Reactive transport constraints on early diagenesis in two soda lakes of the Cariboo Plateau, Canada

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Carbonate-rich hardwater and saline lakes account for ~20% of inland water surface area globally and host some of the Earth's most productive microbiological ecosystems. The high alkalinity "soda" lakes of the Cariboo Plateau of British Columbia, Canada – particularly Last Chance and Goodenough Lakes – represent an especially well-studied subset of these systems. Nevertheless, aqueous geochemical processes accompanying shallow (<50 cm) sediment burial in these lakes, which have implications for their geological preservation and their long-term contribution to Earth's carbon cycle, remain poorly understood.

To provide quantitative constraints on these processes, we undertook a field study of both Last Chance and Goodenough Lakes. We performed piston coring on both lakes and analyzed the mineralogy and geochemistry of the recovered sediments and chemistry of the recovered pore waters. In addition, we sampled lake, spring, and ground waters in and adjacent to the lakes to quantify the water's geochemical evolution from ultimate source to sedimentary sink. Finally, we measured hydraulic head and performed subsurface electrical resistivity tomography imaging along the lakes' shores to constrain the relative contribution of brine subsidence and freshwater infiltration to the pore waters underlying the lakes.

This rich data set provides all of the requisite data for the parameterization and validation of a reactive transport model of early diagenesis in Last Chance and Goodenough Lakes. Our modeling efforts particularly focus on the chemical reactions between pore waters and Mg-silicate clays during this early stage of lacustrine sediment burial. Mg-silicates are commonly used to infer paleo-environment conditions in ancient lacustrine systems and thus deserve focused study in this active, well-constrained modern system. Together, the models and our measurements validate new experimental constraints on Mg-silicate precipitation rates and thus lend confidence to the application of reactive transport models to ancient and modern lacustrine systems worldwide.