CALCIFICATION OF MODERN STROMATOLITES FROM LAKE JOYCE, MCMURDO DRY VALLEYS, ANTARCTICA: PRESERVED CARBON POOL MODIFICATION IN A CHANGING MICROBIAL ECOSYSTEM. T.J. Mackey[1], D.Y. Sumner[1], I. Hawes[2], A.D. Jungblut[3], D.T. Andersen[4], [1]Department of Earth and Planetary Sciences, University of California, Davis, 1 Shields Avenue, Davis, CA 95616 tjmackey@ucdavis.edu. [2]Gateway Antarctica, University of Canterbury, Christchurch, New Zealand, [3]Department of Life Sciences, The Natural History Museum, Cromwell Road, London SW7 5BD, UK, [4]Carl Sagan Center for the Study of Life in the Universe, SETI Institute, Mountain View, CA, USA.

Introduction: Microbial mats form stromatolites with *in situ* mineralization in ice-covered Lake Joyce of the Antarctic McMurdo Dry Valleys (MDV) [1] and provide a model system for preservation of microbial influence on carbon cycling. Net photosynthesis allows thick mats to accumulate at the bottom of similar MDV lakes to depths with >1 µmol m^{-2} s^{-1} summer photon flux [2]. Phototrophic growth takes place in near continuous light of the polar summer, and over the polar winter, rates of respiration are sufficiently low to allow for net biomass accumulation. Mats grew and carbonate precipitated during a period of lake level rise, which both reduced light available for photosynthesis and led to salinity stratification of the water column. Mixing across layers with different densities is limited to molecular diffusion [3], and the resulting chemical isolation of depth layers resulted in the modification of carbon pools by microbial ecosystems.

Lake Joyce is moderated by a perennial ice cover, which isolates the lake from atmospheric interactions [c.f. 3], and prevents wind mixing of the stratified water column. Thus, $\delta^{18}O_{H2O}$ values are most influenced by their original source waters and winter freezing for water in contact with the ice cover [c.f. 4]. In contrast, $\delta^{13}C_{DIC}$ values are most influenced by net rates of autotrophy or heterotrophy in the particular depth layer of the lake. Shallow depth layers with high rates of photosynthesis relative to decay can be expected to increase $\delta^{13}C$ values of DIC, whereas net degradation of organic matter leads to lower $\delta^{13}C_{DIC}$ values [5].

Methods: Stromatolites were collected from 20-22 m, 13.5-16 m and 8.5-12 m depths (relative to 2010) in Lake Joyce by SCUBA divers and dried or frozen. Frozen samples were X-ray CT scanned, and scans allowed for targeted extraction of cut slices. Cut slices were embedded in epoxy to make thin sections for petrographic analysis of carbonates. Samples were collected from mm-scale carbonate layers, and specific carbonate texture subsamples were microdrilled following petrographic analysis. The order of precipitation was interpreted from petrographic observations.

Results: Petrographic analysis of thin sections from selected samples show variability in calcite textures and microbial fabrics. These petrographic relationships demonstrate that calcite precipitated both at the mat surface and within the subsurface. Calcite $\delta^{18}O$ values vary with calcite layer, demonstrating an evolution in water chemistry during stromatolite growth. Stromatolites from all sampled depths also have a progressive enrichment in $\delta^{13}C_{calcite}$, suggesting a net removal of DIC by photosynthesis through time. In the stromatolites collected from 20-22 m depth, isotopic enrichment during stromatolite growth is also greater than the variation between $\delta^{13}C_{calcite}$ values of microdrilled carbonate textures interpreted to have precipitated in either the stromatolite subsurface or at the mat growth surface (Fig. 1). This enrichment indicates that fractionation was not spatially restricted to the photosynthetic surface of the mat, but rather reflects an evolution of bulk water chemistry.

An increase in $\delta^{13}C_{calcite}$ enrichment with stromatolite growth follows rising lake levels. This environmental change reduced irradiance over time, and mats deeper than 13-16 m appeared to be photosynthetically inactive. Despite an expected decrease in photosynthetic rate through time, the youngest calcite layers show the highest $\delta^{13}C_{calcite}$ enrichment. Enrichment is thus taken as a product of the long-term sequestration of photosynthetic biomass in the stratified lake layer with low rates of respiration.

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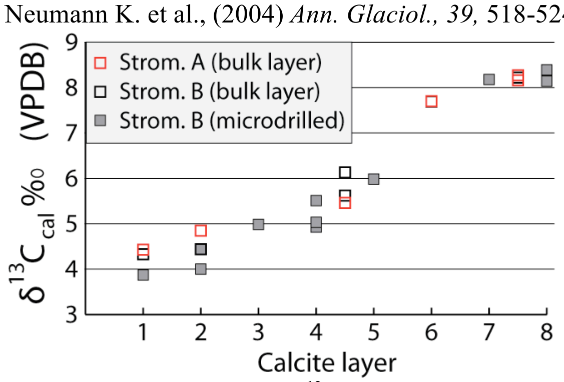

Fig. 1: Trends of increasing $\delta^{13}C_{calcite}$ values during growth of two stromatolites. Layer 1 is oldest, and layer 8 is youngest. Bulk values between layers 4-5 and 7-8 are homogenized layers that could not be subdivided without microdrilling.