IR (1,5years) – Study of the meteoritic organic matter : Optimisation of the parameters for supercritical fluid extraction

Background

The analysis and identification of organic matter inside extraterrestrial samples is one of the main goals in astrobiology. In the past decade, numerous extraterrestrial bodies have been studied during missions or thanks to telescope observations and some of them showed a variety of organic molecules. However, the extraction of organic matter from such a complex environment is often difficult and considered as an analytical lock. Indeed, it can be linked to a mineral matrix and in small quantity which complicates the extraction and consequently the detection and following characterisation.

Currently, the extraction of organic matter from complex matrices (as the extraterrestrial ones) are usually carried out by long multi-steps liquid-solid extractions (and purification). Supercritical fluid extraction (SFE) is a technique that strongly developed those past 10 years. The yields of extraction are equal to better than with other usual techniques while it is fast, greatly limits the risk of contamination and does not need complex manipulation of the sample. Contamination is one of the major issues in the study of extraterrestrial organic matter, therefore this technique seems particularly adapted as first step for these precious samples study. Although SFE is commonly used in various fields as environment, it was rarely used in astrochemistry[1,2]. Each type of sample needs the optimisation of many parameters: pressure, temperature, co-solvents… This optimisation can be carried out with the help of experimental design [3] and thanks to experiments of extraterrestrial analogues. The SFERE project aims to develop supercritical fluid extraction of extraterrestrial organic matter for sample return as first objective. The first step will be to prove the efficiency of this technique on extraterrestrial objects already gathered on Earth and showing a sufficient quantity of organic matter for the extraction: carbonaceous chondritic meteorites[4]. The second step will be the extraction of Martian soil analogues, in the prospect of samples returning from Mars with the MSR mission in about 10 years.

Subject

This research engineer job is financed by the project Integr'AL of PEPR Origins . The hired person will have for principal objective to help the development of the meteoritic organic matter extraction by supercritical fluid extraction (SFE) thanks to the optimisation of the numerous parameters of the instrument.

This work will require the creation of an adapted design of experiments before any labwork, inspired by the work of Devièse et al. 2018 [3]. The several parameters will be tested on a brand new instrument and the extracts analysed at LISA by GC-MS and potentially in Poitiers. Following the experiments data treatment will be necessary to ensure the efficiency of the parameters for carbonaceous chondrites. The experiments will be carried out on analogues before real meteorites (Murchison, Agua Zarcas…). The organic matter extracts recovered will also be analysed by high resolution mass spectrmetry in Poitiers thanks to our collaboration with the IC2MP within the framework of PEPR project.

A PhD student in Analytical chemistry just joined the SFERE team in October to develop the extraction by SFE. He will work together with the IR but also develop chromatographic coupling and the opening of the technique to other materials (Mars analogues).

Professional requirements

We are looking for a young PhD, Master or equivalent in sciences (chemistry, physics, astro) with a curiosity for space. Knowledge of experiment design or previous experience in supercritical fluid extraction is wanted. A knowledge of different extraction techniques and GC-MS will be considered as an advantage.

Laboratory

You will be part of the "Astrochemistry and astrobiology" team inside the Laboratoire Interuniversitaire des Systèmes Atmosphériques (LISA). The LISA has a strong expertise in the development of space instrumentation, is recognised at the international level and participates to numerous space missions (Curiosity, ExoMars, Rosetta…).

The installation of the SFE-SFC-MS instrument is currently in progress and a formation will take place in January in the new laboratories inside the Science and Technologies faculty of Paris-Est Créteil University. The laboratory is easily accessible by metro line 8 and RER D from Paris.

How to apply

All interested candidate must contact the supervisors for supplementary information and apply with a CV, a cover letter and a reference letter.

- Clara Azémard (clara.azemard@lisa.ipsl.fr)
- Fabien Stalport (fabien.stalport@lisa.ipsl.fr)

Starting date is 6th of January.

Bibliographie

1. Abrahamsson, V., Henderson, B. L., Zhong, F., Lin, Y. & Kanik, I. Online supercritical fluid extraction and chromatography of biomarkers analysis in aqueous samples for in situ planetary applications. *Anal. Bioanal. Chem.* **411**, 8091–8101 (2019).
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3. Devièse, T. *et al.* Supercritical Fluids for Higher Extraction Yields of Lipids from Archeological Ceramics. *Anal. Chem.* **90**, 2420–2424 (2018).
4. Sephton, M. A. Organic compounds in carbonaceous meteorites. *Nat. Prod. Rep.* **19**, 292–311 (2002).