EARTH AND ATMOSPHERIC SCIENCES

CROSSROADS CONFERENCE 2024

Crossroads Conference 2024

Indiana University
Earth and Atmospheric Sciences
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Bloomington IN 47405
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sigmagamma.so.indiana.edu

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Trenton Meier ..... Judge/Career Fair Logistics

Anupama Chandroth, Arif Islam .....Presenter Liaisons

Durga Acharya.....Advertising Lead

Welcome

We would like to extend a special thank you to all of those participating in the 22nd 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 2024.

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

Crossroads Judges

Jon Eldon ..... SPEA, Indiana University Bloomington

Stanley Carpenter ..... Colonial Pipeline Company

Ben Macuga ..... Michael Baker International

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

Mark Fisherkeller ..... Arcadis

Stuart Kenderes.....IUPUI Dept. of Earth Sciences

Sydney Olund ..... Arcadis

Career Fair

IGWS 2022

11:30 am - 1:00 pm

Representatives

Matthew Griles ..... Arcadis

Darren Tollstrup IOMS Sales Manager-Americas
.....Thermo Fisher Scientific

Ryan Kammer Research Manager, Carbon Management
.....Great Plains Institute

Madeline Kelly ..... US Aggregates

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EARTH AND ATMOSPHERIC SCIENCES

schedule

FRIDAY MARCH 22

MORNING

7:30-8:30..... breakfast + registration	PATTON ROOM IGWS 2022
8:30-8:45..... welcome	PATTON ROOM IGWS 2022
8:45-10:30 ..... oral session 1	GY 2033
10:30-12:00 .... poster session 1	PATTON ROOM IGWS 2022
12:00-1:30 ..... career fair + lunch	PATTON ROOM IGWS 2022

AFTERNOON

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

EVENING

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

oral sessions

GY 2023

Session 1 Presenters (8:45-10:030 am)

8:45 am Kenia YasminCaro
9:00 am Yu Peng
9:15 am Ricardo Ely
9:30 am Sierra Lopezalles
9:45 am Kwesi Twentwewa Quagraine

Session 2 Presenters (2:00-3:30 pm)

2:00 pm Sinclaire Zebaze
2:15 pm Janelle Cook
2:30 pm Trent Stegink
2:45 pm Nicolas Castro Perdomo
3:00 pm Xander Lowry

oral session 1

GY 2023

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

What changes are occurring in Yellowstone Caldera's geothermal activity with changes in precipitation?: A Thermal Model Study

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Kenderes, K.M. and Kenderes, S.
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Abstract: Yellowstone Caldera (YC), USA, is an area of geothermal activity fueled by a volcanic hotspot. This study aims to analyze the impacts climate change, specifically precipitation change, has on the hydrothermal system. I do this in three ways: (1) understanding the relationship between precipitation and geyser eruptions, (2) comparison with other volcanic systems, and (3) thermal modeling of the YC. My initial study of the area shows a correlation between rainfall and geyser eruptions. Precipitation data from NOAA shows that annual average precipitation has increased by 1.41 inches over the last century. Geyser eruption events were collected from *geysertimes.org*, a publicly sourced database of geyser eruptions. In comparing geyser eruption and precipitation data, there are trends in geyser activity with increasing precipitation in some geysers. I also compared YC to two other calderas, Valles Caldera (VC) in New Mexico and Long Valley Caldera (LVC) in California, which had more active geothermal activity in the past. Both calderas also once had lakes, now dried up, which altered the hydrothermal system. Presently, NOAA shows that the yearly average recipitation near VC has decreased by 0.79 inches over the last century, and the region of LVC has seen little change. This contrasts sharply with YC, which is generally trending toward increasing precipitation. I propose that VC and LVC can be blueprints for future activity at YC.

Using a two-dimensional thermal cooling model, I am modeling the YC volcanic–hydrothermal systems to better assess the relationship between geyser activity and thermal cooling of the magma chamber. I use a four-layer model: (1) hydrothermally active, altered volcanic upper layer, (2) unaltered volcanic rock, (3) granite crust, and (4) the magma chamber. I vary the upper layer between 0–30 % water saturation. This model will help show the role geyser activity plays in the cooling of the magma chamber.

YU PENG
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PhD Student, Climate Resilience

Synergistic effects of cover crop and no-tillage to greenhouse gas emission under real farming conditions

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Abstract: Agricultural production is a significant contributor to anthropogenic greenhouse gas (GHG) emissions, contributing approximately 1.4-1.7 gigatons of carbon emissions and accounting for more than 60 % of global N_2O emissions. Cover cropping and tillage management have long been touted for their conservation benefits to soil and crop performance. However, previous research has yielded mixed results when combining cover crops and tillage practices in terms of GHG emissions from agricultural soils. The specific contributions of this combination to agricultural GHG emissions remain uncertain. Therefore, while NT and cover crops have been promoted for their conservation benefits, there is the possibility that such gains can be offset by potentially increasing GHG emissions. To address this question, this study conducted field simulation experiments at three farm sites from 2021 to 2023 in northeastern Indiana focused on monitoring and comparing CO_2, N_2O, and CH_4 emissions to assess the variations in GHG emissions under three different treatments: cover crop plus no-till (CCNT), no-till alone (NT), and a control treatment (conventional tillage, CT).

Based on the data, the preliminary results indicate that the utilization of CCNT (1.56±0.33) resulted in 31 % higher global warming potential (GWP) than NT (1.19±0.24). The increased GWP is mainly caused by increased CO_2 emission, especially during the growing season. CO_2 flux under CCNT was measured at 1.84±0.33 g C m^{-2} d^{-1} which is the main contributor to the increase in GWP.

RICARDO ELY
Indiana University
PhD Student, Paleontology

Evaluating Early High Disparity Phenotypic Evolutionary Rates and Modes in Ichthyosauria

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Abstract: Ichthyosaurs, fish-shaped marine reptiles occurring throughout the Mesozoic Era, have been the focus of many studies on the tempo and mode of groups originating in the aftermath of the End Permian Mass Extinction (EPME). Ichthyosaurs evolved an impressive variety of morphologies, rapidly exploiting the ecological opportunities left behind in the wake of the EPME. Ichthyosaur morphological disparity has often been labelled a case of 'early high disparity' (EHD), peaking in the Triassic then decreasing throughout the Mesozoic. Many fossil groups display EHD, a pattern evaluated analytically through a variety of methods, but lack development in the field of phylogenetic comparative methods (PCMs). I introduce a novel PCM which combines two modes frequently utilized in PCMs, the Early Burst (EB) and Ornstein-Uhlenbeck (OU) processes, a combination which produces an EHD pattern. This novel mode is tested here using a time-calibrated set of phylogenies and skull length of ichthyosaurs, since this group has often been described as displaying such a pattern. Using a maximum likelihood framework, I fit three canonical modes of evolution, Brownian Motion (BM), OU, EB, as well as the combined OU+EB (EHD) mode to detect if the latter mode best describes the evolution of ichthyosaur disparity. In a set of 108 ichthyosaur phylogenies, EHD is retrieved as best-fitting in 60 % of trees, and EB in 40 % of trees, although mean AICc scores across the phylogenies indicate EB as best-fitting. We can conclude a strong signature of an EB-like process occurring in the early portions of each tree, with conflicting signal between EHD and EB after the time of highest disparity. Even in cases where EHD best describes the data, peak disparity of ichthyosaurs seems to coincide with changes in abiotic processes influencing the potential strength of geological biases on the true pattern of morphological disparity, such as rock area availability and unconformity biases.

SIERRA LOPEZALLES
Indiana University
Ph.D. Student, Paleontology

The Shape of Speed: The Relationship Between 3d Humerus Shape and Maximum Running Speed

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Abstract: Estimates of running speed are useful for many kinds of paleontological reconstructions, including the co-evolution of predators and prey and inferring the hunting strategies of extinct species, however previous studies have failed to find a significant relationship between skeletal morphology and speed. This study capitalizes on the high degree of variation in morphology and functional ability across domestic dog breeds to investigate whether shape data can be used for estimating running speed effectively. Here I utilize three-dimensional landmark-based geometric morphometrics and the exceptional historical records from competitive dog races to assess the relationship between humerus shape and relative maximum running speed across dog breeds. Selective breeding of dogs has pushed the morphological variation in dog breeds to the extremes, creating breeds with a variety of humeral shapes and a wide range of maximum running speeds from the Basset Hound at 34 km/h to the Grey Hound at 65 km/h. For each breed, maximum running speed was determined using records from the AKC's Fast-CAT, which is a timed 100-yard sprint. Speeds were normalized by calculating their Froude number and then regressed onto shoulder height in order to obtain an accurate metric of breeds that are fast for their size. Results indicate that there is a strong and significant relationship between the maximum relative speed of the breed and shape of the humerus driven by a combination of the shape of the distal articulation and bone robustness ($R2 = .47$, $p < .001$). Overall, breeds that are fast for their size have generally more slender humeri with less curvature in the shaft. Tests of this dog-based predictive equation on wild canids have low error rates (%SEE = 12.9 %, PPE = 12.4 %) and support the use of these methods to estimate locomotor performance in fossil canids. Additionally, this method is applied to estimate maximum running speed in a selection of fossil canids, including the dire wolf.

KWESI TWENTWEWA QUAGRAINE
Indiana University
Ph.D. Student, Atmospheric Science

Similarities in Meteorological Composites Among Different Atmospheric River Detection Tools During Atmospheric River Landfall

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Abstract: Many atmospheric river detectors (ARDTs) have been developed over the past few decades to capture atmospheric rivers (ARs). However, different ARDTs have been observed to capture different frequencies, shapes and sizes of ARs. Due to this, many questions including investigating the underlying phenomena for ARs in the ARDTs have been posed. In this paper, we assess four different ARDTs and investigate the underlying meteorological phenomena during landfalling ARs. We find that during landfalling ARs events, there exists a prevalent low-pressure and high-pressure confluence that enhances moisture influx toward the landfalling site. The strength of the pressure gradient in the confluence region enhances the influx of the integrated vapor transport. The four ARDTs predominantly capture similar atmospheric processes, nonetheless, they have statistically different magnitudes.

oral session 2

GY 2023

SINCLAIRE ZEBAZE
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Ph.D. Student,
Atmospheric Sciences

Spatial and temporal Climatology of Coastal Fog: Insights from RegCM-UW Simulations

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Abstract: This study utilizes the Regional Climate Model (RegCM-UW, enhanced by coupling RegCM with the University of Washington boundary layer model) to simulate fog events along the western coast of the United States. Spatial and temporal analyses reveal the model's success in capturing both the spatial distribution and the diurnal, seasonal, and interannual variability of coastal fog occurrences. Comparisons with observed fog data from select airports further validate the model's ability to replicate the temporal patterns of coastal fog. These findings demonstrate the potential of RegCM-UW as a valuable tool for simulating and investigating coastal fog phenomena.

JANELLE COOK
Indiana University
MSc Student, Geochemistry

A Basalt Dissolution and Clay Precipitation Study: Using Multiple Isotope Tracers to Close Knowledge Gaps in Enhanced Rock Weathering

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Abstract: Enhanced rock weathering (ERW)—the spread of rock dust into croplands for the purpose of CO_2 removal—is currently actively investigated for its feasibility as a climate change mitigation strategy. scaling-up this option globally can potentially capture billions of tons of CO_2 from the atmosphere per year if a fast-weathering material like basalt is used. However, predicting rock weathering at a human time scale is a new challenge; Earth scientists are used to studying weathering at geological time scales (10^5-10^6 years), but are now looking to know ERW effects within their lifetimes.

To meet this objective, I will conduct multiple isotope tracer experiments through dissolving crushed basalts to determine the coupling of basalt dissolution and clay precipitation reactions. We hypothesize that, with the range of fine particles present in industrial basalt feedstocks, the system will quickly be driven to near equilibrium with respect to primary minerals in the basalts and will become supersaturated with respect to many clay minerals. In my experiments, initial solutions will be doped with ^{29}Si and trace element Li. Si release rates will be precisely determined by the temporal evolution of $^{29}Si/^{28}Si$ ratios. Clay precipitation indicated by ^{6}Li and coprecipitation of oxidized ferrous Fe with toxic metals will also be measured. The isotope tracer techniques used will be orders of magnitude more sensitive than conventional concentration methods, which is crucial for measuring the rapid reaction rates of the large particle size range found in ERW applications. The precise unidirectional dissolution rates will better inform us of the reactivity of basalts with widely varying mineral and chemical content, which will eventually lead to the development of a basalt reactivity index. Overall, the results of multi-mineral reaction kinetics will provide a basic science foundation and improve the quality of geochemical modeling predictions of CO_2 removal from months to decades.

TRENT STEGINK
Indiana University
MSc Candidate, Geochemistry

Lead Translocation and Isotopic Fractionation After Uptake by *Brassica juncea* (Brown Mustard)

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Abstract: Despite efforts to limit its introduction into the environment, lead (Pb) remains a concerning pollutant for many communities. The utilization of phytoremediation has drawn interest to control the spread of Pb contamination as an alternative to other, more costly and invasive remediation techniques. Additionally, Pb within these plants may be analyzed to detect unique isotopic signatures related to certain contamination sources, providing a way to trace Pb within the soil back to its origin. However, the behavior of Pb during plant uptake is still poorly understood, particularly as it pertains to plant isotopic fractionation patterns and whether they can accurately reflect unique geogenic or anthropogenic sources of contamination. Here, we characterize concentrations and changes in plant Pb ratios during uptake and to determine the feasibility of bioremediation and isotopic fingerprinting for Pb sourcing in *Brassica juncea,* a known accumulator of Pb. Results demonstrate significant translocation of Pb from the roots to the leaves, showing a mean leaf translocation factor of 3.64. Other above-ground parts' translocation factors were consistently below 1 (TF = 0.40, on average). Results also show little biologically induced isotopic fractionation of Pb during uptake. Above-ground part Pb^{206}/Pb^{207} (1.17 – 1.19) were within range of initial substrate values (1.14 – 1.18), though the roots did show a significant enrichment in Pb^{206} (1.21 – 1.22). We were unable to differentiate plants grown from each treated substrate, making them unreliable for the isotopic fingerprinting of the soil. This confirms the limitations of *B. juncea* as a phytoextractor and biomonitoring apparatus, but demonstrates a greater than expected ability to translocate Pb to its above-ground parts.

NICOLAS CASTRO PERDOMO
Indiana University
PhD Student, Geophysics

Slip Deficit Rate Inversions in the Eastern Mediterranean from GNSS-Derived Strain Rates

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Department of Earth and Atmospheric Sciences, Indiana University

Abstract: The Eastern Mediterranean's complex tectonics, involving numerous plates and regimes, presents an ideal setting for investigating crustal deformation and earthquake hazards. Despite recent enhancements in GNSS station density, comprehensive analyses of both on-fault and off-fault deformation on a continental scale are still lacking. Here, we leverage GNSS-derived strain rates to estimate slip deficit rates on 581 faults in the Eastern Mediterranean and model off-fault deformation through distributed moment sources. Our findings reveal that about 50 % of the observed surface strain rates can be explained by elastic coupling on faults and distributed off-fault deformation, with roughly 90 % of the moment accumulation rate taking place on faults and the remaining 10 % off-fault. Notably, the North Anatolian Fault (NAF) displays the highest slip deficit rates, up to 25 mm/yr. We also show this fault displays previously undocumented variations in slip deficit rates, indicating possible along-strike changes in fault coupling.

XANDER LOWRY
Indiana University
Undergraduate Student,
Atmospheric Sciences

Extreme Rapid Intensification of Hurricanes Otis (2023) and Patricia (2015): Machine Learning Diagnoses

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Abstract: Hurricane Otis (2023) presented a particular event for which all current operational hurricane models failed to predict its rapid intensification (RI) repeatedly cycle after cycle. In contrast, the RI onset of Hurricane Patricia (2015), which occurred almost within the same period and location in the Eastern Pacific basin, was much more predictable across operational models. While Otis's extreme RI magnitude in a very short period has always been challenging for models to capture, the fact that the previous generation of hurricane models could capture the even more extreme RI of Hurricane Patricia apparently highlights some missing ingredients in Otis that we wish to explore. Using different architectures of classification and deep learning models, we find an effective combination of environmental features that control the probability of RI onset for both hurricanes Otis and Patricia. Specifically, by trying different groups of environmental features along Otis's track, we show it is the combination of Otis's bigger storm size, stronger vertical wind shear, and slower storm moving speed that is the main cause for the failure of Otis's RI prediction in the model. Decreasing Otis's size and increasing its movement in a weaker shear environment could help improve its RI onset prediction significantly. These results suggest that the failure of operational hurricane models may be due to the large-scale flow inherited from global models when imposing on the larger size of Otis. Our approach presents a new diagnostic approach for RI prediction based on machine learning, as well as a different way to understand RI onset variability beyond the traditional ensemble modeling methods.

poster sessions

IGWS 2022

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

Anupama Chandroth

Ping-Chen Chiang

Syan Das

James H. Gearon

JeongYeon Han

Moses Jatta

Mia Keller

Zax Lin

Sasha Marfin

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

Trung Nguyen

Yu Peng

Brianna Pinnick

Varin Radia

Charles J. Salcido

Samantha Sheahan

Hong Tan

Brooke Vander Pas

Therra Wilbrandt

poster session 1

IGWS 2022

ANUPAMA CHANDROTH
Indiana University
PhD Student, Paleontology

Impact of Morpho-functional group redundancy on the origination and extinction of Caribbean corals

Chandroth, Anupama and
Johnson, Claudia C.
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Abstract: Using Scleractinian growth forms for modern and fossil hermatypic corals, we analyze morpho-functional groups in the Caribbean and assess their impact on macroevolutionary trends. Occurrences of shallow water corals of the Caribbean region was extracted from published literature and Paleobiology Database (PBDB). A species can express more than one growth form, so we use a presence-absence matrix of growth forms to establish morphofunctional groups. A PCOA was performed on the morpho-functional groups to map their locations and visualize shifts over time and space across the Caribbean. We identified a total of 15 and 17 functional groups of the 127 possible combinations for 58 extant and 502 fossil species, respectively. Branching and massive related groups emerged as the largest occupants in both the extant and fossil data. We noticed that in the fossil record 49.4 % of the species belonged to Massive adjacent groups, and it has remained the dominant group throughout Cenozoic. This implies that present-day dominance of massive groups could be associated with its historical functional redundancy. Additionally, the trajectory of morpho- functional groups through the Cenozoic follows the general trajectory of reef development, thus potentially achieving reef stability in this region.

Our study revealed that despite diversity and population of massive groups they did not show any significant impact on either extinction or emergence. We did not observe a significant change among the individuals within a group, which implies that biotic interaction does not play a significant role in the origination or extinction of species within a morpho-functional group and thus indicating the co-existence of similar species. However, we noticed multiple groups such as branching, laminar_massive had a significant impact on the extinction of the co-exiting groups, suggesting that their present-day decline would severely impact the survival and proliferation of other functional groups.

Present-day to Millennial Timescale Plate Kinematics of Mountain Building Across Taiwan

PING-CHEN CHIANG
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MSc Student, Geophysics

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Abstract: Understanding slip rates in active orogens is crucial for understanding mountain-building processes and assessing earthquake hazards. However, previous studies in Taiwan and most mountain belts, globally, rely primarily on horizontal geodetic velocities to estimate slip rates, neglecting the significance of vertical deformation in active orogenic regions. To address this gap, we utilized a 3D lithospheric kinematic plate modeling approach from Johnson *et al.* (2020) in Taiwan. Unlike the traditional block modeling approach, our plate model combines an elastic upper crust overlying an inviscid lower crust and mantle to incorporate vertical motion through fault slip and associated plate flexure. We employed a Bayesian approach to invert fault slip rates, including strike-slip and dip-slip motions, and interseismic locking distributions on faults constrained by short-term horizontal (GPS), short-term vertical (GPS and leveling), and long-term vertical (rock uplift and river incision) rates. The Monte Carlo-Metropolis sampling algorithm is used to generate a discrete representation of the posterior distribution of these parameters. Our inversion method with the kinematic model identified the distribution of slip rates across the entire Taiwan plate boundary, providing valuable insights into the mechanics of mountain building and earthquake behavior in the Taiwan fold-and-thrust belt. Our model explains the overall pattern of crustal deformation, as evidenced by geodetic and geological data across the fold-and-thrust belt and longitudinal valley suture zone. However, we identify systematic misfits to the geodetic data along with high slip rates compared to geology in the southwestern fold-thrust belt and the longitudinal valley suture zone. We can explain much of the systematic misfit with a model for distributed off-fault deformation.

SAYAN DAS
Indiana University
PhD Student, Geomorphology

Disentangling the relationship between tectonic uplift, channel morphology and sediment grain size

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Abstract: Evolution of orogenic landscapes occurs in response to the complex interaction between tectonics and climate. The bedrock rivers draining through the landscape propagate sediment from hillslope and erode the uplifted underlying bedrock. Thus, their local morphology preserves evidence of local drivers, such as rock uplift, lithology, and upstream erosional patterns. Disentangling the influence of these factors over bedrock channel morphology remains an important problem in tectonic geomorphology. The arccontinental collisional orogen of Taiwan provides a natural laboratory for addressing this problem as it is characterized by high seismicity, large gradients of exhumation rates, relatively uniform precipitation with frequent typhoons, and high relief dominated by landslides and fluvial processes. To understand the role of grain size on topography, we collected fluvial grain size data in Central Taiwan across varying lithologies to compare to channel morphology and rates of tectonic rock-uplift. We categorize the data based on the major geological divisions - Hsuehshan Range (HR), Slate belt (SB), Metamorphic complex (MC) and Western Foothills (WF). Testing the sensitivity of the grain size data with rock uplift and morphometric parameters while constraining lithology leads to various first-order conclusions-the largest drainage basins in pre-Tertiary MC produces the coarsest grains (D50: 10.6 cm), while, the smallest basins of WF exhibit the smallest grain size (D50: 3.4 cm). Local channel steepness exhibits variable trends between geological divisions which can be attributed to long term rock uplift. Combining with previous research, the results allow us to analyze orogen-wide grain size patterns which on comparison with local channel morphology and transport capacity, provides valuable insights on the underlying physical mechanism and influence of tectonic uplift on deformation patterns in Central Taiwan.

JAMES H. GEARON
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PhD Student, Geomorphology

Moving past planform morphologies by characterizing the vertical dimension of the world's rivers

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Abstract: Alluvial rivers are three-dimensional systems that are often represented in two dimensions—in planform or crosssection. As a result, the down-stream evolution of a river's vertical near-channel relief remains unknown. However, over the past decade, advancements in the acquisition, transmission, and analysis of remote-sensing data have opened new horizons for fluvial sedimentological research. This has been especially facilitated by the large-scale harmonization of petabytes of remote earth observation data, permitting unprecedented investigations into Earth's surface dynamics. Moreover, the bare-earth accuracy of global Digital Terrain Models (DTMs) has increased, allowing for a first-order analysis of the distribution of surface elevations around active rivers. Making use of several global vector compilations of river centerlines (SWORD and GRWL) as well as algorithmically corrected DTMs (MERIT and FABDEM), we assess directly both the elevation distribution (hypsometry) at discrete intervals along the river as well as the dimensional difference between median elevations close to the river (generally 1.1 to 2.5 channel widths) and further away (~ 3 to 6 channel widths). We find that rivers generally oscillate around mean values of vertical relief (possibly reflective of average alluvial ridge elevations) that appear constant over long reaches of the river, only changing substantially when encountering a valley-exit or just before the shoreline, indicating a cross-scale interplay of alluvial geometries and their hard-to-study vertical dimensions. Future work aims toward a global dataset of nearchannel relief built on existing hydrological river datasets.

JEONG YEON HAN
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PhD Student, Sedimentology

Decoupling in-channel and levee sedimentation in a morphodynamic model of a channel-floodplain system

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Abstract: The erosion, distribution, and storage of sediment occur at the margin of the channel and floodplain. This set of processes generates natural levees which, when breached, release water and sediment to the floodplain, creating crevasse splays or avulsions. Despite the importance of levees, which dictate the floodplain construction and channel mobility, their growth is poorly understood and no model can fully explain dynamic channel-levee evolution. A common simplifying assumption is to set levee and in-channel aggradation rates equally, yet observations indicate otherwise. Here we use a one-dimensional numerical model to create levees with an advection settling equation to quantitatively investigate levee growth decoupled from channel bed aggradation. In our model, we consider two flood mechanisms: 1) when the elevation of overflow exceeds the levee crest height (i.e., frontloading); and 2) when the flooded level is lower than the levee crest height resulting in partial inundation of the distal levee deposits (i.e., backloading). The initial levees aggrade rapidly, which confines the channel, increases bankfull depth and reduces floods. In response to confinement, the channel bed aggrades until the bankfull depth recovers a value close to its initial condition, after which flood frequency increases. This releasing process further promotes overflows, increasing sediment flux onto the floodplain. It suggests aggradational channels undergo confined-release phases of sediment delivery to the floodplain with episodic levee growth and fluctuations in bankfull depth. The number of backloading and confined-release phases are mainly controlled by the in-channel aggradation rate. Rapid in-channel aggradation facilitates more backloading stages and confined-release phases over time. Our results imply avulsions might preferentially occur in decoupled channel-levee systems, which have relatively rapid in-channel aggradation with increasing confined-release processes.

Tracing Microbial Footprints In Greenland's Subglacial Naled Ice Meltwater: An Isotopic Perspective

MOSES JATTA
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MSc Student, Geochemistry

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[3]University of Minnesota

Abstract: The Greenland Ice Sheet (GrIS) is rapidly melting, reaching 42 Gt of ice per year over the last two decades. This meltwater, emerging at the glacier terminus, undergoes chemical changes forming naledi ice platforms. Our study focuses on Isunnguata Sermia in western Greenland, a significant outlet of the GrIS, crucial for understanding climate impacts on ocean circulation, sea levels, and weather patterns.

We investigate naledi alongside subglacial meltwater to understand geomicrobiology's role in meltwater chemistry, crucial as flow conditions shift. We aim to use naled ice to trace subglacial conduits, microbial activity, and seasonal variations. Analyzing sulfate and dissolved inorganic carbon isotopes will differentiate microbial from mineral processes, despite challenges posed by similar isotopic signatures.

Our hypothesis suggests microbial activity increases during winter-to-spring transitions under limited oxygen conditions, resulting in $\delta^{34}S\text{-}SO_4$ and $\delta^{18}O\text{-}SO_4$ increases and $\delta^{13}C\text{-}DIC$ decreases. Conversely, warmer seasons promote mineral erosion, leading to decreases in all isotopes, particularly if pyrite oxidizes.

Initial findings indicate high sulfate concentrations during spring melt, indicating potential pyrite oxidation. Our research promises insights into temporal and environmental factors shaping meltwater chemistry in West Greenland.

MIA KELLER
Indiana University
Undergraduate, Geohazards

Flood Risk in British Columbia

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[1]Hurst, J. and [2]Hedrick, T.J.

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Abstract: In this report, we investigate the factors contributing to flood hazard in British Columbia and their impacts on health, infrastructure, economy, and the environment. We identify the Fraser River Valley as a particularly high-risk area of potential flood risk with impacts on US citizens. We detail Canadian government resources pertaining to flood forecasting, risk mitigation, and preparedness strategies. Using the devastating November 2021 flood in southern British Columbia as a case study, we assess challenges in disaster management and analyze emergency communication strategies utilized during such events. We provide recommendations for the Consulate, including leveraging available resources through the Consulate's social media platforms during significant flood events; educating American citizens regarding flood risk in British Columbia through educational materials; and integration of real-time flood warning systems and educational resources onto the Consulate's website.

Figure 3 - a bridge washed away at Carolin Mine interchange with Coquihalla Highway 5 near Hope, B.C. due to extreme flooding during November of 2021. (photo from Baum et al. 2021

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Characterizing sinuosity in the Oregon Coastal Range for enhanced landscape evolution insights

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Abstract: Interaction between climatic and tectonic forces shapes the process of landscape evolution, with bedrock channels playing a key role.Bedrock channels can respond to climate and tectonic activity, preserving traces of deformation and rock uplift while also embodying the landscape's climate history in morphological features such as slope and sinuosity. Understanding these responses is vital for decoding the complexities of landscape evolution. Our focus here is understanding channel sinuosity, an important but often overlooked morphological feature of bedrock rivers. Traditional models, like the one-dimensional stream power incision model, tend to simplify the intricate processes that shape the 2D planform of a river system, neglecting the influence of sinuosity on the landscape. This is a critical oversight, given that, for a given channel slope, meandering channels can generate a higher relief than straight channels, highlighting the influential role of sinuosity in landscape evolution. To address the influence of sinuosity on landscape evolution, we have developed a novel framework which not only recognizes the significant impact of sinuosity but also quantifies the distribution of energy and geomorphic work along the lateral and vertical axes of river channels. Using lidar data, we have examined the morphology of more than 10 basins across a gradient in tectonic rock-uplift within the Oregon Coastal Range (OCR). Our analysis leverages this rich geomorphologic dataset to investigate the correlation between drainage size and energy allocation. Preliminary findings reveal a rise in the proportion of geomorphic energy expended on lateral erosion relative to vertical incision as drainage area increases in the OCR. Furthermore, our data highlights that channels with larger drainage areas show higher sinuosity, and those with steeper slopes exhibit lower sinuosity. These observations suggest that sinuosity may be influenced by factors such as rock uplift rate and lithology.

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Heterogeneity of the mantle beneath the Kamchatka arc: Tl isotope evidence

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Abstract: Arc magmatism plays a crucial role in generating continental crust and in mass transfer between surface and mantle. A subducting slab is often highly enriched in volatiles such as water, sulfur, and carbon dioxide, which may be lost, along with fluid-mobile elements, during subduction as water-rich mineral phases become unstable at higher pressure, resulting in a slab-derived fluid. These fluids interact with and metasomatize the overlying mantle, known as the mantle wedge, subsequently enriching the magmatic source feeding the arc volcanic system. To track this process, nontraditional stable isotope systems such as molybdenum, lithium, boron, and others are widely used. Here we present thallium (Tl) isotopic compositions (shown as ε^{205}Tl, which is ^{205}Tl/^{203}Tl relative to SRM NIST 997) and trace element data from the north Kamchatka arc setting for 11 Bezymianny volcano (BV) basaltic andesite samples and five mantle wedge spinel harzburgite xenoliths. BV is an andesitic volcano located in the Klyuchevskaya group of volcanoes, with a slab depth of approximately 180 km and a subduction rate of around 8 cm/year. All studied volcanic samples are K-medium basaltic andesite and are characterized by flat rare earth element (REE) distribution (normalized to chondrite), Gd/Yb ~ 1.5, La/Sm ~ 2, Th/Yb ~ 0.5, Nd/Hf ~4.5 and Sr/Y ~ 18.5, which is consistent with Kamchatka volcanic rocks. Basaltic andesite ε^{205}Tl values are indistinct from that of the mantle, ranging from -2.7 to -1.1 (average ε^{205}Tl = -1.5±1, n=11). Peridotite xenoliths have a flat REE distribution pattern and high Ni and Cr content (greater than 1,500 ppm). Here, ε^{205}Tl values vary significantly, from -1.8 to 18.2. We interpret this ε^{205}Tl variation to be the result of multistage metasomatism by isotopically heavy dehydration slab fluids during subduction.

poster session 2

IGWS 2022

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Future intensity-duration-frequency curves of extreme precipitation in the Midwest United States

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Abstract: During the last four decades, global warming has exaggerated extreme precipitation over most of the United States, particularly in the Midwest region (defined here as the region covering Illinois, Indiana, Ohio and Kentucky). To enable climate change adaptation and resilience among various economic-societal sectors, we need updated information on how climate will change in the future. This study introduces a framework to construct the intensity-duration-frequency (IDF) curves of heavy precipitation, which are prominent tools for infrastructure design and water resources management. This framework takes advantage of a 150-year dynamical downscaling dataset at convection-permitting resolution, as well as hourly *in sit*u observations, to generate IDF curves at both sub-daily and multi-day duration. A modified quantile mapping bias-correction technique and the assumption of non-stationary in the distribution parameter fitting process are implemented in this workflow. In comparison with historical IDF curves of 1980–2022, the future projected IDF curves based on the RCP8.5 scenario, during 2058–2100 over 74 stations, show an increase of 10 to 20 % in intensity over most of stations and during all four seasons of interest.

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Synergistic effects of cover crop and no-tillage to greenhouse gas emission under real farming conditions

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Abstract: Agricultural production is a significant contributor to anthropogenic greenhouse gas (GHG) emissions, contributing approximately 1.4-1.7 gigatons of carbon emissions and accounting for more than 60 % of global N_2O emissions. Cover cropping and tillage management have long been touted for their conservation benefits to soil and crop performance. However, previous research has yielded mixed results when combining cover crops and tillage practices in terms of GHG emissions from agricultural soils. The specific contributions of this combination to agricultural GHG emissions remain uncertain. Therefore, while NT and cover crops have been promoted for their conservation benefits, there is the possibility that such gains can be offset by potentially increasing GHG emissions. To address this question, this study conducted field simulation experiments at three farm sites from 2021 to 2023 in northeastern Indiana focused on monitoring and comparing CO_2, N_2O, and CH_4 emissions to assess the variations in GHG emissions under three different treatments: cover crop plus no-till (CCNT), no-till alone (NT), and a control treatment (conventional tillage, CT).

Based on the data, the preliminary results indicate that the utilization of CCNT (1.56±0.33) resulted in 31 % higher global warming potential (GWP) than NT (1.19±0.24). The increased GWP is mainly caused by increased CO_2 emission, especially during the growing season. CO_2 flux under CCNT was measured at 1.84±0.33 g C m^{-2} d^{-1} which is the main contributor to the increase in GWP.

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The impacts of Combined Sewer Overflow (CSO) events on microbial water quality in urban waterways

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Abstract: Current research findings show that the effluent received in urban waterways from CSO events affects the bacterial and viral load (Arnone et al. 2007). This poses serious health risks to the people that interact with these waterways and the other organisms that rely on it. Fecal coliform bacteria such as Escherichia coli is a useful indicator often used for the presence of sewage and potential pathogens but this is still not enough to determine the health risks associated with fecal pathogens present. Therefore, the aim of this research is to quantify and characterize the fecal coliform present in the Pleasant Run Waterway in Indianapolis, Indiana. Water samples were collected before and after precipitation events at sampling sites along the Pleasant Run Waterway. A Qiagen DNA extraction kit was used to extract DNA from the water samples which were then sent for 16S rDNA at Creative Biogene facilities.

The preliminary data showed observable differences in the type of microbes present during wet and dry events and the relative abundance. Overall, the relative abundance of species present in samples collected after a precipitation event was more than twice that of samples that did not experience a precipitation event. Additionally, the results showed that opportunistic bacteria and pathogenic bacteria were present in some of the samples analyzed. One notable observation was the pathogenic bacteria shigella present in three of the samples. In conclusion, the results show that CSO events significantly affect the microbial water quality of urban waterways,emphasizing the need for proper mitigation strategies to safeguard public health and environmental integrity.

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Channel Response to an Anthropogenic Water Diversion in Dump Creek

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Abstract: The study of channel response to anthropogenic events is crucial for effective landscape management as it helps understand how human activities impact river systems and guides strategies to mitigate adverse effects on ecosystems and water resources. Within Idaho's Salmon National Forest, the Dump Creek channel has eroded at an accelerated rate, greatly impacting the Salmon River. Evidence suggests this increase in erosion was caused by hydraulic mining. In 1897, a tunnel was driven from the Dump Creek drainage area and tapped Moose Creek, resulting in a water diversion. Due to this diversion, large volumes of material are continuously deposited into Dump Creek from massive slope failures. This material is transported into the Salmon River, where it causes gravel bar buildup, channel change, slope undermining, and degradation of water quality. By comparing satellite imagery and a DEM over the Dump Creek Channel, the area shows an increase of 36 % between 1947 and 2019. This DEM was also used to estimate the amount of erosion and aggradation as of 2019. The volume of material deposited in the channel from each landslide is estimated by interpolating each landslide area. By taking cross-sections across the channel and projecting a predicted elevation, representing the channel profile before the water diversion, the amount of erosion and aggradation throughout the channel is estimated. Cross-sections are also taken in a control channel, Boulder Creek, at points where the drainage area matched that of Dump Creek. These profiles compare the width difference between the two channels to visualize the impact of the Dump Creek erosional event. Even a century later, this event is still changing the landscape and causing adverse impacts.

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Warming Seas: Analyzing the Link Between Local Sea Surface Temperature Anomalies and Tropical Cyclone Activity

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Abstract: This study examines the relationship between higher local sea surface temperatures (SSTs) and tropical cyclone formation, focusing on regions with SST deviations from the mean. It assesses how these anomalies may influence cyclone activity through data collection, analysis, and visualization. The goal is to better understand climate change's impact on cyclone patterns, contributing to improved prediction and mitigation strategies.

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A paleontological resource inventory of Theodore Roosevelt National Park reveal potential for future vertebrate paleontological research and management

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Abstract: An increasing awareness of paleontological resources in national parks has been followed by an increase in National Park Service (NPS) paleontological inventories to better manage such resources. Theodore Roosevelt National Park (THRO), established in 1947 and located in western North Dakota, preserves portions of badlands containing the Bullion Creek Formation and Sentinel Butte Formation representing six million years of deposition during the Paleocene. Paleontological studies of these formations have been primarily outside of park boundaries and have documented various plants, invertebrate, and vertebrate taxa. Previous surveys of the park showed that these units in the park's boundaries have been very fossiliferous with petrified wood being a known feature and a 1994–1996 survey that recorded 400 localities. This highlights THRO's importance as an area with great potential for scientifically significant material as it is one of the few park units in the NPS system that contains Paleocene fossil-bearing geological units, and only one of two with substantial Paleocene terrestrial records.

The author conducted a survey of THRO in 2020–2021 to create a paleontological resource inventory to determine the scope, significance, distribution, and management issues associated with fossil resources in the park. The survey included 14 weeks of fieldwork which recorded 158 localities over 9.1 km^2 of the park in both the North and South Units. Over 75 % of the localities were from the Sentinel Butte Formation. This survey has shown that the park's geologic units are as fossiliferous as they were in past surveys and has yielded previously unidentified taxa within the park's boundaries. These included two mammalian taxa, one avian chnotaxon, and high-yield fossils.

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Assessing the viability of phosphorus fertilizer rate reduction as a water quality protection strategy in agricultural watersheds of the US Midwest.

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Abstract: The export of nutrients such as phosphorus (P) and nitrogen (N) from intensively managed croplands of the US Midwest has been linked to water quality degradation and the eutrophication of aquatic ecosystems, an ecological condition marked by excessive growth of nuisance algae. Previously evaluated land management strategies (no-till, cover crop) have yielded mixed results in terms of their capacity to reduce nutrient loss from cropland. An edge-of-field study was conducted to assess whether crop yield can be sustained, and agricultural P loading can be reduced with application of less P fertilizer. The study sites (Central Indiana, USA) include two adjacent agricultural fields under the same tillage (no-till) and crop rotation (corn-soybean), but different P fertilizer management. Both fields (West and East) received P fertilizer at the Tri-State recommended rate of 78 kg P/ha in 2016-2017. Starting in 2018, the West field continued to receive P at the recommended rate while the East field was switched to a lower rate of 22 kg P/ha. At its outlet, each field was equipped with flumes, flow sensors, and auto-samplers for continuous collection of both surface and subsurface tile water samples. Samples were analyzed for sediment concentration, nitrate, soluble reactive phosphorus (SRP), and total dissolved P (TDP). Results showed that nutrient loss occurred primarily through subsurface tile drainage for both P and N. With implementation of precision P fertilizer management (70 % reduction in application rate) in the East field, a sharp decline (>85 %) in TDP flux was recorded. The drop in TDP flux was from 4.9 to 0.3 for tile discharge and from 0.18 to 0.03 kg P/ha/yr for surface runoff. These results suggest that P fertilizer rate reduction could be a promising strategy to protect water quality in the regions, but additional research at sites under conventional tillage is needed. Most importantly, the impact of the strategy on crop yield requires further investigation.

Nature of Geoscience Education Research: 2-day Lesson

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Abstract: To better educate the new generation of students on what geoscience is and how it operates, structural education curriculums need to be implemented. By giving students opportunities to discuss with their classmates, do research on case studies, and participate in group activities, it will help improve their critical thinking skills and their knowledge relating to the Nature of Geoscience. Yes, we can agree that we can learn through listening to lectures; however, involving activities that require thinking and sharing opinions with others help set the students up for success. In this study, a two-day Nature of Geoscience Education series was conducted in the "Earth and Our Environment" course to help tudents understand the nature of geoscience. Qualitative surveys through student reflections (N=38) were conducted before and after the two days of Nature of Geoscience education series to gauge students' understanding of the nature of geoscience. The analysis of students' pre-and-post reflections and interviews indicate that students' perspective of the Nature Geoscience's work relating to what geoscientists do, development of knowledge, and issues of diversity improved after the career panel. This presentation will highlight what the students learned through the group activities, case studies, and how the in-class lectures changed their perspectives on geoscience and provide implications for geoscience education.

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Late Ordovician Environmental Dynamics in the Cincinnati Region: New Evidence of the HICE from a Shallow-Marine Sequence in Indiana, USA

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Abstract: The Ordovician period was a pivotal era characterized by significant climatic, geologic, and evolutionary transformations. The transition from an Early Ordovician "hot-house" climate to a Late Ordovician "ice-house" condition, marked by glaciation and cooling, led to major environmental changes, increased biodiversity (GOBE), and a mass extinction event. This mass extinction, one of the "big five" in Earth's history, resulted in the loss of up to 50 % of genera and a staggering 85 % of marine species. In addition, the first appearance and colonization of land plants during the Ordovician may have had extensive consequences on terrestrial and marine ecosystems including fluctuations in atmospheric CO_2 and O_2 concentrations and periods of increased organic carbon burial rates, and subsequent anoxia, evident in two Late Ordovician global positive carbon isotope excursions (GICE and HICE). The evolution of land plants, particularly their ability to reduce CO_2 levels through enhanced calcium-magnesium silicate weathering, including extensive shallow-water phosphate deposits from the Late Ordovician, has been proposed as an important contributor for the decrease in atmospheric CO_2 and subsequent cooling during the Ordovician. Our study focuses on an end- Ordovician sequence collected from the IMI Pendleton Quarry in Indiana, comprised of interbedded dolostones, limestones, and shales, indicative of shallow marine facies. $\delta^{13}C_{carb}$ values show a ~4.5 ‰ excursion in the upper sediments after a period of relatively stable values. This is reminiscent of the HICE and is likely some of the first evidence of the HICE in the Cincinnati region. There is also evidence of local-scale nutrient loading with P/Ti and P/Al showing a sustained period of enhanced nutrient flux. In addition, $\delta^{34}S_{pyrite}$ values do not reflect the global parallel positive excursion seen in other records. Instead, it is probable that they were influenced by local-scale processes,

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Exploring Iron Dynamics Along the Atlantic Mid-Ocean Ridge: A Sequential Extraction Approach

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Abstract: The Atlantic Mid-Ocean Ridge is the cause of new seafloor being created via the Wilson Cycle. This seafloor gives a unique look into how processes in a specific place have changed over geologic time. The sites that were chosen for the 390/393 expeditions range from 6.6 Ma to about 60 Ma. The samples taken give the chance to study how processes have changed overtime. Site U1559 is the youngest, located closest to the Mid Atlantic Ridge, and site U1556 is the oldest and located furthest from the ridge. By analyzing the data and studying the distribution of the different iron species via the sequential iron extraction process, can give insight into the geochemical processes that have influenced and altered the iron minerals in the samples. By performing the sequential iron extraction iron speciation will be known and past processes and conditions will be known. The hypothesis is that the iron species will reveal how influential hydrothermal activity has influenced the samples, as well as mineralogical data. The ratio of Fe^{2} to Fe^{3} will indicate how oxidizing or reducing the environment was.

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