2025 CROSSROADS CONFERENCE

EARTH AND ATMOSPHERIC SCIENCES

Crossroads Conference 2025

Indiana University
Earth and Atmospheric Sciences
1001 East 10th Street
Bloomington IN 47405
earth.indiana.edu
sigmagamma.so.indiana.edu

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WELCOME!

We would like to extend a special thank you to all of those participating in the 23rd annual Crossroads Conference at Indiana University. This conference is a rich tradition for the Department of Earth and Atmospheric Sciences and we anticipate that this year's presentations will uphold previous standards of excellence.

We are excited to incorporate our sixth annual career fair and we want to thank all the individuals and companies that are participating.

Finally, we want to thank our judges, career panelists, the Department of Earth and Atmospheric Sciences at Indiana University, and all of those who have volunteered their time for the preparation and execution of Crossroads 2025

- The Crossroads Committee and members of the Rho chapter of Sigma Gamma Epsilon

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Beth Hall..... Purdue/MRCC/IN State Climate Office

Ryan Kammer ..... Great Plains Institute

Stuart Kenderes..... IU Indianapolis

Yuri Kim ..... IUB Geography

Ben Macuga ..... Michael Baker International

Garrett Marietta..... IGWS

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Matt Griles, Jessica Towell..... Arcadis

Sarah Pietraszek Mattner ..... The Science Profession

CAREER FAIR REPRESENTATIVES

Chris Canfield ..... Colorado DNR

Stan Carpenter ..... Colonial Pipeline Company

Kristi Cox, Christina Spielbauer ... IN DNR, Division of Water

Ginger Davis, Todd Thompson ... IGWS, LPG Representative

Rob Duncan..... Atlas Technical Consultants, Inc.

Ryan Kammer ..... Great Plains Institute

Madeline Kelly ..... U.S. Aggregates

Elizabeth Wallace..... VET Environmental Engineering, LLC

Ben Macuga ..... Michael Baker International

Lauren Nims..... Heritage Construction and Materials

Sydney Olund, Cameron Stewart ..... Arcadis
Jessica Towell, Matt Griles ..... Arcadis

Sarah Pietraszek Mattner ..... The Science Profession

McKailey Sabaj..... Association of Women Geoscientists

John Welch, Taylor Taggart..... IDEM
Indiana Department of Environmental Management

IGWS 2022
11:30 am - 1:00 pm

Dr. Chris Canfield

Environmental Protection Specialist,
Colorado Energy and Carbon Management
Commssion Colorado Department of
Natural Resources (retired)

KEYNOTE SPEAKER

IGWS ROOM 2022

Thank you for inviting me to speak at this year's Crossroads Conference, I truly appreciate the opportunity. I have been involved with the Department's Alumni Advisory Board for several years. During that time, fellow board members, two of whom who are here, have told about this conference and urged me to attend. Unfortunately, until now, work-related conflicts prevented me from coming.

When Alec invited me to speak with you, he stressed that the evolution of my career, which has involved working in the energy industry, consulting on environmental site investigations and remediation, and ultimately working as a regulator with the Colorado Energy and Carbon Management Commission, might be of interest to you.

Based on my experience, I am comfortable predicting that life will not be what you expect it to be and it will include more versions of yourself than you might think to be possible.

My career in geology started here in Bloomington, in the mid 1970's. At that time, a master's degree was the terminal degree for most of the geology students. And, a majority of those students went to work in the energy industry. I certainly fit that profile. For 13 years, I would work in a variety of exploration and production roles, first in western Wyoming, then the San Juan Basin, and ultimately Texas State Waters. For most of that time, commodity prices were rising, or at least steady. As I would learn, my career opportunities would be correlative with commodity prices.

In 1990, I did a hard reset of my career and returned to graduate school at the Colorado School of Mines for a non-thesis master's in hydrology. Upon completing that program, I would spend the next 16 years leading environmental investigations and corrective measures studies under the Resource Conservation and Recovery Act (RCRA) at petroleum refineries, both active and closed refineries, in Montana, Wyoming, Colorado, and Louisiana. RCRA is now most widely known for establishing standards for the treatment, storage, and disposal of hazardous waste. But 35 years ago, a large number of industrial facilities (1714 facilities to be exact, 205 of which were active refineries) were undergoing environmental investigations, risk assessments, and corrective measures studies. Hence my strategic decision to target refineries instead of gas stations.

The business of implementing RCRA had significantly matured by the early 2000's and as a result, it was again time to reset my career. In 2006, I went to work for the Colorado Department of Natural Resources, specifically, the Colorado Oil and Gas Conservation Commission (COGCC). Working at that agency was my favorite career experience because combined all of my academic and professional experience in a manner that I had not previously experienced. I had the good fortune of being involved in historical changes culminating in changing the mission of the agency and rebranding it as the Colorado Energy and Carbon Management Commission (ECMC).

So, as I think back about a career spanning nearly 50 years, I am as I said before, comfortable predicting that life will not be what you expect it to be and it will include more versions of yourself than you might think to be possible.

SCHEDULE

FRIDAY April 4

MORNING

7:30-8:30..... breakfast + registration | PATTON ROOM IGWS 2022

8:30-8:45..... welcome + Keynote address | PATTON ROOM IGWS 2022

8:45-10:00..... oral session 1 | GY 2049

10:00-11:30..... poster session 1 | PATTON ROOM IGWS 2022 + GY 2029

11:30-1:00..... career fair | PATTON ROOM IGWS 2022

11:30-1:00..... lunch | GY 2049

AFTERNOON

1:15-2:00..... break - your choice

2:00-3:00..... oral session 2 | GY 2049

3:30-5:00..... poster session 2 | PATTON ROOM IGWS 2022 + GY 2029

5:00-6:30..... judges' meeting | PATTON ROOM IGWS 2022

5:00-6:30..... break - your choice

EVENING

7:00-9:00..... networking mixer and awards ceremony

Upland Brewing
350 W. 11th Street
Bloomington, IN 47404

SATURDAY April 5

MORNING

9:00-11:00..... Career Development workshop | GY 2029

Sarah Pietraszek Mattner + Chris Canfield

ORAL SESSIONS

GY 2049

Session 1 Presenters (8:45-10:00 am)

8:45 am Sristika Adhikari
9:00 am Alec Siurek
9:15 am Trenton Meier
9:30 am Shanta Banstola

Session 2 Presenters (2:00-3:00 pm)

2:00 pm Eli VanDyke
2:15 pm Ye Jing
2:30 pm Isabelle Caban

ORAL SESSION 1

GY 2049

SRISTIKA ADHIKARI
Indiana State University
PhD Student, Environmental Science

A 2,048-Year Paleolimnological Study of the Common Era Based on the Diatoms and Sediment Chemistry from the Central Basin of Lake Tanganyika

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Indiana State University
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University of Kentucky
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University of Minnesota

Abstract: A 2,048-year fossil diatom and sediment records from Lake Tanganyika (eastern Africa) provides paleo-limnological information from 122 BCE to 1926 CE, which is important to study the nutrient dynamics of the lake in the Late Holocene. There is a knowledge gap in what diatoms can talk about the paleoecology for the common era for Lake Tanganyika. Diatom assemblages from the 109-cm-long sediment record were dominated by valves of *Nitzschia lacustris*, a planktonic and lightly silicified diatom, which suggests that the lake has been oligotrophic for most of this time span. However, *Aulacoseira* spp. blooming from 250 to 650 CE and their higher abundances from ~ 320 to 550 CE, indicates a higher concentration of bioavailable silica and continuous turbulence in the water column. The Si recharge during this interval mainly came from the inflowing streams indicating higher rainfall events. Thus, nutrient input from the runoffs as well as upwelling, both are important for regulating nutrition distribution and diatom productivity. Diatom assemblage mostly dominated by the planktonic, needle shaped, elongated *Nitzschia lacustris* and declining diatom concentration towards the end of the record implies less frequent mixing and low nutrient distribution in the epilimnion. In the predicted scenario of the climate warming, diatom concentration will further decline due to the rise in lake surface temperature and extended stratification periods. This will have severe impact on the livelihood of the fishery dependent people living in the periphery of Lake Tanganyika.the cooling of the magma chamber.

ALEC SIUREK
Indiana University
M.S. Student, Sedimentology

The Indian Creek Member: A New Stratigraphic Unit of the Ste. Genevieve Limestone (Mississippian, Chesterian) of Indiana

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Abstract: The Ste. Genevieve Limestone (Ste. Gen) is a Middle Mississippian shallow marine to non-marine carbonate found within the Illinois Basin (IB). The Ste. Gen is composed predominantly of oolitic and skeletal grainstones, with a smaller variety of other carbonate and siliciclastic rocks, with the grainstones of the Ste. Gen being of interest for their economic potential as oil and gas reservoirs, aggregates, and aquifers. The Indiana Geological & Water Survey (IGWS) currently recognizes two members of the Ste. Gen in Indiana, the lower Fredonia Member and the upper Karnak Member (Droste and Carpenter, 1990), both of which represent shallow marine shoaling deposits. With much of the Ste. Gen composed of grain-supported limestones, the presence of a consistent lime mudstone unit ranging from 4 ft (1.2 m) to nearly 40 ft (12 m) in thickness should be apparent, yet it has historically failed to be recognized for its importance. The IGWS became aware of this mudstone, known informally as the Indian Creek Beds (IC), as a stratigraphically correlative unit for structure mapping (Keith and Thompson, 2020). The mudstones of the IC have been discussed only in small, localized areas or generalized in basin-wide studies, but no regional-scale effort has been made to fully study this package of rock in Indiana yet. This report formally characterizes the IC using outcrops and cores to describe the lithology and cores to build chemostratigraphic profiles using pXRF and stable light isotopes ($\partial^{13}C$ and $\partial^{18}O$). This study uses the litho- and chemostratigraphic analyses performed to determine the depositional environment and history of the IC and recommends that the Indian Creek be formally accepted as a member of the Ste. Genevieve Limestone.

TRENTON MEIER
Indiana University
M.S. Student, Geochemistry

Reconstructing Paleoenvironments of Bed II at Olduvai Gorge, Tanzania During the Technological Evolution of the Oldowan to Acheulean

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Abstract: The research presented here focuses on deciphering the paleoenvironments of the lower to middle Bed II stratigraphy of Olduvai Gorge, Tanzania in East Africa from 1.8 - 1.66 Ma., a time of increased aridity across East Africa. At the gorge, this dynamic time period included multiple tectonic and volcanic events, an increasingly alkaline and saline paleolake, and the Oldowan to Acheulean technological transition. This transition, a shift from simple choppers to a suite of bifacial tools, is one of the earliest examples of technological evolution. We use temporal trends in $\partial^{13}C_{org}$, biomarker distributions, and the $\partial^{13}C$ compositions of biomarkers in clay samples from both correlated sediment cores and archaeological outcrops to reconstruct the local paleoenvironments at the gorge during this period. The methodology of analyzing both sample sources facilitates comparison of their preservation and assesses the viability of outcrop samples for future organic geochemical studies. Because we obtained the core samples from unexposed strata, we expect a higher quantity of preserved biomarkers in the cores than the outcrops. Previous environmental reconstructions of Bed II indicate an expansion of grasslands and open woodlands as landscape aridification took place. We hypothesize that changes in environment affect water availability and consequently the resources available to hominins, manifested in the change in stone tool assemblages. The findings from this research will extend the detailed organic geochemical proxy record of Olduvai Gorge by 140 kyr, further contextualize archaeological sites, and the Oldowan to Acheulean technological transition.

SHANTA BANSTOLA
Indiana State University
Ph.D. Candidate, Urban Climate

Local climate zone classification of the city in Kathmandu Valley, Nepal

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Department of Earth and Environmental Systems
Indiana State University

Abstract: Local climate zones (LCZ) are regions of uniform surface cover, materials, structures, and other anthropogenic activities. It has been a common way of identifying the temperature, rainfall, and air quality locally across the city. Traditionally, the city's local climate classification was limited to the dichotomy classification of the 'urban and rural' zones. This binary method often overlooks the diversity of the urban regions, including variation in building types and natural landcover. LCZ classification of the city is required to address this diversity by dividing the heterogeneous city into multiple climate zones based on surface cover and properties.

One of my PhD research questions is to compare the local climate zones between the current (2025) and past year (1990). I classified Kathmandu Metropolitan City, Nepal, known for its rapid urbanization and diverse urban landscape. Remote sensing and deep learning concepts were rigorously applied. By comparing the LCZs from 1990 to 2025, this research seeks to quantify the spatiotemporal changes in Kathmandu's urban landscape and explore the relationship between urban heat island and local climate patterns. I expect a significant transformation in building types and density between the two years because of rapid urbanization in the valley.

ORAL SESSION 2

GY 2049

ELI VANDYKE
Indiana University
M.S. Student, Sedimentology

Thermochronologic Signatures of Burial and Exhumation Capture Cretaceous Tectonics in Walled Basins of Western Mongolia

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New Mexico Institute of Mining and Technology

Abstract: The Dzereg and Dariv sedimentary basins are walled basins within the Altai Mountain region of western Mongolia. These basins preserve ~ 1.5 – 2.0 km of Jurassic through Pleistocene strata exposed along both intrabasin and basin bounding structures. This study quantifies the magnitude of burial and the timing of exhumation throughout Mesozoicpresent multi-phase tectonic cycles of extension, compression, and transpression to better understand the relationship between intrabasinal deformation and bounding contractional uplift in walled basins. Apatite fission track (AFT) and (UTh-Sm)/He thermochronology data from strata in both basins is used to reconstruct past burial timing and magnitude. Samples that have been thermally reset by burial record the time of post-burial exhumation. Initial AFT and AHe data collection focused on a ~1.9 km thick Mesozoic section in the Dariv Basin. Here, Jurassic strata are thermally reset, whereas Cretaceous and younger strata are unreset. The base of the exposed Jurassic has a reset AFT cooling age of 109 ±11 Ma, whereas 1.3 km up-section, just below the Jurassic/Cretaceous contact the reset cooling age is 126 ±19 Ma. The base of the Cretaceous is unreset at 241 ±37 Ma. The maximum burial threshold and the recorded cooling ages suggest that Jurassic strata must have been buried to a depth of at least 3 kilometers under a greater thickness of Mesozoic strata than is currently preserved, then exhumed in the later Cretaceous. AFT analyses from our stratigraphic sections match new AFT data from low elevation granitoid samples along the basin-bounding ridges (n=2), which also report Cretaceous cooling ages (130 ± 15 Ma and 114 ± 19 Ma). The observed Early Cretaceous cooling ages align with a regional pattern identified across Central Asia. While the precise mechanisms driving this widespread exhumation remain uncertain, potential contributors include the Mongol-Okhotsk orogeny and subsequent orogenic collapse to the east.

YE JING
Indiana University
PhD Student, Geomorphology

The creation of oxbow lakes depends on the bifurcation dynamics

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Indiana University Bloomington

Abstract: Oxbow lakes are characteristic and environmentally important features of meandering river floodplains. They function as critical habitat for many species and as effective sinks for fine sediment and associated contaminants. However, it is unclear why some oxbow lakes are persistent whereas others get filled in quickly. Oxbow lakes are persistent when plug bars form at each entrance, stopping the flow of sediment into the channel . The controls on plug occurrence and size are not clearly constrained. We hypothesize that the formation of persistent oxbow lakes depends on the stability of the bifurcation. When the bifurcation is unstable, the plugs form rapidly, sealing off the oxbow and creating a persistent feature that slowly fills with sediment. Further, we test if unstable bifurcations are associated with neck cutoffs because the significant slope advantage created by the cutoff should lead to rapid plug formation. We built a one-dimensional numerical model to investigate how bifurcation stability contributes to oxbow lake persistence. The model consists of a main channel and an abandoned channel. We analyzed plugging behavior as a function of the length of the cutoff channel (Lc) relative to the abandoned channel (La). Our key result is that as La/Lc increases, the relative plug length decreases. Neck cutoffs with large La/Lc have the shortest plug, which would lead to the biggest oxbow lake compared to the oxbow lake induced by the chute cutoff run. Our model shows that the length ratio determines the plug size and thus the surface area of the oxbow lake. For a given filling rate, lakes with larger surface area should persist longer. These results are consistent with field data that show oxbow lakes formed by chute cut-offs fill twice as fast as those formed by neck cutoffs. Our findings highlight the importance of bifurcation dynamics in the creation of persistent oxbow lakes

ISABELLE CABAN
Indiana University
M.S. Student, Geomorphology

Long-term response of channel geometry to volcanic eruptions in Chile

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Abstract: Volcanic eruptions and associated sediment flux influence river incision rates and channel morphology through controls on sediment supply, tectonic uplift rates, and substrate lithology. However, the relative importance of these factors and their long-term effects on river channels draining active volcanoes remain poorly understood. We conducted field and remote analyses of river channels in Chile's Southern Volcanic Zone (SVZ) ($^{-34}$S – $^{-40}$S), to quantify the primary controls on channel steepness (ksn), wideness (kwn), and erosion potential (ksn/kwn). Our analyses show that (1) channel steepness decreases systematically from north to south, independently of lithology, while sediment grain size and supply strongly influence these gradients. Furthermore, (2) volcanic channels generally exhibit lower steepness and higher wideness compared to non-volcanic channels, consistent with transport-limited conditions. A process-based erosion framework (ksn/kwn) shows volcanic sediment supply significantly reduces erosion potential, especially in southern sites. Grain size analyses reveal volcanic channels transport finer, variable sediment compared to consistently coarser sediment in resistant-lithology dominated non-volcanic channels, emphasizing volcanic sediment's morphological influence. We propose that (1) in northern sites, high uplift rates drive detachmentlimited systems characterized by steep, narrow channels, whereas (2) in central and southern sites, increased volcanic sediment inputs transition channels to transport-limited conditions, resulting in broader, less steep channel forms. These results challenge existing models that link incision rate primarily to uplift and stream power by highlighting the dominant influence of sediment supply and lithology in volcanic terrains. Processes like sediment-induced aggradation and variable erosion efficiency must be considered to fully understand channel dynamics and manage hazards in volcanic landscapes globally.

POSTER SESSIONS

IGWS 2022
GY 2029

Poster session 1 (10:00 - 11:30 am)

Adeline Bowen
Jaxon Bennett
Kenia Caro
Syan Das
Joshua Elms
JeongYeon Han
Madiha Hassan
Taryn Joest
Destiny Legg
Mallory Miller
Emily Pasek
Rebecca Porter

Poster session 2 (3:30-5:00 pm)

Dibya Chakraborty
Lucia Conrad + Eliza Joyce
Carissa Cullen
Annie Hadley
Thomas LaBarge
Garrett O'Hara
Hirak Parikh
Maximillian D. Richter
Lior Segal
Samanatha Sheahan
Emily Throop
Mya Whaley
Madeline Williams

POSTER SESSION 1

IGWS 2022
GY 2029

ADELINE BOWEN
Indiana University
M.S. Student, Sedimentology

U-Pb Geochronology on the Mt. Simon and St. Peter Sandstones of the Michigan Basin

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Abstract: Erosion is a key process for the redistribution of Earth materials and is influenced by factors such as tectonic activity, climate, and biological controls. The interaction between tectonic and climatic controls on erosion has become better understood in recent decades. However, the magnitude at which biological controls, such as vegetation, affect erosion has been harder to quantify. Sedimentary basins are important structures for the storage and preservation of these erosional records, with cratonic basins receiving unique detrital records from both tectonically stable and tectonically active settings. The Michigan Basin is an ideal location for understanding the interaction between tectonic and biologic controls, receiving sediment from varying tectonic settings and storing clastic stratigraphy thatspans the timing of land plant evolution.

To understand how vegetation affects erosion through geologic time, we must first understand how erosion occurs without the influence of vegetation and with early influence of vegetation. Here, I am presenting U-Pb geochronologic data on the Cambrian Mt. Simon and Ordovician St. Peter Sandstones of the Michigan Basin. By targeting units of these ages, we will capture a baseline record of sediment provenance which is necessary to distinguish among the erosional source regions shown here as primarily the stable Archean Craton and Grenville Orogen. This geochronologic data will set the stage for forthcoming (U-Th)/He thermochronologic data, as it is necessary to discern where sediment is coming from to target exhumation histories of particular source regions.

JAXON F. BENNETT
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Undergraduate Student, Sedimentology

A Global Analysis of Deltaic Land Elevation and Population Below Local Mean Sea Level

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Abstract: River deltas are critical landforms that sit at the marine-terrestrial interface and are hotspots of human habitation. Many river deltas are threatened by rising relative sea levels and declining sediment supply, both of which contribute to shoreline transgression and land loss.

A key question regarding river delta resilience is understanding how many people live on deltas and their vulnerability to these changes. Here we use different global digital elevation models (DEMs) to evaluate the deltaic elevations worldwide and amount of land and people below sea level within river deltas. We focus on the area and population below sea level since these regions are some of the most vulnerable. We used latest available global DEMs and applied a proper vertical datum conversion from global geoid models to local mean sea level to correct for vertical errors in coastal land elevation introduced by the offset of global geoid models to local sea level. We considered uncertainties stemming from elevation data by examining the different global DEMs. Our results show that the deltaic area below sea level across these different DEMs varies by a factor of three relative to the total global delta area. The proportion of people living below sea level on river deltas varies by a factor of two. We also investigated whether the variability in area below sea level is driven by delta plain and catchment size, as well as the geological and climatic setting. Our analysis provides new, fundamental insights into the relations between deltaic land elevation and their geographical setting, which extends our understanding of deltaic landscape morphologies in the world and the future sustainability of these valuable landforms.

KENIA YASMIN CARO
Indiana University
Undergraduate Student, Petrology, Geochemistry, Volcanology, Remote Sensing

Do changes in precipation and magma chamber temperature affect the hydrothermal features at Yellowstone Caldera.

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Abstract: Yellowstone Caldera (YC), USA, is a region of geothermal activity driven by a volcanic hotspot. In this study, I analyzed the impacts of climate change, specifically changes in precipitation, on the hydrothermal system. I accomplished this in three ways: (1) examining the relationship between precipitation and geyser eruptions, (2) creating and analyzing land surface temperature (LST) imagery using Google Earth Engine (GEE), and (3) conducting thermal modeling of the YC. Precipitation data from NOAA indicates that the annual average precipitation in Yellowstone has increased by 1.41 inches over the past century. Geyser eruption event data were collected from geysertimes.org, a publicly accessible database. Initial comparisons reveal no consistent correlations between precipitation and geyser activity at Yellowstone Caldera (YC). I also compared YC to two other calderas: Valles Caldera (VC) in New Mexico and Long Valley Caldera (LVC) in California, both of which exhibited greater geothermal activity in the past. Data from NOAA show that the yearly average precipitation near VC has decreased by 0.79 inches over the last century, while LVC has experienced little change. This stands in contrast to the increasing trend observed at YC. To better assess the various factors influencing geyser activity, I collected data using GEE to compare it with precipitation data, specifically focusing on the Norris Geyser Basin. From 2013 to 2014, the average LST cooled by at least 3°C. There is a significant correlation between increased LST and the frequency of geyser eruptions, indicating that high precipitation does not impact LST. This observation suggests the presence of a third factor, potentially related to low rock porosity. I propose that greater water content will cause greater cooling of the magma chamber.

SAYAN DAS
Indiana University
PhD Student, Geomorphology

The role of sediment dynamics in the evolution of Taiwan orogen

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Department of Earth and Atmospheric Sciences
Indiana University Bloomington

Abstract: Orogenic landscapes undergo spatio-temporal variations due to changes in tectonics and climate. Disentangling the influence of these drivers on the topography remains a challenge due to the complex feedbacks that exist between them. Bedrock rivers adjust to the variations in landscape and this response is preserved in the channel morphology. Thus, river morphology is useful for constraining tectonic uplift over the 10^3-10^5 yr timescale. However, rivers are significantly affected by sediments as the impact-based erosion of bedrock varies depending on the magnitude of bedrock exposure and sediment cover, potentially obscuring the tectonic signature encoded in river systems. Therefore, to delineate the tectonic signal, we must account for the effects of sediment dynamics on the river morphology. Taiwan provides a natural laboratory to address this problem due to its high seismicity, high relief, pronounced gradients of exhumation, near uniform precipitation, and frequent typhoons. To understand the impact of sediments on tectonics-induced morphological signal, we collected grain size data from 112 locations across 6 major geological divisions in Taiwan- Hsuehshan Range (HR), Slate belt (SB), Metamorphic Complex (MC), Western Foothills (WF), Coastal Range (CoR), and Southern Taiwan (ST). We also gathered daily and annual discharge data from gauging stations across Taiwan. We used the discharge and D50 grain size data to compare the critical and boundary shear stress, and then calculated the bedload sediment transport capacity (Qb) of the rivers at each sample point. We define a dimensionless ratio of sediment supply to transport (Qs/Qb) as a relative parameter that allows us to characterize the erosional potential of channels based on bedrock exposure. Our results exhibit variable patterns of sediment dynamics across the geological divisions, outlining the importance of considering sediment signal when interpreting erosion and deformation patterns in orogenic landscapes.

JOSHUA ELMS
Indiana University
M.S. Student, Atmospheric Sciences

Not in Kansas Anymore: Out-of-Sample Idealized Tests for Machine Learning Atmosphere Models

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Abstract: Machine learning-based atmospheric models demonstrate impressive skill at forecasting weather conditions from the current climate state, but we have yet to develop trust in their performance under out-of-sample regimes (those outside of the years 1970-2020). The dynamical model core community originated many idealized tests to systematically build trust in models, though idealized testing for machine learning atmospheric models differs in important ways. The optimal tests of out-of-sample performance would follow the dynamical model community's practices by having analytically (not observationally) defined answers, often to simple theoretical questions. We discuss challenges in implementing some of the standard idealized tests, arising from a lack of distinct model components which can be activated or deactivated as in traditional dynamical models. A selection of dynamical model core tests have been adapted for this purpose and conducted on models representing the most popular architectures to date. The study concludes with an intercomparison of the models' test results and expectations for future model development.

JEONGYEON HAN
Indiana University
PhD Student, Sedimentology

Numerical Investigation of Alluvial Ridge Development in Meandering Rivers

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Abstract: In meandering rivers, the overbank aggradation (e.g., levee growth and crevasse splays) and lateral bank migration contribute to the formation of alluvial ridges along the channels. Alluvial ridges are crucial elements of the fluvial system that influence river avulsion processes and the stratigraphic stacking patterns of channels, yet few numerical studies have investigated how these ridges form and the relative importance of lateral and vertical accretion in their formation. This study examines the development of alluvial ridges through a one-dimensional morphodynamic model that incorporates both bend meandering and levee construction in river channels. We then focus on how these factors affect ridge morphology and resultant super-elevation ratios over time, which reflect bankfull channel depth and local relief of levee crest relative to adjacent flood basins. In the model, overbank deposits on the inner bank side resemble scroll bars while outer bank exhibits natural levees or levee-like features, aligning with typical patterns observed in meandering channels. Our results highlight the significant role of both lateral and vertical accretion processes in the formation of alluvial ridge complexes, with channel mobility number serving as a key indicator. By analyzing the relationship between channel mobility, ridge morphology, and super-elevation ratios through a numerical model, we illustrate how channel mobility affects the evolution of alluvial ridges and their avulsion dynamics. These findings suggest that areas with higher channel mobility tend to have gentler and rough ridges, which may take longer time to reach the super-elevation threshold as the channel continuously migrates before achieving maximum accretion. Based on this, our study enhances the understanding of avulsion conditions in meandering rivers.

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Abrupt Climate Change and its Impact on Total Phosphorus Input in Mozambique Channel: Spectral Analysis

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Abstract: Since the last glacial period, Heinrich Events have frequently occurred at a period of 7- 8 ka, caused by freshwater inputs into the North Atlantic Ocean. Heinrich Events resulted from the breakdown of the Laurentide Ice Sheet and were associated with the discharge of icebergs into the North Atlantic Ocean, identified in sediment cores by the presence of ice-rafted debris (IRD). The importance of Heinrich Events is that they cause shifts in the climate state, such as the large, significant cooling in the North Atlantic and disturbances in the Atlantic Meridional Overturning Circulation (AMOC), which is a key element in the functioning of the climate system. Heinrich Events are also connected to other climatic events such as the abrupt Dansgaard-Oeschger cycles, which highlight the close interaction of ocean, ice, and the atmosphere. Such connections provide valuable insights into the climate system during the last glacial period and critical lessons that are useful in predicting future climate change as global warming continues. Change in the northern hemisphere climate indirectly affects the southern hemisphere's weather patterns, thus altering precipitation, influencing terrigenous transport into ocean, affecting primary productivity. Since P is a limiting nutrient while iron (Fe) and titanium are solely sourced from land, the P/Ti ratio serves as a proxy for ocean productivity and an indirect proxy for terrigenous input. The present study aims to analyze the flux of total P, P/Ti, Fe, and Ti input from the Zambezi watershed, identifying the input variation during abrupt climate change from core U1477, Expedition 361, South Africa. Spectral analysis (REDFIT) determined Heinrich periodicity hidden within the record, and wavelet analysis identified when it was dominant. Spectral analysis showed significant peaks with total P (4.24 ka), P/Ti (6.681 Ka and 4.16 Ka), and Fe (7.112 Ka) and none for Ti. Wavelet analysis represents 3 significant zones at ~7ka with TP.

TARYN JOEST
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Paleoclimate Interpretation from the Study of Plant Fossils from the Bond Formation (Upper Pennsylvanian, Missourian) at the Old Dam Site Near New Harmony, Posey County, Indiana

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Abstract: The Bond Formation (Upper Pennsylvanian, Missourian) of the McLeansboro Group consists of shale, siltstone, and sandstone with subordinate layers of coal and limestone. A partial exposure of the Bond Formation is accessible along the Wabash River southwest of New Harmony at the Old Dam Site. Plant fossils were collected from a dark gray shale just below a thin coal deposit, likely the Fairbanks Coal. Above the coal is a 5 cm bed of black shale with localized pyrite concretions, overlain by 50 cm of skeletal wackestone with disaggregated and abraded marine fossils; this latter unit is identified as the Riverview Limestone Member. The plant fossils were collected in late August 2024 by excavating approximately 1 square meter of shale. In the lab, the specimens were sealed with clear acrylic to preserve and enhance their durability. Plant fossils were identified to genus and/or species using a 10x hand lens, Olympus 20x to 40x binocular microscope, and by comparing morphological features to reference collections and published literature. The most common fossils are Medullosans, dominated by Neuropteris. Multiple individual pinnules of Macroneuropteris scheuchzeri occur in samples dominated by N. flexuosa, N. ovata, and N. vermicularis. There is a moderate abundance of Calamites, Cordaites, and Cyclopteris, along with Annularia sphenophylloides and N. fimbriata. There are some trace occurrences of Sphenophyllum dubium, Sphenophyllum emarginatum, and Sphenopteris elegans. The genera identified are typical of the Late Pennsylvanian and are consistent with a wetland environment associated with a broad, river-dominated delta complex, but also indicate a paleoclimate with marginally drier conditions than the Early Pennsylvanian. This gradual shift in flora away from true ferns and lycophytes, which were absent in the collected samples, indicates an environment that is seasonally, or on average, much drier in comparison to the tree-fern and lycopsid-rich swamps of the Lower Pennsylvanian.

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Phosphorus Geochemistry of Marine Sediments Recovered from Site U1478

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Abstract: The International Ocean Discovery Program Expedition 361 collected sediment cores along the southeastern coast of Africa to investigate the Agulhas Current and relationships between African climate and human evolution. Site U1478 is in the Delagoa Bight on the Inharrime Terrace, east of the Limpopo River, at a depth of 488 km. The recovered sediments at this location span the modern to middle Pliocene and are characterized as siliciclastic clay rich silt with the presence of foraminifera and calcareous nannofossils. Today the Limpopo River has very low discharge (6,000 ft^3/s), but in the past, when the Limpopo River and Zambezi Rivers were connected, discharge was presumed to have been much higher. Today the discharge of the Zambezi River is >100,000 ft^3/s. It has been estimated that the Limpopo and Zambezi became disconnected in the late Pliocene. The goal of this project is to study phosphorus geochemistry of the sediments to analyze whether past productivity responded to changes in African climate or global climate changes, such as glacial/interglacial cycles. Another goal is to study changes in terrigenous fluxes and terrigenous provenance at U1478 using terrigenous accumulation rates and elemental ratios such as the Fe/Ti and Zr/Ti ratios. In the modern day, the Limpopo headwaters are in the Kalahari Desert, flowing through arid and semi-arid regions. In dry years, the Limpopo does not flow to the Indian Ocean. Using these proxies for terrigenous accumulation, we hope to further refine the timing to the separation between the Limpopo and Zambezi. Sediments were analyzed using XRF to study the elemental composition and ratios. Fe/Ti ratios are variable but show no correlation with global climate changes while Zr/Ti ratios show some variability with glacial/interglacial cycles. P/Ti ratios were also examined to evaluate changes in primary productivity and terrestrial nutrient inputs. P/Ti ratios have a clear relationship with glacial/interglacial cycles.

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Potential Effects of Enhancement Factors on Glen's Flow Law

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Abstract: The Glen–Nye flow law is a widely used formula relating the strain rate of glacial ice with stress in order to calculate glacial creep. The relation includes a dimensionless exponent of stress, n, which has been derived from field observations and laboratory experiments to reflect glacier movement. The value of n in the literature is generally considered 3, but there have been more recent studies that suggest the value could be closer to 4. One proposed explanation for this variation is that the ability to deform ice changes with its fabric, or the orientation of its individual grains, as it deforms over time, which then appears to alter n. We are examining to what extent the fabric of ice could explain the value of n by analyzing the impact of incorporating scalar enhancement factors for the vertical component of simulated ice fabric into that ice's theoretical Glen-Nye calculation. Long term projections of ice flow when assuming the value of n is 4 rather than 3 do show significant differences over time, which makes investigating potential causes of the variations in observations worthwhile. Our initial results indicate that the enhancement factor does appear to increase n when multiplied with the predicted strain rate, but it could also decrease n or have a lessened effect when the fabric's enhancement factor has plateaued or the temperature is low enough for re-crystallization to dominate the fabric.

EMILY A.S. PASEK
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Teaching and Learning Through Art-Geoscience Intersections: A Systematic Review

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Abstract: The arts are a powerful tool for sparking interest in the geosciences, enhancing understanding of complex concepts, and encouraging diverse ways of thinking. They invite participation in the classroom by students who are otherwise uncomfortable engaging with STEM concepts, inspire curiosity and innovation by geoscientists of all ages and experience levels, and train important observational skills that can be applied across geoscience subfields. Despite these obvious benefits, intentional collaboration between the two fields of study rarely occurs. In this work, I conducted a systematic literature review to study how arts-based interventions are implemented in geoscience research and education. In addition, I aimed to explore how the arts and humanities have engaged with the geosciences in their own teaching and research. Four databases (Web of Science, SCOPUS, EBSCO, and ProQuest) were searched using a common search string. This search identified 775 relevant documents which were then deduplicated, screened, and coded using thematic analysis. Findings from this study indicate that efforts to implement the arts in the geosciences are typically well-received on an individual classroom or project basis, but that their broader use is often hindered by extremely narrow applications and an overall lack of evaluation. In addition, this literature review demonstrated that some high-profile ongoing geoscience-art intersections work is not captured within published peer-reviewed literature, meaning that researchers and educators who might benefit from implementing related ideas in their own fields of practice may not even be aware that they exist. This work suggests that geoscientists and artists at all levels stand to reap massive benefits from participating in interdisciplinary interventions, but that future efforts to use the arts in the geosciences and vice versa must be evaluated and disseminated at a much broader scale in order to be effective.

REBECCA PORTER
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Projections of extreme weather events under a warming climate: using climate models as a guide for decision making

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Abstract: Extreme weather events—such as tornadoes, hurricanes, droughts, and heat waves—can have severe impacts on agriculture and infrastructure, and can often result in the widespread loss of property and life. Together, these effects carry significant societal implications.

For example, Hurricane Helene brought extreme winds, flooding, and mudslides, completely demolishing towns in its path. Its impacts were even seen as far north as Indiana with heavy rainfall and extreme winds, toppling trees and causing extensive power outages.

In order to mitigate risks against extreme events like Hurricane Helene, it is crucial to understand how these events may change in the future. Climate models are a valuable tool for understanding shifts in extremes by creating projections of possible future precipitation and temperature extremes.

This study utilizes a climate model to analyze past extreme weather events under pseudoglobal- warming scenarios, allowing us to understand how these events may evolve in a warmer and wetter climate, and providing essential information for making informed decisions to improve our resilience when struck by such weather events.

POSTER SESSION 2

IGWS 2022
GY 2029

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Nitrate Loss from a Drained Agricultural Watershed in Central Indiana: Effects of Crop Type and Hydrologic Flow Path

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Abstract: Application of nitrogen (N) fertilizer in intensive agricultural systems has become a routine practice to increase crop productivity. However, plants are unable to use all the N fertilizer that are applied to the field. As a result, an appreciable amount of residual N remains in the field and become available for loss through surface runoff and subsurface leaching specially in the form of nitrate. This study was conducted in a field with corn-soybean rotation at School Branch Watershed in Indiana during 2017-2018. Amount of N fertilizer application and the amount of nitrate leaching through surface runoff and sub-surface drainage was monitored. In 2017, corn and in 2018 soybean was planted. N fertilizer was applied in the corn year was 150 Kg N/ha and in soybean year 1,8 Kg N/ha. Surprisingly, the nitrate flux from the field was higher in soybean (12.5 kg N/ha/yr) than corn (3.1 kg N/ha/yr). Because of the distribution of the rainfall during those two seasons played an important role in this unusual result. Usually, the nitrate flux is higher with higher application of N fertilizer. This study will help us in assessing the role of rainfall distribution on N loss from an agricultural field and also will help us to implement mitigation strategies (such as cover crop planting) in appropriate time.

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Tracking Ancient Volcanic Eruptions with Chemical Fingerprints

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Abstract: Western North America has seen wide-spread volcanic activity over the last ~40 million years making sources of volcanic deposits in this region difficult to pinpoint. Cryptotephra, or volcanic deposits of unknown origins, are glass particles from a volcanic eruption that can be used to chemically fingerprint the origin of the volcanic sediment (tephra). Unlike the rest of the sediment from a volcanic eruption, the glass chemistry is more accurate representative of the total chemical composition of the magma chamber of the volcano. We aim to track Cenozoic aged crytotephra samples collected from central Montana to their eruption site using trace elements to chemical fingerprint cryptotephra. Tracking tephra paths allows us to better understand the potential effects of eruptions and better forecast future eruptions. We started our research with three Eocene samples (37.5–37.59 Ma), three Oligocene samples (32.36–32.47 Ma), and four Miocene samples (9.33–10.35 Ma), with the goal of determining whether samples from each respective era came from the same ashfall. All samples were dated at the University of Arizona by K-Ar dating of sanidine. We separated cryptotephra using a microscope and Dr. Shelby Radar helped analyze samples with ICP–MS. We compare our data to samples from the EarthChem online database, and initial results show Miocene samples plot closely to volcanics from the Snake River Plain in Idaho. Two of these samples, 42017 and TVM35-59 appear to have originated from an earlier eruption, whereas sample TVM35-59 appears to be from a later eruption as it has a larger crustal chemical signature and its younger absolute age. Insufficient data is available for volcanics of Oligocene and Eocene age on the EarthChem database and further analysis is required to come to a definite conclusion of the origin of these samples. However, it is clear from our data that these three samples all originated from different volcanoes.

CARISSA CULLEN
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Comparing Volcanic Plumbing Systems Between Boulder Batholith, Montana and Joshua Tree National Park, California

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Abstract: The purpose of this study is to examine depth-dependent variations in chemical processes within Late Cretaceous (82 to 74 Ma), continental volcanic arc plumbing systems. Our selected study sites compare deeper, mid-crustal rock samples from Joshua Tree National Park in southern California with shallower samples from Porcupine Wash in Joshua Tree National Park, as well as from the upper-crustal inner and outer Boulder batholith in Montana, focusing on mineral textures and whole rock compositions. The analysis reveals that the mid-crustal Joshua Tree samples share more similarities with the Porcupine Wash and inner Boulder batholith rocks than with the outer Boulder batholith. Both regions contain intermediate to felsic rocks and show evidence of having undergone longer periods of crystallization, likely involving crystal fractionation. The outer Boulder batholith had shorter periods of crystallization to form intermediate-mafic granodiorite. Mineralogical data indicates that both the Joshua Tree and inner Boulder batholith samples have higher concentrations of intermediate and denser minerals clinopyroxene, hornblende, and magnetite. Chemical and thin section analysis further supports the idea that these inner rocks crystallized over extended time frames, allowing for the separation of minerals during cooling. The time frame for this crystallization period is dated at 76.7 to 74.5 Ma. In contrast, the outer Boulder batholith samples exhibit a more varied mineral composition, reflecting an earlier crystallization history of about 82 to 78 Ma. The broadly overlapping patterns of chemical variations suggest the origin of magmatic diversity arose yet deeper in these arc systems.

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Modeling Exoplanet Biosignatures from Large-Scale Seasonal Biosphere Changes

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Abstract: Tracking visible planetary changes can lead to insight into potential life in the universe and to the coupling of certain aspects of orbital geometry with cycles in ecosystems and planetary biospheres. This project explores large-scale temporal biosignatures: visible changes to a large area of a planetary surface's visible properties – such as color indices, albedo, and/or other spectral data – due to seasonal variations and the environmental responsiveness of life. We present work on creating a simple, computational model of a planet with latitude-dependent seasonal variations corresponding to a large-scale change in the biosphere and examining the temporal variability that would be seen remotely for different orbital geometries and viewing angles. Our model seeks to allow for variations in location and timing of such biosignatures and to generate temporal signal curves that can be used for correlation analysis with exoplanet observations to identify potential temporal biosignatures. Recognizing that life-bearing planets may have properties that also complicate detection, we also consider other non-biological factors that could modify or interfere with a visible biosignature, such as land-to-water ratios, cloud coverage, or relative ice coverage. We relate our model and its properties to the statistics of known exoplanets in the NASA Exoplanet Archive in order to consider potential detection of such a signal.

THOMAS LABARGE
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Ontogenetic Variation in the Tooth Crown Dimensions of Tyrannosaurus rex

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Abstract: The skeletal morphology of Tyrannosaurus rex varied substantially through ontogeny. Immature T. rex were significantly more gracile than their adult counterparts, especially regarding craniodental morphology. Juvenile teeth are narrow in cross-section, and the overall feeding apparatus appears best adapted to the consumption of soft tissues. The mature T. rex skull is extremely large and robust with wide, stout teeth that suggest a specialization towards consuming bone. These morphological differences are hypothesized to relate to ontogenetic shifts in predatory ecology. Based on these trends, isolated tooth crowns of adult and subadult T. rex should be differentiable from juvenile shed teeth. However, no consistent method has been developed for age differentiation using tooth crown dimensions. I present a new, quantitative methodology for classifying isolated tyrannosaur teeth from the Hell Creek Formation. I collected linear measurements of maxilla and dentary teeth from 15 T. rex individuals of estimable maturity. These specimens range in age from juvenile to adult and comprise a sample of 139 individual teeth. Two distinct clusters form when evaluating these measurements, one composed of adult and subadult tooth crowns, and another composed solely of juvenile teeth. A permutation multivariate analysis of variance (PERMANOVA) reveals that juvenile teeth are significantly different in their linear dimensions from both adult ($p = 0.0001$) and subadult ($p = 0.0001$) tooth crowns (pseudo-$F = 99.09$, $p = 0.0001$). These observations will allow for the differentiation of tooth crowns between ontogenetically mature T. rex and juvenile conspecifics. In the context of evaluating the ecology of Hell Creek Dinosauria, this new method for identifying the ontogenetic age of teeth will allow for the accurate description of distinct T. rex semaphoronts in microfossil collections.

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Quantifying the Role of Headcutting in Floodplain Channel Development

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Abstract: Soil erosion on floodplains threatens agriculture, affects water quality, and disrupts land use practices. Unchecked soil erosion across Midwestern floodplains has created networks of secondary channels. Despite their abundance, it is unclear how these channels form. This project involves investigating the hypothesis that headcutting creates and links secondary channels on floodplains. Headcutting occurs when water accelerates and initiates a knickpoint that migrates upstream, carving a channel and contributing to soil erosion. Failure to address the causes of headcutting and soil erosion will make managing the problem even increasingly difficult in a changing climate. I will be locating headcuts within Indiana floodplains and use drone-based lidar to measure their migration rates since 2013. My goal is to find evidence that headcuts link together existing secondary channels.

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Modern Patterns of Diatom Diversity Across Habitats in Historically Mining-Affected Coeur d'Alene Lake in Idaho

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Abstract: Coeur d'Alene Lake in northern Idaho, heavily impacted by historical mining, has accumulated over 75 million metric tons of metalcontaminated sediments. While classified as oligo-mesotrophic and phosphorus-limited, concerns about eutrophication are rising due to population growth and increasing human activities. Diatoms, sensitive to water chemistry changes, are valuable bioindicators for monitoring water quality. However, there is limited research on the spatial variability and ecological responses of modern diatom communities in the lake. This study assesses diatom diversity and community responses to evaluate the ecological status of the lake in the face of anthropogenic influences. It examines spatial variations in diatom assemblages across open-water and benthic habitats, the impact of nutrient influx from riverine inputs, and the role of nitrogen and phosphorus deposition in shaping community composition. The study also aims to identify key diatom taxa as bioindicators of pollution and eutrophication. Diatom samples were collected from openwater and benthic zones (mud, sand, stone biofilms, and aquatic plants), and species composition and water quality parameters such as conductivity, pH, and temperature were analyzed. Non-metric multidimensional scaling (NMDS) assessed species richness and spatial patterns. Results showed that Asterionella formosa and Fragilaria crotonensis dominated the open-water samples, suggesting a potential response to elevated nitrogen levels. In contrast, benthic diatom assemblages exhibited greater species diversity, particularly near the lake's mouth where nutrient inputs were higher. This highlights anthropogenic activities in driving nutrient influx and supporting diatom growth. Identifying A. formosa as a bioindicator of nitrogen pollution will aid in developing monitoring strategies for miningimpacted lakes. The findings underscore the need for targeted monitoring in nutrient-rich areas and inform conservation policies.

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Application of Ti-in-Zircon Thermometry to Track Magma Evolution of the Big Bear Lake Intrusive Suite, Ca.

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Abstract: The Big Bear Lake Intrusive Suite (BLIS) is a Late Cretaceous granitic intrusive suite in the Transverse Ranges, Ca., with interest in this suite stemming from its relatively large size (~440 km^2) and concentric zonation. Work on the similarly sized (1200 km^2) and zoned Tuolumne Intrusive Complex (TIC) has suggested the emplacement of large intrusions in the mid-shallow crust entailed episodic assembly across a protracted period of activity, with most pulses having cooled before the next one intruded. Recent BLIS Pb/U zircon crystallization ages using LA-ICP-MS have a range of ~2 m.y. (from 77.5 to 79.6 Ma), suggesting the BLIS was rapidly assembled, and its units were likely comagmatic. Trace element data were collected from the same zircon spots and this study reports on preliminary Ti-in-zircon thermometry values calculated using the Ferry and Watson 2007 calibration modified by Loucks *et al.* 2020. Here we use these Ti-inzircon temperature values and Hf concentrations to examine the magmatic evolution of the BLIS and improve the resolution of our model. Ti-in-zircon temperatures plotted against their Hf concentrations revealed a tight spread for the granodiorite hosted zircons, while the granite hosted zircons spanned a much wider range of temperature and Hf concentration values. We suggest the BLIS was initially emplaced via rapidly stacked sill injections; this early magma chamber homogenized and began crystallizing zircons starting at ~950 °C; zircon crystallization reached its peak productivity from 850 °C until 750 °C when crystal lockup occurred and slowed down zircon crystallization; compaction of these locked up crystals forced the granitic melt to percolate through and concentrate near the top as a lens, allowing for zircon crystallization to continue in this granitic lens until ~650 °C. Future work will include examining zircon spot locations; comparing the zircon compositions to their host rocks; and magma differentiation modeling.

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Can Meteorite Impacts Form Impact Melts With Primary Carbonate Inclusions

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Abstract: The Canyon Diablo meteorite impacted Earth ~50,000 years ago, forming Barringer Crater (aka Meteor Crater) in Arizona, which is 3,900 ft in diameter and 560 ft deep. The heat and pressure of the impact also melted and vaporized some of the rocks present at the target site, producing new materials known as impact melts. At Meteor Crater, some impact melts contain anomalous carbonate inclusions, the formation of which is heavily debated because carbonate minerals are known to vaporize completely at relatively low temperatures. One hypothesis is that the carbonates melted during impact but did not vaporize completely and then recrystallized as they cooled, forming primary mineral inclusions. The other hypothesis is that original carbonate minerals present in the target rocks volatilized (i.e., vaporized) completely from the melt and that the carbonate inclusions found in the impact melts at Meteor Crater formed sometime later, through a secondary process unrelated to the impact itself. The goal of this project is to determine if the carbonate inclusions formed from the impact or if they formed from a secondary process by conducting high temperature experiments in an aerodynamic levitation laser furnace. Samples of the target rocks at Meteor Crater were melted at temperatures associated with meteorite impacts and then polished and analyzed using a Scanning Electron Microscope (SEM). Initial experiments produced glasses with few distinct mineral phases or inclusions, and no carbonates. A second set of experiments produced visible mineral phases and will be further analyzed to determine the presence of carbonates.

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Phosphorus Loss from US Midwest Croplands: Effects of Fertilizer Management and Cover Crops

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Abstract: Intensive agricultural practices are linked to non-point source pollution of aquatic ecosystems around the world. In recent decades, there has been great impetus to investigate fertilizer management practices that both enhance crop productivity and protect water quality. A six-year study (2016-2021) was conducted in the School Branch watershed (Indiana, USA) to compare phosphorus (P) export from two adjacent fields receiving P fertilizer at different application rates. The fields were under corn-soybean rotation with no-tillage and cover crop management. During the first years (2016-2017) of the study, both fields received P fertilizers at the Tri-state recommended rate (averaged rate of 78.5 kg P/ha/yr). Starting in 2018, the West field continued to receive P at the recommended rates, whereas the East field was switched to lowered rate of P fertilizer at an average rate of 22.4 kg P/ha/yr (or 70% less than Tri-state rate). Water flow and P loss via surface and sub-surface pathways were monitored, and drainage water samples were analyzed for dissolved reactive P (DRP) and total dissolved P (TDP). Results showed no effect of P fertilizer rate on crop yield. However, despite the indication of soil P enrichment due to the initial high P input, reduction in P fertilizer input resulted in a substantial decrease (relative to an average loss of 2.9 kg P/ha/yr during the "Tri-state phase") in the amount of both DRP (25%) and TDP (72%) exported from the East field. The presence of a cover crop had variable effects on seasonal DRP export; in general, the cover crop was not effective in the fall, but and lower (2 to 4-fold) in the spring.

EMILY THROOP
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An Investigation of the Rockiness of Soils as a Result of Tree Throw

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Abstract: An important component of the global weathering cycle is the detachment and breakdown of bedrock into soil. A process that detaches rock, and is unaccounted for in most geomorphic models, is the uprooting of trees. This disruptive surface process of tree uprooting, or tree throw, occurs when a tree is toppled, bringing its root ball to the surface to create the distinct pit-mound couplet geometry. The mound, located between the trunk of the felled tree and the pit, consists of the root ball which retains sediment from deep within the soil column and, often, fragments of bedrock material. The resulting surficial fluctuation is unique and may be selected from digital elevation data via a machine learning model (MLM), effectively pinpointing instances of tree throw. Preliminary data shows that soils are rockier where there is more tree uprooting, the frequency of which depends on slope, aspect, and geology. Soil rockiness affects vegetation growing conditions and soil hydrologic properties, which have important impacts on vegetation biodiversity and erosion control. Tree throw has been studied extensively in its role in surface dynamics of hillslopes and the processes of pedogenesis and sediment transport. While these investigations focus upon the size and density of the pit-mound couplet, no connection has been made between tree throw frequency and the weight percent of rock in the soil. We seek to bridge this gap by testing that the weight percent of rocks in the soil should increase with the frequency of tree throw across different rock types. We compare the density of the detected tree throws with bedrock geology, finding that higher frequency of tree throw is apparent in bedrock lithologies with low structural integrity, such as siltstone. By comparing areas with different bedrock geology (siltstone, limestone, and granulite) and different uprooting frequencies, we examine how these controls have significant implications for the evolution of hillslopes.

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Microplastics and Heavy Metals in Crayfish and Sediments: A Comparative Analysis Between Pollution Accumulation in Streams and Retention Ponds in Hamilton County, Indiana

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Abstract: Since the early 1900's, the use of plastics has increased exponentially, exposing all ecosystems to microplastics (small particles of plastic < 5 mm), which are now ubiquitous. Microplastics have a relatively large surface area and many chemicals, particularly contaminants in the environment, adsorb to these small particles impacting the fate and transport of pollution. While microplastics have been found in virtually every setting on the planet, research is necessary to understand how they are impacting freshwater ecosystems and biogeochemical cycles. The focus of this research is to study microplastics and heavy metals in crayfish and sediments. Crayfish are keystone species among the macroinvertebrates, while also serving as an important food source for mammals and birds. They also live on or in sediments, which makes them ideal organisms to study the links between sedimentary metal concentration and bioaccumulation. For this research, microplastic and heavy metal concentrations in both sediment and crayfish samples will be quantified to understand how the presence of microplastics influence heavy metal pollution in freshwater streams and retention ponds in both rural and more urban areas. By analyzing the types of microplastics found in these systems, we can investigate how, or if, microplastics vary between urban and rural settings, and study the relationships between microplastics and heavy metals in aquatic ecosystems. Evaluating the types of microplastics present in sediments compared to crayfish living in that same sediment will enhance our understanding of topics such as which plastic pollution is more likely to bioaccumulate. This research will produce new data for 32 freshwater systems in Hamilton County, Indiana, analyzing concentrations of microplastic and heavy metals, such as mercury, in sediments and crayfish. Samples are currently being processed, and microplastic identification is ongoing.

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The Impacts of LGM Glaciers on Channels Downstream of the Glacial Termini

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Abstract: During the Last Glacial Maximum (LGM), extensive glaciation covered a significant portion of the Earth's surface, leading to substantial modifications of mountainous landscapes. Such glaciation can impact the evolution of landscapes downstream of valley glacier termini through the efficient generation and supply of sediment, influencing the efficiency of fluvial erosion well downstream of glacial maxima. However, such influences are poorly understood and rarely constrained. We capitalize on a natural experiment in the Tobacco Root Mountains of southwestern Montana where glaciers impacted some valleys, while others remained ice-free, allowing the isolation of glacial impacts to specific river systems. The watersheds that remained free of glaciation serve as a natural control for our experiment. By comparing these control watersheds to those that experienced glaciation, we can isolate and study the glacial impacts. This natural experiment benefits from consistent bedrock composition and tectonic influences across the study area. We predict that downstream of the glacial terminus in previously glaciated watersheds, mean grain size will be larger, and normalized channel steepness will be higher. To test this hypothesis, we measure mean grain size (D50) and normalized channel steepness (Ksn) to understand channel geomorphology and identify variations between previously glaciated watersheds and control watersheds. We calculate Ksn from a 10m DEM. Grain size measurements were collected in the field to quantify channel characteristics not evident in remotely sensed data but that could influence Ksn values. Preliminary results suggest that downstream of the glacial terminus normalized steepness index and grain size are consistently higher when compared to control watersheds, with grain size being 3x greater.

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