VOL. 35, NO. 12 | DECEMBER 2025

GSA TODAY

THE MEMBERSHIP PUBLICATION OF THE GEOLOGICAL SOCIETY OF AMERICA™

2025–2026 DIVISION OFFICERS

Science

SWOT Satellite: A New Tool for Fluvial Geomorphology

PAGE 4

Groundwork

Incorporating Ethics in College Geoscience Education through Community Engagement

p. 14

2026 Section Meetings

Save the Date and Submit Your Abstract

p. 18

The U.S. Geological Survey (USGS) National Cooperative Geologic Mapping Program's

EDMAP

Training the Next Generation of Geologic Mappers

CALL FOR PROPOSALS

The EDMAP component of the USGS National Cooperative Geologic Mapping Program offers 1- to 2-year funding to universities for graduate and upper-level undergraduate student geologic mapping and data synthesis projects:

- Faculty (including adjuncts) at accredited colleges and universities in the U.S. and its territories may apply.
- Applicants may request up to $45,000 to support each primary graduate student mapper, and up to $25,000 to support each primary undergraduate student mapper, per year for up to two years.
- Every Federal dollar requested must be matched 1:1 by the proposing institution.
- Each primary student mapper produces their own first-author geologic map.

Fault Mapping: *An EDMAP student from New Mexico Tech is digging a soil pit to date a surface offset of the Quaternary-active Alamogordo fault, in central New Mexico. Photograph taken by George Pharris, New Mexico Tech.*

Application Deadline: **mid-January 2026** (exact date posted on website); Instructional webinars to be offered during Fall of 2025.

To apply: visit *www.grants.gov,* select "Grant Opportunities" and search for keyword "**EDMAP**"

For more information: visit the EDMAP website via the QR code or contact the NCGMP EDMAP Team directly at EDMAP@usgs.gov.

U.S. Department of the Interior
U.S. Geological Survey

GSA TODAY

GSA TODAY (ISSN 1052-5173 USPS 0456-530) prints news and information for more than 19,000 GSA member readers and subscribing libraries, with 11 monthly issues (March-April is a combined issue). *GSA TODAY* is published by The Geological Society of America® Inc. (GSA) with offices at 3300 Penrose Place, Boulder, Colorado, USA, and a mailing address of P.O. Box 9140, Boulder, CO 80301-9140, USA. GSA provides this and other forums for the presentation of diverse opinions and positions by scientists worldwide, regardless of race, citizenship, gender, sexual orientation, religion, or political viewpoint. Opinions presented in this publication do not reflect official positions of the Society.

Subscriptions: GSA members: Contact GSA Member & Customer Services, +1-800-472-1988; +1-303-357-1000 option 3; gsaservice@geosociety.org for information and/or to place a claim for non-receipt or damaged copies. **Nonmembers and institutions:** *GSA TODAY* is US$117/yr; to subscribe, or for claims for non-receipt and damaged copies, contact gsaservice@geosociety.org. Claims are honored for one year; please allow sufficient delivery time for overseas copies. Periodicals postage paid at Boulder, Colorado, USA, and at additional mailing offices. Postmaster: Send address changes to GSA Member & Customer Services, P.O. Box 9140, Boulder, CO 80301-9140.

***GSA TODAY* STAFF**

Executive Director, CEO, and Publisher: Melanie Brandt

Science Editors: Peter Copeland, University of Houston, Department of Earth and Atmospheric Sciences, Science & Research Building 1, 3507 Cullen Blvd., Room 314, Houston, Texas 77204-5008, USA, copeland@uh.edu; **Christian Koeberl**, Department of Lithospheric Research, University of Vienna, Althanstrasse 14, A-1090 Vienna, Austria, christian.koeberl@univie.ac.at.

Managing Editor: Katie Busser, kbusser@geosociety.org, gsatoday@geosociety.org

Graphics Production: Mia Rincón, mrincon@geosociety.org

For advertising inquiries, contact: advertising@geosociety.org

GSA Online: www.geosociety.org
GSA TODAY: www.geosociety.org/gsatoday

Printed in the USA using pure soy inks.

THE GEOLOGICAL SOCIETY OF AMERICA®

CONTENTS

DECEMBER 2025

The Yukon River, shown here flowing across the Yukon Flats National Wildlife Refuge, drains a vast area within northwest Canada and the Alaskan interior. Its braided geomorphology is caused by an abundant supply of coarse-grained sediment sourced from upstream glaciers. Photo Credit: George Allen.

FEATURES

IN THE ISSUE

PAGE 14

Students in an undergraduate hydrology course conduct field work. Photo Credit: Lixin Wang.

SCIENCE

SWOT Satellite: A New Tool for Fluvial Geomorphology

Molly Stroud,*[,1] George H. Allen,*[,1] J. Toby Minear,[2] Julia Cisneros,[1] and Laurence C. Smith[3]

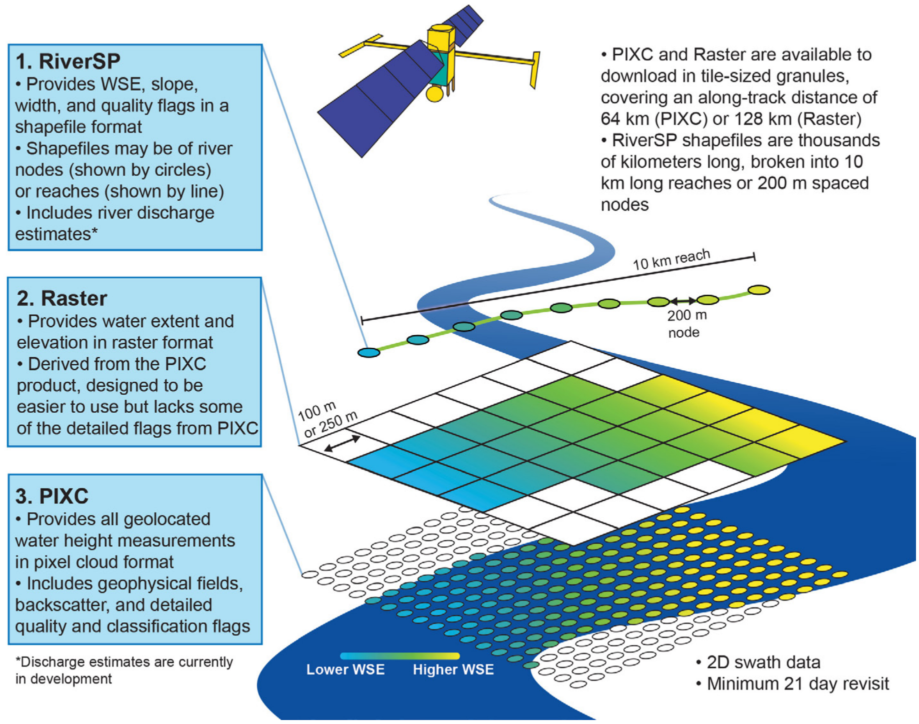


Figure 1. Three Surface Water and Ocean Topography (SWOT) satellite data products that are most relevant to fluvial geomorphology: the River Single Pass Vector Product (RiverSP), Raster Product, and Pixel Cloud Product (PIXC). Also shown are their relevant contents and formatting, such as water surface elevation (WSE) and quality flags.

ABSTRACT

Earth-observing satellites have revolutionized the field of fluvial geomorphology by providing large-scale and spatially contiguous observations. The recently launched Surface Water and Ocean Topography (SWOT) satellite's novel interferometric synthetic aperture radar (inSAR) instrument delivers global measurements of several key geomorphic parameters, such as river surface water elevation, slope, and width, and thus presents the opportunity to study fluvial processes in new ways. Here we explore the utility of the SWOT satellite for advancing understanding of fluvial geomorphology across river systems in the United States, specifically focusing on water surface elevation variations in large braided rivers, temporally dynamic shear stress in bedrock rivers, and the processes associated with knickpoints and dam failures. We also discuss other relevant potential applications of SWOT satellite data related to fluvial geomorphology beyond the scope of these early explorations. By providing global multitemporal observations of several key variables in fluvial geomorphology, SWOT represents a major advance in our ability to quantify, monitor, and understand fluvial systems and their dynamics.

SWOT: A NEW TOOL

Satellite remote sensing has long been used to study fluvial geomorphology, allowing for large-scale quantification of surface processes and changes (Smith and Pain, 2009). In recent decades, the field of fluvial geomorphology has undergone a notable increase in the use of geographic information systems (GISs), digital elevation models (DEMs), and satellite image analysis, although classical methods including field measurements and formulae remain the most commonly applied tools (Piégay et al., 2015). When studying fluvial systems over large areas and over extended time periods, satellite remote sensing provides unparalleled insight into Earth's river processes and dynamics, often representing the only feasible way to contiguously observe very large systems (Marcus and Fonstad, 2010).

The Surface Water and Ocean Topography (SWOT) satellite, launched in December 2022, has the potential to transform the field of fluvial geomorphology by providing new data that are unlike what past satellite missions have offered. SWOT produces high-precision images of surface water topography, enabling a new suite of analyses in fluvial geomorphology. SWOT was primarily designed for oceanography and inland hydrology applications and uses

*Corresponding authors: Molly Stroud, mollystroud@vt.edu; George Allen, geoallen@vt.edu
[1] Department of Geosciences, Virginia Tech, Blacksburg, Virginia 24061, USA
[2] Cooperative Institute for Research in Environmental Sciences, University of Colorado–Boulder, Boulder, Colorado 80309, USA
[3] Department of Earth, Environmental and Planetary Sciences, Brown University, Providence, Rhode Island 02912, USA
CITATION: Stroud, M., et al., 2025, SWOT satellite: A new tool for fluvial geomorphology: GSA Today, v. 35, p. 4–9, https://doi.org/10.1130/GSATG630A.1.

a Ka-band synthetic aperture radar to provide simultaneous measurements of both the elevation and extent of surface water over two 50-km-wide swaths (Fu et al., 2024). These same observations can also be readily utilized for fluvial geomorphology applications. The measured water surface elevation (WSE) is an important geomorphic variable in itself, and it can be used to estimate other variables including river slope and river discharge, both of which are related to sediment transport processes (Wolman and Miller, 1960; Bagnold, 1966; Howard et al., 1994).

Unlike past imaging radar satellites, SWOT's Ka-band and near-nadir look angle are particularly suited to observe water bodies, since water acts as a specular reflector at this frequency and backscatters most of the emitted energy toward the satellite (Biancamaria et al., 2016). Thus, SWOT fills a key observational gap in current satellite missions. Existing spaceborne light detection and ranging (LiDAR) missions, for example, produce highly accurate water elevation estimates, but they only collect data along a few narrow profiles, limiting their spatial coverage and observation frequency. SWOT's swath measurements not only provide global coverage but also allow for a comparatively dense spatiotemporal analysis of water bodies, opening the door for a more comprehensive understanding of Earth's water bodies than ever before (Fig. 1).

The SWOT mission provides a variety of data formats freely available to users—the most useful for fluvial geomorphologists being the high-rate data products, which are designed for inland water bodies and are available in three formats: vector, raster, and pixel cloud (a point cloud of water mask pixels). Figure 1 illustrates these data products and their resolutions, as well as other pertinent information regarding their use. While SWOT's vertical accuracy is still being assessed, early studies have found the WSE estimates to have an overall weighted root mean square error (RMSE) of <10 cm (Maubant et al., 2025). SWOT's mission requirements specify that rivers as narrow as 100 m and lakes as small as 250 m × 250 m must be observable. However, recent research has found that rivers as narrow as 40 m and lakes as small as ~100 m × 100 m can be accurately observed with SWOT (Maubant et al., 2025). Early and ongoing work indicates that SWOT may observe ice well in inland waters, and SWOT can accurately estimate sea-ice height (Kacimi et al., 2025). A product not shown in Figure 1 is the official SWOT river discharge product, which is currently being developed and will be freely available to users upon completion (Durand et al., 2023). For further information on accessing and visualizing SWOT data, including Python workflows, the National Aeronautics and Space Administration (NASA) SWOT Cookbook (podaac.github.io/tutorials/quarto_text/SWOT.html) is a helpful resource.

NEW APPLICATIONS

Here we showcase several examples of the SWOT mission's data products and how they may be applied to the field of fluvial geomorphology, and we conclude with suggestions for other future work.

LARGE RIVER DYNAMICS

Large rivers can have processes and patterns that differentiate them from smaller rivers and streams; for example, they often have greater internal complexity, more anabranching, and a wider range of channel planforms (Ashworth and Lewin, 2012). These complexities can make predicting their geomorphic behavior difficult, and much work has been dedicated to modeling and quantifying the morphology of large and braided rivers (Williams et al., 2016). Still, there remain many unanswered questions. For example, can intrachannel WSE variations help us understand channel path adjustments and avulsions (Wang et al., 2023; Gearon et al., 2024)? How do water-level variations affect sediment transport and deposition? Can water surface slope predict the formation or termination of river branches in multithreaded rivers?

SWOT can help us to answer these questions. SWOT observes large rivers with great spatial detail, and the Pixel Cloud Product (PIXC) product may be used to study multidimensional cross-channel patterns and changes. For example, Figure 2 shows SWOT observations over the Yukon River on the Yukon-Kuskokwim Delta in Alaska. Here, the Yukon River WSE is much higher in July than in February due to increased flow from snowmelt. Although multiple U.S. Geological Survey (USGS) gauges are located along the Yukon, they are at fixed points and do not offer comparable spatial dimensionality. SWOT enables us to observe intrachannel WSE variations and see how they change with different flows. These variations can advance understanding of river confluence dynamics (Biron et al., 2002) as well as meanders and bed shear stress distributions (Dietrich and Whiting, 1989). For example, Dietrich and Whiting (1989) showed that variations in WSE across a meander correlate with bed shear stress distributions, and thus can indicate where a river may be morphologically adjusting due to scour or deposition. Further, SWOT provides access to temporally dynamic global river slopes for the first time, which can be used to easily identify areas of low surface slope, which are commonly associated with anabranching (Wang et al., 2022). SWOT's global river slope observations may also be used for other applications: For example, Langhorst et al. (2019) demonstrated how the concavity of a river elevation profile can spatially correlate with underlying structural geology that may not be otherwise apparent on the surface.

BED SHEAR STRESS

SWOT's novel observations can also be used to estimate key parameters that relate to sediment transport in rivers. For example, channel bed shear stress, a fundamental measure of a river's ability to move bed material, may be calculated using the following equation (Bagnold, 1966):

$$\tau = \gamma RS, \qquad (1)$$

where τ is the shear stress, γ is the specific density of water, R is the hydraulic radius, here approximated as mean depth, and S is the slope of the water surface. Shear stress can change significantly with varying flows, and SWOT, in combination with bathymetric information, provides the

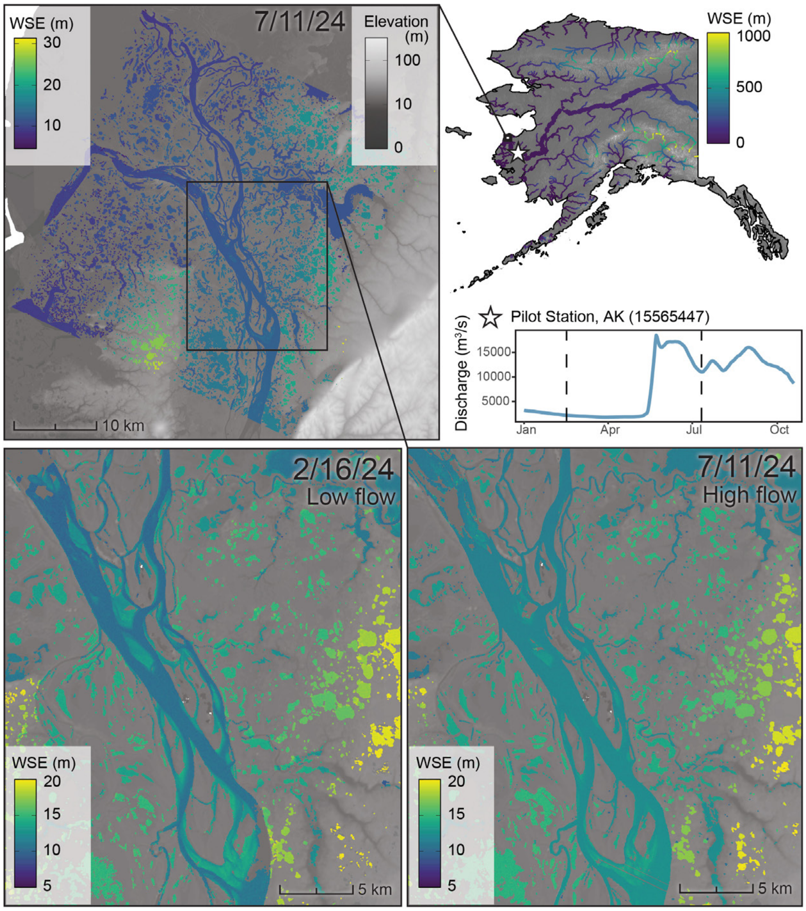


Figure 2. Surface Water and Ocean Topography (SWOT) Pixel Cloud Product (PIXC) data over the Yukon-Kuskokwim Delta in Alaska (AK). Upper-left inset shows a PIXC image from July 2024. Three lower insets show a closer view of the Yukon River during low-flow and high-flow conditions as well as the change raster showing the water surface elevation (WSE) differences between the two dates. The difference in WSE may also be seen at the nearby gauge hydrograph at Pilot Station, indicated by the star. In addition to the Yukon River and its tributaries, SWOT records many small lakes and ponds throughout the landscape, which exhibit less WSE change than the river, as seen in the change raster. Lake levels and river-lake interactions may also be studied with SWOT. Pilot Station is located at 61.9336°, –162.8830°.

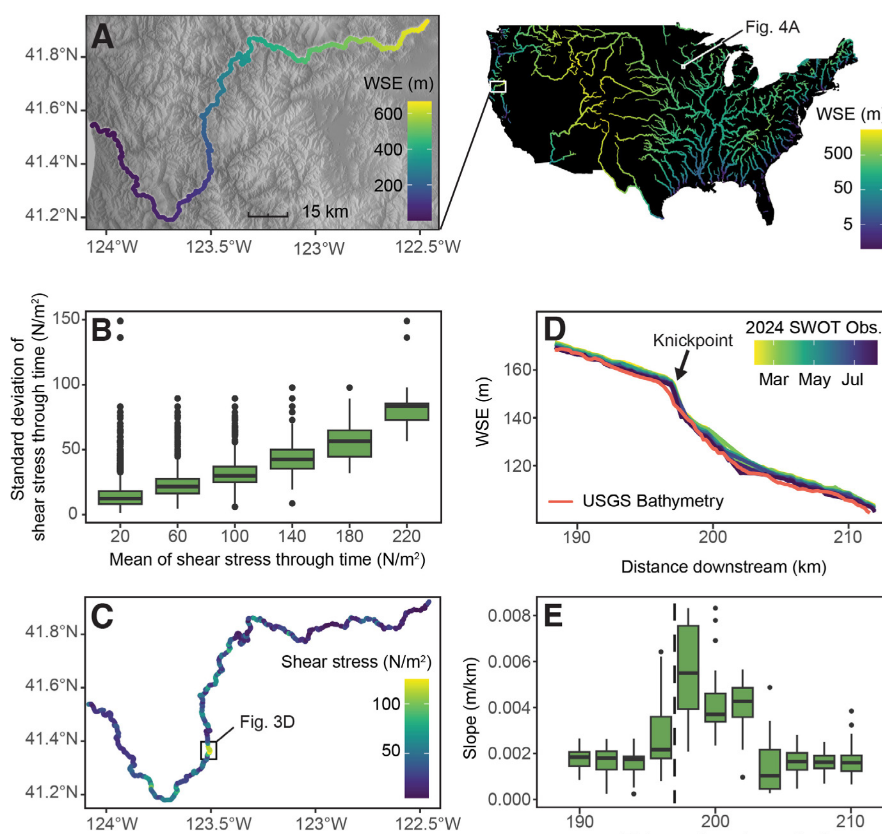


Figure 3. Analysis of bed shear stress with Surface Water and Ocean Topography (SWOT) satellite data from February to September 2024. (A) Water surface elevation (WSE) along the Klamath River in northern California. Mean WSE values were calculated from SWOT RiverSP node data. (B) Binned mean shear stress scales positively with standard deviation of shear stress over time. (C) Mean shear stress estimation along the Klamath over time. (D) Long profile showing knickpoint along the Klamath River from SWOT observations, paired with U.S. Geological Survey (USGS) bathymetry from 2018. (E) Klamath surface slope values upstream and downstream of the knickpoint over time. The knickpoint is marked by the dashed black line.

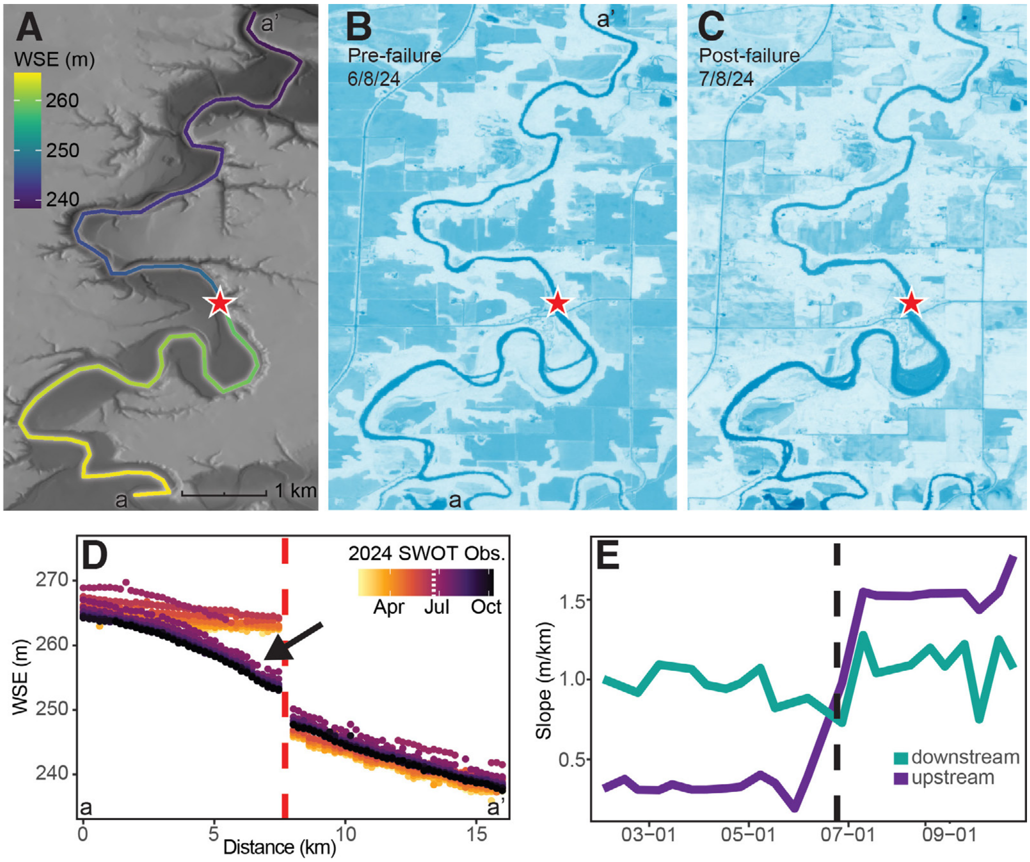


Figure 4. Surface Water and Ocean Topography (SWOT) satellite data over the Rapidan Dam on the Blue Earth River, Minnesota. (A) Average water surface elevation (WSE) of the Blue Earth River from February to September 2024. (B–C) Sentinel-2 images of the Blue Earth River prefailure (B) and postfailure (C), while floods were still occurring. Red star indicates the Rapidan Dam. (D) Long profiles of the Blue Earth River from dates before and after dam failure. Red dashed line indicates the location of dam failure. Arrow indicates newly formed knick zone. White dashed line on color bar indicates the date of dam failure. (E) Change in upstream and downstream mean slope before and after dam failure. Black dashed line indicates the date of dam failure. The Rapidan Dam is located at 44.0926°, –94.1084°.

data necessary to estimate absolute shear stress along Earth's large rivers through time and space. While bathymetric data are necessary to calculate absolute shear stress, SWOT data may still be used to calculate temporal variations in relative shear stress values in locations without bathymetry data. Although these relative values cannot be used to calculate absolute shear stress, or other absolute parameters like the diameter of bed-load particles moved, they may be used to understand areas of relative high and low shear stress along a river reach (as river bathymetry data are not available for most of Earth's rivers). Other related parameters, such as stream power, may also be calculated with SWOT's discharge product.

Figure 3 shows an example of shear stress calculations along the Klamath River in northern California using the SWOT RiverSP node product. The Klamath River is currently a site of great interest due to the ongoing removal of a series of dams along its upper reaches. Here, we estimated absolute shear stress through time and space using SWOT data paired with a 2018 USGS topobathymetry survey (Curtis and Benthem, 2022). SWOT reveals that the temporal and spatial variability in shear stress along the Klamath River scales positively with mean shear stress (Figs. 3B and 3C). The temporal variability of bed shear stress has implications for hydraulic engineering as well as riparian ecology, and it has long been estimated through modeling approaches (Lamouroux et al., 1992). With sufficient sediment supply, areas of higher shear stress have the potential to mobilize and transport a wider range of sediment grain sizes than locations with lower shear stress, which can result in areas of erosion and deposition (Fernandez Luque and Van Beek, 1976). Natural river variability, like the variability in shear stress observed here, has historically created challenges in estimating sediment transport in rivers (Recking et al., 2024). However, with the launch of SWOT, we now have the first global direct observations that enable repeated and spatially contiguous shear stress estimates.

KNICKPOINTS

SWOT observations also offer new insights into long-studied fluvial geomorphology features like knickpoints, which are abrupt increases in downstream slope along a channel profile (Gardner, 1983). These features serve as key indicators of landscape and catchment response to external perturbations, including spatial changes in the erosional resistance of the channel substrate, climate variations, or a relative fall in base level due to tectonic uplift (Kirby and Whipple, 2012). While knickpoints may be detected using existing DEMs, some of the most interesting knickpoints are active features of the landscape that propagate upstream over time. Knickpoint migration is thought to range from 0.001 and 0.1 m yr^{-1} (van Heijst and Postma, 2001), but newly formed knickpoints—such as those resulting from dam removals, aggregate mining pits, or earthquake-generated fault scarps—may migrate significantly faster. Past studies of knickpoint formation and migration have primarily relied on fieldwork, airborne LiDAR surveys, or a combination of the two (Major et al., 2012; Martin et al., 2024), and thus direct, real-time observations are rare for these often unpredictable events.

SWOT provides novel data for observing both persistent knickpoints and the formation and migration of new knickpoints. In Figure 3D, for example, SWOT captured an existing knickpoint on the Klamath River near Somes Bar, California, revealing the dynamic behavior of the bed shear stress and water surface slope around the feature. For the first time, we can track how the water surface slope changes around the knickpoint using satellite observations. At this knickpoint, we find that the slope immediately downstream varies over twice as much as the slope upstream (Fig. 3E). These dynamics are undetectable with a single LiDAR survey or static DEM. SWOT's repeated WSE measurements, by contrast, have the temporal resolution necessary to characterize the hydrodynamics of both fixed and slowly migrating knickpoints.

SWOT also enables the unprecedented characterization of knickpoint formation and migration events with high temporal and spatial detail. For example, in late June 2024, SWOT captured the Rapidan Dam's partial failure on the Blue Earth River in Rapidan, Minnesota (Fig. 4). The river profile changed dramatically due to the failure, and the SWOT RiverSP node product provided detailed multitemporal WSE data before, during, and after the dam failure. The upstream profile postfailure became oversteepened compared to the rest of the profile, representing a newly formed knick zone, or a localized oversteepened zone (Fig. 4D). By comparing the averaged profile before and after the failure, we see that the upstream and downstream slopes inverted their relative steepness (Fig. 4E). SWOT may also allow us to track future knick-zone migration as the knick zone begins to incise into reservoir sediments and move upstream. Forecasting the effects of dam removal (or failure) is challenging, but new data from SWOT will allow us to study the postevent knickpoint migration and channel morphology change, improving our understanding of the geomorphic effects of dam removal (Pizzuto, 2002). Additionally, we now have the capability to directly observe and measure knickpoint and knick-zone migration rates at a global scale and at regular temporal intervals.

EMERGING OPPORTUNITIES FOR SWOT IN FLUVIAL GEOMORPHOLOGY

Beyond the examples discussed above, SWOT will provide many other unexplored opportunities for advancing the field of fluvial geomorphology. SWOT can assist us in understanding the geomorphic impacts of floods: Unlike optical data, SWOT can penetrate cloud cover and thus can provide simultaneous measurements of floodplain extent and water surface elevation during a flood event. In addition to improving flood tracking and observations, SWOT's observations may be used to track sediment movement and deposition due to flood events, as bed shear stress and/or floodwater inundation extent may be used to estimate bed-load transport and deposition. Improved discharge estimates from SWOT, combined with suspended sediment concentration measurements, could advance our understanding of global sediment transport in large rivers. SWOT's discharge product enables the estimation of stream power, which is strongly related to sediment discharge and could help to estimate suspended load. Smaller rivers that are higher up in river networks may also be studied with SWOT, although the accuracy of SWOT's observations on these narrower waters remains to be robustly characterized. As the SWOT mission accumulates a longer data record, more applications will likely become feasible. In this study, we tracked the short-term dynamics of a dam failure, but over a longer time period, SWOT will provide important data for studying the upstream and downstream long-term effects of dam failure as well as dam removal and construction. Other long-term impacts of anthropogenic changes may also be better understood, such as land-use changes and their impacts on stream morphology, with SWOT's longitudinal and cross-sectional (co-temporal width and WSE) observations. Overall, SWOT's observations not only provide direct data on these phenomena but may also improve predictive models and simulations via its spatially contiguous and high-precision data. Ultimately, these capabilities position SWOT as a potentially transformative tool for monitoring global river processes and dynamics, and for expanding our understanding of fluvial geomorphology in an era of rapid environmental change.

ACKNOWLEDGMENTS

Funding for this project was provided by the Department of Geosciences at Virginia Tech. G.H. Allen was partially supported by the SWOT Science Team grant 80NSSC24K1663. L.C. Smith acknowledges SWOT Science Team grant 80NSSC24K1661. All code used for analysis may be found at github.com/mollystroud/SWOT_Geomorph.

REFERENCES CITED

Ashworth, P.J., and Lewin, J., 2012, How do big rivers come to be different?: Earth-Science Reviews, v. 114, p. 84–107, https://doi.org/10.1016/j.earscirev.2012.05.003.

Bagnold, R.A., 1966, An Approach to the Sediment Transport Problem from General Physics: Washington, D.C., U.S. Government Printing Office, 48 p., https://doi.org/10.3133/pp422I.

Biancamaria, S., Lettenmaier, D.P., and Pavelsky, T.M., 2016, The SWOT mission and its capabilities for land hydrology, *in* Cazenave, A., Champollion, N., Benveniste, J., and Chen, J., eds., Remote Sensing and Water Resources: Cham, Switzerland, Springer International Publishing, p. 117–147, https://doi.org/10.1007/978-3-319-32449-4_6.

Biron, P.M., Richer, A., Kirkbride, A.D., Roy, A.G., and Han, S., 2002, Spatial patterns of water surface topography at a river confluence: Earth Surface Processes and Landforms, v. 27, p. 913–928, https://doi.org/10.1002/esp.359.

Curtis, J.A., and Benthem, A.J., 2022, Baseline geomorphic map and land-surface parameters, derived from integrated topobathymetric elevation data, for the mainstem Klamath River corridor downstream of Iron Gate Dam, CA, 2018: U.S. Geological Survey Data Release, https://doi.org/10.5066/P90KEKPH.

Dietrich, W.E., and Whiting, P., 1989, Boundary shear stress and sediment transport in river meanders of sand and gravel, *in* Ikeda, S., and Parker, G., eds., River Meandering: American Geophysical

Union Water Resources Monograph 12, p. 1–50, https://doi.org/10.1029/WM012p0001.

Durand, M., et al., 2023, A Framework for Estimating Global River Discharge from the Surface Water and Ocean Topography Satellite Mission: Water Resources Research, v. 59, https://doi.org/10.1029/2021WR031614.

Fernandez Luque, R., and Van Beek, R., 1976, Erosion and transport of bed-load sediment: Journal of Hydraulic Research, v. 14, p. 127–144, https://doi.org/10.1080/00221687609499677.

Fu, L.L., et al., 2024, The Surface Water and Ocean Topography Mission: A breakthrough in radar remote sensing of the ocean and land surface water: Geophysical Research Letters, v. 51, https://doi.org/10.1029/2023GL107652.

Gardner, T.W., 1983, Experimental study of knickpoint and longitudinal profile evolution in cohesive, homogeneous material: Geological Society of America Bulletin, v. 94, p. 664–672, https://doi.org/10.1130/0016-7606(1983)94<664:ESOKAL>2.0.CO;2.

Gearon, J.H., Martin, H.K., DeLisle, C., Barefoot, E.A., Mohrig, D., Paola, C., and Edmonds, D.A., 2024, Rules of river avulsion change downstream: Nature, v. 634, p. 91–95, https://doi.org/10.1038/s41586-024-07964-2.

Howard, A.D., Dietrich, W.E., and Seidl, M.A., 1994, Modeling fluvial erosion on regional to continental scales: Journal of Geophysical Research: Solid Earth, v. 99, p. 13,971–13,986, https://doi.org/10.1029/94JB00744.

Kacimi, S., Jaruwatanadilok, S., and Kwok, R., 2025, SWOT observations over sea ice: A first look: Geophysical Research Letters, v. 52, https://doi.org/10.1029/2025GL116079.

Kirby, E., and Whipple, K.X., 2012, Expression of active tectonics in erosional landscapes: Journal of Structural Geology, v. 44, p. 54–75, https://doi.org/10.1016/j.jsg.2012.07.009.

Lamouroux, N., Statzner, B., Fuchs, U., Kohmann, F., and Schmedtje, U., 1992, An unconventional approach to modeling spatial and temporal variability of local shear stress in stream segments: Water Resources Research, v. 28, p. 3251–3258, https://doi.org/10.1029/92WR01761.

Langhorst, T., Pavelsky, T.M., Frasson, R.P. de M., Wei, R., Domeneghetti, A., Altenau, E.H., Durand, M.T., Minear, J.T., Wegmann, K.W., and Fuller, M.R., 2019, Anticipated improvements to river surface elevation profiles from the Surface Water and Ocean Topography Mission: Frontiers of Earth Science, v. 7, https://doi.org/10.3389/feart.2019.00102.

Major, J.J., O'Connor, J.E., Podolak, C.J., Keith, M.K., and Grant, G.E., 2012, Geomorphic Response of the Sandy River, Oregon, to Removal of Marmot Dam: U.S. Geological Survey Professional Paper 1792, 64 p., https://pubs.usgs.gov/pp/1792/.

Marcus, W.A., and Fonstad, M.A., 2010, Remote sensing of rivers: The emergence of a subdiscipline in the river sciences: Earth Surface Processes and Landforms, v. 35, p. 1867–1872, https://doi.org/10.1002/esp.2094.

Martin, H.K., Edmonds, D.A., Yanites, B.J., and Niemi, N.A., 2024, Quantifying landscape change following catastrophic dam failures in Edenville and Sanford, Michigan, USA: Earth Surface Processes and Landforms, v. 49, p. 2767–2778, https://doi.org/10.1002/esp.5855.

Maubant, L., Dodd, L., and Tregoning, P., 2025, Assessing the accuracy of SWOT measurements of water bodies in Australia: Geophysical Research Letters, v. 52, https://doi.org/10.1029/2024GL114084.

Piégay, H., Mathias Kondolf, G., Toby Minear, J., and Vaudor, L., 2015, Trends in publications in fluvial geomorphology over two decades: A truly new era in the discipline owing to recent technological revolution?: Geomorphology, v. 248, p. 489–500, https://doi.org/10.1016/j.geomorph.2015.07.039.

Pizzuto, J., 2002, Effects of dam removal on river form and process: Although many well-established concepts of fluvial geomorphology are relevant for evaluating the effects of dam removal, geomorphologists remain unable to forecast stream channel changes caused by the removal of specific dams: Bioscience, v. 52, p. 683–691, https://doi.org/10.1641/0006-3568(2002)052[0683:EODROR]2.0.CO;2.

Recking, A., Johannot, A., Horita, K., Nasr, M., Vázquez-Tarrío, D., Zanker, S., Fontaine, F., and Melun, G., 2024, An attempt to take into account natural variability in 1D bedload prediction: Journal of Geophysical Research: Earth Surface, v. 129, https://doi.org/10.1029/2023JF007601.

Smith, M.J., and Pain, C.F., 2009, Applications of remote sensing in geomorphology: Progress in Physical Geography, v. 33, p. 568–582, https://doi.org/10.1177/0309133309346648.

van Heijst, M.W.I.M., and Postma, G., 2001, Fluvial response to sea-level changes: A quantitative analogue, experimental approach: Basin Research, v. 13, p. 269–292, https://doi.org/10.1046/j.1365-2117.2001.00149.x.

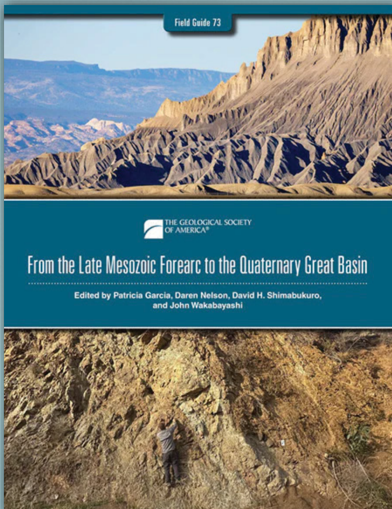
Wang, B., Smith, L.C., Yang, X., Pavelsky, T.M., Altenau, E.H., Gleason, C.J., Pietroniro, A., Rodriguez, E., and Bates, P.D., 2022, Remote sensing of broad-scale controls on large river anabranching: Remote Sensing of Environment, v. 281, https://doi.org/10.1016/j.rse.2022.113243.

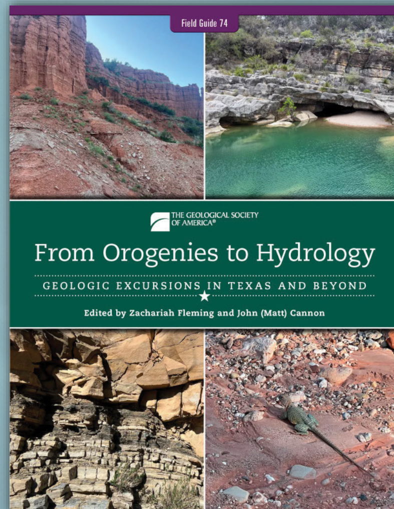
Wang, B., et al., 2023, Athabasca River avulsion underway in the Peace-Athabasca Delta, Canada: Water Resources Research, v. 59, https://doi.org/10.1029/2022WR034114.

Williams, R.D., Brasington, J., and Hicks, D.M., 2016, Numerical modelling of braided river morphodynamics: Review and future challenges: Geography Compass, v. 10, p. 102–127, https://doi.org/10.1111/gec3.12260.

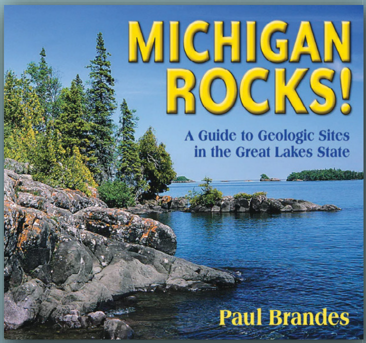
Wolman, M.G., and Miller, J.P., 1960, Magnitude and frequency of forces in geomorphic processes: The Journal of Geology, v. 68, p. 54–74, https://doi.org/10.1086/626637.

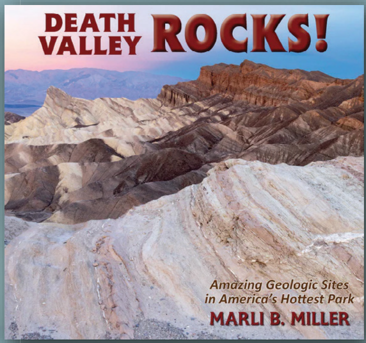
MANUSCRIPT RECEIVED 16 MAY 2025
REVISED MANUSCRIPT RECEIVED 11 AUGUST 2025
MANUSCRIPT ACCEPTED 22 OCTOBER 2025

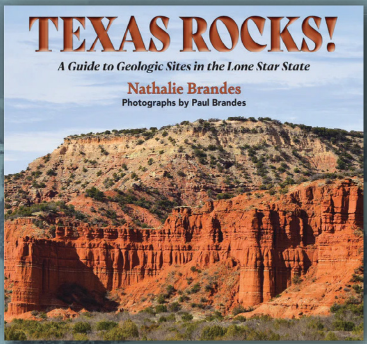




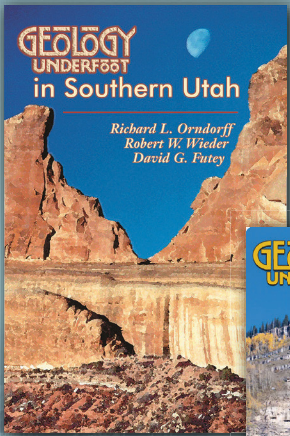
Revisit GSA field trips with our ***Field Guides***, which include detailed road logs and maps.

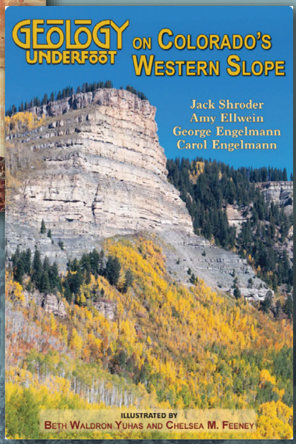






For curious learners of all ages, the ***Geology Rocks!*** series features easy-to-follow maps and introduces basic geology concepts.





Whether you're exploring on foot or from your armchair, get an up-close look at rocks and landforms around the U.S. with ***Geology Underfoot***.

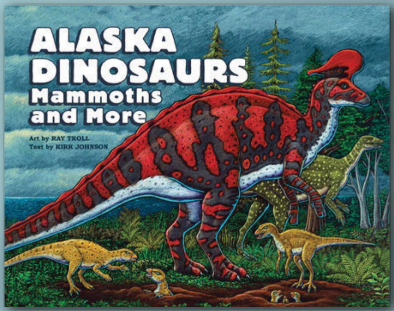
Explore the timeless terrain of nature's wonders with the 2026 GSA calendar, ***Timeless Terrain***.

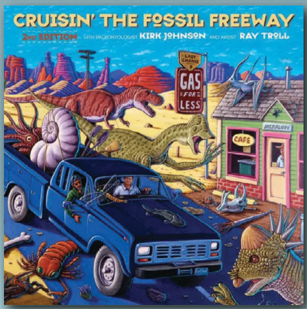
Rite in the Rain notebooks are made with all-weather writing paper, enabling you to write in any weather.

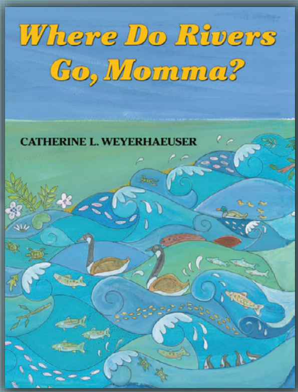
GSA fanny packs and ***water bottles*** make great make great gifts, especially for the hard-to-shop-for person on your list.

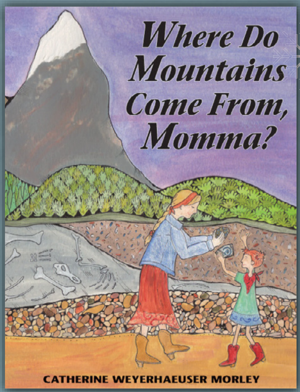
In the field or in the classroom, we've got all the cool ***t-shirts, vests, socks, and hats*** you need you need.

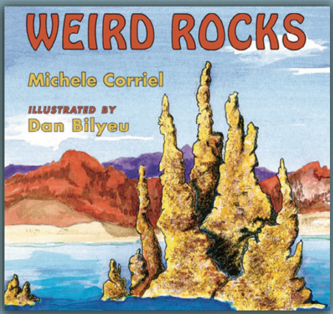
Children's books from author *Kirk Johnson* and artist *Ray Troll* will delight readers of all ages.



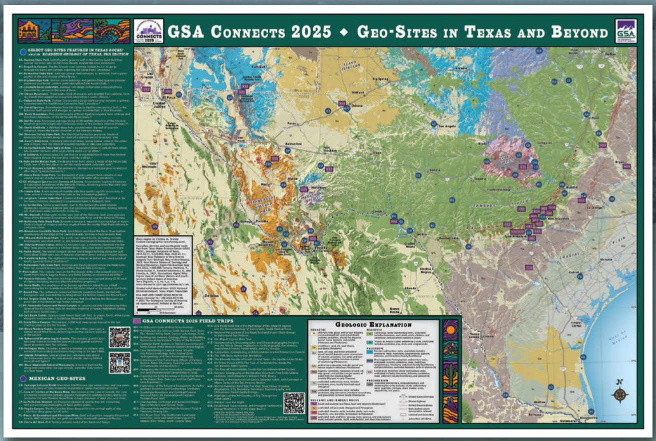


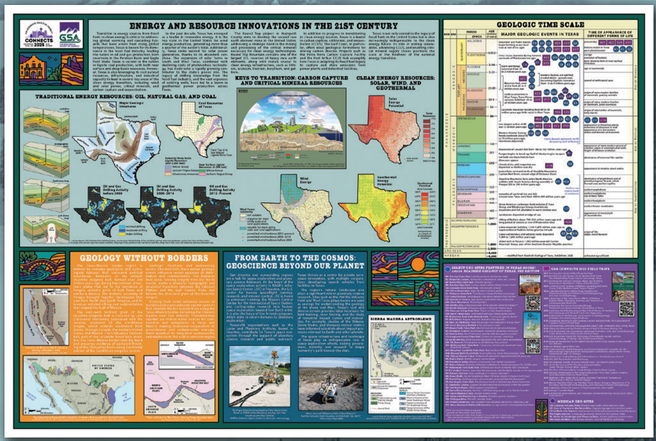






You're never too young to learn about–and fall in love with–geology with GSA's ***children's books***.





Our *GSA Connects 2025 Map* provides an in-depth introduction to the geology of southwest Texas along with a geologic time scale–a perfect way to become acquainted with the region.

THE GEOLOGICAL SOCIETY OF AMERICA®

GSA Publications

Find more ideas at **store.geosociety.org**

THE GEOLOGICAL SOCIETY OF AMERICA®

Incorporating Ethics in College Geoscience Education through Community Engagement

Lixin Wang*,[1] and Grant A. Fore[2]

INTRODUCTION

Ethics has always been important in scientific pursuits, but it has become even more so in today's world. More than ever, science is under attack, and public trust in science in the United States and across many parts of the world is declining (Lupia et al., 2024). Compounding this issue, unethical behaviors in scientific research are increasingly being reported. A notable example is the report that the number of retractions of biomedical research papers in Europe has increased fourfold between 2000 and 2021, with the majority of these retractions being related to research misconduct (Else, 2024). This highlights the critical need for ethical training (Metzger and Curren, 2017; Mogk and Bruckner, 2020; Wang, 2024). College education is typically where students establish the professional norms and standards of scientific practice. Therefore, research ethics education during this period is crucial for cultivating future scientists who will conduct their work ethically (Nyarko et al., 2023). Geoscience is at the forefront of this battle because it is a subject closely related to many major interconnected issues we are facing, such as climate change, pollution, and soaring energy demand (Metzger, 2024).

Involving ethics in geoscience education is not always straightforward. Here, we share experiences and reflections on a successful case of incorporating ethics into a community-engaged college hydrology course. We provide detailed course design and implementation information and then reflect on the experience of incorporating the ethics training. This is an introductory hydrology course, with most students being juniors and seniors. This class is required for environmental science major students, and it often attracts students from other majors, such as biology, chemistry, and environmental management. The class size typically ranges from 10 to 24 students. During the course design, the course instructor (Wang) had extensive discussions with an education expert (Fore) regarding the proposed activities, the prompt questions for reflections, and the related readings. The course instructor also had several meetings to discuss field activities with the community partner, the White River Alliance, an Indianapolis-based nonprofit organization with the mission to improve and protect water quality in the larger Upper White River region in Indiana.

IMPLEMENTATION OF THE ETHICAL INQUIRY

In the context of this course, scientific inquiry was reimagined as ethical inquiry: a virtuous activity where the steps of inquiry—such as awareness, judgment, experimentation, and iteration—are intentionally guided by moral excellencies (e.g., attentiveness, responsibility, justice, and competency; Tronto, 2020). As such, our conceptualization of ethical inquiry is grounded in the tradition of virtue ethics. During the implementation of the ethical inquiry activities, students met with the community partner on three separate occasions and conducted a range of group field activities. Coupled with these experiences, a reflection strategy was incorporated, comprising a reading, a guest ethics lecture (led by Fore), and four reflective journal entries.

The reading was a selection from Joan Tronto's writings on the four elements of care: attentiveness, responsibility, competence, and responsiveness (Tronto, 2020). The guest ethics lecture further discussed an ethic of care and put it into conversation with John Dewey's notion of moral inquiry (Dewey, 1982). Tronto's four elements and facets of Dewey's moral inquiry also provided the themes for each reflective prompt. Students were able to practice the four elements of care and reflectively consider their scientific work as a means of providing care. In addition to the science learning objectives, the specific ethics learning objective was to increase their capacity to care about and analyze the causes and implications of limited water resources. Since these causes and implications are social in nature, the students' caring analyses were directed toward multiple communities (e.g., scientific, peers, local, ecological).

*lxwang@iu.edu
[1]Department of Earth and Environmental Sciences, Indiana University Indianapolis, Indianapolis, Indiana 46202, USA
[2]STEM Education Innovation and Research Institute (SEIRI), Indiana University Indianapolis, Indianapolis, Indiana 46202, USA
CITATION: Wang, L., and Fore, G.A., 2025, Incorporating ethics in college geoscience education through community engagement: GSA Today, v. 35, p. 14–16, https://doi.org/10.1130/GSATG627GW.1.

Objective: My capacity to care about, analyze the causes and implications of limited water resources is increased

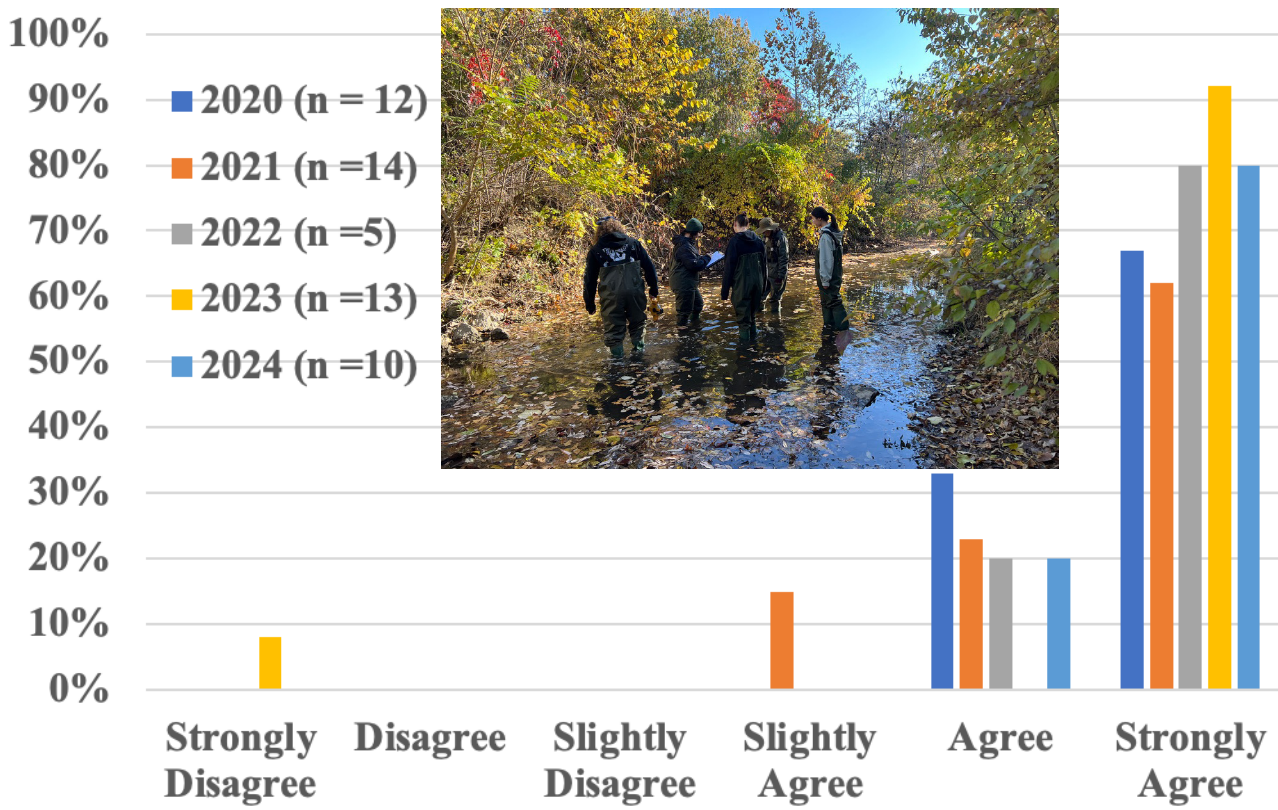


Figure 1. Results of end-of-semester survey of students' responses to the ethical inquiry objective in this course of "increasing their capacity to care about and analyze the causes and a of limited water resources" between 2020 and 2024, where n is the number of students who responded to the end-of-class survey.
Inset: Field photo taken in 2024 by Lixin Wang.

The field activities centered around urban stream health due to the topic's relevance to the course, the urban setting of the university, and the needs of the course's community partner. Stream degradation due to urbanization is a growing issue worldwide, affecting both the ecological systems that depend on streams and the human populations living along them. The impacts of urbanization on local water quality have been studied in different regions (Li et al., 2023). However, there are fewer studies evaluating the impacts of vegetation restoration on stream health in an urban setting. Therefore, studying urban stream health not only addresses an urgent scientific question but also solves practical issues.

Before the first meeting, students were asked to review the community partner's official website to learn about the community partner organization's vision and operations. In their first journal entry, they were asked to come up with three questions they would ask the community partner based on their review. The first meeting featured a guest lecture from the community partner, who introduced their organization and provided details about the fieldwork. The students wrote their second journal entries reflecting on the guest lecture experience and how they might take responsibility for the issue raised by the community partner. Next, students participated in a field experience co-led by the course instructor and the community partner, where students quantified soil properties, vegetation characteristics, and water quality at two sites using a variety of methods. One restoration site was located in Indianapolis' Spade Park, and one control site was located near Harshman Middle School, where no restoration activities had been performed. The soil measurements included infiltration, hydraulic conductivity, bulk density, porosity, gravimetric water content, and heavy metal measurements. The vegetation characteristics were assessed following reach-level assessment from the Center for Watershed Protection's Unified Stream Assessment manual (Kitchell and Schueler, 2005). The water-quality parameters included water temperature, dissolved oxygen, pH, phosphate, nitrate, nitrite, and turbidity, and measurements were collected following the Hoosier Riverwatch methodology (Indiana Department of Environmental Management, 2022). The students then wrote their third journal entry reflecting on the extent to which they competently engaged in the field experience. At the third meeting, students presented their findings to the community partner. The community partner attended the presentations and provided feedback on them. After incorporating the community partner's feedback, a subset of students also presented the class findings to the residents living along the waterway, together with the community partner. The students wrote their last journal entries reflecting on the presentation experience and how they might transform their presentations by being responsive to the community partner's feedback.

RESULTS AND REFLECTIONS

To assess the effectiveness of the course in achieving the ethics learning objective, we conducted an end-of-course survey over five years and collected the students' comments. Based on the class survey results, we achieved our objective. The vast majority of students agreed that their capacity to care about water resources increased (Fig. 1). Students also provided enthusiastic comments about their experience. For example, one student wrote, "I think it was a unique and great experience to go into the community to learn about the subject matter. It is tied with the ethics to my education." Other students also commented on the other dimensions of student experience, namely, the ways the course helped them grow in their capacity to apply hydrology knowledge within the community. For example, "It was an excellent experience conducting hands-on fieldwork with the community partner (even in the blistering cold!). Working alongside them added depth to my learning by connecting classroom concepts to real-world applications." Similarly, another student stated that, "The community partner involvement definitely helped round out the information we were presented in lecture, and it helped to have a real-world example of how these techniques and information can be implemented." Regarding this latter point, the student went on to report that by engaging with a community partner, they not only gained valuable experiences about how to apply scientific knowledge in the context of our everyday lives, but also how such community engagement linked them to a network of potentially like-minded practitioners, which could be "helpful once we graduate." The limitation of this study is that a thematic analysis of the students' journal reflections was not included. Due to this, our results here do not provide details related to the tracking of student ethical growth.

Reflecting on the success of this course, we think the following two key elements are important. First, the mutual benefits between community partners and the course students were crucial to ensuring the project's success. We purposefully aligned the field activities to meet the community partner's needs, ensuring the active involvement of the community partner throughout the course period. This successful collaboration continued even when the community partner switched organizations. Second, collaboration with scholars who possess expertise in ethics helped to ensure that the ethical reflection prompts were effectively aligned with the other course activities. These thoughtfully designed activities and prompts significantly enhanced students' learning.

ACKNOWLEDGMENTS

We acknowledge funding support from National Science Foundation grants (EAR-1554894 and DEB-2307257). We thank Science Editor Peter Copeland and David Mogk for their insightful comments and valuable suggestions, which significantly improved the quality of the manuscript.

REFERENCES CITED

Dewey, J., 1982, John Dewey: The Middle Works, 1899–1924: Volume 12: Carbondale, Illinois, Southern Illinois University Press, 354 p.

Else, H., 2024, Biomedical paper retractions have quadrupled in 20 years—Why?: Nature, v. 630, no. 8016, p. 280–281, https://doi.org/10.1038/d41586-024-01609-0.

Indiana Department of Environmental Management, 2022, Volunteer Stream Monitoring Training Manual: Indianapolis, Indiana, Hoosier Riverwatch, 168 p.

Kitchell, A., and Schueler,T., 2005, Manual 10: Unified Stream Assessment: A User's Manual: Urban Subwatershed Restoration Manual Series: Ellicott City, Maryland, Center for Watershed Protection, 142 p.

Li, R., Filippelli, G., and Wang, L., 2023, Precipitation and discharge changes drive increases in *Escherichia coli* concentrations in an urban stream: The Science of the Total Environment, v. 886, https://doi.org/10.1016/j.scitotenv.2023.163892.

Lupia, A., Allison, D.B., Jamieson, K.H., Heimberg, J., Skipper, M., and Wolf, S.M., 2024, Trends in US public confidence in science and opportunities for progress: Proceedings of the National Academy of Sciences of the United States of America, v. 121, no. 11, https://doi.org/10.1073/pnas.2319488121.

Metzger, E.P., 2024, Reimagining geoscience education for sustainability: Earth Science, Systems and Society, v. 4, no. 1, https://doi.org/10.3389/esss.2024.10116.

Metzger, E.P., and Curren, R.R., 2017, Sustainability: Why the language and ethics of sustainability matter in the geoscience classroom: Journal of Geoscience Education, v. 65, no. 2, p. 93–100, https://doi.org/10.5408/16-201.1.

Mogk, D.W., and Bruckner, M.Z., 2020, Geoethics training in the earth and environmental sciences: Nature Reviews Earth & Environment, v. 1, no. 2, p. 81–83, https://doi.org/10.1038/s43017-020-0024-3.

Nyarko, S.C., Fore, G.A., and Licht, K., 2023, The role of ethical care in the geosciences: Examining the perspectives of geoscience undergraduates: Journal of Geoscience Education, v. 71, no. 4, p. 540–552, https://doi.org/10.1080/10899995.2023.2170621.

Tronto, J., 2020, Moral Boundaries: A Political Argument for an Ethic of Care: New York, Routledge, 242 p., https://doi.org/10.4324/9781003070672.

Wang, L., 2024, To regain lost public trust, incorporate research ethics into graduate training: Nature, v. 631, no. 8019, p. 28–28, https://doi.org/10.1038/d41586-024-02131-z.

MANUSCRIPT RECEIVED 4 APRIL 2025
REVISED MANUSCRIPT RECEIVED 11 SEPTEMBER 2025
MANUSCRIPT ACCEPTED 19 OCTOBER 2025

Connect Locally, Discover Globally: Explore 2026 Section Meetings

Registration

Category	2026 Early Registration	2026 Standard Registration
Professional Member	$225	$425
Professional Non-Member	$265	$465
Professional Senior Member	$150	$245
Lifetime Member	$225	$425
Early Career Professional Member	$195	$295
Early Career Professional Non-Member	$235	$335
Student Member	$95	$110
Student Non-Member	$150	$165
K-12 (Member and Mon-Member)	$115	$145
Guest	$75	$95

Register Early and Save!

Early registration and travel grants open **1 December 2025**!

The Sections are pleased to offer support for the cost of student travel to the 2026 Section Meetings. These travel grants provide students with the opportunity to network, present their research, and gain invaluable experience. **Apply today!**

Early Registration and Student Travel Grant Deadlines:

SE/NC/SC & NE 2026 Section Meeting: 12 February 2026

CD 2026 Section Meeting: 19 March 2026

RM 2026 Section Meeting: 16 April 2026

Contribute to the Conversation—Submit Your Abstract

Abstract submissions are open now! Start planning now to share your research and ideas with a global community of geoscientists. Bring your science to the spotlight.

Abstract Submission Deadline: 13 January 2026

Earn Continuing Education Units at Section Meetings

Section Meetings offer an excellent opportunity to earn CEUs toward your continuing education requirements for your employer, K–12 school, or professional registration. The CEU certificate may be downloaded from the meeting website after the meeting.

https://www.geosociety.org/GSA/GSA/edu-career/ceu.aspx

Triple Joint 75th Southeastern / 60th North-Central / 60th South-Central Annual Section Meeting

Memphis, Tennessee, USA
8–11 March 2026
https://www.geosociety.org/se-mtg

Location
Renasant Convention Center
255 N Main St.
Memphis, Tennessee 38103

Where Geoscience Converges on the Mighty Mississippi

Join us for the Joint Southeastern, North-Central, and South-Central Section Meeting of the Geological Society of America, 8-11 March 2026 in Memphis, Tennessee. This dynamic gathering will bring together geoscientists from across the country to explore new research, share discoveries, and connect with colleagues. Set in the heart of the Mississippi Embayment, Memphis offers a compelling natural classroom—from the loess-capped Chickasaw Bluffs overlooking the Mississippi River to the region's deep sedimentary history and proximity to the New Madrid Seismic Zone. With engaging technical sessions, field opportunities, and networking events, this meeting will highlight the diverse geology and vibrant scientific community shaping the future of the geosciences.

Symposium

S1. Assessing Coal Ash Contamination in White River at Noblesville: A Case Study

Dorothy Sena Gidisu, Ball State University

Theme Sessions

T1. Carbon Capture & Storage: Geological Pathways to Decarbonization

Donald Jordan Yezerski, WSP

T2. Geological Surveys and Resource Mapping/Evaluation Studies

Valarie Joyner Harrison, Tennessee Department of Environment and Conservation, Division of Mineral and Geologic Resources, Tennessee Geological Survey; Bonnie Craighead, Tennessee Department of Environment and Conservation, Division of Mineral and Geologic Resources, Mining Section; William Jackson, Tennessee Department of Environment and Conservation, Division of Mineral and Geologic Resources, Tennessee Geological Survey; Mark Carter, U.S. Geological Survey, Florence Bascom Geoscience Center

T3. Geothermal Power: Harnessing the Earth's Heat for Clean Energy

Donald Jordan Yezerski, WSP

T4. Orphaned, Abandoned, and Idle Well Issues: Insights, Impacts, and Strategies for Success

Chris King

T5. Advances and Integration of Water Management Techniques to Enhance Water Security Under Increasing Demand

Deborah Leigh Leslie, Department of Earth Sciences, University of Memphis; Michele L. Reba; Jesse Radolinski, College of Agriculture, Arkansas State University

T6. Frontiers in Geochronology: Advances and Applications in the Geosciences

Tiffany Rivera, University of Missouri

T7. Advances in Geologic Mapping, Databases, and Dissemination: Establishing Fundamental Resources for the Earth Science Community

Andrew L. Wunderlich, Tennessee Department of Environment and Conservation, Division of Mineral and Geologic Resources, Tennessee Geological Survey; William Thomas Jackson, Tennessee Geological Survey; David R. Soller, U.S. Geological Survey

T8. Advances in Geologic Mapping, Databases, and Dissemination: Student Posters

Andrew L. Wunderlich, Tennessee Department of Environment and Conservation, Division of Mineral and Geologic Resources, Tennessee Geological Survey; William Thomas Jackson, Tennessee Geological Survey; David R. Soller, U.S. Geological Survey

T9. AI-Driven and Machine Learning Approaches in Geospatial Modeling for Hydrologic and Geologic Mapping

Youngsang Kwon, Department of Earth Sciences, University of Memphis

T10. Advances in Understanding Landslides and Other Mass Movements

Daniel M. Sturmer, Department of Geosciences, University of Cincinnati; Mason Doyle, Department of Geosciences, University of Cincinnati

T11. Near-Surface Geophysics and Geoarchaeology: Methods and Mapping

Blair R. Tormey, Western Carolina University; Paul S. Martin, Martin Archaeology Consulting, LLC

T12. Recent Advances in Our Understanding of the New Madrid Seismic Zone

Charles A. Langston, Center for Earthquake Research and Information, University of Memphis; Randy Tom Cox, Department of Earth Sciences, University of Memphis; Christine Ann Powell, Center for Earthquake Research and Information, University of Memphis

T13. Tectonic Inheritance: How Long Is Earth's Memory and Where Does It Reside?

Vadim Levin, Center for Earthquake Research and Information, University of Memphis

T14. Building Connections Between Educators and Geoscientists to Foster the Future Workforce

Christina A. DeVera, U.S. Geological Survey; Sarah Hayes, U.S. Geological Survey; Bernard E. Hubbard, U.S. Geological Survey, Geology, Energy & Minerals Science Center; Elizabeth Tomaszewski, U.S. Geological Survey

T15. Transforming Geoscience Education: Reimagining How We Teach the Earth

Stephanie L. Shepherd, Auburn University; Tyler Smith, Auburn University; Karen McNeal, Auburn University

T16. Undergraduate and Graduate Geoscience Student Showcase

Claire Louise McLeod, Miami University; Kenneth Brown, DePauw University; James H. MacDonald, Florida Gulf Coast University

T17. Advances in Understanding Processes at or Near the Groundwater–Surface Water Interface

Margaret Naber, Department of Geosciences, University of Cincinnati; Reza Soltanian, Department of Geosciences, University of Cincinnati

T18. Machine Learning and Deep Learning Applications in Hydrogeology

Reza Soltanian, Department of Geosciences, University of Cincinnati; Farzad Moeini, Department of Geosciences, University of Cincinnati

T19. Water Quality and Management in Agricultural Regions

Shannon Speir, University of Arkansas

T20. Terrestrial Records of Hydroclimate Variability From the Pleistocene Through the Common Era

Brittany N. Price, Department of Geosciences, Middle Tennessee State University; Rachel C. Lombardi, Department of Earth Sciences, University of Memphis; Derek K. Gibson, Department of Geology, Southern Illinois University

T21. Advances in Ichnology: Walking in Memphis and Other Records of Behavior

Brian F. Platt, University of Mississippi; Jon J. Smith, Kansas Geological Survey

T22. Applications of Igneous Petrology, Geochemistry, and Geochronology to Understanding Earth and Other Planetary Systems

Claire McLeod, Miami University; Danielly Aguirre, Miami University; Jordan Bell, Miami University; Ken Brown, DePauw University

T23. Depositional Systems and Resource Distribution in Eastern and Southern North America: From Orogens to Coastal Plains

John W. Counts, U.S. Geological Survey, Geology, Energy & Minerals Science Center; Ryan T. Deasy, U.S. Geological Survey, Florence Bascom Geoscience Center; Rebecca Totten, Department of Geological Sciences, University of Alabama

T24. Recent Advances in Stratigraphic and Structural Studies of the Northern Mississippi Embayment

Daniel Larsen, Department of Earth Sciences, University of Memphis; Jennifer Pickering, Center for Applied Earth Science and Engineering Research, University of Memphis

T25. Interstate Stratigraphic Correlation: A Practical Geology Session

William R. Doar, South Carolina Geological Survey, South Carolina Department of Natural Resources; Kathleen M. Farrell, North Carolina Geological Survey

T26. Stratigraphy and Resources of the Gulf Coastal Plain: New Data and Innovative Technologies

Joseph Lane, Department of Earth Sciences, University of Memphis; Jennifer Pickering, Center for Applied Earth Science and Engineering Research, University of Memphis

T27. Geologic Maps, Geophysical Maps, 3-D Geologic Models, Digital Mapping Techniques, Map Derivatives, and Digital Map Preparation

Randy L. Kath, Department of Geology, University of West Georgia; Karen S. Tefend, University of West Georgia

T28. New Research in the Appalachian–Ouachita Orogen: Integrated Studies From the Foreland to the Hinterland

Clinton I. Barineau, Department of Earth and Space Sciences, Columbus State University; Ashley S. Lynn, East Carolina University; Arthur James Merschat, U.S. Geological Survey; Jack C. Pashin, School of Geology, Oklahoma State University

T29. Undergraduate Research

Wendi J. W. Williams, South Texas College; Jeffrey C. Strasser, Department of Geology, Augustana College; Robert D. Shuster, University of Nebraska Omaha; Jeffrey G. Ryan, University of South Florida; Lee Phillips, University of Louisville

61st Annual Meeting of the GSA Northeastern Section

Hartford, Connecticut, USA
21–24 March 2026
https://www.geosociety.org/ne-mtg

Location
Connecticut Convention Center
100 Columbus Blvd.
Hartford, Connecticut 06103

Where Ancient Basins Meet Modern Breakthroughs

Join us for the 2026 Northeastern Section Meeting, taking place 21–24 March 2026 at the Connecticut Convention Center in downtown Hartford, Connecticut. Nestled within the ancient Hartford Basin—a rift basin featuring basalt flows, dinosaur-footprint-bearing sediments and glacial landforms—this gathering brings together geoscientists from across disciplines to explore the region's complex lithosphere, hydrosphere and anthroposphere. Attendees will engage in cutting-edge technical sessions, field trips that traverse glacial deltas to ancient pillow basalts, and networking opportunities in a vibrant city setting.

Theme Sessions

T1. Critical Mineral Deposits and Ore Systems of the Northeast

Rebekah Kennedy, Montana State University; Harold Moritz

T2. Applied Geoscience Approaches for Legacy Oil and Gas Wells

Andrea Mullen, Pennsylvania Department of Environmental Protection, Bureau of Oil and Gas

T3. Functions of River Corridors, Floodplains, and Wetlands

Kristen L. Underwood, University of Vermont; Rebecca M. Diehl, University of Vermont

T4. Geologic Frameworks and Conceptual Site Models for Investigating Hydrogeologic Conditions in Overburden and Bedrock Aquifers at Remediation Sites

Nick Hastings, Woodard & Curran, Inc.; Meghan Seemed, Connecticut State Geologist

T5. Old Collections, New Tricks

Lauren Neitzke-Adamo, Department of Earth and Planetary Sciences, Rutgers University; Carol McCarty, NAGPRA Office, Rutgers University; Julie Criscione-Vastano, Natural History, New Jersey State Museum

T6. Geologic Mapping in the Digital Age: Products, Workflows, and Methodologies

Christopher Oest, Pennsylvania Geological Survey; Morgen Baker, Pennsylvania Geological Survey; Aaron Bierly, Pennsylvania Geological Survey

T7. Machine Learning in the Geosciences: Data-Driven Approaches for Earth, Water, and Environmental Challenges

Shaurya Swami, University of Vermont; Harrison Myers, University of Vermont; Ryan van der Heijden, University of Vermont

T8. Ice Sheets, Glaciers, and Landscapes, Oh My!

Amanda Henck Schmidt, Department of Geosciences, Oberlin College; Paul R. Bierman, Rubenstein School of the Environment and Natural Resources, University of Vermont

T9. Sharing Geology: Building the Geocommunity Through Creative Engagement

Adam Ianno, Pennsylvania Geological Survey; Stacey Sosenko Daniels, Pennsylvania Geological Survey; Michelle J. Markley, Mount Holyoke College

T10. Advancements in Undergraduate Education: Connecting Classrooms to Research and Careers in Sustainable Geology

Benjamin H. Chilson-Parks, University of Connecticut; Sarah Elizabeth Mazza, Smith College

T11. Bridging Classrooms and Careers: How Geoscientists Can Inspire Our Youth

Jennifer Field, Science Department, Weston High School; Susan Boehm, Science Department, Henry James Memorial School

T12. Skill Development for the Evolving 21st-Century Geoscience Workforce

Sean Thatcher, Department of Engineering and Environmental Science, City University of New York, College of Staten Island; Jennifer Piatek, Department of Earth and Space Sciences, Central Connecticut State University; Jacklyn Reiszel, Department of Engineering and Environmental Science, City University of New York, College of Staten Island

T13. Advances in Characterizing Groundwater, Surface Water, and Their Interactions

Janet Rice Barclay, U.S. Geological Survey; Andrew S. Reeve, Department of Earth and Climate Sciences, University of Maine; Kalle L. Jahn, U.S. Geological Survey; James Heiss, University of Massachusetts–Lowell

T14. Applied Geological Investigations at State Geological Surveys in the Northeastern Section of GSA

Ben D. DeJong, Vermont Geological Survey; Brian C. Yellen, University of Massachusetts Amherst; Jonathan Kim, Vermont Geological Survey

T15. Hydrogeologic Gems in New England (or Not)

Patrick A. Burkhart, Slippery Rock University of Pennsylvania; Kyle C. Fredrick, PennWest California

T16. Nearshore and Estuarine Research: Dynamics and Future Resiliency in the Coastal Zone

Bryan A. Oakley, Eastern Connecticut State University; Mark Borrelli, University of Massachusetts Boston / Center for Coastal Studies; Zoe J. Hughes, Boston University; Brian C. Yellen, University of Massachusetts Amherst; Tim Cook, Department of Earth, Geographic, and Climate Sciences, University of Massachusetts Amherst; Sintra Reves-Sohn, University of Massachusetts Amherst; Tansir Zaman Asik, Boston University; Phoenix Benjamin Susak, University of Massachusetts Amherst; Ash Oh, University of Massachusetts Amherst

T17. Seafloor Mapping and Marine Resources of the Northeast Margin

Jeffrey David Gardner, Geo SubSea LLC

T18. High-Latitude Paleoceanographic Discoveries From Scientific Ocean Drilling (IODP, ODP, DSDP)

Sandra Paschier, Montclair State University; Tracy Frank, University of Connecticut; Suzanne O'Connell, Wesleyan University

T19. Lake Sedimentary Records of Past Climate and Environment

Redmond Stein, Department of Earth and Environmental Sciences, Columbia University; Abigail M. Cermak, Department of Earth and Environmental Sciences, Columbia University

T20. Paleozoic Events and Processes: Sedimentary Geology, Paleontology, and Geochemistry

Chuck Ver Straeten, Research and Collections, New York State Museum; Alex Bartholomew, Department of Geology, SUNY New Paltz

T21. From Thin Section to Outcrop: Presentation of Undergraduate Research

Sarah Elizabeth Mazza, Smith College; Adrian E. Castro, Wellesley College; David S. Jones, Amherst College

T22. Mesozoic Magmatism, Postrift Tectonics, and Passive Margin Development of Northeastern North America

Jennifer R. Cooper Boemmels, Department of Earth Science, Southern Connecticut State University; Sarah Elizabeth Mazza, Smith College; Maryann Love Malinconico, Lafayette College

T23. Rates, Dates, and Plates: Petrochronological Approaches to Unraveling Tectonometamorphic Histories

Adrian E. Castro, Department of Geosciences, Wellesley College; Emily Peterman, Bowdoin College; Steven J. Jaret, Kingsborough Community College (CUNY)

T24. Surface Processes Across the Solar System

Marisa Christina Palucis, Dartmouth College

T25. Recent Work in Mesozoic East Coast Rift Basins: Structure, Sedimentology, Paleontology, Mapping, and More!

Peter Anthony Drzewiecki, Department of Environmental Earth Science, Eastern Connecticut State University; Randolph P. Steinen, Connecticut Geological Survey

T26. New Advances in Geological and Geophysical Research on the Appalachian Orogen

Nikhil Arolkar, Department of Geology and Geological Engineering, Colorado School of Mines; Yvette D. Kuiper, Department of Geology and Geological Engineering, Colorado School of Mines; Maureen Long, Department of Earth and Planetary Sciences, Yale University

122nd Annual Meeting of the GSA Cordilleran Section

Loreto, Baja California Sur, Mexico, 21–24 April 2026

Loreto, Baja California Sur, Mexico
21–24 April 2026

https://www.geosociety.org/cd-mtg

Location

La Misión Hotel
Rosendo Robles #1
Col. Centro
Loreto B.C.S. México

Where the Mountains Meet the Sea

Join the Geological Society of America (GSA) for the 2026 Cordilleran Section Meeting, taking place 21–24 April 2026 in the stunning coastal community of Loreto, Baja California Sur, Mexico. Set along the Gulf of California—a living laboratory shaped by active tectonics, rifting, volcanic arcs, and desert-coastal processes—Loreto offers an unforgettable backdrop for scientific exploration and collaboration. Attendees will enjoy engaging technical sessions, immersive field trips across world-class geologic terrains, and networking opportunities in a setting where mountains meet the sea and Earth's processes are on full display.

Symposia

S1. Earth–Life Sciences Across the Cordillera

Greer Dolby, University of Alabama at Birmingham; Scott E. K. Bennett, U.S. Geological Survey; Jorge Alberto Miros-Gómez, Universidad Nacional Autónoma de México; Adrián Munguía-Vega, Applied Genomics Lab, University of Arizona

S2. Tectonic Evolution and Competing Models for the Opening of the Gulf of California: From Subduction to Oblique Rifting

Ronald M. Spelz, Universidad Autónoma de Baja California; Raquel Negrete-Aranda, Centro de Investigación Científica y de Educación Superior de Ensenada; Scott E. K. Bennett, U.S. Geological Survey; Elisa Fitz-Díaz, Universidad Nacional Autónoma de México

Theme Sessions

T1. Cordilleran Mineral Systems: Interdisciplinary Perspectives on Critical Metal Ore Deposits

Néstor Alfredo Cano Hernández, Instituto de Geología, Universidad Nacional Autónoma de México; Mélanie Noury, Instituto de Geología, Universidad Nacional Autónoma de México; Cristo Bejarano-Carrillo, Torex Gold; Edith Fuentes Guzmán, Instituto de Geología, Universidad Nacional Autónoma de México; Héctor Gutiérrez-Mendoza, Peñoles; Francisco Quintanar-Ruiz, Fresnillo

T2. Energy Resources and Economic Development in Baja California: Fossil, Renewable, and Transition Minerals

Thomas Lealand Davis, Thomas L. Davis, Geologist

T3. Subsurface Research in Guaymas Basin and the Gulf of California

Andreas P. Teske, Department of Earth, Marine, and Environmental Sciences, University of North Carolina–Chapel Hill; Tobias Höfig, Expedition 385 Project Manager, International Ocean Discovery Program, Texas A&M University; Raquel Negrete-Aranda, Departamento de Geología, Catedrática Conacyt, Centro de Investigación Científica y de Educación Superior de Ensenada; Daniel Lizarralde, Department of Geology and Geophysics, Woods Hole Oceanographic Institution

T4. Cave and Karst Sciences and Communities in México (Poster Session)

Ana K. Celis, Karst Lab México

T5. U.S.–Mexico Exchange on Cave and Karst Science and Conservation

Ana K. Celis, Karst Lab México

T6. Geomorphological, Hydrologic, and Geothermal Investigations of Basin Aquifers in Baja California Sur (BCS), Mexico

Jobst Wurl, Universidad Autónoma de Baja California Sur; Laura M. Norman, U.S. Geological Survey; Enrique Troyo-Diéguez, Centro de Investigaciones Biológicas del Noroeste, S.C.; María Z. Flores López, Universidad Autónoma de Baja California Sur; Loïc Peiffer, Departamento de Geología, División de Ciencias de la Tierra, Centro de Investigación Científica y de Educación Superior de Ensenada

T7. Borderless Geoscience: Linking Baja and Southern California

Young Ho Aladro Chio, Applied Geophysics, Centro de Investigación Científica y de Educación Superior de Ensenada; Erik Ramírez-Ramos, Cuerpo Académico de Ciencias de la Tierra, Instituto de Ingeniería, Universidad Autónoma de Baja California

T8. Geoscience Education in the Western U.S. and México: Practices, Pathways, and Partnerships

Rachel Teasdale, Department of Earth and Environmental Sciences, California State University–Chico/NSF; Rodrigo Gutiérrez Navarro, Facultad de Ingeniería, Universidad Nacional Autónoma de México

T9. Undergraduate Research Posters

Jeffrey Marshall, California State Polytechnic University–Pomona

T10. Submarine Groundwater Discharge (SGD): A Geohydrochemical Continent–Ocean Continuum

Carlos René Green-Ruiz, Unidad Académica Mazatlán, Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México; Pablo Hernández-Morales, Ciencias Marinas y Costeras, Universidad Autónoma de Baja California Sur; Daniel Gonzalez-Duque, School of Earth Sciences, The Ohio State University

T11. Applied Coastal Management: Geoscience Solutions for a Changing Shoreline

Amaia Ruiz de Alegría, Institute of Oceanological Research, Universidad Autónoma de Baja California; Octavio Gómez-Ramos, Institute of Geophysics, Universidad Nacional Autónoma de México

T12. Paleoceanography and Paleoclimate of the Gulf of California and Their Resonance with the Evolution of Other Marginal Seas

Tobias W. Höfig, Texas A&M University; Shijun Jiang, Hainan University; Ligia Pérez-Cruz, Universidad Nacional Autónoma de México

T13. Integrating Metamorphism, Mass Transfer, and Magmatism Across the American Cordillera

Mattia Parolari, Instituto de Geología, Universidad Nacional Autónoma de México; Anthony Ramírez Salazar, Instituto de Geología, Universidad Nacional Autónoma de México; Fabián Gutiérrez Aguilar, Posgrado en Ciencias de la Tierra, Instituto de Geología, Universidad Nacional Autónoma de México; Andrea Viviana Sánchez Gutiérrez, Instituto de Geología, Universidad Nacional Autónoma de México; Arturo Gómez Tuena, Instituto de Geología, Universidad Nacional Autónoma de México

T14. Sedimentary Systems and Provenance in the Western Cordillera

Elena Centeno-García, Instituto de Geología, Universidad Nacional Autónoma de México; Rebecca J. Dorsey, University of Oregon

T15. Evolution of Cordilleran-Type Orogenic Systems

Tomás Capaldi, University of California–San Diego; Susana Henríquez, Department of Geological Sciences, California State University–San Bernardino; Haiyang Kehoe, U.S. Geological Survey

T16. Cenozoic Dynamics of the Western North American Plate Boundary: Insights from Offshore Marine Geology and Geophysics into Cordilleran Tectonics

James Worthington, Department of Geosciences, University of Arizona

T17. Crossing Borders: Large-Scale Tectonic Models of the North American Cordillera

Stacia Gordon, Department of Geological Sciences, University of Nevada–Reno; Basil Tikoff, Department of Geoscience, University of Wisconsin–Madison; Sarah Treviño, Department of Geoscience, University of Wisconsin–Madison

T18. Lost Oceans, Shifting Continents: Interdisciplinary Records of Paleo-Pacific Plate Histories in the American Cordilleras

María Isabel Sandoval, Escuela Centroamericana de Geología, Universidad de Costa Rica; Vanessa Colás, IUCA–Departamento de Ciencias de la Tierra, Universidad de Zaragoza; Elisa Fitz-Díaz, Departamento de Procesos Litosféricos, Universidad Nacional Autónoma de México; Kennet E. Flores, Department of Earth, Marine, and Environmental Sciences, University of North Carolina

T19. Recent Advances in the Gulf of California Oblique Rift: Offshore and Onshore Studies // Avances Recientes en el Rift Oblicuo del Golfo de California: Estudios Marinos y Terrestres

Adriana Piña, Caltech; Scott E. K. Bennett, U.S. Geological Survey; Florian Neumann, MARUM, University of Bremen; Iván Peña-Villa; Karina Fuentes-Bustillos, Centro de Investigación Científica y de Educación Superior de Ensenada

T20. Subduction Zones and Their Volcanic Arcs: Initiation and Evolution, Structure, Metamorphism, Magmatism

Robert M. Holder, Earth and Environmental Sciences, University of Michigan–Ann Arbor; David Hernández Uribe, Earth and Environmental Sciences, University of Illinois–Chicago; Jordan W. Wang, Geosciences, University of Arizona; James Worthington, Geosciences, University of Arizona; John He, Earth, Planetary, and Space Sciences, University of California–Los Angeles; Paul A. Kapp, Geosciences, University of Arizona; Megan Mueller, Geosciences, University of Arizona

T21. Tectonic Controls on Cenozoic Volcanism in the Gulf of California–Salton Trough Region and the Adjacent Southwestern North American Plate Boundary

Bryan P. Murray, Department of Geological Sciences, California State Polytechnic University–Pomona; Cathy J. Busby, Earth and Planetary Sciences, University of California–Davis; Keith D. Putirka, Earth and Environmental Sciences, California State University–Fresno; Michael H. Darin, Oregon Department of Geology and Mineral Industries; Scott E. K. Bennett, U.S. Geological Survey

T22. Tectonic Setting of the Comondú Group: A Discussion of Alternative Interpretations

Luca Ferrari, Instituto de Geociencias, Universidad Nacional Autónoma de México; Mariano Cerca, Instituto de Geociencias, Universidad Nacional Autónoma de México

T23. The Mesozoic Convergent Margin of Alta and Baja California

Joshua Schwartz, Department of Geological Sciences, California State University–Northridge; David Kimbrough, Earth and Environmental Sciences, San Diego State University; Rafael Almeida, Earth and Environmental Sciences, San Diego State University

T24. The Southern Margin of the North American Cordillera Through Time

Bodo Weber, Departamento de Geología, Centro de Investigación Científica y de Educación Superior de Ensenada; Elisa Fitz-Díaz, Instituto de Geología, Universidad Nacional Autónoma de México

T25. The Western Equatorial Pangea: Geological, Geophysical, Geochronological, and Paleoecological Insights on the Youngest Supercontinent Assembly and Breakup on Earth

Mildred Zepeda-Martínez, Instituto de Geociencias, Universidad Nacional Autónoma de México; Bernardo Ignacio García-Amador, Instituto de Geofísica, Universidad Nacional Autónoma de México; N. Betania Palacios-García, Posgrado en Ciencias de la Tierra, Instituto de Geología, Universidad Nacional Autónoma de México; Nancy Riggs, SES Division of Geosciences, Northern Arizona University; Yuly Tatiana Valencia-Morales, Instituto de Geofísica, Universidad Nacional Autónoma de México; Juan Moisés Casas-Peña, Instituto de Geología, Universidad Nacional Autónoma de México

76th Annual Meeting of the GSA Rocky Mountain Section

Albuquerque, New Mexico, USA
17–20 May 2026
https://www.geosociety.org/rm-mtg

Location
Hotel Albuquerque at Old Town
800 Rio Grande Boulevard NW
Albuquerque, New Mexico 87104

Exploring the Geologic Heart of the Southwest

Set against the dramatic backdrop of the Southwestern United States, this meeting offers an exceptional opportunity to explore the intricate geology of the region—from ancient rift systems to volcanic terrain and sedimentary basins. Attendees will engage in cutting-edge technical sessions, hands-on field trips across iconic landscapes, and networking events that bring together professionals, students, and researchers in one vibrant gathering.

Theme Sessions

T1. Advances in Subsurface Characterization for Energy Exploration and Utilization

Pooja Sheevam, New Mexico Bureau of Geology and Mineral Resources; Shari Kelley, New Mexico Bureau of Geology and Mineral Resources; Martin Reyes Correa, New Mexico Bureau of Geology and Mineral Resources

T2. Bridging Worlds: Industry–Academic Collaboration in the Energy Transition

Lisa Stright, Department of Geosciences, Colorado State University

T3. Geological and Geochemical Investigations of Critical Minerals in New Mexico and Beyond, and Technological Advances in Extraction of Critical Minerals

Yongliang Xiong, Sandia National Laboratories; Virginia T. McLemore, New Mexico Bureau of Geology and Mineral Resources; Guangping Xu, Sandia National Laboratories

T4. The Heat Beneath Our Feet: Geologic Controls on Geothermal Resources in the Rocky Mountain Region

Pooja Sheevam, New Mexico Bureau of Geology and Mineral Resources; Shari Kelley, New Mexico Bureau of Geology and Mineral Resources; Eugene Szymanski, Utah Geological Survey; Christian Hardwick, Utah Geological Survey

T5. Mining Legacies and Environmental Remediation in the Southwest

Adrian Brearley, Department of Earth and Planetary Sciences, University of New Mexico; Jose Cerrato, Department of Civil Engineering, University of New Mexico

T6. Geoarchaeological Applications in Cultural Resource Management

Joseph Manuel Birkmann, Department of Anthropology, University of New Mexico; Christopher W. Merriman, Cultural Resources, Espinoza Consulting Services

T7. Geobiology and Astrobiology in Modern and Ancient Environments: From Microbial Interactions to Planetary Exploration

Marisol Juarez Rivera, University of New Mexico; David Antonio Giovannetti-Nazario, University of New Mexico; Mackenzie Brown Best, New Mexico Tech; Lauren Judge, University of New Mexico; Tyler James Mackey, University of New Mexico

T8. Carbon Cycle Dynamics in Desert Landscapes

Marisa Repasch, Department of Earth and Planetary Sciences, University of New Mexico; Miles Kelsey, Department of Earth and Planetary Sciences, University of New Mexico; Catherine Peshek, Department of Earth and Planetary Sciences, University of New Mexico; Aidan Dunne, Department of Earth and Planetary Sciences, University of New Mexico

T9. Critical Minerals Potential in the Land of Enchantment: Past Production and Future Potential

Zohreh Kazemi Motlagh, New Mexico Institute of Mining and Technology; Virginia McLemore, New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology

T10. Hazards and Resources Mapping in the Southwest U.S.: Applications and Future Opportunities

Joel Leonard, Department of Earth and Environmental Science, New Mexico Tech

T11. Environmental Geochemistry and Health Impacts

Andy Jochems, New Mexico Environment Department

T12. Climate Change and Extreme Heat in the Rocky Mountain Southwest: Impacts, Adaptation, and Geoscience Perspectives

Jessica Johnson, Central New Mexico Community College; Melanie Will-Cole, Department of Math, Science, and Engineering, Central New Mexico Community College; Kristen Rahilly, Clark Honors College, University of Oregon; Rick Wiedenmann, Department of Natural Sciences and Engineering, Southeast New Mexico College; Luotao Lin, Department of Individual, Family, and Community Education, University of New Mexico; David Dubois, New Mexico State Climatologist, New Mexico State University; Pamela Martinez, Innovative Media Research and Extension, New Mexico State University

T13. Geologic and Geomorphic Information for Long-Term Flood Frequency Analyses (Paleoflood Analyses for Risk Assessments)

Keith Kelson, U.S. Army Corps of Engineers (Retired); Amy Lefebvre, U.S. Army Corps of Engineers, Risk Management Center

T14. Recent Advances in Neotectonics: Integrating Across Scales

Christine Regalla, School of Earth and Sustainability, Northern Arizona University; Cassandra Bringham, School of Earth and Space Exploration, Arizona State University; Rebecca Bertel, School of Earth and Sustainability, Northern Arizona University

T15. Surficial Geology and Neotectonics in the West: Celebrating and Advancing the Legacy of Kirk Bryan Through Field-Based Geomorphology Studies

Kevin Michael Hobbs, New Mexico Bureau of Geology and Mineral Resources; Cal Ruleman, U.S. Geological Survey

T16. Understanding the Past and Present Cryosphere of the Rocky Mountains

Benjamin J. C. Laabs, U.S. Bureau of Reclamation

T17. Multidisciplinary Studies of Fault and Earthquake Hazard in Low-Strain Environments: Applications to the Intermountain West Region

Urbi Basu, New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology; Veronica Prush, Department of Earth and Environmental Science, New Mexico Institute of Mining and Technology

T18. Everyday Geoscience

Darryl Reano, Arizona State University; Leiaka Welcome, Colorado School of Mines; Wai K. Allen, Arizona State University

T19. Future Voices in Geoscience: Undergraduate Research Posters

Emily Kleber, Utah Geological Survey

T20. Student Research in the Geosciences (Oral)

Cheryl L. B. Manning, Rocky Mountain Section, National Association of Geoscience Teachers; Emily Geraghty Ward, Research and Evaluation, CIRES Center for Education, Engagement, and Evaluation; Mary Kosloski, Science Department, Arvada West High School

T21. Integrated Hydrogeologic Characterization and Modeling for Aquifer Management in Data-Sparse Regions

Sean D. Connell, New Mexico Bureau of Geology; Laila M. Sturgis, New Mexico Bureau of Geology

T22. New Developments in Characterization and Development of Brackish Water Resources in the Arid Southwestern U.S.

Mark Person, Hydrology Program, New Mexico Tech

T23. Technology and Data Advancements in Water Resources: Benefits to Research, Management, and Planning

Rachel Hobbs, New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology; Stacy Timmons, New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology

T24. The Land of Enchantment Through Time: Change in New Mexico From the Past, Through the Present, and Into the Future

Allison Nelson, Bureau of Land Management

T25. Interdisciplinary Paleontology: New Approaches to Solving Complex Paleontological Problems

Jason Richard Moore, Honors College, University of New Mexico; Corinne Myers, Department of Earth and Planetary Sciences, University of New Mexico

T26. The Campanian Crucible: A Synthesis of Vertebrate Paleobiogeography and Ecosystem Dynamics in Laramidia

Heather F. Smith, Midwestern University; Brent Adrian, Arizona State University; Andrew Farke, Raymond M. Alf Museum of Paleontology

T27. Tectonics, Volcanism, and Sediment Dispersal Within and Proximal to the Rio Grande Rift and Southern Rocky Mountains

Carla Eichler, Department of Life, Earth, and Environmental Sciences, West Texas A&M University; Mitchell Clay, Department of Life, Earth, and Environmental Sciences, West Texas A&M University; Rebecca VanderLeest, Department of Geosciences, Colorado State University

T28. Advancements in the Proterozoic Tectonics of Western North America

Chloe E. Bonamici, University of Wisconsin–Madison; Graham B. Baird, Department of Earth and Atmospheric Science, University of Northern Colorado; Mark Edward Holland, Arizona Geological Society

T29. Paleo-Climate and Paleo-Ecosystems of the Southwest and High Plains: From the Paleozoic to the Quaternary

Rachel Bernstein, Department of Geosciences, Colorado State University; Jeremy Rugenstein, Department of Geosciences, Colorado State University; Taylor Bennett, Department of Geosciences, Colorado State University

T30. Stratigraphic Studies in the Colorado Plateau

Eugene Szymanski, Utah Geological Survey; Matthew C. Morriss, Utah Geological Survey; Ryan Gall, Utah Geological Survey; Cari L. Johnson, University of Utah; Elizabeth Mahon, University of Utah

T31. Structural Inheritance in the Rocky Mountain Region

Samantha L. Malavarca, Department of Geosciences, Colorado State University; John Singleton, Department of Geosciences, Colorado State University

T32. Geologic and Paleoclimate Records of Coupled Intraplate Mountain Building and Global Change: Examples From North America and Asia

Nora Vaugha, Lehigh University; Jonathan Anaya, New Mexico Institute of Mining and Technology; Gabriela Sanchez Ortiz, Colorado State University; Frank Pazzaglia, Lehigh University

T33. Geologic Mapping in the West

Jon M. Krupnick, New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology; Rebecca L. Goughnour, New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology; Kyle Gallant, New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology

T34. The Rio Grande Rift and Colorado Plateau: Integrating Geologic and Geophysical Perspectives on Continental Extension

Eric O. Lindsey, Department of Earth and Planetary Sciences, University of New Mexico; Veronica B. Prush, Department of Earth and Environmental Science, New Mexico Tech; Mousumi Roy, Department of Physics and Astronomy, University of New Mexico

T35. Distributed Volcanic Fields of the Southwestern U.S.

Emily Johnson, U.S. Geological Survey, Cascades Volcano Observatory; Kellie Wall, U.S. Geological Survey, Cascades Volcano Observatory; Jisoo Kim, U.S. Geological Survey, Cascades Volcano Observatory; Elisabeth Widom, Miami University (Ohio)

Student Volunteers

Are you a student looking to get involved with GSA and connect with geoscientists across your region? Sign up to volunteer at one of the 2026 GSA Section Meetings! Student volunteers play a vital role in supporting sessions, registration, and meeting logistics—and in return, receive complimentary meeting registration. Volunteer spots are filled on a first-come, first-served basis, so don't wait to secure your place!

To be eligible, you must be a current GSA student member. Not a student member yet?

Visit www.geosociety.org/join to take advantage of this opportunity and more!

Student memberships are only $25/year.

Questions? Email gsastudents@geosociety.org.

Volunteer as a Student Driver for Complimentary Field Trip and Meeting Registration

Students aged 25+ with a valid driver's license can volunteer as field trip drivers to receive complimentary registration for both the trip and the meeting. Email Rebecca Taormina (fieldtrips@geosociety.org) for more information.

Attending a Section Meeting? Consider Mentoring

Please share your experiences and career insights as a mentor at GSA Section Meetings! Whether you are an early career or established professional, your wisdom will help young geoscientists find their paths. Mentors from all geoscience sectors including industry, government, and academia are welcome. You can serve as a table mentor for a career mentoring luncheon, or mentor for career workshops.

Intrigued? Join the mentoring interest list by emailing gsamentoring@geosociety.org. Please include your full name, job title, and employer. Thank you!

Student Opportunities at GSA Section Meetings

GSA Section Meetings offer a variety of ways for students to connect, learn, and build their careers in the geosciences. Whether you're looking to network with professionals, explore career pathways, or strengthen your application materials, there's something for everyone!

Career Mentoring Luncheons: Connect with mentors from industry, government, and academia while learning about nonacademic and applied geoscience career paths. Lunch is $5 per student, and advance registration is required.

Roy J. Shlemon Mentor Program in Applied Geoscience: Discuss career prospects and challenges with applied geoscientists from a variety of sectors.

John Mann Mentors in Applied Hydrogeology Program:
Meet professionals in hydrogeology and hydrology to learn about career options and industry insights.

Geology Club Meetups: Connect with other geology club members from across your region, share ideas, and learn how to start or grow your campus club.

Career Workshop Series: Join interactive sessions covering career planning, geoscience job sectors, résumé/CV and cover letter tips, and networking strategies.

Don't miss these opportunities to take the next step in your geoscience journey! Check back in future issues for registration information, or email gsastudents@geosociety.org.

GSA International

Partner with The Geological Society of America

The Geological Society of America (GSA) welcomes partnerships and collaborations with scientific societies and organizations across the globe that share our vision of advancing geoscience research, discovery, and service to society. GSA currently partners with 89 Associated Societies, including 38 international organizations, working together to promote the geosciences, foster diversity and inclusion, and support scientists at every career stage.

Through these partnerships, we aim to exchange ideas, co-organize meetings and symposia, create joint opportunities, and connect the global geoscience community to address shared challenges.

Join us in shaping the future of geoscience.

Learn more about partnership opportunities at https://www.geosociety.org/GSA/GSA/About/Associated_Societies.aspx.

For inquiries, contact gsa_international@geosociety.org.

Make an Impact: Self Nominate!

Are you passionate about representing student voices within GSA? **The Student Advisory Council (SAC)** provides an incredible opportunity to shape the Society's direction and advocate for the needs of student members across the geosciences.

In recent years, SAC has expanded its leadership presence—now both its Chair and Immediate Past Chair are full voting members of GSA Council. This change strengthens the connection between student members and GSA's leadership.

The nomination process is simple—just complete the online nominations form and answer a few brief questions, just like other GSA leadership applicants.

Nomination Deadline: 31 December 2025

Questions? Contact dwilliams@geosociety.org.

https://www.geosociety.org/GSA/gsa/about/sac.aspx

2025–2026 Division Officers

CONTINENTAL SCIENTIFIC DRILLING DIVISION
Michael M. McGlue — Chair
Lisa E. Park Boush — Vice-Chair
Anders Noren — Secretary-Treasurer
Brett M. Carpenter — Past Chair

ENERGY GEOLOGY DIVISION
Anna Ahlstrom Littlefield — Chair
Lily J. Jackson — First Vice-Chair
TBD — Second Vice-Chair
TBD — Secretary-Treasurer
Qinhong (Max) Hu — Past Chair

ENVIRONMENTAL AND ENGINEERING GEOLOGY DIVISION
William Paul Burgess — Chair
Luke A. McGuire — First Vice-Chair
Ben Leshchinsky — Second Vice-Chair
Kate Mickelson — Secretary-Treasurer
Ann M. Youberg — Past Chair

GEOARCHAEOLOGY DIVISION
Charles F.T. Andrus — Chair
Alyssa Victoria Pietraszek — Vice-Chair
Rebecca A. Taormina — Secretary-Treasurer
Scott H. Pike — Past Chair

GEOBIOLOGY AND GEOMICROBIOLOGY DIVISION
David A. Gold — Chair
Dylan Thomas Wilmeth — Vice Chair
Ana C. Gonzalez-Nayeck — Secretary
Katie M. Maloney — Treasurer
Trinity L. Hamilton — Past Chair

GEOCHRONOLOGY DIVISION
Noah McLean — Chair
John Cottle — First Vice Chair
Mauricio Ibanez-Majia — Second Vice-Chair
Tiffany Rivera — Secretary
TBD — Treasurer
Robin B. Trayler — Diversity Coordinator
Mark Schmitz — Past Chair

GEOINFORMATICS AND DATA SCIENCE DIVISION
Anirudh Prabhu — Chair
Daven Quinn — Vice-Chair
Samuel Shaheen — Secretary-Treasurer
Tao Wen — Past Chair

GEOLOGY AND HEALTH DIVISION
Laura Ruhl-Whittle — Chair
Rachel Marylee Coyte — First Vice-Chair
Sabrina L. Lanker — Second Vice-Chair
Abhishek Roy Chowdhury — Secretary-Treasurer
Malcolm Siegel — Past Chair
Linda Barnum — Member-at-Large

GEOLOGY AND SOCIETY DIVISION
TBD — Chair
Shreya Arora — First Vice-Chair
TBD — Second Vice-Chair
TBD — Secretary-Treasurer
Alan I. Benimoff — Past Chair

GEOPHYSICS AND GEODYNAMICS DIVISION
Shannon A. Dulin — Chair
Benjamin Patrick Magnin — Vice-Chair
Amanda Hughes — Secretary-Treasurer
Anjana K. Shah — Past Chair

GEOSCIENCE EDUCATION DIVISION
Nick Soltis — Chair
Victor J. Ricchezza — First Vice-Chair
Melissa N. Ortega — Second Vice-Chair
Andy Darling — Secretary-Treasurer
Elizabeth Kenderes — Past Chair

HISTORY, PHILOSOPHY, AND GEOHERITAGE DIVISION
Rex A. Hanger — Chair
William M. Andrews Jr. — First Vice-Chair
Roy E. Plotnick — Second Vice-Chair
Christopher L. Hill — Treasurer
Kerry V. Magruder — Past Chair
William C. Parcell — Web Manager

HYDROGEOLOGY DIVISION
Richelle Allen — Chair
Kallina Dunkle — First Vice-Chair
Barret Kurylyk — Second Vice-Chair
Tara L. Root — Secretary-Treasurer
Maureen A. Muldoon — DEI Officer
Donald O. Rosenberry — Past Chair

KARST DIVISION
Jeanne Lambert Sumrall — Chair
Josh Sebree — Vice-Chair
Sierra M. Heimel — Secretary
Natasha Sekhon — Treasurer
Pat Kambeiss — Past Chair

LIMNOGEOLOGY DIVISION
Elana Leithold — Chair
Lesleigh Anderson — First Vice-Chair
Jonathan Obrist-Farner — Second Vice-Chair
Jeremiah Bernau — Secretary
David B. Finkelstein — Treasurer
Kirsten M. Menking — Past Chair

MARINE AND COASTAL GEOLOGY DIVISION
Nicole S. Khan — Chair
Joshua C. Bregy — First Vice-Chair
Joseph Andrew Carlin — Second Vice-Chair
Mohammad Imaran — Secretary-Treasurer
Scott W. Starratt — Past Chair
Shannon Conner — Communications Coordinator

MINERALOGY, GEOCHEMISTRY, PETROLOGY, VOLCANOLOGY
Jade Star Lackey — Chair
Gary S. Michelfelder — First Vice-Chair
Chris Yakymchuk — Second Vice-Chair
J. Alexander Speer — Secretary-Treasurer
Elisabeth Widom — Past Chair

PLANETARY GEOLOGY DIVISION
Lauren M. Jozwiak — Chair
Alex Morgan — First Vice-Chair
TBD — Second Vice-Chair
Claire A. Mondro — Secretary-Treasurer
Jennifer L. Piatek — Past Chair

QUATERNARY GEOLOGY AND GEOMORPHOLOGY DIVISION
Karen B. Gran — Chair
William Ouimet — First Vice-Chair
Bradley G. Johnson — Second Vice-Chair
Lisa Ely — Secretary
Scott F. Burns — Treasurer
Veronica Sosa Gonzalez — DEI Officer
Janet L. Slate — Historian
Sarah Anne Schanz — Communications Coordinator
Jennifer L. Pierce — Past Chair

SEDIMENTARY GEOLOGY DIVISION
Majie Fan — Chair
TBD — Vice-Chair
Jacob Covaul — Second Vice-Chair
TBD — Secretary-Treasurer
Jason Flaum — Past Chair

STRUCTURAL GEOLOGY AND TECTONICS DIVISION
Andrew Zuza — Chair
Elena A. Miranda — First Vice-Chair
TBD — Second Vice-Chair
TBD — Secretary-Treasurer
James Kirkpatrick — Past Chair

SOILS AND SOILS PROCESSESS
Michael Howard Young — Chair
Timothy M. Gallagher — Chair-Elect
William E. Lukens — Secretary-Treasurer
Dennis O. Terry Jr. — Past Chair
Jiawei Da — Communications Officer

Celebrate Excellence in the Geosciences

Recognizing outstanding contributions to geoscience research, service, and education.

Nomination Deadline: 15 February 2026

To nominate, go to **www.geosociety.org/awardnoms**.

Questions? Contact **awards@geosociety.org**.

For details on each award, go to **www.geosociety.org/awards/aboutawards.htm**.

Penrose Medal

Established in 1927 by R.A.F. Penrose, Jr., the Penrose Medal is awarded in recognition of eminent research in pure geology, for outstanding original contributions or achievements that mark a major advance in the science of geology.

Arthur L. Day Medal

Established in 1948 through a donation by Arthur L. Day, the Day Medal is awarded to recognize outstanding distinction in the application of physics and chemistry to the solution of geologic problems, with no restriction to the particular field of geologic research.

Young Scientist Award (Donath Medal)

Established in 1988, this award is given to a young scientist (35 or younger throughout the year in which the award is to be presented) for outstanding achievement in contributing to geologic knowledge through original research that marks a major advance in the earth sciences.

GSA Public Service Award

Established by the GSA Council in honor of Eugene and Carolyn Shoemaker in 1998, the Public Service Award recognizes contributions that have materially enhanced the public's understanding of earth sciences, or significantly served decision makers in the application of scientific and technical information in public affairs and public policy related to the earth sciences.

GSA Distinguished Service Award

Established by GSA Council in 1988, the Distinguished Service Award recognizes individuals for exceptional service to the Society. GSA Members, Fellows, associates, and employees may be nominated for consideration.

Randolph W. “Bill” and Cecile T. Bromery Award for Minorities

Awarded to any minority, preferably African Americans, “who have made significant contributions to research in the geological sciences, or those who have been instrumental in opening the geoscience field to other minorities.”

Doris M. Curtis Outstanding Woman in Science Award

In memory of Doris M. Curtis, this GSA award is presented to a woman who has impacted the field of the geosciences in a major way based on her PhD research. Women are eligible for the first five years following their degree.

GSA Geologic Mapping Award in Honor of Florence Bascom

Established in 2015, this award acknowledges contributions in published high-quality geologic mapping that led the recipient to publish significant new scientific of economic resource discoveries and to contribute greater understanding of fundamental geologic processes and concepts.

Michel T. Halbouty Distinguished Lecturer Award

https://www.geosociety.org/GSA/GSA/Awards/Halbouty.aspx

The Halbouty Distinguished Lecturer Award was established to select a top lecturer on a topic of relevance to natural resources (i.e., water, land, energy, and minerals). Selection of the lecturer will be on the basis of career accomplishments and reputation, as well as the topic of the lecture. Nominations of scholars across this range of topics are encouraged.

John C. Frye Environmental Geology Award

www.geosociety.org/GSA/Awards/Frye.aspx

Deadline: 31 March 2026

In cooperation with the Association of American State Geologists and supported by endowment income from the

GSA Foundation's John C. Frye Memorial Fund, GSA makes an annual award for the best paper on environmental geology published either by GSA or by a state geological survey.

2026 Post-Doctoral Research Awards

Gladys W. Cole Memorial Research

www.geosociety.org/GSA/About/awards/GSA/grants/postdoc.aspx

Deadline: 15 February 2026

This award recognizes research on the geomorphology of semiarid and arid terrains in the United States and Mexico is awarded annually to a GSA member or Fellow between 30 and 65 years of age who has published one or more significant papers on geomorphology.

W. Storrs Cole Memorial Research Award

www.geosociety.org/GSA/About/awards/GSA/grants/postdoc.aspx

Deadline: 15 February 2026

This award recognizes research on invertebrate micropaleontology and is awarded annually to a GSA member or Fellow between 30 and 65 years of age who has published one or more significant papers on micropaleontology.

Tim W. Wawrzzyniec Fellowship Award

https://www.geosociety.org/GSA/About/awards/GSA/Awards/wawrzyniec.aspx

Deadline: 1 February 2026

The Wawrzzyniec Fellowship Award supports research conducted by PhD-holding investigators who have not previously worked through the Rocky Mountain Biological Laboratory. The intent is for the fund to award $5,000 annually.

AGI Medal in Memory of Ian Campbell

https://www.americangeosciences.org/awards/iancampbell

Deadline: 15 February 2026

The AGI Medal in Memory of Ian Campbell for Superlative Service to the Geosciences is awarded in recognition of outstanding performance in and contribution to the geoscience profession.

GSA International Awards and Lectureship

For more details about GSA International awards, visit **https://www.geosociety.org/GSA/About/GSA_International/GSA/International/awards.aspx**.

Questions? Contact **gsa_international@geosociety.org**.

GSA International Honorary Fellow Award

The GSA International Honorary Fellow Award is presented to an international geoscientist who has distinguished him- or herself in geoscience investigations, promoting environmental awareness, linking science and society, providing notable service to implementing public policy in natural resource management, or otherwise making outstanding contributions to science.

Eligibility: Open to non–North Americans residing and working outside North America.

GSA International Distinguished Career Award

The Distinguished Career Award will be given to a GSA member who has made numerous, distinguished, and significant contributions that have clearly advanced the international geological sciences through both scientific investigations and service.

GSA James B. Thompson, Jr. Distinguished International Lectureship

Nominations are being accepted for two dynamic speakers of established scientific stature who can present stimulating and cutting edge geoscience research for one or two tours each. The nominee/s may be either living outside of North America and be able to lecture at North American institutions, or living within North America and be able to lecture outside of North America on topic/s that are at the forefront of research.

For a listing of other national awards and links information and nomination forms, visit www.geosociety.org/awards/national.htm.

A Community of Giving: Shape the Future of Geoscience With Your End-of-Year Support to the GSA Foundation

December is a time of giving thanks and giving gifts. At the GSA Foundation, we are grateful to you, the members of the GSA, who make gifts to support GSA programs.

The mission of the Geological Society of America Foundation is to develop and provide funds to support the goals and programs of the GSA. Your donations strengthen GSA—and impact both lives and the future of the geosciences.

Donations to the GSA Foundation support students like Yueyi Che. The recipient of an On To the Future (OTF) Award to attend GSA Connects in 2021, Yueyi says, “Receiving the acceptance letter from OTF was one of my happiest moments, and I hope more students can have the wonderful experience that I had ... Your donation can help this community keep growing for years to come.”

A PhD student at UC Irvine, Yueyi is also a GSA Foundation supporter. It means so much when past award recipients want to make a difference for future generations of explorers.

In the past five years, the GSA Foundation has provided more than $7 million in funding to GSA programs. These resources help GSA maintain thriving awards for research, scholarships, conference participation, and other priorities of the Society. Many of the GSA Foundation’s 120+ funds target geoscience students and connect them with GSA’s programs and networks, often spurring lifelong engagement with GSA—and building a bright future for the geosciences.

You can direct your gift to whatever aspect of GSA’s work resonates most for you. Some donors give to their Division or Section; others support the Greatest Needs Fund to provide flexible funding for emerging priorities; still others give to one of the GSA Foundation’s 120+ funds.

Darrel Cowan, who was a GSA Foundation Trustee for 10 years and helped establish the Lauren A. Wright & Bennie W. Troxel Research Award, notes, “I support the GSA Foundation because I know it supports the programs of the Society. GSA has been my home society since I was a graduate student. I published my first paper in the bulletin, I gave my first talk at a GSA section meeting, and a GSA grant supported my PhD research.”

Yueyi Chi, 2021 On To the Future Award recipient.

Darrel is a professor emeritus at the University of Washington and further supports the GSA Foundation as one of the leaders of its Death Valley Rendezvous. He says, “My students have been awarded GSA funding for their research in turn. This has led to a real personal appreciation for what GSA provides to the geoscience community. I know what GSA does, I benefited from it, and I want to help continue that support.”

We hope you will be inspired by the generosity of Yueyi, Darrel, and thousands of other GSA members. And if you are already a supporter, we are grateful.

Your contributions help shape the future of geoscience and will help the field thrive for generations to come.

All donations make a difference. Please scan the QR code to make an end-of-year gift now, or contact GSA Foundation Executive Director Sean O’Brien, PhD, at sobrien@geosociety.org to learn about more ways to give. Gifts to the GSA Foundation are fully tax-deductible under U.S. law.

SCAN ME

A Time Interval of Voluminous Magmatism and Global Biologic Significance

GEOLOGY THROUGH THE LENS

In the parking lot behind the Target store in Meriden, Connecticut, USA, the conformable contact between Late Triassic New Haven thinly bedded sediments and densely pillowed Early Jurassic Talcott basalt lavas represents not only the initiation of Central Atlantic Magmatic Province basaltic magmatism within the Hartford rift basin but the time interval during which an End-Triassic extinction event radically altered the Earth's biosphere that resulted in the emergence of dinosaurs as the dominant terrestrial fauna.

Dr. Jack B. Share is a geology enthusiast and author of the blog "Written In Stone . . . seen through my lens" (https://written-in-stone-seen-through-my-lens.blogspot.com/).

POSITION STATEMENT:

The Benefits of Professional Geologist Licensure

Adopted August 2025

Position Summary

State and federal governments are encouraged to promote legislation that supports professional licensure for geologists and protect existing licensure requirements. Professional Geologist Licensure ensures that geoscience professionals specializing in fields related to public welfare, such as geohazards, water supply, environmental quality, natural resources and extractive industries (i.e., energy and mineral commodities), and infrastructure, have the necessary knowledge and expertise to properly address the challenges in these areas. As of July 2025 in the United States, 31 states plus Puerto Rico require licensure for geologists working in domains that affect public safety and health, but some states are attempting to eliminate licensure requirements (ASBOG, 2025b). Competency is essential for responsible and effective application of relevant geoscience principles, techniques, and data sets.

This position statement (1) summarizes GSA's consensus views in support of licensure for professional geologists (Geological Society of America, 2019)[1]; (2) highlights some of the many aspects of applied geology where licensure is vital; (3) stresses the importance of support from governments, the private sector, and institutions of higher learning; and (4) provides a communication tool for use by GSA and its members to discuss why a strong commitment to professional geologist licensure is critical to public health, safety, and welfare.

CONCLUSIONS AND RECOMMENDATIONS

A highly qualified workforce of licensed professional geologists is critical as societies address significant challenges with burgeoning populations, changing climate, and increasing demand for natural resources. Professional licensed geologists in applied fields have tremendous insight into the critical interface between the built environment and the geology on which it resides (The Geological Society of America, 2019). Licensure, in this context, pertains to geologists who apply their proficiency and knowledge in the responsible charge of their work, as an individual contractor, employee of a company, or state or local government employee who is required to be licensed. Geologists engaged in academic research, teaching, federal government oversight, or who are employed directly by energy and mineral companies that are involved in activities within their own domains (i.e., properties and leases) are typically exempt from professional licensure and are not the focus of this position statement.

Indeed, licensed geologists provide pertinent geologic data and interpretation that complement the civil construction societies need to function. In infrastructure projects, geologists assess local, regional, and deep subsurface rock materials, hazards, surface, and groundwater, while civil engineers design construction and foundations appropriate for the site's substrate (ASBOG, 2025a).

[1] This also includes geophysicists and soil scientists. Geologists and geophysicists are included in every State Geologists Licensure Board's Professional Code. Some licensure boards also include soil scientists.

Geologist licensure promotes professionalism, expertise, and accountability in the public domain—ultimately benefiting the consumer, society, and the environment. This is similar to other credentialed professions that advance public protection, such as medicine, architecture, and engineering. Licensure also enhances career growth and earnings for the practitioner, as the bearer has demonstrated competence and ethical behavior in the practice of geology.

- **Governments should support legislation for geologist licensure.** Geology licensure programs (i.e., State Professional Geologist Licensure Boards) provide direct oversight of practicing professionals. Boards establish and maintain the minimum level of competency in the profession, promote accountability, and have the legal authority to conduct investigations of deficient work, consumer complaints, and issues of malfeasance.

- **Licensure assists geoscience departments in maintaining a consistent core of geology courses.** Workforce requirements, such as those practicing applied geology to be licensed, have a strong influence on higher-learning criteria (King, 2013). The ability of geologic practitioners to make qualified observations of earth materials, geologic structures, geophysical and geochemical data, and evidence of natural hazards, and offer sound scientific interpretations is rooted in the geoscience curricula.

- **Institutions of higher learning should inform students of the value and importance of being a licensed professional.** Earth science departments should maintain college-level course work to prepare future geologists for applied work in areas outside academia and research (ASBOG, 2021).[2] Subject matter germane to the Association of State Boards of Geology (ASBOG®) Fundamentals of Geology (FG) exams should be incorporated into geology classes. This may include workshops or courses to demonstrate the value of professional licensure and prepare students for the necessary examinations and internships with professional geologists in their region (ASBOG, 2022). Geoscience majors should be encouraged and incentivized to take the FG exam as soon as they have completed the requirements of their major.

- **Geologists should promote partnerships with engineering departments and engineering professional societies to expand awareness of the geologist licensure credential** and the importance geology has in certain engineering fields (e.g., civil, environmental, mining, geotechnical, agricultural).

- **Advocating for the licensing of geologists requires reaching out and educating elected officials, corporate partners, and the public about the critical role that qualified licensed geologists play.** Fostering partnerships with industry, institutions of higher learning, professional societies, and communities is necessary to most effectively lobby state legislatures and Congress on behalf of professional geologist licensure, and to reduce the potential costs of allowing unqualified geologists to practice in ways that may result in adverse outcomes.

RATIONALE

Geologists seek to understand the complex processes that forged Earth's physical structure, composition, environments, and climate. To wisely manage Earth's resources, ensure public health and safety, improve societal welfare, and support sustainable growth, the public is best served by geologists that meet professional requirements of education, experience, competency, ethics, and accountability. For applied professionals, geologist licensure maintains professional standards and prioritizes societal safety, health, and well-being. Professional licensure of geologists provides pathways to avoid unnecessary and adverse outcomes, as the licensee must assume a greater degree of responsibility than their non-licensed peers (i.e., licensees must attest to the veracity and integrity of their data collection, analyses, and interpretations).

Professional geologist licensing in the United States is regulated by the individual states. Candidates must meet specific coursework requirements in their educational preparation and complete three to seven years of qualifying experience under the supervision of a licensed professional geologist before becoming eligible for licensure (ASBOG, 2022). Candidates must successfully pass two rigorous national-level examinations, administered by ASBOG®. It is recommended that the FG exam be taken right after completion of the undergraduate degree, although some states allow it to be taken before graduation. Twenty-two states plus Puerto Rico then list the successful candidate as a Geologist-in-Training. The Practice of Geology (PG) exam is taken after the required years of work experience are completed. These examinations ascertain the candidate's capacity for professional practice. Several states require subsequent Continuing Education Units (CEU) to maintain professional licensure. Geologists who do not live in a state that provides licensure can instead receive their license from another state, which can enhance their résumé and reputation.

At present, in the United States, some levels of government are promoting less regulation; some state legislators and executive officers are attempting to eliminate the safeguards provided by licensure (Enviro-Equipment, Inc., 2012; Visconti, 2020; Duda, 2016; Neal and Stohr, 2017; Halff Associates, Inc., 2018; Díaz Torres,

[2] According to the ASBOG®, analysis of pass-fail data from 2008 to 2021 of the Fundamentals of Geology (FG) examination indicates that about 35% of the applicants who take the exam lack geologic knowledge at a fundamental level. Additionally, about 25% of applicants taking the Practice of Geology (PG) examination lack the knowledge and/or experience at a professional level for public protection, at a minimum competency level.

2020; WKRN, 2020), which can leave gaps in monitoring and oversight roles. In addition, the U.S. Environmental Protection Agency published a rule that excludes professional geologists from any compliance oversight with coal ash waste management (U.S. EPA, 2025), an area that is very germane to the geosciences. Yet all 50 states and Washington, D.C., require engineers to be individually licensed in order to protect public safety. As of July 2025, 31 states and Puerto Rico require geologists to have some form of licensure (ASBOG, 2025b). At least nine of those licensure laws are currently, or have been recently, threatened (Enviro-Equipment, Inc., 2012; Visconti, 2020; Duda, 2016; Neal and Stohr, 2017; Halff Associates, Inc., 2018; Díaz Torres, 2020; WKRN, 2020).

Professional geologist licensure is a product of legislation that, consequently, establishes the legal oversight, professional standards, and enforcement authority within its state or territory (and, if applicable, any interstate agreements). Professional licensure offers broader jurisdiction and greater public protection than professional certifications and registrations conferred by some geoscience societies (Tepel, 1995). These may be general, like the Certified Professional Geologist (CPG) of the American Institute of Professional Geologists (AIPG; Garcia, 2025), or specialty-related, such as those associated with fossil-fuel or mineral-industry associations. Such accreditations require several years of relevant work experience and references from other certified geologists but may not necessarily entail thorough examination of knowledge. While these certifications may be recognized nationally and/or internationally, and certified geologists may function as expert witnesses or do due diligence, they have no legal authorization to act as regulatory agents.

Areas of licensed geologist practice (ASBOG, 2025c) include:

- **Natural Resource Management:** Mineral-resource evaluation; oil and gas development; mined-land reclamation; acid mine drainage suppression and remediation; groundwater investigations; energy infrastructure siting.
- **Risk Assessment and Mitigation:** Geohazards, including floods, sinkholes, earthquakes, landslides, volcanic eruptions; land surface stabilization; risk analysis (insurance and reinsurance industries).
- **Environmental Protection:** Environmental impacts related to natural resources extraction, soil and water quality, and climate change effects; maintaining the integrity of ecosystems and natural habitats; accurate and reliable geologic/environmental data acquisition (and reporting to government agencies) for public use; safe solid waste management; toxic, nuclear, and hazardous waste disposal siting and management; contaminated soil investigations and remediation.
- **Climate Change Adaptation:** Assessing vulnerabilities, mitigation strategies, and increased resilience to climate-induced challenges (e.g., sea-level rise, extreme weather events, shifting precipitation patterns, and human migration).
- **Other Specific Practice Areas:** Geologic mapping; dam and impoundment construction; highway, roadway, and bridge construction.

Encouraging workforce standards by promoting professional licensure for geologists can reduce risks posed to the public and the environment. Licensure ensures that those engaged in the professional practice of geology possess the necessary training, knowledge, and ethical standards to conduct the appropriate geological work accurately and responsibly (ASBOG, 2025a). Potential risks of non-licensure include:

1. The possibility that an error may cause damage to property and loss of life;
2. Greater costs from incorrect and incomplete work;
3. Greater costs of supervision; and
4. Lower cost/benefit ratios brought about by an inability to do efficient work.

OPPORTUNITIES FOR GSA AND ITS MEMBERS TO HELP IMPLEMENT RECOMMENDATIONS

- Interface with government, public officials, and institutions of higher education (especially in states without geologist licensure) and provide expert input on the value and relevance of licensed applied geologists.
- Track and monitor legislative activity pertaining to professional geologist licensure and relay developments to the membership.
- Work with local and regional planning offices, engineering departments, emergency management agencies, water resources boards, and agricultural services to inform them of the benefits of including licensed geologists in their current and future endeavors. This might include field excursions to highlight specific engineering, environmental, and land management issues.
- Partner with ASBOG® and promote geologist licensure at national and regional meetings of professional earth science and engineering societies (e.g., The Geological Society of America, American Geophysical Union, American Society of Civil Engineers). GSA members can share personal experiences and success stories through mentoring programs, short courses, topical sessions, and serving as volunteers at resource booths. Invite legislators and public officials to engage with licensed members at meetings and ancillary social events.
- Encourage college educators in earth science departments to obtain a professional geologist license. College instructors are well positioned to inform students about geologist licensing and its importance. Education professionals who obtain a PG license should be recognized for their achievement in career advancement reviews.

• Advocate for higher education earth science programs to maintain curricula that provide adequate instruction in the core geologic disciplines (e.g., mineralogy, petrology, stratigraphy, structural geology, and hydrogeology and other Earth-surface processes), which are a necessary foundation on which to build the expertise required of a licensed professional geologist. Incorporate the pertinent concepts of the ASBOG® FG exam into department courses.

• Recommend testing of the ASBOG® FG exam as soon as students have completed their core geoscience coursework.

• Professional and academic members of GSA can provide quality applied science continuing educational opportunities through GSA and member societies to help licensees meet their continuing education requirements.

REFERENCES CITED

ASBOG (National Association of State Boards of Geology), 2021, A Cross Sectional View: https://asbog.org/crosssection/CrossSection_Nov_2021.pdf (accessed August 2025).]

ASBOG, 2022, State Requirement Matrix: https://asbog.org/matrix/ASBOG_Matrix–Oct%202022_11x17.pdf (accessed August 2025).

ASBOG, 2025a, Why Licensure: https://asbog.org/governance/licensure.html (accessed August 2025).

ASBOG, 2025b, State Index: https://asbog.org/state_boards.html (accessed August 2025).

ASBOG, 2025c, Tasks of a Professional Geologist: https://asbog.org/documents/ASBOG_tasksofgeologist.pdf (accessed August 2025)

Díaz Torres, R., 2020, Geologists in Puerto Rico have been unlicensed during seismic emergency period due to government inefficiency: https://periodismoinvestigativo.com/2020/10/geologists-in-puerto-rico-have-been-unlicensed-during-seismic-emergency-period-due-to-government-inefficiency/ (accessed August 2025).

Duda, J., 2016, Much work remains on Ducey professional licensing bill: https://azcapitoltimes.com/news/2016/02/17/commerce-committee-approves-bill-to-deregulate-geologists-yoga-instructors/ (accessed August 2025).

Enviro-Equipment, Inc., 2012, Deregulation of Geologists in South Carolina: https://www.enviroequipment.com/newsletter/south-carolina-geology-licensure (accessed August 2025).

Garcia, D., 2025, Professional Licensure and Certification of Geologists: AIPG's Professional Certification: https://cdn.ymaws.com/aipg.org/resource/resmgr/documents/power_point_presentations/2025aipg_prof_certification.pdf (accessed August 2025).

Geological Society of America, 2019, Position statement: The role of the geoscientist in assuring the safety and integrity of infrastructure: https://www.geosociety.org/GSA/Science_Policy/Position_Statements/Current_Statements/gsa/positions/position5.aspx (accessed August 2025).

Halff Associates, Inc., 2018, Regulation of Professional Geoscientists at stake with Sunset Commission decision: https://www.halff.com/news-insights/%25type%25/regulation-of-professional-geoscientists-at-stake-with-sunset-commission-decision/ (accessed August 2025).

King, D.L., 2013, Geological Education Today: The Professional Geologist, v. 50, no. 5, p. 40–42.

Neal, K., and Stohr, C., 2017, Successfully resisting the repeal of Illinois' Professional Licensing Act—The Chicago way: https://aeg.memberclicks.net/assets/Licensure/AEGNewsarticleonIllinoisLicensure2017AUG1.pdf (accessed August 2025).

Tepel, R.E., 1995, Professional Licensure for Geologists: An Exploration of Issues: Association of Engineering Geologists Special Publication No. 7, p. 11.

U.S. Environmental Protection Agency, 2025, Disposal of Coal Combustion Residuals from Electric Utilities Rulemakings: https://www.epa.gov/coalash/coal-ash-rule (accessed August 2025).

Visconti, A., 2020, Florida passes the most comprehensive deregulation bill to date: https://ascend.thentia.com/insight/florida-deregulation-occupational-licensing-requirements (accessed August 2025).

WKRN, 2020, Tennessee bill would remove license requirements for 25+ jobs: https://www.wkrn.com/news/tennessee-bill-would-remove-license-requirements-for-25-jobs/ (accessed August 2025).


Geoscience Moves the World.
Move it Forward with GSA.
Join the Geological Society of America and be part of a global community of 17,000+ geoscientists advancing discovery, connection, and impact. Wherever you are in your journey—from student to professional—GSA helps you learn, grow, and lead in the geosciences.
Connect.
Collaborate with peers across disciplines and continents. Join Scientific Divisions, Geographic Sections, and the Online Member Community to exchange ideas and inspire innovation.
Learn.
Advance your science and your career through conferences, field trips, short courses, and webinars. Enjoy full access to Geology, GSA Bulletin, and GSA Today.
Grow.
Tap into funding, mentoring, and career programs that open doors—from research grants and scholarships to internships and networking opportunities.
Lead.
Shape the future of geoscience. Volunteer, advocate, and serve. Gain recognition and make an impact in the community that's building a sustainable planet.
Join or Renew Today.
Student membership is just $25 and includes unlimited Division memberships.
Learn more at www.geosociety.org/members