Geophysical Research Abstracts
Vol. 20, EGU2018-15626, 2018
EGU General Assembly 2018

Differentiating inputs of soil and lacustrine branched GDGTs in Sebago Lake sediments (Maine, Northeast U.S.A.)

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Branched glycerol dialkyl glycerol tetraethers (brGDGTs) are lipids present in soils, rivers and lakes, are comprised of two alkyl chains ether-bound to glycerol groups, and contain a varying number of methyl branches and cyclopentane moieties. The degree of methylation, defined by the Methylation of Branched Tetraethers (MBT) Index (Weijers et al., 2007; De Jonge et al., 2014), varies as a function of mean annual soil (air) temperature. brGDGTs are often abundant in lake sediments where they are typically characterized by different distributions in comparison to surrounding catchment soils (e.g., Tierney and Russell, 2009). There is much interest in using brGDGTs as a lacustrine paleothermometer; however, application to lakes is confounded by potential multiple inputs of brGDGTs.

Here, we evaluate the influence of soil-derived brGDGTs to modern lacustrine sediments in a suite of surface sediments from Sebago Lake, a moderately large (117 km2 surface area) and deep lake (∼100 m) located near Portland, ME. An Ekman sampler was used to collect surface sediments at 34 locations, falling along three cross-lake transects. The first transect spans ∼17 km and extends from the Crooked River in the north, the main inflow to Sebago Lake, to Lower Bay in the south. This transect crosses Big Bay, where water depths reach over 100 m. The second transect spans ∼8 km and extends from the western to the eastern side of Big Bay, beginning near the Northwest River inflow. The third transect spans ∼14 km and samples locations within Jorden Bay, which lacks any major river inputs and is isolated from the larger Big Bay by an island and a peninsula. Watershed soil samples were also collected from 16 locations surrounding Sebago Lake, all within <0.5 km of the shore.

Major differences in brGDGT distributions and concentrations between the soil and lake sediments are noted. Like previous studies (e.g., Tierney and Russell, 2009), Sebago Lake sediments contained more methylated brGDGTs and significantly higher brGDGT concentrations in comparison to catchment soils. Furthermore, lake sediments contained both 5- and 6-methyl brGDGTs (mean value of 16% 6-methyl brGDGTs) whereas most soil samples contained solely 5-methyl brGDGTs. These differences allow us to trace inputs of soil-derived brGDGTs from the Crooked and Northwest Rivers into Sebago Lake. We find that samples from depths <40 m and distances of <500 m in front of the inflowing rivers contained mixed soil and lacustrine brGDGT characteristics, with sites located closer to the shore being more similar to soil samples. However, samples collected from the rest of the lake, including those located close to the shore but away from river inputs, are remarkably homogeneous and appear to lack any soil influence. Our results thus support use of brGDGTs as a lacustrine paleothermometer in lakes where substantial soil inputs can be ruled out.