The Organic Capillary Electrophoresis Analyzer (OCEAN) Instrument Concept

Jessica Creamer[1], Aaron Noell[1], Konstantin Zamuruyev[1], Florian Kehl[1], Vlad Cretu[1], Mauro Ferreira Santos[1], Elizabeth Jaramillo[1], Mircea Badescu[1], Fernanda Mora[1], Will Brinckerhoff[2], Richard Quinn[3], Tony Ricco[3], Peter Willis[1]

[1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, United States
[2]NASA Goddard Space Flight Center
[3]NASA Ames Research Center

The Ocean Worlds Life Surveyor (OWLS) instrument suite is designed to search for signs of life by combining the complementary lines of evidence provided by organic chemical analysis and microscopy. Organic chemical analysis in OWLS is performed by the Organic Capillary Electrophoresis Analysis System (OCEANS). OCEANS is designed to search for biological patterns in the distributions of classes of organic molecules such as amino acids, nucleic acids, and carboxylic acids, as well as higher molecular weight polymers such as small peptides or fatty acids.

OCEANS achieves this by coupling the high efficiency separation capability of capillary electrophoresis (CE) with three different detection modes:

- Conductivity (C4D) to detect small common di- and tri-carboxylic acid metabolites that could be present when active organisms are in a sample.
- Laser induced fluorescence (LIF) for highly sensitive detection of amino acid, specifically determining the distribution of amino acid type and chirality.
- Electrospray ionization mass spectrometry (ESI-MS) to broadly survey for organic molecules over the mass range from 75 – 500 m/z, as well as target nucleic acids and fatty acids.

An upstream sample extraction system allows for variable temperature extraction followed by bulk characterization to provide information on the pH, eH, and dominant salts in the sample. Bulk characterization of the sample allows for appropriate preparation by the microfluidic processing ahead of CE separation.

Collectively, OCEANS provides highly sensitive and specific analysis of a broad range organic molecules and their distributions to help discriminate between biotic and abiotic sources; this information is then fed into the overall OWLS instrument suite to determine if life was present in the sample. Additionally, under ICEE-2 funding, OCEANS is being adapted for inclusion as part of the Europan Molecular Indicators of Life Investigation (EMILI, PI Will Brinckerhoff, Goddard Space Flight Center).