**DENIN Environmental Scholars Internship**

Dates of internship: October 1st, 2020 – February 8th, 2021

Location: Harker ISE Lab, University of Delaware, Newark, DE 19711 Number of positions available: 1

Faculty Mentor: Donald Sparks

Professional Staff Mentors: Matthew Fischel

**Project Title:** Kinetics of naturally formed manganese-oxides in a changing climate

**Research Description:**

Manganese-oxides are some of the most reactive and widespread minerals found in the environment. They are especially important in the cycling of redox-sensitive contaminants and nutrients such as phosphorus in soil and aquatic systems. Most of the research done on manganese-oxides’ ability to sorb and oxidize contaminants and nutrients has been performed using manganese minerals synthesized in the laboratory. However, many of these synthetic manganese-oxides have higher surface areas and are more reactive than the minerals found in the environment.

This study will determine the kinetics of arsenic oxidation, in the presence and absence of phosphorus, by naturally formed manganese-oxides in soils from Frederick and Carrol Counties in Maryland. These soils contain elevated manganese and iron concentrations due to the weathering of calcitic and dolomitic marble bedrock. The soils have been farmed for decades and contain elevated levels of phosphorus that can be transported into the nearby Chesapeake Bay. It is critical to determine how arsenic and phosphorus will interact with manganese-oxides in a changing climate to understand the future fate and mobility of these elements.

Two soils will be collected and separated by horizons for chemical and physical characterization. These analyses include the EPA3050B acid digestion, pH, organic matter content, point of zero charge, BET surface area, scanning electron microscopy, X-ray diffraction, and particle size analysis. Then a series of batch reactions will measure the kinetics of arsenite oxidation by each soil horizon in the absence and presence of phosphorus. The reactions will be conducted at varying arsenic and phosphorus concentrations, pH, and temperatures to determine the impact of environmental conditions on the manganese-oxides’ capacity to sorb and oxidize arsenic.

The results of these studies will provide critical insight into how naturally formed manganese-oxides oxidize and sorb arsenic, in relation to phosphorus, under changing environmental conditions. This information will allow for more precise environmental models for contaminant transport and transformation in an increasingly destabilized environment.

# Research Questions:

What are the chemical and physical characteristics of naturally formed manganese-oxides from Maryland and how do changing environmental conditions alter their ability to sorb and oxidize manganese.

1. How do the chemical and physical properties of naturally formed manganese-oxides differ from synthetically made surrogates?
2. What are the kinetics of arsenic oxidation by naturally formed manganese-oxides and how do these reactions change with alterations in pH, temperature, and arsenic concentration and in the presence of phosphorus?

# 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** |
| Work independently | Learn how to work independently to achieve long-term  goals. Problem solve when complications arise. |
| Planning and time management | The ability to manage time and plan for experiments that  may last for several days. |
| Team working and collaboration | Working with others and as part of a team to complete  tasks. |
| Communicate and write efficiently and effectively | The ability to communicate scientific findings to diverse audiences. The development of poster and oral presentations. Scientific writing for technical audiences in order to share results with the broader scientific  community. |
| **Broad Scientific Research Skills** | **Specific Skills** |
| Understand scientific terms | Applied and mechanistic concepts for sorption and redox  chemistry. |
| Literature analysis | Finding and utilizing scientific manuscripts to understand  specific areas of geochemistry. |
| Scientific instrumentation | The ability to use scanning electron microscopy, X-ray  diffraction, and other advanced physical and chemical techniques |
| Data analysis | Using knowledge of soil environmental chemistry concepts  to process and understand qualitative and quantitative data. |
| Experimental design and execution | Understand how to design and perform redox experiments to investigate the kinetics of arsenic oxidation by  manganese-oxides in the presence of phosphorus. |
| Creative thinking | Time and freedom to investigate areas of the research that are novel and interesting based on the information gathered  from previous experiments and literature review. |

# Prerequisites:

Introductory chemistry experience.

# Work Environment and Expectations:

Students will work in ISE 450 laboratory. Hours will be flexible and determined between the 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:

$4,000, direct deposit is required.

# Funding Source:

Delaware EPSCoR

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