Europlanet TA Scientific Report

PROJECT LEADER

Project number: 22-EPN3-091
Name: Evolution under radiation of organics pertaining to Europa (EUROPE)
Home Institution: Aix-Marseille Université, France
TA Facility visited: TA2 Facility 11, (Ice Chamber for Astrophysics Astrochemistry) ATOMKI, Debrecen, Hungary

Project Title:

Scientific Report Summary.
(plain text, no figures, maximum 250 words, to be included in database and published)

Several of the icy moons of Jupiter possess a liquid water ocean under a thick icy crust. In the especially promising case of Europa, a young surface (>100 Myr), and likely recent cryovolcanicactivity (within the last 8 years) imply the presence of ocean material on the surface. Therefore, observations performed by space missions could determine the ocean's composition, and derive indications on its potential habitability (presence of chemical gradients providing metabolic energy, quantity and composition of available organic matter…). Characterizing Europa's ocean and its possible habitability requires to understand processes that alter organic and inorganic molecules in this environment. These processes include the processing by energetic ions coming from Jupiter's magnetosphere and hitting the surface. In this project, we have studied the effect of sulfur ion bombardment on methanol, a species that could be indicative of key characteristics of the ocean, pure and within an ice matrix. The alteration of the sample was followed using infrared spectroscopy, and the resulting complex organic residues were retrieved for ultra-high resolution mass spectrometry.

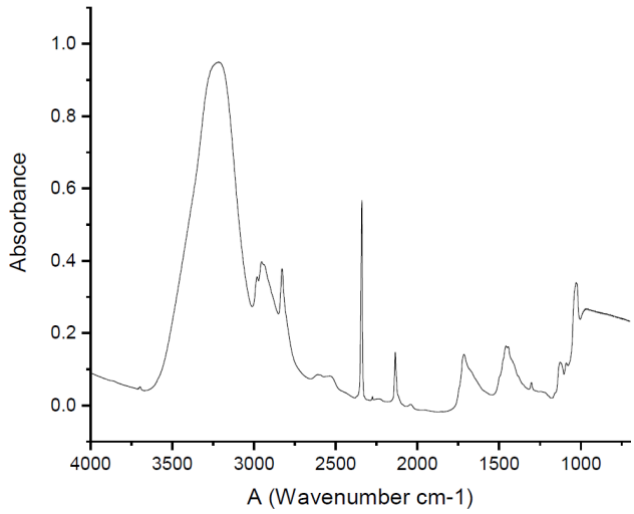
Full Scientific Report on the outcome of your TNA visit

We encourage you to add figures to your report, which should be approx. 1 page of text plus figures.

We deposited a gas mixture of water + methanol (or pure methanol in the case of our third sample) onto the cooled down MgF_2 substrate, at a temperature of 80K, relevant to the range of temperatures on Europa's surface. The first sample was obtained by a multi-layer deposition process (deposition of a thick layer, irradiation with the beam, then deposition of a new layer…), which had already been used in previous experiments in other setups. The two other samples were produced by background co-deposition: the gas mixture was present in the chamber and depositing at the same time as the sample was being irradiated. This process makes it harder to calculate the dose received per unit of volume, but favors retention of products for a better off-site analysis. We always ensured the thickness of the sample was enough to allow implantation of the sulfur ions, opening the possibility of forming sulfur-bearing organics. The beam used was formed with 200 keV S+ ions. After irradiation, the samples were reheated slowly overnight while still under vacuum, sublimating the volatile compounds and retaining the refractory residue.

Infrared spectroscopy allowed to gather data regarding the cross-section of destruction (and therefore lifetime on an irradiated planetary surface) of methanol in an icy matrix, and the most abundant products resulting from its destruction. The organic residues are differently colored depending on the initial sample (with or without water), which hints at differences in composition that will be revealed by ulterior analysis.

The residues will be taken to a facility possessing a Fourier Transform – Ion Cyclotron Resonance (FT-ICR) mass spectrometer for an exhaustive analysis of their content. Complementary ionization techniques such as Laser Desorption Ionization and Electrospray Ionization will be used to detect the variety of compounds (aromatic or aliphatic, oxygen-rich or poor, sulfur-bearing or not) that have been formed.



Left: example spectrum of the irradiated methanol sample, showing the formation of the usual radiolytic products such as CO_2, CO, CH_4, H_2CO. *Right*: MgF_2 substrate with an organic residue resulting from the irradiation and warming up process.

- Give details of any publications arising/planned (include conference abstracts etc)

Data acquired during this TA will be included in future publications. Data analysis is underway, time at an FT-ICR facility has been acquired and will be used to acquire additional data.

- Host confirmation

Please can hosts fill in/check this table confirming the breakdown of time for this TA project:

Dates for travel to accommodation for TA visit (if physical visit by applicant)	Start Date of TA project at facility	Number of lab/field days spent on TA Visit pre-analytical preparation	Number of days in lab/field site for TA Visit	Number of days spent in lab for TA Visit data analysis	End Date of TA project at facility	Dates for travel home (if physical visit by applicant)
Departed: 18-02-24 Arrived: 18-02-24	19-02-24	0	5	0	23-02-24	Departed: 28-02-24 Arrived: 28-02-24

The host is required to approve the report agreeing it is an accurate account of the research performed.

Host Name	dr. Zoltán Juhász
Host Signature	
Date	**19/03/24**

- Project Leader confirmation

Do you give permission for the full version of this TA Scientific Report (in addition to the 250 word summary) to be published by Europlanet 2024 RI on its website and/or public reports?

YES

Project Leader Name	Alexis Bouquet
Project Leader Signature	
Date	**11/03/2024**