QUANTITATIVE ANALYSIS OF MICROBIAL MAT MORPHOLOGIES VIA STRUCTURE FROM MOTION RECONSTRUCTIONS. S. Z. Leidman[1], T. J. Mackey[1], and D. Y. Sumner[1], Department of Earth and Planetary Sciences, University of California Davis, 1 Shields Ave., Davis, CA 95616, szleidman@ucdavis.edu, tjmackey@ucdavis.edu, dysumner@ucdavis.edu

Introduction: Abundant microbial mat communities grow within Lake Joyce, a perennially ice-covered lake in the McMurdo Dry Valleys, Antarctica. These mats have large amounts of morphological variability ranging from flat mats to webbed pinnacle structures. Direct observation via drop camera surveys has shown that there is morphological heterogeneity on the meter to decimeter scale [1], but little research has been done to quantify the amount of heterogeneity present and the geometric variability of the individual structures. The microbial mats have analogous structures to those observed in Archean microbialite deposits [2]. Being able to reconstruct the morphologies seen at Lake Joyce will aid in the interpretation of the environmental conditions during growth of microbial communities found in the rock record.

Methods: During the 2014 austral summer, high-resolution oblique pictures were taken of benthic microbial mat communities at 47 different drill holes and a dive site on Lake Joyce. Images were taken by rotating a boomed drop camera 360 degrees (Fig. 1). Images that had minimal rotational blurring and full coverage of the sides of the microbial mats were selected for analysis then input into Agisoft®, a 3D modeling software. Agisoft® constructs high resolution Digital Elevation Models using Structure from Motion, a process in which pixels in 2D images are coupled to reconstruct 3D structures (Fig. 2). The model outputs were then visualized using the UC Davis Keck CAVES where they were viewed with LidarViewer [3] to analyze the geometric properties of the mats. The models were analyzed with respect to parameters that may inform correlations between geometric and spatial patterns, microbial community distributions, and geochemical properties including pinnacle density, slope, and height to width ratios.

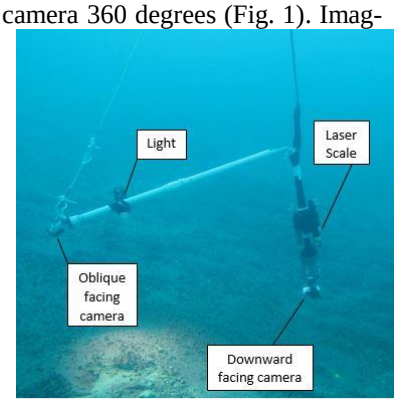

Figure 1. Drop camera set up for oblique photography

Results: 3D reconstructions created from the oblique photography demonstrate that sub-centimeter scale resolution DEMs of benthic microbial mat morphotypes can be produced using Structure from Motion software and commercially available underwater cameras. Analyses in the Keck CAVES produce quantitative measurements of the geometric parameters of the microbial mats which were previously only described qualitatively. The geometric parameters of the mats observed within the Keck CAVES have systematic pinnacle slope and spatial distribution which may aid in the observations from serial sectioned microbialite deposits and gather information about possible biological responses that resulted in the morphologies seen in Archean rocks.

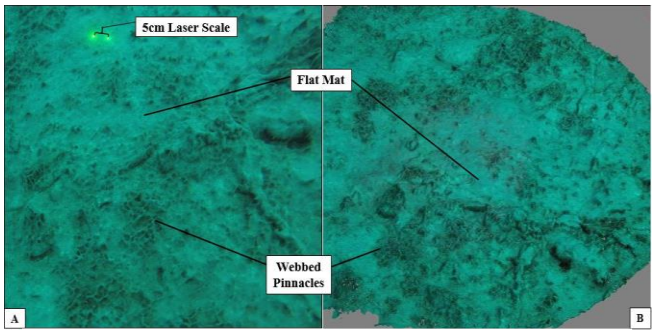

Figure 2. (A) Oblique photo from drop surveys of flat mat and webbed pinnacles taken used to create (B) 3D reconstructions using Agisoft® Structure from Motion software.

Implications: The methodology described offers a unique technique that allows for relatively inexpensive and nondestructive mapping of benthic microbial structures that can be applied to larger areas than CT scanning and higher resolution than ROV transects. The Structure from Motion 3D reconstructions made from drop camera photographs produce a dataset that allows for microbial mat morphotypes observed in ice-covered lakes to be compared quantitatively with the 3D structures studied in Archean microbialites [1]. By applying this methodology, direct correlations can be made between the observed geometric parameters of the mat and the microbial communities and physical parameters of their enviroments.

References: [1] Hawes I. et al. (2011) *Geobiology, 9,* 394-410. [2] Rivera M. J. and Sumner D. Y. (2014) *Journal of Paleontology, 88, 4,* 719-726. [3] keckcaves.org/research/start