PolarTREC Public Science Report
Lucy Coleman
Microbialites in Lake Joyce
Dry Valleys, Antarctica 2014

PolarTREC Expedition Page
http://www.polartrec.com/expeditions/microbialites-in-lake-joyce-antarctica

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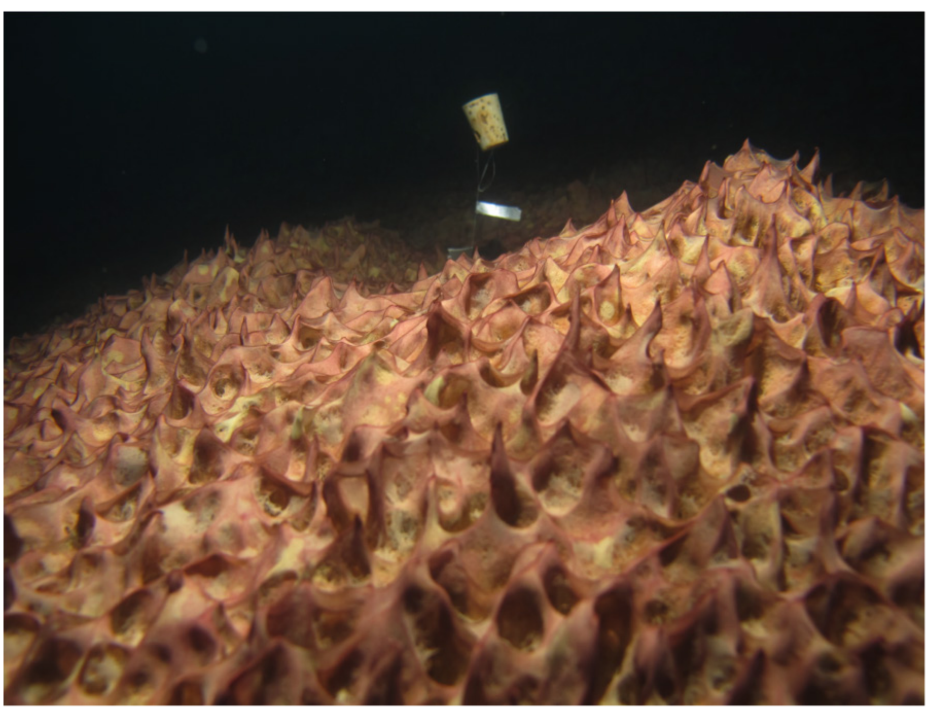
> *"I've come to a frightening conclusion that I am the decisive element in the classroom. It's my personal approach that creates the climate...."*
>
> - Haim G. Ginott

I know that Ginott was talking about teachers in general, but I feel this way about teaching my students *science*. Whether my students understand science, and *like* science, and want to be scientists when they grow up-- that's totally on me, as their teacher. That's so much responsibility!

I became a science teacher because I feel called and compelled to help people understand and appreciate natural processes. I'm always looking for the Best Way to teach each of the concepts in the state standards. I try lessons in my classroom, make notes of what went well and try again with an improved or even more engaging lesson the next year. I love when my students "get it". They can also tell when I'm excited about a topic and when I'm… not so much. After 13 years of teaching, I was still excited about both meeting the needs of my students and keeping lessons fresh and interesting, but I was looking for a way to do that more authentically. I needed to see a little bit more of myself in my teaching.

Enter the PolarTREC experience. I knew as soon as I heard about it that it was what I was meant to do, and I'm so honored and humbled to have been a participant in the program. It's hard to imagine another experience that a teacher could have that would be as transformative as this was for me! It was a tremendous opportunity for me to do science in a way I never have before. Even more so than that, though, the experiences helped me find *what I can become* as a science teacher. Being immersed in a research experience like this has opened my eyes to what a depth of knowledge can bring to my teaching. I plan to spend the next phase of my teaching career integrating new discoveries, innovations, and enthusiasm into my classroom.



Microbial Mat with cork for direction.

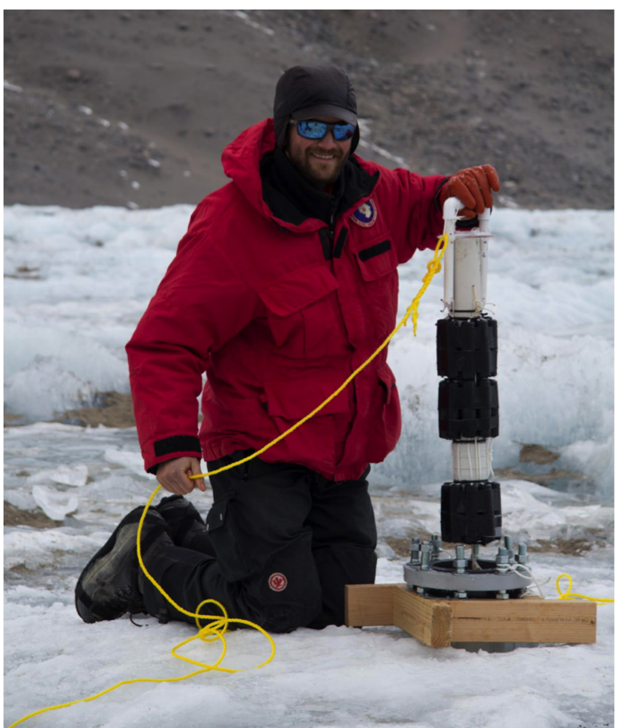
I was embedded with a research team of geologists and microbiologists from U.C.Davis who investigate the microbial mats in Lake Joyce, Antarctica. I can't say enough positive things about the team and how welcoming and encouraging they were to me throughout our time together. Lead graduate student Tyler and Principal Investigator Dawn Sumner both set the clear expectation right from the beginning that I'm an integral part of the team. Additionally, each of my teammates found their own way to share their passion and understanding of science with me, giving me a window into their perspectives and a deeper understanding and appreciation of the science content that I teach.

Water sampling with the team.

During our 6 weeks spent at our remote field camp at Lake Joyce, we accomplished a tremendous amount of science. The team's focus area of research is to better understand the microbial mats of the lake bottom, and what we can learn from them about similar communities preserved in the rock record from 2-3 billion years ago. In particular, THE driving question of this field season was "How does sedimentation affect the morphologies of the microbial mats?". To investigate this question, we began by placing a survey of 20 drill holes in the lake, targeting a water depth of 10-12 meters where the webbed, pinnacled microbial mats grow. Using drop camera footage, we characterized the range of microbial mat morphologies across the topography of the lake bottom, which led us to select the sites for our dive operations, our transect of more concentrated study, and our sediment trap placement. In addition to contributing to a comprehensive study of the microbial mats, the data collected while drilling also allowed us develop a more accurate bathymetric model of the lake. We drilled a total of 57 holes in Lake Joyce ice.


Team pulling the drill flights out of the ice cover.

Placing the sediment traps proved to be one of the greatest challenges of our field season, and will contribute valuable data about sedimentation vs. mat morphology. There were very rich and thoughtful discussions amongst the science team members about where to place the traps to capture data across a range of mat morphologies, and these discussions gave me keen insight into the collaborative and sometimes messy process of scientific inquiry. Additionally, the traps themselves required many hours of trials with a multitude of small adjustments to engineer them so that they would "fly right". We needed them to fall through the PVC casing in the ice and then drift to the side of the hole once they were under the ice. To make them do so required persistence, patience, creative thinking, and a ton of duct tape. There was a profound sense of satisfaction when we got them to "behave" properly! I created a video about the sediment traps for everyone who visited my PolarTREC blog. (https://www.youtube.com/watch?v=db4lC2La0Hw)


Tyler Mackey installing a sediment trap.

We also ran a dive operation on the lake. I learned how to use the generator, Hotsy and hotfingers to melt the the dive hole, and then I learned how to manage the communications box and tether, which supplies air to the diver. Each dive had a specific purpose, allowing Tyler and Ian to do much more detailed investigations of the mats for things like pH and light levels. Diving operations also allowed them to collect samples, which were fascinating to see and show people in my journals. I also made a video explaining our science.
(https://www.youtube.com/watch?v=FhOc05tQj9g)

There were a few challenges that I needed to face over the course of the field season. On a basic level, the learning curve on How to Stay Warm Enough was pretty steep, and the first night out in the field was pretty scary as I lay shivering in my sleeping bag. I quickly fell back on my training (eat a lot, drink a lot, move a lot) and I also swiped the extra sleeping bag that the team brought with us. Also, everyday was a very long day out on the ice doing science. While it was VERY fun, it was also very physically demanding. Although some jobs could have been miserable, my team's sense of humor, adventure and camaraderie made even the hard jobs easier.

Ian Hawes about to take the plunge.

Sasha Leidman and Justin Lawrence adjusting sediment traps.

My self confidence about being a part of this investigation grew as I gained more experience. When I began the journey, I was worried that I didn't know enough science and wouldn't be able to contribute enough to our team efforts. All of the members of the research team were eager to share their work with me, and over time, I grew better able to ask them for more explanations of their work or methodologies so that I could understand it more. That allowed me to share it with my community in a way more people were likely to understand. They also valued my role as "The Communicator" and assigned me times away from field work for me to compose my journals, and this helped me feel like I was an equal part of the team. I also grew more confident in my ability to problem-solve. Tools were constantly getting broken/stuck/frozen and at first, I would think, "I'd better let someone else figure that out because I'll just get it more broken/stuck/frozen". Over time, I grew more confident to problem-solve and take initiative with our field tasks.

Lucy making last minute video edits before they were sent off by helicopter.

The amount of knowledge and experience I gained by being a part of this expedition is immeasurable, and reflects even more than what I thought I would learn:

- Science is a fun, messy process that requires creative and critical thinking. It involves asking lots and lots of questions and letting some of them go for now so you can do a thorough job of investigating others. I knew it was like this, but experiencing it firsthand made me realize that I need to create experiences for my students that show this better.
- It was a delight to learn about science processes and concepts that I previously knew little about. Especially eye-opening were complex relationships between physical and life processes, like how a chemocline relates to the distribution of bacteria. I also learned about thermoclines, ablation and how scientists use chemistry in their investigations.
- Scientists use analogs to investigate things we can't necessarily observe firsthand. Our research can inform us about similar microbial communities on early Earth, and it can also help us understand what kinds of communities might have thrived on Mars. Scientific reasoning leads to connections between a relatively small study like what we were working on and broader questions that we want to know answers to, like what the first life forms on Earth were like.
- In school, we learn (and teach) about community as it applies to megafauna and megaflora, but microbes also form very interesting and complex communities with different members providing different services.
- DNA analysis has transformed the way we understand microbiology.
- Technology plays a critical role in scientific investigations. I was astounded by the types of data we can collect with devices like the microelectrodes for pH, the CTD and bathymetric mapping tools.
- I learned how to use a GPS, GoPro cameras, jiffy drill, dive compressor, solar panels and generator. I also learned how to tie different knots- bowline, trucker's hitch, half-hitch, square…
- Polar science, and science in general, requires a high level of resourcefulness, perseverance, planning and self-reliance for a success.

Lab work

I am developing two formal lessons for my students that are based on my field research experience, and plan to share these lessons with a broader community. Look for both finalized lessons plans on the PolarTREC website through the Learning Resources Database:

1. Using Analogs in Astrobiology: Analogs are used in science investigations to better understand systems we can't access ourselves. In this lesson, students will explore the Dry Valleys of Antarctica to better understand microbial communities on early Earth and what might be possible on Mars.
2. Hypotheses for Life on Mars: Students explore the concept of habitability 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.

In the school year after expedition, I will integrate the following plans into my curriculum, based on my PolarTREC experience:

1. Microbiology- I will revamp my cell biology unit to reflect current thinking about types of cells (protists, Archaea, heterotrophs or autotrophs) and dynamic interactions between cells and within communities, including biotic and abiotic influences. (See my PolarTREC journal "The Microverse".) I'd like to develop a lesson, or series of lessons, in which students collect and cultivate bacteria gathered from various places on campus. I need to learn more about how this process might work, but I think it could lead to some good opportunities for students to design their own investigations. Journal: http://www.polartrec.com/expeditions/microbialites-in-lake-joyce-antarctica/journals/2015-03-04
2. Astronomy- I've learned a lot about comparisons between the geology of Earth and Mars, thoughts on habitability, and how we scientifically investigate these ideas. These could be themes for a restructured student investigation of the solar system and our quest for understanding of what lies beyond Earth in the Universe.

As a lifelong learner myself, I will continue to work on providing experiences for my students in which they practice the messy process of designing and conducting their own investigations and thinking like scientists. However, the PolarTREC experience has set me much further down that road than I ever would have been on my own or with professional development opportunities of smaller scale and impact. I'm now on a self-directed quest to understand the nature of science to a greater depth, and have enrolled in a program through Montana State University to earn a Master's degree in Science Education.

I plan to continue sharing this experience with a larger community. Since returning from the field experience, I have returned to one of my schools visited earlier, and spoken with a Boy Scout troop and a Rotary Club. Also, I have submitted applications to present my work and experiences at the Astrobiology Science Conference and the California Science Teachers Conference. I see rich opportunities to continue to collaborate with my PolarTREC peers. Additionally, I plan to continue coordinating events with my science team at U.C.Davis, inviting them to be guests to my classroom, and visiting their lab.

In conclusion, I am profoundly grateful to had the opportunity to be a PolarTREC teacher. I plan to spend the rest of my teaching career striving to meet the standards for science educators set forth by this program, to continue to grow as a scientist and share my experience with a broader community.

The trek back to our field camp...