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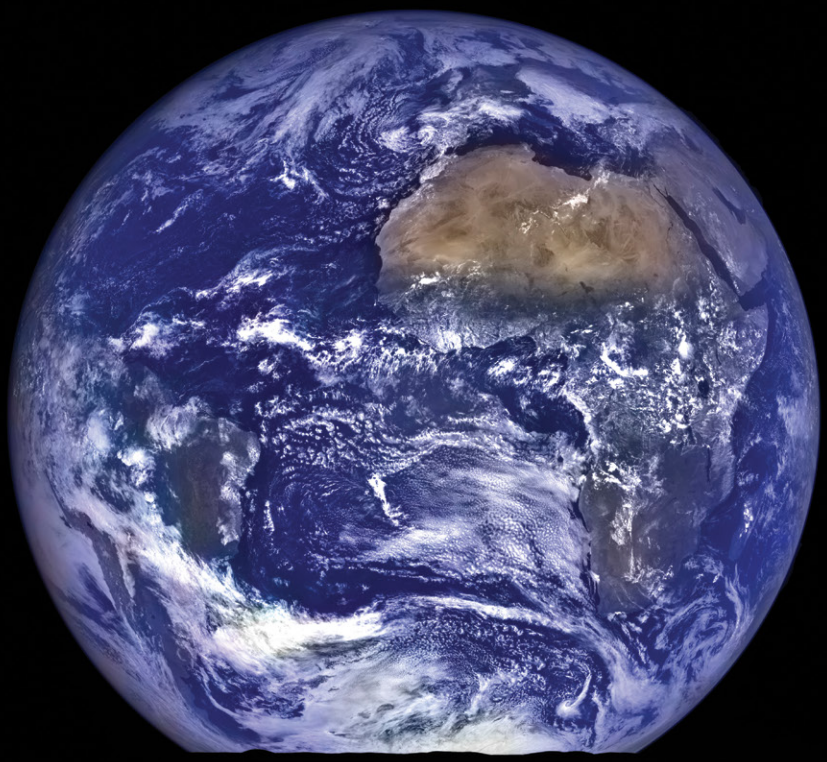

Biotic Enhancement of Weathering over the Past 3.7 Billion Years

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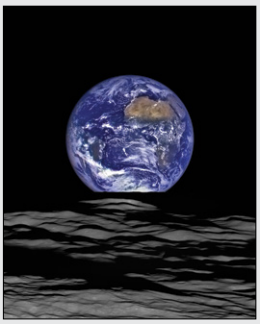

Cover: Earth from the Lunar Reconnaissance Orbiter, 12 Oct. 2015. This composite image has the center of Earth just off the coast of Liberia (N4.04o W12.44o), and the Moon shows crater Compton on the lunar far side. The image is a composite of wide-angle camera color and narrow angle camera black and white (public domain, courtesy NASA/Goddard Space Flight Center/Arizona State University). See related article, p. 4–9.

GSA NEWS

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Biotic Enhancement of Weathering over the Past 3.7 Billion Years

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ABSTRACT

Over the past four billion years, our sun became 30% brighter, yet Earth's water has neither completely frozen nor boiled off during that time. A theoretical solution to this paradox is a carbon dioxide greenhouse planetary thermostat regulated by evolutionary advances in biologically mediated silicate and apatite weathering. This carbon sequestration history can now be quantified using paleosols. Calculations of precipitation-normalized nutrient depletion rates (μmol mm^{-1} a^{-1}) in paleosols ranging in age back to 3.7 Ga show discrete order of magnitude increases in carbon consumption by silicate and apatite weathering due to evolutionary advances in life on land at around the Great Oxidation Event (2.45 Ga) and Neoproterozoic Oxidation Event (0.8 Ga). This biological weathering countered increased solar luminosity and continued emission of volcanic greenhouse gases.

INTRODUCTION

The faint young sun paradox arises from stellar evolution of increased solar luminosity through time (Ribas, 2009), which predicts frigid temperatures on early Earth, with or without present atmosphere (Fig. 1). However, moderate Archean temperatures are inferred from salt stability, water-lain sedimentary structures, and glacial episodes (Walker, 1982). Paleotemperatures from paleosols (Fig. 1) are evidence of long-term stability (Retallack, 2013, 2018; Retallack et al., 2016), averting terminal freezing, apparent from Mars, as well as the other extreme of an uninhabitable inferno, apparent from Venus (Lovelock and Margulis, 1974). Both freezing and steaming may have been prevented by greenhouse gases such as CH_4 and CO_2 regulated by the biological carbon cycle (Schwartzmann, 2017). Continued volcanic degassing of CO_2 prevented a terminal icehouse, whereas building of biomass and consumption of carbonic acid by biotically enhanced silicate and apatite weathering prevented a terminal greenhouse (Retallack, 2022a). Consumption of CO_2 by abiotic silicate weathering in lifeless Precambrian landscapes was modeled by Rye and Holland (1998), but a role for life on land enhancing weathering is indicated as far back as 3.7 Ga by paleosol salts, stable isotopic compositions, and phosphorus depletion (Retallack, 2022b). Thus, theoretical concepts of biotic planetary temperature regulation can now be assessed from the record of fossil soils back to 3.7 Ga. Generally declining atmospheric CO_2 over time (Kasting, 2010) is not the only issue involved, because soil CO_2 increased with increased productivity of terrestrial vegetation (Retallack, 2022b). Paleosols are not only evidence of carbon sequestration by silicate and apatite weathering, but also include fossils as evidence of the evolution of life on land.

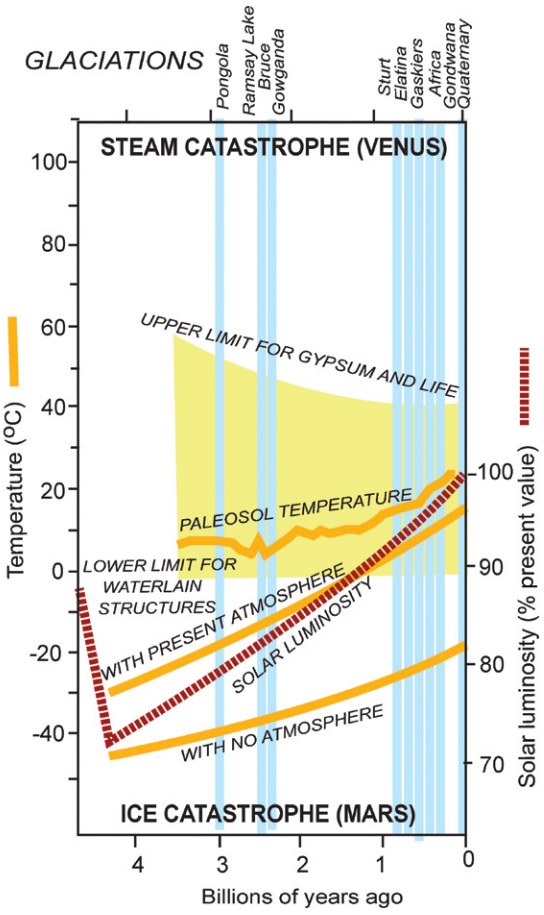

Figure 1. Stellar evolution and planetary temperature and atmospheric composition over the past 4.6 Ga, showing solar luminosity increase and predicted temperature of Earth with current atmosphere or no atmosphere (Ribas, 2009), envelope of permitted temperatures from gypsum and life (Walker, 1982), temperatures inferred from selected paleosols (Retallack, 2013, 2018; Retallack et al., 2016), and ice ages (Walker, 1982).

PALEOSOLS AS PROXIES FOR CARBON SEQUESTRATION

Paleosols are soils of the past, buried in sedimentary or volcanic sequences, and interpretable by comparison with modern soils. Release of soluble alkali and alkaline earth cations and bicarbonate into soil solution by carbonic acid from CO_2 in solution

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can be simplified to Equations 1–4, showing that each mole of oxide consumed 2 moles of CO_2:

$$MgO + 2CO_2 + H_2O \rightarrow Mg^{2+} + 2HCO_3^-, \quad (1)$$

$$CaO + 2CO_2 + H_2O \rightarrow Ca^{2+} + 2HCO_3^-, \quad (2)$$

$$Na_2O + 2CO_2 + H_2O \rightarrow 2Na^{+} + 2HCO_3^-, \quad (3)$$

$$K_2O + 2CO_2 + H_2O \rightarrow 2K^{+} + 2HCO_3^-. \quad (4)$$

Losses of these elements from soils on a molar basis is a proxy for moles of CO_2 consumed by soil over its time of formation (Sheldon, 2006). Whole profile loss can be envisaged as the area under the curves in mole fraction alkali and alkaline earth depletion for decompacted paleosols (Fig. 2).

Dissolution of apatite as a source of P can be reduced to Equation 5, in which 1 mol of CO_2 in aqueous solution liberates 3 moles of soluble phosphate from apatite:

$$Ca_5(PO_4)_3(OH) + CO_2 \rightarrow 5Ca^{2+} + 3PO_4^{3-} + HCO_3^- \quad . \quad (5)$$

This is a simplification of four intermediate apatite dissolution reactions and other intermediate reactions producing carbonic acid from CO_2 in solution (Dorozhkin, 2012). Actual phosphate procurement in soils from relatively insoluble apatite is catalyzed by a variety of carbon-based acid moieties, such as acetic and oxalic acid with higher mole fractions of carbon (Neaman et al., 2005). Another complication is that Archean apatite dissolution also may have been partly achieved by strong sulfuric acid, rather than weak carbonic acid (Retallack, 2022c). Again, this is based on mass transfer, including volume loss during soil formation with depth in reconstructed soils as they would have been before burial compaction and metamorphism (Sheldon, 2006).

Original soils can be reconstructed from paleosols by estimating compaction due to burial by overburden (C as %) from total depth of burial (B in km) and suitable physical constants, in this case taken from Aridisols (Sheldon and Retallack, 2001):

$$C = \frac{-0.51 \times 100}{\left\{ \left(\frac{0.49}{\frac{B}{e^{0.27}}} \right) - 1 \right\}} \quad . \quad (6)$$

Tau analysis of paleosols (Brimhall et al., 1992) calculates mole fraction mass transport ($\tau_{j,w}$) of a mobile element and mole fraction strain ($\varepsilon_{i,w}$) of the profile during soil formation using an immobile element from the parent material (Ti used here). Equations 7–8 for mass transport and strain include bulk density (ρ in g.cm^{-3}) and oxide assay (C in wt%) for successive samples (subscripts i, j) of weathered material (subscript w) and parent material (subscript p) of a single paleosol profile:

$$\varepsilon_{i,w} = \left[\frac{\rho_p C_{j,p}}{\rho_w C_{j,w}} \right] - 1, \quad (7)$$

$$\tau_{j,w} = \left[\frac{\rho_w C_{j,w}}{\rho_p C_{j,p}} \right] \left[\varepsilon_{i,w} + 1 \right] - 1. \quad (8)$$

Soils and paleosols lose mass with weathering and so have negative strain ($\varepsilon_{i,w} < 0$), and also lose nutrient cations and silica, so have negative mass transfer ($\tau_{j,w} < 0$). In contrast, sediment accumulation and diagenetic alteration add elements and mass, so have positive strain and mass transfer. Moles of CO_2 used to displace alkali and alkaline earths during weathering assessed by tau analysis (Equations 7–8) can be used to calculate soil CO_2 (ppm) consumed by the whole profile during its formation using Equations 9–11 (modified from Sheldon, 2006). Components of these calculations are areas under the curves of depletion of bases or phosphorus in reconstructed paleosol profiles, calculated for the whole profile for a square centimeter of surface area of the profile (Fig. 2):

$$pCO_2 = \frac{F}{A\left[\frac{K_{CO_2} P}{1000} + \kappa \frac{D_{CO_2} \alpha}{L} \right]}, \quad (9)$$

$$F = 2\sum \rho_p \frac{C_{j,p}}{100} \int_{Z=0}^{Z=D_{j,w}} \tau_{j,w(z)} \delta Z \quad , \quad (10)$$

$$G = 5\sum \rho_p \frac{C_{j,p}}{100} \int_{Z=0}^{Z=D_{j,w}} \tau_{j,w(z)} \delta Z \quad . \quad (11)$$

Variables and constants for these calculations besides those needed for Equations 6–8 are F (mol CO_2.cm^{-2}) = summed molar mass transfer loss of CaO, MgO, Na_2O, and K_2O using Equation 9; G (mol CO_2.cm^{-2}) = summed molar mass transfer loss of P using Equation 10; Z (cm) = depth in soil represented by analysis corrected for compaction using Equation 10; A (years) = duration of soil formation using Equations 12 and 13; K_{CO_2} (mol./kg.bar) = Henry's Law constant for CO_2 (=0.034, range 0.031–0.0045); P (cm) = mean annual precipitation using Equation 13; κ (s.cm^3.[mol.year]$^{-1}$) = seconds per year divided by volume per mole of gas at standard temperature and pressure (=1430);

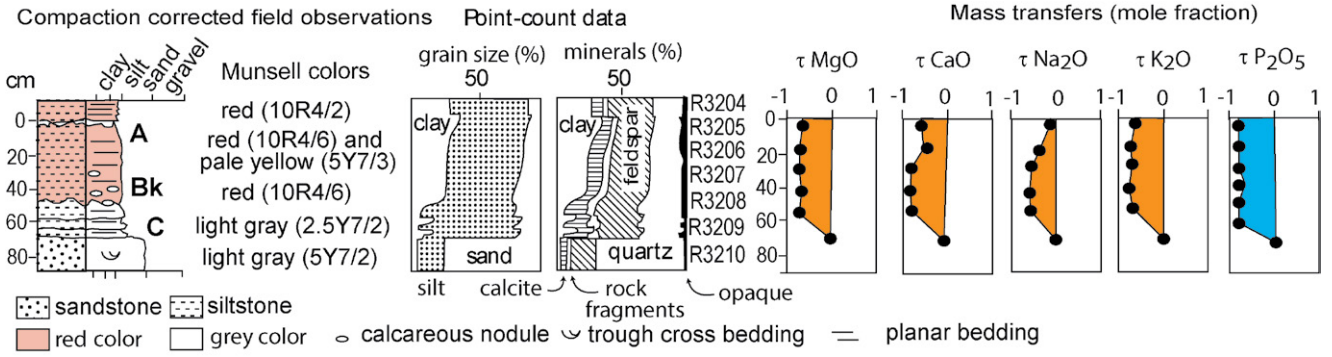

Figure 2. Base and phosphorus depletion in a 550 Ma paleosol from South Australia as an example of output data for each reconstructed paleosol. Parent material was chosen on the basis of petrographic, titania, and sesquioxide similarity detailed elsewhere (Retallack, 2013).

D_{CO_2} ($cm^2.s^{-1}$) = diffusion constant for CO_2 in air (=0.162); α (fraction) = ratio of diffusion constant for CO_2 in soil divided by diffusion constant for CO_2 in air (=0.1, range 0.08–0.12); *L* (cm) = original depth to water table (after decompacted using Equation 6).

The duration of soil formation in years (*A* in k.y.) can be calculated from carbonate nodule diameter (*D* in cm: $r^2 = 0.57$, s.e. = 1.8, p = <0.001) for calcareous soils (Retallack, 2005), or thickness of profile (*T* in cm: $r^2 = 0.79$, s.e. = 140, p = 0.01) for non-calcareous unconformity paleosols (Markewich et al., 1990):

$$A = 3.92D^{0.34}, \quad (12)$$

$$A = 4.915T - 343.4. \quad (13)$$

Mean annual precipitation (*P* in mm) can be obtained by the CIA-K proxy, effectively a chemical index of alteration without diagenetically problematic K (*I* as mole fraction: $r^2 = 0.72$, s.e. = 182, p = <0.0001; Sheldon et al., 2002), or compaction-corrected depth to calcic horizon (*D* in cm: $r^2 = 0.52$, s.e. = 147, p = <0.0001; Retallack, 2005):

$$P = 221.1e^{0.0197I}, \quad (14)$$

$$P = 137.24 + 6.45D - 0.0132^2. \quad (15)$$

The normalized value of μmol *F*.cm^2.mm^{-1}.a^{-1}, where *F* is the sum of the four alkaline and alkaline earth bases, or μmol *G*.cm^2.mm^{-1}.a^{-1}, where *G* is the sum of phosphorus depletions, become proxies for global CO_2 consumption if multiplied by modal mean annual precipitation, which is 764 mm in the modern world, with a standard error of 704 mm (Beck et al., 2005). This modal mean annual precipitation may have changed in deep time, but the current understanding of paleoprecipitation from paleosols shows mainly arid to subhumid estimates (Retallack, 2013, 2018; Retallack et al., 2016), comparable with today (Beck et al., 2005). Estimates of exposed land area in deep time are from published areas of continental crust and hypsometric curves (Cawood and Hawkesworth, 2019). These changing land areas were proportionally scaled to a modern land area of 148,429,000 km^2, and carbon consumption to modern global silicate weathering (Ciais et al., 2013) of 0.3 PgC.a^{-1} (Pg = 10^{15}g). Carbon consumption by silicate weathering can be calculated from stoichiometry of Equations 1–4 and carbon consumption by apatite weathering from stoichiometry of Equation 5.

DATABASE, ERROR CALCULATIONS, AND ALTERNATIVES

Detailed accounts of each of the paleosols used in the compilation for these calculations have all been published elsewhere: citations and component data, including error estimates for individual profiles, are listed in the supplemental material[1]. Criteria for quality of data outlined by Rye and Holland (1998) were used to select paleosols for the compilation. Full petrographic and geochemical data, as well as bulk density determinations, were essential for all horizons (Equations 7 and 8). Also needed was evidence of at least moderate development, such as argillic, calcic, or gypsic horizons (Retallack, 2013, 2018, 2022b). To be included, paleosols had to have chemical weathering demonstrated by tau analysis (Brimhall et al., 1992). Weakly developed, gleyed, and inadequately documented paleosols were not included. The paleosol database includes profiles on bedrock unconformities (Rye and Holland, 1998), as well as within sedimentary sequences (Retallack, 2013, 2018, 2022b). Virtually all suitable Precambrian paleosols are included in the database, along with most suitable Phanerozoic paleosols for which data was available. Errors for the calculations were based on standard errors of transfer functions (Equations 12–15) and Gaussian error propagation from partial derivatives of transfer equations summed in quadrature as outlined by Retallack et al. (2021).

Some of the transfer functions used are compromised by other variables: Equations 14 and 15 for paleoprecipitation include components of temperature (Sheldon et al., 2002) and paleoproductivity, respectively (Breecker and Retallack, 2014), which contribute to cited standard errors. Warmth and high precipitation can also compromise age estimates of paleosols using nodule size (Retallack, 2005) and depth of weathering (Markewich et al., 1990), again within standard error of the data used for the transfer function. Although individual paleosol depletion rate standard deviations were small, the variance of estimated depletion rates is large, so rates were pooled by 500-m.y. increments to calculate standard deviations as the height of the open box (Fig. 3).

STEPWISE BIOTIC ENHANCEMENT OF WEATHERING

The results of mass transfer calculations of paleosols ranging back in age to 3700 Ma show three orders of magnitude increases in nutrient depletion of both phosphorus and alkali and alkaline earths, but on different time schedules (Figs. 3A–3B). Most of the range of alkali and alkaline earth depletion was achieved by the Great Oxidation Event (GOE) of 2.45 Ga, but phosphorus depletion rose markedly at both the GOE and the Neoproterozoic Oxidation Event (NOE) of 0.8 Ga. These changes may reflect increased rates of nutrient procurement due to increased biological productivity at those times.

Alkali and alkaline earth depletion rose steadily from 3.5 to 2.4 Ga under acid-sulfate weathering by anaerobic bacterial soil microbiomes (Retallack, 2018; Retallack et al., 2016), now restricted to waterlogged soils and playa lakes (Benison and Bowen, 2015). Alluvial paleosols from 3.5 to 3.0 Ga contain desert roses of sulfate minerals, such as barite and gypsum, as evidence for weathering by strong sulfuric acid rather than weak carbonic acid (Retallack, 2018; Retallack et al., 2016). The microbiome of desert rose paleosols dated to 3.0 Ga is permineralized with silica, and its microfossils, analyzed for cell-specific carbon-isotopic-composition, reveal an anaerobic community of purple sulfur bacteria, actinobacteria, and methanogens (Retallack et al., 2016).

Other paleosols in the data set formed in humid climates on bedrock (supplemental material [see footnote 1]) and were thick, clayey profiles, with little evidence of soluble salts (Rye and Holland, 1998). These do not stand out as anomalies in Figure 3 compared with paleosols with soluble salts (Retallack, 2022c) because they were normalized for mean annual precipitation (Equations 12–13) and duration of formation (Equations 14–15). CO_2 consumption rates of Paleoproterozoic and Archean paleosols are too low (Fig. 4) to explain paleotemperatures under a faint young sun (Kasting, 2010). Likely sulfur bacteria and methanogens in paleosols support the idea that other greenhouses gases, such as methane, ethane, and SO_2, formed a greenhouse

[1]Supplemental Material. Table S1. Base and phosphorus depletion and paleoenvironments of 97 well-studied paleosols. Go to https://doi.org/10.1130/GSAT.S.20126417 to access the supplemental material; contact editing@geosociety.org with any questions.

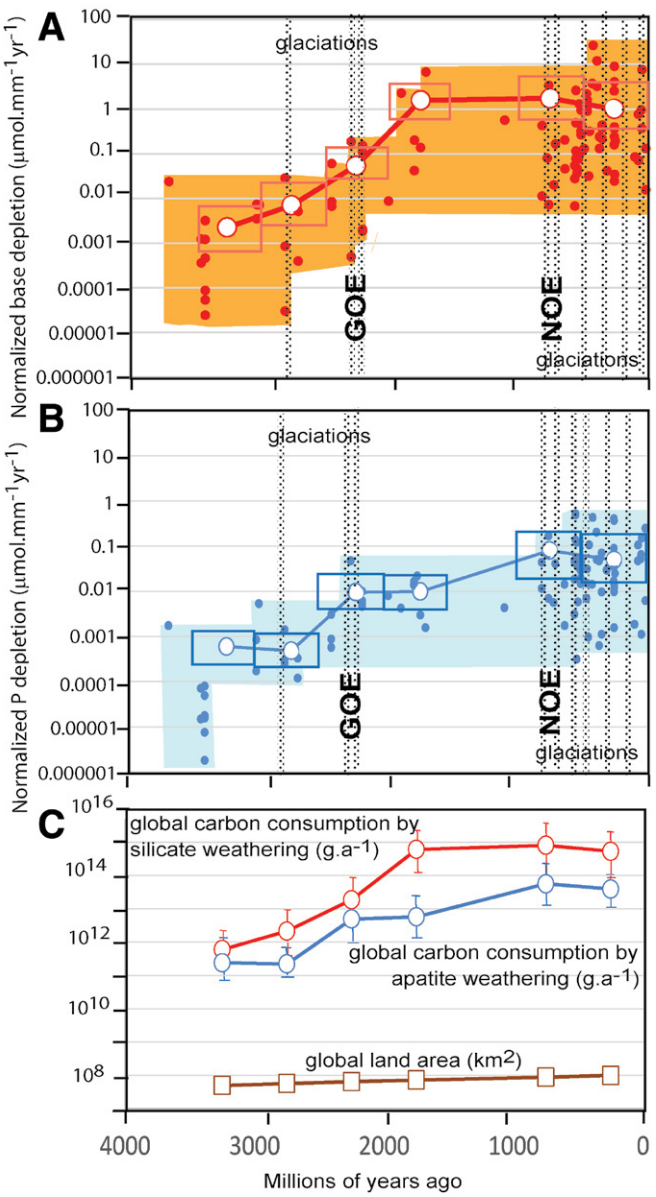

Figure 3. Base (A) and phosphorus depletion (B) and carbon consumption (C) inferred from tau analysis of paleosols over the past 3.7 Ga. (A–B) Closed symbols are individual paleosols, and large open symbols are mean for 500 Ma intervals. Only a single paleosol is known for 1000–500 Ma. (C) Annual rates of C consumption from base depletion and apatite weathering (see supplemental material [see text footnote 1]) and global land area increase calculated from continental area and freeboard estimates (Cawood and Hawkesworth, 2019). Upper and lower box bounds and error bars are two standard deviations. GOE—Great Oxidation Event; NOE—Neoproterozoic Oxidation Event.

haze (Haqq-Misra et al., 2008). Modeling of methane production rates from a P-limited and SO_4-poor Archean ocean would not have produced enough methane for a significant CH_4-greenhouse (Laakso and Schrag, 2019), but anaerobic methanogenesis would have been more widespread in well-drained Archean soils than its current geographic limitation to waterlogged wetlands (Benison and Bowen, 2015). Another Archean warming possibility is three times the current mass of atmospheric N_2 and a H_2 0.1 mixing ratio (Wordsworth and Pierrehumbert, 2013). This seems unlikely because N_2 in the atmosphere was limited to 1.1–0.5 bars judging from nitrogen and argon isotopic ratios in fluid inclusions dated to 3500 Ma (Marty et al., 2013), and total atmospheric pressure at 2700 Ma may have been only half modern judging from the size of lava vesicles and raindrop impressions (Som et al., 2016).

The Archean acid-sulfate weathering style was geographically limited by late Archean spread of carbonic acid weathering, which dominated after the 2.45 Ga GOE (Rye and Holland, 1998). The rise of cyanobacteria as part of a largely freshwater and terrestrial clade of "Terrabacteria" (Battistuzzi and Hedges, 2009) maintained soil productivity, promoting perineutral carbonic acid hydrolysis and free oxygen in both soil and air (Fig. 4). Perineutral pH in soils by 2.4 Ga is indicated by pedogenic carbonate in paleosols of that age and in aridland soils ever since (Pekkarinen, 1979). Thus, hydrolytic weathering systems geographically displaced archaic acid-sulfate weathering, now limited to areas of sulfide ore weathering and anaerobic parts of waterlogged soils and lakes (Benison and Bowen, 2015).

Phosphorus depletion of paleosols rose during the GOE, and again during the NOE (Fig. 3B). The Neoproterozoic does not signify a fundamental change in style of weathering, but rather the evolution of more effective biologically produced ligands, which were mainly bacterial during the GOE, but supplemented by more effective ligands of fungi and lichens during the Neoproterozoic (Neaman et al., 2005; Retallack, 2013; Kump 2014). Both increases in terrestrial productivity coincide in time with Snowball Earth cooling events (Walker, 1982; Kasting, 2010).

IMPLICATIONS FOR SOIL GASES IN DEEP TIME

Some of these same paleosols also have been used to calculate CO_2 consumption as a guide to atmospheric evolution (Sheldon, 2006; Retallack et al., 2021), but they are imperfect guides to the atmosphere. Today, soils may have up to three orders of magnitude more CO_2 than the atmosphere because of soil respiration, and three orders of magnitude less O_2 due to waterlogging (Elberling et al., 2011). The differences in CO_2 and O_2 from the atmosphere are less marked in well-drained soils with open-soil structure (Kyaw Tha Paw et al., 2006). Calculations of gas consumption from paleosols (Sheldon, 2006; Retallack et al., 2021), combined with modern soil gas measurements (Elberling et al., 2011; Kyaw Tha Paw et al., 2006), allow idealized hypotheses for gas concentrations within well-drained alluvial soils over the past 3.7 billion years (Fig. 4). Both O_2 and CO_2 are higher in modern than in Precambrian soils, and geologically younger

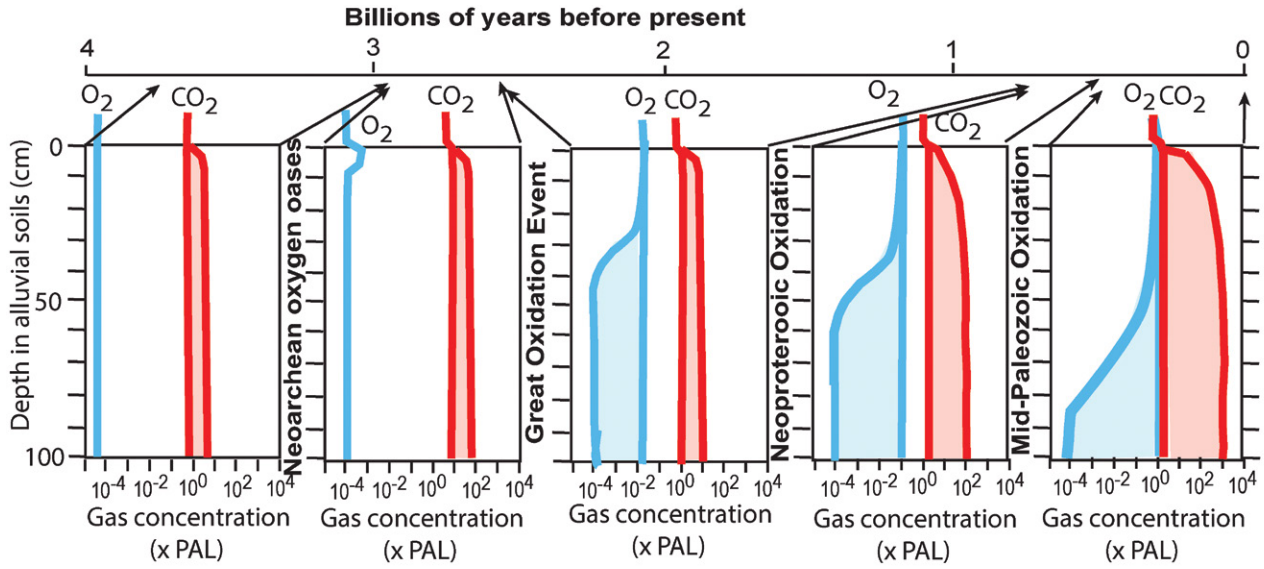

Figure 4. Idealized range of soil gas distributions on Earth over the past 4 billion years. Gas concentrations varied within the envelope shown depending on seasonal productivity and waterlogging, and atmospheric levels of gases inferred from paleosol consumption are shown at the surface. PAL—preindustrial atmospheric level (280 ppm).

soils show more variable concentrations with seasons, within profiles, and geographically (Breecker and Retallack, 2014). Thus, biotic enhancement of weathering was not just a matter of changing the atmosphere (Kasting, 2010), because soil gases at the site of silicate and apatite weathering were critical (Kump, 2014). Neoproterozoic consumption of CO_2 was less by increased silicate weathering than by increased apatite weathering (Fig. 3), suggesting a role for ligands from life on land (Neaman et al., 2005). With later evolution of land plants, soil CO_2 rose orders of magnitude higher than in the atmosphere, supplying carbonic acid for both silicate and apatite weathering (Berner, 1997; Retallack, 2022a, 2022b).

Estimates of CO_2 consumption by Paleoproterozoic and Archean soils do not show expected (Kasting, 2010) high amounts of soil or atmospheric CO_2 (Sheldon, 2006; Retallack, 2018; Retallack et al., 2016, 2021). Common sulfates formed in Archean paleosols despite low atmospheric O_2 suggest that strong sulfuric acid produced by anaerobic sulfur oxidizing bacteria, creating more amorphous colloids such as imogolite than clay, may have been more important than weak carbonic acid in Archean silicate weathering (Retallack, 2018; Retallack et al., 2016). Paleoproterozoic atmospheric oxidation raised rates of atmospheric CO_2 consumption by both oxidative silicate and apatite weathering from aerobic cyanobacteria and actinobacteria, but increases in apatite, not silicate, weathering rates are seen in the Neoproterozoic (Fig. 3), perhaps from newly evolved fungal-lichen microbial earths (Retallack, 2013; Kump, 2014). The advent of land plants did draw down atmospheric CO_2 (Berner, 1997) but did not appreciably alter rates of CO_2 consumption by either silicate or apatite weathering at the coarse 500-m.y. scale of this investigation (Fig. 3). During the past 16 million years, range expansion and contraction of carbon-hungry soils such as Mollisols and Oxisols, with reciprocal adjustment of carbon-lean soils such as Gelisols and Aridisols have acted as a planetary thermostat. Mollisol-Oxisol expansion curbs greenhouse CO_2 spikes, but Gelisol-Aridisol expansion cannot override continued volcanic degassing of CO_2 (Retallack, 2022a). Too few Archean paleosols are now known to demonstrate such counterbalancing carbon sequestration, but biotic enhancement of weathering is suspected then as well. The record of paleosols reveals that atmospheric and soil CO_2 show considerable temporal and presumably also geographic variation (Fig. 3) but not a monotonic increase (Fig. 4). Nevertheless, carbon sequestration by silicate weathering and phosphorus depletion did rise (Fig. 4), as predicted in theory (Schwartzmann, 2017).

COMPARISON WITH EXPERIMENTS

Increases of three orders of magnitude in nutrient depletion of individual paleosols (Fig. 3A) and global carbon sequestration (Fig. 3C) is greater than an estimate of two orders of magnitude of biotic enhancement of weathering derived from compilation of experimental studies (Schwartzmann, 2017) for three reasons. First, experimental studies reveal enhancement factors of major steps in terrestrial productivity, such as the evolution of trees (Retallack, 2022b), and does not consider the origin of microbial life in soils and prokaryotic evolutionary advances in microbiome weathering. Second, global carbon sequestration has been aided by the growth of land area through time. The estimates of land-area increase used here are based on estimates of continental area and paleohypsometry (Cawood and Hawkesworth, 2019), which are relatively conservative, but show a factor of three, rather than a factor of 100 increase through time (Fig. 3C). Third, nutrient depletion fuels biomass carbon sequestration increases of about the same magnitude (Retallack, 2022a). Geographic spread and temporal fluctuation in areas of various kinds of paleosols will be needed for a full accounting of planetary temperature regulation by soils, as has been possible for the Neogene fossil record of soils (Retallack, 2022a).

CONCLUSIONS

Paleosols are now evidence for progressive CO_2 and CH_4 greenhouse reduction by biologically enhanced weathering to offset increased stellar luminosity and continued volcanic greenhouse gas emission. Biological regulation of soil and atmospheric gases may have maintained habitable surface conditions on Earth for the past 3.7 Ga.

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Upcoming Award Deadlines

For details, go to **www.geosociety.org/about-awards.**

Award nominations: Go to **www.geosociety.org/awardnoms.**

You can also email GSA Grants and Awards at **awards@geosociety.org.**

2023 GSA MEDALS AND AWARDS

Nomination deadline: 1 Feb. 2023

- Penrose Medal
- Day Medal
- Young Scientist Award (Donath Medal)
- GSA Public Service Award
- Randolph W. "Bill" and Cecile T. Bromery Award for Minorities
- GSA Distinguished Service Award
- Doris M. Curtis Outstanding Woman in Science Award
- GSA Florence Bascom Geologic Mapping Award
- Honorary Fellow

JOHN C. FRYE ENVIRONMENTAL GEOLOGY AWARD

Nomination deadline: 31 Mar. 2023

In cooperation with the Association of American State Geologists and supported by endowment income from the GSA Foundation's John C. Frye Memorial Fund, GSA makes an annual award for the best paper on environmental geology published either by GSA or by a state geological survey. Learn more at **www.geosociety.org/GSA/About/awards/GSA/Awards/Frye.aspx.**

2023 POST-DOCTORAL RESEARCH AWARDS

Application deadline: 1 Feb. 2023

- The **Gladys W. Cole Memorial Research Award** for research on the geomorphology of semiarid and arid terrains in the United States and Mexico is awarded annually to a GSA member or Fellow between 30 and 65 years of age who has published one or more significant papers on geomorphology.
- The **W. Storrs Cole Memorial Research Award** for research on invertebrate micropaleontology is awarded annually to a GSA member or Fellow between 30 and 65 years of age who has published one or more significant papers on micropaleontology.

Learn more about these post-doc research awards at **www.geosociety.org/GSA/About/awards/GSA/grants/postdoc.aspx.**

OTHER AWARDS

Nomination deadline: 1 Feb. 2023

Submit nominations for the following awards at **www.agiweb.org/direct/awards.html.**

- **AGI Medal in Memory of Ian Campbell** recognizes singular performance in and contribution to the profession of geology.
- **The AGI Marcus Milling Legendary Geoscientist Medal** is given to a recipient with consistent contributions of high-quality scientific achievements and service to the earth sciences having lasting historic value; who has been recognized for accomplishments in field(s) of expertise by professional societies, universities, or other organizations; and is a senior scientist nearing completion or has completed full-time regular employment.

For a listing of other national awards and links information and nomination forms, go to **www.geosociety.org/national-awards.**

Call for GSA Fellowship Nominations

Deadline: 1 February

Nominate a deserving colleague with the honor of GSA Fellowship. GSA members are elected to Fellowship in recognition of distinguished contributions to the geosciences. See election requirements by visiting **www.geosociety.org/Fellowship.**

Be a Part of GSA Connects 2023

Submit a short course and/or technical session proposal.

15–18 October | Pittsburgh, Pennsylvania, USA

GSA Connects 2023 will bring together the geological community to enable you to share your scientific research, network with leaders in the field, and keep your skills relevant in a rapidly changing world. Plan now to be part of this gathering by submitting a proposal for a short course and/or a technical session considering the themes "**Diverse Science for a Sustainable Future**" or "**Climate and Energy Transition**."

Present your evidence-based knowledge to a large international audience by organizing and chairing a technical session.

Proposals are being taken for Pardee Keynote Symposia and topical sessions. Please make your selection on the proposal submission form.

Deadline: 1 Feb. 2023
https://gsa.confex.com/gsa/2023AM/cfs.cgi

Gain recognition as an expert in your topic of research as an instructor of a short course.

Courses run the Friday and Saturday before the meeting and are typically a half day to two full days. Both online and in-person proposals are sought.

Deadline: 1 Feb. 2023
https://gsa.confex.com/gsa/2023AM/shortcourse/cfs.cgi

community.geosociety.org/gsa2023

2022 GSA Research Grant Recipients

The 2022 GSA Committee on Research Grants awarded US$784,655 to 348 graduate students (~59% of the 578 who applied), with an average grant of US$2,301.04. The committee also selected 10 alternate candidates in the event that any grantees return all or part of their funds due to a change in their research project or receipt of funds from another source. The GSA Graduate Student Research Grant Program is funded by GSA, the GSA Foundation, GSA Divisions, GSA Sections, and the National Science Foundation (Award # 1949901). Students receiving NSF funds are indicated with an asterisk.

Committee members: Shichun Huang (Chair), Joseph Asante, Tandis S. Bidgoli, Andy R. Bobyarchick, Robert Brinkmann, Huan Cui, Rhawn F. Denniston, Melissa Ann Foster, Robert A. Gastaldo, Kelly Gibson, Jennifer N. Gifford, Ryan D. Gold, Drew Gorman-Lewis, Tom Hudgins, Kenneth Stephen Hughes, Ethan Hyland, William Thomas Jackson, Jr., Linda C. Kah, Elana L. Leithold, Roberto Molina Garza*, Daniel Jones Morgan, David Mrofka, Sandra Passchier, David M. Pearson, Jason S. Polk, Francis Kevin Rengers, Julie Roberge, Tara Selly, David H. Shimabukuro, Matthew Steele-Macinnis, Brian W. Stewart, Daniel F. Stockli, Benjamin Michael Tutolo, Ashraf Uddin, and Jennifer Anne Wade.

Alternate Committee members: Jason P. Briner, Cathy J. Busby, David R. Cordie, Josh C. Galster, Cindy Palinkas, Christopher J. Potter, Jay Quade, Richard L. Smith, and David S. Vinson.

2022 OUTSTANDING MENTIONS

(proposals having exceptional merit in conception and presentation)

Protik Banerjee, University of Texas at San Antonio
Justine Grabiec, University of Southern California
Michael Jones, University of Arkansas
Mohammad Khorrami, Virginia Polytechnic Institute and State University
William Larsen, Rice University
Sarah Newcomb, Idaho State University
Olasunkanmi Olorunsaye, University of Massachusetts Lowell
Allie Thompson, Western Washington University
Kriddie Whitmore, University of North Carolina at Chapel Hill
Haolin Zhou, Rice University

2022 NAMED AWARDS

Funded by the GSA Foundation

John A. Black Award
Pedro Matos-Llavona, University of Massachusetts Amherst

The John A. Black Award supports graduate student field-based research on coastal processes. All field-based coastal geomorphology research should be located in the USA, Puerto Rico, or Canada. In the event there are no worthy graduate student field-based research projects in coastal geomorphology, the award may be used to support graduate student field-based research in volcanology. All field-based volcanology research should be located in the USA, New Zealand, or Iceland.

Gretchen L. Blechschmidt Award
Catherine Nield, University of Cincinnati

The Gretchen Louise Blechschmidt Award Fund was established for women in the geological sciences who have an interest in achieving a Ph.D. in the fields of biostratigraphy and/or paleoceanography, sequence stratigraphy analysis, particularly in conjunction with research in deep-sea sedimentology, and a career in academic research.

Sam Bowring Geochronology Research Grant
Kathleen Grosswiler, Pennsylvania State University
Jordan Wang, University of Arizona

The Sam Bowring Geochronology Fund supports graduate student field work in geochronology. The recipient is determined by the GSA Geochronology Division.

Ian S.E. Carmichael Research Award
Ami Ward, University of North Carolina at Chapel Hill

The Ian S.E. Carmichael Research Award supports graduate student research and related activities in the fields of igneous petrology and volcanology. The recipient is determined by the GSA Mineralogy, Geochemistry, Petrology, and Volcanology (MGPV) Division.

Allan V. Cox Research Award
Osadebamwen Ohenhen, Virginia Polytechnic Institute and State University

The Allan V. Cox Research Award supports research grants in geophysics. The recipient is determined by the GSA Geophysics & Geodynamics Division.

John T. Dillon Alaska Research Award
Alec Lockett, University of Iowa

The John T. Dillon Alaska Research Award honors the memory of Dr. Dillon, who was particularly noted for his radiometric age-dating work in the Brooks Range, Alaska, USA. Two areas that serve as guidelines for selection of the award are field-based studies dealing with the structural and tectonic development of Alaska, and studies that include some aspect of geochronology (either paleontologic or radiometric) to provide new age control for significant rock units in Alaska.

Robert K. Fahnestock Award
Kelli Moran, Louisiana State University

The Robert K. Fahnestock Award honors the memory of Dr. Fahnestock, a former member of the Research Grants Committee, who died indirectly as a result of service on the committee. The grant is awarded for the best proposal in sediment transport or related aspects of fluvial geomorphology, Dr. Fahnestock's field.

Gould Research Grant
Nathalie Sommer, Yale University

The Gould Research Grant supports graduate student research in the geosciences.

Robert D. Hatcher Research Award
Lance Tully, University of South Carolina

The Robert D. Hatcher Research Award supports field-based research and geologic mapping through an annual award to an outstanding graduate student in the earth sciences to conduct research for that student's master's thesis or Ph.D. dissertation. Preference may be given to students working in the Appalachian orogeny broadly construed but is not restricted to this region.

Grant and Jody Heiken Research Grant
Watts Dietrich, University of Cincinnati

The Grant and Jody Heiken Research Grant supports graduate student research in any fieldwork-oriented, geoscience-related discipline.

William B. and Dorothy Heroy Research Grant
Angie De La Cruz, University of Texas at San Antonio
Zoe Havlena, New Mexico Institute of Mining and Technology
Ane Slabic, University of Houston Clear Lake

The William B. and Dorothy Heroy Research Grant supports graduate student research in the geosciences.

John W. Hess Research Grant
Hanna Leapaldt, The Pennsylvania State University

The John W. Hess Research Grant in Karst Research Studies supports student research involving any aspect of cave and karst studies aimed at providing improved understanding of how caves and karst work, including how these resources can be better managed. The recipient is determined by the GSA Karst Division.

Lincoln S. and Sarah W. Hollister Graduate Student Research Award
Juan Felipe Bustos Moreno, Lehigh University
Peter Lindquist, University of Washington
Julisan Street, University of Michigan

The Lincoln S. and Sarah W. Hollister Graduate Student Research Award funds field-based research using the tools of metamorphic petrology to understand the formation of continental crust.

Roscoe G. Jackson II Award
Josh Malone, University of Texas at Austin

The Roscoe G. Jackson II Award funds one recipient per year in the field of sedimentology.

Lipman Research Award
Lindsey Abdale, The University of British Columbia
Brooke Benz, University of Missouri Kansas City
Mariana Berger, The Ohio State University
Sarah Brooker, University of Texas at Austin
César Bucheli Olaya, Missouri State University
Weiming Ding, University of Minnesota Twin Cities
Joy Foluso, University of California Davis
Elmer Gonzalez, University of Puerto Rico Mayaguez
Alex Holmwood, University of Nevada Reno
Jessica Johnson, University of New Mexico
Tess Johnson, East Carolina University
Nathaniel Lenhard, Missouri State University
Chuck Lewis, Oregon State University
Mary Macquistan, University of British Columbia
Emily McQuarrie, Western Washington University
Cissy Ming, Virginia Polytechnic Institute and State University
Venkata Sailaja Pappala, North Carolina State University
Travis Parsons, State University of New York at Buffalo
Mollie Pope, University of Wyoming
Nanci Reyes Guzman, Miami University
Carli Schmidt, Northern Illinois University
Ashley Thrower, Louisiana State University
Simin Zhao, Georgia Institute of Technology

The Lipman Research Fund was established in 1993 and is supported by gifts from the Howard and Jean Lipman Foundation. The purpose of the fund is to promote and support student research grants in volcanology and petrology. The president of the Lipman Foundation, Peter W. Lipman, was the recipient of a GSA research grant in 1965. The recipient is determined by the GSA Mineralogy, Geochemistry, Petrology, and Volcanology (MGPV) Division.

John T. and Carol G. McGill Award
Helbert Garcia-Delgado, Syracuse University
Antonio Reveles-Hernandez, University of Northern Colorado
Rakiba Sultana, University of Wisconsin Milwaukee

The John T. and Carol G. McGill Award, which is in the memory of John T. McGill, supports graduate student scholarships and research grants in engineering geology and geomorphology.

On To the Future (OTF) Research Grant
Iliansherry Santiago, Northern Illinois University

The purpose of this grant is to recognize an excellent student research proposal and connect the student to GSA's On To the Future (OTF) Program. OTF is a grassroots initiative that addresses GSA's overall strategic commitment to building a diverse geoscience community by engaging groups traditionally underrepresented in the geosciences. The student chosen for this grant will be invited to participate in the On To the Future program and receive a partial travel award, full meeting registration, and be recognized at the Diversity in the Geosciences Reception at GSA Connects.

Bruce L. "Biff" Reed Scholarship Award
Sloane Kennedy, Western Washington University
Mahinaokalani Robbins, Western Washington University

The Bruce L. "Biff" Reed Scholarship Fund was established to provide research grants to graduate students pursuing studies in the tectonic and magmatic evolution of Alaska primarily, and also can fund other geologic research.

Charles A. and June R.P. Ross Research Award
Teresa Avila, The Ohio State University
James Beech, University of Southern California
Maddie Gaetano, University of Cincinnati
Anne Kort, Indiana University Bloomington
Jose Marquez, Stanford University
Noah Slade, Utah State University
Jordan Todes, University of Chicago
Clark Ward, University of Cincinnati

The Charles A. and June R.P. Ross Research Fund is awarded to support research projects for graduate students, post-graduate students, and post-doctorate researchers in the fields of biostratigraphy (including, but not limited to, fossil age dating and the study of evolutionary faunal successions), stratigraphy and stratigraphic correlation, paleogeography and paleobiogeography, interpreting past environments of deposition and their biological significance, and the integration of these research areas into better global understanding of (1) past plate motions (plate tectonics and seafloor spreading); (2) past sea-level events, including their identification and ages; and/or (3) climate changes and effects of those climate changes on Earth's inhabitants through geologic time.

Alexander Sisson Research Award
Lena Capece, University of California Santa Barbara
Alex Villa, University of Wisconsin Madison

Family members of Alexander Sisson established a fund in his memory to promote and support research for students pursuing studies in Alaska and the Caribbean.

Parke D. Snavely, Jr., Cascadia Research Award
David Bruce, Virginia Polytechnic Institute and State University

The Parke D. Snavely, Jr., Cascadia Research Award Fund provides support for field-oriented graduate student research that contributes to the understanding of the geologic processes and history of the Pacific Northwest convergent margin or to the evaluation of its hazard or resource potential.

Harold T. Stearns Fellowship Award
Alejandro Giraldo Ceron, Penn State University

Stearns established the Harold T. Stearns Fellowship Award in 1973 for student research on aspects of the geology of the Pacific Islands and the circum-Pacific region.

Tim F. Wawrzyniec Research Grant
Matt Aleksey, University of Wisconsin Madison
Luke Basler, University of Idaho
Carlos Montejo, University of Idaho

The purpose of the Tim F. Wawrzyniec Fund is to support graduate and undergraduate student research fieldwork in the Rockies and the Colorado Plateau, with preference for projects in the following areas: structure, tectonics, paleomagnetism, petrology, petroleum geology, and Quaternary geomorphology.

Lauren A. Wright and Bennie W. Troxel Student Research Award
Sofia Marino, University of North Carolina Chapel Hill

The Lauren A. Wright and Bennie W. Troxel Student Research Fund supports two graduate students in master's or Ph.D. programs conducting field-based research (1) in the region broadly centered on Death Valley National Park or (2) in the western and southern Basin and Range Tectonic Province.

Continued, p. 16

2022 GSA Graduate Student Research Grant Recipients

(Students are listed in alphabetical order by university. Students receiving NSF funds are indicated with an asterisk.)

Arizona State University
Kenzie Shandonay

Auburn University
Shifat Monami
Tyler Smith
Md Riaz Uddin
Dogancan Yasar

Ball State University
Abdulgadir Elnajdi

Baylor University
Alix Fournier
Nathan Wright*

Boise State University
Naheem Adebisi
Zahra Ghahremani
Tanzila Hanif
Maggie Holahan
Courtney Mcdavid
Allyson Randall
Hannah Richardson
Angela Seibert

Brown University
Andrea Mason*
Bryce Mitsunaga*

California State University Fresno
Nicholas DeSisto

California State University Fullerton
Diana Urda*

California State University Long Beach
Trang Tran

California State University Northridge
Joella Campbell
Judit Campos*
Francine Robles*

Carleton University
Dana Korneisel*
Misha Whittingham

Central Michigan University
Luiza Maria Pierangeli

Central Washington University
Garet Huddleston*

Clemson University
Abby Boyd
Gavin Gleasman

College of Charleston
Hannah Quast

Colorado School of Mines
Kim Cone*
Kenny Swift Bird*

Colorado State University
Sarah Dunn
Luis Carlos Escobar Arenas
Cecilia Hurtado
Emily Iskin
Mickey Means-Brous
Wyatt Reis

Cornell University
Jaleigh Pier

Dalhousie University
Anna Ryan

Dartmouth College
Josephine Benson*
Christian Erikson
Victoria Halvorson
Eliza Malakoff

Drexel University
Lena Champlin*
Andrew Payne

Duke University
Zhen Wang
Gordon Williams

Duquesne University
Anna Vietmeier*

East Carolina University
Tess Johnson

Florida International University
Jeanette deCuba

Florida State University
Jay Goodin

George Mason University
Alex Gray
Ana Shirley*

Georgia Institute of Technology
Dru-Ann Harris
Simin Zhao

Georgia State University
Kiersten Crye*
Forrest Dabbs*

Harvard University
Robert Welch

Idaho State University
Sarah Newcomb

Illinois State University
Elisa Hong*

Indiana University Bloomington
Anne Kort
Hao Yuan

Institut National de la Recherche Scientifique (INRS)
Zahoor Muhammad Zahoor

Johns Hopkins University
Supratik Roy

Kansas State University
Alex Bearden*
Vidhesh Shukla

Kent State University
Emily Mehta*
Sachini Ranasinghe
Alyssa Reinhardt
Kyle Smart

Lehigh University
Juan Felipe Bustos Moreno

Louisiana State University
Kristoffer Fowler
Kelli Moran*

Mustuque Munim
Ashley Thrower
Julian Traphagan*

McGill University
Emily Mick

Miami University
Abigale O'Connor
Nanci Reyes Guzman

Missouri State University
César Bucheli Olaya
Nathaniel Lenhard

Missouri University of Science and Technology
James Quick

Montana State University
Natali Kragh

Montclair State University
Hermann Bermúdez

New Mexico Institute of Mining and Technology
Zoe Havlena

New Mexico State University
Lee Hughes

North Carolina State University
Iffat Azmi
Raja Das
Venkata Sailaja Pappala

Northern Arizona University
Rachel Forney*
Emma Palko

Northern Illinois University
Viviane dos Santos Rocha
Mary Eensalu
Garnet Flora-Holmquist*
Cheryl Manning*
Iliansherry Santiago*
Carli Schmidt

Northwestern University
Aidan Burdick
Luca Podrecca

Ohio University
Skyler Houser*

Oklahoma State University Center for Health Sciences
Celine Cortes*

Oregon State University
Suhail Alhejji
Jonas Donnenfield*
Layla Ghazi*
Chuck Lewis
Lourdes Moreu*

Portland State University
Darlene Gilroy*

Rice University
William Larsen
Stewart Williams*
Haolin Zhou

Rutgers University
Hailey Riechelson

Simon Fraser University
Mahmud Muhammad

South Dakota School of Mines and Technology
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GSA International, GSA Divisions, and GSA Sections have recognized the following student research grant recipients who submitted proposals of exceptionally high merit in conception and presentation in their fields.

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Carson Broaddus, University of Montana
Yuval Shmilovitz, The Hebrew University of Jerusalem

This grant is to encourage and support desert studies by students worldwide either in their senior year of their undergraduate studies or at the master's or Ph.D. level.

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Shifat Monami, Auburn University
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GEOPHYSICS AND GEODYNAMICS DIVISION

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Geophysics Student Research Grant Award and Supplement
Efemena Emmanuel, University of Toledo
Alysa Fintel, University of Washington

HYDROGEOLOGY DIVISION

Hydrogeology Division Student Research Grant Awards and Travel Grants
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William Larsen, Rice University
Julianna Martin, University of Idaho
Sarah Newcomb, Idaho State University
Olasunkanmi Olorunsaye, University of Massachusetts Lowell

MINERALOGY, GEOCHEMISTRY, PETROLOGY, AND VOLCANOLOGY DIVISION

James B. Thompson Jr. Graduate Student Research Grant in Metamorphic Petrology and Geochemistry
Megan Kalina, The University of Texas Permian Basin
Luiza Pierangeli, Central Michigan University

QUATERNARY GEOLOGY AND GEOMORPHOLOGY DIVISION

Peter Birkeland Soil Geomorphology Research Award
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Telemak Olsen, Western Washington University
Richard B. Waitt Research Award for Field-Based Research
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SEDIMENTARY GEOLOGY DIVISION

Sedimentary Geology Division Student Research Grant Award
Francis Kovalick, University of California Riverside

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Structural Geology and Tectonics Division Student Research Travel Grant Awards
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SECTION GRADUATE RESEARCH GRANTS

Southeastern Section Graduate Research Grants
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2022 AGeS-DiG (Diversity in Geochronology) Grants

The AGeS-DiG (Diversity in Geochronology) funds pilot initiatives to increase access to geochronology for those underrepresented in the earth sciences. The program goals are to:

- Engage, train, and educate students at any level (including undergraduate and community college) who have not traditionally had equal access to geochronology data and training.
- Generate and test innovative ideas to expand geochronology access for those underrepresented in the earth sciences.

The 2022 AGeS-DiG program was supported by the National Science Foundation under the following awards: EAR-1759200, EAR-1759353, and EAR-1759201. For more information, see the AGeS-DiG homepage: www.colorado.edu/program/agesgeochronology/ages-dig. In 2022, six AGeS DiG awards were given:

Christopher Bailey, College of William & Mary, "Cracking open Rodinia—Engaging underrepresented students in U-Pb geochronology to better understand Iapetus rifting in the central Appalachians."

Jaclyn Baughman and **Melanie Michalak,** California State Polytechnic University Humboldt, "An undergraduate cohort thermochronology research and mentorship experience documenting Northern California's response to Eocene Siletzia accretion."

Isabella Bennett, University of Vermont, "Authentic Undergraduate Geochronology Research (AUGR)."

Kevin Konrad, University of Nevada Las Vegas, "Three-phases of $^{40}Ar/^{39}Ar$ geochronology research into ancient marine volcanoes."

Lyman Persico, Whitman College, "A project focused on landscape evolution and climate change to introduce research to first-year students from underrepresented backgrounds."

Darryl Reano, Arizona State University, "GeoConnections 2 (GC2)."

Savannah Devine, a 2022 J. David Lowell Field Camp Scholarship awardee.

J. David Lowell Field Camp Scholarships

GSA and the GSA Foundation are proud to announce that J. David Lowell Field Camp Scholarships will be available to undergraduate geology students for the summer of 2023. These scholarships will provide students with US$2,000 each to attend the field camp of their choice. Applications are reviewed based on diversity, economic/financial need, and merit. **Application deadline:** 31 Mar. 2023.

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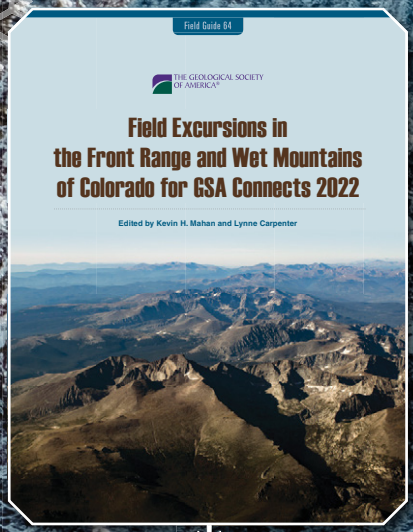
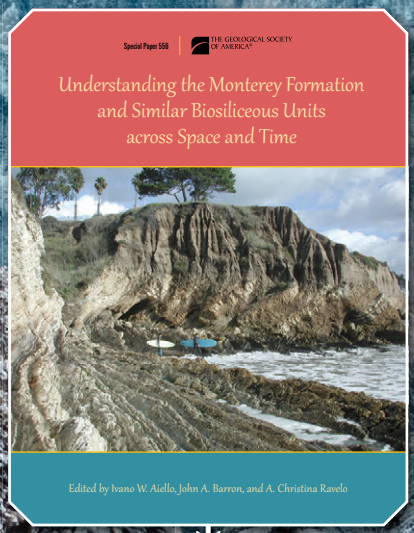


Field Excursions in the Front Range and Wet Mountains of Colorado for GSA Connects 2022

Edited by Kevin H. Mahan and Lynne Carpenter

The three field guides in this volume, associated with GSA Connects 2022 held in Denver, Colorado, USA, tackle some interesting aspects of Colorado geology and paleontology. Learn about dinosaur tracks, microbial mat, and applied photogrammetry at Dinosaur Ridge; explore the nature and extent of the Mesoproterozoic Picuris orogeny in Colorado; and learn more about Paleoproterozoic tectonics of the northern Colorado Rocky Mountains Front Range in the context of the authors' proposed tectonic models.

FLD064, 66 p., ISBN 9780813700649
$29.00 | **member price $20.00**



Understanding the Monterey Formation and Similar Biosiliceous Units across Space and Time

Edited by Ivano W. Aiello, John A. Barron, and A. Christina Ravelo

The Monterey Formation is a Miocene marine unit that occurs extensively in the Coast Ranges and in the continental margins of California, and analogous biosiliceous deposits are found around the Pacific Rim and elsewhere in the world. Classic studies on the diatomaceous deposits that characterize the hemipelagic/pelagic facies of the Monterey Formation have been key to understanding the oceanographic and tectonic conditions that lead to the preservation of large volumes of organic-rich hemipelagic biosiliceous sediments, and the properties of these sedimentary deposits once they convert into rocks. This volume presents a collection of recent studies on the Monterey and other similar biosiliceous deposits that offer modern and updated interpretations of this classic unit and its analogues. The volume is dedicated to the memory of Professor Bob Garrison.

SPE556, 315 p., ISBN 9780813725567
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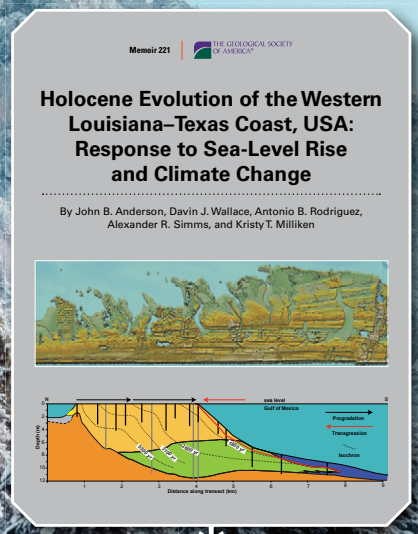

Holocene Evolution of the Western Louisiana–Texas Coast, USA: Response to Sea-Level Rise and Climate Change

By John B. Anderson, Davin J. Wallace, Antonio B. Rodriguez, Alexander R. Simms, and Kristy T. Milliken

Global sea-level rise increased during the twentieth century from 1.5 to 3.0 mm/yr and is expected to at least double over the next few decades. The Western Louisiana and Texas coast is especially vulnerable to sea-level rise due to low gradients, high subsidence, and depleted sediment supply. This Memoir describes the regional response of coastal environments to variable rates of sea-level rise and sediment supply during Holocene to modern time. It is based on results from more than six decades of research focused on coastal and nearshore stratigraphic records. The results are a wake-up call for those who underestimate the potential magnitude of coastal change over decadal to centennial time scales, with dramatic changes caused by accelerated sea-level rise and diminished sediment supply.

MWR221, 81 p., ISBN 9780813712215
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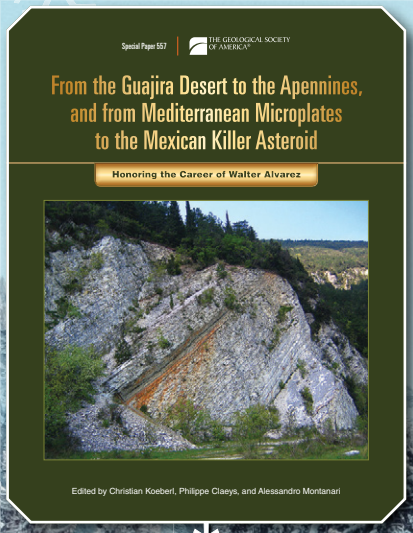

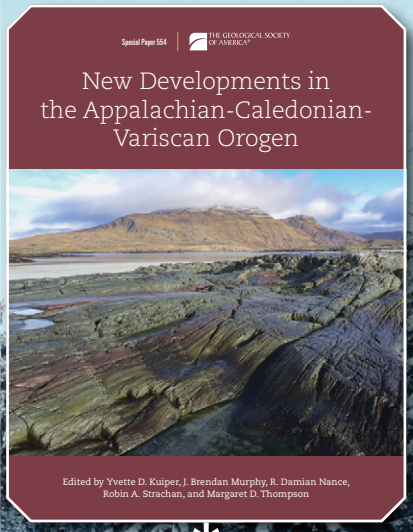

From the Guajira Desert to the Apennines, and from Mediterranean Microplates to the Mexican Killer Asteroid: Honoring the Career of Walter Alvarez

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.

SPE557, 600 p., ISBN 9780813725574
$95.00 | **member price $66.00**

New Developments in the Appalachian-Caledonian-Variscan Orogen

Edited by Yvette D. Kuiper, J. Brendan Murphy, R. Damian Nance, Robin A. Strachan, and Margaret D. Thompson

New analytical and field techniques, as well as increased international communication and collaboration, have resulted in significant new geological discoveries within the Appalachian-Caledonian-Variscan orogen. Cross-Atlantic correlations are more tightly constrained and the database that helps us understand the origins of Gondwanan terranes continues to grow. Special Paper 554 provides a comprehensive overview of our current understanding of the evolution of this orogen. It takes the reader along a clockwise path around the North Atlantic Ocean from the U.S. and Canadian Appalachians; to the Caledonides of Spitsbergen, Scandinavia, Scotland, and Ireland; and thence south to the Variscides of Morocco.

SPE554, 436 p., ISBN 9780813725543
$80.00 | **member price $56.00**

2023 Calendar: *Earth Unveiled*

Unveiling a variety of splendors, GSA's newest calendar offers extraordinary views from places near and far for all to enjoy throughout 2023. This 12-month calendar showcases breathtaking images of Grand Staircase–Escalante National Monument, City of Rocks National Reserve, Tjarnargígur, pyrite framboids in Marcellus Shale, and Pinnacles Desert.

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Rocky Mountain Section

72nd Annual Meeting of the Rocky Mountain Section, GSA

Fort Collins, Colorado, USA | 23–25 May 2023

www.geosociety.org/rm-mtg

Pineridge Natural Area. Photo credit: Jan Alexander from Pixabay.

LOCATION

We are excited to announce that the GSA 2023 Rocky Mountain Section Meeting will be held in Fort Collins, Colorado, USA, on the campus of Colorado State University. This meeting site is near the foothills of the geologically diverse Front Range, which includes complex Proterozoic rocks and shear zones, well-exposed Pennsylvanian to Cretaceous strata, spectacular Laramide structures, Late Cretaceous–Paleogene intrusive bodies and associated mineral deposits, and a wide range of geomorphic features. Fort Collins is about a one-hour drive from Denver International Airport and is a small, dynamic city with a nationally renowned and very walkable downtown, arts, restaurant, and outdoor recreational scene (including a very large number of notable breweries).

CALL FOR PAPERS

Abstract deadline: 28 Feb. 2023
Submit online at **www.geosociety.org/rm-mtg**
Abstract submission fee: GSA members: professionals, US$35; students, US$20. Non-members: professionals, US$60; students, US$35.

TECHNICAL PROGRAM

Technical Sessions
Session and short-course meeting co-chairs: Ken Sims, ksims7@uwyo.edu; Rick Aster, rick.aster@colostate.edu.

T1. **The Laramide Belt: End to End.** *Endorsed by GSA Structural Geology and Tectonics Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division.* Jacob O. Thacker, Montana State University Billings, jacoboliverthacker@gmail.com; Carla Eichler, Oklahoma Geological Survey, carla.eichler@ou.edu; Nikki M. Seymour, Stanford University, nseymour@stanford.edu; Brian Hampton, New Mexico State University, bhampton@nmsu.edu.

T2. **Planning to Reduce Landslide Hazard Losses.** *Endorsed by GSA Environmental and Engineering Geology Division; GSA Quaternary Geology and Geomorphology Division.* Stephen L Slaughter, U.S. Geological Survey, sslaughter@usgs.gov; Jonathan Godt, U.S. Geological Survey, jgodt@usgs.gov.

T3. **Past and Present Glaciation of Western North America.** *Endorsed by GSA Quaternary Geology and Geomorphology Division.* Keith Brugger, University of Minnesota Morris, bruggeka@morris.umn.edu; Jordan Dahle, North Dakota State University, jordan.dahle@ndsu.edu; Eric Leonard, Colorado College, eleonard@coloradocollege.edu.

T4. **Geophysical Studies of Crust-Mantle Structure and Surface Deformation in the Rocky Mountains.** *Endorsed by GSA Geophysics and Geodynamics Division.* Brandon Schmandt, University of New Mexico, bschmandt@unm.edu; Julien Chaput, University of Texas at El Paso, jchaput82@gmail.com.

T5. **Drivers of Continental Magmatism.** *Endorsed by GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division.* Pamela Kempton, Kansas State University, pkempton@ksu.edu; Claudia Adam, Kansas State University, cadam@ksu.edu; Matthew Brueseke, Kansas State University, brueseke@ksu.edu.

T6. **Integrated Science Approaches to Addressing Complex Earth Science Challenges.** *Endorsed by GSA Geology and Society Division; GSA Hydrogeology Division; GSA Environmental and Engineering Geology Division; GSA Soils and Soil Processes Division; GSA Geoscience Education Division; GSA Geoinformatics and Data Science Division.* Jason Alexander, U.S. Geological Survey, jalexand@usgs.gov; Rebecca Frus, U.S. Geological Survey, rfrus@usgs.gov; Patrick Anderson, U.S. Geological Survey, andersonpj@usgs.gov; Joseph Hevesi, U.S. Geological Survey, jhevesi@usgs.gov; Adrian Monroe, U.S. Geological Survey, amonroe@usgs.gov; Sharon Qi, U.S. Geological Survey Colorado, slqi@usgs.gov; Katharine Dahm, U.S. Geological Survey, kdahm@usgs.gov.

T7. **Geoscience, Hydrology, and Water Management of Our Public Lands.** *Endorsed by GSA Hydrogeology Division.* Forrest "Ed" Harvey, National Park Service–Water Resources Division, forrest_harvey@nps.gov; Steve Rice, National Park Service, steven_rice@nps.gov; Tyler Gilkerson, National Park Service, tyler_gilkerson@nps.gov; Nicole O'Shea, National Park Service, nicole_oshea@nps.gov; Erin White, National Park Service, erin_white@nps.gov; Matt Dawson, The Geological Society of America, mdawson@geosociety.org.

T8. **The Yellowstone Hotspot Geologic Province: Examining the Effects of Yellowstone Volcanism on the North**

American West. *Endorsed by GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division.* Cole Messa, University of Wyoming, cmessa@uwyo.edu; Mark Stelten, U.S. Geological Survey, mstelten@usgs.gov, Kenneth Sims, University of Wyoming, ksims7@uwyo.edu.

T9. **Tectonism and Magmatism in the Rio Grande Rift.** *Endorsed by GSA Structural Geology and Tectonics Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division.* Greg Stark, University of Wyoming, gstark2@uwyo.edu; John Singleton, Colorado State University, John.Singleton@colostate.edu; W. Scott Baldridge, Los Alamos National Laboratory, sbaldridge@lanl.gov; Kenneth Sims, University of Wyoming, ksims7@uwyo.edu.

T10. **Past and Present Stable Isotopes of the Western U.S. and Beyond.** *Endorsed by GSA Quaternary Geology and Geomorphology Division.* Jeremy Rugenstein, Colorado State University, jeremy.rugenstein@colostate.edu; Tyler Kukla, Colorado State University, Tyler.Kukla@colostate.edu; Daniel E. Ibarra, Institute at Brown for Environment and Society, Brown University, daniel_ibarra@brown.edu.

T11. **A Changing Cryosphere: The Rocky Mountains and Beyond.** *Endorsed by GSA Quaternary Geology and Geomorphology Division; GSA Hydrogeology Division.* Randall Bonnell, Colorado State University, rbonnell@colostate.edu; Lucas Zeller, Colorado State University, lucas.zeller@colostate.edu; Sierra Melton, Pennsylvania State University, smm1084@psu.edu; Wyatt Reis, Colorado State University, wyatt.reis@colostate.edu.

T12. **Geohydrobiology of the Yellowstone Hydrothermal System.** *Endorsed by GSA Hydrogeology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division.* Andrew E. Miller, University of Wyoming, amille78@uwyo.edu; Kenneth Sims, University of Wyoming, ksims7@uwyo.edu; Daniel Colman, Montana State University, daniel.colman@montana.edu; Eric Boyd, Montana State University, eboyd@montana.edu.

T13. **Post-Wildfire and Other Debris Flows.** *Endorsed by GSA Environmental and Engineering Geology Division.* Jonathan Lovekin, Colorado Geological Survey, jlovekin@mines.edu; Amy Crandall, Colorado Geological Survey, acrandall@mines.edu; Kassandra Lindsey, Colorado Geological Survey, kolindsey@mines.edu.

T14. **Geologic and Geohazard Mapping: Recent Advances in Mapping and Age-Dating Techniques and Use of Lidar.** *Endorsed by GSA Environmental and Engineering Geology Division.* Kassandra Lindsey, Colorado Geological Survey, kolindsey@mines.edu; Steve Keller, Colorado Geological Survey, skeller@mines.edu; Amy Crandall, Colorado Geological Survey, acrandall@mines.edu; Jonathan Lovekin, Colorado Geological Survey, jlovekin@mines.edu.

T15. **Geologic Mapping in the Rocky Mountains: Evolving Techniques and Challenges (Posters).** Nathan Hopkins, Idaho Geological Survey, nhopkins@uidaho.edu; Russ Di Fiori, Idaho Geological Survey, russelld@uidaho.edu.

T16. **Intraplate Seismicity: Ancient and Modern.** *Endorsed by GSA Geophysics and Geodynamics Division.* Kyren Bogolub, Colorado Geological Survey, kbogolub@mines.edu; Matthew Morgan, Colorado Geological Survey, mmorgan@mines.edu; Anne Sheehan, University of Colorado Boulder, anne.sheehan@colorado.edu; James P. McCalpin, GEO-HAZ Consulting, Inc., mccalpin@geohaz.com.

T17. **Landscape Evolution across Time Scales from the High Plains to the Colorado Plateau.** *Endorsed by GSA Quaternary Geology and Geomorphology Division.* Sean Gallen, Colorado State University, sean.gallen@colostate.edu; Eyal Marder, Indiana University, emarder@iu.edu.

T18. **Crust Formation, Deformation, Metamorphism, Plutonism, and Thermal Evolution of the Rocky Mountains: Proterozoic to Present.** *Endorsed by GSA Structural Geology and Tectonics Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division.* Andreas Möller, University of Kansas, amoller@ku.edu; Graham Baird, University of Northern Colorado Greeley, Graham.Baird@unco.edu; Timothy P. Grover, University of Northern Colorado Greeley, timothy.grover@unco.edu; A. Kate Souders, U.S. Geological Survey, asouders@usgs.gov.

T19. **The Field Fellows: A Network of Diversity and Inclusion Champions within the Earth Sciences.** Gillian Bowser, Department of Ecosystem Science and Sustainability, Colorado State University, gbowser@colostate.edu; Lisa White, University of California Berkeley; Philip Haliwell, Colorado State University.

T20. **Quaternary Paleoclimate Records of the Rocky Mountain Region.** *Endorsed by GSA Quaternary Geology and Geomorphology Division.* Shannon Mahan, U.S. Geological Survey, smahan@usgs.gov; Tammy Rittenour, Utah State University, tammy.rittenour@usu.edu; Peter Fawcett, University of New Mexico, fawcett@unm.edu.

T21. **Data Preservation for the Geosciences: Recent Advances in Geo-Databases, Repository Practices, and Big Data Applications.** Amy Atwater, U.S. Geological Survey, aatwater@usgs.gov; Kelly Thomson, U.S. Geological Survey, kthomson@usgs.gov; Victoria Crystal, U.S. Geological Survey, vcrystal@usgs.gov.

SHORT COURSES

Practical Python for Earth Scientists. *Endorsed by Rocky Mountain Association of Geologists.* Matthew W. Bauer, P.G., Colorado School of Mines and V.P. Data Science & Analytics, Energy Royalty Partners, matthew.w.bauer.pg@gmail.com.

Core Workshop: Recent Advances in Stratigraphy and Origin of Mid-Carboniferous Strata, Heath and Tyler Formations, Central Montana, USA. Richard J. Bottjer, Denver Museum of Nature & Science, rjbottjer@coalcreekresources.com.

Luminescence (OSL) Dating Short Course: Essential Guide for Sampling and Dark Secrets Behind the Technique. *Endorsed by GSA Quaternary Geology and Geomorphology Division; GSA Geochronology Division.* Shannon Mahan, U.S. Geological Survey, smahan@usgs.gov; Tammy Rittenour, Utah State University, trittenour@usu.edu.

FIELD TRIPS

Field trip co-chairs: John Singleton, john.singleton@colostate.edu; Yvette Kuiper, ykuiper@mines.edu; Jonathan Caine, jscaine@usgs.gov.

After the Asteroid: Stratigraphy and Paleontology of the K-Pg Succession at Corral Bluffs, Colorado. *Endorsed by GSA Sedimentary Geology Division.* James Hagadorn, Denver Museum of Nature & Science, jwhagadorn@dmns.org; Tyler Lyson, Denver Museum of Nature & Science, tyler.lyson@dmns.org; Gussie MacCracken, Denver Museum of Nature & Science, gussie.maccracken@dmns.org.

Proterozoic Tectonics of the Northern Colorado Front Range. *Endorsed by GSA Structural Geology and Tectonics Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division.* Graham Baird, University of Northern Colorado, graham.baird@unco.edu; Tim Grover, University of Northern Colorado, timothy.grover@unco.edu; Kevin Mahan, University of Colorado Boulder, kevin.mahan@colorado.edu.

Stratigraphy and Structural Geology of the Front Range near Fort Collins, Colorado. John Singleton, Colorado State University, john.singleton@colostate.edu; Jeremy Rugenstein, Colorado State University, jeremy.rugenstein@colostate.edu.

An Examination of Late Paleozoic Stratigraphy, Laramide Folds, and the Rocky Mountain Erosion Surface. Michael Kendrick, Retired Petroleum Geoscientist, mkendrick9@icloud.com; John Singleton, Colorado State University, john.singleton@colostate.edu.

Overview and Geologic History of Quaternary Fluvial and Eolian Deposits in the Northern Colorado Piedmont. *Endorsed by GSA Quaternary Geology and Geomorphology Division.* Stephen M. Keller, Colorado Geological Survey, skeller@mines.edu; Michael K. O'Keeffe, Colorado Geological Survey, okeeffe@mines.edu; Kassandra O. Lindsey, Colorado Geological Survey, kolindsey@mines.edu; Alexander E. Marr, Colorado Geological Survey, alexmarr131@gmail.com; Matthew L. Morgan, Colorado Geological Survey, mmorgan@mines.edu.

Geomorphology and Structures in the Epicentral Area of the 1882 M6.6 Earthquake. James P. McCalpin, GEO-HAZ Consulting, Inc., mccalpin@geohaz.com.

Cenozoic Geology and Geomorphology of the Laramie Mountains, Wyoming. *Endorsed by GSA Quaternary Geology and Geomorphology Division; Wyoming Geological Survey.* Emmett Evanoff, University of Northern Colorado, emmett.evanoff@unco.edu.

A VIP Behind-The-Scenes Tour at the Denver Museum of Nature & Science. James Hagadorn and others, Denver Museum of Nature & Science, jwhagadorn@dmns.org.

From Mantle to Mountain Top—Palinspastic Restoration of the I-70 Transect across the Basement Uplifts of Central Colorado. *Endorsed by GSA Structural Geology and Tectonics Division.* Ned Sterne, independent geologist, nedsterne@aol.com; Bob Raynolds, Denver Museum of Nature & Science, bobraynolds1@gmail.com; Jim Granath, consulting structural geologist, jwgranath@q.com.

Introduction to the Stratigraphy and Depositional Settings of the Classic Outcrops of the Book Cliffs. *Endorsed by GSA Sedimentary Geology Division.* Howard Feldman, Colorado State University, howard.feldman@colostate.edu; Vitor Abreu, Act Geosciences, vitor@act-geo.com.

Why is Kilometer-Scale Exhumation Diachronous across the Colorado Rockies and Great Plains? *Endorsed by GSA Structural Geology and Tectonics Division; GSA Geochronology Division.* Lon Abbott, University of Colorado, lon.abbott@colorado.edu; Rebecca Flowers, University of Colorado, rebecca.flowers@colorado.edu; James Metcalf, University of Colorado, james.metcalf@colorado.edu; Sabrina Kainz, University of Colorado, sabrina.kainz@colorado.edu.

REGISTRATION

Early registration deadline: 17 April
Registration cancelation deadline: 24 April

For further information or if you need special accommodations, please contact the organizing chair, Rick Aster, rick.aster@colostate.edu.

ACCOMMODATIONS

Hotel registration deadline: 2 May

A block of rooms has been reserved at the Fort Collins Hilton located next to the Colorado State University campus and within easy walking distance of the Lory Center meeting venue. The meeting rate is US$189 per night plus tax. The hotel offers many amenities (restaurants, bar, pool, Wi-Fi), and the convention center is just steps away. Reservations can be made by calling +1-970-482-2626. Please reference group code **RMGSA23**.

OPPORTUNITIES FOR STUDENTS AND EARLY CAREER PROFESSIONALS

Career Mentoring Luncheons

Ask your career-related questions and learn about non-academic pathways in the geosciences while networking with professionals at the Roy J. Shlemon and John Mann Mentor Luncheons. GSA student members are welcome.

Career Workshop Series

This three-part series will feature career development planning, an exploration of geoscience job sectors, and information on best practices for crafting a résumé and cover letter. Non-technical skills and workforce statistics will be reviewed. The series will be led by workshop presenters and geoscientists. No registration is required, and everyone is welcome.

Questions? Contact Jennifer Nocerino at jnocerino@geosociety.org. Learn more at **www.geosociety.org/mentors.**

Student Volunteers

Take advantage of work opportunities to earn free meeting registration. Students interested in helping with the various aspects of the meeting should contact Rick Aster at rick.aster@colostate.edu.

Professionals

If you like to share your interest, enthusiasm, and experience in applied geology, consider being a GSA mentor at the meeting. Being a mentor is a rewarding experience. To learn more, contact Jennifer Nocerino at jnocerino@geosociety.org.

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

SPONSORSHIP OPPORTUNITIES

If you, your organization, or someone you would recommend have an interest in highlighting their organization or business while supporting the GSA community by sponsoring at the meeting, please contact Rick Aster, rick.aster@colostate.edu.

LOCAL COMMITTEE

Organizing Chair: Rick Aster, Colorado State University, rick.aster@colostate.edu
Technical Program Co-Chairs: Ken Sims, University of Wyoming, ksims7@uwyo.edu; Rick Aster, Colorado State University, rick.aster@colostate.edu
Field Trip Co-Chairs: John Singleton, Colorado State University, john.singleton@colostate.edu; Yvette Kuiper, Colorado School of Mines, ykuiper@mines.edu; Jonathan Caine, U.S. Geological Survey, jscaine@usgs.gov

SECOND ANNOUNCEMENT

South-Central Section

57th Annual Meeting of the South-Central Section, GSA

Stillwater, Oklahoma, USA | 13–14 March 2023

okla.st/gsa2023
www.geosociety.org/sc-mtg

Geosciences at the Crossroads of America

Gypsum formations of Western Oklahoma. Photo by Todd Halihan.

LOCATION

The 57th Annual Meeting of GSA's South-Central Section will take place in Stillwater, Oklahoma, USA, at the Wes Watkins Center of Oklahoma State University (OSU), which is located on the scenic shoreline of the Permian Sea, and currently sits at the crossroads of major U.S. highways, petroleum pipelines, and ecosystems. The university has provided an intersection of geologic disciplines since the inception of the Boone Pickens School of Geology at OSU with a history in petroleum, water, and agriculture. The meeting will have a diverse program of workshops, technical sessions, short courses, and field trips that covers a spectrum of geologic disciplines. The meeting is during the spring break for the OSU campus to give some flexibility with facilities. Stillwater is accessible by interstate or air transportation at the Stillwater airport (SWO).

REGISTRATION

Early registration deadline: 6 Feb.
Cancellation deadline: 13 Feb.

For further information or if you need special accommodations, please contact Todd Halihan at todd.halihan@okstate.edu. All fees are in U.S. dollars.

REGISTRATION FEES (all fees are in U.S. dollars)

Member Type	Early		Standard	
	Full Mtg.	One Day	Full Mtg.	One Day
Professional Member	$275	$200	$375	$300
Professional Member 70+ & 30-year member	$200	$150	$300	$250
Professional Nonmember	$325	$225	$425	$325
Early Career Professional Member	$175	$150	$200	$175
Student Member	$80	$80	$180	$180
Student Nonmember	$160	$160	$260	$260
K–12 Professional	$150	$125	$250	$225
Guest or Spouse	$75	$75	$175	$175
Field Trip/Short Course Only	$75	n/a	$75	n/a

ACCOMMODATIONS

Hotel registration deadline: 21 Feb.

A block of rooms has been reserved at two locations: (1) Hampton Inn & Suites Stillwater at 717 E. Hall of Fame Ave., Stillwater, OK 74075, USA, at a special meeting rate of US$96 per night plus tax. Reservations should be made by calling the hotel at +1-405-743-1306. (2) A second block of rooms is reserved at The Atherton Hotel, OSU's boutique hotel, located on the university campus, at a meeting rate of US$149.95. Reservations for The Atherton should be made by calling the hotel at +1-405-744-6835. **Please let both hotels know that you are part of GSA.** Both include breakfast with your accommodations.

TECHNICAL PROGRAM

Please direct questions related to the following sessions to the technical program co-chairs: Ahmed Ismail, ahmed.ismail@okstate.edu, and Tracy M. Quan, tracy.quan@okstate.edu.

T1. **Discovering Earth through a Multi Geophysical Sensor Approach.** Luel Emishaw, Oklahoma State University, luel.emishaw@okstate.edu; Andrew Katumwehe, Midwestern State University, andrew.katumwehe@msutexas.edu; Zelalem Demissie, Wichita State University, zelalem.demissie@wichita.edu; Mohamed Abdel Salem, Oklahoma State University, mohamed.abdel_salem@okstae.edu; Kevin Mickus, Missouri State University, kevinmickus@missouristate.edu.

T2. **Geoscience Education Recruitment and Retention: Adapting Pedagogy for Long-Term Inclusion, Diversity, and Interest in Geoscience.** April Moreno-Ward, Rose State College, mynroux@gmail.com.

T3. **Geoscience Education: Advancing Justice, Equity, Diversity, and Inclusion through Research, Curriculum and Systemic Change.** Wendi J.W. Williams, South Texas College, wwilliam@southtexascollege.edu.

T4. **A Sustainable Earth: Exploring the Interactions of Geology and Sustainability.** Michael DeAngelis, University of Arkansas at Little Rock, mtdeangelis@ualr.edu.

T5. **Improving Natural Hazard Resilience of Society.** Zelalem Demissie, Wichita State University, zelalem.demissie@wichita.edu; Glyn Rimmington, Wichita State University, glyn.rimmington@gmail.com; Mara Alagic, Wichita State University, mara.alagic@wichita.edu; Atri Dutta, Wichita State University, Atri.Dutta@wichita.edu; Ajita Rattani, Wichita State University, ajita.rattani@wichita.edu.

T6. **Geoscience and Hydrology of Your Federal and Other Public Lands: STEM Internships, Research, Science, Mapping, Resource Management, and Education (Posters).** Matt Dawson, The Geological Society of America, mdawson@geosociety.org

T7. **Hydrogeology and Water Resources: Long-Term Sustainability and Management.** William Andrews, Oklahoma State University, william.andrews@okstate.edu; Robert Mace, Texas State University, robertmace@txstate.edu.

T8. **Hydrogeologic Challenges and Roles in Earth Systems.** Kevin M. Befus, University of Arkansas, kmbefus@uark.edu; John G. Richins, University of Arkansas, jgrichin@uark.edu.

T9. **Sedimentary Geochemical Characterization of Aquatic Oxygen Dynamics.** Natascha Riedinger, Oklahoma State University, natascha.riedinger@okstate.edu; Tracy M. Quan, Oklahoma State University, tracy.quan@okstate.edu.

T10. **Microbial Interactions with Metal, Mineral, and Nutrient Cycling.** Tingying Xu, Oklahoma State University, tingying.xu@okstate.edu; Sabrina Beckmann, Oklahoma State University, sabrina.beckmann@okstate.edu.

T11. **Remediation and Management of Produced Water for Beneficial Uses.** Babu Fathepure, Oklahoma State University, babu.fathepure@okstate.edu; Mark Krzmarzick, Oklahoma State University, mark.krzmarzick@gmail.com.

T12. **Advances in Geologic Carbon Capture and Storage (CCS).** Jack Pashin, Oklahoma State University, jack.pashin@okstate.edu; Camelia Knapp, Oklahoma State University, camelia.knapp@okstate.edu.

T13. **Paleoecology of the South-Central United States.** Anne Weil, Oklahoma State University Center for Health Sciences, anne.weil@okstate.edu; Oghalomeno Ononeme, Oklahoma State University, oghalomeno.evih.ononeme@okstate.edu.

T14. **Advances in Early to "Mid" Cretaceous Stratigraphy, Paleoclimate, Paleoenvironments, and Paleontology in the Gulf Coast and South-Central Region.** Marina B. Suarez, The University of Kansas, mb.suarez@ku.edu; Celina A. Suarez, The University of Arkansas, casuarez@uark.edu; Alexis Godet, The University of Texas at San Antonio, Alexis.Godet@utsa.edu; Dan Lehrmann, Trinity University, dlehrman@trinity.edu; Thomas Adams, Witte Museum, thomasadams@wittemuseum.org.

T15. **Geomorphological, Sedimentological, and Pedological Archives of Human-Environmental Change.** Carlos Cordova, Oklahoma State University, carlos.cordova@okstate.edu.

T16. **Shale Lab and Field Projects: Sciences and Techniques on Unconventional Resources.** Yulun Wang, Oklahoma State University, yulun.wang@okstate.edu; Carl Symcox, Oklahoma Geological Survey, carl.w.symcox-1@ou.edu; Fengyang Xiong, Oklahoma State University, fxiong@okstate.edu; Jim Puckette, Oklahoma State University, jim.puckette@okstate.edu; Michael Grammer, Oklahoma State University, michael.grammer@okstate.edu; Nicholas Hayman, Oklahoma Geological Survey, hayman@ou.edu; Mileva Radonjic, Oklahoma State University, mileva.radonjic@okstate.edu.

T17. **Mississippian Formation Reservoir Characterization: The Need to Improve Future Development Results.** Bob Springman, GTSeis, LLC, rspringman@gtseis.com.

T18. **From Pore- to Field-Scale Petrophysical and Elastic Characterization of Rocks and Fluid Flow Simulations.** Javier Vilcaez, Oklahoma State University, vilcaez@okstate.edu; Priyank Jaiswal, Oklahoma State University, priyank.jaiswal@okstate.edu.

FIELD TRIPS

For additional information, please contact the field trip co-chairs: Jim Puckette, jim.puckette@okstate.edu, and Brandon Spencer, spbr@okstate.edu.

Pre-Meeting

FT1. **Geology of the Wichitas and Slick Hills: Rifts, Ruptures, and Modern Consequences.** Sat.–Sun., 11–12 March, 7 a.m.–5 p.m. Cost: US$254. Leaders: Brandon Spencer, Oklahoma State University, spbr@okstate.edu; Shannon Dulin, University of Oklahoma, sdulin@ou.edu; Carla Eichler, Oklahoma Geological Society, carla.eichler@ou.edu; Molly Turko, Turko Tectonics, turkotectonics@gmail.com.

FT2. **Tar Creek Superfund Site Field Trip: A Journey to Metal Contamination and Remediation.** Sun., 12 March, 7 a.m.–5 p.m. Cost: US$94. Leaders: Tingying Xu, Oklahoma State University, tingying.xu@okstate.edu; Robert W. Nairn, University of Oklahoma, nairn@ou.edu; Kato Tsosie Dee, University of Oklahoma, kdee@ou.edu.

Post-Meeting

FT3. **Managed Aquifer Recharge in the Arbuckle Simpson Aquifer.** Tues.–Wed., 14–15 March. Depart 14 March at 6 p.m., return at 6 p.m. on 15th. Cost: US$265. Leaders: Guy Sewell, East Central University, gsewell@ecok.edu; William Andrews, Oklahoma State University, william.andrews@okstate.edu; Madison Culver, Oklahoma State University, madison.culver@okstate.edu; Duane Smith, Oka' Institute, dasmith@ecok.edu.

FT4. **Recent to Modern Sedimentary Processes in Northwestern Oklahoma: Caves, Crystals, and Dunes:** Wed., 15 March, 7 a.m.–7 p.m. Cost: US$115. Leaders: Carla Eichler, Oklahoma Geological Survey, carla.eichler@ou.edu; Brandon Spencer, Oklahoma State University, spbr@okstate.edu.

SHORT COURSES

SC1. **Core Workshop: Introduction to Carbonate and Siliciclastic Depositional Systems for Oil and Gas, Groundwater, and Carbon Capture and Storage.** Sun., 12 March, 9 a.m.–1 p.m. Michael Grammer, Oklahoma State University, michael.grammer@okstate.edu; Jim Puckette, Oklahoma State University, jim.puckette@okstate.edu.

SC2. **The Future of Geoscience Education: Implementing Technology for Engagement and Recruitment.** Sun., 12 March, 9 a.m.–4 p.m. Ashley Burkett, Oklahoma State University, ashley.burkett@okstate.edu; Caitlin Barnes, Oklahoma State University, caitlin.barnes@okstate.edu; Tracy M. Quan, Oklahoma State University, tracy.quan@okstate.edu.

SC3. **Field Geophysics.** Sun., 12 March, noon–4 p.m. Andrew Katumwehe, Midwestern State University, andrew.katumwehe@msutexas.edu; Ahmed Ismail, Oklahoma State University, ahmed.ismail@okstate.edu.

SC4. **Direct Imaging with Direct Push Technology.** Sun., 12 March, noon–4 p.m. Dan Pipp, Geoprobe Systems, pippd@geoprobe.com; Nick Basore, Geoprobe Systems, basoren@geoprobe.com.

SC5. **Geomicrobiology Culturing Strategies: From Sediment to Microbial Culture.** Wed., 15 March, 9 a.m.–5 p.m. Sabrina Beckmann, Oklahoma State University, sabrina.beckmann@okstate.edu; Tingying Xu, Oklahoma State University, tingying.xu@okstate.edu.

SC6. **Fundamentals of Petroleum-Produced Water Characterization, Treatment, and Disposal into the Subsurface.** Wed., 15 March, 9 a.m.–5 p.m. Javier Vilcaez, Oklahoma State University, vilcaez@okstate.edu.

SC7. **Fundamentals of Geologic CO_2 Storage.** Wed., 15 March, 9 a.m.–1 p.m. Jack Pashin, Oklahoma State University, jack.pashin@okstate.edu; Camelia Knapp, Oklahoma State University, camelia.knapp@okstate.edu.

OPPORTUNITIES FOR GSA STUDENTS AND EARLY CAREER PROFESSIONALS

Career Mentoring Luncheons

Ask your career-related questions and learn about non-academic pathways in the geosciences while networking with professionals at the Roy J. Shlemon and John Mann Mentor luncheons. GSA student members are welcome.

Roy J. Shlemon Mentor Program in Applied Geoscience Luncheon: Mon., 13 March.

John Mann Mentor in Applied Hydrogeology Program Luncheon: Tues., 14 March.

Career Workshop Series

This three-part series will feature career development planning, an exploration of geoscience job sectors, and information on best practices for crafting a résumé and cover letter. Non-technical skills and workforce statistics will be reviewed. The series will be led by workshop presenters and geoscientists. No registration is required, and everyone is welcome.

To learn more about mentors and career workshops, go to **www.geosociety.org/mentors** or contact Jennifer Nocerino at jnocerino@geosociety.org.

PROFESSIONALS

If you like to share your interest, enthusiasm, and experience in applied geology, consider being a GSA mentor. Being a mentor is a rewarding experience. To learn more, contact Jennifer Nocerino at jnocerino@geosociety.org.

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

LOCAL COMMITTEE

General Chair: Todd Halihan, todd.halihan@okstate.edu
Technical Program Co-Chairs: Ahmed Ismail, ahmed.ismail@okstate.edu; Tracy M. Quan, tracy.quan@okstate.edu
Field Trip Co-Chairs: Jim Puckette, jim.puckette@okstate.edu; Brandon Spencer, spbr@okstate.edu
Exhibits/Sponsorship Co-Chairs: Jack Pashin, jack.pashin@okstate.edu; Lawrence Walker, lpwalk62@icloud.com
Student Volunteer Chair: Tingying Xu, tingying.xu@okstate.edu
Judging Coordinator: Natascha Riedinger, natascha.riedinger@okstate.edu

THE GEOLOGICAL SOCIETY OF AMERICA®

Mark Your Calendar for Meetings Closer to Home

South-Central Section

13–14 March
Stillwater, Oklahoma, USA
Todd Halihan, todd.halihan@okstate.edu
www.geosociety.org/sc-mtg

Edmon Low Library, Oklahoma State University.
Photo credit: rseigler0 from Pixabay.

Joint Southeastern & Northeastern Sections

17–19 March
Reston, Virginia, USA
Arthur Merschat, amerschat@usgs.gov; Patrick Burkhart, patrick.burkhart@sru.edu
www.geosociety.org/se-mtg

Reston Town Center water fountain.
Photo credit: J. Rodysill.

North-Central Section

4–5 May
Grand Rapids, Michigan, USA
Tara Kneeshaw, kneeshta@gvsu.edu; Ginny Peterson, petersvi@gvsu.edu
www.geosociety.org/nc-mtg

L.V. Eberhard Center at GVSU. Photo credit: Amanda Pitts, University Communications, Grand Valley State University.

Cordilleran Section

17–19 May
Reno, Nevada, USA
Stacia Gordon, staciag@unr.edu
www.geosociety.org/cd-mtg

Panorama from the Mono Lake South Tufa Area.
Photo credit: Dr. Philipp Ruprecht.

Rocky Mountain Section

23–25 May
Fort Collins, Colorado, USA
Rick Aster, rick.aster@colorado.edu
www.geosociety.org/rm-mtg

Pineridge Natural Area.
Photo credit: Jan Alexander from Pixabay.

2023

SECOND ANNOUNCEMENT

Joint Southeastern & Northeastern Sections

72nd Annual Meeting of the Southeastern Section, GSA
58th Annual Meeting of the Northeastern Section, GSA

Reston, Virginia, USA | 17–19 March 2023

www.geosociety.org/se-mtg

Sediments, Structures, Shores, and Storms: Keeping a Keen Eye on Eastern Geology

Reston Town Center water fountain. Photo credit: J. Rodysill.

LOCATION

The joint meeting of GSA's Southeastern and Northeastern Sections will be held in Reston, Virginia, USA. Situated at the Fall Zone and the transition from the southern to the central and northern Appalachians, Reston provides a unique vantage point to examine all aspects of eastern geology. Reston is a modern, planned community located in northern Virginia. The numerous historic and cultural attractions of Washington D.C. are just a short distance away and ready to be explored. Immediately outside of the Hyatt Regency Reston lies a mix of bistros, restaurants, and shops along an extensive pedestrian mall.

We invite you to take a field trip across the Blue Ridge or to the Atlantic Coastal Plain, visit Capitol Hill, or see the connections between geology and the terrain of a Civil War battlefield. Or take a virtual trip to the Gulf of Mexico and enjoy the plenary talk: Drilling into the Chicxulub Impact Crater! Join us at Reston 2023 to enjoy a broad scope of technical sessions, symposia, short courses, and field trips that will help us keep a keen eye on eastern geology.

REGISTRATION

Early registration deadline: 13 Feb.
Cancellation deadline: 21 Feb.

Registration fees are in U.S. dollars. For further information or if you need special accommodations, please contact one of the general co-chairs, Arthur Merschat, amerschat@usgs.gov, or Patrick Burkhart, patrick.burkhart@sru.edu.

REGISTRATION FEES (all fees are in U.S. dollars)

Member Type	Early		Standard	
	Full Mtg.	One Day	Full Mtg.	One Day
Professional Member	$225	$175	$295	$200
Professional Member 70+	$110	$110	$160	$130
Professional Nonmember	$290	$200	$320	$230
Early Career Professional Member	$175	$150	$200	$175
Student Member	$85	$67	$101	$95
Student Nonmember	$120	$110	$150	$125
K–12 Professional	$85	$75	$110	$95
Guest or Spouse	$70	$60	$80	$65
Field Trip/Short Course Only	$40	n/a	$40	n/a

ACCOMODATIONS

Hotel registration deadline: 22 Feb., 5 p.m. Eastern Time

A block of rooms has been reserved at the Hyatt Regency Reston, 1800 Presidents Street, Reston, Virginia, 20190, USA, located in the vibrant Reston Town Square. The meeting rate is US$159 per night plus tax. The hotel offers many amenities (restaurants, bar, pool, Wi-Fi) and a complimentary shuttle to/from Dulles International Airport. Reservations can be made by calling +1-703-709-1234. Please be sure to identify yourself with the group code SEGSA23 and that you are attending the GSA Southeastern and Northeastern Sections Joint Meeting. Parking is available at the hotel and at Reston Town Parking Garage next to the hotel.

TECHNICAL PROGRAM

Symposia

S1. **Sea-Level History from the U.S. East Coast—Insights for Projecting Future Change.** Robert Poirier, U.S. Geological Survey, rpoirier@usgs.gov; Michael Toomey, U.S. Geological Survey, mtoomey@usgs.gov; Thomas M. Cronin, U.S. Geological Survey, tcronin@usgs.gov.

S2. **Deciphering the Devonian World, from Biotic to Environmental Crises across the Globe.** Sarah Carmichael, Appalachian State University, carmichaelsk@appstate.edu; Cole Edwards, Appalachian State University, edwardsct4@appstate.edu; Diana Boyer, Winthrop University, boyerd@winthrop.edu; Daniel Doctor, U.S. Geological Survey, dhdoctor@usgs.gov.

S3. **Internal and External Controls on Landscape Evolution.** Kristin Chilton, Virginia Tech, kchilton@vt.edu; Charlie Shobe, West Virginia University, charles.shobe@mail.wvu.edu.

S4. **Enhancing Diversity in the Geosciences.** Alexander Gates, Rutgers University, agates@rutgers.edu; Marilyn Suiter, National Science Foundation, msuiter@nsf.gov.

S5. **Environmental Radionuclides: Geochemical Behavior, Tracer Applications, and Potential Health Consequences.** Jim Kaste, William & Mary Geology, jmkaste@wm.edu; Joshua D. Landis, Dartmouth College, Joshua.D.Landis@dartmouth.edu.

S6. **The Grenville Orogen in Eastern North America.** Greg Walsh, U.S. Geological Survey, gwalsh@usgs.gov; Paul Mueller, University of Florida, pamueller@ufl.edu; Peter Valley, U.S. Geological Survey, pvalley@usgs.gov.

S7. **From the Margins to the Deep: A Tribute to the Science and Art of A. Conrad Neumann.** Blair Tormey, Western Carolina University, btormey@wcu.edu; Al Hine, University of South Florida, hine@usf.edu; Paul Hearty, University of Texas at Austin, kaisdad04@gmail.com.

Theme Sessions

T1. **Resilience and Resource Strategies for the Coastal and Nearshore Zone in a Changing World.** Joshua Long, U.S. Geological Survey, jhlong@usgs.gov; Till Hanebuth, Coastal Carolina University, thanebuth@coastal.edu; Katherine Luciano, South Carolina Geological Survey, LucianoK@dnr.sc.gov; Clark Alexander, Skidaway Institute of Oceanography, Clark.Alexander@skio.uga.edu.

T2. **So Near but Yet so Far: A Review of U.S. Offshore Resources of Minerals for Renewable Energy.** Frank T. Manheim, George Mason University, fmanhei1@gmu.edu.

T3. **Geologic Maps, Geophysical Maps, 3-D Geological Models, Digital Mapping Techniques, Map Derivatives, and Digital Map Preparation (Posters)**. Randy L. Kath, University of West Georgia, rkath@westga.edu; Karen S. Tefend, University of West Georgia, ktefend@westga.edu.

T4. **Taconic Orogeny in the North, Central, and Southern Appalachians: Tectonics of the Early Paleozoic Margin of Laurentia.** Clinton Barineau, Columbus State University, barineau_clinton@columbusstate.edu; James Tull, Florida State University, jtull@fsu.edu; Steven Whitmeyer, James Madison University, whitmesj@jmu.edu; Paul Karabinos, Williams College, pkarabin@williams.edu.

T5. **Solid and Aqueous Contaminant Fate and Transport in the Watershed (Posters).** Golam Kibria, Morehead State University, m.kibria@moreheadstate.edu.

T6. **Geoscience and Hydrology of Your Federal and Other Public Lands: STEM Internships, Research, Science, Mapping, Resource Management, and Education (Posters)**. Matt Dawson, Geological Society of America, mdawson@geosociety.org.

T7. **Integrated Ichnostratigraphy: Trace Fossils at Unconformities**. Andrew K. Rindsberg, University of West Alabama, arindsberg@uwa.edu; Corey J. Hensen, Cornell University, cjh352@cornell.edu.

T8. **Small-Scale Geologic Mapping in the Northeastern U.S.: Addressing the USGS National Cooperative Geologic Mapping Program's Goals for a Seamless, National 2D/3D Geologic Framework Model of the United States.** Donald Sweetkind, U.S. Geological Survey, dsweetkind@usgs.gov; Joseph Colgan, U.S. Geological Survey, jcolgan@usgs.gov; David Soller, U.S. Geological Survey, drsoller@usgs.gov; Jenna Shelton, U.S. Geological Survey, jlshelton@usgs.gov.

T9. **Landslide Investigations in the Eastern United States.** Jonathan Kim, Vermont Geological Survey, jon.kim@vermont.gov; George Springston, Norwich University, gsprings@norwich.edu; Keith Klepeis, University of Vermont, kklepeis@uvm.edu.

T10. **Trace Elements in the Environment**. Melissa Lombard, U.S. Geological Survey, mlombard@usgs.gov; Isabelle Cozzarelli, U.S. Geological Survey, icozzare@usgs.gov; Madeline Schreiber, Virginia Tech, mschreib.vt.edu.

T11. **Geomorphic Evolution of River Corridors in the Eastern United States from the Pleistocene to the Anthropocene.** Max Huffman, University of Delaware, mhuffman@udel.edu; Samantha Dow, University of Connecticut, samantha.dow@uconn.edu; Brad Johnson, Davidson College, brjohnson@davidson.edu.

T12. **Undergraduate Research (Posters).** *Endorsed by Council on Undergraduate Research Geosciences Division.* Lee Phillips, University of North Carolina at Greensboro, plphilli@uncg.edu; Jeff Ryan, University of South Florida, ryan@mail.usf.edu.

T13. **Advances in Machine-Learning–Based Applications to Surficial Geologic Questions.** William Odom, U.S. Geological Survey, wodom@usgs.gov; Daniel Doctor, U.S. Geological Survey, dhdoctor@usgs.gov; Aaron Maxell, West Virginia University, Aaron.Maxwell@mail.wvu.edu; Charlie Shobe, West Virginia University, Charles.Shobe@mail.wvu.edu.

T14. **Oil- and Gas-Produced Water—Accidental Releases and Intentional Re-Use Considerations.** Isabelle M. Cozzarelli, U.S. Geological Survey, icozzare@usgs.gov; Madalyn S. Blondes, U.S. Geological Survey, mblondes@usgs.gov; Denise M. Akob, U.S. Geological Survey, DAkob@usgs.gov; Matthew S. Varonka, U.S. Geological Survey, mvaronka@usgs.gov.

T15. **Using the Sedimentary Record to Investigate Appalachian and Ouachita Tectonics.** William T. Jackson, Jr., University of Memphis, wtjckson@memphis.edu; Matthew P. McKay, Missouri State University, matthewmckay@missouristate.edu; Brian S. Cook, Geological Survey of Alabama, bcook@gsa.state.al.us.

T16. **Geoscience for National Security and Law Enforcement**. Christopher Bernhardt, U.S. Geological Survey, cbernhardt@usgs.gov; Peter Chirico, U.S. Geological Survey, pchirico@usgs.gov.

T17. **The Mineral-Security Nexus: Toward a Practical Roadmap for Integrative Strategic Mineral Analysis (PRISM).** *Cosponsored by GSA Mineralogy, Geochemistry,*

Petrology and Volcanology Division; Mineralogical Society of America. Thomas Hale, Friends of Mineralogy, hthomas94@gwu.edu; Alex Speer, Mineralogical Society of America, jaspeer@minsocam.org.

T18. **Alleghanian Overprinting of Pre-Alleghanian Accreted Terranes.** Ryan McAleer, U.S. Geological Survey, rmcaleer@usgs.gov; Ryan Deasy, U.S. Geological Survey, rdeasy@usgs.gov; Rebecca Stokes, U.S. Geological Survey, mstokes@usgs.gov.

T19. **Mapping in the Geosciences: Processes and Products (Posters).** Libby Ives, U.S. Geological Survey, eives@usgs.edu; Greg Walsh, U.S. Geological Survey, gwalsh@usgs.gov.

T20. **Early Career Voices of Appalachian Tectonics.** *Endorsed by GSA Geochronology Division; GSA Structure and Tectonics Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division.* Allie Nagurney, University of South Carolina, nagurney@vt.edu; Elizabeth Bollen, Geological Survey of Alabama, EBollen@gsa.state.al.us; Zach Foster-Baril, University of Texas, zfosterbaril@utexas.edu; Jonny Prouty, Virginia Tech, jonathanprouty@vt.edu.

T21. **Bridges to Our Shared Future: Support for K–12 Geoscience Education.** *Endorsed by Southeast/New England Sections of National Association of Geoscience Teachers (NAGT).* Mary I. Abercrombie, Florida Gulf Coast University, mabercrombie@fgcu.edu; Susan Meabh Kelly, CSDE and University of Connecticut, susankelly.ct@gmail.com.

T22. **Building Student Knowledge of Geoscience Careers.** *Endorsed by GSA Geoscience Education Division; National Association of Geoscience Teachers (NAGT).* Joyce Smith, North Carolina State University, jsmith45@ncsu.edu; David McConnell, North Carolina State University, damcconn@ncsu.edu.

T23. **Soil, Water, and Biogeochemical Interactions.** *Endorsed by GSA Soils and Soil Processes Division; GSA Hydrogeology Division; GSA Geobiology and Microbiology Division.* Zsuzsanna Balogh-Brunstad, Hartwick College, balogh_brunz@hartwick.edu; Justin Richardson, The University of Massachusetts Amherst, jbrichardson@umass.edu; Oluyinka Oyewumi, Central Connecticut State University, oyewumi@ccsu.edu.

T24. **Undergraduate and Graduate Geoscience Student Showcase Lighting-Round.** *Endorsed by Counsel on Undergraduate Research Geoscience Division.* James H. MacDonald, Florida Gulf Coast University, jmacdona@fgcu.edu; Marian Buzon, Western Georgia University, mbuzon@westga.edu; Mary Abercrombie, Florida Gulf Coast University, mabercrombie@fgcu.edu.

T25. **What Do the Ages Mean? Overcoming the Challenges for Geo- and Thermochronology in the Polydeformed Appalachian Orogenic System.** Ryan Thigpen, University of Kentucky, ryan.thigpen@uky.edu; Maggie Curry, North Carolina State University, mcurry2@ncsu.edu; Ryan McAleer, U.S. Geological Survey, rmcaleer@usgs.gov.

T26. **Young Features in an Old Range: Quaternary Landscape Evolution in the Appalachian Mountains and Foothills.** Brad Johnson, Davidson College, brjohnson@davidson.edu; Mark Carter, U.S. Geological Survey, mcarter@usgs.gov.

T27. **Energy Geology Research.** Joao S. Meyers, U.S. Geological Survey and George Mason University, jsmeyers@usgs.gov; Marc L. Buursink, U.S. Geological Survey, mbuursink@usgs.gov.

T28. **Engineering and Environmental Aspects of Karst Terrains.** Wendell Barner, Barner Consulting, LLC., wendell.barner@gmail.com; David German, Volusia County Schools, dpgerman@volusia.k12.fl.us.

T29. **Mapping Surficial Deposits in the Appalachians: Field Methods, Digital Techniques, and Classification Strategies (Posters).** Matt Heller, Virginia Department of Energy, matt.heller@energy.virginia.gov; Anne Witt, Virginia Department of Energy, anne.witt@energy.virginia.gov; William Andrews, Kentucky Geological Survey, wandrews@uky.edu; Phil Dinterman, West Virginia Geological and Economic Survey, pdinterman@wvgs.wvnet.edu; Steve Kite, West Virginia University, jkite@wvu.edu.

T30. **The 200th Anniversary of the First State Geological Survey—The North Carolina Geological Survey.** Kenneth B. Taylor, North Carolina Geological Survey, kenneth.b.taylor@ncdenr.gov; Phil Bradley, North Carolina Geological Survey, pbradley@ncdenr.gov; Kathleen Farrell, North Carolina Geological Survey, kathleen.farrell@ncdenr.gov; James Chapman, North Carolina Geological Survey, james.chapman@ncdenr.gov; Bart Cattanach, North Carolina Geological Survey, bart.cattanach@ncdenr.gov; Heather Hanna, North Carolina Geological Survey, heather.hanna@ncdenr.gov; Norman Gay, North Carolina Geological Survey, Kenny.gay@ncdenr.ov; Amy Pitts, North Carolina Geological Survey, amy.pitts@ncdenr.gov.

T32. **Conventional and Unconventional Critical Mineral Resources in the Eastern United States.** *Endorsed by GSA Geophysics and Geodynamics Division; GSA Environmental and Engineering Geology Division; GSA Sedimentary Geology Division; GSA Soils and Soil Processes Division; GSA Structural Geology and Tectonics Division.* Anjana K. Shah, U.S. Geological Survey, ashah@usgs.gov; Nora K. Foley, U.S. Geological Survey, nfoley@usgs.gov; Bernard Hubbard, U.S. Geological Survey, bhubbard@usgs.gov; Arthur Merschat, U.S. Geological Survey, amerschat@usgs.gov.

T33. **Structural Geology and Tectonics Undergraduate Research (Oral Presentations Only)**. *Endorsed by GSA Structural Geology and Tectonics Division; Council of Undergraduate Research.* Jackie Langille, University of North Carolina–Asheville, jlangill@unca.edu; Cheryl

Waters-Tormey, Western Carolina University, cherylwt@email.wcu.edu.

T34. **Geological, Seismological, and Paleoseismological Research into Eastern North American Earthquakes.** Kevin Stewart, University of North Carolina Chapel Hill, Kevin_Stewart@unc.edu; Mark Carter, U.S. Geological Survey, mcarter@usgs.gov.

T35. **Breaking Barriers and Challenging Traditions in Geoscience Education.** *Endorsed by Southeastern Section of the National Association of Geoscience Teachers (NAGT).* Stephanie L. Shepherd, Auburn University, slshepherd@auburn.edu; Melissa Hage, Oxford College of Emory University, melissa.hage@emory.edu.

T36. **Mapping and Stratigraphic Studies of the Atlantic Coastal Plain and Inner Shelf.** Kathleen M. Farrell, North Carolina Geological Survey, Kathleen.Farrell@ncdenr.gov; William R. Doar, III, South Carolina Geological Survey, DoarW@dnr.sc.gov; M. Scott Harris, College of Charleston, HarrisS@cofc.edu.

T37. **Student Oral Presentations.** Marian Buzon, University of West Georgia, mbuzon@westga.edu; Brittani McNamee, University of North Carolina Asheville, bmcnamee@unca.edu.

T38. **Opportunities for Students in a Time of Systemic Change.** Aisha Morris, National Science Foundation, armorris@nsf.gov; Eleanour Snow, U.S. Geological Survey, esnow@usgs.gov.

T39. **Driving Systemic Change in the Geosciences.** Eleanour Snow, U.S. Geological Survey, esnow@usgs.gov; Aisha Morris, National Science Foundation, armorris@nsf.gov.

T40. **Igneous and Metamorphic Petrology Enigmas in Eastern North America: A Session in Honor of Brent Owens.** Chuck Bailey, William & Mary, cmbail@wm.edu; Kristie Caddick, Virginia Tech, kcaddick@vt.edu.

T41. **Barrier Island and Backbarrier Sediment Dynamics.** Zoe Hughes, Boston University, zoeh@bu.edu; Lucila Houttuijn Bloemendaal, Boston University, lbloem@bu.edu; Alice Staro, Boston University, astaro@bu.edu.

T42. **Paleoenvironment and Paleobiology of Late Cretaceous Sediments near Coon Creek, Tennessee.** Michael Gibson, University of Tennessee Martin, mgibson3@utm.edu; Tom Byl, U.S. Geological Survey and Tennessee State University, tdbyl@usgs.gov.

T43. **Geoscience Careers for New Geoscience Graduates.** Michael Lawless, Draper Arden Associates, mlawless@daa.com; Ronald Wallace, rw30075@yahoo.com.

FIELD TRIPS

For additional information, please check the meeting website or contact the field trip co-chairs: Jean M. Self-Trail, jstrail@usgs.gov, and Laurel M. Bybell, lbybell@usgs.gov.

Pre-Meeting

FT1. **Geology and the Civil War at the North Anna River Fall Zone, Virginia.** Wed., 15–16 March. Cost: US$175. Max. participants: 17. Leader: Chuck Bailey, William & Mary, cmbail@wm.edu.

Post-Meeting

FT2. **Experience Capitol Hill: Geoscience and Public Policy in Washington, D.C.** Mon., 20 March. Cost US$67. Max. participants: 20. Leader: Kasey White, Geological Society of America, kwhite@geosociety.org.

FT3. **Geology and Paleontology of Cretaceous and Paleocene Sediments of Cabin Branch and Tinkers Creek, Prince Georges County, Maryland.** Mon., 20 March. Cost: US$78. Max. participants: 22. Leaders: Jean M. Self-Trail, U.S. Geological Survey, jstrail@usgs.gov; David L. Govoni, U.S. Geological Survey (emeritus), dgovoni@usgs.gov; Laurel M. Bybell, U.S. Geological Survey (emeritus), lbybell@usgs.gov.

FT4. **Proterozoic and Paleozoic Tectonic Evolution of the Northern Shenandoah Massif.** Mon., 20 March. Cost: US$76. Max. participants: 30. Leaders: Bill Burton, U.S. Geological Survey, bburton@usgs.gov; J. Steven Schindler, U.S. Geological Survey, sschindl@usgs.gov; Alan Pitts, U.S. Geological Survey, apitts@usgs.contractor.gov.

SHORT COURSES

For additional information, please contact the short course co-chairs: Daniel H. Doctor, dhdoctor@usgs.gov, and Patrick Burkhart, patrick.burkhart@sru.edu.

SC1. **Applied Micropaleontology for Non-Paleontologists: How to Interpret and Use Fossil Data.** 16 March. US$50 for professionals; US$25 for students. Location: USGS National Center, Reston, Virginia. Leaders: Marci M. Robinson, U.S. Geological Survey, mmrobinson@usgs.gov; Jean M. Self-Trail, U.S. Geological Survey, jstrail@usgs.gov.

SC2. **Stormwater Management in Karst Terrain—A Regional Perspective.** 16 March. US$50 for professionals; US$25 for students. Location: Hyatt Regency Reston. Leader: Robert K. Denton Jr., Terracon Consultants Inc., robert.denton@terracon.com.

SC3. **Integrating ESRI Mobile, Online, and Desktop GIS for Real-Time Collaborative Field Data Acquisition.** 16 March. US$50 for professionals; US$25 for students. Location: USGS National Center, Reston, Virginia. Leaders: Alan Pitts, U.S. Geological Survey, apitts@usgs.contractor.gov; Daniel H. Doctor, U.S. Geological Survey, dhdoctor@usgs.gov.

SC4. **Luminescence (OSL) Dating Short Course—Essential Guide for Sampling and Dark Secrets Behind the Technique.** 16 March. US$50 for professionals; US$25 for students. Location: Hyatt Regency Reston. Leaders: Michelle Nelson, Utah State University, michelle.nelson@usu.edu, and Virginia Geological Survey, michelle.nelson@energy.virginia.gov; Paula Figueirdo, North Carolina State University, paula_figueiredo@ncsu.edu; Ginni DeWitt, East Carolina University, dewittr@ecu.edu; Shannon Mahan, U.S. Geological Survey, smahan@usgs.gov.

OPPORTUNITIES FOR STUDENTS AND EARLY CAREER PROFESSIONALS

Career Mentoring Luncheons

Ask your career-related questions and learn about non-academic pathways in the geosciences while networking with professionals at the Roy J. Shlemon and John Mann Mentor luncheons. GSA student members are welcome.

Career Workshop Series

This three-part series will feature career development planning, an exploration of geoscience job sectors, and information on best practices for crafting a résumé and cover letter. Non-technical skills and workforce statistics will be reviewed. The series will be led by workshop presenters and geoscientists. No registration is required, and everyone is welcome.

To learn more about mentors and career workshops, go to **www.geosociety.org/mentors.** Questions? Contact Jennifer Nocerino at jnocerino@geosociety.org.

Student Volunteers

Take advantage of work opportunities to earn free meeting registration. Students interested in helping with the various aspects of the meeting should contact Michael H. Trippi, U.S. Geological Survey, mtrippi@usgs.gov.

TRAVEL GRANTS

Application deadline: 13 Feb.

Students who are GSA members and who register for the meeting are eligible to apply for student travel grants from their respective sections. For further information see **www.geosociety.org/gsa/about/sections/GSA/Sections/se/students.aspx#travel** for the Southeastern Section and **www.geosociety.org/GSA/Education_Careers/Grants_Scholarships/Travel_Grants/GSA/grants/negrant.aspx** for the Northeastern Section.

PROFESSIONALS

If you like to share your interest, enthusiasm, and experience in applied geology, consider being a GSA mentor at the joint |meeting. Being a mentor is a rewarding experience. To learn more, contact Jennifer Nocerino at jnocerino@geosociety.org.

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

LOCAL COMMITTEE

General Co-Chairs: Arthur Merschat, amerschat@usgs.gov; Patrick Burkhart, patrick.burkhart@sru.edu
Technical Program Co-Chairs: Chuck Bailey, cmbail@wm.edu; Wendell Barner, wendell.barner@gmail.com
Field Trip Co-Chairs: Jean M. Self-Trail, jstrail@usgs.gov; Laurel M. Bybell, lbybell@usgs.gov
Sponsorships Chair: Patrick Burkhart, patrick.burkhart@sru.edu
Short Course Co-Chairs: Daniel H. Doctor, dhdoctor@usgs.gov; Patrick Burkhart, patrick.burkhart@sru.edu
Exhibits Chair: Daniel Harris, harris_d@pennwest.edu
Treasurer: Patrick Burkhart, patrick.burkhart@sru.edu
Student Volunteer Chair: Michael H. Trippi, U.S. Geological Survey, mtrippi@usgs.gov

2023 CALENDAR

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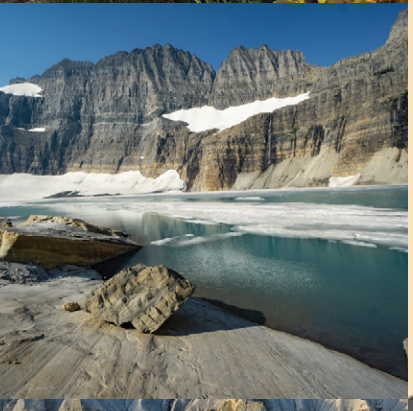

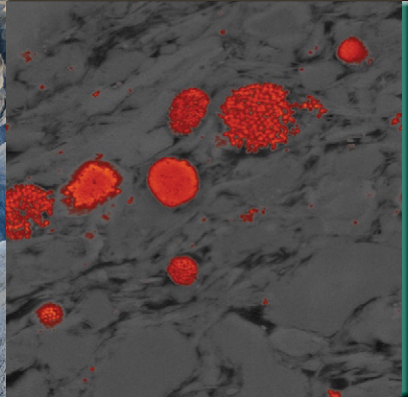

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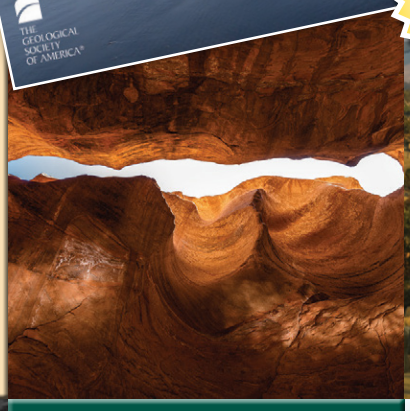

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In Memoriam

The Society notes with regret the deaths of the following members (notifications received between 2 May 2022 and 2 Oct. 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.

Muawia Barazangi
Ithaca, New York, USA
Date of death: 30 Mar. 2022

Carol S. Breed-McCauley
Flagstaff, Arizona, USA
Date of death: 16 June 2022

Paul E. Carrara
Denver, Colorado, USA
Date of death: 12 Oct. 2021

Nikolas I. Christensen
Anacortes, Washington, USA
Date of death: 19 May 2022

Dwight E. Deal
Parker, Colorado, USA
Date of death: 11 June 2022

Arthur Grantz
Palo Alto, California, USA
Date of death: 18 Nov. 2021

Henry L. Helenek
Milwaukee, Wisconsin, USA
Date of death: 7 Mar. 2021

A.M. Hopgood
Cupar, Scotland, UK
Date of death: 12 Aug. 2022

James R. Kramer
Ancaster, Ontario, Canada
Notified: 23 Sept. 2022

Richard Lung
Santa Barbara, California, USA
Date of death: 21 Jan. 2022

Thomas Joseph Messenger
Moab, Utah, USA
Date of death: 1 July 2022

Betty M. Tinklepaugh Miller
Mount Pleasant, Michigan, USA
Date of death: 14 Dec. 2021

Peter H. Molnar
Boulder, Colorado, USA
Date of death: 23 June 2022

Frederic (Ted) Mullin
Saint Helens, Oregon, USA
Date of death: 18 Aug. 2022

Herman S. Muskatt
Syracuse, New York, USA
Date of death: 31 Dec. 2019

Charles T. Prewitt
Tucson, Arizona, USA
Date of death: 28 Apr. 2022

William Christopher Robinson
Vancouver, Washington, USA
Notified: 7 July 2022

John Brandt Roen
Monkton, Maryland, USA
Date of death: 12 Dec. 2021

Karen Sheffield
Houston, Texas, USA
Date of death: 18 June 2021

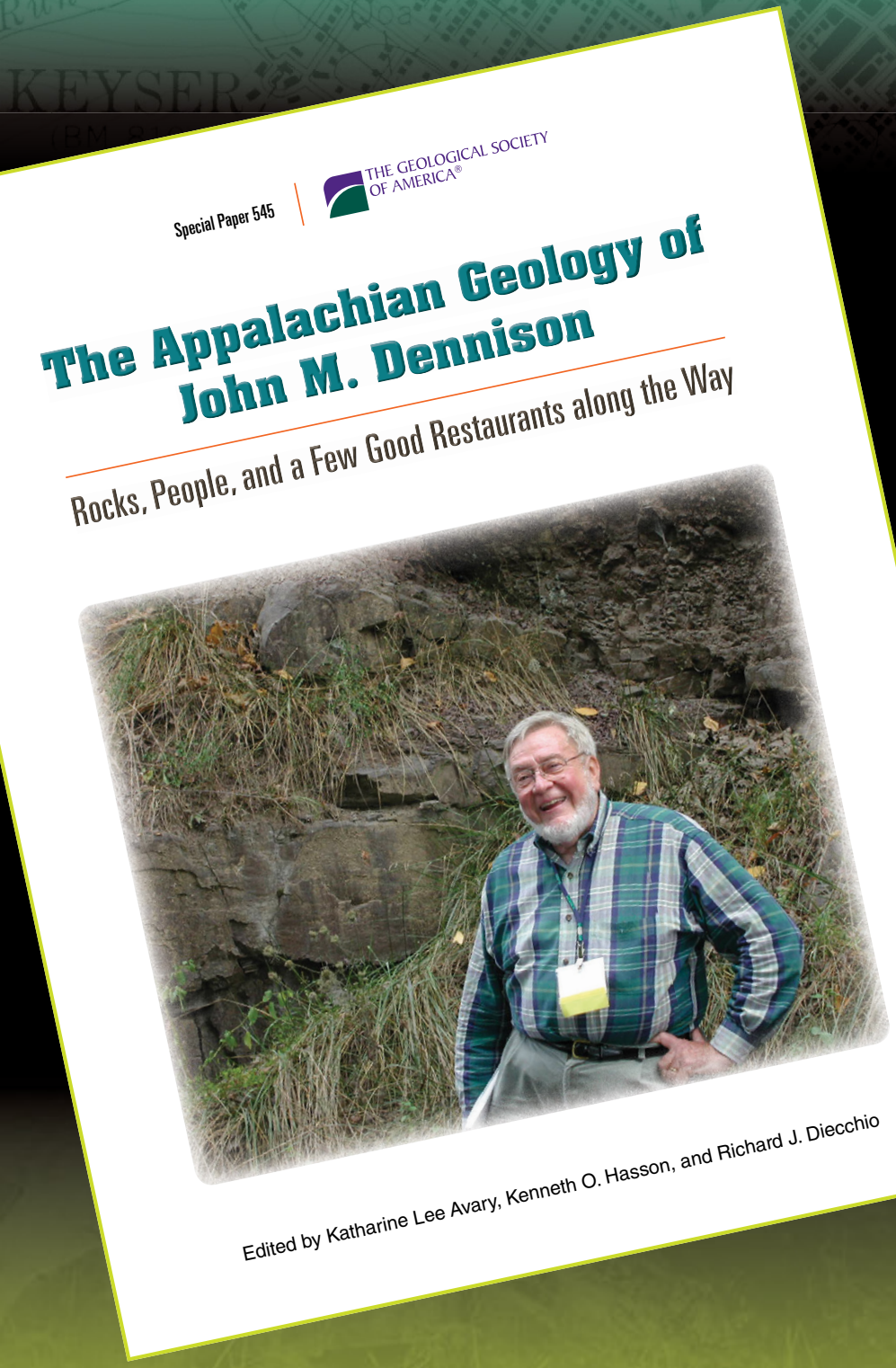
Nancy S. Simon
Reston, Virginia, USA
Date of death: 4 Dec. 2021

William A. Thomas
Tuscaloosa, Alabama, USA
Date of death: 30 Sept. 2022

Alan Keith Turner
Golden, Colorado, USA
Date of death: 20 May 2022

William Bedford Turner
Houston, Texas, USA
Notified: 27 May 2022

Robert J. Weimer
Boulder, Colorado, USA
Notified: 8 Aug. 2022



The Appalachian Geology of John M. Dennison: Rocks, People, and a Few Good Restaurants along the Way

Edited by Katharine Lee Avary, Kenneth O. Hasson, and Richard J. Diecchio

Dr. John M. Dennison spent his career studying the Appalachians; teaching and mentoring his students and professional colleagues; publishing papers; leading field trips; and presenting ideas at regional, national, and international conferences. This volume is a collection of papers contributed by former students and colleagues to honor his memory. Topics include stratigraphy and paleontology ranging in age from Ordovician to Mississippian in Kentucky, New York, Tennessee, Virginia, and West Virginia; Devonian airfall tephras throughout the eastern United States; a Devonian lonestone; a Middle Eocene bentonite in North Carolina and its relationship to a volcanic swarm in western Virginia; and a 3D model of a ductile duplex in northwestern Georgia. The stratigraphic and geologic diversity of the papers reflects Dennison's many interests and collaborative relationships.

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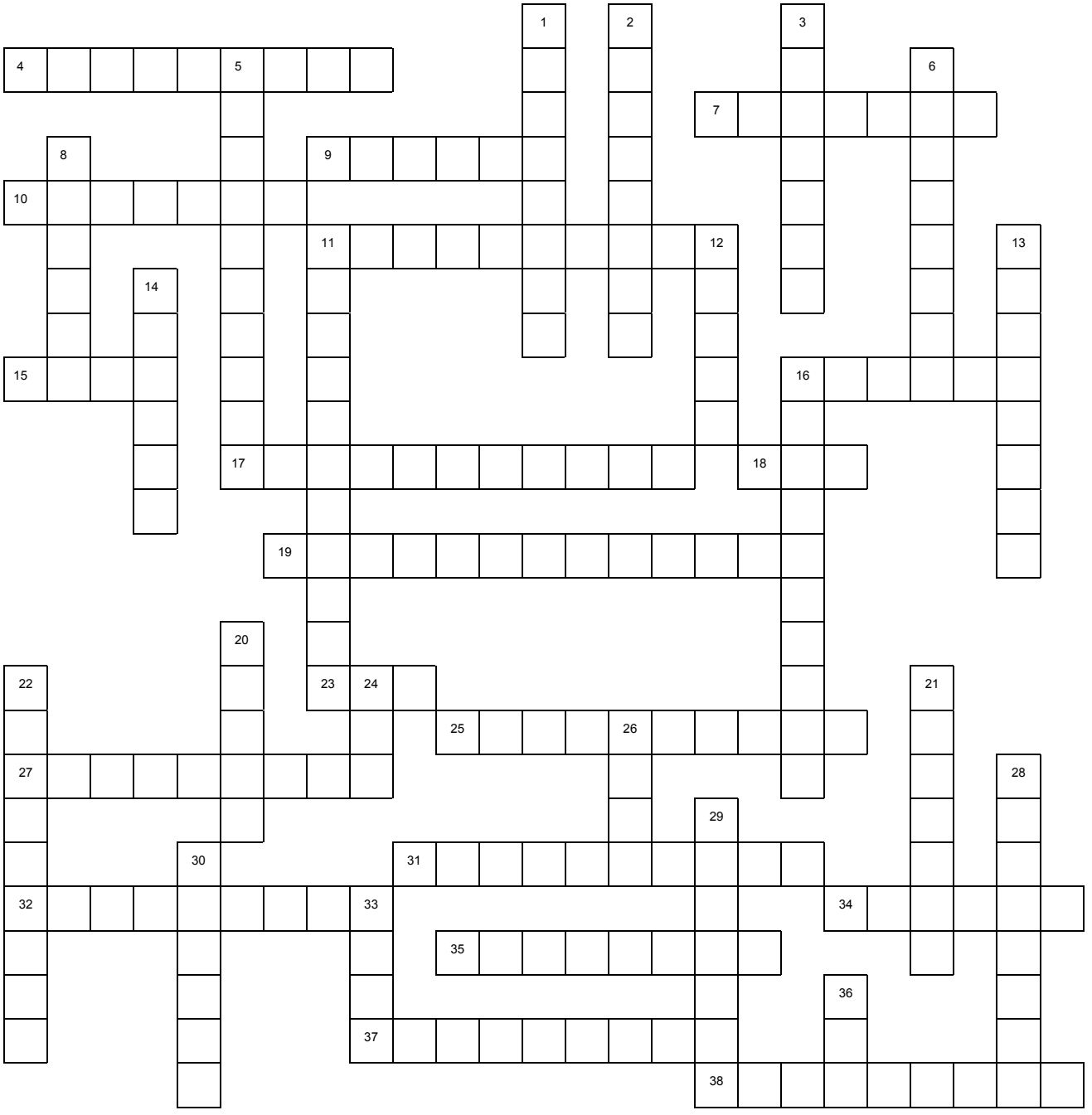

See answers, p. 50

ACROSS

4 GSA's online-only journal
7 Isolated hill or peak that projects through the surface of a glacier
9 It's too dry to wash here
10 Large volcanic depressions formed by subsidence and collapse
11 GEOLOGY's most-cited paper featured experiments with this material
15 A scale of hardness used in classifying minerals
16 Most common of lead minerals
17 This horse won the Triple Crown in 1973 (the year the first issue of GEOLOGY was published)
18 "Big Al" (the 9-foot-tall boulder in the atrium at GSA headquarters) weighs 8 of these
19 Mount St. Helens is a _____
23 Ages and ages, in geology
25 Fiery rock dust cloud
27 Wacky sandstone
31 Steep-sided, loosely packed volcano formed from ejected lava fragments
32 Rippled, fining up formation
34 Amethyst color
35 The April 2007 cover of GEOLOGY featured these giants (some up to 11 m in length!)
37 Above sea-level oceanic crust
38 Someone who cannot pass a pretty rock without picking it up

DOWN

1 Rock formed by the accumulation of large shear strain, in ductile fault zones
2 Volcanic glass
3 GSA's iconic benefactor
5 Process in which water chemically breaks down minerals
6 Ropey basaltic rock
8 Dark, coarse-grained igneous rock
11 GEOLOGY articles are timely, innovative, and _____
12 "A generation comes, a generation goes, the _____ remains forever."
13 Vent that emits gases and vapors
14 The geo-famous Florence
16 GSA's Twitter handle is @_____
20 Another term for a volcanic mudflow
21 GSA headquarters was located in this state until 1968
22 The frontier between igneous and metamorphic rocks
24 Can you dig it?
26 Broad, low-relief volcanic crater
28 GSA's first journal
29 GSA headquarters is here
30 GSA's current president
33 Canyon sound
36 GEOLOGY's first article featured a proposal to abandon this particle grade scale in favor of one based on the metric system

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POSITIONS OPEN

Sedimentology, Stratigraphy, and Earth-Surface Processes, University of Minnesota, Twin Cities

ABOUT THE JOB. The Department of Earth & Environmental Sciences at the University of Minnesota–Twin Cities invites applications for a tenure-track faculty position in sedimentology, stratigraphy, and/or Earth-surface processes. This search is broad, encompassing the deep-time sedimentary record to modern-day processes and deposits; the full range of field, laboratory, theoretical, and computational approaches; and the marine realm to the terrestrial surface and cryosphere. We seek to fill this position at the assistant professor level, though higher ranks may be considered for exceptional candidates.

ABOUT THE DEPARTMENT. The Department of Earth & Environmental Sciences is part of the College of Science & Engineering. It hosts diverse research programs and state-of-the-art facilities within the recently renovated Tate Hall. In addition to the department, the School of Earth & Environmental Sciences encompasses the Continental Scientific Drilling (CSD) Facility, the Institute for Rock Magnetism (IRM), the Polar Geospatial Center (PGC), and the Minnesota Geological Survey (MGS). Further information about the department may be found online at https://cse.umn.edu/esci.

Additional centers and strengths at the University of Minnesota include the Saint Anthony Falls Laboratory (SAFL), the Institute on the Environment (IonE), the Midwest Climate Adaptation Science Center (CASC), GEMS (Genomics Environment Management Socio-Economic) Informatics, the Biotechnology Institute, and the Water Resources Center. Beyond these, the University hosts strong programs across the Earth and environmental sciences, ecology, forestry, soils and agricultural sciences, fluid mechanics, and geography.

Additional important information. Successful applicants are expected to contribute to a diverse research and teaching community by developing a vigorous, internationally recognized, and externally funded research program; through teaching courses at both undergraduate and graduate levels; and through service including engagement in Diversity, Equity, and Inclusion (DEI) initiatives. The Department of Earth & Environmental Sciences is part of the College of Science & Engineering and houses research programs as well as state-of-the-art analytical facilities spanning a broad spectrum of Earth Science disciplines.

Applicants must: Have a Ph.D. in the geosciences or a related field at the time of appointment; Have a track record of peer-reviewed publications

Applicants must submit:

- A cover letter
- A curriculum vitae
- Statements (up to two pages each) on
- Research interests, experiences, and future directions
- Teaching interests, experiences, and future directions
- Experience with and plans to advance diversity, equity, and inclusion
- Names and contact information (email, phone) of three references.

These materials must be submitted online through Interfolio: apply.interfolio.com/115843.

The research statement will be evaluated on past accomplishments and the potential of future plans for impactful or transformative contributions. The teaching statement should include information on educational and mentoring philosophy, pedagogical approach(es), past experience, and proposed courses to teach and/or develop. The DEI statement should encompass past and anticipated actions to advance diversity, equity, and inclusion in the earth and environmental sciences alongside an understanding of the role and significance of this work. Expectations for the extent of past experience in each category will be based on the applicant's career stage.

Appointment may begin as early as Fall Semester 2023. Review of applications will begin on January 2, 2023, and continue until the position is filled. For further information or questions, please contact search-committee chair Andrew Wickert (awickert@umn.edu).

The University of Minnesota values a diverse faculty, which fosters a richness of perspectives and an inclusive environment, and whose members serve as role models for the next generation of geoscientists and the broad student body engaging in our courses. The University provides equal access to and opportunity in its programs, facilities, and employment without regard to race, color, creed, religion, national origin, gender, age, marital status, disability, public assistance status, veteran status, sexual orientation, gender identity, or gender expression.

Assistant Professor in Earth and Planetary Surface Processes, University of Washington

The Department of Earth and Space Sciences, in the College of the Environment at the University of Washington, is soliciting applications for two permanent, full-time, 9-month, tenure-track assistant professors in Earth and planetary surface processes.

Position 1: Assistant Professor in Geomorphology. We seek a geomorphologist who will build a strong field-oriented research program. Areas of focus could include but are not limited to landscape evolution and dynamics, fluvial and watershed processes, or cryosphere geomorphic processes. Contributions to interdisciplinary research and teaching in areas such as geologic hazards, field geology, environmental sustainability, or preparation for the professional workforce are desirable.

Position 2: Assistant Professor in Earth and Planetary Surface Processes. We seek applicants in Earth and planetary surface processes, broadly defined. Areas of focus could include but are not limited to weathering and soil-forming processes, biogeochemical cycling, and landscape evolution on Earth and/or other planets. Contributions to interdisciplinary research and teaching in areas such as planetary sciences, remote sensing, geobiology, or critical zone research are desirable.

All University of Washington faculty engage in teaching, research, and service. Successful candidates will be expected to build vibrant and externally funded research programs that contribute to science of global significance. For both positions, we value the ability to quantify processes and make observational or theoretical advances specific to the surface and near-surface environment. The successful candidates will teach within the core Earth sciences curriculum at both the undergraduate and graduate levels and will demonstrate a commitment to working collaboratively with other faculty and to mentoring students from a wide range of disciplines, cultures, and academic backgrounds.

The successful candidates will join a dynamic interdisciplinary department, including seven new faculty hires in the past four years. The Department of Earth and Space Sciences includes 35 research and teaching faculty, 90 graduate students, and 200 undergraduate majors. Opportunities for interdisciplinary collaboration exist within the department, as well as with other units at UW, including the Schools of Oceanography, Aquatic and Fisheries Sciences, and Environmental and Forest Sciences; the departments of Atmospheric Sciences and Civil and Environmental Engineering; the programs in Astrobiology and Climate Change, the Quaternary Research Center, the eSciences Institute, Future Rivers program, GeoHazards institute, initiatives in subduction zone science, and with USGS geohazards researchers on campus.

The University of Washington is located in the Seattle metropolitan area and offers one of the most exceptional research and teaching environments in the United States. It serves a diverse population of 80,000 students, faculty, and staff, including 25% first-generation college students, over 25% Pell Grant students, and faculty from over 70 countries. The College of the Environment seeks to attract and promote a diverse workforce to maintain the excellence of the University, and to offer students richly varied disciplines, perspectives

and ways of knowing and learning. UW, the College of the Environment and the Department of Earth and Space Science offer a range of networking, mentoring and professional development opportunities for junior faculty.

QUALIFICATIONS. Applicants must apply through the UW's Interfolio portal at https://apply.interfolio.com/116035. The selected candidates must have a Ph.D., or foreign equivalent in a relevant field by the start of the appointment. The anticipated start date is September 1, 2023.

APPLICATION INSTRUCTIONS. Applicants should indicate in the cover letter which position best fits their interest and expertise. All applications will be reviewed by a single hiring committee, and all applicants will be considered for both positions. Review of applications will begin January 3, 2023.

Required materials include: *A one-page cover letter; *Curriculum vitae with publication list; *Three statements (no more than 10 pages total) addressing (1) research and leadership accomplishments, as well as future research plans; (2) a statement on teaching and mentoring, including evidence of teaching effectiveness; and (3) contributions or plans to support diversity, equity, and inclusion (see http://www.washington.edu/diversity/diversity-blueprint/); *Contact information for three (3) references.

Questions about the application process or position in general should be addressed to essasst@uw.edu.

Assistant Professor, Near Surface Geophysics, University of Toronto

The Department of Earth Sciences [https://www.es.utoronto.ca/] in the Faculty of Arts and Science at the University of Toronto invites applications for a full-time tenure stream position in Near Surface Geophysics. The appointment will be at the rank of Assistant Professor, with an expected start date of July 1, 2023.

Applicants must have earned a Ph.D. in earth or environmental sciences, geophysics, physics, or a closely related discipline by the time of appointment, or shortly thereafter, with a demonstrated record of excellence in research and teaching. We seek candidates whose research and teaching interests complement and enhance our existing departmental strengths. [https://www.es.utoronto.ca/people/faculty/] The successful candidate would be pursuing innovative research in near-surface geophysics, combining field-based and modelling approaches to topics such as hydrogeology, cryosphere science, natural hazards, archaeology, forensics, and/or other environmental aspects of critical zone science. The successful candidate will be expected to pursue impactful and independent research at the highest international level and to establish an outstanding, competitive, and externally funded research program.

Candidates must provide evidence of research excellence, which can be demonstrated by a record of publications in top-ranked and field relevant journals, the submitted research statement, presentations at significant conferences, a track record of obtaining independent research funding, awards and accolades and strong endorsements from referees of high standing.

Evidence of excellence in teaching will be provided through teaching accomplishments, the teaching dossier (with required materials outlined below) submitted as part of the application, as well as strong letters of reference. The successful candidate will be expected to contribute substantively to both graduate and undergraduate teaching in the Department.

Candidates are also expected to show evidence of a commitment to equity, diversity, inclusion, and the promotion of a respectful and collegial learning and working environment demonstrated through the application materials. Demonstration of how the candidate would bring new perspectives to the Department, experiences, and meaningful plans for connecting to groups that have been historically marginalized in the geosciences are criteria that will be considered in our evaluation of excellence.

Salary will be commensurate with qualifications and experience.

The University of Toronto provides exceptional opportunities for collaborative and interdisciplinary research and teaching, and actively encourages cutting-edge scholarship. Furthermore, it offers the excitement of working with a diverse, high-achieving student population. The Department of Earth Sciences maintains a suite of modern equipment for hands-on geophysics teaching, and offers a vibrant, top-ranked Earth Sciences graduate program [https://www.es.utoronto.ca/programs/graduate/] spanning the three campuses of the University of Toronto (including the Department of Physical and Environmental Sciences at University of Toronto Scarborough [https://www.utsc.utoronto.ca/physsci/welcome-physical-environmental-sciences] and the Department of Chemical and Physical Sciences at University of Toronto Mississauga) [https://www.utm.utoronto.ca/cps/welcome-cps]. The successful candidate would also have ample opportunity to engage with cognate units such as the School of the Environment [https://www.environment.utoronto.ca/], the Archaeology Centre [https://archaeology.utoronto.ca/], the Centre for Global Change Science [https://cgcs.physics.utoronto.ca/], the Climate Positive Energy Initiative [https://cpe.utoronto.ca/], or the Faculty of Applied Science and Engineering [https://www.engineering.utoronto.ca/]. Opportunities are also available to work with a wide range of public and private organizations, groups, and institutions that reflect the region's diversity. Seen as one of the most multicultural places in the world, Toronto is a thriving cultural and intellectual hub offering an outstanding quality of life.

All qualified candidates are invited to apply online by clicking the link below. Application materials must include the following:

- Cover letter (maximum 2 pages)
- Current curriculum vitae
- A statement outlining contributions to equity, diversity, and inclusion, which might cover topics such as (but not limited to): research or teaching that incorporates a focus on underrepresented communities, the development of inclusive pedagogies, or the mentoring of students from underrepresented groups (1 page)
- A research statement outlining current and future research interests (maximum 3 pages)
- Electronic copies of three most significant research publications

A teaching dossier to include:

- a statement of teaching interests and philosophy (maximum 2 pages)
- any other documentation demonstrating excellence in teaching, which can include activities as a teaching assistant or course instructor, experience leading successful workshops or seminars, mentorship, outreach or conference presentation or posters, as well as teaching evaluations, course materials.

Applicants must provide the name and contact information of three references. The University of Toronto's recruiting tool will automatically solicit and collect letters of reference from each after an application is submitted (this happens overnight). Applicants remain responsible for ensuring that references submit letters (on letterhead, dated and signed) by the closing date.

Submission guidelines can be found at http://uoft.me/how-to-apply. Your CV and cover letter should be uploaded into the dedicated fields. Please combine additional application materials into one PDF file.

If you have any questions about this position, please contact Ampy Tolentino, Assistant to the Chair of Earth Sciences, at geol_sec@es.utoronto.ca.

All application materials, including reference letters, must be received by December 15, 2022.

Assistant Professors, Water-Earth Surface Processes Cluster Hire, University of Nevada, Las Vegas

The University of Nevada, Las Vegas (UNLV) invites applications for up to three tenure track positions in a Water-Earth surface processes themed Cluster Hire at the Assistant Professor level as part of an interdisciplinary cluster in the broad field of Sustainability in Arid Lands. Two of the positions will be in the fields of Water-Earth surface processes (Position Numbers P0023073, P0103372, and the third will include a charge to spearhead the development of an online MS program in Water Resources Management (Position Number P0027657). Full details are provided in the job announcement (link: https://nshe.wd1.myworkdayjobs.com/

UNLV-External/job/UNLV1-Main-Campus-Las-Vegas/Assistant-Professor-in-Sustainability-of-Arid-Lands--Geoscience-Department--College-of-Science--R0133607-_R0133732)

Review of applications will begin on January 17th, 2023. Application materials must be submitted through the UNLV enterprise management software portal (link https://nshe.wd1.myworkdayjobs.com/UNLV-External/job/UNLV1-Main-Campus-Las-Vegas/Assistant-Professor-in-Sustainability-of-Arid-Lands--Geoscience-Department--College-of-Science--R0133607-_R0133732) we do not accept emailed materials. Questions about the application process can be directed to Dr. David K. Kreamer, Search Committee Chair.

Assistant Professor, Isotope Geochemistry, University of Nevada, Las Vegas

The Department of Geosciences at the University of Nevada, Las Vegas (UNLV) invites applications for a tenure track position in Isotope Geochemistry at the Assistant Professor level. We seek outstanding scholars who will establish an innovative research program focused around solution chemistry mass spectrometry. The position contains a start-up package that includes a Nu Sapphire inductively coupled plasma mass spectrometer with collision cell and facilities for clean solution chemistry. The successful candidate should show experience in operating comparable analytical equipment.

Application materials must include a (1) cover letter, (2) curriculum vitae, (3) proposed research plan (three-page limit), (4) statement of teaching philosophy and interests (two-page limit), (5) a statement of past or potential contributions to diversity, equity, and inclusion (one-page limit), (6) 1–4 representative publications, and (7) contact information for at least four referees.

Review of applications will begin on January 17th, 2023. Materials should be addressed to Dr. Kevin Konrad, Search Committee Chair, and must be submitted through Workday, as we do not accept emailed materials.

Tenure-track Faculty Position in Planetary Science at CU Boulder

The Laboratory for Atmospheric and Space Physics at the University of Colorado invites applications for a tenure-track faculty position to start in August 2023 in the general field of planetary science. The opening is targeted at the level of Assistant Professor, but experienced candidates with appropriate credentials will be considered for an Associate Professor appointment. Depending on the background and teaching interest, the successful candidate would also be affiliated with the appropriate academic department at CU.

Areas of interest include: Research approaches from remote sensing, to instrument development,to space missions, to laboratory studies and to theory, addressing research targets both within our solar system and exoplanets, and applying fields such as atmospheric science, planetary geology, astrobiology, geophysics, space environments, dynamics, etc.

The University of Colorado Boulder is committed to building a culturally diverse community of faculty, staff, and students dedicated to contributing to an inclusive campus environment. We are an Equal Opportunity employer, including veterans and individuals with disabilities.

Evaluation of applications starts November 28, 2022. Position will remain open until filled.

For further information about LASP see https://lasp.colorado.edu/home/.

Full job posting at https://jobs.colorado.edu/jobs/JobDetail/?jobId=43550.

Tenure Track Faculty Position, Structural Geology/Tectonics, Auburn University

The Department of Geosciences at Auburn University invites applications for a tenure-track faculty position at the Assistant or Associate Professor level in Structural Geology/Tectonics, beginning in the Fall Semester 2023. Applicants must hold a Ph.D. in geosciences or a related field at the time appointment begins. Appointment rank will depend on the qualifications of the selected candidate. Specialties may include, but are not limited to, field studies, microstructural analysis, quantitative structural and basin modeling, and rock mechanics. We seek a dynamic individual who will play a strong role in propelling our Geology Master's and interdisciplinary Earth System Science Ph.D. programs. New faculty with expertise in Structural Geology/Tectonics will complement the University's considerable existing expertise in the areas of Geochronology, Petrology, Economic Geology, Isotope Geochemistry, Geophysics, Geomorphology, Engineering Geology, Environmental Geology, GIS and Remote Sensing. Faculty in the Geosciences Department within the College of Sciences and Mathematics have active regional and global collaborative research programs with many other colleges across the university (e.g., College of Engineering) and external institutions. The successful candidate is expected to develop a rigorous, externally funded research program, publish scholarly work, and advise and mentor graduate and undergraduate students. The successful candidate will also have teaching duties that include undergraduate and graduate courses (e.g., Structural Geology, Summer Field Camp, Tectonics) based on his/her expertise. Excellent written and interpersonal communication skills are necessary. The candidate selected for this position must meet eligibility requirements to work in the United States on the date the appointment is scheduled to begin and must be able to continue working legally for the proposed term of employment.

Applications must include: 1) the applicant's curriculum vitae, 2) copies of transcripts, and 3) the names and contact information of three professional references, as well as up to 2 pages each for: 4) a cover letter/letter of interest, 5) a statement of research interests, 6) a statement of teaching philosophy and interests, and 7) a statement of diversity, equity, and inclusion (DEI). In the statement of DEI, please describe how your experience and/or potential contributions in research, teaching, and service will advance our mission of creating a more diverse, equitable and inclusive workplace. The College of Sciences and Mathematics is committed to providing resources to enhance awareness and appreciation of cultural and individual diversity, promote community, and prepare students, faculty, and staff to have a global impact in STEM (https://www.auburn.edu/cosam/departments/diversity/index.htm). To apply please go to: https://www.auemployment.com/postings/32485, complete the online form and upload the required application documents.

Applicants are encouraged to visit the AU website to learn more about Auburn University and Geosciences program http://www.auburn.edu/cosam/departments/geosciences/. Auburn University is understanding of and sensitive to the family needs of faculty, including dual-career couples. Please visit the following link for more information: http://www.auburn.edu/academic/provost/facultyjobs/. Review of applications will begin December 2, 2022, and will continue until a candidate accepts appointment.

Auburn University is an EEO/Vet/Disability employer and committed to building a diverse and inclusive community.

Faculty Position, Planetary Geosciences, Auburn University

The Department of Geosciences at Auburn University invites applications for a Planetary Geosciences faculty position at the rank of tenure-track Assistant Professor or Associate Professor. The appointment would begin August 2023. Applicants must hold a Ph.D. in Geosciences (broadly defined) or in a closely related field at the time appointment begins. Post-doctoral experience is desirable. Specialties may include, but are not limited to, terrestrial analogue studies of planetary surface processes (e.g., impact cratering and volcanic processes), orbital and/or surface robotic mission-related geosciences (e.g., missions to the Moon and Mars), planetary mineralogy and petrology (including geochronology, e.g., study of meteorites and/or future returned samples), instrument science for planetary missions, planetary geophysics and climate dynamics, and related disciplines such as astrobiology. We seek a dynamic individual with strong research potential who can obtain external funding and can link their research program to existing department strengths in geochemistry, geochronology, geomorphology, tectonics,

climate science, remote-sensing and GIS, and sedimentary geology. Auburn University supports multi-departmental research efforts in the Planetary Science area in both the College of Sciences and Mathematics and the College of Engineering. The successful candidate is expected to develop a vigorous, externally funded research program, publish scholarly work, and advise graduate and undergraduate students. The successful candidate will also participate in the educational mission through teaching new specialty courses in Planetary Geosciences as well in teaching existing courses at the undergraduate and graduate levels in Geosciences and in our interdisciplinary Earth System Science Ph.D. degree program. Excellent written and interpersonal communication skills are necessary. The candidate selected for this position must meet eligibility requirements to work in the United States on the date the appointment is scheduled to begin (August 2023) and must be able to continue working legally for the proposed term of employment.

Applications must include the applicant's curriculum vitae, copies of transcripts, and the names and contact information of three professional references, as well as up to 2 pages each for the cover letter/letter of application, the statement of research interests, the statement of teaching philosophy and interests, and the statement of inclusion. In the statement of inclusion, please describe how your experience and/or potential contributions in research, teaching, and service will advance our mission of creating a more diverse, equitable and inclusive workplace. The College of Sciences and Mathematics is committed to providing resources to enhance awareness and appreciation of cultural and individual diversity, promote community, and prepare students, faculty, and staff to have a global impact in STEM (http://www.auburn.edu/cosam/departments/diversity/index.htm). To apply please go to https://www.auemployment.com/postings/32497, complete the online form and upload the required application documents.

Applicants are encouraged to visit the AU website to learn more about Auburn University and Geosciences program http://www.auburn.edu/cosam/departments/geosciences/. Auburn University is understanding of and sensitive to the family needs of faculty, including dual-career couples. Please visit the following link for more information: http://www.auburn.edu/academic/provost/facultyjobs/. Review of applications will begin during December 1, 2022, and will continue until a candidate accepts appointment.

Auburn University is an EEO/Vet/Disability employer and committed to building a diverse and inclusive community.

Structural Geologist, Western Washington University

The Geology Department at Western Washington University (WWU) invites applications for a tenure-track Assistant Professor position specializing in Structural Geology to begin Fall 2023. We seek individuals who will establish a vigorous research program, are enthusiastic about teaching, will involve undergraduate and Masters-level students in their research, and will work to improve diversity, equity, and inclusivity through their teaching, research, and service efforts.

The ideal candidate will complement our existing teaching and research strengths in tectonics, petrology, geomorphology, and geophysics by developing new courses and research avenues in structural geology. We broadly seek individuals who will apply field-based observations and analytical techniques to understand the structural and tectonic evolution of the Earth's continental crust and lithosphere. Areas of interest include but are not limited to the structural analysis and evolution of mountain belts, the kinematics and rheology of faults or shear zones, and the timescales and rates of continental deformation. Primary teaching responsibilities include structural geology, field mapping and methods (field camp), and advanced courses in structural geology and tectonics, as well as introductory / physical geology courses.

For details about the position, application information and instructions, go to the WWU Employment website: Careers - Faculty | Human Resources | Western Washington University (wwu.edu) 9-month salary range will be $75,000-82,000 depending on experience.

Review of applications begins December 16, 2022, and continues until position is filled. Please contact the search committee chair, Sean Mulcahy (mulcahs@wwu.edu) or the Geology Dept chair, Bernie Housen (bernieh@wwu.edu) for questions about this position.

Tenure-Track Faculty, Assistant or Associate Professor, Marine Geology, Geology and Environmental Geosciences, College of Charleston

The College of Charleston Department of Geology and Environmental Geosciences invites applicants with a Ph.D. in Geosciences or closely related field for a tenure-track faculty position to begin in August 2023. We seek a faculty colleague able to teach courses in marine geology, seafloor mapping, introductory geology, and one or more courses in their field of specialty, and mentor student experiential learning activities. Candidates who can develop their own research program and secure external funds in areas such as marine geology, hydrography, and geoinformatics are strongly desired.

Read the complete position description and apply at https://jobs.cofc.edu/postings/12735.

Any questions should be directed to Timothy Callahan at callahant@cofc.edu. Applications will be reviewed beginning on November 11, 2022; the position will remain open until filled.

Assistant or Associate Professor (Environmental and Aquatic Restoration and Sustainability Cluster Hire; multiple positions), Grand Valley State University

The College of Liberal Arts and Sciences (CLAS) and the Brooks College of Interdisciplinary Studies (Brooks) at Grand Valley State University are hiring at least five tenure track faculty with expertise related to Environmental Sciences, Aquatic Restoration, Environmental Studies, and Sustainability to start August 6, 2023. CLAS invites a broad range of applications from all subdisciplines of Environmental Science and Aquatic Science and related fields. The Biology Department invites applicants with expertise in any area of Environmental Science or Aquatic Biology. Of particular interest are applicants that use data analytics and/or modeling to address environmental issues. The R. B. Annis Water Resources Institute (AWRI) and the Department of Chemistry invite applicants with expertise in Analytical Chemistry to lead the AWRI Environmental Chemistry lab. This supervisory responsibility comes with a reduced teaching load. Of particular interest are applicants with expertise in aquatic chemistry, toxicology, or green chemistry. The Geology Department invites applicants with expertise in areas related to Environmental and Earth Surface Materials and Systems. Of particular interest are applicants who can engage students in instrumental or modeling experiences. A fourth position is open to applicants from any field whose work applies to the cluster's focus on Environmental Science and Aquatic Restoration and Sustainability.

For additional details and how to apply, please consult the CLAS Cluster Hire in Environmental and Aquatic Restoration and Sustainability [https://www.gvsu.edu/clas/clas-cluster-hire-1198.htm] webpage.

OPPORTUNITIES FOR STUDENTS

Graduate Research Opportunities, Purdue. The Department of Earth, Atmospheric, and Planetary Sciences (EAPS) at Purdue University is looking for enthusiastic and self-motivated graduate students for a variety of research projects in Geology and Geophysics, Planetary, Environmental, and Atmospheric Sciences. As a multidisciplinary department within the College of Science, EAPS draws students from a variety of STEM backgrounds. Students with demonstrated academic and research excellence are invited to explore research opportunities at http://www.eaps.purdue.edu/gradresearch. We believe diversity makes our department stronger and our science better, and so we proudly encourage students from underrepresented or minoritized groups to apply or simply contact us to learn more about our program by emailing Emjai Gregory at egregor@purdue.edu.

Ph.D. and M.S. Students, Department of Geosciences, Baylor University. The Department of Geosciences at Baylor University invites applications for Ph.D. and M.S. students starting in August 2023. Admission to the program includes 5 years of financial support for Ph.D. students and 2 years of financial support for M.S. students through graduate assistantships. Admitted students also receive a tuition waiver, 80% health insurance subsidy, annual conference travel funding, and research funding for graduate students on a competitive basis. Candidates should have at least an undergraduate degree in geology, geophysics, or in a related area and excellent analytical and writing skills. Students holding a B.S. degree may apply directly to the Ph.D. program.

Faculty research covers a broad spectrum of geosciences, with strengths in biogeosciences, energy geoscience, hydrological and surface processes, lithospheric processes, paleoclimate, and solid Earth and planetary sciences. For more information about the Department of Geosciences, our research areas, and the graduate program please visit www.baylor.edu/geosciences.

Applications are due by January 5, 2023, for Fall 2023 program entry. Details about the application process and priority deadline can be found here: https://www.baylor.edu/geosciences/index.php?id=952059. Applications can be submitted online here: https://grad.baylor.edu/apply/. Please contact us at geosciences@baylor.edu for more information or with questions.

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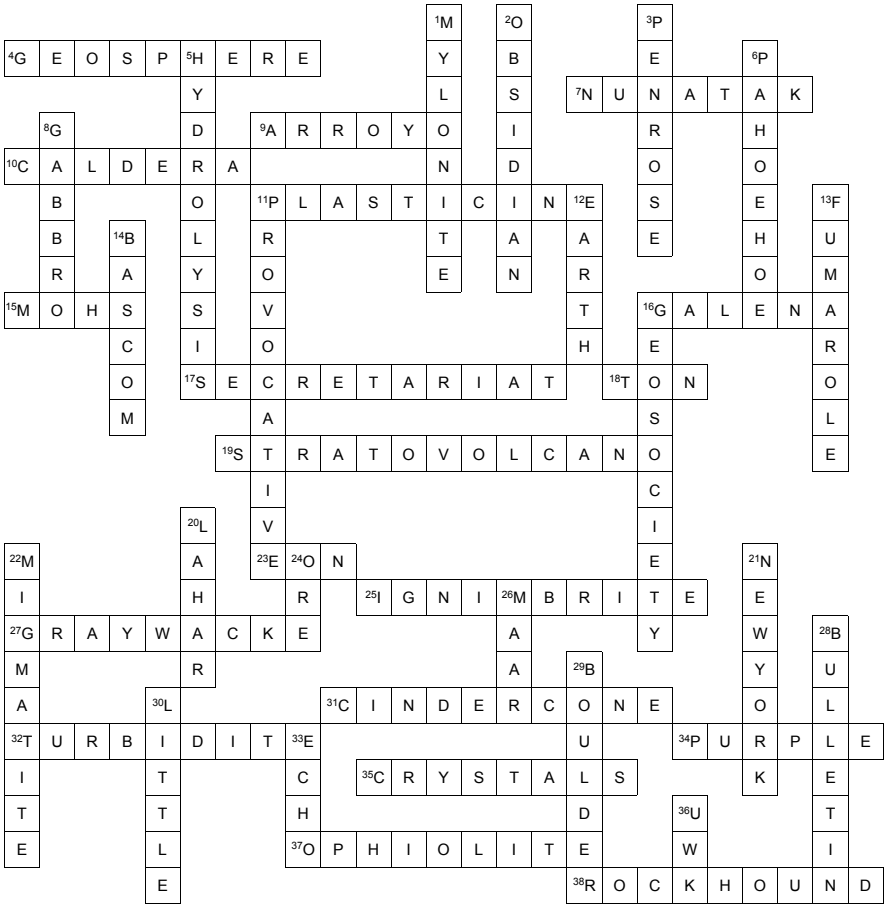

Science Editor Openings for 2024

GSA seeks applications for science co-editors for GSA Books (two positions), *GSA Bulletin* (one position), and *Geology* (two positions). The four-year terms begin 1 January 2024. Duties include: ensuring stringent peer review and expeditious processing of manuscripts; making final acceptance or rejection decisions after considering reviewer recommendations; and, along with your co-editors, setting the editorial tone of the publication and maintaining excellent content through publication of a diverse range of papers.

POSITION DETAILS

Research interests that complement those of the continuing *GSA Bulletin* editors include but are not limited to: tectonics; tectonophysics; structural geology; low-T thermochronology; deformation; archaeological geology; economic geology; geochronology; geodynamics; paleomagnetism; petrology; Precambrian geology; sedimentary geology.

GSA Books editor duties include soliciting high-quality book proposals and ensuring that proper peer-review procedures are followed by volume editors. Editors handle the entire peer-review process for authored volumes. The successful candidate will have a wide range of interests and expertise, prior editing experience, and a strong publication record.

Research interests that complement those of the continuing *Geology* editors include, but are not limited to: paleontology; paleomagnetism; paleoceanography; marine geology; economic geology; stratigraphy; subsurface geophysics.

> Note: Because of the volume of papers received by *Geology* and the breadth of the topics covered, editors must be willing to handle papers outside of their main disciplines.

Editors work out of their current locations at work or at home. The positions are considered voluntary, but GSA provides an annual stipend and funds for office expenses.

Evaluation Process: The GSA Publications Committee will evaluate applications and make its recommendations to GSA Council based on the combination of how a candidate's disciplinary expertise fits with the needs of the publication and on the candidate's application, which should provide documentation of the required and preferred qualifications listed here.

GSA affirms the value of diverse scientific ideas and the connection between diverse scientific ideas and a diverse group of contributors of those ideas. Accordingly, GSA welcomes applications from all qualified persons and encourages applications that highlight diversity.

To Apply: In a single PDF, submit your curriculum vitae and a letter of application that demonstrates how your interests and experience fulfill the required and preferred qualifications listed below to Bridgette Moore, bmoore@geosociety.org. **Deadline: 1 March 2023.**

REQUIRED QUALIFICATIONS

- Experience as an editor or associate editor for a geoscience journal. Include details of the duties and duration of the position(s) held.
- Demonstrated expertise in two or more fields in the geosciences or in interdisciplinary fields broadly related to the geosciences.
- Demonstrated experience handling a significant editorial workload and ability to make timely decisions.
- Because of the breadth of topics covered in GSA publications, the applicant must clearly express willingness to handle papers outside of their main disciplines.
- Demonstrated ability to communicate clearly and be responsive to author needs.

PREFERRED QUALIFICATIONS

- Experience with a GSA journal as a reviewer, associate editor, or editor.
- Breadth of interdisciplinary experience to complement that of existing editors; demonstrated interest in interdisciplinary research.
- International reputation and connections with the geoscience communities.
- Interest in encouraging innovation; willingness to take risks.
- Ability to support a positive team dynamic; ability to work with GSA staff and other editors to enhance the reputation of the publication.

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AGeS³: Micro-Funding an Inclusive Community Grassroots Effort to Better Understand the Earth System

R.M. Flowers, *Dept of Geological Sciences, University of Colorado Boulder, Boulder, Colorado 80309, USA;* **J.R. Arrowsmith,** *School of Earth & Space Exploration, Arizona State University, Tempe, Arizona 85287, USA*

MOTIVATION

Geochronology data provide the temporal information required for earth science from the mantle through the critical zone, yet National Academy reports have repeatedly highlighted challenges for geochronology data access, training, and technical innovation. The 2020 National Academies report "A Vision for Earth Sciences, 2020–2030: Earth in Time" recommends that the National Science Foundation's (NSF) Division of Earth Sciences "should fund a National Consortium for Geochronology." This recommendation builds on previous National Research Council (NRC) reports that emphasize the importance of geochronology data for addressing first order questions in earth-system science related to climate change, biologic and landscape change, earthquake cyclicity and hazards, and solid Earth evolution.

The Advancing Geochronology Science, Spaces, and Systems (AGeS³ or AGeS-cubed) initiative is an NSF-funded project to increase access to geochronology data and expertise, to support and grow the geochronology community, and to promote inclusive and collaborative science (Fig. 1). Current coordination efforts envision founding the National Geochronology Consortium with an infrastructure trio: Human Infrastructure, Technical Instrument-based Infrastructure, and Cyberinfrastructure (as defined in the 2020 Earth in Time report). AGeS³ is focused on growing the Human Infrastructure pillar in sync with other efforts. To accomplish this, AGeS³ builds on the success and cooperative spirit of the NSF-funded AGeS1 and AGeS2 programs (Fig. 2; Flowers et al., 2019) through the launch of analogous micro-grant opportunities to crowd-source solutions for community-identified geochronology needs.

MICRO-FUNDING

The AGeS³ project will make ~160 strategic micro-awards of US$8–US$15k each through a trio of competitive, proposal-driven, peer-reviewed, micro-funding programs (Fig. 1). This initiative will ultimately engage hundreds across the earth sciences in collaborative science, training, review, and governance activities over its five-year duration. It has been suggested that micro-funding (Rappert, 2017) can have a transformative impact on the sciences, as micro-loans have done for the well-being of many populations around the world. The small and flexible AGeS grants can have a cascading effect in the earth sciences, catalyzing cross-disciplinary collaborations, attracting students with diverse cultural and scientific backgrounds, and enabling important scientific advances that may not happen within the bubble of more standard grants.

The three AGeS³ subprograms are:

- The mature **AGeS-Grad (Graduate Student Research) subprogram** (up to US$10k awards) will support high-impact collaborative science projects between graduate students, labs, and home institution mentors. These awards provide funds for graduate students to visit geochronology labs for a week or more to acquire data and be mentored by geochronologists on projects of joint interest. AGeS³ anticipates making ~110 Grad awards over five proposal cycles.
- The prototype **AGeS-DiG (Diversity in Geochronology) subprogram** (up to US$15k awards) will fund pilot initiatives to increase access to geochronology for those underrepresented in the earth sciences. Priority will be given to projects that emphasize authentic research experiences, that mentor multiple students, and that foster a cohort experience for participants. AGeS³ will make ~30 DiG awards over three proposal cycles.
- The new **AGeS-TRaCE (Training and Community Engagement) subprogram** (up to US$10k awards) will support community-led efforts to address other self-

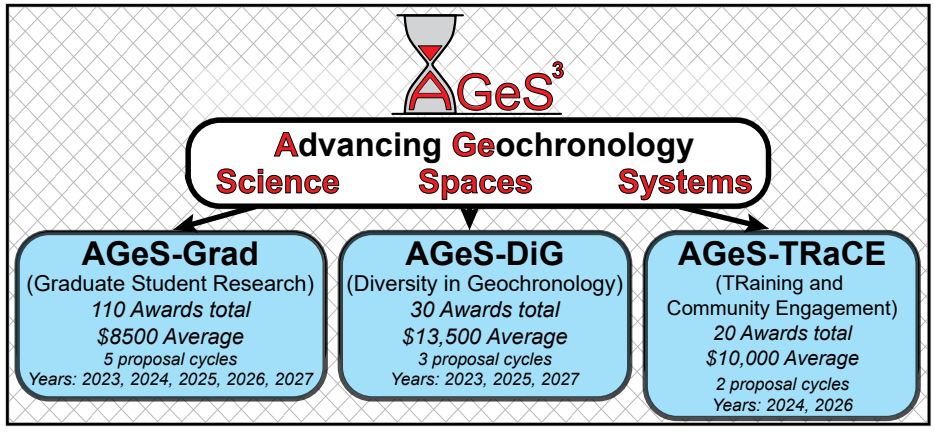

Figure 1. Structure of the AGeS³ initiative that combines the mature AGeS-Grad, the prototype AGeS-DiG, and the new AGeS-TRaCE micro-award programs to advance inclusive science and training in geochronology.

GSA Today, v. 32, https://doi.org/10.1130/GSATG549GW.1.

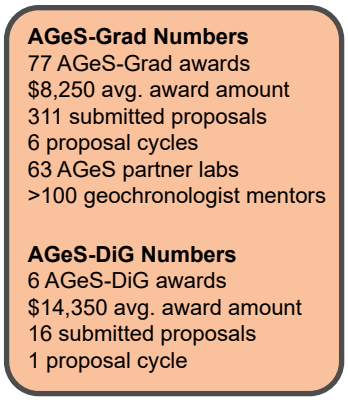

Figure 2. Project numbers associated with the AGeS1 and AGeS2 programs. The AGeS-DiG program was first piloted in 2022.

identified geochronology needs. Examples of AGeS-TRaCE projects include, but are not limited to, accessible webinars, tutorials, and workshops on best practices, lab procedures, instrument design, statistics and uncertainties, or data interpretation; focused meetings to discuss interlaboratory calibration, spikes, new and emerging chronometers, data management systems, or modeling tool development; and other community needs. AGeS^3 plans to fund ~20 TRaCE projects over two proposal cycles.

A common element of the three activities is making small investments that cumulatively advance the field. The well-established AGeS-Grad program will promote interdisciplinary science between graduate students and geochronology labs. The prototype AGeS-DiG and new AGeS-TRaCE programs will serve as innovation incubators, addressing challenges in diversity, inclusion, disciplinary expertise, and technique development by enabling the grassroots ideas of community members to be piloted and grown.

BUILDING ON THE SPIRIT OF AGES1 AND AGES2

AGeS^3 expands and adapts the successful model used by the AGeS (Awards for Geochronology Student) research program (Flowers et al., 2019). The AGeS program was created as a collaborative strategy to address needs articulated in the 2012 NRC report "New Research Opportunities in the Earth Sciences" (NRC, 2012) to expand access to geochronology data and training. AGeS has accomplished this through a competitive graduate student micro-support program supported by two NSF awards (AGeS1 and AGeS2). Each year this funding opportunity has provided a concrete deadline to motivate new connections between geochronology data users and experts to discuss and tune ideas for cross-disciplinary research. Through this process, hundreds have been involved in AGeS proposals (Fig. 2). AGeS1 and AGeS2 count 87 abstracts; 30 peer-review articles published, in review, or in substantial preparation; and many other presentations and products. The AGeS program has also developed a loose consortium of 63 U.S. partner labs and >100 affiliated geochronologists, consisting mostly of individual-investigator based facilities that contain the majority of the geochronology technical infrastructure distributed across the U.S. The list of partner labs on the AGeS website continues to offer a key informational resource to connect geochronology data consumers and producers. For each lab, information about instrumentation, training, sample preparation, analysis, analytical rates, and contact personnel is provided. The successful trajectory of this micro-award program will continue in AGeS^3 through the AGeS-Grad activity.

A COLLABORATIVE GEOSCIENCE MODEL

AGeS^3 is designed around a collaborative geoscience model that harnesses expertise and creativity across the earth sciences to address challenges in geochronology. Assessment and evaluation will provide formative feedback to shape the initiative over its arc. Belonging, accessibility, justice, equity, diversity, and inclusivity (BAJEDI) will be integrated throughout all activities. In particular, AGeS-DiG provides the opportunity to evaluate, test, and learn new approaches to BAJEDI, which can be assimilated into other community efforts. Still broader engagement and integration will be sought through annual, virtual, fully open AGeS community meetings, and an AGeS^3 website that will host project summaries and other tangible products. AGeS^3 adopts a formalized governance model that includes steering and review committees with rotating members who will balance experience with new engagement. Evaluation of the structure, administration, and governance of AGeS^3 can contribute to the development of a potentially transferable or generalizable model of community-led initiatives.

For more information about AGeS^3, go to www.agesgeochronology.org.

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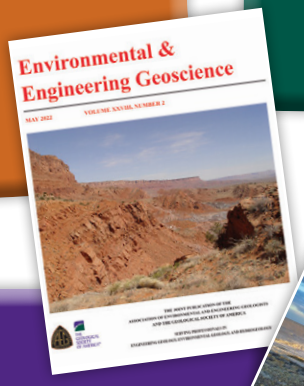

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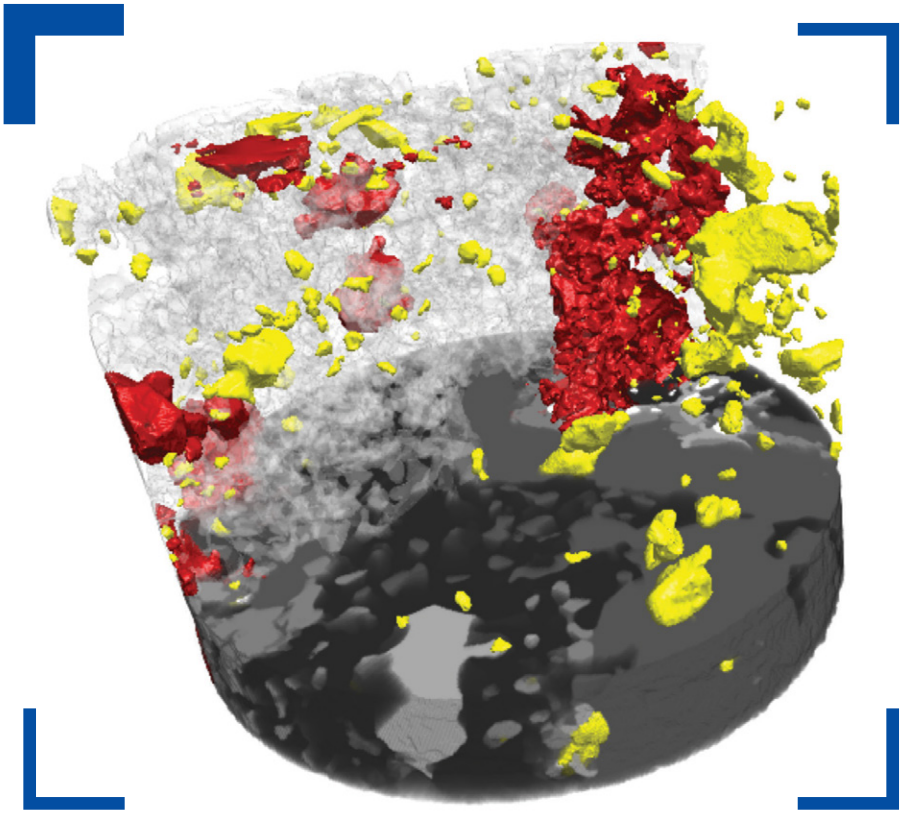

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