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Sedimentary Records of Mercury and Organic Matter in Canadian Lakes; Relationship between Climate Change and Contaminants

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Recent studies in the remote pristine lakes in the Canadian High Arctic has shown that historical trends of mercury (Hg) are often paralleled with those of mainly algal-derived organic matter (OM) over past decades and centuries. This correlation is especially important during the latter half of the 20th Century when phytoplankton productivity increased by several orders of magnitude from historically low levels; suggesting that the dynamics and fate of Hg in High Arctic lakes may have been seriously confounded by increased algal productivity as the result of recent climate change. The important questions facing this hypothesis are (1) the degree that climate change and resulting algal productivity influence the Hg flux into the aquatic systems (2) whether or not this phenomena is limited to Arctic region and what is the role of depositional environment in the observed pattern (3) how atmospheric flux of Hg as related to the local/regional anthropogenic source(s) may influence the Hg-OM correlation observed in the sedimentary records.

This study aims to answer some of these questions by examining the historical records of Hg and OM from 40 high-resolution lacustine/marine sediment cores representing a wide range of depositional environment, climatic, and geographical conditions across Canada. Organic geochemistry in conjunction with organic petrography provide unique information on the composition of sedimentary OM as defined by the source and type of kerogen. The results show that the nature of the relationship between sedimentary Hg and algal-derived OM may significantly change depending on the degree of Hg influx, and quantity and composition of the OM content of the sediments. It appears that OM, in particular, labile algal-derived OM primarily controls the Hg distribution in the sediments when the Hg influx (atmospheric deposition, runoff, etc) is within or close to background levels (e.g., as in Arctic lakes). When the Hg influx exhausts the capacity of OM scavenging (in the case of high anthropogenic input), excess Hg can be found in sediments, showing a clearly different temporal pattern to its organic counterpart. Only in these cases will sedimentary Hg profiles follow the history of anthropogenic Hg deposition. Given the relative homogeneity and paucity of OM in many Arctic and Sub-arctic lakes, small changes in climate may induce dramatic shifts in the rate of suspended OM scavenging of Hg, which is reflected in the sedimentary record of Hg.