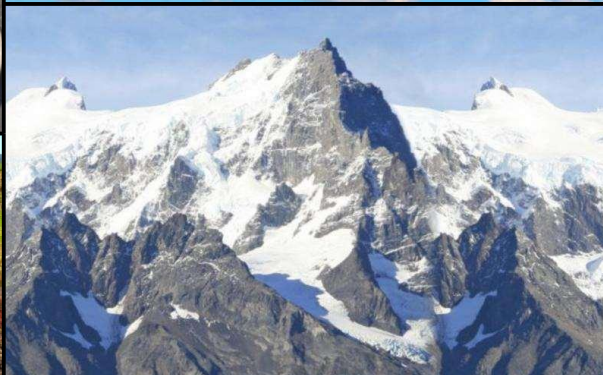
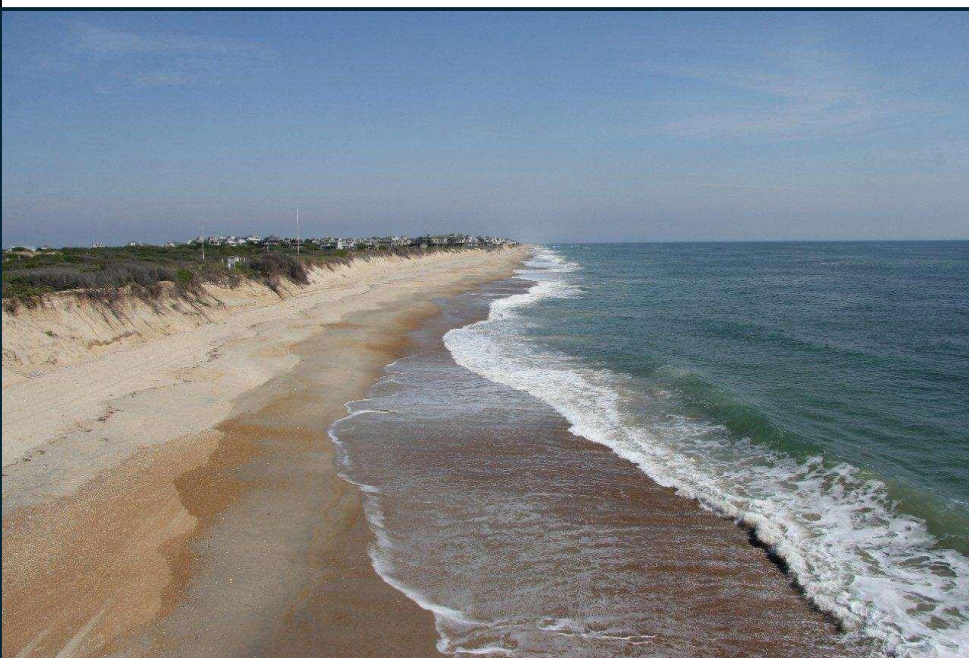
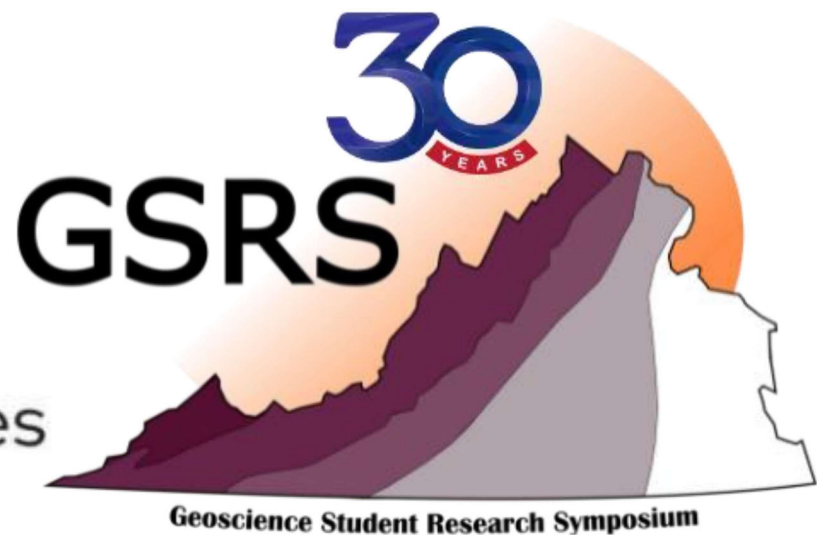
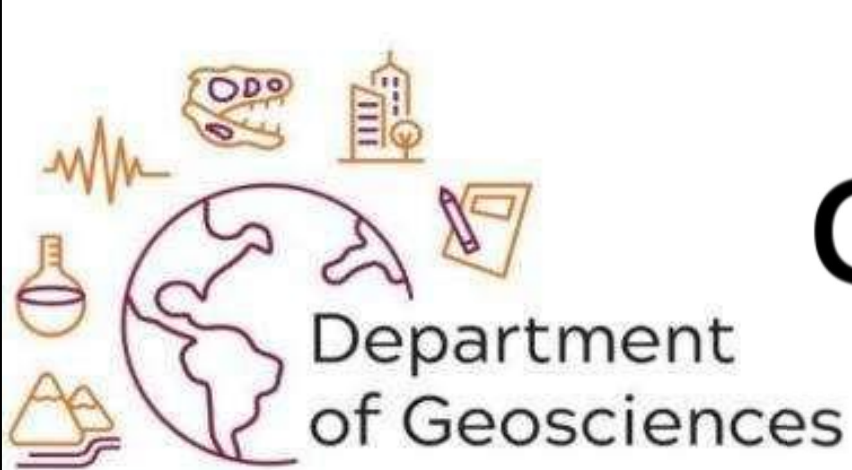




30th Annual Geosciences Student Research Symposium



Welcome to the Geosciences Student Research Symposium (GSRS), a conference produced and organized by graduate students of the Department of Geosciences at Virginia Tech. The main objective of the symposium is to help students gain experience in developing communication skills, event preparation, leadership, mentorship, and team building. GSRS provides a platform for students to communicate their research to all the corners of the far-reaching disciplines of our department. This promotes student growth as scientists as well as strengthens our department as a whole. GSRS offers a unique opportunity for students to prepare for future larger-scaled conference talks and presentations through the gained practice of presenting their research to a broader audience of scientists on campus.



Through scientific talks, poster sessions, and discussions during breakfasts, lunches, and the department's favorite banquet, we can all learn and grow together. As always, GSRS will feature an exciting series of talks and posters presented by VT Geoscience graduate and undergraduate students.



Constructive feedback on student presentations from faculty, students, and visiting guests is highly encouraged. We will give oral and poster presentations in Conference Room 310 in Kelly Hall and room 4069 in Derring Hall on Thursday and Friday. We will also have light snacks and refreshments in the USLB Building followed by our banquet and awards ceremony Friday evening also in the USLB Building.

2025 GSRS Code of Conduct

All participants and audience members in the 2025 Geoscience Student Research Symposium will be expected to...

SHOW RESPECT

- Participants and audience members should be respectful to students running the event and each other
- If you must enter/exit the conference room while a presentation is in progress, do so quietly and respectfully
- Show consideration and listen with an open and receptive mindset
- Avoid saying or doing anything that may be perceived as harassment or bullying
- Limit talking during presentations, whisper if necessary
- Keep phones on silent during presentations

BE INCLUSIVE

- Show that you welcome a diversity of individuals, identities, and abilities
- Demonstrate an appreciation of differing perspectives
- Refrain from making exclusionary comments or engaging in behaviors based on any identity-based factors
- Be mindful of personal and professional biases

BE PROFESSIONAL

- Maintain professional conduct during all GSRS events
- Respect others' wishes regarding having their presentation filmed or photographed
- Keep questions brief, respectful, and relevant to the topic

In addition to this Code of Conduct, the VT [Undergraduate](#) and [Graduate](#) Honor Codes and [Principles of Community](#) also apply. We will follow all university policies for reporting misconduct, see the [Graduate Student Handbook](#) and [Reporting Flow Charts](#) for explicit policies and resources.

This document was ratified by the full body of GSRS committees on February 10, 2025.

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Co-Chairs: Denise Burgett and Esther Oyedele

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Workshop Series: Kameron Finch (chair), Hana Thurman

Food: Isaac Pugh (chair), Delaney Kirr, Natalie Hermosillo, Tarisa Ross

Banquet: Tarisa Ross (chair), Tabitha Nowak, Isaac Pugh, Delaney Kirr, Natalie Hermosillo

GS(art)S: Danielle Fitzgerald (chair), Anya Gupta, Molly Stroud, Helen Burch

Abstract Book/Scheduling: Hana Thurman (chair), Luisana Rodriguez Sequeira, Tabitha Nowak, and Desire Piphus

Communications and Photography: Molly Stroud (chair), Anya Gupta (chair), Carmen Atkins

Undergraduate Poster Session: David Bunin (chair), David Go

UpGoer5: Yohtaro Kobayashi (chair), Luisana Rodriguez Sequeira

Judiciary: Luisana Rodriguez Sequeira (chair), Orin Lole Durbin

Moderators: Alix Ehlers (chair), Luisana Rodriguez Sequeira, Tarisa Ross, Yohtaro Kobayashi

Senior Advisors: Cecelia Wood and Amy Hagen

Special thanks to:

Faculty Advisor: Dr. Brian Romans

Workshop Leaders: Dr. Madeline Schreiber, Brandon Hatcher, and Hana Thurman

Student volunteers throughout the GSRS event

2025 GSRS Schedule

THURSDAY, APRIL 3

Location: Kelly Hall, Room 310

8:30 **Breakfast**

8:50 **Opening remarks**, Jim Spotila

Talk Session 1

Water Past & Present: Hydrological Dynamics and Redox Insights

- | | | |
|------|--------------------------|--|
| 9:00 | Hana Thurman | Linking River Discharge and Lake Storage with Global Observations from the SWOT Satellite |
| 9:15 | Nitheshnirmal Sadhasivam | Did the Record-Breaking Rains and Snow of Water Year 2023 Recharge Deep Aquifers of California's Central Valley? |
| 9:30 | Danielle Fitzgerald | Paleoredox of the Mall Bay Formation (Early Ediacaran, Canada): Evidence for Oxygenation During the Protracted Onset of the Gaskiers Glaciation? |
| 9:45 | Cecelia Wood | Hypolimnetic Oxygenation Promotes Iron Removal Via Homogeneous and Heterogeneous Oxidation Mechanisms in Drinking Water Reservoirs |

10:00 **Coffee Break**

Talk Session 2

Earth Moves! Fault Dynamics, Earthquake Modeling, and Subduction Processes

- | | | |
|-------|-------------------|---|
| 10:15 | Elizabeth Curtiss | Influences on Damage Zone Width and Off-Fault Deformation in the Eastern California Shear Zone |
| 10:30 | Karen Williams | Robust Present-Day Vertical Land Motion Solution of the Chesapeake Bay Derived from GPS Observations |
| 10:45 | Brandon Hatcher | Mapping Fine-Grained Tsunami Deposits to Extend Inundation Limits Beyond Sand Deposition |
| 11:00 | Mohammad Khorrami | Why was the 2004 Parkfield Earthquake Delayed? |
| 11:15 | Alaina Helm | Reaction-Induced Dehydration Pulses During Subduction and their Implications for Tracing Metasomatic Fluids |

11:30 **Lunch and Poster Session 1**

Posters: Kelly Hall Lobby

- | | |
|-------------------|--|
| Sarah Bartholomew | Color as a Clue: Investigating Iron-Bearing Minerals in Soils from Northern Africa |
| Zachary Crizer | Enhancing Microplastic Removal from Water with a Food-Grade Hydrophobic Polymer |

Julia Gadsby	Reconstructing the Carbon Cycle During the Stairsian Extinction Event of the Early Ordovician: Insights from Western Maryland, U.S.A.
Liz Johnson	Assessment of the North American Mesozoic Rift Basins for Carbon Capture and Storage
Cora Jones	Comparing Morphology of Refurbished and Natural Coastal Dunes
Amelie Le Strat	Astrophyllite's Flexible Structure: A Gateway to Novel Material Design
Morgan Lundberg	Anoxic Sample Preservation for Accurate Fe(II) Quantification in Hypolimnetic Suspended Sediments
Sean Markle	Extracting and Compiling Fracture Attributes from 3D Outcrop Models
Tallory Wendell	Quantifying Cycling of Ca, Mg, and Na in Drinking Water Reservoirs near Roanoke, Virginia
Saye Woodard	Terminal Ediacaran Microfossils from the Upper Huqf Supergroup in Oman

Talk Session 3

Clues from the Interior: Critical Zone, Fossil Records, and Geophysical Insights

1:15	Tarisa Ross	Using Basaltic Shergottites to Understand the Martian Interior Environment with Experimental Petrology
1:30	Noah Keller	Small Shelly Fossil Taxonomic Wrangling: Salterella, Lidaconus, and their Ongoing Ambiguity
1:45	Emmanuel Irumhe	Imaging the Radial Structure of Seismic Attenuation using Multiple S-wave Datasets
2:00	Denise Burgett	Mapping Heterogeneity on the Critical Zone Using an Interdisciplinary Approach
2:15	Natalie Hermosillo	Carbon and Sulfur Isotopic Analysis of the Record of a Cambrian Extinction Event from Lawson Cove, Utah

2:30 Coffee Break

Talk Session 4

Environmental and Ecological Processes: Modeling, Seismic Exploration, and Early Life Evolution

2:45	Helen Burch	Modeling Correlations Between Crown Height and Body Mass for Determination of a Functional Trait from Microfossils
3:00	Yohtaro Kobayashi	Light Availability Estimates for River Surfaces in the Contiguous United States

3:15	Shiv Mangal Gupta	Uncovering the Secrets Beneath Giant Sequoias using Seismic Refraction Tomography Coupled with Advanced Seismic First Arrival Picker
3:30	Prescott Vayda	Life at the Limits: Data from Southwestern Mongolia Document Redox Fluctuations and the Diversification of Early Animals in the Cambrian
Talk Session 5 <i>Tiny Particles, Big Impact</i>		
3:45	Orin Lole Durbin	Microfossils of the Ediacaran Shuurgat Formation, Zavkhan Terrane, Southwest Mongolia
4:00	Tabitha Nowak	Reconstructing Vertical Deformation Using Stratigraphy and Microfossils to Infer Megathrust Rupture History on Sitkinak Island, Alaska
4:15	Desire Piphus	Sulfide Mineral Characterization of Potomac Aquifer Sediments in Southeastern Virginia
4:30	David Bunin	Effects of Mineral Dust on the Performance and Efficiency of Gas Turbine Engines
4:45	Kameron Finch	Characterizing the Temporal Trends in the Concentration and Composition of Microplastics Over the 20th Century to Present in the Chesapeake Bay Region

FRIDAY, APRIL 4

Friday Morning Location: Derring Hall, Room 4069

8:30 Breakfast

Talk Session 6

Geospatial Dynamics: From Atmosphere to Terrain

9:00	Maryam Karami	Mineralogical Evolution of Atmospheric Dust: From African Soil to Aerosols Over the Canary Islands, Spain
9:15	Emily Ellis	Satellite-Based Observations of River Surface Temperature Changes Downstream from Large United States Dams
9:30	Elpidio Guzman De La Cruz	Linking Morphodynamics of Superimposed Dunes Across Environments
9:45	Carmen Atkins	Mapping Ground Deformation Across Alaska with Interferometric Synthetic Aperture Radar

10:00 Coffee Break

Talk Session 7

Fluids and Landscapes: Hydrology, Geomorphology, and Geothermal Over Time

10:15	David Go	Width Variability in the Platte River Basin from Satellite Remote Sensing
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10:30	Daniel Alvarez	Quantifying Bedform Morphology in Meandering Rivers
10:45	Carly Bauer	Hydrologic and Environmental Drivers of Aluminum and Barium in Drinking Water Reservoirs in Southwestern Virginia
11:00	Noah Crook	Vendotaenia as a Classic Example of Disaster Taxa at the Ediacaran-Cambrian Boundary
11:15	Rahi Abrar	Multiscale Optimization of Enhanced Geothermal System Stimulations
11:30	“Up-Goer Five” Talks	
	Emily Ellis	"Walls in Top of Land Water Makes Water Hot or Cold"
	Mohammad Khorrami	"Why Did the 2004 Shake in the Park Field Happen Later Than Expected"
	Molly Stroud	"Big pictures of water"
12:00	Lunch and Poster Session 2	
	<i>Posters: Derring Hall, Room 4069 and Fourth Floor Lobby</i>	
	Andrew Allard	Investigation Geologic Influences on Karst Springs in the Hanging Rock Valley, Virginia
	Isabella Andrade	Site-Scale Evaluation of Geologic Carbon Storage at the Matagorda Island Leasing Area, Offshore Texas
	Matthew Centofanti	Delineating Karst Hydrologic Pathways in the Hanging Rock Valley, Virginia
	Bella Chuchro	dMODELS 2024 vs. 2023: A Comparison of GNSS and InSAR Inversions at Ol Doinyo Lengai
	Brooklyn Harris	Investigating the Link Between Ocean Deoxygenation and the End-Steptoean Biome Extinction
	Erin Herald	Electron Probe Microanalyzer Characterization of Pleistocene Glacial-Marine Sediment, Ross Sea, Antarctica
	Denyce Jasicki-Velin	Identifying Shark Cartilage in the Fossil Record: The First Occurrence of Xenacanthid Cartilage in the Western United States
	Sofia Kryder	Microscopic Past: Evaluating Sediment Processing of Late Triassic Microvertebrate Sites
	Ethan Wilcoxen	Analysis and Characterization of Particles Injected into an Aircraft Engine
	Saye Woodard	Description of a New Occurrence of a Caecilian (Lissamphibia) Pseudodontary from the Upper Triassic Of Texas
	Eleni Ziu	Controlled Synthesis of Nickel-Dominant NMC Hydroxides as Precursors for Lithium-Ion Battery Cathodes
1:45	Transition to Kelly Hall	
	<i>Friday Afternoon Location: Kelly Hall, Room 310</i>	
	Talk Session 8	
	<i>Sediment Dynamics: Climate, Water, and Urban Impacts</i>	

2:00	Faizan Sabir	Deciphering Greenland Ice Sheet History Through Sediment Analysis of the Melville Bugt Trough Mouth Fan (TMF)
2:15	Luisana Rodriguez Sequeira	Using Water Quality as a Proxy to Estimate Microplastic Concentrations Via Sentinel-2 in the New River, VA
2:30	Afrida Aranya	Quantifying Urban Growth and its Implications for Sediment Transport and Morphology in Lake Austin, TX
2:45	Delaney Kirr	Investigating Manganese Removal and Mobilization Mechanisms During Managed Aquifer Recharge
3:00	Anya Gupta	Lateral Variability in Soil Depths and Tree Root Distribution in Yosemite’s Mariposa Grove of Giant Sequoias
3:15	Coffee Break	
Talk Session 9		
Geochronology, Tectonics, and Isotopic Studies in Earth Systems		
3:30	Benjamin Eppinger	Time-Frequency-Phase Waveform Inversion Based on the Continuous Wavelet Transform: Applications for Critical Zone Exploration
3:45	Kathryn Hughes	Development of a U-Th-Pb Monazite Dating Procedure Using EPMA at Virginia Tech
4:00	Ella Davis	Tectonic Transport Directions and Timing of Metamorphism in the Southern Part of the Northern Highlands Terrane, Scotland
4:15	Mark Nohomovich	New Fossil Anuran Materials from the Late Triassic Reveal the Origins of Novel Structures
4:30	Amy Hagen	Patterns of Life and Death During the Cambrian Spice Event Preserved in Appalachia
4:45	Closing Remarks, Steve Holbrook	
Friday Evening Location: Undergraduate Science Laboratory Building		
5:00	Social with Light Snacks	
5:30	Banquet and Prize Ceremony	

Presentation Format and Logistics

Oral presentations: Graduate and undergraduate students will be presenting 12-minute talks followed by 3 minutes for questions.

Poster Presentations: Undergraduate students will be presenting posters on Thursday between 11:30 am–1:15 pm and on Friday between 12:00 pm–1:45 pm. Students will present their posters and field questions during these timeframes.

Up-Goer Five: The ‘Up-Goer Five’ Challenge is a presentation format where scientists communicate their research using only the 1,000 most commonly used words in the English language; a talk format geared towards science communication to a broad audience. Our Up Goer Five challenge, scheduled from 11:30 am–12:00 pm on Friday, April 4 in Derring Hall, room 4069, will feature 5-minute graduate student presentations in the Up-Goer 5 format. This format lets students practice science communication skills accessible to a broad audience and are notorious for their humorous aspects.

GS(art)S: GS(art)S is a science communication exhibition during GSRS that uses art to share geoscience interests. Student artwork including photography, painting, sculpture, fiber arts, and more will be displayed in the upstairs lobby of Kelly Hall.

3rd Annual GS(art)S

“Art and science are often seen as two very different disciplines. One studies the natural world through observing, testing and experimenting against theories. The other is an interpretation of what one sees around them to create something. But the two can work together, and when they do, it can create something rather different and unique.”

~Jan Freedman

Geologist for the Royal Commission for Alula

The history of art and geosciences is deeply intertwined, particularly through the influence of landscapes and geological formations on artists, with many artists throughout history depicting the natural world, often incorporating detailed observations of geological features like rock formations, erosion patterns, and even fossils, capturing the Earth's history in their work. Today, geoscience students at Virginia Tech embrace the intersection between art and science as an effective way to communicate their research.

GSRS 2025 is very excited to continue GS(art)S, a geoscience themed art exhibition featuring hand-made pieces from graduate and undergraduate students on display during both days of the symposium.



2024 GS(art)S Gallery Wall

Abstracts for Student Oral Presentations

LINKING RIVER DISCHARGE AND LAKE STORAGE WITH GLOBAL OBSERVATIONS FROM THE SWOT SATELLITE

THURMAN, Hana, Dept. of Geosciences, Virginia Tech, Blacksburg, VA 24061

Lakes are hydrologically connected to rivers, although the two are often treated as separate systems for remote sensing applications. For example, the new Surface Water and Ocean Topography (SWOT) satellite provides discharge estimates for large rivers worldwide, but it does not consider river-lake mass conservation. A recent algorithm called LakeFlow (Riggs et al., 2023) can help bridge this continuum. LakeFlow uses a mass balance approach to constrain lake and reservoir inflows and outflows, incorporating SWOT measurements (e.g., lake surface areas and elevations; and river widths, elevations, and slopes) and ancillary estimates of evaporation and tributary discharges. However, so far the algorithm has only been applied in North America on synthetic SWOT measurements. For the first time, we run LakeFlow on a subset of global lakes and reservoirs using data from SWOT's science orbit, which began in July 2023. We compare simulated inflows and outflows to gauge measurements to evaluate the algorithm's performance. Additionally, we explore how discharge estimates from LakeFlow vary across lake sizes and types within different regions around the world. This research will serve as a first step for the planned integration of LakeFlow into SWOT's discharge computation platform. Preliminary results can also provide valuable insights into human water use and river-lake dynamics, particularly within ungauged basins.

DID THE RECORD-BREAKING RAINS AND SNOW OF WATER YEAR 2023 RECHARGE DEEP AQUIFERS OF CALIFORNIA'S CENTRAL VALLEY?

SADHASIVAM, Nitheshnirmal, Dept. of Geosciences, Virginia Tech, Blacksburg, VA 24061

After enduring severe drought conditions from 2020 to 2022, California experienced an exceptionally wet 2023 water year, driven by a series of atmospheric rivers, unusually frequent tropical storms, and extreme snowfall during the winter months. This led to a surge in surface water levels across the state, potentially reducing the reliance on groundwater for agricultural purposes and allowing for the recharge of aquifers. The Central Valley of California, a major agricultural hub responsible for producing more than a quarter of the food consumed in the US, heavily depends on groundwater from deep confined aquifers for farming. Years of excessive groundwater extraction have led to significant land subsidence in the southern part of the Central Valley. Following the extremely wet water year of 2023, questions persist about whether the increased availability of surface water has positively impacted the deep confined aquifers of the Central Valley, which have suffered from severe overdraft for decades. To address this pressing question, we estimate the recharge volume of both shallow (unconfined) and deep (confined) aquifers during the water year 2023 (Sep 2022 – Aug 2023) using multiple hydro-geodetic techniques. For which, we combine water storage dataset from GRACE-Follow On (GRACE-FO), poroelastic deformation from Interferometric Synthetic Aperture Radar (InSAR), and measurements of groundwater. We observed a significant rise in groundwater head levels across most wells in the Central Valley, with approximately 599 wells (89%) recording positive rates. We measured poroelastic deformation ranging from 10.4 cm/year to -29.3 cm/year using 88 Sentinel-1 SAR images covering the entire Central Valley. Using the Total water storage data from GRACE-FO and removing the other water storage components, we estimated a net gain in groundwater storage amounting to approximately $19.4 \pm 4.1 \text{ km}^3$ during the 2023 water year. Further using the head level changes from well measurements and aquifer properties, we quantified the groundwater storage change in unconfined (shallow) aquifer to be $24.3 \pm 7.7 \text{ km}^3$ and in confined (deep) aquifer to be between 3.3 to 13.4 km^3 for the aquifer thickness of 50 to 200 m, respectively. To further independently validate storage change in deep aquifers, we use 1D poroelastic modeling after physically modeling delayed compaction and subtracting it from the observed poroelastic deformation. We quantify groundwater storage change to be between 1.7 and 6.9 km^3 in deep confined aquifers, which aligns with conventional (GRACE-FO) and empirical (field-based well measurements) approaches, considering the underlying physical processes and uncertainties.

PALEOREDOX OF THE MALL BAY FORMATION (EARLY EDIACARAN, CANADA): EVIDENCE FOR OXYGENATION DURING THE PROTRACTED ONSET OF THE GASKIERS GLACIATION?

FITZGERALD, Danielle, Dept. of Geosciences, Virginia Tech, Blacksburg, VA 24061

The Conception and St. John's groups of the Avalon Basin in Newfoundland, Canada host an important record of early animal evolution and environmental change. Previous iron speciation studies of this succession suggest a pronounced shift in local water column redox occurred between the deposition of the predominantly anoxic and ferruginous, glaciogenic Gaskiers Formation and the overlying oxic, non-glaciogenic Drook to Fermeuse formations. Ediacara-type fossil impressions of the Mistaken Point biota are known only from above the Gaskiers Formation, and this potentially implies a causal relationship between oxygenation and the appearance of biological complexity in the wake of the Gaskiers glaciation.

The record of marine redox prior to the Gaskiers glaciation and the appearance of Ediacaran fauna in Avalon Basin, however, is unclear. Iron speciation work on the underlying Mall Bay found that the majority of strata from this unit could either reflect deposition under oxic or anoxic, ferruginous water columns. Still, this previous study only sampled the upper 120 m of the formation and our geochemical, sedimentological and petrographic study examines its entire 800 m thickness. Thus far over 40% of the new iron speciation data classify as oxic, whereas less than 5% are definitively anoxic, ferruginous. One potential caveat to the interpretation of the iron speciation data, however, is that highly reactive iron could have been incorporated into silicate phases during diagenesis and metamorphism, leading to false oxic signals. Yet, total iron-to-aluminum ratios show that most Mall Bay samples do not have total iron enrichments, suggesting they reflect deposition under an oxic water column. Therefore, based on our data, the first deep-water oxygenation in the Avalon Basin may have preceded the appearance of the Mistaken Point biota by 5-to-25 million years. Moreover, it was recently found that the uppermost Mall Bay Formation exhibits increasing evidence of glaciation (i.e., dropstones, till pellets, and glendonites), implying a protracted onset of the Gaskiers glaciation. If the oxic signals from the Mall Bay Formation are caused by glacially enhanced downwelling, this mechanism for deep-ocean ventilation may apply to other Ediacaran basins and highlights the need for this to be further explored as a mechanism for deep-ocean oxygenation during the Neoproterozoic dawn of animal life.

HYPOLIMNETIC OXYGENATION PROMOTES IRON REMOVAL VIA HOMOGENEOUS AND HETEROGENEOUS OXIDATION MECHANISMS IN DRINKING WATER RESERVOIRS

WOOD, Cecelia, Dept. of Geosciences, Virginia Tech, Blacksburg, VA 24061

Iron (Fe) is a geogenic, redox-active metal that can degrade water quality when accumulated in drinking water reservoirs during seasonal stratification. In water supplies with elevated Fe^{2+} , water quality managers are increasingly using hypolimnetic oxygenation (HOx) to promote Fe oxidation and precipitation of Fe minerals. Many studies confirm HOx effectiveness, but few investigate how oxygenation, and other water column conditions (pH, Fe^{2+} , dissolved oxygen), may affect Fe mineralogy. Rapid oxidation results in poorly crystalline Fe oxyhydroxides via homogeneous Fe oxidation (oxidation by O_2), but heterogeneous Fe oxidation (oxidation by electron transfer between Fe^{2+} and Fe^{3+}) may transform them to more stable Fe oxides, like goethite and lepidocrocite. We hypothesized that HOx would decrease Fe^{2+} and thus change the relative proportions of the heterogeneous Fe oxidation products (goethite and lepidocrocite). To test these hypotheses, we collected solids fortnightly that precipitated in two freshwater reservoirs - one with HOx and one without. Additionally, we compared samples from when HOx was operating at a limited capacity vs fully operational. We analyzed solids using two methods: acid digestion coupled with ICP-MS to quantify total Fe mass and X-ray total scattering coupled with pair distribution function analysis to determine mineralogic abundance. Pair distribution function data were analyzed using linear combination fitting to determine the relative mineral fractions of the different solids. Additionally, we analyzed water samples for total and soluble Fe concentrations with ICP-MS. Our results suggest that differing Fe^{2+} in each reservoir resulted in different relative amounts of ferrihydrite, goethite, and lepidocrocite in the solids. Low dissolved oxygen and low Fe^{2+} in the reservoir with HOx resulted in higher proportions of lepidocrocite, whereas low dissolved oxygen and high Fe^{2+} in the control reservoir resulted in similar proportions of goethite and lepidocrocite. Additionally, the relative mineral proportions are less variable when HOx is at full capacity. Given the differing stabilities of these minerals, heterogeneous Fe oxidation could impact the long-term stability of HOx-produced Fe oxides against reductive dissolution upon burial in the sediment. Ultimately, our results suggest that both homogeneous and heterogeneous oxidation mechanisms contribute to Fe removal during artificial oxygenation of drinking water reservoirs.

INFLUENCES ON DAMAGE ZONE WIDTH AND OFF-FAULT DEFORMATION IN THE EASTERN CALIFORNIA SHEAR ZONE

CURTISS, Elizabeth, Dept. of Geosciences, Virginia Tech, Blacksburg, VA 24061

Off-fault deformation (OFD) refers to strain and distributed fracturing beyond the main fault plane during an earthquake. This deformation forms the fault damage zone—the region of enhanced fracturing surrounding a fault—which plays a key role in rupture behavior and long-term fault evolution. The Eastern California Shear Zone (ECSZ), a system of oblique right-lateral faults, exhibits high OFD rates, averaging ~30% across the region, with the 1992 Landers rupture reaching 46%. However, fault damage zone widths and OFD distribution vary along strike, and the factors controlling this remain poorly understood.

We focus on the roles of fault geometric complexity—specifically restraining bends, where faults curve and concentrate stress—and preexisting crustal weaknesses in controlling OFD. Structural inheritance, where preexisting geological features such as dikes or older fault fabrics influence later fault systems, may be key to this variability. In particular, we examine Jurassic-age mafic dikes from the Independence Dike Swarm, a network of igneous intrusions proposed to influence fault behavior, including the 2019 Ridgecrest rupture. Preexisting mafic dikes create crustal anisotropy, directional variations in mechanical properties that influence deformation, potentially controlling fracture distribution. Using high-resolution remote mapping and field transects in the southern Mojave block, we quantify bedrock fracture spatial distribution and intensity as a proxy for OFD. These intensities are then compared to dike distribution and fault geometry. Preliminary results indicate that fractures are widespread but do not directly correlate with fault bends as initially hypothesized. Instead, a stronger relationship emerges between fracture intensity and preexisting mafic dikes, suggesting that crustal anisotropy exerts greater control on fracture distribution and fault damage zone widths.

The alignment of fault traces with dike orientations along strike, including changes in strike reflected in both dikes and faults, could suggest structural inheritance is a dominant process. These inherited weaknesses could localize strain over broader zones, leading to higher OFD where faults intersect dikes. By comparing the orientations of preexisting mafic dikes, bedrock joint sets, and fault traces, we aim to disentangle key relationships: Are dikes influencing fault development? Are faults controlling fracture patterns? Or are dikes directly shaping fracture distributions? These findings highlight the critical role of crustal heterogeneity and structural inheritance in fault deformation, providing new insights into fault zone evolution and seismic hazard assessment.

ROBUST PRESENT-DAY VERTICAL LAND MOTION SOLUTION OF THE CHESAPEAKE BAY DERIVED FROM GPS OBSERVATIONS

WILLIAMS, Karen, Dept. of Geosciences, Virginia Tech, Blacksburg, VA 24061

The Chesapeake Bay, a region of high financial, historical, and ecological value, contains the highest rates of relative sea-level rise on the East Coast of the United States. It is well-established that regional land subsidence significantly contributes to observed high rates of relative sea-level rise, however quantified rates of vertical land motions remain poorly resolved and vary substantially in published solutions. From 2019 to 2023, a collaborative effort led by the USGS was conducted to collect new Global Positioning System (GPS) campaign data (53 stations) throughout the Chesapeake Bay. The new campaign measurements were combined with continuous GPS data from the region covering the same time-period (156 stations) and processed with GAMIT-GLOBK to produce consistent estimates of vertical velocities and their associated uncertainties. Uncertainties were investigated to identify potential sources that could lead to specific sites having higher than average uncertainties. Possible sources of uncertainty include the quantity of data/epochs, seasonal variations, and types of monumentation. Next, we use the Robust Network Imaging algorithm to interpolate our combined campaign and continuous GPS velocity solution for a new regional vertical land motion map of the Chesapeake Bay. Land subsidence is consistent throughout the region, but rates vary at major cities in the Chesapeake Bay such as Washington DC (-1.2 ± 0.8 mm/yr), Baltimore, MD (-1.8 ± 0.7 mm/yr), Ocean City, MD (-2.6 ± 0.2 mm/yr), and Hampton, VA (-2.5 ± 0.7 mm/yr). Finally, we compare our vertical land motion rates with a geodetic-based solution from 1974. Our comparison indicates that the locations of maximum subsidence have shifted since the 1970's likely due to changes in groundwater pumping practices. For example, we see a decrease in land subsidence rates near the West Point withdrawal center (1974: -3.8 mm/yr, present-day: -2.3 mm/yr) and the Franklin withdrawal center (1974: -4.8 mm/yr, present-day: -1.2 mm/yr). The results of this work underline the importance of regular monitoring of vertical land motions and will improve projections of relative sea-level changes, flooding, and inundation hazard maps for communities in the Chesapeake Bay region.

MAPPING FINE-GRAINED TSUNAMI DEPOSITS TO EXTEND INUNDATION LIMITS BEYOND SAND DEPOSITION

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Coastal marshes along the Cascadia Subduction Zone (CSZ) preserve widespread stratigraphic evidence of the most recent great (~M9) earthquake, which occurred in 1700 CE, including sandy tsunami deposits. To better constrain the magnitude and distribution of slip during this event, earthquake source models are often evaluated based on their ability to generate simulated tsunamis that match or exceed the minimum inundation extent recorded by these sandy deposits. However, modern tsunami observations indicate that sandy deposits often underestimate true inundation extent, as finer-grained sediments (mud and silt) can be transported farther inland than sand. By identifying and incorporating these fine-grained deposits into tsunami reconstructions, we can ensure that earthquake source models more accurately capture the full extent of inundation, reducing the risk of underestimating slip during the 1700 CE earthquake.

At the Salmon River estuary, Oregon, evidence of earthquake subsidence and tsunami inundation from the 1700 CE earthquake is preserved as organic-rich wetland soils sharply overlain by normally graded sand, which transitions into tidal flat silts. Here, we assess whether tsunami deposits extend beyond previously mapped sandy deposits by analyzing grain size, diatoms, and computed tomography (CT) scans from sediment cores spanning the inland tsunami sand deposition boundary. New grain size data reveal silty sand (72% sand) and sandy silt (35% sand) above the sharp 1700 CE subsidence contact up to ~1 km inland of the previously mapped tsunami sand extent. Preliminary diatom analyses show that assemblages characteristic of tsunami-transported sediments, observed within sandy deposits, are also present in finer-grained sediments above the subsidence contact, including at sites beyond the mapped tsunami sand limit.

These findings suggest that the full extent of tsunami inundation during the ca. 1700 event may be greater than previously estimated based on sand deposits alone. Expanding this approach to other CSZ sites will improve reconstructions of past tsunami inundation, providing more accurate constraints on earthquake and tsunami models and enhancing future hazard assessments.

WHY WAS THE 2004 PARKFIELD EARTHQUAKE DELAYED?

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Since 1857, Parkfield has experienced a magnitude 6 earthquake on average every 22 years. In 1985, scientists predicted another significant earthquake by 1993. However, it was not until 2004 that a magnitude 6 earthquake occurred. This unexpected delay raises essential questions about the underlying mechanisms and predictive models. This study investigates a previously unquantified factor, i.e., injection operations at the nearby San Ardo oil field, and how these might have contributed to this delay. We integrate seismic, in-situ water disposal, steam flood injection, geological data, and advanced computational modeling to explore the reasons for the deviation from the expected earthquake cycle. A fully coupled poroelastic half-space model calculates the spatial and temporal changes in poroelastic stresses and pore pressure induced by fluid injection at well locations. Our analysis considers nearly 30 years of disposal and injections from 1975-2004 and evaluates crustal stress alterations due to the injection operation. Our preliminary results suggest that the imparted negative Coulomb stress perturbations on the San Andreas fault are sufficient to delay the Parkfield earthquake. Our findings highlight the need for a more nuanced approach to earthquake forecasting, incorporating a broader range of variables and their interactions including anthropogenic contributions. This research enhances our understanding of the Parkfield earthquake and has implications for global seismic hazard assessments.

REACTION-INDUCED DEHYDRATION PULSES DURING SUBDUCTION AND THEIR IMPLICATIONS FOR TRACING METASOMATIC FLUIDS

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Fluid-rock reactions impact seismicity, arc-magma chemistries, and volatile cycling at convergent plate boundaries. In subduction environments, metamorphic reactions involving hydrous fluids lead to volume changes that establish stress gradients and facilitate metasomatic alteration. Fingerprinting the source of fluids that traverse and alter subducting lithologies is, however, challenging. We use phase assemblage modeling to predict evolving mineralogy and fluid compositions during subduction along representative PT-paths, assessing closed-system and progressive fluid fractionating assumptions. Our calculations consider simplified hydrated mid-ocean ridge basalt, hydrated harzburgite, and average subducted sediments, predicting equilibrium mineralogy, fluid abundance, and fluid composition for each using thermodynamic and solubility models with *Perple_X* (Connolly and Galvez, 2018; Holland and Powell, 2011). This allows us to identify fluid solute ratios unique to a given source lithology or mineral breakdown reaction. For example, the hydrous mineral lawsonite is well known to decompose and release fluids during heating through the blueschist facies. Our results indicate that lawsonite breakdown in subducted sediments and hydrated basalts coincides with a peak in the Mg and Si content of fluids relative to those produced by reactions at higher and lower temperatures. This reaction results in a bulk volume change of up to 0.5%. Breakdown of antigorite and brucite in the hydrated harzburgite corresponds with a similar spike in Mg and Si solubility, though with a different Mg:Si ratio. This reaction results in a calculated volume change of approximately 8% and thus likely has significant geophysical consequences (Jung et al., 2004). In general, fluids derived from the sedimentary composition are predicted to have a higher proportion of Na to Mg and Si than those derived from basalts at the same subduction PT condition. Fluids produced during deserpentinization of hydrated harzburgite contain a higher proportion of Ca. In fractionating models where hydrous fluids are immediately removed from the system as they are produced, the bulk composition of each lithology evolves differently along different geotherms. For instance, once a hydrated basalt has been subducted to 100 km depth, it is predicted to have lost 98.5% of its initial water content along a typical cold subduction geotherm and all its water along a hotter subduction path. These dehydrated basalts are also slightly depleted in Si, Mg, and Na, and can be entirely depleted in K by 200 km for hotter geotherms. Together, these results help to constrain the potential sources of fluids that metasomatize subducting rocks and the overlying mantle wedge.

USING BASALTIC SHERGOTTITES TO UNDERSTAND THE MARTIAN INTERIOR ENVIRONMENT WITH EXPERIMENTAL PETROLOGY

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Knowing the composition of Mars is crucial to understanding the planet's thermal evolution and extent of volcanism over time. Erupted lavas, i.e., the Gusev basalts measured by the Spirit rover and the basaltic shergottites, can be compared with experimental partial melts to determine possible bulk compositions of Mars. Additionally, the age range between the shergottites (100–500 Ma) and the much older Gusev basalts (~4 Ga) point to continued volcanic activity on the planet. The most studied of these bulk compositions is that of Dreibus and Wanke (1985). However, the partial melts of this composition do not align with the CaO and Al₂O₃ of the shergottites (Agee and Draper 2003), and is likely to iron rich (Agee and Draper 2003). We constructed a new bulk silicate Mars composition to determine its partial melting behavior over a range of pressures suitable for the martian interior. We conducted piston cylinder experiments at 1 and 3 GPa from 1350 to 1700 °C, using our newly calculated bulk Mars composition. Run products were analyzed with the electron microprobe using WDS analysis and BSE imaging to determine mineralogy, composition of any partial melts, and overall texture. Our initial results constrain the martian solidus between 1375 and 1425 °C at 3 GPa, which indicates that martian volcanism with a lower melting temperature than the melting temperature identified as 1492°C at 3 GPa (Duncan et al., 2018). A lower melting temperature allows for more melt generation and thus can sustain martian volcanism in larger quantities for longer periods of time. Also, some of the lower melt fraction experimental partial melts provide a much closer compositional match to the shergottites than previous results (Duncan et al., 2018).

SMALL SHELLY FOSSIL TAXONOMIC WRANGLING: SALTERELLA, LIDACONUS, AND THEIR ONGOING AMBIGUITY

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The Cambrian is host to staggering quantities of new-found diversity within the animal kingdom. Due to the increasing number of niches created and the increasing number of species adapting to fill them, the period marked a time of tumult both when it was happening and retrospectively for those among us attempting to describe it.

Enter *Salterella*, a small shelly fossil that has long been used in North America as a biostratigraphic tool. It is remarkable for possessing a unique skeletal configuration among the animal kingdom. *Salterella* constructed its skeleton through a combination of a conical biomineralized shell and an infilling of layered, agglutinated sediments. This unique body plan has placed it and its relatives into the isolated Phylum of Agmata. Agmatans are notable not only for the morphological experimentation of the time but also the taxonomic ambiguity these alien forms present.

Here we seek to resolve one such instance of ambiguity between two agglutinating forms described from the Harkless Formation of western Nevada. *Lidaconus* and *Salterella* are both centimeter scale, curved conical forms known from Stage 4 of the Cambrian in the region, but are both poorly documented and studied. We use morphological and histological analyses to compare specimens of each genus to understand their potential relationship and clarify the taxonomy of conical forms from the Harkless Formation. This work has implications for the biostratigraphic application of agmatans, and helps us better understand the diversity of this unique group of organisms. This talk seeks to guide the viewer through one such example of muddled taxonomy as I look at one locality containing two separately described genera from the Harkness formation of Nevada, *Lidaconus* and *Salterella*, and attempt to determine whether they are both valid taxa from a morphological standpoint. I hope to present the viewer with a strong diagnosis for either genus and possible species should they be found to be distinct.

IMAGING THE RADIAL STRUCTURE OF SEISMIC ATTENUATION USING MULTIPLE S-WAVE DATASETS

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The seismic quality factor (Q) of the mantle is crucial for understanding Earth's physical and chemical properties. While existing global 1-D Q models generally agree that the lower mantle exhibits slightly higher Q values than the upper mantle, significant discrepancies remain, particularly in the lower mantle, limiting our understanding of seismic attenuation. A recent study by Zhu et al. (2022) demonstrated that amplitude measurements of multiple reflected S waves (S, SS, SSS, and SSSS) can improve constraints on the radial Q structure. Their results indicate that seismic Q values at depths of approximately 600–900 km are higher than those in current global Q models. This newly identified high- Q region aligns with recent mantle viscosity structures inferred from geodetic data and has important implications for mantle dynamics, as a strong layer at this depth could impede the penetration of subducted slabs into the lower mantle. Building on this work, our study expands the dataset of Zhu et al. (2022) by incorporating core-reflected (ScS) and core-diffracted (Sdiff) S waves to enhance depth resolution in the lower mantle. We analyze amplitude ratios between observed and synthetic seismograms in the frequency domain to quantify attenuation. Our inversion results confirm the existence of the high- Q region in the uppermost lower mantle (600–900 km depth) and suggest that Q values in the lowermost mantle are higher than those in the Preliminary Reference Earth Model (PREM).

MAPPING HETEROGENEITY ON THE CRITICAL ZONE USING AN INTERDISCIPLINARY APPROACH

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The critical zone (CZ) is the outermost layer of Earth where rocks, water, soil, life, and air interact in a wide array of processes. The CZ is challenging to observe because it mostly lies hidden underground. Exposures of the CZ in roadcuts and outcrops comprise a largely untapped resource for exploring CZ heterogeneity, and to address the question, do CZ processes create heterogeneity or destroy it? Weathering processes might be expected to homogenize chemical composition by transforming diverse weatherable bedrock minerals into clays. However, we also might expect near-surface CZ processes to create heterogeneity, through opening fractures, bioturbation, and infiltration of surface water. Which processes dominate?

We created an interdisciplinary approach to answer these questions by combining physical and chemical measurements at a roadcut that exposes weathered biotite gneiss in a SW Virginia quarry. This will provide unprecedented views of CZ properties at multiple. LiDAR and photogrammetry data form the base of a 3D model that incorporates geochemical data, ground-penetrating radar (GPR), seismic refraction, and electrical resistivity data. We collected 70 rock samples in two 7 m vertical transects at 20 cm intervals and determined geochemical composition using handheld and benchtop XRF spectrometers. A vertical profile of modified chemical index of alteration shows values between 80-95%, indicating a highly weathered saprolite layer. While some trends exist in the geochemical data, the overall pattern suggests vertical heterogeneity in weathering at the meter scale. Seismic velocities are laterally heterogeneous, varying from 500-1,500 m/s at 5 m depth, in patterns that match the visible distribution of corestones in the photogrammetry. Overall the geochemical, geophysical, and photogrammetry data show a CZ that is highly heterogeneous at multiple vertical and lateral scales. Next we will collect more detailed XRF data, calculate chemical depletion, and perform higher-resolution seismic surveys to better resolve subsurface structure. Finally, we hope to create a virtual model with a simple user interface that will provide new scientific insights and an interactive educational platform to bring CZ science into K-12 and college classrooms.

CARBON AND SULFUR ISOTOPIC ANALYSIS OF THE RECORD OF A CAMBRIAN EXTINCTION EVENT FROM LAWSON COVE, UTAH

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A series of marine extinction events occurred between the Cambrian Explosion and the Great Ordovician Biodiversification Events in the Early Paleozoic between ~500 to 480 million years ago. One of the least studied of these extinction events is the Skullrockian Extinction Event. Investigating this event is important for reconstructing early marine ecosystems and identifying the environmental factors that caused changes in biodiversity during this time. Geochemical evidence from better-studied extinction events in this interval have suggested that ocean deoxygenation and euxinia (where the ocean is both anoxic and sulfidic) were key contributors to marine biodiversity turnover. To explore these factors during the Skullrockian extinction, we will analyze carbon ($\delta^{13}\text{C}$) and sulfur ($\delta^{34}\text{S}_{\text{CAS}}$) isotope records in marine carbonate samples from Lawson Cove, Utah. These isotopic proxies are commonly used to trace the ancient carbon and sulfur cycles, offering insights into marine redox conditions, carbon burial rates, and the potential for sulfidic environments. Our data from Lawson Cove show noticeable changes in the carbon isotope record, foremost among these is the negative carbon isotope shift known as the Hellnmaria Red Tops Boundary (HERB), which has been previously documented at this site. The carbon isotope record around the Skullrockian Extinction is different from previously studied extinctions, which usually occur at the start of positive carbon isotope excursions. Moreover, the HERB happens before the Skullrockian Extinction, so it's still unclear how these two events are mechanistically connected. The changes in the carbon cycle reflected by the HERB and other shifts in the carbon isotope record are likely linked to environmental instability, but the exact causes are still unknown. We plan to use our $\delta^{34}\text{S}_{\text{CAS}}$ data to specifically investigate for changes in the rate of sulfate reduction and pyrite burial, and prevalence of euxinic conditions during this time interval. These isotopic studies will clarify the potential role of oceanic anoxia in the Skullrockian extinction and the broader relationship between unstable marine oxygenation and early Paleozoic extinction events.

MODELING CORRELATIONS BETWEEN CROWN HEIGHT AND BODY MASS FOR DETERMINATION OF A FUNCTIONAL TRAIT FROM MICROFOSSILS

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Functional traits describe an organism's use of its environment (e.g., diet, feeding mode, mobility, tiering, and body size) and are fundamental to modelling ecological roles in a community. Characterization of functional traits is a challenge in modern vertebrate ecosystems and is even more problematic in extinct communities, which are affected by the biases of the fossil record. Vertebrate community paleoecology often fails to utilize microfossils, largely overlooking teeth even though they are excellent indicators of ecological roles as they are linked to body size, diet, and diagnostic to larger clades. In reptile-dominated communities, like those of the Triassic Period, isolated teeth are often the most abundant remains: enamel enables teeth to survive transport and burial, and most reptiles continuously replace their teeth throughout their lifetime. Incorporating isolated teeth in ecological analyses therefore samples a more complete portion of the community compared to using only skeletal material. Our research aims to determine relationships between tooth crown height and body mass among different phylogenetic affinities to promote the use of isolated teeth in modelling community ecology. Crown height and body mass are known to be strongly correlated in small groups (e.g., primates, rabbits, sharks, and alligators), but this relationship has yet to be characterized more broadly across vertebrates. Body mass data from specimens among lepidosauromorphs, archosauromorphs, and amphibians were recorded from museum collections and computed tomography data for extinct and extant taxa ($n \sim 150$) using direct measurements if available, or from reliable correlates (e.g., proximal limb and skull dimensions). We analyzed a suite of tooth measurements with the body mass data using a log-transformed linear regression in each group sampled, recovering a strong correlation between the average tooth crown height and body mass within Archosauromorpha, Lepidosauromorpha, and Amphibia, respectively ($r^2=0.70$, $r^2=0.70$, $r^2=0.68$). We show that any isolated tooth, body mass can be estimated and bracketed by the maximum and minimum mass for the animal assuming smallest/biggest tooth in the mouth. Our methods greatly expand the quantity of specimens, and further, the number of microvertebrate assemblages, fit to be included in paleoecological analyses across the entire Mesozoic Era. This will ultimately improve the resolution (both geographical and stratigraphic) of ecological analyses and evolutionary patterns.

LIGHT AVAILABILITY ESTIMATES FOR RIVER SURFACES IN THE CONTIGUOUS UNITED STATES

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Light availability on river surfaces is an important factor for river ecology. The intensity and duration of sunlight influences the activity of the heterotrophs and autotrophs within a river reach which in turn determines the river metabolism. While sunlight affects multiple processes within a river, this research focused on the potential available photosynthesis throughout the year. Photosynthesis utilizes the visible range of the electromagnetic spectrum as the photosynthetic active radiation (PAR). The available PAR on the water surface is determined by site parameters such as atmospheric conditions, topography, channel geometry, solar geometry, and the riparian canopy. Measuring PAR on water surfaces for a single location or throughout a river network can be challenging as it requires deploying high-frequency PAR sensors. Deploying sensors at a large scale to understand the light dynamics of river network would be unfeasible. To get an understanding of the light dynamics of a river network, we utilized a river solar shading model to estimate PAR on the water surface.

Here we present results from StreamLight, a canopy radiative transfer shading model, applied to all nationally mapped rivers and streams in the contiguous U.S. StreamLight is driven by site parameters and uses remotely sensed and modeled data for downwelling shortwave radiation flux, leaf area index, and riparian canopy height. Our application of StreamLight utilizes nationally available geospatial datasets and hydraulic geometry-based estimates which approximate river surface water elevation and channel geometry.

The model estimated the distribution of light availability in terms of PAR for all rivers and streams contained in the U.S. National Hydrography Dataset Plus V2 dataset at an hourly-per-month average (24 hours * 12 months = 288 timesteps). The model estimates were validated from 17 National Ecological Observatory Network sites with a mean R^2 of 0.52 and a mean RMSE of 223.41 $\mu\text{mol}/\text{m}^2\text{s}$. We found that as the stream width increases, the seasonal PAR becomes more distinct. We also found that the tree height was the most significant driver of PAR throughout the year across stream widths. These results are the first known national-scale quantification of riverine light with potential for understanding aquatic processes including water quality and greenhouse gas emissions from inland water bodies.

UNCOVERING THE SECRETS BENEATH GIANT SEQUOIAS USING SEISMIC REFRACTION TOMOGRAPHY COUPLED WITH ADVANCED SEISMIC FIRST ARRIVAL PICKER

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Giant sequoia trees (*sequoiadendron giganteum*) are the world's largest single-stemmed tree and an iconic species in the Sierra Nevada mountains. Giant sequoias require large volumes of groundwater for transpiration, but little is known about subsurface critical zone structure beneath giant sequoias, hindering our understanding of the resilience of these giants to environmental change. We determined the quasi-3D seismic P-wave velocity structure beneath a grove of four giant sequoia trees in the Mariposa Grove, Yosemite National Park, CA, using seismic refraction tomography. A key feature of this study is the implementation of an interactive, automatic picker based on the short-time average/long-term average (STA/LTA) algorithm to precisely identify seismic first arrivals. This advanced picking method enhances the precision of seismic first arrivals and significantly reduces data processing time. The resulting detailed seismic velocity structure provides valuable insights into the subsurface characteristics beneath these ancient trees. High seismic velocities are observed directly beneath standing sequoia stems, suggesting that enhanced pressure from the mass of the tree changes soil structure beneath the trees. The velocity structure also reveals important details about root zone structure and the extent of weathering in the critical zone beneath the giant sequoias, giving us a better understanding of the subsurface environment that supports the giant sequoias.

LIFE AT THE LIMITS: DATA FROM SOUTHWESTERN MONGOLIA DOCUMENT REDOX FLUCTUATIONS AND THE DIVERSIFICATION OF EARLY ANIMALS IN THE CAMBRIAN

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The radiation of animals in the early Cambrian has been attributed to numerous biological and environmental factors including gene regulation, predator-prey dynamics, redox changes, or nutrient availability. While it was likely a combination of these and many other factors that allowed animals to proliferate, the contribution of each component can be investigated to understand how these elements drive animal evolution. Specifically, we can investigate the timing and magnitude of environmental shifts and determine how well they correlate with biological changes. Here we present new paleontological and geochemical evidence from the mixed shale and carbonate succession of the Bayan Gol Formation of southwestern Mongolia. This stratigraphic succession represents deposition in a shallow tropical foreland basin during the earliest Cambrian, notably marked by the first occurrence of small shelly fossils. We document abundant tubular animal and macroalgae fossils in shales underlying the first small shelly fossils, representing a lower diversity fauna that preceded the explosion of biomineralizing organisms. Iron speciation data suggest that oxygen levels may have been low, but potentially not anoxic through this interval, allowing animals to survive. However, these conditions were ephemeral and anoxic conditions returned after the first radiation of shelly taxa. These data contribute to mounting evidence that life in the early Cambrian lived at the edge of habitability and that even minor fluctuations in environmental conditions could potentially drive great shifts in marine ecosystems.

MICROFOSSILS OF THE EDIACARAN SHUURGAT FORMATION, ZAVKHAN TERRANE, SOUTHWEST MONGOLIA

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The Shuurgat Formation, part of the Zavkhan Terrane in Southwest Mongolia, is hypothesized to have been deposited during the early Ediacaran. However, the inferred age of this formation is primarily derived from carbon isotope chemostratigraphy correlations, in addition to comparisons of $^{87}\text{Sr}/^{86}\text{Sr}$ values with other Ediacaran assemblages. Thus, the age of the Shuurgat Formation is poorly constrained compared to other early Ediacaran successions. Carbonate hosted chert nodules from the Shuurgat Formation have previously been reported to preserve a community of filamentous and spheroidal microfossils. Given the inferred age of the formation, it is hypothesized that the Shuurgat Formation microbiota may also contain spiny acanthomorphic acritarchs, which would provide a further constraint on the age of the formation via biostratigraphic correlation with other early Ediacaran deposits that contain acritarchs. Investigation of thin sections from the Shuurgat Formation have so far revealed a microbiota containing spheroidal leiospheres in addition to several examples of filamentous microfossils: *Oscillatoriosis*, *Polytrichoides*, *Siphonophycus*, and *Salome hubeienesis*. Of significance within this assemblage is the hypothesized cyanobacterium *Salome hubeienesis*, which has also been identified from the Doushantuo and Krol A formations (South China and Greater Himalaya, respectively), providing a potential avenue for biostratigraphic correlation between these localities.

RECONSTRUCTING VERTICAL DEFORMATION USING STRATIGRAPHY AND MICROFOSSILS TO INFER MEGATHRUST RUPTURE HISTORY ON SITKINAK ISLAND, ALASKA

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Short historical records of great ($M_w > 8.0$) earthquakes and tsunamis along the Alaska-Aleutian Subduction Zone (AASZ) limit our ability to assess long-term rupture behavior and variability. Key questions remain about the persistence of rupture boundaries, the magnitude potential of past events, and the recurrence of megathrust earthquakes over centuries to millennia. Coastal marsh stratigraphy preserves evidence of coseismic deformation and tsunami inundation, offering a critical archive for extending earthquake and tsunami records beyond historical observations. However, while stratigraphic records document broad patterns of land-level change, precise reconstructions of vertical deformation remain limited. Diatom microfossils, which are sensitive to changes in salinity and tidal inundation, can provide a higher-resolution record of coseismic deformation. By statistically relating modern diatom assemblages to intertidal elevations using transfer functions, we can generate quantitative estimates of past vertical deformation from fossil cores that serve as essential constraints for rupture models.

Recent work on Sitkinak Island, located at the western edge of the 1964 CE rupture boundary, suggests that this boundary is not persistent, as evidenced by a mixed record of uplift and subsidence. Here, we present new stratigraphic and diatom evidence from a coastal marsh east of the previous Sitkinak Lagoon study site, where we analyzed a 130 cm-long sediment core. We identified two peat-mud contacts indicating subsidence and three mud-peat contacts indicating uplift, with radiocarbon and Cs-137 analyses suggesting correlation to previously identified earthquakes at Sitkinak. These events include subsidence in 1964 CE and 640–510 cal yrs BP and uplift episodes at 290–0, 520–300, and 1050–790 cal yrs BP.

To address the existing uncertainty in coseismic vertical deformation estimates, we will apply a diatom-based transfer function to each earthquake contact. By integrating these quantitative estimates into rupture models, our results will help clarify slip variability along the AASZ, improve reconstructions of past megathrust earthquakes, and refine hazard assessments for future events.

SULFIDE MINERAL CHARACTERIZATION OF POTOMAC AQUIFER SEDIMENTS IN SOUTHEASTERN VIRGINIA

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In 2018, the Hampton Roads Sanitation District (HRSD) began the Sustainable Water Initiative for Tomorrow (SWIFT) program, a managed aquifer recharge (MAR) operation involving the injection and storage of treated wastewater effluent into the Potomac Aquifer in southeastern Virginia. MAR addresses the issues associated with groundwater extraction over time. Human activities, including MAR, can mobilize the arsenic (As) bound to sediments into groundwater through changes in geochemistry. Arsenic is important due to its carcinogenicity and presence in elevated concentrations in groundwater in many regions worldwide. Elevated As has been measured in a monitoring well close to the SWIFT injection well, indicating that As mobilization is also a potential risk at this MAR site. One mechanism controlling Arsenic mobilization during MAR is the oxidation of As-bound pyritic minerals (FeS_2). Testing this mechanism involves two parts, characterization of pyritic minerals in aquifer sediments and an oxidation batch experiment. Extensive sediment characterization of core sub-samples and drill cuttings from both the screened and clay intervals of the Potomac Aquifer revealed associations between As, Fe, S, and finer grain sizes. A multiple linear regression equation was derived from these data to help pinpoint depth ranges vulnerable to pyrite oxidation and subsequent As mobilization. Scanning Electron Microscope (SEM) analysis confirmed the presence of pyrite within the clay interval sediment. Heavy liquid density separation was performed using Lithium Meta Tungstate to extract pyrite from PAS confining layer sediment. The next step is the pyrite oxidation batch experiment. Reaction data will be incorporated into the SEAM3D reactive transport model to delineate the extent of As migration in the Potomac Aquifer.

EFFECTS OF MINERAL DUST ON THE PERFORMANCE AND EFFICIENCY OF GAS TURBINE ENGINES

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Airborne mineral particles are present in Earth's atmosphere, and they have effects on geologic processes and human activities around the world. These particles have a profound effect on the aviation industry, as their ingestion in the gas turbine engines used in aircraft propulsion can cause erosion of components and can form deposits within, which changes the airflow through the engine and decreases performance and efficiency. To completely understand these processes, it is important to not only study changes to the engine, but to also study changes to the particles. By studying the evolution of particle shape, size, and composition through an engine, as well as studying where these particles deposit, we can better understand the interaction between particles and engine components. We can also use the particles as a proxy for engine conditions, providing insight into flow dynamics and operating temperatures. A series of tests run on Rolls-Royce M250-C20 turboshaft engines at Virginia Tech's Advanced Propulsion and Power Lab have generated a wide range of particle and engine data across a range of operating conditions and input particle characteristics. By studying particles from various locations in the airflow and in engine deposits, we can better identify damage mechanisms, which will help to decrease maintenance and fuel costs and increase aviation safety.

CHARACTERIZING THE TEMPORAL TRENDS IN THE CONCENTRATION AND COMPOSITION OF MICROPLASTICS OVER THE 20th CENTURY TO PRESENT IN THE CHESAPEAKE BAY REGION

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Plastic production began to increase worldwide in the mid-20th century and has continued to grow rapidly to present day. As plastic production has increased, microplastics (particles < than 5 mm) have been accumulating in both onshore and offshore sediment. Intertidal ecosystems, such as wetlands and estuaries, serve as significant sinks for microplastics due to daily tidal inundation, natural sediment accumulation processes, and inputs from atmospheric, marine and freshwater sources. Despite documented microplastics in coastal waters and sediments, quantitative studies on how their concentration and composition has changed over time are scarce. Here, we analyzed sediment cores from intertidal wetlands on both the bayside and seaside of the Chesapeake Bay to quantify microplastic concentrations and characterize polymers. We collected two 50-cm deep sediment cores from a bayside wetland in the Saxis Wildlife Management Area (Saxis) and a seaside wetland on Wallops Island National Wildlife Refuge (Wallops). Microplastic particles were extracted from the cores in 1-cm intervals, isolated, counted, and classified to determine morphology and color. Following classification, a subset of particles was characterized using μ Raman Spectroscopy to determine polymer type. ^{210}Pb and ^{137}Cs analyses provided a chronology of the sediment sequences, showing that ~40 cm core depth corresponds to 1900 and ~15 cm corresponds to 1963. Data from Saxis revealed an increase in microplastics concentrations from the bottom (~0.47 particles/g and 5.7 fibers/g) to the top (~2.3 particles/g and 10.8 fibers/g) of the core. Dominant polymers shifted from polystyrene and nylon at the bottom to PETE at the top. Data from Wallops demonstrated an overall lower concentration of microplastics when compared to Saxis (<1 particle/g). However, Wallops still saw an overall increase in microplastic concentration from the bottom of the core (~ 0.096 particles/g and ~ 3.43 fibers/g) to the top (~0.53 particles/g and 7.8g/gram) of the core. Dominant polymers shifted from PETE, polyethylene, and polyamide at the bottom to polystyrene at the top. At both sites, microplastics were present in sediments from the early 20th century, however, at Saxis, early microplastics are consistent with polymers in use during that period, while at Wallops, the microplastic concentration and composition suggest possible sediment mixing due to bioturbation. Future work will aim to explore further down core at both locations to identify at what depth plastic disappears from the sediment record.

MINERALOGICAL EVOLUTION OF ATMOSPHERIC DUST: FROM AFRICAN SOIL TO AEROSOLS OVER THE CANARY ISLANDS, SPAIN

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Dust aerosols play a crucial role in Earth's climate system, influencing atmospheric processes, radiative forcing, and global biogeochemical cycles. The Earth Surface Mineral Dust Source Investigation (EMIT) mission by NASA measures light reflected from the Earth's surface to identify minerals from space. This data is essential for refining our understanding of surface mineralogy, particularly in arid regions where dust generation is significant. However, while EMIT provides valuable insights into surface mineral composition, it does not directly measure the mineralogy of airborne dust particles. Despite significant advancements in atmospheric dust research, key gaps remain in our understanding of how dust mineralogy evolves during atmospheric transport and its subsequent role in Earth's radiation balance. This study investigates the mineralogical composition of aerosol dust samples collected from Tenerife, Spain (Canary Islands), where deposition is primarily sourced from northern Africa and influenced by various atmospheric processes, including transport dynamics and precipitation. Weekly samples collected from April 2023 to April 2024 from two distinct locations at different elevations (Izaña and La Laguna) provide a rich dataset for studying the evolution of dust as it travels from its source through the atmosphere. The mineralogical composition of these dust aerosols is analyzed using powder X-ray diffraction (XRD) for precise mineral identification and quantification, while scanning electron microscopy (SEM) is employed to examine particle size and morphology, and elemental composition, allowing for a comprehensive characterization of the samples. Preliminary results indicate the presence of abundant minerals, including gypsum, halite, quartz, and kaolinite along with other mineral phases. Given the role of mineral dust in radiative forcing, further analysis is needed to determine whether other minerals in minor abundance, such as iron oxides (hematite, goethite), contribute more significantly to dust's climatic effects. This analysis will also provide a deeper understanding of the dust's mineralogical composition and its potential environmental impacts. This research aims to trace the mineralogical evolution of dust throughout its atmospheric journey, ultimately enhancing our understanding of its implications for climate change and environmental systems.

SATELLITE-BASED OBSERVATIONS OF RIVER SURFACE TEMPERATURE CHANGES DOWNSTREAM FROM LARGE UNITED STATES DAMS

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Dams have been shown to influence river temperatures. Alterations to a river's natural thermal regime can affect vital downstream biogeochemical and ecological processes. Thus, it is imperative to identify how dams modify river temperatures on a broad-scale basis. Current studies use a combination of in situ data, remotely sensed imagery, and/or modeling to quantify dams' thermal impacts on water temperature. These assessments, however, are frequently limited in scope to dam-specific or regional evaluations. Thermal satellite remote sensing can provide a more spatially continuous option for observing river surface temperatures across a much larger footprint. This study uses satellite-based thermal observations to identify water surface temperature differences along large (i.e., ≥ 100 meters in width), obstructed rivers up and downstream of more than 250 major dams in the United States. We extracted $>11,000$ longitudinal river temperature profiles from the U.S. Geological Survey's Landsat 8 Collection 2 Surface Temperature product between 2013 to 2024. Intra-image temperature comparisons show close agreement between satellite-derived surface water temperature and USGS gages (RMSE = 1.77°C , MAE = 1.29°C , Bias = -0.33°C) to verify their utility in assessing differences along the profiles. We identified a significant difference between upstream (pre-reservoir) and downstream river temperatures in the majority (71%) of the profiles. Over half of the profiles exhibiting significant temperature differences, were warmer within the first 20 km downstream from the dam. Additionally, we found that downstream temperature differences compound moving downstream and displayed seasonal variability with the highest absolute differences occurring during spring and summer months. Detecting the extent, magnitude, and seasonality of river surface temperature changes downstream from large US dams enables us to better understand their spatiotemporal impact on thermal regimes at a national level.

LINKING MORPHODYNAMICS OF SUPERIMPOSED DUNES ACROSS ENVIRONMENTS

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The occurrence, formation and interactions between multiple scales of bedforms across a range of environments is unknown. Superimposed dunes are bedforms that form and climb over existing primary dunes. These dunes can form in aeolian and fluvial regimes. In rivers, the conditions of multiple scales of bedform formation have been linked to flow and sediment flux variability. These studies have informed our understanding of compound bedforms and the agents that shape them in fluvial regimes, offering a framework to investigate similar interactions in aeolian environments. First, we review the state of frameworks used to investigate bedform morphodynamics in both environments. Then, we present an image analysis method to reveal the interactions between multiple scales of bedforms in the aeolian regime.

The Algodones Dune Field is a US National Natural Landmark located in California, near the US-Mexico Border. The area spans approximately 72.4 km long by 9.7 km wide. Its isolated geography constitutes this area as a favorable location for dune dynamics studies. The regions of interest in Algodones are an area with giant primary and superimposed dunes, and an area with primary dunes of a similar scale to the superimposed dunes. We use repeat DEMs from Lidar to quantify the spatial migration of bedform scales from 2016 to 2020.

Temporal DEMs show that the superimposed dunes have uniform migration direction from the primary dune trough, over the stoss, and to the crest. Bedforms similar in scale to superimposed bedforms exist as primary bedforms ~1 km to the west. In this area, bedforms have a large spatial variability in their movement and do not move in one direction. This suggests the morphology of the primary dune the superimposed dunes climb over plays a role in determining the migration direction of the superimposed dunes.

The observed dune migration are preliminary steps that contribute to our understanding of how multiple scales of bedforms interact across environments. The tools used to investigate these trends support the use of frameworks developed in fluvial settings to inform the dynamics of other environments. Thus, we provide the foundation to offer improvements in how dune morphology and superimposition in aeolian regimes are parametrized and characterized.

MAPPING GROUND DEFORMATION ACROSS ALASKA WITH INTERFEROMETRIC SYNTHETIC APERTURE RADAR

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Alaska is experiencing rapid environmental change due to climate change, with Arctic temperatures rising four times faster than the global average (Rantanen et al., 2022). Large areas of Alaska feature continuous or discontinuous permafrost. This permafrost thaws and refreezes seasonally, but as temperatures increase, permafrost thaws at rates that exceed the typical seasonal fluctuations. This process and increasing trend in thawing deforms the ground and induces long-term subsidence, degrading ground stability and posing threats to buildings, roads, airports, and pipelines. These local hazards are of growing concern for a wide range of communities in Alaska, from indigenous communities, or Native Villages, to Department of Defense (DoD) military installations. Thawing permafrost can also impact the hydrological regime and water quality in local water sources, by releasing contaminants from previously frozen sediment into the water supply. In addition to these acute, localized hazards occurring throughout the state, permafrost thaw poses a global threat, as thawing permafrost releases greenhouse gases, further exacerbating the warming already taking place and inducing a concerning feedback loop. Current climate models only account for gradual permafrost thaw processes. This overlooks the fact that the largest quantities of greenhouse gases are released rapidly and nonlinearly through abrupt thaw events. These events include the thawing of ground beneath thermokarst lakes and active retrogressive thaw slumps.

The importance of monitoring all permafrost thaw processes and quantifying their impacts is evident, but in-situ data across Alaska, especially the Arctic regions, are limited. We apply a multitemporal interferometric synthetic aperture radar (InSAR) technique, processing Sentinel-1 data using wavelet-based InSAR (WabInSAR) software (Shirzaei, 2013; Lee & Shirzaei, 2023) to generate a statewide ground deformation map. Our results reveal spatially varying trends of subsidence and/or uplift across the state and corresponding time series reveal oscillatory patterns, which could be from the freeze/thaw cycle. This study provides wide-scale insight into the quickly changing environment across Alaska, opening up multiple research avenues regarding permafrost thaw, its contribution to greenhouse gas emissions, spatial variation across landscapes, and implications for infrastructure resilience.

WIDTH VARIABILITY IN THE PLATTE RIVER BASIN FROM SATELLITE REMOTE SENSING

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Surface area is a key determinant of global river greenhouse gas emissions: for a given flux per unit area, a broader surface area leads to greater emissions (Raymond et al., 2013). Global river surface area is thus an essential input for models of global carbon emissions. River networks exhibit fractal geometry, meaning that widening of large rivers is accompanied by lengthening of non-perennial headwater streams. Expansion and contraction of river networks causes wetting and drying of riverbanks and non-perennial streambeds drive organic matter decay and is one mechanism by which rivers emit greenhouse gases. For this project, I use satellite remote sensing to measure river widths in the Platte River Basin from 2017 to the present to investigate multiannual trends, seasonal variability, and geographic patterns in river width. This project contributes to a larger body of work investigating width variation of river networks from a global scale (Feng et al., 2022) to the headwater scale (Allen et al., 2018; Barefoot et al., 2019).

QUANTIFYING BEDFORM MORPHOLOGY IN MEANDERING RIVERS

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Within sand-bedded alluvial channels, erosion and deposition redistribute sediment throughout the channel, causing rivers to meander and migrate over and into their floodplains. In these channels, eroded sediment from the outer bank deposits at the inner bank. This process causes flow depth to increase near the outer bank and decrease near the inner bank, altering the channel geometry by creating a variable flow depth. Additionally, these variations in flow depth redirect flow toward deeper sections of the channel, resulting in acceleration within these areas and deceleration in the shallower regions. Over time, the hydraulic heterogeneity causes the channel to migrate toward the outer bank, leading to the formation of river bends and the development of meandering rivers. So, flow speed, shear stress, and kinetic energy play crucial roles in bank stability and meander formation (Barman et al. 2022), whereas hydraulic and morphodynamic conditions dictate meandering rates (Hooke 2023). Bedforms, formed by bedload accumulation, influence flow dynamics through the development of flow recirculation and turbulence, and their migration dominates bedload transport in alluvial channels. Recent research highlights the spatial variability and complexity of bedform morphology in straight rivers, highlighting the need to incorporate these findings into flow roughness and sediment transport predictions (Cisneros et al. 2020). Using multibeam echosounder surveys and bedform analysis techniques, we measure bedform morphology in the Sheepnose Bend, Missouri River, MS, to quantify morphologic variability. These measurements allow us to connect the spatial variability of bedform morphology and water levels to predict the stress distribution acting on the bed. This information offers insight into the evolution of the channel through the prediction of erosion and deposition rates. Thus, we aim to observe how hydraulic heterogeneity in a river bend modulates bedload transport. These findings will improve our understanding of the links between bedform dynamics and meandering rates.

HYDROLOGIC AND ENVIRONMENTAL DRIVERS OF ALUMINUM AND BARIUM IN DRINKING WATER RESERVOIRS IN SOUTHWESTERN VIRGINIA

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Freshwater sources are essential for drinking water. Naturally occurring metals pose environmental and human health risks. Metals such as aluminum (Al) and barium (Ba) are regulated by the U.S. EPA, making it crucial to understand their behavior in drinking water reservoirs to protect water quality. Their concentrations are affected by common hydrologic and geochemical processes found in surface water reservoirs; however, the specific drivers affecting Al and Ba have not been studied. I hypothesize that hydrologic (inflow, turbidity, precipitation) factors influence Al concentrations and redox (DO, pH) variables influence Ba concentrations in drinking water reservoirs.

To address these hypotheses, I measured Al and Ba concentrations in the water column and in settling particulate matter along with key explanatory variables in two seasonally stratified drinking water reservoirs in southwestern Virginia – Falling Creek Reservoir (FCR) and Beaverdam Reservoir (BVR) – from 2020-2023. FCR is equipped with a hypolimnetic oxygenation (HOx) system to maintain oxic conditions in bottom waters, whereas BVR lacks this system, serving as the reference reservoir for comparison. To quantify the drivers of Al and Ba, I analyzed depth-related metal concentrations, DO, pH, and turbidity, metal removal fluxes, discharge, and composite water samples of the inflow. I then applied Principal Component Analysis (PCA) to classify metals based on their behaviors (e.g., redox-sensitive, chemically or physically weathered) and used an autoregressive integrated moving average (ARIMA) model to identify explanatory variables significantly influencing Al and Ba concentrations over time.

Preliminary results indicate a positive relationship between Al concentrations and high-flow events, with inflow sediments primarily composed of Al, suggesting that hydrologic processes are the dominant driver of Al concentrations in the reservoirs. In contrast, I observed increased Ba removal under increasing oxygen conditions, indicating that environmental factors, such as redox processes, play a key role in regulating Ba concentrations. This research provides valuable insights into the hydrologic and environmental controls of Al and Ba in drinking water reservoirs, helping water authorities make informed decisions to protect water quality.

VENDOTAENIA AS A CLASSIC EXAMPLE OF DISASTER TAXA AT THE EDIACARAN-CAMBRIAN BOUNDARY

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The Ediacaran-Cambrian marks a critical transition point in the history of life, preceded by dual extinctions termed the Kotlinian Crisis. This crisis is defined by an observed drop in diversity between the White Sea and Nama assemblages, followed by the complete disappearance of a number of distinct taxa at the boundary itself. However, some taxa persisted through the crisis and new forms emerged. *Vendotaenia* is one such taxa which has been perceived to have thrived during the crisis, though this observation lacks quantitative support. Here, we document a large number of *Vendotaenia* specimens from drill core samples of the Nama Group of Namibia. We used integrated observations from light and scanning electron microscopy to analyze the morphology and taxonomic affinity of *Vendotaenia*. Our analysis reveals that the observed vendotaenids represent a single population of tubular macroalgae which were likely planktonic in nature. Their abundance and temporal occurrence after the first extinction pulse make *Vendotaenia* a classic example of a disaster taxa. Thus, like Phanerozoic mass extinctions, the Kotlinian Crisis is characterized by the decimation of many species, a transient proliferation of several disaster taxa, and subsequent diversification of a new cohort of life.

MULTISCALE OPTIMIZATION OF ENHANCED GEOTHERMAL SYSTEM STIMULATIONS

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Geothermal energy has the potential to significantly contribute to the world's energy matrix. Enhanced Geothermal Systems (EGS) allow exploiting geothermal energy with little geographical constraints. EGS consist in injecting pressurized fluids in deep underground rocks to create permeability by opening or reactivating fractures in shear. Their development has been limited by (1) the inability to predict and control fluid flow in the subsurface, and (2) induced seismicity. This research studies the complex links between geomechanics and fluid flow in deep crystalline rocks under high stresses, at scales from micrometres to kilometres.

On the one hand, we will study the effect of geomechanical deformation on fluid flow in faults at micron to centimetre scale. Hydro-shearing involves injecting fluids at high pressure for reactivating existing fractures for permeability enhancement. Previous studies have observed that at low effective normal stress, shear slip causes an increase in permeability. Conversely, at high stresses no such increase is observed. Our predominantly experimental study aims to understand the mechanics behind this process by investigating the parameters (effective normal stress, material strength, contact geometry, and amount of slip) controlling shear induced permeability evolution. Contact mechanics theory will help develop a mechanistic model for fluid flow through faults. This model can help inform stimulation strategies for EGS.

On the other hand, we will study how coupled fluid flow and geomechanical deformation affect seismicity, and how to minimize it at reservoir scales. A model for fluid-flow, geomechanical deformation and seismicity has succeeded at forecasting induced seismicity in real stimulations. We will add a feedback loop based on the mathematical theory of control which jointly maximizes pore pressure at multiple wells while keeping seismicity rates below controller targets. The controller will inform if stimulation targets are feasible given the physics at play and can be used to optimize the stimulation in real-case scenarios for multiple injection wells.

DECIPHERING GREENLAND ICE SHEET HISTORY THROUGH SEDIMENT ANALYSIS OF THE MELVILLE BUGT TROUGH MOUTH FAN (TMF)

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The Greenland Ice Sheet (GrIS) is undergoing significant melting contributing to sea-level rise. Studying paleoclimate patterns and warming trends of the GrIS is crucial in understanding its implications on global climate. Reconstructions of GrIS response to past climate change can provide important context and constraints for long-term projections. Analyzing sediments from two sites drilled during IODP Expedition 400 that were deposited on the Greenland continental slope during the past ~1 million years helps understand the recurring glacial-interglacial events and associated GrIS dynamics.

Numerous thin sand beds, interpreted as turbidites in core images, are more frequent in Site U1603, which is closer to the turbidity current channel, compared to the more distal Site U1604. Overall, ~8,000 turbidite events are recorded at Site U1603, occurring as alternating sand and mud layers with sparse ice-rafted debris. However, the presence of alternating sand beds may indicate repetitive glacial cycles within the sedimentary record. In addition to counting and measurement of the sand layers, we plan to conduct grain-size analysis, which will provide information about sediment transport energy. To achieve this, we are analyzing 160 samples for grain size and interpreting >800 core images from both sites.

Our aim is to decipher the evolution of the Melville Bugt TMF during ice-sheet advance and retreat through sedimentary processes, using turbidites layer dataset coupled with grain size measurements. This study will improve our understanding of gravity flow processes during the glacial-interglacial intervals and their implications for GrIS in this region.

USING WATER QUALITY AS A PROXY TO ESTIMATE MICROPLASTIC CONCENTRATIONS VIA SENTINEL-2 IN THE NEW RIVER, VA

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Microplastic (<5 mm) pollution in rivers poses a threat to ecosystems and human livelihood around the world yet the ways we quantify and monitor their transport are highly limited. About 20% of all plastics are mismanaged, and they make their way into rivers through a variety of factors such as direct dumping and hydrometeorological variables (wind, surface runoff, etc.). To detect and quantify microplastic abundance in rivers, current detection methods rely on various collection techniques that sample an area at one point in time. These methods are time-consuming and require laborious field collection and laboratory work, inhibiting real-time and high-frequency insight over large spatial extents, needed to better understand the sources, sinks, and dynamics of microplastic pollution. On the other hand, satellite remote sensing can provide regular water quality estimates in rivers with large spatial and temporal coverage, which we could use as a proxy for surface river microplastic concentrations. In this study, we validate the satellite normalized difference turbidity index (NDTI) by comparing it to co-temporal in situ turbidity, and we also establish a relationship between in situ turbidity and surface water microplastic concentrations. We focused our study on the New River, in Southwest Virginia, USA. From September 2023 through September 2024, we collected over 100 co-temporal water quality measurements and surface water microplastic concentration samples and mapped these days out using satellite imagery as well. Using a linear regression, we derived a relationship between NDTI and in situ turbidity that explains 71% of the relationship's variance ($R^2 = 0.71$). A significant relationship was found between in situ turbidity and microplastic concentrations during the winter season. We combined the equation relating NDTI and in situ turbidity with the equation used to relate in situ turbidity with co-temporal microplastic concentrations index in order to directly relate satellite-derived NDTI to microplastic concentrations. With this new equation, we can estimate microplastic concentrations along the New River on clear days using Sentinel-2 at 10m resolution, thus allowing us to further understand and gauge where microplastics are along the river. By providing more observations than can be done with *in situ* sampling alone, we can improve our ability to track microplastics leading to better assessments of sources and sinks of mismanaged plastic waste in surface waterways.

QUANTIFYING URBAN GROWTH AND ITS IMPLICATIONS FOR SEDIMENT TRANSPORT AND MORPHOLOGY IN LAKE AUSTIN, TX

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Urbanization transforms natural landscapes by expanding impervious surfaces, increasing surface runoff, and accelerating sediment transportation in watersheds. Studies looking at the effects of urbanization are often focused on gravel-bed rivers because of their convenience in modeling and measuring larger grain sizes. Sand-bedded-river systems are usually underexplored despite being dynamic and experiencing higher sediment mobility – making them highly susceptible to urbanization impacts. This study examines the historical urbanization trends within the Austin-Colorado watershed; and evaluates how land cover changes may have altered the sediment composition and morphology of Lake Austin and its tributary creeks.

Using GIS-based spatial analysis, historical land cover data for Lake Austin and surrounding regions were compared to quantify urban expansion over time. Thematic change detection was conducted to determine the nature of these changes – such as transitions from vegetated land to developed surfaces or low-intensity to high-intensity development – helping to assess the extent and intensity of the urban expansion. These analyses allow us to identify creek systems most affected by urbanization induced runoff and sediment transport, which we hypothesis will exhibit the most pronounced sedimentary and geomorphic responses to urban growth.

This work serves as a preliminary assessment to identify key locations for further investigations into the impacts of urbanization on sediment composition and morphology. Identification of creek systems most affected by urbanization sets the groundwork for future field-based sediment sampling and geomorphic analysis. The next phase of this research will focus on assessing the creeks' spatial sediment composition, types, distribution, and morphological alterations in response to urbanization. Ultimately, these findings will contribute to guiding sustainable watershed management practices tailored to sand-bedded systems facing urban expansion.

INVESTIGATING MANGANESE REMOVAL AND MOBILIZATION MECHANISMS DURING MANAGED AQUIFER RECHARGE

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Managed aquifer recharge (MAR) can benefit communities by increasing groundwater yields, preventing land subsidence, and reducing saltwater intrusion in coastal areas. One method of MAR is injecting treated wastewater into aquifers. However, injecting water with a chemical composition that differs from native groundwater may result in unintentional releases of geogenic contaminants, including arsenic, chromium, fluoride, and manganese (Mn). Despite the increasing numbers of MAR sites reporting geogenic contaminant mobilization, water quality observations for MAR operations are relatively scarce, with less than 1% of ~1200 MAR case studies across 62 countries reporting water quality data.

My study focuses on the removal and mobilization of Mn in the Potomac Aquifer System, Virginia resulting from the Sustainable Water Initiative for Tomorrow (SWIFT). The SWIFT is an ongoing MAR project implemented in 2018 by the Hampton Roads Sanitation District to address the overuse of groundwater in the Potomac Aquifer and reduce the nutrient load to the Chesapeake Bay. Mn was selected for this study due to its adverse health effects, including intellectual impairments in children. Mn levels in drinking water are guided by a secondary maximum contaminant level set by the Environmental Protection Agency.

In this study, I will utilize batch experiments, laboratory columns, and large-scale columns with Potomac Aquifer sediments and various water chemistries to test biogeochemical conditions that can promote the removal or release of Mn into groundwater of the Potomac Aquifer. I will analyze water samples from these experiments for metals, total organic carbon, dissolved oxygen, pH, temperature, and specific conductance to understand the chemical mechanisms influencing Mn concentrations in the Potomac Aquifer during the SWIFT. The release or retention of Mn depends on microbially-mediated reactions, including Mn reduction driven by oxidation of dissolved organic carbon. Mn concentrations in aquifers are also governed by abiotic chemical Mn removal and mobilization processes, such as adsorption, desorption, and complexation with organics. Based on analysis of groundwater monitoring data collected during the SWIFT, I hypothesize that 1) Mn is being removed from the Potomac Aquifer via oxidation due to injection of oxygenated recharge water and 2) Mn is mobilized during stoppages of recharge via microbially-mediated Mn reduction driven by oxidation of dissolved organic carbon. Identifying the Mn removal and mobilization mechanisms acting in a large-scale MAR operation will inform operational conditions to minimize release of geogenic contaminants at the SWIFT and other MAR efforts worldwide.

LATERAL VARIABILITY IN SOIL DEPTHS AND TREE ROOT DISTRIBUTION IN YOSEMITE'S MARIPOSA GROVE OF GIANT SEQUOIAS

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Giant sequoias are the largest trees by mass on the planet. Some of their oldest members were just saplings at the start of the Bronze Age in 1200 BC and have since witnessed the rise and fall of Rome, and the entirety of modern human civilization. Beyond their role as indispensable natural wonders, sequoias are critical in promoting biodiversity and ecosystem stability. They have shown resilience to drought, disease, and fire, all of which are becoming more frequent and intense with worsening climate change. Along the southeastern boundary of Yosemite National Park, the ~250-acre Mariposa Grove of Giant Sequoias is home to over 500 mature sequoias, two of which are among the 30 largest in the world. Recent studies of sequoia groves have focused on the above-ground critical zone, examining factors such as foliage, tree crowns, and various biological adaptation mechanisms in response to climate change (Ambrose et al., 2018; Martin et al., 2018; Soderberg et al., 2024). Climate factors like extreme drought impact trees from being able to transfer water from their roots to photosynthetic tissues, which can lead to physiologic changes (Baeza et al. 2021). The key to their survival may lie in the subsurface, and how roots and water are distributed below ground.

To image the unexplored subsurface beneath the giant sequoias, we will combine high resolution geophysical imaging, including seismic refraction and ground penetrating radar, to examine root structures, subsurface porosity, and lateral soil depth variability. Seismic data images indicate where there is soil, saprolite, and fractured bedrock. This may provide insights into where and how sequoias get their water – is it from soil moisture, water within the saprolite layer, or bedrock moisture? (Rempe and Dietrich 2018). We aim to: (1) visualize the variation in soil depths across a 35-meter section of a sequoia grove, and (2) provide detailed 3D imaging of giant sequoia roots within a 35m x 23m subplot. By combining these two datasets, (3) we hope to identify root distribution in relation to the soil depths. Understanding how these trees are adapting to a rapidly changing environment is crucial for developing management strategies that enhance their resilience.

TIME-FREQUENCY-PHASE WAVEFORM INVERSION BASED ON THE CONTINUOUS WAVELET TRANSFORM: APPLICATIONS FOR CRITICAL ZONE EXPLORATION

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Over the past decades, full waveform inversion (FWI) has matured as a technology and evolved into a state-of-the-art geophysical imaging method. FWI is widely used for global tomography, resource exploration, and currently, there is increasing interest in expanding the application of FWI to environmental contexts such as imaging Earth's critical zone (CZ). The CZ extends from the vegetation canopy to unweathered bedrock and plays a vital role in terrestrial hydrology and ecological processes. Over the last decade, classical seismic imaging methods such as first arrival travel time tomography have gained popularity for CZ characterization, and now, there exists a growing interest in utilizing advanced seismic imaging techniques to create high-resolution, elastic images of the near-surface. However, the CZ presents a challenging context for FWI because the upper ~50 m of Earth's crust usually hosts extreme velocity gradients and heterogeneous media. This results in CZ seismic refraction data exhibiting complex amplitude responses and overlapping waveform phases. Here we advance FWI for CZ study by developing a new misfit function based on the continuous wavelet transform (CWT). Inspired by previous work leveraging time-frequency analysis for global FWI, our approach aims to optimally use near-surface seismic refraction data by robustly extracting and fitting phase information. In this work, first, we introduce the CWT and use it to derive a novel misfit function and a corresponding adjoint source. Next, we verify our new approach by inverting synthetic data and then go on to invert field data collected from the Blair-Wallis Catchment, Wyoming, USA. The results of the field data inversion are ground-truthed using borehole V_p and V_s logs which show that our FWI results agree better with in situ velocity measurements than the starting traveltime tomography model.

DEVELOPMENT OF A U-TH-PB MONAZITE DATING PROCEDURE USING EPMA AT VIRGINIA TECH

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Monazite is a common accessory mineral found in igneous and metamorphic rocks, which can be dated due to its relatively high concentrations of U and Th. While monazite is typically dated using laser ablation- and ion probe-based mass spectrometry, it has also been dated successfully using electron probe microanalysis (EPMA), which is less precise but provides superior spatial resolution compared to these other methods. We have been developing a monazite dating protocol on a new JEOL JXA-iHP200F microprobe at Virginia Tech using procedures for the measurement of U, Th, Pb, and Y described previously in the literature and well-characterized monazites with known ages to constrain the likely uncertainty that users can expect. Initial analysis of three samples previously studied for use as standards and an additional low-actinide, young sample acting as a “blank” were used to build an empirical calibration curve to for uncertainty assessment.

Because EPMA is a spectroscopic method that performs elemental quantification using characteristic X-rays, treatment of elemental interferences (e.g. Y $L\gamma$ vs Pb $M\beta$) and background fitting (e.g. curved vs linear background models) are fundamental considerations affecting our results. Wavelength scans were conducted around the peak and background collection points for Th, U, and Pb for each standard to check for possible interferences from higher-order X-ray lines. Background correction was done through linear interpolation on each point measured. This final procedure yields results that are generally accurate to 10s of Ma, though the discrepancy is generally lower for some Phanerozoic and late Proterozoic samples. We found limited improvement to the accuracy of the method from using longer analysis times at higher beam power, which suggests that methodological uncertainty provides a first order limitation on the accuracy of monazite ages obtained using EPMA, and errors introduced by X-ray counting statistics are less significant. Ongoing work aims to optimize sample throughput and minimize analytical error to provide the SE US petrologic community with another resource for the rapid and cost-effective dating of monazite at sufficient accuracy and precision to resolve major trends.

TECTONIC TRANSPORT DIRECTIONS AND TIMING OF METAMORPHISM IN THE SOUTHERN PART OF THE NORTHERN HIGHLANDS TERRANE, SCOTLAND

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Determining the directions, senses, and timing of rock movement during orogenesis is fundamental in understanding the tectonic evolution of any mountain belt. Microstructural and petrologic research on the Moine metasedimentary rocks in northern Scotland have played an important role in characterizing tectonic transport directions associated with thrust faulting in the Northern Highland Terrane (NHT) during Caledonian orogenesis (450-435 Ma). Microstructural, quartz crystal fabric, and isotopic analyses of samples in the northern part of the NHT show that local tectonic transport changed from top to the north at 450-440 Ma in the core of the orogen to top to the west at 435 Ma along the western foreland margin (Law et al. 2021). To extend these studies to cover the southern part of the NHT we are conducting similar kinematic and isotopic analyses along four E-W transects across the Sgurr Beag thrust (SBT) within the NHT Steep Belt and in the Flat Belt, the structurally simpler eastern part of the Sgurr Beag thrust sheet. From north to south these transects include: Loch Monar, Glen Sheil, Kinloch Hourn, and Lochailort.

Quartz fabrics in samples collected from the transects in the Steep Belt show a top down to the SE shear sense with deformation temperatures decreasing from the footwall to the hanging wall of the SBT. Grain sizes of dynamically recrystallized quartz remain constant from footwall to hanging wall crossing the SBT, suggesting that this recorded shearing post-dates the thrust. However, fabrics analyzed in the Flat Belt, east of the Steep Belt transects, indicate a top to up to the NNW shear sense similar to what has been observed in the northern NHT.

Preliminary analysis of titanite isotopic U-Pb data collected for samples from Glen Sheil, Lochailort, Loch Monar, and in the Flat Belt indicate multiple age populations of grains. Many titanites are complexly zoned in yttrium, with core ages ranging from 750 to 690 Ma and rim ages ranging from 450 to 415 Ma. Grains with no zoning have ages between 450-415 Ma. These ages suggest an original phase of Knaydatrian metamorphism which was then succeeded by Grampian - Scandian phases of metamorphism and penetrative deformation.

NEW FOSSIL ANURAN MATERIALS FROM THE LATE TRIASSIC REVEAL THE ORIGINS OF NOVEL STRUCTURES

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Salientians (living frogs and their closest relatives) first appeared in the fossil record ~250 MYA. These earliest taxa include *Triadobatrachus* and *Czatkobatrachus*, which had some traits of living frogs like elongated ilia but maintained other plesiomorphic traits like an elongated vertebral column, a tail, and unfused limb bones. That early salamander-like body plan likely used an undulating or wave-like locomotion. The first appearance of true frogs in the Early Jurassic, with *Prosilurus bitis*, already preserved the unmistakable frog-like body plan that allows for their iconic saltatory (jumping) locomotion. Adaptations for jumping in frogs include fusion of the limb bones, a shortened vertebral column, the presence of a urostyle, and elongated ilia. Recent discoveries of frog fossils from the Upper Triassic Chinle Formation, Arizona, and from the Jameson Land Basin, Greenland, revealed a similar pelvic morphology compared to crown group frogs. Now, new material from the Dockum Group of Texas and New Mexico adds to the number and type of early frog fossils known from the Triassic. These new postcranial fossils show a remarkable collection of derived anuran traits like fused limb bones and the presence of a urostyle (fusion of caudal vertebrae and ossified hypochord) that are typical of crown anurans. Additionally, the new material also extends the geographic range of Late Triassic anurans in equatorial Pangea further east than previously known. For my dissertation, I will conduct a comparative morphological analysis using the Early and Late Triassic salientians and Early Jurassic frogs to examine the timing and order of appearance of synapomorphic traits and bone density. Preliminary observation of μ CT scan data and osteohistological thin sections show a fused though still morphologically segmented urostyle that reveals information regarding the evolutionary processes surrounding unique anatomical structures. The new specimens from the Upper Triassic Dockum Group provide growing evidence that Late Triassic frogs had already begun the evolution of unique crown frog synapomorphies that permitted saltatory locomotion and ecological diversification of the clade.

PATTERNS OF LIFE AND DEATH DURING THE CAMBRIAN SPICE EVENT PRESERVED IN APPALACHIA

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The late Cambrian was characterized by elevated extinction rates, dramatic sea level changes, and large carbon cycle perturbations such as the Steptoean Positive Isotopic Carbon Excursion (SPICE event). The SPICE was a global, 4-6‰ carbon isotope excursion that broadly cooccurred with a trilobite extinction event and Laurentian sea level shift. Here we present high-resolution geochemical, sedimentological, and paleontological data from three new SPICE sections in Virginia and Maryland that show a complex relationship between biological patterns and environmental change. We found that relative to the SPICE event, the timing of trilobite extinction and sea level change varies according to each section's paleowater depth and position within the basin. We also collected fossil occurrence and point count data that record a decline in fossil abundance and diversity just prior to the onset of the SPICE, but with variation specific to each section. For example, only in our western Maryland section did we observe all pre-SPICE animal groups (trilobites, echinoderms, brachiopods, and sponges) reappearing after the event. We suggest that the overarching biological patterns observed here were a product of both global and regional processes (i.e., the spread of anoxia in deeper, more restricted waters) but are locally variable because of basin geometry and local environments.

Abstracts for Undergraduate Student Poster Presentations

COLOR AS A CLUE: INVESTIGATING IRON-BEARING MINERALS IN SOILS FROM NORTHERN AFRICA

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Dust transported from the Sahara Desert through the atmosphere impacts primary productivity in the ocean, influences hurricane formation, and plays a key role in global climate change models. This study aims to improve our understanding of the mineralogical composition of Saharan soils from known dust source areas. Iron oxide minerals are vital because they provide nutrients to the oceans and influence the absorption and reflection of solar radiation in the atmosphere. We are analyzing soil samples from eight African countries and the Canary Islands, Spain, using powder X-ray diffraction and spectroscopy to determine their mineral composition. Additionally, we are conducting fundamental color analysis to assess whether soil color correlates with total iron content. We hypothesize that redder soils indicate higher iron content and are associated with iron-rich minerals such as hematite and goethite. Detecting natural hematite and goethite in soils is challenging as these minerals are typically nanosized and may be present in low concentrations (a few weight percent or less). Powder X-ray diffraction analysis will identify the major and minor types but might not be sensitive to the presence of goethite or hematite. Therefore, X-ray spectroscopy will quantify total iron content, though it cannot determine the specific type of iron-bearing minerals present. Soil color, quantified through digital imaging and compared with mineral composition results, may serve as a rapid screening tool for soil iron content.

ENHANCING MICROPLASTIC REMOVAL FROM WATER WITH A FOOD-GRADE HYDROPHOBIC POLYMER

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Microplastics, defined as plastic shards less than five millimeters long, can persist in human biological systems for years. Their effects on our biology are still being studied, but research shows they may cause oxidative stress, immune system disruption, and an increased risk of Alzheimer's disease. Wastewater treatment plants currently have systems to remove microplastics, but their removal efficiencies (RE) are around 60–70%. Drinking water standards for microplastics don't exist, but the increased prevalence of them in drinking water suggests the need for improved methods of microplastic removal. Our previous research indicated that adding a food-grade hydrophobic polymer induced aggregation of smaller plastic particles into larger particles, suggesting its potential as an additive in current water treatment methods. This research investigates the RE of microplastics using a hydrophobic polymer in filtered water and salt water that has been artificially contaminated. Commercial glitter plastics, a common plastic pollutant, were used as a model microplastic. Experiments involved mixing various hydrophobic polymer and glitter microplastic (GMP) concentrations in water, then filtering through small holes, and calculating RE. The RE of GMPs from filtered water using hydrophobic polymer was 95% ($\pm 3\%$), significantly higher than the control samples. RE in saltwater using hydrophobic polymer was 93% ($\pm 4\%$), whereas control samples had a RE of 12.3% ($\pm 5\%$). These findings suggest that the use of a food-grade hydrophobic polymer could improve microplastic removal in wastewater treatment plants globally by enhancing current water treatment methods such as coagulation, flocculation, and sedimentation.

RECONSTRUCTING THE CARBON CYCLE DURING THE STAIRSIAN EXTINCTION EVENT OF THE EARLY ORDOVICIAN: INSIGHTS FROM WESTERN MARYLAND, U.S.A.

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The Great Ordovician Biodiversification Event (GOBE) occurred approximately 485 to 460 million years ago and was the turning point in the evolution of marine ecosystems characterized by a tripling of marine biodiversity. Prior to this event was the first major diversification of marine animals, the Cambrian Explosion (545 to 525 Ma), which was followed by a 40-million-year plateau in marine diversity that occurred before the GOBE. Within this diversity plateau several rapid extinction events occurred, but the causes of these extinction events are unknown. Here I examine the carbon isotope record of the final extinction event of this interval, the Stairsian extinction (~484 million years ago). Carbon isotopes from sedimentary rock can be used to understand the changes in the ancient carbon cycle and here I will use them to understand the environmental changes that may have influenced the carbon cycle during this event.

Studies from sedimentary successions now in present day Nevada and Utah show a positive shift or excursion in carbon ($\delta^{13}\text{C}$) isotopes over the Stairsian extinction that reflect a change in the ancient carbon cycle. These successions were deposited in what was the Panthalassa Ocean at the time and since we only have the carbon isotope records from one ocean basin it is unclear whether this excursion reflects local change in the carbon cycle or a global one. Here I examine the carbon isotope record from succession located in the Chesapeake and Ohio (C&O) Canal Historical Park in Maryland to determine if similar carbon isotope changes are found there. The succession represents deposition that occurred in the Iapetus Ocean, a different ocean basin at the time. By comparing carbon isotope trends from different ocean basins, we can determine whether shifts in the carbon cycle were indicative of broader global-scale changes. Identifying these patterns could offer critical insight into the conditions that preceded and influenced one of the most significant biodiversification events in Earth's history.

ASSESSMENT OF THE NORTH AMERICAN MESOZOIC RIFT BASINS FOR CARBON CAPTURE AND STORAGE

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Carbon capture and storage (CCS) is becoming an increasingly critical technology for mitigating climate change and reducing anthropogenic carbon emissions. Due to the economic and regulatory challenges of transporting captured CO₂ across long distances, storing CO₂ within geologic formations near to major point source emissions is often preferred. This presents a challenge in regions such as the Atlantic coast of North America, which hold significant carbon emissions but with a limited history of petroleum production. One potential storage location is within the Mesozoic rift basins along the east coast of North America. These basins stretch from the eastern Gulf of Mexico to the northeastern tip of Canada. Some of these basins have been previously investigated for hydrocarbon resources and some operate as oil producing fields, with highly favorable results. These previous investigations have discovered potential saline aquifers that may have properties suitable to act as reservoirs for carbon storage. Additionally, the rifting process during the breakup of Pangea deposited igneous formations including basalt, which may be viable for large-scale carbon mineralization. This, in combination with growing interest in oil production and carbon capture storage within these basins, puts the basin chain at a favorable disposition for a comprehensive carbon capture storage review, accompanied by the existent research into potential within basins of interest. This study conducts a comprehensive review of the Mesozoic rift basins of North America, examining their proximity to emission point sources and the geologic formations that may be suitable for permanently storing thousands to millions of tons of CO₂. We identify the South Georgia Basin, Fundy Basin, and the Jeanne d'Arc Basin as highly suitable for CCS development based on these criteria.

COMPARING MORPHOLOGY OF REFURBISHED AND NATURAL COASTAL DUNES

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Coastal frontal dunes are the first line of defense against storm surges. As storm surges increase in severity and frequency frontal dunes face increased erosion. Coastal conservation methods have been studied to determine efficacy. Yet, the effects of these methods on dune morphology are understudied. In this study, I evaluated dune morphology of two beaches, one natural and one refurbished, along North Carolina's coast. The two beaches included in this research are Fort Fisher, an east-facing, unpopulated beach with no significant refurbishment projects; and Oak Island is a south-facing beach town with a large refurbishment history. The morphology of the dunes on both beaches were first evaluated by DEM from North Carolina Spatial Download. We defined a research area of 1.4 km x 35 m on each beach. High spatial resolution DEMs were created over smaller regions in both study areas using a KAARTA Stencil 2 handheld Lidar unit. The Fort Fisher dunes reach a maximum height of 4.9 m, and the crestline of the dune extends across the entire research area (1.4 km long). Oak Island dunes reached a height of 3.9 m and have distinct human-made breaks every ~24.3 m. These breaks work as access points to the beach; these access points cause loss of sediment on the dune. Stark differences are observed when comparing dune profiles across beaches. Grain size and beach face measurements via Lidar survey suggest Fort Fisher's dunes have thick vegetation on the stoss and lee sides and are composed of well-sorted fine-medium quartz sand. Oak Island dunes are dominantly composed of fine-medium-sorted quartz sand but are capped by a 2-8 cm thick crust of shells, roots, and other miscellaneous sediments. We conclude the morphological differences observed can be attributed to the extensive dredge and dump operations and revegetation efforts on Oak Island. At Oak Island, we hypothesize that sediment from previous dump operations does not function well with young rooting sea grass, leaving frontal dunes susceptible to high rates of erosion. These findings offer insight towards future management strategies to protect communities that depend on coastal resiliency.

ASTROPHYLLITE'S FLEXIBLE STRUCTURE: A GATEWAY TO NOVEL MATERIAL DESIGN

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Phyllosilicates are a diverse group of minerals characterized by their sheet-like structures. Their unique structural and chemical properties pose different adaptations based on their chemical bonding. Astrophyllite, a rare, titanium-rich mineral, typically forms as an accessory mineral in pegmatites within alkaline igneous rocks. It exhibits multiple properties that phyllosilicates possess, as the structure contains both octahedral and tetrahedral layers. However, astrophyllite exhibits a variety of different structure types not found in phyllosilicates. For instance, in its most common polymorph, the octahedral layers are curved and exhibit triclinic symmetry whereas in a rarer polymorph with monoclinic symmetry, these layers remain flat. To investigate the flexible nature of the structure, a triclinic crystal of astrophyllite was loaded in a diamond anvil cell (DAC) and Raman spectroscopy was utilized to study the changes in structure at high pressure. It was discovered that astrophyllite undergoes an unusual deformation at high pressure. The silicate and metal-oxygen layers realign resulting in a flattening of the octahedral layers that is consistent with a change in symmetry from triclinic to monoclinic. This phase transition is reversible, allowing the layers to bend on the release of pressure. This unusual phenomenon astrophyllite possesses provides insight into potential applications for designing materials with chemical “struts” that can change under applied loads. Astrophyllite’s flexibility and unique deformation behavior may inspire innovations in the development of new materials.

ANOXIC SAMPLE PRESERVATION FOR ACCURATE Fe(II) QUANTIFICATION IN HYPOLIMNETIC SUSPENDED SEDIMENTS

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Freshwater drinking reservoirs provide approximately 74% of U.S. surface water, but seasonal anoxia in these systems can trigger the reductive dissolution of minerals in bottom sediments, particularly iron (Fe) oxides, releasing contaminants such as arsenic and lead. Engineered hypolimnetic oxygenation (HOx) systems reduce dissolved metal concentrations by oxidizing Fe(II) to Fe(III), causing them to precipitate as ferric hydroxide, which returns to the sediment until the cycle repeats. Our recent work shows Fe precipitated in the water column of the hypolimnion of two reservoirs in Vinton, VA – one with a HOx system, and one without – is primarily nanosized ferrihydrite, with lesser amounts of goethite and lepidocrocite. Surprisingly, no Fe(II)-containing minerals, like magnetite, have been observed, despite the reservoir without a HOx system having high dissolved Fe(II) concentrations that may favor its formation. Magnetite, highly prone to oxidation, may have unintentionally transformed during oxygen-exposed sample handling, processing and analysis, limiting a full understanding of the system. This study examines Fe(II) presence in sediment samples from the hypolimnion, hypothesizing that samples from the reservoir without a HOx system will have higher Fe(II) levels than those with HOx. To minimize unwanted oxidation, suspended sediment samples were filtered, dried, and digested with hydroxylamine hydrochloride in an anoxic glovebox, followed by ferrozine assays to quantify Fe(II) and total Fe concentrations. A calibration curve was developed using ferrous sulfate ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$). After anaerobic drying, powder X-ray diffraction of samples sealed in capillaries will identify Fe-bearing minerals. This study aims to enhance understanding of Fe mineral formation, stability, and its role in water quality. Additionally, it emphasizes the importance of anoxic sample processing for accurate Fe mineral characterization. Findings from this research can inform water management strategies to better address Fe-related water quality issues.

EXTRACTING AND COMPILING FRACTURE ATTRIBUTES FROM 3D OUTCROP MODELS

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Standard methods for documenting rock fractures typically rely on direct measurements from outcrops. Unfortunately, these outcrop-based methods can be time-consuming and cannot be employed on hazardous and other difficult-to-access outcrops. High-resolution surveying methods, such as lidar and photogrammetry, enable the rapid creation of georeferenced 3D models of outcrops for digital mapping and analysis. We have developed a workflow that uses fractures mapped on these 3D models to efficiently calculate fracture attributes. This method allows users to define specific locations and analysis parameters, enabling the user to make decisions similar to those that would be made for field-based measurements, but with improved data processing speed. Our Python-based scripts, designed to integrate with ArcGIS geoprocessing tools, employ a spherical sampling method as an alternative to the traditional circular scanline approach used in field-based fracture measurements. The primary script generates a sphere at a user-defined radius to calculate fracture intensity, density, and mean trace length at each sample location. A supplementary script extends this method by measuring these attributes across a range of sphere radii, allowing users to examine how variations in radius influence the resulting fracture attributes. A separate script analyzes fracture orientations with customizable options for input parameters, analysis, and output products. Each fracture attribute measurement retains the sampling location, enabling spatial mapping of these attributes across the outcrop and analysis of attribute variability. By replicating the field methods in our digital workflow, we ensure that fracture attribute measurements can be directly compared between methods. Combining the 3D outcrop model, digitally mapped fractures, and the measured fracture attributes, provides a rich data archive that is well-suited for publication and future re-use.

QUANTIFYING CYCLING OF CA, MG, AND NA IN DRINKING WATER RESERVOIRS NEAR ROANOKE, VIRGINIA

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Freshwater reservoirs are essential sources of public drinking water, but their water quality is influenced by the presence of geogenic metals such as magnesium (Mg), calcium (Ca), and sodium (Na). These metals, derived from geological weathering and hydrological inputs, can play significant roles in water hardness and salinity. However, the mechanisms driving their inputs and removal remain understudied in drinking water reservoir systems. Addressing this gap is vital for optimizing water treatment processes.

To investigate these mechanisms, we measured Mg, Ca, and Na concentrations in the water column and suspended sediment in two seasonally stratified drinking water reservoirs in southwestern Virginia: Falling Creek Reservoir (FCR) and Beaverdam Reservoir (BVR). FCR is equipped with a hypolimnetic oxygenation system (HOx), which can be activated to maintain oxic conditions in the hypolimnion, whereas BVR serves as a reference reservoir. Using data collected from 2021 through 2023, we examined seasonal trends of metal concentrations in water and suspended sediment and analyzed the role of oxygenation in metal removal.

Our results reveal distinct stratification patterns for Mg, Ca, and Na with higher concentrations of Mg and Ca observed in the hypolimnion in FCR and BVR. Sodium exhibited a more uniform distribution throughout the water column but showed occasional spikes. Similar cumulative metal fluxes in the water column in both BVR and FCR suggest that oxygenation has little effect on these metals, as nearly all Ca and Mg in the reservoirs remain in soluble form. Patterns in pH and the presence of Ca and Mg suggest desorption from bottom sediments, driving these metal processes. Lower pH in the water column during stratification is associated with higher concentrations of Ca and Mg, suggesting release from bottom sediment due to pH-dependent desorption.

This study underscores the challenges of managing drinking water reservoirs, particularly in addressing geogenic metal dynamics. While oxygenation systems are effective in removing certain metals, such as Fe and Mn, from the water column, they appear to have minimal influence on Ca, Mg, and Na. Instead, pH plays a more significant role, emphasizing the need for tailored water quality management strategies in drinking water reservoirs.

TERMINAL EDIACARAN MICROFOSSILS FROM THE UPPER HUQF SUPERGROUP IN OMAN

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The Huqf Supergroup in the Sultanate of Oman is one of the best preserved and most continuous successions of the upper Neoproterozoic to lower Cambrian. It consists of, in stratigraphically ascending order, the Abu Mahara, Nafun, and Ara groups. The Huqf Supergroup was deposited between ~720 and 520 Ma. Geochronometric data indicate that the Ediacaran-Cambrian boundary lies in the Ara Group. Previous studies have recovered terminal Ediacaran shelly fossils *Cloudina* and *Namacalathus* from shallow-water carbonate facies of the Ara Group. However, there have yet to be any reports of microfossils from deep-water sediment, hampering our understanding of biostratigraphic correlation between different facies of the upper Huqf Supergroup and paleoecological distribution of terminal Ediacaran organisms in Oman. To fill this knowledge gap, we sampled a black chert unit of the lower Fara Formation for paleontological analysis. The samples were taken from Wadi Bani Awf in the Jabal Akhdar region in northern Oman. The sampled unit is interpreted to have been deposited in a deep-water offshore environment, sits below a volcanoclastic unit dated at $547.23 \pm 0.28/0.36/0.96$ Ma, and is correlated with either the uppermost Nafun Group or the lowest Ara Group. Fifty-two thin sections have been prepared from these samples. The thin sections were examined under a transmitted light microscope and microfossils were photographed and then analyzed using the software ImageJ for morphological quantification. The microfossil assemblage of the lower Fara Formation is depauperate in diversity, consisting of simple forms (such as *Cyanonema*, *Oscillatoriosis*, *Obruchevella*, and *Siphonophycus*) that are conventionally interpreted as cyanobacterial filaments, as well as rare spheroidal and coccoidal microfossils. Overall, the lower Fara microfossil assemblage is consistent with a terminal Ediacaran age. Future research should focus on resolving the provenance of the Fara filamentous cyanobacteria in order to determine whether they were planktonic organisms or transported from shallow waters, ultimately constraining the deep-water chert of the Fara Group was deposited in the photic zone.

INVESTIGATION GEOLOGIC INFLUENCES ON KARST SPRINGS IN THE HANGING ROCK VALLEY, VIRGINIA

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The State Fish Hatchery in Paint Bank, Virginia, relies solely on water from three karst springs. Understanding the source and flow paths to each of the springs helps the fish hatchery and local landowners make resource management decisions to maintain fish health. The fish hatchery lies within the Hanging Rock Valley, a breached NW-vergent, NE-SW striking anticline comprised of Ordovician carbonates exposed in its core that form the valley floor and Ordovician to Silurian siliciclastics forming its resistant limbs. The springs resurge in proximity (<215m) of a NE-SW trending NW-directed thrust fault within the Ordovician carbonates along the subvertical forelimb. Although new 1:24,000-scale bedrock mapping has brought greater detail to the placement of lithologic unit contacts and geologic structures in the area, their relation to karst features and hydrologic flow paths have not been extensively studied. Previous research on Shires Cave has shown that cave development follows fold-axis-parallel (NE) and perpendicular (SE) joint sets. We aimed to understand the effects of faulting and fracturing on the karst hydrology of the valley by conducting a new detailed karst hydrogeologic inventory. We hypothesize that the fault influences groundwater flow paths and possibly partitions the northernmost spring in the footwall from the two springs in the hanging wall. To test this hypothesis, we identified surface-to-subsurface connections using lidar and verified them in the field. Dye traps were set at each of the springs, the confluence of the springs along a gaining reach, and the Valley Branch: a surficial drainage divide east from the fish hatchery. Rhodamine WT and Fluorescein were injected into two sinking streams on the northern and southern ends of the valley, respectively. The dye trace results show that rhodamine WT was found only in the northernmost spring, while fluorescein was found only in the southernmost spring. The strong recovery of rhodamine WT in the northernmost spring could be explained by groundwater conduits that cut across the fault. Future research should aim to perform further traditional mapping of the fault to identify the existence of potential structures that allow groundwater conduit systems to cut across the NW-SE trending fault.

SITE-SCALE EVALUATION OF GEOLOGIC CARBON STORAGE AT THE MATAGORDA ISLAND LEASING AREA, OFFSHORE TEXAS

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Geologic carbon storage is undergoing rapid commercialization with many projects planned or in the early stages of construction and/or permitting. The Gulf of Mexico is widely recognized as a promising geographic region for carbon storage due to its geology being well characterized from oil and gas exploration. Additionally, there are several metro areas including Corpus Christi and Victoria along the Texas coast which are sites for major refineries, petrochemicals, and LNG production. Furthermore, two major growth faults in this region, the Corsair and Clemente-Tomas Faults, run parallel to the Texas coast and create structural trapping opportunities for CO₂ storage. As part of the SEG EVOLVE Carbon Solutions program, this study develops a site-scale evaluation of the Miocene sands within the Matagorda Island region, offshore Texas. This study builds a reservoir model based on 3D seismic data, completes static and dynamic modeling to assess reservoir storage capacity, and develops a cost estimate for long-term storage. This study utilizes 3D seismic reflection data combined with well-log data to identify potential reservoir and sealing units within Miocene age formations as well as major structural features such as the Corsair and Clemente-Thomas faults. Key formations are exported from the seismic data in order to construct a static geomodel to assess potential storage volumes and property distributions. Dynamic simulations are run to assess the trapping characteristics of the saline reservoirs for carbon capture and storage potential. Results from 3D seismic mapping demonstrate the extensive lateral distribution of potentially high quality reservoir units within Miocene saline aquifers. Additionally, the Corsair and Clemente-Thomas faults create structural traps that are likely capable of storing millions of tons of CO₂. Simulation results combined with economic projections provide evidence that Matagorda Island is capable of hosting a hub-scale CCUS project, resulting in a worthwhile project revenue under current tax credit systems. While many CCUS projects are being considered in the Gulf Coast region, none are currently in development in the Matagorda Island block or anywhere within federal waters of the Gulf of Mexico. We present novel site characterization and simulation results to support further commercial development of CCUS in offshore regions, such as Matagorda Island, due to their large storage volumes and ability to decarbonize industrial metro areas such as Corpus Christi and Victoria, Texas.

DELINEATING KARST HYDROLOGIC PATHWAYS IN THE HANGING ROCK VALLEY, VIRGINIA

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Karst hydrologic pathways are difficult to predict because they commonly follow irregular, non-linear routes beneath surface topographic divides through conduits, fractures, and voids. Three closely spaced karst springs at the southwest end of Hanging Rock Valley supply water to the Paint Bank (VA) Fish Hatchery. The recharge areas for these springs are not delineated, rendering decision-making for land managers regarding water resource protection difficult. Bedrock units in the study area consist of valley-forming Ordovician limestones and dolostones overlain by shales exposed along slopes capped by ridge-forming Silurian sandstones. Streams and springs along the mostly siliciclastic slopes sink at or near the carbonate contact. We hypothesized that these allogenic waters flow along discrete pathways to one or more of the hatchery springs. To test this hypothesis, dye injections were performed in October 2024 at two sinking streams on the southeastern side of Hanging Rock Valley along the northwestern slope of Potts Mountain. Rhodamine WT injected in a sinking stream ~2km northeast of the spring complex was recovered only in the northeastern most spring. Fluorescein injected into a sinking stream ~1km southwest of the spring complex was recovered only in the southwestern most spring. No dye was recovered in the central spring. In addition, measurements of specific conductance and temperature revealed differences between springs. In October 2024, the northeastern most spring had an average temperature of 11.26 C and an average specific conductivity of 225 $\mu\text{S}/\text{cm}$, the central spring had an average temperature of 11.45 C and an average specific conductivity of 176 $\mu\text{S}/\text{cm}$, and the southwestern most spring had an average temperature of 11.55 C with an average specific conductivity of 288 $\mu\text{S}/\text{cm}$. The dye traces and specific conductivity and temperature data all point to discrete flow paths despite the springs' close geographic proximity. Dye tracing data confirmed flow from two stream sinks to the springs. Further dye injections are needed to fully delineate the springs' recharge areas, including the third, central spring. Continued monitoring of specific conductivity and temperature can help us understand how the system reacts to precipitation which can inform our understanding of how water moves through the system.

DMODELS 2024 VS. 2023: A COMPARISON OF GNSS AND INSAR INVERSIONS AT OL DOINYO LENGAI

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dMODELS is a MATLAB-based software developed by the United States Geological Survey that is used primarily for interpreting crustal deformation near volcanoes and active faults. It has been utilized in recent years to decipher aspects of the magmatic plumbing system beneath Ol Doinyo Lengai, an active volcano in the Natron Rift. In past studies based on geodetic data spanning 2016-2022, results from dMODELS indicated a deflating spherical source situated northeast of the Ol Doinyo Lengai crater. In this study, I assess the 2023 version of dMODELS used in detecting this deflating source with the same Global Navigation Satellite System (GNSS) and Interferometric Synthetic Aperture Radar (InSAR) observations against a revised 2024 version of dMODELS. First, I employ the 2023 dMODELS software to invert the GNSS and InSAR data for a spherical source and establish that my results are consistent with the previous published study. Second, I use the 2024 version of dMODELS to invert the same datasets for a spherical source. Furthermore, I also experiment with inverting a suite of spatial domains of the InSAR data. Lastly, the differences between the products of the two softwares are assessed, including the coordinates and volume change of a spherical source determined in the inversions. I found that the 2023 and 2024 version of dMODELS produce consistent results within 1-sigma uncertainty values for inversions of GNSS observation. With InSAR, however, the magma source locations are varied and inconsistent. For instance, the horizontal source location in the X direction differs by 3676 m. These discrepancies lie in the inversion algorithms of the InSAR datasets and further testing is needed to resolve the disparity. Doing so will advance the accuracy of dMODELS and its ability to interpret crustal deformation from InSAR data in a user-friendly, straightforward way.

INVESTIGATING THE LINK BETWEEN OCEAN DEOXYGENATION AND THE END-STEPTOEAN BIOMERE EXTINCTION

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During the Cambrian Period (542-521 million years ago), marine animals with skeletons appeared and their diversity significantly increased during an event called the Cambrian Explosion. However, after this initial diversification, animal diversity plateaued for ~40 million years until the Great Ordovician Biodiversification Event. During this diversity plateau there were a series of extinction events followed by rapid diversification events. The specific extinction we investigate here is the end-Steptoean bioturbation extinction as recorded in the sedimentary succession at Lawson Cove Reservoir in Utah to reconstruct the environmental changes that occurred during this event. We constructed a carbon isotope ($\delta^{13}\text{C}$) record to track variations in the carbon cycle and measured the concentration of several major and trace elements (Ca, Mg, Mn, Fe, Sr, P) from the carbonate rocks in the Lawson Cove section. We documented a positive carbon isotope excursion of 1‰ associated with the end-Steptoean extinction that occurs just after the extinction horizon. Additionally, there are also increased manganese concentrations in the carbonates deposited during and after the extinction interval that may suggest more reducing depositional conditions locally. Together the positive carbon isotope excursion and increased manganese concentrations suggests that marine deoxygenation led to increased organic carbon burial and maybe a factor in the extinction event. Similarity between geochemical records of the end-Steptoean extinction and those of the well-studied end-Marjuman and Stairsian extinctions also from this time interval suggest that marine deoxygenation maybe a common driver behind these events. More broadly, this highlights the links between ocean deoxygenation, fluctuations in the carbon cycle, and marine diversity following the Cambrian Explosion and prior the Great Ordovician Biodiversification Event.

ELECTRON PROBE MICROANALYZER CHARACTERIZATION OF PLEISTOCENE GLACIAL-MARINE SEDIMENT, ROSS SEA, ANTARCTICA

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The Antarctic Ice Sheet is a significant component of the Earth's climate system and its climate sensitivity is a significant driver of global sea-level change. In the Ross Sea, sediment cores were recovered from scientific drilling to explore the response of the West Antarctic Ice Sheet to past climate and environmental change. While previous studies have focused on the physical sedimentology of the deposits, the composition of the ice-rafted sands has yet to be characterized. This work aims to determine the mineralogical composition of ice-rafted sand using elemental abundance data from electron microprobe analysis. The microprobe generated high-resolution maps of various elements (e.g., Si, Al, Mg), which can then be processed to interpret mineralogical composition. Preliminary analysis suggests the sands are primarily quartz and feldspar with further detailed work focused on other constituents. Mineralogy of the sands provides information relating to the source area of sediments of which only a portion is revealed at the surface at present. These results, combined with existing available information, can be utilized to infer the source area of sediments that could indicate a correlation to history and evolution of the ice sheet. Understanding the source of ice-rafted sediments contributes to understanding the history of the West Antarctic Ice Sheet and its response to past climate change.

Advisor: Dr. B. W. Romans

IDENTIFYING SHARK CARTILAGE IN THE FOSSIL RECORD: THE FIRST OCCURRENCE OF XENACANTHID CARTILAGE IN THE WESTERN UNITED STATES

JASICKI-VELIN, Denyce, Dept. of Geosciences, Virginia Tech, Blacksburg, VA 24061

In the fossil record, preserving hard tissues such as bones and teeth is relatively common, but soft tissues like cartilage are preserved less frequently. Fossilized cartilage from extinct sharks is present beginning in the Paleozoic Era, but there are long gaps (tens of millions of years) in the fossil record. Moreover, the identification of fossil cartilage is hampered by the lack of a set of diagnostic characteristics. Here, we define specific criteria to identify the first fossil cartilage from the Upper Triassic. We focus on two occurrences, one from the Chinle Formation (~220 million years ago) within Petrified Forest National Park in Arizona and two specimens from the Dockum Group (~220 million years ago) in Texas. Images of the cartilage specimens were obtained using a Scanning Electron Microscope (SEM) to document and analyze their surface structure. We used histological methods to examine internal anatomical features and CT data to access surface and internal details. Based on this data, we determined that the patterns match other occurrences of fossil cartilage from the Devonian Period and Permian Period. Furthermore, we compared our data with tessellated shark cartilage from living chondrichthyans, which, when examined, also exhibited features that matched our specimens. We find that fossil and tessellated shark cartilage from living representatives are characterized by prismatically calcified, polygonal structures with uncalcified fibrous zones between the stiff tesserae, which would have allowed for flexible articulation. We suggest that the Upper Triassic cartilage belonged to a member of the Xenacanthida, a group of marine and freshwater sharks that first diversified during the Devonian and were among the earliest to exhibit the defining features of TCC. Xenacanthid teeth occur in the same layers at both localities where the Upper Triassic cartilage was recovered. Evaluating the properties of this xenacanthid cartilage allows us to fill in the gaps of when different identifiable characteristics of TCC began to develop and how they were preserved in the fossil record. Using this information, we can establish a system for identifying calcified cartilage in the fossil archive, which helps expand our understanding of cartilage and shark diversification throughout time.

MICROSCOPIC PAST: EVALUATING SEDIMENT PROCESSING OF LATE TRIASSIC MICROVERTEBRATE SITES

KRYDER, Sofia, Dept. of Geosciences, Virginia Tech, Blacksburg, VA 24061

Microvertebrate fossil sites are filled with valuable paleoecological data that provide a broader picture of extinct communities and their environment. Sampling and processing the sediment collected from these sites is very labor intensive and requires a large amount of dedicated time. The process starts with wet sieving the sediment to break up larger pieces of mudstone and letting the sieved material dry before sorting by grain size with dry sieves. Sediment is sorted into three grain sizes; 90 μ m, 1000 μ m, & greater than 2380 μ m. To determine if we have sufficiently sampled the microvertebrate fossil site, a rarefaction analysis is used by plotting the diversity of morphotypes, fossils that potentially represent a new species, against the number of samples. When a clear asymptote in the rarefaction curve becomes present, the likelihood of discovering new morphotypes is highly unlikely. This analysis allows us to identify a relative species diversity of the community and the point at which sampling can be considered sufficient. A team of 12 students processed a large quantity of sediment collected from two late Triassic microvertebrate fossil sites from the Petrified Forest National Park in Arizona, to assess how much sediment needs to be processed in order to observe the full extent of species diversity present in each site. Here, my goal is to estimate the amount of sediment and time required to pick bone, teeth, and scales out of the sediment to show a clear picture of the species diversity present in a microvertebrate fossil site. I will accomplish this goal by maintaining an accurate log of time spent picking, the weights of the sediment, removed fossils, the identified morphotypes, and dates of identification. Optimizing the methodology of this process will allow for future, more efficient collections of sediment and time allocation for sorting which will expand the paleontological knowledge on microvertebrate fossils.

ANALYSIS AND CHARACTERIZATION OF PARTICLES INJECTED INTO AN AIRCRAFT ENGINE

WILCOXEN, Ethan, Dept. of Geosciences, Virginia Tech, Blacksburg, VA 24061

Aircraft engines are relatively fragile pieces of machinery as the surfaces within different sections of engine are designed to direct air flow in exact paths, so having smooth surfaces and unobstructed airflow is paramount when considering the efficiency and reliability of an aircraft engine. Ash clouds from volcanic eruptions have disrupted flights in the past and ash ingestion in aircraft engines can lead to engine surge and a loss of thrust, this is the main concern in larger engines that combust at higher temperatures. Engines can also degrade over time if in particularly dusty environments and this can cause a decrease in reliability and efficiency. The aim of my research is to analyze and characterize dust particles that have been experimentally injected and deposited into a Rolls-Royce M250 engine. So far, we have done tests using 100-micron sized quartz and dolomite particles. After a test, we use carbon tape and other sampling methods to pick up the dust particles that are deposited in the different compartments of the engine. These pieces of tape are then further analyzed and imaged at a scanning electron microprobe; the images are then physically analyzed using a software called MIPAR that allows us to measure different physical attributes of individual particles. These particles can range from 50 to 5 microns in size. The main focus right now is to characterize particle shape and size from different data sets taken from different parts of the engine, this will allow us to eventually build a full deposition gradient across different sections of the engine. So far, we have collected some data, but we have yet to find a way to categorize and compare the particles quantitatively, this is being worked on presently. While this research is still ongoing with many more particle tests and analyses to conduct it will lead to a better understanding of the interaction between particles and aircraft engines which will allow engineers to build solutions and improve the consistency of our air travel.

DESCRIPTION OF A NEW OCCURRENCE OF A CAECILIAN (LISSAMPHIBIA) PSEUDODENTARY FROM THE UPPER TRIASSIC OF TEXAS

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Today, there are two main groups of Lissamphibia (amphibians): Batrachia (salamanders and frogs) and Gymnophiona (caecilians). Of these three groups, caecilians have the worst fossil record with approximately eleven occurrences because they are subterranean burrowing animals. Due to this, there is a gap in the fossil record for the Late Paleozoic lineage of caecilians. Any fossils concerning this area of study are greatly needed to trace the early evolution of the group. The specimen of interest in this research was found in the Late Triassic of Texas, which is intriguing because caecilian fossils have not been found in this locale before. Our study aims to describe this newly found caecilian pseudodentary element and find the similarities and differences of another Upper Triassic form, *Funcusvermis gilmorei*, found in the Chinle Formation of Petrified Forest National Park in Arizona. The Texas jaw element is around five mm in length. The caecilian jaw is specialized for fossoriality and only has two lower jaw components: the pseudodentary and pseudoangular. We know this element is a caecilian pseudodentary because we can see two rows of alveoli and the presence of unique ossification. The finding of *Funcusvermis gilmorei* extended the caecilian record by more than 20 Ma. We aim to know if this jaw element from Texas is a new occurrence in locality, has new morphologies, or is even a new taxon altogether. We will compare the two specimens by using three-dimensional CT scans of *Funcusvermis gilmorei* and the Texas jaw. We will analyze the phylogenetic relationships of these fossils by comparing diagnostic features like the number and orientation of alveoli, the presence of certain grooves, and the tooth attachment patterns. If this specimen is found to be the same taxon as *Funcusvermis gilmorei*, we can enlarge the paleobiogeography of extinct caecilians and learn more about their paleoecology in Texas. On the other hand, if we find new morphologies, we can infer this specimen is a new species. Finding caecilians in Arizona and Texas is a convincing indicator to search for caecilian fossils in areas like New Mexico in the Upper Triassic deposits.

CONTROLLED SYNTHESIS OF NICKEL-DOMINANT NMC HYDROXIDES AS PRECURSORS FOR LITHIUM-ION BATTERY CATHODES

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Nickel-manganese-cobalt (NMC) hydroxides serve as key precursors for lithiated cathode materials in lithium-ion batteries. These hydroxides offer several advantages, including high energy density and enhanced stability, and their properties can be tailored by adjusting the component ratios. Precursor synthesis conditions play a crucial role in determining the electrochemical performance of NMC, as the distribution and bonding environments of the different metal species directly impact the structure and functionality of the final cathode material. Batch reactor synthesis, where all reactants are combined and mixed in a single step, is a common and cost-efficient method for synthesizing NMC. However, this approach can introduce challenges in process control, as particles form at different rates and pH levels, leading to early aggregation and unwanted heterogeneity in material properties. In this study, we use a Mixed Flow Reactor (MFR) to create a more stable and controlled synthesis environment to produce nickel-dominant NMCs (90% nickel, 10% manganese and cobalt). To establish a baseline synthesis, we first produce high purity Ni hydroxide using NiSO_4 and NaOH in the MFR. An in-line pH probe is used to continuously monitor pH conditions at the effluent of the reactor. Powder X-ray diffraction analysis of the resulting synthesis products will be used to identify structural characteristics and assess purity with respect to secondary phases. In situ powder X-ray diffraction measurements will examine the transformation of Ni hydroxide at conditions relevant to calcination, which is how NMC is normally converted to an active cathode material. Future experiments will assess the impacts of incorporating Mn and Co into our synthesis. This research aims to enhance the understanding of controlled synthesis methods for NMC, ultimately contributing to the development of more efficient and reliable battery precursor materials.

GS(art)S Artist Statements



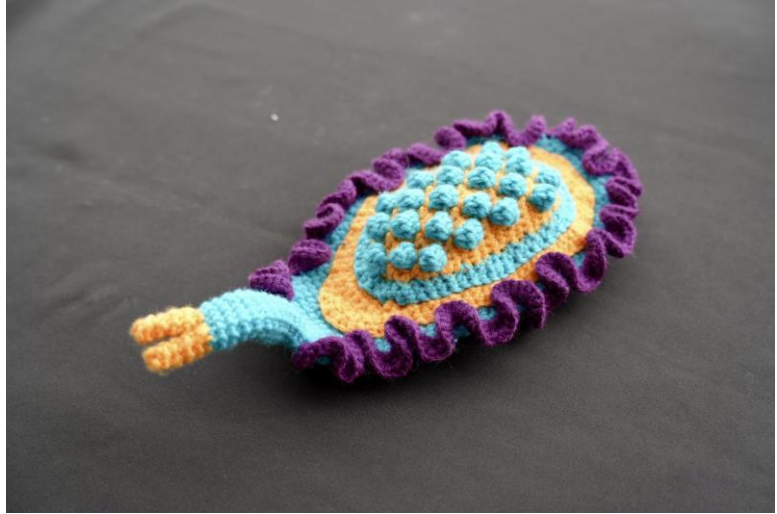
To celebrate the 30th anniversary of GSRS, we wanted to highlight the wonderful symposium—and the more recent addition of GS[art]S—with a fun sticker for all attendees. We organized a department-wide sticker competition, and after the votes were counted, the GSRS x Rite in the Rain sticker designed by PhD candidate Molly Stroud emerged as the winner. We hope you love the design and place it on your water bottles, laptops, and perhaps even on your own Rite in the Rain!

Statement from the artist:

Rite in the Rain notebooks are a staple tool in the field of geology. Whether you study geophysics, paleontology, structural geology, or geomorphology, nearly every geologist that you meet will keep a Rite in the Rain in their field kit. They're bright yellow, hard to miss, and—as the name suggests—allow you to write in the rain. I wanted to design a sticker that was universal to the geosciences experience, and this design almost immediately popped into my head. I can't wait to see the stickers printed out and being used!

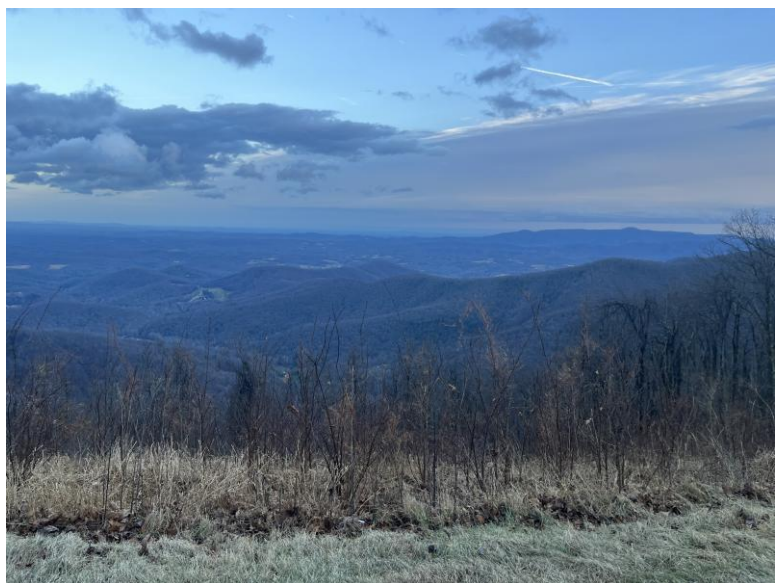
Amy Hagen
***Kimberella*, 2025**
Crochet

Kimberella was an early bilaterian animal from the Ediacaran Period. Due to its morphology and the hypothesis that it scraped microbial mats to obtain food, the organism is often described as ‘slug-like’. Here, I represent Kimberella in the vibrant colors of a sea slug found in the Pacific and Indian oceans. Because we are usually unable to detect an organism’s true colors in the fossil record, I like to imagine fossil organisms were just as vibrant as their extant relatives.



Brooklyn Harris
***On Top of the World*, 2022**
Photograph

This photograph was taken on my first ever Geoscience field trip in Earth’s Dynamic Systems. This was taken near the end of the trip, I felt like I could breathe as I finished something I never thought I could accomplish. This was the start, the start of being a hokie, my STEM degree, and my love with Geoscience. At the beginning, I was unsure but by the end I knew this is where I needed to be. I felt as if I was on top of the world and as I looked down at the landscape in front of me, I knew I was on top.



Hunter Cornwell

The black and white of Geology, 2025

Photograph

This work is a combination of nine photos I have taken of my personal collection. These images represent both the chronology of my mineral procurement, reaching as far back as 2020, and the development of my mineral knowledge. However, the title of this piece is meant as a commentary of struggles in our science: sometimes all that is black-and-white in the geosciences are the rocks themselves.



Anya Gupta

Mariposa Grove of Giant Sequoias, 2023

Acrylic, paper, thread, and glass on cardboard

Yosemite's Mariposa Grove played a pivotal role in sparking the American conservation movement. Inspired by the grandeur of the Mariposa Grove and Yosemite Valley, the public heavily lobbied for their indefinite protection by the government in the late 1800s. It was successful: California Senator John Conness proposed a bill in Congress to preserve and protect these areas, and President Abraham Lincoln then



signed the Mariposa Grant Act at the peak of the Civil War in June 1864. This was the first time in history that land was set aside explicitly for “public use, resort, and recreation.” This set the foundation for the modern national park system, with the establishment of Yellowstone occurring 8 years later. Yosemite became a national park in 1890.

“God has cared for these trees, saved them from drought, disease, avalanches, and a thousand storms; but he cannot save them from fools...” - John Muir

Chloe Blaz

Preserve and Protect, 2025

Digital

Nature is a privilege we all share. In my drawing I wanted to depict one of the most beautiful lakes I've been to, Moraine Lake in Banff, Canada. I used organic shapes and borders to frame the background, channeling Art Nouveau for that whimsical feel while giving the piece more structure. I left a simple message, "preserve and protect" alongside a bird carrying an olive branch, reminding us that it's our duty to protect the lands we cherish. A Hokie Stone styled pattern in the background brings the image from Canada back to Blacksburg.



Molly Stroud

Topographic Mug, 2025

Stoneware clay with glaze

Most of my research involves looking at Earth from space using satellite imagery. This birds-eye view offers unique perspectives on Earth's surface. One of my favorite ways to study the Earth is via topographic maps, which are full of curving lines and concentric shapes that reflect changes in the elevation of the ground. The carvings on this mug were inspired by topographic maps. After throwing and partially drying the mug, I carved out concentric shapes. I then bisque fired the piece and filled in the carved space with glaze and fired it once more to produce the final product.



Claudia Cave

In the Blue, 2025

Photograph

While visiting Georgia National Aquarium over spring break, I was drawn to the Ocean Voyager gallery. The rhythmic movement amidst the bustling crowd outside prodded at my emotions. Life seemed so smooth in the exhibit, so meaningful. A green sea turtle kept passing by my sliver of looking glass. This photo was captured as everyone else's attention fell to the whale shark passing overhead. The brief moment felt intimate as if the turtle knew I longed to be in there, too.



Danielle Fitzgerald

Immersed, 2025

Watercolour and photograph

A young scientist, reduced to the size of the ancient Ediacaran fossil *Fractofusus*, investigates a world over 570 million years old in Newfoundland, Canada. Her curiosity reflects humanity's quest to understand life's origins. The intricate fossils tell stories of Earth's primordial life, emphasizing the vastness of time and nature's resilience. Her wonder inspires viewers to reflect on evolution and the fragile web of life, offering a glimpse where past and present meet, evoking awe and curiosity about our planet's ancient history.



Ella Davis

Structure Project, 2025

Watercolor and ink on collaged paper

Most of us have had the experience carving little figures or making pinch pots out of that mushy red clay in school. It was so fun to see how it squished and folded. However, when I have to describe how rocks fold, shift, and squish I realize for most non-geoscientists, and quite honestly for many of us in geology, the idea of these massive units being able to move in such a way is seemingly impossible. Maybe we should just think of it as a big clay project?



Tanween Syed

Hollow Form, 2025

Diorama

This diorama was made to depict a coelophysis in an estimation of its natural habitat. The dinosaur is shown to be watching over its eggs and hunting a small crurotarsan reptile, all while leaving footprints in the muddy shore line, which could eventually be fossilized. The diorama is mainly composed of cork board and clay, which was then painted with acrylic paint, then covered in miniature plants. Resin was also used to create the water effects present in the lake and the footprints of the coelophysis.



Morgan Lundberg

Faults to Fibers: A Stitched Map of Geologic History, 2025

Hand Embroidery

This hand-embroidered geologic map of Virginia turns scientific data into a work of textile art, tracing the natural flow of the state's diverse landscapes. Just like embroidery takes patience, precision, and time, so does the Earth as it slowly shapes its terrain over millions of years. Each stitch represents the ancient forces that have molded Virginia's geology, weaving together a story of shifting rock and quiet transformation. By

blending traditional mapping with embroidery, this project creates a tactile, hands-on way to explore the deep connection between art and the ever-changing history of our planet.



Natalie Hermosillo

Desert Solitude, 2025

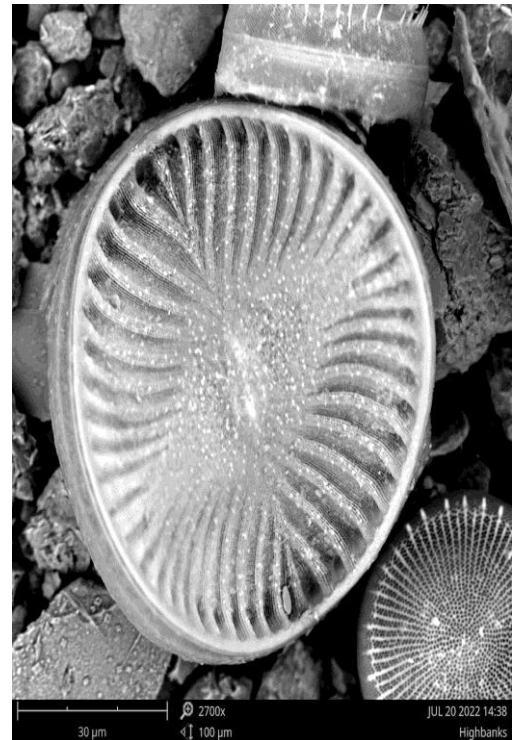
Photograph

This photograph captures the quiet expanse of the Nevada desert during a recent fieldwork trip. The wide-open landscape highlights the isolation and beauty of the region. The lone figure, fellow grad student Amy Hagen, in the distance adds a sense of scale, emphasizing how vast and remote the region truly is. This photo reflects some of the greatest rewards of fieldwork—hiking through breathtaking scenery while searching for clues about Earth's history.



Kameron Finch
***Campylodiscus*, 2022**
SEM photograph

The submitted image represents an SEM photo of a diatom called *Campylodiscus* which can be found in both freshwater and saltwater environments. The above image was taken from a sample from Chautauqua Lake which is located in New York.



Anya Gupta
***Firefall*, 2025**
Watercolor and gouache on Arches cold press paper

Every February, for a couple of weeks, the low-angle winter sun strikes El Capitan's Horsetail Falls at just the right angle, making it appear as though molten lava is cascading down the granite monolith. This year, during the Firefall event, an upside-down flag was displayed in protest of the thousands of public lands employees who were illegally and unjustly fired by the current administration. I was inspired to paint this in solidarity with my friends and former coworkers who were wrongfully removed from their positions.

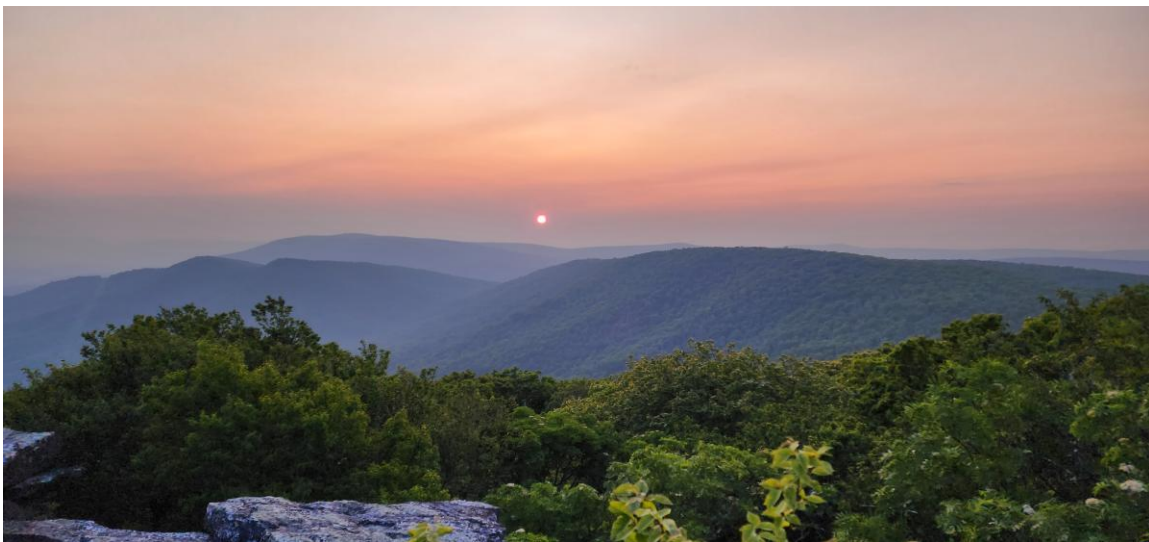


David Bunin

Wildfire Smoke Sunset at Bald Knob, 2023

Photograph

In the late spring into the summer of 2023, the largest wildfire season in recorded history ravaged Canada. Smoke traveled thousands of miles, and it brought many hazy days to Blacksburg. While beautiful sunsets like this one were common that summer, the impacts of the fires were much greater than an Appalachian sunset can show. While wildfires have obvious effects at ground level, the ash in the upper troposphere can have interesting effects on aviation as well. Researchers in the aerospace industry, including some here at Virginia Tech, seek to understand the effects of wildfire ash on aircraft turbine engines.



GSRS 2025

Celebrating the 30th anniversary

Thank you to:
Carol Lee Donuts
Next Door Bake Shop
El Rodeo
Ruby Tuesday
Our Daily Bread



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Geoscience Student Research Symposium