EARTH AND ATMOSPHERIC SCIENCES

2023 CROSSROADS CONFERENCE

Crossroads Conference 2023

Indiana University
Earth and Atmospheric Sciences
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Sigma Gamma Epsilon, Rho Chapter

Thomas LaBarge..... Acting President

EAGSA President of Activities..... Charles J. Salcido

SGE Treasurer ..... Mia Keller

Crossroads Committee

Committee Chair ..... Charles J. Salcido

Committee Co-Chair ..... Thomas LaBarge

Judge/Career Liaison..... Garrett Marietta

Judge/Career Logistics..... Sayan Das

Advertising Lead .....Harley Bailey

Catering Lead..... Kenia Caro

Catering Team.....Katie Snodgrass, Wylah Brahaum

Presenter Liaison..... Anupama Chandroth

Welcome

We would like to extend a special thank you to all of those participating in the 21st 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 present our keynote speaker, Darren Tollstrup from Thermo Fisher Scientific. Additionally, 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 2023.

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

Crossroads Judges

Jose Luis Antinao-Rojas ..... Indiana Geological and Water Survey

Jessica Towell.....Arcadis

Cameron Stewart .....Arcadis

Joel Degenstein .....EAS Advisory Board/Retired El Paso E&P

Sarah Pietrazek-Mattner..... EAS Advisory Board/ExxonMobil/The Science Profession

Larry Whitmer..... Retired Wabash Energy

schedule

FRIDAY MARCH 24

MORNING

7:30-8:30..... breakfast + registration	GY 2029
8:30-8:45..... welcome	PATTON ROOM IGWS 2022
8:45-10:00..... oral session 1	PATTON ROOM IGWS 2022
10:00-11:30..... poster session 1	GY 2033
11:30-1:00 ..... career fair + lunch	GY 2029

AFTERNOON

1:00-1:45..... KEYNOTE ADDRESS	PATTON ROOM IGWS 2022
1:45-2:00 ..... break	your choice
2:00-3:00 ..... oral session 2	PATTON ROOM IGWS 2022
3:00-5:00 ..... poster session 2	GY 2033
5:00-6:30 ..... judges meeting	GY 2048
5:00-6:30 ..... break	your choice

EVENING

6:30-9:00 ..... networking dinner and awards ceremony	Crazy Horse 214 W. Kirkwood Ave. Bloomington, IN 47404

keynote speaker

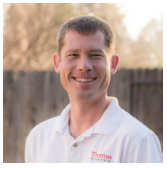
IGWS ROOM 2022
1:00 - 1:45 pm

Title: The Value of an Advanced Earth Science Degree

Darren Tollstrup

IOMS Sales Lead, Americas

Thermo Fisher Scientific



Darren received his Ph.D. in geochemistry from the University of California Santa Cruz, worked as a cosmochemistry Post-Doc at the University of California Davis, and as a research scientist in nuclear forensics at Lawrence Livermore National Laboratory. He joined Thermo Fisher Scientific as a service engineer for inorganic mass spectrometry (IOMS) products in 2011 before transitioning into sales in 2017.

Some recent publications include:

The breakthrough is in what you don't see: Thermo Scientific™ Neoma MS/MS™ MC-ICP-MS.
C Bouman, G Craig, J Roberts, N Lloyd, M Pfeifer, H Wehrs, D Tollstrup. 2022 Goldschmidt Conference

Detecting low levels of radioactive Sr in environmental samples using RPQ-TIMS.
S Wakaki, J Aoki, K Suzuki, T Miyazaki, J Roberts, H Vollstaedt, Y Takagai. 2022 Goldschmidt Conference

In situ 87 Rb–87 Sr analyses of terrestrial and extraterrestrial samples by LA-MC-ICP-MS/MS with double Wien filter and collision cell technologies.

N Dauphas, T Hopp, G Craig, ZJ Zhang, MC Valdes, PR Heck. *Journal of Analytical Atomic Spectrometry* 37 (11), 2420-2441

career fair

GY 2029
11:30 am - 1:00 pm

The following companies will be represented:

Arcadis..... Jessilca Towell, Cameron Stewart, Matthew Griles

Great Plains Institute..... Ryan Kammer

The Science Profession and ExxonMobil .....Sarah Pietrazek-Mattner

Thermo Fisher Scientific..... Darren Tollstrup

oral sessions

IGWS ROOM 2022

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

8:45 am Anne Kort

9:10 am Charles J. Salcido

9:40 am Danielle Peltier

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

2:00 pm Harrison Martin

2:20 pm Jake Gearon

oral session 1

IGWS ROOM 2022

ANNE KORT
Indiana University
Ph.D. Candidate, Paleontology

Photogrammetry and Fortnite®: Epic new tools for 3D digitization and a word of caution about their use

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Abstract: 3D digitization has become a core component of paleontological and archaeological research, but scientists in these fields often use tools designed for other, larger industries out of necessity. Initially, the software and scanning methods used by researchers were primarily designed for engineering and medical applications, but increasingly researchers are adopting software tools aimed at the entertainment industry for use in creating movies and games. Though these tools have exciting applications, the business structures around them pose potential problems for researchers. As a case study, I examined the license agreements and pricing structures of software owned by Epic Games Inc. (Epic®), a major video game developer. In 2021, Epic purchased Reality Capture, a prominent photogrammetry software, and SketchFab, a platform for sharing and viewing 3D models online; both tools are actively used by researchers in paleontology and archaeology. The pricing structure of Reality Capture reflects video game microtransactions, as customers pay per model exported from the software. For quick, occasional scanning needs, this may save money compared to subscription-based software like Metashape. However, cost quickly balloons with size, presenting a problem to researchers working on large scale digitization efforts. For SketchFab, on the other hand, the licensing agreement presents the biggest concern. By uploading a model to SketchFab, the user essentially gives Epic license to use the model however they like. Given Epic's ownership of the Unreal game engine, it is likely that this agreement was implemented to give Epic a continual influx of assets for their games. Researchers, therefore, may need to wary of continuing to use SketchFab if they do not want their models to appear in Fortnite. Although alternatives to both these tools exist, similar issues may continue to appear as photogrammetry and asset libraries become increasingly important in entertainment.

CHARLES J. SALCIDO
Indiana University
Ph.D. Candidate, Paleontology

Functional drivers of evolutionary rates in mandible shape of carnivorous therian mammals: a study using biomechanical modeling and geometric morphometrics

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IU Earth and Atmospheric Sciences

Abstract: Evolution of the mandible in mammalian carnivores is influenced by ecological demands and the phylogenetic history of a clade. Because of this, analysis of functional morphology of the mandible has been used to infer the ecology of extinct mammal species and how mandible shape has evolved in regards to these factors. This study uses geometric morphometrics to assess relative rates of evolution in different parts of the mandible during acquisition of carnivoran in several therian clades including Metatheria, Mesonychia, "Creodonta," and Carnivoramorpha and uses biomechanical modeling to partition the evolution changes into several potential functional biomechanical drivers. Functional variables analyzed include maximum bending force, relative mandibular force in bending (both using the concept of beam theory), and bite force exemplified in measurements such as mechanical advantage. The analysis of the evolution of the shape of the mandible of therian carnivores shows an integrated relationship between the horizontal ramus and the coronoid body of the mandible where the coronoid body shows higher rates of evolution and may be a greater driver of mandible shape than the horizontal ramus. Measured functional variables support that the coronoid body is a greater influence on the overall shape of the mandible. Specifically, mechanical advantage and stress measurements explain more of the variance in shape than the beam theory measurements around the horizontal ramus reflecting the influence of the coronoid body on mandibular shape evolution. Regression of these variables on Procrustes-aligned shape on biomechanical factors show that as the latter get larger, mandibular shape changes by shortening and thickening of the mandible, increasing areas of muscle attachment, and increasing carnassial blade length. However, phylogeny has overall greater ability in explaining shape than ecology and function.

DANIELLE PELTIER
Indiana University
Ph.D. Candidate, Paleontology

Biostratigraphic framework of Bed II, Olduvai Gorge, Tanzania

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IU Earth and Atmospheric Sciences

Abstract: Olduvai Gorge, Tanzania is a prominent paleoanthropological site within an off-axis rift platform basin separated from main East African Rift System by the Ngorongoro Volcanic Highlands (NVH). Of the ~2 Ma exposed sedimentary record, Bed II is of significance because of the appearance of *Homo erectus* and disappearance of Paranthropus *boisei* and *Homo habilis*. Bed II ranges from ~1.8–1.14 Ma and records five major lake transgression-regression cycles coupled with climatic variability, both of which have been a major focus in hominin paleoecological studies. Synsedimentary faulting and NVH volcanism had major impacts on drainage patterns in the basin, including reversal of main drainage direction. These processes also impacted lake size, but their role in hominin paleoecology is less understood. We digitized and georeferenced published stratigraphic cross sections of Bed II localities across the gorge. The cross sections were regionally flattened on primary marker tuffs of Bed II for correlation and identified the major disconformities that separate the five lake sequences. Facies within each sequence were correlated to assign paleoenvironments and depositional changes across the basin. Vertebrate fossil sites were placed within the spatially expanded stratigraphic framework to identify if faunal material was primarily or secondarily deposited, to assess correlations between faunal diversity and depositional environments, and investigate paleohabitat distribution changes. We then identify the spatial and temporal patterns of vertebrate faunal diversity and distribution during an integral period of hominin evolution through this biostratigraphic framework.

oral session 2

IGWS ROOM 2022

HARRISON MARTIN
Indiana University
Ph.D. Candidate, Geomorphology

Point Bar and Cutbank Morphodynamics on a Rapidly Meandering River Revealed by More Than Twenty Drone-based Lidar Scans

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Abstract: Meandering rivers scroll across landscapes by depositing sediment on their inner banks (point bars) and eroding on their outer banks (cutbanks), but the exact way that each of these processes occurs is not well understood. Further, meandering rivers tend not to widen or narrow as they move over long timescales, meaning that both deposition and erosion must happen in roughly equal quantities. Why should this be, and does one cause the other? How long can a river widen or narrow before it has to return towards normal? For the last four years, we have collected high-resolution measurements of a point bar and cutbank on the quickly meandering White River near Worthington, IN, using a lidar sensor attached to a drone. Lidar lets us map landscapes, even when there is vegetation (like forest canopies) in the way of the ground. We have collected 22 of these "bare-earth" surveys so far. We measure the landscape before and after floods, meaning that we can associate specific changes with specific floods, and more generally relate the type and size of change to different flooding intensities. We show how complicated meandering rivers can be when one looks very closely and very often. These results are important because meandering rivers are vital to societies and ecosystems alike as conduits for water, food, nutrients, transportation, recreation, and much more.

JAKE GEARON
Indiana University
Ph.D. Candidate, Sedimentology

Investigating Hypotheses for River Avulsion using Space-Borne Lidar

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Abstract: River avulsions, when a river channel changes its course, pose a threat to human life and long-term food security. Avulsions are thought to initiate by two mechanisms. Alluvial ridge superelevation occurs when the channel bed aggrades above the local floodplain, whereas gradient advantage occurs when the local cross-channel slope is steeper than the down-channel slope. In both cases, the channel is unstable and a trigger is likely to cause an avulsion. Despite the prevalence of these two mechanisms in models and in explanations of why avulsions occur, the existence of these setup conditions, and their relative importance, has not been evaluated across different environments. Here we present a dataset of 65 globally distributed river avulsions and use NASA's ICESat-2, a space-borne lidar satellite launched in 2018 with sub-metre resolution in the horizontal and vertical dimension, to measure superelevation and gradient advantage in low-relief fluvial environments. Superelevation is calculated as the alluvial ridge height divided by channel depth. Gradient advantage is calculated as the ratio of cross-channel to down-channel slope. The spatial distribution of modern avulsions is bimodal, with most observed avulsions occurring less than 5% or greater than 85% of the distance to the mountain front. Superelevation values are high in mountain-front fans and alluvial floodplains (~ 1) but anomalously low in deltas (~ 0.47), particularly low-sloping deltas (~ 0.1). Gradient advantage is lowest on fluvial and alluvial fans (~ 1) and is highest in floodplains (~14) and deltas (~7).

poster sessions

GY 2033

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

Cameron Adams

Sam Anderson

Kenia Caro

Etienne Chenevert

Carter Dills

Silvia Lombardo

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

Nicolas Castro-Perdomo

Anupama Chandroth

JeongYeon Han

Kirsten Hawley

Thomas LaBarge

Ya-Shien Lin (Zax)

poster session 1

GY 2033

CAMERON ADAMS
IU EAS
B.S. Undergraduate,
Geochemistry

Constraints on the Remobilization of Thallium and Fluid-Mineral Interactions During High-Pressure Metamorphism

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IU Earth and Atmospheric Sciences

Abstract: Subduction is a primary driver for the recycling of Earth materials, but the controls on how trace elements are recycled during this process are not well understood. Partial melting of a subducted plate can recycle elements to the surface, resulting in volcanism, or the crustal material may be driven down into the mantle instead, essentially removing material from Earth's surface. Interactions of various fluids with the subducted slab can remobilize elements based on their preference for a fluid or a melt, resulting in elemental suites being lost or appreciably depleted or enriched. Here, we focus on the Schistes Lustrés complex of rocks from the Western Alps. This complex was part of a subduction zone that experienced high-grade metamorphic conditions, marked by pressures (P) of 1.5-3 GPa and temperatures (T) of 300-550°C. During this process, certain mineral phases became unstable, causing them to break down and mobilize elements across mineral assemblages with new, stable mineral phases forming in their place. Exhumation of the subducted rocks preserved mineral phases of interest along the entire subducted path from near-surface conditions to high P-T metamorphic conditions, providing insight into how elements are mobilized through subduction. The primary focus of this research is to use the trace element thallium (Tl) as a proxy to better understand how minerals and rocks evolve through subduction, primarily looking at elemental remobilization. By using the two isotopes of Tl, 205Tl and 203Tl, as well as concentration data, we can monitor how various fluids might have interacted with the subducted slab and remobilized elements through either introduction or removal. Because Tl is very fluid-mobile and redox sensitive, it can track how various types of sediments may be involved in subduction and provide insight into fluid behavior. This allows us to understand fluid conditions, how fluids interact with the subducted slab, and controls on elemental remobilization.

SAM ANDERSON
Indiana University
M.S. Student, Sedimentology

Geoarchaeological Mapping with UAV, SfM Photogrammetry and GIS at Olduvai Gorge, Tanzania

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[3]IU Department of Anthropology

Abstract: Despite Olduvai Gorge, Tanzania being one of the most pivotal sites in the discipline of paleoanthropology, no continuous, detailed, digitally accessible geological map currently exists, complicating outreach, conservation and fieldwork planning efforts. This proof-of -concept project employs imagery of a 3 km sq subset of the gorge captured with consumer-grade UAV technology in the summer of 2022 to generate high-resolution topographic data with SfM photogrammetry. With lithological "control points" provided by previously published stratigraphic columns, a DSM to provide information about variations in the slope of lithological bodies and orthomosaic imagery providing the color and texture of the beds, shapefile datasets representing the extent of geological units were generated in QGIS. As such, this project translates an existing body of geological work that is discrete, point-based and scattered across decades of publications to continuous geospatial data that can be visualized and manipulated with open-source software. The workflow developed for this project is repeatable and scalable, such that producing a geological map of the entire gorge will be feasible after another field season. Future steps with this dataset include linear feature extraction for the detection of lineaments, tracing the lateral extent of previously excavated 'occupational floors' and (upon publication) packaging products for use by the paleoanthropological community.

KENIA YASMIN CARO
Indiana University
B.S. Undergraduate
Petrology/Climate Change

How do changes in precipitation affect volcanic activity at Yellowstone?

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IU Earth and Atmospheric Sciences

Abstract: Yellowstone National Park (YNP), located in the states of Wyoming, Idaho, and Montana, has a diverse setting for geology. YNP is infamously known for its "super volcano" on the Yellowstone Plateau (The Yellowstone Hotspot). The Yellowstone Plateau is the result of an uplift from volcanic and tectonic activity and a collapsed caldera is a feature in the plateau. YNP has had three recent volcanic cycles (between 2.2 Ma and 1.2 Ma) that have created three calderas and two resurgent domes. The most recent eruption of Yellowstone was 77,000 years ago which was a lava flow. Not all eruptions from volcano like Yellowstone are super volcanic eruptions. It is widely accepted that volcanic gases released from volcanoes can impact regional or global climate, but my research works to address whether climate change impacts volcanic activity. To do this, I will look at precipitation changes, geyser activity, and earthquake activity at YNP. The historic records of precipitation in Yellowstone County, Montana show an increase of +1.41 inches per century. The average precipitation change was calculated from data from 1895-2022 (NOAA). Geyser data has been collected to see the frequency of eruptions from various geysers including: Constant Geyser, Steamboat Geyser, and Echinus in the Norris Geyser Basin. I am examining the data to determine if the increase in precipitation in YNP is also correlated to changes in the eruption rates of geysers. If the results point to a correlation between these data, then it can point to a correlation between climate change and geyser activity at Yellowstone. If there is correlation between precipitation and geyser activity, we will further investigate whether this correlation affects other volcanic activity like earthquakes or minor volcanic eruptions.

ETIENNE CHENEVERT
Indiana University
M.S. Student, Geomorphology

Using Explainable Machine Learning to Investigate the Controls of Vertical Accretion on the Mississippi River Deltaic Plain, Louisiana, USA.

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IU Earth and Atmospheric Sciences

Abstract: The interplay between marsh vertical accretion, shallow subsidence, and surface elevation change is crucial for the sustainable management of the Louisiana deltaic plain. Yet, the mechanisms regarding marsh vertical accretion rates remain poorly understood due to the complex interaction of biological, physical, and hydrological processes across a range of spatial and temporal scales. Here, we leverage data from the largest coastal monitoring program in the world, the Louisiana Coastal Reference Monitoring System (CRMS), to study the drivers of vertical accretion across the deltaic plain. We use this dataset to both analyze the influence of each environmental variable on accretion and obtain a predictive model for vertical accretion using machine learning approach. For this study, we chose to use a Bayesian ridge model due to its interpretable properties and performance during testing. We then conduct two experiments. First, we train the model on all data from all the stations and, second, we train three different Bayesian ridge models on four subsets of the data corresponding to the marsh community in which the station resides. Results suggest that accretion is stochastic across the delta and is, therefore, hard to extract a predictive model for it. The best results were obtained for the saline and freshwater marshes, with averaged R-squared values of ~45%. Variables identified as important predictors were NDVI, tidal amplitude, average height of both dominant, total suspended sediment, and soil porewater salinity, and average flood depth. The finding that tides are commonly identified as a key variable in various groups for determining vertical accretion rates, highlights the potential importance of tides even in a microtidal system. Future work includes refining this approach to develop a more generalized understanding of the drivers of sedimentation on this threatened delta.

CARTER DILLS
Indiana University
B.S. Undergraduate, Geophysics

Analysis of earthquake-induced landslides in Costa Rica using a global landslide prediction model

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[3]University of Costa Rica

Abstract: Among the most devastating secondary effects of earthquakes are earthquake-induced landslides (EQIL). We report on observed patterns of EQIL associated with moderate-magnitude earthquakes in Costa Rica: M7.6 Limon 1991, M6.1 Cinchona 2009, and M6.5 Buenavista 1983. In addition, we use a global statistical model to estimate the probability of EQIL occurring in a given area based on factors such as slope, aspect, and lithology as well as a spatial distribution of the intensity of ground shaking from the USGS ShakeMap software. As part of this collaborative study, we have developed a new landslide inventory for the 1983 Buenavista earthquake comprising over 2000 landslides that range from 50 m2 to 0.4 km2 in size and up to 19 km from the epicenter. We note that the landslides follow a power-law distribution, with smaller landslides increasing in frequency up to a completeness threshold. We compare the landslide inventories of these three historical earthquakes in Costa Rica with the model-predicted locations of landslides. We find that the global model algorithm tends to correctly predict areas where EQIL are more likely to occur for each earthquake but overestimates the areal distribution of landslides in these cases. Further research will focus on developing a region-specific model to more accurately predict EQIL location, and in turn to aiding rescue efforts by identifying landslide-prone areas in the immediate aftermath of destructive earthquakes.

SILVIA JOSEFINA LOMBARDO
Indiana University
B.S. Undergraduate,
Atmospheric Sciences

Improving Avalanche Forecasts: Verification and Bias Correction of GFS Precipitation Forecasts in Little Cottonwood Canyon

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Abstract: There are over 50 avalanche paths that cross State Route 210 (SR-210) and pose a threat to highway traffic, buildings, and winter recreationists in Little Cottonwood Canyon (LCC) near Salt Lake City, Utah. To anticipate avalanche hazards along SR-210, accurate winter-storm forecasts are essential. Here we examine the accuracy of quantitative precipitation forecasts (QPF) produced by the Global Forecast System (GFS), relative to manual observations collected by the Alta Ski Patrol at their Alta-Collins snow-study plot. We show that the GFS under forecasts heavy cool-season (October to May) precipitation events, which may reflect the inability of the GFS to adequately resolve the complex terrain of the central Wasatch Range due to its coarse grid spacing (~13 km). To correct for this under-forecasting bias, we applied a down-scaling QPF ratio based on higher resolution, monthly mean precipitation analyses for the central Wasatch, which improved forecasts. These results highlight the importance of down-scaling coarse resolution computer model forecasts in mountainous regions where complex terrain plays a fundamental role in atmospheric processes and precipitation events.

poster session 2

GY 2033

Abstract: Geodetic data are now being used to estimate fault slip rates in the US National Seismic Hazard Model (NSHM) using kinematic models that relate long-term fault slip rates to surface velocities. However, there are still challenges in inferring fault slip rates using geodetic data, especially in regions of diffuse faulting and distributed off-fault deformation, and best practices for incorporating geodetic data in hazard models are still under consideration. Due to a lack of confidence in off-fault strain rate estimates, the 2014 and 2023 NSHM did not incorporate off-fault rates. Here we implement an alternative approach using geodetically-derived strain rates to infer slip rate deficits directly. We aim to address two challenges of working with strain rates: 1. Strain rate inferences are non-unique, and the uncertainties are poorly understood, and 2. Methods to infer slip deficit rate on faults directly from strain rate are underdeveloped. To address these, we compare strain rate maps and uncertainties in the western US using different methods for estimating strain rates from geodetically-derived velocities. We further implement a viscoelastic earthquake cycle model to run inversions of strain rate observations for slip deficit rates on all western US faults included in the NSHM.

NICOLÁS CASTRO-PERDOMO
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Ph.D. Student, Geophysics

Using Geodetically-Derived Strain Rates to Infer Slip Deficit Rates on Faults in the Western US

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ANUPAMA CHANDROTH
Indiana University
Ph.D. Student, Paleontology

Mapping the spatial shift in community structure of shallow water corals in the Caribbean

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Abstract: Corals are key components of ecosystem functioning. The architectural complexity of coral reefs protects coastlines from major storms and waves, and reef ecosystem products contribute billions of dollars worth of resources to the global ecosystem. However, over the last few decades, we have seen large-scale degradation of reefs through bleaching events and diseases as a result of climate change. Conservation practitioners and researchers are actively trying to identify the historical baselines of the reef systems prior to the decline by incorporating paleoecological data; however, a comparison of the current distribution of species might result in an unachievable target. Thus, by establishing a morpho-trait-based community structure we could easily compare historical data and assist in developing a concrete plan for the conservation of coral reefs. Coral functional traits like calcification rate and rugosity index have been used along with the coral cover and species diversity to estimate changes in the coral community as a result of climate change. I hypothesize that a morpho trait-based approach for studying the community will help us determine which traits are more adaptive to an ecoregion. In the poster, I would compare the traditional diversity variations across the Caribbean ecoregions over the last two decades and then use a simple trait-based comparison to visualize its differences and similarities with respect to conventional method.

JEONG YEON HAN
Indiana University
Ph.D. Student, Geomorphology

The Bifurcated Channel Networks in Modern River Deltas depending on Climate

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[1]IU Earth and Atmospheric Sciences

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Abstract: The distributary channel network in river deltas is an important key for revealing the depositional processes where channel bifurcations evolve with combining effects of coastal reworking and the formation of river mouth bars. The mouth bar deposition and the channel bifurcation can be affected by sediment grain size, sediment supply, river discharge, intermittency, vegetation growth, human impact, and climate changes. Using aerial images, I here measured the bifurcation lengths of the main channels in five natural deltas, obtaining that dimensionless and characteristic delta bifurcation lengths end to increase towards semiarid and arctic climate deltas. In those deltas, they have relatively longer bifurcation lengths compared to the deltas in tropical regions. This study focused on the decoupling influence of water temperature that may lead to changes in sediment transport mechanisms and thus organize varying channel-networkpatterns. I suggest that mouth bars in arctic deltas would develop farther away from the channel mouths as low water temperature results in high kinematic viscosity of water and in turn, impedes the settlement of suspended sediment and vice versa. These findings can be useful to understand delta network evolution in different climate settings and predict how climate change in global deltas will change the patterns of the channel network.

KIRSTEN HAWLEY
Indiana University
Ph.D. Student, Geoarchaeology

Geochemical examination of submerged archaeological ceramics from eastern Dominican Republic

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IU Earth and Atmospheric Sciences

Abstract: Archaeologists commonly utilize geochemical methodologies in ceramic provenance studies, which aim to divide ceramics into source groupings based on the idea that different clay sources have distinct compositions. These studies generally assume that there has been little to no post-depositional change to the ceramics and that the geochemical composition of the artifact is a direct proxy for the composition of the original clay source. However, this assumption is not always true, especially in the case of ceramics that are submerged for long periods of time. This project aims to integrate trace element analysis, lead stable isotope analysis, and ceramic petrography to identify post-depositional alterations to submerged archaeological ceramics recovered from freshwater submerged cavern sites in eastern Dominican Republic. Results of trace element analysis indicate that there is significant post-depositional geochemical enrichment of several metals. This poster will present comparisons of trace element and lead isotope data from ceramics recovered from submerged and terrestrial environments, explore mechanisms that may drive lead isotope fractionation in underwater environments, and discuss next steps to integrate raw material analyses. Results of this study will impact the research design of ceramic provenance studies and contribute to knowledge of underwater archaeological site formation.

THOMAS LABARGE
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Ph.D. Student, Paleontology

The Evolutionary Ecology of Gigantism in Terror Birds

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Abstract: Terror birds (Aves, Phorusrhacidae) are an extinct group of large flightless birds with prominent predatory characteristics. How these animals evolved into large apex predators has remained obscure. Here, we estimate a new phylogeny for Phorusrhacidae using Bayesian inference. This tree resolves phorusrhacid systematics for the presence of all five originally hypothesized subfamilies. We find significant support for a distinct crown group associated with the quintessential 'terror bird' characteristics. We use this phylogeny to analyze the evolution of body size and cursoriality. Our results demonstrate that size overlap was rare between co-occurring subfamilies, which supports the hypothesis that these traits were important for niche partitioning. We find that gigantism evolved in a single clade, containing the subfamilies Phorusrhacinae and Brontornithinae. Differences in cursoriality within this clade may have allowed the coexistence of multiple gigantic species: Phorusrhacos longissimus, although gigantic, was significantly smaller and more cursorial than Brontornis burmeisteri, and thus could ecologically coexist with these larger taxa. However, after the apparent extinction of Brontornithinae, phorusrhacines increased in size and became less cursorial, which suggests an ecological succession of the former by the latter. Our findings suggest that the evolution of body size and cursoriality drove terror bird niche partitioning and competitive exclusion controlled phorusrhacid diversity.

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The Dynamics of Bedrock Channel Incision and Lateral Migration under Various Rates and Patterns of Rock Uplift

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Abstract: Landscape evolution, driven by the dynamic interaction of rivers and hillslopes, plays a vital role in the interaction of climate and tectonics. Bedrock rivers can respond to climate and tectonics, preserve evidence of deformation and rock uplift, and record the landscape signature of climate. Therefore, how bedrock rivers respond to tectonics and climate is essential to understanding the evolution of landscapes. The interaction of river and hillslope processes is complicated. The hillslope system provides sediment into the river system, the magnitude of which varies by the gradient of the hillslope which is influenced by the erosion of the river. The sediment in the river system can inhibit or increase channel erosion depending on whether the sediment acts as a protection or a tool in the river. Thus, researchers often turn to numerical modeling to illuminate how rivers evolve across a range of tectonic and climatic environments. Geomorphologists usually use a one-dimensional stream power incision model to quantify a river system, yet these approaches do not account for the 3-dimensional nature of river evolution. Here, we employ a modeling approach that describes the dynamic width and/or lateral migration of a river system and yet maintains computational efficiency to explore river evolution over timescales relevant to mountain development. We use the Smith River, a bedrock meandering river in the Oregon Coast Range, and the McKinley River in central Alaska, a bedrock river incision through a growing anticline, as motivating field areas. We use a modified version of the OTTER model to simulate how a river system adjusts its slope, width, and sinuosity to imposed tectonic and climatic conditions. We model river dynamics through different rock uplift patterns to explore how sediment supply, rock erodibility, and stochastic discharge impact river adjustment through these uplift patterns. Our preliminary results show that the river narrows and steepens through areas of increasing rock uplift; these channel responses in turn affect lateral migration behaviors, allowing a more dynamic representation of bedrock river meandering. This approach will allow us to quantify channel width, slope, and sinuously in response to tectonics and climate, an endeavor not possible with the ubiquitous 1D stream power model.

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