A GEOPHYSICAL INVESTIGATION OF A SULFATE DOMINATED HYPERSALINE LAKE SYSTEM IN BRITISH COLUMBIA, CANADA

Mitchell Barklage, Illinois State Geological Survey, Champaign, IL
Bailey Fluegel, Northwestern University, Evanston, IL

Abstract

The Basque Lakes are an MgSO₄ dominated hypersaline lake system with salinities of ~34% that have a spotted appearance due to evaporation that leads to the formation of discrete brine pools separated by ridges of mud and salt (Figure 1). These lakes are known to aid in the preservation of biological materials, and have important implications concerning the search for life on other planets. To better understand the biosignature preservation potential of the hypersaline system, we conduct a geophysical mapping survey of the Basque Lakes located in British Columbia, Canada. The objective of the survey is to map salt concentrations in the subsurface to better understand the spatial distribution of salt beneath the lakes and how that distribution is related to the unique textures and features observed on the surface of the lakes as well as the geochemistry and microbiology of the lake system. The geophysical survey consists of a frequency domain electromagnetic (FEM) survey using a GSSI Profiler EMP-400 to map the conductivity structure of the subsurface. This instrument works particularly well in hypersaline lake systems where strong conductivity variations in the upper 3-4 m are observed. The profiler is walked along pre-marked traverses spaced from 1 to 10 m apart depending on field conditions and other logistical constraints. The sensor works by generating an electromagnetic field in a coil of wire at three separate input frequencies ranging from 1 kHz to 15 kHz simultaneously. This primary field then induces a secondary field (eddy current) in conductive bodies in the subsurface. A second receiver coil separated by a distance of 1.2 m measures the in-phase and quadrature components of the induced field. The two components are then gridded and contoured to generate a map of the subsurface electrical structure, and the quadrature component is used as a measure of the apparent ground conductivity. For this survey, the profiler was deployed in the winter on top of the frozen lakes, and the measurements include an integrated signal of the subsurface including ice, lake sediment, and salt. The contrasting electrical properties of the salt with the surrounding lake sediments and ice generate observable geophysical anomalies that reveal the subsurface complexity of these lakes. We also invert the observed data to generate a layered model of true conductivity as a function of depth using the EM4soil inversion software from EMTOMO. These geophysical observations provide the basis for understanding the biosignature preservation potential and hydrologic connectivity of the brine pockets by showing the concentration and distribution of salt in the subsurface beneath the hypersaline lakes.
Figure 1: Pictures of the hypersaline lakes that are the subject of this abstract. Note the unique textures and characteristics of the surface features.