Experiments for the Identification of Biosignatures in Ice Grains from Extraterrestrial Ocean Worlds

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Abstract

Identification of biosignatures, such as amino acids, fatty acids and peptides, on extraterrestrial ocean worlds is key in the search for life or its emergence. These investigations are possible using in situ spacecraft-based impact ionization mass spectrometers to assess the abundances of organic species in ice grains emitted from ocean-bearing moons like Enceladus and Europa. One such mass spectrometer, Cassini's Cosmic Dust Analyzer (CDA), has proven to be very successful in analyzing inorganic and organic grain constituents to characterize the habitability of Enceladus' ocean [1][2][3]. Hitherto biosignatures have not been identified in extraterrestrial ocean environments. We simulate, with an analogue Laser Induced Liquid Beam Ion Desorption (LILBID) experiment, previously shown to reproduce accurately the mass spectra of water ice grains at different impact velocities [4], the mass spectral appearance of amino acids, fatty acids and peptides in water ice grains and determine their detection limits to be at the ppm or ppb level [5]. The investigated organic molecules and their fragments are clearly identifiable in the mass spectra [5] and by comparison with spacecraft data we can recognize these key organic biosignatures in ice grains from icy moons with a subsurface ocean. These results form part of a comprehensive organic analogue compound spectral reference library for in situ mass spectrometers and can be applied to available (CDA) and future space craft data (e.g. Surface Dust Analyzer (SUDA) on board the Europa Clipper mission).

References

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