

PAVILION LAKE RESEARCH PROJECT: UNDERSTANDING THE CONDITIONS FOR MICROBIALITE GROWTH AND DEVELOPMENT IN PAVILION LAKE, CANADA. D. S. S. Lim^{1,2}, A. L. Brady³, R. Shepard⁴, M. M. Marinova⁵, A. Forrest⁶, M. Wilhelm⁷, Z. Cardman⁸, B. Cowie⁹, O. Chan¹⁰, B. Laval⁶, G. F. Slater³, A. Trembanis¹¹, D. Y. Sumner⁴, I. Hawes¹², D. Andersen², M. Gernhardt¹³, R. Arnold¹³, D. Reid⁸ and C. P. McKay¹. ¹NASA Ames Research Center, M-S 245-3, Moffett Field, CA 94025, Darlene.lim@nasa.gov, ²SETI Institute, 515N Whisman Road, Mountain View, CA, ³School of Geology and Geography, McMaster University, Hamilton, Ontario, Canada, ⁴Geology Department, University of California, One Shields Avenue, Davis, CA USA, ⁵Planetary Science, California Institute of Technology, MC 150-12, Pasadena, CA USA, ⁶Department of Civil Engineering, University of British Columbia, Vancouver, B.C., Canada, ⁷Cornell University, ⁸University of North Carolina at Chapel Hill, Department of Marine Sciences, 340 Chapman Hall, CB 3300, Chapel Hill, NC 27599-3300, ⁹Applied Geochemistry Group, University of Calgary, 2500 University Drive NW, Calgary, Alberta, Canada, ¹⁰University of Hong Kong, ¹¹University of Delaware College of Earth, Ocean, and Environment 109 Penny Hall, Newark, DE 19716-3501, ¹²Aquatic Research Solutions Ltd., New Zealand, ¹³NASA Johnson Space Center, 2101 NASA Parkway Houston, Texas, USA 77058.

Introduction: One of the main questions regarding microbialite formation is whether precipitation is occurring abiotically or with biological influence. By studying modern microbialite systems, we are afforded the opportunity to gain further understanding of mechanisms of their formation and the microbial metabolic processes that may leave preserved biosignatures. In the case of biologically controlled carbonate precipitation, it can be postulated that the basic structure of the microbialite should be directly related to biological and physical organization of the surface association. The diversity of microbialite formations (Figure 1) in Pavilion Lake, B.C., Canada (50°51' N, 121°44' W) allows for the testing of this and related hypotheses.

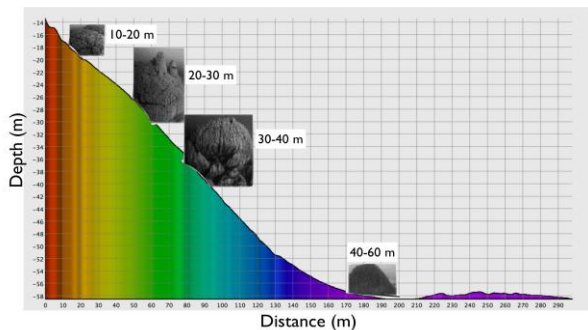


Figure 1. Pavilion Lake morphotypes by depth (m)

In testing these hypotheses, what is important to consider is that while the Pavilion Lake microbialites can be meter-scale or larger discrete structures that cover kilometer-scale regions, the organisms associated with their growth and development are much smaller (less

than millimeter scale) and a multi-scale approach to understanding their provenance, maintenance and morphological characteristics is required. Research members of the Pavilion Lake Research Project (PLRP) (www.pavilionlake.com) have been working to understand microbialite morphogenesis in Pavilion Lake and the potential for biosignature preservation in these carbonate rocks using a combination of field and lab based techniques. Specifically, research participants have been: (1) exploring the physical and chemical limnological properties of the lake, especially as these characteristics pertain to microbialite formation, (2) using geochemical and molecular tools to test the hypothesized biological origin of the microbialites and the associated meso-scale processes, (3) using geochemical and microscopic tools to characterize potential biosignature preservation in the microbialites on the micro scale, and (4) using geoacoustic tools to quantifiably measure the morphology of the microbialite features in the lake.

Many of the experiment based and data collection activities at Pavilion Lake have been facilitated through SCUBA, single-person DeepWorker submersible (Figure 2), and Autonomous Underwater Vehicle (AUV) exploration. Recent PLRP studies [1,2,3,4,5] and other on-going research outline the interactive role of the physical, chemical and biological components in the growth and morphological development of microbialites in Pavilion Lake.



Figure 2. DeepWorker mapping microbialites in Pavilion Lake

This presentation will provide a scientific synopsis of the PLRP's findings to date, however we invite you to attend a two other complementary presentations on the PLRP's (1) exploration science research, and (2) Education and Public Outreach activities. These presentations will be given in the 'Analog Missions' and 'ASTEP' sessions, respectively. The 'Analog Missions' presentation will include a focus on PLRP research that is helping to inform lunar and martian science operations with human explorers.

References: [1] Brady A.L., G. Slater, C.R. Omeion, G. Southam, G. Druschel, D.T. Andersen, I. Hawes, B. Laval and D.S.S. Lim. Photosynthetic isotope biosignatures in laminated micro-stromatolitic and non-laminated nodules associated with modern, freshwater microbialites in Pavilion Lake, B.C. *Chemical Geology* (in review). [2] A. L. Brady, G. F. Slater, D. S. S. Lim and B. E. Laval. Constraining carbon sources and growth rates of freshwater microbialites in Pavilion Lake using ^{14}C analysis. *Geobiology* 7, 544-555. [3] Lim, D. S. S., B. E. Laval, G. Slater, D. Antoniadis, A. Forrest, W. Pike, R. Pieters, M. Saffari, D. Reid, D. Andersen and C. P. McKay. 2009. Limnology of Pavilion Lake B.C. - Characterization of a microbialite forming environment. *Fundamental and Applied Limnology*, 173(4): 329-351. [4] Forrest, A.L. B.E. Laval, R. Pieters and D.S.S. Lim. 2008. Convectively driven transport in temperate lakes. *Limnology and Oceanography* 53: 2321-2332. [5] Marinova, M.M., et al. Microbialite morphological distribution in Pavilion Lake, Canada. In preparation.