WITHIN THE ICE: A BIOGEOCHEMICAL ANALYSIS OF BRINES IN BRITISH COLUMBIA'S HYPERSALINE LAKES. Emma K. Brown[1], Jacob J. Buffo[2], Meg Grantham[1], Alexandra Pontefract[3], Benjamin Klempay[4] Jennifer Glass[1], Ellery Ingall[1], Peter Doran[5], Mario Toubes-Rodrigo[6], Hannah Dion-Kirschner[7], Chris Carr[8], Jeff S. Bowman[4], Britney E. Schmidt[1], and the OAST Team. [1]Georgia Institute of Technology (emma.brown@gatech.edu) [2]Darmouth College, [3]Georgetown University, [4]Scripps Institute of Oceanography, [5]Louisiana State University, [6]Open University, [7]Northwestern University, [8]Massachusetts Institute of Technology

Introduction: Ice-ocean worlds are promising candidates in the search for habitable environments beyond Earth. Of particular interest is the boundary between ice and underlying oceans/brines, as this interface sustains a rich biosphere in analogous terrestrial environments [1-3]. As we are currently unable to directly measure these locales on icy worlds, it is highly informative to understand how biogeochemical processes function under different pressures and across different thermal and chemical regimes in analogous ice-ocean/ brine environments on Earth.

An important feature of terrestrial ice-brine interfaces is their multiphase nature. When saltwater freezes, the salt is rejected from the crystalline ice structure, creating pockets and channels of concentrated brine in which microbes thrive [2, 3]. The chemical composition of these concentrated brines govern biologically relevant system properties, such as pH, water activity, and chao-/kosmotropicity [4, 5]. These combined chemical and physical processes dictate how well brines can entrain and sustain biosignatures. Biogeochemical analysis of terrestrial analogs can be used to inform predictive models of ice-ocean/brine system evolution on other ice-ocean worlds (e.g. remnant/relict Martian ice-brine systems [6], perched water bodies within the ice shell of Europa [1, 7]).

An exceptional testing ground for understanding ice/brine dynamics is the hypersaline lakes of the Cariboo plateau in central British Columbia [8, 9]. These lakes span a large range of salinities ((0-350 g/L) [8]) and have diverse chemistries ($MgSO_4$, $NaCO_3$) which may better reflect the chemistry of icy world oceans and Martian brines than does our own ocean's composition [6, 10]. This drastic variability provides a natural laboratory to investigate how thermochemical and environmental pressures affect biosignature distribution within and biogeochemical evolution of uniquely relevant analog systems.

Here, we present the first chemical and biological profiles for the ice cover of these lakes. We introduce a multiphase reactive transport model capable of simulating the evolution of these systems and compare simulated ice chemistries to the measured profiles. We highlight the implications this work has for quantifying ice-ocean world habitability and discuss recent summer and winter fieldwork.

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Biogeochemical Profiles: In February 2020, ice samples from four lakes (Salt Lake [51°04'27.7"N 121°35'05.4"W], Last Chance Lake [51°19'39.7"N, 121°38'01.7"W], Basque Lake 1 [50°36'00.0"N, 121°21'30.9"W], and Basque Lake 4 [50°35'19.21"N, 121°20'35.39"W]) were taken at progressive depths for biogeochemical analysis (ion chromatography analysis (IC), cell counts). Examples of the ionic profiles can be seen in Figure 1. Bioburden profiles were acquired by flow cytometry.

Numerical Model: We have modified the one-dimensional multiphase reactive transport model of *Buffo et al.,* 2018, which simulated the physical and thermochemical evolution of sea ice, to accommodate the diverse chemistries of the British Columbia lakes. We simulate the seasonal top-down solidification of the lakes and produce ionic profiles which can be compared to those acquired in the field. Validation of the model's ability to reproduce the observed chemical profiles in these unique terrestrial analog systems bolsters its utility as a tool for assessing the thermochemical evolution of planetary ice-brine environments.

Additional Field Work: During previous fieldwork in September 2019, lake samples were collected, HOBO temperature sensors were installed, and a scientific camera was placed alongside each of the observed lakes. To obtain a temperature profile of these systems, one HOBO data logger was positioned directly above the sediment layer of the pools, and another was placed right below the surface at each of the sampled lakes. In addition, one logger was attached to the scientific cameras to collect air temperatures surrounding the lakes. Fieldwork in February 2020 consisted of further ice/brine sampling, the recovering of temperature sensors, and a geophysical survey to characterize the conductivity structure underneath the ice.

Future Work: Analysis of cell count data and geophysical conductivity data from the February 2020 field season is in progress. Cell count data will be incorporated into the ion profiles for the lakes and analyzed. Additional future work includes integrating a biological component into the modified numerical model in order to simulate bioburden profiles.

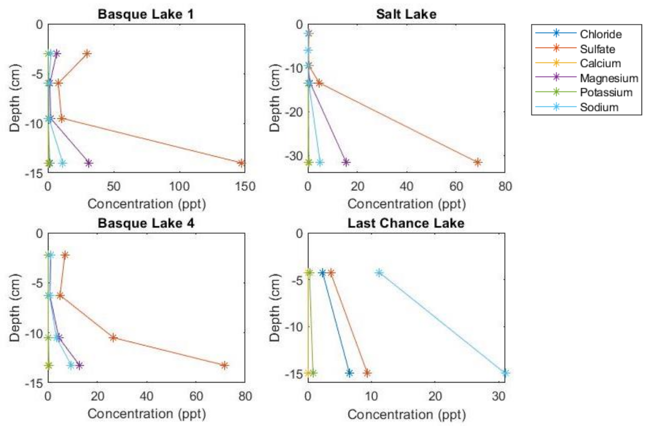

Figure 1: Ion profiles of a single site for each of the sampled lakes. General trend of all data exhibit a 'c-shaped' profile, similar to the characteristic bulk salinity profiles of first year sea ice.

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