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Phosphorus dynamics in lake sediments: Insights from field study and reactive-transport modeling

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Phosphorus is an indispensable nutrient for organisms in aquatic systems and its availability often controls primary productivity. At the sediment-water interface, intensive microbiological, geochemical and physical processes determine the fraction of organic matter, nutrients and pollutants released into the overlying water. Therefore, detailed understanding of the processes occurring in the top centimeters of the sediment is essential for the assessment of water quality and the management of surface waters. In cases where measurements are impossible or expensive, diagenetic modelling is required to investigate the interplay among the processes, verify concepts and predict potential system behavior.

The main aims of this study are to identify and predict the dynamics of phosphorus (P) in sediments and gain insight into the mechanism of P release from sediments under varying environmental conditions. We measured redox, O_2 and pH profiles with micro-sensors at the sediment-water interface; analyzed phosphate and metals (Fe, Mn, Al, Ca) content in pore waters collected using in situ samplers, so called “peepers”; determined P binding forms using sequential extraction and analyzed metals associated with each fraction. Following the sediment analysis, P binding forms were divided in five groups: inert, carbonate-bound, organic, redox-sensitive, and labile P.

Using the flux of organic and inorganic matter as dynamic boundary conditions, the diagenetic model simulates P internal loading and predicts P retention. This presentation will discuss the results of two years studies on P dynamics at the sediment-water interface in three different lakes ranging from heavy-polluted Hamilton Harbor and Bay of Quinte to pristine Georgian Bay in Ontario, Canada.