Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.6922

Detecting microbial biosignatures in ice grains from Europa and Enceladus using mass spectrometry

FABIAN KLENNER[1], MARYSE NAPOLEONI[1], JANINE BÖNIGK[1], MIRIAM PAVLISTA[1], JON HILLIER[1], NOZAIR KHAWAJA[1], MARIE DANNENMANN[2], EBERHARD KLAUCK[1], BERND ABEL[3,4], KAREN OLSSON-FRANCIS[5] AND FRANK POSTBERG[1]

[1]Freie Universität Berlin
[2]University of Zurich
[3]Leibniz-Institute of Surface Engineering
[4]Universität Leipzig
[5]The Open University

Presenting Author: f.klenner@fu-berlin.de

Identifying biosignatures is vital in the search for life. Cryovolcanically active ocean worlds, such as Saturn's moon Enceladus and potentially Jupiter's moon Europa, eject ice grains formed from subsurface water into space [1]. The emitted ice grains can be sampled by impact ionization mass spectrometers on board spacecraft, thereby providing insights into the oceans' compositions. As well as salts [2], organic molecules have already been identified in ice grains from Enceladus [3,4]. These discoveries were supported by laboratory Laser Induced Liquid Beam Ion Desorption (LILBID) experiments, proven to reproduce mass spectra that are accurate analogues of those generated by impact ionization of ice grains [5]. Using this approach has shown that bioessential molecules, namely amino acids, fatty acids and peptides can be detected and characteristic biotic and abiotic spectral signatures of these molecules can be discriminated from each other down to the ppm or ppb level [6,7].

Here we present the next steps – LILBID experiments with DNA and membrane lipids extracted from *Escherichia coli* (strain W3110) and *Sphingopyxis alaskensis* undertaken to predict the spectral appearances of these molecules as indicators for potential life. The corresponding aqueous phase produced during the lipid extraction step and potentially contained polar molecules, was also investigated with LILBID. To mimic the effects of a salty Enceladean or Europan ocean, the molecules were investigated in increasingly NaCl-rich matrices.

In the resulting mass spectra, we identified characteristic microbial biosignatures from the tested extracts, such as fatty acids deriving from the bacteria's membrane lipids. Sensitivity to spectral signals characteristic of the extracts (including the polar molecules) decreased with increased salt concentration. These spectra, together with those of other organic and inorganic compounds, are part of a comprehensive database that provides analogue data applicable to future space-based impact ionization mass spectrometers.

References

[1] Porco et al. (2006) Science 311:1393-1401.
[2] Postberg et al. (2009) Nature 459:1098-1109.
[3] Khawaja et al. (2019) Mon Not R Astron Soc 489:5231-5243.
[4] Postberg et al. (2018) Nature 558:564-568.
[5] Klenner et al. (2019) Rapid Commun Mass Spectrom 33:1751-1760.
[6] Klenner et al. (2020a) Astrobiology 20:179-189.
[7] Klenner et al. (2020b) Astrobiology 20:1168-1184.