Life Below an Ice Sheet: Mercer Subglacial Lake, West Antarctica

Christina L. Davis[1], Wei Li[2], Tristy Vick-Majors[3], Joel D. Barker[4], Alexander Michaud[5], John E. Dore[2], Matthew Siegfried[6], Martyn Tranter[7], Mark Skidmore[2], Christopher B. Gardner[4], Ryan Venturelli[8], Timothy Campbell[2], Molly Patterson[9], Amy Leventer[10], David Harwood[11], Brad E. Rosenheim[8], John C. Priscu[2] and Brent C. Christner [1]
[1]University of Florida, [2]Montana State University, [3]University of Montana, Flathead Lake Biological Station, [4T]The Ohio State University, School of Earth Sciences and Byrd Polar and Climate Research Center, [5]Aarhus University, [6]Colorado School of Mines, [7]University of Bristol, [8]University of South Florida, [9]Binghamton University, [10] Colgate University, and [11]University of Nebraska-Lincoln

Introduction: Chemoautotrophy in Whillans Subglacial Lake (SLW, Fig. 1) produced sufficient organic carbon to support the heterotrophic carbon demand in a permanently dark subglacial environment (Christner et al. 2014). The ground-breaking work produced from SLW begs the question: what energy sources drive biosynthesis in subglacial ecosystems? We hypothesize that subglacial hydrology and chemoautotrophy is presently regulating microbial ecosystem processes, and relict organic carbon deposited during past marine incursions serves as a secondary carbon source.

Study Site: Mercer Subglacial Lake has a maximum area of 136 km^2 and is located ~130 km from the grounding line and Ross Sea (Figure 1). In January 2019, microbiologically clean drilling techniques (Priscu et al. 2013) were used to access the 15 m water column that exists beneath ~1070 m of ice.

Results: During 9 days of borehole operations, we collected physical measurements and samples of the water and sediment (up to 1.7 m depth). The lake water was oxic, fresh and unstratified with respect to temperature and salinity. Mid-depth water column (7.5 m below ice ceiling) and water-sediment interface samples contained cell densities of ~10^4 cells ml^{-1}, with greater autotrophic than heterotrophic biomass production at both depths. However, dissolved organic carbon concentrations from the sediment-water interface are greater than the water column. Culture media incubated at 4ºC to enrich for various physiologies have resulted in the isolation of a range of bacteria from the water and sediment columns up to 10 cm below the sediment surface.

Significance: Aquatic environments under polar ice sheets are the closest earthly analog to conditions on Ocean Worlds, which may also harbor life (Priscu and Hand 2012). In particular, the physiologies driving primary production in this dark environment provide information on processes that may operate in oceans under thick ice shells, such as on Europa.

References:

Christner, B. C. et al. (2014) *Nature 512*: 310-313.
Priscu, J. C. and Hand K. P. (2012) *Microbe 7*: 167-172.
Priscu, J. C. et al. (2013) *Antarctic Science 25*(5): 637-647.

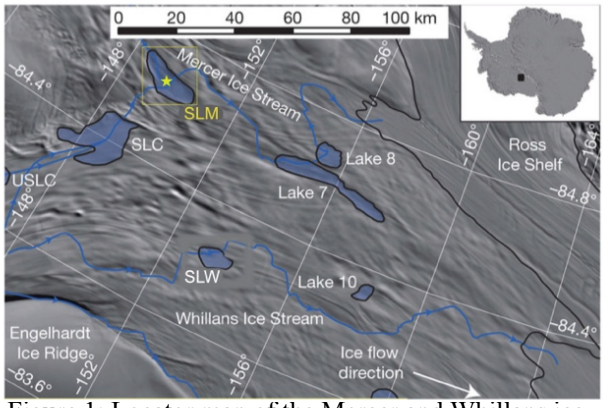

Figure 1: Locator map of the Mercer and Whillans ice streams. The yellow box and star indicate the lake location and approximate drill location, respectively. Modified from Christner et al. 2014.