Muskingum University

Research

Annual Fall Research & Internship Forum

2011

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2011 Poster Presenters

X-RAY FLUORESCENCE: DETERMINING COMPOSITIONS OF UNKNOWN MATERIALS

Derek Anderson
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X ray fluorescence is the emission of secondary x ray's from a material that has been excited by incident x rays. The energy and intensity of energy from these secondary x rays allows scientist to determine the chemical composition of different materials by energy states of electrons in different elements with accurate results. A sample of approximately 60 samples were shipped to AMG by a sister company for chemical composition determination by x ray analysis. This material had to first be prepared to go on the x ray machine by making pressed pellets in a 20 ton hydraulic press. After the samples were ran on the x ray the samples were analyzed using software that fits the peaks with what element is characterized by that particular peak. After the software fit the peaks, they had to be further analyzed to give a more accurate of the chemical composition. The materials were rare earth metals. They included heavy concentrations of barium, cerium, praseodymium and other rare elements.

2010 Locations of Student Internships and Research

Muskingum University

The Wilds, Cumberland, Ohio

Allied Machine and Engineering Corporation
Dove, Ohio

St. Olaf College
Northfield, Minnesota

The Ohio State University
Columbus, Ohio

ODNR, Division of Mineral Resource Management

OHIO DEPARTMENT OF NATURAL RESOURCES, DIVISION OF MINERAL RESOURCES MANAGEMENT: PROTECTING THE ENVIRONMENT, REGULATING COAL EXTRACTION AND POWERING THE U.S.A.

Sara Young
Department of Geology

With all of the concern about fossil fuels in today's economy the state of Ohio has been working harder than ever to keep producing one of the United States most precious resources; Coal. Eastern Ohio sits on 33 seams of coal; the most mined of these coal seams is the Pittsburgh #8, which ranges in heights and depths depending on the area. The Ohio Department of Natural Resources (ODNR), Division of Mineral Resources Management's (DMRM) job is split up into two missions. ODNR's mission is 'to ensure a balance between wise use and protection of our natural resources for the benefit of all.' DMRM's mission is 'to provide for the safe and environmentally sound development and restoration of mineral and fossil fuel extraction sites.' Both of these agencies come together to create the regulatory force behind Ohio's coal mines.

There are several different types of mining methods for both surface and underground mining. Area mining and Highwall mining are two common types for surface mining while Room & Pillar and Longwall mining are two common underground types of mining. Ohio's two biggest mines are operated using the Longwall mining method with a small portion of Room & Pillar. For a mining company to get approval to mine they have to go through a series of steps and processes set by DMRM, the Ohio government and the federal government.

This internship was based in the permitting/technical reviews aspects of the application to mine in the state of Ohio. All these processes are sent to an application manager to be reviewed for administratively completeness. DMRM then dispatches portions of the submission to the appropriate sections of DMRM. DMRM's coal program is split up into 4 sections; Permitting, Engineering, Inspections and Hydrology. Engineering and Hydrology are both categorized under technical review which also houses Soils and Archeology. The engineer checks the mining slopes pound construction and Haul road construction using the data that the company provides. The soil scientist checks the permitted area for prime farmland and to make sure that the company has labeled it on their maps. The hydrologist takes the initial water samples and walks the streams to make sure there are no problems. The archeologist checks the permitted area for any historical buildings (buildings older than 50 years) or artifacts (pottery, arrow heads, etc.).

USE OF AN INVASIVE GRASS BY SMALL MAMMAL SPECIES ON A RESTORED PRAIRIE

John Bourne and Dr. Diane Angell
St. Olaf College Biology Department
Muskingum Department of Biology

Grasslands and prairies throughout the Midwest have been colonized by reed canary grass, an invasive grass species. This species has been known to outcompete native species and cause a decline in plant biodiversity in regions it has colonized. Small mammal species play an important role in prairie ecosystems and little is known how they are impacted by reed canary grass. The goal of this project was to live trap for small mammal species on a restored prairie and evaluate whether small mammals used reed canary as habitat or as a food source. Through trapping it was discovered that trap rates tended to be higher in reed canary habitat compared to areas of native diversity. Through stable isotope analysis it was discovered that species trapped in reed canary were more depleted in carbon suggesting a diet of C_3 plants as well as more depleted in nitrogen suggesting a lower trophic status. These results suggested that reed canary was used as a habitat and possibly as a food source for small mammal species despite the deficiency of nutrients in the C_3 reed canary grass.

MOLECULAR SIMULATIONS OF COGNITIVE PROTEINS USING GROMACS MOLECULAR DYNAMIC MODELING SOFTWARE

Joe Castle
Department of Mathematics and Computer Science

GROMACs is a set of molecular dynamic modeling software packages licensed under the GNU project and used to perform large and small molecular simulations. The use of this software in the molecular biology field is becoming ever increasing due to many factors. Molecular dynamic modeling of large cognitive proteins allows for a reasonably realistic visual of the constant interaction of these molecules and their surrounding solvent. By taking a look at these interactions it can be better known what protein conformations are obtained at the given conditions and also active site availability. Knowing these two pieces of information are critical when experimenting because not only can the research scientist gain a feel for the likelihood of success of a reaction, but also the scientist can narrow down a wide range of possible experiments to a shorter list of high probability experiments in order to save time and money.

CONSTRUCTION OF THE 135 AND 155 PENTA MUTANTS OF *BACILLUS SUBTILIS* ADENYLATE KINASE

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Department of Chemistry

Adenylate Kinase is a ubiquitous protein found in many organisms. It is an enzyme that catalyzes the conversion of adenosine diphosphate (ADP) into adenosine triphosphate (ATP) and adenosine monophosphate (AMP). It is constituted of three domains, including the core domain, AMP binding domain, and the LID domain. The LID domain closes down over the substrate after it has bound to the active site of the enzyme to prevent water from disrupting the reaction. The LID domain differs between gram positive and gram negative bacteria. The gram positive ADK chelates a zinc ion and the gram negative does not. The purpose of the project was to mutate two residues in the LID domain from a gram positive *Bacillus subtilis* tetra mutant of ADK to create a penta mutant that resembles a gram negative *Escherichia coli* version of ADK. The two positions in the LID domain that were mutated were 135 and 155. The 135 penta mutant was only one that was successful.

THE REPRODUCTIVE SUCCESS OF VARIOUS GRASSLAND BIRD SPECIES AT THE WILDS, A RECLAIMED SURFACE MINE

Julie Long, Alex Roth, Paige Williams, James L. Dooley, and Danny Ingold
Department of Biology

Within recent years, conservation science has emerged as an important field of biology. Loss of habitat has forced many grassland birds to utilize other areas such as reclaimed surface mines. These locations serve as some of the few remaining habitats for grassland birds in the U.S. The objective of this research was to look at the reproductive success of not only grassland bird species, but non-grassland species occupying the study sites at The Wilds. Through various methods such as rope dragging, bird observation and individual surveying, bird nests discovered were recorded and multiple measurements were taken. When a nest was found, GPS coordinates, the number of eggs/nestlings in the nest, and the species were recorded. There were a total of ninety-two nests found including fourteen different species. Among the most common grassland birds found (Eastern Meadowlark, Bobolinks, Red-Winged Blackbird, Grasshopper Sparrows), 56% of the nests were successful. Two of the main factors leading to unsuccessful nests was predation and human interference. Eastern Meadowlarks and Grasshopper Sparrows had the highest success rate whereas Bobolink nests had the largest clutch size and number of fledglings. These results suggest that The Wilds provides suitable habitat for most of the grassland bird species that nest there; however, with the encroachment of autumn olive and other woody plants, this reclaimed grassland may become less attractive to obligate grassland birds in the future.

THE WILDS: PROTOZOA, SNAKES, & FUNGUS

Melanie Cox, Erin Ferris, Dr. Amy Santas, Dr. Jenise Bauman, and Dr. Barbara Wolfe
Department of Biology

My summer internship was at The Wilds, a conservation center which is an active research facility located in Cumberland, Ohio. During the summer of 2011, my efforts focused on three research projects including a survey of the presence of *Neospora caninum* on The Wilds' property, optimization of snake semen preservation, and the identification of ectomycorrhizae on The Wilds property. *Neospora caninum* is a protozoan which increases the rate of abortions of cattle and other ungulates it infects. To assess the potential risk of the endangered ungulates at The Wilds a survey of the presence of *Neospora caninum* was conducted by examining feces from the definitive host—coyote (). Coyote fecal samples were collected from The Wilds propoerty, fecal flotation was performed to isolate parasites, genomic DNA was isolated and PCR analysis was performed to verify presence of *Neospora caninum*. Preliminary results indicate that *Neospora caninum* is present at The Wilds. The snake semen preservation optimization project examined the motility and viability of snake semen at different osmolalities and whether or not snake semen could survive cryopreservation. Semen was subjected to different osmolalities (300 mOsm, 600 mOsm, 900 mOsm, and 1200 mOsm) via different concentration of Ham's F-10 and the sperm were cryopreserved at 600 mOsm and 1200 mOsm. The motility was evaluated using microscopic visualization and viability was determined using fluorescent Live/Dead sperm dyes. There was a lack of data that produced inconclusive results although the sperm were determined to have survived the cryopreservation procedure upon thawing. At the early stages of this project, it appears that sperm viability can be maintained at all osmolalities tested. And, the two tested osmolalities supported viability post-dTcryopreservation. Ectomycrorrhizae form a symbiotic relationship with tree roots facilitating the uptake of nutrients and water and therefore promoting the long term survival of the tree. This project set out to identify which ectomycorrhizae are associated with trees thriving on The Wilds property through DNA extraction and PCR analysis. PCR analysis indicated that ectomycorrhizae was present on The Wilds property and may serve as a predictor of tree success on The Wilds property.

HYDROGEN BONDING CHANGES MOLECULAR STRUCTURE: A MICROWAVE SPECTROSCOPY / AB INITIO INVESTIGATION

Ashley Fox
Department of Chemistry

Microwave Spectroscopy is a method used to determine the precise structure of a molecule. Theoretical modeling was done on 2-aminophenol and guaiacol monomers and water complexes. *Ab initio* calculations were used to determine the lowest energy conformation of each species from the set of theoretical models. RRFIT was initially used to predict rotational transitions for each lowest energy conformer. Lines were obtained for the guaiacol monomer and assigned the corresponding quantum numbers. ZFAP was used to fit 52 experimentally determined guaiacol monomer lines and assign the spectrum. Rotational constants were measured as A = 2607.0664(6), B = 1560.7967(2), and C = 982.8721(1). These rotational constants are related to the moments of inertia of the molecule, which directly depends on molecular structure. Rotational constants and centrifugal distortion constants for guaiacol were obtained using ZFAP. The obtained guaiacol spectrum matches the lowest energy conformer of the guaiacol monomer. This is evident by the strong μ_a and μ_b dipoles that correspond to the *a*-type and *b*-type lines that were found on the instrument. Currently, rotational transitions for the guaiacol water complex are being seeked. Once the guaiacol water complex spectrum is assigned, changes in the molecular structure of guaiacol when intermolecular hydrogen bonds replace intramolecular hydrogen bonds will be observed.

ELECTRICAL RESISTIVITY MEASUREMENTS IN UNDISTURBED AND SURFACE-STRIPPED SOILS

Brandon Leyda and Brian Sayre
Advisor: Sandra Soto-Cabán
Physics and Engineering Department

It is well known that the resistance of an earth electrode is heavily influenced by the resistivity of the soil in which it is driven and as such, soil resistivity measurements are an important parameter when designing earthing installations. Knowledge of the soil resistivity at the intended site, and how this varies with parameters such as moisture content, temperature and depth, provides a valuable insight into how the desired earth resistance value can be achieved and maintained over the life of the installation with the minimum cost and effort. The goal of this project is to measure the electrical resistivity of undisturbed soils and soils that have been reclaimed after surface mining activities and analyze their differences. Values of electrical resistance of different soils were measured using a resistivity meter. These measured values were used to calculate the resistivity of the different soils. The two study sites were Muskingum University in New Concord, OH and The Wilds in Cumberland, OH. Soils at Muskingum University represent the undisturbed soils. Soils at The Wilds were reclaimed after been surface-stripped for decades. Measurements and analysis of the results are presented.

TOOLING DESIGN ENGINEER

Andrea Larkin
Department of Physics and Engineering

The Allied Machine and Engineering Corporation, located in Dover, Ohio, meets the needs of many companies around the world by designing and producing tools specified for each customer. After the need is expressed, teams of engineers work together to formulate a general design, and therefore time and cost estimates. From there, design engineers use a computer program entitled ProEngineer to create a specific blue-print for the tool, first by making a three-dimensional design of the tool, which is then turned into a drawing which is set to the shop to be produced for the customer. Allied Machine hires college engineering students during the summer as a part of this team of design engineers. This allows the students to gain knowledge and experience in the engineering field as well as gives the students an opportunity to exercise the knowledge that is received in engineering classes.

THE SPECIES PROFILE OF LOTIC FISH COMMUNITIES AFFECTED BY LANDSCAPE LEVEL SURFACE MINING DEGRADATION

Jesse E. Hardval
Conservation Science Program

Deforestation in riparian buffers has been shown to increase stream temperature. Water temperature increases alter metabolism, growth rates, inter-specific competition, susceptibility to disease and mortality of the organisms that live in the stream. Deforestation can also change species profiles by increasing nutrient levels leading to increased algal production and loss of oxygen. In an area that has been surface mined and a significant percentage of trees have been removed, elevated temperature can be a driver of changes to the fish diversity patterns. The goal of this research is to develop a species profile at several sites and streams at the Wilds. The Wilds is an area that has experienced deforestation due to landscape level surface mining occurring over 25 years ago. The Wilds is now a wildlife conservation center containing over 9 thousand acres of degraded land. There are several streams on the property. Specimens will be collected from stream sites by use of seine nets. Physical stream characteristics will also be recorded. To date six seinings have occurred at four different sites. Seventy specimens have been netted, with seven species being identified and six hybrid sunfish specimens. Many specimens of sunfish, particularly green sunfish (*Lepomis cyanellus*) have been collected in seining thus far. This was not expected, as literature indicated minnow species (Cyprinidae) would seemingly dominate

CREATING AN ANDROID APPLICATION FOR A CLINIC IN HAITI

Sarah Hare
Department of Mathematics and Computer Science

This project was to research the Android platform and work to create an Android application with an interface that walks the user through entering information, with the goal of eventually using this application in a foreign clinic. Android, as an open source platform supported by Google, is widely available in a variety of devices, including inexpensive devices that could be acquired by the clinic. We cannot rely on standard user interface techniques being known to the clinic workers, and so must research intuitive user interfaces, especially those developed specifically for mobile devices and non-technologically literate populations. Data gathering is a basic need in any situation. The same application, extended to other sorts of problem domains, could greatly improve the quality of services the clinic could provide.

TIME RESOLVED ION SELECTIVITY STUDIES ON THE NATROLITE

Rachel Hentz
Department of Biology

The mechanics of ion exchange and ion mobility within zeolitic materials and aqueous solutions are not well understood due to the rate of reaction and the difficulty in probing samples *in situ*. Knowing the reaction process and understanding the behaviors of ion mechanics in the solid state can we tailor materials for specified functions. In this study, we conducted time resolved ion exchange using Raman spectroscopy, on natrolite with a focus on understanding the crystallographic and chemical transformations. Natrolite successfully sequestered ions through its elliptical channels and has previously exhibited high selectivity for large ion radius cations. Our studies had shown that there is a two step exchange process: 1) softening of the 8 member rings as K exchanges directly into the Na site, and 2) after an unmeasured amount of K had exchanged, the 4 member ring columns rapidly distort to open the 8 member rings as K migrates to one side (see figure below).