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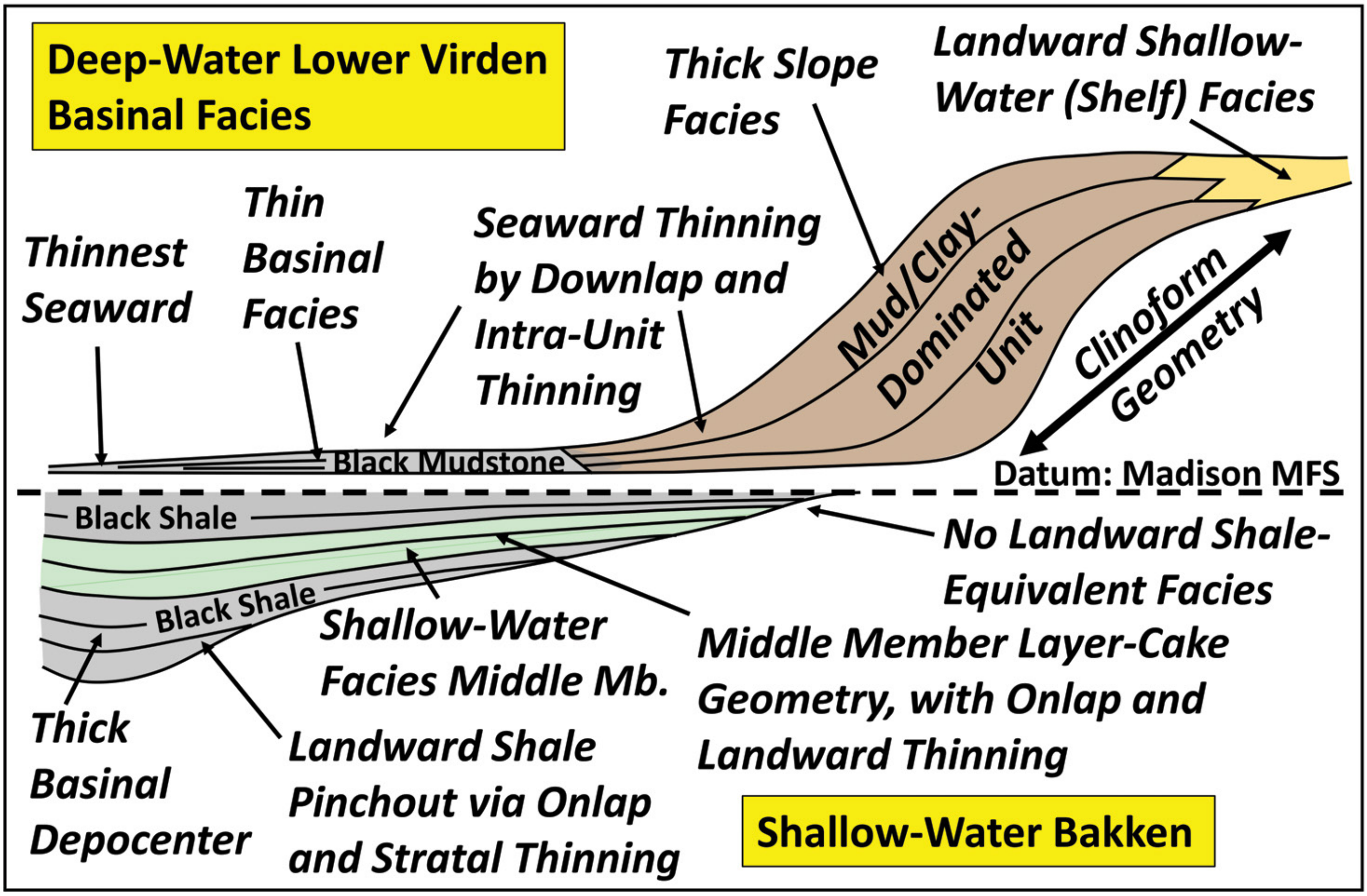
Shallow-Water versus Deep-Water: Stratigraphic Geometries in the Organic-Rich Shale/ Mudstone Debate



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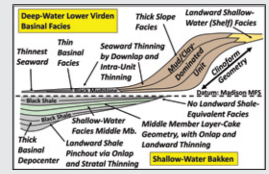
SCIENCE



Cover: Schematic diagram summarizing the shallow-water stratigraphic geometry that characterizes the Bakken Formation relative to the deep-water stratigraphic geometry that characterizes the overlying basinal facies of the lower Virden subinterval in the North Dakota portion of the Williston basin, USA. See related article, p. 4–10.

GSA CONNECTS 2022

GSA NEWS

Shallow-Water versus Deep-Water: Stratigraphic Geometries in the Organic-Rich Shale/Mudstone Debate

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ABSTRACT

In the central Williston basin, USA, the Bakken Formation and overlying lower Lodgepole Formation both have fine-grained, organic-rich stratigraphic units that have been interpreted sedimentologically to represent deep-water deposition in a low-energy, distal-marine environment; however, these formations display vastly different stratigraphic geometries that challenge the conventional sedimentology interpretations. The Bakken Formation spans the Devonian-Carboniferous boundary and includes black, organic-rich (2%–26% total organic carbon [TOC]) shale units. Stratigraphic characteristics strongly support deposition of all Bakken sediments in shallow water, as indicated by (1) the Bakken stratigraphic position overlying a major subaerial unconformity; (2) the restriction of Bakken strata to basinal areas; (3) the absence of shale-equivalent landward deposits; (4) a layer-cake, onlap, landward-thinning stratigraphic geometry for all Bakken units; (5) gradual landward shale pinchouts that occur by intra-shale onlap and stratal thinning, not erosional truncation; (6) unequivocal evidence for very shallow-water middle Bakken deposition; and (7) the absence of evidence for large intra-Bakken sea-level changes. Lower Lodgepole strata in the Williston basin are characterized by prominent sigmoidal clinoforms. In the lower Virden clinoform, argillaceous mudstone, laminated microcrystalline dolostone, microbial-peloidal-intraclastic packstone, and skeletal-oolitic limestone form a shelf facies that transitions seaward into a thick (maximum 80 m), skeletal-peloidal mudstone to packstone slope facies, which transitions seaward into seaward-thinning (10 m to 1 m), black, organic-rich (1%–8% TOC) carbonate mudstone in a basin-floor facies, inferred to have been deposited in water as deep as 140 m.

INTRODUCTION

There has been a +100-year debate over depth of deposition interpretations for fine-grained, organic-rich, upper Devonian–lower Carboniferous stratigraphic units in North America (Conant and Swanson, 1961; Ettensohn and Barron, 1981; McCollum, 1988), and this debate has accelerated in recent years. The upper Devonian–lower Carboniferous debate is part of a larger worldwide discussion on the origin of fine-grained, organic-rich stratigraphic units, as represented by session #144 at GSA Connects 2021, titled "Broken paradigms: Shallow-water deposition of organic-rich facies through Earth history" (Landing et al., 2021). Regional stratigraphic relationships that define shallow-water organic-rich depositional systems have recently been proposed for Devonian black shales in New York and suggested as a worldwide model for similar black shale depositional systems (Smith et al., 2019). Key shallow-water indications include onlap onto subaerial unconformities and the absence of a base-clinoform setting. However, the regional stratigraphic relationships for these black shales remain debated, and additional support data from comparable black shale stratigraphic systems is required to further define shallow-water relationships.

Research on upper Devonian–lower Carboniferous black shale units in the Bakken Formation in the North Dakota portion (Fig. 1) of the Williston basin illustrates the shallow-water versus deep-water

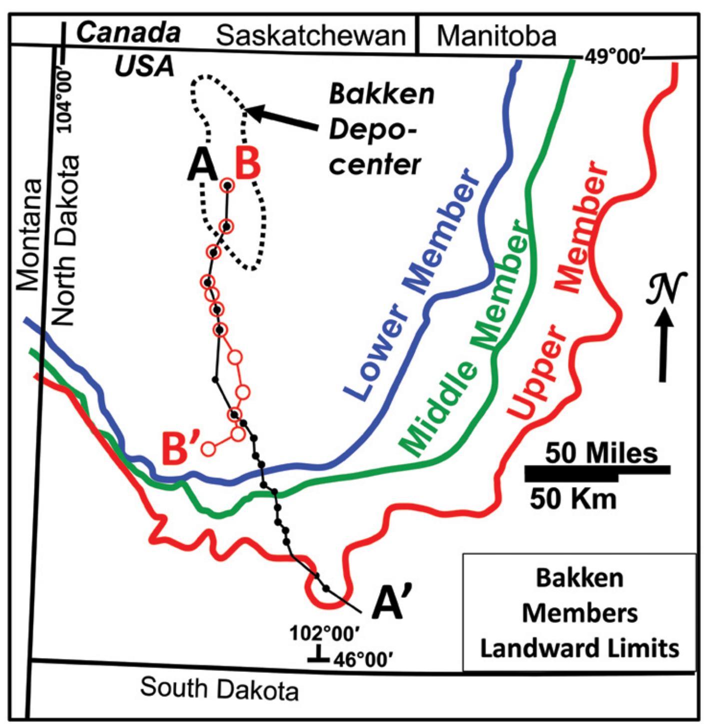

Figure 1. Landward limits for Bakken Formation members, with cross section locations.

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debate (see review in Petty, 2019a), with 66% of studies (61 out of 93) supporting deep-water Bakken deposition versus 34% of studies (32 out of 93) supporting shallow-water Bakken deposition. The debate continues, with Hart and Hofmann (2020) and Egenhoff and Fishman (2020) advocating for deep-water Bakken black shale deposition and Petty (2019a, 2021) advocating for shallow-water Bakken black shale deposition. Although paleontology, geochemistry, and worldwide-event studies contribute to this discussion, the essence of the argument is a sedimentology versus stratigraphy debate, with conventional sedimentology interpretations (e.g., fine grain size, clay content, laminations) suggesting deep-water deposition while stratigraphic observations (e.g., onlap onto subaerial unconformity and lack of landward-equivalent shallow-water strata) indicate shallow-water deposition. Recent studies suggest that sedimentology attributes are not unequivocal indicators of deep-water mud deposition (Schieber, 2016); thus, the stratigraphic geometry may be the ultimate arbitrator.

Although the Bakken Formation has been intensely studied, overlying stratigraphic units have received less attention. The term "false Bakken" has been applied to lower Lodgepole stratigraphic units or lithologies that superficially resemble organic-rich shale units in the underlying Bakken Formation. Most "false Bakken" designations refer to the basinal facies of the lower Virden subinterval, which lies a few meters above the top-Bakken in the basin-center, and this unit will be the focus of the Lodgepole study. To date, all studies (seven total) that offer an opinion on the origin of the organic-rich facies of the lower Virden conclude that it formed in a deep-water setting. As discussed below, this unit displays a dramatically different stratigraphic geometry from the Bakken Formation, and this contrast may offer evidence in the deep-water versus shallow-water debate.

STRATIGRAPHIC SETTING

The Madison 2nd-order sequence within the Williston basin was defined by Petty (2006), who placed the Bakken Formation in the transgressive systems tract and the Lodgepole Formation in the highstand systems tract (Fig. 2). Bakken strata lie on the Acadian unconformity (Fig. 2), which is characterized by sub-unconformity weathering near the basin-center (Bottjer et al., 2011) and extensive stratal truncation with deep sub-unconformity, paleokarst diagenesis in basin-margin areas (Petty, 2017, 2019a). The lower, middle, and upper members of the Bakken Formation display a regional onlap pattern defined by younger stratal units extending progressively farther landward than underlying stratal units (Meissner, 1978; Webster, 1984). Onlap is best displayed on the eastern to southern basin-flank (Fig. 1) where stable cratonic conditions persisted. Bakken deposition was followed by a major sea-level rise that formed the 2nd-order maximum flooding surface (Fig. 2) and flooded western North America, resulting in widespread epeiric conditions during early highstand deposition of lower Lodgepole sediments (Petty, 2019a, 2019b).

LITHOSTRATIGRAPHIC UNITS

Bakken lithostratigraphic descriptions are from wells in Figures 3 and 4, with mineralogy from Petty (2019a, table 1). The formation and member nomenclature of LeFever et al. (2011) is used for Bakken Formation units (Fig. 2). The gamma-ray character for lithostratigraphic units is illustrated with type logs in Figure 5. Pronghorn Member sediments were deposited on the Acadian unconformity in local depocenters with compositions reflecting erosion from local sources. Above the Pronghorn, all Bakken lithostratigraphic units can be correlated from the basin-center to the landward Bakken limit (Fig. 3). The Lower Member consists dominantly of black, faintly laminated to massive, organic-rich (7%–25% TOC from LeFever, 2008), high gamma-ray (250–1200 American Petroleum Institute [API] units), argillaceous (35% clay minerals),

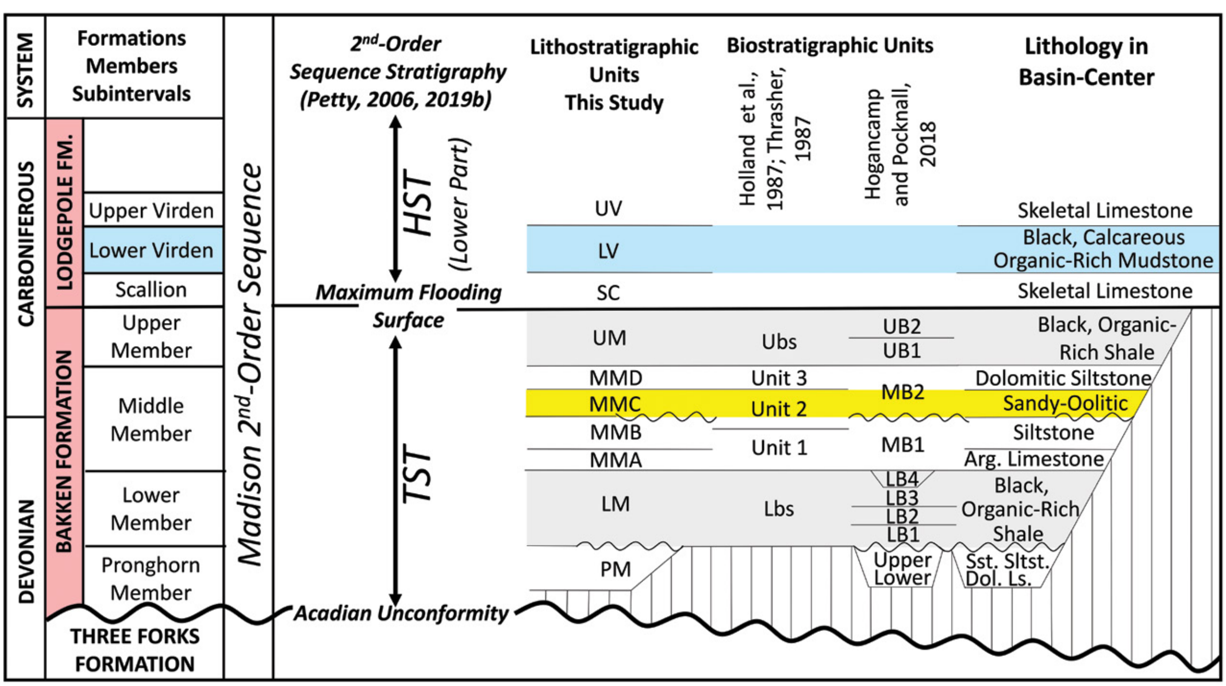

Figure 2. Stratigraphic column for the Bakken Formation and basal portion of the Lodgepole Formation. Arg.—argillaceous; Dol.—dolostone; Ls.—limestone; Sst.—sandstone; Sltst.—siltstone; HST—highstand systems tract; TST—transgressive systems tract.

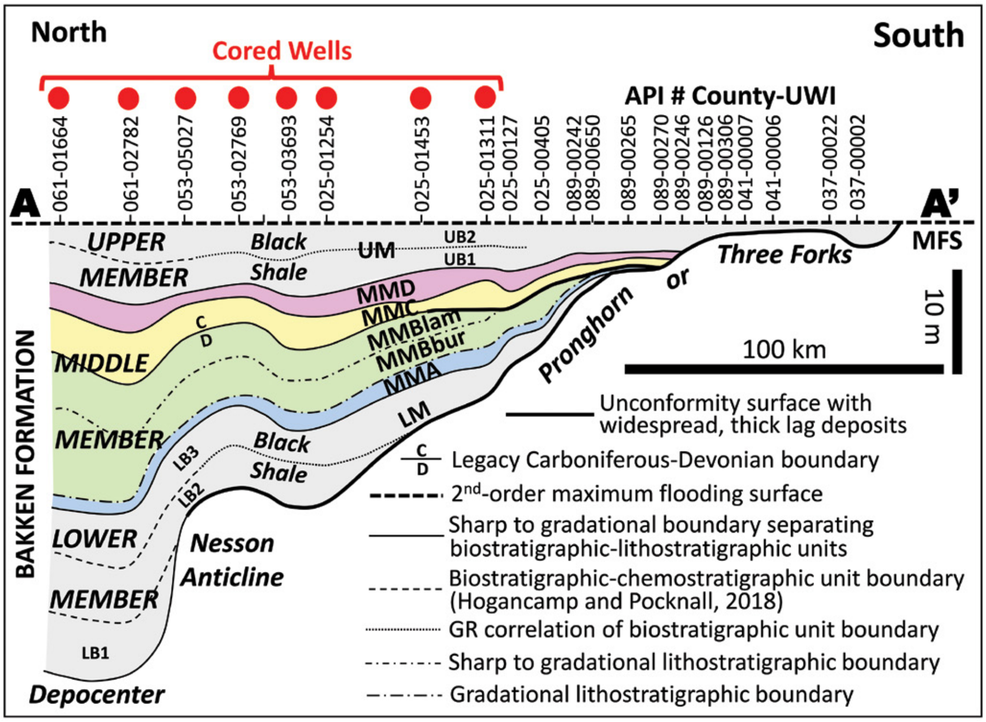

Figure 3. Cross section A–A′ showing correlation of Bakken lithostratigraphic units shown in Figure 2. Cross section location in Figure 1. GR—gamma ray; MFS—maximum flooding surface.

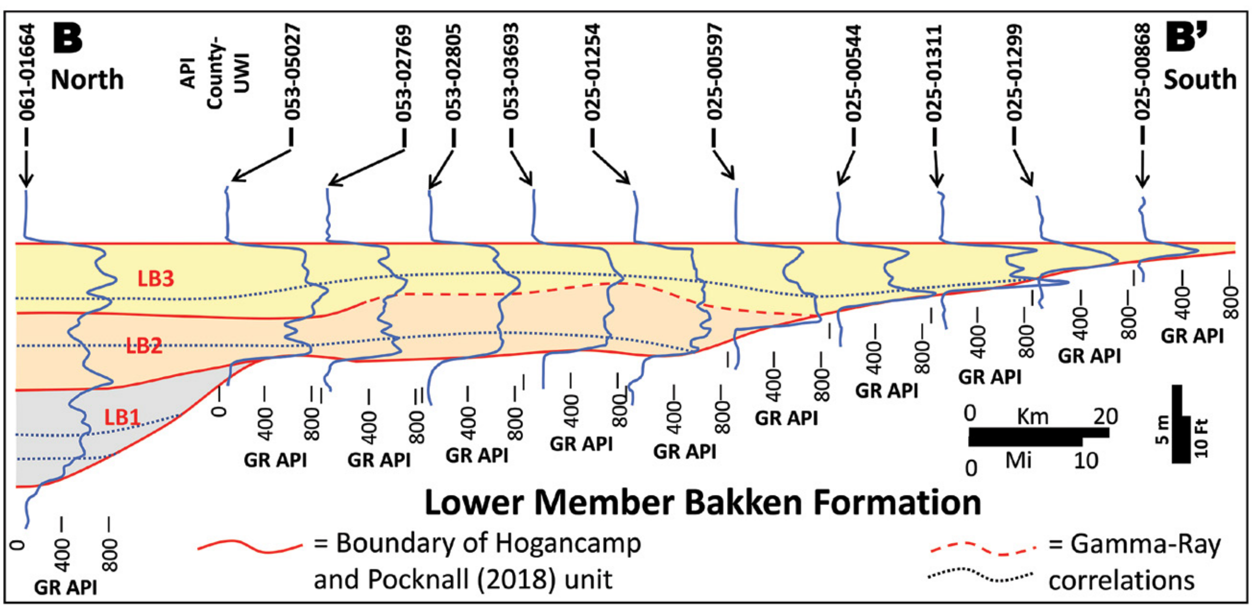

Figure 4. Cross section B–B′ shows lithostratigraphic-biostratigraphic-chemostratigraphic correlations for the Lower Member of the Bakken Formation for two seaward wells (from Hogancamp and Pocknall, 2018, fig. 5), and gamma-ray correlations for landward wells. Cross section location in Figure 1. API—American Petroleum Institute.

pyritic (7%), low-calcite (1%), silty shale. Cross section B–B′ (Fig. 4) shows a regional north-south correlation of the LB1, LB2, and LB3 subunits within the shale (see biostratigraphy below). This illustrates landward, intra-shale onlap with younger units extending progressively farther landward. The Middle Member A (MMA) lithostratigraphic unit consists of silty, burrowed, argillaceous limestone. The Middle Member B (MMB) lithostratigraphic unit consists of two facies: a lower bioturbated siltstone facies (MMBbur), and an upper laminated siltstone facies (MMBlam). The Middle Member C (MMC) lithostratigraphic unit is defined by a low gamma-ray response (Fig. 5) that represents the lowest clay content (4%) within the Bakken Formation. The

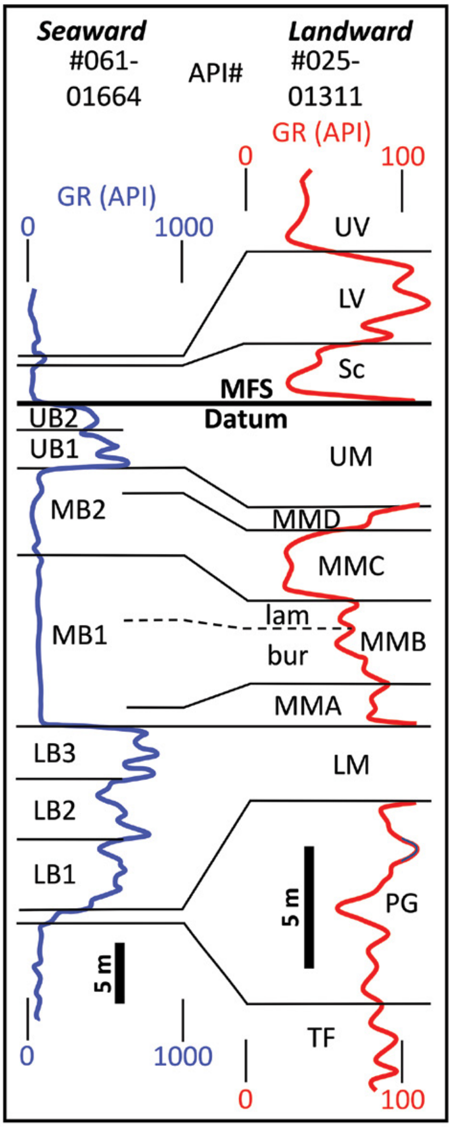

Figure 5. Type logs with gamma-ray character for lithostratigraphic units of this paper (right) and Bakken biostratigraphic units (left) of Hogancamp and Pocknall (2018, fig. 5). Logs represent the most-seaward and most-landward cored wells in Figure 3. Note that logs have different vertical scales (meters) and horizontal scales (API units). API—American Petroleum Institute.

presence of oolitic grainstone, skeletal-oolitic grainstone, sandy-oolitic grainstone, sandstone, and prominent cross stratification makes the MMC the most distinctive Middle Member unit. The Middle Member D (MMD) lithostratigraphic unit consists of argillaceous, dolomitic siltstone. The Upper Member consists dominantly of black, faintly laminated to massive, organic-rich (2%–26% TOC from LeFever, 2008), high gamma-ray (150–1100 API units), argillaceous (30% clay minerals), pyritic (6%), low-calcite (2%), silty shale that displays a layer-cake geometry regionally (Fig. 3).

Lodgepole lithostratigraphic descriptions are from locations in Figures 6 and 7. Log-defined units described in Manitoba by Stanton (1958) and carried through North Dakota by Grover (1996) are used within the Lodgepole Formation. The lower Virden subinterval is defined by a higher gamma-ray response than the underlying Scallion and overlying upper Virden subintervals (Fig. 6). Grover (1996) defined a clinoform geometry that was correlated throughout North Dakota where a thin (5–15 m) landward shelf facies transitions seaward to a thick (10–80 m) slope facies, which transitions seaward to a thin (1–10 m) basinal facies, as depicted in Figure 6. The lower Lodgepole clinoform geometry is illustrated in Grover (1996, figs. 14, 16, 18, 20, 22, and 33), Skinner et al. (2015, slide 12), Petty (2019a, figs. 10 and 11) and Figure 6 (this paper). In the Black Hills and the type area of Virden Field (Fig. 7), the shelf facies is characterized by skeletal-oolitic limestone, microbial-peloidal-intraclastic packstone, argillaceous mudstone, laminated microcrystalline dolostone, and thin stratiform breccias that represent former evaporite beds. The slope facies consists of brown to gray, massive to faintly laminated, argillaceous, medium gamma-ray (40–100 API units), organic-lean (0.4% TOC), silty, skeletal-peloidal, calcareous mudstone to packstone. The slope facies transitions seaward to the basinal facies that is confined to the center of the Williston basin (Fig. 7). This facies thins from 10 m or less landward to 1 m or less in the basin-center. Basinward thinning within the lower Virden is caused by downlap and stratal thinning. The basinal facies consists of gray to black, generally massive, locally laminated, moderately high gamma-ray (100–150 API units), organic-rich, sparsely skeletal, argillaceous (39% clay), calcareous (37% calcite), low-pyrite (1%), silty mudstone. TOC contents vary from 1.1%–5.3% for three samples from wells in Figure 6, to 5%–8% for mature samples in Price and LeFever (1994), equivalent to 7%–12% in immature samples.

BAKKEN BIOSTRATIGRAPHIC UNITS

Bakken biostratigraphy studies define stratigraphic units characterized by lithology, paleobiology, and chemostratigraphy. All of these are described as "biostratigraphic units" in Figure 2. The Lower Member of the Bakken Formation was subdivided into four lithostratigraphic-biostratigraphic-chemostratigraphic units in North Dakota by Hogancamp and Pocknall (2018); these were designated LB1, LB2, LB3, and LB4. These units display a regional, landward, intra-shale onlap pattern in a northeast-southwest profile (Hogancamp and Pocknall, 2018, fig. 4); the LB4 unit is present locally. The Middle Member lithostratigraphic units of this study (MMA, MMB, MMC, and MMD) either correspond with, or parallel, the Middle Member biostratigraphic units of Holland et al. (1987), Thrasher (1987), and Hogancamp and Pocknall (2018), as depicted in Figures 2 and 5. The Upper Member of the Bakken Formation was subdivided into two lithostratigraphic-biostratigraphic-chemostratigraphic

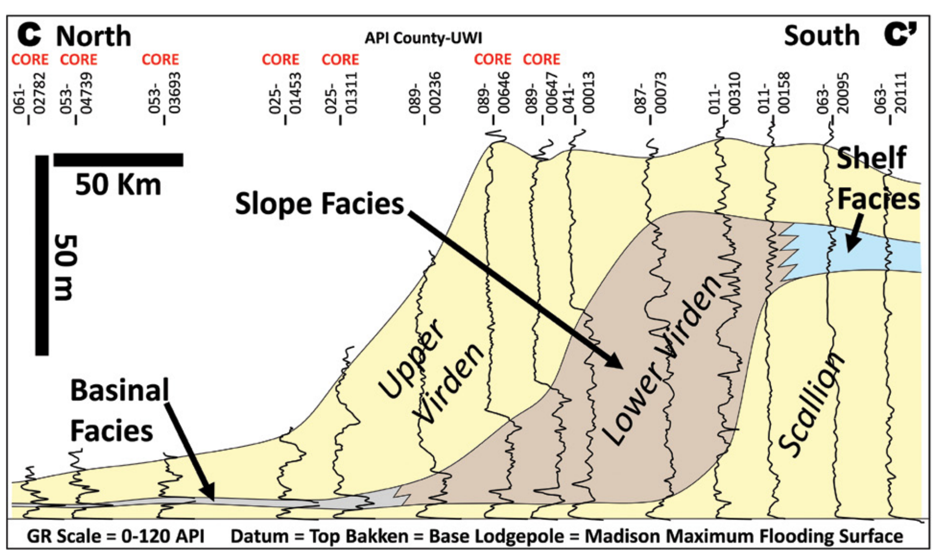

Figure 6. Cross section C–C′ showing lower Lodgepole stratigraphic relationships. Cross section location in Figure 7. API—American Petroleum Institute; GR—gamma ray.

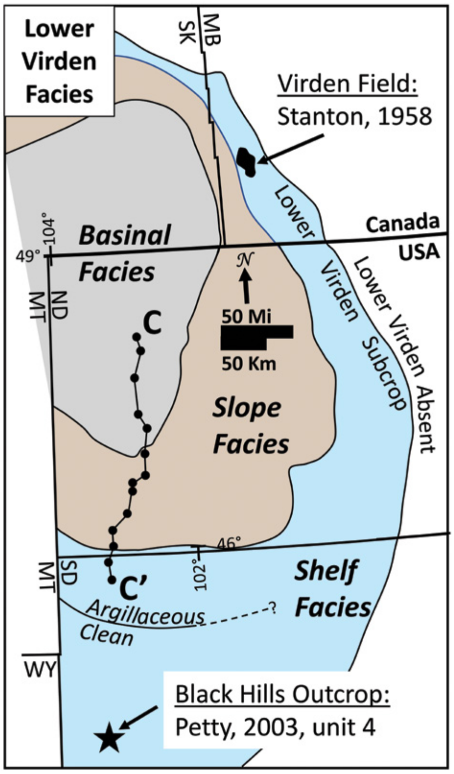

Figure 7. Lower Virden facies. Canada portion modified after Young and Rosenthal (1991). MB—Manitoba; MT—Montana; ND—North Dakota; SD—South Dakota; SK—Saskatchewan; WY—Wyoming.

units in North Dakota by Hogancamp and Pocknall (2018); these were designated UB1 and UB2. These units display a regional layer-cake pattern in a northeast-southwest profile (Hogancamp and Pocknall, 2018, fig. 4).

INTERPRETATION

Bakken Stratigraphic Geometry

The Bakken biostratigraphic units are regarded as "nearly isochronous" (Thrasher, 1987, p. 65). The parallelism or concordance between Bakken lithostratigraphic units and Bakken biostratigraphic units (Figs. 2 and 5) strongly indicates that all Bakken lithostratigraphic units represent layer-cake, near-isochronous deposition. The Bakken lithostratigraphic units (Fig. 2) define a landward-thinning, onlap geometry (Fig. 3) for the lower, to middle, to upper members of the Bakken Formation. Additionally, intra-shale lithostratigraphic-biostratigraphic-chemostratigraphic correlations (Hogancamp and Pocknall, 2018) and intra-shale gamma-ray correlations (Fig. 4) define an intra-shale, onlap geometry, with landward thinning at the pinchout edge.

There is no evidence via gamma-ray correlations or biostratigraphy that the Bakken black shales transition landward into any other lithology, an observation acknowledged by many deep-water advocates (Caplan and Bustin, 1998; Smith and Bustin, 2000; Egenhoff and Fishman, 2013). The intra-shale, onlap stratal geometry, and gradual landward thinning of the Lower Member black shale (Fig. 4) precludes the erosional-remnant interpretation for the Lower Member because the long-distance correlation of intra-shale gamma-ray character indicates minimal intra-shale erosion within the Lower Member. The black shale of the Upper Member is interpreted to have undergone minimal truncation in the southern basin area based on the presence of uniform, landward stratal thinning (Fig. 3) and the absence of mappable truncation features.

Large intra-Bakken sea-level changes, possibly greater than 200 m, have been inferred (Smith and Bustin, 1995, 1996, 2000; Caplan and Bustin, 2001; Hart and Hofmann, 2020) based on the assumption that upper Member and lower Member black shale units formed in deep water, while middle Member strata formed in shallow water. However, no intra-Bakken stratigraphic geometries (e.g., mappable clinoforms, mappable back-step geometries, mappable progradational geometries, major onlaps, major offlaps, etc.) were documented that support large intra-Bakken sea-level changes. Conversely, the presence of oolitic limestone, stromatolites, paleosols, and root traces in the Middle Member C unit (Petty, 2019a, p. 59) is considered as unequivocal evidence for shallow-water Bakken deposition. The stratigraphic evidence indicates that Bakken black shale represents deposition in water depths of <30 m (Petty, 2019a, p. 62), and it is suggested here that the meager stratigraphic record for large intra-Bakken sea-level changes is, in fact, evidence for the absence of large sea-level changes.

Lower Virden Stratigraphic Geometry

The largest intra-Madison sea-level change is inferred to have occurred during the Madison maximum flooding event (Figs. 2, 3, and 6) that separated underlying Bakken deposition from overlying Lodgepole deposition. Smith (1977) and Petty (2019a) estimated this sea-level rise to be ~100 m in central Montana and the Williston basin. The basinal facies of the Scallion subinterval of the basal Lodgepole is estimated to have been deposited in a maximum water depth of 120 m (Petty, 2019a) based on Scallion clinoform thickness and compaction assumptions. Using similar assumptions for the lower Virden, the basinal facies is estimated to have been deposited in a maximum water depth of 140 m.

The most significant advancement in the understanding of the lower Virden regional stratigraphy within the Williston basin was the recognition and regional mapping of the lower Lodgepole clinoform geometry (Grover, 1996). The lower Virden clinoform is interpreted to represent shelf, to slope, to basinal depositional environments, and the corresponding facies are broadly referred to as the shelf facies, slope facies, and basinal facies (Figs. 6 and 7). The clinoform is defined by a thin (<15 m), landward shelf facies that transitions seaward into a thick (maximum 80 m) slope facies that transitions farther seaward into a thin (<10 m) basinal facies.

Beyond the clinoform geometry, the main defining stratigraphic characteristics for the lower Virden system are (1) the presence of a landward facies with definitive shallow-water lithologies that include oolitic grainstone, microbial grainstone and packstone, and solution breccia; (2) the seaward transition to finer-grained lithologies; (3) the seaward transition to more clay-rich lithologies; (4) the seaward transition to mudstone-appearing lithologies that probably represent compacted peloidal packstone; (5) seaward thinning within the slope facies by downlap and intra-unit thinning; (6) continued seaward thinning within the basinal facies; and (7) the thinnest development (<1 m) in the basin-center. Many of these characteristics are the opposite of those seen in the Bakken shallow-water system.

SUMMARY AND CONCLUSIONS

The shallow-water Bakken stratigraphic geometry below the Madison maximum flooding surface differs dramatically from the deep-water lower Lodgepole stratigraphic geometry above the Madison maximum flooding surface. Key stratigraphic geometry differences between the Bakken and lower Virden portion of the lower Lodgepole include:

1. The lower Virden has a well-defined lateral transition from the basinal facies, landward into the slope facies, and farther landward into the shelf facies, but there is no lateral transition from Bakken stratigraphic units into landward shallow-water

units because all Bakken stratigraphic units are shallow-water facies.

2. Bakken lithostratigraphic and biostratigraphic units are relatively uniform laterally, while there is great lateral lithostratigraphic variability within the lower Virden.
3. The thickest Bakken development occurred in the basin-center, while the thickest lower Virden development occurred in the slope facies.
4. There are no mappable clinoforms within the Bakken; conversely, the clinoform geometry is the most conspicuous geometric feature of the lower Virden.
5. All Bakken stratigraphic units thin landward, while the "false Bakken" (lower Virden organic-rich, basinal facies) thins seaward.
6. Bakken lithostratigraphic units display prominent onlap, while overlying lower Lodgepole stratigraphic units display downlap or extreme basinward thinning.
7. Bakken Formation black shales pinch-out landward via intra-shale onlap and stratal thinning; conversely, lower Virden black mudstone thins seaward via downlap and stratal thinning.

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Manuscript received 2 Feb. 2022
Revised manuscript received 11 Apr. 2022
Manuscript accepted 12 Apr. 2022

The Evolution of Paleontological Art

Edited by Renee M. Clary, Gary D. Rosenberg, and Dallas C. Evans

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

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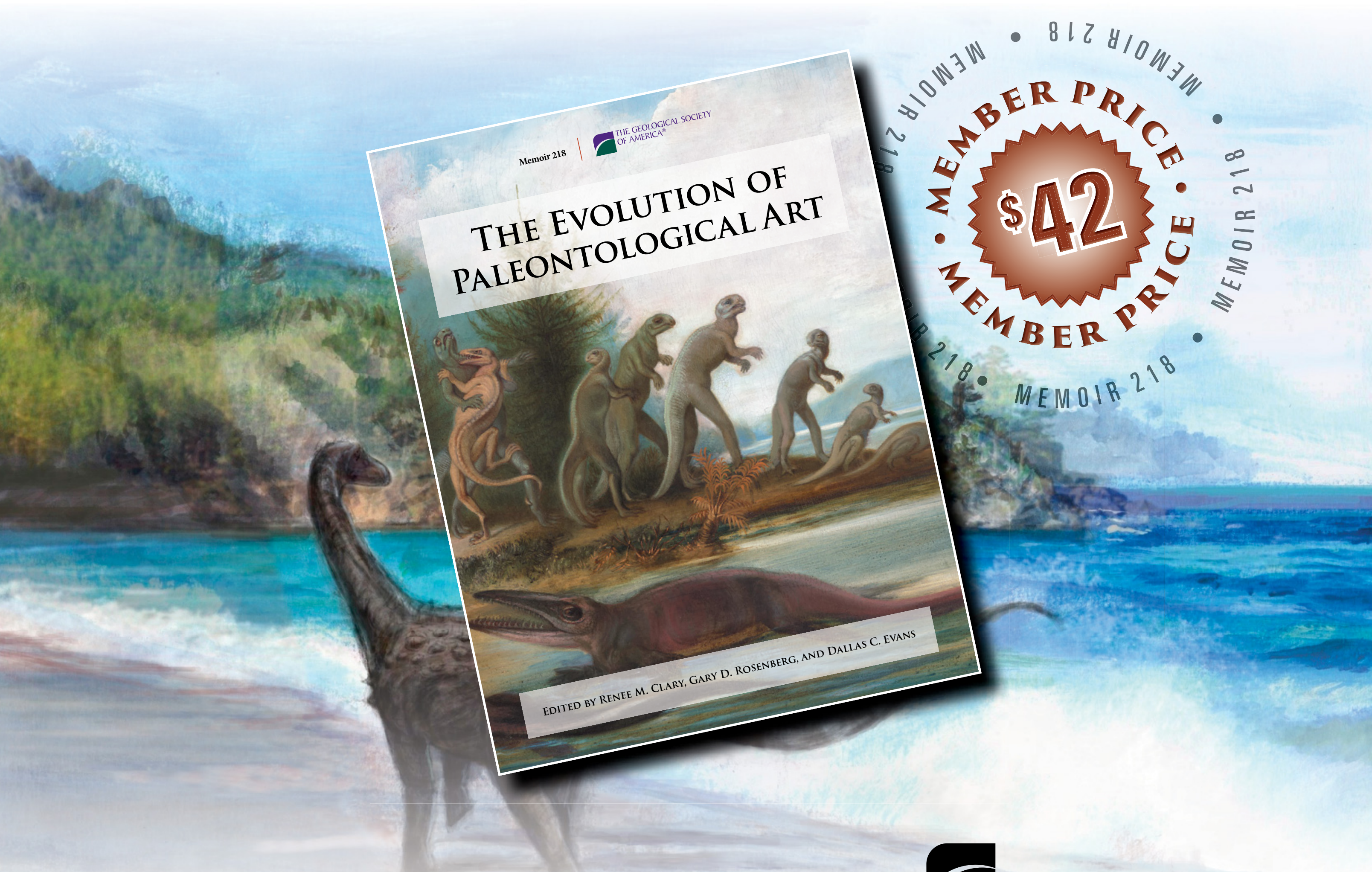

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STUDENT/ECP TRAVEL GRANTS

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 2022. Check the website at **community.geosociety.org/gsa2022/connect/student-ecp/travel-grants** for application and deadline information. Note: Eligibility criteria and deadline dates vary by grant. The deadline to apply for the GSA Student Travel Grant is 6 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 until you sign up as a volunteer to register for the meeting, unless you want to reserve a space in a field trip or short course. Details are on the GSA Connects 2022 website at **community.geosociety.org/gsa2022/registration/volunteers.**

2022 Michel T. Halbouty Distinguished Lecture

Jani Ingram, "Environmental Health Investigations on the Navajo Nation"

Tues., 11 Oct., 12:15–1:15 p.m.

During the mid-1900s, the United States was locked in a nuclear arms race with the former Soviet Union in an era known as the Cold War. In order to meet demands, uranium mines were dug across the Navajo reservation in the U.S. Southwest. Although the Cold War officially ended in 1989 with the fall of the Berlin Wall and the dissolution of the Soviet Union in 1991, these abandoned uranium mines on the Navajo reservation have left a legacy of contamination that infiltrates all aspects of life on the reservation. Uranium is a known toxicant due to its properties as a heavy metal, and uranium mining has been suggested to exacerbate exposure to other elemental toxicants, such as arsenic. Current understanding of the extent of contamination on the Navajo lands is ill-defined. Our research team seeks to elucidate exposure to these toxicants through quantifying uranium and other toxic elemental contaminants in environmental samples including water, soil, plants, and sheep, so as to understand the nature of exposure. Collected data is used to usher change to environmental public policies on the reservation and to increase saliency of the issue through community meetings.

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- Career Presentations
- Résumé Review Clinic
- Drop-In Mentoring
- Early Career Professional Coffee
- Geology Club Meet Up
- Networking Event
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If you're not attending the meeting, consider registering for an upcoming webinar or viewing past career exploration webinars at **www.geosociety.org/webinars.**

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An Yin, University of California

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Priscilla Grew, University of Nebraska

ARTHUR L. DAY MEDAL

Timothy Lyons, University of California

YOUNG SCIENTIST AWARD (DONATH MEDAL)

Kimberly Lau, Penn State University

GSA PUBLIC SERVICE AWARD

Lucile M. Jones, Lucy Jones Center for Science and Society
Yumei Wang, Oregon State Department of Geology and Mineral Industries

RANDOLPH W. "BILL" AND CECILE T. BROMERY AWARD FOR MINORITIES

Frederic H. Wilson, U.S. Geological Survey

DORIS M. CURTIS OUTSTANDING WOMAN IN SCIENCE AWARD

Annie M. Bauer, University of Wisconsin

GSA FLORENCE BASCOM GEOLOGIC MAPPING AWARD

Daniel J. Koning, New Mexico Bureau of Geology and Mineral Resources

GSA DISTINGUISHED SERVICE AWARD

Jennifer Nocerino, Geological Society of America

2022 HONORARY FELLOW AWARDS

Laura DeSantis, National Institute of Oceanography and Applied Geophysics, Italy
Lin Ding, Institute of Tibetan Plateau Research, People's Republic of China

2022 Division Primary and International Awards

GILBERT H. CADY AWARD
Energy Geology Division
Sue M. Rimmer, Southern Illinois University

E.B. BURWELL, JR., AWARD
Engineering and Environmental Geology Division
Carey, J.A., Pinter, N., Pickering, A.J., Prentice, C.S., and Delong, S.B., 2019, Analysis of landslide kinematics using multi-temporal unmanned aerial vehicle imagery, La Honda, California: Environmental and Engineering Geoscience, v. 25, no. 4, p. 301–317.

RIP RAPP ARCHAEOLOGICAL GEOLOGY AWARD
Geoarchaeology Division
David Wright, Smithsonian National Museum for Natural History

DISTINGUISHED CAREER AWARD
Geobiology and Geomicrobiology Division
John W. Valley, University of Wisconsin

M. LEE ALISON AWARD FOR GEOINFORMATICS
Geoinformatics and Data Science Division
Yolanda Gil, Information Sciences Institute

GEORGE P. WOOLLARD AWARD
Geophysics and Geodynamics Division
Ray Wells, U.S. Geological Survey

BIGGS AWARD FOR EXCELLENCE IN EARTH SCIENCE TEACHING
Geoscience Education Division
Christy Visaggi, Georgia State University

MARY C. RABBITT HISTORY OF GEOLOGY AWARD
History and Philosophy of Geology Division
Marianne Klemun, University of Vienna

O.E. MEINZER AWARD
Hydrogeology Division
Beth L. Parker, University of Guelph

GSA DISTINGUISHED CAREER AWARD
International Committee
Anke Friedrich, Ludwig Maximilian University of Munich

ISRAEL C. RUSSELL AWARD
Limnogeology Division
Christopher A. Scholz, Syracuse University

DISTINGUISHED GEOLOGIC CAREER AWARD
Mineralogy, Geochemistry, Petrology, and Volcanology Division
Jane Selverstone, University of New Mexico

G.K. GILBERT AWARD
Planetary Geology Division
Allan Treiman, Lunar and Planetary Institute, Universities Space Research Association

KIRK BRYAN AWARD FOR RESEARCH EXCELLENCE
Quaternary Geology and Geomorphology Division
Timothy Beach, University of Texas, for Timothy Beach, Sheryl Luzzadder-Beach, Samantha Krause, Tom Guderjan, Fred Valdez Jr., Juan Carlos Fernandez-Diaz, Sara Eshleman, and Colin Doyle, 2019, Ancient Maya wetland fields revealed under tropical forest canopy from laser scanning and multiproxy evidence: Proceedings of the National Academy of Sciences, v 116, no. 43, p. 21,469–21,477.

LAURENCE L. SLOSS AWARD
Sedimentary Geology Division
Judith Parrish, University of Idaho

CAREER CONTRIBUTION AWARD
Structural Geology and Tectonics Division
Peter Molnar, University of Colorado

Cole Award

GSA FOUNDATION

The W. Storrs Cole Memorial Award for postdoctoral research is funded by the GSA Foundation.

W. STORRS COLE MEMORIAL RESEARCH AWARD

Dr. Pete van Hengstrum, Texas A&M University, will be awarded US$5,500, from the W. Storrs Cole fund for the research project, “Documenting subtropical climate and rainfall variability during the Dansgaard-Oeschger Events of Marine Isotope State 3 using foraminiferal and ostracod paleoecology.”

The award will be presented at Cushman Foundation for Foraminiferal Research Awards Ceremony at GSA Connects 2022 in Denver, Colorado, USA, on Tuesday, 10 October.

John C. Frye Memorial Award in Environmental Geology

AASG
Association of American State Geologists

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In cooperation with the Association of American State Geologists (AASG), GSA makes an annual award for the best paper on environmental geology published either by GSA or by one of the state geological surveys.

Anna Fehling and **David Hart** in recognition of the outstanding publication:

Potential effects of climate change on stream temperature in the Marengo River head-waters: Wisconsin Geological and Natural History Survey Bulletin 115, 74 p., 3 pl., 3 datasets.

2022 Field Award Recipients

J. DAVID LOWELL FIELD CAMP SCHOLARSHIP AWARD

GSA FOUNDATION

BRUNTON

These 30 undergraduate students will each be awarded US$2,000 and a new Orange Standard Transit to attend the summer field camp of their choice based on diversity, economic/financial need, and merit.

Elizabeth Baron, North Carolina State University
Lauren Cannon, Kansas State University
Justin Coley, University of North Carolina Charlotte
Ashley Dann, University of Florida
Gabrielle Davy, University of Alaska Fairbanks
Savannah Devine, Appalachian State University
Jason Drebber, University of Vermont
Mable Hagans, Western Colorado University
Easton Hitchens, University of Mount Union
Celeste Hofstetter, University of California Riverside
Jordan James, College of Charleston
Alexya Lee, Mount Holyoke College
Kitsel Lusted, University of Utah
McKenzie Miller, University of North Carolina Charlotte
Leyla Namazie, University of California Berkeley
Ethan Oleson, Montana State University
Stine Ornes, Davidson College
Charis Peever, University of Idaho
James Regensburger, Pennsylvania State University
Kristi Rasmussen, Weber State University
Megan Ryan, The University of Akron
Alec Siurek, Indiana University Northwest
Cassia Snyder, Indiana University Purdue University at Indianapolis
Karrah Spendlove, University of Utah
Benjamin Thomas, Franklin & Marshall College
Elysia Viengkham, University of Washington
Donovan Vitale, Western Michigan University
Braxton Ward, Morehead State University
Zachary Williams, University of Oklahoma
Brynn Wooten, Fort Hays State University

GSA FIELD CAMP EXCELLENCE AWARD

GSA FOUNDATION

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.

Emily Finzel, University of Iowa Field Camp

Meet Your Fiscal Year 2023 Officers & Councilors

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GSA COUNCILORS

Term: July 2019–June 2023

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Pocatello, Idaho, USA

Margaret Eggers
Eggers Environmental Inc.
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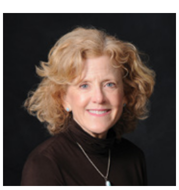
University of Washington
Seattle, Washington, USA

Term: July 2020–June 2024



Susan G. Stover
Emerita Kansas Geological Survey;
Consultant
Topeka, Kansas, USA

Madeline E. Schreiber
Professor, Virginia Tech
Blacksburg, Virginia, USA

Abhijit Mukerjhee
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Kharagpur (ITT KGP)
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Term: July 2021–June 2025

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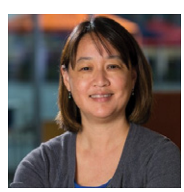
Reston, Virginia, USA



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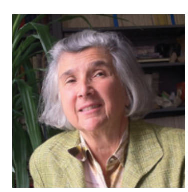
Sedimentary Geology Consultants
Calgary, Alberta, Canada



Donna M. Jurdy
Northwestern University
Evanston, Illinois, USA

NEWLY ELECTED
Term: July 2022–June 2026

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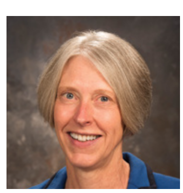
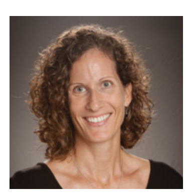
Lettis Consultants
International Inc. (LCI)
Sacramento, California, USA



Carol D. Frost
University of Wyoming
Laramie, Wyoming, USA



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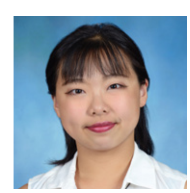

GSA STUDENT ADVISORY COUNCIL CHAIR
Yueyi Che (through October 2022)
University of California Berkeley
Berkeley, California, USA

In Memoriam

The Society notes with regret the deaths of the following members (notifications received between 23 December 2021 and 1 May 2022). 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.

Richard T. Bell
Toronto, Ontario, Canada
Date of death: 15 January 2022

Peter W. Birkeland
Boulder, Colorado, USA
Date of death: 25 January 2022

Roberto Molina Garza
Querétaro, Mexico
Date of death: 29 December 2021

Leon T. Silver
Pasadena, California, USA
Date of death: 31 January 2022

Colin W. Stearn
Waterloo, Ontario, Canada
Notified 20 January 2022

Rowland W. Tabor
Portola Valley, California, USA
Date of death: 13 January 2022

Loren M. Toohey
Houston, Texas, USA
Notified 11 February 2022

George W. Whitney
Denver, Colorado, USA
Date of death: 15 December 2021

Jean A. Wosinski
Corning, New York, USA
Date of death: 4 December 2021

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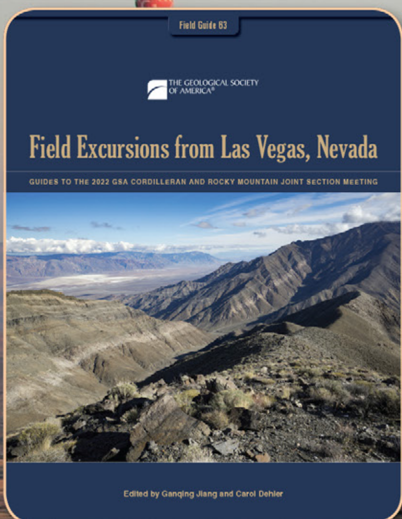

Field Excursions from Las Vegas, Nevada: Guides to the 2022 GSA Cordilleran and Rocky Mountain Joint Section Meeting

Edited by Ganqing Jiang and Carol Dehler

With this Field Guide in hand, enjoy a trip to the Buckskin-Rawhide and northern Plomosa Mountains metamorphic core complexes in Arizona; explore the geology of Frenchman Mountain and Rainbow Gardens and landslide deposits and mechanisms in the eastern Spring Mountains in Nevada; and learn about microbialites in Miocene and modern lakes near Las Vegas. When weather permits, unravel the geological history of southern Death Valley, California, and explore vertebrate paleontology and Cenozoic depositional environments in Death Valley.

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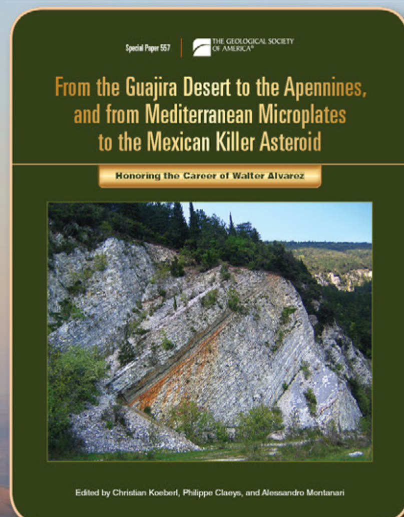

From the Guajira Desert to the Apennines, and from Mediterranean Microplates to the Mexican Killer Asteroid: Honoring the Career of Walter Alvarez

Edited by Christian Koeberl, Philippe Claeys, and Alessandro Montanari

A tribute to the great career and extensive scientific accomplishments of Walter Alvarez, on the occasion of his 80th birthday in 2020, this volume presents a series of papers written by many of his close collaborators and friends that provide current advances in and highlight specific aspects of the many topics Walter has covered, including tectonics of microplates, structural geology, paleomagnetics, Apennine sedimentary sequences, geoarchaeology and Roman volcanics, Big History, and most famously the discovery of evidence for a large asteroidal impact event at the Cretaceous–Tertiary (now Cretaceous–Paleogene) boundary site in Gubbio, Italy, 40 years ago.

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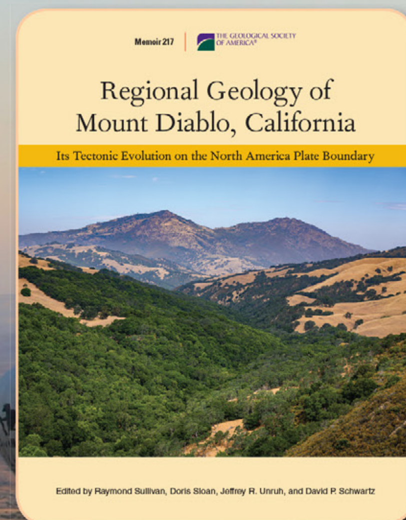

Regional Geology of Mount Diablo, California: Its Tectonic Evolution on the North America Plate Boundary

Edited by Raymond Sullivan, Doris Sloan, Jeffrey R. Unruh, and David P. Schwartz

Celebrating the Northern California Geological Society’s 75th anniversary, this Memoir illustrates the complex Mesozoic to Cenozoic tectonic evolution of the plate boundary and includes papers on structure, stratigraphy, tephrochronology, zircon provenance studies, apatite fission track analyses, and foraminifera and calcareous plankton assemblages tied to Cenozoic climate events. Readers will also discover the history of geologic work and the resource development of oil and gas, mercury, coal, and sand, and road aggregate in this fascinating region.

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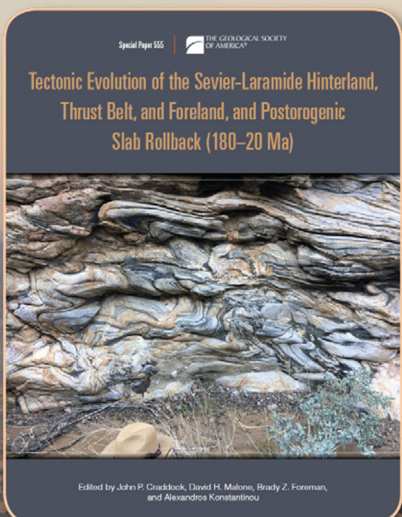

Tectonic Evolution of the Sevier-Laramide Hinterland, Thrust Belt, and Foreland, and Postorogenic Slab Rollback (180–20 Ma)

Edited by John P. Craddock, David H. Malone, Brady Z. Foreman, and Alexandros Konstantinou

This Special Paper focuses on the evolution of the crust of the hinterland of the orogen during the orogenic cycle, and describes the evolution of the crust and basins at metamorphic core complexes. The volume includes a regional study of the Sevier-Laramide orogens in the Wyoming province, a regional seismic study, strain analysis of Sevier and Laramide deformation, and detrital zircon provenance from the Pacific Coast to the foreland between the Jurassic and the Eocene.

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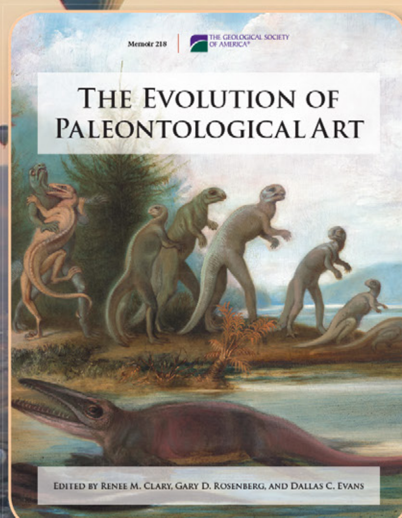

The Evolution of Paleontological Art

Edited by Renee M. Clary, Gary D. Rosenberg, and Dallas C. Evans

This volume samples the history of art about fossils and the visual conceptualization of their significance starting with biblical and mythological depictions, extending to renditions of ancient life as it flourished in long-vanished habitats, and moving forward to a modern understanding that fossil art conveys lessons for the betterment of the human condition. The chapters illustrate how art about fossils has come to be a significant teaching tool about evolution of past life and conservation of our planet for the benefit of future generations.

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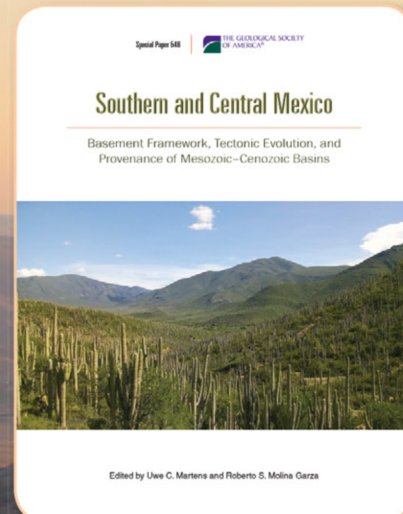

Southern and Central Mexico: Basement Framework, Tectonic Evolution, and Provenance of Mesozoic–Cenozoic Basins

Edited by Uwe C. Martens and Roberto S. Molina Garza

This seminal work furthers our understanding of key basins in central and southern Mexico, and establishes links to exhumed sediment source areas in a plausible paleogeographic framework. Authors present data and models on the relations between Mexican terranes and the assembly and breakup of western equatorial Pangea, plate-tectonic and terrane reconstructions, uplift and exhumation of source areas, the influence of magmatism on sedimentary systems, and the provenance and delivery of sediment to Mesozoic and Cenozoic basins.

SPE546, 468 p., ISBN 9780813725468
$120.00 | **member price $84.00**

Geoscience and Human Health (GeoHealth): Impacts and Mitigation of Impacts on Human Health Due to a Changing Natural Environment

Kasey White, *GSA Director for Geoscience Policy;* ***Barb Dutrow,*** *2021–2022 GSA President*

Under the overarching theme of GeoHealth, the National Science Foundation (NSF) requested that the Geological Society of America (GSA) contribute innovative ideas that have the potential for solving societal problems and provide commercialization potential on a short time frame. GSA gathered feedback from its network, including its members and Associated Societies, through a series of targeted brainstorming sessions, online questionnaires, Section Meeting events, and directed outreach to experts in the community of practice. GSA is grateful to its members and the broader community for their thoughtful input and to the NSF for the opportunity to participate.

The responses underscore the fundamental linkage that Earth's health influences human health. Human health intersects with all of Earth's spheres: lithosphere, hydrosphere, atmosphere, and biosphere. It is therefore essential that geoscientists, who analyze all of Earth's spheres, partner with those in the health, epidemiological, and toxicological fields to maximize the identification, monitoring, communication, and mitigation impacts on human health that occur through geologic processes. In concert, those same partners provide synergy to use geological materials to improve human health. A summary of responses to NSF's posed questions follows, along with a brief description of our methodology. The full report is online at **www.geosociety.org/geohealth-solutions.**

What are the highest priority challenges in GeoHealth that can be addressed with actionable solutions in a two- to three-year timeframe?

Earth scientists can inform and partner with health researchers to identify, predict, and mitigate health impacts brought about by climate change as mediated through geologic processes. Examples include sea-level rise, over-use of groundwater, increased aridity and desertification, and severity and impact of wildfires. Climate mitigation efforts, such as increased mining activities for mineral resource extraction to fuel the low-carbon transition, could also affect health.

Additional opportunities at the intersection of geology and health include developing geologic materials into products that benefit human health, such as the use of antibacterial clays to defeat antibiotic-resistant pathogens, enhanced pathogen research, and deeper understanding of human uptake of metals.

Massive datasets for geological parameters, as well as various health parameters, are available. These datasets can be mined, analyzed, and mapped using geospatial tools to create new insights and high-impact visuals for communication among scientists and non-scientists. The application of geospatial tools is a vastly underutilized method to determine correlations between geological data (e.g., soil and groundwater contaminant concentrations) and health and demographic parameters. Such studies can help pinpoint areas or neighborhoods with the greatest risks of excessive exposure to various contaminants, such as PFAS, microplastics, and pharmaceuticals, as well as mine waste and agricultural runoff.

How would you reach those GeoHealth goals? What stakeholders, technology, and/or partnerships are needed?

Transdisciplinary collaboration, particularly with health scientists, will be a key requirement for many of the research initiatives, in part to gain access to fine-scale health data that are subject to confidentiality provisions outside of the researchers collecting the data. New funding sources and funding models are needed to incentivize and support these collaborations between geoscientists and medical/biomedical researchers at the state, federal, and international levels. In addition, it will be useful to develop technology partners to better connect high-resolution geospatial data with health data.

How do we effectively communicate the critical role of geoscience in addressing environmental impacts on human health to the public and decision makers?

Communication and outreach are crucial to GeoHealth, both for identifying areas of needed research and for sharing results. To be effective and to drive participation, communication and outreach efforts must be funded, supported, and valued and involve professionals at all career stages and stakeholders in the community. A range of communication strategies, including visualization tools, are needed. Partnerships with not-for-profit organizations allow geoscientists to build upon their proficiencies in this area, while connections with high-visibility organizations allow for enhanced outreach to the general public.

What changes and resources are needed to embed a culture of innovation, entrepreneurialism, and translational research in GeoHealth?

Development of new funding mechanisms (e.g., with National Institutes of Health [NIH] and education) and reward structures to incentivize partnerships and transdisciplinary research are needed. In addition, opportunities exist to develop course content in geosciences to be embedded into traditional biological/medical sciences.

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.

John R.L. Allen*
Richard B. Alley*
Lisa Amati
Lesleigh Anderson
Charles B. Andrews*
Paul K. Atkinson
Cliff Baines
Gregory Stephen Baker
Beth Ann Bartel
Frederick C. Beall
Thomas P. Becker
Patricia A. Beddows
Wayne R. Belcher
Jacob S. Benner
Sue Ann Bilbey
Janice L. Bishop*
Ingo Blechschmidt
Steve M. Bohaty
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Alan Boudreau
Barry E. Bowman
Nathalie Nicole Brandes
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Carolyn H. Brown
Gordon E. Brown Jr.*
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Reed J. Burgette
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Norlene R. Emerson
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Carmala N. Garzione*
Michael A. Gibson
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Joseph R. Graney
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Motomu Ibaraki
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Carrie Ellen Jennings*
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John V. Leone
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Michael E. Matthews
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Leslie A. Melim
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James P. Robinson
Tara L. Root
Stephen M. Rowins
Jamie Rueda-Gaxiola
Cal Ruleman
Dibyendu Sarkar*
Karen L. Savage
Allan W. Scheer
Christian M. Schrader
Christopher Allen Schultz
Peter H. Schultz*
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Dixon Van Hofwegen
Robert Kelly Vance
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Al F. Waibel
Deborah J. Waiting
Robert Lee Ward
Cheryl Waters-Tormey
Richard M.T. Webb
Mark Webster
Paul H. Wetmore
Jennifer Whisner
S. Christopher Whisner
Scott M. White
Judy L. Wilkinson
Gene Roger Williams
Steven H. Williams
Alicia M. Wilson*
John L. Wilson III*
James D. Wright
Shuhai Xiao*
Katsuyuki Yamashita
Gary T. Yoshiba
Vitaly A. Zlotnik*

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 **https://rock.geosociety.org/membership/50YearFellows.asp.** Asterisks (*) indicate GSA Fellows.

David M. Abbott*
Thomas H. Anderson*
Bruce E. Archinal
Raymond E. Arvidson*
Randal Jack Ashley
Genevieve Atwood*
Steven A. Austin
Frederick W. Bachhuber
Brian G. Barber
Mervin J. Bartholomew*
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Earl H. Bennett
Herbert S. Bensinger
Evelynne M. Berg
Antony Robert Berger
Suzanne Beske Diehl
Gary N. Bigham
Robert Blackstone
John Anthony Blair
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Gary Ray Byerly*
Victor E. Camp*
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Linda Provo Fulton
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Walter M. Leis.
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John Maddry
Douglas Maercklein
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Helaine Walsh Markewich*
James M. Mattinson*
Florentin J. Maurrasse
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David L. Meyer
Douglas G. Mose
Bimal Mukhopadhyay
Carl W. Myers*
Douglas D. Nelson
William D. Nesse
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J. Frederick Sarg*
Michael L. Sargent
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Lane D. Schultz*
David Richard Schwimmer
Graig D. Shaak
John M. Sharp Jr.*
Stephen L. Shaw
Robert J. Shedlock
Jay L. Smith
Michael Alexis Smith*
Mitchell D. Smith
Norman B. Smyers
Steven G. Spear
William Speidel
Steven M. Stanley*
Edward F. Stoddard*
William D. Stuart
Edmund Stump*
Charles F. Sutphen
Sanford A. Taylor
Jorn Thiede*
Peter R. Thompson
Woodrow B. Thompson*
Carlos Maria Urien
Grant M. Valentine*
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Karl Vonder Linden*
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Robert D. Winn
Michael F. Wolfert
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Thomas E. Yancey*
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William D. Zogg

2022 GSA Fellows

Society Fellowship is an honor bestowed on the best of our profession by election at the spring GSA Council meeting. GSA members are nominated by other GSA members in recognition of 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 2022. We invite you to read some of what their nominators had to say:

Kenneth D. Adams (Desert Research Institute): Dr. Kenneth D. Adams is an outstanding field geoscientist who translates his observations of sedimentology, stratigraphy, and geomorphology of ancient and extant lakes in the Great Basin and elsewhere into exciting new approaches to paleoclimate and landscape reconstructions, including water depth, wind strength, wave height, and effects of isostatic rebound. —Marith C. Reheis

Laurie C. Anderson (South Dakota School of Mines & Technology): Dr. Anderson's contributions to the geoscience community include new discoveries in paleobiology and taphonomy, education and mentorship of the next generation of geoscientists, active engagement in professional societies, and supporting early-career and female academics. She is a dedicated teacher, academic, and mentor in the field and lab. —Sarah Wheeler Keenan

Pranoti M. Asher (American Geophysical Union): Pranoti Asher is an exemplar of scholarship, service, and dedication to broadening participation and advancing inclusion of all people in geosciences. We honor her decades of service and leadership in GSA, Association for Women Geoscientists, Council for Undergraduate Research, National Association of Geoscience Teachers, and the American Geophysical Union. —Stephen K. Boss

José Rafael Barboza-Gudiño (Instituto de Geología UASLP): The attainment of Fellowship by Dr. José Rafael Barboza-Gudiño recognizes his important contributions to the fields of regional geology, stratigraphy, and tectonics of northeastern Mexico, his capable development of a distinguished geology program at the Universidad Autónoma de San Luis Potosí, and his training of future geoscientists. —Timothy F. Lawton

Jaime D. Barnes (University of Texas): Jaime has made seminal contributions to understanding subduction-zone processes through novel application of halogen and stable-isotope geochemistry to components of subduction systems: downgoing altered oceanic crust, overlying metamorphic rocks, and arc volcanic rocks. She also is exemplary in promoting the involvement of women in cutting-edge science and science education. —William P. Leeman

Paul A. Bedrosian (U.S. Geological Survey): Paul Bedrosian has made fundamental contributions to basement mapping and tectonics, to mineral and groundwater resource studies, and to volcano, seismic and geomagnetic hazards understanding through application of electromagnetic geophysical methods, principally magnetotellurics (MT). His works have been published in top journals and he has mentored numerous young professionals. —Philip E. Wannamaker

Andrew M. Bush (University of Connecticut)**:** We recognize Andrew M. Bush, invertebrate paleontologist and paleoecologist, for developing elegant, quantitative approaches to illustrating patterns and processes in the history of marine life, which have informed present understanding of how environmental changes interact with the ecological and physiological traits of organisms to drive changes in diversity. —Tracy D. Frank

Christopher G. Daniel (Bucknell University): Chris Daniel is a highly regarded, versatile metamorphic petrologist whose impactful papers, field trips, and presentations have, for example, led to significant revision of the Proterozoic tectonic history of New Mexico with implications that extend across Laurentia. He has shown deep commitment to and engagement with GSA's mission. —Mary Beth Gray

Saugata Datta (University of Texas at San Antonio): We are nominating Dr. Saugata Datta for GSA Fellowship based on his exemplary long-term service and leadership for the GSA and other professional organizations, his extensive and widely recognized scientific achievements, his distinguished service to his university, and his enduring commitment to developing future geoscientists. —Jeff Rubin

"… an outstanding geologist, valued colleague, and major contributor to the geological community for over fifty years."

Andrew P. de Wet (Franklin & Marshall College): For outstanding service as a fine teacher and exceptionally inspiring mentor in research of so many students in geology, planetary science, and environmental science; for his innovative application of GIS and remote sensing to research and education in these fields; and for his valuable contributions to GSA programs, notably in planning and leading field excursions and meetings. —Roger D.K. Thomas

Paul K. Doss (University of Southern Indiana): Professor Paul Doss is an ardent proponent of incorporating geoscientific knowledge into sound public policy, as evidenced by his leadership on GSA Committees and as a GSA Visiting Scholar on Geology and Public Policy. He also has demonstrated exemplary and innovative student education and mentorship in geohydrology and environmental studies. —Lisa A. Morzel

Eva Enkelmann (University of Cincinnati): Dr. Enkelmann is a top scientist in the field of thermochronology. She has published landmark papers on interactions of erosion and tectonics; has served GSA well; and has been an excellent student mentor. —Terry L. Pavlis

Andrea Festa (University of Torino, Italy): Nominated as GSA Fellow for his systematic and quantitative studies and classification of on-land and submarine subduction–accretion complexes and mélanges around the globe, his high-impact and transformative papers on these subjects, and his service to the Society. —Yildirim Dilek

Bonnie Fine Jacobs (Southern Methodist University): Bonnie Jacobs is nominated for GSA fellowship for her pioneering work in paleobotany, notably on grasslands and the fossil floras of Africa; for mentoring numerous young scientists, especially women; for establishing environmental science programs at Southern Methodist University; and for staunch perseverance in the face of adversity. —Ellen Currano

"… a shining example of scientific achievement and training and mentoring of geoscientists."

Alicia Kahn (Chevron Corporation): Alicia Kahn's dedicated service in professional societies and community outreach encompasses GSA student members through GeoCareers, Women in Geology, and drop-in mentoring at GSA annual meetings. Her ability to balance professional and family life, plus outreach, make her an excellent role model, especially for students and early career professionals. —Miriam E. Katz

David T. King Jr. (Auburn University): Dr. King's three main areas of distinction are: work with Wetumpka crater, spanning 25 years, establishing a bona fide crater, and yielding many papers, theses, and research grants; stratigraphic work in Belize making him the leading expert there; and 30 years studying Alabama coastal plain that is of enduring value. —Ashraf Uddin

Kurt O. Konhauser (University of Alberta): Kurt Konhauser is an international leader in geobiology. He uniquely integrates biological experiments and geological analyses to illuminate the interplay of life and environments on the early Earth. He had the vision to establish and now direct geobiology's journal, society, and conference, and his prolific mentorship helps ensure its future. —Rowan C. Martindale

Jade Star Lackey (Pomona College): Jade Star excels at combining field study, precise analytical work, and teaching. He is a shining example of how two of GSA's nomination categories, scientific achievement and training and mentoring of geoscientists, can be, and should be, intertwined. —Allen F. Glazner

Rebecca A. Lange (University of Michigan): Dr. Rebecca A. Lange should be elected a Fellow for her contributions to the thermodynamic properties of magmas and her leadership in earth science programs and organizations. —Youxue Zhang

Nathaniel A. Lifton (Purdue University): Nat Lifton is a global leader in cosmogenic nuclides, widely recognized for his pioneering work developing reliable extraction methods for in situ ^{14}C from mineral grains, and for his work modeling cosmogenic nuclide production rates, which serves as a benchmark for calculating exposure ages and other cosmogenic nuclide applications globally. —Darryl E. Granger

Glen S. Mattioli (UNAVCO Inc.): For quantifying tectonic and magmatic systems in the Caribbean region and elsewhere through deployment and application of advanced techniques in geodesy, for excellence in teaching and mentorship, and for admirable administrative leadership at universities, at NSF, and in UNAVCO. —Barry Voight

Rodney V. Metcalf (University of Nevada Las Vegas): Dr. Rodney V. Metcalf is a professor emeritus, after 30 years at UNLV. His exemplary service to GSA, geo-administration, science-communication, and volcanic-plutonic, ophiolite, and asbestos research is remarkable. His rock-solid ethics, exceptional intelligence, and caring attitude make him one of the very best colleagues anyone could ever hope to have. —Brenda J. Buck

Joseph Michalski (University of Hong Kong): Dr. Joseph Michalski should be elected Fellow of GSA for forging novel and paradigm-shifting theories about Mars in the areas of volcanism, climate history, and a potential deep biosphere, for mentoring and training young planetary scientists, for thoughtful leadership of geoscience programs, and for service to GSA and our community. —Janice L. Bishop

Ingrid Padilla (University of Puerto Rico): For her sustained research contributions to understanding groundwater flow and contaminant transport in karst aquifers with its implications for the protection and remediation of drinking-water resources and for her leadership of interdisciplinary collaborative efforts to explore human-health outcomes of exposure to contaminated groundwater. —Dorothy J. Vesper

Sandra Passchier (Montclair State University): Dr. Sandra Passchier is a leading Antarctic sedimentologist whose extensive research highlights Cenozoic paleoclimate change. She has accomplished this work while training and mentoring a diverse group of future scientists. —Suzanne OConnell

Jeffrey B. Plescia (Johns Hopkins University/APL): Dr. Jeff Plescia has served the geoscience community over an illustrious career. Besides his excellent and long scientific research record, he has contributed to helping GSA conferences attract an annual gathering of international experts in the field of impact cratering, inspiring many early-career scientists who have attended these sessions. —Christian Koeberl

"… an excellent role model, especially for students and early career professionals."

Rene M. Price (Florida International University): For her outstanding research contributions to understanding groundwater–surface-water interactions in the Florida Everglades and the role of sea-level change in modifying the hydrological and biogeochemical environment and for her support and training of minority students in hydrogeology to prepare a new generation of professionals addressing pressing environmental concerns. —Janet S. Herman

Mark K. Reagan (University of Iowa): Mark is nominated for outstanding contributions to scholarship over a 40-year career in earth science. He has published 94 papers in peer-reviewed journals and is internationally recognized for his expertise in subduction-related magmatism and the application of uranium-series dating to a broad range of geoscience problems. —Charles Thomas Foster Jr.

Jason A. Rech (Miami University): Jason Rech is nominated for GSA fellowship for his work on geologic deposits associated with springs and wetlands in desert environments of the Americas and Near East, radiocarbon dating and stable isotopes of gastropod shells, and the uplift of the Andes and evolution of the Atacama Desert. —Jeff Pigati

"… an exemplar of scholarship, service, and dedication to broadening participation and advancing inclusion of all people in geosciences."

Michael Savarese (Florida Gulf Coast University): Mike Savarese is an outstanding geosciences educator in every respect. His sustained leadership service and multimedia outreach to the Southwest Florida community on the issues of climate-change preparedness, sea-level rise, and coastal adaptation has been and continues to be an invaluable asset for the entire region. —H. Allen Curran

Elizabeth R. Schermer (Western Washington University): Dr. Elizabeth Schermer has had a distinguished career of research, training and mentoring of undergrads and graduate students, and of service to GSA. She has served in leadership positions for the Division of Structural Geology and Tectonics, she has led GSA field trips, and she has chaired numerous sessions. She has been a regular attendee of annual and section meetings of GSA. Her accomplishments make her highly deserving of the distinction of Fellow. —Mary S. Hubbard

Alan L. Smith (California State University): Dr. Alan L. Smith is an outstanding geologist, valued colleague, and major contributor to the geological community for over fifty years. He is widely recognized as one of the leading experts in the world on Caribbean volcanic history and processes, publishing widely and involving many students in this work. —Joan E. Fryxell

James A. Spotila (Virginia Tech): For research and teaching in active tectonics, notably the behavior of continental deformational systems, the interaction of tectonics and surficial processes, and the impact of tectonics on society. Specifically for studies of transpressive strike-slip systems, the processes that control glacial erosion, and landscape development of landscapes in ancient orogens. —Lewis A. Owen

Caroline A.E. Strömberg (University of Washington, Seattle): Caroline Strömberg is nominated for GSA fellowship for founding a new field of research using phytoliths to investigate fossil floras and ecosystems, for fundamental research on grasses and grassland evolution, for mentoring numerous young scientists, and for outreach to high school and middle school girls with an interest in science. —Matthew J. Kohn

Pieter T. Visscher (University of Connecticut): Pieter Visscher has made commendable contributions in carbon biogeochemistry, geomicrobiology, and marine sedimentology. He has been an active member of GSA for 15 years and has presented regularly at GSA meetings. More so, Pieter has successfully trained many students and peers. —Nora Noffke

Catherine Weitz (Planetary Science Institute): Dr. Catherine Weitz should be elected as a Fellow of GSA for her innovative, revolutionary, and influential discoveries on the geology of Mars, the Moon, and Venus, including work on missions, research, and publications, as well as for her support of GSA and contributions to the planetary science community. —R. Aileen Yingst

Nancy S. Williams: During eight years (2013–2021) as secretary of the North-Central Section of GSA, Nancy Williams has not only kept the Section on an even keel in trying times but has overseen the doubling of the Section Endowment, which will provide more funds for student grants and travel in the future. —Joseph T. Hannibal

Doug Yule (California State University, Northridge): Doug Yule has had a distinguished teaching and research career. He taught across the curriculum, sustained the field program, and sought opportunity for underrepresented students. His research established constraints on the kinematics, earthquake history, and seismic potential of the San Andreas and other faults. —Andrew Meigs

Thanks to the GSA Fellows Nominators

Thank you to the following GSA members who made a GSA fellowship nomination in 2022.
For more information on how to nominate a deserving colleague, go to **www.geosociety.org/Fellows.**

Donald Francis F. Argus
Joan Florsheim
Jason P. Briner
Lisa E. Park Boush
P. Thompson Davis
Shaun Keith Frape
Marith C. Reheis
Sarah Wheeler Keenan
Stephen K. Boss
Timothy F. Lawton
Alfred S. McEwen
William P. Leeman
Robert Hadley Sydnor
Philip E. Wannamaker
Tracy D. Frank
Diane Ruth Smith
Mary Beth Gray
Jeff Rubin
Roger D.K. Thomas
Lisa A. Morzel
Terry L. Pavlis
Yildirim Dilek
Ellen Currano
Miriam E. Katz
Jens Thomas Birkholzer
Ashraf Uddin
Rowan C. Martindale
Allen F. Glazner
Youxue Zhang
Darryl E. Granger
Barry Voight
Brenda J. Buck
Janice L. Bishop
Dorothy J. Vesper
Suzanne OConnell
Christian Koeberl
Tom M. Scott
Janet S. Herman
Charles Thomas Foster Jr.
Jeff Pigati
H. Allen Curran
Mary S. Hubbard
Joan E. Fryxell
Lewis A. Owen
Matthew J. Kohn
Nora Noffke
R. Aileen Yingst
Joseph T. Hannibal
Andrew Meigs

Welcome New GSA Members

The following new members joined between 6 August 2021 and 23 February 2022 and were approved by GSA Council at its spring meeting.

PROFESSIONALS

Pride T. Abongwa
Ademuyiwa Adetunji
Jeffrey Andrilenas
Ozair Ashraf
Romain Augier
Catia Fernandes Barbosa
Brooke Bennett
James Bentkowski
Aaron David Bierly
Randall Gene Billinger
Issam Bou Jaoude
Steven Richard Broom
Kyle Brudvik
Lori Lea Bryan
Gary Ronald Burton
Lilja Elyse Carden
Cornelia Clarke
Kimberly Ann Collingwood
David Rhys Converse
William Joseph Cook
Sara Rosenzweig Cribbs
Marshall C. Crouch III
Brian Patrick Crowley
Steve Cumella
Michael Danielsen
Rondi Davies
Elizabeth Pierce Davis
Francisco De Azevedo Jr.
Catherine Marie Donohue
Trevor Ryan Dwyer
Peter Englert
Neal Farmer
Catherine Fitzgerald
Alyssa K. Fjeld
Heather Louise Ford
Robert G. Ford
Christopher Galagan
Christopher Gammons
David L. George
Jen Georgen
Dianna Gielstra
Max Darryl Gilliland
Tom Gilmore
Arthur Glasfeld
Stuart M. Gluck
Evelyn Goebel
Murray William Grigg
Nathan Grigsby
Amy Louise Gross
Ross Jeffrey Grundler
Alfred C. Guiseppe
Zhilin Guo
Wendy S. Hale-Erlich
Angela Halfpenny
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Anthony Iannacchione
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Sean Sean Jahanian
Earl James
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Nori Leilani Koehler
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Erin Rose Lacount
Philippe Lambert
Michael Warren Laneville
Katherine Lester
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Erin A. Lynch
Marion Lytle
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Steven L. Martin
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Stacey Metzler
Michael Meyer
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Yani Najman
Carole Lynn Nash
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Matthew Noerpel
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Engil Pereira
Jessica Preston
Jacek Puziewicz
Frank Raviola
Julie A. Reese
Rodney Edwin Reeve
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Ashley Marie Rowe
Joe Schilter
Tobias Schneider
Daniel Carl Schneidereit
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Charles H. Simonds
Douglas B. Sims
Sara Leeann Solis
W. Geoffrey Spaulding
Andrew Isaac Stearns
Frank Geo. Strickland
Anna Lee Strimas
Jessica Swann
Lindsay Cave Taliaferro III
Peter Tilke
Trang T. Tran
Frank Tsai
Nick Vaka
William Vales
Maria Waller
Daphanee Waters
Hannah Weiler
Doug and Peg Weimer
William J. Weiss
Cheryl Muzyl Weitzel
William B. White
Siri Wickramaratne
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Tamara Yanina
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Sanna Alwmark
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Suzanne Birner
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Kevin T. Burke
Benjamin Burnett
Ryan Caspary
Paula Castillo
Julien Jacques Caubel
Frank Clougherty
Kenton Cobry
Caitlin Colleary
Kayla Ranee Creedon
Nathan Cutler
Javier Roberto De Anda
Amber Degon
Neil Dezarn
Austin J. Dilla
Grant Elliott
Shannon English
Timothy Frisa
Madilyn R. Frisk
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Emalyn Rose Glastetter
Deborah Glenn
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Sean P. Grasing
Patrick Trent Greiner
Eric Hammers
Gerhard Richard Henneberger
Rachael Alyce Hines
Elizabeth Hoffmann
Maria Anastasia Hruska
Xiang Huang
Haitao Jin
Amber Skye Johnson
Ian Johnson
Md Golam Kibria
Stephan Kolzenburg
Kevin Konrad
Jennifer Lamp
Raymond Lee
Diana Rose Lewis
Gray Fisher Livingston
Gary Long
Radik Makshaev
Samantha Marks
Ryan McKay
Caitlin Ana Meadows
Joseph Miller
Tushar Mittal
Alistair Monteath
Staunen Morian
Stevie Lynn Morley

Ameha A. Muluneh
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Tyler Alan Norris
Aransiola Opeyemi IV
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Mario Pawlicki
Carly Peltier
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Amanda Meeks
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Sourav Mukhopadhyay Sr.
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Alana Rose Pengilley
Madeline Thompson
Kahlan Tripp

Biogeosciences
Caden Michael Bokarae
Gabriel Zeballos Castellon
Shane Coffield
Celine Cortes
Sanjukta Dhar
Kaitlin Fraley
Terra Ganey
William Hawkins
Sophia Katerina Larson
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Jordan Marie Wallace Ulmer
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Climatology/Meteorology
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Nathan Alexander Cardona
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Rana Gahwagy Gahwagy
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Sean Marble
Tyler Joseph Martin
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Chukwudi Ebenezer Nwoko
Junhee Park
Julie Powers
Grace A. Viner
Kiera E. Walsh
Hannah Wudke

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Anita Bauer
Grace Clara Borst
Katie Ellen Bristol
Julianna Ko Cannato
Phillip Choi
Dennis Patrick Coyle
Isaac Alexander Dale
Jennifer Karl
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Matthew Swarr
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Stephanie Vicroy
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Emmanuel Cobbinah
Justin Coley
Okiemute Commander
Adison Cox
Venus Cruz
Sarah Dabous
Michael Stephen Daniels
Ashley Bianca Dann
Lea Davidson
Leah Elizabeth Dechant
Lorenzo Michael Deprado
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Danielle Hare
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Joseph Robert Hoberg
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Amanda Marie Howell
Julianna Catherine Huba
Ally Jacoby
Eusebius Junior Kutsienyo
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Carly Marcella Maas
Filomeno Merid
Laura Michelle Montalvo
Natalie A. Moore
Jade Mountain
Dalton Mullins
Beau C. Neidich
Samuel Nesheim
Sadie Que Nguyen
William David Nguyen
Baylee Madison Olds
Olasunkanmi Taiye Olorunsaye
Micah Olson
Thomas Paine
Maggie Pasour
Rose Eliza Pond
Lauren Jessica Rockwell
Christian Roumelis
Nick Rudolph
Linnea Saby
Iliansherry Santiago
Sydney Shelton
Nicholas Smith
Mohan Song
Sean Nicholas Stegner
Debbie Sulca
James Paul Summers III
Raka Sunderland
Sadeya Ulfat Tashnia
Darren Thomas
Boyao Tian
Md Riaz Uddin
Christopher Vickers
Elizette Viramontes
Christopher Thomas Wheeler
Rhiannon Paige Whitehead
Hannah Whorton
Ebony Leah Williams
Eva Williams

Karst
Safa Al Salmi
Laura Calabro
Lorelei Dellavedova
Marissa Loftus
Enzo Ray Monfre
Christopher Pelczarski
Olivia Saleen Salazar
Benjamyn Savard
Thomas Spotloe
Jonathan Cory Turco

Limnogeology
Emily Adler
Josephine Benson
Justine Paul Berina
Tomas Edmundson
Elynor Lynne Head
Skylar Hooler
Kira Louise McKinley
Matthew Rechenberg
Lindsey Nicole Schaefer
Hailey Kaye Sinon

Marine and Coastal Geosciences
Katya Beener
Chelsea Alexis Brown
Allison Carter
Scarlett Duncan
Ian Patrick Dwyer
Pamela Catherine Edris
Andrea Emmanuelli
Kevin James Ferris
Rachael Gray
Alize Marie Hardin
Makenna Harris
Clare Therese Helmer
Emily S. Hermann
Joshua Himmelstein
Rowan Bishop Kirkpatrick

Zachary Levitan
Skye A. Lewis
Xinggang Christopher Liu
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Kate Lynn Meyers
Gayatri Mishra
Ms. Emily Nicholson
Sarah Olmstead
Andrew Payne
Hailey Riechelson
Louise Riou
Sara San Juanita Rojas
Christopher Shell
Megan Delaney Siragusa
Priyanka Soni
Brin Strouse
Nico Tamposi
Matthew Brian Vincent
Tahi Wiggins
Vincy Yesudian Winifred
Paul Kozol Wojtal

Mineralogy/Geochemistry/ Petrology/Volcanology
Lindsey Abdale
Evelyn Ankudovich
Blanca Sughey Apolinar Morales
Eric Balthis
Layali Banna
Brooks Edward Bartlett III
Olivia Faith Beasley
Cassie Becker
Mariana Berger
Ankan Bhattacharyya
Jonathan Donald Bixler
Graham Evan Brady
Catriona Breasley
Hannah Adwoa Buamono
Cesar Andres Bucheli-Olaya
Juan Felipe Bustos Moreno Sr.
Joella Campbell
Grace Cantele
Kayla Michelle Chaudoir
Mackenzie Elizabeth Coffee
Riley Stephen Cox
Kiersten R. Crye
Forrest Elizabeth Dabbs
Dominic D'Amato
Victor Ortega Diaz
Michele Dodge
Ethan T. Dreger
Samantha Marie Dunn
Frederick Robert Ede
Lydia Fairhurst
Sawyer Glen Fallin-Hornsberger
Kirsten Paige Fentzke
Ashlee Marie Ferro
Sabrina Nichole Fisher
Stephanie Fones
Madeline Marie Freed
Darlene B. Gilroy
Elmer Gonzalez
Gianna Greger
Nanci Reyes Guzman
Sean Michael Hager
Raegan Hamilton
Reece Reece Hammond
Aryo Dwi Handoko
Sydney Hansen
Sara Hayes
Alaina A. Helm
Christiana Hoff
Haeden Hoffman
Sarah Rose Holland
Kiersten A. Hottendorf
Morgan Robert Howe
Lee Hayden Hughes
Megan T. Kalina
Mari Kathleen Kelley
Shahbaz bin Khalid
Denali Paige Kincaid
Ava Hailey Kopellas
Arnoldus Daniel Kotze IV
Francois R. Lalague
Jacob Lansaw
Catherine Lau
Victor Alejandro Leal-Cuellar
Nathaniel Lenhard
Selene C. Lisbey
Augustine Apolinario Flores Lodise
Amanda Marie Maceda
Mary Macquistan
Dominique Marie Martello
Daniela Martinez
Joseph Mayala Nsingi
Justin Charles Maynard
Kyle Patrick McCaffery
Eleanor Carmen Mcintosh
Emily Mehta
Emily Mick
Katarina Mihajlovic
Geoffrey Montour
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Spencer Napiwocki
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Sarah Lin O'Leary
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Francine Robles
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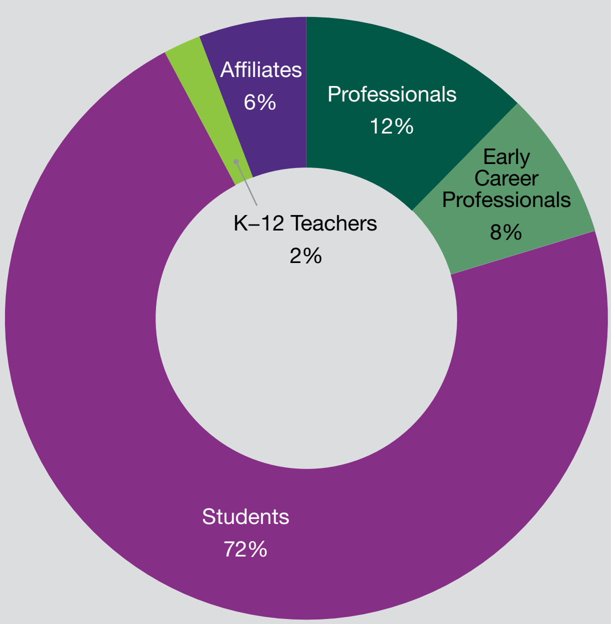
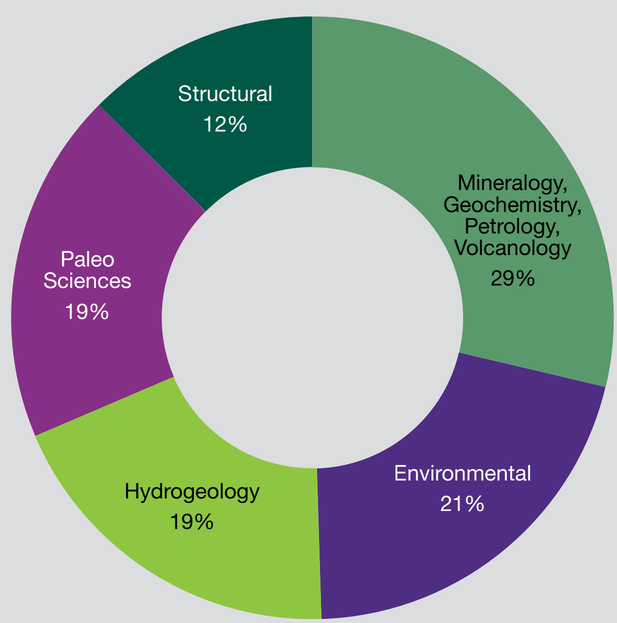
Thilini Nishika Samarakoon
Erendira Maria Sanchez
Tamara Satterwhite
Audrianna Schneider
Taylor Scully
Ana Shirley
Sarah Rose Simmons
Natalia Siqueiros
Carter Smith
Laurie Smith
Rachel Lauren Smith
Grace Catherine Stevens
Julisan Decola Street

NEW MEMBERS BY MEMBER TYPE



TOP PROFESSIONAL INTERESTS OF NEW STUDENT MEMBERS



Cole Lucien Strubbe
Samantha Taylor Swartz
Steven Tapanes
Fernando Tapia Sr.
Hannah Seibel Tebbens
Erica Victoria Thompson
Andrea Tonato
Kambray Annika Townsend
Alejandra Gomez Valencia
Bennett George Van Horn
Owen P. White
Cecelia Elaine Wood
Mason Woodard
Lealem Beza Zerihun
Tianyu Zhou

Paleo Sciences
Jamie Lynn Alumbaugh
Mira Anderberg
Edward Aaron Armstrong
Jacob Daniel Beasecker
Cassandra C. Bennett
Marybeth Bennis
Alexandra Bonham
Irysa Boyer
Alyssa Nicole Brantley
Paul Joseph Byrne
Lilja Elyse Carden
Ethan Wallace Warner Cowgill
Matthew Craffey
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Rebecca Noel Dekoster
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Jonas Donnenfield
Kira Joy Eaton
Ahmed El Manharawy
Kiana Eleazer
Emily Ellefson
Luis Alejandro Giraldo Ceron
Erika Robin Goldsmith
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Bret Edward Potter
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Frances Stephenson
Janeanne McKenzie Stockton
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Haley Nicole Vantoorenburg
Jensen Marie Wainwright
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Clark Ward
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William Thomas Whittenberg
Samantha Wright
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Jonas Zajonz
Alysha Zazubec

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Daniel Price
Adrian Ralser
Anja Jo Riedel
Angelina Nicole Rodriguez
Caitlin Susan Ruelas
Noshin Sharmili
Sourabh Shubham
Vincent Alexander Soldano
Adomas Valantinas

Policy/Regulatory
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Omar Rosales-Cortez
S.M. Anisuz Zaman

Quaternary Geology/Geomorphology
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Erika Elizabeth Wintersteen

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Olana Rose Costa
Lehlomela Simon Mofali
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Autumn Skye Routson
Kyle Edward Smart
Nathalie Sommer
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Kelli Woo

Stratigraphy/Sedimentology
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Hao Yuan
Haolin Zhou

Structural Geology/Tectonics
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Aaron James Leatherwood
Oliver Robin Marvin
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Evan Parker
Abutu Sunday Peter
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Taran Roger jon Polzin
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Sarah Mock
Monica Moorman
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Corey Puckett
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John Casper Branner (1850–1922): Rock Star in Two Countries

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John Casper Branner in 1873 when he was at Cornell University (https://exhibits.stanford.edu/su-photos/catalog/xr781dp2555).

Upon Dr. Branner's arrival, I came under the spell of a great scientist and a great teacher, whose friendship lasted over his lifetime.
—Herbert Hoover

EARLY YEARS

John Casper Branner was born in New Market, Tennessee, USA, on 4 July 1850, the second of nine children. At age two, his family moved to a farm on the French Broad River, near Dandridge, Tennessee. That allowed him to have close contact with the natural world, probably influencing his decision to become a geologist. At six, he and his sister, age 10, attended a female academy, but he went to the boy's academy the following year. During the Civil War, the family home became a field hospital, and the family lost everything. Twice Branner left school to enlist, unsuccessfully, in the Confederate Army; he was only 12 the first time and 13 the second.

Branner studied a year at Horton Academy in New Market in 1865, and in 1867 attended Maryville College (Tennessee). While there he became interested in the new university in Ithaca, New York, founded by Ezra Cornell. In 1869, planning to do a divinity course, he traveled to Ithaca where he studied at Ithaca Academy before entering Cornell in 1870. He covered expenses by teaching Latin, washing dishes, and other odd jobs, but often went hungry due to the lack of funds. He began the "classical course" (Branner 1913, p. 371), but took mostly science classes, including geology, which brought him in contact with Charles Hartt, who created the geology department in 1868; thus, changing Branner's life and beginning his involvement with Brazil.

BRAZIL

Even without having a degree, Hartt chose Branner to accompany him to Brazil in 1874. Hartt's goal was to create a geological survey, and the "Geological Commission of Brazil" was founded in 1875 but was discontinued in early 1878. Hartt died of yellow fever in March of 1878. Branner moved to the State of Minas Gerais to work in the gold mines, but the pay was poor and Branner returned to the U.S. in 1880.

However, Brazil beckoned and Branner went back, working for Thomas Edison, focusing on vegetable fibers for incandescent light bulbs. After traveling about 25,000 miles in his unsuccessful search, Branner returned home by the end of 1881, and received his B.S. from Cornell in 1882. The U.S. Department of Agriculture commissioned him to study the cotton-growing industry in Brazil, which lasted until the spring of 1883.

The "Geological Commission of Brazil" personnel (left to right) John C. Branner, Elias Fausto Pacheco Jordão, Charles F. Hartt, Herbert H. Smith, Orville A. Derby, Marc Ferrez, Unknown, Richard Rathbun.

STATE SURVEYS AND TEACHING

In 1883, Branner was appointed to the Second Geological Survey of Pennsylvania but didn't stay long. In the spring of 1885, with the assistance of his Cornell fraternity mate, David Starr Jordan, then President of Indiana University, Branner was elected a professor of geology, and the university granted him an honorary Ph.D. Branner and Jordan developed a center of educational excellence and cutting-edge geological research. However, Branner was soon on the move again. In the spring of 1887, he was appointed the first state geologist of Arkansas.

A state geological survey was needed because of possible gold and silver deposits in the Ouachita Mountains. Based on unverified beliefs, mining companies were formed to exploit the deposits. Branner's former Cornell classmate Theodore Comstock investigated these mining areas and found very little precious metal content. Considering about $113 million[1] had been invested in the mining ventures, the news was not welcomed. Branner

[1] Approximately US$3.3 billion in 2021 dollars (https://futureboy.us/fsp/dollar.fsp [accessed 23 July 2021]).

recognized this difficulty, but followed the science, stating that the "… investigations of the gold mines of the State must prove a disappointment to many, and that they will excite the animosity of others, are foregone conclusions. Public welfare and official integrity, however, alike demand that these results be made known" (Branner, 1888, p. XXXI). Animosity hardly describes the reaction, for Branner holds the distinction of being a state geologist who was hanged and burned in effigy. Fortunately, Governor Simon P. Hughes supported Branner.[2] However, not all the news was bad, for Branner and his team discovered exploitable deposits of bauxite and other materials.

In 1891, David Starr Jordan, founding president of Leland Stanford Junior University, asked his friend to join him in California. In 1892, Branner resigned his other positions to become Stanford's first professor of geology. In 1894, a Miss Lou Henry attended one of Branner's public lectures, "The Bones of the Earth," and this turned her toward geology.[3] With Branner's help and encouragement, she became the first female geology student at Stanford, and there she met, and later married, another young geology student, Herbert Hoover, who eventually became president of the United States. Branner's geological work included seismic studies after the 1906 California earthquake. The governor appointed him to the State Earthquake Investigation Commission, and he became a charter member of the Seismological Society of America. At Stanford, Branner served as vice president in 1899, and upon Jordan's retirement in 1913, was the second president of Stanford University. He retired in 1915 and immediately went to the Panama Canal Zone to investigate earthquakes and related landslides.

BRAZIL PUBLICATIONS

Branner maintained a lifelong interest in Brazil, traveling in 1899 to study the reefs along the coast of Pernambuco, a region he had worked with Hartt. In 1907, he investigated the diamond districts in the State of Bahia and the geology of Sergipe and Alagoas. Finally, in 1911, he examined the geology and biology of the coastal areas around the mouth of the Amazon River. On these trips, Branner often worked with his classmate, Orville Derby, who restarted the Hartt survey in 1906, namely the *Serviço Geológico e Mineralógico do Brasil* [Geological and Mineralogical Survey of Brazil], which is still active today.

Noted also as a linguist, in 1906, Branner published an elementary Brazilian geology book in Portuguese. In 1909, he published a massive bibliography of Brazilian geological publications, and, in 1910, he brought out a Portuguese grammar book. All his geological work came together when he published a new geologic map of Brazil[4] in 1919. In the accompanying notes, Branner expressed his feeling for Brazil and its people: "… it [the map] is meant especially to be of service to the Brazilian people, among whom I have spent many years, to whom I am strongly attached, and in whose welfare I am deeply interested" (Branner, 1919, p. 199).

Branner and Susan D. Kennedy, a Vassar graduate, married in 1883. They had a daughter and two sons, one of whom, George C. Branner, became the state geologist of Arkansas when the survey was reestablished in 1923.[5] Branner, who died on 1 March 1922, impacted the understanding of the geology in two countries. For Branner, "… the greatest honor of all is that which comes to one having … '…his students doing good and honest work in every quarter of the globe' " (quoted in Penrose 1924, p. 22).

FURTHER READING[6]

Branner, J.C., 1888, Annual Report of the Geological Survey of Arkansas for 1888, vol. i: Little Rock, Arkansas, Press Printing Company, I–XXXI, 320 p.

Branner, J.C., 1913, Casper Branner of Virginia and His Descendants: Stanford, California, Stanford University, privately printed, 469 p.

Branner, J.C., 1919, Outlines of the geology of Brazil to accompany the geologic map of Brazil: Bulletin of the Geological Society of America, v. 30, no. 1, p. 189–338, https://doi.org/10.1130/GSAB-30-189.

De Linde, H.S., and Howard, J.M., 1999, Arkansas State Geological Survey publications, a record of 140 years of public service, *in* Howard, J.M., ed., Contributions to the Geology of Arkansas, Volume IV: Little Rock, Arkansas, 116 p.

Jackle, F.R., 1967, John Casper Branner and Brazil [Ph.D. dissertation]: Ph.D. Stanford, California, Stanford University, 310 p. (Dissertation Services #67-11,038).

Penrose, A.F., 1924, Memorial to John Casper Branner: Bulletin of the Geological Society of America, v. 36, p. 15–44.

[2] For the next 30 years, the Arkansas legislature, however, refused to fund an independent state geological survey. But more than 100 years later, no geological evidence has been discovered to dispute the conclusions in that report (de Linde and Howard, 1999, p. 80).

[3] See "Lou Henry Hoover (1874–1944): An Independent Woman of Action," by Joanne Bourgeois, Michele Aldrich, and Léo F. Laporte; Rock Stars, *GSA Today*, Oct. 2021, p. 48–50.

[4] https://library.stanford.edu/blogs/stanford-libraries-blog/2015/04/john-casper-branners-map-brazil-original-or-facsimile (accessed 23 July 2021).

[5] https://www.geology.arkansas.gov/ags-history.html (accessed 23 July 2021).

[6] For additional references, please contact the senior author, wbrice@pitt.edu; for Branner's publications, see Penrose, 1924, p. 23–44, and Jackle, 1967, p. 273–297.

From Carbonates to Congress: Applying the Geosciences to the Policy-Making Process

Amanda L. Labrado

When I interviewed for the GSA-USGS Congressional Science Fellowship in February 2021, COVID-19 vaccines had only been available for a few weeks, I was at the very end of writing my doctoral dissertation, and I had spent the last year in quarantine. The pandemic highlighted, among many issues, that scientifically sound policies were vital to the health of the world, and it became apparent to me that I needed to apply my geologic training and knowledge to try and create tangible, impactful differences.

I started my fellowship at the end of September 2022 in the office of Congresswoman Alexandria Ocasio-Cortez (D-NY), where I was selected to help her build up her environmental, climate, and energy portfolios. At the beginning of my fellowship, the Build Back Better Act (BBB) and Infrastructure Investment and Jobs Act (IIJA) were still works in progress. A large part of BBB was addressing climate and environmental issues. I was tasked to work with other House and Senate offices on developing the Civilian Climate Corps (CCC) with the BBB, along with other initiatives within both pieces of legislation that addressed the impacts of climate change on our workforce, infrastructure, and environment. Although IIJA was passed and signed into law, BBB was passed through the House and now sits with the Senate with an uncertain future.

Because Ocasio-Cortez is one of the champions for the Green New Deal (GND), the Committee of Oversight and Reform, on which she sits, organized a hearing on the importance of the GND. The main objectives of this piece of legislation are to promote transition from fossil fuels to renewable energies, strengthen the economy by creating jobs and training people in skills that will become more important as our global climate shifts, and lift historically disadvantaged communities up by having them drive this transition.

As a geoscientist, climate change and protecting the natural world around us have been key reasons for much of the scientific research conducted. My own research focused on how microorganisms can help create large carbonate rock assemblages deep underground. The environment these microbes thrive in is considered very hard to exist in because there is no sunlight and very little water or oxygen. One microbe on its own may not seem important, but when there are a large group of them cycling different chemical compounds over time, these microscopic creatures can create large rock packages that are meters thick and many square meters wide. I see this as similar to how Congress operates. When various stakeholders and members of Congress come together, legislation is passed that can create impact and meaningful change to the lives of many people. It is also the reason I believe the optimism and energy some members of Congress have is justified. Over time, working together has created pieces of legislation that have helped create and protect national parks, save endangered species, and ensure clean air and water. Legislation like the GND can help make the strides necessary to become more resilient to climate change by working together and having these efforts led by communities that have been historically left behind. Like the microbes in caves and deep underground that I studied, we can also thrive in uncertain times and conditions when we work together.

When people asked me what I envisioned for my future after earning my Ph.D., I did not imagine I would have the opportunity to help organize congressional hearings, which highlight major issues such as the housing problem our country is currently experiencing, on a national platform. During my graduate studies, I spent my days measuring isotopes of carbonates, conducting microbial incubation experiments, and generally being in either a lab or at my computer reading and/or writing. Working in the office of a congressperson is much more fast paced and generally revolves around learning as much as possible as quickly as possible so that votes can be made, questions can be asked to expert witnesses during hearings, or legislation can be created with various stakeholders to help improve the everyday lives of Americans.

Engaging in the policy-making process has allowed me to utilize the skills geoscientists learn to sharpen in different ways. The ability to make observations, analyze data, apply knowledge, and effectively communicate have been crucial to me learning how to present policies, work in a bipartisan manner, and remain calm and productive during tight turnarounds. I am in awe of Hill staffers and members of Congress who work tirelessly day in and day out to create a better future for the United States, and our world at large, and I only aim to continuing playing a role, however small, in helping make it a reality during the rest of my fellowship.

The manuscript is submitted for publication by Amanda Labrado, 2021–2022 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 G22AP00100-00. 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. Labrado worked in the office of Congresswoman Ocasio-Cortez (D-NY) and can be contacted by e-mail at allabrado719@gmail.com.

Position Statement Draft

GEOSCIENCES AND ENERGY POLICY

GSA members are invited to submit comments and suggestions regarding the following major revision to the Geosciences and Energy position statement by 15 August. Go to **www.geosociety.org/PositionStatements** to learn more and submit comments.

Position Summary. Development of a comprehensive energy policy that includes approaches for significant reduction of U.S. greenhouse gas emissions is essential for the future economic vitality, environmental well-being, and health and security of the citizens of the United States as well as other nations. Geoscientists locate, quantify, and help develop energy resources and the critical mineral resources required for the transition to a low-carbon future and, along with professionals in other disciplines, assess and mitigate the impact of energy-resource development, operations, and use on the environment. Accordingly, input from geoscientists must be an integral part of all energy policy deliberations.

This position statement provides a communications tool and summarizes the importance of (1) the geosciences in developing fundamental data, information, and knowledge upon which sound energy policy should be based; and (2) the contributions geoscientists can make to the framing of energy policy. Most energy sources, including fossil fuels, nuclear fuel sources, and renewables have important and distinct geologic components that should be considered when analyzing the life-cycle impacts related to exploration, siting, extraction, development, production, human consumption, waste disposal, recycling, decommissioning, and reclamation of these energy sources.

CONCLUSIONS AND RECOMMENDATIONS

The Geological Society of America (GSA) supports the collection, use, application, and communication of scientific data, information, and knowledge as critical to public policy and decision making regarding energy resources. Decisions surrounding the development and stewardship of finite energy and related mineral resources have direct bearing on the economic and environmental health of the world and its societies, with important impacts on the reduction of global carbon emissions to help mitigate the effects of climate change.

- **Geoscience expertise**—Geoscientists are essential to discussions about energy policy to ensure that scientific evidence is a foundation to policy formulation and implementation. The geoscience community understands Earth's complex systems, including the timeframes over which geologic processes operate, the capacity of Earth systems to generate different energy resources, and the impact of energy development and use on the environment. Decision makers can connect with geoscientists through organizations and programs such as GSA and other geoscience societies, federal and state geoscience-mission agencies, geoscience departments of colleges and universities, current and past American Association for the Advancement of Science (AAAS) Science and Technology Policy Fellows, and private industry.
- **Adaptation**—State, federal, and global energy policies must be developed in a way that is adaptive to circumstances and innovations and continuously updated to reflect changing conditions. Energy markets are global and dynamic due to emerging technologies, different national and regional economies, the finite nature of nonrenewable resources, the geographic and geologic dependencies for the location of energy resources, and supply disruption potential due to social or political stresses. The continued responsible development of current and emerging energy resources will ensure national energy security and reliable supplies for the future. The skills of geoscientists are well-suited for the transition to a renewable energy economy.
- **Climate change**—GSA's position statement on climate change recognizes that "human activities (mainly greenhouse-gas emissions) are the dominant cause of rapid warming since the middle 1900s" and "addressing the challenges posed by climate change will require a combination of adaptation to the changes that are likely to occur and mitigation of future impacts through global reductions of CO_2 and other greenhouse gas emissions from anthropogenic sources." GSA encourages the responsible transition away from fossil fuel energy resources by supporting renewable energy and climate research, recognizing that a variety of energy sources will be required to meet global energy demand through the transition and that no form of energy is perfectly secure or devoid of potential social, environmental, health, or economic impacts.
- **Research and public investments**—Research on energy sources and the mineral resources required for low-carbon energy technologies, and the environmental, economic, health, and social impacts and benefits of their development, is vital. Continued public investments in geoscience-mission agencies and academic institutions and public-private partnerships are critical for advancing understanding of the occurrence and formation of energy resources (renewable and non-renewable), assessments of commodity quantity and quality, optimal siting of renewable energy facilities, impacts of extraction and energy use on land, ground and surface water, air quality and atmosphere, and forecasts of resource availability and environmental impacts.
- **Energy security—**GSA supports national energy security through environmentally, socially, and economically responsible development of energy resources, along with improvements in energy efficiency and energy conservation, as the nation transitions to an economy with low greenhouse-gas emissions.

RATIONALE

Geoscientists who work in the petroleum, coal, uranium, mineral, and geothermal industries, engineering geologists, environmental geoscientists, hydrologists, geochemists, oceanographers, meteorologists, and climatologists all play important parts in evaluating and implementing the development of all forms of energy. It is also the geoscience community that assesses the impact of energy development on water resources, ecosystems, air quality, and climate. Geoscientists understand the dynamics of Earth's natural processes and are able to reconstruct climates from the past using atmospheric CO_2 levels, and the associated sea-level stands, ecosystem diversity and distribution, and sea-water composition. For those reasons, geoscientists can assess how human activities can influence nature and which activities are environmentally sustainable. Accordingly, geoscientists have an essential role to play in energy policy.

The use of abundant and relatively inexpensive fossil fuels over the past century has contributed to the emergence of the United States as an economic power and has raised the standard of living for much of the developed world. Oil, gas, and coal resources supply fuels for transportation, electric power, and industrial and residential heating. They also provide the energy and basic chemical feedstocks for the manufacture of the steel, plastics, and textiles that support our modern standard of living, and the fertilizers and pesticides needed to feed a growing global population. However, anthropogenic greenhouse-gas emissions, the majority from fossil fuel combustion, have a profound impact on global climate, with effects on local and regional ecosystems and public health. There is a clear policy rationale and a United Nations mandate to reduce global carbon and other greenhouse gas emissions in order to mitigate the impact of climate change.

Global demand for energy is predicted to grow significantly through 2050 as the human population approaches eight billion, and developing and emerging countries transition to consumer-based economies (www.eia.gov/outlooks/ieo/). While the forecasts indicate a significant increase in global fossil fuel consumption, the absolute and proportional increase in renewables (solar, wind, hydro, geothermal, biomass) is dramatic.

The challenge for energy policy makers is to develop a plan that will provide cost-effective improvements for the efficient and sustainable use of Earth's energy resources, provide reliable and affordable energy to the world's developing economies as well as the developed nations of the world, reduce carbon emissions, and accelerate the transition to renewable energy without adversely impacting global standards of living. The knowledge and expertise of geoscientists take on added importance as countries and industries worldwide adapt to climate change and work to reduce carbon emissions.

In its 2020 pamphlet, "Geosciences Supporting a Thriving Society in a Changing World," the American Geosciences Institute stated the importance of energy and the role of the nation's geoscientists as follows:

> Energy supports economic growth and national security and is essential for all the elements of daily life—food, water, transportation, communication, and entertainment. The United States' robust and secure energy systems enable our high quality of life. Geoscientists find and develop earth- and ocean-sourced energy resources, such as oil, natural gas, coal, uranium, and geothermal hotspots. They also find and develop the raw materials needed for renewable energy sources: cement and metals for dams, critical metals for wind turbine generators and solar installations, and battery storage metals like lithium and cobalt. In addition, geoscientists help determine appropriate locations for energy infrastructure including refineries, transmission lines, dams, and wind farms.

Resolution of the energy issues that are presently being debated will have significant economic, strategic, environmental, health, and security consequences. Input from geoscientists is critical to informing the public and policy makers about the consequences of different options.

REFERENCES AND INTERNET LINKS

Energy Statistics

United States Energy Information Agency (EIA) International Energy Outlook 2021: http://www.eia.gov/outlooks/ieo/

International Energy Agency: https://www.iea.org/data-and-statistics

ExxonMobil Updated 2021 Energy & Carbon Summary (April 2021): https://corporate.exxonmobil.com/-/media/Global/Files/energy-and-carbon-summary/Energy-and-carbon-summary.pdf

BP Statistical Review of World Energy: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html

International Energy Forum (IEF): https://www.ief

Climate Statements of GSA and Other Scientific Societies

AAAS Board statement on climate change: https://www.aaas.org/sites/default/files/s3fs-public/aaas_climate_statement1.pdf

Climate information statement of the American Meteorological Society: https://www.ametsoc.org/ams/assets/File/aboutams/statements_pdf/AMS_Statement_Climate_Change_April2019.pdf

Climate position statement of the American Geophysical Union: https://www.agu.org/-/media/Files/Share-and-Advocate-for-Science/Position-Statements/Society_Must_Address_the_Growing_Climate_Crisis_Now_2019.pdf

Climate public policy statement of the American Chemical Society: https://www.acs.org/content/dam/acsorg/policy/publicpolicies/sustainability/globalclimatechange/climate-change.pdf

Climate scientific statement (Executive Summary) of the Geological Society of London: https://www.geolsoc.org.uk/~/media/shared/documents/policy/Statements/CC%20Statement%20Exec%20Statement.pdf?la=en

GSA Position Statement on Climate Change: https://www.geosociety.org/documents/gsa/positions/pos10_climate.pdf

Other Relevant Professional Society Documents

American Geosciences Institute (AGI) "Geosciences Supporting a Thriving Society in a Changing World: Energy" (2020) https://www.americangeosciences.org/policy/critical-needs/2020/energy

GSA Position Statement on Critical Minerals and Materials https://www.geosociety.org/documents/gsa/positions/pos23_CriticalMinerals.pdf

GSA Position Statement on Role of Government in Mineral and Energy Resources Research: https://www.geosociety.org/documents/gsa/positions/pos11_GovInEnergy.pdf

International Organization Climate Reports

CC Climate Change 2021 Summary for Policy Makers: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM_final.pdf

Sixth Assessment Report (AR6) of the United Nations Intergovernmental Panel on Climate Change (IPCC): https://www.ipcc.ch/report/ar6/wg1/

United Nations Intergovernmental Panel on Climate Change (IPCC) 2014 Synthesis Report: https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf

United Nations Paris Agreement on Climate Change: https://treaties.un.org/doc/Treaties/2016/02/20160215%2006-03%20PM/Ch_XXVII-7-d.pdf

Other Climate Information Sources

NASA: https://climate.nasa.gov/

National Academies: https:// www.nationalacademies.org/topics/climate

National Oceanic and Atmospheric Administration: http://www.noaa.gov/climate

University of Maine Climate Change Institute: https://climatechange.umaine.edu/climate-matters/maines-climate-future/

U.S. Environmental Protection Agency: https://www.epa.gov/climate-change

OPPORTUNITIES FOR GSA AND ITS MEMBERS TO HELP IMPLEMENT RECOMMENDATIONS

To facilitate implementation of the goals of this position statement, the Geological Society of America recommends the following actions:

- GSA members should seek opportunities to communicate effectively the role and importance of geoscientists to society in locating, evaluating, and developing all forms of energy resources and assessing the impact of energy resource development and operations on the natural environment.
- GSA members should make clear to national, state, and local governments, community groups, local decision makers, and the general public the link between fossil fuel use and climate change, and the importance of reducing carbon and other greenhouse gas emissions by transitioning to renewable energy resources.

• GSA members should emphasize the importance of including geoscientists in the process of developing and implementing energy policy, because it is the geoscience community that understands Earth's natural processes, Earth's capacity to produce energy from fossil and renewable resources, and the impact of energy use on the environment.

The Geological Society of America

• Can provide members with readily accessible print, web, and personnel resources that support geoscientists' communications with decision makers regarding the value of the geoscience community in developing energy policy.
• Can raise awareness of the role of geology and government in mineral and energy resources by publishing articles and conducting symposia, technical sessions, and workshops at annual and sectional meetings on these subjects.
• Can help GSA members rise to the challenge of informing the public and decision makers about energy and climate policy by supporting access to objective and reliable energy and climate data.

Three Position Statements Updated

In April 2022, GSA Council approved minor revisions to three position statements: Geoheritage, The Value of Geologic Mapping, and Freedom of Scientific Expression. Summary statements are below; full versions of all position statements are online at **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.

GEOHERITAGE

GSA supports the conservation of Geoheritage sites to meet present and future educational, scientific, aesthetic, cultural, and economic needs.

THE VALUE OF GEOLOGIC MAPPING

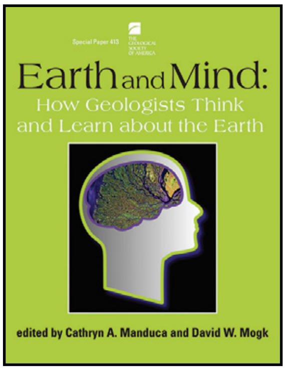
To improve the scientific basis for public and private natural resource and land-use decisions, GSA supports comprehensive geologic mapping on local, state, and national scales and advocates increased public investments for current state and national geologic mapping programs.

FREEDOM OF SCIENTIFIC EXPRESSION

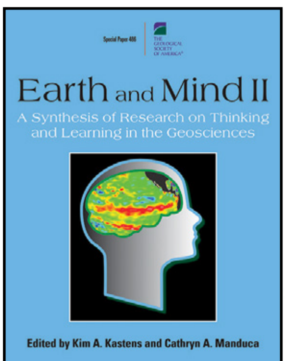
GSA supports the principles outlined in the American Meteorological Society's Freedom of Scientific Expression statement including, and in particular, the role of scientists in presenting their results and interpretations. GSA also strongly believes that science and society benefit greatly from careful and ample technical peer review of scientific findings, and subsequent communication of scientific results must be permitted freely and without concern by the scientist for censorship, intimidation, or political interference.

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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Update

Legacy Gifts: Giving over a Longer Time Scale

More than most, geologists know the value of considering a longer time scale. Often, donations are made to meet an immediate need, but a legacy gift can ensure support far beyond current needs and, usually, on a larger scale.

GSA has served geologists at all stages of their careers for nearly 135 years, thanks in large part to generous donors who have included the Society in their estate plans. Even as needs change and technology becomes more advanced, geoscience remains relevant and essential for addressing many of the challenges facing us around the world.

Those who include GSA in their estate plans become members of the Pardee Legacy Circle—named in honor of Joseph T. Pardee (1871–1960) due to the US$2.7 million bequest from the estate of Pardee's daughter, Mary Pardee Kelly (1905–1994). The Pardee-Kelly bequest is the second largest in the history of GSA, bested only by the Penrose bequest in 1931 of nearly US$4 million. These tremendous contributions still provide support for GSA today, and their impact on the geologic community decades later cannot be overstated.

A legacy gift allows you to make a lasting difference for the Society, the programs you are passionate about, and geoscience as a whole. There are no costs or fees to set up a planned gift, and you may be able to give more through your estate than during your lifetime, which allows you to make a larger impact and leave a legacy that reflects your values.

If you are interested in including GSA in your estate plans, you can find more information on the Foundation website at **https://gsa-foundation.org/planned-giving/** or contact Cliff Cullen at +1 303-357-1007 or ccullen@geosociety.org.

Top: Walter Keller and students from the University of Missouri Branson Field Laboratory, the longest continuously running field camp in the U.S., on top of Wind River Peak in 1935. Bottom: Students and teaching assistants from the University of Missouri Branson Field Laboratory on top of Wind River Peak in 2018.

"For Nancy and me, putting the GSA Foundation in our estate plans was obvious and gratifying. We have both been the recipients of the past generosity of others who did so. We both feel that it is incumbent upon us to assist future generations of students and early career geoscientists so that they may have careers as satisfying and as much fun as we have had. We feel it a privilege to share our good fortune so that our science can thrive." —Dr. P. Geoffey Feiss, past GSAF president

Field Guide 59

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OPPORTUNITIES FOR STUDENTS

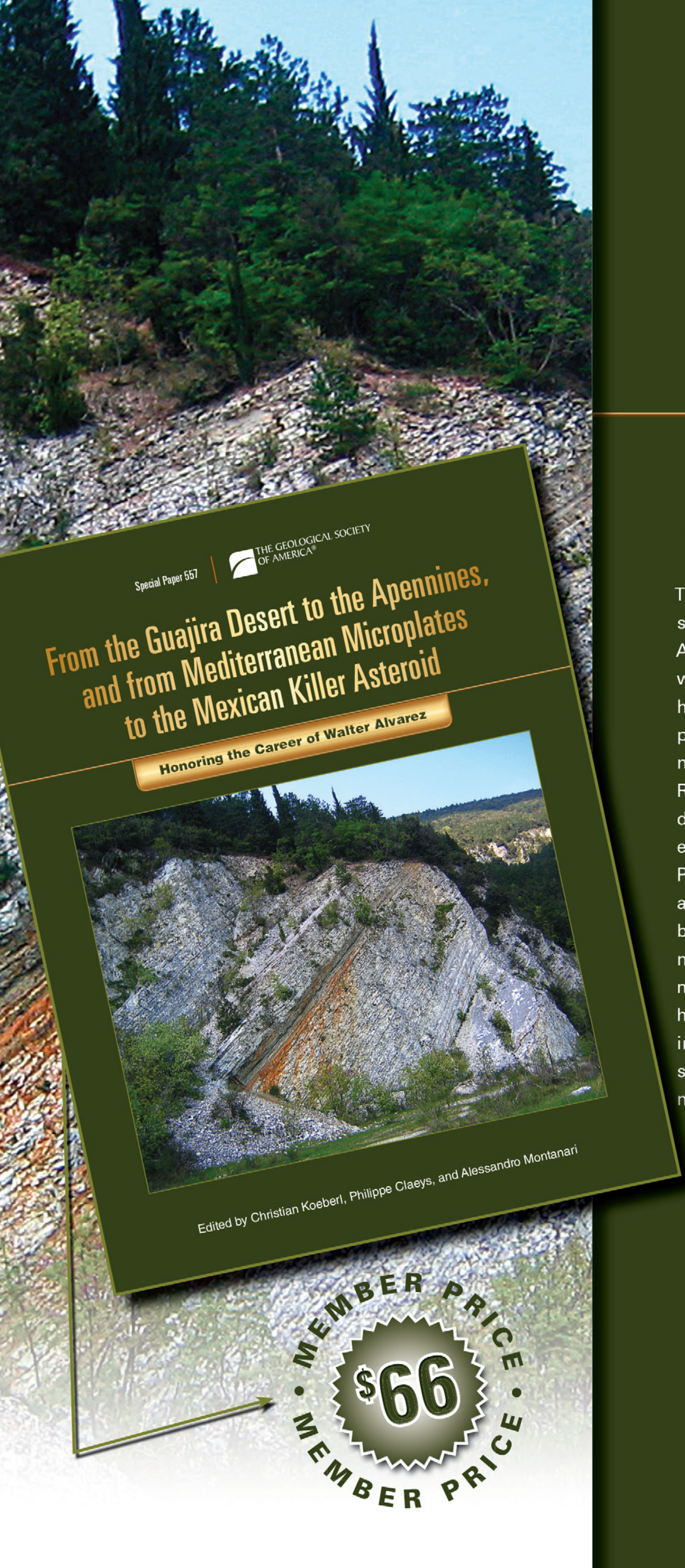
MS and Ph.D. Opportunities in Economic Geology, Colorado School of Mines. The Department of Geology and Geological Engineering at the Colorado School of Mines seeks students interested in pursuing graduate degrees (MS and Ph.D.) focused on mineral exploration, economic geology, and the geochemistry and petrology of ore deposits. Motivated applicants could enter our graduate program in January or August 2023. Successful students will be embedded into the NSF-supported Center for Advanced Subsurface Earth Resource Models (CASERM) with funding provided by industry partners. Successful students will gain significant experience and preparation for a booming mineral industry sector over the course of their study. Opportunities are also available through the parallel Professional Master's degree in Mineral Exploration, a one-year non-thesis study program. For more information, please contact mineralexploration@mines.edu.

Funded Ph.D. Scholarship, Near-Real-Time Models of Earthquake-Related Flood Hazard, University of Canterbury. Research Goal: To develop, test, and validate near-real-time models of surface hydrological changes following large earthquakes.

Overview: This funded Ph.D. scholarship will integrate remote sensing, structural geology, geomorphology, and surface hydrology to develop near-real-time forecasts of coseismic flood hazard. This project is a part of the GNS-led programme Rapid Characterisation of Earthquakes and Tsunami: Fewer deaths and faster recovery. The candidate will be based at the School of Earth and Environment at University of Canterbury in Christchurch, New Zealand.

Application Details: The successful candidate will have a broad, quantitative background in geoscience and an interest in developing tools that contribute to seismic resilience. An MSc in Geology, Engineering Geology, or Physical Geography; or BSc with relevant research and/or work experience is required. Other fields may be considered for exceptional candidates. Some experience with one or more programming languages is preferred. The successful candidate will be awarded a fully funded 3-year Ph.D. scholarship, which includes University fees and stipend, and join the vibrant Active Tectonics and Disaster Risk Resilience groups at UC. We are committed to promoting a diverse and inclusive work environment. Candidates from historically underrepresented groups in the geosciences are encouraged to apply.

If interested, please send a 1-page cover letter and CV to timothy.stahl@canterbury.ac.nz before 15 July 2022.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