Chemical evolution of morphologically similar freshwater and hypersaline High Arctic coastal lakes

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The numerous lakes along the coasts of the High Arctic Archipelago, exhibit a wide range of salinities; from entirely freshwater to hypersaline. Although common, the evolutionary mechanisms controlling the chemical signatures of these lakes are poorly understood. The few studies that have examined the role of these processes are equivocal in their findings due to limited data collection. Consequently, it remains disputed as to what processes are critical in the development of lacustrine brine in polar lakes.

This project will investigate the differences in the hydrological and limnological regime that may dictate the state change between hypersaline and freshwater lakes with otherwise similar limnological and watershed conditions. The lakes, situated at ~75^{o}N on Melville Island, have approximate areas of 2 km^2 and maximum depths of 30-34 m. West Lake, Cape Bounty is a freshwater system and the second study lake at Shellabear Point is hypersaline (48-56 PSU).

Given that the processes that generate meromixis should occur in all deep coastal uplifted lakes, the presence of both freshwater and hypersaline systems in similar settings is enigmatic. Preliminary investigation has revealed that at times, dense, subsurface percolation of solute-rich water can accumulate at depth; driving the formation of a weak chemocline. It is hypothesized that hyperpycnal flows can purge deep saline waters during peak nival melt. Without annual flushing during peak river discharge, the chemocline could strengthen with time as concentrated input is accumulated at depth. Results suggest that the high conductivity zone is eroded quickly in years with a large winter snowpack, which generate strong and intense hyperpycnal currents.

The small catchment size of the study lakes result in low-velocity hyperpycnal flows, less than 5 cm/s. With the aid of an Aquadopp high-resolution profiler, the internal variation and thickness of currents will be resolved both below and above the chemocline. Current measurement is critical for understanding lacustrine evolution, for paleoenvironmental reconstructions, and for predicting future variations in lake chemistry. If the balance between states of hypersalinity and freshwater is held in equilibrium by snowmelt runoff, climatically-induced changes in snow water equivalence could alter the chemical signature in similar High Arctic lakes. Prolonged alteration to this balance would have significant impacts on the biological and physical regimes in lakes.