VOL. 35, NO. 8 | AUGUST 2025

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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.

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AUGUST 2025

A debris flow originating from a small upstream catchment blocked a culvert and flowed onto Interstate 70 in Glenwood Canyon following the Grizzly Creek Fire. This debris flow was triggered during a storm on 31 July 2021. That storm resulted in widespread debris-flow activity in the burn area, and damage to the road due to the debris flows forced a closure of Interstate 70 for two weeks Credit: Todd J. Blake. See related article on p.16–21.

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DEPARTMENTS

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Beautiful sunny beach scene on the Falkland Islands.

The Falkland Islands: Goal-Directed vs. Open-Ended Discovery

Thomas F. Shipley[1] and Basil Tikoff*,[2]

Geology logline: *Both Alexander du Toit and Charles Darwin made scientific advances when studying the Falkland Islands, the former effectively demonstrating continental drift.*

Cognitive science logline: *The mind at its best engages in both goal-directed enquiry and curious exploration, and the two modes have different mechanisms and functions.*

> *"In every walk with nature one receives far more than [one] seeks."*
>
> ***—J. Muir (1877)***

The Falkland Islands are located at 52° S latitude in the southern Atlantic Ocean, ~500 km east of southern Argentina, 1200 km north of the Antarctic peninsula, and 6500 km west-southwest of South Africa (Fig. 1). The archipelago was part of Gondwana. The rocks include Carboniferous tillites and contain fossils of clear Gondwanan affinity. The islands were visited by two extraordinary geologists, ninety years apart: Charles Darwin and Alexander du Toit. These two scientists had very different goals, scientific styles, and funding mechanisms. As a result, they epitomize two end-member models for how science is done.

Darwin arrived in the Falkland Islands in 1833. To say that he was not attracted to the landscape would be an understatement. He wrote: "An undulating land, with a desolate and wretched aspect, is every where covered by a peaty soil and wiry grass, of one monotonous brown colour" (Darwin, 1846, p. 245). Also, consider this gem of what-not-to-put-in-a-travel-guide: "The weather was very boisterous and cold, with heavy hailstorms. We got on, however, pretty well; but excepting in the Geology, nothing could be less interesting than our day's ride" (Darwin, 1846, p. 246). Yet, Darwin goes on to recognize asymmetrical folding (i.e., fold vergence; Fig. 2), geomorphic features ("stream of stones"),

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CITATION: Shipley, T.F., and Tikoff, B., 2025, The Falkland Islands: Goal-directed vs. open-ended discovery: GSA Today, v. 35, no. 8, p. 4-8, https://doi.org/10.1130/GSATG111GM.1.

Devonian fossils (e.g., Stone and Rushton, 2024), and all sorts of organisms (geese, sea slugs, etc.). He speculates on all of them. For example, he contemplates why the Paleozoic fossils are so similar to those in England, even though the creatures living there today are so different. What you can tell is that he is thinking—about everything. Darwin published an article on the geology of the Falkland Islands (Darwin, 1846), and it forms a chapter within his 1839 book, The Voyage of the Beagle (Darwin, 1839).

Alexander du Toit came to the Falkland Islands (and eastern South America) in 1923 as a person on a mission. Alfred Wegener had recently published his book arguing for continental drift (1915 in German; English version in 1921). His basic argument was that the shapes of the continents and the distribution of fossils, particularly in the southern hemisphere, match very well if the two continents were moved back together (Fig. 1). Fossils from the Falkland Islands, including those found by Darwin, were part of the evidence that Wegener used to advocate for continental drift. If the landmasses were once contiguous, then the geology—in addition to the fossils—should be compatible. Despite nearly universal rejection of the continental drift hypothesis in North America, the Carnegie Institute of Washington, DC—due to the influence of Reginald Daly of Harvard University—was willing to fund a geological mission to South America to determine if continental drift could be correct (see Oreskes, 1999).

Du Toit was one of the foremost experts in the geology of South Africa. Both du Toit and Wegener noted that the fossil record is insufficient to prove continental drift because the data can be explained by alternative hypotheses (moving continents or the rise and fall of land bridges). During his fieldwork, du Toit documents two additional compelling lines of evidence to support continental drift. The first is that the stratigraphy of the Falklands Islands and South Africa are nearly identical, and both are similar to the stratigraphy in South America. This is du Toit's most fundamental insight: The striking stratigraphic similarity makes a case that the regions were adjacent. The second line of evidence involves the EW-trending Cape fold-thrust belt with asymmetric folds indicating northward vergence (Fig. 2). This belt crosses into South America exactly where it would project from South Africa if the continents were restored (Fig. 3). Asymmetric folds are also found on the Falkland Islands, but with an opposite direction of vergence (southward; see below) and are located significantly south of the equivalent features on South Africa and South America. To explain this observation, du Toit restores the Falkland Islands to the north relative to their current position (Fig. 3). The data provided by du Toit are compelling: The continents must have moved relative to each other. This conclusion is given in the book A Geological Comparison of South America with South Africa (du Toit and Reed, 1927), with the results incorporated into Our Wandering Continents (du Toit, 1937).

The cognitive theme of this essay is the contrast between two modes of attention, also referred to as modes of

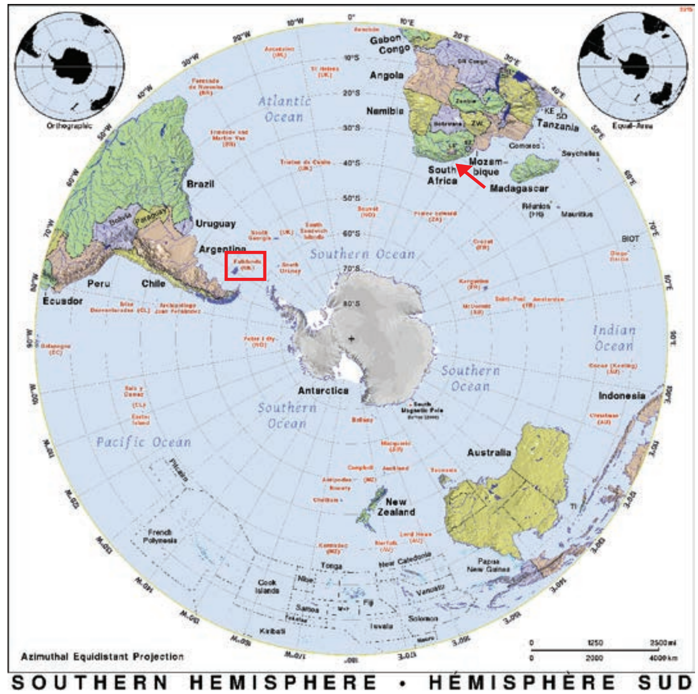

Figure 1. The polar view of Earth, showing the location of the Falkland Islands (red box) with respect to southern South America and southern Africa. The red arrow shows the approximate location that the Falkland Islands restore to prior to Gondwana rifting. Credit: Ian Macky, https://ian.macky.net/pat/map/shem/shem.html.

consciousness, exhibited so well by Darwin and du Toit: spotlight mode and lantern mode (Gopnik, 2009). A spotlight provides bright illumination in a small area, and that area is surrounded by darkness. Spotlight mode (think about du Toit) occurs when one is answering a specific question and focuses attention on only the aspects of the world that are relevant to achieving an answer to that specific question. The upside of focused attentional resources is that learning can advance quickly. The downside is the learning is typically narrow, meaning the learned solution applies to the case that generated the goal, but may not generalize well. A lantern, in contrast, provides dimmer illumination, but provides it everywhere. Lantern mode (think about Darwin) refers to diffuse attention, meaning that the individual is open to all potential inputs in the world around them. The advantage of this mode is there is no filtering by preconceived ideas about what is important. The disadvantage is that learning may be slow and progress hard to see or feel. It has been argued that children use lantern mode to learn a language; this mode is necessary to extract a language's complex grammatical rules from speech, given all the ways that meaning is conveyed by grammar in the world's languages (Gopnik, 2009).

These modes of attention have different functions, and there is significant benefit to moving back and forth between them. In spotlight mode, exemplified by du Toit, behavior appears generally work-like, familiar in the pursuit of hypothesis-driven data collection. In lantern mode, modeled by Darwin, behavior is more play-like and exploring occurs in response to curiosity without specific aim. To a goal-oriented observer, a scientist in lantern mode can appear unproductive.

Psychologists have argued that deep learning requires both goal-directed and playful interactions with the world (Gopnik, 2009). Goal-directed attention is optimal for refining knowledge about something that is well understood, to fill in missing pieces or collect information that will improve understanding to serve a purpose. In contrast, when confronted with something wholly new, robust learning is better achieved through exploring and interacting with the problem without a singular goal. Goal-directed attention, as occurs in spotlight mode, is ill-advised in this situation, as one is likely to focus on some aspect of a situation that is marginal. The resultant learning is likely to be brittle, not serving the learner when the situation changes slightly.

The modes also have different brain mechanisms, which contribute to different types of learning and manifest themselves as different overt behaviors. Two functionally distinct networks in the brain organize activity that aligns with the two modes of attention. The fronto-parietal network is active when working on a problem using focused attention, as occurs in spotlight mode. This network spatially restricts processing and is engaged for working memory tasks, where memories necessary for a task are actively maintained (Menon, 2011). Direct, focused attention on a problem, such as, "Are the rocks in the Falkland Islands similar to the rocks in South Africa?" will be answered in spotlight mode. The fronto-parietal network boosts processing in local regions of visual space (and the conceptual space of similar concepts), making things in that region more salient and surrounding things less salient (Menon, 2011). Solutions found in spotlight mode are likely to be a conceptually proximal solution. The problem with spotlight-mode solutions is that, although they are often locally optimum, they can be globally poor. We hypothesize that the assumption of simplicity is a product of a spotlight mode of thinking, which is neither the only way a problem can be solved nor necessarily the optimal way to solve a problem (see Tikoff and Shipley, 2025).

These problems of spotlight mode can be illustrated from the history of determining the tectonic reconstruction of the Falkland Islands. To explain why the Falkland Islands contain the EW-trending Cape fold-thrust belt with its asymmetric folds, du Toit and Reed (1927) restored the Falkland Islands northward prior to breakup of the continents. The issue is that the southward fold vergence in the Falkland Islands (Fig. 2) is inconsistent with the northward fold vergence of the Cape fold-thrust belt (Fig. 3). Most modern reconstructions, following Adie (1952), place the Falkland Islands on the east side of South Africa prior to Gondwana breakup (Fig. 3). This reconstruction includes a 180° rotation of the Falkland Islands as they moved as a micro-plate around Cape of Good Hope in southernmost Africa, which allows the repositioned Falkland Islands to

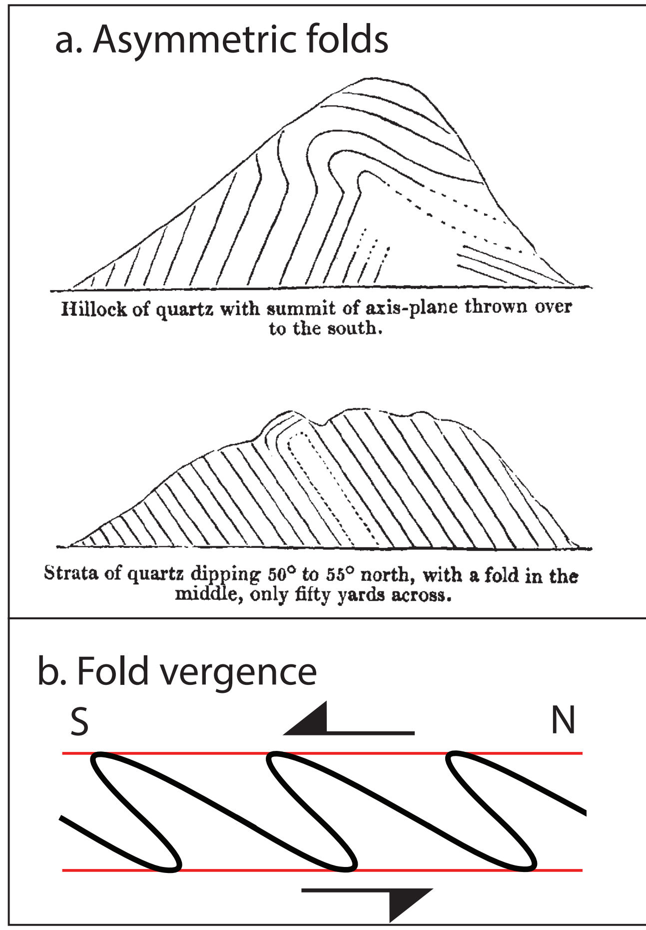

Figure 2. (A) Two sketches from C. Darwin of asymmetric folding in the Falkland Islands, which formed as part of the Cape fold-thrust belt in South Africa (from Darwin, 1846, p. 272). (B) A cartoon of idealized fold vergence shown in a vertical cross section.

have the same (northward) fold vergence as the Cape fold-thrust belt. Note that neither du Toit or Adie knew about transform faults, which provide an independent constraint on the direction of motion between Africa and Antarctica. Adie's reconstruction is neither the shortest distance nor simplest solution, but it fits with the constraints of the data. Scientists usually choose the simplest possible solution, particularly when working in spotlight mode. This inference is consistent with this sentiment:

"... subjected to the principle of least astonishment, geologic science has always tended to adopt the most static interpretation allowed by the data, and evidence indicating displacements larger than conceivable . . . has consistently met strong resistance" (Seeber, 1983, p. 1528).

The reason, in part, is that working "efficiently" typically involves dealing with proximal causes.

Cognitive science research offers an intriguing perspective on thinking about geological displacements. Locations in real space are represented in the brain in such a way that greater distances between locations correspond to

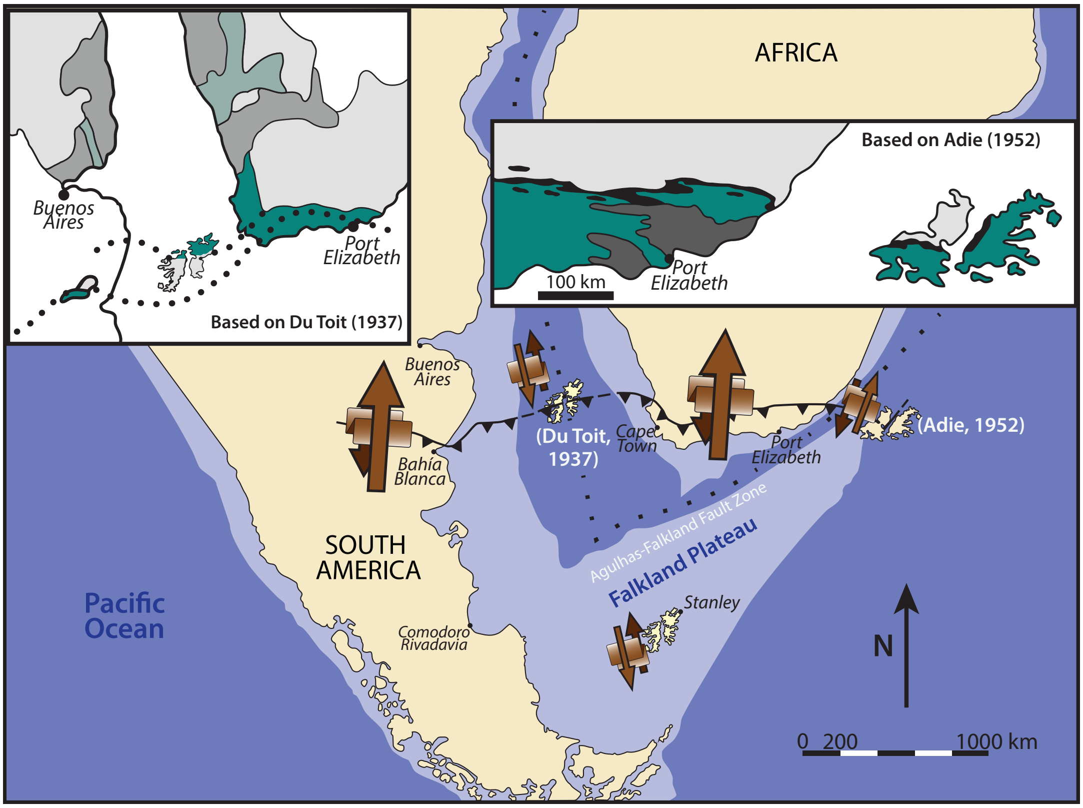

Figure 3. Two possible locations of the Falkland Islands prior to the rifting of Gondwana, based on du Toit (1937; following du Toit and Reed, 1927) and Adie (1952). The brown arrows indicate the direction of fold vergence, as shown by folds. The thrust fault demarcates the extent of the orogenic front associated with the Cape fold-and-thrust belt in Africa. Du Toit reconstructs the Falkland Islands straight northward, in order to place them on the trend of the Cape fold-and-thrust belt in South Africa and its equivalent in South America. Adie reconstructs a slightly longer and curved path, to place the Falkland Islands adjacent to the Cape fold-and-thrust belt on the eastern side of South Africa. The Adie (1952) reconstruction is generally accepted, although it requires significant rotation, in addition to longer translation, of the Falkland Islands. Figure modified from Ramos et al. (2017).

greater distances in the brain. In some cases, it is a physical distance (Knudsen and Konishi, 1978); in other cases, it is a similarity in network activity (Morgan et al., 2011). Consider this finding from a functional magnetic resonance imaging (fMRI) study:

"fMRI response levels in the left hippocampus corresponded to real-world distances between landmarks shown on successive trials, indicating that this region {of the brain} considered closer landmarks to be more representationally similar and more distant landmarks to be more representationally distinct" (Morgan et al., 2011, p. 1238; text in parentheses are our addition).

That is, distant parts of the brain tend not to communicate with each other, with connections dropping off with intra-brain distance as a power function (Iturria-Medina et al., 2008). To return to geology, the connectivity suggests that a representation of a long curving path connecting past location to present location (e.g., reconstruction of Adie) is less likely to occur in the brain than a short, straight path (e.g., reconstruction of du Toit), and consequently will be less likely to be thought.

A different network of circuits, the default mode network, appears to be engaged in lantern mode. The default mode network is active for a range of mental activities including daydreaming, watching movies, listening to stories, and recalling specific incidents from one's past. All of these activities involve events and some narrative (Simony et al., 2016). The default mode network is active when not working with focused attention. The details of how the mind connects far things in the brain are currently unclear. However, there is a functional value to connecting far-apart ideas in the world. Such connections could move important relationships, which are highly dissimilar on the surface but share a common deep structure, to the foreground.

Forming such distant connections typically does not occur with focused attention. Inspiration—flashes of insight into how to solve a challenging problem or reconceptualize a model to fit data—typically come as solutions to problems you were not conscious your mind was working on. After the initial insight in lantern mode, work in spotlight mode can "backfill" the connection for conscious articulation of the underlying logic.

The goal-directed approach of spotlight mode will likely seem familiar to many readers, particularly those actively engaged in trying to fund research projects where clearly stated goals and explanations of how to meet those goals are expected. Yet, play-like, exploratory research happens at both a community scale and at an individual scale. The 2003–2018 EarthScope program, funded by the National Science Foundation, was largely exploratory science, using seismology to make a map of the mantle below the United States and some parts of adjacent Canada (Meltzer, 2003). Individual scientists may engage in play-like investigations. At any given time, scientists may have an unfunded side project in which they are fascinated by an idea or a set of observations. Each of the authors has a couple of ongoing side projects that are unfunded and do not advance a major research objective, but our history tells us these side projects often move to the foreground when they yield surprising new data or ideas.

Some psychologists have argued that lantern-mode attention is primarily available to children, whereas adults only occasionally slip into this mode (Gopnik, 2009). In our casual conversations with other scientists, it seems that interdisciplinary science involves the occasional lapse into lantern mode, particularly for ideas that cross traditional boundaries and require mental permeability. Retrospectively, we see that our work on these essays required a cycle between lantern and spotlight modes.

Both spotlight and lantern modes yield discoveries. Spotlight mode efficiently fleshes out models and effectively tests specific hypotheses; it keeps research programs on track. Theories that come out of lantern mode are likely to be novel, connecting ideas that had not been part of the standard approach in an area. Lantern mode is more likely to provide conceptual breakthroughs. Knowing these endmember approaches, and how they were used in the Falkland Islands, a person would do well to both work assiduously like du Toit and wander curiously like Darwin.

ACKNOWLEDGMENTS

Ellen M. Nelson is thanked for assistance with figure drafting. Reviews by an anonymous reviewer and A. Egger significantly improved this manuscript. NSF support for BT (2311822) and TS (2311820) is acknowledged.

REFERENCES CITED

***denotes suggested further reading**

Adie, R.J., 1952, The position of the Falkland Islands in a reconstruction of Gondwanaland: Geological Magazine, v. 89, p. 401–410, https://doi.org/10.1017/S0016756800068102.

Darwin, C.R., 1846, Geological Observations on South America: Being the Third Part of the Geology of the Voyage of the Beagle, under the Command of Capt. Fitzroy, R.N. during the Years 1832 to 1836: London, Smith Elder and Co.

Darwin, C.R., 1839, The Voyage of the Beagle: London, Henry Colburn.

du Toit, A.L., 1937, Our Wandering Continents; A Hypothesis of Continental Drifting: London, Oliver & Boyd, 366 p.

*du Toit, A.L., and Reed, F.R.C., 1927, A Geological Comparison of South America with South Africa: Washington, D.C., Carnegie Institution of Washington, 188 p.

*Gopnik, A., 2009, The Philosophical Baby: What Children's Minds Tell Us about Truth, Love, and the Meaning of Life: New York, Farrar, Straus and Giroux, 304 p.

Iturria-Medina, Y., Sotero, R.C., Canales-Rodríguez, E.J., Alemán-Gómez, Y., and Melie-García, L., 2008, Studying the human brain anatomical network via diffusion-weighted MRI and Graph Theory: NeuroImage, v. 40, no. 3, p. 1064–1076, https://doi.org/10.1016/j.neuroimage.2007.10.060.

Knudsen, E.I., and Konishi, M., 1978, A neural map of auditory space in the owl: Science, v. 200, no. 4343, p. 795–797, https://doi.org/10.1126/science.644324.

Menon, V., 2011, Large-scale brain networks and psychopathology: a unifying triple network model: Trends in Cognitive Sciences, v. 15, no. 10, p. 483–506, https://doi.org/10.1016/j.tics.2011.08.003.

Meltzer, A., 2003, EarthScope: Opportunities and challenges for earth-science research and education: The Leading Edge, v. 22, no. 3, p. 268–271, https://doi.org/10.1190/1.1564533.

Morgan, L.K., Macevoy, S.P., Aguirre, G.K., and Epstein, R.A., 2011, Distances between real-world locations are represented in the human hippocampus: Journal of Neuroscience: v. 31, no. 4, p. 1238–1245, https://doi.org/10.1523/JNEUROSCI.4667-10.2011.

Muir, J., 1877, Mormon Lilies: Liliaceous Wonder-A Mountain Covered with Flowers Gorgeous Lily Gardens-A Sublime Scene-The Queen of All: Special Correspondence of the Bulletin, Daily Evening Bulletin, San Francisco, 19 July 1877.

Oreskes, N., 1999, The Rejection of Continental Drift Theory and Method in American Earth Science. Oxford, UK, Oxford University Press, https://doi.org/10.1093/oso/9780195117325.001.0001.

Ramos, V.A., Cingolani, C., Chemale, F., Naipauer, M., and Rapalini, A., 2017, The Malvinas (Falkland) Islands revisited: The tectonic evolution of southern Gondwana based on U-Pb and Lu-Hf detrital zircons isotopes in the Paleozoic cover: Journal of South American Earth Sciences, v. 76, p. 320–345, https://doi.org/10.1016/j.jsames.2016.12.013.

Seeber, L., 1983, Large scale thin-skinned tectonics: Reviews of Geophysics, v. 21, no. 6, p. 1528–1538, https://doi.org/10.1029/RG021i006p01528.

Simony, E., Honey, C.J., Chen, J., Lositsky, O., Yeshurun, Y., Wiesel, A., and Hasson, U., 2016, Dynamic reconfiguration of the default mode network during narrative comprehension: Nature Communications, v. 7, https://doi.org/10.1038/ncomms12141.

Stone, P., and Rushton, A.W.A., 2024, Charles Darwin's discovery of Devonian fossils in the Falkland Islands, 1833, and its controversial consequences: Geological Society of London Special Publication 543, p. 205–216, https://doi.org/doi:10.1144/SP543-2022-190.

Tikoff, B., and Shipley, T.F., 2025, Mt Stuart, Washington State: Beware Ockham's razor: GSA Today, v. 35, no. 5, p. 4–9, https://doi.org/10.1130/GSATG108GM.1.

Wegener, A., 1915, The Origin of Continents and Oceans (Die Entstehung der Kontinente und Ozeane): Braunschweig, Germany, Friedr. Vieweg & Sohn, 94 p.

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How It Works:

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Deadline: 27 August

We're pleased to offer student travel grants to help make your journey to Connects 2025 more affordable. Whether it's covering transportation or lodging, these grants are designed to ease the cost of attending. Connects offers an incredible opportunity to present your research, connect with professionals and peers, and gain experience that can help launch your career.

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GEOCAREERS: YOUR PATH TO CAREER SUCCESS

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The GeoCareers program is one of GSA's top initiatives for helping students and early career professionals cultivate a fulfilling career path. This year's program features GeoCareers Day, a half-day event that includes lunch and interactive sessions with geoscience professionals. Also, be sure to visit the GeoCareers Corner, a dedicated space with ongoing programs on job search strategies, 1:1 résumé review and mentoring, mentorship, networking, and more.

GeoCareers Day

Sunday, 19 October, 9 a.m.–1 p.m.

If you are entering the job market, supporting someone who is, or just want more information on the types of non-academic geoscience careers available in industry or with the federal government, you'll want to attend this series of events. Registration is required, and there is a $20 fee (which includes lunch). Sign up online under "Ticketed Events" when you register for Connects.

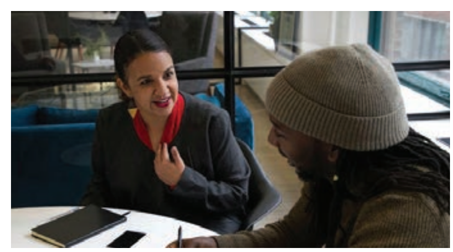
- Résumé and USAJobs Workshop
- Company Connection
- Mentor Roundtables
- GeoCareers Panel Luncheon

GeoCareers Corner:

Sunday–Tuesday, 19–21 October, 9 a.m.–5 p.m.

Everyone registered for GSA Connects is welcome to attend these GeoCareers events. The GeoCareers Corner, in the Henry B. González Convention Center, also provides a friendly, relaxing space if you need a break.

- Career Presentations
- 1:1 Résumé Review
- 1:1 Mentoring
- Early Career Professional Coffee
- Geology Club Meet-Up
- Networking Reception
- Women in Geology Program
- Post or View Job Listings



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Sign up at: https://bit.ly/3USbUNI.

Calling All On To the Future Scholars and Alumni!

2024 OTF Photography Silent Auction Submission by Piper Hattenbach

SUBMIT YOUR BEST WORK FOR THE OTF PHOTOGRAPHY SILENT AUCTION

Are you an On To the Future (OTF) scholar or alumnus? Share your geoscience journey through photography and support future scholars! The OTF Silent Auction at GSA Connects 2025 will feature original photographic works submitted by OTF participants and alumni. Proceeds will directly benefit the OTF program.

We're looking for high-quality images that highlight your experiences—whether it's a stunning field site, a fascinating specimen, or an action shot of you at work in the geosciences.

The auction will be held in person during GSA Connects 2025 in San Antonio, Texas, 19–22 October.

Submission deadline: 26 September 2025

To participate or learn more, contact CPE Program Coordinator Samira Rosario Martinez at srmartinez@geosociety.org.

Prizes will be awarded to the top entries:

1st Place
$100

2nd Place
$75

3rd Place
$50

Forecast, Monitor, Adapt

A Multi-Agency Effort to Protect People during Postfire Debris Flows

Francis K. Rengers,*[,1] Jason W. Kean,[1] Cory A. Williams,[2] Mark F. Henneberg,[2] J. Ryan Banta,[3] Eric Schroder,[4] Cara Sponaugle,[5] David Callery,[5] Erin Walter,[6] Todd Blake,[7] and Dennis M. Staley[8]

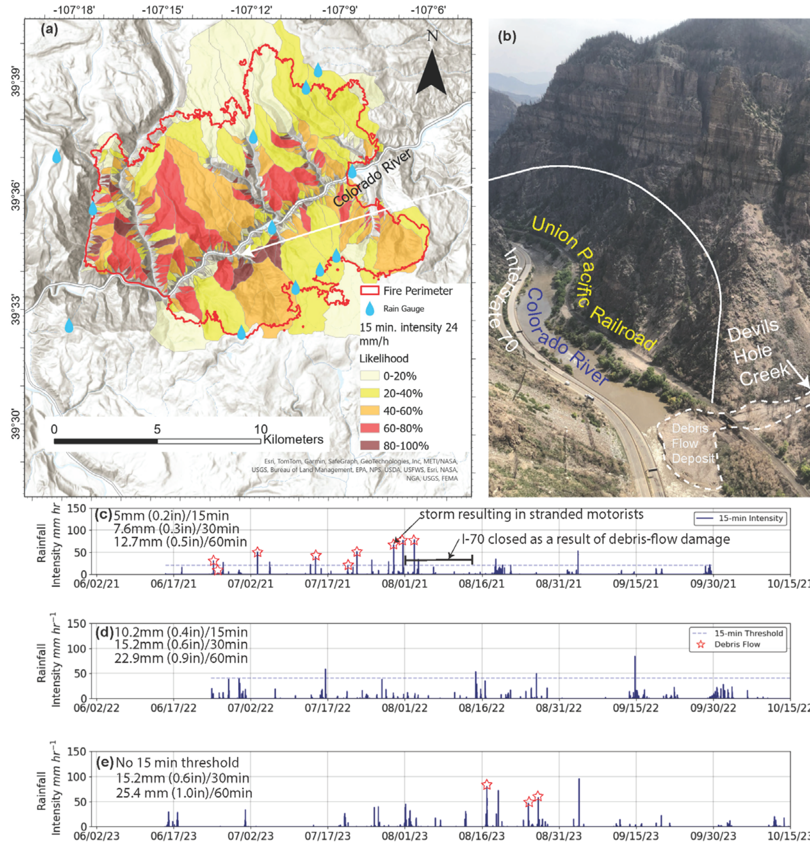

Figure 1. (A) Hazard assessment map showing the debris-flow likelihood in small watersheds assuming a rainfall rate of 24 mm/hr following the methods of Staley et al. (2017). (B) Photo of one of the 26 recorded debris flows during the summer of 2021 (Photo Credit: F. Rengers). This debris flow originated in the Devils Hole Creek watershed and deposited underneath a railroad trestle, narrowing the Colorado River width by more than two-thirds. (C) Maximum 15 min rainfall intensity (measured from 11 rain gauges) during the summer of 2021 (one year postfire). Stars indicate a debris-flow observation; the specific locations of debris flows are indicated in Rengers et al. (2024). (D) Maximum 15 min rainfall intensity (measured from 11 rain gauges) during the summer of 2022 (two years postfire). (E) Maximum 15 min rainfall intensity (measured from 11 rain gauges) during the summer of 2023 (three years postfire). Rainfall thresholds to issue hazard warnings, which are listed in the upper left corner of each yearly panel, were adjusted upwards each year based on observations of debris-flow activity. Units are listed in millimeters and inches over specified time durations.

ABSTRACT

In 2020, a wildfire burned across Glenwood Canyon in Colorado, USA. A history of postfire debris flows in the region and a hazard assessment for the burn area indicated that potentially life-threatening debris flows could be triggered by rainfall within months of a wildfire. As a result, four government agencies evaluated strategies to help mitigate hazards, including the loss of human life, that may be associated with debris-flow events. After the fire, 26 large debris flows occurred in the summer of 2021 and three sediment-laden flows occurred in the summer of 2023, but there were no major injuries or fatalities reported. We found that integrating hazard assessment/forecasting, monitoring, and adaptation scenarios was a successful strategy for reducing postfire debris-flow risks

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CITATION: Rengers, F.K., et al., 2025, Forecast, monitor, adapt: A multi-agency effort to protect people during postfire debris flows: GSA Today, v. 35, no. 8, p. 16–21, https://doi.org/10.1130/GSATG611A.1.

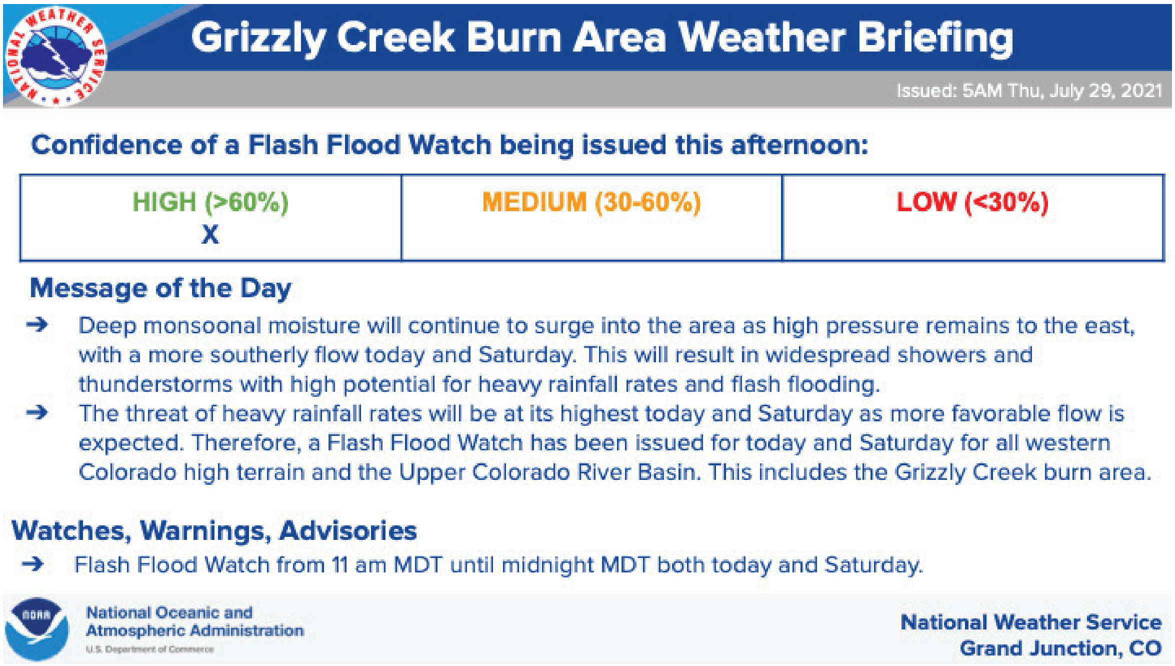

Figure 2. Example of an email message from the National Weather Service with forecasting information. The briefing demonstrated here was issued at 5 a.m. local time (MDT) on 29 July 2021.

to human life (including injuries and fatalities). Weather forecasts and estimates of debris-flow triggering rainfall thresholds, likelihood, and volume were used to anticipate the timing, location, and magnitude of debris-flow events. Rainfall monitoring and detailed recordkeeping of storms that triggered debris flows were used to validate and update debris-flow warning thresholds that varied with time following the wildfire. Although the governmental agencies working in this burn area had distinct and differing agency mandates, they were able to integrate information to reduce the risk of debris-flow events to human life.

INTRODUCTION

Wildfires create a variety of secondary natural hazards including rockfall, debris flows, and flooding (e.g., McGuire et al., 2024). These natural hazards can cross-cut boundaries of landownership and infrastructure type. Consequently, effective planning to enhance public safety from postfire natural hazards can benefit from collaboration across government agencies that manage land and assets the natural hazards might intersect. Because government management agencies are composed of specialists with specific mandates ranging from forest management to highway transportation, working across those specialties is critical for managing large-scale natural hazards.

In the fall of 2020, state and federal government agencies in Colorado, USA, were confronted with the challenge of preparing response scenarios for postfire hazards following the Grizzly Creek Fire. The Grizzly Creek Fire burned 13,000 ha across Glenwood Canyon in Colorado, a steep gorge that also hosts a variety of critical infrastructure. Interstate 70 (I-70), which serves as a major transportation corridor moving up to $1 million/hour (Erku, 2023); the Union Pacific Railroad; and the Colorado River, an important source of drinking water, energy generation, and recreation are located at the bottom of Glenwood Canyon (Rengers et al., 2024; Fig. 1). The burn area included large swaths of the White River National Forest managed by the U.S. Forest Service (USFS), Bureau of Land Management parcels, private land, and corridors managed by the Colorado Department of Transportation (CDOT). The postfire natural hazard potential threatened many activities and assets such as road safety, water supply, water quality, fish habitat, and train operations. Here, we focus on government agency activities to help mitigate hazards to highway operations through the canyon from postfire debris flows.

There is a history of postfire debris flows in the region that caused concern following the Grizzly Creek Fire (Cannon et al., 2003, 2001). For example, following both the South Canyon Fire (1994) and the Coal Seam Fire (2002) near Glenwood Canyon, debris flows were recorded within two months of the wildfire and affected highway safety (Cannon et al., 2003, 2001). Consequently, following the Grizzly Creek Fire, the U.S. Geological Survey (USGS), USFS, CDOT, and National Weather Service (NWS) worked together to develop a set of potential scenarios based on the best available science to address and mitigate postfire hazards. During the fire, and following containment, these four government agencies contributed to developing ways to mitigate postfire hazards based on their respective organizational mandates: USGS (debris-flow hazard assessment and monitoring), NWS (meteorological forecasting and warning), CDOT (road safety logistics and observation), and USFS (soil burn severity, hydrologic analysis, and postfire emergency risk assessment on National Forest Service lands).

The USGS, NWS, CDOT, and USFS used a strategy of forecasting (prior to a storm), monitoring (during and after storms), and adapting (before and after storms) to mitigate postfire debris-flow hazards. Forecasting included estimating rainfall rates from weather models, as well as statistical modeling of debris-flow initiation and debris-flow volume based on the fire burn severity, terrain, and probable rainfall scenarios. Monitoring activities included measuring rainfall rates with a network of gauges installed across the burn area (Fig. 1A) and recording the location and timing of debris flows in the burn area based on cameras and surveys along I-70 by CDOT following each storm. Finally, adaptation included anticipating hazards prior to storms and preemptively closing I-70, as well as adapting debris-flow rainfall thresholds based on observations.

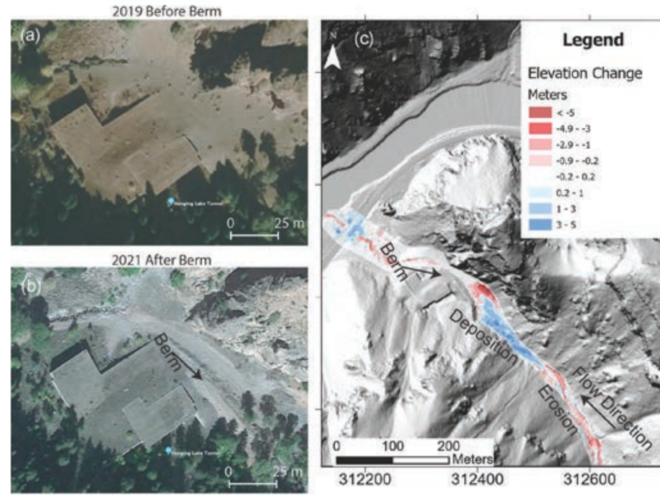

Figure 3. (A) Google Earth imagery (accessed 4 Dec. 2024) of the Colorado Department of Transportation (CDOT) command center prior to the fire. (B) Google Earth imagery of the CDOT command center after the construction of a berm recommended by the U.S. Forest Service Burned Area Emergency Response team. (C) Light detection and ranging (LiDAR) difference showing debris-flow deposition that was prevented from hitting the infrastructure because of the construction of the berm. Coordinates are in UTM Zone 13 N. LiDAR shaded relief developed from topography located in Rengers et al. (2023a).

AFTER THE FIRE BEFORE THE STORMS

Forecasting Hazards

The postfire forecasting response to the Grizzly Creek Fire began while the fire was still burning. The Grizzly Creek Fire started on 10 August 2020, burned within Glenwood Canyon until 24 August 2020, and was not fully contained until 18 December 2020. I-70 and the White River National Forest were closed for two weeks in August 2020 as the fire progressed (Stroud, 2021a). During this time, management agencies recognized that developing ways to reduce debris-flow hazard risks could help protect public safety along the I-70 corridor.

To forecast future debris flows and reduce risks associated with landslide threats to property, infrastructure, and life, the USGS developed a preliminary debris-flow hazard assessment on 14 August 2020 (after the fire started) using estimates of the potential burn severity (Staley et al., 2018). The hazard assessment was used to forecast debris-flow likelihood and volume, and to estimate the triggering rainfall thresholds for individual drainage basins and channel segments based on topography, soil burn severity, and soil erodibility (Staley et al., 2017). Because the hazard assessment identified areas that could be affected by debris flows, it provided an opportunity to develop plans to avoid those hazards.

An advance USFS Burned Area Emergency Response (BAER) team was also assigned to the area to forecast hazards and coordinate with partners, followed by a standard BAER team assessment after additional fire containment (U.S. Forest Service, 2020). BAER teams are mandated to assess postfire risk to resources and infrastructure and to recommend mitigation on USFS lands to minimize hazards associated with burned-area conditions. These assessments typically occur when fire containment is nearing completion, but concern over immediate threats to the numerous assets below White River National Forest lands prompted an advance team prior to the full assessment team. On 17 August 2020, this advance BAER team obtained satellite imagery to develop a preliminary soil burn severity map and released the validated map publicly on 18 August 2020 (U.S. Forest Service, 2020). This soil burn severity map was used by the USGS to generate a new postfire debris-flow assessment hazard map on 18 August 2020 based on field-verified data (Fig. 1; U.S. Geological Survey, 2020).

Following the advance BAER team assessment, several state and local emergency response agencies were invited to coordination meetings with stakeholders, including: the City of Glenwood Springs, CDOT, Emergency Service leaders from Garfield and Eagle Counties, NWS, USGS, Natural Resources Conservation Service (NRCS), Bureau of Land Management (BLM), Xcel Energy, and the Union Pacific Railroad. A standard BAER team was initiated on 8 September 2020 to assess the postfire risks to USFS lands, property, and resources in closer detail. A final soil burn severity map for the Grizzly Creek Fire was completed on 10 September 2020 (U.S. Forest Service, 2020) and soil erosion, hydrologic response, and debris-flow model input was updated by the USGS to generate final hazard assessment maps (U.S. Geological Survey, 2020). Consequently, these agencies forecasted hazards using multiple models, which were continuously refined as more information was obtained.

Figure 4. Differences in flow size from the first to third year after the wildfire. (A) A debris flow during the first postfire summer (2021) depositing material on both east-bound and west-bound highway lanes, as well as in the Colorado River. (B) A sediment-laden flow during the third year after the fire (2023) depositing material behind a concrete barrier with minor mud on the highway. (Photo credits: Colorado Department of Transportation).

COORDINATED INTERAGENCY RESPONSE

No intense rainstorms affected the Grizzly Creek burn area in the late summer/autumn after the fire started. During the winter following wildfire containment, agencies coordinated to continue debris-flow forecasting in preparation for the following summer when the North American Monsoon (NAM; Adams and Comrie, 1997) typically results in thunderstorms. The USGS hazard assessment included an estimate of the fire-wide rainfall threshold for debris-flow initiation. This rainfall threshold was provided to the NWS. The estimated threshold for the Grizzly Creek burn area (6.5 mm in 15 min) was within the range of rainfall thresholds observed in the 2002 Coal Seam Fire (3.3mm–9.6mm in 10 min; Cannon et al., 2008). However, the NWS decided to adopt a slightly lower threshold (5 mm in 15 min) as a conservative starting point for warnings (Fig. 1C). Subsequently, the NWS forecasted rainfall intensities of incoming storms over the burn area using radar and weather models. This led to an operational strategy for road closure by CDOT. CDOT decided to station workers at both ends of Glenwood Canyon on I-70 to close the road if the NWS generated a flash flood watch, which is an official nomenclature that also includes debris flows (National Weather Service, 2025). The NWS would initiate the flash flood watch with 1 hr to 1 day lead time if a weather forecast had a greater than 50% chance of rainfall above the threshold. If the NWS elevated the watch to a warning (issued when a storm is imminent), CDOT staff would close the highway, which could drastically affect commute times along I-70. The decision to close the road had a high consequence, increasing a drive that normally takes 15–20 min to a detour that could take drivers up to 4 hr (Collins, 2021). The NWS additionally provided storm outlook messages for decision makers twice per week (Fig. 2).

As part of monitoring efforts, USGS landslide hazard scientists worked with the USFS to install three (non-telemetered) rain gauges in the White River National Forest to monitor incoming storms in September 2020. Seven additional (telemetered) rain gauges were installed in the summer of 2021 by USGS scientists working in partnership with local stakeholders. Five of the telemetered USGS rain gauges maintained cellular connections, providing near-instantaneous notification to NWS of rainfall events. Two additional telemetered rain gauges were installed by CDOT, although due to mechanical failure, only one of the CDOT rain gauges was usable. The network of telemetered rain gauges distributed across the burn area (Fig. 1A) provided near-real-time data on rainfall that complimented estimates of rainfall from weather radar. Finally, CDOT monitored I-70 for flow activity after each rainstorm using stationary cameras, roadway surveys, and aerial surveys, and cataloged whether a debris flow or a flood was observed.

The adaptation effort prior to the monsoon rain season focused on developing ways to mitigate hazards associated with debris flows. For example, during the fire, the USFS BAER team used the USGS debris-flow hazard assessment to help identify the potential infrastructure (such as roads and buildings) and ecosystems (such as forests, wetlands, and species) that could be at risk. Based on their assessment, the BAER team suggested building a berm near the CDOT command center (Fig. 3), which is only one of four in the state used to monitor road safety in the canyon and throughout a large quadrant of the state of Colorado. Additional effects to local waterways were anticipated from the debris flows, and instream monitoring of water quality was implemented by the USGS to mitigate potential effects to downstream water-supply infrastructure.

2021 MONSOON RAINS

Beginning on 26 June 2021, rainstorms associated with the seasonal monsoon began delivering high-intensity rain to the Grizzly Creek burn area. During the summer of 2021, there were 49 rainstorms and I-70 was closed 14 times (Rengers et al., 2024). Nine of the rainstorms produced debris flows, with the highest recorded rainfall event taking place on 31 July 2021. That rainstorm resulted in extensive damage to I-70 (which closed the highway for 2 weeks), and the estimated repair costs were $116 million (Otarola, 2021). During this time, water-quality conditions in the Colorado River were affected by high sediment concentrations that required enhanced treatment processes to prepare water for municipal consumption. During the post-storm adaptation phase, USGS scientists used an inventory of rainfall and debris-flow observations from the continuous monitoring (Rengers et al., 2023b) in order to guide adjustments to the warning strategies. For example, the inventory largely validated the year one 15 min rainfall threshold, and that data helped to justify increases in the thresholds in subsequent years as gradual recovery of vegetation reduced debris-flow hazards (Fig. 1C–E).

In this case study of the Grizzly Creek Fire, the effort to "forecast, monitor, and adapt" was effective to help mitigate potential debris-flow hazards. Despite nine major storms causing debris flows in 2021, there were no major reported debris-flow-related injuries or fatalities in Glenwood Canyon, likely because I-70 was frequently closed as a result of debris-flow hazard mapping, rainfall monitoring efforts, and the warning system developed by the USGS, NWS, CDOT, and USFS. An example of a near-miss scenario happened on the evening of 29 July 2021 (Fig. 1C). The highway (I-70) was closed late in the afternoon due to an NWS flash flood warning issued at 4:12 p.m. (local time), but the warning was canceled at 5:18 p.m. (local time) and the road reopened. Around 8:30 p.m. another round of heavy rains began (Fig. 1), which prompted a second flash flood warning for the day at 8:45 p.m. However, this rainstorm triggered multiple debris flows that inundated the road before it could be closed. By 9 p.m., motorists trapped in the canyon were escorted to safety in the Hanging Lake Tunnel, which is underground and adjacent to the CDOT command center (Fig. 3), where they remained for the entire night (Stroud, 2021b). One motorist's vehicle was struck by the debris flow, and she narrowly escaped by abandoning her car and running down the highway to safety (Otarola, 2021). The command center was nearly hit by a debris flow, but damage was prevented by the protective berm that was constructed immediately after the Grizzly Creek wildfire based on recommendations by the USFS BAER team (Fig. 3).

EVOLVING HAZARD WITH TIME

Following the summer of 2021, the interagency team of the USGS, NWS, CDOT, and USFS continued to work together to mitigate debris-flow hazards. The team used annual inventories of storms and debris-flow activity to update rainfall thresholds. In the second year following wildfire, there were no observed debris flows. However, in the third year after the fire, three sediment-laden flows were observed (Fig. 4). The sediment for the sediment-laden flows in the third year appeared to be derived from remobilized sediment from drainages that previously produced debris flows. The effects of the third-year flows were minor compared to the first year (Fig. 4). Currently, there is guidance in the scientific literature on rainfall thresholds for the first year after the fire, but similar guidance for rainfall thresholds for the second and following years is not well known and dependent on local rates of vegetation recovery (Graber et al., 2023).

CONCLUDING REMARKS

When government agencies bring their individual expertise together, they can use science and engineering to formulate methods that may mitigate the effects of natural hazards and provide critical guidance to help inform public safety. The collaboration between multiple government agencies (USFS, USGS, NWS, and CDOT) following the Grizzly Creek Fire demonstrates how risks (including the potential for injury and loss of human life) from natural hazards can be mitigated when government agencies coordinate and leverage their interdisciplinary expertise. The government agencies involved in the Grizzly Creek postfire response (USFS, USGS, NWS, CDOT) integrated forecasting (hazard assessments and weather), monitoring (collecting data), and adaptation (anticipating hazards and adjusting warning criteria) to develop monitoring criteria to reduce the potential for loss of human life in a region with critical infrastructure that may be highly susceptible to debris-flow events following wildfires. This integration of agency data and interdisciplinary expertise may help inform future scenarios where debris-flow hazards can affect human life, critical infrastructure, and property.

ACKNOWLEDGMENTS

This work was supported in part by the U.S. Geological Survey Landslide Hazards Program, Groundwater and Streamflow Information Program, and Next Generation Water Observing System Program. Additional support was provided by local stakeholders and agencies, including the Middle Colorado Watershed Council and the Colorado River District. Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

REFERENCES CITED

Adams, D.K., and Comrie, A.C., 1997, The North American monsoon: Bulletin of the American Meteorological Society, v. 78, p. 2197–2213, https://doi.org/10.1175/1520-0477(1997)078<2197:TNAM>2.0.CO;2.

Cannon, S., Gartner, J.E., Holland-Sears, A., Thurston, B.M., and Gleason, J.A., 2003, Debris-flow response of basins burned by the 2002 Coal Seam and Missionary Ridge fires, Colorado: Association of Engineering Geologists Special Publication 14.

Cannon, S., Gartner, J.E., Wilson, R.C., Bowers, J.C., and Laber, J.L., 2008, Storm rainfall conditions for floods and debris flows from recently burned areas in southwestern Colorado and southern California: Geomorphology, v. 96, p. 250–269, https://doi.org/10.1016/j.geomorph.2007.03.019.

Cannon, S., Kirkham, R.M., and Parise, M., 2001, Wildfire-related debris-flow initiation processes, Storm King Mountain, Colorado: Geomorphology, v. 39, p. 171–188, https://doi.org/10.1016/S0169-555X(00)00108-2.

Collins, V., 2021, Mudslide on scenic Colorado highway tests limits of aging infrastructure in era of climate change: https://www.nbcnews.com/news/us-news/mudslide-scenic-colorado-highway-tests-limits-aging-infrastructure-era-climate-n1278771 (accessed May 2025).

Erku, R., 2023, Steady revegetation on Glenwood Canyon burn scar is a ray of sunshine for interstate commerce: https://www.postindependent.com/news/steady-revegetation-on-glenwood-canyon-burn-scar-a-ray-of-sunshine-for-interstate-commerce (accessed April 2023).

Graber, A.P., Thomas, M.A., Kean, J.W., 2023, How long do runoff-generated debris-flow hazards persist after wildfire?: Geophysical Research Letters, v. 50, no. 19, https://doi.org/10.1029/2023GL105101.

McGuire, L.A., Ebel, B.A., Rengers, F.K., Vieira, D.C., and Nyman, P., 2024, Fire effects on geomorphic processes: Nature Reviews Earth & Environment, v. 5, p. 486–503, https://doi.org/10.1038/s43017-024-00557-7.

National Weather Service, 2025, National Weather Service Glossary: https://forecast.weather.gov/glossary.php (accessed May 2025).

Otarola, M., 2021, "The whole car went black:" What it was like being trapped in the I-70 Glenwood Canyon mudslide: https://www.cpr.org/2021/08/03/i-70-glenwood-canyon-mudslide-trapped-tunnel (accessed December 2021).

Rengers, F.K., Bethel, M., Group, R., Vessely, M., and Anderson, S., 2023a, Airborne Lidar Data (2016 and 2021) Capturing Debris Flow Erosion and Deposition after the Grizzly Creek Fire in Glenwood Canyon, Colorado: U.S. Geological Survey Data Release, https://doi.org/10.5066/P99OT77K.

Rengers, F.K., Bower, S.J., Knapp, A., Kean, J.W., Staley, D.M., Banta, J.R., and Williams, C., 2023b, Debris Flow, Precipitation, and Volume Measurements in the Grizzly Creek Burn Perimeter June 2021–September 2022, Glenwood Canyon, Colorado (ver. 1.1, October 2023): U.S. Geological Survey Data Release, https://doi.org/10.5066/P9Z7RROL.

Rengers, F.K., Bower, S., Knapp, A., Kean, J.W., vonLembke, D.W., Thomas, M.A., Kostelnik, J., Barnhart, K.R., Bethel, M., Gartner, J.E., Hille, M., Staley, D.M., Anderson, J.K., Roberts, E.K., DeLong, S.B., Lane, B., Ridgway, P., and Murphy, B., 2024, Evaluating post-wildfire debris-flow rainfall thresholds and volume models at the 2020 Grizzly Creek Fire in Glenwood Canyon, Colorado, USA: Natural Hazards and Earth System Sciences, v. 24, no. 6, https://doi.org/10.5194/nhess-24-2093-2024.

Staley, D.M., Negri, J.A., Kean, J.W., Laber, J.L., Tillery, A.C., and Youberg, A.M., 2017, Prediction of spatially explicit rainfall intensity–duration thresholds for post-fire debris-flow generation in the western United States: Geomorphology, v. 278, p. 149–162, https://doi.org/10.1016/j.geomorph.2016.10.019.

Staley, D.M., Tillery, A.C., Kean, J.W., McGuire, L.A., Pauling, H.E., Rengers, F.K., and Smith, J.B., 2018, Estimating post-fire debris-flow hazards prior to wildfire using a statistical analysis of historical distributions of fire severity from remote sensing data: International Journal of Wildland Fire, v. 27, no. 9, p. 595–608, https://doi.org/10.1071/WF17122.

Stroud, J., 2021a, 2020's story of the year—Grizzly Creek Fire forces evacuations, two-week closure of I-70 in Glenwood Canyon: https://www.postindependent.com/news/2020s-story-of-the-year-grizzly-creek-fire-forces-evacuations-two-week-closure-of-i-70-in-glenwood-canyon/ (accessed May 2025).

Stroud, J., 2021b, Travelers stranded during second Glenwood Canyon closure Thursday night, hole up at tunnels until they could be escorted out safely: https://www.vaildaily.com/news/travelers-stranded-during-second-glenwood-canyon-closure-thursday-night-hole-up-at-tunnels-until-they-could-be-escorted-out-safely/ (accessed December 2022).

U.S. Forest Service, 2020, Grizzly Creek Colorado 2020 Soil Burn Severity Map: https://edcintl.cr.usgs.gov/downloads/sciweb1/shared/MTBS_Fire/data/baer/grizzlycreek_sbs.zip (accessed May 2025).

U.S. Geological Survey, 2020, Grizzly Creek (White River National Forest, CO) Post-Wildfire Debris Flow Hazard Assessment: https://landslides.usgs.gov/hazards/postfire_debrisflow/detail.php?objectid=295.

MANUSCRIPT RECEIVED 8 AUGUST 2024
MANUSCRIPT ACCEPTED 14 JULY 2025

Join a Division!

GSA's 22 specialty Divisions connect you with a vibrant community in your field of interest Divisions shape the GSA Connects technical program, publish newsletters, recognize excellence, and offer opportunities for leadership, mentoring, and service.

Student members can join unlimited Divisions for free upon registration.

www.geosociety.org/divisions

Congratulations to GSA Scientific Divisions on Their 2025 Milestones!

The Geological Society of America

Geology & Health Division

Geology and Health Division

community.geosociety.org/geologyhealthdivision/home

20 Years

The Geology and Health Division creates the intersection of geological conditions, whether natural or anthropogenic in origin, with health, disease, pathology, and death in modern and fossil humans, animals, and plants.

The Geological Society of America

Sedimentary Geology Division

Sedimentary Geology Division

community.geosociety.org/sedimentarygeologydiv/home

20 Years

The Sedimentary Geology Division ensures the presentation of sedimentary-related topics and sessions at GSA meetings, while highlighting and advancing the study of sedimentary geology both within the geosciences and to the nonscientific community. The Division fosters the work of students through research, presentation, and travel awards.

Structural Geology and Tectonics Division

community.geosociety.org/sgt/home

45 Years

The Structural Geology and Tectonics Division brings together scientists interested in structural geology and tectonics to facilitate the presentation and discussion of their problems and ideas, while stimulating communication with other earth scientists.

Quaternary Geology and Geomorphology Division

community.geosociety.org/qggdivision/home

70 Years

The Quaternary Geology and Geomorphology Division facilitates presentation and discussion of problems and ideas related to Earth's surface that connect processes driven by climate, tectonics, and human activities. The Division has a long tradition of supporting field trips and community conversations around the way we humans engage with the resources and environment that enables our livelihood and recreational pursuits.

Nominate a Colleague for a GSA Division Award

Celebrate achievement, support students, and strengthen your scientific community.

GEOARCHAEOLOGY DIVISION
Richard Hay Student Paper/Poster Award

Nominations due: 30 August
Submit to: gsa.agd@gmail.com

Hay was a long-standing member of the Division and had a long and distinguished career in sedimentary geology, mineralogy, and archaeological geology. He is particularly well known for his work on the Olduvai Gorge and Laetoli Hominid-bearing sites and was awarded the Division's Rip Rapp Award in 2000. The Division is proud to have our student travel award bear his name.
The award is a travel grant for a student (undergraduate or graduate) presenting a paper or poster at the GSA's annual meeting. The grant is competitive and will be awarded based on the evaluation of the scientific merit of the research topic and the clarity of an expanded abstract for the paper or poster prepared by a student for presentation in the Division's technical session at the meeting.

community.geosociety.org/geoarchdivision/awards/student/hay

HISTORY, PHILOSOPHY, AND GEOHERITAGE DIVISION
History and Philosophy of Geology Student Award

Nominations due: 31 August
Submit to: Christopher Hill, chill2@boisestate.edu

The History, Philosophy, and Geoheritage Division provides a student award in the amount of US$1000 for a paper to be given at the national GSA meeting. Awards may also be given for second place. Oral presentations are preferred. Faculty advisors may be listed as second author, but not as the lead author of the paper. The proposed paper may be (1) a paper in the history or philosophy of geology; (2) a literature review of ideas for a technical work or thesis/dissertation; or (3) some imaginative aspect of the history or philosophy of geology we have not thought of before. Students should submit an abstract of their proposed talk and a 1,500–2,000-word prospectus for consideration. The Awards Committee will assist the winner(s) with review of abstracts facilitating presentation according to GSA standards. Currently enrolled undergraduates and graduate students are eligible as are students who received their degrees at the end of the fall or spring terms immediately preceding the national GSA meeting. The award is open to all students regardless of discipline, provided the proposed paper is related to the history or philosophy of a geological idea/person. The award is made possible by a bequest from the estate of Mary C. Rabbitt.

community.geosociety.org/histphildiv/awards/student

PLANETARY GEOLOGY DIVISION

Eugene and Carolyn Shoemaker Impact Cratering Award

Nominations due: 5 September
Apply at: https://www.lpi.usra.edu/Awards/shoemaker/
For questions, contact: David Kring, kring@lpi.usra.edu

The Eugene M. Shoemaker Impact Cratering Award is for undergraduate or graduate students, of any nationality, working in any country, in the disciplines of geology, geophysics, geochemistry, astronomy, or biology. The award, which will include US$2500, is to be applied to the study of impact craters, either on Earth or on the other solid bodies in the solar system. Areas of study may include but shall not necessarily be limited to impact cratering processes; the bodies (asteroidal or cometary) that make the impacts; or the geological, chemical, or biological results of impact cratering.

community.geosociety.org/pgd/awards/shoemaker

Ronald Greeley Award for Distinguished Service

Nominations due: 15 August
Submit to: Jennifer Piatek, piatekjel@ccsu.edu

In 2011, the PGD established the Ronald Greeley Award for Distinguished Service. This award may be given to those members of the PGD, and those outside of the Division and GSA, who have rendered exceptional service to the PGD for a multi-year period. The award is not open to currently serving members of the management board but may be awarded to past members of the management board who have provided exceptional service to the PGD after their term on the management board has ended. Nominations for the award, which should include a description of what the nominee has given to the PGD community, may be made by any PGD member to the management board.

community.geosociety.org/pgd/awards/greeley

Pete Mouginis-Mark Prize in Planetary Volcanology

Deadline: 6 August
Submit to: Lauren Jozwiak, lauren.jozwiak@jhuapl.edu

The Pete Mouginis-Mark Prize in Planetary Volcanology recognizes outstanding undergraduate and graduate student presentations in planetary volcanology (talks or posters) at the annual GSA Connects Meeting. Planetary volcanology, for the purpose of this prize, is defined as research into volcanoes and volcanic processes on the planets (Mercury, Venus, Mars, Moon), asteroids, or the moons of the outer planets. Volcano studies may include the geomorphology and tectonics of summit craters, the lava flows on their flanks, and the deformation of the flanks. Volcanic processes may include numerical modeling of eruptions, as well as petrologic studies of samples from known volcanic areas of the Moon, Mars, or asteroids. Remote sensing (spectral, radar, gravity) of volcanoes and their products is also appropriate. Studies of terrestrial volcanoes and volcanic processes are only eligible if the primary focus is on extraterrestrial volcanism.

community.geosociety.org/pgd/awards/mouginis-mark-prize

Congratulations to the 2025 GSA Fellows

Society fellowship is an honor bestowed on the best of our profession by election at the spring GSA Council meeting. GSA members are nominated by other GSA members in recognition of a sustained record of distinguished contributions to the geosciences and the Geological Society of America through such avenues as publications, applied research, teaching, administration of geological programs, contributions to the public awareness of geology, leadership of professional organizations, and taking on editorial, bibliographic, and library responsibilities.

What their nominators had to say...

Gordon Baird, State University of New York at Fredonia

"During his long (35-year) career teaching at SUNY Fredonia, he was a tremendously strong influence on both his students and regional colleagues. His biggest impact was through the field trips he led, leading or co-leading an astonishing 50 field trips (at least—we were only able to count the field trips where he authored a guidebook). Gordon's trips are remarkable because of his broad knowledge of a vast array of topics, and his undaunted enthusiasm even under stressful conditions. He has often been described as a 'force of nature.' These field trips have been an important part of the field geology education not only for Gordon's students, but for students all over the region. In addition, he has been an important mentor for his younger colleagues."

Paul Baldauf, Nova Southeastern University

"Over the past 37 years, since joining GSA as a student, Paul has significantly influenced the earth science community. He has a fine record of service to the Geological Society of America. He presents a rich record of training geoscientists. He remains an active scientist. He is an upstanding individual with a reputation for integrity and excellence. As such, we wholeheartedly state that he deserves this recognition."

William Burns, Oregon Department of Geology and Mineral Industries

"Bill has an exemplary record of service to GSA and has been an energetic leader in GSA activities for his more than 25-year career. Bill has focused on serving the client needs of his organization (the people of the State of Oregon), and through this effort has produced landslide products that are used widely throughout the world. The publications and maps that Bill has produced over his career have steadily helped to build one of the most widely accessible online landslide maps for any state in the United States, the Statewide Landslide Information Database for Oregon (SLIDO)."

Mark Carter, U.S. Geological Survey

"Mark is a well-recognized authority on the geology of the Central and Southern Appalachians, from the Blue Ridge to the Fall Zone. His expertise stems largely from his vast field experience, beginning with his MS thesis in the Blue Ridge of eastern Tennessee, through his employment as a mapping geologist at the North Carolina and Virginia state geological surveys, to his current employment as a research geologist at the U.S. Geological Survey. Mark's output of geologic maps is especially notable. He has served as first author on fifteen 7.5-minute quadrangle maps and co-authored at least six others, covering parts of Virginia, North Carolina, and Tennessee. In addition to quadrangle maps, Mark was lead author on a geological map along the entire Blue Ridge Parkway in Virginia and part of the Parkway in North Carolina."

Elena Centeno-Garcia, Instituto de Geología, Universidad Nacional Autónoma de México

"Dra. Centeno-García's early papers established her as a global leader in the characterization of tectonostratigraphic terranes and their role in global paleogeographic reconstructions. Her publications since then have established her as one of the very top experts on the geologic evolution of Mexico. The topics of her research papers are amazingly diverse, spanning the Paleoproterozoic to Recent, and including the following: paleontology, sedimentology, stratigraphy, volcanology, tectonics and structural geology, sandstone provenance, U-Pb zircon and detritral zircon geochronology, ophiolite geology, petroleum geology, and economic geology. She was awarded a UNAM medal for female faculty with outstanding careers (2007). In the past several years, Dra. Centeno-García has also contributed to the development of forensic geology in Mexico (e.g., 2022 paper on heavy metal pollution in the Sonora River basin). She has done all of this while acting as a major leader in geoscience programs and professional organizations."

Jay Chapman, University of Texas at El Paso

"Jay has two extraordinary qualities, in one person, that set him apart: (1) exceptional creativity—thinking outside the box as they say; and (2) an extraordinary communication ability—the best writer of ANY person I have worked with, and I collaborated with probably 100 people or more over the years. Additionally, he is heavily involved as a co-PI in the resurrection of the pathways program at UTEP (a mentoring program to recruit underrepresented groups into the geosciences), which has been very successful in bringing Hispanic students into geosciences. Moreover, he is clearly showing important outreach efforts with his very successful YouTube video series on structural geology in the field that is being used across the country as teaching material."

David Chew, Trinity College Dublin

"Dave is an outstanding geoscientist. He is curious about how Earth operates over space and time, chases great problems along this direction, and finds innovative solutions, particularly through geochemistry. Over the last 20 or so years, he has become an internationally recognized leader in geochronology, especially using LA-ICP-MS techniques. This has led to an amazing publication record across dozens of journals, including *Geology* and *GSA Bulletin*, with strong contributions and collaborations spanning multiple geoscience subdisciplines. Indeed, his work ranges from field mapping, such as across Achill Island, through development of new laboratory techniques, most recently U-Pb dating of carbonates; it spans rock sequences from multiple continents, notably from a GSA perspective, South America. Accordingly, Dave has outstanding Google metrics (January 2025: citations 9293; h-index 52) for a geoscientist receiving a 2001 PhD."

José Constantine, Williams College

"José Constantine is the whole package: an innovative and productive research scientist, a caring and effective mentor of geoscience students, and a proactive ambassador for geoscience in service of the public good. José won a 2020–2024 EAGER grant to investigate the role of Mississippi River bottomland channels in driving flooding in economically vulnerable communities. The work includes close engagement with affected communities, and partnership with Harris-Stowe State, a HBCU. His current 2023–2026 NSF grant examines controls on whether oxbow lakes persist or whether they fill rapidly with sediment, and will also model pollutant storage within oxbow systems. José's stature in the geoscience community is indicated by the number of people and institutions that want to hear what he has to say. Since 2017, he has given 21 invited talks at conferences and universities across the U.S., including five invited presentations at the GSA and AGU annual meetings."

Matthew Crawford, University of Kentucky, Kentucky Geological Survey

"Dr. Crawford's exceptional work in science communication, outreach, and citizen science programs has significantly advanced the public's understanding of geosciences while addressing critical societal challenges. His innovative communication strategies, impactful presentations to government agencies, commitment to underserved communities, and leadership in citizen science programs underscore his profound impact on the public's understanding of geoscience. I am confident that his election as a Fellow will bring distinction to the Society and inspire continued efforts in public engagement."

Brian Currie, Miami University

"We nominate Dr. Brian Currie to be admitted to the GSA fellowship for his scientific achievement in the

field on the tectonic evolution of mountain belts and sedimentary basin analysis. This research has entailed 50 peer-reviewed papers, almost 5,000 citations, and an h-index of 33, demonstrating the significant impact of his academic work. Dr. Currie has also been an innovator in training geoscientists in the field and in industry-related skills. He has taught field camp at Indiana University, the University of Arizona, and Miami University for over 25 years, and trained numerous students who have gone on to have highly successful careers in industry and in academia."

Michael Fenster, Randolph-Macon College

"Michael is a marine geologist who joined the Randolph-Macon faculty in 1999. He served as director of the environmental studies program from 2006 until he retired in 2024 and is now emeritus but still very active. Michael has flourished with an impressive research program and a highly commendable publishing record. He has accomplished this by providing his undergraduates with field and laboratory research opportunities, collaborating with a large group of colleagues at nearby universities and elsewhere, and engaging numerous research scientists at national agencies. It is Mike's love of science and inquiry that have made him an internationally recognized coastal expert."

Gary Gianniny, Fort Lewis College

"While Gary is a superb sedimentologist with a distinguished record that includes publications I use on a regular basis, I think the fellowship qualifications that stand out most to me are his training and mentoring of his students and his administration of a geoscience program. Over the last 30 years, my memories of Gary at GSA meetings are of him proudly showing me his students' posters and presentations. Their research, largely funded through grants to Gary from various corporations, were important research projects that any experienced scientist would have been proud to have conducted. His students have produced results in a wide variety of topics, from Paleozoic sequence stratigraphy to stream ecology. I can still remember several of these posters as exemplars of field research. In studying his vitae, I found no less than 86 student co-authors on abstracts, mostly from GSA meetings. Gary's former students can be found throughout GSA and our profession."

Stacia Gordon, University of Nevada, Reno

"Dr. Stacia Gordon has made important contributions through her research, mentorship, and professional service, including in increasing public awareness of geology. Dr. Gordon's publication record clearly shows the impressive breadth to her high-quality research. This research has led to ~40 publications, including at least 10 in GSA publications (*GSA Bulletin*, *Geology*, *Geosphere*, *Lithosphere*, and GSA Field Guides). A unifying theme is the application of high-precision geochronology, metamorphic petrology, field observations, and structural analysis to tackle fundamental tectonic problems. A major focus of her research and publications is on the role of partial melting and fluids in influencing the dynamic rheology of orogenic belts. This research has led to insights into the evolution of mid- to deep crust during melting in magmatic arcs and collisional orogens, including in the North Cascades, Bhutan, Papua New Guinea, and Norway."

Brian Jicha, University of Wisconsin–Madison

"Dr. Jicha has a distinguished research record as documented in his curriculum vitae and full bibliography, with 192 published papers in peer-reviewed journals and 13 in review, and >$700,000 in NSF-sponsored research grants. His position at the University of Wisconsin is Distinguished Scientist. These facts attest to his prolific professional career and his worthiness to be a GSA Fellow. Dr. Jicha exemplifies one of the virtues of working in geology: the willingness to collaborate with others to solve geologic problems no matter where it might take him, from the wilds of Alaska to the hostile desert of Ethiopia. He and the state-of-the-art geochronology laboratory that he supervises have been open to countless American and foreign scientists to provide critically needed high-quality ages to answer fundamental geological questions. Those who know Brian consider him to be extremely friendly and willing to collaborate in the field and laboratory. This is evident in his CV by the many, many co-authored papers with colleagues at other institutions.”

David John, U.S. Geological Survey, Emeritus

“In a long and distinguished career with the USGS, David John made fundamental contributions to economic geology and our understanding of the Cenozoic tectonic and magmatic development of the western US Cordillera. His best-known work—on epithermal gold deposits in the Great Basin and, in particular, the recognition that they can be associated with continental tholeiitic basalts—transformed our understanding of the genesis and distribution of these important sources of precious metals. Dave has also contributed substantially to the origin, evolution, and co-product character of porphyry copper-molybdenum systems. He is recognized as an expert in epithermal and porphyry copper-molybdenum-gold deposits within the USGS, leading or participating in numerous mineral assessment projects, and within the economic geology community more broadly, especially with his contributions and service as a long-time associate editor of the journal *Economic Geology*. Dave’s ideas and his scientific publications have been used widely in the minerals exploration business in many technical reports, testifying to his impact on exploration for new resources.”

Patricia Kambesis, Western Kentucky University

“[Dr. Kambesis] is a stellar example of how someone can combine scientific exploration with scientific research. She has made important scientific contributions to interdisciplinary karst topics in hydrogeology, geomorphology, conservation, and data management. She has authored or co-authored 20 peer-reviewed publications, 18 book chapters, and many refereed proceedings and professional meeting abstracts. One of the important and perhaps unique ways in which Dr. Kambesis trains geoscientists is through cave cartography and cave management. She is especially well known for teaching an immersive cave and karst visualization course through the WKU karst field studies program. Dr. Kambesis is well known as a cave explorer and cartographer, and arguably her most important contributions for promoting public awareness of geology and stewardship of geologic resources stem from her cave exploration and conservation activities.”

Melissa Lamb, University of St. Thomas

“As [Dr. Lamb’s] CV and bibliography show, her scientific contributions include important insights into our understanding of sedimentation and tectonics in southern Mongolia, some of the first work by western geoscientists after the Soviet period. Since arriving at UST, she has included 62 students in all phases of her work. Early in her career, she brought three students to Mongolia, and each were able to develop projects that led to GSA abstract publications and presentations. Her work in Nevada includes many abstract publications with undergraduate researchers as first or co-authors, in addition to undergraduate co-authorship on peer-reviewed publications in GSA journals and special publications. This is on top of a 25 year record of sustained, energetic, creative, and cutting-edge teaching in the classroom.”

Isaac Larsen, University of Massachusetts Amherst

“Across twenty years of research, Isaac has built a sustained and distinguished record of scientific contributions. He has developed skills in geochemistry, remote sensing, and numerical modeling to address geomorphic problems that he derives from field observation. Those problems include (1) landscape erosion rates, especially soil erosion in agricultural areas, with implications for soil carbon budgets; (2) soil production and chemical weathering in mountainous environments; and (3) bedrock erosion and canyon incision, especially by floods from glacial Lake Missoula. Linking much of this work is Issac’s uncommon care and creativity in applying cosmogenic nuclides to estimate rates of Earth-surface processes.”

Amy Leventer, Colgate University

“Amy Leventer is an accomplished scientist working at the intersection of biological oceanography, sedimentology, and glacial history and who is renowned for her dedication to mentoring the next generation of scientists, while building both community and infrastructure for future researchers. Her qualifications for fellowship include publishing over 130 papers, with at least 8 in GSA journals, including *GSA Bulletin*, *Geology*, and *GSA Today*; serving as a reviewer for many journals, including *Geology* and *GSA Bulletin*; convening and chairing sessions at both national and sectional GSA meetings; authoring and co-authoring numerous GSA abstracts, most recently in 2023 and 2024; and encouraging students to participate in both the annual and sectional GSA meetings and guiding them in work presented there over at least 25 years.”

Arthur Merschat, U.S. Geological Survey

“Throughout his 16-year career as a research geologist with the U.S. Geological Survey, Arthur has made the Geological Society of America the focus of sustained professional service and a major outlet for his scholarship. He has made significant and important outreach contributions to the general public and educational and other geological organizations. He has coauthored articles in *GSA Today* and *Geology*, and has published first-author papers in GSA Memoirs 200, 206, and 213. In addition, he is an Associate Editor of Memoir 213. He has been a coauthor of 109 GSA abstracts, 41 of which he presented at annual or Section meetings. Arthur has co-led seven GSA field trips, including at a Penrose Conference, the annual meeting, and numerous Southeastern Section Meetings. He was co-chair of the 2023 joint Southeastern-Northeastern GSA Section Meeting in Reston, Virginia. He is currently the 2024–2025 chair-elect of the GSA Southeastern Section."

Jason Polk, Western Kentucky University

"Dr. Polk was one of the founding members of the GSA Karst Division, and served in a leadership role since its inception in 2014. During his tenure, Jason helped increase the stature of the Karst Division within GSA and nationally; grew membership by more than 20% with an emphasis on student recruiting; developed the booth and marketing materials (including a logo); and nearly tripled funding. His many projects include working across sectors to improve groundwater contamination hazard response (he developed first web-based contaminant response model for urban karst areas), flood prediction and monitoring (he developed first validated predictive flood model for karst systems), sinkhole risk and evaluation, and karst and climate vulnerability assessments, which all span local to international scales working with city and local government, nonprofits, federal partners (NPS, EPA, USGS, USDA), and community stakeholders."

Antonio Rodriguez, University of North Carolina at Chapel Hill

"Dr. Rodriguez is a highly accomplished coastal field geologist with expertise in sedimentology and stratigraphy whose interests and expertise have evolved to include geomorphology, biogeochemistry, and ecology. His focus lies in understanding the impacts of climate change and human stressors on modern coasts. He has published extensively (90+ peer-reviewed manuscripts) in high impact journals, including *Nature Climate Change*, *Earth's Future*, and *Geology*. His research findings frequently result in valuable insights that have been applied to managing coastal environments in the face of changing land use and climate. Finally, his research has resulted in a digital legacy left to current and future coastal scientists."

Raymond Rogers, Macalester College

"Ray has made essential contributions to understanding Mesozoic terrestrial paleoenvironments, with particular focus on vertebrate stratigraphy and evolution. In the past two years, Ray has published multiple highly influential papers, many of which are with former students. In addition to being an exceptional in-class teacher—recognized with Macalester's Jack and Marty Rossmann Excellence in Teaching Award—Ray has mentored an impressive 41 students from diverse backgrounds through their Senior Honors Theses. Ray has made substantial contributions to the fields of taphonomy and sedimentary geology over his 30+ year career, all while mentoring the next generations of geoscientists to follow in his footsteps."

Zachary Sharp, University of New Mexico

"A hallmark trait of Zach Sharp is his enthusiasm for learning new things, which leads him to figure out ways to measure things no one has measured before. He uses stable isotopes to probe the history and to understand the fundamental processes of Earth and of our Solar System. His accomplishments in the fields of igneous, metamorphic, and economic geology alone would be sufficient for recognition as a GSA Fellow, as would his development of the now universally used laser fluorination protocol."

Noah Snyder, Boston College

"Although still a mid-career scientist, Noah has assembled a professional profile that would rival a more senior scholar. Through his research and publication record, his enviable record of external funding, his teaching and mentoring of students, and his dedication to GSA and an array of other professional organizations, Noah not only meets the high standards of being a Fellow of GSA but far exceeds those standards. I have been around the field of geomorphology for >40 years and have witnessed the emergence of key themes over that time period. Two of the most salient sub-fields to have emerged include tectonic geomorphology—and its associated focus on landscape evolution modeling—and the development and application of high-resolution airborne LiDAR digital elevation models to quantify geomorphic processes, and Noah's work was foundational to the development of both sub-fields."

Paul Spry, Iowa State University

"Dr. Paul Spry is a leading geoscientist with an outstanding body of research, has contributed greatly to mentoring a generation or more of students, and has provided outstanding service and administration to the geoscience profession, including to GSA. Dr. Spry has made important contributions to economic geology, geochemistry, and metamorphic petrology, and has published 131 peer-reviewed journal articles, six book chapters, 26 refereed conference proceedings, three books, and 181 abstracts. His work is highly integrated and grounded in fieldwork with subsequent layers of mineralogical and analytical data, which includes

utilization of stable and radiogenic isotopes, and various microbeam methods (e.g., EPMA, LA-ICP-MS, SIMS, SHRIMP, SEM, XRD). Moreover, he utilizes both thermodynamic and geochemical/mineralogical modeling for explaining and testing field, mineralogical, and chemical observations. Dr. Spry has made globally significant contributions to the field of economic geology, including the origin and genesis of sediment- and volcanic-hosted ore deposits, metamorphism of sulfide deposits and the chemical/mineralogical consequences thereof, the geology and genesis of Au-Te deposits, and geochronology and utilization of unconventional isotope systems to understand ore forming processes."

Amy Weislogel, West Virginia University

"Over the past 26 years, Dr. Amy Weislogel has established herself as an important international researcher on four continents with special expertise in the Appalachian region of the United States, the tectonics of central China, the Karoo basin of South Africa, and the northeastern rim of the Gulf of Mexico. She mentors geologists of the next generation by advising undergraduate and graduate students and encouraging their participation in professional meetings, not only of the GSA, but also AAPG, SEPM, and AGU. She is an active participant in The Geological Society of America through her service to the Sedimentary Geology Division as well as her editorial work and scientific contributions to our journals and books."

Michael Wizevich, Central Connecticut State University

"Dr. Wizevich's outstanding and continuous service to the Geological Society of America has resulted in two, and likely a third, very successful regional meetings. His publication record in GSA's and other peer-reviewed journals have made a significant and lasting contribution to science. Finally, Dr. Wizevich's mentorship in guiding the growth of many young people as scientists and professionals is an important contribution to the sustainability of the geoscience professions and therefore to GSA."

Rainbow Rock

GEOLOGY THROUGH THE LENS

An isolated resistant block of Jurassic ribbon chert in Franciscan melange, Rainbow Rock, southern Oregon, forms a headland that displays its spectacular folding and coastal erosional features.

Marli Miller is a faculty member of the Earth Sciences Department at the University of Oregon. Her website, geologypics.com, provides free earth science photographs for teachers.

Want your photo to be featured in *GSA Today*? Email submissions to gsatoday@geosociety.org.

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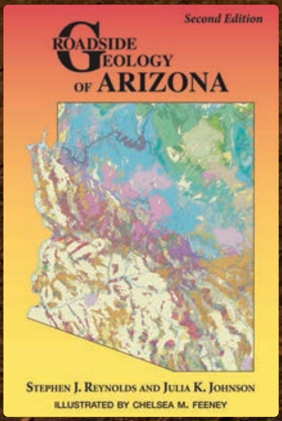

Roadside Geology of Arizona, Second Edition

Stephen J. Reynolds and Julia K. Johnson
Illustrated by Chelsea M. Feeney

With this colorful book as your guide, gain greater appreciation for the rocky scenery of Arizona as you learn about badlands in the Painted Desert, environments preserved in Sedona's sandstone cliffs, fossilized logs at Petrified Forest National Park, and the copper mined at Bisbee, Morenci, and Bagdad. Impressive gorges cut through the landscape, including those of the Little Colorado, Gila, and Salt Rivers, but the most spectacular gorge is the Grand Canyon. From the Colorado River's earliest stream deposits near Yuma to ancient sand dunes preserved in Canyon de Chelly, and from volcanic tuffs near Kingman to silver veins at Tombstone, *Roadside Geology of Arizona* crisscrosses the state to cover all its fascinating geologic history.

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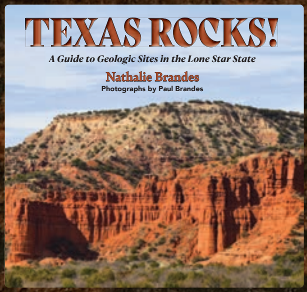
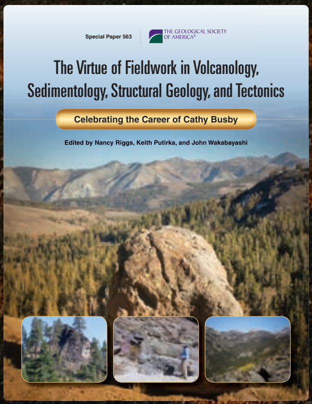


Texas Rocks! A Guide to Geologic Sites in the Lone Star State

Nathalie Brandes
Photographs by Paul Brandes

From the dramatic cliffs of Palo Duro Canyon State Park to the rugged beauty of Big Bend National Park, the floodplain ecosystem of Brazos Bend State Park, and beyond, *Texas Rocks!* guides you through 80 accessible and awe-inspiring geologic sites. With vivid descriptions and 174 full-color photographs and maps, this book is your essential companion for exploring Texas's diverse geological landscapes. *Texas Rocks!* brings the Lone Star State's geologic wonders to life, unearthing Texas's billion-year history.

ISBN 9780813741253 • 396-GRKTX • paperback • 162 pages • 9 × 8⅜ • **US$26.00**



The Virtue of Fieldwork in Volcanology, Sedimentology, Structural Geology, and Tectonics—Celebrating the Career of Cathy Busby

Edited by Nancy Riggs, Keith Putirka, and John Wakabayashi

In 2022, the editors of this volume convened a GSA Connects session to honor Cathy Busby, recipient of the 2020 GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division's Distinguished Geological Career Award, and encouraged participants to contribute to this volume. The papers range in scope from petrology to facies analysis to sedimentation, and they span time from Permian to Holocene, and space from Mexico and California to Taiwan and Izu-Bonin. Papers from the western Pacific Ocean follow these, and this final section also includes process and textural studies. All of the papers celebrate Busby's dedication to fieldwork as the foundation for geological studies.

ISBN 9780813725635 • SPE563 • paperback • 511 pages • 8½ × 11 • US$96.00 •
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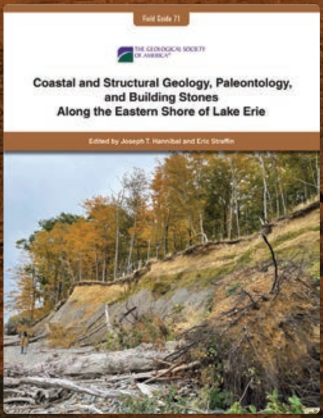

Coastal and Structural Geology, Paleontology, and Building Stones Along the Eastern Shore of Lake Erie

Edited by Joseph T. Hannibal and Eric Straffin

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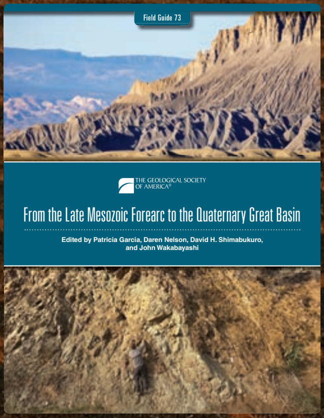

From the Late Mesozoic Forearc to the Quaternary Great Basin

Edited by Patricia Garcia, Daren Nelson, David H. Shimabukuro, and John Wakabayashi

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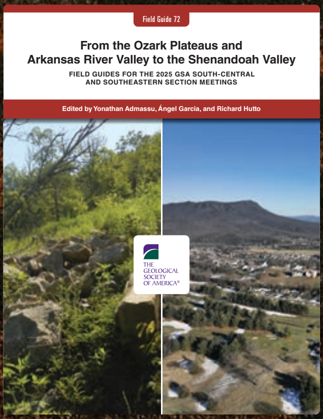

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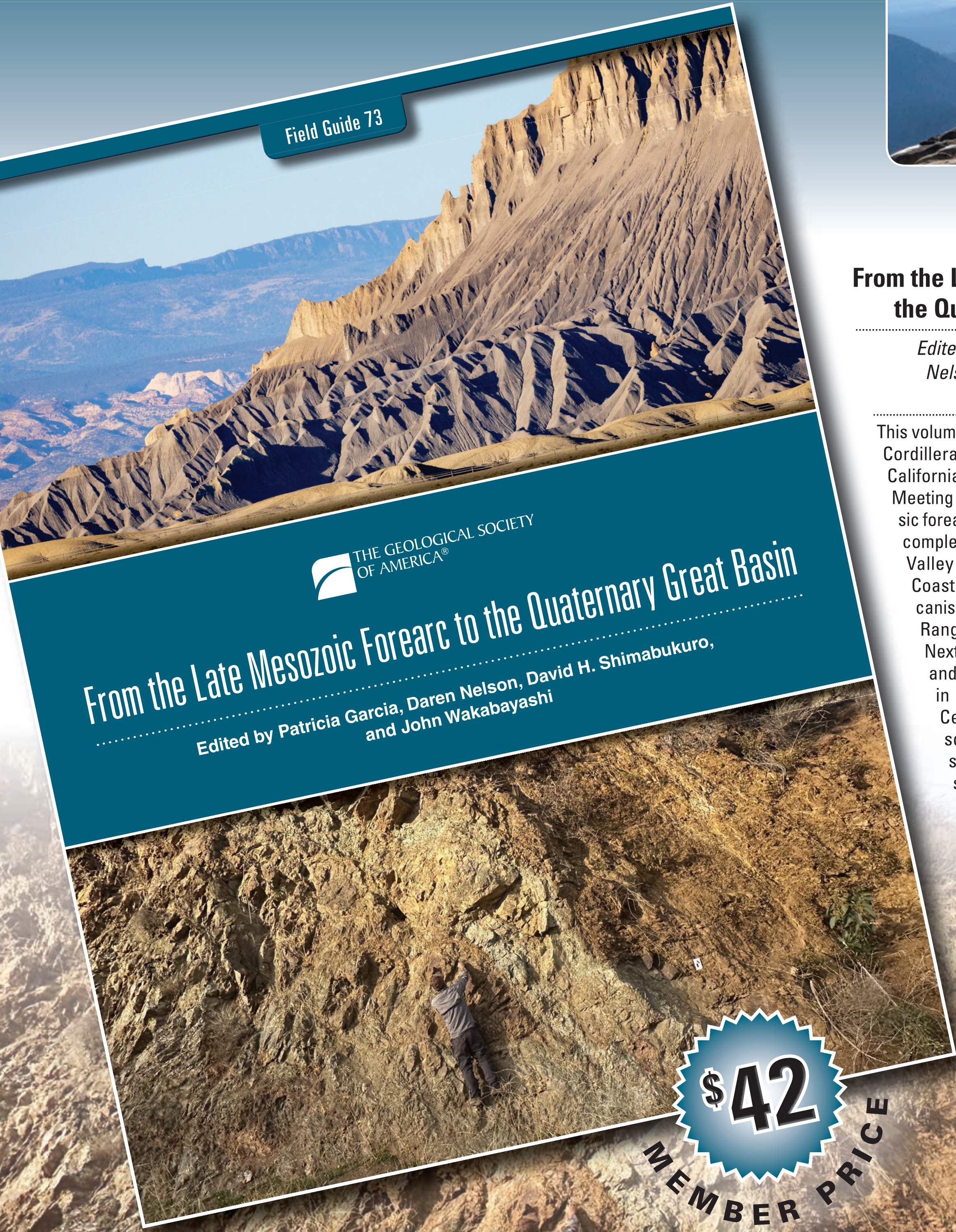
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