Benthic Microbial Mat Communities Along an Oxygen Gradient in a Perennially Ice-Covered Antarctic Lake. M. Krusor[1], A. D. Jungblut[2], I. Hawes[3], T. J. Mackey[1], P. Doran[4], D. Y. Sumner[1], and C. Hillman[3], [1]Department of Earth and Planetary Sciences, University of California, Davis, 1 Shields Avenue, Davis, CA 95616; [2]Department of Life Sciences, The Natural History Museum, London; [3]Gateway Antarctica, University of Canterbury; [4]Department of Geology and Geophysics, Louisiana State University.

Introduction: Lake Fryxell is a perennially ice-covered lake in the McMurdo Dry Valleys of Antarctica. Its steep oxygen gradient is embedded in a water column that is density-stabilised by salinity. In 2012, dissolved oxygen fell from 20 mg L^{-1} to undetectable over one vertical meter from 8.9 to 9.9 m depth. Irradiance declined over this same depth from 0.8 to 0.3% surface incident. We provide the first description of the benthic mat community morphologies and assemblages in this oxic to anoxic transition zone, using a combination of *in situ* oxygen measurements, pigment analysis, morphological descriptions and next generation sequencing of 16S rRNA gene bacterial community.

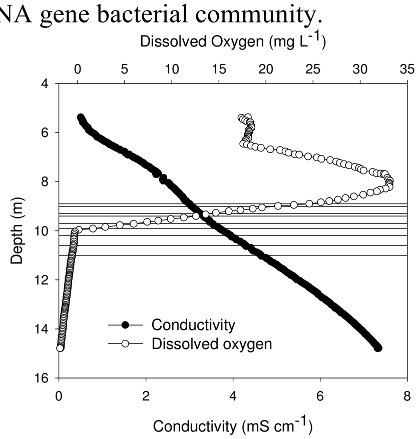

Figure 1. Profile of dissolved oxygen and conductivity through the water column. Horizontal lines show the depth of transect sites.

Results: Oxygen profiles were determined for the water column (Fig. 1) and within pinnacle, ridge, and prostrate microbial mats in Lake Fryxell. Upon penetration into the microbial mat, oxygen concentration initially increased (at all depths measured). In pinnacle mats from 9.9 m, the peak was 6 mg O_2 L^{-1} above ambient; similar but smaller peaks were seen in ridged mats There was little or no photosynthetic peak in the ridged mat, and the concentration of oxygen in the water occupying mat pits fell rapidly, to approach zero by 6 mm depth.

Flat prostrate mats were abundant in the upper anoxic zone, dominated by a green cyanobacterium identified as *Phormidium pseudopriestleyi* (based on 16S rRNA gene phylogenetic analysis), and the diatom *Diadesmis contenta*. *P. pseudopriestleyi*-dominated microbial mats created an oxygen-rich (> 1 mg L^{-1}) micro-habitat in an otherwise euxenic region of the lake during the austral summer.

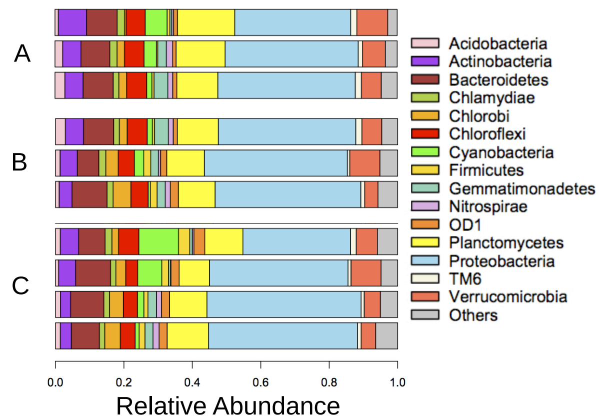

Figure 2. Relative abundance of 16S Phyla assignments of dissected laminae sampled at A) 9.4 m, B) 9.5 m, and C) 10.4 m.

Implications: Microbial communities appear to shift across redox gradients with both depth in the lake and depth into mats. This community transition is reflected in shifts in composition, pigment complement and gross mat morphology, and we argue that it is driven by the light determined limit to which oxygenic photosynthesis can maintain an oxidized environment. Although the location of the transition from oxic to anoxic waters appears to vary slightly over decades, and the balance between oxygenic and anoxygenic microbial communities appears to be dynamic. We are aware of no other studies that have examined a transition in oxygenic photosynthesis across an oxic to anoxic gradient lakes.

Two additional considerations highlight the importance of continued research in Lake Frxyell. First, cyanobacteria and diatoms were able to create oxygen-rich, microhabitats within the mats; these microhabitats are likely seasonal, and the phototrophs living there are likely sulfide-tolerant. Second, the growth of historically deeper mophologies into shallower areas suggests that the location of the transition from oxic to anoxic waters has risen in recent years. If this proves to be correct, it demonstrates how changing lake conditions, associated with climate-driven hydrological change, are resulting in changes to the microbial ecology and positions of fundamental biogeochemical boundaries in the lake.