

2014 Sigma Xi Symposium

Schedule and Oral Paper Abstracts

Gustavus Adolphus College

May 2, 2014

Session 1: Oral Papers, Nobel Hall 201	
2:30 pm	<p>Developing a New Method for Synthesizing Primary Arylphosphines Carl Schiltz Advisor: Brian O'Brien</p> <p>Phosphines that possess reactive functionalities, and especially primary and secondary arylphosphines (ArPH_2 and Ar_2PH, respectively), are useful in the synthesis of ligands for use in metal-based catalysis; however, methods for producing these primary arylphosphines tend to be fairly labor-intensive and specific to the phosphine being produced. The goal of this project is to develop a simplified protocol for synthesizing primary arylphosphines using a wide variety of aromatic compounds. The key to this work lies in a relatively new method of generating stable aryldiazonium tosylate salts, which are highly reactive, electrophilic compounds. These diazonium salts can then be reacted with a phosphine precursor (potassium phthaloylphosphide) to create an intermediate product that can be converted to a primary arylphosphine. Thus far we have been able to synthesize several aryldiazonium tosylate salts, and have subsequently reacted them with phthaloylphosphide. Based on the color changes of the solutions and the precipitation of a white solid (presumably potassium tosylate), a reaction is taking place. Evidence from ^{31}P NMR suggests that our desired compounds, arylphthaloylphosphines, are being produced; however, difficulties in purifying the products have not allowed us to fully characterize them. As a consequence, our future work will focus on purifying the major products from the reaction of potassium phthaloylphosphide and aryldiazonium tosylate salts and characterizing the products via NMR, IR, and mass spectrometry.</p>
2:45 pm	<p>The Prevalence and Plasmid Profile Analysis of Antibiotic Resistant <i>Escherichia coli</i> among College-Aged Adults Mikie Phan Advisor: John M Lammert</p> <p>Abstract: This clinical study aims to investigate the prevalence of antibiotic resistant <i>Escherichia coli</i> among college-aged adults in the upper Midwest for six commonly used antibiotics (ampicillin, ciprofloxacin, penicillin G, streptomycin, tetracycline, and trimethoprim/sulfamethoxazole). These strains of <i>E. coli</i> are not considered to be pathogenic. In order to further assess resistance, R plasmids (small circular DNA molecules where most resistance genes reside) was purified for plasmid profile analysis. Roughly 70% of all volunteers' rectal swabs were positive presence of <i>E.coli</i> ($n=36$). The hypothesis was such that resistance likely exists for at least one type of antibiotics among all isolates. A total of 38 <i>E. coli</i> strains were successfully isolated. From these strains, 13 different resistance patterns emerged, showing both individual and multi-drug resistance.</p>

3:00 pm	<p>Mercury Dynamics In Sub-Arctic Lake Sediments Across A Methane Ebullition Gradient</p> <p>Lance Erickson¹; Florencia Meana-Prado²; Martin Wik³; Joel P. DeStasio⁴; Madison J. Halloran⁵; Jacob B. Setera²; Julia Bryce²; Patrick Crill³; Joel E. Johnson²; Ruth K. Varner⁴</p> <p>¹Department of Geology, Gustavus Adolphus College, St Peter, MN, USA</p> <p>²Department of Earth Sciences, University of New Hampshire, Durham, NH, USA</p> <p>³Department of Geological Sciences, Stockholm University, Stockholm, Sweden</p> <p>⁴Institute for the Study of Earth, Oceans and Space, University of New Hampshire, Durham, NH, USA</p> <p>⁵Department of Environmental Studies, Carleton College, Northfield, MN, USA</p> <p>Recent studies have suggested that Arctic warming may play a key role in enhancing carbon (C) and mercury (Hg) export from permafrost peatlands, yet the mechanisms by which Hg is mobilized during thaw remain enigmatic. To elucidate the links between these chemical systems, we investigated Hg concentrations in cores taken in organic C rich sediments in lake Villasjön (avg. depth 1.5m) at the Stordalen Mire, Abisko, Sweden. We chose coring sites based on zones with significantly different ebullitive methane (CH_4) fluxes established in earlier studies and we hypothesized that the microbial community producing CH_4 is also potentially mobilizing Hg. Recovered sediment cores (~44, 41, 40 and 39cm in depth) are characterized by having roughly 30cm of organic-rich silt material on top of a transition to more clastic material in the bottom ~10cm. Cores were sub-sampled every 2cm, and the sediment samples were then freeze-dried and subsequently analyzed for extractable Hg via cold vapor inductively coupled plasma mass spectrometry (2 cores) and also via thermal decomposition and cold vapor atomic fluorescence (2 cores). Mercury is most abundant in the upper portions of all sediment cores, after which concentrations decrease with depth. The highest ebullition site had Hg concentrations exceeding $80 \text{ ng}_{\text{Hg}}/\text{g}_{\text{sediment}}$ at the core top that decreased to a low Hg concentration $< 15 \text{ ng}_{\text{Hg}}/\text{g}_{\text{sediment}}$ at the core base. The lowest ebullition site had overall lower concentrations compared to the higher ebullition sites with more intermediate values ($< 50 \text{ ng}_{\text{Hg}}/\text{g}_{\text{sediment}}$) starting at 2cm depth, dropping to $< 15 \text{ ng}_{\text{Hg}}/\text{g}_{\text{sediment}}$ at ~ 26 cm. We found differences ($\geq 50\%$) in overall Hg contents between cores in the top layers of the core. Mercury content positively correlated with total organic C (TOC, $R^2=0.74$) and sulfur (S, $R^2=0.92$) in the highest ebullition site. Mercury content also negatively correlated with dissolved inorganic carbon (DIC) in the highest ebullition site ($R^2=0.71$). These relationships are only seen in the higher ebullition sites, whereas in the lower ebullition sites, Hg links with other geochemical data (e.g., TOC, C, nitrogen, S, DIC) were more variable. Our findings imply that (1) processes that enhance CH_4 mobilization may also affect Hg dynamics in sediment cores and (2) assessing overall Hg behavior in lakes requires cores in multiple locations.</p>
3:15 pm	<p>Characterization of Gamma-Glutamylcysteine Ligase</p> <p>Beth Wiese and Katie Diederichs Advisor: Dr. Brenda Kelly</p> <p>Gamma-glutamylcysteine ligase (γ-GCL) is the enzyme that catalyzes the rate-limiting step in the synthesis of glutathione. Glutathione is necessary for the survival of most organisms, including bacteria, as it functions to detoxify cells. <i>In vitro</i>, <i>E. coli</i> γ-GCL exists in at least three different structural states, a monomeric form that consists of a single polypeptide chain, a dimeric form that consists of two polypeptide chains that fold to form a functional protein unit, and a higher order oligomeric form that is induced by some oxidizing agents. The goals of this project were to study the involvement of noncovalent interactions in the monomer to dimer transition and to identify the molecular weight of the higher order oligomeric form of γ-GCL. Native polyacrylamide gel electrophoresis was used to monitor transitions between the monomeric and dimeric forms upon the addition of the protein denaturant, urea. These</p>

	<p>results will advance our understanding of the role of noncovalent interactions in the monomer to dimer transition. For the molecular weight determination, the higher order oligomer of γ-GCL was induced using ascorbic acid and native polyacrylamide electrophoresis was performed on the samples for a Ferguson analysis. The molecular weight determination is important to the characterization of this newly discovered oligomeric form of the protein.</p>
3:30 pm	<p>Taphonomy of Bison Bones from the Des Moines River Dominic Delmont Advisor: Hilary Christensen</p> <p>This project is focusing on the taphonomy of bison bones found in the Des Moines River. Taphonomy is the study of the process that living organisms go through after they die and become a fossil. By looking at how organisms become fossils we can find information on how the bones got to the river where they were found, as well as information on the climate, and possible behavior patterns of other organisms from the time when the bison were alive. I will be focusing on the physical state of the bones, looking at features such as teeth markings from scavengers, weathering from river transport and even ancient tool markings. With this information multiple hypotheses can be made about where these bones came from.</p>
3:45 pm	<p>Sediment Mobilization in Ravines Draining Minnesota Cropland Andrew Wallace Choquette Advisor: Laura Triplett</p> <p>In recent years, studies have found that Lake Pepin, a naturally-dammed lake on the Mississippi River on the border of Minnesota and Wisconsin, is filling in with sediment at an alarming rate. Most of this sediment comes from the Minnesota River, which contributes about 80% of all the sediment being deposited in Lake Pepin, even though it contains only 35% of the upstream area. This study focuses on understanding sediment derived from ravine erosion in a tributary of the Minnesota River basin through event monitoring of two ravines in the Le Sueur River watershed. Ravines represent one of the key sediment sources in the Le Sueur watershed, with sediment mobilized through ravine widening and headcutting. In addition, sediment may be mobilized through riverbank and bluff erosion and erosion of the topsoil. A major effort is underway to reduce the amount of sediment in the Minnesota River and Lake Pepin, so we must discover what is causing the sediment to be mobilized and when. Dominant land use in the area is agricultural with over 90% of the crops consisting of row crops. Field drainage in these agricultural areas is heavily influenced by the installation of drainage ditches and drain tile. While this has increased crop yield, it has altered the natural drainage of the area. Southern Minnesota is covered by a thick layer of glacial till allowing the landscape to rapidly respond to hydrologic conditions within a relatively short amount of time, and those changes could include ravine widening or elongation. To better understand how ravines respond to different hydrologic events, we monitored ravines over the course of one monitoring season. From April-October 2013, three Sigma 930 automated samplers measured discharge and collected water samples for total suspended sediment analysis at three sites in two ravines. We tested whether the volume, intensity or seasonality of precipitation events is most important in mobilizing sediment in the ravines. Data are being analyzed to calculate sediment budgets and identify key hydrologic factors that control sediment movement out of these ravines and into the river.</p>

4:00 pm	<p>Bison Remains: Migration, Diet and Climate Kara Helgeson Advisor: Hilary Christensen</p> <p>My project is the examination of a set of fossil bison bones that were gathered from the Des Moines River to learn about the biological characteristics of the bison. I will investigate how these bison lived, including their diet, whether they are a migratory or sedentary species, and the climate of their habitat. To learn these things I will be analyzing the chemistry of the bison's teeth and bones using stable isotopes. I will be looking specifically at isotopes of oxygen and carbon gathered from the fossilized bison bones and teeth.</p> <p>Carbon isotopes represent variations among land vegetation. Oxygen isotopic values are related to precipitation, which varies according to local temperatures. As mammals maintain a constant body temperature oxygen isotopes from their teeth have been used as a reliable indicator of temperature (Koch 1998). Because climate has changed a great deal in Minnesota over the time period under investigation knowing the age of the fossil material is critical to interpretation of these isotope results.</p>
4:15 pm	<p>Rare earth element trace of bison fossils in the Des Moines River with unknown origins Serenity Mahoney Advisor: Hilary Christensen</p> <p>Fossilized remains of American bison collected from over 40 miles of the Des Moines River suggested that some catastrophic event occurred, resulting in a mass execution. The large number of remains found convoluted the theories of where the bones were washing downstream from and whether one execution site yielded all of the fossils, or multiple sites. Using radiocarbon dating the age of the bison remains was ascertained and using ICP-MS the rare earth elements contained in the stream-worn were traced back to the point of origin.</p>
<p>Sigma Xi New member reception 4:30 Nobel Hall Atrium</p>	

Session 2: Poster Papers sponsored by Sigma Xi
Presented at the Celebration of Creative Inquiry
Jackson Campus Center, 5:00 pm to 7:00 pm

Characterization of Monomeric and Dimeric Gamma-Glutamylcysteine Ligase

Katie Diederichs, Emily Hamberg, Stefano Rosati, Beth Wiese

Advisor: Brenda Kelly

The Gustavus AMO Lab: Time of Flight Mass Spectrometer and Coulomb Crystals

Will Doebler, Joshua Wolanyk

Advisor: Jessie Petricka

Cryptochrome Interactions With Other Circadian Clock Proteins

Hana M. Fischer, Monica E. Johnson, Stefano W. Rosati, Claire E. O'Neill

Advisor: Karla E. Marz

Towards Synthesis of a Novel Switchable Aromatic 8,10,21,23-tetrahydroxyhemiporphyrazine Ligand

Daria Grishina

Advisor: Thomas Gardner

Investigating The Relationship between Salicylate-Induced Tinnitus And Circadian Rhythmicity

Travis Sigafoos

Advisor: Janine Wotton