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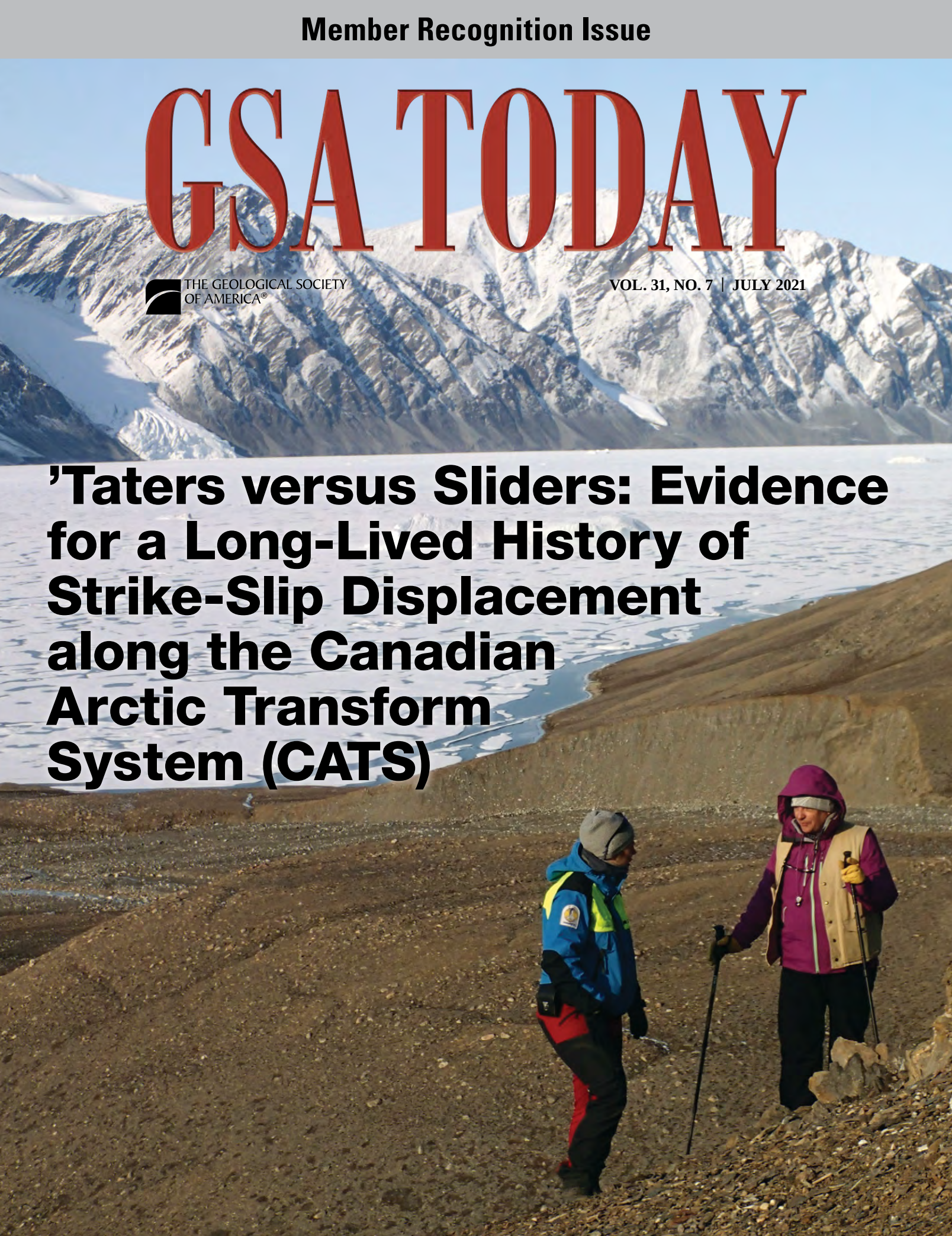

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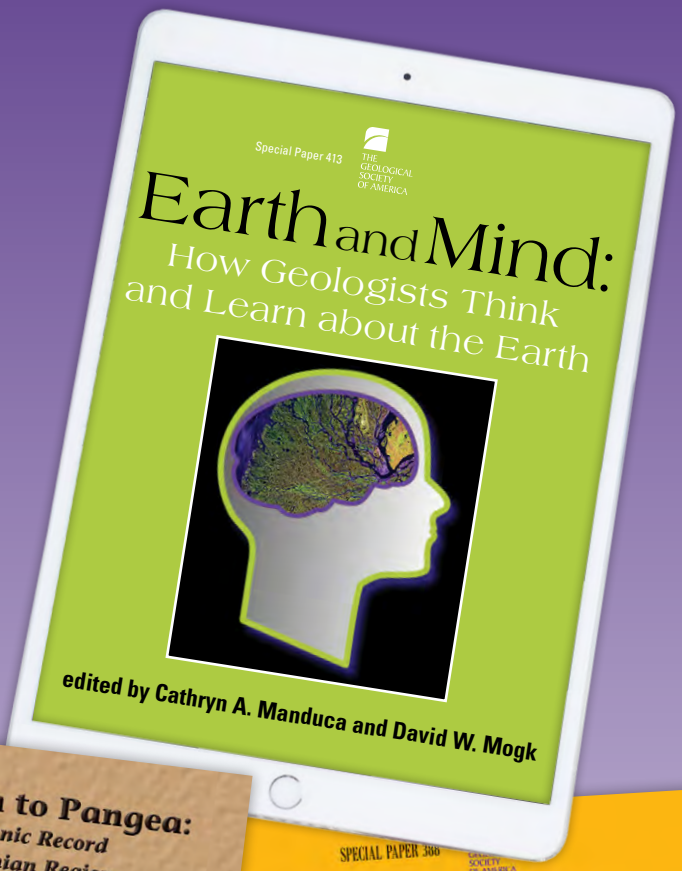


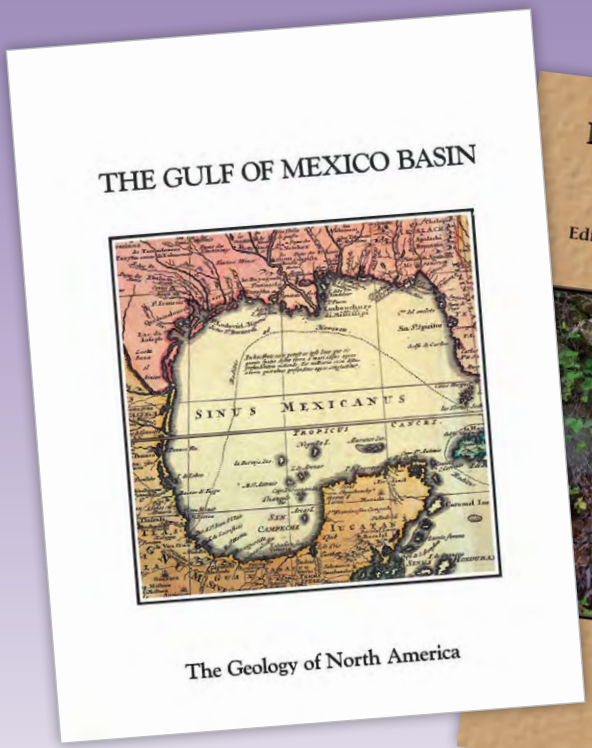


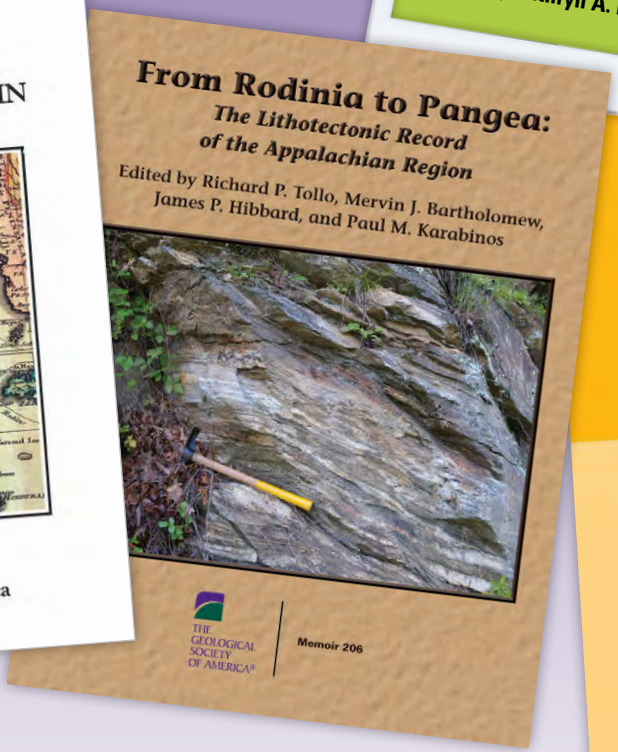


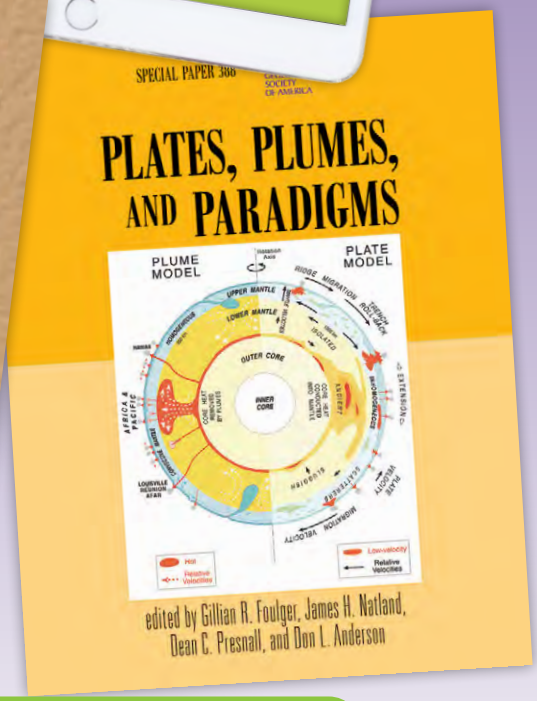


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***GSA TODAY* STAFF**

**Executive Director and Publisher:** Vicki S. McConnell

**Science Editors: Mihai N. Ducea,** University of Arizona, Dept. of Geosciences, Gould-Simpson Building, 1040 E 4th Street, Tucson, Arizona 85721, USA, ducea@email.arizona.edu; **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.

**Managing Editor:** Kristen "Kea" Giles, kgiles@geosociety.org, gsatoday@geosociety.org

**Graphics Production:** Emily Levine, elevine@geosociety.org

**Advertising Manager:** Ann Crawford, +1-800-472-1988 ext. 1053; +1-303-357-1053; Fax: +1-303-357-1070; advertising@geosociety.org

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**Cover:** Geologists studying structures along the Petersen Bay fault, a segment of the Canadian Arctic transform system (CATS), on northern Ellesmere Island. Photo taken by B. McClelland. See related article, p. 4–11.

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THE GEOLOGICAL SOCIETY OF AMERICA®

# 'Taters versus Sliders: Evidence for a Long-Lived History of Strike-Slip Displacement along the Canadian Arctic Transform System (CATS)

***William C. McClelland,*** *Dept. of Earth & Environmental Sciences, University of Iowa, Iowa City, Iowa 52242, USA;* ***Justin V. Strauss,*** *Dept. of Earth Sciences, Dartmouth College, Hanover, New Hampshire 03755, USA;* ***Maurice Colpron,*** *Yukon Geological Survey, Whitehorse, Yukon Y1A 2C6, Canada;* ***Jane A. Gilotti,*** *Dept. of Earth & Environmental Sciences, University of Iowa, Iowa City, Iowa 52242, USA;* ***Karol Faehnrich,*** *Dept. of Earth Sciences, Dartmouth College, Hanover, New Hampshire 03755, USA;* ***Shawn J. Malone,*** *Dept. of Geoscience, University of Wisconsin, Green Bay, Wisconsin 54311, USA;* ***George E. Gehrels,*** *Dept. of Geosciences, University of Arizona, Tucson, Arizona 85721, USA;* ***Francis A. Macdonald,*** *Earth Science Dept., University of California, Santa Barbara, California 93106, USA;* ***John S. Oldow,*** *Borealis, 200 E. Troxell Road, Oak Harbor, Washington 98277, USA,* and *Dept. of Geology, Western Washington University, Bellingham, Washington 98225, USA*

## ABSTRACT

Recent field-based studies indicate that the northern margin of North America is best interpreted as a tectonic boundary that experienced a long, complex history of strike-slip displacement. Structures juxtaposing the Pearya and Arctic Alaska terranes with North America are linked and define the Canadian Arctic transform system (CATS) that accommodated Paleozoic terrane translation, truncation of the Caledonian orogen, and shortening within the transpressional Ellesmerian orogen. The structure was reactivated during Mesozoic translational opening of the Canada Basin. Land-based evidence supporting translation along the Canadian Arctic margin is consistent with transform structures defined by marine geophysical data, thereby providing a robust alternative to the current consensus model for rotational opening of the Canada Basin.

## INTRODUCTION

Recent ocean- and land-based studies of the circum-Arctic region bring significant advances in high-quality data to formulate new models for the tectonic evolution of the Arctic margin (e.g., Pease and Coakley, 2018; Piskarev et al., 2019; Piepjohn et al., 2019). Nevertheless, evolution of the Canada Basin remains one of the most enigmatic and contentious topics of the Arctic. Two end-member models for the Mesozoic opening of the Canada Basin invoke Arctic Alaska (1) rifting and rotating (*'taters*) from or (2) translating (*sliders*) along the Canadian Arctic margin (Fig. 1 inset). Late Paleozoic and Mesozoic stratigraphic correlations between the northwestern Alaskan and Canadian Arctic margins provide the clearest rationale for the rotation model (Embry, 1990), which is by far the most commonly expressed mechanism (e.g., Hutchinson et al., 2017; Miller et al., 2018). In contrast, we explore the implications of a growing set of onshore observations that indicate that the northern Laurentian margin has experienced a protracted history of translation. This view is bolstered by a variety of data that support models of Paleozoic large-magnitude terrane translation through the Arctic region (Colpron and Nelson, 2009). Despite early calls for large-magnitude sinistral offsets (e.g., Boreal fault of Bally in Kerr et al., 1982; Canadian transcurrent fault of Hubbard et al., 1987; Porcupine fault of Oldow et al., 1989), the Canadian Arctic margin generally has not been viewed as a viable candidate for transform boundaries to accommodate evolution of the Arctic region (e.g., Doré et al., 2016). Results of our recent field studies on the northern margin of Laurentia challenge this conclusion and support translation.

## CURRENT SETTING

The Canadian Arctic Islands expose a south to north transition from shallow marine deposits of the Paleozoic Arctic platform into deep-water rocks of the late Proterozoic to early Paleozoic Franklinian basin that were deformed in the Devonian and overlain by late Paleozoic and early Mesozoic rocks of the Sverdrup basin. Rocks of the Franklinian basin were deposited after the Neoproterozoic breakup of Rodinia and rifting along the northern Laurentian margin, which closely followed mafic magmatism associated with the Franklin Large Igneous Province at 720 Ma (Macdonald et al., 2010; Cox et al., 2015). The basin is flanked to the north by Ordovician to Silurian clastic and subduction-related mafic and ultramafic rocks and allochthonous units of the Pearya terrane (Fig. 1; Trettin, 1998). The Pearya terrane is dominated by two assemblages juxtaposed in the Ordovician: a displaced peri-Laurentian crustal fragment that records early Neoproterozoic (Tonian) and Ordovician convergent margin magmatism (Malone et al., 2017, 2019) and a latest Neoproterozoic (Ediacaran) to Ordovician mafic arc complex built on Tonian basement (Majka et al., 2021). Steeply dipping faults juxtaposed Pearya with the Laurentian passive margin by the Devonian (Trettin, 1998; Malone et al., 2019). Subsequently, units of both the Pearya terrane and Franklinian basin were deformed within the Devonian–Carboniferous Ellesmerian fold belt and overlain by Carboniferous and younger deposits of the Sverdrup basin. Structures of the Ellesmerian fold belt extend westward to Prince Patrick Island where they, and Carboniferous to Mesozoic structures of the Sverdrup basin, are truncated at a high angle by the present-day Arctic margin (Fig. 1; Harrison and Brent, 2005).

Autochthonous strata of the Laurentian margin in northern Yukon are juxtaposed with peri-Laurentian platform and basinal strata of the North Slope subterrane of Arctic Alaska (Macdonald et al., 2009; Strauss et al., 2019a, 2019b; Colpron et al., 2019) on a near-vertical fault zone broadly referred to as the Porcupine shear zone (Fig. 1; von Gosen et al.,

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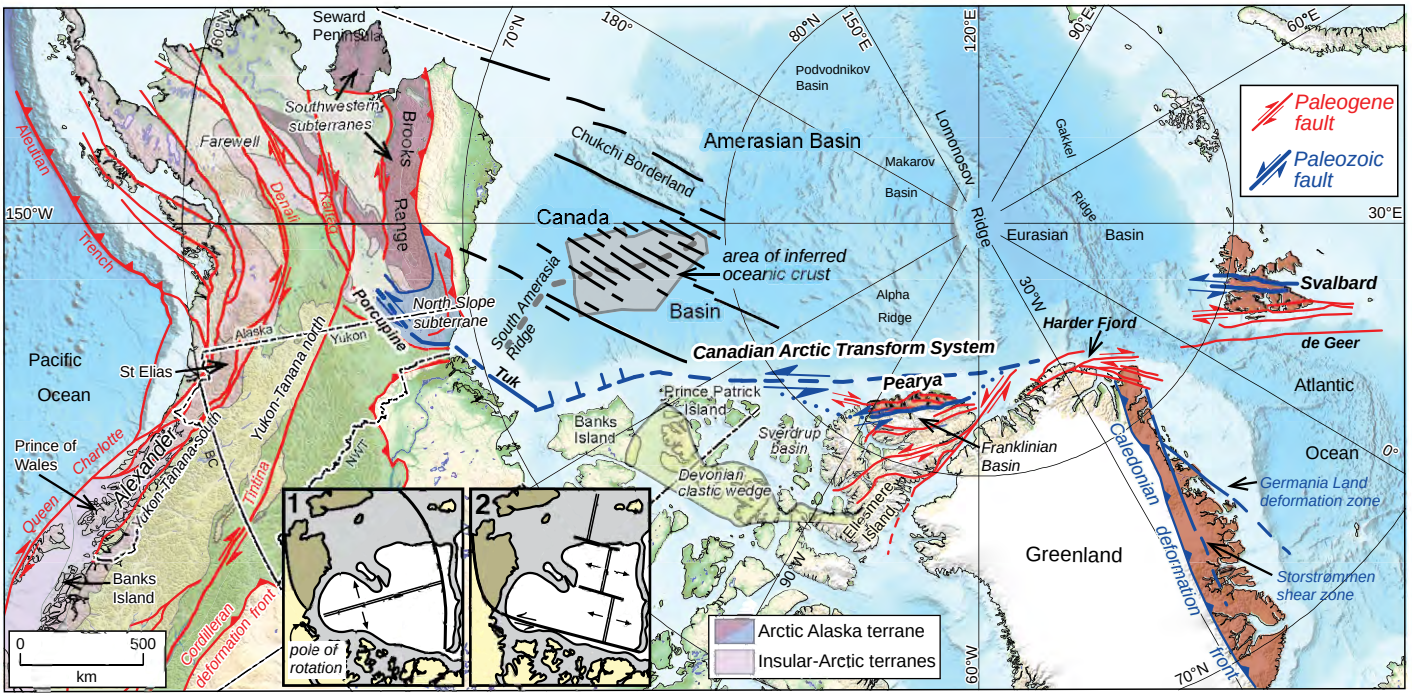


**Figure 1. Generalized terrane map showing the location of the Canadian Arctic transform system, geophysically defined features in the Canada Basin, and terrane distribution on the Arctic and Cordilleran margins of Laurentia (modified after Colpron et al., 2019). Insets show simplified (1) rotation and (2) translation models (from Patrick and McClelland, 1995).**

2019). The North Slope subterrane was incorporated into the greater Arctic Alaska terrane and juxtaposed with the Laurentian margin by the Carboniferous (Strauss et al., 2013). South-directed Late Devonian–Carboniferous structures on the north side of this boundary mark the probable offset western continuation of the Ellesmerian orogen (Oldow et al., 1987).

## PALEOZOIC TERRANE ACCRETION AND TRANSLATION ON THE PEARYA AND PORCUPINE SHEAR ZONES

Models that invoke terrane translation from the Arctic domain to the Cordilleran margin (e.g., Northwest Passage model; Colpron and Nelson, 2009) require a transcurrent boundary along the Paleozoic Arctic margin. Evidence for such a boundary on Ellesmere Island was outlined by Trettin (1998) in his assessment of the history of Pearya. Recent fieldwork has confirmed that Pearya is separated from the Laurentian margin by vertical strike-slip structures that record a complex history of reactivation, overprinting, and reversals in displacement direction (Piepjohn et al., 2015). Current timing estimates for Paleozoic sinistral displacement suggest a long-lived Ordovician to Devonian metamorphic and deformation history associated with juxtaposition and translation of Pearya along the Laurentian margin (McClelland et al., 2012; Kośmińska et al., 2019).

Structures that accommodated translation of Pearya project eastward to faults with similar timing and kinematics in Svalbard (Fig. 1; Mazur et al., 2009). Although commonly linked with strike-slip faults in the Caledonides (e.g., Storstrømmen shear zone; Fig. 1), we suggest that faults in Svalbard truncate the Caledonian structures and continue eastward to Scandinavia as the de Geer transform (Fig. 1; Lundin and Doré, 2019). The Harder Fjord fault zone, a long-lived steep structure that juxtaposes Ediacaran arc rocks with the Franklinian margin on North Greenland (Rosa et al., 2016), is similar to faults in Pearya and Svalbard (Fig. 1).

Strike-slip faults project westward from Pearya to the boundary between the Laurentian margin and North Slope subterrane in Yukon (Fig. 1). This boundary is marked by the Porcupine shear zone, a broad fault zone (>17 km wide) of older sinistral and recent (late Cenozoic) dextral brittle deformation (von Gosen et al., 2019). The lithology and structural history of the North Slope subterrane contrast sharply with the adjacent Laurentian margin rocks and are more akin to units in northeastern Laurentia (Macdonald et al., 2009; Strauss et al., 2013; Gibson et al., 2021). Although originally interpreted to crosscut the shear zone (Lane, 1992), Devonian granitoids common to the North Slope subterrane were emplaced within the Porcupine shear zone while it was an active lithosphere-scale transform (Ward et al., 2019). Strike-slip basin sedimentation may be recorded by the newly recognized Devonian–Carboniferous Darcy Creek formation within the Porcupine shear zone (Faehnrich et al., 2021).

Linking strike-slip structures across Svalbard and northern Ellesmere Island to Yukon and Alaska on the basis of orientation, timing, and kinematics defines a throughgoing Paleozoic fault system on the northern Laurentian margin (Fig. 1), referred to here as the Canadian Arctic margin transform system (CATS). Recognition of CATS carries significant implications for Paleozoic paleogeographic reconstructions of the northern Laurentian margin. Displacement and terrane juxtaposition along the margin culminated with south-directed shortening of the Late Devonian–Early Carboniferous Ellesmerian orogeny and development of a thick clastic wedge derived from a continental sediment source to the north. The nature of this northern source remains tentative but is most probably derived from the Arctic Alaska–Chukotka terrane (Beranek et al., 2010; Anfinson et al., 2012). The CATS model that accommodates large-magnitude translational motion of terranes suggests the source may have varied through time.

## GRAINS AND TERRANES: WHERE DID THEY COME FROM?

Evidence for terrane displacement along the Arctic margin can be evaluated by comparing detrital zircon data from the Paleozoic passive margin to terranes thought to have moved along it. Critical components include (1) variation in detrital zircon signatures across northern Laurentia; (2) the ca. 970 Ma signature of the convergent margin external to Rodinia; (3) Neoproterozoic magmatic ages; and (4) Ordovician, Silurian, and Devonian arc magmatism common to many of the displaced terranes. Tracking detrital zircons in combination with their Hf isotopic signatures demonstrates significant differences in provenance history between Arctic terranes and the Laurentian margin. For example, Proterozoic to Devonian units of Svalbard remain similar throughout their evolution, whereas Proterozoic to Silurian components of the Alexander terrane are highly variable but coalesce to a common signature in the Devonian (Fig. 2A).

The terranes of Svalbard, Pearya, and North Slope show clear evidence of Mesoproterozoic and older material consistent with derivation from Laurentia but distinct from passive margin units in the Franklinian basin. The Precambrian signature of the North Slope subterrane is most compatible with northeastern Laurentia (Greenland), making a strong case for large-scale translation of a peri-Laurentian fragment along the Arctic margin (Gibson et al., 2021). The Tonian (ca. 970 Ma) signature of the Pearya, Svalbard, Arctic Alaska, and Farewell terranes clearly distinguishes these crustal fragments from the Franklinian margin (Fig. 2). The Tonian signature is subtle to absent in the Alexander and Yukon-Tanana terranes, making it a useful discriminant as well. Evidence for Neoproterozoic–early Paleozoic (710–520 Ma) magmatism coeval with activity in the Timanide orogen of eastern Baltica (Fig. 3) appears in the Pearya, Arctic Alaska, Farewell, and Alexander terranes, but is notably missing from the Laurentian signature of the North Slope subterrane and Franklinian basin. Terranes with this signature are assigned origins adjacent to Baltica or Siberia (e.g., Beranek et al., 2013; White et al., 2016), consistent with faunal (Soja and Antoshkina, 1997) and paleomagnetic (Bazard et al., 1995) data.

Ordovician to Silurian arc magmatism observed in the Arctic terranes indicates that they largely represent displaced arc fragments. The age of individual peaks varies by terrane, and Hf isotopes range from juvenile (>+5 $\varepsilon Hf_t$) to evolved (<–5 $\varepsilon Hf_t$) settings (Fig. 2B), tracking differences in arc basement and proximity to active convergent boundaries. For example, Ordovician signatures are dominant in the Pearya, Alexander, Farewell, and Arctic Alaska terranes, but lacking in Svalbard and portions of the Yukon-Tanana terrane. Silurian magmatic rocks are absent from Pearya and the North Slope subterrane although both regions record influx of Silurian detrital components. The $\varepsilon Hf_t$ signatures for Ordovician and

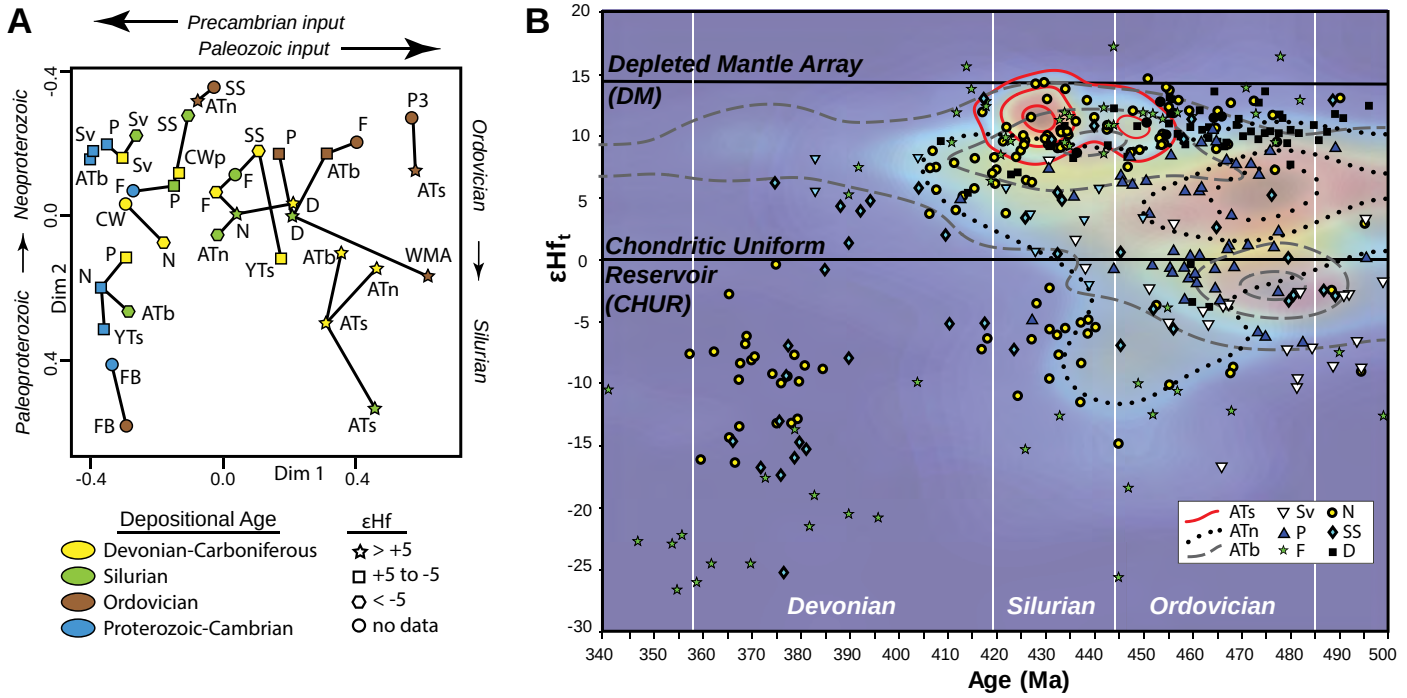


**Figure 2. (A) Two-dimensional multidimensional scaling (MDS) plot (Saylor et al., 2017; Kolmogorov-Smirnov comparison of probability density plots, metric squared test = 0.137) and (B) age-$\varepsilon Hf_t$ plot of detrital zircon data from units involved in translation along the Canadian Arctic transform system. Annotations on (A) show general detrital age trends reflected in the MDS plot. Alexander terrane data in (B) is plotted as contoured density maps of bivariate kernel density estimates with contours of 68% (1σ) and 95% (2σ) of peak density and cool to hot color gradient reflecting increasing peak density (Sundell et al., 2019). Data from Svalbard (Sv); Franklinian basin (FB); Pearya terrane (P; P3—Succession 3); Canadian Arctic Islands clastic wedge (CW; CWp—Parry Islands Formation); Arctic Alaska terrane (N—North Slope subterrane; SS—southwestern subterranes; D—Doonerak; WMA—Whale Mountain Allochthon); Farewell terrane (F); Alexander terrane (AT: ATn—northern, St. Elias; ATs—southern, Prince of Wales Island; ATb—Banks Island assemblage); the Yukon-Tanana terrane (YTs) in southeastern Alaska is presented in additional plots and references in the supplemental material[1].**

[1]Supplemental Material. Probability plots, Shepard plot, and sources of U/Pb data in Figure 2A. Go to https://doi.org/10.1130/GSAT.S.14442635 to access the supplemental material; contact editing@geosociety.org with any questions.

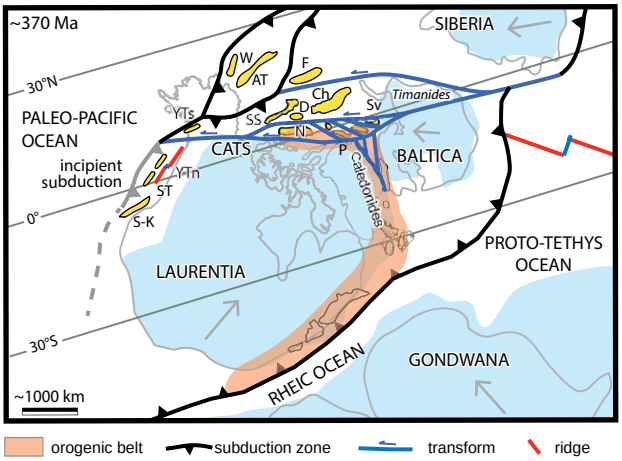


**Figure 3. Schematic Devonian paleogeographic reconstruction showing terrane translation on the Canadian Arctic transform system (CATS). Modified after Torsvik and Cocks (2017). AT—Alexander terrane; Ch—Chukotka; D—Doonerak arc; F—Farewell; N—North Slope subterrane; P—Pearya terrane; S-K—Sierra-Klamath terranes; SS—southwestern Arctic Alaska subterranes; ST—Stikinia; Sv—Svalbard; W—Wrangellia; YTn—Yukon-Tanana terrane in Yukon; YTs—Yukon-Tanana terrane in southeastern Alaska.**

Silurian zircon in most terranes, ranging from +5 to –15, record evolution in settings with variable input from older continental sources, either from the arc basement or influx of continentally derived sedimentary material. In stark contrast, the southern Alexander terrane on Prince of Wales Island, along with the Doonerak arc and Whale Mountain allochthon of Arctic Alaska, consistently have a juvenile signature that indicates evolution in an intraoceanic setting isolated from any continental input throughout their pre-Devonian history (Fig. 2).

Devonian–Carboniferous detrital zircon signatures define amalgamation of terranes and juxtaposition with the Arctic margin. The Devonian clastic wedge in the Canadian Arctic Islands records deposition on Laurentia from a more juvenile source emplaced along the Franklinian margin (Patchett et al., 1999). Late Devonian units (e.g., Parry Islands Formation) at the top of the wedge are dominated by Neoproterozoic to Devonian grains with juvenile $\varepsilon Hf_t$ (Anfinson et al., 2012). This shift in signature is consistent with recycling of Silurian units from the Pearya, Farewell, northern Alexander, and Arctic Alaska terranes (Fig. 2). The $\varepsilon Hf_t$ values for Ordovician to Early Devonian grains in many terranes are markedly juvenile but show a sharp pull down in the Late Devonian (Fig. 2), which reflects increased crustal involvement due to contraction and perhaps collision. The Banks Island and northern (St. Elias) units of the Alexander terrane (Fig. 1) show a transition from strongly evolved in Ordovician–Silurian grains to dominantly juvenile values—a signature that is more consistent with the southern Alexander terrane (Fig. 2). This transition, combined with the similarity in detrital zircon patterns, suggests Devonian amalgamation of the disparate Alexander fragments.

## PALEOZOIC EVOLUTION OF THE NORTHERN LAURENTIAN MARGIN

The variations in zircon age and $\varepsilon Hf_t$ signatures in circum-Arctic and Cordilleran terranes record changes in Paleozoic arc magmatism that broadly represent a northern continuation of the arc system associated with closure of Iapetus and the subsequent Silurian collision of Baltica with Laurentia (Fig. 3; Strauss et al., 2017). These arc complexes are best viewed as age equivalent to subduction-related rocks preserved in the thrust sheets of the Caledonides. Svalbard represents a Caledonian signature; however, the other circum-Arctic terranes are arc complexes that extended beyond the Caledonides and are characterized by a mixture of juvenile intraoceanic fragments (e.g., southern Alexander terrane, Doonerak) and arc fragments with continental substrates (e.g., Pearya, northern Alexander terrane).

Translation associated with the CATS initiated as Ordovician and Silurian subduction migrated along the northern Laurentian margin. Subduction-related rocks inboard of Pearya are inferred to record transpressional collapse of the Ordovician arc against the Franklinian margin, with Silurian arc activity continuing offshore as subduction migrated westward. The location of Siberia and its role in the transfer of circum-Arctic terranes to the Cordilleran margin is poorly understood, but relative motion between Baltica, Siberia, and the Arctic terranes likely increased after the Silurian Baltica–Laurentia collision. Silurian translation placed several crustal fragments and arc terranes along the Arctic margin. Silurian to Early Devonian arc activity continued in outboard terranes destined to approach the Cordilleran realm.

Devonian displacement on the CATS emplaced Pearya and the North Slope subterrane along the Laurentian continental margin, with the rest of Arctic Alaska and Alexander located farther outboard. Final contraction in the northern Caledonides, represented by ultrahigh-pressure metamorphism at 360 Ma in North-East Greenland, was accompanied by sinistral and dextral translation that accommodated margin-parallel escape from the orogen (Gilotti and McClelland, 2007). This intra-Caledonian strike-slip system was truncated by the CATS, effectively transferring Caledonian rocks of Svalbard to the Arctic margin (Fig. 3). The eastern continuation of CATS projects toward the truncated margin of northern Scandinavia marked by the Trollfjord-Komagelva fault system, requiring an Ordovician–Devonian strike-slip history on this or an outboard structure along the Timanide-Baltica suture.

The amalgamated terranes translated along the Arctic margin shed detritus with characteristic juvenile isotopic signatures (e.g., Anfinson et al., 2012) southward into the Canadian Arctic Island clastic wedge (Fig. 1). Middle Devonian arc magmatism developed in Arctic Alaska simultaneously with clastic wedge deposition. This activity was contemporaneous with Uralian arc magmatism on the Baltican margin, but the two systems were separated by the CATS. The Late Devonian marks a transition to subduction initiation along the western margin of Laurentia with granitic magmatism present in the North Slope subterrane to the north and Yukon-Tanana, Stikinia, Quesnellia, Kootenay, and Sierra-Klamath terranes to the south (Fig. 3). The CATS effectively accommodated migration of Paleozoic arcs active outboard of the Laurentian margin into the paleo-Pacific realm. Latest stages of Ellesmerian shortening and translation on the northern margin coincide with the start of Yukon-Tanana magmatism in the northern Cordillera (Colpron and Nelson, 2009).

## MESOZOIC TRANSLATION AND OPENING OF THE CANADA BASIN

Despite lithologic, sedimentologic, and structural arguments for translation of Arctic Alaska along the northern Laurentian margin (Patrick and McClelland, 1995; Oldow et al., 1987, 1989; Dickinson, 2009), Early Cretaceous counterclockwise rotation of Alaska is the generally accepted model for opening of the Canada Basin (Grantz et al., 2011). The rotation model persists in large part due to a perceived lack of evidence for Mesozoic displacement on the Canadian

Arctic margin. Strike-slip faults are clearly exposed on Ellesmere Island and record a complex history of post-Carboniferous to Eocene sinistral and dextral displacement (Piepjohn et al., 2013). These structures record reactivation of the Paleozoic transform margin. West of Ellesmere Island to the Yukon-Alaska mainland, the structural history of the Canadian margin is in question.

Although conventionally interpreted as representative of Mesozoic extension, published seismic reflection profiles across the northern boundary of the Sverdrup basin (Embry and Dixon, 1990) show the boundary to be disrupted by near-vertical faults more reasonably interpreted as strike-slip faults. The faults separate blocks with substantial differences in thickness of Late Jurassic and Early Cretaceous sedimentary rocks. The faults cut and are locally sealed by Late Cretaceous clastic rocks that indicate displacement into the late Mesozoic. Along Prince Patrick Island, the faults truncate Paleozoic and Mesozoic stratigraphic and structural trends at a high angle to the margin (Harrison and Brent, 2005). Local evidence of extensional deformation is described along Banks Island (Fig. 1; Helwig et al., 2011) in a segment of the boundary characterized by a slight deflection in strike consistent with an extensional step in a sinistral transcurrent fault system (Fig. 4). Seismic sections west of Banks Island document near-vertical structures that truncate the continental margin along the Tuk transform (Helwig et al., 2011).

The Porcupine shear zone, separated from the Tuk transform to the east by a series of north-striking Cenozoic faults that record east-west contraction and disrupt the simple continuation of the CATS, is essential to translation models for opening of the Canada Basin. Preliminary structural studies supported Late Jurassic to Early Cretaceous sinistral transpression along the Porcupine shear zone (Oldow and Avé Lallemant, 1993). Recent studies have demonstrated that reactivation of the Porcupine shear zone involved Jurassic and Cretaceous rocks (von Gosen et al., 2019). Although the magnitude and timing of Mesozoic displacement on the Porcupine shear zone is not well documented at present, sinistral translation associated with opening of the Canada Basin is clear.

Marine geophysical data have long been interpreted in support of the rotation model, particularly satellite gravity data that was inferred to represent a spreading center (McAdoo et al., 2008). New data suggest a much more limited extent of oceanic crust (Chian et al., 2016), and interpretation of geophysical lineaments as transform structures has produced models invoking strike-slip faults within the Canada Basin (Hutchinson et al., 2017). These new models will be greatly improved by incorporating the CATS. In fact, the recent transform model of Døssing et al. (2020) explicitly requires sinistral translation on the Porcupine shear zone. Many uncertainties remain regarding the crustal composition and the timing and magnitude of extension within the Canada Basin and broader Amerasian Basin (Lebedeva-Ivanova et al., 2019), but tectonic models place the region in a back arc setting relative to the Mesozoic Cordilleran margin (Miller et al., 2018). Integrating our land-based observations of translation with the offshore geophysics provides a realistic geodynamic model for the Cretaceous opening of the Canada Basin in this setting (Fig. 4). The greater Amerasian Basin is best viewed as a domain of large-magnitude extension in response to slab rollback on the paleo-Pacific margin that is bound by strike-slip displacement on the Laurentian and Siberian margins (Miller et al., 2018). Transforms on the Siberian margin and within the Canada Basin are commonly accepted as components of the rotational model (Amato et al., 2015; Doré et al., 2016). Sinistral reactivation of the CATS on the Laurentian margin similarly bounds the extensional domain to the south. Block rotation of northern Alaska related to opening of the Canada Basin is permissible but no longer required.

Cenozoic reactivation of the CATS is recorded along its length. Displacement on the de Geer transform during opening of the Eurasian Basin records reactivation at the eastern end (Doré et al., 2016). Dextral displacement along the Arctic margin (Piepjohn et al, 2013) and the Porcupine shear zone marks reactivation of the central and western segments of the CATS, respectively. Activity on the western CATS was linked with continued evolution of the Cordilleran strike-slip orogen (Murphy, 2019).

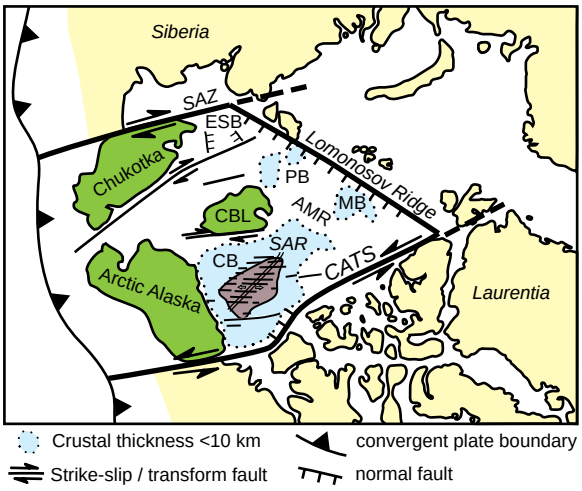


**Figure 4. Schematic Mesozoic paleogeographic reconstruction showing the role of the Canadian Arctic transform system (CATS) in opening of the Canada Basin and large magnitude extension in the Amerasian Basin. Modified after Patrick and McClelland (1995), Dickinson (2009), Miller et al. (2018), and Døssing et al. (2020). AMR—Alpha-Mendelev Ridge; CB—Canada Basin; CBL—Chukchi Borderland; ESB—East Siberian basins (see Nikishin et al., 2021); MB—Makarov basin; PB—Podvodnikov basin; SAR—south Amerasia ridge; SAZ—South Anyui suture zone. Extent of thin crust (<10 km) is from Lebedeva-Ivanova et al. (2019).**

## CONCLUDING REMARKS

Available field evidence strongly supports the presence of a long-lived strike-slip fault extending from North Greenland westward to Alaska along the northern Laurentian margin. Onshore and offshore observations are consistent with Paleozoic translation of arc terranes and crustal fragments along the CATS, followed by Mesozoic reactivation to accommodate regional extension of continental and hybrid crust (Miller et al., 2018) during translational opening of the Canada Basin. Ongoing geochronologic and kinematic studies of fault rocks will provide additional insight on the magnitude, timing, and direction of displacement along the length of the boundary. Pre-Devonian terrane translation complicates restorations based on age or lithologic similarities since many correlations are non-unique. In addition, extension within the Canada Basin accommodated by transform boundaries on the Canadian and Chukchi Borderland margins does not preclude block rotation within the basin, leading to hybrid models (Miller et al., 2018).

The rotation model for opening of the Canada Basin has long rested on stratigraphic arguments (e.g., Embry, 1990). Early structural analysis recognized translation of units with different Paleozoic and Mesozoic deformation histories (Oldow et al., 1987, 1989), but the necessary kinematic and timing constraints were missing, thus allowing the

rotation model to persist as the consensus model with little supporting structural evidence. For instance, no demonstrable increase in shortening along the length of the Brooks Range or obvious contraction south of the rotation axis in the Mackenzie delta exists to support rotation. The rotation model has in essence achieved the status of a Geomyth (Dickinson, 2003) since it is commonly assumed and rarely tested. Future models for Mesozoic opening of the Canada Basin will need to merge existing stratigraphic and geophysical observations with the substantial database that documents the Paleozoic evolution and Mesozoic–Cenozoic reactivation of the CATS in order to solve a tectonic problem that has dogged the community for decades.


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THE GEOLOGICAL SOCIETY OF AMERICA®

# CONNECTS 2021

10–13 October
Portland, Oregon, USA

# Welcome!

**Barbara (Barb) L. Dutrow**

I'm thrilled to welcome you to the GSA Connects 2021 meeting 10–13 October, which is planned to be held in person in Portland, Oregon, USA. As we (hopefully) exit the worst of the COVID-19 pandemic, GSA's resilient and nimble leadership, the dedicated organizing committee, and all of you will bring back the excitement that only comes with in-person geoscience meetings. GSA Connects 2021 offers opportunities for renewed scientific engagement, synergistic networking with colleagues, mentoring opportunities, visits with vendors and sponsors, and hundreds of exciting, ground-breaking symposia and topical sessions.

Geoscientists confronting the climate crises are now more important than ever. Providing solutions to the climate crises is the topic of the Halbouty lecture and a Pardee symposium linking the climate crises to diversity, equity, and inclusion and practices of leadership and inclusivity. Another Pardee Symposium underscores the need to elevate the voices of geoscientists at local, national, and international levels.

Listen to our 2020 Bromery Award winner speak about other worlds—and planetary habitability—or stick closer to home and attend sessions focusing on Cordilleran subduction dynamics or even with our own gift to the public in Geoheritage opportunities. Elevate your community outreach by bringing art to your science—in a special lecture on joining visual culture and scientific evidence.

GSA's commitment to diversity, equity, and inclusion is woven throughout the program.

There is a bounty of field trips, a hallmark of GSA, and other sessions of interest. For the full program and our commitment to care, go to **https://community.geosociety.org/gsa2021.**

A highlight of GSA Connects 2021 is the awards ceremony, where we celebrate the outstanding achievements of our GSA members and fellows, who encompass early career professionals to senior scientists. I strongly encourage as many to attend as possible, especially students. Following the awards ceremony is my presidential address, which focuses on the unique role that minerals play from archiving billions of years of Earth's history to sequestering carbon to their role as chemical reservoirs for critical minerals to a tool for enriching spatial and penetrative thinking skills in the next generations of geoscientists and more.

We recognize the importance of offering online meeting options for those who will not be able to participate in person. Stay tuned for updates on the sessions and Symposia to be streamed live. I am excited to participate and am looking forward to seeing you all in Portland, in person or via a small box on a video screen.

**Barbara L. Dutrow,** GSA President

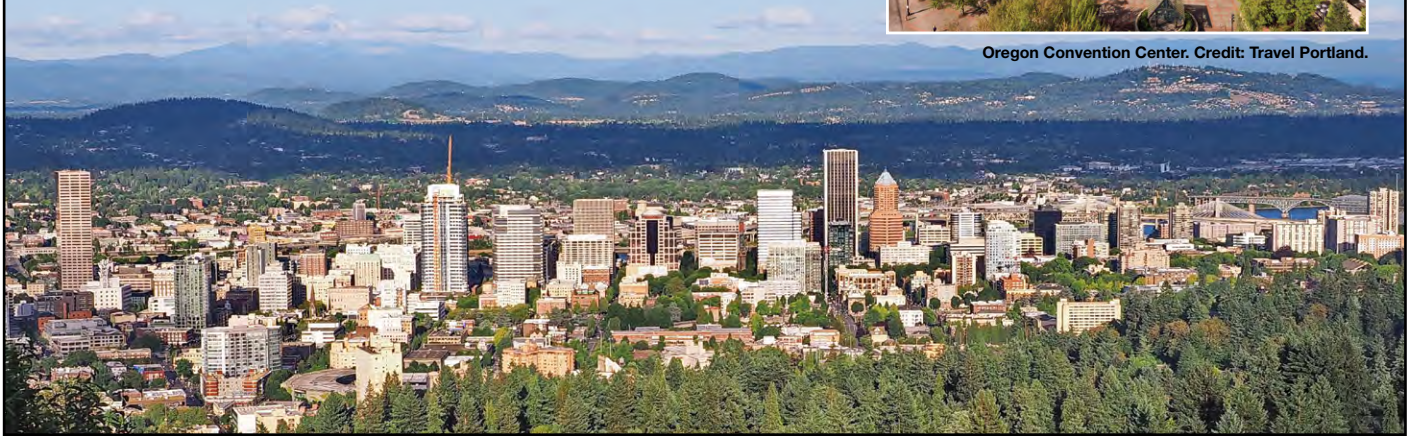
# Honoring the Best at GSA Connects 2021

*Plan to attend GSA's premier event and honor GSA's awardees in Portland this October.*

**GSA Presidential Address & Awards Ceremony**
Sunday, 10 Oct., noon–1:30 p.m. PST

**GSA Presidential Address**
Barbara L. Dutrow, "Minerals Matter: Science, Technology, and Society"


Oregon Convention Center. Credit: Travel Portland.



# Register Today for Best Pricing

**Deadline:** 11:59 p.m. MDT on 7 Sept.
**Cancelation deadline:** 11:59 p.m. MDT on 1 Oct.
**https://community.geosociety.org/gsa2021/registration**

GSA Connects 2021 registration is open. Take advantage of early registration prices and assure your spot on field trips, short courses, and events by registering now.

## TRAVEL GRANTS

You still have time to apply for grants. Various groups are offering grants to help defray your costs for registration, field trips, travel, etc., for GSA Connects 2021. Check the website at **https://community.geosociety.org/gsa2021/connect/student-ecp/travel-grants** for application and deadline information. Note: Eligibility criteria and deadline dates may vary by grant. The deadline to apply for the GSA Student Travel Grant is 7 Sept.

## STUDENT VOLUNTEERS

The Student Volunteer Program will open in late July. Earn complimentary registration when you volunteer to work for at least ten hours, plus get an insider's view of the meeting. Please wait to register for the meeting until you sign up as a volunteer unless you want to reserve a space in a Field Trip or Short Course. Details: **https://community.geosociety.org/gsa2021/registration/volunteers.**

## RISK-FREE REGISTRATION

Fully recognizing that every individual's situation is in flux—between job losses, company travel freezes, etc.—GSA's goal is to make it easier for you to attend Connects 2021 in Portland, Oregon. As a result, we have implemented a risk-free registration. Once you register, if you are not able to attend the live event, full refunds will be available if you cancel by 1 Oct. You can also change your registration to the online experience and receive a refund for the difference in registration rates. **Refund policy:** The deadline to request a full refund or transfer your registration to the online experience is Friday, 1 Oct. Cancelations must be received by the stated cancelation deadline and will be accepted in writing only. No-shows for the event will not receive a refund.

# 2021 Michel T. Halbouty Distinguished Lecture

Asmeret Asefaw Berhe

**Asmeret Asefaw Berhe,** "On Soil Erosion and Biogeochemical Cycling of Essential Elements"
Monday, 11 Oct., 12:15–1:15 p.m. PDT

**Abstract:** Most of the earth's terrestrial ecosystem is composed of sloping landscapes, where soil organic matter dynamics are partly controlled by the mass movement events that laterally distribute topsoil. Accurate estimation of the global soil carbon stock or the potential of soils to sequester atmospheric carbon dioxide are complicated by the effects of soil redistribution on net primary productivity, decomposition, and physical and chemical processes that regulate persistence of organic matter in soil. In this presentation, I will discuss: (1) why and how soil erosion can constitute a C sink, and how soil erosion is being considered within the context of global climate models; (2) the role of soil erosion on determining spatial distribution and stocks of soil organic matter (SOM), stability, and stabilization mechanisms; and (3) emerging understanding of the role of soil erosion controls of soil nitrogen and the dynamics of pyrogenic carbon post-fire. I will conclude the presentation by highlighting remaining knowledge gaps in our understanding of the role of soil erosion in soil phosphorus dynamics and SOM dynamics in temperate forests and arctic ecosystems.



The Geological Society of America®

# GEOCAREERS

If you are entering the job market or are supporting someone who is and want more information about career pathways in the geosciences, plan to attend one or more of the events below.


## ONLINE GEOCAREERS PROGRAMS

Visit **https://community.geosociety.org/gsa2021/connect/student-ecp/geocareers** for event details. Note that dates are before the meeting.

- GeoCareers Résumé Workshop, 4 Oct., noon–1 p.m. PDT
- Women in Geology, 4 Oct., 2–3 p.m. PDT
- GeoCareers Company & Agency Information Session, 5 Oct., noon–1 p.m. PDT
- Networking Event, 5 Oct., 2–3 p.m. PDT
- GeoCareers Career Pathways Webinar, 6 Oct., noon–1:30 p.m. PDT
- Early Career Networking Event, 6 Oct., 2–3 p.m. PDT

## GSA CONNECTS 2021 GEOCAREERS CENTER

**Open Sun.–Tues., 10–12 Oct., 9 a.m.–5 p.m.**

GSA will provide a safe environment for participants by following health and safety guidelines as outlined by the Oregon Convention Center in addition to using plexiglass partitions and other interventions to reduce transmission risk.

- Post or view jobs
- Drop-in mentoring
- Résumé/CV review clinic

## Be a Mentor and Make a Difference

*"GSA has given me a platform to share my story and help students prepare for a career."* —Brandy Barnes, Draper Aden Associate

- Drop-in Mentor (in-person)
- Résumé or CV Mentor (in-person)
- On To the Future Mentor (in-person or online)
- Networking Event Mentor (online)
- Women in Geology Mentor (online)

Learn more about being a mentor at **https://forms.gle/TVxWtJchpZiJHmSF7.**

## Transform Your Career by Attending a Short Course

- Learn a new topic
- Build your skills
- Network
- Take courses taught by industry professionals
- More than 20 courses offered online, several before the meeting
- Earn continuing education unit credits (CEUs)

Register for a short course today! Course costs go up $30 after 7 September.

**https://community.geosociety.org/gsa2021/program/short**

# 2021 GSA Medal & Award Recipients

### Penrose Medal
**Ian W.D. Dalziel,** Institute for Geophysics and Dept. of Geological Sciences, Jackson School of Geosciences, The University of Texas at Austin

### President's Medal of the Geological Society of America
**Marcia McNutt,** National Academy of Sciences

### Arthur L. Day Medal
**Katherine Freeman,** Pennsylvania State University

### Young Scientist Award (Donath Medal)
**Lidya Tarhan,** Yale University

### GSA Public Service Award
**Christopher Jackson,** University of Manchester

### Randolph W. "Bill" and Cecile T. Bromery Award for Minorities
**Hendratta N. Ali,** Fort Hays State University

### Doris M. Curtis Outstanding Woman in Science Award
**Sarah M. Aarons,** Scripps Institution of Oceanography

### GSA Florence Bascom Geologic Mapping Award
**Fernando Flecha Alkmim,** Universidade Federal de Ouro Preto
**Peter W. Lipman,** U.S. Geological Survey

### GSA Distinguished Service Award
**Alicia C.M. Kahn,** Chevron Corporation
**Christopher L. Atchison,** University of Cincinnati

### Honorary Fellow
**Christopher Jackson,** University of Manchester

# 2021 Primary Division and International Awards

*Energy Geology Division*
**Gilbert H. Cady Award**
**Xavier Querol,** Institute of Environmental Assessment and Water Research, Barcelona

*Environmental and Engineering Geology Division*
**E.B. Burwell, Jr., Award**
**Hatheway, A.W., and Speight, T.B.,** 2018, Manufactured Gas Plant Remediation: A Case Study: Boca Raton, Florida, CRC Press, 1084 p.

*Geoarchaeology Division*
**Rip Rapp Archaeological Geology Award**
**Joseph Schuldenrein,** Geoarcheology Research Associates

*Geobiology and Geomicrobiology Division*
**Distinguished Career Award**
**Frank Corsetti,** University of Southern California

*Geoinformatics Division*
**M. Lee Alison Award for Geoinformatics**
**Peter Fox,** RPI Tetherless World Constellation

*Geophysics and Geodynamics Division*
**George P. Woollard Award**
**Cindy Ebinger,** Tulane University

*Geoscience Education Division*
**Biggs Award for Excellence in Earth Science Teaching**
**Katherine Ryker,** University of South Carolina

*History and Philosophy of Geology Division*
**Mary C. Rabbitt History of Geology Award**
**Stephen Rowland,** University of Nevada–Las Vegas

*Hydrogeology Division*
**O.E. Meinzer Award**
**Mark Person,** New Mexico Tech

*Limnogeology Division*
**Israel C. Russell Award**
**David T. Long,** Michigan State University

*Mineralogy, Geochemistry, Petrology, and Volcanology Division*
**Distinguished Geologic Career Award**
**Michael Brown,** University of Maryland

*Planetary Geology Division*
**G.K. Gilbert Award**
**Janice Bishop,** SETI Institute

*Quaternary Geology and Geomorphology Division*
**Kirk Bryan Award For Research Excellence**
**Maureen H. Walczak,** Oregon State University: Walczak, M.H., and 13 others, 2020, Phasing of millennial-scale climate variability in the Pacific and Atlantic Oceans: Science, v. 370, p. 716–720, https://doi.org/10.1126/science.aba7096.

*Sedimentary Geology Division*
**Laurence L. Sloss Award**
**Sidney Hemming,** Columbia University

*Structural Geology and Tectonics Division*
**Career Contribution Award**
**Bradley R. Hacker,** University of California Santa Barbara

*GSA International*
**GSA Distinguished Career Award**
**John P. Grotzinger,** California Institute of Technology

GSA FOUNDATION

# 2021 Cole Awards

The Gladys W. Cole and W. Storrs Cole Memorial Awards for postdoctoral research are funded by the GSA Foundation.

## Gladys W. Cole Memorial Research Award

**Ellen Wohl,** Colorado State University, will be awarded US$6,576 from the Gladys W. Cole Fund for research in the geomorphology of semiarid and arid terrains for her project, "Characterizing the wood loads and geomorphic functions of large wood in ephemeral streams of the Southwestern US." The award will be presented at the Quaternary Geology and Geomorphology Awards Ceremony at GSA Connects 2021 in Portland, Oregon, USA, on Tues., 11 Oct.

## W. Storrs Cole Memorial Research Award

**Qing Tang,** Virginia Tech University, will be awarded US$6,607 from the W. Storrs Cole Fund for research in invertebrate micropaleontology for the project, "Taphonomic study of early Cambrian sponge fossils in South China." The award will be presented at the Cushman Foundation for Foraminiferal Research Awards Ceremony at GSA Connects 2021 in Portland, Oregon, USA, on Tues., 11 Oct.

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*Get into the Field with GSA*

# 2021 Field Award Recipients

## J. David Lowell Field Camp Scholarship Award

GSA FOUNDATION

These 16 undergraduate students will be awarded US$2,000 each to attend the summer field camp of their choice based on diversity, economic/financial need, and merit.

**Alexandra Banks,** Southern Illinois University
**Luke Basler,** Bowdoin College
**Lauren Breederland,** Wheaton College
**Sydney Briggs,** University of Alabama
**Holly Harris,** Bowdoin College
**Mark Hehlen,** University of Vermont
**Alina Hernandez,** San Diego State University
**Michael Keedy,** University of Maine
**Lauren Livers,** University of Alaska Fairbanks
**Cissy Ming,** Pennsylvania State University
**Lauren Nickell,** Southern Utah University
**Emma Palko,** Miami University
**Jasmine Peach,** San Diego State University
**Joseph Powell,** Arizona State University
**Rayann Rehwinkel,** University of Minnesota Duluth
**Justin Sharpe,** University of Texas at San Antonio

## GSA/ExxonMobil Field Camp Excellence Award

GSA FOUNDATION

ExxonMobil

This field camp will receive an award of US$10,000 to assist with the summer field season. This award will be based on safety awareness, diversity, and technical excellence.

**Eric Pyle,** James Madison University, Field Geology, Mapping in Ireland Field Camp

# GSA Expanding Representation in the Geosciences Scholarships

These six undergraduate students from groups underrepresented in the geosciences have been awarded US$1,500 scholarships plus one-year GSA memberships and full registration to GSA Connects 2021.

**Ziona Bates-Norris,** University of North Carolina Charlotte

**Sebastian Perez-Lopez,** Stanford University

**Jeanette Ralph,** University of California Los Angeles

**Ashley Rivas,** Smith College

**Mackenzie Rutherford,** Miami University

**Paige Wise,** Georgia Institute of Technology

# 50-Year Member Anniversaries

GSA salutes the following members and Fellows on their 50-year membership anniversaries. We appreciate their dedication and loyalty to GSA. To view a full list of members who have surpassed the 50-year mark, go to **http://rock.geosociety.org/membership/50YearFellows.asp**. Asterisks (*) indicate GSA Fellows.

Carlos E. Albrizzio
David W. Andersen*
Timothy A. Anderson
John M. Armentrout*
David D. Ashenden
James Wiley Babcock
Henry A. Bart
Robert L. Bauer*
C. Richard Berquist Jr.
Thomas Bobal
Peter E. Borella
Arthur H. Brownlow*
James N. Brune*
George T. Cardwell
Sam Carmalt
David W. Carpenter
L. David Carter*
Richard Allen Castle
Timothy Michael Chowns
Stan E. Church*
John W. Cochran
Barry P. Cohn
George Herbert Davis*
Richard A. Davis Jr.*
Howard W. Day*
Mark J. De Lisle
Stuart L. Dean*
Jean-Michel Dercourt*
Thomas A. Dumper
Michael A. Dungan
Steven I. Dutch
David E. Eby
Lloyd N. Edwards
Richard W. Ely
J. Mark Erickson*
Robert H. Fakundiny*
P. Geoffrey Feiss*
Leon R. Follmer*
Eric R. Force*
O.L. Franke
Göran Fredrikson
Virgil A. Frizzell Jr.*
George D. Gardner
Roger Lee Gilbertson
Arthur R. Green*
John H. Grimes
Donald W. Groff
George R. Hallberg*
Susan D. Halsey*
Russell S. Harmon*
Donald A. Hartman
Charles T. Helfrich
Richard Hereford*
Michel Hermelin*
Reinhard Hesse*
A. M. Hopgood*
Michael J. Hozik
Peter J. Hudleston*
O. Frank Huffman
Graham Hunt
William C. Johnson*
Daniel E. Karig*
E.A. Keller*
Wayne R. Kemp
Dennis Kent*
Kim Donald Klitgord*
Jan Krason
Madhurendu B. Kumar
Dale S. Kunitomi
Les J. LaFountain
Garland C. Lamb
Steven J. Lambert*
Abraham Lerman*
Gerald R. Licari
William J. Ludwig*
David N. Lumsden*
David L. Mari
Richard F. Marvin
Allen F. Mattis*
George R. McCormick III*
Robert T. Misen
Peter J. Modreski
John H. Mossler
Paul A. Mueller*
Kent C. Nielsen*
Dennis L. Nielson*
James A. Nowacki*
Ervin G. Otvos*
Howard Parish
Eugene F. Pearson*
William A. Pirkle
David P. Price
John M. Proffett*
Loren A. Raymond*
William D. Rebuck
Scott C. Reeve
Dallas D. Rhodes*
Martin E. Ross
Joseph F. Ruzicka
Charles K. Scharnberger*
Judith A. Schiebout
David Schleicher*
Frank W. Schwartz*
John G. Sclater*
William E. Scott*
Barun K. Sen Gupta*
Gerald I. Shiller
John F. Slack*
Roger S.U. Smith
Henry R. Spall*
David B. Stearns Jr.
Howard L. Stensrud
Robert J. Stull
Lee J. Suttner*
Anthony J. Tankard*
John Z. Tomich
C. Brian Trask
Brian E. Tucholke*
James F. Tull*
David T. Vaniman*
William W. Vernon
G.D. Webster*
Robert L. Wesson*
David S. Westerman
Peter W. Whaley
Russell L. Wheeler
Karen R. Whiteley
Jeff Williams*
Joseph L. Wooden*

# 25-Year Member Anniversaries

GSA salutes the following members and Fellows on their 25-year membership anniversaries. We appreciate their dedication and loyalty to GSA. Asterisks (*) indicate GSA Fellows.

Geoffrey A. Abers*
Mark J. Abolins
Thierry Adatte
Stephen T. Allard
Douglas C. Allen
Joseph E. Andrew
Emmanuelle Arnaud
Jonathan D. Arthur*
Greg Balco*
Clinton I. Barineau
Laurence R. Becker
Mark D. Behn
Chaim Benjamini
Gail K. Bennington
Callan X. Bentley*
Prajukti Bhattacharyya
Ilya N. Bindeman
Marianne Binkin
Michael Bizimis
Dawnika L. Blatter
Katherine L. Blow
Maeve A. Boland
Polly A. Bouker
John R. Bowman*
Mark Elliott Brandriss
Brendan R. Bream
Tom H. Brikowski
Thomas Mark Brocher*
John H. Burris
Sergio Chávez-Pérez
Constance M. Christensen
Eric H. Christiansen*
Donald L. Clark
Robert W. Clayton
Edward B. Coalson
David W. Cobrain
Geoffrey C. Collins
Curtis A. Consolvo
Joseph E. Cotten Jr.
Stephen F. Cox
Janet Wert Crampton
Suanna Selby Crowley
Anna M. Cruse
Dyanna M. Czeck
Carina Dalton-Sorrell
Gregg R. Davidson
Michael R. Davis
Marc A.O. De Batist
William R. Doar III
Daniel H. Doctor
Nelia W. Dunbar*
Laurie Schuur Duncan
David K. Eastwood
W Crawford Elliott*
Geoffrey S. Ellis
John Encarnacion
Annette Summers Engel*
Martha Cary (Missy) Eppes*
Kenneth A. Farley*
Robert A. Farrar
John S. Fedorowich
Luca Ferrari*
Eric J. Fielding
Jim Fleming
John R. Foster
Mark R. Frank
Andrew Bentley Freed
Kurt C. Friehauf
Todd G. Fritch
Duane G. Froese
Stan J. Galicki
Marshall W. Gannett
Scott D. Giorgis
Edwin Gnos
Cory J. Godwin
Craig N. Goodwin
Carrie L. Gordon
Rob M.A. Govers*
Gregory Graham
Bryan Grigsby
Christodoulos H. Hadjigeorgiou
Michael A. Hamilton
Thomas C. Hanks
Judson W. Harvey*
M. Jim Hendry*
Michael W. Hernandez
Melody R. Holm
Feng Sheng Hu
Marzena M. Jaminski
Kimberly M. Janson
Jiu J. Jiao*
Bev J. Johnson
John W. Johnston
Bradley L. Jolliff
Katie KellerLynn
Nancy June Ketrenos
Lifetime Kilner
Gerald L. Kirkpatrick
Andre C. Klein
Lori M. Kloesel
Elizabeth P. Knapp
Kurt O. Konhauser
Phivos C. Kyprianou
Jade Star Lackey
Rebecca A. Lange
Lawrence A. Lawver*
Amy Leventer
Norman S. Levine*
Julie C. Libarkin*
Chul Lim
Deborah Anne Luchsinger
Ian P. Madin
Monte Marshall
Carrie M. Martin
Daniel H. McCrumb
R.M. McFarlane
Larry D. McKay*
Margaret E. McMillan
Luis G. Menendez
Susan Mills
Charles E. Mitchell*
Danielle Montague-Judd
John L. Muntean
Jerel G. Nelson
Lars G. Nelson
Linda P. Nicks
Daria L. Nikitina
Hiroshi Nishi
Douglas H. Oliver
Eric W. Peterson*
Sarah E. Pfeiffer
Stephanie Phippen
Michael Polenz
Chris J. Poulsen*
Rene M. Price
David W. Ramsey
R. Ragnar Rasmussen
Robert Stephen Regis
James S. Reichard
Minghua Ren
Amy Larson Rhodes
Richard D. Ricketts
Luca L. Rigo de Righi
Bruce E. Robertson
Delores M. Robinson*
Antonio B. Rodriguez
Prem K. Saint
Randall J. Schaetzl*
Geary Michael Schindel*
Esther K. Schmaedicke
Carrie E. Schweitzer*
James S. Scoates
Douglas L. Shrake
Barry L. Sidwell
Daniel A. Stephen
Charles E. Stoner IV
Margaret M. Streepey Smith
Ben E. Surpless
Neil J. Tabor*
Thomas A. Taylor
W. Lansing Taylor
Berry H. Tew Jr.*
Douglas M. Thompson*
Stephen C. Thompson
Bradley W.C. Thurber
Daniel R. Tormey
Mark John Triebold
Gregory E. Tucker
Ana L. Unruh
Michael A. Urban
John J. Vander Veer
Manuel Antonio Víquez
Karen M. Viskupic
Dave W. Waters
John J. Watkins
James S. Watson
Arlo Brandon Weil*
Gary S. Weissmann
Raelyn E. Welch
Paul Wessel*
William M. Whiting III
Dean G. Wilder
David Bruce Williamson
Stephen R. Worthington*
Melinda C. Wright
Michael E. Wysession
Jiun-Yee Yen
Christopher Zeliznak

# 2021 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 existing GSA Fellows in recognition of their distinguished contributions to the geosciences. Learn more at **https://www.geosociety.org/fellowship.** GSA's newly elected Fellows will be recognized at GSA Connects 2021. We invite you to read some of what their nominators had to say:

**Timothy Bechtel** (Franklin & Marshall College): Elected to Fellowship as the 2020 recipient of the GSA Public Service Award.

**Gale C. Blackmer** (Pennsylvania State Geological Survey): Dr. Gale C. Blackmer is nominated for GSA Fellow primarily for her activities as the twelfth state geologist of Pennsylvania: management of staff and resources, oversight of projects, relationships with stakeholders, and perhaps most importantly attention to the Pennsylvania Geological Survey's regard and status as a bureau in state government. —Helen Delano

**Maeve A. Boland** (Univ. College Dublin): Maeve has had wide-ranging impact, from geoscience organizations to the U.S. government. She has provided guidance within and across these groups, and used her platforms to promote awareness of policy issues within the broader geoscience community, as well as helping shape our evolving conversation about ethical behavior. —Rónadh Cox

**Stephen K. Boss** (Univ. of Arkansas): Boss spearheads and serves as a tireless advocate for broadening participation within the geosciences. He is instrumental in the Geological Society of America's efforts to increase the diversity within our profession and facilitate the inclusion of underrepresented groups. —Renee Clary

**Jason P. Briner** (Univ. at Buffalo–SUNY): We recognize Jason Briner's research, including the synergistic merging of benchmark geological records and modeling to provide frameworks for, and test, hypotheses regarding past glacier and ice sheet sensitivity, which informs present understanding. Also, for mentoring, and deepening our understanding of geomorphology, paleoglaciology, and paleoenvironments in the Arctic system. —Michael Kaplan

**Debra Buczkowski** (Johns Hopkins Univ. Applied Physics Laboratory): I am writing this letter to nominate Dr. Debra L. Buczkowski for Fellow of the Geological Society of America; she has demonstrated an excellent track record in planetary geology. She meets all the criteria for nomination, by her strong publication and winning proposal record, and her continuous service. —Robert Anderson

**Natalie Bursztyn** (Univ. of Montana): Natalie Bursztyn is an exemplary geoscience educator devoted to using cutting-edge technology and field experiences to increase undergraduate students' access to the geosciences. Her service to the GSA Geoscience Education Division strengthened the Division and GSA's position as a professional home for high-quality geoscience education. —Nicole LaDue

**Victor E. Camp** (San Diego State Univ.): Vic Camp is a distinguished teacher-scholar responsible for a series of deeply influential field-based publications on crustal evolution and Cenozoic magmatism in the Pacific Northwest and Middle East over the past four decades, as well as an exemplary record of teaching and student mentoring. —David Kimbrough

**Rosemary C. Capo** (Univ. of Pittsburgh): Recognized for her high-impact, creative, and technically demanding research applying solute and isotope chemistry to fundamental and applied problems in geosciences; selfless and successful mentoring of geoscience students and junior faculty; and skilled and dedicated leadership in professional organizations. —Jennifer McIntosh

**Eric C. Carson** (Wisconsin Geological and Natural History Survey): Eric Carson is a very successful and well-regarded geomorphologist and Quaternary geologist. In particular, he has, and is, making substantial contributions to our knowledge of geomorphic processes in the Uinta Mountains in Utah and the Driftless Area of Wisconsin through his publications, many GSA presentations, and public outreach. —David M. Mickelson

**John A. Chermak** (Virginia Tech.): For his outstanding training of geologists at Virginia Tech, his applied research on environmental issues related to mining in the U.S. and abroad, and his contributions to GSA within the Geology and Society Division and Geology and Public Policy Committee. —Madeline Schreiber

*"A tireless advocate for broadening participation within the geosciences."*

**Jeffrey A. Coe** (U.S. Geological Survey): For sustained and comprehensive applied research, leadership, and civil service related to a wide range of geological processes and problems, including landslide and debris-flow initiation, mobility, frequency, and magnitude, paleoseismology, geochronology, and structural geology. Jeff is a mentor and inspiration to a great number of scientists in the U.S. and abroad. —Dennis Staley

**J.V. Degraff** (Michigan Technological Univ.): Elected to Fellowship as the 2020 recipient of the E.B. Burwell, Jr., Award.

**Carlota Escutia** (Spanish Research Council): Elected to Fellowship as a 2020 Honorary Fellow.

**David A. Ferrill** (Southwest Research Institute): Dr. David A. Ferrill is nominated for GSA Fellow in recognition of his outstanding research contributions in structural geology focused on understanding deformation processes and their consequences. His extensive publication record is based on international applied

geological research spanning hydrocarbon exploration, groundwater resources, natural hazard assessment, and planetary research applications.—Ronald Green

**Dru J. Germanoski** (Lafayette College): Dru Germanoski is being nominated for GSA Fellowship based on three decades of distinguished and award-recognized training of geologists, his two decades of selfless administrative leadership of academic geological programs, his high impact, transformative scholarship on alluvial channels, and service to the Society. —Frank Pazzaglia

**Laura Giambiagi** (CONICET): Elected to Fellowship as a 2020 Honorary Fellow.

*"A national leader of the geosciences."*

**Mickey E. Gunter** (Univ. of Idaho): Over his long career, Mickey Gunter has been a leading educator, advisor, and book author; led seminal research in the field of optical mineralogy; contributed to public health through his work with asbestos minerals; and served our profession as conference organizer, journal editor, and organizational leader. —M. Dyar

**James A. Heller** (Alabama Dept. of Environmental Management): James Heller is a leader promoting the value of professional geologist licensure through preparatory workshops, Alabama's Board of Licensure, at ASBOG®, and through GSA. His strong GSA service includes the Geology and Public Policy Committee, Geology and Society Division board, advisory and award committees, topical sessions, and hosting guest lecturers. —Susan Stover

**José M. Hurtado Jr.** (The Univ. of Texas El Paso): José Hurtado is an exceptional trainer of geoscientists, not only as a university professor but also as a trainer of astronauts and NASA personnel as well as outreach activities promoting diversity in the geosciences. He has mentored many students at all levels, including many from underrepresented groups. —Terry Pavlis

**John M. Jaeger** (Univ. of Florida): Dr. Jaeger is an exceptional member of the Marine and Coastal Geoscience Division of GSA who is known for quantitative studies of sedimentary processes from source to sink. His contributions illuminate the role of the cryosphere in sedimentary systems. He is a gifted teacher, mentor, and international leader in scientific drilling. —Sean Gulick

**Tamie Joy Jovanelly:** For her applied research in the fields of water quality, water resources, and environmental hydrology in locations around the globe, and her dedication to undergraduate geology education stressing extensive mentoring, active classrooms, field experiences, and research opportunities. —Laurie Brown

**Ian P. Madin** (Oregon Dept. of Geology & Minerals): Ian Madin is one of the best geologists in the state of Oregon. He has been the main geologist at our state geological survey for over 25 years. He is a specialist here in geological hazards and communication of them to the public. He helps the public and professionals alike! —Scott Burns

**MaryAnn Love Malinconico** (Lafayette College): Dr. MaryAnn Malinconico is nominated for having an outstanding 30+ year record of serving the Geological Society of America in a leadership capacity, being a compelling advocate to promote geosciences, and a contributor to the understanding of Appalachian tectonics and sedimentary basin evolution. —Nazrul Khandaker

**Lindsay J. McHenry** (Univ. of Wisconsin–Milwaukee): Lindsay J. McHenry is a tephrostratigrapher, geoarchaeologist, volcanologist, and planetary geologist who fingerprints highly altered volcanic ash beds at important paleoanthropological sites in Tanzania to establish high-resolution stratigraphic frameworks and characterizes hydrothermally or saline-alkaline fluid-altered volcanic materials to aid in understanding the evolution of the martian surface. —John Isbel

**Jeffrey M. McKenzie** (McGill Univ.): Professor Jeffrey McKenzie is a highly productive and accomplished Earth scientist and a long-time, committed member of the Geological Society of America. His diverse contributions include innovations and leadership in Arctic groundwater research, tirelessly advocacy for the Earth sciences, and training of the next generation of hydrogeologists. —Galen Halverson

**Abhijit Mukherjee** (Indian Institute of Technology): Abhijit Mukherjee has distinguished himself through publication of results of geologic research and applied research. Through field, laboratory, and numerical studies, he has made substantive contributions to understanding geogenic arsenic globally and groundwater resources in the Indian subcontinent, which have practical implications for the health and well-being of millions. —Alan Fryar

**Julie Newman** (Texas A&M Univ.): Julie Newman is a uniquely capable observer and interpreter of microstructures in naturally and experimentally deformed rocks and has contributed significantly to our understanding of deformation in mantle and crustal rocks. Her work on StraboSpot, the digital data system to organize and share structural data, illustrates some of her community service. —Basil Tikoff

**Jeffrey Oslund** (Tirohanga Energy): Jeff Oslund is vice-chair of the GSA Foundation Board of Trustees. He was co-chair of the successful GSA Campaign for the Future and now leads the new Lowell Program for field camp scholarships. His tireless endeavors for students, professionals, and the Society demonstrate his worthiness of being a GSA Fellow. —Wes Ward

*"A mentor and inspiration to a great number of scientists in the U.S. and abroad."*

**Joel L. Pederson** (Utah State Univ.): Joel Pederson has been nominated for his outstanding contributions to student training, geoscience education and outreach, and program administration through excellence in teaching, development of innovative programs, procedures, and assessment, and development of educational materials. —Sarah Sheffield

**Shanan E. Peters** (Univ. of Wisconsin–Madison): The record of biological evolution and the processes that shaped our planet are preserved in sedimentary rocks. Dr. Peters is a paleobiologist and sedimentary geologist who engages with computational approaches to vast data sets, uniquely positioning him to show how Earth is a product of geologic processes and events. —Judith Parrish

**Michael Patrick Poland** (U.S. Geological Survey): Michael P. Poland is recognized for his outstanding leadership, research, outreach, and mentoring contributions that have resulted in increased public safety and awareness to volcano hazards. —Shaul Hurwitz

**Peir K. Pufahl** (Queen Geological Sciences): Professor Peir Pufahl is an internationally recognized expert on the deposition and diagenesis of bioelemental sediments, including cherts, phosphates, and ironstones. He has researched and published on Precambrian to modern deposits globally. A renowned thinker, teacher, mentor, and journal editor, he is sought after by industry and research funding agencies. —Noel James

**Jay Pulliam** (Baylor Univ.): Dr. Pulliam has been a leader of training geologists and non-geologists in field and theoretical seismology. His work has used seismology to solve geological problems involving the crust and mantle in North American and the Caribbean regions. —Kevin Mickus

**Frank C. Ramos** (New Mexico State Univ.): Dr. Frank Ramos is recognized for his contributions to novel sample preparation and mass spectrometry techniques that have enhanced understanding of the evolution of magmas, for his extraordinary contributions to the training of students and as a positive role model, and for his leadership and service to the geoscience community. —Wendy Bohrson

**Peter D. Roopnarine** (California Academy Sciences): Dr. Roopnarine's scholarship focuses on understanding the evolution of ecological systems viewed through the lens of paleontology, deep time, and complex system dynamics. He curates a world-class research museum collection, and is dedicated to public outreach and engagement. Peter is also deeply committed to diversity, equity, and inclusion in geosciences. —David Gillikin

**Michael C. Rygel** (SUNY Potsdam): Mike Rygel was the 2010 Biggs Awardee, an honor recognizing his exemplary work in geoscience education. His public outreach, recruitment of majors, and research mentorship all exemplify the best in our profession. —Callan Bentley

**Mark D. Schmitz** (Boise State Univ.): Mark Schmitz' nomination reflects innovative and widely recognized research in radioisotopic geochronology. His work has advanced the fundamental systematics of U-Pb dating and its application to myriad geologic phenomena, including calibration of the most widely used geologic time scale. Moreover, Mark is an effective advocate and teacher of geochronology. —Brad Singer

**Paul A. Schroeder** (Univ. of Georgia): Paul Schroeder's contributions include outstanding research and publication on clay minerals and more generally nanoparticles in the critical zone, sustained and admirable administration of the department of geology of the Univ. of Georgia, spectacular efforts in teaching, extensive outreach to the public at all levels, and organization of scholarly meetings. —L. Railsback

**Richard A. Schweickert** (Univ. of Nevada–Reno): Professor Emeritus Richard A. Schweickert is an excellent scholar and field geologist who has also provided significant service to the profession and the educational endeavor. His grandest achievement has been synthesis of the complex Mesozoic history of the Sierra Nevada of California and Nevada. —Raymond Ingersoll

*"A renowned thinker, teacher, mentor, and journal editor."*

**Michael S. Smith** (Univ. of North Carolina): In three decades of teaching, Michael instructed, advised, and mentored hundreds of undergraduate and graduate students in subjects ranging from physical and historical geology to petrology and paleontology. Even in "retirement," Michael continues to be active in the geoscience community through service to GSA and consulting. —David Spears

**Christopher Spencer** (Queen's Univ.): Elected to Fellowship as the 2020 recipient of the Young Scientist (Donath Medal) Award.

**Greg M. Stock** (Yosemite National Park): Dr. Greg M. Stock serves as park geologist for Yosemite National Park. He has dozens of publications on rockfalls and Quaternary glaciation of Yosemite Valley. Dr. Stock has served as an external committee member for 10 master's and five Ph.D. geology students. He has extensive internal service to GSA as an associate editor and reviewer. —Robert Sydnor

**Deborah J. Thomas** (Texas A&M Univ.): Debbie Thomas has enjoyed a distinguished career as a scientist, profoundly contributing to our understanding of past ocean and atmospheric circulation. Her passion, talent, and drive with respect to the administration of geological programs has led to becoming a national leader of the geosciences as dean at Texas A&M. —Franco Marcantonio

**Jolante W. van Wijk** (New Mexico Tech): For sustained contributions to advancing understanding of the continental lithosphere and the processes shaping continental and oceanic rifts, and for selfless contributions to community geodynamic computing infrastructure and to public science education. —Dennis Harry

**Bridget Wade** (Univ. College London): Bridget Wade is being nominated for GSA Fellow for her exceptional and sustained contributions to Cenozoic micropaleontology and biochronology. Wade's research on the taxonomy, calibration of bioevents and geochemical signatures of planktonic foraminifera has advanced our knowledge of biotic response and paleoceanographic change. —Kevin Pickering

**Timothy S. White** (Penn State): Nominated for extensive and ongoing research contributions in sedimentary geology through the application of the tools of isotope geochemistry, organic petrology, sequence stratigraphy, palynology, and geologic

mapping, as well as for significant support to the study of critical zone processes. —Ira Sasowsky

**Greg C. Wiles** (College of Wooster): Professor Greg Wiles is a prominent dendrochronologist and geomorphologist with many significant contributions to climate-change research. He is also an inspiring teacher who has recruited many students into the Earth sciences. He is an effective mentor with large numbers of undergraduate students who author publications and enter graduate school. —Mark Wilson

**Crayton J. Yapp** (Southern Methodist Univ.): Crayton Yapp is being nominated for his fundamental research contributions to stable isotope geochemistry in low-temperature systems as diverse as land snail shells, modern and fossil plant cellulose, and iron oxy-hydroxides. Dr. Yapp also has contributed substantially to the growth and development of an entire generation of stable isotope geochemists. —Neil Tabor

**Shihong Zhang** (China Univ. of Geoscience): Dr. Shihong Zhang's outstanding contributions to paleogeographic reconstruction improve our understanding of the position of North and South China in supercontinents Nuna and Rodina. His studies on cyclostratigraphy help refine the time scale of critical geological events in Earth history. —Ganqing Jiang

# Welcome New GSA Members

The following new members joined between 15 Sept. 2020–23 Feb. 2021 and were approved by GSA Council at its spring meeting.

## PROFESSIONALS

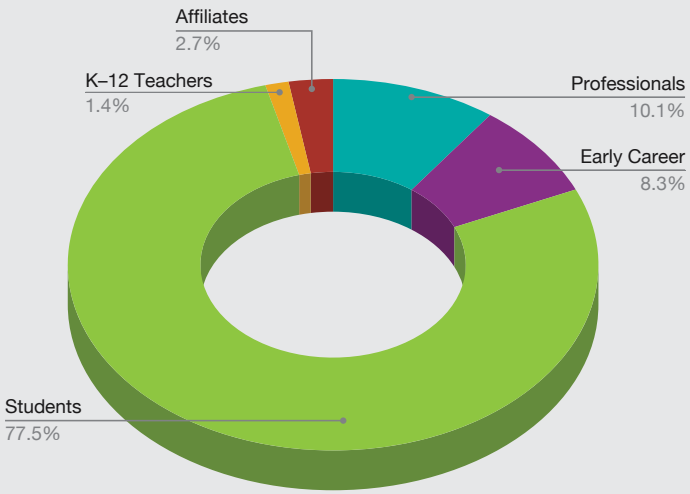
Linda Abriola
Mohammed Abubakar
Lancie Affonso
Ahmet Akoglua
Montaha Alammar
Jason Albert
Justy Alicea
Luis Anchondo
Robin Anthony
Alexander Arita
Ayse Atakul Ozdemir
Nuha Bakheet
Sara Baldwin
Matt Balme
Patrick Barnes
Melony Barrett
Bennett Bearden
Saïd Belkacim
Gino Bianchi-Mosquera
Chris Bonds
Andrew Bonilla
Matthew Brain
Alfredo Camacho
Heather Campbell
Elena Centeno-Garcia
Corrie Chamberlain
Nolwenn Coint
Terri Cook
Wendy Crane
Rolando Cruzado
Paul Cutlip
Silas Dada
Sarah Dare
Gregory Dick
Peter Dillon
Sarah Doliber
Wendy Drummond
Manuel Duguet
Dennis Earl
Amy Edwards
Madeline Every
Karl Fabian
Dawei Fan
Malvin Felix
Anjali Fernandes
Andrew Frederiksen
Mark Frey
Mohammed Gad
Alan Galley
Michael Gardner
Sandra Garzon
Jun Ge
William Godwin
Kathryn Goesssel
Karen Goldenberg
Danna Gomez
Raul Gonzalez
Amanda Griffith
Juliane Gross
Santa Guerrero Bonnett
Zhilin Guo
Snæbjörn Guðmundsson
Beth Halfkenny
Jared Hamela
Colleen Hansel
Dan Harman
Kristine Harper
Russell Harrel
Brock Harris
Nicholas Hastings
Daniel Haug
Scott Hauswirth
David Heerschap
Amy Henrici
William Herbst
Emilio Herrero-Bervera
Bryson Hinkins
Mai Hirano
John Hooker
Mong-han Huang
Alessandro Ielpi
Kristin Irish
Aigbedion Isaac
Batsukh Jargalsaikhan
Ambrose Jearld
Chan-Duck Jeong
Scott Johnson
David Jones
Gregory Jones
Ronald Jones
Alan Kafka
Zachary Kaplan
Megan Kelly
Gerry Kilfoil
John Knox
Eric Koenig
Szilamér Kovács
Prakash Kumar
Paul Lambert
Hershel Lanier
Paul Lawrence
Rene Lefebvre
Chris Lepre
John Lopez
Russ Lotspeich
David Lowe
Allison Luengen
Robert Mace
Marc Macias-Fauria
Daniel Mann
Filippo Mantovani
Kate March
Cericia Martinez
Veronica McCann
Deanna McCay
Karen McNeal
Steve Metzger
D'arcy Meyer-Dombard
Matt Miller
Fatin Minhat
Daisuke Miura
Loago Molwalefhe
Laurindo Muginga
Aldiyar Mukhatzhanov
Robert Najewicz
Gonzalo Zambrano Narvaez
Clark Niewendorp
Guangrong Ning
Tank Ojha
Mark Olson
Douglas Parker
Vivi Pedersen
Felix Perriello
Jacob Peterson
Katharina Pfaff
Brian Phillips
Michael Polkinghorn
Fred Portofe
Christopher Prince
Christopher Reed
Richard Robertson
Stephanie Rogers
Rodrigo Rojas-Arancibia
Eric Rosa
John Ryan
Hamish Sandeman
Spruce Schoenemann
Rudy Schuster
Tomieka Searcy
Sanjeev Sharma
Dylan Shoemaker
Bill Short
Karin Sigloch
Lauren Simkins
Moses Sinclaire
Jessica Slagter-Enaohwo
Valerie Sloan
Cornelia Spiegel
Jeannine-Marie St-Jacques
Kimberlee Stevens
Yelena Stroiteleva
Michael Sweet
Gary Tackman
Debojit Talukdar
Xuan Tang
Julie Therrien
Mark Thompson
Christina Tipp
Amy Tizzard
Michael Trippi
Leah Turner
Renee Veresh
Peter Ward
Steve Warren
Warren Watkins
Laura Wehrmann
Thomas Weiskopf
Edward Wellman
Florian Wellmann
Donald Welsh
Elijah White
Aaron Wieting
Sam Woodland
Mark Woodruff
Allison Woolsey
Thoti Yellappa
Sarah Yuhas Kirn
Ibsa Yusuf
Feifei Zhang

## EARLY CAREER PROFESSIONALS

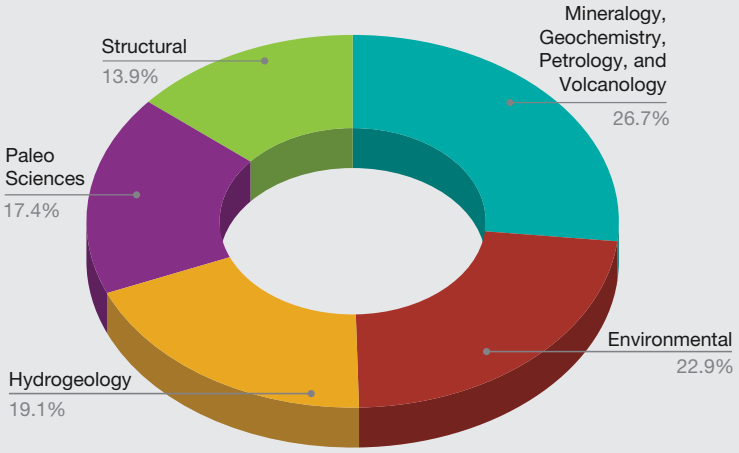
Ayombo Victor Adekanle
Joshua Ahmed
Odiney Alvarez-Campos
Erica Ashe
Margaret Avery
Rami Ali Bakhsh
Quinn P. Barnhart
Jesse Bausell
Flavien Beaud
Noah Beck
Pierre Bedeaux
John William Bednarek
Rehemat Bhatia
Kayla Lynn Bicknell
Dylan T. Blaum
Emerson Higgins Blotz
Colby Boutte
Samantha Bova
Alodie Bubeck

Giselle Andrea Burrell
Brice Phillip Callahan
Thomas Caron
Ethan Cerasani
Yunfeng Chen
Lexi A. Christensen
Craig Thomas Connolly
Jessica Cook Hale
Alissa H. Cox
Peter W. Crockford
Vincent Crombez
Andrew J. Cross
Connor Dacey
Souvik Das
Jenna N. Davis
Thomas Didonato
Kennedy Doro
Loren V. Eggenschwiler
Eric Minani Elias
Mojtaba Fakhraee
Amanda Lynn Feltz
Paula Figueiredo
Ben Frieman
Morgan Gabor
Benjamin Vitaliano Gaglioti
Alexander Gagnon
Bianca Gallina
Kyle Gawinski
Dominique Genna
Austin Gholson
Francesco Giuntoli
Jessica Guillotte
Christa Haney
Nathan Hatch
Jon R. Hawkings
Tyler Hayduk
Lisa Herbert
Wei-li Hong
Emily Hou
Katherine Hunt
Kyle Hideaki Ikeda
Mohd Yusuf Jameel
Scott Jess
Jonathan Kabiito
Alireza Kavousi
Eric D. Kees
Murtaza Khan
Kelsey Kirkland
Andrew Knapp
Anika Knight
Vera A. Korasidis
Emma Krolczyk
Youngsang Kwon
Maxwell Lechte
Andrew Leslie
Charlotte R. Levy
Qiuyi Li
Janne Liebmann
Natalia Malina
Stephen James Marotta
Erin Lee Martin
Tyler Matthews
Steven R. McDonnell
Akshay Mehra
Amelia Embeth Midgley
Zoe Keiki Mildon
Aric Howard Mine
Jasper Miura
Rehab Masoud
Kellen George Mollohan
Lilia Montoya
Michael L. Nguyen
Brittany Nulph
Olabanji Adeolu Ojo
Alexander Orkhonselenge
Logan Allen Owen
Andrea Joy Pain
Chelsea Pedederson
Joel Podgorski
Diego Pons
Colleen Proctor
Owolabi Rasaq Rahman
Gizeh Rangel-de Lazaro
Ashraf Rateb
Morgan Reeves
Sandor Ricketts
Gabriella Rodriguez
Nathan J. Rodriguez
Kristyn Rodzinyak
Taehyun Roh
Carla R. Romano
Chelsie Romulo
Ashley Rudy
Janelle Renae Ruth
Prafulla Kumar Sahoo
Catalina Sanchez Roa
Cody Robert Schmidt
John Schwally
Aaron Seals
Enrique Sedas
Andrew G. Simpson
Eileah Sims
Silvina Slagter
Matthew Smith
Morgan Snyder
Sergey Solonin
Lauren D. Somers
Patricia Spellman
John Stangel
Andre Steenken
Jennifer M. Stepina
Jeremy Stock
Gaia Stucky de Quay
Fnu Suriamin
Ze Tao
Valentina Taranovic
Laurel Teague
Ryan Tengelsen
Kira Tomenchok
Jordan Renea Toney
Fiorenza Torricella
Meredith Townsend
Lorraine Tual
Sasha Wagner
Tristan Walker
Huilin Wang
Cecilia White
Dhanuska Wijesinghe
Carrie Williams
Tim Williams
Levi E. Windingstad
Mckenzie Woodman
Vashan Wright
Bo Yang
Shengyu Yang IV
Alexander Yard
Zhiming Zhang
Laura Alice Zinke

## NEW MEMBERS BY MEMBER TYPE




## TOP PROFESSIONAL INTERESTS OF NEW STUDENT MEMBERS



## STUDENTS

(Listed by Professional Interest)

**Archaeological Geology**
Jade Morgan Benson
Sydney Ann Clayton
Jeffrey Daniel DeMario
Emily Elizabeth Doyle
Julien Favreau
Emma Caroline Literski
Félix Marois
Abigale Nicole Maxey
Benjamin Pavlic
Evan Alton Rouse
Lara Mercedes Sanchez-Morales
Mattison Ryan Shreero
Alden Thompson Vought
Thomas Zych

**Biogeosciences**
Olawale Oluwafemi Alo
Noah Anderson
Nerissa Barling
Katherine Bober
Beth Bouchard
Gordon Hall Bowman
Victoria Cassady
Lena Champlin
Mackenzie Renae Eskey
Julia Fearon
Camden Miller Hatley
Evan Hill
Sawyer Griffin Hilt
Lilly Hinkle
Yi Hou
Cecilia Howard
Katie Marie Jamson
Jingjun Liu
Esteban David Lopez-Murillo
Judy Malas
Kimberley Marshall-Mills
Madeleine Mathews
Sean McCollum
Madeleine Meadows-McDonnell
Ziqin Ni
Christine Nims
Jose Santiago Ocana
Sydney Riemer
Ichiko Sugiyama
Jaclyn Torkelson
Anna Catherine Vietmeier
Leeza Wells
Stephanie Wilson

**Climatology/Meteorology**
Paola Araya-Salgado
Hannah Baker
Julian Baw
Lena Campisi
Savannah Anne Collins-Key
Tracy Donelli
Kate Doubleday
Elizabeth Lauren Driscoll
Michelle Elizabeth Frazer
Catherine Anne Gagnon
Kathrine Izzo
Jonathan Kane
Nicholas Edward Kelly
Colby Knight
Leah Marshall
Ellen Mutter
Joseph Novak
Gemma O'Connor
Joseph Oleski
Alexia Breanna Reyes
Erika Ap Schreiber
Rohini Shivamoggi
Mary Katherine Sorensen
Megan Sutcliffe
Caitlin M. Walker
Francis Zurek

**Economic Geology**
Shelby Austin-Fafard
Dallan Beaudin
Alexandre Beaudry
Colton W. Bell
Luke Bickerton
Connor James Caglioti
Justin Casaus
Joseph Caleb Chappell
Ethan Joseph Depew
Bradley Earl
Alexander Henry Ficken
Alejandro Gaitan
Breanda Gomez
Latia Hocker
Diego Jaime Rodríguez
William Rexton Jarvis
Jose Jonathan Jimenez
Benjamin A. Jones
Alan Matthew Ketring
Taylor Jacob Ledoux
Well-shen Lee
Neal Mankins
Jeremy Raymond Nederbo
Renata Augusta Sampaio Paes
Carlos Zulueta Rafael
Gustavo Adolfo Ramirez
Carl Robert Ravenscroft
Kyle Thomas Rehmeier
John Rewis
Elyssa Rivera
Ilyhanee Robles
Cody D. Schwenk
Hoon Seo
Sarah R. Shapley
Owen Ford Smith
Stanley Dawson Stone
Asti Sulastri
Marko Szmihelsky
Taylor Dawn Wasuita
Jed Stanton Wilson
Kayla Young
Jarred Zimmerman

**Energy Geology**
Olatayo Sunday Abimbola
Ashley Aguilar
Christopher J. Alexis Jr.
Yesenia Arroyo
Justin Bierwagen
Brendan Bishop
Dean Cobianchi
Brady J. Derick
Benjamin Thomas Doggett
Christiana Fumnanya Eziashi
Autumn Graf
Leon E. Hibbard
Aoqi Jia
Xinyang Jiang
Philip King
Lars Koehn
Christine N. Leary
Binyu Ma
Zijie Ma
Thomas Marinucci Jr.
Gustavo A. Martins
Dustin Trevor Morgan
Conner Francis O'Reilly
Enrique Sedas
Jozef E. Szypulski
Haley Thorson
Zach Toews
Chad R. Trammell
Julia Massie Visy
Chenhui Wu
Tao Zhang

**Engineering Geology**
Jacob Barnhart
Jonah Bettger
Ryan Michael Cook
Alexander D. Davis
Quinn James Fredine
Evaristo J. Garcia
David Gilkey
Raymond Hess
Gang Lei
Nicholas Majeske
Airlia Martz
Leta Rane Mccullough
Robin Moloney
Max Morrison
Kaley Nelson
Chad Kawika Neptune
François Noël
Kassidy R. O'Connor
Kaushik Sarker
Natalie Noel Steenken
Gabriella Anna Walsh
Kena Worobec

**Environmental Science**
Philip Adrian
Sakinat Mojisola Ahmad
Jacob Anderson
Peleibaou Ani
Fiona Anstey
David Bernard Baldus
Allison Bandera
Protik Banerjee
Cheyenne V. Bartelt
Kennedy Beasley-Watson
Aidan Becker
Rae Nicole Belhumeur
Avni Sukhdai Bhalla
Madeleine Bitting
Adriana Brown
Hunter Bruhn
Brianna P. Burger
Rebecca Ann Burkhart
Rylynn Hokulea Carney
Elizabeth Clark
Emily Alyson Cocke
Clare K. Considine
Cara Elizabeth Cywinski
Sydney Melody Dale
Luis Carlos Azevedo Dasilveira
Virginia Davidson
Gordon Michael Davies
Gary Davis
Kristi Dobra
Jaydee A. Edwards
Ryan Ferree
Meghan Forbes
Sarah Fuller
Corrinne Gauntt
Lauren Graham
Sara Graham
Bridget Hall
Mckenzie Hamilton
Caitlyn Herron
Mo Holley
Madison Savanah Huelskamp
Robert F. Ibey
Alexandra Marie Jahn
Kelly Anne James
Mallory Ann Jordan
Andy P. Kasun
Jaclyn Genevieve Kreeger
Dodge Krick
Aaron Kurz
Megan Lapinsky
Melaney Lara

Isabelle Law
Camille C. Lederer
Jenelle Marie Leib
Giles Thomas Waldman Lemmon
Siyu Mao
Nicole Lee Messerlian
Ara C. Metz
Ellie Margaret Miller
Hannah R. Miller
Reginald Minor
Zoey Mondshine
Taylor Murphy
Shakarah S. Nelson
Sameer Neve
Kayla Elaine Newman
Jocelyne Nolasco
Fiona Noonan
Katelyn O'Dell
Kaj Alexander Overturf
Hannah Partridge
Jessica Pasi
Cameron Austin Peterson
AiLi Pigott
Oren Rabinovich
Rumya Ravi
Steven Parker Rehmus
Riley K. Richardson
Lindsey Catherine Riikola
Robert A. Rioux IV
Michael Roberts
Tyler Anakin Roberts
Katalina Salas
Hailey Sauer
Jay T. Simonds
Myles N. Sornborger
Justin Spencer
Alexis Stansfield
Emily Kathleen Stashak
Christopher Stiles
Emma R. Strong
Eric Young Suh
Bridget Susman
Allison Swartz
Diana Alejandrina Taj
Sharissa Thompson
Adrian Torti-Feener
Kaitlyn Marie Truss
Annemarie Underwood
Alexandra Valencia
Nolan Cary Vlahovich
Morganne Vogel
Alex Khawaja Waheed
Alec Wallen
Chloe Walsh
Alexis Warren
Izzy Werness
Eva Wetzel
Connor Wichterich
Cassandra C. Wiggins
Noah Grinnell Willis
Ilayda Ecem Wilson
Katherine Sue Wojcik
Hannah Wolf
Alex Won
Cyan Woodward
Georgia Wright
Meleine Yao
Elisha Lynn Yellow Thunder
Alice Christine-Nichi Yerby

**Geography**
Caroline Brisbois
Maxwell Carter
Julie Edwards
Roberta Tuurraq Glenn
Rebecca R. Hutton
Muhammad Tariq Khan
Paul Minsker
Antoine Morin
Lucas Mulhall
Carl Nowack
Maia Somers
Erika L. Stocker
Kevin Lewis Wright

**Geoinformatics**
Kristan O. Ellsworth
Megan Hale
Drew Heasman
Moein Izadi
Rui Jiang
Shubham Nandkumar Mahajan
Jill Maureen Mayhew-Ridings
Robert John McJimsey
Gailin L. Pease
Karissa Venezia
Corin Zahn
Jiayan Zhao

**Geology and Health**
Mohammad Tayseer Alfetiani
Anna Sofia Calderon
Sasithorn Chornkrathok
Kevin Daniels
Stephanie Draper-Moore
Matthew Gregory Henson
Charlotte Anne Jannach
Simeon Maglich
Sydney McKim
Dorian V. Miller
Brigit C. Naughton
Emmet D. Norris
Charles A. Schaberg
Angela Trejo
Anais Vazquez
Teresa Vossen
Melanie L. Wright

**Geophysics/Tectonophysics**
Susheel Adusumilli
Marzieh Arshian
Jamie Nicole Asan
Asif Ashraf
Brin Bailey
Carol Vanessa Barrera López
Julia A. Baumgarte
Logan Tanner Bergh
Sonie Brandon
Saida Burns-Moore
Katelyn Marie Carpi
Chiara Chung-Halpern
Elisabeth Clyne
Elizabeth Demers
Efemena Destiny Emmanuel
Celine Fliedner
Graham Gevirtz
Andrew Osten Hoffman
Margaret A. Holahan
Guo Qiong Hua
Holland Jade Ladage
Jialin Li
Jiawei Li
Aryana Mattmann
James Christopher McCaslin
Rebecca Moskal
Akinwale Oluwadamilare Ogunkoya
Shelley J. Peirce
Anusha Prasad
Irfan Raza
Alexus C. Richardson
Valentin Shumakov
Hailey Marie Smith
Brett A. Steck
Bill S. Sweidan
Alina Valop
Andrea Vanne
Jeannette Xiu Wen Wan
Meagan Alyse White
Erik Young

**Geoscience Education**
Jacob Paxton Baker
Allison Bergeron
Shailee Bhattacharya
Evelyn Abagayle Boyd
Jena Brown
Nicola S. Gacy
Logan Eugene Gin
Johana Andrea Barrera González
Heather Angela Gunn
Curtis McMillan Hope Hill
Linqing Huang
Ivy Miranda Jaramillo Durazo
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Pauline Peterson
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Rebecca Lin Richards
Jose Sebastian Gomez Romero
Carissa M. Root
Omadevi Singh
Katherine C. Sorrows
Pamela Tetford
Cameron Kane Weiner

**Geothermal**
Randall Vincent Debes II
Katherine M. Owens

**History/Philosophy of Geology**
Nicolas Kenton Morse

**Hydrogeology/Hydrology**
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Toluwaleke Ajayi
Lindsey Aman
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Diego Aviles
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Devon Gorbey
Hillary Lynn-Anne Johnson

**Marine and Coastal Geosciences**
Shemica Adenwalla
Kelsey Lynn Albert
Carlos Barron
Brandon Blake Bell
Chris Blanco
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Natalia Konstancja Szymanska
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Nathan C. Woodruff

**Mineralogy/Geochemistry/Petrology/Volcanology**
Taryn Adam
Shamsuddin M. Ahmed
Christian James Anderkin
Tiago Valim Angelo
Kiira Antenucci
Brianna M. Arnold
Tyler Richard Ayres
Mary Katherine Bailey
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Brooklyn Boatright
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Shanon J. Brailsford
Lauren Elise Breederland
Maximilian Burnham
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Nils Caliandro
Darcy M. Carrion
Rory Michael Changleng
Zhengqiang Che
Julia Ann Chen
Junxing Chen
Zakiya Chikwendu
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Elodia Ciprian
Banner Cole
Connor Joseph Dalessandro
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Levi J. De Crescenzo
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Blanca Elena Pineda-Valenzuela
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Rayann Rehwinkel
Gray Richardson
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Ekaterina Rojas Kolomiets

Alicia Joy Ruplinger
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Randolph L. Rutledge
Dean M. Sampson
Paolo Sanchez
Émilie Saucier
Erik Jeffery Schoonover
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Gregory Stark
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Heather Winslow
Paige Midori Wise
Emily Wright
Jordan Wright
Ian Van Wynn
Xianghe Xu
Nitzan Yanay
Jannitta Yao
Noah Zaffino
Qin Zhang

**Paleo Sciences**
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Mio Alt
Lian Carmalita Anderson
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Nicole Leanne Barnes
Elliot Julian Blake
Ted Bobik
Brooke Bogan
Destin Bogart
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Kayli Arisa Stowe
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Mai Tran
Natalya Sergeiyevna Usachenko
Saray Valdez Hernandez
Patrick James Verbryke
Alexis Maria Williams
Kevin James Woeste
Clara Kimiko Wong
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Whitney Worrell
Amelia Rose Zietlow

**Planetary/Space Science**
Birat Adhikari
Evelina Alcantara
Erin Alexander
Zachary Allen
Pranto Anandmaya
Trevor Austin
Liz Baron
Benjamin Boatwright
Madison Evelyn Borrelli
William Henderson Brown
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Ilankuzhali Elavarasan
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Chance Sturrup
Andrew Swift
Catherine Lauren Talkington
Zoltan Vaci
Hunter Vannier
Yingchi Yingchi Wang
Luke Whitenburg
Edward Williams
Joshua M. Williams

**Policy/Regulatory**
Sasha Malu Laponsa
Casie Venable

**Quaternary Geology/ Geomorphology**
Tamara Aranguiz
Marina Olivia Argueta
Marie Bergelin
Reyce Bogardus
Matthew Bolton
Jamison Noah Braun
Rachel Breunig
William Charles Buckley II
David Busby
Michael Buyco
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Sarah Dendy
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Christian M. Erikson
Duane Gachne
Colvin Geiman
Adam S. Grodek
Victoria Elizabeth Halvorson
Erich Herzig
Audray Hinkemeyer
Anselm Quan Peter Krause
Christy Li
Callie Little

Christian Lundy
Dean Maraldo
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Patrick Miller
Quinn Miller
Ailish Mills
Ginevra Moore
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Paul Monroe Morgan
Amber Netherton
Matthew Nixon
Christopher Orrison Norcross
Melissa Reusche
Amelia Richardson
Vidhesh Shukla
Vaibhav Singh
Noah Slade
Emma Lee Sullivan
Sullivan C. Swearingen
Robert Matthew Taylor
Anna Weniger
Katelyn Wilcox
Ruqaiya Yousif

**Seismology**
Diego Aedo Ortiz
John Sena Akoto
Kathy Barton
Charlie Carr
Igor Jose Eufrasio de Oliveira
Ashish Kumar
Meng Liu
Charity Ann Mann
Mariana Reyes
Cristhian Paul Salas Pazmiño
Kathryn Waters

**Soil Science**
Brianna Rae Beseler
Chelsea Braz
Abigail Olivia Cook
Fiona Marie Ellsworth
Maddie Holicky
Rachel Mia Huffman
Kaipeng Ji
Luke D. Lawrence
Elaina Maxwell
Luna Natoli
Alyssa Elizabeth Sims
Ji won Suh
Jeffrey Alan Szybist
Cody Brandt Tate
Henry Westly
Chenlei Zhao

**Stratigraphy/Sedimentology**
Heba Allah Mohamed Adel Abou Awad
Faisal Ahmed
Craig Aimone
William Arnuk
Jack Avolio
Alexander Berniche
Sophie Black
Maya Yamei Bradford
Hannah Brommecker
Madeline Jolie Brosky
Ross Campbell
Arijit Chattopadhyay
Constance E. Cooper
Charles Davis
Caitlyn Dempsey
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Peyton J. Fischer
Danielle Fitzgerald
Rachel Caroline Forney
Kristoffer Colton Fowler
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Luke Joseph Gezovich
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J. Wilder Greenman
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Mingxi Hu
Gillian Ivey
Evan Robyn King
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Liam Lauckner
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Matthew Omar Robert Rahamut
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Katarina Savatic
Samuel J. Shekut
Leandro Silva
Jack Andrew Simmons
Marina Seraine Fernandes Souza
Eric Stauffer
Maya Stefanelli
Grace O. Taiwo
Brian Terrell
Katherine Thompson
Angela Torres-Zamora
Geila Volga Uzeda Orellana
Margaret Whelan
Henry Owen Williams
William Wong

**Structural Geology/Tectonics**
Pawan Kumar Acharya
Raquel Maria Aguirre Dardet
Emery Orion Anderson-Merritt
Chris J. Anthonissen
Robert Atnip
Ashlynn Nicole Bolek
Jamie Bowie
Nina Bowness
Claire Brandhorst
Noah Brown
Jordan Davenport Burkey
Talia Nicole Colangelo
Jason Westlee Craig
Kade Damant
Sydney G. Drier
Thibaut Ducat
Andrew Dunning
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Virginia Eleanor Ferry
Judith Gauriau
Kaitlyn Gerstler
Jordan Gist
Eve Gosselin
Whitney Hanson
Isabelle Harris
Nathaniel Harris
Chelsea Hill
Katharina Anne Holt
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Olalekan Jemilugba
Nick Jenkins
Kayla Kopinski
Brenna Koretke
Szu-ting Kuo
Aubrey Laplante
Carly Lee
José Maria Marmolejo
Hollianne Clara McClure
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Lawrence Jason Medlin
Andre Michael Mere
Erin B. Milligan
Zachary Molitor
Taylor Rae Ivana Morrell
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Fiia Nurminen
Casey Parker
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Sheldon Pierce
S.E. Portnoy
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Michael Colton Sitar
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Stephanie A. Thrasher
Nicholas Trautman
James Trotter
Evan Unruh-Friesen
Nicole Irene Wagner
Andrew B. Williams
Allie Ann Wolverton
Noah Joshua Workman
I. Dogancan Yasar

**Other Professional Interests**
Blaize Baruch Adler-Ivanbrook
Anthony Aguilar
Alexander Allegra
Emily Bergel
Brigid Bernier
Carolyn Bienvenu
Elizabeth Birmingham
Sophie Bright
Nicholas James Burk
Kyle Carty
Kevin Cetin
Man Wai Chan
Sara Jane Cluff
Connor Cozad
Alexander Drift
Briesa Ellsworth
Olivia Farbarik
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Nicholas Gilchenok
Kalei Gordon
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Brogan Kellermann
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Emma Lassy
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Nahuel Losano
Lyujian Lu
Lawrence Lual Chol
Yantao Luo

Chris Morales
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Dedrick Moulton
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Ryan Pastor
Gavin S. Perri
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Audrey Turcotte
Monica Villegas
Nina Webb
Cole Westbrook
Caroline Wexler
Eo Xia Lai Wills
Wang Yue
Kayley C. Zabinski

## K–12 TEACHERS

Alicen Adkins
Rachel Arbor
Shannon Renee Babiak
Katherine Curtis
Jasmine DeCosta
Covey Ashe Denton
Emily Dill
Tovah Dyann DiPrinzio
Sharma Dronamraju
Wendy Sue Esch
Barbara Fishel
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Kari Hughes
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Heidi Lux
Jaiwantie Manni
Katie McNulty
Jennifer Miller
Tara A. O'Brien
Cristen Olson
Katy Montgomery Souder
Steven G. Tebor
Anthony Thomas

## AFFILIATES

Andrew Abraham
Jennifer Angone
Keiara Auzenne
Katie Brown
Frank Casella
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Floyd Catchpole
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Glorianna Davenport
Buckingham Dillinger
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Ian Wilson
Andrew Zwilling

# In Memoriam

The Society notes with regret the deaths of the following members (notifications received between 1 Sept. 2020 and 14 Apr. 2021). Memorials to deceased members are published open access at **www.geosociety.org/memorials.** Visit that page for links to information on how to honor someone with a memorial.

**Clarence R. Allen**
Pasadena, California, USA
Date of death: 21 Jan. 2021

**Jean A. Aubouin**
Nice, France
Date of death: 19 Dec. 2020

**Nadine G. Barlow**
Flagstaff, Arizona, USA
Date of death: 17 August 2020

**Francis S. Birch**
Durham, New Hampshire, USA
Date of death: 1 Mar. 2020

**G. Martin Booth III**
Sparks, Nevada, USA
Notified: 11 Feb. 2021

**David L. Campbell**
Tiffin, Iowa, USA
Date of death: 21 Dec. 2019

**Wilfred J. Carr**
Loveland, Colorado, USA
Date of death: 1 Jan. 2015

**Clement G. Chase**
Tucson, Arizona, USA
Date of death: 19 Feb. 2020

**William R. Church**
London, Ontario, Canada
Notified: 15 Sept. 2020

**William A. Clemens**
Berkeley, California, USA
Date of death: 17 Nov. 2020

**William A. Crawford**
Bryn Mawr, Pennsylvania, USA
Date of death: 30 June 2020

**John D. Dolan**
Casper, Wyoming, USA
Date of death: 22 Aug. 2020

**Charles Brown Douthitt**
Safford, Arizona, USA
Date of death: 1 Dec. 2020

**Avery Ala Drake Jr.**
Reston, Virginia, USA
Date of death: 1 July 2020

**Grover H. Emrich**
Wayne, Pennsylvania, USA
Date of death: 30 Aug. 2020

**Donald R. Fowler**
Tucson, Arizona, USA
Notified: 1 Feb. 2021

**Peter Fox**
Troy, New York, USA
Date of death: 27 Mar. 2021

**Samuel A. Friedman**
Norman, Oklahoma, USA
Date of death: 22 Sept. 2020

**Hal J. Gluskoter**
Denver, Colorado, USA
Date of death: 3 Sept. 2020

**Ken Hasson**
Asheville, North Carolina, USA
Notified: 3 Feb. 2021

**Alfred J.J. Holck**
San Rafael, California, USA
Date of death: 27 Jan. 2021

**Roger LeBaron Hooke**
Deer Isle, Maine, USA
Date of death: 10 Mar. 2021

**Norris W. Jones**
Oshkosh, Wisconsin, USA
Date of death: 9 Apr. 2020

**Edmund Kiessling**
Pasadena, California, USA
Date of death: 23 Aug. 2020

**John C. Kraft**
Newark, Delaware, USA
Date of death: 27 Jan. 2020

**Stanley J. Luft**
Chaska, Minnesota, USA
Notified: 21 Nov. 2020

**Michael D. Max**
Washington, D.C.
Date of death: 31 May 2020

**H. Jay Melosh**
West Lafayette, Indiana, USA
Date of death: 11 Sept. 2020

**Douglas M. Morton**
Moreno Valley, California, USA
Date of death: 16 Sept. 2020

**James F. O'Connell**
Amarillo, Texas, USA
Date of death: 27 June 2020

**Michael A. Ozol**
Baltimore, Maryland, USA
Date of death: 19 Apr. 2018

**Hans O. Pfannkuch**
Minneapolis, Minnesota, USA
Date of death: 19 Nov. 2020

**Roger J. Phillips**
Longmont, Colorado, USA
Date of death: 19 Nov. 2020

**Robert E. Reynolds**
Redlands, California, USA
Date of death: 1 July 2020

**John F.V. Riva**
Quebec City, Québec, Canada
Date of death: 29 July 2020

**Anne M. Sanquini**
Saratoga, California, USA
Date of death: 1 Nov. 2020

**Harry L. Siebert**
Centennial, Colorado, USA
Notified: 1 Sept. 2020

**Orrin Lee Slind**
Calgary, Alberta, Canada
Date of death: 17 May 2020

**George C. Soronen**
Houston, Texas, USA
Date of death: 1 Aug. 2020

**Keene Swett**
Iowa City, Iowa, USA
Date of death: 26 May 2020

**Harry E. Thomas**
Nome, Alaska, USA
Notified: 13 Oct. 2020

**Dennis Trombatore**
Austin, Texas, USA
Date of death: 18 July 2020

**Michael A. Tuohy**
Buford, Georgia, USA
Date of death: 7 Mar. 2021

**Samuel J. Tuthill**
Wheatland, Iowa, USA
Notified: 16 Sept. 2020

**Jan Erik Ulmius**
Lund, Sweden
Notified: 12 Nov. 2020

**K.S. Valdiya**
Bangalore, India
Date of death: 22 Sept. 2020

**Charles W. Welby**
Lexington, North Carolina, USA
Date of death: 22 Sept. 2020

**Robert J. Willard**
Minneapolis, Minnesota, USA
Date of death: 12 Nov. 2020

**Ronald Willden**
Salt Lake City, Utah, USA
Date of death: 20 June 2020

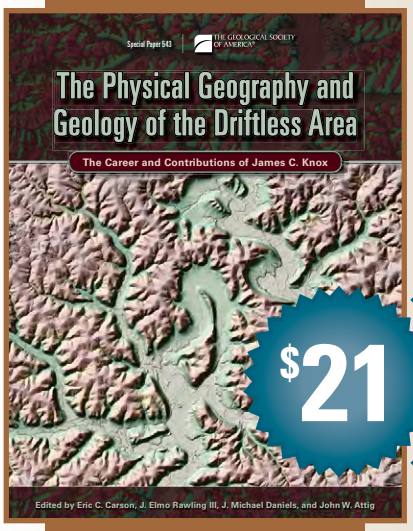
**Lee A. Woodward**
Albuquerque, New Mexico, USA
Date of death: 16 Aug. 2020

**Thomas S. Wright**
Ogdensburg, New York, USA
Notified: 8 Sept. 2020

**Grant M. Young**
London, Ontario, Canada
Date of death: 1 Aug. 2020

# EXPLORE WISCONSIN GEOLOGY

Special Paper 543




## The Physical Geography and Geology of the Driftless Area: The Career and Contributions of James C. Knox

**Edited by Eric C. Carson, J. Elmo Rawling III, J. Michael Daniels, and John W. Attig**

Over the course of his 43-year career, James C. Knox conducted seminal research on the geomorphology of the Driftless Area of southwestern Wisconsin. His research covered wide-ranging topics such as long-term landscape evolution in the Driftless Area; responses of floods to climate change since the last glaciation; processes and timing of floodplain sediment deposition on both small streams and on the Mississippi River; impacts of European settlement on the landscape; and responses of stream systems to land-use changes. This volume presents the state of knowledge of the physical geography and geology of this unglaciated region in the otherwise-glaciated Midwest with contributions written by Knox prior to his passing in 2012 and by a number of his former colleagues and graduate students.

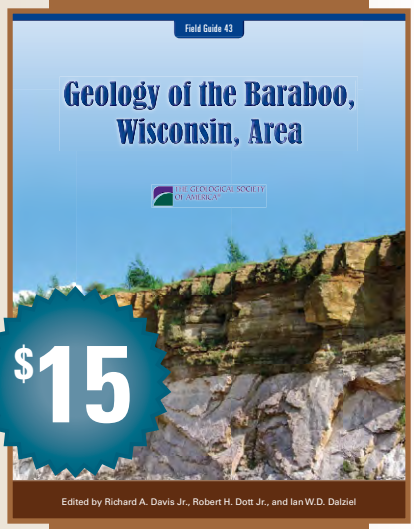
SPE543, 156 p.
ISBN 9780813725437
list price $30.00

Field Guide 43

## Geology of the Baraboo, Wisconsin, Area: Geological Society of America Field Guide

**Edited by Richard A. Davis Jr., Robert H. Dott Jr., and Ian W.D. Dalziel**

With its wide variety of geological features and phenomena packed into a small area, the Baraboo of south-central Wisconsin is among the most visited parts of the Midwest by geology students. This guidebook, the first comprehensive look at the area in decades, covers the spectrum of geological features present in the area, and it is useful as a teaching tool. An exceptional outdoor classroom, the Baraboo area contains a spectrum of geology, including excellent examples of geomorphology, glacial geology, structural geology, petrology, stratigraphy, and sedimentology. Ages of the strata range from 1.7-billion-year-old Precambrian to the Quaternary. The area has been studied for about a century, but it still holds surprises for professionals and students alike.

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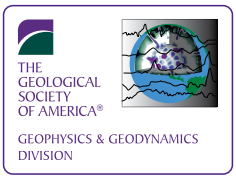
# GSA Scientific Division Milestones

GSA has 22 scientific Divisions that any member may join. Divisions help you stay connected with your colleagues worldwide and receive specific information related to your area of interest. They provide opportunities for leadership and service, specialty meetings, awards, student support, and development of the GSA meeting technical program.

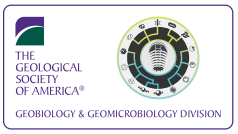



**50 Years:** GSA's **Geophysics and Geodynamics Division** (est. 1971) facilitates the presentation and discussion of the ideas of scientists interested in geophysics, fosters communication among geophysicists and other earth scientists, and promotes research and publication. This Division sponsors the George P. Woollard Award and lecture for outstanding contributions to geology through the application of the principles and techniques of geophysics. For students, the Division offers the Allan V. Cox Student Research Award and the GSA Geophysics and Geodynamics Division Student Research Award.


**45 Years:** GSA's **History and Philosophy of Geology Division** (est. 1976) works to encourage the study and communication of the philosophy and history of geology. The Division sponsors technical sessions at GSA meetings and honors geologists for their research, writing, and historical work through the Mary C. Rabbitt History of Geology Award, the Gerald M. and Sue T. Friedman Distinguished Service Award, and the History & Philosophy of Geology Student Award.

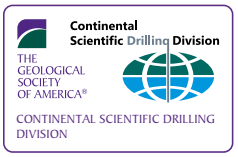

**40 Years:** GSA's **Planetary Geology Division** (est. 1981) fosters interactions among planetary scientists, facilitates the presentation and discussion of their research and ideas, stimulates communication with other earth scientists, and promotes planetary geology to a broad audience. Awards sponsored by the Division include the G.K. Gilbert Award, the Ronald Greeley Award for Distinguished Service, and, for students, the Eugene M. Shoemaker Impact Cratering Award, the Stephen E. Dwornik Awards for best student presentations at the annual Lunar and Planetary Science Conference, Student Travel Grants, and (jointly with the Meteoritical Society) the Pellas-Ryder Award for the best student-authored paper in planetary science.


**30 Years:** GSA's **Geoscience Education Division** (est. 1991) fosters the active participation of GSA members in all aspects of earth-science education. The Division complements and expands on the contributions of GSA's Education, Communications, and Outreach group, the National Earth Science Teachers Association (NESTA), the National Association of Geoscience Teachers (NAGT), the National Science Teachers Association (NSTA), and other similar organizations. It sponsors the Biggs Earth Science Teaching Award and a Distinguished Service Award.




**20 Years:** GSA's **Geobiology and Geomicrobiology Division** (est. 2001) promotes interdisciplinary research focusing on the interplay between the biosphere, lithosphere, hydrosphere, and atmosphere. More specifically, geobiologists and geomicrobiologists examine the effects of biological activities on geological processes and the influences of geological settings on biological processes—both at the macro- and micro-biological scales, in the past through the present. Members are invited to the yearly lunch banquet where winners of the annual Outstanding Contributions to Geobiology & Geomicrobiology Awards are celebrated.


**15 Years:** GSA's **Geoinformatics and Data Science Division** (est. 2006) advances "Data to Knowledge," providing GSA members with an opportunity to participate in the emerging field of cyberinfrastructure. The Division actively promotes and sponsors short courses, symposia, and books that emphasize information technology–supported discovery and integration of geoscience data leading to a more comprehensive understanding of Earth and the planets as complex systems. Each year, the Division presents the Outstanding Contributions in Geoinformatics Award.




**5 Years:** GSA's **Continental Scientific Drilling Division** (est. 2016) was founded to advance the exploration and investigation of Earth's continental subsurface through scientific drilling. Its purpose is to provide a community for GSA members who use scientific drilling in their research; to foster communication and collaboration between scientists from across the GSA Divisions who use scientific drilling to study the Earth's subsurface; to support workshops, symposia, sessions, and other activities that educate GSA members and promote research using scientific drilling; and to advise officers and committees of the Society on issues relevant to continental scientific drilling.

# A Climate Scientist on Capitol Hill: Encountering Uncertainty in Science and Practice

Charles Gertler

On 29 Feb. 2020, I took the train to Union Station in Washington, D.C., hopped on the Red Line to Metro Center, and walked about a block to the GSA office to interview for the remarkable opportunity to serve as a Congressional Science Fellow. There, I sat in a conference room with 10 strangers and talked, unmasked, for almost an hour. As I write this more than a year later, that was the last time I rode on public transit or had unrestricted interactions with such a large group of people, and it is surreal to think we once took such experiences for granted.

As COVID-19 cases exploded during the spring and summer, and as we struggled to mount an effective defense against the virus, uncertainty grew as to when and how we would ever return to normal. At the same time, smaller-scale uncertainty grew for myself and the roughly 30 other Congressional Science Fellows, funded by a host of scientific societies, bracing for the transition to becoming Hill staffers. Already unsure as to what to expect in our new roles, we became quickly unsure how we would even perform them. The set of experiences that followed can be characterized most broadly by uncertainty, but I have come to learn in my time on Capitol Hill so far that even in "normal" years, dealing with uncertainty is at the core of the alchemy of federal policy making.

All scientists, but geoscientists in particular, are trained to understand the robustness of conclusions and predictions given differing levels of uncertainty. This skill first proved useful in my current role upon entering the office of Senator Edward J. Markey in October of an election year, with the fate of Senate control and the presidency hinging on the outcome of an election. The alternate permutations of the potential futures we were likely to face soon in the federal government meant that planning legislative priorities and oversight actions had to be probabilistic in nature: multiple contingencies for multiple scenarios, with a proportionate amount of effort and time. During that period, I produced dual memos on many issues with different recommendations on approach depending on the outcome of the election.

In the narrative of my time on the Hill so far, no date looms as large as 6 Jan., when a series of shocking tragedies and disgraces occurred in my new workplace, and my new colleagues and the senator whom I serve were placed in harm's way. That was also the day that decided the working reality of the Senate for the next two years, with the elections in Georgia officially cementing an evenly split body. A whole new suite of uncertain events then came to bear on my work: how would the two parties share power? What would be the legislative plan? What kind of legislation can pass through budget reconciliation, thereby bypassing the filibuster? These questions were now superimposed on the uncertainty of the COVID-19 pandemic regarding cases, vaccines, and the return to "normal."

After the presidential inauguration, key Senate tasks took center stage. Confirmation hearings for presidential nominees, and the preparatory meetings between nominees and members of Congress, were the first major order of business. My office also turned its attention more fully to policy initiatives and priorities where I have seen yet another form of uncertainty play out—uncertainty about the final outcome of a project. With legislation, cosponsors are often brought on board and may suggest edits, and interest groups and outside experts are often consulted to ensure the legislation will accomplish its goals, bringing along further suggestions and changes. It is an iterative process, with difficult-to-predict outcomes.

My time on Capitol Hill so far has been spent entirely on Zoom, save one in-person press conference for a bill on which I worked extensively. In all this time, I have nonetheless drawn deeply on the lessons, skills, and ways of thinking I developed while training to become a scientist—understanding of uncertainty, project iteration, navigating complexity, and structured analysis—to contribute to the policy-making process. I have gained a deeper understanding of just how complex and at times unpredictable policy making can be, and I have built an appreciation for all there is to learn by working with seasoned and dedicated experts. The privilege I feel to be able to serve my country, my home state, and the geoscientific community in this way is immense, and I can only hope the second half of my experience is as fruitful and perhaps slightly less uncertain.

*This manuscript is submitted for publication by Charles Gertler, 2020–2021 GSA-USGS Congressional Science Fellow, with the understanding that the U.S. government is authorized to reproduce and distribute reprints for governmental use. The one-year fellowship is supported by GSA and the U.S. Geological Survey, Department of the Interior, under Assistance Award No G20AP00106. The views and conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. government.* *Gertler works in the office of Sen. Edward Markey (D-MA) and can be contacted by email at charles.gertler@gmail.com.*

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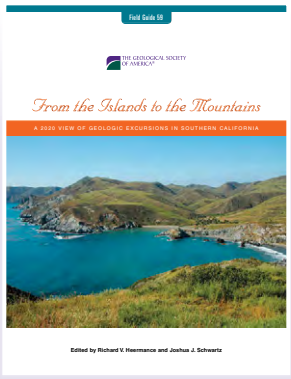


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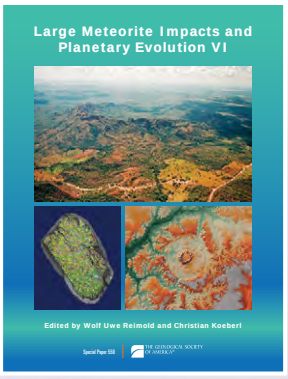


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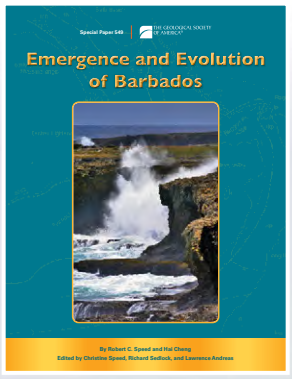


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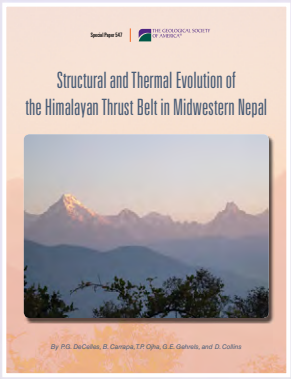


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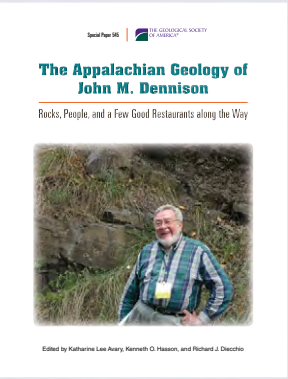


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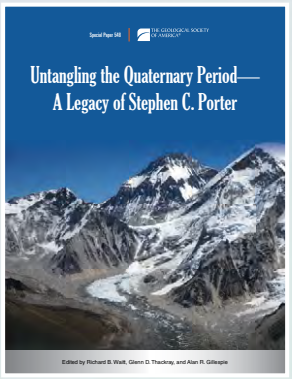


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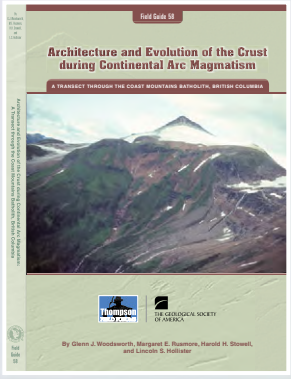


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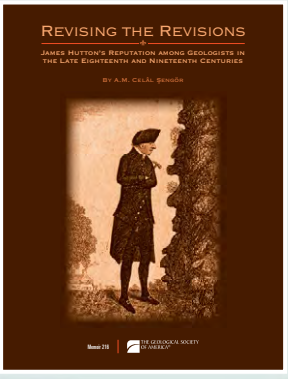


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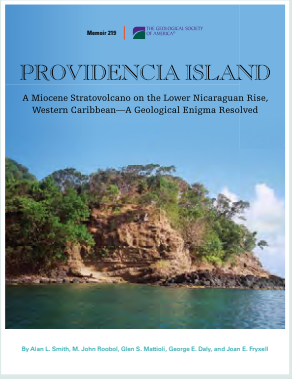


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# New and Updated Position Statements

In May 2021, GSA Council approved minor revisions to three position statements: Expanding and Improving Geoscience in Higher Education, The Importance of Teaching Earth Science, and Diversity in the Geosciences Community. Summary statements are below, and full versions of all position statements are available online at **https://www.geosociety.org/positionstatements**. GSA members are encouraged to use the statements as geoscience communication tools when interacting with policy makers, students, colleagues, and the general public.

**Expanding and Improving Geoscience in Higher Education**

Robust geoscience programs at institutions of higher learning equip students with the scientific literacy required to address crucial societal issues and planetary challenges. Providing geoscience instruction that is accessible to all higher-education students will thus help society develop the scientific literacy it needs to address the major challenges facing our planet.

**The Importance of Teaching Earth Science**

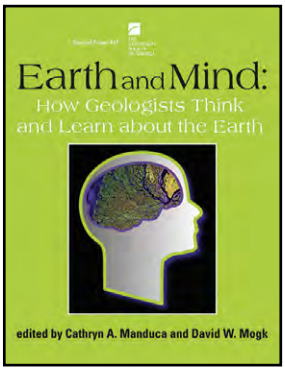
To meet the environmental challenges and natural resource limitations of the twenty-first century, and to inspire future generations of scientists, earth-science education must be integrated into science education across all public and private schools, starting in kindergarten and continuing through twelfth grade. Earth-science curricula should be delivered by teachers with direct training in earth-science education.

**Diversity in the Geosciences Community**

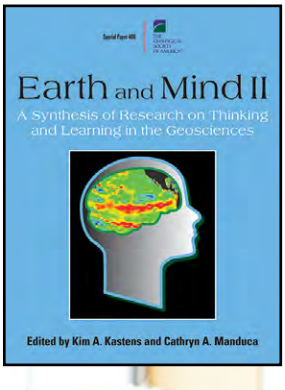
The Geological Society of America (GSA) is committed to promoting a diverse scientific body and diversity of scientific ideas and the connections among them. This position statement (1) summarizes the consensus view of GSA regarding the Society's commitment to diversity among GSA membership and to Earth literacy for all people; (2) provides information that is intended to raise awareness among geoscience professionals implementing those policies and evaluating the short-and long-term consequences; and (3) encourages geoscientists to participate in implementing suitable diversity practices at local, regional, state, and national levels.

# Geology in the Classroom

If you're an educator looking for insight and inspiration to help keep you motivated, you'll want to check out these Special Papers from GSA. Both volumes, which are available for download from the GSA bookstore, explore how improved understanding of how humans think and learn about the Earth can help educators prepare the next generation of geoscientists.




***Earth and Mind: How Geologists Think and Learn about the Earth*** presents essays by geoscientists, cognitive scientists, and educators that explore how geoscientists learn and what the implications are for student learning. (SPE413P, 188 p., ISBN 0813724139, US$9.99)




***Earth and Mind II: A Synthesis of Research on Thinking and Learning in the Geosciences*** explores the ways in which geoscientists use the human senses and mind to perceive, analyze, and explain the workings of the earth system and how to help students master the thought processes of the geosciences. (SPE486P, 210 p., ISBN 9780813724867, US$9.99)

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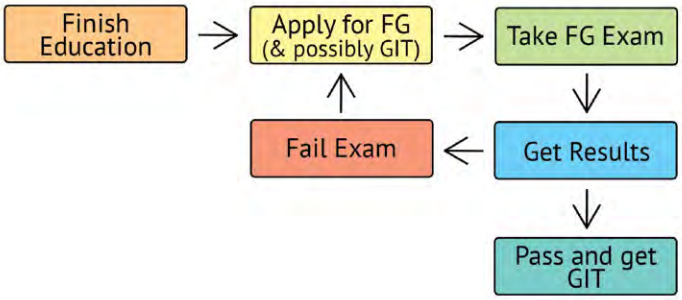
# Professional Geologist Licensure Requirements Webinar

*Jazzy Graham-Davis*

GSA offered a webinar about professional geologist requirements on 14 April. It quickly filled, and numerous questions were generated. For those of you who are interested in the Fundamentals of Geology (FG) exam, go to GSA's Webinar Library to view the webinar and its PowerPoint slides (**https://www.geosociety.org/webinars**). Also, here is a summary of the information to earn the Geologist in Training (GIT; Fig. 1) certificate, which should be considered once you have taken all your required geology coursework. Many students take this exam after graduating with a bachelor of science in geology.




In the United States, geologist licensure and certification availability and requirements differ by state. Many states use exams written by the National Association of State Boards of Geologists (ASBOG®), offered twice a year in March and October. The first exam is the FG, which may be used to get a GIT certificate; second is the Practice of Geology (PG) that is taken after working under a licensed geologist for a specified amount of time to become licensed. To take either of the ASBOG® exams, you need to need to apply to the board overseeing geology licensure in the state in which you will take the exam.

Some states offer the option to take the FG exam upon or near completion of your geology education, for example during the final year or after completing a bachelor's degree in geology or necessary geology courses. States may also offer a GIT certificate for passing the FG exam. As each state varies on the exact requirements it is essential that you check with your state. Typically, to take the FG exam, you need to submit official transcripts from all colleges you attended, including international, the application, and fees (~$100-$300+). States may require additional documents; California applicants must also supply fingerprints. It may take months to hear back from the state board regarding applications.

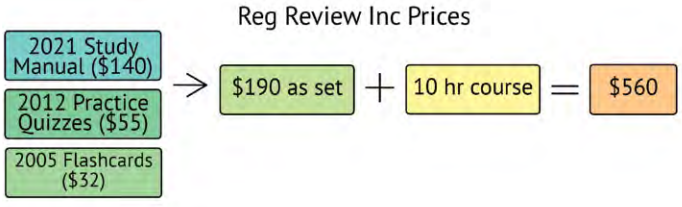
Not every state offers GIT certificates, allows the FG exam to be taken before acquiring geology work experience, or has geology licensure. If it's not offered in your state, it may be beneficial to take the exam in a nearby state; residency isn't required to take the FG exam and get a GIT certificate. If you stay in good standing with your state's board and pass the FG exam you usually do not need to take it again for another state that utilizes ASBOG® exams. Some states may have other requirements and exams that do not transfer as easily. You will have to pay fees to every state you apply, even if you have already passed the FG exam, so take that into consideration when deciding when and where to apply.

There are cases where ASBOG® exams may need to be retaken. Letting geology certificates and licenses expire may result in scores being invalid. Geology licenses and some GIT certificates need to be renewed; the length of validity varies by state. You may retake the FG exam as many times as needed until you pass, but you may need to wait to reapply until you receive your exam results. This may result in only being able to sit for one exam a year.

Taking the FG exam and getting a GIT certificate is not needed for every geoscience career, but having it can open opportunities and increase pay. Taking the FG exam as soon as possible after education will make the study process much easier. The FG exam contains 140 multiple choice questions over four hours. Ensure you are mentally able to study and take an exam of that length. For the one exam, you will need to prepare for one to six months; one month of studying would be a full-time job, whereas six months would be easier while working or in school. Exam accommodations for disabilities can be requested with your state board. There are limited dates and locations to take the exams, so have all application documents ready early and utilize checklists to ensure your application is complete.

There are free and purchasable study materials available for ASBOG® exams. The ASBOG® website has an examination blueprint breaking down the exams by topics, and a "Candidate Study Handbook" of free textbooks, pdfs, and web resources. Geology textbooks, online lectures, and ASBOG®-provided material are excellent resources that you may already have or are free. Flashcards are cheap and writing down terms and definitions increase memory retention.

Reg Review Inc. (Fig. 2) sells study manuals (US$140), practice quizzes (US$55), flashcards (US$32), and courses (US$560) for both ASBOG® exams and the California-specific exam (prices for the exams not included). All Reg Review material except the quizzes do not differentiate between the FG and PG topics, but it has many positive reviews. FG topics are definitions and geologic concepts, and PG topics are more specific to industry practice and are mathematically based.




Regardless of study materials, you should practice with the non-programmable calculator, protractor, and other allowed tools that you will use in the exam. Check the rules published by your state to ensure you have items that are allowed and that you are dressed appropriately but comfortable. Make a bag the night before your exam with your flashcards, calculator and tools, exam entrance ticket, and any other items you wish to bring. Eat breakfast even if you're not hungry and get a good night's rest to set you up for a positive testing experience.

# Top Tips for Authors: How to Nail the Initial Quality Check and Ensure Your Paper Gets to the Editor Faster

Once you've submitted your paper to a GSA publication, it will go through an initial quality check before it is sent to the editor. If it doesn't pass, the paper will be returned to you to fix. You can save yourself the extra step and get your paper to the editor without delay by making sure your submission ticks these boxes first. (Your manuscript will be considered officially submitted only after it has passed the quality check.) You can also visit the publication's author information page for specific requirements: **https://www.geosociety.org/AuthorInfo.**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# Ensure Support for Future Geoscientists

## *Remember GSA in Your Estate Plan*

There are many ways donors choose to give back to the Geological Society of America. For Dr. Scott F. Burns, one important way to ensure a future for aspiring geoscientists was to include GSA in his estate plan. The Foundation gratefully acknowledges the foresight and dedication demonstrated by thoughtful donors like Dr. Burns and honors them through the Pardee Legacy Circle. The Pardee Legacy Circle is named in honor of Joseph T. Pardee (1871–1960) in recognition of a US$2.7 million bequest from the estate of Pardee's daughter, Mary Pardee Kelly (1905–1994). Joseph Pardee spent his entire career as a U.S. Geological Survey geologist in the Pacific Northwest and is best known for his work on Glacial Lake Missoula.

Scott, like Joseph T. Pardee, has spent much of his career in the Pacific Northwest teaching and studying the local geology, including Glacial Lake Missoula. Scott joined GSA as a student in 1973, became a fellow in 2004, and has served in many volunteer positions, including chair of the Environmental and Engineering Geology Division, treasurer of the Quaternary Geology and Geomorphology Division, chair of the Cordilleran Section, and many other roles. He has also received several GSA awards, including the Richard H. Jahns Distinguished Lecturer Award and the GSA Public Service Award.

Scott has a voracious appetite for knowledge, a passion for supporting future geoscientists, and a love of connecting with the many friends he has made over the years at GSA meetings: "When I think about what GSA has meant to me over my nearly fifty-year membership, there are many things that come to mind. One is the knowledge I've gained through the publications; *Geology* and the *GSA Bulletin* are excellent sources for geoscience that I still use in my classroom today. I also appreciate the Annual Meetings—I've been to most of them over the last fifty years. I enjoy listening to friends give talks and every year I try to give at least one talk myself. I also make a point of bringing students so they can experience what for many of them is their first professional geoscience meeting. I am also very thankful for and supportive of the scholarship money that GSA gives out. I always push my students to apply for scholarships. When I was a student, I had no money and even small grants would make a huge difference."

This enthusiasm for future geoscientists is why Scott decided to include GSA in his estate plan. "I am passionate about ensuring support for the next generation of geoscientists. Now that I am well established in my career, I give back every chance I get. I included GSA in my will so that I can give back to more students than just my own. I highly recommend that others do the same. It's a way for your name to live on and it helps the students of the future. All gifts are much appreciated, because almost everything the Foundation gives out goes to students."

If you would like to include the GSA Foundation in your estate plan like Scott, there are several options for doing so, including bequests; gifts of retirement plan assets; life income gifts through charitable remainder trusts, charitable lead trusts, and charitable gift annuities; and gifts of life insurance in the form of a new or existing policy. For more information, including sample language and other resources, visit **https://gsa-foundation.org/planned-giving/** or contact Clifton Cullen at +1 303-357-1007 or ccullen@geosociety.org.

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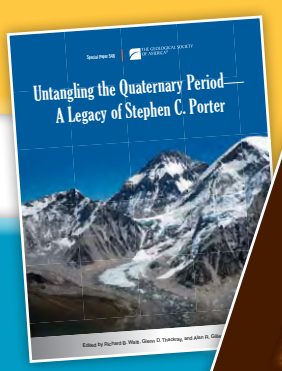



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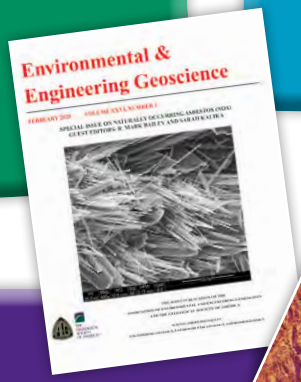



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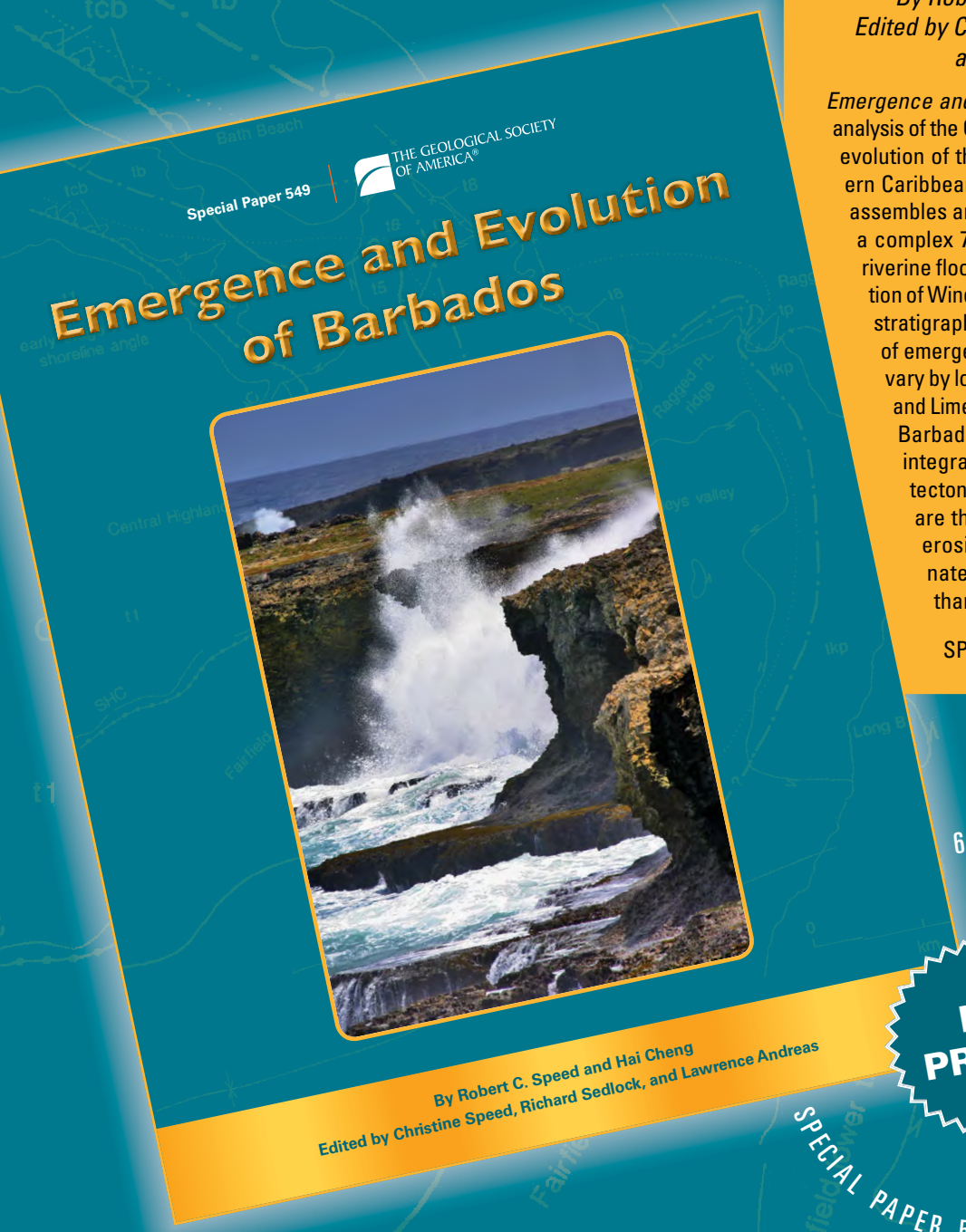


## Emergence and Evolution of Barbados

*By Robert C. Speed and Hai Cheng; Edited by Christine Speed, Richard Sedlock, and Lawrence Andreas*

*Emergence and Evolution of Barbados* is a three-part analysis of the Quaternary geologic and geomorphologic evolution of the island of Barbados in the southeastern Caribbean. "Geology of Southeastern Barbados" assembles and integrates detailed observations into a complex 700 k.y. history of marine sculpting and riverine flooding processes. "Marine Terrace Evolution of Windward Barbados" revises the Quaternary stratigraphy of the island, describes the tectonics of emergence, and demonstrates that uplift rates vary by location. "Active Emergence, Chronology, and Limestone Facies in Southeastern Windward Barbados" is the first comprehensive study to integrate marine erosion and deposition with tectonic uplift rates. Major findings of this work are that Barbados' Central Highlands are an erosional remnant, and that terraces originated principally by marine erosion rather than by reef construction.

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