USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

A. RESEARCH PROPOSAL

1. **TITLE:** Organic Matter Binding and Photoreduction of Mercuric Ion and Methylmercury in Surface Water

2. Focus Categories: TS, WQL, HYDGEO

3. Keywords: Mercury, Methylmercury, Humic Matter, Photochemistry, Biogeochemical Cycles, Complexation, Sulfur

4. Duration: August 15, 1998 to August 14, 2000

5. Federal Funds:$56,064

6. Nonfederal (Matching) Funds: $113,422

7. Principal Investigators

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8. Congressional District: Fourth and Fifth

9. Statement of Critical Regional or State Water Problem

Mercury (Hg) pollution is a global-scale problem with both ecological and human health implications. Thousands of lakes in Europe, Canada and the United States, many in remote and pristine areas, contain fish with methylmercury (CH_3Hg^+) concentrations above public health guidelines for human consumption. The problem is prevalent in the lake regions of the Upper Midwest, and especially common in the soft-water, acid-sensitive lakes of northeastern Minnesota, northern Wisconsin, and Upper Michigan. For example, the State of Minnesota has issued fish consumption advisories for more than 500 lakes because of elevated Hg levels in one or more species of game fish. It should be noted that even this number reflects the relatively small fraction of Minnesota lakes from which fish have been collected for Hg analysis rather than an accurate estimate of the

magnitude of the problem in the state. Although the primary concern with elevated Hg levels in fish relates to human health effects, wildlife, especially water fowl and top predators, also can be impacted negatively by elevated Hg levels in fish, as has been demonstrated by studies in such disparate areas as northern Minnesota and the Florida Everglades.

In spite of significant advances made over the past decade, critical gaps remain in our understanding of Hg sources, transport, and cycling processes in aquatic and terrestrial systems. For example, it is widely acknowledged that the most important source of Hg in lakes is atmospheric deposition, and fossil fuel combustion and incinerators are thought to be major emission sources for Hg. Nonetheless, the occurrence of elevated Hg levels in fish of lakes within a small geographic area is patchy, despite the regional homogeneity in loading implied by an atmospheric source. Among the various water chemistry factors thought to be responsible for these differences in lake responses, interactions between Hg forms and natural organic matter (e.g. humic material) are perhaps the most important. Unfortunately, our understanding of Hg-organic matter interactions is based mostly on qualitative observations and statistical correlations, and quantitative, mechanistic information is lacking on this key issue.

10. Statement of Expected Results or Benefits

In this study we will quantify the strength of binding (chemical complexation) of Hg^{2+} and CH_3Hg^+ to natural dissolved organic matter (NDOM) and determine the chemical nature of the binding. We also will evaluate the role of Hg^{2+} and CH_3Hg^+ complexation by NDOM in mediating the photoreduction of these species to elemental Hg, which is volatile and thus is subject to subsequent efflux from water bodies. A full understanding of the transport and transformations of Hg in natural waters requires quantitative information on these processes. Results of the proposed study will greatly aid in modeling of the behavior of Hg in surface waters and in understanding the bioavailability of Hg bound to NDOM.