

DEVELOPING A SEDIMENTARY FACIES MODEL FOR PERENNIALY ICE COVERED LAKES: IMPLICATIONS FOR MARS HABITABILITY. F. Rivera-Hernández¹, T. J. Mackey¹, D. Y. Sumner¹, ¹Earth and Planetary Sciences, University of California – Davis, Davis, CA, 95616; friverah@ucdavis.edu

Introduction: Perennially ice covered lakes (PICL) have characteristic sedimentary processes and deposits that differ from those in other glacial and periglacial lakes [e.g., 1-6]. Previous studies of sedimentation in modern PICLs provide important insights into processes and deposits [e.g., 1-7], but broad systematic criteria have not been established to differentiate PICL deposits from those in ice-free or transiently ice-covered lakes in the rock record. Determining if an ancient lacustrine environment had a perennial ice cover is important for deciphering the climatic, hydrogeologic, and possibly biologic history of a planetary body. Thus, to develop a sedimentary facies model for PICLs, we are compiling characteristics of deposits and processes in modern PICLs in the McMurdo Dry Valleys, Antarctica. Here, we present a preliminary model.

Overview of sedimentation in modern perennially ice covered lakes: In addition to typical lacustrine deposition, sediments deposited in PICLs reflect processes occurring in the ice cover [e.g., 1-7]. Sediment can be deposited on the ice and transported laterally by wind-induced saltation and rolling, or via movement of the ice across the lake [e.g., 1-6]. Sediment on the ice can absorb solar radiation, melt surrounding ice and migrate downward via cracks or gas bubble channels [e.g., 7; Fig. 1b and d]. How far into the ice the sediment migrates depends on the grain size and color [7]. Fine sediment (≤ 1 cm; mostly silt to sand) is preferentially transported downward through the ice whereas coarser sediment remains on the ice surface [7]. Due to melting of the ice by sediment, the ice can become rough, which can affect the lateral transport of sediment [e.g., 1-6; Fig. 1b and c]. Sediment is sorted during these processes. The ice cover is thus a natural sieve, controlling the size distribution of sediment released into the lake. Sediment can also be introduced into a PICL through the moat during the summer and through cracks in the ice [e.g., 5, 6; Fig. 1a].

Previous studies and our own observations show that PICLs with different ice cover thicknesses are associated with different sedimentary processes and unique sedimentary structures [e.g., 1-6]. PICLs with thick ice covers (≥ 3 m) have highly localized sedimentation, producing ridges and sand mounds [e.g., 1-4]. Our observations suggest that PICLs with thin ice covers ($\sim < 3$ m) do not show these characteristic sedimentary deposits, and instead have more laterally homogenous deposits of sand sized grains across the lake

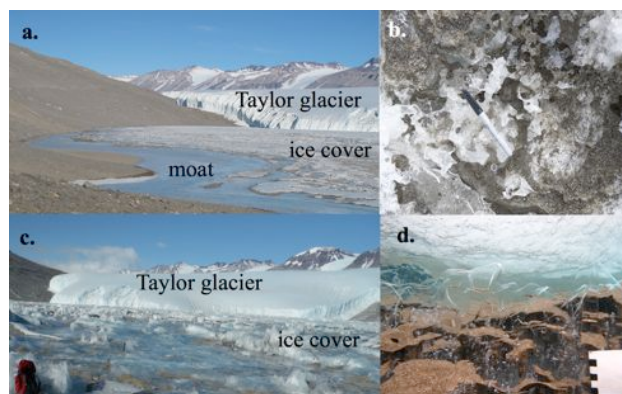


Figure 1. Proglacial Lake Joyce. a) During the summer, some PICLs develop open water areas along the lake shore (moat) and sediment is introduced into the lake. b) Sediment melting the ice cover. c) Due to melting of the ice by sediment, the ice cover can become rough (backpack for scale). d) Sand size sediment within the ice cover.

bottom. Sealed PICLs, lakes where the ice cover extends to the lake bottom, represent another end-member case [e.g., 8]. What gets preserved from this setting in the sedimentary record has yet to be constrained.

Implications for Mars habitability: Lakes are particularly good for preserving biosignatures on Earth and are a major exploration target on Mars [9]. Abundant evidence for liquid water early in Mars' history has accumulated from rover, orbiter, and landed missions. During this interval, there were likely small lakes similar to the modern PICLs on Earth, for example, Yellowknife Bay at the toe of the Peace Vallis fan could have been ice covered [10]. Until we have sedimentary criteria to distinguish between open water and ice-covered lakes deposits in the sedimentary record, it will be difficult to evaluate the possible presence of perennial ice.

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