ASTROBIOLOGY LESSONS COMPARING LAKE JOYCE, ANTARCTICA AND MARS. L. Mowchan[1], T. J. Mackey[2], J. Lawrence, S. Leidman[2], , M. Krusor[2], D. Y. Sumner[2]. [1] Natomas Charter School, 4600 Blackrock Drive, Sacramento, CA 95835 lcoleman@natomascharter.org [2]Department of Earth and Planetary Sciences, University of California, Davis, 1 Shields Avenue, Davis, CA 95616 tjmackey@ucdavis.edu.

Introduction: Two of the most compelling questions humans ask are: "How did life begin?" and "Are we alone in the Universe?" These questions tie together Earth History and Astrobiology, offer rich content for students to explore, and serve a number of learning goals for middle school students. Here we present two lesson plans designed for middle school classrooms that relate to students the investigative nature of field research and communicate the relevance of a science team's work to the history of life on Earth and the exploration of Mars.

These lessons were developed as a direct result of the experiences of PolarTREC teacher Lucy Mowchan, a middle school science teacher from Natomas Charter School. Ms. Mowchan was embedded with a team of scientists from U.C. Davis during their 2014 field season at Lake Joyce in Antarctica.

Lake Joyce is a perennially ice-covered lake in the McMurdo Dry Valleys of Antarctica. Microbial mats carpet the bottom of the lake, forming pinnacles and other morphologies that resemble microbial structures from 2.5 billion years ago.[1] Variation in modern microbial mat morphology across different lake environments provides a natural laboratory to test models of mat growth relevant to ancient ecosystems.

The process of fieldwork necessary to address the connections among environment, microbial communities, and Earth history provides a teaching model for the scientific method. The first lesson resulting from this field season introduces middle school students to how scientists make discoveries about Earth's history by using modern analogous environments. Students also investigate the environment of the McMurdo Dry Valleys as a proxy for Mars. In the second lesson, students explore the concept of habitablitiy by using their knowledge of genetics to hypothesize about the genes and characteristics that would be needed for microbes to survive on early Earth and Mars.

The Lessons:

Lesson 1: Students will examine photographs, written descriptions, and artistic renderings of early Earth, the Dry Valley lakes, and Mars. They will compare and contrast the atmospheres, available water, nutrients, and climatic conditions. They will then create a written assessment of whether they think life is possible on Mars, supported with evidence.

Figure 1: Lake Joyce, Dry Valleys, Antarctica with surrounding topography and environment.

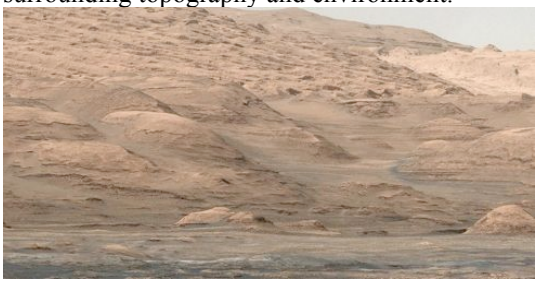

Figure 2: Mount Sharp Buttes and layers from near Darwin, Mars. Courtesy of NASA/JPL-Caltech/MSSS

Lesson 2: Students begin this lesson by reading and annotating two articles; "Busy Bacteria Leave a Big Mark" and PolarTREC journal titled "The Microverse."[2] These provide background and context for understanding the microbial mat communities. They will have also created Winogradsky columns in class to familiarize themselves with mat communities. They will then choose both an environment (Lake Joyce, early Earth or Mars) and microbial traits from a list (e.g., photosynthesis, heterotrophy, autotrophy or respiration). Students will draw and annotate their own microbe and explain why it is suited for surviving in it's particular niche.

Outcomes: These lessons challenge students to use the skills of a scientist as outlined in the Next Generation Science Standards. These skills include constructing arguments based on evidence of life's parameters and explaining how environmental and genetic factors influence the growth of organisms and populations.

References: [1] Sumner D. Y. (1997) *Palaios, 12*, 302- 318. [2] Ornes S. (*2011) Science News for Students.*