

A fly-through mission strategy targeting peptide as a signature of chemical evolution and possible life in Enceladus plumes

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Abstract: *In situ* detection of organic molecules in the extraterrestrial environment provides a key step towards better understanding the variety and the distribution of building blocks of life and it may ultimately lead to finding extraterrestrial life within the Solar System. Here we present combined results of two separate experiments that enable us to realize such *in situ* life signature detection from the deep habitats of the “Ocean World”: a hydrothermal reactor experiment simulating complex organic synthesis and a simulated fly-through capture experiment of organic-bearing microparticles using silica aerogels, followed by subsequent analysis. Both experiments employ peptide as a plausible organics existing in Enceladus plume particles produced in its subsurface ocean.

Recent laboratory hydrothermal experiments and a theoretical model on silica saturation indicated an ongoing hydrothermal reactions in subsurface Enceladus ocean [1]. Given the porous chondritic origin of the core, it is likely that organic compounds originated by radiation chemistry such as amino acid precursors could have been provided, leached, and altered through widespread water–rock interactions. By using the same laboratory experimental setup from the latest water-rock interaction study [2], we performed amino acid polymerization experiments for 144 days and monitored the organic complexity changing over time.

So far over 3,000 peaks up to the size of > 600 MW were observed through the analysis of capillary electrophoresis time-of-flight mass spectrometry (CE-TOF-MS) with an indication of amino acid derivatives and short peptides.

Generally abiotic polymerization of enantiomeric amino acids results in forming stereoisomeric peptides with identical molecular weight and formula [3] as opposed to homochiral biopolymers. Assuming Enceladus plume particles may contain a mixture of stereoisomeric peptides, we were able to distinguish 16 of the 17 stereoisomeric tripeptides as a test sample using capillary electrophoresis (CE) under optimized conditions. We further conducted Enceladus plume fly-through capture experiment by accelerating peptides soaked in rock particles up to a speed of 5.7 km/s and capturing with originally developed hydrophobic silica aerogels [4]. Direct peptide extraction with acetonitrile-water followed by CE analysis led to detection of only but two stereoisomeric acidic peptide peaks, presenting the first run-through hypervelocity impact sample analysis targeting peptides as key molecule to understand the ongoing astrobiology on Enceladus.

Reference

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