Molecular microstratigraphy via laser-desorption ionization Fourier-transform ion cyclotron resonance mass spectrometry (LDI-FT-ICR-MS)

THORSTEN DITTMAR[1]*, SAMUEL ABIVEN[2], JUTTA NIGGEMANN[1] AND JENS FUCHSER[3]

[1]Max Planck Research Group for Marine Geochemistry, University of Oldenburg, Germany, (*correspondence: tdittmar@mpi-bremen.de; jniggema@mpi-bremen.de)
[2]University of Zurich, Soil Science and Biogeography, Switzerland (samuel.abiven@geo.uzh.ch)
[3]Bruker Daltonics, Bremen, Germany (Jens.Fuchser@bdal.de)

Ultrahigh-resolution mass spectrometry via the Fourier-transform ion cyclotron resonance technique (FT-ICR-MS) offers fundamentally new insights into the molecular world of natural waters. Oceans and freshwater systems are among the most complex molecular mixtures on Earth, containing ten-thousands if not millions of different compounds, collectively known as dissolved organic matter (DOM). With help of FT-ICR-MS, DOM can now be appreciated in its full molecular complexity, and a holistic geo-metabolomic approach is in sight that will allow a mechanistic understanding of element cycles in the ocean. In sediments and soils similar progress has been hampered by limited capabilities for the ionization of organic matter from solid samples for FT-ICR-MS analysis. In the life sciences, different laser-desorption ionization techniques (LDI) coupled to FT-ICR-MS are established tools for the molecular characterization of metabolites in organic tissues. Recently, this technique was extended for two-dimensional imaging of organic tissues allowing the identification of specific metabolites on a micrometer spatial scale. Objective of our study was to apply LDI-FT-ICR-MS for the molecular imaging of sediments. We obtained detailed molecular fingerprints of finely layered marine sediments, spatially resolved on a 50 micrometer scale. These first molecular images of marine sediments illustrate the enormous potential of LDI-FT-ICR-MS for the geosciences. Instead of targeting a small number of specific biomarkers, molecular formulae of hundreds to thousands of individual compounds are simultaneously obtained. Micrometer-scale stratification can be resolved on an extremely small amount of sample which is otherwise not accessible to molecular analysis.

Origin of iron layer in sediment of Lake Superior: Abiotic vs. biotic

M. DITTRICH[1], J. GORDON[1], B. RAOOF[1], A. CHESNYUK[1], S. QUAZI[1], R. SHEN[1], J. BOLLMANN[2], S. KATSEV[3] AND R. FULTHORPE[1]

[1]Department of Physical and Environmental Sciences, University of Toronto Scarborough, 1265 Military Trail, Toronto, Canada, M1C 1A4, (*correspondence: mdittrich@utsc.utoronto.ca)
[2]Department of Earth Sciences, University of Toronto, 22 Russel St, Toronto, Canada, M5S 3B1, (bollman@utoronto.ca)
[3]Large Lakes Observatory 2205 East 5th Street, Duluth, MN 55812, (skatsev@d.umn.edu)

In spite of being the largest by surface and one of the most oligotrophic fresh water bodies in the world, Lake Superior is rather a blank spot on the map of modern Geochemistry and Geomicrobiology. Although the limnological puzzles of Lake Superior are increasingly attracting scientists [1], very little is known about the sediments and their associated microflora. In this study we investigated geochemical and microbiological processes that may lead to the formation of a two cm thick iron layer about 10 cm below the sediment surface. Sediment cores from two stations (EM, 230m water depth and ED, 310m water depth) in East Basin were used. We monitored oxygen and pH depth profiles with microsensors, porewater and sediment solid matter were analyzed for nutrient and metal contents. The total cell count was determined using DAPI. DNA was extracted from the sediment samples and 16S ribosonal RNA amplicons were analyzed with denaturing gradient gel electrophoresis (DGGE).

The cluster analysis performed on the DGGE fingerprint revealed that there is no distinct microbial community in the iron layer, infact the bacterial community of the iron layer was 97% similar to that of adjacent layers. The scanning electron microscope (SEM) images from the iron layer 10-12cm show filament like structures that was encrusted with spheres ca. 20 nm in diameter (Figure 1A,B).

A B

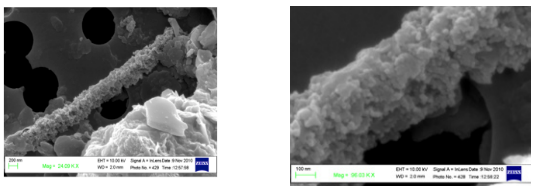

Figure 1. SEM images of filament like structure in the iron layer (A). Filament or tube covered was with spheres (B).

[1] Steiner R. (2011) *Inland Water* **1**, 29-46.