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## What's Soil Got to Do with Climate Change?

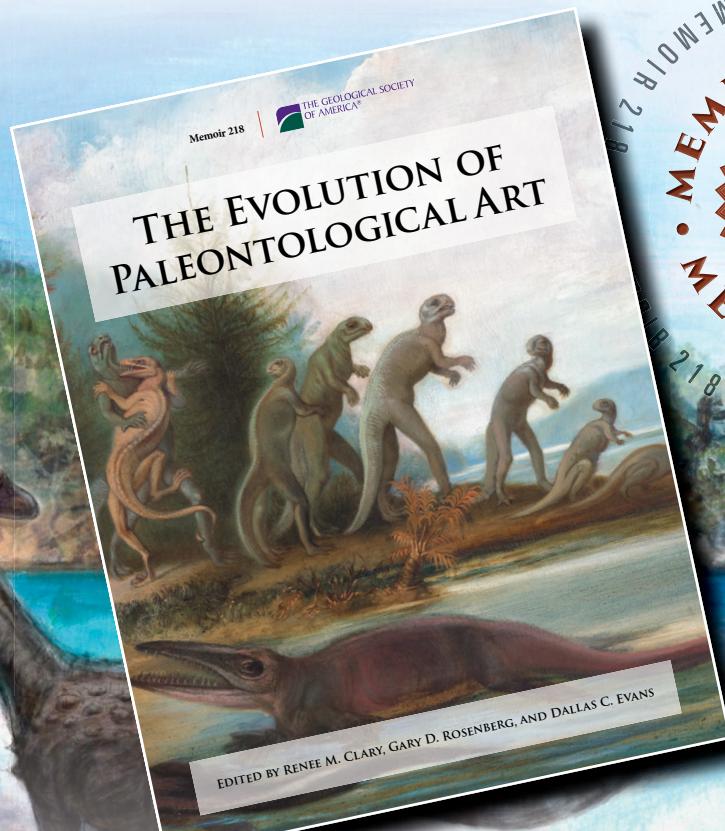


# THE EVOLUTION OF PALEONTOLOGICAL ART

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Fossils have stirred the imagination globally for thousands of years, starting well before they were recognized as the remains of once-living organisms and proxies of former worlds. This volume samples the history of art about fossils and the visual conceptualization of their significance starting with biblical and mythological depictions, extending to renditions of ancient life as it flourished in long-vanished habitats, and on to a modern understanding that fossil art conveys lessons for the betterment of the human condition. The 29 papers and accompanying artwork illustrate how art about fossils has come to be a significant teaching tool, not only about evolution of past life, but also about conservation of our planet for the benefit of future generations.

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## SCIENCE

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*Todd Longbottom et al.*

**Cover:** Soils support life on Earth, storing twice as much carbon as Earth's atmosphere and vegetation combined. For this reason, soils are inherently vulnerable to enhanced degradation due to conventional agriculture and anthropogenic climate change. Strategies aimed at conserving the global soil resource not only mitigate rising atmospheric carbon dioxide concentrations, but also promote numerous ecosystem co-benefits. Effective soil conservation is necessary to secure food, fuel, and fiber for a burgeoning human population. Image from Shutterstock. See related article, p. 4–10.



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**Erratum:** The March-April issue of *GSA Today* listed Barry Raleigh as deceased. This is not true. *GSA Today* deeply regrets this error.

# What's Soil Got to Do with Climate Change?

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## ABSTRACT

Soils are the foundation of life on land and represent one of the largest global carbon (C) reservoirs. Because of the vast amount of C that they store and the continuous fluxes of C with the atmosphere, soil can either be part of the solution or problem with respect to climate change. Using a bank account analogy, the size and significance of the soil organic C (SOC) pool is best understood as the balance between inputs (deposits) from net primary productivity and outputs (withdrawals) from SOC through decay and/or physical transport. Reversing the current problematic trend of increasing concentration of greenhouse gases in the atmosphere must be met with reduced fossil fuel emissions. At the same time, we argue that “climate-smart” land management can promote both terrestrial sequestration of atmospheric carbon dioxide ( $\text{CO}_2$ ) and contribute to improving soil health and benefits. In this review, we highlight environments that are particularly vulnerable to SOC destabilization via land use and climatic factors and outline existing and emerging strategies that use soils to address anthropogenic climate change.

## INTRODUCTION

The health and diversity of natural ecosystems—and human civilization—depend on our coordinated responses to global changes that threaten earth's long-term habitability. Soils, the thin veneer on the global land surface that supports terrestrial life, are an integral component of anthropogenic climate change mitigation strategies (Paustian et al., 2016; Loisel et al., 2019).

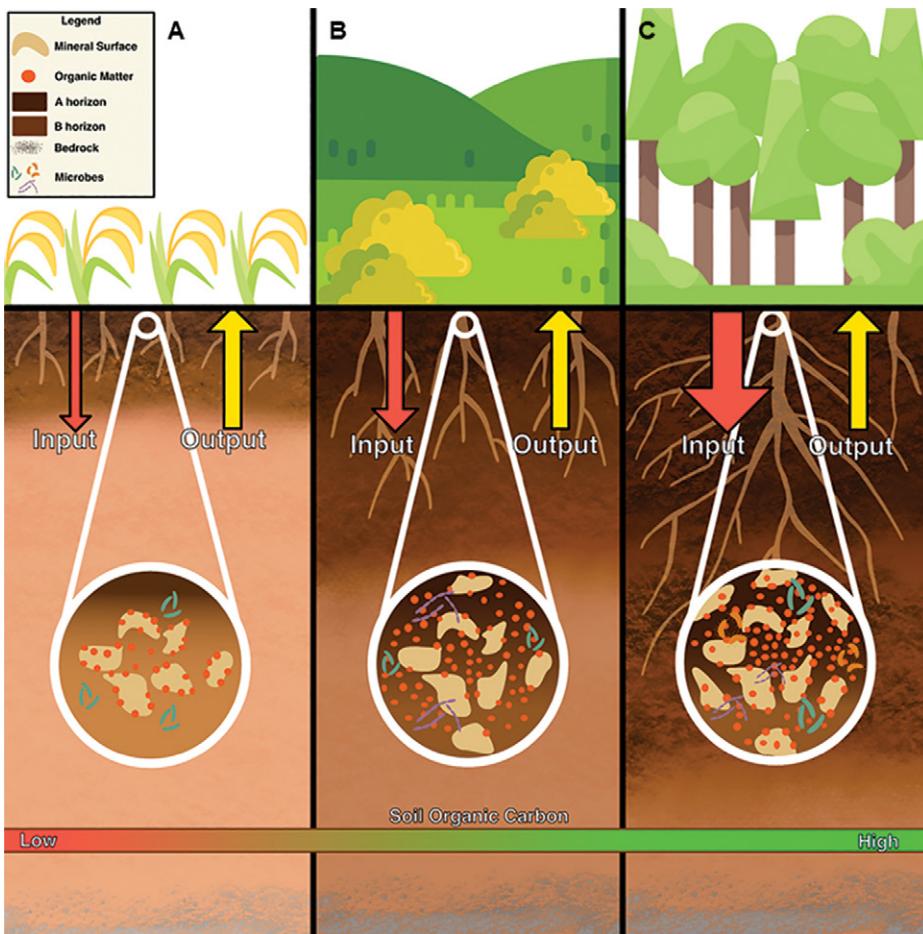
Soils are a necessary part of the solution for human-induced climate change because they represent one of the largest terrestrial carbon (C) reservoirs, storing twice as much C as the earth's atmosphere and vegetation combined (up to 2500 Pg C; IPCC, 2013; Friedlingstein et al., 2020). Terrestrial C pools are a powerful C sink, with the potential to offset up to 30% of anthropogenic C emissions, where some of the sequestered C persists in soil over millennial time scales (Friedlingstein et al., 2020). Because of the relative sizes of the different C reservoirs, even slight changes in the amount of C stored in soil can represent significant changes in the global atmospheric concentration of carbon dioxide ( $\text{CO}_2$ ) and the earth's climate future.

How do we unlock soil's potential for combating climate change? An important component of a comprehensive response is to store more C in soils, particularly in soil pools that cycle C at slower rates compared to the other reservoirs (ex., atmosphere, biomass, and on near surface soil layers) (Schmidt et al., 2011). The amount of carbon stored in soil (soil organic C or SOC) is a balance between inputs and outputs of carbon (Berhe, 2019a; Lavalée and Cotrufo, 2020). SOC storage in a given area (plot, catchment, region, or another spatially constrained system) has been likened to a bank account, where the “balance” is the bulk SOC stock or inventory (Fig. 1). Bank “deposits” are contributed by vegetation litter, root exudates, living soil biota, deposition of eroded C, and remains of formerly living organisms. The depletion of the balance in the soil carbon bank account

is driven by microbial decomposition of organic C inputs to  $\text{CO}_2$  and dissolved and particulate transport of C through leaching and/or erosion.

The SOC that exists in soil can be subdivided into “slow-cycling” and “fast-cycling” pools akin to checking and savings accounts (Lavalée and Cotrufo, 2020), respectively. Slow-cycling C is either mineral-associated C that is found physically protected in soil aggregates or chemically bound to the surfaces of reactive soil minerals; both mechanisms restrict decomposition and associated losses of SOC, allowing it to persist in soil for decadal to millennial time scales (Schmidt et al., 2011; Hemingway et al., 2019). In contrast, fast-cycling C is more readily degradable and prone to physical transport in shorter time scales (Schmidt et al., 2011; Hemingway et al., 2019). Fast C cycling, which is akin to funds in a checking account, is critical for maintenance of life in soil, because decomposition is the main mechanism that recycles nutrients needed by organisms that call the soil home (Janzen, 2006). Even small, but sustained, deposits into the soil C savings account over time allow for long-term buildup of C in the slow-cycling pool with significant potential for climate change mitigation.

Increasing urgency for addressing the global climate emergency demands that we reduce the release of greenhouse gasses from burning of fossil fuels, while finding appropriate alternatives to draw down some atmospheric carbon through soil carbon sequestration and other means. As we seek these solutions, it is important to remember that decomposition of organic matter (i.e.,



**Figure 1.** Soil organic carbon (SOC) is a dynamic and complex admixture. Here, three contrasting ecosystems reveal differing SOC richness and dynamics: (A) agricultural, (B) grassland/shrubland, and (C) forested. Conventional agriculture (A) often leads to lower carbon stocks, and overall, less carbon input to the soil carbon pool. Grasslands (B) can harbor plants with deeper and more extensive root systems, medium to high amounts of SOC stock, and greater carbon inputs to the SOC pool. Forests (C) can have the deepest rooting system, a high amount of soil C stock, greatest density of mineral-associated C, and high rate of input of C to soils. Overall, organo-mineral association(s) and SOC pool is a function of the “balance” of C inputs and outputs in the soil organic carbon “bank account.”

withdrawal of some of the balance from the soil carbon checking account) is a critical ecosystem process because decay of organic residue provides essential nutrients for plants and microbes in soil (Janzen, 2006). For this reason, we cannot expect zero withdrawal from the soil carbon bank and must figure out how we can continue to “invest” in soil C to maximize its input and retention in the soil, thus preventing fast release of C as greenhouse gasses to the atmosphere. Maintenance of soil health through “smart” management practices has been proven to simultaneously achieve SOC sequestration and provision of clean air, water, and a functional habitat (Billings et al., 2021; Kopittke et al., 2022). Here, we explore prevailing issues with conventional soil management, vulnerability of SOC to loss in a changing world, and strategies to alleviate climate-change impacts on soil resources.

In this framework, we identify strategies for soil C sequestration and ways to prevent “overspending” in an uncertain future marked by changing climate and increased demands to ensure food and nutritional security of the growing human population.

### CARBON LOSSES DUE TO CONVENTIONAL SOIL USE AND DEGRADATION

An increasing human population and onset of the industrial age led to an increased demand for food, energy, and water resources, and overall intensification of the agricultural sector. With intensive agricultural practices came large-scale degradation of the global soil resource that included increased rates of soil erosion (i.e., loss from working lands) that outpaced new soil production by 1–2 order(s) of magnitude, largely resulting from deforestation to clear

land for agriculture, conventional tillage practices, and overgrazing (Lal, 2004; Montgomery, 2007). Conventional land management practices cause physical disturbance of soils and have historically promoted enhanced agricultural yields, to the detriment of SOC content, topsoil thickness, and overall soil health and structural stability (Phillips et al., 1980; Reganold et al., 1987; Amundson et al., 2015). The systematic exploitation and modification of undisturbed soils has led to the resulting agricultural soils being dubbed “domesticated,” lacking hallmark resilience of their wild predecessors (Amundson et al., 2015). Soil domestication for agriculture also presents broader, associated ecosystem issues, such as diminished biodiversity from engineered crop community monocultures, introduction of chemical pesticides to hydro- and pedospheres, and the delivery of vast quantities of esp. nitrogen and phosphorus fertilizers to coastal margins. Conservation tillage and organic farming have been proposed as alternative approaches that enhance soil health and to limit unsustainable soil “mining” and associated SOC overspending (Montgomery, 2007). Estimates maintain that tillage management, when paired with cropping systems, can sequester 0.03–0.11 Pg C yr<sup>-1</sup> (Follett, 2001). Despite these promising advances, human civilization and associated changes in land use and land cover led to the loss of 120 Pg C in the upper ~2 m of soils since humans adopted agriculture, with the fastest rate of loss occurring in the past 200 years (Sanderman et al., 2018).

Land Use/Land-Use Change (LULUC) practices such as conventional agriculture, deforestation, and wetland conversion contribute 10%–14% of overall anthropogenic greenhouse gas emissions (Paustian et al., 2016). The SOC pools impacted by LULUC have the potential to release massive amounts of C to the atmosphere, making the preservation of these environments critical to protect soil C from loss both by reducing future releases of C from soil to the atmosphere (avoided fluxes) and promoting drawdown of C that is already in the atmosphere (sequestration of atmospheric CO<sub>2</sub>). Deforestation was historically practiced to clear land for agriculture, but also continues to occur due to urban development, logging, and an increase in wildfire frequency and intensity. These activities can destabilize SOC, releasing slow-cycling C stored even in deeper soil layers (Drake et al., 2019). This also lowers ecosystem functions that SOC

can provide, such as water retention and nutrient cycling (Veldkamp et al., 2020). Similarly, histosols (wetland soils, including peatlands with no underlying permafrost) can play a critical role because they make up only 1% of soils globally, yet contain a larger proportion of SOC (179 Pg C, or ~12% of SOC in the upper 100 cm globally: Brady and Weil, 2017). This SOC accumulation can be attributed to a lower rate of decomposition of SOC due to waterlogging and resultant limitation in availability of free oxygen for the heterotrophic soil microorganisms that can otherwise effectively decompose organic matter. Histosols have historically been targets for drainage and conversion to high-yielding agricultural lands (Holden et al., 2004). Draining of histosols, due to atmospheric warming and/or anthropogenic practices, can lead to rapid decomposition of SOC release to the atmosphere (Couwenberg et al., 2011). Overall, the soil system stores large amounts of carbon, but it has continued to experience rapid degradation due to human actions. However, adoption of climate-smart land management practices has a clear potential to reduce the atmospheric CO<sub>2</sub> burden and increase the amount of carbon stored in the soil carbon bank, with multiple benefits for improving ecosystem health and human welfare.

## VULNERABILITY OF SOC TO LOSS WITH UNCERTAIN FUTURE

Climate is a primary factor driving the rate of decomposition of SOC (Brady and Weil, 2017). Global climate change can accelerate SOC losses due to increasing global atmospheric temperature, altered precipitation patterns, and other changes (Bellamy et al., 2005; Walker et al., 2018). Warming often increases the rate of microbial decomposition of SOC and subsequent CO<sub>2</sub> efflux to the atmosphere (Lloyd and Taylor, 1994; Lehmeier et al., 2013; Min et al., 2019). The effects of increasing temperature on SOC losses vary with molecular complexity of SOC and environmental conditions (e.g., water limitation, aggregation, mineral association) (Davidson and Janssens, 2006). Complex SOC, with high activation energy, is more sensitive to temperature than simple SOC (Lehmeier et al., 2013; Lefèvre et al., 2014). The temperature sensitivity of protected, slow-cycling C has been less studied (Karhu et al., 2019), which necessitates future studies that explore the relationship between slow-cycling C and

its sensitivity to environmental changes. Contrary to the positive relationship between temperature and SOC decomposition rate, increases in water availability can increase (Kaiser et al., 2015; Min et al., 2020) or decrease SOC decomposition (Freeman et al., 2001), depending on the systems of interest. Precipitation can also indirectly affect SOC storage by inducing soil erosion, changes in pore connectivity, and altering ecosystem structure (Pimentel et al., 1995; Smith et al., 2017; Wu et al., 2018). In eroding landscapes, lateral distribution of topsoil C and its deposition in lower-lying landform positions (Berhe et al., 2018) causes mixing of the relatively fast-cycling C with slow-cycling C in deep soil layers.

The response of carbon stored in soil to climate change and other perturbations varies depending on the nature of the soils and the type of change to the system (Berhe, 2019b). Here, we highlight how SOC will respond to climate change using three important areas of concern and uncertainty (e.g., gelisols, paleosols, and deep soil).

### Gelisols

Gelisols are soils of very cold climate conditions and store ~1000 Pg C in the upper 3 m of active and underlying layers of permafrost soils (Tarnocai et al., 2009; Hugelius et al., 2014). Gelisols have accumulated C because of climate-driven slow decomposition rates (Ping et al., 2015; Turetsky et al., 2020). Warming in the northern hemisphere is predicted to release 12.2–112.6 Pg C by 2100, according to Representative Concentration Pathway 4.5 and 8.5 warming scenarios (IPCC, 2013). This huge uncertainty in the projected C release in the northern hemisphere is partly due to considerable variability in hydrology, soil conditions, and vegetation (McGuire et al., 2009; Schuur and Abbott, 2011; Ping et al., 2015). The rapid destabilization of polar and high-altitude environments, often referred to as the most sensitive barometers of climate change, serves as a benchmark for understanding anthropogenic modifications to the global climate system.

### Paleosols

Paleosols are soils that developed in different environmental conditions when topsoil was transported downhill and buried by alluvial, colluvial, aeolian deposition, volcanic eruption, or human activities over centuries to millennia (Marin-Spiotta et al., 2014; Chaopricha and Marin-Spiotta, 2014).

This process promotes SOC-mineral association(s) (Rumpel and Kögel-Knabner, 2011) that build up soil C stock in the slow-cycling soil C savings account (Schmidt et al., 2011). Recent estimates suggest that paleosol C is a significant global C reservoir (Lehmkuhl et al., 2016), but it is spatially variable depending on landscape and climate history, thus making it difficult to estimate the total storage. The effect of any environmental change on buried SOC is complex and poorly understood because paleosols are not considered for the global C stock inventory and models. The possibility of the vast storage of SOC raises questions on how the previously buried SOC will interact in the presence of water, modern soil surface microbes, and addition of new fresh SOC, and finally if they will become a sink or a source of greenhouse gasses in the presence of all the optimal conditions for decomposition.

### Deep Soil

The overwhelming majority of soil C studies have focused on shallow soil depths, with little attention paid to the amount of C stored in or the vulnerability of C in deep soil layers. Soils can develop to >10 m depth, and deep soils (below 30 cm) can store up to 74% of the total profile C with radiocarbon ages of 5,000–20,000 years old (Moreland et al., 2021). It is estimated that 28 Pg C is stored in soils with deep weathered bedrock, suggesting that deep soil C is a large C reservoir that may be potentially vulnerable to a changing climate (Moreland et al., 2021). Some soils are already showing evidence of warming by 2 °C, since 1961, which has been observed at up to 3 m depths (Zhang et al., 2016). Although decomposition rates are slower in deeper soils than in surface soils, recent studies have shown that deep SOC is more vulnerable to loss than previously thought (Rumpel and Kögel-Knabner, 2011; Hicks Pries et al., 2017; Min et al., 2020). Experimental warming to a depth of 1 m found that warming increased annual soil respiration by ~35% and estimated that with a 4 °C increase, deep soils have the potential to release 3.1 Pg C yr<sup>-1</sup>, equivalent to 30% of fossil fuel emissions (Hicks Pries et al., 2017; Friedlingstein et al., 2020).

In the following section, we focus on “working lands,” where the global soil degradation problem can be effectively addressed (in a cost- and time-efficient manner) through a suite of natural climate change solutions.

## SOILS AS NATURAL CLIMATE CHANGE SOLUTIONS

Intergovernmental Panel on Climate Change (IPCC) assessment reports and the Paris Agreement have highlighted the importance of immediate action to prevent catastrophic changes to the earth system. Inclusion of soils in local to global climate change mitigation strategies is a proven and cost-effective strategy. Natural climate solutions can provide 37% of cost-effective  $\text{CO}_2$  mitigation necessary for a >66% chance of holding warming below 2 °C by 2030 (Griscom et al.,

2017). The “4 per 1000” effort has proposed soil as a natural climate change solution and endeavors to increase SOC storage by 0.4% annually (Rumpel et al., 2020), thereby offsetting one third of global fossil fuel emissions. Here, we provide a review of the available solutions to increase the amount of C stored in the soil C savings account through a variety of land stewardship practices, including use of amendments such as compost, biochar, waste, and management interventions such as reforestation, inclusion of deep root perennials, and cover crops.

Restoring degraded lands and avoiding further land conversion (e.g., afforestation) can also help mitigate climate change (Fig. 2; Table 1). Afforestation of degraded sites in the United States is estimated to potentially sequester 2.43 Pg C  $\text{yr}^{-1}$  in the upper 30 cm of soil over 30 years (Cook-Patton et al., 2020). Although afforestation efforts can increase SOC storage on decadal time scales, the effects are largely site-specific. For example, depending on the prevailing climate of an area, restoring grasslands might be a better option for C sequestration

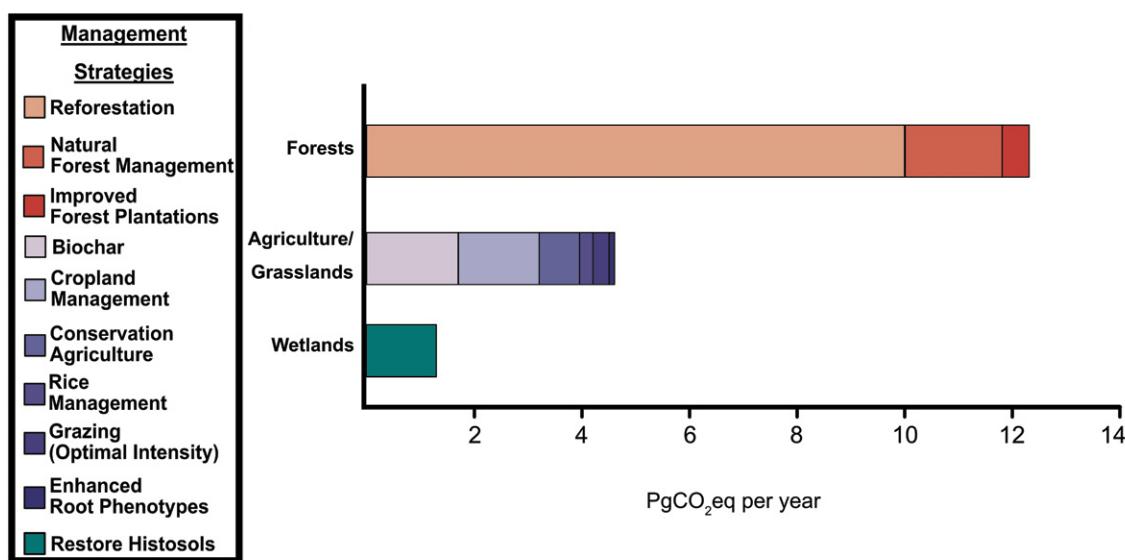


Figure 2. Various management strategies in forested, agriculture/grassland, and wetland ecosystems exhibit differing propensities to take up  $\text{CO}_2$ . Overall, these strategies represent a way to expand terrestrial ecosystem uptake of carbon (Friedlingstein et al., 2020; Paustian et al., 2016; Griscom et al., 2017).

TABLE 1. CLIMATE MITIGATION POTENTIALS OF VARIOUS LAND USE PRACTICES ACCORDING TO POSSIBLE AREA OF PRACTICE ADOPTION

Practice	Climate Mitigation Potential (Pg $\text{CO}_2$ eq $\text{yr}^{-1}$ )	Area of Practice Adoption (Mha)	References
<b>Forests</b>			
Reforestation	10	3665	
Natural forest management	1.8	3665	1, 2
Improved forest plantations	0.5	204	
<b>Agriculture and Grasslands</b>			
Biochar	1.7	2000–3000	
Conservation agriculture	0.8	750–2000	
Grazing—Optimal intensity	0.4	500–2000	2, 3
Cropland management	1.5	750–2000	
Rice management	0.3	20–50	
Enhanced root phenotypes	0.1	1000–2000	
<b>Wetlands</b>			
Restored histosols	1.3	10–15	2, 3

<sup>1</sup> Siry et al., 2005

<sup>2</sup> Griscom et al., 2017

<sup>3</sup> Paustian et al., 2016

than afforestation/reforestation, and converting grasslands to forest may yield less net SOC storage than converting cropland to forest (Li et al., 2012; Bárcena et al., 2014). Soil restoration, specifically for wetlands, has the potential to return these environments to a net C sink (Table 1; Waddington et al., 2010) and represents a cost-efficient mitigation strategy—projected to cost ~US\$20 per Mg of sequestered C (Humpenöder et al., 2020).

Regenerative agriculture (RA) also holds a substantial role in attaining negative carbon emissions from rangeland and agricultural soils (Fig. 2; Table 1). RA is a set of locally adapted land practices that minimize soil disturbance (e.g., no-till, minimum tillage, cover cropping) and losses (e.g., erosion, degradation), while self-sustaining its ecosystem services (e.g., productivity, biodiversity; Gonzalez-Sanchez et al., 2015) using agroecology-based theory and management (e.g., compost application, crop, and grazing rotation, etc.). Hence, RA promotes C sequestration and soil health while simultaneously reducing net SOC losses by providing a direct layer of protection from disturbance. Ultimately, avoiding land conversion and disturbance a priori is the most effective strategy to maintain SOC storage, as restoration of degraded lands accrues SOC slowly (Guo and Gifford, 2002). Both active and preventative restoration practices are vital in providing ecosystem service co-benefits such as water filtration and storage.

Land managers have added organic amendments to their soils since the early periods of agriculture. The addition of C-rich amendments can improve soil health via enhancing nutrients and water storage, plant productivity, microbial diversity, and soil structure (Woolf et al., 2010; Farooqi et al., 2018; Amelung et al., 2020). Studies have now documented significant, positive impacts of organic amendments that include a 2.3 Mg C ha<sup>-1</sup> yr<sup>-1</sup> increase in SOC stock in corn fields after six years of biochar amendments (Blanco-Canqui et al., 2020), and a projected SOC sequestration potential of 1.2 Mg C ha<sup>-1</sup> yr<sup>-1</sup> in croplands after application of manure, sewage sludge, or straw (Smith, 2004). In parts of the world that have large amounts of excess biomass (ex., agricultural residue, manure, forest clippings, etc.), these amendments are viable options for climate change mitigation (Fig. 2; Table 1), while at the same time replenishing C and nutrient stocks to increase the ecosystem's overall health and resilience (Koide et al., 2015).

Recent advances in plant-based strategies have also provided new insights to address net SOC loss. These strategies rely on the ability of plants to self-regulate and self-optimize resource uptake and allocation, and thus are considered cost-effective and sustainable with limited environmental footprints. Plant roots are known to be a main source of SOC (Rasse et al., 2005), and root-derived SOC is preferentially retained by minerals (Bird et al., 2008). Therefore, the introduction of roots into deep soils can enhance slow-cycling C formation (Kell, 2011; Paustian et al., 2016). However, root exudates enhance soil microbial activity and reduce SOC stock via priming (Fontaine et al., 2007; Keiluweit et al., 2015). For this reason, plant roots are considered as a double-edged sword for SOC formation (Dijkstra et al., 2021). Still, there is evidence that deeply rooting vegetation (esp. perennial grasses) can sequester C into the deep soil (Slessarev et al., 2020). Extensive root systems introduce C to the subsoil, enhancing SOC-mineral associations, aggregate protection, and reduced access to SOC by soil microbes. In this manner, rhizosphere engineering benefits overall soil health and resource use efficiency (Dessaux et al., 2016). With proper implementation, plant-based strategies can synergize with existing strategies (e.g., conservation agriculture) to promote more SOC in the long-term savings account (Fig. 2).

## CONCLUDING THOUGHTS

Soils have supported life and stored C throughout geological history. However, human civilization has spurred drastic land use changes through agriculture and other activities. Additionally, profound alteration to the global climate system has resulted from widespread fossil fuel utilization and resulting greenhouse gas emissions. As we apply sophisticated models and propose novel technologies for understanding and addressing anthropogenic climate change, a piece of the solution is found in the soil. Natural climate change solutions involving soil health are not only cost effective, but also non-negotiable, because they are key for securing the food, fuel, and fiber necessary for an ever-increasing human population. Earth scientists, land managers, and policy makers must collaborate to continue “spending” SOC while “investing” in SOC to increase its retention in the soil and maximize its ability to support life. It’s a win-win climate solution that’s right beneath our feet. Let’s keep it there.

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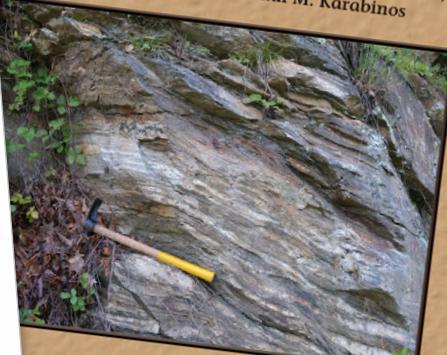
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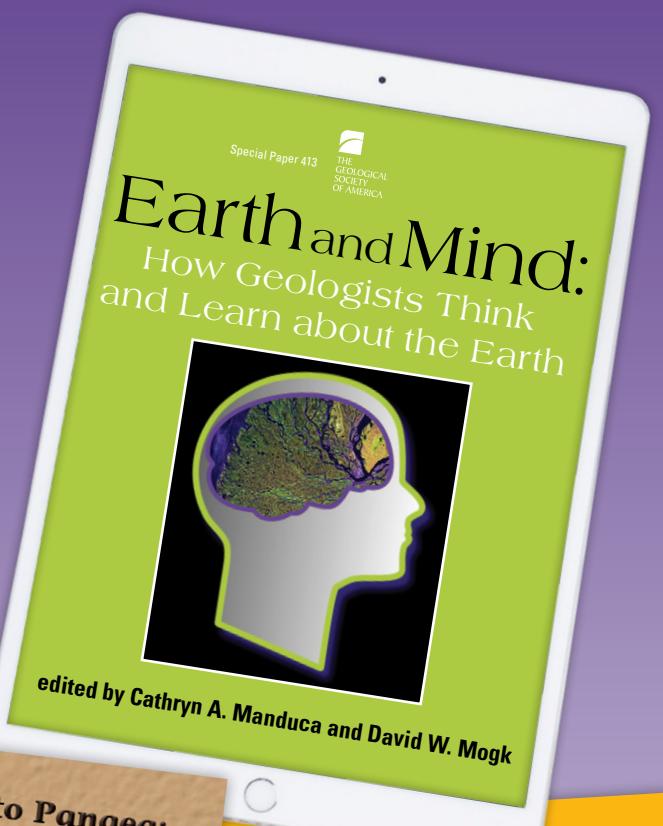
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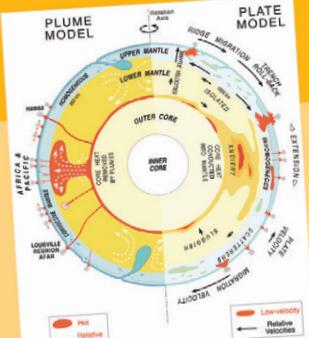


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## Greetings!

Colorado, home to stunning scenery of mountains, rivers, and plains, welcomes the Geological Society of America's 2022 Connects meeting (9–12 October) to Denver. Since the last GSA meeting in Denver six years ago, we enjoyed the full gamut of normal life activities during the pre-COVID years, hopefully navigated the syn-COVID years unscathed, and at this year's meeting perhaps we will excitedly enter a post-COVID time.

This meeting will be fully hybrid; nonetheless, the two of us look forward to seeing you all during this stimulating scientific meeting, which includes 176 topical sessions, five Pardee Symposia, 38 short courses, and 14 field trips. As GSA does so well, we have planned plenty of engaging activities for students, early-career geoscientists, and K–12 educators, and we will have a vibrant Resource & Innovation Center. One of the special aspects of an in-person meeting is the spontaneous and not-so-spontaneous informal gatherings you make with colleagues, former students, friends, and new scientists.

Want a break from the meeting? Enjoy a hike in the Front Range in one of dozens of parks where you can walk across flat-lying Cenozoic sedimentary deposits and basalt flows that unconformably overlie tilted Mesozoic and late Paleozoic sedimentary rocks that unconformably overlie Proterozoic igneous and gneissic rocks. If you gain enough elevation, be greeted by a stunning panorama of Denver and the Great Plains of Colorado. Or visit one of the many museums, like the Denver Museum of Nature & Science, with offerings from art to minerals to dinosaurs and more.

While in Denver, check out the recently opened Meow Wolf Convergence Station, Meow Wolf's third permanent exhibition in the United States. Check out Dinosaur Ridge and then visit the best place to see the stars, Red Rocks Park and Amphitheatre, and see King Gizzard and the Lizard Wizard. Walk the River North Arts District and see some of the best murals and graffiti. A palette of flavors awaits you among Denver's distinct restaurants, roving food trucks and food carts, and cuisine from some of Denver's semifinalists in this year's James Beard Awards.



Jeff Lee



Cal Barnes

We look forward to seeing you in Denver,

**Jeff Lee**, research professor, Dept. of Geophysics, Colorado School of Mines

**Cal Barnes** professor (retired), Dept. of Geosciences, Texas Tech University

*GSA 2022 Connects General Co-Chairs*

## Important Dates

**Now open:** Abstracts submission

**Now open:** Non-technical event space/event listing system

**June:** Housing opens

**Early June:** Registration and travel grant applications open

**6 June:** Meeting room request deadline—fees increase after this date

**19 July:** Abstracts deadline

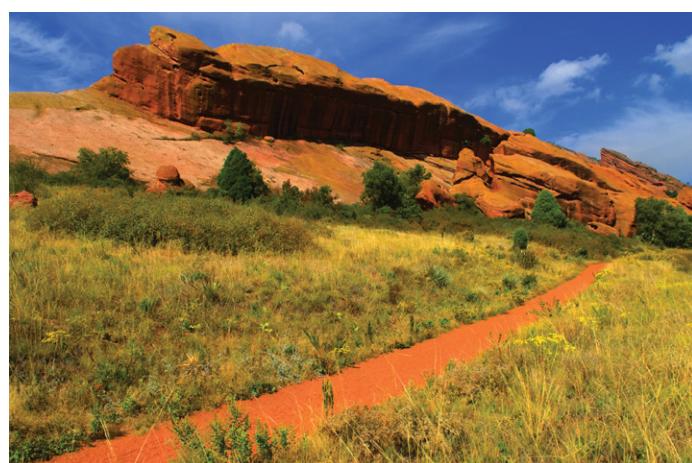
**Late July:** Student volunteer program opens

**6 September:** Early registration deadline

**6 September:** GSA Sections travel grants deadline

**12 September:** Registration and student volunteer cancellation deadline

**14 September:** Housing deadline for discounted hotel rates



## Official GSA Locations

**Colorado Convention Center**

700 14th Street, Denver, Colorado 80202, USA

**Hyatt Regency Denver at the Colorado Convention Center (Hyatt Regency)**

650 15th Street, Denver, Colorado 80202, USA



Left: Red Rocks Amphitheatre. Right: Blue Bear at Colorado Convention Center. Photos courtesy of Visit Denver.

## GSA Partners with Its Associated Societies

GSA has a long tradition of collaborating with like-minded organizations in pursuit of mutual goals to advance the geosciences. The Society seeks to build strong, meaningful partnerships with other societies and organizations across the country and around the world in service to members and the global geoscience community. National and international societies with consistent aims and missions of advancing the geosciences and/or science in general are invited to affiliate with GSA as an Associated Society.

GSA currently works with its 77 Associated Societies and 22 scientific Divisions to build a dynamic technical program and stimulating events during Connects 2022. Many of our Associated Societies will present their representative science, hold tailored events, and have exhibit booths during the meeting. GSA is looking forward to hosting these valued partners and organizations. Members of Associated Societies also receive the GSA member registration rate.

For more information about the GSA Associated Societies and a full list, go to [www.geosociety.org/GSA/About/Who\\_We\\_Are/Associated\\_Societies/GSA/About/Associated\\_Societies.aspx](http://www.geosociety.org/GSA/About/Who_We_Are/Associated_Societies/GSA/About/Associated_Societies.aspx).

## Non-Technical Event Space Requests

Deadline for first consideration: **6 June**

Please let us know about your non-technical events via our online event space & event-listing database connect via <https://community.geosociety.org/gsa2022/connect/events/plan>. Space is reserved on a first-come, first-served basis; in order to avoid increased fees, you must submit your request by MONDAY, 6 JUNE. Event space/event listing submissions should be used for business meetings, luncheons, receptions, town halls, etc.

- For events held at the Colorado Convention Center (CCC) or Hyatt Regency Denver at CCC (HQ Hotel)
- For off-site events (events that are being held at another location in Denver that you have arranged on your own)
- For online events being held 7–13 October 2022

Meeting room assignments will be sent out in July.

# Call for Papers

**Abstracts deadline:** 19 July

## SUBMITTING AN ABSTRACT

**Abstracts form open:** 1 May

**Submission deadline:** Tuesday, 19 July

- **Abstract non-refundable submission fee:** GSA MEMBERS: professionals: US\$60; students: US\$25. NON-MEMBERS: professionals: US\$80; students: US\$50.
- To begin your submission, go to <https://community.geosociety.org/gsa2022/program/technical>
- For detailed guidelines on preparing your submission, please view “preparing an online submission” at <https://gsa.confex.com/gsa/2022AM/categorypreparation.cgi>.

## TWO-ABSTRACT RULE

- You may submit two volunteered abstracts, *as long as one of the abstracts is for a poster presentation*;
- Each submitted abstract must be different in content; and
- If you are invited to submit an abstract in a Pardee Keynote Symposium or a topical session, the invited abstracts do not count against the two-abstract rule.

## POSTER PRESENTERS

- You will be provided with one horizontal, free-standing 8-ft-wide by 4-ft-high display board and Velcro for hanging your display at no charge.
- Electricity is available for a fee.
- AM Session: Posters will be displayed 9 a.m.–1 p.m., with presenters present 11 a.m.–1 p.m.
- PM Session: Posters will be displayed 2–6 p.m., with presenters present 4–6 p.m.

## ORAL PRESENTERS

The normal length of an oral presentation is 12 minutes plus three minutes for questions and answers. You *must* visit the Speaker Ready Room at least 24 hours before your scheduled presentation. All technical session rooms will be equipped with a PC Windows 10/MS Office 2013. Presentations should be prepared using a 16:9 screen ratio.

## HYBRID EVENTS

GSA is planning an in-person meeting in Denver, Colorado, USA. We will be offering an online component to all technical sessions, in addition to the GSA Presidential Address, Pardee Keynote Symposia, and noontime lectures.

## ABSTRACTS SUBMISSION: EXPECTED BEHAVIOR

The submission of an abstract implies a sincere intent to present the submitted research during the meeting. Authors and presenters are expected to display integrity in disseminating their research; adhere to the content and conclusions of abstracts, as submitted and reviewed; remain gracious by offering collaborators the opportunity for recognition as a co-author; make sure that listed co-authors have made a bona fide contribution to the project, are aware of their inclusion, and have accepted that recognition; and be diligent in preparing a polished product that conveys high quality scholarship. GSA strives to promote diversity among conveners and presenters when organizing panels, keynotes, and other invitational sessions.

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# Topical Sessions

## GEOCHRONOLOGY

### T1. Advances and Applications of Thermochronology in Tectonic, Magmatic, Basin, and Geomorphic Studies

**Endorsers:** GSA Quaternary Geology and Geomorphology Division; GSA Geochronology Division

**Disciplines:** Geochronology, Tectonics/Tectonophysics, Structural Geology

**Advocates:** Scott Jess; Kendra Murray; Gilby Jepson; Alyssa Abbey

Thermochronology is applied widely to better understand a variety of fundamental earth-system processes. This session aims to highlight work applying these methods to improve our understanding of tectonism, magmatism, basin histories, and landscape evolution.

## GEOMORPHOLOGY

### T2. Quaternary Climate from the Great Plains to the Great Basin: Geomorphic and Sediment Records across “Great” Landscapes

**Endorsers:** GSA Geochronology Division; GSA Quaternary Geology and Geomorphology Division; GSA Limnogeology Division

**Disciplines:** Geomorphology, Geochronology, Environmental Geoscience

**Advocates:** Shannon Mahan; Sylvia Nicovich; Michelle S. Nelson; Joanna Redwine

This session focuses on regional records that enhance our understanding of Quaternary paleoclimate and landscape evolution. Presentations will showcase geochronology, mapping, or stratigraphic descriptions used across a wide swath of the interior and western basins of North America.

### T3. Advances in Fluvial Geomorphology

**Endorsers:** GSA Quaternary Geology and Geomorphology Division; GSA Geology and Society Division

**Disciplines:** Geomorphology, Quaternary Geology, Environmental Geoscience

**Advocates:** Joshua C. Galster; José Constantine

This session focuses on work in fluvial systems, including work on sediment transport, flooding, and watershed studies. Efforts to partner with local communities and include environmental justice issues are particularly encouraged.



### T4. Advances in the Science of Wildfire-Related Earth-Surface Processes

**Endorsers:** GSA Quaternary Geology and Geomorphology Division; GSA Environmental and Engineering Geology Division; GSA Geology and Society Division; GSA Soils and Soil Processes Division

**Disciplines:** Geomorphology, Soils, Environmental Geoscience

**Advocates:** James Guilinger; Natalie Collar; Luke McGuire; Ann Youberg; Francis Rengers

Wildfire is a catalyst for change in the Earth's critical zone and is increasing in its impact. This session encourages submissions of fundamental and applied research on fire impacts to hydrologic, geomorphic, and biophysical processes.

### T5. Between Big Ice: Paleoclimatic and Geomorphic Records of MIS 5-3

**Endorsers:** GSA Quaternary Geology and Geomorphology Division; Geochemical Society

**Disciplines:** Geomorphology, Quaternary Geology, Geochronology

**Advocates:** Carly Peltier; Alice Doughty; Tammy M. Rittenour; Glenn Thackray

Records from periods between end-member global ice volumes provide important baseline conditions and processes during the majority of the late Pleistocene. We encourage discussion of data and models incorporating a range of systems and archives.

### T6. From the Australian Highlands to Scottish Mills: Celebrating the Geomorphological Legacy of Paul Bishop

**Endorsers:** GSA Quaternary Geology and Geomorphology Division

**Disciplines:** Geomorphology, Quaternary Geology, Geoarchaeology

**Advocates:** Eric Portenga; Miguel Castillo; Réka Fülop

Paul Bishop left his footprints around the world in his decades-long career uncovering the influences of tectonics, rivers, ice, and humans on landscape evolution. This session commemorates Paul's influence in tectonics, geomorphology, and physical geography.

### T7. Landscape Evolution from an Alluvial Fan Perspective

**Endorser:** GSA Quaternary Geology and Geomorphology Division

**Disciplines:** Geomorphology, Quaternary Geology, Sediments, Clastic

**Advocates:** Andrew Cyr; Sylvia Nicovich

We seek submissions related to the effect of post-depositional processes on primary depositional sedimentary and surface

## INDUSTRY TRACKS

GSA's technical program offers sessions relevant to applied geoscientists.

Look for these icons, which identify sessions in the following areas:



Economic Geology



Energy



Engineering



Hydrogeology and Environmental Geology

characteristics, including the spatial and temporal scales over which such characteristics can be used to infer past landscape dynamics.

## T8. Non-Perennial Streams and the Fluvial System

**Endorsers:** *GSA Quaternary Geology and Geomorphology Division; GSA Soils and Soil Processes Division*

**Disciplines:** Geomorphology, Hydrogeology, Environmental Geoscience

**Advocates:** Julianne Scamardo; John Kemper; Kristin Jaeger; Daniel Cadol

We encourage submissions of all aspects of non-perennial stream research, including non-perennial stream dynamics and processes, the role of non-perennial streams in shaping landscapes, and the impacts of non-perennial streams on downstream waterbodies and communities.

## T9. Over the Hills and through the River: The Mechanisms of Change in Bedrock River Influenced/Controlled Landscapes

**Endorser:** *GSA Quaternary Geology and Geomorphology Division*

**Disciplines:** Geomorphology, Quaternary Geology

**Advocates:** Stephanie Shepherd; Brian Yanites

This session will highlight emerging work focused on the role of climate, lithology, tectonic, and sediment supply in controlling how bedrock rivers evolve over time.

## T10. Physical and Biological Processes, Interactions, and Restoration in River Systems

**Endorser:** *GSA Quaternary Geology and Geomorphology Division*

**Disciplines:** Geomorphology, Environmental Geoscience, Sediments, Clastic

**Advocates:** Sharon Bywater-Reyes; Alan Kasprak; Katherine Lininger; Anna E. Marshall

In this session, we welcome contributions that highlight or uncover the interactions among physical and/or biological processes in fluvial settings, both within and outside the active channel.

## T11. Soils and Geomorphology: In Memory of Pete Birkeland

**Endorsers:** *GSA Quaternary Geology and Geomorphology Division; GSA Soils and Soil Processes Division; GSA Geoarchaeology Division; GSA Geology and Society Division*

**Disciplines:** Geomorphology, Soils, Engineering Geology

**Advocates:** Marith Reheis; James McCalpin; Vance T. Holliday; Daniel R. Muhs; Scott Burns; Bradley Johnson; Janet L. Slate; Bradley D. Sion

The contributions of Pete Birkeland unify soils, geomorphology, and Quaternary stratigraphy, leading to better understanding of alpine glacial records, landscape change, surficial deposits, slope evolution, and applications to archaeology, geologic hazards, and critical zone studies.

## QUATERNARY GEOLOGY

### T12. Aeolian System Response to Environmental Change

**Endorsers:** *GSA Quaternary Geology and Geomorphology Division; GSA Soils and Soil Processes Division*

**Disciplines:** Quaternary Geology, Geomorphology, Sediments, Clastic

**Advocates:** Mark Sweeney; Jordan Bretzfelder; Nicholas Lancaster

This session will explore research focused on all aspects of the response of aeolian processes and landforms to natural and anthropogenic change.

## T13. The Legacy of Kenneth L. Pierce: Interdisciplinary Studies along the Track of the Yellowstone Hotspot and Beyond

**Endorsers:** *GSA Quaternary Geology and Geomorphology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Structural Geology and Tectonics Division; Geochemical Society; GSA Geochronology Division*

**Disciplines:** Quaternary Geology, Volcanology, Tectonics/Tectonophysics

**Advocates:** Lisa Morgan; Joseph Licciardi; Cathy Whitlock; Kenneth Cannon; Jennifer Pierce

This session honors Ken Pierce (1937–2021) and his distinguished work on the Yellowstone hotspot track integrating neotectonics, volcanology, mantle dynamics, glaciation, geomorphology, paleoecology/climatology, and archaeology in the Yellowstone Geosystem. We welcome submissions within these disciplines.

## T14. The Status of the Laurentide Ice Sheet during MIS-3

**Endorsers:** *GSA Quaternary Geology and Geomorphology Division; GSA Marine and Coastal Geoscience Division*

**Disciplines:** Quaternary Geology, Paleoclimatology/Paleoceanography, Marine/Coastal Science

**Advocates:** Gifford Miller; Michel Lamothe

The configuration and volume of the Laurentide Ice Sheet during MIS-3 remain debated, with strong implications for sea level and the status of the Antarctic Ice Sheet. We seek contributions that help resolve these uncertainties.

## SEDIMENTS, CARBONATES

### T15. Toward Unravelling the Dolomite Problem: New Approaches and Novel Perspectives

**Endorsers:** *Mineralogical Society of America; GSA Karst Division; SEPM (Society for Sedimentary Geology); GSA Geobiology and Geomicrobiology Division*

**Disciplines:** Sediments, Carbonates, Geochemistry, Geomicrobiology

**Advocates:** Bing Shen; Meng Ning; Ruimin Wang

This session provides a platform to communicate progress in dolomite studies with applications of diverse sedimentological, geochemical, numerical modeling, and experimental approaches and to share novel ideas toward understanding the dolomite problem.

## SEDIMENTS, CLASTIC

### T16. Deep-Time Critical Zone and Terrestrial Records of Paleozoic Climate Dynamics

**Endorsers:** *GSA Sedimentary Geology Division; GSA Limnogeology Division*

**Disciplines:** Sediments, Clastic, Limnogeology, Paleoclimatology/Paleoceanography

**Advocates:** Jonathan Knapp; Amy Weislogel

We encourage researchers using multidisciplinary approaches to investigating deep-time critical zones and terrestrial sedimentary systems from a broad range of records, in order to constrain the dynamics and feedbacks operating during Late Paleozoic climate transitions.

## SOILS

### T17. Emerging Voices in Soil and Paleosol Science

**Endorsers:** *GSA Soils and Soil Processes Division; GSA Quaternary Geology and Geomorphology Division; GSA Geology and Society Division; Geoscience Division of the Council on Undergraduate Research*

**Disciplines:** Soils, Geomorphology, Quaternary Geology

**Advocates:** Lauren A. Michel; Zsuzsanna Balogh-Brunstad; William E. Lukens

This session highlights undergraduate and graduate students' research related to soils or paleosols. We encourage submissions of any soil related topics including Critical Zone science, geochemistry, soil physics, mineral weathering and soil formation, and paleoclimatology.

### T18. Recent Advances in Soil and Paleosol Science

**Endorsers:** *GSA Soils and Soil Processes Division; Geochemical Society; Mineralogical Society of America*

**Disciplines:** Soils, Hydrogeology, Environmental Geoscience

**Advocates:** Zsuzsanna Balogh-Brunstad; Lauren A. Michel

This session encourages submissions from all scales of laboratory, field, and modeling studies that encompass a wide range of soil and paleosol research, such as Critical Zone studies, stable isotopes, biogeochemistry, micromorphology, and soil physics.

### T19. Soils and Paleosols across Space and Time: A Celebration of Steven G. Driese

**Endorsers:** *GSA Soils and Soil Processes Division; GSA Quaternary Geology and Geomorphology Division; GSA Geoarchaeology Division; GSA Sedimentary Geology Division; SEPM (Society for Sedimentary Geology)*

**Disciplines:** Soils, Sediments, Clastic, Paleoclimatology/ Paleoceanography

**Advocates:** William Lukens; Lauren Michel; Gary Stinchcomb; Emily Beverly

This session highlights the contributions of Steven G. Driese to (paleo)pedology, critical zone science, clastic sedimentology, paleoclimatology, micromorphology, geoarchaeology and geochemistry from across the geologic time scale. Photomicrographs are encouraged in all presentations.

## STRATIGRAPHY

### T20. Geology across Geographic Boundaries: Identifying Challenges and Opportunities Related to the Creation of a Digital Geologic Map of the United States by the End of This Decade

**Endorsers:** *Association of American State Geologists; GSA Geoinformatics and Data Science Division; GSA Quaternary Geology and Geomorphology Division; GSA Sedimentary Geology Division; GSA Structural Geology and Tectonics Division*

**Disciplines:** Stratigraphy, Quaternary Geology, Structural Geology

**Advocates:** Joseph Colgan; William Andrews Jr.; Samuel Johnstone; Barbara A. Lusardi

This session highlights the questions, implications, and outcomes encountered when blending or using multiple geologic maps. We encourage submissions on the practical and technical challenges, emerging methodologies, applications, and findings of geologic map syntheses.

### T21. Mountains, Rivers, and Lakes: Integrated Records of Paleogene Landscape Evolution, Western United States

**Endorsers:** *GSA Limnogeology Division; GSA Geochronology Division*

**Disciplines:** Stratigraphy, Limnogeology, Geochronology

**Advocates:** Michael Smith; Alan Carroll

This session focuses on new perspectives on tectonics, landscape evolution, paleoelevation, sediment dispersal, and paleoenvironmental change across the U.S. Intermountain West during the Cenozoic.

### T22. Sedimentary Geology Division/SEPM Student Research Poster Competition: Dynamics of Stratigraphy and Sedimentation (Posters)

**Endorsers:** *SEPM (Society for Sedimentary Geology); GSA Energy Geology Division*

**Disciplines:** Stratigraphy, Sediments, Clastic, Sediments, Carbonates

**Advocates:** Brian Hampton; Amy Weislogel

Students may present posters of original research on any topics within sedimentary geology: carbonates, clastics, chemical sediments, ancient and/or modern systems. Posters are judged for monetary awards distributed at the "Seds and Suds" reception.

### ⌚ T23. The Geological Evolution of Northern Alaska: A Session in Honor of Charles "Gil" Mull

**Endorsers:** *GSA Energy Geology Division; GSA Structural Geology and Tectonics Division; GSA Sedimentary Geology Division*

**Disciplines:** Stratigraphy, Tectonics/Tectonophysics, Energy Geology

**Advocates:** Justin V. Strauss; Dave Houseknecht; Marwan Wartes

Charles "Gil" Mull spent decades mapping the Brooks Range, while enthusiastically mentoring the next generation of geoscientists. In the spirit of Gil's passion for research, we encourage contributions that advance our understanding of northern Alaska.

### T24. Unconformities and Global Hypsometry: Integrating Constraints on Lateral and Vertical Continental Lithospheric Dynamics

**Endorser:** *GSA Geochronology Division*

**Disciplines:** Stratigraphy, Geophysics/Geodynamics, Geochronology

**Advocates:** Adrian Tasistro-Hart; Barra Peak

This session focuses on applications of diverse types of data such as sequence stratigraphy, geochronology, thermochronology, seismic tomography, and geodynamic modeling, to constrain lateral and vertical lithospheric motions through time and their implications for sea level and paleogeography.

## STRUCTURAL GEOLOGY

### T25. Best Student Geologic Mapping Competition (Posters)

**Endorsers:** Association of American State Geologists; U.S. Geological Survey; Geological Society of America; GSA Foundation; American Geosciences Institute; American Institute of Professional Geologists

**Disciplines:** Structural Geology, Stratigraphy, Geomorphology

**Advocate:** Michael Marketti

Students will present their research through geologic mapping projects that have a significant field component that addresses scientific or societal issues. The top three geologic maps will be awarded.

### T26. Deformation Zones in Time and Space: A Celebration of the Career of Steven Wojtal

**Endorser:** GSA Structural Geology and Tectonics Division

**Disciplines:** Structural Geology, Tectonics/Tectonophysics

**Advocates:** Basil Tikoff; Julie Newman

This session honors the research contributions of Steve Wojtal in structural geology. Contributions are encouraged on any aspect of rock deformation, including fold-and-thrust belt evolution, microstructures and rheology of high-strain zones, and three-dimensional fault arrays.

### T27. From Outcrops to the Base of the Crust: Integrated Geophysical and Geological Illumination of Earth's Tectonic Fabrics to Refine Understanding of Crustal Evolution and Natural Resources

**Endorsers:** GSA Structural Geology and Tectonics Division; GSA Geophysics and Geodynamics Division; U.S. Geological Survey

**Disciplines:** Structural Geology, Tectonics/Tectonophysics, Geophysics/Geodynamics

**Advocates:** Jonathan Caine; Michael Frothingham; Kevin Mahan; Vera Schulte-Pelkum

The revolution in digital data acquisition, access, and analyses allows new correlations from surface to depth. Integrated geologic and geophysical studies highlighting new ways to test hypotheses in crustal evolution, hazards, and Earth resources are welcomed.

### T28. Integrative Field Rheology for the Investigation of Tectonic Systems

**Endorsers:** GSA Structural Geology and Tectonics Division; GSA Geochronology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division

**Disciplines:** Structural Geology, Tectonics/Tectonophysics, Geochronology

**Advocates:** Nicolas Roberts; Alexander D. Lusk; Caroline Seyler; Nicole Aikin

This session focuses on field-based approaches for investigating lithospheric strength evolution in active (or formerly active) tectonic settings, with a special emphasis on the integration of multiple techniques.

### T29. Structural Analysis of Polyphase Deformation from Orogen to Thin Section: A Special Session in Honor of Sharon Mosher

**Endorsers:** GSA Structural Geology and Tectonics Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division

**Disciplines:** Structural Geology, Tectonics/Tectonophysics

**Advocates:** Miriam Barquero-Molina; Jamie Levine; John Singleton; Paul Betka

This session recognizes Sharon Mosher's esteemed career in structural geology and tectonics research. We seek presentations that highlight field-based research, understanding multiply deformed orogens, and using structural petrology to unravel complex tectonic questions.

## TECTONICS/TECTONOPHYSICS

### T30. Advances in Reconstructing Paleotopography

**Endorsers:** GSA Structural Geology and Tectonics Division; GSA Geochronology Division; GSA Geophysics and Geodynamics Division; GSA Quaternary Geology and Geomorphology Division; GSA Geobiology and Geomicrobiology Division

**Disciplines:** Tectonics/Tectonophysics, Paleoclimatology/ Paleoceanography, Geomorphology

**Advocates:** Kristina Butler; Kurt E. Sundell; Emma Heitmann

This session aims to highlight novel and interdisciplinary approaches to reconstructing earth-surface elevation histories. We are keen to feature regional compilations, new methodologies, and applied studies that are highly cross-disciplinary.

### T31. Basin Analysis, Strike-Slip Faults, and Tectonics: Honoring the Contributions of Paul Umhoefer

**Endorser:** GSA Structural Geology and Tectonics Division

**Disciplines:** Tectonics/Tectonophysics, Structural Geology, Stratigraphy

**Advocates:** Robert Miller; Margaret Rusmore; L. Sue Beard; Donna Whitney

We seek contributions on basin analysis, stratigraphy, structural geology, transport of microplates and terranes, and the tectonics of western North America and Anatolia to honor the distinguished career of Paul Umhoefer.

### T32. Cenozoic Tectonism, Magmatism, Sedimentation, and Landscape Evolution in the Intermountain West

**Endorsers:** GSA Sedimentary Geology Division; GSA Geochronology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Geophysics and Geodynamics Division; Geochemical Society; GSA Limnogeology Division; GSA Quaternary Geology and Geomorphology Division; GSA Continental Scientific Drilling Division

**Disciplines:** Tectonics/Tectonophysics, Structural Geology, Stratigraphy

**Advocates:** Theresa Schwartz; Amy K. Gilmer; Jens-Erik Lund Snee

We seek abstracts focused on the Cenozoic tectonic, magmatic, sedimentary, and landscape evolution of the Intermountain West. Studies using a broad range of methods to investigate events on any time scale are welcome.

### T33. CR Evolution 2.9: Evolution of the Colorado River System from the Rocky Mountains to the Gulf of California

**Endorser:** GSA Quaternary Geology and Geomorphology Division

**Disciplines:** Tectonics/Tectonophysics, Geomorphology, Quaternary Geology

**Advocates:** Karl Karlstrom; Ryan Crow; L. Sue Beard; Andres Aslan; Brian F. Gootee; Richard A. Young; Kyle House; Laura J. Crossey

Cenozoic history of the Colorado River and precursor rivers in the Rocky Mountains–Colorado Plateau–Gulf of California region has implications for geodynamics, geomorphology, thermochronology, and neotectonics of the western USA and other orogenic plateaus.

### T34. Crustal Deformation: How and When? Linking Long-Term Landscape Signatures with Earthquakes and Seismic Hazard

**Endorsers:** *GSA Quaternary Geology and Geomorphology Division; GSA Structural Geology and Tectonics Division; GSA Geology and Society Division*

**Disciplines:** Tectonics/Tectonophysics, Quaternary Geology, Geomorphology

**Advocates:** Jessica A. Jobe; Nadine Reitman; Charles Trexler; Paula Figueiredo

Landscapes record deformation from many earthquake cycles, but seismic hazard models require inputs that characterize short-term hazard. We seek abstracts focusing on longer-term geomorphic records to characterize deformation and/or link with short-term fault behavior.

### (\$) T35. Evaluation of Proterozoic Tectonic Styles in North America and Their Influence on Phanerozoic Structures and Mineralization

**Endorsers:** *GSA Structural Geology and Tectonics Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Geophysics and Geodynamics Division*

**Disciplines:** Tectonics/Tectonophysics, Precambrian Geology, Structural Geology

**Advocates:** Yvette Kuiper; Ruth F. Aronoff; Christopher G. Daniel; Graham B. Baird; Michael F. Doe; Eric D. Anderson

We welcome contributions that address tectonic styles in parts of or throughout the Proterozoic, and/or how these controlled the location of Phanerozoic structures and mineralization. We encourage discussion on changes in tectonic styles through time.

### (\$) T36. Future Directions in Tectonics and Lithospheric Processes: A Session for Early Career Researchers

**Endorsers:** *GSA Structural Geology and Tectonics Division; GSA Geochronology Division*

**Disciplines:** Tectonics/Tectonophysics, Geochronology, Structural Geology

**Advocates:** Trevor Waldien; Margo Odlum; Jaclyn Baughman; Kristina Butler

This session aims to enhance collaboration among early-career researchers by highlighting innovative and interdisciplinary work of students, postdocs, and pre-tenure faculty using the rock record to address questions in tectonics and lithospheric processes.

### (\$) T37. Influence of the Evolving Ouachita–Marathon Orogen on Late Paleozoic Tectonics and Sedimentation in Laurentia and Gondwana

**Endorsers:** *GSA Sedimentary Geology Division; GSA Structural Geology and Tectonics Division; GSA Geophysics and Geodynamics Division; GSA Geochronology Division*

**Disciplines:** Tectonics/Tectonophysics, Sediments, Clastic, Stratigraphy

**Advocates:** Xiangyang Xie; Timothy Lawton; Dennis Kerr

This session seeks contributions addressing late Paleozoic tectonics and sedimentation, especially evolution of sedimentary processes, in the vicinity of the Marathon–Ouachita orogenic belt. Perspectives from surrounding areas and adjoining continents, especially Gondwana, are welcome.

### T38. Late Paleozoic to Cenozoic of Mexico and Beyond: Stratigraphy, Magmatism, Geochronology, Tectonics, and Paleomagnetism: A Tribute to Roberto Stanley Molina-Garza

**Endorsers:** *GSA Structural Geology and Tectonics Division; GSA Geophysics and Geodynamics Division; Union Geofísica Mexicana (UGM); Geochemical Society; GSA Geochronology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division*

**Disciplines:** Tectonics/Tectonophysics, Geophysics/Geodynamics, Petrology, Igneous

**Advocates:** Alexander Iriondo; Timothy F. Lawton; John W. Geissman; Uwe C. Martens; José Rafael Barboza-Gudiño; María Isabel Sierra-Rojas

Roberto Stanley Molina-Garza was an interdisciplinary geoscientist at the forefront of North American tectonics. This session welcomes abstracts related to Roberto's research, which left an indelible mark on the understanding of tectonic reconstructions of Mexico

### T39. New Insights into the Evolution and Geodynamics of Metamorphic Core Complexes in North America and Around the World

**Endorsers:** *GSA Structural Geology and Tectonics Division; GSA Geophysics and Geodynamics Division; GSA Geochronology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division*

**Disciplines:** Tectonics/Tectonophysics, Structural Geology, Geochronology

**Advocates:** Andrew Zuza; Nikki Seymour; Gilby Jepson

## INDUSTRY TRACKS

GSA's technical program offers sessions relevant to applied geoscientists. Look for these icons, which identify sessions in the following areas:



Economic Geology



Energy



Engineering



Hydrogeology and Environmental Geology

Metamorphic core complexes (MCCs) develop in contractional and extensional settings globally. We aim to convene scientists working on different MCCs to compare their igneous, metamorphic, and structural evolutions; deformation characteristics; basinal histories; and driving mechanisms.

#### **T40. The Thermal Structure of Subduction Zones: Constraints, Evolution, and Consequences**

**Endorsers:** *GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Geophysics and Geodynamics Division*

**Disciplines:** Tectonics/Tectonophysics, Geophysics/Geodynamics, Petrology, Metamorphic

**Advocates:** Cailey Condit; Besim Dragovic; Victor Guevara; Adam F. Holt

The thermal structure of subduction zones influences slip behaviors, the location of metamorphic reactions, and arc volcanism. We welcome contributions from a wide range of geological and geophysical approaches studying the subduction zone thermal structure.

#### **T41. What's in a Slip Rate?**

**Endorsers:** *GSA Quaternary Geology and Geomorphology Division; GSA Structural Geology and Tectonics Division*

**Disciplines:** Tectonics/Tectonophysics, Geomorphology, Quaternary Geology

**Advocates:** Alexandra Hatem; Nadine Reitman; Richard W. Briggs; Jessica Ann A. Jobe; Christopher B. DuRoss; Harrison Gray; Reed Burgette

Geologic slip rates depend on dated offset features but may not faithfully record past fault behavior. This session seeks submissions on methods, caveats, and best practices to determine geologic slip rates and their uncertainties.

### **GEOPHYSICS/TECTONOPHYSICS**

#### **T42. Applications of Geophysics to Solve Near-Surface Geological Problems**

**Endorsers:** *GSA Geophysics and Geodynamics Division; GSA Quaternary Geology and Geomorphology Division; GSA Hydrogeology Division; GSA Environmental and Engineering Geology Division; GSA Geoarchaeology Division; GSA Karst Division; GSA Soils and Soil Processes Division*

**Disciplines:** Geophysics/Geodynamics, Environmental Geoscience, Engineering Geology

**Advocate:** Kevin Mickus

Abstracts are requested the use geophysical methods to investigate near-surface features in environmental, engineering, karst, hydrological, archaeological, and geological studies.

#### **T43. Archives and Observations of Glacial and Related Earth-System Processes from Sub-Ice Environments**

**Endorser:** *GSA Quaternary Geology and Geomorphology Division*

**Disciplines:** Geophysics/Geodynamics, Paleoclimatology/ Paleoceanography, Quaternary Geology

**Advocates:** Ryan Venturelli; Wilson Sauthoff; Marion McKenzie; Matthew Siegfried

This interdisciplinary session explores how modern observations and models of sub-ice systems can improve our interpretation of paleoclimate records and how inferences from paleoclimate

records can help contextualize the relevance and magnitude of glacial processes.

#### **T44. Critical Minerals and Framework Geology: The USGS Earth Mapping Resources Initiative (Earth MRI) and Related Activities**

**Endorsers:** *GSA Geophysics and Geodynamics Division; GSA Structural Geology and Tectonics Division; GSA Environmental and Engineering Geology Division; Association of American State Geologists; Society of Exploration Geophysicists; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Energy Geology Division*

**Disciplines:** Geophysics/Geodynamics, Tectonics/Tectonophysics, Engineering Geology

**Advocates:** Arthur Merschat; Anjana Shah; Benjamin Drenth; Jamey Jones III; Douglas Kreiner; Laurel G. Woodruff

Earth MRI is improving our knowledge of critical mineral resources and their geologic frameworks through new geologic mapping, airborne geophysics, geochemistry, and lidar acquisition. We welcome submissions of Earth MRI research and related studies.

#### **T45. Evolution of the Rio Grande Rift and River System**

**Endorsers:** *GSA Geophysics and Geodynamics Division; GSA Structural Geology and Tectonics Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Quaternary Geology and Geomorphology Division; GSA Sedimentary Geology Division; GSA Hydrogeology Division; New Mexico Geological Society; GSA Rocky Mountain Section; Geochemical Society; GSA Geochronology Division*

**Disciplines:** Geophysics/Geodynamics, Tectonics/Tectonophysics

**Advocates:** Dennis Harry; Jolante van Wijk; Brian A. Hampton; Jason Ricketts; Sean Gallen

We encourage presentations elucidating the interplay between deep Earth, tectonic, sedimentary, magmatic, and surficial processes that shaped the Rio Grande Rift and River system, and how these inform understanding continental rift and river systems globally.

#### **T46. Geologic Carbon Storage**

**Endorsers:** *GSA Geophysics and Geodynamics Division; GSA Geology and Society Division; GSA Continental Scientific Drilling Division; GSA Soils and Soil Processes Division; GSA Energy Geology Division*

**Disciplines:** Geophysics/Geodynamics, Environmental Geoscience

**Advocates:** Lianjie Huang; Ting Chen; Delphine Appriou; William Ampomah

Geologic carbon storage session solicits abstracts on site selection, geologic and geophysical site characterization, modeling and monitoring of CO<sub>2</sub> injection/migration, risk evaluation, and case studies of large-scale geologic carbon storage projects including carbon storage hubs.

#### **T47. GSA Geophysics and Geodynamics Division 50th Anniversary Special Session and George Woppard Lecture**

**Endorser:** *GSA Geophysics and Geodynamics Division*

**Disciplines:** Geophysics/Geodynamics, Tectonics/Tectonophysics

**Advocates:** Kevin Mickus; Ting Chen

The GSA Geophysics and Geodynamics Division is one of the oldest Divisions within GSA. We want to encourage past George Woppard Award winners to give presentations, with the last presentation being the current award winner.

#### T48. Impact Ejecta Processing and Transport Interdisciplinary Review

**Endorser:** GSA Geophysics and Geodynamics Division

**Disciplines:** Geophysics/Geodynamics, Geoinformatics, History and Philosophy of Geology

**Advocates:** Thomas Harris; Michael Davias

Familiar and unfamiliar concepts of planetary impact ejecta processing and transport are up for discussion and review in an interdisciplinary format, covering fieldwork, lab results, numeric and analytic treatments, etc.

#### ⌚ T49. Lubricating Rifting: The Roles of Fluids, Faults, and Evolving Fault Strength

**Endorsers:** GSA Geophysics and Geodynamics Division;

GSA Structural Geology and Tectonics Division

**Disciplines:** Geophysics/Geodynamics, Tectonics/Tectonophysics, Volcanology

**Advocates:** Cynthia Ebinger; Michele Cooke; Laurent Montesi; Craig MaGee

This session explores the influence of aqueous and magmatic fluids and volatiles on fault initiation and linkage in rifts and back-arc basins and considers the relative importance of fluid interactions on strength evolution.

#### ⌚ 💧 T50. Using Geophysics to Aid in Mineral, Energy, or Groundwater Investigations

**Endorsers:** GSA Geophysics and Geodynamics Division; GSA Energy Geology Division; GSA Hydrogeology Division; Society of Economic Geologists; GSA Karst Division

**Disciplines:** Geophysics/Geodynamics, Economic Geology, Energy Geology

**Advocate:** Kevin Mickus

Abstracts are requested that use geophysics to explore and investigate mineral, petroleum, geothermal, coal, and groundwater resources.

### ECONOMIC GEOLOGY

#### ⌚ T51. Assessing Critical Mineral and Rare Earth Element Potential from Unconventional Resources in the United States

**Endorsers:** Society of Economic Geologists; Mineralogical Society of America; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Energy Geology Division

**Disciplines:** Economic Geology, Engineering Geology, Environmental Geoscience

**Advocates:** Bridget Scanlon; Tristan Childress; Charles Nye

This session is designed to provide information on critical minerals (CMs) and rare earth elements (REEs) from unconventional sources, including sources such as coal and coal byproducts, sand, clay, seawater, produced water, and industrial waste.

#### ⌚ T52. Convergent Margin Magmatism and Ore Deposits to Honor the Range of Contributions by John H. Dilles

**Endorsers:** Society of Economic Geologists; Mineralogical Society of America; Geochemical Society; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division

**Disciplines:** Economic Geology, Petrology, Igneous, Structural Geology

**Advocates:** Richard Tosdal; Thomas Monecke

Ore deposits associated with magmatism are responsible for much of the metal supply to economies. This session seeks contributions across the geosciences on the magmatic, hydrothermal, and structural evolution of deposits at convergent margins.

#### ⌚ ⚡ T53. Mathematics, Statistics, and Machine Learning in the Geosciences. How Can We Solve Today's Challenges through Data Mining and Artificial Intelligence?

**Endorsers:** Society of Economic Geologists; Society for Geology Applied to Mineral Deposits

**Disciplines:** Economic Geology, Energy Geology, Geophysics/Geodynamics

**Advocates:** Katharina Pfaff; Eric D. Anderson

This session aims to bring together geoscientists from a wide variety of fields for a series of presentations focused on artificial intelligence in the geosciences and data integration of heterogeneous data from across scales.

#### ⌚ ⚙️ 💧 T54. Metal Recovery and Remediation at Hard Rock Legacy Mine Sites

**Endorsers:** Society of Economic Geologists; GSA Environmental and Engineering Geology Division; Association of American State Geologists; GSA Geology and Society Division; Geochemical Society

**Disciplines:** Economic Geology, Engineering Geology, Geoscience and Public Policy

**Advocates:** Thomas Cramford; Tanya J. Gallegos

This session will focus on the prioritization and selection of legacy mine sites for work, metal recovery and remediation technologies, and regulatory issues and societal concerns.

#### ⌚ T55. Metals in Hydrothermal Systems: From Source to Sink

**Endorsers:** Society of Economic Geologists; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division

**Disciplines:** Economic Geology, Geochemistry

**Advocate:** Thomas Monecke

Hydrothermal deposits are an important source of metals for modern society, including many elements required for the green energy transition. This session examines hydrothermal metal transport from source to sink in diverse geological environments.

### PRECAMBRIAN GEOLOGY

#### ⌚ T56. PC<sup>2</sup> = PreCambrian Colorado: Perspectives on the Growth and Metallogeny of the North American Craton in the Western USA

**Endorsers:** Colorado Scientific Society; Denver Regional Exploration Geologists' Society; Escalante Resources Group; MagmaChem Research Institute; GSA Geochronology Division

**Disciplines:** Precambrian Geology, Economic Geology, Petrology, Metamorphic

**Advocates:** Lewis Kleinhans; Lisa Fisher; Libby Prueher

This session is a contribution to the knowledge base of Precambrian Colorado and its relationship to correlative rocks of the western USA, with a focus on paleotectonic environments, protoliths, economic geology, metallogeny, geochronology, petrology, and more.

## ENERGY GEOLOGY

### ⌚ T57. Energy: Environmental Legacies and Futures

**Endorsers:** GSA Geology and Society Division; GSA Energy Geology Division

**Disciplines:** Energy Geology, Environmental Geoscience, Geology and Health

**Advocates:** Zhen Wang; Rachel Coyte; Nathaniel Warner

This session welcomes scientific and/or policy presentations (online or in person) on the environmental and human health impacts, both legacy and incipient, caused by the exploration, development, and utilization of conventional and emerging energy resources.

### ⌚ T58. Exploration of Helium in Sedimentary Basins: The New “Gold” Rush?

**Endorsers:** Geochemical Society; GSA Energy Geology Division

**Disciplines:** Energy Geology

**Advocates:** Daniele Pinti; Oliver Warr; Barbara Sherwood Lollar

This session addresses the mechanisms controlling the migration and accumulation of helium in sedimentary basins at exploitable concentrations, through a multidisciplinary approach involving all working parties, from noble gas specialists to petroleum geologists.

## ENGINEERING GEOLOGY

### ⌚ T59. A Bird’s Eye View: Remote Sensing Applications for Geohazards

**Endorsers:** GSA Environmental and Engineering Geology Division; GSA Quaternary Geology and Geomorphology Division; GSA Geology and Society Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division

**Disciplines:** Engineering Geology, Geomorphology, Environmental Geoscience

**Advocates:** Corey Scheip; Karl W. Wegmann

This session is aimed at novel uses of remote sensing technologies to investigate geohazards, including, but not limited to, floods, landslides, volcanic eruptions, earthquakes, and atmospheric disturbance events.

### ⌚ T60. Case Studies and Professional Projects—A Day in the Life of Practicing Geologists

**Endorsers:** GSA Geophysics and Geodynamics Division; GSA Karst Division; GSA Hydrogeology Division; GSA Energy Geology Division; GSA Quaternary Geology and Geomorphology Division; GSA Environmental and Engineering Geology Division; Society of Economic Geologists; GSA Karst Division; GSA Geology and Society Division; GSA Geobiology and Geomicrobiology Division; GSA Geobiology and Geomicrobiology Division; GSA

Geochronology Division; GSA Continental Scientific Drilling Division; GSA Marine and Coastal Geoscience Division

**Disciplines:** Engineering Geology, Economic Geology, Environmental Geoscience

**Advocates:** Douglas Gouzie; Kevin Mickus

We seek case studies or projects from practicing professionals: resources to environment to engineering to health. This session will also let students see a variety of employment opportunities and typical projects in those fields.

### ⌚ T61. GSA Environmental and Engineering Geology Division Student Research Competition (Posters)

**Endorsers:** GSA Environmental and Engineering Geology Division; GSA Geology and Society Division; Geoscience Division of the Council on Undergraduate Research

**Disciplines:** Engineering Geology, Energy Geology

**Advocates:** Thomas Oommen; Arpita Nandi; Francis Rengers

We encourage graduate and undergraduate students to submit poster presentations on topics related to applied research in environmental and engineering geology. Monetary awards will be given to the top presenters at the Division awards ceremony.

### ⌚ T62. GSA Environmental and Engineering Geology Division

**Endorsers:** GSA Environmental and Engineering Geology Division; GSA Geology and Society Division

**Disciplines:** Engineering Geology, Environmental Geoscience, Energy Geology

**Advocates:** Thomas Oommen; Arpita Nandi; Francis Rengers

This session for the GSA Environmental and Engineering Geology Division provides an opportunity for the geosciences community to present their research, data, and work pertaining to environmental and engineering geology.

### ⌚ T63. Reassessing Natural Hazard Risk in a Changing World (Posters)

**Endorsers:** GSA Environmental and Engineering Geology Division; GSA Geology and Society Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division

**Disciplines:** Engineering Geology, Environmental Geoscience, Geoscience and Public Policy

**Advocate:** Barbara EchoHawk

Are current methods for assessing natural hazard risk sufficient and appropriate to inform decision makers, citizens, and other stakeholders of the likely impacts of hazardous events? Past history and recent events provide perspective.

### ⌚ T64. Understanding Landslides Role in Hillslope and Landscape Evolution

**Endorsers:** GSA Environmental and Engineering Geology Division; GSA Environmental and Engineering Geology Division—Landslide Committee; GSA Quaternary Geology and Geomorphology Division; Association of Environmental & Engineering Geologists; GSA Geology and Society Division; GSA Soils and Soil Processes Division

**Disciplines:** Engineering Geology, Geomorphology, Quaternary Geology

**Advocates:** William Burns; Matthew Crawford; Anne Witt; Stephen L. Slaughter

This session will highlight innovative landslide research as related to hillslope and landscape evolution.

## ENVIRONMENTAL GEOSCIENCE

### T65. Integrated Drought Science and Technology

**Endorsers:** *GSA Environmental and Engineering Geology Division; GSA Soils and Soil Processes Division; GSA Geoinformatics and Data Science Division; GSA Geoscience Education Division; GSA Hydrogeology Division; U.S. Geological Survey Utah Water Science Center; U.S. Geological Survey Nevada Water Science Center; U.S. Geological Survey Rocky Mountain Regional Office; GSA Geology and Society Division; GSA Limnogeology Division; GSA Soils and Soil Processes Division*

**Disciplines:** Environmental Geoscience, Hydrogeology, Geoinformatics

**Advocates:** Rebecca Frus; Katharine Dahm; Anne Tillary; Daniel Jones; Patrick Anderson; William Andrews; Eric D. Anderson

This session focuses on data collection of aquatic and terrestrial systems, analysis of patterns and impacts of drought, developing and applying predictive models, and delivering information and decision-making tools to anticipate, assess, and mitigate drought conditions.

### T66. Intersections of Sustainability and Geosciences

**Endorsers:** *GSA Geology and Society Division; GSA Quaternary Geology and Geomorphology Division; GSA Soils and Soil Processes Division; GSA Energy Geology Division*

**Disciplines:** Environmental Geoscience, Geoscience Education, Geoscience and Public Policy

**Advocates:** Leslie North; Robert Brinkmann

The session seeks to highlight works that combine the fields of sustainability and geoscience to examine or educate about environmental and/or societal problems. Topics such as water management, pollution, and climate change will be explored.

### T67. Microplastics

**Endorsers:** *SEPM (Society for Sedimentary Geology); GSA Limnogeology Division; GSA Soils and Soil Processes Division; GSA Marine and Coastal Geoscience Division*

**Disciplines:** Environmental Geoscience, Hydrogeology, Hydrogeology

**Advocate:** Stephanie DeVries

Microplastic pollutants have become ubiquitous to terrestrial and aquatic ecosystems. This session highlights recent advances in methods of collecting, detecting, or quantifying microplastics and their movement through aquatic and terrestrial environments.

### T68. Sigma Gamma Epsilon Student Research Exhibition (Posters)

**Endorsers:** *Sigma Gamma Epsilon; GSA Quaternary Geology and Geomorphology Division; GSA Limnogeology Division; GSA Soils and Soil Processes Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Marine and Coastal Geoscience Division*

**Disciplines:** Environmental Geoscience, Geomorphology, Structural Geology

**Advocates:** Diane Burns; James C. Walters

All Sigma Gamma Epsilon student members are encouraged to submit their research to this poster session to showcase results as well as compete for awards. ALL geological investigations, from archaeological geology to volcanology, are welcome.

### T69. Three M's of Microplastics: Methods, Measurements, and Milestones

**Endorsers:** *GSA Geology and Society Division; SEPM (Society for Sedimentary Geology); GSA Limnogeology Division*

**Disciplines:** Environmental Geoscience, Geochemistry, Hydrogeology

**Advocates:** Stephanie DeVries; Jordan Mader

Microplastic pollutants have become ubiquitous to terrestrial and aquatic ecosystems. This session highlights recent studies that focus on collection, detection, quantification, transport, and health impacts of microplastics in these environments.

### T70. Urban Geochemistry

**Endorsers:** *International Association of GeoChemistry; GSA Geology and Society Division; GSA Soils and Soil Processes Division*

**Disciplines:** Environmental Geoscience, Geochemistry, Geology and Health

**Advocates:** W. Berry Lyons; David Long

This session encourages presentations that qualify and quantify the geochemical and biogeochemical impacts (temporal and spatial) of urbanization and urban activities on soil, water, and air resources as well as on human and ecosystem health.

## GEOLOGY AND HEALTH

### T71. Challenges to Tribal Water Resources and the Health of Indigenous Communities in North America

**Endorsers:** *GSA Geology and Health Division; GSA Energy Geology Division; GSA Hydrology Division; GSA Quaternary Geology and Geomorphology Division; GSA Geology and Society Division; GSA Environmental and Engineering Geology Division; GSA Soils and Soil Processes Division; GSA Limnogeology Division*

## INDUSTRY TRACKS

GSA's technical program offers sessions relevant to applied geoscientists. Look for these icons, which identify sessions in the following areas:



Economic Geology



Energy



Engineering



Hydrogeology and Environmental Geology

**Disciplines:** Geology and Health, Environmental Geoscience, Geoscience and Public Policy

**Advocates:** Margaret Redsteer; Malcolm Siegel; Abhishek RoyChowdhury

Environmental health in Indigenous communities is linked to the availability and quality of water resources. We encourage studies on the effects of urbanization, mining, industry, agriculture, and climate change on water quality in tribal communities.

### **T72. Natural Contamination, Natural Hazards, Health Risk, and Public Policy: Success Stories and Models for Managing, Communicating, and Updating Policy to Address Health Risks of Natural Contamination and Hazards**

**Endorsers:** GSA Geology and Health Division; Geochemical Society; GSA Geology and Society Division; GSA Soils and Soil Processes Division

**Discipline:** Geology and Health

**Advocates:** Amy J. Keyworth; Evan O. Kane; Caroline Loop

This session will consider how managing the public health risks from natural hazards and contaminants are addressed differently than manmade contaminants. Available resources, policy, and educating the public are all handled differently. Share your successes.

## **GEOARCHAEOLOGY**

### **T73. Geoarchaeological Insights into the Peopling of the Americas**

**Endorsers:** GSA Geoarchaeology Division; GSA Quaternary Geology and Geomorphology Division; GSA Geochronology Division; GSA Soils and Soil Processes Division

**Disciplines:** Geoarchaeology, Soils, Quaternary Geology

**Advocates:** Laura R. Murphy; Brendan Fenerty

This session features recent applications of concepts and methods from the earth sciences to interpret or re-interpret the terminal Pleistocene–early Holocene (PaleoIndian) archaeological record of the Americas and neighboring regions.

### **T74. Geoarchaeology at the Micro-Scale: New Applications of Microanalytical Techniques**

**Endorsers:** GSA Geoarchaeology Division; GSA Quaternary Geology and Geomorphology Division; Geochemical Society; GSA Soils and Soil Processes Division

**Disciplines:** Geoarchaeology, Soils, Stratigraphy

**Advocates:** Justin A. Holcomb; Devlin Gandy; Michael Aiualasit

This session will serve as a forum for researchers to present novel applications in geoarchaeology at the micro-scale. We welcome researchers employing any microscopic analytical methods, regardless of the temporal or geographic focus.

## **GEOCHEMISTRY**

### **T75. Advances in Non-Traditional Stable Isotope Measurements and Utility as Proxies in Modern and Paleo-Settings**

**Endorsers:** GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Geobiology and Geomicrobiology Division; GSA Quaternary Geology and Geomorphology Division; Geochemical Society; GSA Soils and Soil Processes Division

**Disciplines:** Geochemistry, Paleoclimatology/Paleoceanography, Geomicrobiology

**Advocates:** Jiuyuan Wang; Yi Wang; Jordan Wostbrock

Non-traditional stable isotopes greatly advance our understanding of geological processes. In this session, we welcome contributions that cover analytical methodology, proxy development, and application of non-traditional stable isotope systems.

### **T76. Bridging Geochemistry and Geobiology with Advanced Water Purification, Desalination, and Water Reuse**

**Endorsers:** GSA Hydrogeology Division; GSA Environmental and Engineering Geology Division; GSA Geology and Society Division; GSA Geobiology and Geomicrobiology Division; Geochemical Society; GSA Energy Geology Division

**Disciplines:** Geochemistry, Geomicrobiology, Hydrogeology

**Advocates:** Harshad Kulkarni; Drew Johnson; Keisuke Ikehata; Mohammad Alauddin; Saugata Datta

This session will enhance our understanding of geochemical and geobiological processes involved in the treatment (advanced purification and desalination) of relatively untapped water resources, such as ocean water, wastewater, and brackish and saline groundwater.

### **T77. Characteristics, Reactivity, and the Role of Natural Organic Matter (NOM) in Mobilizing Trace Elements of Health Concern in the Environment**

**Endorsers:** GSA Geology and Health Division; GSA Geobiology and Geomicrobiology Division; GSA Hydrogeology Division; GSA Geology and Society Division; Geochemical Society; GSA Soils and Soil Processes Division

**Disciplines:** Geochemistry, Hydrogeology, Geomicrobiology

**Advocates:** Harshad Kulkarni; Thomas Varner; Natalia Malina; Ann Ojeda; Mohammad Alauddin; Karen Johannesson; Saugata Datta

This session will enhance our understanding of the characteristics, reactivity, and role of natural organic matter (NOM) in cycling of elements of human health concern in the environment.

### **T78. Environmental Geochemistry and Health**

**Endorsers:** GSA Geology and Health Division; GSA Geology and Society Division; GSA Hydrogeology Division; GSA Environmental and Engineering Geology Division; GSA Karst Division; GSA Soils and Soil Processes Division

**Disciplines:** Geochemistry, Environmental Geoscience, Geology and Health

**Advocates:** Jean Morrison; Ann Ojeda; Sarah Hayes

We encourage presentations on the environmental fate of contaminants and their impact on human and environmental health. Transdisciplinary contributions examining the rock-soil-water-human nexus at all scales having strong public outreach or societal impact are welcome.

### **T79. GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division Awards Session**

**Endorsers:** GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; Mineralogical Society of America

**Disciplines:** Geochemistry, Volcanology, Petrology, Metamorphic

**Advocates:** Dennis L. Newell; Amanda B. Clarke

The GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division honors its 2022 student research, Distinguished Geological Career (DGCA), and Early Geological Career (EGCA) awardees. The 2020 DGCA and EGCA will also be honored in this session.

### **T81. Radiogenic Isotopes as Tracers of Geologic Processes: Dates, Rates, and Proxies**

**Endorsers:** *GSA Geochronology Division; GSA Quaternary Geology and Geomorphology Division; GSA Sedimentary Geology Division; GSA Geobiology and Geomicrobiology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Geophysics and Geodynamics Division; Geochemical Society*

**Disciplines:** Geochemistry, Geochronology, Paleoclimatology/Paleoceanography

**Advocates:** Alexie Millikin; Jennifer Kasbohm; Timothy Gibson; Alan Rooney

This session aims to bring together diverse applications of radiogenic isotope geochemistry (geochemical tracers, geochronology, thermochronology) as proxies for tectonic, climatic, and biotic processes and constraining the timing and rates of earth-system changes.

### **T82. The Geology and Environmental Impacts of Lithium Resources in North America**

**Endorsers:** *GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; Society of Economic Geologists; Mineralogical Society of America; GSA Geology and Society Division; GSA Limnogeology Division; Geochemical Society; GSA Environmental and Engineering Geology Division; GSA Energy Geology Division*

**Disciplines:** Geochemistry, Economic Geology, Hydrogeology

**Advocates:** Thomas Benson; Lisa Stillings

This session will focus on the geology, mineralogy, hydrogeology, and origin of different types of lithium resources in North America and the potential environmental impacts of extracting this energy-critical element.

### **T83. The Role of Halogens in Crustal Processes**

**Endorsers:** *GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; Geochemical Society*

**Disciplines:** Geochemistry, Petrology, Metamorphic, Economic Geology

**Advocates:** Johannes Hammerli; Dave Jenkins

Halogens play key roles in magmatic and metamorphic processes, such as mass transfer and crustal anatexis. This session focuses on new research including analytical advances to better understand the importance of halogens for crustal processes.

### **T84. Using Iron Oxides for Quantitative Reconstruction of Thermal Histories, Paleoenvironments, Hydrothermal Alteration, Planetary Evolution, and Fault Zone Processes**

**Endorsers:** *GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Geochronology Division; GSA Structural Geology and Tectonics Division; GSA Planetary Geology Division*

**Disciplines:** Geochemistry, Geochronology, Environmental Geoscience

**Advocates:** Peter E. Martin; Florian Hofmann; Jordan Leo Jensen

We seek presentations that apply or develop modern analytical techniques to iron oxides to study their formation conditions and/or thermal history and apply these data to understand a range of environments and processes.

## **VOLCANOLOGY**

### **T85. Lava Flows and Their Hazards: A Session Inspired by Hannah Dietterich's Early Career Award from the Mineralogy, Geochemistry, Petrology, and Volcanology Division**

**Endorsers:** *GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Geology and Society Division*

**Discipline:** Volcanology

**Advocates:** Mark E. Stelten; Katharine Cashman; Einat Lev; Thomas (Tom) Sisson

Recent lava eruptions, imaged by drones and studied with petrologic, computational, and analog approaches, enable quantitative lava-hazard assessments. We seek presentations on lava emplacement, broadly, in recognition of Hannah Dietterich's MGPV Division early career award.

### **T86. The Virtue of Fieldwork in Volcanology, Sedimentology, Structural Geology, and Tectonics: A Session to Honor Cathy Busby, MGPV Distinguished Geological Career Award Recipient of 2020**

**Endorsers:** *GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; SEPM (Society for Sedimentary Geology)*

**Disciplines:** Volcanology, Tectonics/Tectonophysics, Stratigraphy

**Advocates:** Keith Putirka; Nancy Riggs; John Wakabayashi

This session honors the career of Cathy Busby, whose diverse field studies have impacted volcanology, sedimentology, structural geology, and tectonics. Studies within or at the boundaries of these disciplines are welcome.

## **PETROLOGY, IGNEOUS**

### **T87. Source to Surface Magma Thermodynamics and Transport: Interdisciplinary Approaches to Documenting the How, Where, and When of Magma Generation and Evolution during Ascent, Storage, and Eruption**

**Endorsers:** *GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Geophysics and Geodynamics*

*Division; GSA Planetary Geology Division; Geochemical Society*

**Disciplines:** Petrology, Igneous, Geochemistry, Volcanology

**Advocates:** Wendy A. Bohrson; Valerie Strasser; Monika Distefano; Paula Antoshechkin; Frank J. Spera

This session will focus on research that integrates field, computational, experimental, and analytical approaches to document source to surface transport dynamics and thermodynamics of magmas on Earth and other planetary bodies.

## **MINERALOGY/CRYSTALLOGRAPHY**

### **T88. Charting Soils at the Atomic Scale: A Tribute to the Careers of David L. Bish and Jeffrey E. Post**

**Endorsers:** *Mineralogical Society of America; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; Clay Minerals Society; GSA Soils and Soil Processes Division*

**Disciplines:** Mineralogy/Crystallography, Environmental Geoscience, Soils

**Advocates:** Peter Heaney; Sasha Wilson

Dave Bish and Jeff Post have inspired a generation of environmental scientists to harness X-ray diffraction to illuminate clay structures. This session welcomes contributions in the broad areas of soil and nanoparticle crystallography and geochemistry.

### T89. Early Career Investigators in Mineralogy and Crystallography

**Endorsers:** *GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; Mineralogical Society of America*

**Disciplines:** Mineralogy/Crystallography, Petrology, Igneous, Petrology, Metamorphic

**Advocates:** Tyler Spano; Si Chen

This session provides a platform for early-career, student, and postdoctoral mineralogists and crystallographers to share their research and provide fresh perspectives, new ideas, and creative answers to mineralogical problems.

### (\$) T90. Gemological Research in the Twenty-First Century—Gem Minerals and Localities

**Endorsers:** *Geochemical Society; Mineralogical Society of America*

**Disciplines:** Mineralogy/Crystallography, Economic Geology, Geoscience Information/Communication

**Advocates:** James Shigley; Wuyi Wang; Barbara Dutrow; John W. Valley; Caroline Nelms

Gemstones are among the most recognized of all minerals. This session focuses on diverse aspects of gems, including exploration, deposits and their formation, identification, as well as mineral inclusions in gems and their geological implications.

### T91. Volatile Cycles from Earth's Surface to the Core: In Honor of 2020 Mineralogical Society of America Medalist Jin Liu

**Endorsers:** *Mineralogical Society of America; High Pressure Science & Technology Advanced Research (HPSTAR); GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; Geochemical Society*

**Disciplines:** Mineralogy/Crystallography

**Advocate:** Hokwang Mao

Recent advances in mineral physics have revealed a number of unexpected transitions and phenomena, such as super-oxidation and super-ionization in volatile-bearing minerals that lead to paradigm change in our understanding of volatile cycles.

## PLANETARY GEOLOGY

### T92. Best Practices and Exciting Discoveries in Identifying, Mapping, and Analyzing Planetary Landforms and Terrestrial Analogues

**Endorsers:** *GSA Planetary Geology Division; GSA Quaternary Geology and Geomorphology Division*

**Disciplines:** Planetary Geology, Geomorphology, Geoinformatics

**Advocates:** Kelsey Crane; Jon Rich

We welcome abstracts that investigate the methodology of planetary and terrestrial landform analysis or that explore these

methodologies as a means of achieving insight into the evolution of those landforms.

### T93. Friends of Hoth, Episode VI: Return of the Small, Icy, and Ocean Worlds

**Endorsers:** *GSA Planetary Geology Division; GSA Quaternary Geology and Geomorphology Division*

**Discipline:** Planetary Geology

**Advocates:** Erin Leonard; D. Alex Patthoff; Emily S. Martin

We seek abstracts relating to surface, structural, and tectonic processes; interior, and thermal evolution; and planetary analogs as they pertain to icy satellites in the outer solar system. This includes experimental, observational, and theoretical approaches.

### T94. Geomorphology and Landscape Evolution of Mars

**Endorsers:** *GSA Planetary Geology Division; GSA Quaternary Geology and Geomorphology Division; SEPM (Society for Sedimentary Geology); GSA Karst Division; GSA Limnogeology Division*

**Disciplines:** Planetary Geology, Geomorphology, Hydrogeology

**Advocates:** Elena Favaro; Matthew Chojnacki

This session focuses on aeolian, fluvial, glacial, lacustrine, and crater degradation processes to investigate the geomorphology and landscape evolution of Mars. We welcome research using martian orbital and rover data, as well as terrestrial analogues.

### T95. Impact Cratering in Space and Time

**Endorsers:** *GSA Planetary Geology Division; GSA Structural Geology and Tectonics Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Continental Scientific Drilling Division; GSA Geophysics and Geodynamics Division*

**Disciplines:** Planetary Geology, Continental Scientific Drilling, Structural Geology

**Advocates:** Jeffrey Plescia; Christian Koeberl

Impact cratering is probably the primary geologic process for solid bodies throughout the solar system. This session focuses on the geologic, geochemical, and geophysical signatures of impacts, the impact flux, and implications for geologic evolution.

### T96. Martian Dark Streaks—Wet or Dry?

**Endorsers:** *GSA Planetary Geology Division; GSA Quaternary Geology and Geomorphology Division*

**Disciplines:** Planetary Geology, Geomorphology, Geophysics/Geodynamics

**Advocates:** David Stillman; Amitushkin; Katie Primm

This session explores observations and formation mechanisms of non-polar martian dark streaks (Recurring Slope Lineae, slope streaks, or similar). We welcome research utilizing orbital and rover data, as well as terrestrial analogues or laboratory experiments.

### T97. Planetary Exploration and Education: How We Learn about Our Solar System and Beyond

**Endorsers:** *GSA Planetary Geology Division; GSA Geoscience Education Division; GSA Geology and Society Division; National Association of Geoscience Teachers (NAGT)*

**Disciplines:** Planetary Geology, Geoscience Education

**Advocates:** Nicholas Patrick Lang; Robert Jacobsen

This session links how we teach and learn about the solar system to how we have gained that information (i.e., space missions). Descriptions of outreach efforts to bring planetary science to the public are encouraged.

**T98. Planetary Geology Division's G.K. Gilbert Session**

**Endorser:** *GSA Planetary Geology Division*

**Discipline:** Planetary Geology

**Advocates:** Nicholas Patrick Lang; Marisa Palucis; Jennifer Piatek; Samuel Birch

This session honors the Planetary Geology Division's winner of the G.K. Gilbert Award for this year.

**T99. The Interplay of Volcanism, Tectonism, and Impacts across the Solar System**

**Endorsers:** *GSA Planetary Geology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Structural Geology and Tectonics Division*

**Disciplines:** Planetary Geology, Volcanology, Tectonics/Tectonophysics

**Advocates:** Mallory Kinczyk; Kelsey Crane

We solicit contributions that compare volcanic, tectonic, and impact landforms and processes on Solar System bodies, including how specific studies can help understand the complex interplay between these phenomena across the Solar System in general.

**T100. Tiny Worlds with Big Potential: Exploring Small Bodies throughout the Solar System**

**Endorser:** *GSA Planetary Geology Division*

**Disciplines:** Planetary Geology, Geomorphology, Geophysics/Geodynamics

**Advocates:** Kynan Hughson; Jennifer Scully; David A. Williams; Debra Buczkowski

We welcome abstracts regarding the geological, geophysical, geochemical, and/or geotechnical analysis of small worlds through the use of spacecraft data, telescopic observations, modeling studies, laboratory studies, astromaterial studies, resource utilization studies, and/or future exploration.

**T101. Venus: Second Rock from the Sun**

**Endorsers:** *GSA Planetary Geology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division*

**Disciplines:** Planetary Geology, Structural Geology, Volcanology

**Advocates:** Debra Buczkowski; Nicholas Patrick Lang

This session solicits abstracts on the volcanism, tectonism, impact cratering, and geologic mapping of Venus. It encompasses surface geology, interior evolution, and comparative planetary studies with observational, experimental, or theoretical approaches.

**PALEOClimATOLOGY/PALEOCEANOGRAPHY****(\$) (P) T102. Comings and Goings of Proterozoic Global Glaciations**

**Endorsers:** *Geochemical Society; GSA Geobiology and Geomicrobiology Division; Paleontological Society*

**Disciplines:** Paleoclimatology/Paleoceanography, Paleontology, Diversity, Extinction, Origination, Geochemistry

**Advocates:** Bing Shen; Maoyan Zhu; Xianguo Lang

This session focuses on global glaciations and geology-geobiology in the Proterozoic.

**(P) (W) T103. Cushman Foundation Symposium: Latest Advances on Foraminiferal Research: From Paleo-Sea-Level Reconstructions and Paleoecological Interpretations to Applications to Environmental Science. A Tribute to the Extraordinary Lives of John Haynes, John Murray, and David Scott**

**Endorsers:** *GSA Marine and Coastal Geoscience Division; Geochemical Society; Paleontological Research Institution; Paleontological Society*

**Disciplines:** Paleoclimatology/Paleoceanography, Paleontology, Biogeography/Biostratigraphy, Environmental Geoscience

**Advocates:** Lizette Leon-Rodriguez; Kenneth G. Miller; Scott Ishman; Benjamin P. Horton

The Cushman Foundation for Foraminiferal Research Symposium will showcase recent advances and applications of foraminifera to the understanding of sea-level fluctuations, ecological reconstructions, and environmental science.

**T104. Do Carbon Sources or Sinks Drive the Phanerozoic Carbon Cycle?: Understanding Geobiologic Forcings and Feedbacks**

**Endorser:** *GSA Geobiology and Geomicrobiology Division*

**Disciplines:** Paleoclimatology/Paleoceanography, Geochemistry, Tectonics/Tectonophysics

**Advocates:** Jeremy Rubenstein; Kimberly Lau; Daniel Ibarra; Matthew Winnick

Recent research has focused on new carbon cycle processes and underappreciated feedbacks between the solid Earth, climate, and biology; new approaches are necessary to integrate these findings into understanding the geologic carbon cycle and climate.

**T105. Dynamics of Earth's Climate System and Biogeochemical Cycles in Deep Time**

**Endorsers:** *SEPM (Society for Sedimentary Geology); GSA Limnogeology Division*

**Disciplines:** Paleoclimatology/Paleoceanography, Geochemistry, Stratigraphy

**INDUSTRY TRACKS**

GSA's technical program offers sessions relevant to applied geoscientists.

Look for these icons, which identify sessions in the following areas:



Economic Geology



Energy



Engineering



Hydrogeology and Environmental Geology

**Advocates:** Ying Cui; Shuang Zhang; Gerilyn (Lynn) S. Soreghan

This session will feature new research on the dynamics of Earth's past climate and biogeochemical cycles using the sedimentary record, emphasizing work that integrates sedimentological and geochemical datasets and modeling.

### **T106. Insights from Microfossils and Their Modern Analogs: From Traditional and Emerging Approaches to Critical Re-Evaluations**

**Endorsers:** Cushman Foundation; Paleontological Society; Geochemical Society; Paleontological Research Institution; GSA Marine and Coastal Geoscience Division; SEPM (Society for Sedimentary Geology); GSA Limnogeology Division

**Disciplines:** Paleoclimatology/Paleoceanography, Geochemistry, Paleontology, Biogeography/Biostratigraphy

**Advocates:** Robert Poirier; Chiara Borelli

Assemblage- and proxy-based (i.e., geochemical) records derived from microfossils comprise two foundational pillars of paleoclimate research. We seek studies applying traditional and novel microfossil-based reconstructions, including those seeking to revisit old assumptions that may bias paleo-reconstructions.

### **T107. New Perspectives for Reconstructing Past Arctic Environments: Climate, Ecosystems, and Depositional Systems**

**Endorsers:** GSA Quaternary Geology and Geomorphology Division; GSA Soils and Soil Processes Division

**Disciplines:** Paleoclimatology/Paleoceanography, Paleontology, Paleoecology/Taphonomy, Sediments, Clastic

**Advocates:** Paul McCarthy; Anthony R. Fiorillo

This session will provide new perspectives for interdisciplinary, multi-proxy research addressing all aspects of climate, ecosystems, and depositional systems in past Arctic environments across the spectrum of geologic time.

### **T108. Oceans and Climates through Earth History: From Proxy Reconstructions to Model Assessments (Posters)**

**Endorsers:** Cushman Foundation; Paleontological Society; Geochemical Society; Paleontological Research Institution; GSA Marine and Coastal Geoscience Division; SEPM (Society for Sedimentary Geology)

**Disciplines:** Paleoclimatology/Paleoceanography, Geochemistry, Paleontology, Paleoecology/Taphonomy

**Advocates:** Megan Fung; Miriam E. Katz

This session brings together modelling, proxy, and proxy development studies to improve our understanding of rapid ocean and climate events, and shifts between long-term climate/ocean states, within the context of normal variability throughout earth history.

### **T109. The Last Glacial–Interglacial Transition in Western North America: Paleoclimate Proxies, Environmental Responses, and Data-Model Comparisons**

**Endorsers:** GSA Quaternary Geology and Geomorphology Division; GSA Limnogeology Division

**Disciplines:** Paleoclimatology/Paleoceanography, Quaternary Geology, Geochronology

**Advocates:** Sarah Crump; Joseph Licciardi; Alia J. Lesnek; Darren J. Larsen

This session brings together paleoenvironmental studies from the Last Deglaciation (ca. 18–12 ka) in western North America, including paleoclimate and paleoecology records, glacier chronologies, paleolake reconstructions, and model simulations, with an emphasis on abrupt climate changes.

## **PALEONTOLOGY**

### **T110. Cambrian–Ordovician Faunas and Events: A Session in Honor of John F. Taylor and John E. Repetski**

**Endorser:** Paleontological Society

**Disciplines:** Paleontology, Biogeography/Biostratigraphy, Sediments, Carbonates, Stratigraphy

**Advocates:** Paul Myrow; Justin V. Strauss

To honor John Taylor's and John Repetski's careers, we seek contributions that cover emerging concepts related to the evolution of fauna, biostratigraphy, and changes in environments, oceans, atmosphere, and paleogeography during the Cambrian and Ordovician.

### **T111. Cephalopods Present and Past: Evolution, Paleoecology, and Links to Paleoenvironmental Change**

**Endorsers:** Paleontological Research Institution; Paleontological Society

**Disciplines:** Paleontology, Diversity, Extinction, Origination, Paleontology, Paleoecology/Taphonomy, Paleontology, Biogeography/Biostratigraphy

**Advocates:** Jone Naujokaityte; Shannon Brophy; Amane Tajika

This session will feature the latest research on fossil and modern cephalopods, including cephalopod paleobiology, evolution, and the use of cephalopods in paleoenvironmental reconstruction.

### **T112. Halo-Dash: The Deep and Shallow History of Aquatic Life's Passages between Marine and Freshwater Habitats**

**Endorsers:** GSA Limnogeology Division; Paleontological Society

**Disciplines:** Paleontology, Diversity, Extinction, Origination, Paleontology, Paleoecology/Taphonomy, Paleontology, Phylogenetic/Morphological Patterns

**Advocates:** Lisa Park Boush; Christine Hall; Eric Schultz; Anthony Shillito

This session will examine the historical pathways and conditions for taxa transitioning between marine and freshwater, catalyzing new interdisciplinary research directions on biotic exchanges between saline and fresh habitats and how they profoundly shaped life.

### **T113. Modeling Ecological Niches and Species Distributions in the Fossil Record: Approaches and Applications**

**Endorsers:** Paleontological Society; GSA Geobiology and Geomicrobiology Division

**Disciplines:** Paleontology, Diversity, Extinction, Origination, Paleontology, Paleoecology/Taphonomy, Paleontology, Biogeography/Biostratigraphy

**Advocates:** Ceara Purcell; Rhiannon Nolan

This session will feature the latest research on the application of ecological niche modeling and other quantitative ecological methods to test spatiotemporal hypotheses of Earth-life interactions

and their relationship to macroevolutionary, macroecological, and biogeographic change.

### **T114. No Mistakes, Only Happy Accidents: Cutting-Edge Research That is Still in the Troubleshooting Stages**

**Disciplines:** Paleontology, Diversity, Extinction, Origination, Paleontology, Paleoecology/Taphonomy, Paleoclimatology/Paleoceanography

**Advocates:** Amanda Godbold; Jeanette Pirlo; Jood Al Aswad

As scientists, we are always pushing the boundaries of our understanding. However, success does not come overnight. The goal of this session is to discuss cutting-edge research that is still in the troubleshooting stages.

### **T115. Punctuated Equilibrium: 50 Years Later**

**Endorsers:** Paleontological Society; Paleontological Research Institution; GSA History and Philosophy of Geology Division

**Disciplines:** Paleontology, Diversity, Extinction, Origination, Paleontology, Phylogenetic/Morphological Patterns, Paleontology, Biogeography/Biostratigraphy

**Advocates:** Donald Prothero; Linda Ivany; Patricia H. Kelley; Bruce S. Lieberman; Margaret Yacobucci

For the fiftieth anniversary of the original “punctuated equilibrium” paper by Niles Eldredge and Stephen Jay Gould, this session will discuss the influence of one of the most cited ideas in the history of paleontology.

### **T116. Stratigraphic Paleobiology: Working with the Nature of the Stratigraphic Record to Address Paleobiological Questions**

**Endorsers:** Paleontological Society; GSA Geobiology and Geomicrobiology Division; SEPM (Society for Sedimentary Geology)

**Disciplines:** Paleontology, Diversity, Extinction, Origination, Paleontology, Phylogenetic/Morphological Patterns, Stratigraphy

**Advocates:** Annaka Clement; Pedro Monarrez

This session will highlight recent research that addresses paleobiological questions within the context of the stratigraphic record. Approaches include, but are not limited to, the application of sequence stratigraphy, phylogenetics, sediment-basin modeling, and geochemistry.

### **T117. Conservation Paleobiology: Lessons from the Past, Guidance for the Future**

**Endorsers:** Paleontological Society; GSA Geology and Society Division

**Disciplines:** Paleontology, Paleoecology/Taphonomy, Paleontology, Diversity, Extinction, Origination

**Advocates:** Erin M. Dillon; Paul G. Harnik; Nussaibah Raja schoob

This session will focus on how near- and deep-time fossil records are used in contextualizing and mitigating the biotic impacts of anthropogenic change.

### **T118. Ecosystem Engineering through Earth History**

**Endorsers:** Paleontological Society; GSA Geobiology and Geomicrobiology Division; Society of Vertebrate Paleontology; Association for Women Geoscientists

**Disciplines:** Paleontology, Paleoecology/Taphonomy, Paleontology, Diversity, Extinction, Origination, Geochemistry

**Advocates:** Matthew Caffey; Alison Cribb; Reilly Hayes; Benjamin Muddiman; Sandra Schachat; Katherine Turk

This session will showcase research across fields within the geosciences—including paleobiology, geochemistry, and geobiology—to facilitate further understanding of the role of ecosystem engineers on macroevolutionary and macroecological processes throughout earth history.

### **T119. Laws of the Grave: Advances in Taphonomy across the Paleontologic Record**

**Endorsers:** Paleontological Society; GSA Geobiology and Geomicrobiology Division

**Disciplines:** Paleontology, Paleoecology/Taphonomy, Stratigraphy, Quaternary Geology

**Advocates:** Broc Kokesh; Rachel Laker

This session emphasizes the interdisciplinary and ubiquitous nature of taphonomy for analysis of the fossil record. We welcome submissions focused on understanding taphonomic processes or its impacts across any paleontologic subdiscipline, taxon, or geologic era.

### **T121. Terrestrial Ecosystem Disturbance through Geologic Time**

**Endorsers:** Paleontological Society; American Quaternary Association; The Palynological Society; SEPM (Society for Sedimentary Geology)

**Disciplines:** Paleontology, Paleoecology/Taphonomy

**Advocates:** Christopher Schiller; Allison T. Karp

From fire to floods to volcanism, disturbance has shaped terrestrial ecosystems through geologic time. We seek speakers exploring the role of ecological disturbance from the Quaternary back through the Phanerozoic and into the future.

### **T122. Exploring the Mechanisms of Morphologic Change**

**Endorsers:** Paleontological Society; Paleontological Research Institution; GSA Geobiology and Geomicrobiology Division

**Disciplines:** Paleontology, Phylogenetic/Morphological Patterns, Paleontology, Paleoecology/Taphonomy, Paleontology, Biogeography/Biostratigraphy

**Advocates:** James Lamsdell; Sarah Sheffield; Jennifer E. Bauer; Adriane R. Lam

Paleontological studies provide unique perspectives in understanding what drives morphologic change. This session focuses on the mechanisms that drive, facilitate, or limit morphologic change. Topics include ecological transitions, developmental shifts, and alterations in evolutionary rate.

### **T123. Integrative Perspectives on Morphological Change: Shaping Our Understanding of the Fossil Record**

**Endorsers:** GSA Geobiology and Geomicrobiology Division; Paleontological Society; Society of Vertebrate Paleontology; Association for Women Geoscientists; Paleontological Research Institution

**Disciplines:** Paleontology, Phylogenetic/Morphological Patterns, Paleontology, Diversity, Extinction, Origination, Paleontology, Biogeography/Biostratigraphy

**Advocates:** Katherine Turk; Shamindri Tennakoon; Carmi Milagros Thompson; Josh Zimmt

This session will bring together researchers from across taxonomic groups and geologic time periods to answer questions of morphology in novel and cross-disciplinary ways.

#### **T124. Phylogenetic Approaches in Paleobiology and Paleoecology**

**Endorsers:** Paleontological Society; Paleontological Research Institution; GSA Geobiology and Geomicrobiology Division; GSA Geoinformatics and Data Science Division

**Disciplines:** Paleontology, Phylogenetic/Morphological Patterns, Paleontology, Diversity, Extinction, Origination, Paleontology, Paleoecology/Taphonomy

**Advocates:** William Gearty; Katherine Jordan

This session highlights recent advances integrating phylogenetics with fossil data to address evolutionary and ecological questions through deep time. Topics include, but are not limited to, macroevolutionary trends, diversification dynamics, trait evolution, macroecology, and paleobiogeography.

### **GEOMICROBIOLOGY**

#### **T125. New Advances in Geobiology**

**Endorsers:** Paleontological Society; GSA Soils and Soil Processes Division

**Disciplines:** Geomicrobiology, Paleontology, Diversity, Extinction, Origination, Geochemistry

**Advocates:** Trinity Hamilton; Victoria A. Petryshyn; David Gold; Lydia Schiavo Tackett; Rowan Martindale; Zoe Havlena; Alison Cribb; Lucy Webb

This session will focus on new research at the intersection between geologic and biologic processes with special emphasis on novel materials and methods, new field sites, and advances at the intersections of scientific fields.

#### **T126. New Voices in Geobiology**

**Endorsers:** GSA Geobiology and Geomicrobiology Division; GSA Limnogeology Division; Paleontological Society; GSA Soils and Soil Processes Division

**Disciplines:** Geomicrobiology, Paleontology, Biogeography/Biostratigraphy, Paleontology, Paleoecology/Taphonomy

**Advocates:** Trinity Hamilton; Victoria A. Petryshyn; David Gold; Lydia Schiavo Tackett; Rowan Martindale; Zoe Havlena; Lucy Webb; Alison Cribb

This session will bring together new research focusing on the interplay between geologic and biologic processes with a special emphasis on work by early-career scientists exploring new questions and hypotheses.

### **HYDROGEOLOGY**

#### **T127. A Showcase of Undergraduate Research in Hydrogeology (Posters)**

**Endorsers:** GSA Hydrogeology Division; Geoscience Division of the Council on Undergraduate Research

**Discipline:** Hydrogeology

**Advocates:** Jordan Caylor; Miguel Valencia; Jobel Y. Villafane-Pagan; Laura K. Rademacher; Tyler V. King

This session is designed for undergraduates presenting research and senior theses in the field of hydrogeology. Prizes will be

awarded for top presentations. Employers and graduate advisers are encouraged to attend.

#### **T128. Advances in Simulating Groundwater Flow and Transport**

**Disciplines:** Hydrogeology, Environmental Geoscience, Geoscience and Public Policy

**Advocates:** James Berglund; Madeline Gotkowitz; Andrew T. Leaf

This session explores applications of numerical models to geologically complex and hydrologically dynamic systems. Techniques used to simulate groundwater–surface water interactions, effects of pumping or agricultural processes, recharge mechanisms, and climate cycles are of interest.

#### **T129. Arsenic, Fluoride, and Other Geogenic Contaminants in Groundwater Systems: Advances in Data Science for Monitoring Long-Term Risks and Mitigation**

**Endorsers:** GSA Hydrogeology Division; GSA Geology and Health Division; GSA Geology and Society Division; GSA International; International Society of Groundwater for Sustainable Development (ISGSD); International Medical Geology Association (IMGA); International Water Association (IWA) Specialist Group Metals and Related Substances in Drinking Water (METRELS); Geochemical Society; GSA Environmental and Engineering Geology Division; GSA Geoinformatics and Data Science Division

**Disciplines:** Hydrogeology, Geology and Health, Geoinformatics

**Advocates:** Prosun Bhattacharya; Abhijit Mukherjee; Arslan Ahmad; Julian Ijumulana; Joseline Tapia; Saugata Datta; Kazi Matin Ahmed; Ines Tomašek; Jyoti Prakash Maity

The growing trend of data aggregation in recent years enables us to consolidate our understanding through machine learning on the water quality perspectives in groundwater basins for direct consumption and/or treatment for groundwater supplies.

#### **T130. Coastal and Marine Hydrogeology in an Age of Rising Seas: From the Shore to the Oceanic Ridge**

**Endorsers:** GSA Hydrogeology Division; American Geophysical Union; Consortium of Universities for the Advancement of Hydrologic Science, Inc; International Association of Hydrogeologists; Soil Science Society of America: Soil Physics and Hydrology Division; GSA Environmental and Engineering Geology Division; GSA Geobiology and Geomicrobiology Division; GSA Geoinformatics and Data Science Division; GSA Marine and Coastal Geoscience Division; National Ground Water Association; GSA Geophysics and Geodynamics Division; GSA Geology and Society Division; GSA Karst Division; GSA Quaternary Geology and Geomorphology Division; GSA Soils and Soil Processes Division

**Disciplines:** Hydrogeology, Marine/Coastal Science, Engineering Geology

**Advocates:** Michael Sukop; Christopher Russoniello; Martina Rogers; Shellie Habel; Kevin M. Befus

As sea levels rise, hydrogeology is crucial in coastal areas. Seawater intrusion can lead to loss of potable or agricultural water supplies. Water-table rise from sea-level rise can increase flooding and affect infrastructure.

### ⌚ T131. Coastal Aquifers: Investigations of Submarine and Coastal Groundwater Discharge

**Endorsers:** GSA Karst Division; GSA Marine and Coastal Geoscience Division

**Disciplines:** Hydrogeology, Marine/Coastal Science, Environmental Geoscience

**Advocates:** Lorenzo Deprado; Rene Price

This session focuses on recent advances in the transport of water and constituents and biogeochemical reactions related to coastal groundwater discharge and submarine groundwater discharge. All types of research are encouraged, including field, laboratory, modeling, remote sensing, machine learning.

### ⌚ T132. Groundwater for the Present and Future in the Mississippi Embayment Aquifer System, South-Central United States

**Endorsers:** GSA Hydrogeology Division; GSA Geology and Society Division; GSA Sedimentary Geology Division; GSA Quaternary Geology and Geomorphology Division; GSA Geophysics and Geodynamics Division

**Disciplines:** Hydrogeology, Geochemistry, Sediments, Clastic

**Advocates:** Dan Larsen; Katherine Knierim; Burke Minsley

This session will highlight recent studies of the combined Mississippi River Valley alluvial and Mississippi embayment aquifer system, water resources, and structural and stratigraphic aspects of this groundwater basin.

### ⌚ T133. Groundwater Security Toward Sustainable Development

**Endorsers:** GSA Hydrogeology Division; GSA International; GSA Geology and Society Division; GSA Environmental and Engineering Geology Division; GSA Geoinformatics and Data Science Division; GSA Geology and Health Division; International Association of Hydrogeologists; International Society of Groundwater for Sustainable Development; GSA Karst Division

**Disciplines:** Hydrogeology, Environmental Geoscience, Geoscience and Public Policy

**Advocates:** Abhijit Mukherjee; Alice Aureli; Prosun Bhattacharya; David Kreamer; Alan MacDonald; Roger Sathre

This session seeks topical interdisciplinary studies that bridges groundwater quantification and pollution to solutions and sustainability, from science to policy, from technology to clean water and food, through pathways of transforming groundwater knowledge to policy and governance

### ⌚ 💧 T134. Human Impacts on the Hydrologic Cycle

**Endorsers:** GSA Hydrogeology Division; GSA Geology and Society Division; GSA Limnogeology Division; GSA Soils and Soil Processes Division

**Disciplines:** Hydrogeology, Geoinformatics, Geoscience and Public Policy

**Advocates:** Misty E. Porter; Andrea E. Brookfield; Jessica Ayers

Anthropogenic activities impact the hydrologic cycle, affecting water quality and quantity. Effective management requires science-informed decisions.

### ⌚ T135. Making Groundwater Knowledge Accessible through Visual and Experiential Learning

**Endorsers:** GSA Hydrogeology Division; GSA Geology and Society Division; GSA Geoscience Education Division; The Groundwater Project; GroundwaterU; Integrated GroundWater Modeling Center; Department of Geology, Earth, Energy, and Environment Center, University of Kansas; GSA Energy Geology Division

**Disciplines:** Hydrogeology, Geoscience Education, Geoscience Information/Communication

**Advocates:** Eileen Poeter; Ineke Kalwij

This session presents innovative methods and tools that facilitate spatial/temporal thinking for developing a deeper understanding of groundwater science, which is essential for practitioners to solve local- and global-scale groundwater problems.

### T136. Uranium Fate and Transport in the Environment

**Endorsers:** GSA Hydrogeology Division; GSA Geology and Health Division; GSA Environmental and Engineering Geology Division; GSA Geology and Society Division; Geochemical Society; GSA Energy Geology Division

**Disciplines:** Hydrogeology, Geology and Health, Geochemistry

**Advocates:** Raymond Johnson; Charles Paradis; Johanna Blake; Martin Dangelmayr

Due to the complexities of uranium geochemistry and its importance as a contaminant, this session aims at bringing together researchers from multiple disciplines in better understanding uranium fate and transport mechanisms in the environment.

### T137. Using 3D Geological Models to Explore Geologic Processes, Assess Natural Resources and Hazards, and Meet Societal Needs

**Endorsers:** GSA Quaternary Geology and Geomorphology Division; GSA Geophysics and Geodynamics Division

**Disciplines:** Hydrogeology, Engineering Geology, Economic Geology

**Advocates:** Brad T. Gooch; Donald Sweetkind; Ryan Gall; Laila Sturgis

3D geological models are used to explore geologic processes, assess natural resources and hazards, and meet societal needs. Abstracts should relate to 3D geologic model development and usage, including public communication of published models.

### INDUSTRY TRACKS

GSA's technical program offers sessions relevant to applied geoscientists.

Look for these icons, which identify sessions in the following areas:



Economic Geology



Energy



Engineering



Hydrogeology and Environmental Geology

## KARST

### T138. Karst Ecosystems and Biogeochemistry

**Endorsers:** GSA Karst Division; GSA Environmental and Engineering Geology Division; GSA Geobiology and Geomicrobiology Division; GSA Hydrogeology Division; National Cave and Karst Research Institute; Karst Waters Institute; Geochemical Society; GSA Soils and Soil Processes Division

**Disciplines:** Karst, Geomicrobiology, Geochemistry

**Advocates:** Daniel Jones; Patricia N. Kambesis

This session seeks abstracts that deal with the study of cave and karst ecosystems, including the identification, quantification, and/or discussion of biota, flora, microbial, and related biogeochemical processes or environments in or near karst features.

### T139. Karst Hazards and Monitoring

**Endorsers:** GSA Karst Division; GSA Environmental and Engineering Geology Division; GSA Geophysics and Geodynamics Division; National Cave and Karst Research Institute; Karst Waters Institute; GSA Geology and Society Division

**Disciplines:** Karst, Engineering Geology

**Advocates:** Daniel Jones; Patricia N. Kambesis

Hazards (e.g., sinkholes, pollution, radon, development) and monitoring approaches (e.g., GIS applications, historical data analyses) in karst landscapes, including technical applications (e.g., LiDAR, 3D scanning, geodatabase development) and management implications (resource management, education, policy, regulation).

### T140. Karst Hydrology and Hydrogeology

**Endorsers:** GSA Karst Division; GSA Environmental and Engineering Geology Division; GSA Geophysics and Geodynamics Division; National Cave and Karst Research Institute; Karst Waters Institute

**Disciplines:** Karst, Hydrogeology

**Advocates:** Lewis Land; Natasha Sekhon; Daniel Jones

This session covers fundamental aspects of fluid-rock interactions within karst landscapes, including geologic, hydrogeologic, and hydrologic investigations. Appropriate topics range from dye tracing and aquifer processes to surface-subsurface hydrologic interactions and quantitative modeling.

### T141. Karst Processes and Speleology

**Endorsers:** GSA Karst Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Quaternary Geology and Geomorphology Division; National Cave and Karst Research Institute; Karst Waters Institute; Geochemical Society

**Disciplines:** Karst, Geomorphology, Geochemistry

**Advocates:** Daniel Jones; Patricia N. Kambesis

This session covers the myriad of cave and karst forming processes, geomorphic evolution of karst landscapes, and cave system development. Includes carbonate weathering, diagenesis, hypogene processes, carbonate mineralogy, structural controls, and pseudokarst processes and features.

### T142. Karst Sedimentary, Paleoclimate, and Historical Records

**Endorsers:** GSA Karst Division; GSA Geochronology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Quaternary Geology and Geomorphology Division;

GSA Sedimentary Geology Division; National Cave and Karst Research Institute; Karst Waters Institute; Geochemical Society

**Disciplines:** Karst, Paleoclimatology/Paleoceanography, Geoarchaeology

**Advocates:** Natasha Sekhon; Daniel Jones

This session seeks contributions on cave deposits (sediments, speleothems, tufa, etc.), karst environmental records (sedimentary, carbonate stratigraphy, etc.), and geoarchaeological and historical investigations to interpret past climates, landscapes, extreme events, and land-use histories, and to model or predict future changes.

### T143. New Frontiers in Cave and Karst Research: In Honor of the International Year of Caves and Karst

**Endorsers:** GSA Karst Division; GSA Geochronology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Quaternary Geology and Geomorphology Division; GSA Hydrogeology Division; GSA Environmental and Engineering Geology Division; GSA Geophysics and Geodynamics Division; GSA Geobiology and Geomicrobiology Division; GSA Sedimentary Geology Division; National Cave and Karst Research Institute; Karst Waters Institute; Geochemical Society

**Disciplines:** Karst, Hydrogeology, Environmental Geoscience

**Advocates:** Daniel Jones; Lewis Land; Patricia N. Kambesis; Rachel Bosch; Louise Hose; Natasha Sekhon; Sarah Arpin; Jason S. Polk

We encourage submissions in any field of cave and karst science, with special emphasis on novel techniques, interdisciplinary approaches, and contributions from diverse early-career researchers (students, postdocs, and faculty).

## LIMNOGEOLogy

### T144. Lakes Past, Present, and Future—Archives of Climate Variability, Paleoenvironment, Geohazards, and Economic Resources

**Endorsers:** GSA Limnogeology Division; GSA Geobiology and Geomicrobiology Division; GSA Marine and Coastal Geoscience Division; GSA Sedimentary Geology Division; GSA Geochronology Division; GSA Quaternary Geology and Geomorphology Division; AMQUA; SEPM (Society for Sedimentary Geology); GSA Geology and Society Division; GSA Continental Scientific Drilling Division

**Disciplines:** Limnogeology, Stratigraphy, Paleoclimatology/Paleoceanography

**Advocates:** Scott W. Starratt; Jason R. Price

Lakes contain important historical records because their sediments are archives of climate change, local human impact, tectonic and volcanic activity, coastal processes, and ecological succession. This session explores terrestrial and extraterrestrial lacustrine research.

## MARINE/COASTAL SCIENCE

### T145. Advances and New Voices in Marine and Coastal Geoscience

**Endorsers:** GSA Marine and Coastal Geoscience Division; GSA Limnogeology Division

**Disciplines:** Marine/Coastal Science, Paleoclimatology/

Paleoceanography, Sediments, Carbonates

**Advocates:** Patricia Standring; Andrea D. Hawkes; Lauren Toth; Katherine Luciano; Stephen Phillips; Deirdre D. Ryan

We encourage abstracts on oceanography, marine geology, geomorphology, sediment transport, geophysics, tectonics, glaciology, climate, marine paleobiology, or other marine- and coastal-themed research. We especially want to inspire students and early-career scientists to submit.

### T146. Inundation Signatures on Rocky Coastlines

**Endorsers:** GSA Marine and Coastal Geoscience Division; GSA Quaternary Geology and Geomorphology Division; ISROC (Inundation Signatures on Rocky Coastlines) Research Coordination Network; GSA Geology and Society Division; GSA Limnogeology Division

**Disciplines:** Marine/Coastal Science, Environmental Geoscience, Geoscience and Public Policy

**Advocates:** Rónadh Cox; Robert Weiss

Understanding extreme coastal wave inundation is fundamental for long-term risk analysis. We welcome presentations related to all aspects of hard-coast inundation, including field and modeling studies, and those at the intersection with engineering and policy.

## GEOSCIENCE AND PUBLIC POLICY

### T147. From Field to Repository: Addressing Theoretical and Practical Issues in Paleontological Collecting and Collections

**Endorsers:** Paleontological Society; Paleontological Research Institution; Cushman Foundation; GSA Geology and Society Division

**Disciplines:** Geoscience and Public Policy, Paleontology, Biogeography/Biostratigraphy, Paleontology, Paleoecology/Taphonomy

**Advocates:** Sandra J. Carlson; Lee Cone; Jessica D. Cundiff; Talia S. Karim; Joshua Lively; Donald Mikulic; Stephanie Plaza-Torres; Carmi Milagros Thompson

This session focuses on successes and outstanding issues associated with fossil collections and collecting on private, federal, and tribal lands by professionals and amateur paleontologists; preserving physical and digital fossil data post-collection; and consistent, effective stewardship of fossils and repositories.

### T148. Geoscience and Hydrology of Your Federal and Other Public Lands: STEM Internships, Research, Science, Mapping, Resource Management, and Education

**Endorsers:** National Park Service; USDA Forest Service; Bureau of Land Management; GSA Quaternary Geology and Geomorphology Division; GSA Geology and Society Division; GSA Hydrogeology Division; GSA Energy Geology Division; GSA Geophysics and Geodynamics Division

**Discipline:** Geoscience and Public Policy

**Advocates:** Chelsea Bitting; Brent H. Breithaupt; Matthew Dawson; F. Edwin Harvey; Jason Kenworthy; Lesley Petrie; Limaris Soto

This is an interdisciplinary forum for earth scientists, land managers, Geoscientists-in-the-Parks, Scientists in Parks, and GeoCorps

America participants, sponsors, and educators to present work and describe its relevance to the public and land managers.

### T149. Geoscience and the Sustainable Development Goals: Contributions from Students and Early Career Professionals

**Endorsers:** GSA Geology and Society Division; GSA Geoscience Education Division; GSA Environmental and Engineering Geology Division; European Geosciences Union; Humanitarian Engineering Program, Colorado School of Mines; Department of Geology and Environmental Science, Wheaton College; Department of Geology, San Jose State University; Department of Earth, Environmental and Resource Sciences, University of Texas at El Paso; The International Association for Promoting Geoethics; The Global Network for Geoscience and Society; Geology in the Public Interest; Geology for Global Development; GSA Soils and Soil Processes Division

**Disciplines:** Geoscience and Public Policy, Geoscience Education, Environmental Geoscience

**Advocates:** Gregory Wessel; Ellen P. Metzger; Vincent S. Cronin

This session inspires students at all levels and early career professionals to present ongoing or recently completed work addressing one or more of the UN's sustainable development goals by applying geoscience for the public good.

### T150. Is This the Way the World Ends? Policy, Preparedness, and Adaptation to a Rapidly Changing Earth

**Endorser:** GSA Geology and Society Division

**Disciplines:** Geoscience and Public Policy, Environmental Geoscience, Geoscience Information/Communication

**Advocates:** James Heller; Lily Jackson; David Spears

This interdisciplinary session invites presentations that examine potentially calamitous outcomes resulting from environmental and resource issues of outsized (global and regional) magnitude. Presenters are invited to conjecture possible societal outcomes, plausible solutions, and mitigation strategies.

### T151. The American Geosciences Institute at 75: Implementing a Vision of Sustainability as a Unifying Geoscience Framework

**Endorsers:** GSA Geology and Society Division; GSA Geoscience Education Division; American Association of Petroleum Geologists; American Institute of Professional Geologists; Association of American State Geologists; Mineralogical Society of America; Society of Exploration Geophysicists; Society of Economic Geologists; Geological Association of Canada; Society for Sedimentary Geology; Society for Mining, Metallurgy, and Exploration; GSA Energy Geology Division

**Disciplines:** Geoscience and Public Policy, Geoscience Information/Communication, Geoscience Education

**Advocates:** Jonathan Arthur; Paul Weimer; Jonathan Price; David Wunsch

The rationale behind the inception of AGI 75 years ago remains relevant today as the geosciences face unprecedented transition in scope and imperative. Looking forward at our science and profession, sustainability provides a unifying framework.

## GEOSCIENCE EDUCATION

### T152. Bringing Inquiry into Geoscience Labs for Students, Teaching Assistants, and Faculty

**Endorsers:** National Association of Geoscience Teachers (NAGT); National Association of Geoscience Teachers (NAGT) Geo2YC Division; GSA Geoscience Education Division; National Association of Geoscience Teachers (NAGT) Geoscience Education Research (GER) Division; National Association of Geoscience Teachers (NAGT) Teacher Education Division (TED); GSA Geoscience Education Division

**Disciplines:** Geoscience Education, Geoscience Information/Communication

**Advocates:** Katherine Ryker; Rachel Teasdale; Kelsey Bitting

Inquiry-based learning engages students in “doing science” in geoscience labs. Presenters will share their experiences creating and testing inquiry-based labs, data on their efficacy, and strategies for supporting other instructors (e.g., graduate teaching assistants).

### T153. Career Paths and Licensure: Program Strategies to Help Students Explore Career Pathways in the Earth Sciences

**Endorsers:** National Association of Geoscience Teachers (NAGT); GSA Geoscience Education Division; GSA Geology and Society Division

**Disciplines:** Geoscience Education, Geoscience and Public Policy, Geoscience Information/Communication

**Advocates:** Craig Nichol; James Kubicki; Karen Viskupic; Matthew Pendleton

This session explores strategies that departments and programs have initiated to help students explore career paths in earth sciences, to enhance teaching of skills needed for careers, and to support paths to careers and professional licensure.

### T154. Connecting High School and Undergraduate Students to the Geosciences through Multidisciplinary Approaches to Geologic Issues (Posters)

**Endorsers:** GSA Environmental and Engineering Geology Division; GSA Geology and Society Division; National Earth Science Teachers Association (NESTA); GSA Geoscience Education Division; GSA Quaternary Geology and Geomorphology Division; GSA Sedimentary Geology Division; GSA Energy Geology Division; National Association of Geoscience Teachers (NAGT); Geoscience Division of the Council on Undergraduate Research; GSA Marine and Coastal Geoscience Division

**Disciplines:** Geoscience Education, Geoscience Information/Communication, Geoscience and Public Policy

**Advocates:** Nazrul Khandaker; Julie Bloxson; Arif Sikder

This session encourages high school and undergraduate students to share their research to a greater number of audiences, particularly in the geosciences. Topics may highlight a variety of geologic processes and relevant multidisciplinary subjects.

### T155. Gatebreaking: Passing along Your Biggest Lessons Learned in the Geosciences

**Endorsers:** GSA Geoscience Education Division; GSA Geology and Society Division; GSA Quaternary Geology and Geomorphology Division; GSA Society for Sedimentary Geology; GSA Marine and

Coastal Geoscience Division; National Association of Geoscience Teachers (NAGT) Teacher Education Division (TED)

**Disciplines:** Geoscience Education, Geoscience Information/Communication, Soils

**Advocates:** Monica Rasmussen; Kathleen Benison; Stephanie Shepherd

As a geoscientist, you've dedicated months or years to field-work, publications, grant proposals, navigating industry, developing methods, and other accomplishments. Come share your best tips so we can all learn from your experiences!

### T156. G-IRL: Collaborations and Conversations on Practicing Geoscience and In-Real-Life Applications for Dismantling Scientific Siloes

**Disciplines:** Geoscience Education, Geoscience Information/Communication, Geoscience and Public Policy

**Advocates:** Akilah Alwan; Leila M. Joyce Seals; Darryl Reano

This session is an inclusive science communication space for a broad spectrum of geoscientists and non-geoscientists interested in discussing how science, academia, and/or geoscience culture plays a role in real life, “IRL.”

### T157. Hands-On Teaching Demonstrations that Combine Geoscience and Societal Issues: Audience Participation Requested!

**Discipline:** Geoscience Education

**Advocates:** Tiffany Rivera; Elizabeth Nagy

Unique interactive oral session that involves audience participation in presenters' activities. Authors demonstrate teaching activities that integrate geosciences with societal concerns. Demonstrations must include live audience participation. Online presenters should join us in real time.

### T158. Harnessing Social Media, Crowd Source, and Other Modern Open Media to Advance Geoscience Research and Enhance Outreach and Education

**Endorser:** GSA Geology and Society Division

**Disciplines:** Geoscience Education, Geoscience Information/Communication, Geoinformatics

**Advocates:** Richard MacKenzie III; Paul Bremner; Lesley Galyas; Dallin Laycock

This session proposes to show how social media, crowd sourcing, and other forms of modern communication media can enhance any aspect of the geosciences from pure research to education and outreach.

### T159. Improving Student Learning Outcomes Using Cognitive Science-Informed Strategies in Geoscience Teaching and Practice

**Endorsers:** National Association of Geoscience Teachers (NAGT); National Association of Geoscience Teachers (NAGT) Geoscience Education Research (GER) Division

**Disciplines:** Geoscience Education, History and Philosophy of Geology, Geoscience Information/Communication

**Advocates:** Alexandra Davatzes; Shondricka Burrell; Thomas F. Shipley

Geoscience knowledge construction is a complex process. Collaboration between geoscientists, educators, and cognitive scientists leads to innovative research in education and practice that

can identify additional strategies that effectively support student engagement, learning, and retention.

## **T160. Innovations in Holistic Student Training and Development**

**Endorser:** *National Association of Geoscience Teachers (NAGT)*

**Disciplines:** Geoscience Education, Geoscience Information/Communication

**Advocates:** Dana Thomas; Diana Dalbotten; Rebecca Batchelor

This session provides a platform for sharing ways that departments, student success programs, research internships, “post-bacs,” and more, both within and beyond university settings, are addressing training and development for undergraduate and graduate students.

## **T161. Institutional and Grassroots Efforts Promoting Diversity, Equity, and Inclusion in the Scientific Workplace**

**Endorsers:** *GSA Geophysics and Geodynamics Division; GSA Geoscience Education Division; SEPM (Society for Sedimentary Geology); GSA Geology and Society Division; National Association of Geoscience Teachers (NAGT); GSA Quaternary Geology and Geomorphology Division; GSA Energy Geology Division*

**Disciplines:** Geoscience Education, Geoscience Information/Communication, Geoscience and Public Policy

**Advocates:** Jenna L. Shelton; Tina Roberts-Ashby; Jennifer Malpass

The session will be focused on unique efforts that individuals (i.e., grassroots) and institutions are developing or implementing to promote diversity, equity, and inclusion in the geoscience workplace.

## **T162. Iris Moreno Totten Research in Geoscience Education Session**

**Endorsers:** *GSA Geoscience Education Division; National Association of Geoscience Teachers (NAGT); National Association of Geoscience Teachers (NAGT) Geoscience Education Research (GER) Division*

**Discipline:** Geoscience Education

**Advocates:** Charles Doug Czajka; Meagan M. Gilbert

This session will highlight empirical research being done in the field of geoscience education. Early career and student presenters will be considered for the Geoscience Education Division's Totten Award.

## **T163. Leveraging Virtual Spaces for Geoscience Education: Exploration and Learning through Augmented and Virtual Reality**

**Endorsers:** *GSA Geoscience Education Division; National Association of Geoscience Teachers (NAGT); National Association of Geoscience Teachers (NAGT) Geoscience Education Research (GER) Division*

**Discipline:** Geoscience Education

**Advocates:** Kelly Lazar; Stephen M. Moysey; Sabarish Babu; Catherine Mobley; D. Matthew Boyer; Gavin Gleasman

Virtual experiences are critical for bringing students into environments that are difficult to reach through conventional teaching modalities. We encourage developers, creators, researchers, and practitioners to share their research and best practices in these spaces.

## **T164. Making Sense of Methodologies and Theoretical Frameworks in Geoscience Education Research**

**Endorsers:** *GSA Geoscience Education Division; National Association of Geoscience Teachers (NAGT)*

**Disciplines:** Geoscience Education, Geoscience Information/Communication

**Advocates:** Leilani Arthurs; Larry Collins; Kristen Foley; Cory Forbes; Peggy McNeal; Emily Scribner; Emily Ward

Methods and theoretical frameworks from within and outside of geoscience education research shape our field. Presenters are encouraged to highlight their decision-making process in research studies. New approaches and applications of established methods/frameworks are welcome.

## **T166. Showcase of Undergraduate Research Posters by 2YC and 4YCU Geoscience Students (Posters)**

**Endorsers:** *National Association of Geoscience Teachers (NAGT); National Association of Geoscience Teachers (NAGT) Geo2YC Division; National Association of Geoscience Teachers (NAGT) Geoscience Education Research (GER) Division; GSA Geoscience Education Division; Geoscience Division of the Council on Undergraduate Research*

**Discipline:** Geoscience Education

**Advocates:** Gretchen Miller; Adrienne Leinbach; Stephanie Rollins

This session is designed for two-year college (2YC) and four-year college and university (4YCU) students presenting research posters in any subdiscipline of geoscience.

## **T167. The Role of Geoethics, Equity, and Environmental/Ecological Justice Education in STEM: The Geosciences Story**

**Disciplines:** Geoscience Education, Geoscience Information/Communication, Geoscience and Public Policy

**Advocates:** Samuel Cornelius Nyarko; Grant A. Fore

The literature suggests continuous geoethics, equity, and justice education for students and professionals. This session will bring together researchers and educators doing work in this area of need to inform future plans and decisions.

### **INDUSTRY TRACKS**

GSA's technical program offers sessions relevant to applied geoscientists.  
Look for these icons, which identify sessions in the following areas:



Economic Geology



Energy



Engineering



Hydrogeology and Environmental Geology

## T168. What's in Your Data? Mining Existing Databases to Plot the Course of K–16 Geoscience Education

**Endorsers:** GSA Geoscience Education Division; GSA Geology and Society Division; GSA Geoinformatics and Data Science Division; National Earth Science Teachers Association (NESTA); National Association of Geoscience Teachers (NAGT); National Association of Geoscience Teachers (NAGT) Geoscience Education Research (GER) Division; National Association of Geoscience Teachers (NAGT) Teacher Education Division (TED); National Association of Geoscience Teachers (NAGT) Geo2YC Division; GSA Energy Geology Division

**Disciplines:** Geoscience Education, Geoscience Information/Communication, Geoscience and Public Policy

**Advocates:** Lisa Dunn; Linda Musser

We seek to identify data sources available for geoscience education, considering how these data can be used to produce efficiencies of effort that maximize the impact of available resources to inform policy- and decision-making.

## GEOSCIENCE INFORMATION/COMMUNICATION

### T169. Climate—Weather Extreme Adaption and Mitigation: An Aggressive Call for an Interdisciplinary, Conference of Parties (COP), and United Nation (UN) Involvement

**Endorsers:** GSA International; GSA Geology and Society Division

**Disciplines:** Geoscience Information/Communication, Geoscience and Public Policy, Environmental Geoscience

**Advocates:** Onema Adojoh; Mohammed Chaanda

The intersectionality of ancillary disciplines should be strengthened to increase professional diversity and retention in climate science to meet the proposed COP27 agreement in the future.

### T170. From Yellowstone Earthquakes to a Delaware River Odyssey and Numerous Places and Projects in between: A Memorial Tribute to USGS Jack Epstein on His Work, Legacy, and Friends Made along the Way (U.S. Geological Survey 1958–2020)

**Endorsers:** U.S. Geological Survey; National Park Service; GSA Geology and Society Division; GSA Quaternary Geology and Geomorphology Division

**Disciplines:** Geoscience Information/Communication, Karst

**Advocates:** David Weary; Randall Orndorff; Timothy Connors

Celebrate the U.S. Geological Survey career of Jack Epstein with presentations on geologic mapping in the central Appalachians; mapping and karst research in the Black Hills; or topics related to outreach work with the National Park Service.

### T171. Geology in Motion: Presenting and Promoting Geomorphic and Geologic Research Using Video and Augmented Reality (Posters)

**Endorser:** GSA Quaternary Geology and Geomorphology Division

**Disciplines:** Geoscience Information/Communication, Geomorphology, Geoinformatics

**Advocates:** Sean D.T. Fletcher; Dallin Laycock; Paul Bremner; Richard MacKenzie III

The use of video and augmented reality is an underutilized resource in the geosciences and may provide a resource to better understand concepts limited by print media publication.

## T172. Geoscience Information: Innovation and Applications in a Changing Landscape

**Endorsers:** Geoscience Information Society; GSA Soils and Soil Processes Division

**Disciplines:** Geoscience Information/Communication, Geoinformatics, Geoscience Education

**Advocates:** Lisa Dunn; Linda Musser

The evolving information environment presents challenges for those managing, creating, and accessing geoscience information. How are we innovating, developing agile strategies, re-thinking boundaries, exploring applications, forming new partnerships? Share your ideas, best practices, and outcomes.

## T173. Giving Voice to Geosciences beyond the Science World

**Endorsers:** GSA Geology and Society Division; University Corporation for Atmospheric Research; National Association of Geoscience Teachers (NAGT) Teacher Education Division (TED); GSA Geoscience Education Division; GSA Quaternary Geology and Geomorphology Division; Colorado Riparian Association; GSA Soils and Soil Processes Division

**Disciplines:** Geoscience Information/Communication, Geoscience Education, Geoscience and Public Policy

**Advocates:** Emily Iskin; Sarah Lamm

This session showcases creative communication of geosciences with various media in venues beyond traditional university settings, highlighting multidisciplinary collaborations and diverse voices by connecting with diverse audiences.

## HISTORY AND PHILOSOPHY OF GEOLOGY

### T174. Case Studies in the History & Philosophy of the Geosciences: People, Places & Things

**Endorsers:** GSA History and Philosophy of Geology Division; GSA Geoscience Education Division

**Disciplines:** History and Philosophy of Geology, Geoscience Education, Geoscience Information/Communication

**Advocate:** Eric Pyle

This session seeks presentations that share the development, use, and impact of case studies that inform the development of the geosciences discipline and can be used in formal and informal geoscience teaching and learning settings.

## GEOINFORMATICS

### T175. Geologic Maps and Their Derivatives (Posters)

**Endorser:** Association of American State Geologists

**Disciplines:** Geoinformatics, Hydrogeology, Structural Geology

**Advocates:** Richard Berg; Harvey Thorleifson

This poster session will highlight new geologic maps, mapping programs, and innovations in geological mapping, including data management, web accessibility, 3D, and applications in water and land management.

### T176. Innovations in Geological Mapping

**Endorser:** Association of American State Geologists

**Disciplines:** Geoinformatics, Hydrogeology, Structural Geology

**Advocates:** Richard Berg; Harvey Thorleifson

This session will highlight new geologic maps, mapping programs, and innovations in geological mapping, including data management, web accessibility, 3D, and applications in water and land management.

**(\$) (G) T177. Mineralogy, Petrology, and Geochemistry: New Approaches to Harnessing the Multidimensionality of Complex Systems**

**Endorsers:** *GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; Mineralogical Society of America; Geochemical Society*

**Disciplines:** Geoinformatics, Mineralogy/Crystallography, Planetary Geology

**Advocates:** Shaunna Morrison; Shuang Zhang; Xiaogang Ma

The application of data science to problems in mineralogy, petrology, and geochemistry has revealed insights into emergent behaviors of complex systems. We welcome submissions exemplifying this in Earth and planetary systems, geo-bio-coevolution, and geoinformatics.

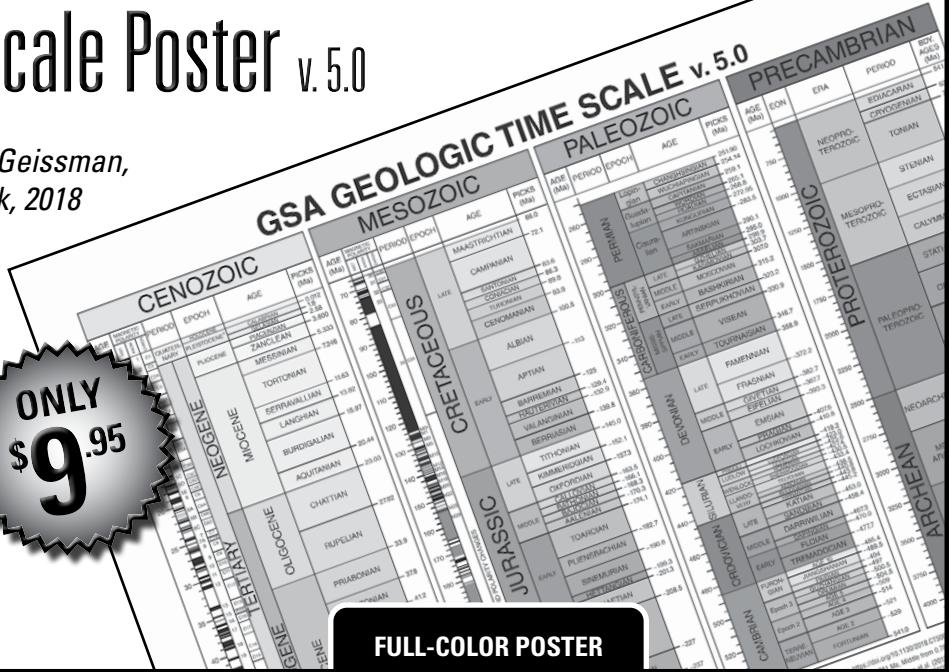
# Geologic Time Scale Poster v. 5.0

Compiled by J.D. Walker, J.W. Geissman, S.A. Bowring, and L.E. Babcock, 2018

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# 2022 Joint Technical Program Committee (JTPC)

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 Technical Program Vice-Chair: Patrick Burkhart, patrick.burkhart@sru.edu  
 GSA Technical Program Manager: Nancy Wright, nwright@geosociety.org

JTPC CONTACT(S)	DISCIPLINE	REVIEW GROUP
Monica Easton	geoscience information/communication	Association of Earth Science Editors
Marie D. Jackson; Jayde Hirniak	continental scientific drilling	GSA Continental Scientific Drilling Division
Elizabeth A. Heise; Claire McLeod		Council on Undergraduate Research Geosciences Division
Jenna L. Shelton; Marc Buursink; Denise Hills	energy geology	GSA Energy Geology Division
Arpita Nandi; Robert Mitchell; Anne Witt; Francis Rengers	engineering geology; environmental geoscience	GSA Environmental & Engineering Geology Division
Samantha Marie Krause	geoarchaeology	GSA Geoarchaeology Geology Division
Lydia Schiavo Tackett	geobiology; geomicrobiology	GSA Geobiology & Geomicrobiology Division
Eugene Szymanski; Andrea Dutton	geochronology	GSA Geochronology Division
Frank Ramos	geochemistry	Geochemical Society
Kenneth Rubin; Shanan Peters; Denise Hills	geoinformatics	GSA Geoinformatics and Data Science Division
Laura Suzanne Ruhl; Reto Giere	geology and health	GSA Geology and Health Division
Beth Ann Bartel	geoscience and public policy	GSA Geology and Society Division
Shannon Dulin; Anjana Shah	geophysics/geodynamics	GSA Geophysics and Geodynamics Division
Meagan M. Gilbert; Sydney Steele; Katherine Ryker	geoscience education	GSA Geoscience Education Division
Elise Gowen	geoscience information/communication	Geoscience Information Society
Mary Hubbard		GSA International
Eric Pyle; Renee Clary	History and Philosophy of Geology	GSA History and Philosophy of Geology Division
Andrea Brookfield; Kenneth Belitz	hydrogeology	GSA Hydrogeology Division
Daniel Jones; Lewis Land; Patricia Kambesis	karst	GSA Karst Division
Scott Starratt; Jason R. Price	limnogeology	GSA Limnogeology Division
Andrea Hawkes	marine/coastal science	Marine/Coastal Geology
Amanda B. Clarke; J. Alex Speer; Alan Whittington	mineralogy/crystallography; geochemistry; petrology, volcanology	GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division
Philip Brown	mineralogy/crystallography; petrology, igneous; petrology, metamorphic; volcanology	Mineralogical Society of America
Katherine Ryker	geoscience education	National Association of Geoscience Teachers (NAGT)
Miriam E. Katz	paleoclimatology/paleoceanography	Paleoceanography/Paleoclimatology
John Huntley; Sarah Jacquet	paleontology, biogeography/biostratigraphy; paleontology, diversity, extinction, origination; paleontology, paleoecology/taphonomy; paleontology, phylogenetic/morphological patterns	Paleontological Society

(continued...)

JTPC CONTACT(S)	DISCIPLINE	REVIEW GROUP
Jennifer Piatek; Samuel Birch; Debra Buczkowski	planetary geology	GSA Planetary Geology Division
Gregory Dumond	Precambrian geology	Precambrian Geology
Karl W. Wegmann; Arjun M. Heimsath; Brad Johnson	geomorphology; Quaternary geology	GSA Quaternary Geology and Geomorphology Division
Will Jackson; Howard Harper	sediments, carbonates; sediments, clastic; stratigraphy	GSA Sedimentary Geology Division
Howard Harper	sediments, carbonates; sediments, clastic; stratigraphy	SEPM (Society for Sedimentary Geology)
Richard Goldfarb; Thomas Monecke	economic geology	Society of Economic Geologists
Tim Beach; Emily Jane Beverly	soils	GSA Soils and Soil Processes Division
Juliet Crider; Rebecca Dorsey; John Singleton; Ramon Arrowsmith	structural geology; tectonics	GSA Structural Geology and Tectonics Division

## Discipline Sessions

In addition to topical sessions, GSA offers vibrant discipline sessions. Discipline sessions are an essential addition to the fulfillment of the overall meeting. We will have technical sessions that relate to recent advances in:

- Continental Scientific Drilling
- Economic Geology
- Energy Geology
- Engineering Geology
- Environmental Geoscience
- Geoarchaeology
- Geochemistry
- Geochronology
- Geoinformatics
- Geology and Health
- Geomicrobiology
- Geomorphology
- Geophysics/Geodynamics
- Geoscience Education
- Geoscience Information/Communication
- Geoscience and Public Policy
- History and Philosophy of Geology
- Hydrogeology
- Karst
- Limnogeology
- Marine/Coastal Science
- Mineralogy/Crystallography
- Paleoclimatology/Paleoceanography
- Paleontology, Biogeography/Biostratigraphy
- Paleontology, Diversity, Extinction, Origination
- Paleontology, Paleoecology/Taphonomy
- Paleontology, Phylogenetic/Morphological Patterns
- Petrology, Igneous
- Petrology, Metamorphic
- Planetary Geology
- Precambrian Geology
- Quaternary Geology
- Sediments, Carbonates
- Sediments, Clastic
- Soils
- Stratigraphy
- Structural Geology
- Tectonics/Tectonophysics
- Volcanology

## Your Guide to Career Success

Perfect your professional portfolio by attending GeoCareers events at GSA Connects 2022.

### **GEOCAREERS DAY**

*Direct Access to Company Representatives*

- Résumé Workshop
- Company and Agency Information
- Mentoring Session
- Career Panel

### **GEOCAREERS CENTER**

*Career Guidance and Information*

- Career presentations
- Résumé Review Clinic
- Drop-in Mentoring
- Early Career Professional Coffee
- Geology Club Meet-Up
- Networking Event
- Women in Geology Program
- Post or View Jobs



Learn more about a career in the geosciences by viewing past recorded webinars at [www.geosociety.org/webinars](http://www.geosociety.org/webinars).

## Expanding Representation in Geosciences (ERG) Scholarship

Undergraduate students from groups who are underrepresented in the geosciences are encouraged to apply or be nominated for a scholarship at [www.geosociety.org/erg](http://www.geosociety.org/erg). Up to six awards include a US\$1,500 scholarship, student membership, and full meeting registration for GSA Connects 2022. Qualified applicants must be U.S. citizens studying at an accredited university or college in one of GSA's regional sections (including Canada and Mexico). Deadline: 15 May.

## Be a Mentor—Share Your Experience

Become a mentor and help students navigate GSA Connects 2022, introduce them to contacts, discuss career paths, and offer advice. Graduate students, early career professionals, professionals, and retirees are welcome to serve as mentors. Learn more and sign up at <https://community.geosociety.org/gsa2022/mentor>.

# Scientific Field Trips

*Descriptions and leader bios are online. ECP—early career professional.*

 #401. **Black Hills and Badlands: A Synopsis of Geological Time.** Thurs.–Sat., 6–8 Oct. Endorser: *Edmunds Central School District*. Leader: Spencer Cody, Edmunds Central School District.

 #402. **PC<sup>2</sup> = PreCambrian Colorado: The Role of the Mesoproterozoic Picuris Orogeny in Colorado.** Fri.–Sat., 7–8 Oct. Endorsers: *GSA Structural Geology and Tectonics Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; Colorado Scientific Society (CSS); Denver Regional Exploration Geologists' Society (DREGS); Escalante Resources Group*. Leaders: Ruth F. Aronoff, Furman University; Yvette Kuiper; Christopher G. Daniel.

 #403. **PC<sup>2</sup> = PreCambrian Colorado: Geology and Economic Geology of the Colorado Central Front Range; Field Observations and Perspectives Bearing on the Growth and Metallogeny of the North American Craton.** Fri.–Sat., 7–8 Oct. Endorsers: *Colorado Scientific Society Denver Regional Exploration Geologists' Society; Escalante Resources Group*. Leaders: Lisa Fisher, Colorado Scientific Society; Lewis Kleinhans.

#404. **A Bike Tour: Geology, Geochronology, and Geochemistry of the Table Mountain Shoshonite, Golden, Colorado.** Sat., 8 Oct. Endorsers: *GSA Geochronology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division*. Leaders: Leah Morgan, Geology, Geophysics, and Geochemistry Science Center; Alexie Millikin.

#405. **Dinosaur Tracks and Microbial MAT in Photogrammetric 3D Relief: The Classic Trace Fossils of the Dinosaur Ridge Area.** Sat., 8 Oct. Endorser: *Dinosaur Ridge*. Leaders: Martin Lockley, Dinosaur Trackers Research Group; Nora Noffke; Brent Breithaupt.

 #406. **World-Class Geologic Heritage Sites of the Metropolitan Denver, Colorado, Area (pre-meeting).** Sat., 8 Oct. Endorsers: *Colorado Scientific Society; GSA Geology and Society Division*. Leader: Tim Connors.

#407. **Accessible Tour of Colorado Geoscience for Students & Faculty.** Sat., 8 Oct. Endorser: *UNAVCO-NSF GAGE*. Leaders: Anika Knight, UNAVCO; Kelsey Russo-Nixon.

#408. **Developing Instructional Materials from Field-Based Experiences: A Field Trip for K–12 Teachers to Corral Bluffs.** Sat., 8 Oct. Endorsers: *NGSS-ESS (Next Generation Science Standards-Earth and Space Science) Working Group*. Leaders: Missy Holzer, NESTA; Aida Awad; Ed Robeck; Matthew Dawson.

#409. **Mountain Highs and Valley Lows: An Accessible Introduction to the Geology of the Pikes Peak Area.** Wed.–Thurs., 12–13 Oct. Endorser: *International Association for Geoscience Diversity (IAGD)*. Leaders: Anita Marshall, University of Florida; Christine Siddoway; Michele Cooke; Nancy R. Riggs; Chris Atchison.

 #410. **PC<sup>2</sup> = PreCambrian Colorado: Paleoproterozoic Tectonics of the Northern Colorado Front Range.** Thurs., 13 Oct. Endorsers: *GSA Structural Geology and Tectonics Division; The Colorado Scientific Society (CSS); Denver Regional Exploration Geologists' Society (DREGS); Escalante Resources Group*. Leaders: Graham Baird, University of Northern Colorado; Timothy Grover, Kevin H. Mahan.

 #411. **World-Class Geologic Heritage Sites of the Metropolitan Denver, Colorado, Area (post-meeting).** Thurs., 13 Oct. Endorsers: *Colorado Scientific Society; GSA Geology and Society Division*. Leader: Tim Connors.

#412. **Exploring Morrison: Jurassic Morrison Formation at Dinosaur Ridge and Beyond.** Thurs.–Fri., 13–14 Oct. Leaders: Matthew Mossbrucker, Morrison Natural History Museum; Erin Rose LaCount, Dinosaur Ridge; Robert Bakker, Paul Murphey.

 #413. **Landslides and Other Geohazards along Highway I-70 Denver to Glenwood Springs.** Thurs.–Fri., 13–14 Oct. Leaders: Lynne Carpenter, USDA Forest Service; Ty Ortiz, Ben Arndt.

 #414. **PC<sup>2</sup> = PreCambrian Colorado: Peraluminous Gold Deposits Emplaced above a 1.75 Ga Flat Subduction Zone in South-Central Colorado.** Thurs.–Fri., 13–14 Oct. Endorsers: *PC<sup>2</sup> = Precambrian Colorado; Denver Region Exploration Geologists' Society (DREGS); Colorado Scientific Society (CSS); MagmaChem Research Institute; Escalante Resources Group*. Leaders: Monte Swan, MagmaChem Research Institute; Lewis Kleinhans; Stanley B. Keith.

## INDUSTRY TRACKS

GSA's program offers field trips relevant to applied geoscientists. Look for these icons, which identify trips in the following areas:



Economic Geology



Energy



Engineering



Hydrogeology and Environmental Geology

# Short Courses

*Learn and explore a new topic. Build your skills.*

**Learn:** Ground-penetrating radar, geo-thermo-petro-chronology, virtual microscopy, geostatistical modeling of geochemical data, hydrogeological layered modeling, computational petrology skills, modeling detrital geochronology data, climate adaptation and planning, and volcanic crisis awareness.

**Explore:** Planetary image analysis with ArcGIS, the NASA SCoPE program, machine learning for datasets, geochronology, digital petrography, medical geology fundamentals, multiphysics modeling, and cave and karst research on federal lands.

**Strengthen your research, data collection, and fieldwork skills using** 3D geological mapping and modeling, the StraboSpot and StraboMicro Data Systems, Multiple Point Statistics, surface processes with the CSDMS Workbench, 3D video-game-style geologic field trips, the Paleobiology Database, resistivity surveying, drones, SfM and GNSS methods in the field, and field safety leadership.

**Gain tips using** active learning strategies, geophysics to address real-world questions in geoscience courses, and improv to improve the geoscience community.



**Students and early career professionals can learn about** NSF Graduate Research Fellowship proposal preparation and sequence stratigraphy, and OTF awardees can attend a professional development workshop.

For details and course descriptions, check the upcoming June issue of *GSA Today* or go to <https://community.geosociety.org/gsa2022/program/short>.

*This is a great opportunity to earn continuing education credits!*

## FIELD GUIDE 62

### From Terranes to Terrains

#### From Terranes to Terrains: Geologic Field Guides on the Construction and Destruction of the Pacific Northwest

*Edited by Adam M. Booth and Anita L. Grunder*

The eight field trips in this volume, associated with GSA Connects 2021 held in Portland, Oregon, USA, reflect the rich and varied geological legacy of the Pacific Northwest. The western margin of North America has had a complex subduction and transform history throughout the Phanerozoic, building a collage of terranes. The terrain has been modified by Cenozoic sedimentation, magmatism, and faulting related to Cascadia subduction, passage of the Yellowstone hot spot, and north and westward propagation of the Basin and Range province. The youngest flood basalt province on Earth also inundated the landscape, while the mighty Columbia watershed kept pace with arc construction and funneled epic ice-age floods from the craton to the coast. Additional erosive processes such as landslides continue to shape this dynamic geological wonderland.

FLD062, 352 p., ISBN 9780813700625

list price \$60.00 | member price \$42.00



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# Letter to the Editors

We are writing to express our concern with the editorial published in *GSA Today* in the December 2021 issue titled “Why Publish in *GSA Today*?” and authored by that publication’s two science editors, Mihai Ducea and Peter Copeland. After laying out the reasons for submitting a science article to *GSA Today*, including that it is “one of the most visible venues for... the earth sciences” and that a *GSA Today* article can “reach much further than the ‘normal’ papers.” Ducea and Copeland go on to give examples that are appropriate, including review papers at the graduate student level, “interdisciplinary papers that reach into new directions,” and technological advances. We agree that *GSA Today* has an impressive potential to reach across all subdisciplines of the geosciences and is an excellent venue for publication of science that is of broad interest and applicable for a wide audience.

Our concern comes with their statement about what is *not* appropriate for a science article, namely, “social science/social justice or geo-education pieces.” Ducea and Copeland justify their dismissal of these topics, continuing,

The Society is deeply involved in increasing the diversity of its constituency and of our community in general. Therefore, such papers are in theory needed; we encourage authors to investigate the Groundwork format for those. As far as the main science article, it is difficult for editors with experience and expertise in earth science to review (or even identify appropriate referees for) manuscripts whose main focus lies not on rocks and minerals but lies more in the domains of sociology, social work, law, and related fields. Current and former editors of *GSA Today* agree that the feature science articles should be concerned with earth materials and processes, not the people who are studying them. Nevertheless, Groundwork articles are good vehicles to communicate the latest adjustments in the way we do our work (e.g., teaching in times of COVID) or a variety of other topics.

As leaders in the National Association of Geoscience Teachers (NAGT), an Associated Society of GSA, NAGT’s Geoscience Education Research (GER) Division, and its research journal, the *Journal of Geoscience Education*, we find this statement regressive, exclusionary, and condescending, and it puts GSA—with *GSA Today* as its member journal—in danger of becoming irrelevant in the modern landscape of geoscience.

The published guidelines ([www.geosociety.org/GSA/Publications/GSA\\_Today/author\\_info/GSA/GSAToday/Author\\_Info/home.aspx](http://www.geosociety.org/GSA/Publications/GSA_Today/author_info/GSA/GSAToday/Author_Info/home.aspx)) for submission of science articles state that science articles should be “timely, high-quality, appealing to a broad geoscience audience” and “innovative and focused on current topics & discoveries in geoscience.” We argue that some of the most timely and innovative work being done in geoscience right now lies at the intersection of science and society, and these issues are of profound importance to GSA’s membership and the health of the society as a whole, including how systemic racism influences the type of science that gets published and rewarded. Why should we all know about “cool tools” but not effective, evidence-based teaching practices? Ducea and Copeland are displaying their affinity bias for scientists who do science like they do, despite the fact that the society they represent has scientific Divisions, such as geology and health, geology and society, and geoscience education. The science done by the members of these Divisions is not

“social work”: these are robust, data-driven, interdisciplinary fields in which innovations can have immediate relevance to society and can also substantiate the relevance of the geosciences as a whole to the well-being of society. These fields are also more diverse and include more early-career scientists, and the consequences of excluding their contributions can be severe.

We agree that Groundwork articles can be an excellent option for publication, but they cannot be the only venue. As noted by Ducea and Copeland, science articles are lavishly illustrated and include a front cover image at no charge; they are allowed six pages to Groundwork’s two. Graduate-level review articles in geoscience education research, geology and health, and the interactions between geology and society are invaluable to our community, and could help build the momentum established by URGE (Unlearning Racism in the Geosciences) to reach students coming into the geosciences and ground them in social and environmental justice.

We are particularly confounded by the statement that the editors struggle to review and find reviewers for manuscripts that cover anything other than “rocks and minerals.” They seem to have no trouble finding reviewers for these manuscripts when they are submitted as Groundwork articles, which also undergo rigorous peer review (at least according to GSA’s published guidelines and the experience of several signatories of this letter), so we are curious why this is a concern for science articles. Current and former editors of the *Journal of Geoscience Education* (JGE) on this letter also face the challenge of finding appropriate reviewers and integrating their reviews of papers that lie outside their specific expertise; this is the primary responsibility of an editor. We can recommend not only the authors of previously submitted science and Groundwork articles but the authors of articles published in JGE as excellent starting places, as well as GSA’s own members in their Geoscience Education Division. Working with editorial boards of research journals of other Associated Societies could build the community that values and publishes in *GSA Today*.

Most disturbing, however, is the editors’ statement that such papers are “in theory needed” to support the diversity efforts of the society as a whole, but yet they are not willing to implement that theory in practice, instead choosing to maintain the inequitable status quo. We ask: Is this truly the view of the GSA leadership?

As geoscientists and educators, we call on GSA to recognize the essential scientific contributions of *all* of its members by embracing the vast array of geoscience endeavors that are worthy of publication in *GSA Today*, including those that lie at the intersection of Earth and humanity.

Because *GSA Today* is the member journal of the organization, we also urge the elected leaders and executive director to respond publicly to this letter.

Respectfully, the National Association of Geoscience Teachers (NAGT) leadership:

**Margaret Crowder**, President  
**Christy C. Visaggi**, 1st Vice-President  
**Reginald Archer**, 2nd Vice-President  
**Jennifer M. Wenner**, Past-President

**Karen Viskupic**, Past-President

**Anne E. Egger**, Executive Director and GSA Fellow

**Leilani Arthurs**, Geoscience Education Research Division

President

**Kimberly A. Hannula**, Editor-in-Chief, *Journal of Geoscience Education*, former member of GSA's Education Committee and Public Service Award Committee

**Michael A. Phillips**, Secretary-Treasurer and Advocacy

Committee chair, GSA Fellow, and former member of GSA's Geology & Public Policy Committee

**Katherine Ryker**, Councilor-at-Large, Past-President Geoscience Education Research Division, GSA Fellow, and GSA Education Committee member

## Response from GSA Executive Committee to the National Association of Geoscience Teachers (NAGT) Letter to *GSA Today* Editors

*GSA Today* has been designed as the Society's versatile and multipurpose communication magazine. The goals are to provide its readers with stimulating and relevant information that can increase their geoscience knowledge base and, at the same time, keep them abreast of GSA activities and benefits. It is also used to highlight educational and job opportunities. These many-pronged objectives can sometimes be difficult to keep separate but focused.

We, the GSA Executive Committee, thank the National Association of Geoscience Teachers (NAGT) for its concern that GSA gave the impression of limiting the breadth of manuscript submissions. The officers and members of the Executive Committee support the call that manuscripts to *GSA Today* are "timely, high-quality, appealing to a broad geoscience audience" and "innovative and focused on current topics and discoveries in geoscience." In addition, Groundwork articles are typically "short, hot-topic or issue-driven articles" that "promote greater influence

of the earth sciences on education, policy, planning, and funding." There is no doubt that at times the subject of a manuscript could satisfy both those calls and perhaps only be limited by the size of the submission. In the future, such size limitations may be removed. We also thank NAGT for offering its assistance to our *GSA Today* editors with locating experienced peer reviewers for multidisciplinary-themed manuscripts and for those that may fall into areas of NAGT expertise. Experience from all of our Associated Societies is needed to build and maintain a strong communication and scientific platform.

In discussions with the *GSA Today* editors, they have expressed the same opinion and they are open to considering a wide variety of manuscript submissions that may fit our present categories. This conversation has also re-opened the internal discussion about the format of *GSA Today* and our ultimate needs. Please stay tuned for additional updates.

# Help Shape the Future of Geoscience

**Deadline:** 15 June 2022

**Terms begin 1 July 2023** (unless otherwise noted)

GSA has opportunities for you to network, build your skillset, and work toward common goals. We invite you to volunteer or nominate a fellow GSA member to serve on a committee or as a representative to another organization. Volunteers are the lifeblood of GSA.

Go to <https://rock.geosociety.org/Nominations/CS.aspx> to volunteer or nominate. Open positions and qualifications are also detailed online at <https://rock.geosociety.org/forms/viewopenpositions.asp>. Questions? Contact Dominique Olvera, dolvera@geosociety.org; P.O. Box 9140, Boulder, CO 80301-9140, USA; fax: +1-303-357-1060. You can volunteer at any time; terms begin 1 July 2023 unless otherwise noted.

## Academic and Applied Geoscience Relations Committee

**Member-at-Large Industry (3-year term; E, M)**

This committee is charged with strengthening and expanding relations between GSA members in applied and academic geosciences. As such, it proactively coordinates the Society's effort to facilitate greater cooperation between academia, industry, and government geoscientists. **Qualifications:** Committee members must work in academia, industry, or government and be committed to developing a better integration of applied and academic science in GSA meetings, publications, short courses, field trips, and education and outreach programs. Professional interest: environmental and engineering geology, hydrogeology, karst, quaternary geology and geomorphology, structural geology and tectonics, and/or sedimentary geology. Members must also be active in one or more GSA scientific Divisions.

## Annual Program Committee

**Two Members-at-Large (4-year term; B, E, M); Member-at-Large Student (2-year term)**

This committee is charged with developing a plan for increasing the quality of the annual and other society-sponsored meetings in terms of science, education, and outreach; evaluating the technical and scientific programs annually to identify modifications necessary for accomplishing the Society's long-range goals; conducting short and long-range planning for the meetings; and developing a long-term logistical plan/strategy for the technical programs of all GSA meetings and other Society-sponsored meetings. One member-at-large should have previous meeting experience.

## Arthur L. Day Medal Award

**Two Members-at-Large (3-year term; E, T)**

This committee selects candidates for the Arthur L. Day Medal. **Qualifications:** Members should have knowledge of those who have made "distinct contributions to geologic knowledge through the application of physics and chemistry to the solution of geologic problems." All the committee's work will be accomplished during the months of February and March. Committee decisions must be made by 1 April.

## Bascom Mapping Award Committee

**Member-at-Large Government; Member-at-Large; Member-at-Large Industry (3-year term; E, T)**

This committee selects candidates for the Florence Bascom Geologic Mapping Award. This award acknowledges contributions in published high-quality geologic mapping that led the recipient to publish significant new scientific or economic-resource discoveries, and to contribute greater understanding of fundamental geologic processes and concepts. **Qualifications:** Members should be knowledgeable in the field of mapping.

## Diversity in the Geosciences Committee

**Two Members-at-Large; Member-at-Large Student; Member-at-Large Industry (3-year term; E, M)**

This committee provides advice and support to GSA Council, raises awareness, and initiate activities and programs that will increase opportunities for diverse groups in the geosciences particularly in the dimensions of race, ethnicity, gender, and physical abilities. The committee is also charged with stimulating recruitment and promoting positive career development. **Qualifications:** Members of this committee must have professional or experiential knowledge of issues relevant to the goals of the committee. GSA strongly encourages members who are from the communities for which this committee is expected to serve.

## Education Committee

**4-Year College Faculty Representative (4-year term; E, M); Member-at-Large (4-year term; E, M); Graduate Student Representative (2-year term; B, E, M)**

This committee works with GSA members representing a wide range of education sectors to develop informal, pre-college (K-12), undergraduate, and graduate earth-science education and outreach objectives and initiatives. **Qualifications:** Members of this committee must have the ability to work with other interested scientific organizations and science teachers' groups.

## Geology and Public Policy Committee

**Two Members-at-Large (3-year term; E, M); Member-at-Large Student (3-year term; E, M)**

This committee provides advice on public policy matters to Council and GSA leadership by monitoring and assessing international, national, and regional science policy; formulating and recommending position statements; and sponsoring topical white papers. This committee also encourages the active engagement in geoscience policy by GSA members. **Qualifications:** Members should have experience with public-policy issues involving the science of geology; ability to develop, disseminate, and translate information from the geologic sciences into useful forms for the public and for GSA members; and familiarity with appropriate techniques for the dissemination of information.

B—Meets in Boulder or elsewhere; E—Communicates by phone or video; M—Meets at the Annual Meeting; T—Extensive time commitment required during application review period.

## **GSA International**

**Chair (4-year term; E, M); Member-at-Large (4-year term; E, M); Secretary (4-year term; E, M)**

Serve as GSA's coordination and communication resource seeking to promote, create, and enhance opportunities for international cooperation related to the scientific, educational, and outreach missions shared by GSA and like-minded professional societies, educational institutions, and government agencies. Build collaborative relationships with GSA's scientific Divisions and Associated Societies on international issues and serve as a channel for member-generated proposals for international themes.

## **Membership and Fellowship Committee**

**Two Members-at-Large Industry (3-year term; B); Member-at-Large Student (3-year term; B)**

This committee contributes to the growth of the GSA membership, enhances the member experience, and serves a vital role in the selection of Fellows, with the goal of fostering a membership community as pertinent and global as our science. Committee members should understand what various segments of members want from GSA and should be familiar with outstanding achievers in the geosciences worthy of fellowship. **Qualifications:** Committee members should have experience in benefit, recruitment, and retention programs.

## **Nominations Committee**

**Two Members-at-Large (3-year term; B, E)**

This committee recommends nominees to GSA Council for the positions of GSA Officers and Councilors, committee members, and Society representatives to other permanent groups. **Qualifications:** Members must be familiar with a broad range of well-known and highly respected geoscientists.

## **North American Commission on Stratigraphic Nomenclature**

**GSA Representative (3-year term; E, M)**

This committee develops statements of stratigraphic principles, recommends procedures applicable to classification and nomenclature of stratigraphic and related units, reviews problems in classifying and naming stratigraphic and related units, and formulates expressions of judgment on these matters. **Qualifications:** Members must be familiar with of the fields of paleontology, biostratigraphy, and stratigraphy.

## **Penrose Conferences and Thompson Field Forums Committee**

**Member-at-Large (3-year term; E)**

This committee reviews and approves Penrose Conference and Thompson Field Forum proposals and recommends and implements guidelines for the success of these meetings. **Qualifications:** Committee members must be early-career scientists/professionals.

## **Penrose Medal Award Committee**

**Two Member-at-Large (3-year term; E, T)**

Members of this committee select candidates for the Penrose Medal Award. Emphasis is placed on "eminent research in pure geology, which marks a major advance in the science of geology." **Qualifications:** Members should be familiar with outstanding achievers in the geosciences worthy of consideration for the honor.

All of the committee's work will be accomplished during the months of February and March. All decisions must be made by 1 April.

## **Professional Development Committee**

**Two Members-at-Large (3-year term; E)**

This committee directs, advises, and monitors GSA's professional development program; reviews and approves proposals; recommends and implements guideline changes; and monitors the scientific quality of courses offered. **Qualifications:** Members must be familiar with professional development programs or have adult education teaching experience.

## **Public Service Award Committee**

**Member-at-Large (3-year term; B, E, M)**

The purpose of this committee is to generate, receive, and evaluate candidates for the GSA Public Service Award and the AGI Outstanding Contributions to the Public Understanding of the Geosciences Award. These awards are in recognition of outstanding individual contributions to either public awareness of the earth sciences or the scientific resolution of earth-science problems of significant societal concern.

## **Publications Committee**

**Member-at-Large (4-year term; B, E, M)**

The primary responsibilities of the committee are nomination of candidates for editors when positions become vacant; reviewing the quality and health of each Society publication; and reporting annually to Council including recommendations for changes in page charges, subsidies, or any other publishing matter on which Council must make a decision. To carry out this charge, headquarters will provide the committee with all necessary financial information.

## **Research Grants Committee**

**Eleven Members-at-Large with various specialties (3-year term; B, T)**

The primary function of this committee is to evaluate about 800 graduate student research grant applications and award specific grants to chosen recipients, including some named grants supported by funds within the GSA Foundation. **Qualifications:** Members may come from any sector (academia, government, industry, etc.) and should have experience in directing research projects and in evaluating research grant applications. GSA strongly encourages nominations of geoscientists from diverse backgrounds and institutions, particularly from minority-serving institutions. **Extensive time commitment required 15 Feb.–15 April.** Each member reviews about 40 applications. Learn more about the grants program at [www.geosociety.org/gradgrants](http://www.geosociety.org/gradgrants).

## **Young Scientist Award (Donath Medal) Committee**

**Three Members-at-Large (3-year term; E, T)**

Committee members investigate the achievements of young scientists who should be considered for this award and make recommendations to GSA Council. **Qualifications:** Members should have knowledge of young scientists with "outstanding achievement(s) in contributing to geologic knowledge through original research which marks a major advance in the earth sciences." All the committee's work will be accomplished during the months of February and March. All decisions must be made by 1 April.

# GSA Scientific Division Awards

## GEOARCHAEOLOGY DIVISION

### Richard Hay Student Paper/Poster Award

**Nominations due** 1 Sept.

Submit nominations to [gsa.agd@gmail.com](mailto:gsa.agd@gmail.com).

Richard Hay was a long-standing member of the Division and had a long and distinguished career in sedimentary geology, mineralogy, and archaeological geology. The award is a travel grant for a student (undergraduate or graduate) presenting a paper or poster at GSA's annual meeting. The grant is competitive and will be awarded based on the evaluation of the scientific merit of the research topic and the clarity of an expanded abstract for the paper or poster prepared by a student for presentation in the Division's technical session. <https://community.geosociety.org/geoarchdivision/awards/student/hay>

## GEOLOGY AND HEALTH

### Geology and Health Scientific Division Meritorious Service Award

**Nominations due** 15 July

Submit nominations to [lsruhl@ualr.edu](mailto:lsruhl@ualr.edu).

The award recognizes outstanding contributions to the mission of the Geology and Health scientific Division. The awardee must be a member of the Geology and Health Division and will be recognized at the annual Division business meeting during GSA Connects 2022. <https://community.geosociety.org/geologyhealthdivision/events32/upcoming-awards>

## HISTORY AND PHILOSOPHY OF GEOLOGY DIVISION

### History and Philosophy of Geology Student Award

**Nominations due** 15 June

Submit nominations to the Division's secretary/treasurer.

This award provides US\$1000 for a paper to be given at the national GSA meeting. Awards may also be given for second place. Oral presentations are preferred. Faculty advisors may be listed as second author, but not as the lead author of the paper. The proposed paper may be (1) a paper in the history or philosophy of geology; (2) a literature review of ideas for a technical work or thesis/dissertation; or (3) some imaginative aspect of the history or philosophy of geology we have not thought of before. Students should submit an abstract of their proposed talk and a 1,500–2,000-word prospectus for consideration. Currently enrolled undergraduates and graduate

students are eligible as are those who received their degrees at the end of the fall or spring terms immediately preceding the national GSA meeting. The award is made possible by a bequest from the estate of Mary C. Rabbitt. Monies for the award are administered by the GSA Foundation. <https://community.geosociety.org/histphldiv/awards/student>

## LIMNOGEOLGY DIVISION

### Kerry Kelts Research Award

**Nominations due** 30 June

Nominations should be forwarded electronically to the Division chair.

This award is for undergraduate or graduate student research related to limnogeology, limnology, or paleolimnology. <https://community.geosociety.org/limnogeologydivision/awards/kerrykelts>

## PLANETARY GEOLOGY DIVISION (PGD)

### The Eugene M. Shoemaker Impact Cratering Award

**Nominations due** 19 Aug.

This award is for undergraduate or graduate students, of any nationality, working in any country, in the disciplines of geology, geophysics, geochemistry, astronomy, or biology. The award, which will include US\$2500, is to be applied to the study of impact craters, either on Earth or on the other solid bodies in the solar system. Areas of study may include, but are not limited to, impact cratering processes; the bodies (asteroidal or cometary) that make the impacts; or the geological, chemical, or biological results of impact cratering. <https://community.geosociety.org/pgd/awards/shoemaker>

### Ronald Greeley Award for Distinguished Service

**Nominations due** 30 June

This award is given to members of the PGD, and those outside of the Division and GSA, who have rendered exceptional service to the PGD for a multi-year period. The award is not open to serving members of the management board but may be awarded to past members of the management board who have provided exceptional service to the PGD. Nominations, which should include a description of what the nominee has given to the PGD community, may be made by any PGD member to the management board. <https://community.geosociety.org/pgd/awards/greeley>

# GSA Receives Award for Connects 2021

On Wed., 9 March 2022, GSA Connects 2021 General Co-Chairs Jeff Rubin and Ian Madin represented the Geological Society of America as it was awarded the Twin Spires Award from Travel Portland at their 42nd Annual Tourism and Hospitality Industry Awards Ceremony. The Twin Spires award is presented to an individual or association that has made a significant contribution to convention business in Portland. GSA was recognized for hosting our Connects 2021 meeting in Portland as the first citywide convention since the start of the pandemic, demonstrating a strong commitment and contribution to help move Portland's hospitality community into recovery. GSA has long supported the city of Portland, hosting the Cordilleran Section's 115th Annual Meeting in 2019 and the Annual Meeting & Exposition in 2009.

Congratulations to Jeff, Ian, the local organizing committee, and the GSA staff for preserving through the past challenging year and hosting its first in-person annual meeting since 2019. For the full press release, go to <https://www.geosociety.org/events>.



GSA Connects 2021 general co-chair Ian Madin, Travel Portland's Cathy Kretz, and co-chair Jeff Rubin.

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# J Harlen Bretz (1882–1981): Outrageous Geological Hypothesizer

*Victor R. Baker, Dept. of Hydrology and Atmospheric Sciences, The University of Arizona, Tucson, Arizona 85721-0011, USA*



**J Harlen Bretz.**

Experienced geologists know well that their field counts among its most able and stellar practitioners a strong-willed array of “characters.” Outstanding from this pantheon is J (editors take note: insert no period after this one-letter first name!) Harlen Bretz (1882–1981). In his studies of the origin of the Channeled Scabland landscape in eastern Washington, beginning in the early 1920s, J Harlen Bretz provided a type example for what William Morris Davis (1850–1934) subsequently defined as an “outrageous geological hypothesis.”

As a science, geology is as much characterized by its methodology as it is by its down-to-earth subject matter. That methodology, so ably described by Thomas Chowder Chamberlin (1843–1928), one of the professors for Bretz’s Ph.D. studies, is focused on hypotheses. Geological hypotheses, unlike those in physics, are not merely parsimonious conjectures formulated as propositions to be tested or falsified. Geological hypotheses are “working” and even “regenerative” (Chamberlin’s terminology) in that they are meant to be fruitful for further inquiry. Moreover, geological hypotheses can occasionally be outrageous, though such outrage must never be imposed upon what nature presents to the geologist. An outrageous geological hypothesis can only be fruitful if it illuminates the inadequacy of prevailing theories and points toward more productive lines of inquiry.

This outrageous geological hypothesizer was born Harley Bretz (the “J Harlen” came later) on 2 September 1882 in the small farming town of Saranac, Michigan, USA. Though young Harley had interests in many aspects of natural science, his overriding passion was for astronomy. Unfortunately, as an undergraduate at Albion College, he did poorly in mathematics, a failing that he later ascribed to falling out of bed as a toddler and hitting a part of his head—the part that does mathematics. His interests then turned to biology and geology.

After graduating from Albion in 1905, Bretz taught biology for a brief period in Flint, Michigan. In 1907, he and his wife, Fanny, moved to Seattle, Washington, where he taught science at three different high schools over the next several years. During the long summer breaks, he explored the local glacial geology. His mapping of Pleistocene surficial deposits eventually covered the entire Puget Sound region from Centralia and Chehalis to the Canadian border. Bretz used these extensive field studies as the basis of a Ph.D. dissertation in geology from the University of Chicago in 1913.

The “J Harlen” name arose during this period. Bretz’s biographer John Soennichsen quotes Bretz’s daughter, Rhoda: “He invented the Harlen thing, just as he had invented the J in front of his name—made the whole thing up. Harley Bretz was his given name, but it just didn’t ring a bell for him; maybe he didn’t think it sounded professional enough.” In reviewing the submitted Ph.D. dissertation, Rollin D. Salisbury (1858–1922), Bretz’s Ph.D. supervisor at Chicago, asked him to spell out the first name on the author line. When Bretz responded that “J” was his entire first name, Salisbury admonished, “Then never put or allow a typist or printer to use a period after that J.”

Upon receiving his Ph.D., Bretz spent a year as an assistant professor of geology at the University of Washington, but in 1914 Salisbury recruited him to return to the University of Chicago, first as instructor in geology (1914–1915), then as assistant professor (1915–1921). His responsibilities at Chicago emphasized teaching in the field. Perhaps influenced by his own largely self-taught path to geological understanding, and reinforced by his Chicago mentors, Bretz became a lifelong advocate of geological education in the field. He wrote in his unpublished memoirs, “My ideal was to teach geology from the field as much as possible.” He instinctively rejected, “...text book and lecture methods without field work.”

At Chicago, Bretz became renowned as a teacher. Starting in 1915, he was responsible for the field course held each summer in the Devil’s Lake region near Baraboo, Wisconsin. Over the next thirty years or so, “Doc” Bretz served as mentor to hundreds of budding geologists, emerging from their tents near the lake each day, generally during the month of September, just before the start of classes. His teaching method was Socratic. It was the students who made all the discoveries, but they were ultimately guided in their geological hypothesizing by Doc’s questioning. As Bretz wrote in his unpublished memoirs, “I never would tell. I always made them work out their own salvation.”

In 1916, Bretz initiated an advanced field course during the early summer, in which he took small numbers of University of Chicago students to the northwestern U.S. In the summer of 1922, this advanced course moved to the Columbia Plateau region of eastern Washington. Thomas Large, a teacher at Lewis and Clark High School in Spokane, Washington (and one of the founders of the Northwest Scientific Society), aided with local logistical arrangements. In the course of work during the summers of 1922 and 1923, Bretz and his students documented an amazing



Bretz (on left) with University of Chicago geology graduate students standing in front of a Model T that was provided by Thomas Lodge for the field seasons of 1923 and 1924. (Photograph provided by Lodge's grandson, Brian McDonald.)

assemblage of landforms that included coulees, immense dry cataracts, rock basins, anastomosing channel ways, and gravel bars. Field relations among these features, most notably the multiple levels of divide crossings, led Bretz to propose that an immense cataclysmic flood had swept across the Columbia Plateau in late Pleistocene time, creating the great plexus of channel ways that he named the “Channeled Scabland.”

In a 1923 paper, Bretz concluded, “It was a debacle which swept the Columbia Plateau.” He named this debacle the “Spokane Flood,” thereby initiating the famous controversy. As he well knew, the notion of catastrophic flooding directly challenged substantive and epistemological notions of uniformitarianism that were thought to underpin geology as a science. These uniformitarian principles held that cataclysmic processes were unsuitable topics for proper scientific investigation. To counter this presumption, Bretz conducted extensive field investigations each summer, the results of which he meticulously detailed in more than a dozen major papers from 1923 to 1932.

How was it that this outrageous hypothesis got published? In today’s culture of “publish or perish,” outrageous hypotheses tend to get soundly squelched within the secret rituals of peer review. Today’s younger scientists, wary of their h-index rankings, can be reluctant to expend effort on topics that deviate from currently fashionable paths of inquiry. But Bretz had some advantages in this regard. First, he became tenured shortly before he formulated

his outrageous hypothesis. Second, and just prior to the paper submission to the *Journal of Geology*, he was named to the editorial board of that journal.

Although the “Spokane Flood Debate” would rage on for several decades, Bretz largely abandoned the scabland scene after his decade of intensive fieldwork. He trusted that a resolution of the controversy would eventually be found when others devoted appropriate field investigations to the problem. Beginning in 1933, Bretz initiated new lines of research, beginning with glacial studies as a member of the Louise A. Boyd Expedition to East Greenland. From 1938 to 1961, Bretz devoted considerable research to the origin of limestone caverns. His cave studies in 17 states, Mexico, and Bermuda placed physical speleology on a firm scientific basis, and his insights and energy were important to the late twentieth-century resurgence of karst geomorphic and hydrologic studies in the United States.

Resolution of the Channeled Scabland controversy came gradually, initially with the documentation by Joseph Thomas Pardee (1871–1960) of ice-dammed Pleistocene glacial Lake Missoula in western Montana as a plausible source for the scabland megaflooding. Eventually the accumulating field evidence became overwhelming, particularly when Bretz and others synthesized new data obtained by the U.S. Bureau of Reclamation’s Columbia Basin Irrigation Project in the 1950s. Especially important for convincing skeptics was the discovery that giant current ripples (gravel dunes) cap many of the scabland gravel mounds that Bretz had noted in the 1920s to be immense river bars. By the late 1960s and early 1970s, as the field evidence mounted and as advances were made in understanding the physical processes of high-energy megaflooding, Bretz’s bold hypothesis came to be generally accepted by the geological community.

At age 97, in recognition for more than 70 years of scientific achievements, J Harlen Bretz was honored with the 1979 Penrose Medal of The Geological Society of America. In accepting, Bretz listed his major research accomplishment as follows: “Perhaps I can be credited with reviving and demystifying legendary catastrophism and challenging a too rigorous uniformitarianism.”

#### FURTHER READING

Baker, V.R., 2008, The Spokane Flood debates: Historical background and philosophical perspective, in Grapes, R., Oldroyd, D., and Grigelis, A., eds., *History of Geomorphology and Quaternary Geology*: Geological Society, London, Special Publication 301, p. 33–50.

Soenichsen, J., 2008, Bretz’s flood: The remarkable story of a rebel geologist and the world’s greatest flood: Seattle, Washington, Sasquatch Books, 289 p.

# GSA Science Policy Fellow: Applying a Scientific Perspective to Policy



**Morgan Disbrow-Monz**

Looking back on my academic trajectory and the passions I developed, I am not surprised by my pivot toward science policy, and I am incredibly grateful for the opportunity through GSA to be working as their 2021–2022 Science Policy Fellow. I pursued this fellowship to expand my understanding of the unique roles scientists play in the policy process and to learn how to apply my technical scientific background to legislative efforts. As a lifelong scientist with a limited policy background, the fellowship is providing me with the essential skills, mentorship, and a professional network to be an effective communicator in the policy arena.

My career trajectory has always been guided by my love of the outdoors and a desire to better understand the complex interactions between human behavior and the environment. I pursued a Ph.D. from the University of Minnesota focused on connecting my passion for structural geology with my desire to protect the world I grew up exploring. My research focused on a better understanding of the flow of ice, which is essential for constraining the speed at which glacial discharge occurs, building more accurate climate models, and preparing for the impacts of sea-level rise and increased coastal erosion. While I loved pushing the boundaries of understanding by tackling scientific challenges and questions through research and enjoyed sharing my passion for the geosciences through teaching and outreach, I became increasingly curious about how the science itself was being used for effective policy implementation.

I began seeking opportunities to better understand the policy process late in my academic career. The GSA Science Policy Fellowship presented a unique opportunity to work directly with the legislative process by tracking geoscience-related legislation in Congress and working collaboratively with stakeholders to develop strategic communication to policymakers. This position fulfills my curiosity needs by allowing me to continue expanding my knowledge of scientific issues but with an emphasis on building human relationships to promulgate that knowledge.

The fellowship also serves as a direct way to work toward bridging the communication gap between scientists and policymakers—an effort that is essential to developing strong legislation. Specifically, I rely on creative communication strategies to serve

as a liaison between GSA members and policymakers. My efforts include writing about current legislation on GSA's *Speaking of Geoscience* blog, expanding GSA's public toolkits for effective meetings with policymakers, developing informational webinars, and interacting with members directly at GSA's various meetings.

As is consistent with most offices on and around the Hill, the fellowship is currently operating in a hybrid style due to the COVID-19 pandemic. My schedule is exciting, varying daily, but it almost always includes a number of meetings. I often attend and prepare reports on congressional hearings and briefings to stay up to date on geoscience-related issues and track legislation relevant to the geoscience community. I also work directly with a variety of different working groups and coalitions to (1) coordinate messaging to Congress supporting the advancement of scientific research, and (2) develop informational briefings that support congressional priorities to help bring clarity to different scientific issues.

I strongly encourage students who are planning on graduating soon and are curious about science policy to apply for the 2022–2023 Science Policy Fellowship. The fellowship offers an incredible opportunity to develop a foundational understanding of Congress, increase communication skills, build a network of professionals, and work with fantastic mentors. Additionally, GSA fosters an inclusive and supportive work environment that goes unmatched. For more information about the fellowship and the application process, go to [www.geosociety.org/policy](http://www.geosociety.org/policy) and click on "Science Policy Fellowship."

GSA also hosts additional science policy opportunities and resources, many of which can be explored in detail on GSA's website, and includes position statements, recorded webinars, toolkits to engage with policymakers, and letters and testimonies supported by GSA. The GSA Congressional Science Fellowship, which is jointly sponsored by the U.S. Geological Survey, places a Ph.D. scientist within a congressional office or on a congressional committee for a year. The fellowship has an annual 15 January application deadline ([www.geosociety.org/csf](http://www.geosociety.org/csf)). GSA also partners with other earth-science societies to host geoscience congressional visit days, bringing geoscientists to D.C. to learn about the policy process and increase the visibility of the importance of the geosciences in Congress through congressional visits. If you are interested in learning more about these opportunities, please reach out to the GSA policy office at [sciencepolicy@geoscociety.org](mailto:sciencepolicy@geoscociety.org).

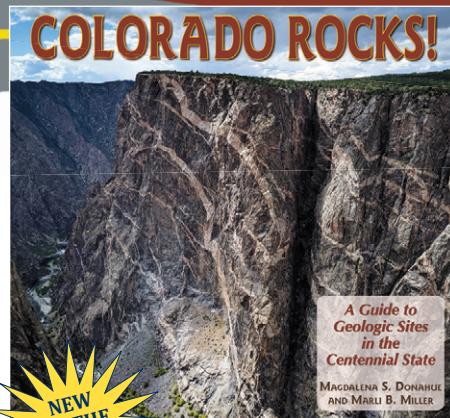
# Expand Your Professional and Peer Network by Applying to the On To the Future Program



Applications are now being accepted for GSA's On To the Future (OTF) program. If you are a student or recent graduate from a group underrepresented in the geosciences who has never attended an annual meeting, apply by 3 June. Awardees attending in person will receive a travel grant to attend the GSA Connects 2022 meeting in Denver, Colorado, USA. Included with your award is a one-year free GSA membership, full in-person or online meeting registration, one-on-one mentorship during the meeting, special events with GSA leadership, and professional and peer connections that will last you a lifetime. Scholars and mentors may participate in person or virtually.

[www.geosociety.org/OTF](http://www.geosociety.org/OTF)

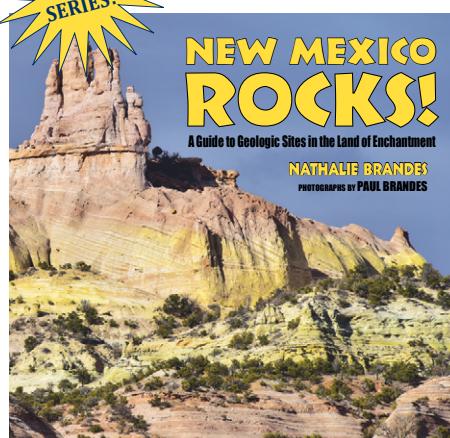
*GSA encourages low-income, Black, Indigenous, and People of Color, first-generation, non-traditional, women, veterans, LGBTQIA+, and students with disabilities to apply.*



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# Nomination of T.rex (*Tyrannosaurus rex*) for National Fossil Reptile and Nomination of the American Mastodon (*Mammut americanum*) for National Fossil Mammal

America has a national fossil day but no national fossil. It is time to fill that void. Fossils are a part of America's heritage and a great introduction to science, beginning in kindergarten.

The selection of the bison as America's national mammal in 2014 opens the door for selecting two national fossils, a reptile and a mammal. There are two fossils with a pure North American pedigree that stand out above all others: the dinosaur *Tyrannosaurus rex*, known as T.rex, and the American mastodon, *Mammut americanum*.

For many Americans, the first fossil that comes to mind is T.rex, which roamed western North America between about 68 and 66 million years ago. No other fossil comes close to matching the appeal of T.rex to young and old alike, the world over. It fits the mold of other national symbols and is the perfect candidate for national fossil reptile.

For national fossil mammal, the mastodon would be an excellent choice. It roamed throughout North America from about 2.4 million years ago to about 10,500 years ago when it became extinct. Mastodon fossils are found, or could be found, in every state except Hawaii. Mounted mastodons are featured attractions in museums in at least fifteen states and the District of Columbia.

A lingering question is, "Why select the mastodon over the more popular look-alike, the mammoth?" Elimination of the mammoth for consideration as national mammal fossil is based on two issues. First, there are two species of mammoths in America, a potential source for confusion, and the more popular wooly mammoth is best known from fossils in Siberia. Second, the mammoth

is an elephant, the symbol of a national political party. Politics must be kept out of the selection of a national fossil.

In the fall of 2021, Randy Frye, a member of Indiana's House of Representatives, visited the Hanover College Science Center, where casts of Tinker, a juvenile T.rex, and Sandy, the Burning Tree mastodon, are on display. That visit prompted him to introduce House Bill 1013, naming the American mastodon, *Mammut americanum*, as Indiana's state fossil.

For the Indiana legislature, the approval of a state fossil rested largely on its educational value. House Bill 1013 was approved 92–0 by the House and 39–6 by the Senate. The bill becomes effective 1 July.

The same approach should be applicable at the national level, where new educational opportunities would be welcomed and valued. Paired together, the T.rex and the mastodon offer a wide range of topics in science education at all grade levels. They certainly fit the mold of other American symbols in representing the best of what makes America great.

What's next? If you agree with my proposal, contact your elected representatives to Congress. I plan to do the same. Working together, we can make it happen. You may contact me at [totten@hanover.edu](mailto:totten@hanover.edu). I would appreciate hearing from you.

Stanley M. Totten  
Professor Emeritus of Geology  
Hanover College  
Hanover, Indiana 47243, USA

# Exceptional Reviewers for 2021

GSA appreciates the many people who make its peer-reviewed journals possible: the authors, science editors, editorial board members, associate editors, and most of all, the reviewers. Peer review of papers is the cornerstone of scientific publishing, but reviewing papers is all too often a thankless task. For all those who complete timely, thorough, and even-handed reviews, GSA

thanks you. GSA's journal science editors have selected the following people for special recognition of the many prompt, insightful, meticulous, and tactful reviews they completed. (Photos of these colleagues are posted at [www.geosociety.org/GSA/Publications/GSA/Pubs/exceptional\\_reviewers.aspx](http://www.geosociety.org/GSA/Publications/GSA/Pubs/exceptional_reviewers.aspx).)



## GSA BULLETIN

**Thomas Algeo**, University of Cincinnati

**William R. Guenthner**, University of Illinois at Urbana-Champaign

**Stephen T. Johnston**, University of Alberta

**Xiaoping Long**, Northwest University

**Xuxuan Ma**, Institute of Geology, Chinese Academy of Geological Sciences

**J. Brendan Murphy**, St. Francis Xavier University

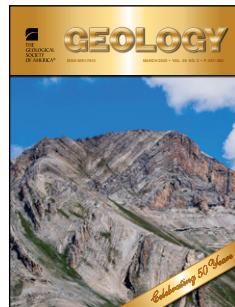
**John F. Slack**, U.S. Geological Survey (emeritus)

**Greg M. Stock**, National Park Service, Yosemite National Park

**Qiang Wang**, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences

**Jin Zhang**, Institute of Geology, Chinese Academy of Geological Sciences

**Ze-Ming Zhang**, Institute of Geology, Chinese Academy of Geological Sciences



## GEOLOGY

**Fatima Abrantes**, Instituto Português do Mar e da Atmosfera

**Peter Burgess**, University of Liverpool

**Christopher D. Henry**, University of Nevada

**Susan Ivy-Ochs**, University of Zurich

**Sam Purkis**, Rosenstiel School of Marine and Atmospheric Science, University of Miami

**Troy Rasbury**, Stony Brook University

**Randy Williams**, University of Wisconsin–Madison



## GEOSPHERE

**Cal Barnes**, Texas Tech University

**Andrew Meigs**, Oregon State University

**Calvin F. Miller**, Vanderbilt University

**Terry L. Pavlis**, University of Texas at El Paso

**Bradley W. Pitcher**, Vanderbilt University

**Sarah Roeske**, University of California, Davis



GSA FOUNDATION

# Update

## From Field Geologist to CEO: Brunton Is in New Hands

Corporate engagement has long been a crucial part of the development and financial support of the GSA Foundation and GSA programs. Our partners are highly committed to the next generation of geoscientists, and we are thrilled to highlight recent, exciting happenings at GSA's organizational partner, Brunton. Brunton is now a family-owned, geologist-owned—and, for the first time, woman-owned—Wyoming small business.

The Brunton brand is known and sold worldwide, especially in the geology community, where a pocket transit of any model is simply called “a Brunton.” The Geological Society of America is eager to continue working with the company under its new ownership. In Lauren Heerschap, GSA has a true partner with deep connections: She received a GSA graduate student research grant while working on her master’s degree and participated in a GSA Penrose Conference in Taiwan. She became a student member of GSA in 2002 and has attended, presented, and worked at many GSA annual and Section meetings since then.

Lauren remembers the day she first learned how to use a Brunton pocket transit. She was 20 years old, at an outcrop of Cambrian sandstone in the Black Hills of South Dakota, and it was the first week of an eight-week undergraduate geology field camp. “I argued with my team for over an hour about how to measure strike and dip,” says Heerschap. “The sandstone bed was almost horizontal, and we couldn’t figure out how to do it.”

So began Heerschap’s journey with Brunton compasses. After seven or so years of using Bruntons in teaching field methods, she came up with the idea for a new pocket transit model that solved many of the issues she had experienced as a student. That idea was prototyped into reality by her husband, David Heerschap, in their garage over winter break. Dave was also a science educator at the time and had just started a company that offered homemade teaching tools and field equipment for science teachers and students. Lauren and Dave patented the idea, tested it with field camps that summer, then approached Brunton in the fall of 2014 about licensing the idea.



Brunton's new Orange Standard Transit, being awarded to each of the 30 GSA 2022 J. David Lowell Field Camp Scholarship recipients.



**Brunton's Lauren Heerschap gets help from the littlest field assistant: Hannah, Lauren and David's daughter, who is "now too heavy to carry for miles up into the mountains—she has to hike it herself!"**

Two years later, the Axis transit was born—renamed and rebranded, with Lauren and Dave involved throughout the product development and rollout phases. The Heerschaps worked the Brunton booth for several geological conferences to help introduce the Axis and support the rest of the product line. Their increasing involvement led to a job opportunity and career switch for Dave when the previous Brunton engineer of 40 years was nearing retirement. A few years later, in early 2021, Lauren also officially joined the Brunton team as pro & international sales manager.

And that's when things got interesting. The Heerschaps were approached by the previous brand management, who presented the opportunity to acquire the Brunton brand and all of its assets. A fortuitous combination of a favorable offer from the previous brand owner and family investors made the acquisition possible.

The company is an organizational partner that supports GSA's annual meeting through sponsorship and an exhibit hall booth, and provides demo fleets of compasses for some of GSA's field trips. In 2021, the company solidified its partnership with the Society in yet another meaningful contribution, specifically to students: Brunton provided a personalized, engraved ComPro Transit for each of GSA's 2021 J. David Lowell Field Camp Scholarship recipients. In 2022, they will increase this already generous gift to an Orange Standard Transit for all 30 field camp scholarship recipients. The contribution further decreases equipment expenses for each of these students while providing them with the geologist's most essential instrument.

Together, GSA and Brunton can maximize the collective ability to foster current and future leaders in the geoscience community. We strive to engage business and industry as a positive force to advance science, stewardship, and service, joining with corporations in the meaningful impacts of partnership. If you want to learn how you or your employer can join these efforts, please contact Debbie Marcinkowski at +1-303-357-1047 or [dmarcinkowski@geosociety.org](mailto:dmarcinkowski@geosociety.org)

For more information about Brunton, go to [www.brunton.com](http://www.brunton.com).

Memoir 219



# PROVIDENCIA ISLAND

A Miocene Stratovolcano on the Lower Nicaraguan Rise,  
Western Caribbean—A Geological Enigma Resolved



By Alan L. Smith, M. John Roobol, Glen S. Mattioli, George E. Daly, and Joan E. Fryxell

## Providencia Island: A Miocene Stratovolcano on the Lower Nicaraguan Rise, Western Caribbean— A Geological Enigma Resolved

By Alan L. Smith, M. John Roobol,  
Glen S. Mattioli, George E. Daly,  
and Joan E. Fryxell

Providencia is the only example of subaerial volcanism on the Lower Nicaraguan Rise. In this volume, the authors examine this volcanism and the geological history of the western Caribbean and the Lower Nicaraguan Rise, whose origin and role in the development of the Caribbean plate has been described as enigmatic and poorly understood.

While the Providencia alkaline suite is similar to others within the Western Caribbean Alkaline Province, its subalkaline suite is unique, having no equivalent within the province. In order to unravel its complex history and evolution, this volume presents new and previously published results for the geology, geochemistry, petrology, and isotopic ages from the Providencia island group.

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### **POSITION OPEN**

#### **Tenure Track Assistant Professor in Coastal Processes, University of Hawai'i at Mānoa**

The Department of Earth Sciences in the School of Ocean and Earth Sciences and Technology, University of Hawai'i at Mānoa seeks to fill a tenure track faculty position at the level of Assistant Professor in the broad area of coastal processes. The coastal zone is a nexus of climate, society, resources and the Earth Sciences regionally and globally. We seek a talented scientist eager to leverage our unique Pacific Island location to conduct studies of both regional and global Earth Science topics using observational and/or computational approaches. The successful applicant is expected to establish an externally funded and nationally recognized research program, enthusiastically contribute to graduate and undergraduate advising and teaching, and carry out professional service activities. Willingness to engage with faculty, staff, and students in a collaborative fashion that supports Indigenous values and perspectives, as well as diversity and inclusivity are essential.

We are specifically interested in an individual who will use field observations, laboratory studies and/or modeling to improve understanding of dynamic coastal processes, coastal geomorphology and geology (including use of modern and paleo archives), impacts of sea level rise, coastal hazards and other societal impacts, and/or nearshore hydrodynamics. Expertise in the design and maintenance of observational systems to underpin empirical decision-making, track coastal environmental changes, and/or to support data-assimilating model development are desirable. Collaboration with a new SOEST Climate Resilience Initiative provides opportunities to leverage partnerships with economists, physical oceanographers, architects, and other professionals working on the problems associated with sea level rise and other climate change hazards. See position number 83271 at [workatuh.hawaii.edu](http://workatuh.hawaii.edu) for the complete vacancy announcement.

The Department of Earth Sciences (<http://www.soest.hawaii.edu/earthsciences/>) is one of thirteen research units and four academic departments within the School of Ocean and Earth Science and Technology (SOEST) (<https://www.soest.hawaii.edu/soestwp/>), a world-class research and academic institution focused on informing solutions to some of the world's most

vexing problems. The Department has 22 tenured or tenure-track faculty as well as 30 additional cooperating graduate faculty in the Hawai'i Institute of Geophysics and Planetology (<https://www.higp.hawaii.edu/>). Together these faculty instruct and advise approximately 50 graduate students and 40 undergraduate majors.

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Apply online at <https://www.governmentjobs.com/careers/hawaiiedu>. Search for position number 83271 and click on the "Apply" (top right corner of the screen). If this is your first time using NEOGOV you will need to create an account. Applicants must upload a single-file PDF containing six parts (1) A one-page cover letter; (2) A curriculum vitae with a publication list; (3) Names and contact information of three individuals willing to provide professional reference letters; (4) A statement describing research interests, accomplishments, and future research plans; (5) A statement describing experiences in, and approaches to, teaching and mentoring students; and (6) A statement describing contributions to diversity and inclusion, and plans to foster an inclusive environment in their role at the University of Hawai'i at Mānoa. In particular, your approaches to inclusion of Indigenous perspectives are encouraged.

Review and evaluation of applications will begin immediately and continue until the position is filled. Preference will be given to applications received on or prior to April 15, 2022, but applications received after this date may also be considered. Further questions about the faculty position can be addressed to Prof. Brian N. Popp, [popp@hawaii.edu](mailto:popp@hawaii.edu).

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Scholarship application deadline for this program is due by 31 July 2022, but we encourage you to contact us well in advance.

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More details on Faculty and Staff in Earth Sciences at James Cook University [<https://www.jcu.edu.au/college-of-science-and-engineering/meet-our-academic-teams/earth-and-environmental-science-staff>].

If you are interested, please contact EGRU ([egrugr@jcu.edu.au](mailto:egrugr@jcu.edu.au)) with your CV and a Cover Letter indicating your project(s) of interest and background.

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- Paleozoic stratigraphy and petrology of carbonates and clastics (Prof. Liz Measures)
- The stratigraphy and paleontology of Upper Cretaceous–Paleogene strata of the Big Bend and northern Mexico (Prof. Thomas Shiller)

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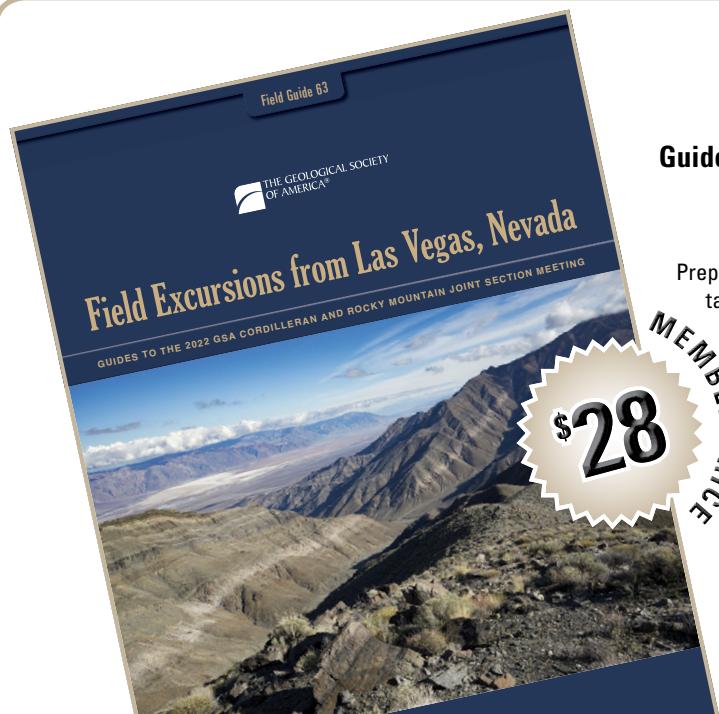
Sul Ross is a small university in the mountainous region of far west Texas, near three national parks and in proximity to the geology faculty's research areas. Our faculty are committed to providing individual attention and excellent resources to each student.

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## FIELD GUIDE 63



### Field Excursions from Las Vegas, Nevada: Guides to the 2022 GSA Cordilleran and Rocky Mountain Joint Section Meeting

*Edited by Ganqing Jiang and Carol Dehler*

Prepared in conjunction with the 2022 GSA Cordilleran and Rocky Mountain Joint Section Meeting, this Field Guide showcases trips to geologically interesting areas in Arizona, Nevada, and California. Enjoy a three-day trip to the Buckskin-Rawhide and northern Plomosa Mountains metamorphic core complexes in Arizona. In Nevada, learn about the geology of Frenchman Mountain and Rainbow Gardens and landslide deposits and mechanisms in the eastern Spring Mountains. Or learn about microbialites in Miocene and modern lakes near Las Vegas. When weather permits, unravel the geological history of southern Death Valley, and explore vertebrate paleontology and Cenozoic depositional environments in Death Valley, California.

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# Rapid Sediment Re-Deposition May Limit Carbon Release during Catastrophic Thermokarst Lake Drainage

**Brian S. Burnham\***, School of Geosciences, University of Aberdeen, Aberdeen, AB24 3UE, UK; **Peter P. Flaig**, Bureau of Economic Geology, Jackson School of Geosciences, The University of Texas at Austin, Austin, Texas 78712, USA; **Brice R. Rea, Matteo Spagnolo**, School of Geosciences, University of Aberdeen, Aberdeen, AB24 3UE, UK; **Michael H. Young**, Bureau of Economic Geology, Jackson School of Geosciences, The University of Texas at Austin, Austin, Texas 78712, USA

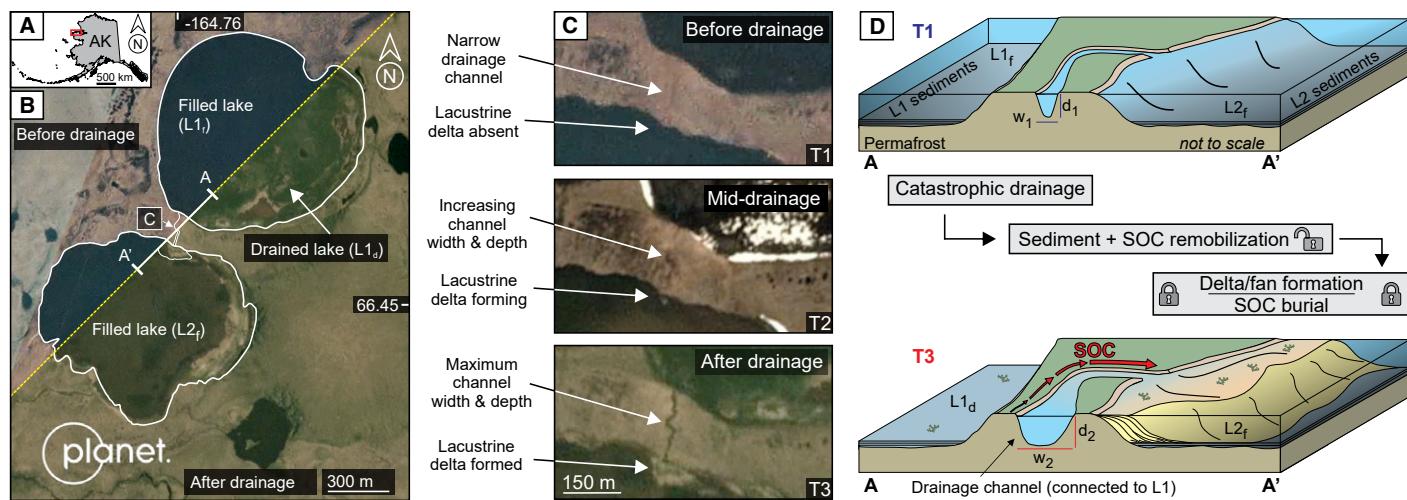
## A CARBON SOURCE

Arctic soil organic carbon (SOC), the largest terrestrial organic carbon reservoir (Tarnocai et al., 2009; Schuur et al., 2015), is typically locked up in permafrost (Tarnocai et al., 2009; Olefeldt et al., 2016; Turetsky et al., 2020), but is under threat. The mean annual air temperature in the Arctic is rising twice as fast as the global average (Schuur et al., 2015). Permafrost will further degrade, exposing significant quantities of SOC to decomposition and respiration, releasing greenhouse gases (GHG), like  $\text{CO}_2$  and  $\text{CH}_4$ , into the atmosphere (Walter et al., 2006; Mackelprang et al., 2011; Cory et al., 2014; Turetsky et al., 2020), driving a feedback loop of increasing air temperatures and degrading permafrost (Schuur et al., 2015).

A complex relationship of interlinked processes (e.g., climate, precipitation, erosion) drives permafrost degradation and differential land subsidence that generates thermokarst lakes (van Huissteden et al., 2011) (Fig. 1), which expand slowly through heat conduction, enhancing permafrost thaw and mass wasting at lake margins. Thermokarst lake expansion is projected to continue under future climate warming (Smith et al., 2005; Walter, et al., 2006; van Huissteden et al., 2011). Thermokarst lakes may also drain catastrophically (Mackay, 1988), creating thermo-erosion gullies (Figs. 1B and 1C) that result in substantial (discharge rates up to  $25 \text{ m}^3 \text{s}^{-1}$ ; Jones and Arp, 2015) sediment and SOC erosion from lake margins and along drainage channels. This is assumed to decrease the permafrost

carbon store because the liberated SOC is vulnerable to degradation and GHG release (Vonk and Gustafsson, 2013), resulting in a net flux (positive) to the atmospheric carbon pool.

Catastrophic drainage events may increase in frequency (Jones et al., 2020), but the fate of released carbon is poorly constrained. A first-order approximation of carbon released by erosion during catastrophic thermokarst lake drainage events suggests that a significant volume of the eroded material, and potentially SOC, is rapidly re-deposited (hours to days) (Jones and Arp, 2015) in proximal downstream deltas/subaerial fans (Fig. 1B), limiting the net carbon release. Data on SOC volumes partitioned into particulate organic carbon (POC) available for re-deposition, or dissolved organic carbon



**Figure 1.** Catastrophic lake drainage and lacustrine delta formation. (A) Approximate location of the five thermokarst lakes analyzed herein. (B) Planet CubeSat imagery of two thermokarst lakes (Lake ID 99492) showing images before ( $L1_f$ ) and after ( $L1_d$ ) drainage, where lake  $L1$  rapidly drained into lake  $L2$  ( $L2_f$ ). (C) Satellite imagery showing  $L1$  drainage through a preexisting channel (T1: 27 Sept. 2017) that evolved into a thermo-erosion gully (T2: 7 June 2018). This event eroded, transported, and deposited large volumes of sediment and remobilized soil organic carbon (SOC) into the delta in  $L2$  (T3: 11 July 2020). (D) Schematic model of  $L1$  drainage, creation of a thermo-erosion gully, and deposition of a delta in  $L2$ . AK—Alaska.

(DOC) available for degradation, are limited. If a significant volume of POC is buried in delta deposits, however, the potential for GHG release is minimized. Counter-intuitively, catastrophic drainage of thermokarst lakes, and gully and lake margin erosion, may provide limited carbon release to the atmosphere.

## METHODS AND RESULTS

We analyzed satellite imagery (Planet Team, 2017) for five thermokarst lakes ( $98.5\text{--}1,403\text{ km}^2$ ) in NW Alaska that drained between 2017 and 2018 (Fig. 1A) (Nitze et al., 2020). Following catastrophic drainage, all channels widened by  $>1.7\text{ m}$  (Fig. 1C), and lengths remained constant (supplemental Table S1<sup>1</sup>). Channel depths could not be measured from available imagery. A delta or fan always formed in the receiving lake. SOC in the top two meters average  $8843.31\text{ g/m}^2$  (Zhu and McGuire, 2016), suggesting, conservatively, that  $>3.22\text{ Gg}$  of carbon may be remobilized during a single drainage event, or  $>42.2\text{ Gg}$  from the five events combined (supplemental Table S2 [see footnote 1]). Carbon eroded from lake margins proximal to channels could not be quantified, so the remobilized carbon calculations are conservative minima.

## A CARBON SINK

Material eroded during catastrophic lake drainage is commonly rapidly re-deposited, burying remobilized organic carbon into proximal lacustrine deltas/fans (Fig. 1C). Organic carbon in superficial deltaic sediments may undergo further degradation (Blair and Aller, 2012), but most carbon in the delta may no longer represent a source of GHG. Our conceptual model (Fig. 1D) suggests that thermokarst lake deltas/fans produced by catastrophic drainage may serve as proximal sinks of organic carbon.

Long-term organic carbon fate in these deposits remains uncertain. An increased magnitude and frequency of drainage and

re-deposition events will increase their impact on the local and regional carbon stores. Further work is required to identify the precise role of catastrophic thermokarst lake drainage in Arctic carbon fluxes.

## ACKNOWLEDGMENTS

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<sup>1</sup>Supplemental Material. Table S1: Geometric measurements obtained from satellite imagery of rapidly drained thermokarst lakes and associated deltas and thermo-erosion gullies. Lake ID relates to drained lakes identified in Nitze et al. (2020). Table S2: Estimated soil organic carbon content measured in gigagram (Gg) in top 2 m removed from thermo-erosion gullies. Estimates and approximate spatial resolution are derived from spatial statistical models presented in Zhu and McGuire (2016). Go to <https://doi.org/10.1130/GSAT.S.19083299> to access the supplemental material; contact [editing@geosociety.org](mailto:editing@geosociety.org) with any questions.

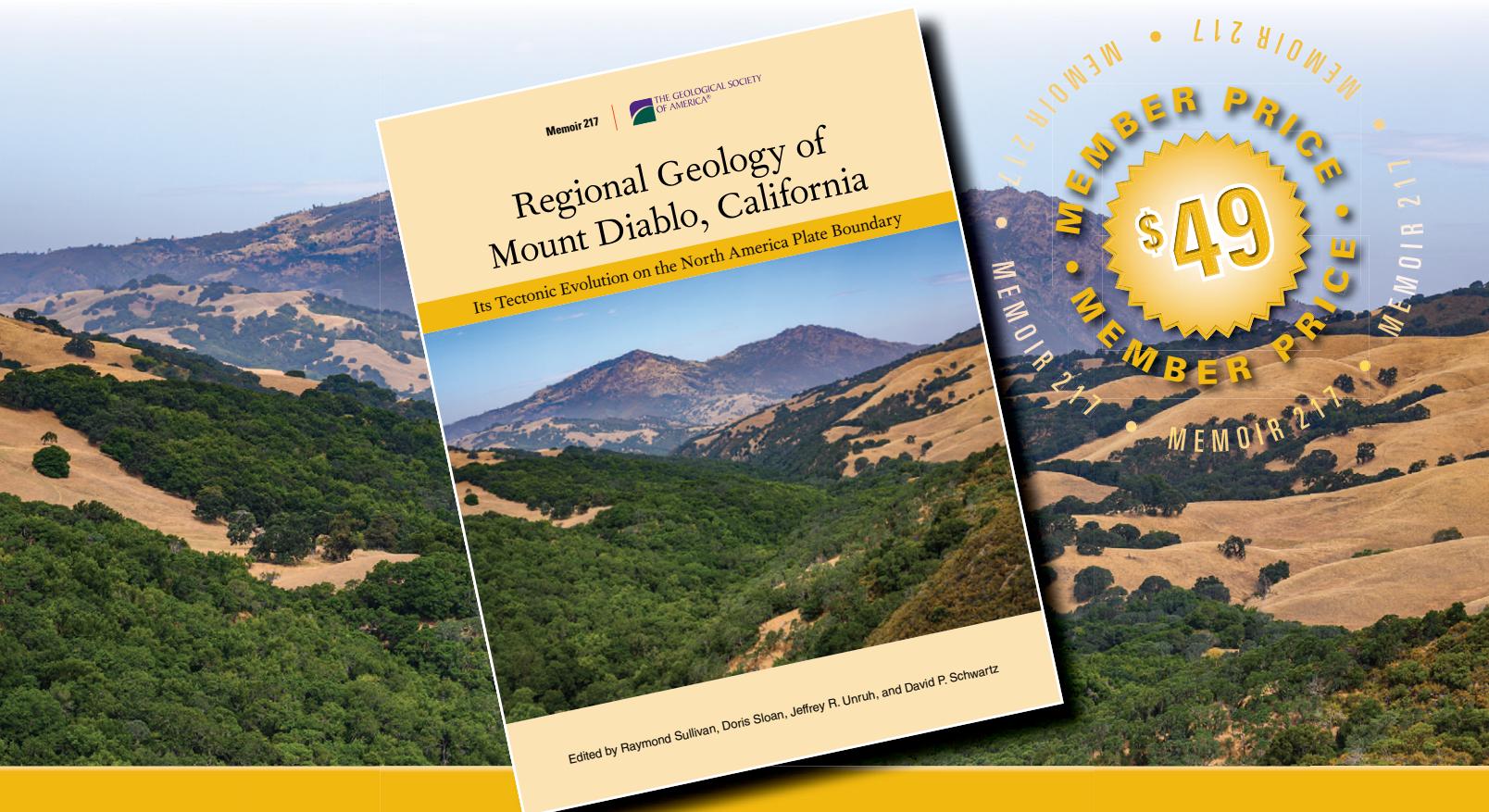
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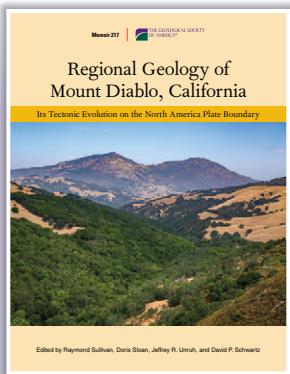
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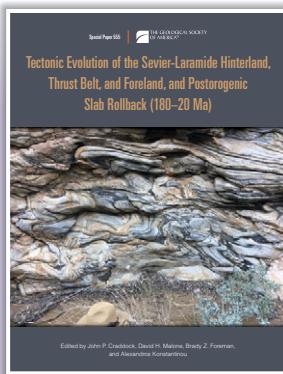


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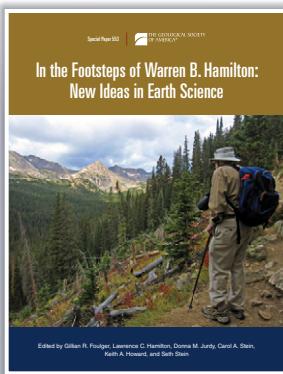
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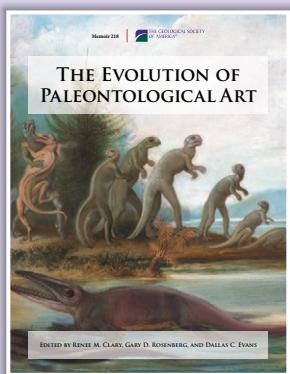
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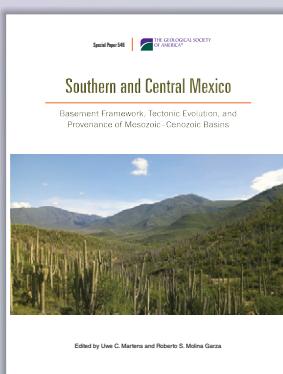
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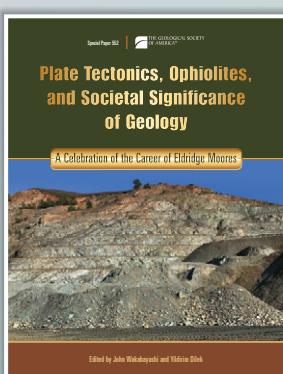
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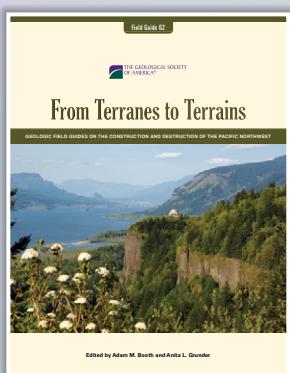
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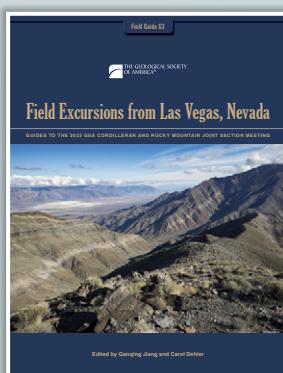
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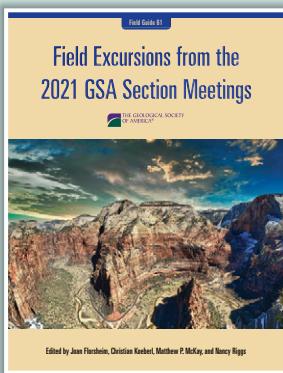
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