CROSSROASDS GEOLOGY CONFERENCE 2014

Welcome

We want to say a special thank you to all of you who are participating in this year's Crossroads Geology Conference at Indiana Universities Department of Geological Sciences. Crossroads has a long and rich tradition at Indiana University, and we anticipate this year will be even better with numerous student presentations, a keynote presentation from Indiana University Professor R.J. Barthelmie, and a number of companies represented. We want to thank our sponsors, listed below, as well as all of the judges who have committed their time to this event, and the Department of Geological Sciences at Indiana University for their support of this event. Thanks, and we hope you enjoy Crossroads 2014.

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Schedule

Friday, March 28, 2014

8:00 am	Student Check-in (GY Lobby); Breakfast For Participants (GY S201)
9:00 am	**Poster Session I (MSBII Lobby):** Sediments, Low Temperature Geochemistry, Paleontology, and Geoarchaeology
10:15 am	**Oral Session I (GY 126):** Geophysics and Tectonics, High Temp. Geochemistry and Petrology
11:00 am	**Keynote Speaker:** R.J. Barthelmie (GY 126) Wind Energy: Everything you wanted to know but were afraid to ask.
12:00 pm	Lunch For Participants (GY S201)

1:00 pm	**<u>Poster Session II (MSBII Lobby):</u>** Geophysics and Tectonics High Temp. Geochemistry and Petrology **<u>Oral Session II (GY 126):</u>** Atmoshperic, Environmental Geology, and Hydrology
3:00 pm	**<u>Poster Session III (MSBII Lobby):</u>** Atmospheric, Environmental Geology, and Hydrology **<u>Oral Session III (GY 126):</u>** Sediments, Low Temp. Geochemistry, Paleontology, and Geoarchaeology
5:00 pm	Judges meeting (GY214)
5:30 pm	Break
7:00 pm	Networking Social at Backroom of Crazy Horse (214 W Kirkwood Ave)

Saturday, March 29, 2014

8:00 am	Breakfast For Participants (GY 201)
9:00 am	Awards Ceremony (GY S201)
9:30 am	Company Panel Discussions (GY 214)
10:30 am	Petroleum Systems Short Course, Tom Skirvin and Jeff Oslund (GY 220)
1:00 pm	Lunch For Participants (GY S201)

Oral Sessions: 15-minute standard presentations (GY 126)

High Temp. Geochemistry and Petrology, Geophysics and Tectonics	Atmospheric, Environmental Geology, and Hydrology	Sediments, Low Temp. Geochemistry, Paleontology, and Geoarchaeology
10:15 am	1:00 pm	3:00 pm
Yinzhi Wang	Poonam Giri	David Grossnickle
Agnieszka Furmann	David Mase	Patrick Cavanagh
Hind Ghanem	Olivia Miller	Lin Wei
	Ryan Sullivan	
	Wendell Walter	
	Timothy Wright	
	Quin Zhang	

Poster Sessions: 2-hour standard poster presentation (MSBII Lobby)

Sediments, Low Temp. Geochemistry, Paleontology, and Geoarchaeology	High Temp. Geochemistry and Petrology, Geophysics and Tectonics	Atmospheric, Environmental Geology, and Hydrology
9:00 am	1:00 pm	3:00 pm
Cherie Achilles	Joseph Biasi	Aaron Baer
Silivia Ascari	Samuel Blazey	Nicholas Clercin
Allison Bormet	Anna Nowicki	Robert Conrick
Allison Bryan	James Wallace	Paula Doubrawa
Scott David	Crystal Wespestad	Heather Foxx
Paul Farrugia	Xiaotao Yang	Jase Hixson
Blaire Hensley Marchand		Jake Willingham
Ryan Kuhn		
Amishi Kumar		
Natasha Terrel		
Elizabeth Olliver		
Brendan Paddack		
Owen Rudloff		
Lucas Stamps		
Qiqi Wang		
Kevin Webster		
Ryan Wells		

Keynote Speaker: Professor R.J. Barthelmie

Rebecca J. Barthelmie is Professor of Atmospheric Science and Sustainability at Indiana University. She previously held positions at the University of Edinburgh in the UK and at the Danish Technical University (Risø). Her research in wind energy focuses on resources and wind turbine wakes. She is author of 110 journal papers and over 330 conference papers and reports. She is co-chief editor of the journal Wind Energy, and on the scientific and technical committees of many wind energy conferences. She received the 2009 scientific award from the European Wind Energy Academy for 'her extraordinary efforts and achievements in the field of wind energy research'. She currently leads research projects funded by the Department of Energy and National Science Foundation.

Everything you wanted to know about wind energy – but were afraid to ask.

Abstract:

Wind energy has become enormously successful and now contributes to safe, reliable electricity generation at a cost that is comparable to that of natural gas. This presentation will address 10 commonly held myths about wind energy using recent research and data to support the facts about this type of electricity generation. It will also focus on the link between atmospheric science research and the development of large wind farms by describing wind turbine wakes, how they are measured and modeled and how improving understanding of wind turbine wakes will lead to better wind farm optimization.

Sediments, Low Temperature Geochemistry, Paleontology, and Geoarcheology

Title: X-ray Diffraction Studies of Ferrian Saponite Under Martian Humidity Conditions: Implications for Phyllosilicates in Yellowknife Bay, Gale Crater, Mars
Author: Cherie Achilles (achillec@indiana.edu)
Institution: Department of Geological Sciences, Indiana University, Bloomington, IN, USA
Pursing Degree: PhD
Presentation: Poster
Abstract: The Mars Science Laboratory (MSL) rover reported the presence of phyllosilicate minerals in an ancient lacustrine mudstone. Drill samples measured by the CheMin X-ray diffraction (XRD) instrument reveal two broad diffraction peaks at 10 Å and 13.2 Å. The 10 Å peak likely corresponds to a collapsed 2:1 trioctahedral smectite but the identity of the 13.2 Å peak remains speculative. Several hypotheses have been proposed, including a hydrated smectite containing interlayer cations with high hydration energies, such as Mg+2 or Ca+2, and a smectite with incipient chloritization. Although each can produce a broad low-angle peak in an XRD pattern, more research is needed to differentiate between these two suggestions under low humidity and temperature conditions. This study focused on the behavior of a natural and cation-exchanged Fe-saponite at low relative humidities (RH). Preliminary findings reveal that at 1-3% RH, K-, Na-, Ca- and Mg-exchanged samples did no! t collapse to 10 Å. These data suggest that the Fe-saponite has a low layer charge allowing the smectite's interlayer cations to be partially hydrated even at low RH. This Fe-saponite is not a good analog for the 10 Å smectite in the Mars CheMin XRD data. However, these results do have implications for the 13.2 Å phyllosilicate, and future studies will characterize this and other saponites under low-temperature and low-RH conditions. As MSL continues to traverse to the phylosillicate-rich regions of Gale Crater, characterizing the stability of smectites under martian conditions will be essential to identifying and understanding the clay minerals encountered by MSL.

Title: The Diversification of Early Mammals: Implications from a Geometric Morphometric Analysis of Molar Shape

Author: David M. Grossnickle (grossnickle@uchicago.edu)
Institution: The Department of the Geophysical Sciences, The University of Chicago, Chicago, Illinois

Pursing Degree: PhD

Presentation: Oral

Abstract: The eradication of dinosaurs at the Cretaceous-Paleogene (K-Pg) extinction event opened ecological niche opportunities that were subsequently exploited by Cenozoic mammals. However, some evidence suggests dinosaur dominance had already begun to falter prior to their extinction. If this theory is true, then the radiation of mammals would have likely started during the Late Cretaceous. Diversification into new ecological niches would have led to new diets, and, consequently, new structures and shapes of molars that are reflective of specific diets. Therefore, an increase in shape variation within molars of Late Cretaceous mammals would be expected if mammals radiated during this time. Here, I examine molar cusp patterns of Cretaceous therians, the mammalian group that gave rise to a majority of modern mammals. Images of upper and lower molars were collected from the primary literature for 58 therian species. Geometric morphometrics, a technique used to analyze shape differences, was performed on two-dimensional landmark data from the tooth surface of solitary molars. Therian species were separated into Cretaceous time bins based on their taxonomic ranges, and variation of molar shape was calculated for each time bin. Patterns through time of lower molar shape variation offer weak support for the hypothesis that mammals had begun to radiate ecologically prior to the K-Pg boundary, while results from the upper molars do not support this hypothesis. Next, taxa from North America and Asia were separated and analyzed independently for comparison of regional evolutionary patterns. Although the two continents consisted of unique mammalian faunas, results demonstrate parallel patterns over time, which could indicate dispersal between continents or global selection pressures. Finally, therians were separated into their two major groups, metatherians and eutherians, and analyzed separately to compare differences in molar shape. The molar shapes of these known species where then compared to molars of unknown species, and statistical tests were used to help predict the group to which they most closely aligned.

Title: Reconstruction of East African paleoenvironment based on stable isotopes

Author: Silvia Ascari (sascari@indiana.edu)
Institution: Department of Geological Sciences, Indiana University, Bloomington, IN, USA
Pursuing Degree: M.S.
Presentation: Poster

Abstract: The Olduvai Gorge is a valley situated along the East African Rift Valley where many early hominin fossils have been exposed and found due to the rifting. The paleoenvironment of the Olduvai Gorge is important for determining what factors influenced early human evolution. One way of determining the paleoenvironmnet of a given region is by conducting isotopic studies on the bones of animals that lived in that region. Animals tend to incorporate the isotopic composition of what they eat and drink into their tissues. Trees and shrubs have lower concentrations of 13C whilst grasses, which can tolerate hotter, arid climates with low atmospheric CO2 levels, have higher 13C concentrations. Higher 18O concentrations from the water that the animals drink are likewise associated with aridity. We can use the collagen from fossil bones and teeth to analyze their isotopic composition and thereby reconstruct the paleoenvironments that the animals lived in. For this study we used both fossil and modern teeth and bones from the Olduvai Gorge to determine their isotopic compositions. We used 32 modern and fossil crocodile teeth and herbivore bones and teeth. The fossil specimens were from beds aged 1.8 and 1.85 Ma. We were able to do a comparative analysis between the modern and fossil bones and teeth to determine how the climate in East Africa was different in the past. The oxygen isotope composition of the samples indicate that the paleoenvironment at 1.8 and 1.85 Ma had higher precipitation levels than in the present, with slightly higher levels at 1.85 than at 1.8, indicating an overall increase in aridity through time. The carbon isotope composition of both crocodiles and mammal herbivores indicate that the environment in the past was dominated by woodlands, whereas in the present it is dominated by arid grasslands.

Title: Bison do not march in unison: a geometric morphometric approach to differentiating North American bison species based on hoof shape morphology

Author: Allison K. Bormet (akbormet@indiana.edu)
Institution: Department of Geological Sciences, Indiana University, Bloomington, IN, USA
Pursing Degree: PhD
Presentation: Poster

Abstract: Modern North American bison are large, horned animals that exist in regions of Canada and Alaska as Bison bison athabascae, the wood bison, and in the American west as Bison bison bison, the plains bison. These animals are smaller bodied with shorter horns than their recently extinct Pleistocene counterparts, Bison latifrons and Bison antiquus. Limb dimensions of B. latifrons suggest it was a large-bodied animal that was less adapted for fast running than modern bison. Its geographic range included heavily wooded environments of western America. B. antiquus, considered to be the ancestor of modern bison, is also not as adapted for speed when compared to B. b. bison, but is more adapted than B. latifrons. It most likely inhabited pockets of woodland steppe in southwestern America. Due to the overlap of geographic ranges and skeletal similarity, these species have been difficult to differentiate in the fossil record. Typically, fossils were assigned to the species level based off of horn fragments. Due to the varying degree of habitats the genus has inhabited, analysis of limb bones using geometric morphometrics may help discern ecomorphological variation (i.e. a shape related to habitat) between the species. The distal phalanx bone, which is encased in the hoof, was analyzed in this study because of good fossil preservation and its direct interaction with terrain, suggesting it may show shape variations across habitat types (i.e. woodland versus prairie). Using photographs, shape outlines were placed around the underside surface of the hoof bone, and analyzed using geometric morphometrics to test for differences in shape. The greatest shape variation among the species can be seen as differences in the width, length and curvature of the hoof bone. Results of a multivariate statistical test (i.e. MANOVA) indicate that hoof bone shapes of B. antiquus and B. b. bison are significantly different, with B. antiquus having more hoof bone variation and elongation. This suggests that bison species living in a prairie environment may be distinguished from woodland bison species based off of their hoof bone morphologies. B. latifrons tends to have a more prominent posterior-lateral projection on the hoof bone than B. bison or B. antiquus. However, a larger sample size of B. latifrons is needed to determine if this species' hoof bone shape is significantly different than B. antiquus or B. b. bison. In addition, modern B. b. athabascae specimens will be added to the analysis to further compare morphological similarities between the extinct species, which lived in areas with more tree cover.

Title: Zn isotope fractionation during adsorption on birnessite
Author: Allison Bryan (allybrya@indiana.edu)
Institution: Department of Geological Sciences, Indiana University, Bloomington, IN, USA
Pursing Degree: M.S.
Presentation: Poster
Abstract: The biogeochemical cycling of zinc (Zn), an important micronutrient in the ocean, may influence primary productivity and species composition within surface waters. The chemical speciation and bioavailability of Zn is governed by diverse abiotic and biotic processes. These processes include adsorption reactions at mineral/water interfaces, as nanoparticles of oxyhydroxide minerals are known to adsorb significant amounts of Zn in surface waters (and during formation of ferromanganese crusts). Investigation of Zn isotope fractionation caused by adsorption onto birnessite, the dominant manganese oxide mineral in ferromanganese crusts, may help to explain the enrichment of heavy Zn isotopes in ferromanganese crusts (Maréchal et al., 2000). This will provide insight into the role of adsorption of Zn to nanoparticulate minerals in surface waters and into the overall biogeochemical cycling of Zn. This work aims to determine the mechanism and magnitude of Zn isotope fractionation during adsorption onto synthetic birnessite ($KMn_2O_4 \cdot 1.5H_2O$) at low and high ionic strength conditions. Our experiments involve mixing solutions of approx. 130 ppb of ICP Zn with aliquots of birnessite suspension (proportions varied to give a range of surface coverage) and a fixed pH near that of seawater at ~8.5. The high ionic strength solutions contain a synthetic seawater solution with the six most abundance salts in the ocean. The mixtures react for 48 hours. The recovered dissolved Zn and adsorbed Zn are then separated, purified, and analyzed isotopically on a Nu Plasma MC-ICP-MS. Results exhibit enrichment of light Zn isotopes on the mineral surfaces with an average magnitude of fractionation of $\Delta 68/66Zn_{sorbed\text{-}aqueous} = -0.18 \pm 0.05$ ‰ driven by differences in coordination numbers and bond partners between dissolved and adsorbed Zn complexes. Conversely, at high ionic strength, Zn p! referentially adsorbs heavy Zn on the birnessite surface with a $\Delta 68/66Zn_{sorbed\text{-}aqueous}$ range of 2.74 ± 0.05 ‰ to 0.12 ± 0.05 ‰ driven by coordination chemistry with the addition of salts creating a change in Zn speciation. The isotope results over a range of percentage of Zn adsorbed at both low and high ionic strength suggest an equilibrium isotope fractionation effect driven by differences in coordination numbers and bond partners between dissolved and adsorbed Zn complexes. Dissolved Zn is octahedrally coordinated with oxygen atoms, but an EXAFS study by Manceau et al. (2002) reported a transition from octahedrally coordinated Zn at low surface loading conditions to a mixture of tetrahedrally and octahedrally coordinated Zn sorbed on Mn oxides at high surface coverage. We hypothesize, the structural disorder on the birnessite surface creates a distorted octahedral coordination for birnessite-sorbed Zn compared to a symmetrical octahedral geometry found in aqueous Zn species. Additionally, tetrahedral Zn complexes impart a larger isotope fractionation compared to octahedral complexes. In general, the heavy isotopes of an element preferentially concentrate in the species with the preferred geometry to create stronger and stiffer bonds.

Title: Linear Programming Methods to Constrain Mineralogy at Gale Crater, Mars
Author: Patrick D. Cavanagh (pdcavana@indiana.edu)
Institution: Department of Geological Sciences, Indiana University, Bloomington, IN, USA
Pursing Degree: Phd
Presentation: Oral
Abstract: Linear Programming Methods to Constrain Mineralogy at Gale Crater, Mars The Mars Science Laboratory (MSL) Curiosity rover is currently gathering a wealth of scientific data about the surface properties around the Gale Crater landing site. Recent analyses of Gale Crater's chemistry and mineralogy have concluded that the crater contains an ancient lacustrine environment with evidence of past weathering and strong potential for habitability [Grotzinger et al., 2014]. Visible and infrared remote sensing analyses (Mars Reconnaissance Orbiter, MRO; Compact Reconnaissance Imaging Spectrometer for Mars, CRISM) have also detected clay minerals in the form of Fe3+-rich smectites in Endeavor Crater [Arvidson et al., 2014]. In order to understand the correlation between orbital spectroscopic signatures and ground-truth measurements (e.g., CheMin X-ray diffraction measurements), the mineralogy on Mars must be constrained. Additionally, CheMin XRD data have shown that a significant proportion of the martian surface composition can only be described by a highly variable amorphous (non-crystalline) component [Bish et al., 2013]. By using numerical methods and the combination of multiple data sets and mineralogical constraints, the relative abundances of the crystalline and amorphous component can be more accurately described, which will improve the current understanding of both the global martian soil and mineralogy and chemistry at Gale Crater. A linear programming model was used to combine the Alpha Particle X-Ray Spectrometer (APXS) chemical data with the CheMin X-ray diffraction data in order to constrain the maximum and minimum values for crystalline and amorphous components of martian soil and rocks. This model is defined by a system of equations relating various constraints, phase variables, and a constant bulk soil composition vector (APXS data). The goal of the linear programming model is to maximize a particular phase, Xj, such that the chemical mass balance equations are satisfied. Each phase has an estimated chemical variability built into the model, defined as ΔXj. The total mineral mixture is the sum of multiple phases defined as: Xj q'j + 2[Δq]jΔXj, where q'j is the composition from literature values and 2[Δq]j is the compositional range of interest. The numerical model allows the phase compositions to vary in order to maximize the weight fraction of a selected phase. Results obtained from fou! r mineral phases, plagioclase, forsterite, augite, and pigeonite, converge on a solution that yields promising abundance results, however, further refinement and inclusion of additional mineral phases and constraints are required to create a more robust and accurate model. Ultimately, the model will also include constraints for potential amorphous components. With an abundance of data from MSL and MRO, it is becoming possible to confirm remote sensing results using the new MSL ground truth data. Using refined mineral phase constraints determined through a numerical model combining multiple data sets, the mineralogy of the martian surface can be better approximated. Future research will use the phase abundance results to verify the spectroscopic mineralogy results derived from CRISM data sets.

Title: Floodplain Topography and Its Implication for Accessory Channel Formation
Author: Scott David (davids@indiana.edu)
Institution: Department of Geological Sciences, Indiana University, Bloomington, IN, USA
Pursuing Degree: M.S.
Presentation: Poster
Abstract: Floodplain morphology plays an essential role in conveying floodwaters, sediment transport during floods, and inevitably the mechanics of the main channel. The acquisition of high-resolution topographic data (e.g. LiDAR) reveals a wealth of previously unappreciated geomorphic floodplain features. Utilizing 1.5m LiDAR DEMs from Indiana, we find three distinct floodplain morphologies in Indiana. The three floodplain morphologies include: featureless with minimal floodplain topography, topography directly due to river meandering (ex. Oxbow lakes and scroll bar topography), and those containing topography due to river meandering and accessory channels. We find that floodplains of Indiana rivers often contain a surprising number of accessory channels. For instance, on the White River the accessory channels account for ~25% of the floodplain area. Individual channels are linear to sinuous, with widths ranging from 15-35% of the main channel, and lengths ranging from 500-3500 meters. The floodplain accessory channels are only active during times of overbank discharge, which is confirmed by Landsat images of inundated floodplains. Even more remarkable, during a ~10-year flood on the White River, the accessory channels conveyed all the flood discharge leaving the reaches between the channels dry.

To assess the pervasiveness of floodplain accessory channels we inventoried all the floodplains of Indiana rivers with channel widths greater than 20 m. We mapped the modern floodplains of each river, while avoiding terraced floodplains related to the last glacial maximum. In total we mapped ~3080 km^2 of floodplain; 38% of that area showed evidence for floodplain accessory channels. Moreover, there is a high concentration of floodplains exhibiting floodplain accessory channels in central-southern Indiana occurring along the transition from glacial till into bedrock.

Our preliminary hypothesis for the formation of floodplain accessory channels is these channels form by connecting together pre-existing topographic lows, such as abandoned channels. Geomorphic mapping of a seven kilometer stretch of the White River's floodplain reveals that the concave portions of accessory channels are associated with scroll-bar topography and abandoned meander loops from the main channel. In fact, 73% of the accessory channels reoccupied abandoned meander loops. Based on this we conclude that accessory channels are associated with meandering rivers because frequent meander loop cutoffs of the main channel create pre-existing conduits that are then linked together during floods. These long coherent down-valley accessory channels have important implications for the morphodynamics of floodplains and flood wave propagation.

Title: Paleoecological Reconstruction of Hominin Landscapes at Olduvai Gorge, Tanzania
Author: Paul Farrugia (pfarrugi@indiana.edu)
Institution: Department of Geological Sciences, Indiana University, Bloomington, IN, USA
Pursuing Degree: PhD
Presentation: Poster
Abstract: The DK site, excavated by Mary Leakey in the 1960s, dates to 2 million year ago and is the earliest archaeological site at Olduvai Gorge, Tanzania. Classified as a 'living site,' a safe location on the landscape frequently returned to for social activities (e.g., food consumption, tool making) DK records evidence of a human created shelter, stone tools, and butchered faunal remains. However, sedimentological and paleontological studies indicate that this site was located in a wetland environment, which entails high predation risks for our earliest stone-tool using ancestors. Archaeological excavations at the DK site yielded the highest concentration of crocodile teeth from the Olduvai sites, suggesting that this carnivorous reptile occupied the immediate area. Furthermore, mammalian carnivores (e.g. felids, hyaenids) were also active when hominins occupied the site, as represented by tooth-marked bones of large vertebrates. This paleontological and sedimentological evidence challenges the fundamental premise of the "living site" interpretation. Here, we present a preliminary analysis of the archaeofaunal assemblage, dominated by crocodile teeth and highly fragmented, bite-marked bones, recovered from the DK site during the 2002-2013 field seasons. Our objective is to infer the relative risk of crocodile predation at the DK site and test the hypothesis that the DK site represents a safe, 'living site' for hominins.

Title: Hippopotamus at Olduvai Gorge Indicates Persistent Wetland Environments During a Period of Increasing Aridification in Early Hominin Evolution
Author: Blaire Hensley-Marschand (bahensle@indiana.edu)
Institution: Department of Geological Sciences, Indiana University, Bloomington, IN, USA
Pursuing Degree: PhD
Presentation: Poster
Abstract: Olduvai Gorge is a large paleoanthropological and paleontological site located in the East African Rift Valley of Tanzania. The gorge is nearly 30km in length and exposes up to 90 vertical meters of Pleistocene sediments along its course. A recent excavation conducted by the Olduvai Landscape Paleoanthropology Project (OLAPP) uncovered a new paleoanthropological site that included the partial skeleton of a hippopotamus. The remains include both cranial and postcranial elements and represent a minimum of one individual; their large size and morphology indicate an affinity with the highly amphibious Hippopotamus gorgops. The fossil remains are located in Bed I within a lens of clay to volcaniclastic sandstone that lies directly above Tuff 1E and below the Ng'eju Tuff. New dates for these tuffs provide an age for this excavation of 1.81-1.83 million years old. The climate at Olduvai during this time was one of increasing aridification, causing a contraction of paleo! -Lake Olduvai. This excavation, with such tightly constrained dates and strict stratigraphic control, provides critical paleoecological information regarding the extent of wetlands within the lake margin setting that was also utilized by multiple species of Pleistocene hominins at this time. These hippopotamus remains were found in

association with a dense concentration of Oldowan stone tools, demonstrating the presence of hominin activities at this site and posing further questions about the evolution of the early land-use behavior of our ancestors.

Title: FORMATION OF IRON AND ALUMINUM PRECIPITATES IN AN ACID MINE DRAINAGE SOLUTION
Author: Ryan Kuhn (rkuhn1@sycamores.indstate.edu)
Institution: Department of Geological Sciences, Indiana University, Bloomington, IN, USA
Pursuing Degree: PhD
Presentation: Poster
Abstract: Acid mine drainage (AMD) is notoriously elevated in iron, aluminum, and numerous trace elements. The chemical behavior of AMD changes as it becomes diluted by such factors as increased discharge from rainfall and snow melt that decrease acidity. This, in turn, impacts solubility and migration of iron, aluminum, and trace elements in the environment. This preliminary study evaluates precipitation behavior from an AMD sample as it is titrated across a range of pH from 3.00 to 10.00 and characterizes both the resulting solid and liquid phases. Three liters of AMD were collected from a constructed channel lined with carbonate rip-rap at the Green Valley abandoned coal mine site in western Indiana. AMD pH at the time of sampling was 3.30. In the laboratory, the sample was separated into three 1-L aliquots so that triplicate titrations could be performed to establish reproducibility. Both pH and Eh were measured continuously as AMD was titrated with 1 M NaOH to induce precipitation. The solution mixture was continuously stirred to maintain homogeneity. Twenty-five mL samples were taken at each 0.5 pH interval and pipetted into individual pre-weighed plastic centrifuge tubes. Samples were then centrifuged and decanted to separate precipitates and solution, resulting in 15 liquid and 15 precipitate samples. Initial acidity curves for these tests indicate three primary precipitate reactions occurring around pH's 3.00, 5.00 and 9.00, reflecting removal of Fe, Al, and possibly Mg, respectively, from the AMD solution. Noticeable precipitation increases occurred at about every 2 to 3 pH increments. Eh and pH values will be plotted on known Pourbaix diagrams to demonstrate partitioning of Fe, Al and Mg into liquid versus solid phases. Future work includes analysis of the liquid and precipitate phases by inductively coupled plasma mass spectrometry to determine trace element concentrations and associated coprecipitation.

Title: PAHs in the Santa Barbara Basin

Author: Amishi Kumar (amikumar@indiana.edu)
Institution: Department of Geological Sciences, Indiana University, Bloomington, IN, USA
Pursuing Degree: M.S.
Presentation: Oral

Abstract: Polycyclic aromatic hydrocarbons (PAHs) are a class of persistent, yet ubiquitous organic pollutants coming from both natural and anthropogenic sources. The EPA has recognized seven of these compounds on their priority chemical list due to their toxicity, carcinogenicity, and mutagenicity. Usually the sources of PAHs can be divided into two distinct groups- pyrogenic and petrogenic. Pyrogenic PAHs come from the incomplete combustion of carbon-rich compounds; different combustion fuels release a distinct variety of PAHs providing a signature of the pollutant source. Petrogenic PAHs can be released from oil, coal, tar, and bitumen; these also have a distinct grouping of compounds. The Santa Barbara basin is a geologically interesting location full of active oil seepages and high sedimentation rates. The Santa Barbara basin in located off the coast of urbanized South California. This area receives a constant supply of nutrients via upwelling thus creating a very active photic zone. However the decomposition of large masses of phytoplankton causes an anoxic environment below the photic zone. The lack of bioturbation and an anaerobic microbial mat covering the ocean floor, which limits sediment redistribution, produces an annually laminated, or varved, sediment record. The varved nature of these sediments allow for a very precise reconstruction of the past sediment characteristics. This project will examine Santa Barbara basin sediments cored in 1989 that span the years from 1835-1987. These sediments will provide insight on the major PAHs contaminating the area and define any input fluxes into the basin. Classification and determining the concentration of the individual PAHs will help diagnose if their sources are pyrogenic (most likely coming from anthropogenic activities) or petrogenic (probably derived from the naturally occurring active oil seeps). Proposed analysis of another set of Santa Barbara sediments cored from a later date will aid in discerning if degradation plays a major role in preservation of PAHs. A comparative analysis of the same varved sections will resolve two pressing concepts: (1) if PAHs concentrations remain consist between varves then no degradation occurred in situ or if a change occurred then preservation of PAHs is not stable within a sediment column (2) if a change in concentration occurred from surface sediments in the 1989 core to the corresponding varve in the later core then some surface, probably microbial-based processes, plays a significant role in degradation and ultimate preservation rate of PAHs within the Santa Barbara basin.

Title: DETAILED PHOSPHORUS GEOCHEMISTRY OF SEDIMENT CORES FROM LAKES IN NORTHEASTERN GLACIAL NATIONAL PARK, MONTANA, UNITED STATES

Author: Natasha Nicole Terrell (nterrell2@sycamores.indstate.edu)
Institution: Department of Earth and Environmental Systems, Indiana State University, Terre Haute, IN 47809

Pursuing Degree: M.S.

Presentation: Poster

Abstract: In 1910, President William Howard Taft passed a bill making Glacier National Park the 10th established national park in the country. Glacier National Park (GNP) is located along a portion of the Rocky Mountains in Montana in the Western United States. The glacial activity in GNP has fluctuated considerably, primarily due to climate changes since the Little Ice Age. Using a combination of geochemical and biologic proxies (diatoms), we hope to reconstruct a history of glacial advance and retreat for the region using lake sediment core records that were collected during summer 2013. For this study, two sites within the GNP area were chosen. Cosley Lake and Glenns Lake are located in the upper Northeastern corner of the park close to the Montana-Canadian border. The research presented here will focus on the use of detailed phosphorus geochemistry within the lake sediment cores and soils surrounding the lakes to better understand P biogeochemical cycling on the landscape and wit! hin the lakes themselves. As glaciers retreat, fresh unweathered minerals (apatite) are exposed at the surface, and as the landscape matures and soil develops, a change from mineral P to organic P should be observable in the lake geochemical records. Sequential chemical extractions for phosphorus identifies that phosphorus which is associated with oxides, mineral phases, and organic matter. Evaluating these temporal variations in phosphorus geochemistry coupled with fossil diatom assemblages and other geochemical proxies will ultimately provide a history of landscape nutrient status, weathering fluxes, and glacial activity.

Title: The role of vegetation in the development and resiliency of coastal freshwater deltaic systems.
Author: Elizabeth Olliver (eolliver@indiana.edu)
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Pursuing Degree: M.S.
Presentation: Poster
Abstract: In the realm of coastal deltaic sciences, great strides have been made in our understanding of their geomorphology. However, relatively little work has been done to explore the relationship between vegetation within a delta and its geomorphic development. In my research I will look to more fully understand the role vegetation on deltaic islands plays in the process of sedimentation in freshwater deltaic wetlands and determine if there is an optimal vegetation height that enhances this process. A combination of remote sensing analysis, numerical modeling, and field assessments and monitoring of the Wax Lake Delta in Louisiana will be used to study this relationship. I present my preliminary data from the analysis of remotely sensed NDVI imagery of a series of deltaic islands within the Wax Lake Delta complex. These islands were selected from areas across the delta with varying degrees of fluvial versus tidal and wave dominated influences to study the development of these islands under varying morphodynamic regimes and the role that vegetation plays in it. The knowledge gained from these and future results in my research could help to better assess the condition and resiliency of a delta to relative sea level rise and aid in planning for the restoration and prevention of further degradation of coastal freshwater deltaic wetlands.

Title: The Taphonomy of Deep-Sea Benthic Foraminifera from the Southern California Bight
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Pursuing Degree: Undergrad
Presentation: Poster
Abstract: In an effort to understand the relationship between living and fossil assemblages of benthic foraminifera in the oxygen minimum zone (OMZ) of the Southern California Bight, living (Rose Bengal stained) populations were compared with dead (not stained) assemblages from the same multicorer samples. Analyses of the greater than 150 micron size fraction samples showed that the ratios of living/dead benthic foraminifera vary between different species. This study provides information about how closely fossil assemblages in the OMZ of this region reflect living populations. These taphonomic results help in the interpretation of paleo-environmental conditions based on fossil foraminifera.

Title: Lake records of Northern Hemisphere South American summer monsoon variability from the Cordillera Oriental, Colombia: Initial results from Laguna de Ubaque
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Presentation: Poster
Abstract: The lack of decadally resolved terrestrial paleoclimate records from the Northern Hemisphere Andes has meant that our understanding of abrupt South American summer monsoon (SASM) variability during the Holocene is almost exclusively based on data from Southern Hemisphere sites. In order to develop a more integrated and complete picture of the SASM as a system and its response during rapid climate changes, new high-resolution paleoclimate records are needed from the Northern Hemisphere Andes. To this end, we present initial results from analysis of lake sediment cores that were collected from Laguna de Ubaque in the Eastern Cordillera of the Colombian Andes in July 2013 as part of an ongoing research initiative. Lago de Ubaque (2070 m asl) is a small east facing moraine-dammed lake in the upper reaches of the Rio Meta watershed near Bogotá that contains finely laminated clastic sediments. The initial sedimentological and chronological results demonstrate that Lago de Tota and Laguna de Ubaque hold tremendous potential for resolving Northern Hemisphere SASM variability at decadal time scales or better. Such records will provide important counterparts to high-resolution paleoclimate records from the Southern Hemisphere Andes.

Title: A laminated carbonate record of mid-continental climate during the late Glacial and Holocene from Martin Lake, northeastern Indiana: Initial sedimentological and chronological results.
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Presentation: Poster
Abstract: Paleoclimate records from the mid-continental United States that span the Holocene with sub-decadal resolution are rare. This is especially true for geochemical records that capture the isotopic composition of precipitation or local precipitation/evaporation balances. As a result, many questions remain about the hydrologic expression of abrupt climate events in this region that today is one of the largest agricultural centers in the world. The importance of answering these questions is underscored by recent severe summer droughts that significantly diminished crop yields, and predictions that such droughts may become more frequent and severe in coming decades. This work seeks to place current droughts within the context of natural climate variability by developing high-resolution (5 years average per sample) hydroclimate records from Indiana that span the Holocene. An approximately 8-meter-long sediment core has been collected from Martin Lake in LaGrange County, Indiana. Today, this kettle lake is hydrologically open with a stratified water column and bottom water anoxia. The preliminary sedimentological and radiocarbon results presented here sugges that the sediments from this lake will produce a high-resolution record of Holocene hydroclimate.

Title: PRELIMINARY LITHOLOGICAL AND PALYNOLOGICAL INVESTIGATION OF MESOZOIC-CENOZOIC STRATA IN THE GORGE OF THE NILE, ETHIOPIA

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Presentation: Poster

Abstract: The Gorge of Nile in Ethiopia exposes layers of rock laid down over hundreds of millions of years of earth history. The Triassic sandstones of Gohasion Formation lie below the younger Triassic and Jurassic limestone and gypsum layers in the Gohasion and Antalo formations. The sandstones and limestones are sandwiched between Precambrian granites and 30 million-year old flood basalts. Samples from the Gohasion, Antalo and organic-rich chert interbedded with the flood basalts were studied for their palynological contents. Palynology has been integrated with lithologic data to make preliminary interpretations about depositional conditions. Transmitted light microscopy was used to identify and count palynomorphs and dispersed organic matter. Palynomorph recovery is poor in most samples, but one organic-rich gypsum sample is very productive. Common spore taxa recovered are Converrucosisporites sp., Matonisporites sp., and Concavissimisporites variverrucatus, while pollen grains ar! e rare. Identified organic components include fungal remains, pollen, spores, structured phytoclasts (wood, cuticles), degraded phytoclasts, comminuted phytoclasts, opaque debris and amorphous organic matter (AOM). Organic components were point counted (300 specimens) and analyzed using principal components analysis and cluster analysis to recognize four palynofacies assemblages. Palynofacies assemblage A correlates with the flood basalt interbedded sediments and is exceptionally rich in structured phytoclasts (>=50%). Degraded phytoclasts and the highest percentage of AOM define assemblage B. Assemblage C correlates with the Antalo limestones. Palynofacies assemblage D is characterized by an elevated percentage of AOM and comminuted phytoclasts but fewer structured phytoclasts; it correlates with the siliciclastic sediments of the Gohasion Formation. Although marine palynomorphs appear to be absent, abundant phytoclasts and moderate amounts of AOM coupled with lithological! data suggest marine depositional conditions with high input of terrestrial material into the basin. Kerogen data also yield information on source rock potential in the study area when analyzed on the AOM-Phytoclast-Palynomorph ternary plot. Sixteen out of the 21 samples plot in the gas-prone, phytoclast-rich type 3 kerogen field.

Title: Methane Dynamics in Caves
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Presentation: Poster
Abstract: The study of methane (CH4) dynamics in caves has implications for climate change and extraterrestrial life detection. CH4 is a strong greenhouse gas. One molecule of CH4 contributes 20 times the amount of radiative forcing to Earth's atmosphere than one molecule of carbon dioxide (CO2). Caves frequently develop in karst landscapes and are thought to be a promising environment in the search for extra-terrestrial life. Karst comprises 13 to 20 % of the global non-glaciated land cover and thus may play a significant role in global CH4 dynamics. The estimates of CH4's individual sources and sinks to and from the atmosphere have greatly improved since the late 1980s and early 1990s. Despite these improvements, little is known about CH4 dynamics at the rock-atmosphere interface. In some cases, like those common in karst landscapes, the porosity and permeability of rock units are large enough to allow for the advective flow of atmospheric CH4 through rocks. We measured CH4 concentrations and H,C-isotope ratios (e.g., δ13CCH4 values), and CO2 concentrations and C-isotope ratios (δ13CCO2 values) in 22 limestone caves in Indiana, Kentucky, Pennsylvania, Virginia, and Tennessee as well as one cave in Mexico to gain insight into cave CH4 cycling. CH4 concentrations were quantified using in-situ spectroscopic methods and/or discrete sampling methods followed by laboratory quantification. δ13CCH4 and δ13CCO2 values from cave air were measured using a gas chromatograph and a stable isotope ratio mass-spectrometer. Nearly all of the caves (21 of 23) showed sub-atmospheric CH4 concentrations and two showed elevated CH4 concentrations compared to the outside atmosphere (about 1.84 ppm). CH4 concentration in the caves with depleted CH4 concentrations showed spatial heterogeneity. Less ventilated rooms further from cave entrances showed the lowest CH4 concentrations (~ 0.30 to 0.08 ppm). Additionally, less ventilated rooms showed decreased or increased δ13CCH4 values (~ -55 or ~ - 30 ‰) compared to more ventilated cave rooms (~ -45 ‰). CH4 from caves with enriched CH4 concentrations showed the greatest concentrations at spring entrances. Our data suggest that both microbial methane consumption (methanotrophy) and methanogenesis in karst environments account for the patterns of CH4 concentrations and δ13CCH4 values present in the studied caves. For instance, in well-ventilated rooms atmospheric sources may dominate the CH4 signal. In poorly ventilated cave rooms (i.e. rooms without significant atmospheric inputs), a slow, continuous seepage or in-situ production and consumption of 13C-depleted CH4 may dominate the signal. Methanotrophy in poorly ventilated rooms may increase the δ13CCH4 values of residual methane. Caves circulate significant volumes of air during the course of the year and may represent a significant sink for CH4. Our results also suggest that cave atmospheric composition reflects the metabolic activity of microbes in the cave. Such biosignatures may aid in the identification of life on extraterrestrial bodies.

Title: Influence of Soxhlet-extractable bitumen/oil on porosity in thermally maturing organic-rich shales

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Presentation: Oral

Abstract: Porosity in shales is important for storage of shale gas in reservoirs. As organic-rich shale thermally matures and enters the oil window, generated bitumen and oil can fill pore spaces, block pore connectivity, and reduce porosity. Analytical methods to quantify meso and microporosity via nitrogen (N2) and carbon dioxide (CO2) gas adsorption techniques traditionally do not take into account that gases can access not only open pore spaces in shale, but may also dissolve in hydrocarbon phases like oil and bitumen. This study evaluates the influence of the extracted bitumen/oil on porosity and discusses the importance of N2 and CO2 solubility during porosimetric measurements in shales with maturities across the oil window. Low-pressure N2 and CO2 adsorption techniques were used to quantify mesoporosity (pore size 2-50 nm, accessible to N2 and CO2) and microporosity (pore size <2 nm, accessible to CO2 only) in four New Albany Shale samples of Devonian age from Indiana and Illinois ranging from marginally mature (vitrinite reflectance Ro=0.55%) to post-mature (Ro=1.41%). These shale samples were Soxhlet-extracted in refluxing dichloromethane (boiling temperature 39.6°C) to remove soluble oil/bitumen, vacuum-dried, and the meso and microporosities re-measured. Subsequently, the same samples were Soxhlet-extracted in toluene (boiling temperature 111°C, with enhanced solubility of oil/bitumen), vacuum-dried, and again characterized porosimetrically. The maturation sequence of the four original, non-extracted shales expressed an initial increase in mesoporosity that was followed along increasing maturity by an intermittent decrease, and a subsequent increase in mesoporosity. The intermittent decrease in mesoporosity is consistent with partial filling of pore spaces with bitumen/oil until secondary cracking reclaims some of the lost open pore space from liquid hydrocarbon phases. Organic matter transformation is thus a pivotal cause for the observed evolution of mesoporosity in original, non-extracted shales. Solvent extraction of soluble bitumen and oil from the shale samples generally opened additional pore space for N2 and CO2 adsorption, although the specific effects on mesoporosity and microporosity depend on maturity, total organic carbon (TOC) content, type of solvent, and grain size of the Soxhlet-extracted shales. The mesopore volume increased more in extracted samples with higher maturity, whereas the strongest gain in micropore volume was observed at elevated TOC content and highest maturity. Comparative porosities of original and Soxhlet-extracted shale samples constrain the evolution of porosity along maturation, as well as the effect of partial oil/bitumen filling of pores. The occupancy and blockage of pore spaces in shales by bitumen and oil significantly affects customary porosity measurements based on adsorption of gases N2 and CO2 (and presumably also penetration of metallic mercury, Hg). N2 and Hg have limited affinities to dissolve in liquid hydrocarbon phases. In contrast, CO2 and hydrocarbon gases can easier dissolve in bitumen and oil, especially in a pressurized low-temperature shale gas reservoir, and can therefore access hydrocarbon-filled pore spaces that are

less available to N2 and CO2. In effect, traditional N2 and CO2-based porosity measurements may correctly estimate the open mesopore space (due to low N2 solubility in liquid hydrocarbons) but overestimate the open micropore space where CO2 dissolving into fluid hydrocarbons mimics CO2 adsorption along open micropore surfaces. The apparent bias does not decrease until the onset of secondary cracking when fluid hydrocarbon phases transform to gas and pyrobitumen and open pore space is regenerated.

Title: Ni isotope fractionation via sorption onto manganese oxyhydroxides
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Presentation: Poster
Abstract: Nickel isotopes are a tool that can provide insight into the evolution of marine life over much of Earth's history. To properly utilize Ni isotopes for this purpose, we must first understand and quantify the major processes that fractionate Ni isotopes. Ferromanganese oxyhydroxide minerals likely play an important role in controlling the isotopic composition of Ni in natural waters. These minerals can adsorb/desorb Ni during rock weathering, altering the isotopic composition of the freshwater that will eventually supply Ni to the oceans. Additionally, ferromanganese crusts on the seafloor, one of the few major repositories for dissolved Ni in the oceans, may also impart a Ni fractionation effect. Here we present laboratory experiments to investigate the fractionation effect caused by the adsorption of Ni onto birnessite, a manganese oxyhydroxide mineral. Experiments were run at controlled pH in both low ionic strength solutions (freshwater) and high ionic strength solutions (mock sea water) with varying proportions of dissolved Ni and birnessite. After mixing, each experiment was filtered to separate sorbed Ni from dissolved Ni, and isotope ratios were measured in each fraction using a Nu MC-ICP-MS. Nickel sorbed to birnessite particles was isotopically lighter than the dissolved Ni in both the low and high ionic strength experiments with a Δ60/58Ni value of ~1.4‰ and 2.0 to 4.0‰, respectively. Adsorption of light Ni isotopes to ferromanganese minerals likely contributes to the heavy isotopic composition of rivers compared to average continental rocks (Cameron and Vance 2013). This mechanism appears to be time sensitive, since Δ60/58Ni decreases over time, perhaps suggesting that some adsorbed Ni gets incorporated into the birnessite mineral structure over time (Peacock and Sherman 2007). This could help to explain why natural ferromanganese crusts contain heavy Ni, while the birnessite in our experiments contains light Ni (Gall 2013). Cameron and Vance (2013) Mineralogical Magazine 77, 811 Gall et al. 2013 EPSL, 375, 148 Peacock and Sherman (2007) Chemical Geology 238, 94

Geophysics and Tectonics

Title: Modeling Equilibrium and Bedrock Controlled Geomorphology Using Terrain Analysis
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Presentation: Poster

Abstract: The research described in this this combines field mapping with geographic information system analysis (GIS) of digital elevation models aimed at gaining a better understanding of the timing of events and ages that lead to the development of the tectonic geomorphology preserved in the North Boulder Basin of southwestern Montana. Particular attention was given to the mapping and correlation of remnant pediment surfaces and stream valley knickpoints in an 8 km by 15 km portion of the study area. The bedrock geology consists primarily of uplands containing Mississippian Madison Group to Cretaceous Kootenai formations and Cenozoic Bozeman Basin fill sediments. The boundary between the uplands and basin fill is a recently active normal fault. The GIS analysis revealed three remnant geomorphic surfaces (pediments) that were projected above the current location of the North Boulder River were consistent with base level changes of +25 m, +135 m, and +155 m. The ages o! f pediment surfaces were estimated through a terrain analysis of the amount of material removed by subsequent erosion and dividing the volume removed per unit area by the denudation rates of 43mm/1000yr, 50mm/1000yr, and 100mm/1000yr. Estimates for the ages and development times of the lowest pediment remnant indicate a minimum age of 33.1K years and a maximum age of 2.8M years. The maximum age applicable for the highest pediment surface is 6.2M years based on the timing of the Bozeman Group and minimum age is 2.1 M years. Major knickpoint locations and characteristics were analyzed in relation to the normal fault and exposed bedrock. Knickpoints have larger relief in the Madison Group, Phosphoria, and Quadrant formations as compared to the Six Mile member of the Bozeman Group Basin Fill. The knickpoints with the largest offset are formed proximal to the normal fault. The overall patterns of landscape evolution are consistent with long period of basin fill excavation that has persisted throughout the late Cenozoic with progressively less vertical displacement along the normal fault the separates the Main Basin from the Syncline Basin of North Boulder.

Title: Insights into Subduction Zone Coupling and Strain Partitioning in the Philippine Mobile Belt based on GPS Observations and Deformation Modeling
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Presentation: Poster
Abstract: I present a suite of crustal deformation models for the Philippine Mobile Belt, a seismically active, rapidly deforming plate boundary zone situated along the convergent Philippine Sea/Eurasian plate boundary. These models are based on a newly available suite of GPS data from a dense nationwide network. The Philippine Mobile Belt is represented by 14 independently moving rigid tectonic blocks, separated by active faults and subduction zones. These elastic deforming block models are constrained by observed GPS observations, geologic fault rates, and known fault geometries, which are used to invert for an estimate of block rotations and fault coupling. In these block models, interseismic distortion along faults is introduced using a model of uniform slip along block boundaries, combined with backslip along locked plate boundary segments. I model block interaction using various kinematic approaches: (1) uniform backslip above a (solved-for) locking depth; (2) distribu! ted backslip with laplacian smoothing; or (3) unregularized backslip (no smoothing) using Markov chain Monte Carlo (MCMC) methods. Models that minimize misfit between observed and predicted geodetic velocity vectors are chosen as best-fit, preliminary models, which can then be used to examine the spatial variation of subduction zone coupling along the five active subduction zones surrounding the Philippine plate boundary zone. This is accomplished through dynamic modeling of subduction-zone creeping and locked segments, while solving for the minimum and maximum amounts of moment accumulation on each trench that fits the observed data. These preliminary models of subduction zone coupling provide critical constraints on the potential for large earthquakes and tsunamis along these subduction zones, which can be used to further understand and mitigate the seismic hazard in the Philippines.

Title: Structural evolution of the J-Fold Anticline; A multi-scalar approach to modeling kinematic fold evolution in the Cordilleran fold-thrust belt, southwest Montana

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Presentation: Poster

Abstract: The northeast corner of the London Hills Structural Complex, referred to herein as the Highway 2 structural complex, is located on the southeastern margin of the Helena salient in Gallatin Co., southwestern Montana. The most prominent structural feature in the Highway 2 structural complex is the Late-Cretaceous J-fold, a fault driven, east trending, double hinged anticline plunging to the northeast. The purpose of this study is to produce a model that describes the kinematic evolution and provides insights into the mechanical behavior of the J-fold. This is accomplished by conducting a multifaceted examination of the J-fold using high-resolution terrestrial laser scanning combined with detailed field measurements of kinematic indicators, and laboratory analysis of microstructures in thin section. Geometric analysis of the J-fold suggests that this fold has undergone 2 stages of fault-bend folding to produce the present day geometry. The first stage of Late-Cretaceous thrusting produced initial folding in the J-fold as the hanging wall moved southeastward up to a detachment in the Jurassic Morrison shale. The second stage thrusting drove the addition of a second northern anticline and refolded the existing southern anticline of the J-fold as the hanging wall moved to higher detachment in the Cretaceous Colorado shale. Traditional geologic field mapping coupled with terrestrial laser scanning LiDAR analysis have provided evidence of significant thinning in Permian Phosphoria formation in the southern refolded anticline of the J-fold. Localized pressure solution observed around chert grains in the Phosphoria formation thin sections located in the southern refolded hinge are hypothesized to be a mechanical response to the refolding and responsible for the mass thinning in the formation.

Title: Generalized Iterative Deconvolution of Passive Seismic Array Data
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Presentation: Oral
Abstract: We developed a frequency-domain iterative deconvolution approach, which is demonstrated as the generalization of conventional iterative deconvolution, and applied it to estimate receiver functions from teleseismic earthquakes recorded on passive seismic arrays. Generalized iterative deconvolution improves the resolution of receiver function estimation by using an inverse operator that can be tuned to maximize resolution instead of the conventional cross-correlation operator, which is the major theoretical breakthrough of iterative deconvolution. We also showed that the signal to noise ratio of the result can be improved by applying a different convergence criterion than the standard method, which measures the energy left after each iteration. The efficacy of the approach was evaluated with synthetic experiment in various signal and noise conditions. We further validated the approach with real data from the USArray. We compared our results with data from the EarthSc! ope Automated Receiver Survey and found that our results show a comparable consistency on the distribution of calculated correlation coefficients without even applying any quality control process and results from larger events have overall higher consistency. However, in order to get further improvement in the result, similar selective procedure as the one applied by EarthScope Automated Receiver Survey is required. Our implementation of the generalized iterative deconvolution makes use of parallel computing and is an example of an algorithm that was not computationally feasible only a decade ago. We describe how the algorithm can be further generalized for application to large gathers from multiple sources and/or receivers.

Title: Imaging the Lithosphere under Southern Illinois Basin based on Ozark-Illinois-INdiana-Kentucky (OIINK) Flexible Array Experiment
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Presentation: Poster
Abstract: The OIINK Flexible Array experiment was designed to improve our understanding of the deep structure and tectonic processes of the continental interior of North America. This experiment will ultimately utilize 140 FA stations spanning across the southern Illinois Basin and its adjacent structural units being merged with USArray Transportable Array and broadband data from the New Madrid seismic network. We analyzed local seismicity within the transitional region between Ozark Dome and Illinois Basin. The higher density of stations yields approximately twice the number of events located by the New Madrid seismic network for this region. Earthquakes inside this transitional region are distributed diffusely around the St. Genevieve Fault Zone with predominantly strike-slip focal mechanisms. Teleseismic P-wave travel-time residuals showed a variation of about +1.0 s from west to east across the array. This is approximately consistent with the sediment thickness pattern from existing models for Illinois Basin. However, the delay times derived from those models are not sufficient to account for the full difference. This might be indication of the deep velocity contrast across the boundary between Ozark dome and Illinois Basin. The relative P-wave travel-time data were used in teleseismic travel-time tomography processing. The preliminary result shows a velocity structure of the deep crust and upper mantle that correlates with major structural units. Finally, the receiver function stacks determined from OIINK broadband data indicates that the crust is greater than 40 km thick in much of this region. The crust thickens significantly at the transition between the Illinois Basin and Ozark dome to approach 50 km in eastern Missouri. Furthermore, the pulses used to mark the Moho interface have different widths and amplitudes in Illinois Basin from those in the surrounding areas. Corrections for basin sediments are needed to better define the Moho geometry. Additional work using other wavefield processing methods and the most recent data is in progress.

High Temperature Geochemistry and Petrology

Title: Magma Mingling in the Passadumkeag River Pluton, Maine
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Presentation: Poster

Abstract: The Passadumkeag River pluton is a reverse zoned, Devonian-age granitic pluton located in east-central Maine. The pluton is part of the Bottle Lake Complex, which lies between the towns of Lincoln and Topsfield. Ayuso (1984) divided the pluton into a rim facies (71 to 77 % SiO_2) and an inner core facies (67 to 72 % SiO_2). Along the western margin of the pluton a recent cut has exposed new outcrop not previously available for study. Within the exposure, dark circular enclaves of medium-fine grained diorite (62-63% SiO_2) are randomly dispersed throughout granites with both core and rim compositions. Both field and thin section observations indicate a distinct, non-gradational contact between the enclaves and the host rock. The smaller grain size of the dioritic enclaves also indicates rapid cooling. These observations and the field relations are consistent with the co-mingling of a small amount of hot, dioritic magma with a much larger volume of cooler granitic magma. Recent geochemical analysis has been done to both the enclaves and the host rocks. The results of these analyses show that the enclaves are not genetically related to the host granites or the wall rock around the pluton. This data, combined with geothermometer and geobarometer calculations, indicates that these enclaves are representative of a foreign magma that was injected into the pluton.

Title: Characterization of the hybrid source rock/ reservoir Second White Specks and Belle Fourche Formations

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Presentation: Oral

Abstract: This study presents approaches for evaluating hybrid source rock/reservoirs within tight-rock petroleum systems. The emerging hybrid source rock/reservoir shale play in the Upper Cretaceous Second White Specks and Belle Fourche formations in central Alberta, Canada is used as an example to evaluate organic and inorganic compositions and their relationships to pore characteristics. Nineteen samples from a 77.5 m-long core were analyzed using organic petrography, organic geochemistry, several methods of pore characterization, and X-ray powder diffraction (XRD). The lower part of the studied section includes quartz- and clay-rich mudrocks of the Belle Fourche Formation with low carbonate content, whereas the upper portion contains calcareous mudrocks of the Second White Specks Formation. Strata are mineralogically composed of quartz plus albite (18-56 wt. %), carbonates (calcite, dolomite, ankerite; 1-65 wt. %), clays (illite, kaolinite, chlorite; 15-46 wt. %), and pyrite (2-12 wt. %). Petrographic examinations document that organic matter represents marine Type II kerogen partly biodegraded with limited terrestrial input. Vitrinite reflectance Ro (0.74-0.87 %), Tmax values (438-446 °C) and biomarkers indicate mid-maturity within the oil window. The relatively poor remaining hydrocarbon potential, expressed as an S2 value between 2.1 and 6.5 mg HC/g rock, may result from an estimated 60-83 % of the original kerogen having been converted to hydrocarbons, with the bulk having migrated to adjacent sandstone reservoirs. However, the present-day remaining total organic carbon TOCpd content remains relatively high (1.7-3.6 wt. %), compared with the estimated original TOCo of 2.4-5.0 wt. %. The calculated transformation ratio of 60-83 % suggests that the remaining 17 to 40 wt. % of kerogen are able to generate more hydrocarbons. The studied section is a tight reservoir with an average Swanson permeability of 3.37•10-5 mD (measured on two samples) and! total porosity between 1.7 and 5.0 vol. % (3 vol. % on average). The upper part of the sandy Belle Fourche Formation, with slightly elevated porosity values (3.5-5 vol. %), likely represents the interval with the best reservoir properties in the studied core interval. Total pore volume ranges between 0.0065 and 0.0200 cm3/g (measured by a combination of helium pycnometry and mercury immersion). Mesopores (2-50 nm ∅) are the most abundant pores and occupy 34 to 67 % of total porosity or a volume of 0.0030-0.0081 cm^3/g. In comparison, micropores (<2 nm ∅) cover a wide range from 6 to 60 % (volume 0.0007-0.0053 cm3/g), and macropores (> 50 nm ∅) reach up to 57 % with the exception of some samples failing to indicate the presence of this pore fraction (volume 0.0000-0.0107 cm^3/g). Macroporosity is mostly responsible for variations in total porosity, as suggested by macroporosity's strongest correlation with total porosity within the section. The relatively narrow ranges of TOC and minerals contents among measured samples limit our ability to further deconvolute factors that influence changes in total porosity and pore size distribution.

Title: P-T-time paths in East-Central Maine: Insights from thermochronology and geobarometry of Devonian plutons and their metamorphic host rocks

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Pursuing Degree: PhD

Presentation: Oral

Abstract: 40Ar/39Ar step-heating experiments conducted on hornblende (Hbl), biotite (Bt), K-feldspar (Kfs), and muscovite (Ms) from Devonian plutons east and west of the Central Maine Boundary fault (CMBF) support cooling from the Acadian orogeny. These data combined with published zircon U/Pb and whole-rock Rb/Sr ages for the plutons and new Al in Hbl barometer data constrain estimates for the P-T-t paths for both the igneous and the lower greenschist facies metamorphic host rocks. The Al in Hbl barometer yields ~3.5-3.8 kbar average estimates for the pressure of emplacement of plutons, consistent with depths of ~10-11 km. The middle Silurian – early Devonian formations in the area were regionally metamorphosed to lower greenschist facies by ~410 Ma and stayed below the closure temperature (Tc) of Ar in Ms (~350°C) as evidenced from 40Ar/39Ar ages of multiple populations of Ms. This implies a geothermal gradient < 35 ºC/km, and a loading rate of no greater than 0.5-2 mm/yr. Crystallization temperatures of ~750°C from the dated granitoids along with Hbl, Ms, and Bt cooling ages (TC ~500°C, 350°C, 300°C respectively), constrain estimates of the cooling rate of the plutons toward the ambient temperature of the country rocks. Cooling ages of Hbl are younger than the crystallization ages by 12-15 Ma implying a cooling rate of ~17-21°C/Ma. West of the CMBF Hbl, Ms and Bt cooling ages overlap at ~390 Ma, whereas east of the fault, Bt cooling ages of ~360 Ma are ~5 Ma younger than Hbl cooling ages. The relatively rapid cooling of the western plutons could be due to their smaller sizes. Cooling from ~300°C to the TC of argon in Kfs is slower in plutons west of the fault, at a rate of 1.3 °C/Ma compared to 2.7°C/Ma for plutons to the east. This comparison suggests tectonically induced cooling of the plutons east of the CMBF, which supports east-side-up movement along the fault. The Kfs cooling ages from rocks across the fault indicate similar cooling curves from the early Carboniferous through the Triassic. The net cooling rate through the Triassic of ~1.1ºC/Ma is consistent with an exhumation rate of 0.03 mm/yr. These results along with the ~410-385 Ma ages of Acadian cleavages indicate that peak loading in east-central Maine ended by the Late Devonian, consistent with regional trends established in western Maine.

Atmospheric, Environmental Geology, and Hydrology

Title: Metals analysis at a sulfate-reducing bioreactor in Pike County, Indiana **Authors:** Aaron Baer (acbaer@indiana.edu)
Institution: Department of Geological Sciences, Indiana University, Bloomington, IN, USA
Pursuing Degree: Undergraduate
Presentation: Poster

Abstract: Sulfate reducing bioreactor cells (SRBC) are an emerging technology for remediation of acid mine drainage (AMD). AMD is created when pyrite and other sulfides present in coal oxidize in contact with oxygen and water. The water seeping from mine refuse piles is thus concentrated in sulfuric acid and dissolved metals. The SRBC at the Blackfoot site in Pike County, Indiana, is designed to promote biological reduction of sulfate to sulfide, which incorporates heavy metals as it precipitates, and to generate alkalinity by dissolution of limestone. This is the first study to measure metal concentrations at the Blackfoot site. Analysis of metal concentrations can be useful for assessing the performance of the SRBC. Water samples have been collected from ports throughout the bioreactor and from the inflow, outflow, and downstream near where the outflow joins a tributary of the Patoka River. Samples have been collected since February, 2011, as part of a larger Indiana Geological Survey monitoring effort, and analyzed for trace metal concentrations by ICP-MS. The Blackfoot bioreactor has proven to be highly effective for metal precipitation. Preliminary results show several toxic metals are above EPA limits at the inflow, but all are at acceptable levels at the outflow. However, higher concentrations are measured at the downstream station and are likely caused by mixing with untreated water. A sequential leaching procedure was applied to solids from the SRBC in an effort to constrain metal removal mechanisms by determining speciation and host phases for metals, especially for those elements that do not readily co-precipitate with Fe sulfides. A procedure adapted from that of Tessier et al., (1978) was used initially but extremely high concentrations of Fe and organic matter in the samples led to compromised results. A modified leaching procedure is in preparation.

Title: Potential Triggers for Algal Growth and Metabolites Production in Eagle Creek Reservoir, Central Indiana

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Presentation: Poster

Abstract: Cyanobacteria (blue-green algae) cause a multitude of water-quality concerns, including the potential to produce toxins and taste-and-odor (T&O) compounds. These algal metabolites (toxins and T&O compounds) may cause significant economic and public health concerns, and are of particular interest in lakes, reservoirs, and rivers that are used for drinking-water supply, recreation, or aquaculture. Many cyanobacteria produce intracellular and extracellular metabolites, such as the potent cyanotoxins microcystins and odorous compounds (e.g., 2-methylisoborneol (MIB), trans-1,10-dimethyl-trans-9-decalol (geosmin)) that impact water supplies in reservoirs, rivers, canals, and even within water treatment plants. Geosmin and MIB have extremely low odor thresholds to humans and can be detected by consumers at concentrations as low as 5–10 ng/L (or ppt, part per trillion). Aesthetics are the primary criteria that determine consumer confidence in the safety of a water supp! ly for water industries. These metabolites, particularly in dissolved (extracellular) forms, have been shown to be resistant to conventional water treatment. The presence of odorous metabolites in the finished water can be a source of numerous complaints by consumers. However, contrary to cyanotoxins, T&O compounds found in water have no known adverse effects on human health. Investigations focused on Eagle Creek Reservoir (Central Indiana) where water samples were collected biweekly at three different locations in the reservoir to characterize the seasonal variability. Descriptive statistics and the Spearman's rho coefficient were utilized to determine correlations between environmental variables, algal communities and their metabolites. Pelagic cyanobacteria were found at all sampling stations of the reservoir throughout the sampling period from April to October, every year (2009-2013), with highest densities during the summer periods. Statistical analyses revealed that cyanobacteria were negatively correlated with the reservoir water level ($p<0.05$) whereas algal metabolite occurrences were correlated to high discharge periods (MIB, $p<0.01$; geosmin, $p<0.05$), strong winds (geosmin, $p<0.05$) and cool water temperatures (MIB, $p<0.001$; Geosmin, $p<0.001$; microcystin, $p<0.01$), corresponding to spring conditions. Two cyanobacterial species, Pseudana baena limnetica and Planktothrix agardhii, were identified and found dominant in the reservoir water under these conditions. Characterization of the temporal variability among environmental samples was carried out by applying Canonical Component Analysis (CCA). This multivariate analysis explained 77.71% of the total variance of the dataset and isolated important environmental factors (low light penetration, high turbidity, low temperature, mixed water column and high Total Phosphorus concentrations) as favorable for the growth of P. limnetica and P. agardhii. This latter was strongly correlated with geosmin ($p<0.001$) and microcystin ($p<0.001$) occurrences. High algal metabolite concentrations were also found while other algal groups (Diatoms, Cryptophytes, Euglenophytes and Dinoflagellates) densities were elevated in the water, thus suggesting a possible allelopathic effect.

Title: Analyses of intense and extreme wind speeds over the eastern United States
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Pursuing Degree: Undergraduate
Presentation: Poster
Abstract: Intense and extreme wind events present a major risk to energy and transportation infrastructure and thus to socio-economic sectors such as the reinsurance industry. The overarching objective of the research presented herein is to improve understanding of the causes and scales of intense and extreme wind speeds over the eastern United States of America. Major research findings are: (i) Based on analysis of hourly wind speed data for 1973-2000 from 85 stations we show high wind speed events in the eastern USA are coherent over distances of up to 1000 km, and exhibit largest 'footprints' during the cold season. (ii) Cold fronts are a major cause of high wind speed events. Analyses of mean wind speeds and gust magnitudes during cold front passages indicate: • Although sustained and gust wind speeds do tend to increase with frontal intensity (temperature gradient across the front), the relationship is not statistically significant. • Periods with high 5-second gusts (> 10 m/s) can extend up to 18 hours in duration. • Gust factors (ratio of gust magnitude to 10 minute sustained wind speed) exhibit a non-linear relationship with sustain wind speed. The mean gust factor over the eastern USA is 1.57, which is in good agreement with prior research on extra-tropical cyclone gust factors. (iii) Wind loading leads to the vibration of human structures that can be measured using seismometers. Thus we examine the degree to which seismic data from the EarthScope Transportable Array (TA) seismic network can be used to detect and measure wind gusts, and demonstrate that seismic data from TA exhibit well-defined spectral signatures associated with wind gusts.

Title: A Wind Atlas for the Great Lakes from Satellite and In Situ
Author: Paula Doubrawa (pdoubraw@indiana.edu)
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Pursuing Degree: PhD
Presentation: Poster
Abstract: According to the US Environmental Protection Agency, the Great Lakes are the largest surface freshwater system on earth and the Basin has a population of 33 million. The Great Lakes are potential locations for large offshore wind farms because of their expected wind resource, because they are close to large load centers and some areas have moderate water depths. However, offshore wind resources over the Great Lakes are difficult to quantify accurately due the spatial sparseness of offshore observations, the formation of ice during winter months, and the temporal and spatial variability of satellite imagery available for wind field retrieval. This study combines measured wind data from coastal land stations, buoys, QuikSCAT and SAR-derived wind fields to estimate the wind resource of the Great Lakes through the generation of wind atlases. The objective is to capture the long-term variability of the wind resource using long-term coastal and buoy data sets but to combine this with the spatial coverage from satellite wind retrieval. The technique is based on the wind atlas methodology for satellite-derived wind speeds that has been used successfully in other regions. The results presented here refer to the first part of the study, where observations from 20 buoys and 70 coastal sites are used and the results are presented in the Wind Atlas format. A major challenge is to provide both spatial and temporal variability of the wind resource for the Great Lakes. Each available data set has both advantages and disadvantages e.g. the long-term wind speed datasets at coastal sites are for relatively low heights and represent coastal conditions. The buoy data capture offshore conditions but are not available during the ice season. The satellite-derived wind speeds provide excellent spatial coverage in some, but not all regions, and are temporally limited and sometimes sparse. By combining the data sets with the WAsP model, a Wind Atlas for the Great Lakes is being produced that can address some of the data gaps and quantify the wind resource. Because the Great Lakes system is a high-latitude fresh water system it is subject to extensive winter ice cover. Aside from the technical challenges for wind energy development, it also represents a challenge for resource assessment. Here, the buoy time series were corrected based on the Method of Ratios using coastal sites and reanalysis data as a reference. The success of the technique depends to some extent on how robust the relationships are between the reference/target site wind speeds. Previous studies of the Great Lakes wind resource have mainly been based on modeling due to the difficulties of quantifying the resource from remote and ground-based data sets that are temporally and/or spatially limited. For this presentation, we will focus on Lake Erie and present our approach, results, and the comparison with SAR-derived winds. The next and final step is to incorporate the satellite data into the resource maps, in order to reduce biases that are brought on by the spatial sparseness of in situ observations.

Title: Relationship between Pb in urban soils and demographic characteristics to predict exposure risks in Terre Haute, Indiana

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Presentation: Poster

Abstract: Older cities around the world continue to suffer from legacy environmental issues related to their long history of industry and manufacturing, extensive road and rail networks, and historic neighborhoods containing multiple pre-1940 homes that have led to high rates of childhood lead (Pb) poisoning in urban centers. Terre Haute, Indiana is no different. The improper removal and deterioration of Pb based paints on homes as well as Pb solder used in gutters appear to be significant sources of Pb in homes and soils. The purpose of the study is to understand the spatial distribution of Pb across Terre Haute, IN, and predict areas at higher risk for childhood Pb poisoning based on demographic characteristics. Surface soil samples were collected from city owned properties (i.e. parks, cemeteries, and redevelopment lots), Indiana State University land holdings, residential properties, and community gardens. Samples were dried, crushed, and analyzed with a handheld XRF and ICP-OES. Attached to each sample is corresponding grid coordinates that allow the use of multiple-indicator kriging to create a continuous soil Pb map. Pb concentrations indicate that the highest concentrations are found near the dripline of homes in historic neighborhoods. Within each census block, the highest Pb concentration was used to estimate the potential for Pb exposure and compared directly with census data. OLS regression models indicate a statistically significant correlation between high concentrations of Pb and a high percentage of vacant homes. In addition, specific census blocks and neighborhoods have been identified as having a high risk of potential exposure.

Title: Shale Gas Production and Methane Migration to Appalachian Basin Aquifers
Author: Poonam Giri (pgiri@indiana.edu)
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Pursuing Degree: PhD
Presentation: Oral
Abstract: The majority of public apprehension regarding natural gas development is directed at the fracing process. Among concerns is the possibility of drinking water contamination. Numerous accounts of stray methane migration and breakthrough at the surface have been reported in PA and WV, while methane concentrations above the DEP Action Level have been reported in the near-well shallow groundwater supplies. It has been argued that shale gas drilling is the underlying cause, yet the mechanism responsible remains under debate. Outstanding questions include the origin of stray methane gas and its pathway to the aquifer. This research, funded by the U.S. Department of Energy, seeks to understand some of the basic hydrologic criteria necessary for transport and accumulation of methane within shallow, fractured aquifers. We propose that trapped pressurized-air from the drilling process may exert enough of a pressure differential to liberate naturally exsolving methane from fracture walls and mobilize it (Soeder, 2012). Recognizing the hydrologic conditions that will permit such migration within fracture networks is critical in developing this model. Specifically, it is necessary to understand how methane adheres to fracture walls and quantify the surge required to liberate adhering methane. To investigate the minimum flow rate required to liberate and entrain methane gas in a fracture, laboratory studies were conducted at the National Energy Technology Lab. Computed Topography (CT) scanning was performed on a fractured Berea Sandstone core containing brine and methane gas, under varying volumetric flow rates. The geometry of the fracture was characterized using a NETL FreeMat code on the scan data (assuming a Gaussian distribution of aperture widths) prior to a series of experimental runs under three pre-selected flow rates. Experimental results were analyzed using ImageJ to determine the distribution of gas along the fracture walls and the volumetric loss of methane corresponding to each flow rate. The results demonstrate that sudden flows, or “surges”, do enable the entrainment and transport of methane within a fractured rock, making the proposed model a viable mechanism for methane migration to shallow, Appalachian Basin aquifers.

Title: TRACKING EUTROPHICATION THROUGH A CHAIN OF LAKES IN AGRICULTURAL INDIANA

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Presentation: Poster

Abstract: Chain O' Lakes State Park, located in northern Indiana, consists of nine interconnected lakes and four satellite lakes, with depths that range from 1-20 m. Chain O' Lakes State Park is bordered by farmland in the northeast and southwest corners, and a correctional facility in the eastern-most section of the park. Park managers have reported increasing cyanobacteria blooms throughout last decade, which has resulted in periodic closure of recreational facilities. Some additional nutrient loading may be coming from leaks in the on-site sewage treatment plant associated with the corrections facility. Park managers are concerned about the impact on the lake ecosystems and tourism to the park. In the 2013, we collected plankton from the lakes, along with sediment cores from the interconnected lakes for diatom analysis. Modern plankton samples show the present flora is dominated by diatom species indicating elevated nutrient levels. Species indicative of higher phosphorus levels tended to be greatest in the eastern lakes, decreasing through the chain westward. Analysis of sediment cores has shown that increased nutrients have only occurred in recent sediments, suggesting anthropogenic sources. Our project is designed to explore the impact of eutrophication through a chain of interconnected lakes, and the impacts of development and agriculture on the system of lakes over the last two centuries. We will be analyzing diatom assemblages from short cores from each lake in the system. One long core will be taken from Long Lake in order to establish a long-term baseline nutrient level for the lake systems. We intend to compare the timing of eutrophication within individual systems to explore the influence of lake hierarchy on nutrient cycling in a flow-through system. We will also attempt to track nutrients through the interconnect lake system to determine if the corrections facility is a point source for contamination.

Title: A simple model for the prediction of oxygen-18 values in atmospheric nitrate: Understanding the causes of nitrate oxygen-18 shifts at Tucson, AZ
Author: David Mase (dmase@purdue.edu)
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Presentation: Oral
Abstract: The oxidation of nitrogen oxides (NOx) to nitrate in the atmosphere can affect the production and loss of several important chemical compounds, and impact climate. A number of studies have used stable isotopes to understand the sources of NOx and chemical mechanisms that transform it into nitrate. Elevated and variable oxygen-18 values in atmospheric nitrate have been reported in a number of papers, but without any quantitative interpretation as to what chemical or physical processes within the NOx cycle cause them. A photochemical box model, ISO-RACM, has been developed for the quantitative prediction of oxygen-18 values in atmospheric nitrate. This modeling study is focused on the Tucson, AZ region where aerosol samples have been collected and analyzed for nitrate oxygen-18 values. Model predictions with a fixed ozone oxygen-18 value reproduce aerosol observations within 3% on average, with the highest accuracy during the winter months and lowest during the summer months. For Tucson, the model results suggest a strong influx of volatile organic compounds (VOC) in the summer from biogenic sources due to both increased precipitation during the monsoon season and increased heat stress on desert plants. Increased VOC leads to higher production of peroxy radicals (and subsequent formation of NO2 through peroxy radical reaction pathways), driving isotope values down in the summer months. BVOC emissions are not as prevalent in the winter months and O3 is the dominant oxidant, which leads to high nitrate oxygen-18 values during the winter months. As the first model of its kind, ISO-RACM represents an important first step for future development of oxygen-18 models and improved understanding of stable isotope shifts in a variety of environments.

Title: Long-term deeper snow causes changes in plant chemistry and litter quality in moist acidic tundra in Northern Alaska

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Presentation: Oral

Abstract: Tundra ecosystems store over one third of the global terrestrial organic C pool and have the potential to release large amounts of CO2 as organic matter decomposition rates are expected to increase with warming climate. A warming climate and soil thermal insulation from increased snow pack is expected to shift dominant vegetative cover type affecting above and below ground litter quality and soil organic matter storage in soils. These changes can affect the magnitude and even direction of soil C storage in the Arctic tundra. At a eighteen-year snow fence experiment at Toolik Lake, Alaska, we investigated relationships between shifting dominance of plant species, changes in plant chemistry, and impacts to soils using a multi-proxy biomarker approach in plants and soils from experimental zones of deep, intermediate, and low snow accumulation. Analyses focus on first identifying changes in plant chemistry across the snow zones and will be used to track and relate changes in soil chemistry later. Preliminary data shows leaf, stem and root tissue C/N ratio decreasing in the deep snow zone, driven by the increase in plant N content. We also observed changes in the allocation of nutrients to carbohydrate versus amino acid production in stem and root tissue with respective evidence of these changes in soil chemistry. These results demonstrate litter quality amendments in response to snow pack thermal insulation that could influence accumulation versus decay rates and the chemical nature of soil carbon under warming climate conditions with deeper snow in winter.

Title: Spatial coherence of aerosol particle properties observed from satellites
Author: Ryan Sullivan (sullivrc@indiana.edu)
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Pursuing Degree: M.S.
Presentation: Oral
Abstract: Atmospheric aerosol particles pose a significant threat to public health and are responsible for both direct and indirect climate forcing. Due to limited direct in situ observations, the radiative forcing from particles is a major source of uncertainty in understanding climate change and climate modeling. Satellite observations provide measurements over a large, nearly continuous spatial domain, and can prove to be critical tool to fill in the observational data void. Measurements of daily aerosol optical depth (AOD) and Angstrom Exponent (Å, which is related to particle size) over the Eastern U.S. during 2000-2013 from the MODerate resolution Imaging Spectroradiometer (MODIS) instruments aboard the Terra and Aqua satellites are used here to: (i) Develop an annual and seasonal mean climatology of total column particle loading. (ii) Examine the spatial (and temporal) scales of variability in order to diagnose controls on these climate relevant properties. AOD is highest over eastern North America during summer (reflecting highest aerosol loading during that season), and there is a clear pattern in the lag+1 correlation indicating particle advection from the Midwest into the Eastern U.S. AOD is coherent on spatial scales of up to 2200 km during summer indicating very strong climate forcing (net surface cooling) during that season, but is lower during winter and spring. Å values exhibit a more anisotropic spatial field over the eastern North America with scales of spatial autocorrelation varying between season and the two satellites. Wavelet analysis of time series of these properties indicate AOD variability is focused on synoptic and annual time scales, whereas Å exhibits variability on synoptic, semiannual, and annual scales, likely linked to changes in particle and precursor emissions, and the influence of temperature and humidity on atmospheric chemical processes.

Title: Natural and Anthropogenic Impacts on the Stable Isotopes of Oxygen of Ice Core NO3-
Author: Wendell Walters (waltersw@purdue.edu)
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Presentation: Oral
Abstract: The stable isotopes of nitrogen and oxygen of the Ross Ice Drainage System (RIDS) ice-core nitrate were measured in approximately 2-3 year time resolution using a Delta V Isotope Ratio Mass Spectrometer (IRMS). The nitrogen isotope variation (δ15N) and the mass-independent fractionation of oxygen ($\Delta 17O = \delta 17O - 0.52*\delta 18O$) yield a detailed picture of the changes in the global nitrogen cycling and the shift in the oxidation capacity of the atmosphere in response to natural and anthropogenic induced climate change. This is one of the few studies on stable isotopes of ice-core nitrate for time periods prior to the 1800's and will increase our understanding of the oxidation feedbacks of the atmosphere in response to volcanic events, the Little Ice Age, the Maunder Minimum, and anthropogenic emissions in the Southern Hemisphere.

Title: An Examination of the Relationship Between Foraminiferal Test Pore Characteristics and Dissolved Oxygen Availability: A New Proxy for Bottom-Water Oxygen
Author: Jake Willingham (jakewillingham789@gmail.com)
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Pursuing Degree: M.S.
Presentation: Poster
Abstract: A relationship between foraminiferal test morphology and ambient oxygen availability has been noted by a number of studies (Glock et al., 2011; Kuhnt et al., 2013). In attempt to quantify this relationship between ambient oxygen availability and foraminiferal test pore characteristics, percentage and number of surface pores of 97 specimens of Cibicidoides wuellerstorfi and related taxa were examined from a variety of habitats along an oxygen gradient (0.04 – 6.20 ml/l). Using ArcGIS and high-resolution SEM images of living (Rose Bengal stained) specimens of Cibicidoides, percentages and number of pores on the tests were quantified. Surface pore percentage (SPORE) analyses of a standardized subset of penultimate and antepenultimate chambers plotted verses ambient bottom-water oxygen concentration yielded a negative correlation with an R2 value of 0.7291, $p < 0.001$. This SPORE method provides an efficient means to assess ancient bottom-water oxygen concentrations f! rom epifaunal Cibicidoides.

Title: Quantifying the Influence of Irrigated Agriculture on Atmospheric Heat Content and Boundary Layer Dynamics
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Presentation: Oral
Abstract: The effects of irrigated agriculture on the overlying atmosphere are assessed during the growing season using equivalent potential temperature (θe) and potential evapotranspiration (ETo), since these are better metrics for quantifying total atmospheric heat content near the surface than temperature alone. These are calculated from data collected at adjacent surface stations near and away from the influence of irrigation. Satellite-derived surface albedo and emissivity are used to quantify the differences in net radiation at the surface between adjacent irrigated and non-irrigated landscapes. These data are compared to θe and ETo in a spectrum of climates across the United States to quantify impacts of irrigation in each regime. The results indicate the effects depend on both the climate and surrounding land cover. For arid regions, like the Desert Southwest, net radiation and θe are higher over irrigation, while ETo and temperature are lower. However, in some cases θe and net radiation are lower because of a large increase in emissivity, despite a large reduction in albedo and associated enhanced solar heating. Latent heat exchange (LE) and associated lower temperatures over irrigation are found to be greatest in this region because of the commonly dry air. In the Great Plains, lower albedo and its forcing on net radiation exceeds the increase in emissivity, which associate with observed higher θe and lower ETo. Conversely, temperature data reflect cooling, which are a result of increased LE over irrigation, despite the climate being more humid than the Southwest. In the mid-Mississippi River Valley, a small increase in albedo and decrease in emissivity result in a small increase in net radiation. However, the increase in θe and decrease in ETo far exceed what the change in net radiation suggests. It is surmised that the long (400-600km) fetch over irrigation in the region leads to thermal loading of the atmosphere. Temperatures are higher, likely a result of increased θe ov! ercoming limited LE in the region's humid climate. Effects on the boundary layer dynamics are rooted in the aforementioned changes in net radiation and heat fluxes. LE reduces surface temperatures, and thus, convection over irrigation, despite increased humidity. However, differential heating of the patchwork of natural land surfaces and adjacent irrigated agriculture result in convergent boundaries, a focus for convection over adjacent non-irrigated areas.

Title: Numerical simulation of geochemical reactions involving fixated flue-gas desulfurization scrubber sludge and groundwater occurring at coal mine reclamation sites
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Presentation: Oral
Abstract: Resuse of the coal combustion byproducts are of great importance in the effort to make coal power more sustainable. In 2009, there were over 125 million tons of FGD materials and other coal-combustion by-products (CCBs) generated in the US, while only 44% of the waste materials were being beneficially used. Flue-gas desulfurization sludge (FGD) is a common by-product from coal-fired power plants which employ oxygen-inhibited stack gas scrubber to lower SO2 emission. When combining with fly ash, and lime, it become a material called fixated scrubber sludge (FSS), which is cementitious with moderate alkalinity. The low permeability and moderate alkalinity of such engineered materials make them potentially useful as structural filling and capping materials in abandoned mine land settings. Although there are laboratory experiments and monitoring studies of CCBs, they are not sufficient to address the long-term issues of how using engineered CCBs would affect groundwate! r quality. This study uses data collected from the Midwestern AML site in southwestern Indiana, which was reclaimed using fixated scrubber sludge (FSS) cap over pyritic refuse. Numerical simulations of reactive flow and transport modeling were conducted using TOUGHREACT to evaluate the overall efficiency of FSS under two contrasting environments over 100 years (ambient groundwater vs anoxic mine water). Preliminary results indicate that FSS can buffer acidic mine drainage by generating moderate alkalinity. Primary minerals are dissolved, especially when the FSS is in constant contact with acidic mine water. Hannebachite gets oxidized to gypsum, with a faster rate under ambient groundwater flow. Secondary clay minerals (e.g. kaolinite), hydroxides (e.g. gibbsite) and amorphous silica precipitation have been observed. The formation of secondary minerals also provides a possible removal mechanism to adsorb existing trace elements by surface complexation.