WATER RESOURCES RESEARCH GRANT PROPOSAL

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Title: Does aluminum geochemistry control the trophic status of oligotrophic lakes?

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Abstract

Watershed and geological factors exert important controls on the trophic condition of lakes. These natural controls may mitigate or enhance the natural sensitivity of lakes to cultural eutrophication from development and non-point source pollution. Phosphorus is an especially important water quality problem from non-point source pollution. However, phosphorous-release and retention mechanisms in lakes are not fully understood.

Abundant data by our research group and many others indicates that phosphorous flux from sediments is usually correlated to iron flux. Reduction of iron(III) to iron(II) releases the hydroxide-bound phosphorous as iron(III) hydroxide is reduced and dissolves. However, some oligotrophic and mesotrophic lakes that develop anoxic hypolimnia during summer do not release phosphorous in correlation with iron. The puzzle is that despite summer anoxia and significant iron release, these lakes maintain low phosphorous concentrations and do not support algae blooms.

Based on our recent findings and those of others, we hypothesize that colloidal aluminum hydroxide from tributaries may be responsible for scavenging and inactivating phosphorous in these high-iron, low-phosphorous lakes. This hypothesis is based on the wide-spread observation that acidic precipitation leaches aluminum from many soil types through dissolution.

In lakes and streams, we have demonstrated that this aluminum precipitates as colloidal Al(OH)3 and scavenges phosphorous from the water column. The questions are whether this mechanism has been important historically in these lakes, and whether the process can quantitatively reduce phosphorous release from sediments under anoxic conditions.

We will test this hypothesis in a two-part workplan using aquatic chemistry and paleolimnology. We will compare the flux of iron and phosphorous from the sediments of three lakes versus the seasonal concentrations of phosphorous and particulate aluminum in streams and the lake water column. The three lakes span the range of phosphorous, iron, and summer anoxia found in Maine, based on decades of data from USGS WRD, Maine DEP, and the University of Maine. Dated sediment cores taken from these lakes will be analyzed to determine the temporal changes in concentrations of labile aluminum and phosphorous relative to the historical development of the watersheds.

The methods and results from this study can be applied to similar lake watershed systems with low alkalinity in all regions of the northern US and Canada. If the results from this study support the hypothesis, this information will provide a new tool for state and federal agencies to protect lake water quality based on their sensitivity to cultural eutrophication. Understanding the relative importance of natural factors for the protection of water quality is essential in light of recent emphasis on Total Maximum Daily Load (TMDL) studies and nutrient criteria.