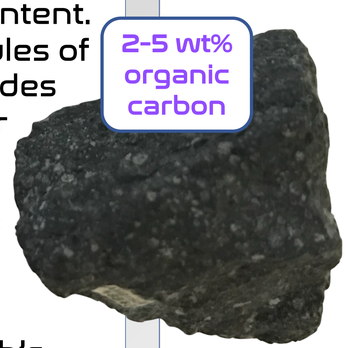
Soluble Organic Compounds in Carbonaceous Chondrites: Methodologies for Investigation

Alexandra Zetterlind[1], Christian Potiszil[2], Jonathan S. Watson[3], Mark A. Sephton[3], Ben Hoefnagels, Floris van der Tak[4,5], Inge Loes ten Kate[1]

[1]Department of Earth Sciences, Utrecht University, the Netherlands, [2]Pheasant Memorial Laboratory, Institute for Planetary Materials, Okayama University, Japan, [3]Impacts and Astromaterials Research Centre, Department of Earth Science and Engineering, Imperial College London, United Kingdom, [4]SRON Netherlands Institute for Space Research, Groningen, the Netherlands, [5]Kapteyn Astronomical Institute, University of Groningen, the Netherlands

Introduction

Carbonaceous chondrites are a specific class of meteorites that contains a high organic content. Examining organic molecules of these astromaterials provides insights into the early solar system's prebiotic organic budget and their potential contribution to an origin of life on Earth or elsewhere.

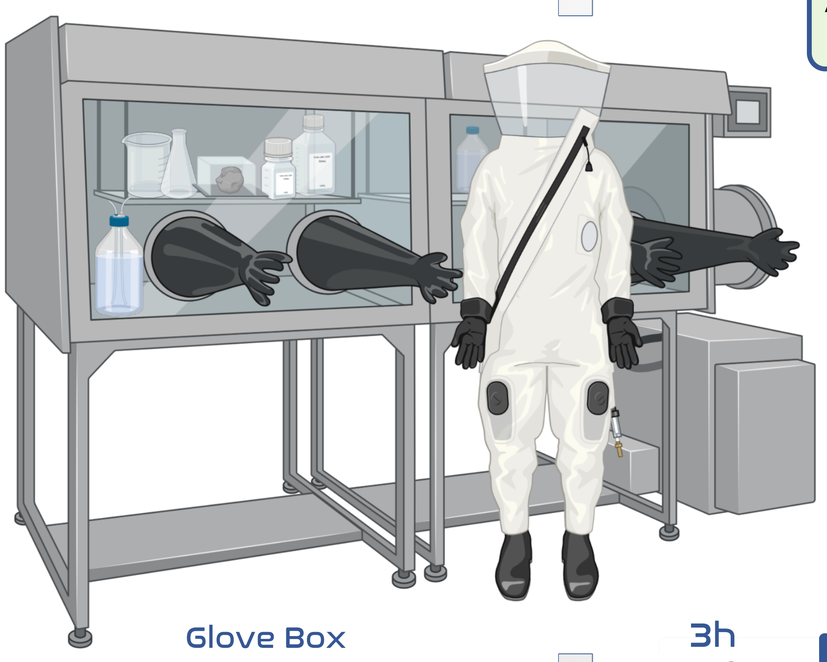


However, extraterrestrial samples reaching the Earth's surface are vulnerable to terrestrial organic contaminants due to the presence of life and its derivates.

In the present work, we outline a comprehensive approach for analysis of soluble organic compounds in carbonaceous chondrites, with an emphasis on mitigation and monitoring of sample contamination.

Laboratory Requirements

The delicacy of the material requests a special care prior to and during organic analyses.



Glove Box

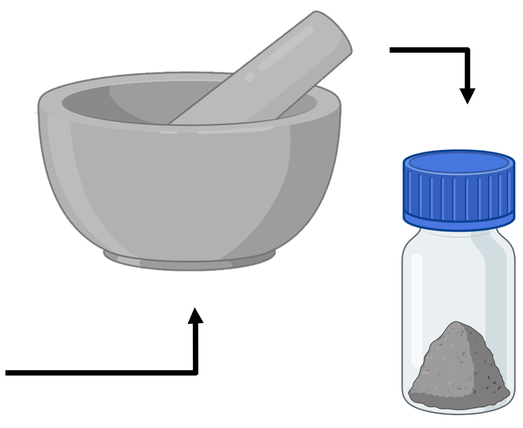
This includes measures such as:

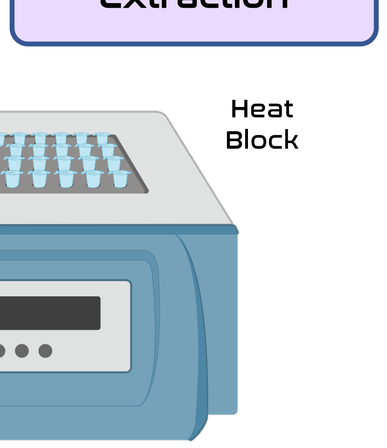
- ☆ Work in clean room laboratory conditions
- ☆ Glassware and tools are heat-sterilized (at ≥500°C) & solely used for meteoritic sample handling
- ☆ Removal of the fusion crust of meteorites
- ☆ Use of only high purity solvents & ultrapure water
- ☆ Measurement of background levels of organics present in chemical reagents
- ☆ Analysis of procedure blanks in parallel with samples

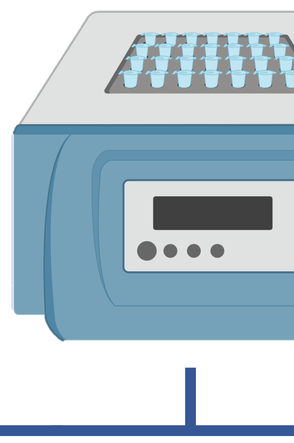
Intrinsicality Monitor

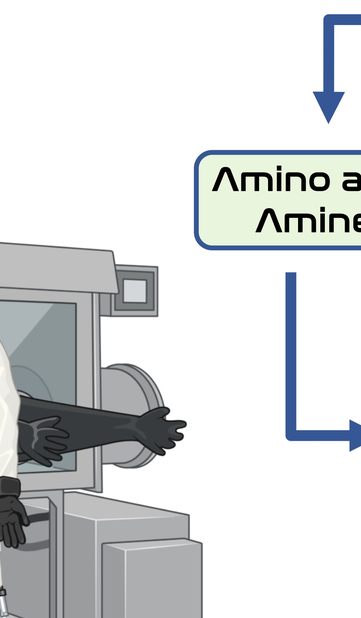
- ☆ Molecular characteristics (e.g., chirality)
- ☆ isotopic signatures ($\delta^{13}C$ and δD)

Sample Extraction Protocols

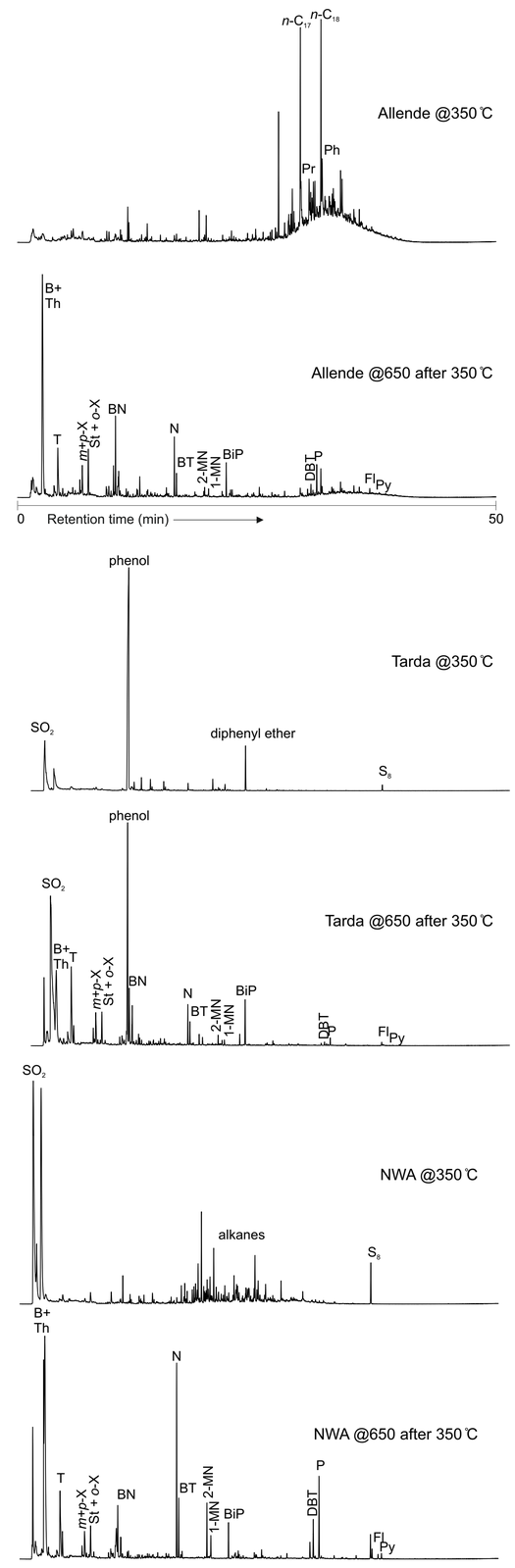








Preliminary Trials



Pyrolysis-GC-MS chromatograms of Allende, Trada and NWA 10834 performed at 350°C and 650°C.

Abbreviations: Pr – pristine, Ph – phytane, B – benzene, T – toluene, Th – thiophene, St – styrene, N – naphthalene, BT – benzothiophene, MN – methylnaphthalene, BiP – biphenyl, DBT – dibenzothiophene, P – phenanthrene, Fl – fluoranthene, Py – pyrene, S8 – octasulfur

Further work

- ☆ In depth analyses of soluble organics in carbonaceous chondrites Allende, Tarda, NWA 10834, Aguas Zarcas
- ☆ Liberation of organic compounds into primordial Earth's environments
- ☆ Spatial analyses of minerals-organics associations within carbonaceous chondrites

References

Sephton, M. A. (2014). Organic Geochemistry of Meteorites. In *Treatise on Geochemistry: Second Edition.*

Simkus, D. N., Aponte, J. C., Elsila, J. E., Parker, E. T., Glavin, D. P., & Dworkin, J. P. (2019). Methodologies for analyzing soluble organic compounds in extraterrestrial samples: Amino Acids, Amines, Monocarboxylic Acids, Aldehydes, and Ketones. *Life, 9,* 47. MDPI AG.

Contact a.o.zetterlind@uu.nl

Utrecht University · 岡山大学 惑星物質研究所 IPM Institute for Planetary Materials · Imperial College London · university of groningen · NWO PEPSci Planetary and Exoplanetary Science · NWO