WEEKS RESEARCH SYMPOSIUM 2021

APRIL 21-22

Oral Presentations

Wednesday, April 21 – 10-11:00 a.m. and 2-3:00 p.m.
Thursday, April 22 – 11:00 a.m.-12:15 p.m.

Poster Presentations

Thursday, April 22 – 1:30 -2:30 p.m.

Elevator Pitches

Available Wednesday, April 21 – 11:00 a.m.

Keynote Presenter

Thursday, April 22 – 12:30 p.m.

Organized by the

Geology Graduate Student Association

Oral Presentations

https://wisc-geo-symposium21.github.io/

Wednesday, April 21

10:00 a.m. **A generalized approach to aquifer characterization and uncertainty Quantification through oscillatory flow interference testing**
Jeremy Patterson *(presenter) and Michael Cardiff*

10:15 a.m. **Fracturing and pore fluid distribution in the Marlborough region, New Zealand from body-wave tomography: Implications for regional understanding of the 2016 Kaikoura Earthquake**
Ben Heath *(presenter), Donna Eberhart-Phillips, Federica Lanza, Clifford Thurber, Martha Savage, Tomomi Okada, Satoshi Matsumoto, Yoshihisa Iio, Stephen Bannister*

10:30 a.m. **Testing the detachment fault refrigeration hypothesis at highspatial resolution by SIMS oxygen isotope analysis**
Claudia Roig *(presenter) and Claudia Bonamici*

10:45 a.m. **New $^{40}Ar/^{39}Ar$ and U-Pb age determination of magnetochron M0r from the Qingshan Group, Jiaolai Basin, eastern China**
Youjuan Li *(presenter)*

2:00 p.m. **Tectonic and astronomical influences on climate and deposition revealed by a Bayesian age-depth model of the Early Eocene Green River Formation, Wyoming**
Benjamin Bruck *(presenter), Brad S. Singer, Mark D. Schmitz, Alan R. Carroll, Brian R. Jicha, Stephen Meyers, Andrew Walters*

2:15 p.m. **Environmental expression of the Shuram-Wonoka carbon isotope excursion in North America**
Daniel Segessenman *(presenter) and Shanan Peters*

2:30 p.m. **Assessment of Dinosaur Diversity and Sediment Coverage in Cretaceous North America**
Shan Ye *(presenter), Scott Hartman, and Shanan Peters*

2:45 p.m. **Early Miocene cyclostratigraphy in the Southern Ocean: A window into the history of the Antarctic Ice Sheet**
Nicholas Sullivan *(presenter) and Steven Meyers*

Oral Presentations

https://wisc-geo-symposium21.github.io/

Thursday, April 22

11:00 a.m. Covariation of cross-divide differences in denudation rate and χ: Implications for drainage basin reorganization in the Qilian Shan, northeast Tibet
Kai Hu *(presenter)*

11:15 a.m. Climatological effects on surface exposure dating
Shan Ye *(presenter), Daven Quinn, and Shaun Marcott*

11:30 a.m. Experimental insight into the entrainment and transport of subglacial debris
Dougal Hansen *(presenter) and Luke Zoet*

11:45 a.m. Holocene glacier length variations along the American Cordilleras from paired ^{14}C-^{10}Be measurements
Andrew Jones *(presenter), Andrew L Gorin, Tori M Kennedy, Shaun A Marcott, Jeremy D Shakun, Brent M Goehring, Gordon R Bromley, Douglas H Clark, Andrew Hein, Vincent Jomelli, Emilio Mateo, Bryan Mark, Brian Menounos, Don Rodbell, and Andrew Wickert*

Keynote Presenter

https://wisc-geo-symposium21.github.io/

Thursday, April 22

12:30-1:30 p.m. Multiscale study of fluid, contaminant, and colloid transport processes in permeable media

Dr. Chris Zahasky *cazhasky@wisc.edu*

Poster Presentations

https://wisc-geo-symposium21.github.io/

Thursday, April 22   1:30 p.m.

1:30-2:45 p.m. Three-dimensional permeability inversion using convolutional neural networks for better prediction of contaminant transport in aquifer materials
Zitong Huang *(presenter) and Chris Zahasky*

1:45-2:00 p.m. First occurrence *'Metoposaurus' bakeri* in the Popo Agie Formation (Upper Triassic, WY) and implications for vertebrate biostratigraphy
Aaron Kufner *(presenter)*

2:00-2:15 p.m. Thermodynamic modeling of magma storage conditions beneath Mocho-Choshuenco Volcanic Complex, Chile
Pablo Moreno-Yaeger *(presenter), Brad S. Singer, and Brian R. Jicha*

2:15-2:30 p.m. Fabric studies from the western Idaho shear zone, Sweet-Ola region, Idaho
Ellen Nelson *(presenter)*

Elevator Pitches

https://wisc-geo-symposium21.github.io/

Laboratory simulations of glacial abrasion
Jeremy Brooks *(presenter), Lucas Zoet, Shaun Marcott, and Dougal Hansen*

The Effects of Ice on Coastal Erosion
Stefanie Dodge *(presenter), Luke Zoet, Elmo Rawling, and Ethan Theuerkauf*

Microbially-mediated oxidation of trace element-bearing sulfide minerals in Cambrian Sandstones of Trempealeau County, WI
Lisa Haas *(presenter), Eric Roden, Matt Ginder-Vogel, and Jay Zambito*

Intercalibration of the Servicio Nacional de Geología y Minería (SERNAGEOMIN), Chile and WiscAr $^{40}Ar/^{39}Ar$ Laboratories for Quaternary Dating
Jacob Klug *(presenter), Adain Ramirez, Emily Mixon, Brad Singer, Brian Jicha, and Paola Martinez*

A Tale of Two Rivers: A Source-To-Sink Comparative Analysis of The Aspen and Idaho Paleoriver Systems
Ethan Parrish *(presenter)*

Testing assumptions on last interglacial seawater $\delta^{234}U$ composition
Alexandra Villa *(presenter)*

Numerical modelling of Lake Michigan nearshore evolution under low wave conditions
Chelsea Volpano *(presenter), Lucas Zoet, J. Elmo Rawling, and Ethan Theuerkauf*

Abstracts by Presenter

elevator pitch – ep, oral presentation – op, poster presentation - pp

Jeremy Brooks *(presenter - ep), Lucas Zoet, Shaun Marcott, and Dougal Hansen*

Laboratory simulations of glacial abrasion

Glacial erosion is an important process for landscape development on geological timescales. However, the factors that control glacial erosion are not well-constrained quantitatively, therefore landscape evolution models for glaciated terrain are unreliable. Numerous mathematical relationships have been proposed to predict glacial abrasion rate given certain parameters, but they differ in functional form and parameterization. None of the proposed abrasion rate relationships are unequivocally supported by field evidence; possibly related to the difficulty in accurately measuring abrasion rate (and the parameters it depends upon) in the field. Therefore, laboratory experiments conducted under realistic glaciological conditions have the potential to empirically verify the parameterization of an abrasion rate function. Here, we describe experiments to simulate glacial abrasion by sliding rock slabs underneath debris-laden ice. We systematically vary the clast concentration, the clast contact force, and the relative clast hardness. Preliminary results illustrate the dependence of abrasion rate on clast contact force. These experiments enable the formulation of an empirically-verified "abrasion wear law" that describes abrasion rate given glaciological and geological parameters. This abrasion wear law can be incorporated into landscape evolution models of glaciated terrain.

Benjamin Bruck *(presenter - op), Brad S. Singer, Mark D. Schmitz, Alan R. Carroll, Brian R. Jicha, Stephen Meyers, Andrew Walters*

Tectonic and astronomical influences on climate and deposition revealed by a Bayesian age-depth model of the Early Eocene Green River Formation, Wyoming

The Wilkins Peak Member (WPM) of the Green River Formation in Wyoming comprises alternating lacustrine and alluvial strata that preserve a detailed record of terrestrial climate during the Early Eocene Climatic Optimum (EECO). We use a Bayesian framework to develop age-depth models for three sites, based on newly determined $^{40}Ar/^{39}Ar$ sanidine and $^{206}Pb/^{238}U$ zircon ages from seven silicic tephras. The new models provide two- to ten-fold increases in temporal resolution compared to previous radioisotopic age models, permitting direct comparison of WPM facies to astronomical solutions for insolation. Starting at ~51 Ma, basinwide flooding surfaces atop 6 successive alluvial intervals coincide closely in time with short eccentricity maxima, which has been linked with marine isotopic evidence for hyperthermal events. We infer that warmer conditions caused increased precipitation and lake expansion. Strata deposited ~30% more rapidly prior to ~51 Ma do not exhibit the same relationship however, suggesting that the sensitivity to astronomical forcing was tempered by tectonically induced subsidence of the basin, and that more radioisotopic time control is necessary to account for potential rapid changes in sedimentation rate.

Stefanie Dodge *(presenter - ep), Luke Zoet, Elmo Rawling, and Ethan Theuerkauf*

The Effects of Ice on Coastal Erosion

Winter shore ice alters sediment transport in the nearshore and accurate modeling of coastal evolution in cold climates is hindered by a limited understanding of these processes. Consistent ice cover likely buffers the upper shore face from the erosive impacts of winter storm waves, while shorelines with ice subject to breakup events likely enhances erosion and sediment transport. Previous work has shown that shore fast ice has the capability to entrain and transport large volumes of sediment away from the nearshore, however, there is limited data on rates of sediment transport and a lack of quantitative information on the mechanics of sediment entrainment. To quantify how cold climate shorelines will respond to reduced winter ice cover associated with climate change we use a combination of field investigations and laboratory experiments to better understand the processes that lead to sediment entrainment within shore ice.

Ice cores were collected from five beach sites around Lake Superior and Lake Michigan. In locations near the shoreline and below ridges, ice cores contained frozen on basal sediment. Ice cores were melted, and sediment content was measured. A large flume was constructed and used to simulate the effect of wave motion on sediment entrainment in shore ice. A plunging wave generator at one end of the flume, propagates waves through the sample chamber. A sediment bench with ramp simulates beach, nearshore, and offshore environments. A ring shear device was used to simulate how the ice cores with debris frozen to the base could be ripped away from the bed by wave action or ice shove. This device rotates an annulus of ice that has been frozen into a thick bed of saturated coarse sand. Cameras mounted on the side wall monitor the movement of sediment within the chamber. Using this device, we can estimate the stress needed to rip it away and determine if the strength of the system is regulated by the sediment or some combination of the ice and sediment.

Lisa Haas *(presenter - ep), Eric Roden, Matt Ginder-Vogel, and Jay Zambito*

Microbially-mediated oxidation of trace element-bearing sulfide minerals in Cambrian Sandstones of Trempealeau County, WI

Iron disulfide (pyrite) mineral oxidation in circumneutral pH (subsurface) environments is a relevant groundwater quality subject for Wisconsin's sandstone and carbonate Cambrian-Ordovician aquifer system. This aquifer system has been observed to host varying abundances of metal-sulfide minerals, such as pyrite, across Wisconsin. Pyrite can oxidize, or degrade, when exposed to oxygenated groundwater or earth-surface conditions. Acid is generated during this reaction and could exceed the buffering capacity of the groundwater. Divalent metal(loid)s go into solution in acidic environments.

We carried out ex situ microcosm experiments, monitoring chemical and biological parameters indicative of active, microbial pyrite oxidation (sulfate production, pH, cell viability). The microcosms contained ceramic-pulverized ex situ sandstone with either natural, negligible, or spiked abundances of pyrite with unadulterated groundwater containing live bacteria. Groundwater was collected from a private well pumping from same geologic unit(s) as the geologic material in the experiment.

One microcosm treatment showed a 5x greater rate of sulfate production (0.2 to 3 mM) in circumneutral pH after 86 days in live microcosms with natural abundance of pyrite compared to their abiotic controls. ^{16}S rRNA genes was extracted from that treatment identified eletroautotrophic- and chemolithotrophic-like bacteria. Results imply accelerated microbially-mediated pyrite oxidation in circumneutral pH.

Dougal Hansen *(presenter - op) and Luke Zoet*

Experimental insight into the entrainment and transport of subglacial debris

Please contact the author for more information ddhansen3@wisc.edu

---

Ben Heath *(presenter - op), Donna Eberhart-Phillips, Federica Lanza, Clifford Thurber, Martha Savage, Tomomi Okada, Satoshi Matsumoto, Yoshihisa Iio, Stephen Bannister*

Fracturing and pore fluid distribution in the Marlborough region, New Zealand from body-wave tomography: Implications for regional understanding of the 2016 Kaikoura Earthquake

Individual earthquake ruptures are usually assumed to occur on individual faults and are often associated with narrow regions (< 5 km) of altered physical properties, such as areas of increased fracturing and/or increased pore fluids. Recently, earthquakes such as the 2016 Kaikoura, New Zealand earthquake have ruptured multiple faults with different orientations over regions with widths spanning > 25 km. We test whether such regions hosting these earthquakes are associated with anomalous physical properties. We use seismic arrival-time tomography in the Kaikoura region to investigate lateral variations in Vp and Vp/Vs, using these parameters to infer variation in crustal faulting/fracturing. By modeling the effect of fluid-filled fractures on lateral variations in Vp and Vp/Vs, we are able to attribute the lateral variation in seismic velocities (over scales of > 50 km) to fault damage and pore fluid distribution. We find that the immature fault zones ruptured during the Kaikoura earthquake are on average characterized by decreased Vp and elevated Vp/Vs, features that decay (over distances of 50 km) towards background levels with increased distance from Kaikoura earthquake faults (and increased proximity to more mature fault zones). Drops in Vp in the Kaikoura rupture region are found to linearly relate to increases in Vp/Vs at a rate that is consistent with elevated 0.01 aspect ratio fractures, with highest fracturing within 10 km of the ruptured faults. The broad regional fracture distribution is likely the result of distributed long-term deformation, with increased deformation in the Kaikoura region. In contrast to more mature fault zones, which have localized strain accommodation and limited regional fracture distribution, immature fault zones are characterized by broadened, extensive fractures which contribute to complicated rupture dynamics.

Kai Hu *(presenter - op)*

Covariation of cross-divide differences in denudation rate and χ: Implications for drainage basin reorganization in the Qilian Shan, northeast Tibet

Please contact the author for more information kai.hu@wisc.edu

---

Zitong Huang *(presenter - pp) and Chris Zahasky*

Three-dimensional Permeability Inversion Using Convolutional Neural Networks for Better Prediction of Contaminant Transport in Aquifer Materials

Understanding the transport of solutes inside of porous media is important for subsurface contaminant control. To model the transport, multiscale permeability heterogeneity characterization is required. However, measuring permeability across spatial scales remains a major challenge. Recent utilization of positron emission tomography (PET) allows for the measurement of solute transport in spatial and temporal dimensions. 3-D permeability heterogeneity characterization through these measurements is anticipated improve the modeling of contaminant transport in complex geologically relevant systems. This study aims to provide an inversion method through a deep convolutional encoder-decoder neural network utilizing multilevel residual learning strategy and the dense connection structure that can efficiently approximate the 3-D permeability field by using the temporal PET imaging measurements as input. Through the network, the inversion modeling task is transformed to an image-to-image regression task, which extracts high-level features from the high-dimensional inputs through encoder and then refines the features to invert the outputs through decoder. Our current network can invert the general pattern of the permeability fields and the mean permeability value. The network is expected to provide an accurate permeability heterogeneity characterization for simulating subsurface flow, which is important for subsurface contaminant control.

Andrew Jones *(presenter - op), Andrew L Gorin, Tori M Kennedy, Shaun A Marcott, Jeremy D Shakun, Brent M Goehring, Gordon R Bromley, Douglas H Clark, Andrew Hein, Vincent Jomelli, Emilio Mateo, Bryan Mark, Brian Menounos, Don Rodbell, Andrew Wickert and Luke Zoet*

Holocene glacier length variations along the American Cordilleras from paired ^{14}C-^{10}Be measurements

Rising global temperatures in the industrial era have led to the smallest observed glacier lengths since record keeping began a few centuries ago. The degree to which modern glacier size is anomalous within the context of the Holocene, however, remains largely unknown. Here, we present cosmogenic in situ ^{14}C and ^{10}Be measurements in recently exposed proglacial bedrock for 10 glaciers spanning 60^0 N to 60^0 S along the American Cordilleras in order to quantitatively assess if modern alpine glaciers are at their smallest extents of the Holocene.

We collected ~5 bedrock samples at each glacier abutting modern ice along a transect perpendicular to flow. ^{10}Be exposure ages represent cumulative exposure durations during the Holocene, while ^{14}C is used to infer burial, as ^{14}C will experience significant decay (t1/2=5,700 years) when shielded from nuclide production by ice on Holocene time scales. Because nuclide concentrations can only provide cumulative exposure and burial durations, observed $^{14}C/^{10}Be$ ratios were compared to 100,000 possible exposure-burial histories by Monte Carlo simulation to quantify when glaciers advanced or retreated during the Holocene.

Modeled glacier extents for 4 tropical glaciers, 1 glacier in the Sierra-Nevada, CA, and 1 in Patagonia, CL are at their smallest extent of the Holocene, providing evidence that present-day warming may have already exceeded the warmest periods of the Holocene. Other study sites in the Northern and Southern hemispheres (30-60^0) exhibit a transition from smaller to larger glaciers during the mid-Holocene, suggesting a late Holocene cooling trend that is in agreement with global proxy data, but contrasts climate model simulations.

Jacob Klug *(presenter - ep), Adain Ramirez, Emily Mixon, Brad Singer, Brian Jicha, and Paola Martinez*

Intercalibration of the Servicio Nacional de Geología y Minería (SERNAGEOMIN), Chile and WiscAr $^{40}Ar/^{39}Ar$ Laboratories for Quaternary Dating

The $^{40}Ar/^{39}Ar$ method is employed to date many types of volcanic materials, however, dating young (<150 ka) K_2O poor samples can be challenging owing to low radiogenic $^{40}Ar^*$ contents, which can be difficult to distinguish from trapped atmospheric argon. To address this challenge, a collaborative intercalibration between the UW-Madison WiscAr and SERNAGEOMIN labs is underway on a common set of samples.

Groundmass and plagioclase samples were analyzed on a 5-Collector Noblesse mass spectrometer, whereas measurements in the SERNAGEOMIN lab were performed using an ARGUS VI spectrometer. Intercalibration samples were collected from three Andean SVZ volcanoes to test the capability of each lab in dating different materials. Lava flows were collected from Planchon-Peteroa and Calbuco Volcano. Single crystals of plagioclase were separated from pumice collected from two outcrops of the >450 km^3 Diamante (Pudahuel) ignimbrite sourced from the Diamante Caldera. Multiple rounds of experiments include co-irradiation of samples at Oregon State University, as well as irradiations using the reactor in Chile to investigate differences in neutron fluence procedure and parameters. Although less precise than plateau ages, all isochron ages generated in the two labs agree at 2σ. All co-irradiated samples from Planchon-Peteroa yield plateau ages that also show inter-lab agreement at 2σ. The low K2O lavas from Calbuco are more challenging with only 1 out of 5 plateau ages in agreement between labs. Differences in the variability of the ^{36}Ar blanks between the two labs may explain the discrepancy. Single plagioclase crystals analyzed from each outcrop of the Diamante ignimbrite differed significantly in precision and highlight the difficulties in dating young tephra deposits. Single crystals analyzed in each lab from sample PUD-15-02 yielded precise ages (WiscAr:126.3 ± 2.5 ka and SERNAGEOMIN: 131.5 ± 2.7 ka) that agree at 2σ and highlight the capability of each lab to date young tephras.

Aaron Kufner *(presenter - pp)*

First occurrence *'Metoposaurus' bakeri* in the Popo Agie Formation (Upper Triassic, WY) and implications for vertebrate biostratigraphy

The Popo Agie Formation of the Chugwater Group in Wyoming is a series of fluvio-lacustrine sandstone and mudstone beds with carbonaceous components at the bottom and top of the formation. No geochronologic constraints independent of vertebrate biostratigraphy are available to date the Popo Agie Fm beyond the Late Triassic. All previously known metoposaurids–characteristic Late Triassic temnospondyl amphibians with a near global distribution–from the Popo Agie Fm have been assigned to the species Anaschisma browni and were found in the upper units (purple-ochre transition and the ochre unit) of the Popo Agie Fm. Radioisotopically dated units in the Chinle Formation of Arizona that yield A. browni are no older than the middle Norian (<221 Ma), but workers generally agree that occurrences of the species 'Metoposaurus' bakeri within the Dockum Group of Texas lower than occurrences of A. browni represent an older fauna (often referred to as Otischalkian) and may be late Carnian-early Norian in age. Here I demonstrate the presence of a second metoposaurid species referable to 'M.' bakeri but from the lower purple unit of the Popo Agie Fm. This corresponds well with the other tetrapods of the Popo Agie Fm that are more similar to the tetrapod fauna of the lowest units of the Dockum Group than they are to the fauna from the lowest units of the Chinle

Fm. This suggests that deposition of both the lowest Popo Agie Fm and lowest Dockum Group preceded Chinle Fm deposition.

Youjuan Li *(presenter - op)*

New $^{40}Ar/^{39}Ar$ and U-Pb age determination of magnetochron M0r from the Qingshan Group, Jiaolai Basin, eastern China

Please contact the author for more information yli2268@wisc.edu

Pablo Moreno-Yaeger *(presenter - pp), Brad S. Singer, and Brian R. Jicha*

Thermodynamic modeling of magma storage conditions beneath Mocho-Choshuenco Volcanic Complex, Chile

The Mocho-Choshuenco Volcanic Complex (MCVC, 39.9^{0}S) is one of the most active volcanoes in the Southern Volcanic Zone (SVZ) with >20 km^3 Holocene tephra products erupted from 13 ka to 1864 A.D. Radiocarbon ages coupled with tephra compositions have led to a model (Rawson et al., 2016) of magma reservoir response to rapid unloading of >1 km thick glaciers during the local Last Glacial Maximum (LGM, 18-16 ka). This model suggests that unloading triggers magma ascent and eruption of long-stored silicic magma from 13 to 8 ka, followed by refilling of the reservoir to produce mafic eruptions from 7 to 3 ka, and uptick in andesitic activity in the last 2.4 ka. However, the Holocene tephras only provide a record of post-LGM explosive eruptions. Here we test this model by estimating thermodynamic parameters of both pre-LGM lava flows, in addition to several of the Holocene tephras.

Recent $^{40}Ar/^{39}Ar$ measurements in WiscAr Lab on pre-LGM lavas indicate that much of the upper portion of the edifice is younger than previous ages determined by the SERNAGEOMIN. Moreover, petrography and geochemistry analyses suggest two distinct groups in the lava flows of MCVC. The first group is comprised of basaltic andesites with 20-30% crystals. The presence of glomerocrysts, sieve texture, zonation, and quenched mafic inclusions (QMI) suggest magma mixing/mingling processes, probably by a basaltic source. The second group is comprised of andesites and dacites with <10% crystals, and the lack of zonation, glomerocrysts and QMI, suggesting a different genesis compared to the first group. Thermodynamic models using the MELTS algorithm suggest crystallization at 1-3 kbar (4-12 km depth), with most post-LGM eruptions originating from a deeper portion of the reservoir system than the pre-LGM lavas. Electron probe microanalysis underway will test this hypothesis. Additional $^{40}Ar/^{39}Ar$ dating underway and cosmogenic ^{3}He exposure dating will constrain the latest Pleistocene eruptive history.

Ellen Nelson *(presenter - pp)*

Fabric studies from the western Idaho shear zone, Sweet-Ola region, Idaho

The western Idaho shear zone (WISZ) is a transpressional dextral shear zone that juxtaposes continental North America and the accreted Blue Mountain terranes. The WISZ is interpreted as a shear zone that overprints the original suture zone. The WISZ varies in orientation along strike, with the northern (McCall) segment striking NS and the southern (Owyhee) segment striking NNE. The change in orientation of the WISZ occurs just north of Sage Hen Reservoir.
This study focusses on exposed basement rocks near Sweet-Ola, Idaho, located south of Sage Hen Reservoir. These are the westernmost exposed basement rocks, as the voluminous Columbia River Basalts Groups cover most basement rocks to the west. Field data and microstructural analysis suggest that the deformed basement rocks are part of the WISZ. The composition of both a porphyritic orthogneiss and hornblende-bearing tonalite (Payette River tonalite), are similar to igneous units located elsewhere in the shear zone. The fabrics at Sweet-Ola have downdip lineations and steeply E-dipping, NNE-oriented foliations, consistent with expected fabrics in the WISZ. We identify the Sweet-Ola region as the southernmost exposure of the WISZ located north of the western Snake River plain.

Ethan Parrish *(presenter - ep), Brad S. Singer, and Brian R. Jicha*

A Tale of Two Rivers: A Source-To-Sink Comparative Analysis of The Aspen and Idaho Paleoriver Systems

The well exposed early Eocene, lacustrine Green River Formation (GRF) of southwestern Wyoming captures the interplay between two well documented paleoriver systems and offers an ideal locality for a source-to-sink (S2S) study of a lacustrine-terminating system. To date, S2S analysis has been largely limited to either modern or marine-terminating sediment routing systems (SRSs), in part due to the challenges of studying complete SRSs in the ancient. These challenges include temporal/geographic constraint, and sedimentologic closure, of the system, as well as the lack of preservation of source areas, and the incompleteness of the stratigraphic record. Ancient lakes present compelling localities for S2S studies as they offer the potential to systematically address several of these challenges. A rich history of research in the GRF has resulted in an unparalleled basin-scale temporal framework and a foundation on which a holistic S2S study can be built. Until recently, however, interest in the GRF has largely focused on the system's sink. Recent and ongoing research has begun to ameliorate this issue by employing detrital zircon (DZ) analysis paired with petrographic and paleocurrent analysis to investigate the provenance of the two primary fluvial systems feeding the GRF - namely the Aspen and Idaho paleorivers. Studies of both SRSs has revealed sedimentation to be more complex than previously recognized, with distal and local sediment sources playing important roles in both. Despite coeval deposition, however, deposits from both SRSs differ significantly.

The present research seeks to compare the two SRSs feeding the GRF, on the basis of sediment caliber, composition, volume, and fluvial architecture, both in the field and using acquired 3D models, to 1) understand the propagation and preservation of early Eocene hypothermal signals which may aid our understanding of our warming climate today, and 2) to improve and broaden the applicability of S2S analysis in general.

Jeremy Patterson *(presenter - op) and Michael Cardiff*

A Generalized Approach to Aquifer Characterization and Uncertainty Quantification Through Oscillatory Flow Interference Testing

Fractures in sedimentary bedrock aquifers act as preferential flow paths that serve to enhance mass and energy transport. Given this, extensive research efforts have been dedicated to developing methods that characterize and model fracture flow and transport in an accurate manner. Recent studies have implemented periodic pressure signals to characterize fracture flow properties; however, current analytical inversion strategies use a single stimulation frequency at a given radial distance to determine the effective fracture flow parameters in a deterministic sense. Our work proposes a gradient-based maximum likelihood inversion approach that incorporates multiple stimulation frequencies during inversion, with parameter uncertainties determined through linearized error propagation.

Using established analytical solutions, we constructed models using a fully confined (fracture bounded by impermeable bedrock) conceptualization and a leaky (fracture bounded porous media) conceptualization. Under the fully confined conceptual model, by exploring a large parameter space, we show that multi-frequency inversion reduces the size of local minima throughout the parameter space and decreases uncertainty of fracture flow parameter estimates. Under the leaky fracture conceptualization, we extend previous type curve analyses and demonstrate the ability of the proposed inversion algorithm to estimate fracture flow parameters with uncertainty comparable to the confined analysis by incorporating multiple frequencies during inversion.

Claudia Roig *(presenter - op) and Chloe Bonamici*

Testing the detachment fault refrigeration hypothesis at high-spatial resolution by SIMS oxygen isotope analysis

Metamorphic Core Complexes (MCC's) are the focus of large-scale tectonics research in the Basin and Range Western US, as well as a natural laboratory for understanding the effects of crustal extension, and the role of fluid dynamics in places with complex thermal histories. Extensional detachment systems, like the Oligocene-Miocene Whipple detachment fault (WDF), are important orogen-scale structures for fault-controlled hydrothermal activity and fluid-assisted deformation processes that occur within an actively exhuming detachment system. Oxygen isotopes are useful in preserving records of variation in time-temperature-fluid conditions and thus present an avenue to study detachment system dynamics. This study aims to assess the extent of rock-fluid interaction at the grain-scale, and how it influenced cooling and deformation along the WDF. The grain-scale oxygen isotope record will be targeted using Secondary Ion Mass spectrometry (SIMS) oxygen isotope analysis to measure $\delta^{18}O$ in quartz and epidote mineral pairs, since these are a good $\delta^{18}O$ thermometery pair and are affected by fluids. Quartzofeldspathic mylonites were collected along a 50-m transect parallel to the WDF transport direction to assess the spatial relation of temperature gradients and fluids to the main detachment surface. Preliminary backscattered electron imaging of epidote porphyroclasts with REE-rich cores in the mylonites display textural and chemical features consistent with modification by syn-deformational hydrothermal reactions. Intragrain oxygen isotope data will be compared to electron microprobe data to track fluid chemistry and assess the roles of deep crustal vs. shallow crustal/meteoric fluids on WDF deformation. Future work will include the use of oxygen isotope geospeedometry to model intragrain (core-to-rim) $\delta^{18}O$ variations in mineral grains that have shown potential to record thermal diffusion zoning during cooling across a range of temperatures.

Daniel Segesseman *(presenter - op) and Shanan Peters*

Environmental expression of the Shuram-Wonoka carbon isotope excursion in North America

Carbon isotope excursions recorded in marine carbonates have been identified as proxies signifying major geologic, atmospheric, and geochemical change in ancient Earth systems. The Shuram-Wonoka anomaly of the Ediacaran geologic period (635-541 Ma) is the greatest magnitude carbon isotope excursion measured in the stratigraphic record, with a positive excursion that climbs to a maximum of +12‰ and a negative excursion that falls to a minimum of -12‰. In addition to the Shuram-Wonoka excursion, Ediacaran age rocks record the deglaciation of Cryogenian 'Snowball Earth' glaciations, the final stages of Rodinia rifting, contain the earliest known occurrences of animal fossils, and mark a shift from deposition of sediments predominantly on short-term recycled oceanic crust to long-term storage on continental crust. The Shuram-Wonoka anomaly's relationship to the aforementioned critical transitions in the Ediacaran and the overall driving mechanism behind the expression of the Shuram-Wonoka anomaly remain a matter of debate. One potential factor that could contribute to the observed Shuram-Wonoka isotopic excursion is if there was a shift in the primary depositional environment of marine carbonates during the Ediacaran. Using a compilation of $\delta^{13}C$ and $\delta^{18}O$ measurements from Ediacaran carbonates set in a chronostratigraphic framework of Ediacaran rocks on North America, we show that there was a shift in primary carbonate depositional environment from continental shelf to primarily slope/basin settings. An expansion of carbonate depositional area coincides with the initial positive excursion of the Shuram-Wonoka, but the pronounced negative excursion does not occur until an expansion of slope/basin depositional settings for marine carbonates in the Ediacaran. Our results are in keeping with existing hypotheses of global sea level rise that coincided with the occurrence of the Shuram-Wonoka anomaly (~580-565 Ma) and global geochemical change in Ediacaran oceans.

Nathan Stevens *(presenter - op) and Shanan Peters*

A Seven Decade History of Flow at Saskatchewan Glacier

Glacier dynamics respond to climate cycles that operate on timescales of decades to megaannum, but direct observations of these dynamics are limited to the last two centuries. Glacier flow is the sum of internal deformation and slip of the glacier over its bed, which respond in different ways to external forcing from climate. Wide scale observations of glacier flow are limited to the past 5 decades from satellite imaging, but even these are subject to constraints of instrument resolution and the distribution of ground-truth data. Temporal, geographic, and resolution constraints put a premium on connecting observational studies prior to the satellite-era to modern observation. One such study site is Saskatchewan Glacier, in Banff National Park of Canada, which had extensive observation of its dynamics collected in 1952-1954. Subsequent studies of its geometry and flow are scattered through time, and largely leverage space-borne observations. In 2017 and 2019 we collected extensive on-ice observations of the geometry, flow dynamics, and hydrology of Saskatchewan Glacier, providing a bridge between vintage observations and modern data sets. We construct a 7-decade history of the flow dynamics of this mountain glacier under the influence of short-period climate cycles and anthropogenic forcing. This record demonstrates that basal sliding has become the prominent, and perhaps perennial, process of glacier flow near the toe of Saskatchewan Glacier in the past two decades. Our findings highlight the importance of rising melt water availability on glacier dynamics.

Nicholas Sullivan *(presenter - op) and Stephen Meyers*

Early Miocene cyclostratigraphy in the Southern Ocean: A window into the history of the Antarctic Ice Sheet

Please contact the author for more information nbsullivan@wisc.edu

Alexandra Villa *(presenter - ep)*

Testing assumptions on last interglacial seawater $\delta^{234}U$ composition

The use of U-series dating of fossil corals has proved to be a crucial tool in creating Last Interglacial (LIG) chronologies of sea level change. These archives preserve the primary chemistry used to calculate a radiometric age, and track the position in sea level using their assumed paleodepth habitat. Using the U-series dating, we can achieve extremely accurate and precise measurements of age and elevation, under the assumption of presumed LIG $\delta^{234}U$ value of seawater. This has been assumed to reflect modern day values of about 145 per mil, given the fact that U in the ocean is relatively constant. However, recent studies have suggested a 5-10 per mil $\delta^{234}U$ change during the LGM, which challenges the assumption that LIG fossil corals reflect modern day values. This study seeks to determine possible values and changes in LIG $\delta^{234}U$ values through a series of leaching experiments.

Chelsea Volpano *(presenter – ep), Lucas Zoet, J. Elmo Rawling, and Ethan J. Theuerkauf*

Numerical modelling of Lake Michigan nearshore evolution under low wave conditions

Coastal erosion is currently exacerbated by above average water levels in Lake Michigan. The increased rate of shoreline erosion has called attention to the lack of predicative tools for coastal management that can simulate conditions that are likely to cause extensive property damage or introduce large volumes of sediment to the littoral system. Numerical models are not commonly applied to simulate the response of Lake Michigan beaches to different hydrodynamic conditions, leading to knowledge gaps on how long term elevated lake levels influence nearshore evolution and sediment transport. We applied the open source nearshore hydrodynamic model Xbeach to a sandy beach on the western shore of Lake Michigan. Two topobathymetric surveys were conducted approximately 1 month apart. We calibrated site specific sediment transport parameters within the model and then compared the predicted morphologic change to that observed in our surveys. We also collected nearshore wave data to determine how basin scale model outputs of offshore wave conditions influence nearshore morphodynamic simulations. Results show that predicting morphodynamic change under low wave conditions on these temporal scales is at the limit of detection for our survey methodology and the capabilities of Xbeach. This is significant because it suggests that it is difficult to analyze the impacts of seasonal increases in water levels during typically low wave conditions.

Shan Ye *(presenter - op), Daven Quinn and Shaun Marcott*

Climatological effects on surface exposure dating

Cosmogenic surface exposure dating is a widely applied tool in glaciated landscapes for determining the glacial histories. In western North America (NA), exposure dating with ^{10}Be has been measured on moraine boulders deposited by alpine glaciers to determine stable glacier positions and infer past climate conditions. The production rate of ^{10}Be varies in space, so a geographic scaling is required for age calibration. However, the effects of many geologic and climatologic processes on surface exposure ages are not quantified and incorporated into this step, which could lead to discrepancies amongst ages across large spatial ranges and obscure our knowledge of glacial histories. Here, we compile a dataset of 1140 ^{10}Be ages from 46 alpine moraines across western NA and archive them in our newly developed Sparrow database. Ages in our data span the past 20 ka and moraines are across a large space and complex mountainous topography. Steep climate gradients across this terrain can influence surface dating in many ways but most notably in snow shielding of moraine deposits and surface erosion of moraine boulders. We apply a regional model to test the potential effects of snow on the ^{10}Be dating. We utilize modern remote sensing and snow reanalysis data to reconstruct the history of snow depth and density in NA to study the influence of the snow on ^{10}Be production rates at moraine locations. This modeling approach assumes that the climatology across our study area has remained stationary over the past 20 ka, so we will incorporate snowfall data from transient modeling simulations across this period to test the snow sensitivity of ^{10}Be ages. Future work will also incorporate effects of erosion on the moraine ages and apply an erosion model based on local climatology and geology and consistently scaled across our model domain. This work will then be applied to existing moraine ages to provide better uncertainty estimates of 10Be ages and insight into past glacier changes.

Shan Ye *(presenter – op), Scott Hartman and Shanan Peters*

Assessment of Dinosaur Diversity and Sediment Coverage in Cretaceous North America

Whether the diversity of North American dinosaurs was decreasing prior to the K/Pg extinction has long been debated. Some hypothesize the diversity of North American non-avian dinosaurs declined gradually in the latest Cretaceous since Campanian, making them susceptible to extinction. Alternatively, others propose dinosaurs show no obvious decline in diversity and suffered an abrupt extinction during the catastrophic vents of the K/Pg boundary. Time series of dinosaur diversity has been constructed to analyze the extinction process of dinosaurs, but it has been proposed that the diversity record of North American dinosaurs is likely biased by the fossil sampling and the availability of sediments. To better understand the pattern of dinosaur extinction in North America, here we use Macrostrat and Paleobiology Database to reconstruct the dinosaur diversity, geological map areas of sediments, and sub-surface sedimentary rock distributions in Cretaceous North America from a spatiotemporal perspective. Our reconstructions show significant positive correlations between fossil preservation and map areas. These results illustrate that the availability of sedimentary rocks could influence the abundance of dinosaur fossils over time, and thus it might have influenced the spatiotemporal reconstruction of the dinosaur diversity and our perception of diversity and the macroevolutionary process leading into the K/Pg extinction. Our time series analysis indicates that dinosaur diversity reached a high level in Campanian and Maastrichtian and then had an abrupt decrease approaching the end of the Maastrichtian. Our results show that there is no evidence for a long-term decline of dinosaur diversity in North America before the abrupt decline at the K/Pg mass extinction.