesting molecules than with other laboratory techniques (solid-liquid extraction or off-line protocole).
- Impact of the **heterogeneous distribution of organic matter** and the **presence of water** (consumption of the derivatization agent) on the detection.

Conclusion

- Ability to detect life-relevant molecules including **carboxylic acids**, **amino acids** and **nucleobases** with a **« MOMA-like »** derivatization-GC-MS **setup.**
- Importance of the **evaluation** of the setup **performances** (limits of detection and quantification…).
- Importance of the **optimization** of the analytical **parameters**, particularly the sample-to-agent ratio.
- Importance of testing the **complementarity** of the **other agents** (DMF-DMA and TMAH).

work in progress

References :
[1] *Goesmann et al., The Mars Organic Molecule Analyzer (MOMA) Instrument: Characterization of Organic Material in Martian Sediments, Astrobiology, 2017.*
[2] *Vago et al., Habitability on Early Mars and the Search for Biosignatures with the ExoMars Rover, Astrobiology, 2017.*