**DENIN Environmental Scholars Internship**

Dates of internship: October 1st, 2019 –May 7th, 2020

Location: Harker ISE Lab, University of Delaware, Newark, DE 19711

Number of positions available: 1-2

Faculty Mentor: Donald L. Sparks

Professional Staff Mentors: Elizabeth K. Coward & Matthew J. Fischel

**Project Title:** Coupled iron-carbon chemistry in a warming permafrost environment

**Research Description:**

The vast reservoir of carbon (C) currently stored in permafrost deposits is both the largest stock of C in any terrestrial system and the most vulnerable to release to the Earth’s atmosphere as carbon dioxide and methane. While an abundance of research has emerged over the last decade investigating the rate of such mineralization, little attention has been paid to iron (Fe)-C complexation, a key mechanism that may stabilize permafrost C against microbial respiration and mobilization, despite strong supporting evidence for complex formation. Furthermore, as permafrost systems thaw and hydrologic regimes respond in tandem, Fe - and associated C - will undergo oxidation-reduction (redox) oscillations capable of drastically altering Fe speciation and driving disparate stabilization capacity over broad spatial and temporal scales. This research will investigate the role of molecular-scale reactions between Fe and C in determining ecosystem-scale C stability under temporally dynamic temperature and oxidation conditions, employing a host of advanced experiments and techniques. Students working on this project would be a component of a multi-institutional project using permafrost samples collected from the Fairbanks Permafrost Tunnel in Alaska, operated by the US Army Corp of Engineers, and specific project goals will be formed to cater to students’ interests.

**Research Questions:**How do unique biological, chemical, and physical properties correlate to carbon currently sequestered in permafrost environments?

1. What is the abiotic and biotic stability of iron-associated carbon in permafrost under increasing temperature and/or fluctuating redox conditions?
2. How do changes in temperature and/or redox environments drive the speciation of iron and carbon in these systems, and what effects might such drivers have on the ecosystem at large?

**Student Learning Objectives: Professional and Research Skills**

This internship focuses on the development of the following professional and scientific skills:

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| Broad Professional Skills | Specific Skills |
| Planning and time management | Ability to set and complete specific goals of varying scope |
| Work independently | Independent work ethic - work independently to problem-solve |
| Collaborative skills | Learning to complete tasks efficiently and effectively with others |
| Express ideas in writing and verbally | Communicate with diverse audiences - Development of impactful poster and oral presentations. Honing ability to deliver scientific results/impacts to people of interdisciplinary background. |
| Broad Scientific Research Skills | **Specific Skills** |
| Understand scientific terms  | Mechanistic and applied concepts regarding sorption and redox chemistry |
| Literature analysis | Ability to effectively find and utilize scientific manuscripts related to environmental chemistry |
| Use scientific tools | X-ray absorption spectroscopy, Infrared spectroscopy, scanning electron microscopy, and additional advanced physical and chemical techniques |
| Recognize simple patterns in research data | Applying soil environmental chemistry concepts to qualitative and quantitative data. |
| Apply research tools and techniques in research experiments  | Selective extractions, sorption reactivity experiments, redox experiments, etc. to investigate organo-mineral relationships. |
| Analyze research data  | MATLAB, R, Excel, Plotly, Origin, and instrument-specific software utilization to form effective figures and tables. |
| Understand, apply, and explain scientific concepts and theories | Freedom to form questions and plan methods for addressing challenges. Learning to effectively communicate results through oral presentations and manuscript writing. |

**Prerequisites:**

Introductory experience with chemistry.

**Work Environment and Expectations:**

Students will work both in the Sparks laboratory and their own office space within Harker ISE Lab 4th floor. Hours are flexibly determined between student and mentor. Students will work part time during the fall semester, with the opportunity to work full time during UD Winter Session 2020.

**Stipend:**

$3,500, direct deposit is required.

**Funding Source:**

National Science Foundation, Delaware EPSCoR Track I

**How to apply:** <https://ugresearch.udel.edu/PUB_Program.aspx>