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Dynamics of methane level in oxic waters in an embayment of Georgian Bay, Lake Huron

KHOREN AVETISYAN[1], XIAOQING SHAO[1], DAVID SWEETNAM[2] AND MARIA DITTRICH[1]

[1]University of Toronto Scarborough

[2]Georgian Bay Forever

Presenting Author: khoren.avetisyan@utoronto.ca

Methane (CH_4) is a greenhouse gas and a common byproduct of anaerobic decomposition of organic matter. The discovery of methane production in oxic marine and limnic waters has redefined the role of CH_4 cycle in aquatic environments. Recent studies showed that methane production in oxic zones increases in response to global warming (Günthel et al. 2019), eutrophication, and urbanization. Although CH_4 accumulation in oxic surface waters became recognized in recent years, the understanding of CH_4 production under oxic conditions is still subject to controversial discussions. This study aimed to provide insights on iron/manganese-methane couplings in the water column of on embayment of Lake Huron. Our main goals are 1) to elucidate an interplay of redox processes and methane formation in oxic surface water and 2) to explore the role of microbes in methane cycle.

Water column samplings were performed at the deepest site (17m water depth) of North Bay Honey Harbor in Georgian Bay of Lake Huron, the second largest Laurentian Great Lake (Ontario, Canada) between July to October 2021. We analyzed the geochemical depth profiles of iron, manganese, nutrients, photosynthetically active radiation (PAR), CH_4 concentration and stable isotope composition of $\delta^{13}C\text{-}CO_2$. Furthermore, the DNA were extracted from the samples at the oxic/anoxic interface and the oxic methanogenic zone.

Stable thermal stratification during August-September is expressed in anoxic conditions below 6-9 m depths, with increasing concentrations of iron and manganese in hypolimnion. The monitoring of CH4 concentrations suggests a formation of CH4 above oxic/anoxic interface. Our results demonstrate a substantial amount of CH_4 is accumulated in the oxic water column, suggesting that the oxic CH_4 production can be a significant contributor to the CH_4 efflux from stratified lakes.

Günthel M., Donis D., Kirillin G., Ionescu D., Bizic M., McGinnis D.F., Grossart H.P and Tang K.W. (2019). Contribution of oxic methane production to surface methane emission in lakes and its global importance. *Nat Commun* 10, 5497.