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Phosphorus recycling and retention in Lake of the Woods: Reactive-transport diagenetic modeling across spatial and temporal Scales

Md Samrat Alam[1], Arthur Zastepa[2], and Maria Dittrich[1]
[1]Department of Physical and Environmental Sciences, University of Toronto Scarborough, 1065 Military Trail, Scarborough, Toronto, ON, Canada (samrat.alam@utoronto.ca)
[2]Environment and Climate Change Canada, Canada Centre for Inland Waters Burlington, ON, L7S 1A1, Canada

The dynamics of sediment phosphorus (P) remobilization and recycling in many polymictic systems due to distinct external and internal loading conditions are poorly understood. Here we used a multifaceted approach of quantifying sediment P binding forms and corresponding metal contents in sediment cores down to 30 cm from 8 different locations at Lake of Woods (LOW) in different seasons. We also measured pH, redox potential and dissolved oxygen uptake across the sediment-water interface and the concentration of nutrient and metals in pore water at different depths. Additionally, we applied a reaction-transport diagenetic model to construct the spatial and temporal trend of internal P loading in response to environmental variations. The summer diffusive fluxes of P ranged between 3 and 83 μmol m^{-2} d^{-1} whereas the winter fluxes were lower ranged from 0.1 to 0.35 μmol m^{-2} d^{-1}. P recycling efficiency were 13% to 77%. P bound to redox sensitive iron (Fe)-P binding forms in sediments were the major source of P release in all stations, while P immobilization is controlled by redox-insensitive calcium (Ca)-P phases. The modeling results supported the notion that P release was mostly driven by the diagenetic recycling of redox sensitive and organic bound P.