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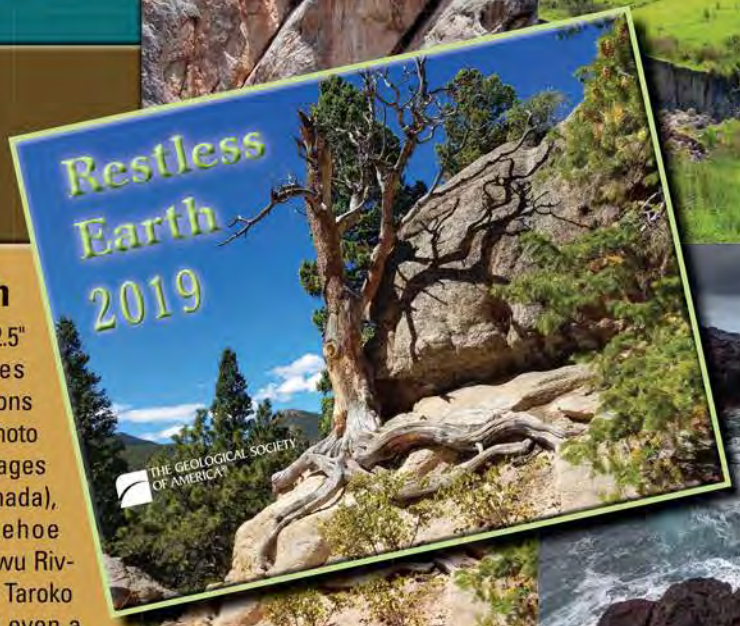

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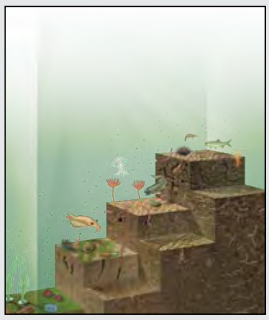

Cover: Animal-substrate interactions have changed dramatically through time. Limited bioturbation resulted in pristine preservation of Ediacaran primary lamination. Increased bioturbation and a new set of players characterized the Cambrian explosion. Further changes took place during the rest of the Phanerozoic with the appearance of new bioturbators. Artwork by David Mazierski. See related article, p. 4–10.

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THE GEOLOGICAL SOCIETY OF AMERICA®

The *other* biodiversity record: Innovations in animal-substrate interactions through geologic time

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ABSTRACT

Tracking biodiversity changes based on body fossils through geologic time became one of the main objectives of paleontology in the 1980s. Trace fossils represent an alternative record to evaluate secular changes in diversity. A quantitative ichnologic analysis, based on a comprehensive and global data set, has been undertaken in order to evaluate temporal trends in diversity of bioturbation and bioerosion structures. The results of this study indicate that the three main marine evolutionary radiations (Cambrian Explosion, Great Ordovician Biodiversification Event, and Mesozoic Marine Revolution) detected in the body-fossil record are also expressed in the trace-fossil record. Analysis of ichnodiversity trajectories in marine environments supports Sepkoski's logistic model, which was originally based on analysis of marine body fossils. The trace-fossil record of continental environments suggests variable rates of increases in ichnodiversity, with major radiations in the Ludlow–Early Devonian, Cisuralian, Early Jurassic, Late Cretaceous, and Eocene, and slower increases or plateaus in between these periods. Our study indicates that ichnologic information represents an independent line of evidence that yields valuable insights to evaluate paleobiologic megatrends.

INTRODUCTION

The astounding diversity of animals in modern oceans and continents is the result of macroevolutionary processes operating in deep time. Conservative estimates suggest the modern biosphere hosts close to 13 million species, of which approximately only 4% are marine (Benton, 2001). Despite the impressive growth of fields exploring other sources of data (e.g., molecular), the fossil record is arguably still the main line of evidence to reconstruct the diversity of life through time (Valentine, 1969; Raup, 1972, 1979; Bambach, 1977; Sepkoski, 1978, 1979, 1984, 1997). However, this has been marked by controversies regarding the nature of diversity trajectories and their potential biases (e.g., Sepkoski et al., 1981; Alroy, 2010; Crampton et al., 2003; Holland, 2010; Bush and Bambach, 2015). In these studies, diversity has been invariably assessed based on body fossils.

Trace fossils represent an alternative record to assess secular changes in biodiversity. Trace-fossil data were given less attention and were considered briefly in only one of the more classic studies of biodiversity through time (e.g., the so-called consensus paper by Sepkoski et al., 1981; see also Miller, 2009). Ichnologic information in the consensus paper was based on early attempts of quantifying trace-fossil diversity, which were supported by the very limited data available at the time (Seilacher, 1974, 1977). The decision by Dolf Seilacher to decline co-authorship of the consensus paper reflects his doubts with respect to the support that trace-fossil evidence was actually providing to the diversity curves based on body fossils. In a letter addressed to Sepkoski, dated 23 February 1981, Seilacher stated, "By lumping the two groups you may get a curve that pleases you, but this might be an accident. The curve you have in mind (based on the record of body fossils) is mainly one of shallow marine diversity. Including the flysch (i.e., the deepwater) counts (which by their high diversity influence the results very much), I am afraid will do no justice to the cause, although the result may fit the general picture" (Miller, 2009, p. 379).

No attempts to produce global comprehensive compilations have been done since the pioneer work by Seilacher (see also Crimes, 1974). Subsequent ichnologic compilations focused on specific environments (e.g., Buatois et al., 1998; Orr, 2001; Uchman, 2004; Minter et al., 2016a, 2016b, 2017) or evolutionary radiations (e.g., Mángano and Droser, 2004; Mángano and Buatois, 2014; Buatois et al., 2016a), rather than on the whole Phanerozoic. In this study we tackle this issue based on a systematic and global compilation of trace-fossil data in the stratigraphic record. We show that quantitative ichnologic analysis indicates that the three main marine evolutionary radiations inferred from body fossils, namely the Cambrian Explosion, Great Ordovician Biodiversification Event, and Mesozoic Marine Revolution, are also expressed in the trace-fossil record. In addition, the trace-fossil record of continental environments suggests variable rates of increases in diversity, with major radiations in the Ludlow–Early Devonian, Cisuralian, Early Jurassic, Late Cretaceous, and Eocene, and slower increases or plateaus in between these periods.

CONCEPTS AND METHODS

Trace fossils comprise distinctive structures of biogenic origin, reflecting organism behaviors while interacting with the substrate (Fig. 1). Trace fossils may be preserved in a wide variety of substrates. Bioturbation structures occur in sediment, whereas bio-erosion structures are produced in rigid substrates, such as hardgrounds, clasts, bones, or rocks (Frey and Wheatcroft, 1989). Although the same type of trace-fossil can be produced by phylogenetically unrelated animals, in many instances trace fossils can be attributed to a producer with variable levels of confidence. For example, the branching burrow system *Ophiomorpha* is commonly regarded as produced by decapod crustaceans, typically callianassids (Fig. 1) (Frey et al., 1978). However, such links are not possible to establish in the case of ichnofossils having less distinct morphologic features. The trace-fossil record encompasses marine and continental environments and spans from Ediacaran to Holocene (Buatois and Mángano, 2016).

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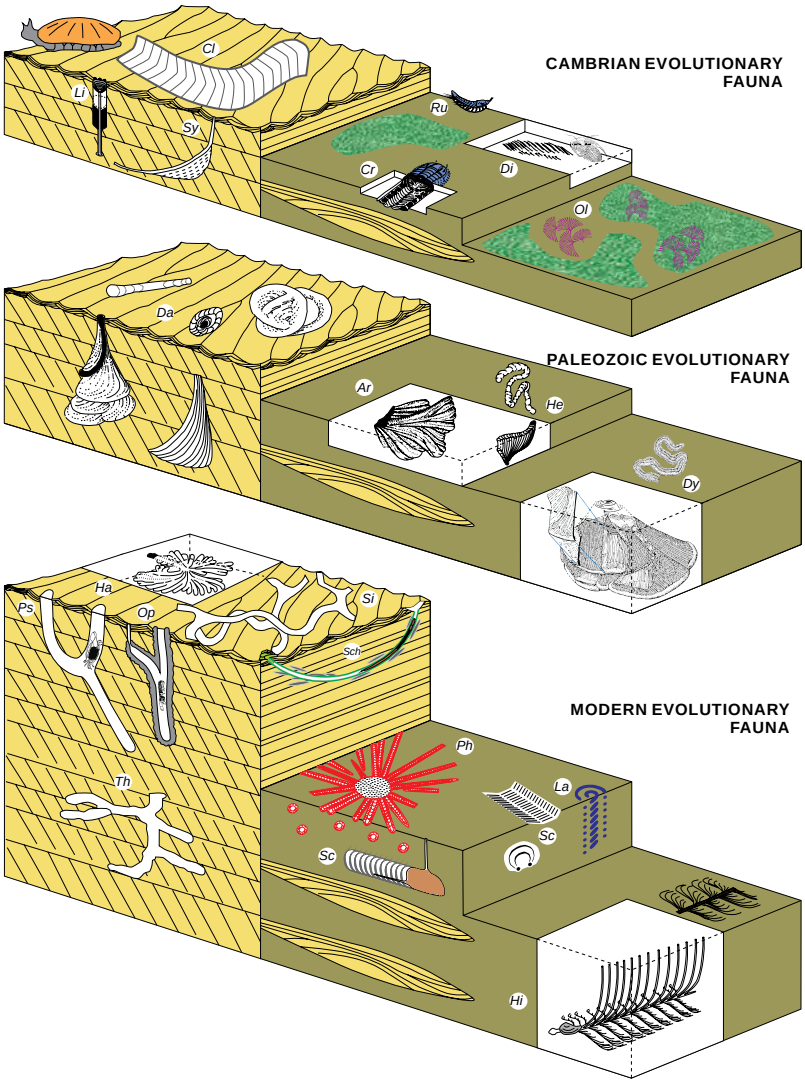

Figure 1. Ichnologic equivalents of Sepkoski's evolutionary faunas. Representative elements of the Cambrian evolutionary fauna include trilobite trace fossils, such as *Rusophycus* (*Ru*), *Cruziana* (*Cr*) and *Dimorphichnus* (*Di*), and the inarticulate brachiopod burrow *Lingulichnus* (*Li*). Trace fossils of worm-like organisms include *Syringomorpha* (*Sy*) and *Oldhamia* (*Ol*), whereas *Climactichnites* (*Cl*) has been attributed to mollusk-like producers. Examples of the Paleozoic evolutionary fauna include ichnotaxa produced by worm-like animals, such as *Daedalus* (*Da*), *Arthrophycus* (*Ar*), *Heimdallia* (*He*), and *Dictyodora* (*Dy*). The Modern evolutionary fauna is dominated by crustacean burrows, such as *Psilonichnus* (*Ps*), *Ophiomorpha* (*Op*), *Thalassinoides* (*Th*), and *Sinusichnus* (*Si*), as well as bivalves, such as *Hillichnus* (*Hi*), and irregular echinoids, such as *Scolicia* (*Sc*). Structures produced by worm-like organisms include *Lapispira* (*La*), *Schaubcylindrichnus* (*Sch*), *Phoebichnus* (*Ph*), and *Haentzschelinia* (*Ha*). For bibliographic sources, see supplementary material in the GSA Data Repository (see text footnote 1).

Whereas the main focus of studies on biodiversity has been on the number of species or higher taxa (Sepkoski, 1997), ichnodiversity (or trace-fossil diversity) studies focus on the different behaviors involved in animal-substrate interactions. Ichnodiversity refers to the number of trace-fossil types (ichnotaxa) present in any given assemblage or geologic period, therefore providing a measurement of behavioral richness (Buatois and Mángano, 2011, 2013). Ichnogeneric compilation was based on literature and personal data (GSA Data Repository Tables DR1 and DR2[1]). The total number of invertebrate ichnogenera identified as valid is 534, encompassing 428 for bioturbation structures and 106 for bioerosion structures (updated from Buatois et al., 2017). We follow the common practice of assessing ichnodiversity at ichnogeneric rank, because there is a general agreement that taxonomy is more firmly established at ichnogenus level than at ichnospecies rank. Only invertebrate trace-fossil data were considered. Individual curves were produced for continental, shallow-marine, and deep-marine bioturbation, and marine and continental bioerosion (Fig. 2). Additional diversity curves were compiled for all marine bioturbation, all marine (bioerosion plus bioturbation), and all continental (bioerosion plus bioturbation) ichnogenera. A rarefaction analysis of the data pertaining to the Cambrian and Ordovician portions of the marine curves showing rapid ichnodiversity increases was undertaken to evaluate the effects of sample size on the curves (Buatois et al., 2016a). Diversity data for the continental Paleozoic were standardized by using the residuals method to evaluate potential sampling biases regarding the abundance of nonmarine clastic rock volume, the number of ichnofossil-bearing formations, and the number of trace-fossil assemblages documented (Minter et al., 2017). Potential biases are discussed in the supplementary material (see footnote 1).

RESULTS

Behavioral innovations seem to have taken place in pulses rather than at a steady pace (Fig. 2). For marine environments, a 433% increase in ichnodiversity occurred during the Terraneuvian, a 48% increase took place between the Early and Late Ordovician, and a more protracted and modest increase occurred later in the Mesozoic with increases in the Early Jurassic (8%) and Late Cretaceous (20%), totaling an overall increase of 37% (between the Late Triassic and Late Cretaceous) (Table DR3 [see footnote 1]).

[1] GSA Data Repository item 2018307, Fig. DR1, Tables DR1–DR3, and further comments on concepts and methods, is available online at http://www.geosociety.org/datarepository/2018/.

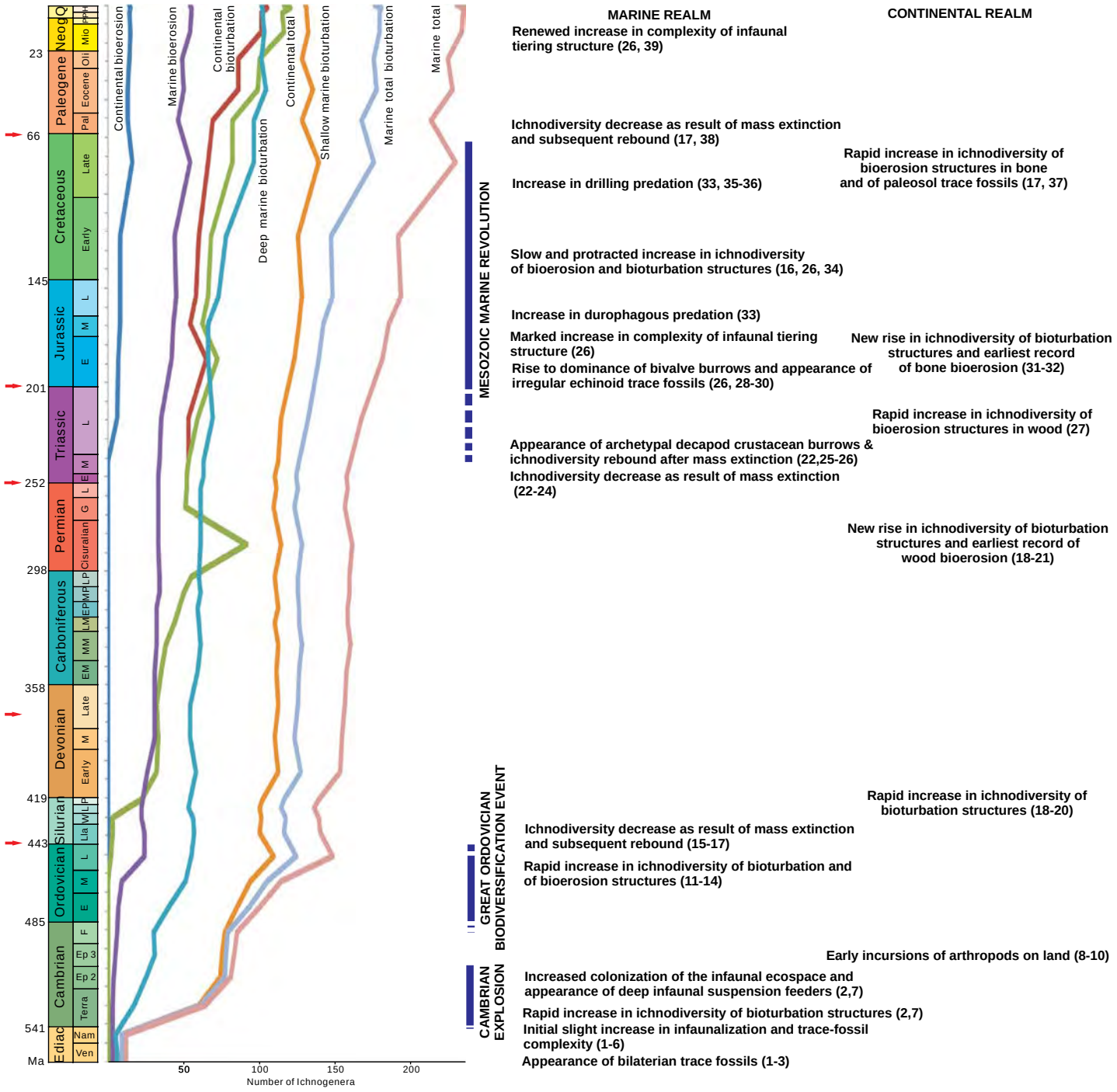

Figure 2. Ichnodiversity changes and milestones in animal-substrate interactions through geologic time as reflected by the trace-fossil record. Arrows indicate mass extinctions. Numbers correspond to bibliographic sources indicated in the supplementary material in the GSA Data Repository (see text footnote 1).

The Terraneuvian increase, attributed to the Cambrian Explosion, is restricted to bioturbation (Mángano and Buatois, 2014; Buatois et al., 2016a). The Cambrian Explosion is characterized by the rise of the Cambrian evolutionary fauna, which was dominated by trilobites, one of the most significant elements not only based on the body-fossil record, but also from an ichnologic perspective (Seilacher, 1985). In addition, inarticulate brachiopods, another important component, are represented by the ichnogenus *Lingulichnus* (Pemberton and Kobluk, 1978). However, the high ichnodiversity that characterizes the Cambrian reflects the activity of soft-bodied clades that are poorly known from the body-fossil record (and, therefore, not listed as members of the Cambrian evolutionary fauna). Several ichnogenera are restricted to the Cambrian (e.g., *Climactichnites, Oldhamia, Syringomorpha*). Trilobite trace fossils, as well as those ichnogenera showing stratigraphic ranges restricted to the Cambrian, may be regarded as the ichnologic equivalent of Sepkoski's Cambrian evolutionary fauna (Figs. 1 and DR1 [see footnote 1]).

The Ordovician increase in ichnodiversity is attributed to the Great Ordovician Biodiversification Event and is reflected not only by an increase in diversity of bioturbation, but also by bioerosion structures (Ordovician bioerosion revolution of Wilson and Palmer, 2006) (Fig. 2, Table DR3 [see footnote 1]). This revolution in the ability of organisms to penetrate skeletal material and hardgrounds occurred ~80 m.y. after the Cambrian Explosion in bioturbation (Buatois et al., 2016a). The Great Ordovician Biodiversification Event signals a shift from dominance of elements of the Cambrian evolutionary fauna to those of the Paleozoic and Modern evolutionary faunas (Sepkoski, 1981; Miller and Connolly, 2001). Articulate brachiopods, rugose and tabulate corals, and crinoids are dominant elements of the Paleozoic evolutionary fauna (Sepkoski, 1981). Unsurprisingly given their modes of life, none of these clades are significant from an ichnologic standpoint, obscuring characterization of an equivalent of the Paleozoic evolutionary fauna. However, a few ichnogenera showing restriction or peak abundance during the Paleozoic (e.g., *Arthrophycus, Dictyodora, Daedalus, Heimdallia*) may be regarded as typical of the Paleozoic evolutionary fauna (Figs. 1 and DR1 [see footnote 1]). In addition, the trace-fossil record of the Great Ordovician Biodiversification Event reflects the dilution of trilobite faunas inferred from the body-fossil record. Contribution of trilobite-produced trace fossils to alpha ichnodiversity at ichnospecies level in the Tremadocian averages 41.5%, whereas only a 30.6% was attained in the Floian–Darriwilian, and just 12.1% for the Sandbian–Hirnantian (Mángano et al., 2016).

The Mesozoic ichnodiversity increase (Fig. 2, Table DR3 [see footnote 1]), concomitant with the rise to dominance of the modern evolutionary fauna (MEF), is attributed to the Mesozoic Marine Revolution. Bivalves, gastropods, echinoids, crustaceans, and marine vertebrates are dominant elements (Sepkoski, 1981). Irregular echinoids, crustaceans, and bivalves are the most important bioturbators in marine settings, in addition to worms (Buatois et al., 2016b), illustrating the ichnologic equivalent of the MEF (Figs. 1 and DR1 [see footnote 1]). Heart urchins (spatangoids), known since the Early Jurassic, are the producers of the ichnogenera *Bichordites, Cardioichnus,* and *Scolicia* (Smith and Crimes, 1983; Plaziat and Mahmoudi, 1988), all typical bioturbators in post-Paleozoic seas. Crustacean burrows include ichnogenera that occurred for the first time during the Mesozoic (e.g., *Ophiomorpha, Psilonichnus, Sinusichnus, Spongeliomorpha*) and a few that are known since the Paleozoic but became more abundant as a result of the Mesozoic Marine Revolution (*Gyrolithes, Thalassinoides*) (Carmona et al., 2004). Other crustacean ichnotaxa occurred for the first time in the Neogene (*Parmaichnus, Lepeichnus*). The most common trace fossils produced by bivalves *(Protovirgularia, Lockeia*), although known since the early Paleozoic, became more abundant since the Mesozoic (Buatois et al., 2016b). *Siphonichnus* is common in the late Paleozoic, reflecting an evolutionary radiation of infaunal bivalves, but it is particularly abundant since the Triassic (Knaust, 2015). *Hillichnus*, attributed to the activities of tellinacean bivalves (Bromley et al., 2003), is a product of the Mesozoic Marine Revolution. Some of the trace fossils produced by worms (e.g., *Haentzschelinia, Lapispira, Patagonichnus, Phoebichnus*) are only known in post-Paleozoic marine strata, but the vast majority (e.g., *Cylindrichnus, Macaronichnus, Schaubcylindrichnus*) have been documented since the Paleozoic. However, some of these ichnogenera became much more common since the Mesozoic (Buatois et al., 2016b). The most significant bioeroders were sponges, gastropods, bivalves, echinoids, and worms. The sponge bioerosion ichnogenus *Entobia* is known since the Devonian (Tapanila, 2006), but it became abundant in the Mesozoic, when various ichnospecies originated. Significant bioerosion innovations are represented by *Radulichnus* (gastropods and chitons), *Teredolites* (pholadid bivalves), *Gnathichnus* (regular echinoids), and *Maeandropolydora* (spionid polychaetes) (Taylor and Wilson, 2003; Radley, 2010; Villegas-Martín et al., 2012).

Ichnodiversity in continental environments (Fig. 2, Table DR3 [see footnote 1]) is more difficult to evaluate due to the patchiness of the trace-fossil record (Minter et al., 2016a, 2016b, 2017). A 967% ichnodiversity increase characterizes the Silurian–Devonian transition, followed by a plateau until the Early Mississippian (Table DR3), although the latter most likely reflects the scarcity of Upper Devonian continental strata (Minter et al., 2016b). New rises in ichnodiversity took place during the Cisuralian (65%) and the Early Jurassic (22%) (Table DR3). Subsequent to this peak, ichnodiversity experienced a gradual and continuous increase. The earliest uncontroversial evidence of continental bioerosion is from the late Permian (Labandeira et al., 2017), but it is by the Late Triassic when rapid diversification took place (Tapanila and Roberts, 2012). The earliest record of bone bioerosion is from the Early Jurassic (Xing et al., 2015). An increase in ichnodiversity of continental bioerosion occurred in the Late Cretaceous (100%) followed by a plateau that continues until the Holocene (Fig. 2, Table DR3). Overall, the ichnodiversity increases that took place in continental environments by the end of the Mesozoic may reflect the appearance of sophisticated insect nesting structures in soils (Genise, 2016).

DISCUSSION: SIGNIFICANCE, CAVEATS, AND PROSPECTS

The concepts of Cambrian Explosion, Great Ordovician Biodiversification Event, and Mesozoic Marine Revolution are all based on body fossils. The fact that these evolutionary radiations are also reflected by the trace-fossil record provides independent support to the notion that these were truly macroevolutionary events, rather than taphonomic artifacts (Buatois and Mángano, 2016). Although some hard-bodied invertebrates (e.g., bivalves) produce trace fossils, most biogenic structures are made by soft-bodied organisms (sometimes collectively and informally referred to as worms, but in fact

encompassing a wide variety of clades) or poorly skeletonized invertebrates (e.g., thalassinidean crustaceans). The trace-fossil record provides information on animals that are typically underrepresented in the body-fossil record. Assessing the record of small and soft-bodied organisms making the majority of the biomass ("tackling the 99%" in Sperling's 2013 analogy) is of fundamental importance to reconstructing the history of life. Also, our results are consistent with the observation that each evolutionary fauna shows more ecologic complexity than the previous one, revealing an increased use of the ecospace (Bambach et al., 2007; Bush et al., 2007).

Diversification curves may adopt three different patterns, as illustrated by the straight (representing additive increase), exponential (implying doubling of diversity within fixed units of time if speciation and extinction rates remain constant), and logistic (comprising initial slow diversification followed by a rapid rise and a plateau) models (Benton, 2001). In turn, logistic models represent equilibrium models because they imply that global equilibria in diversity is attained, whereas exponential models are non-equilibrium models implying that a ceiling to diversity has not been reached or that there is no such ceiling (Benton, 2001). Diversification of marine invertebrates is apparently best described by a logistic model (Sepkoski, 1978, 1984), but diversification of continental biotas may have followed an exponential model (Benton, 1985, 2001; Labandeira and Sepkoski, 1993). However, in recent years it has been argued that fluctuating equilibrium diversities through time may produce a pattern of intervals of relative stability alternating with times of radiations, which is apparently similar to a coupled logistic model, but resulting from a different underlying evolutionary dynamics (Alroy, 2010; Foote, 2010; Bush et al., 2016).

According to the logistic model, marine evolutionary radiations display the pattern of early slow growth, subsequent rapid growth, and final slowing of growth reaching a plateau (Sepkoski, 1978, 1984). This is particularly illustrated by the Cambrian Explosion and the Great Ordovician Biodiversification Event, which displayed very rapid growths of diversity in their initial stages until reaching a plateau (Sepkoski, 1978, 1979). In contrast, diversity rose more slowly during the initial phase of the Mesozoic Marine Revolution and apparently has not reached a plateau yet (Sepkoski, 1981, 1984). The three-phase kinetic model developed by Sepkoski (1984) provided an analytical view of marine diversification with different global equilibria for each of the three evolutionary radiations (but see Kowalewski et al., 2006; Kiessling et al., 2008; Alroy et al., 2008; Alroy, 2010, 2014). Studies based on standardized curves indicated that late Cenozoic diversity is only slightly higher than the Paleozoic maximum (e.g., Alroy et al., 2008; Alroy, 2010, 2014). However, recent work shows a pattern that is more consistent with the original Sepkoski's curves, indicating Cenozoic diversity levels that doubled Paleozoic values (Bush and Bambach, 2015).

The curves for marine invertebrate trace fossils show a similar trajectory to that of body fossils (Sepkoski, 1997), providing empiric independent support to the three-phase kinetic (logistic) model (Sepkoski, 1984) and indicating similar diversity trajectories for animal diversity and their behaviors. The explosive Terraneuvian diversification in bioturbation was preceded by a slow increase during the terminal Ediacaran and followed by a plateau during the middle to late Cambrian, underscoring the logistic nature of the Cambrian Explosion. This diversification preceded the Cambrian Explosion as indicated by body fossils, which took place later in the early Cambrian (Mángano and Buatois, 2014). A similar case of logistic pattern of diversification can be made for the Great Ordovician Biodiversification Event with a rapid rise taking place through the Ordovician and a plateau lasting for roughly the remaining of the Paleozoic. In turn, the rapid rise in ichnodiversity of the Late Cretaceous was preceded by a more protracted increase that started during the recovery after the end-Permian mass extinction and was followed by a plateau until the present. This represents a departure from the diversity trajectory of post-Paleozoic faunas, which does not show any evidence of a plateau (Sepkoski, 1981, 1984).

Variable rates of increases in ichnodiversity are detected for continental bioturbation, with major radiations in the Ludlow–Early Devonian, Cisuralian, Early Jurassic, Late Cretaceous, Eocene, and Miocene (Fig. 2, Table DR3 [see footnote 1]). No plateau indicative of an equilibrium stage is apparent, suggesting that the invasion of the land is still an ongoing process (Miller and Labandeira, 2002). This is consistent with the non-equilibrium nature of models currently envisaged for diversification in continental environments based on body fossils (Benton, 2001). On the contrary, a plateau seems to have been reached by the end of the Mesozoic in the case of continental bioerosion. However, our knowledge of continental bioerosion lags considerably behind that of bioturbation, so available patterns should be taken with extreme caution.

Forty years of ichnologic research since the compilation by Dolf Seilacher prompt us to question if his reluctance to get involved in the consensus papers is still justified by the now available evidence. Our study shows that after the initial burst in ichnodiversity that took place during the Cambrian Explosion, subsequent diversification was most clearly manifested in the deep sea (83% increase between the end of the Cambrian and the end of the Ordovician and 58% between the Middle Jurassic and the Eocene) (Table DR3 [see footnote 1]). However, the increase was not restricted to the deep sea, but also took place in shallow water (42% increase between the end of the Cambrian and the end of the Ordovician and 26% through the whole Mesozoic) (Table DR3). Further ichnodiversity increases are apparent for bioerosion, which cannot be attributed to innovations in the deep sea (Fig. 2).

However, Seilacher's original compilations, showing constant ichnodiversity levels in shallow water and increased diversification in the deep sea, were not of global ichnodiversity, but of maximum alpha ichnodiversity. Therefore, these curves reflect richness at a community level rather than globally. Ongoing work is attempting to produce a database compiling alpha ichnodiversity for specific environments through the Phanerozoic in order to evaluate changes in within- and inter-habitat ichnodiversity. Previous work on deep-sea trace fossils by Uchman (2004) suggested a more nuanced scenario to that originally indicated by Seilacher (1974, 1977). Although an overall increase in maximum alpha ichnodiversity is apparent, this trend has been punctuated by several fluctuations, including significantly low levels from the Carboniferous to the Middle Jurassic (Uchman, 2004). Comparative analysis of brackish-water marginal-marine environments indicates that, even in these stressful settings, alpha ichnodiversity has increased through the Phanerozoic (Buatois et al., 2005).

The explosive development of analytical paleobiology demonstrates the need for standardizing trace-fossil data in the same fashion that has been done with body-fossil

data. Ongoing ichnologic work is showing the usefulness of this approach, which has produced robust trace-fossil data to compare the Cambrian Explosion and the Great Ordovician Biodiversification Event (Buatois et al., 2016a), and to reconstruct the Paleozoic invasion of the continents (Minter et al., 2017). In conclusion, ichnologic information has a lot to offer to the reconstruction of the history of life, representing an independent line of evidence that yields valuable insights to evaluate paleobiologic megatrends.

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CALL FOR NOMINATIONS

2019 GSA Awards & Medals

Penrose Medal

The Penrose Medal was established in 1927 by R.A.F. Penrose Jr. to be awarded in recognition of eminent research in pure geology, for outstanding original contributions, or for achievements that mark a major advance in the science of geology. This award is made only at the discretion of the GSA Council, and nominees may or may not be members of the Society. Penrose's sole objective was to encourage original work in purely scientific geology, which is interpreted as applying to all scientific disciplines represented by GSA. Scientific achievements should be considered rather than contributions in teaching, administration, or service. Mid-career scientists who have already made exceptional contributions should be given full consideration for the award.

Day Medal

The Arthur L. Day Medal was established in 1948 through a donation by Arthur L. Day, Founding Director of the Geophysical Laboratory of the Carnegie Institution of Washington. It is awarded annually, or less frequently at the discretion of the Council, to recognize outstanding distinction in the application of physics and chemistry to the solution of geologic problems, with no restriction to the particular field of geologic research. It was Dr. Day's wish to provide an award to recognize outstanding achievement in research and to inspire further effort, rather than to reward a distinguished career, and so it has been the longstanding practice of The Society to award this medal to geoscientists actively pursuing a research career.

Young Scientist Award (Donath Medal)

The Young Scientist Award was established in 1988 to be awarded to a young scientist (35 years or younger throughout the year in which the award is to be presented—*for 2019, only those candidates born on or after 1 Jan. 1984 are eligible*) for outstanding achievement in contributing to geologic knowledge through original research that marks a major advance in the earth sciences. The award consists of a gold medal (the Donath Medal) and an honorarium.

How to Nominate

To ensure thorough consideration by the respective committees, please follow these nomination instructions carefully; additional information supplied will not enhance the nomination. For each candidate please submit the following:

1. **Nomination form:** Please go to **www.geosociety.org/nominate** to submit the form online.

2. **Supporting documents**, to be submitted as e-mail attachments or via post; for Penrose, Day, and Donath, the following supporting documents are required:
   - Curriculum vitae
   - Summary (300 words or less) of the scientific contributions to geology that qualify the candidate for the award
   - Selected bibliography of no more than 20 titles (for the Donath medal, only 10 titles are required)
   - Letters of support from each of five GSA Fellows or members ***in addition*** to the person making the nomination. **For the Day Medal only:** letters from five scientists with at least three of those being from GSA Fellows or members and up to two from fellows or members of the Mineralogical Society of America, Geochemical Society, or American Geophysical Union.

The deadline for receipt of all GSA medal, award, and recognition nominations is 1 Feb. 2019.

CALL FOR NOMINATIONS

2019 GSA Awards & Medals

Florence Bascom Geologic Mapping Award

The Florence Bascom Geologic Mapping Award was approved by GSA Council in October 2013 and the first award was presented in 2015. This award acknowledges contributions in published high-quality geologic mapping that led the recipient to publish significant new scientific discoveries, to bring about greater understanding of fundamental geologic processes and concepts, and to contribute to the application of new knowledge to societal needs and opportunities in such areas as mineral resources, water resources, and the environment.

The recipient will have authored high-quality geologic maps, cross sections, and summary reports that have received scientific acclaim and are available to both peers and the public, through Federal or State agencies or major scientific societies. In evaluating the merits of nominees for this award, scientific achievements should be considered rather than contributions in teaching, administration, or service. Nominees may or may not be members of the Society, and they may be from any nation.

The selection criteria employed by the Geologic Mapping Award Committee are as follows: (A) Excellence of the nominee's published geologic maps. (B) Clear record of greater understanding of fundamental geologic processes and/or concepts, and high-quality publication of same, emerging directly from the meritorious quality of the geologic mapping. (C) Peer acclaim of the practical usefulness of the geologic mapping and the new discoveries that emerged from the mapping.

How to Nominate

1. **Nomination form:** Please go to **www.geosociety.org/nominate** to submit the form online.

2. **Supporting documents,** to be submitted as e-mail attachments or via post:
   - Curriculum vitae
   - Letter of nomination (300 words or less) addressing the evaluation criteria
   - Selected bibliography of geologic maps (20 titles or less)
   - Selected bibliography of peer-reviewed publications (20 titles or less)
   - PDFs or web-site links to several key geologic maps authored by the nominee
   - Letters of support from three (3) scientists with at least two (2) from GSA Fellows or members and one (1) from a member of another professional geoscience organization. Diverse supporters (i.e., including individuals who are not currently/recently associated with the nominee's institution) are strongly encouraged.

The Bromery Award for Minorities

The Bromery Award for Minorities should be given to any minority, preferably African Americans, who qualify under at least one of these two categories:

1. Nominee has made significant contributions to research in the geological sciences, as exemplified by one or more of the following:
   - Publications which have had a measurable impact on the geosciences
   - Outstanding original contributions or achievements that mark a major advance in the geosciences
   - Outstanding lifetime career which demonstrates leadership in geoscience research
2. Nominee has been instrumental in opening the geoscience field to other minorities, as exemplified by one or more of the following:
   - Demonstrable contributions in teaching or mentoring that have enhanced the professional growth of minority geoscientists
   - Outstanding lifetime career service in a role which has highlighted the contributions of minorities in advancing the geosciences
   - Authorship of educational materials of high scientific quality that have enjoyed widespread use and acclaim among educators or the general public.

How to Nominate

1. **Nomination form:** Please go to **www.geosociety.org/nominate** to submit the form online.

2. **Supporting documents,** to be submitted as e-mail attachments or via post:
   - Curriculum vitae
   - Letter of nomination (300 words or less)
   - Letters of support from three (3) scientists with at least two (2) from GSA Fellows or members and one (1) from a member of another professional geoscience organization
   - Optional selected bibliography of no more than 10 titles

The deadline for receipt of all GSA medal, award, and recognition nominations is 1 Feb. 2019.

CALL FOR NOMINATIONS

2019 GSA Awards & Medals

Doris M. Curtis Outstanding Woman in Science Award

The Doris M. Curtis Outstanding Woman in Science Award recognizes a woman who has had a major impact on the field of the geosciences based on her Ph.D. research. The generous support of the Doris M. Curtis Memorial Fund makes this award possible. GSA's 103rd president, Doris Curtis pioneered many new directions for geology, not the least of which was her tenure as GSA president after an unbroken chain of 102 men. Causes dear to her were women, public awareness, minorities, and education. Women are eligible for this award the first three years following their Ph.D. degree.

How to Nominate

1. **Nomination form:** Please go to **www.geosociety.org/nominate** to submit the form online.
2. **Supporting documents,** to be submitted as e-mail attachments or via post:
   - Curriculum vitae including dissertation title and abstract
   - Letter of nomination that clearly states how the Ph.D. research has impacted the geosciences in a major way
   - Letters of support from three (3) scientists with at least two (2) from GSA Fellows or members and one (1) from a member of another professional geoscience organization
   - Selected bibliography of no more than 10 titles

GSA Distinguished Service Award

GSA Council established the GSA Distinguished Service Award in 1988 to recognize individuals for their exceptional service to the Society. GSA members, Fellows, associates, and employees may be nominated for consideration, and any GSA member or employee may submit a nomination for the award. GSA's Executive Committee will select awardees, and GSA Council must ratify all selections. Awards may be made annually, or less frequently, at the discretion of Council.

How to Nominate

1. **Nomination form:** Please go to **www.geosociety.org/nominate** to submit the form online.
2. **Supporting documents,** to be submitted as e-mail attachments or via post:
   - Curriculum vitae
   - Letter of nomination (300 words or less)
   - Brief biographical sketch that clearly demonstrates the applicability of the selection criteria
   - Optional selected bibliography of no more than 10 titles

GSA Public Service Award

GSA Council established the GSA Public Service Award in 1998 in honor of Eugene and Carolyn Shoemaker. This annual award recognizes contributions that have materially enhanced the public's understanding of the earth sciences or have significantly served decision makers in the application of scientific and technical information to public affairs and earth science–related public policy. This may be accomplished by individual achievement in:

- Authorship of education materials of high scientific quality that have enjoyed widespread use and acclaim among educators or the general public
- Acclaimed presentations (books and other publications, mass and electronic media, or public presentations, including lectures) that have expanded public awareness of the earth sciences
- Authorship of technical publications that have significantly advanced scientific concepts or techniques applicable to the resolution of earth-resource or environmental issues of public concern; and/or
- Other individual accomplishments that have advanced the earth sciences in the public interest

The award will normally go to a GSA member of any nation, with exceptions approved by Council, and may be presented posthumously to a descendant of the awardee.

How to Nominate

1. **Nomination form:** Please go to **www.geosociety.org/nominate** to submit the form online.

2. **Supporting documents,** to be submitted as e-mail attachments or via post:
   - Curriculum vitae
   - Letter of nomination (300 words or less)
   - Brief biographical sketch that clearly demonstrates the applicability of the selection criteria
   - Selected bibliography of no more than 10 titles

The deadline for receipt of all GSA medal, award, and recognition nominations is 1 Feb. 2019

CALL FOR NOMINATIONS

2019 GSA Awards & Medals

Honorary Fellow

Established by the GSA Council in 1909, Honorary Fellowship may be bestowed on individuals who have made outstanding and internationally recognized contributions to geoscience, or in rare circumstances, provided notable service to the Society. In practice, nearly all candidates are non-North Americans who live and work outside of North America. The most noteworthy exceptions were astronauts. The awardee does not have to be a member of the Society to receive the award. No more than two Honorary Fellows will be awarded annually. Honorary Fellows will be recognized during the GSA Annual Meeting and will receive complimentary life-time membership to the Society.

How to Nominate

1. **Nomination form:** Please go to **www.geosociety.org/nominate** to submit the form online.
2. **Supporting documents,** to be submitted as e-mail attachments or via post:
   - Curriculum vitae
   - Letter of nomination (300 words or less) that clearly demonstrates the applicability of the selection criteria
   - Letters of support from three (3) scientists with at least two (2) from GSA Fellows and one (1) from a GSA Fellow or a person of equivalent international stature
   - Selected bibliography of no more than 20 titles

GSA Fellowship

Fellowship is an honor that is bestowed on the best of our profession once per year at the spring GSA Council meeting and is recognized at GSA's Annual Meeting. GSA members are elected to Fellowship in recognition of distinguished contributions to the geosciences. A member can be nominated for Fellowship only by a Fellow of the Society who initiates the process by completing the nominating sponsor's form and identifying two other Fellows, or one Fellow and one member, who agree to support the nomination. A GSA Fellow may only support two nominees per election cycle and only one as a primary nominator.

How to Nominate

The primary nominator:

1. Completes online nomination form at **www.geosociety.org/FellowNoms;**
2. Writes a letter of support;
3. Collects two (2) additional letters of support (one must be from a Fellow; both must be GSA members);
4. Obtains nominees current CV or résumé; and
5. Submits all documents in one packet to **awards@geosociety.org.**

Award Notes

Candidates whose names are submitted by the respective award committees to GSA Council but who do not receive an award will remain under consideration by those committees for three years. For those still under consideration, it is recommended that an updated nomination letter be sent to GSA, P.O. Box 9140, 3300 Penrose Place, Boulder, CO 80301-9140, USA, +1-303-357-1028, **awards@geosociety.org.**

All nomination forms and submission instructions can be found online at **www.geosociety.org/awards/.** Nomination forms and instructions may also be obtained from: GSA Grants and Awards, P.O. Box 9140, 3300 Penrose Place, Boulder, CO 80301-9140, +1-303-357-1028, **awards@geosociety.org**

The deadline for receipt of all GSA medal, award, and recognition nominations is 1 Feb. 2019

CALL FOR NOMINATIONS

2019 GSA Awards & Medals

John C. Frye Environmental Geology Award

Deadline: 31 March 2019

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

Anyone can nominate a paper as long as it is selected from a GSA or state geological survey publication and published during the preceding three full calendar years. The nomination letter must include a paragraph stating the importance of the paper. Up to three (3) letters from users of the publication can be included to support the nomination.

Each nominated paper will be judged on its uniqueness or significance as a model of its type of work and its overall worthiness for the award. The paper must (1) establish an environmental problem or need; (2) provide substantive information on the basic geology or geologic process pertinent to the problem; (3) relate the geology to the problem or need; (4) suggest solutions or provide appropriate land-use recommendations based on the geology; (5) present the information in a manner that is understandable and directly usable by geologists; and (6) address the environmental need or resolve the problem. It is preferred that the paper be directly applicable to informed laypersons (e.g., planners, engineers).

Please send your nominations to GSA Grants and Awards, P.O. Box 9140, Boulder, CO 80301-9140, USA. For more information, go to **www.stategeologists.org/awards_honors.php.**

CALL FOR NOMINATIONS

2019 AGI Awards

AGI Medal in Memory of Ian Campbell

The AGI Medal in Memory of Ian Campbell recognizes singular performance in and contribution to the profession of geology. Candidates are measured against the distinguished career of Ian Campbell, whose service to the profession touched virtually every facet of the geosciences. Campbell was a most uncommon man of remarkable accomplishment and widespread influence, and in his career as a geologist, educator, administrator, and public servant, he was noted for his candor and integrity. To submit a nomination, go to **www.americangeosciences.org/awards. Deadline 1 Feb. 2019**

AGI Marcus Milling Legendary Geoscientist Medal

The 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. To submit a nomination, go to **www.americangeosciences.org/awards/legendarygeoscientist. Deadline 1 Feb. 2019**

GSA 2018 Schedule at-a-Glance

Saturday, 3 Nov.

1. Short Courses: 8 a.m.–5 p.m. (some begin on Friday)
2. Pre-Meeting Field Trips (some begin earlier)
3. Various Business Meetings of GSA, GSA Divisions, and Associated Societies
4. INDY ICEBREAKER: 5–7 p.m.

Sunday, 4 Nov. (Daylight Saving Time Ends)

1. Oral Technical Sessions: 8 a.m.–noon
2. GeoCareers Day: 8 a.m.–1 p.m.
3. Poster Sessions: 9 a.m.–5:30 p.m.
4. Lunch Break: noon–1:30 p.m.
5. GSA Presidential Address & Awards Ceremony: noon–1:30 p.m.
6. Oral Technical Sessions: 1:30–5:30 p.m.
7. Exhibits Open: 2–7 p.m.
8. Exhibits Opening Reception: 5:30–7 p.m.

Monday, 5 Nov.

1. Oral Technical Sessions: 8 a.m.–noon
2. Poster Sessions: 9 a.m.–6:30 p.m.
3. Exhibits: 10 a.m.–6:30 p.m.
4. Lunch Break: noon–1:30 p.m.
5. Feed Your Brain: 12:15–1:15 p.m. (*Lunchtime Enlightenment*; buy your food and take it in)
6. Oral Technical Sessions: 1:30–5:30 p.m.
7. Libations & Collaborations—Posters & Conversations: 4:30–6:30 p.m.
8. Alumni Receptions: Evening hours

Tuesday, 6 Nov. (U.S. Mid-Term Election Day)

1. Oral Technical Sessions: 8 a.m.–noon
2. Poster Sessions: 9 a.m.–6:30 p.m.
3. Exhibits: 10 a.m.–6:30 p.m.
4. Lunch Break: noon–1:30 p.m.
5. Feed Your Brain: 12:15–1:15 p.m. (*Lunchtime Enlightenment*; buy your food and take it in)
6. Oral Technical Sessions: 1:30–5:30 p.m.
7. Libations & Collaborations—Posters & Conversations: 4:30–6:30 p.m.

Wednesday, 7 Nov.

1. Oral Technical Sessions: 8 a.m.–noon
2. Poster Sessions: 9 a.m.–6:30 p.m.
3. Exhibits: 10 a.m.–2 p.m.
4. Lunch Break: noon–1:30 p.m.
5. Feed Your Brain: 12:15–1:15 p.m. (*Lunchtime Enlightenment*; buy your food and take it in)
6. Oral Technical Sessions: 1:30–5:30 p.m.
7. Libations & Collaborations—Posters & Conversations: 4:30–6:30 p.m.

Thursday, 8 Nov.

1. Post-Meeting Field Trips

GSA 2018

4–7 November

Indianapolis, Indiana, USA

GSA 2018 Registration and Information

You still have time to register for GSA 2018!

Space is available on some tours, ticketed events, scientific field trips, and short courses. You can register online at **community.geosociety.org/gsa2018/registration** throughout the meeting, or visit the onsite registration desk in the Indiana Convention Center (ICC).

BADGES must be worn and be visible at all times while you are in the ICC. Badges will be available at the registration desk starting at 7 a.m. on Sat., 3 Nov. Staff at the registration desk can also reprint your lost or misplaced badge. Badge ribbons will be available at the GSA Information Desk in the ICC during onsite registration hours. Eligible attendees should inquire there.

REGISTRATION FEES

	Standard/Onsite Registration
Prof Member—Full Meeting	US$499
Prof Member—1 Day	US$295
Prof Member—>70 Full Meeting	US$380
Prof Member—>70 1 Day	US$220
Prof Non-Member—Full Meeting	US$690
Prof Non-Member—1 Day	US$435
Early Career Professional—Full	US$340
Early Career Professional—1 Day	US$199
Student Member—Full Meeting	US$170
Student Member—1 Day	US$105
Student Non-Member—Full Meeting	US$225
Student Non-Member—1 Day	US$145
High School Student	US$50
K–12 Professional—Full Meeting	US$70
Field Trip or Short Course Only	US$40
Guest or Spouse	US$99
Low Income Country**	50%

Participants from countries classified as "Low or Lower Middle Income Economies" by the World Bank need only pay 50% of the category fee for full meeting or one day registration. Online registration is not available for "Low or Lower Middle Income Economy" attendees. Please come to the onsite registration desk to register. **Important: Fees for onsite registration will be collected in U.S. dollars.

GSA Section Travel Grants

Recipients of GSA Student Travel Grants will need to check in at the GSA Annual Meeting Office, ICC, Room 209, show identification, verify their address, and sign the check-in sheet to receive their check. Checks will be mailed to the recipient following the Annual Meeting. If you do not check in, you will not receive your grant.

Ticketed Events

Several GSA Divisions and Associated Societies hold ticketed events for breakfast, lunch, dinner, or reception awards presentations. Ticketed events are open to everyone; learn more at **community.geosociety.org/gsa2018/social-business/events/ticketed.** We recommend you **purchase your tickets in advance** for these events. If you have already registered for the meeting and would like to add a ticketed event, please contact GSA Sales & Service at +1-888-443-4472. A minimal number of tickets will be available onsite in the registration area up to 48 hours prior to the event.

Hotels

VisitIndy, GSA's official housing bureau, will continue to assist you with hotel reservations through 24 Oct. (group rates are not guaranteed after 10 Oct.). If rooms are not available at the hotels in the GSA block, VisitIndy will provide you with a list of hotels in the area that have availability. Learn more at **community.geosociety.org/gsa2018/attendeeinfo/accommodations/reservations.**

Critical Housing Dates

24 Oct.: All changes, cancellations, and name substitutions must be finalized through VisitIndy Housing Bureau by this date.

25 Oct.: Beginning on this date, you must contact the hotel directly for all changes, cancellations, and new reservations.

Before You Arrive in Indianapolis

Review the arrival/departure dates on your hotel acknowledgement for accuracy. If you do not show up on the date of your scheduled arrival, the hotel will release your room AND you will be charged for one night's room and tax. If you have travel delays and cannot arrive on your scheduled arrival date, contact the hotel directly to make them aware of your new arrival date.

Child Care

KiddieCorp is providing childcare services for GSA attendees Sat.–Wed., 7 a.m.–6 p.m. The program is open to children six months to 12 years old and the cost is only US$9 per hour, per child (one-hour minimum). KiddieCorp must receive their registration form and payment in full to hold any advance reservations. You are also welcome to try to register on-site; however, there is no guarantee and it is not recommended. Learn more at **community.geosociety.org/gsa2018/attendeeinfo/needs/family.**

DOWNTOWN INDIANAPOLIS HOTELS & ATTRACTIONS

GEOLOGICAL SOCIETY OF AMERICA | NOVEMBER 4-7, 2018

For information about things to see and do in Indianapolis, go to VisitIndy.com

Thank You Sponsors

Your support of the Geological Society of America's Annual Meeting & Exposition continues a longstanding tradition of serving science and the profession. The Society appreciates your investment in the growth of current and future leaders in the geoscience community. The following list is as of **30 Aug. 2018.**

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Apply Today!

You're invited to an open house, or an upcoming webinar, at the Museum. Complete details are available at **amnh.org/mat**

With deepest appreciation, the Museum acknowledges Kathryn W. Davis for her generous founding support of the Master of Arts in Science Teaching (MAT) Program.

Leadership support for the MAT program is provided by The Shelby Cullom Davis Charitable Fund.

The MAT program is supported in part by the National Science Foundation under Grant Number DUE-1340006 and the U.S. Department of Education under Grant Number U336S140026.

amnh.org/mat mat@amnh.org | 212-313-7464 | @amnh | facebook.com/amnhmat

Special Presentation

Making Guided Earth Science Field Trips Accessible and Affordable Using Virtual Reality: A Virtual Walking Tour of the Indiana University Bloomington Campus Limestone Architecture

▶ Mon., 5 Nov., 2018 4:30–5:30 p.m., Indiana Convention Center, Halls JK

Brian Keith and **Chauncey Frend**

The middle Mississippian Salem Limestone, commonly known as "Indiana limestone," is a popular building stone used in prominent buildings across the United States, including the Empire State Building, the Pentagon, the National Cathedral, and several memorials on the National Mall in Washington, D.C. Quarried exclusively from a 30-mile-long band of Salem Limestone in the south-central Indiana Stone Belt, this small exposure has supplied up to 75% of all limestone used in North American buildings. Its uniform composition, thick bedding, and soft texture has allowed architects and carvers to create intricate ornamental designs and carvings for almost two centuries.

Indiana University Bloomington is in the heart of the Stone Belt and boasts limestone buildings in a variety of architectural styles, garnering a reputation as one of the most beautiful college campuses in the country. See these grand structures for yourself in a new guided tour using virtual reality. This tour showcases both technology and geology and provides a template for generating broad public interest in natural history and geologic processes by using immersive technology to deliver interactive and dynamic content. Brian Keith, Indiana Geological and Water Survey, Indiana University, Bloomington, Indiana, USA, is a carbonate sedimentologist and creator of the campus limestone walking tours. Chauncey Frend, Advanced Visualization Laboratory, Indiana University, Indianapolis, Indiana, USA, specializes in immersive content delivery that appeals to learners of all ages and types.

Learn more about how to use virtual reality to provide an inexpensive overview of far-flung places and concepts in a repeatable workflow designed to promote student engagement and learning. Virtual field trips are, of course, never a replacement for field experiences but are increasingly useful for attracting new generations of students that may not be familiar with the geosciences. Virtual reality can serve as a novel recruitment tool for educators, administrators, parents, and students.

Stop by the Indiana Geological & Water Survey/Indiana University booth (702) in Exhibit Hall I to experience a new "Maker Space." Information on creating your own virtual reality field trips will be available.

Lunchtime Enlightenment

Lava Flows, Summit Collapse, Earthquakes, Vog: Science and Crisis Response at Kīlauea Volcano, Hawai'i

▶ Wed., 7 Nov., 12:15–1:15 p.m., Indiana Convention Center

Christina Neal on behalf of the staff of the U.S. Geological Survey/Hawaiian Volcano Observatory and many U.S. Geological Survey and collaborating responding scientists.

Decades of eruptive activity at Hawai'i's Kīlauea Volcano took a dramatic turn in late April 2018 with a new lava outbreak in the lower East Rift Zone, a significant increase in volcanic air pollution or vog, and onset of ash emission, caldera subsidence, and steady, damaging seismicity at the summit. Events demanded a combined scientific and emergency volcanic eruption response perhaps unrivaled in the United States since the Mount St. Helens reawakening in 1980. The USGS Hawaiian Volcano Observatory (HVO) and partners at the University of Hawai'i and other USGS volcano observatories soon became part of a multi-agency, local-state-federal incident command created to manage the response. As of mid-July, more than 700 structures have been destroyed by lava and ground cracks, high levels of sulfur dioxide as emission have plagued residential areas downwind, and recurring moderate earthquakes in the Kīlauea summit region have shuttered Hawaii Volcanoes National Park and severely impacted local residents. This extraordinary combination of events at Kīlauea poses significant challenges to HVO, emergency authorities, and island residents who must learn to cope with high degrees of uncertainty as well as impacts from ongoing hazards. As the event enters its fifth month, attention has turned somewhat to key research questions and the eventual recovery phase, including discussion of long term hazard assessments and land use planning.

Christina (Tina) Neal began her USGS career at the Hawaiian Volcano Observatory in 1983, arriving just four episodes into the


Christina Neal

Pu'u 'Ō'ō eruption, where she joined the HVO team tracking activity. She transitioned to the Geologic Map of the Island of Hawai'i project in 1984 and prepared updated geologic maps of Kīlauea's summit and southwest rift zone. In 1990, Tina joined the new Alaska Volcano Observatory (AVO), where she conducted geologic mapping and studies of eruptions and unrest at more than a dozen Aleutian volcanoes. From 2005–2015, she led USGS/AVO's cooperative work with Russian volcanology counterparts at observatories in the Russian Far East. She is an expert on volcanic ash and aviation safety and interagency coordination during volcanic eruption response. From 1998–2000, she served as the first geoscience advisor to the Office of U.S. Foreign Disaster Assistance. In 2004, she spent two months as a science fellow at the U.S. Embassy in Quito, Ecuador, working on volcano hazard mitigation. At HVO, her focus in the first three years of her tenure as scientist in charge has been on staff development, support, and preparing for unrest and eruption at Mauna Loa Volcano.

James F. Reilly, U.S. Geological Survey director, will be our Tuesday Feed Your Brain lecturer; look for more information on the website as the meeting approaches.

GSA 2018 Late-Breaking Session

Kīlauea 2018:
Geoscience and Communication During a High-Profile Natural Event

Mon., 5 Nov., Indiana Convention Center, Sagamore Ballroom 5, 8 a.m.–noon

Conveners: Ken H. Rubin, **krubin@hawaii.edu,** University of Hawai'i at Mānoa; Aaron J. Pietruszka, **apietruszka@usgs.gov,** U.S. Geological Survey, Geology, Geophysics, and Geochemistry Science Center.

Sponsors: *GSA Geophysics and Geodynamics Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Structural Geology and Tectonics Division; Mineralogical Society of America; GSA Geology and Society Division.*

Fissure 8 and the resulting flow from the East Rift Zone eruption taken on 25 June by Ben Gaddis, USGS.

GSA welcomes the new cohort of 72 On To the Future (OTF) award recipients. The following events are open to OTF students and mentors:

Showcasing the Best You: A Writing Workshop to Help You Gain Internships, Fellowships, and Jobs, Sat. 3 Nov., 8:30–5:30 p.m., ICC, Mentoring Center, Rooms 206-207

OTF Group Photo, Sun., 4 Nov., 6:15 p.m., ICC, Exhibits Hall, GSA Foundation

OTF Gatherings, Mon.–Wed., 5–7 Nov., 7:30 a.m., ICC, Mentoring Center, Rooms 206-207

Diversity in the Geoscience and OTF Alumni Reception, Tues., 6 Nov., 5:30 p.m., ICC, Room 211

Diversity and Inclusion Events

Short Course 521. Unconscious Bias and Active Bystander Intervention Training to Promote Positive Work Climates. Sat., 3 Nov., 8 a.m.-noon. US $10. Location TBD.

Pardee Keynote Symposium: Women Rising: Removing Barriers and Achieving Parity in the Geosciences
Mon., 5 Nov., 1:30–5:30 p.m., ICC, Sagamore Ballroom 5

Women in Geology Career Pathways Reception
Sun., 4 Nov., 5:30–7 p.m., ICC, Mentoring Center, Room 206-207

GSA RISE: Harassment Resistance and Active Bystander Intervention
Tues., 6 Nov., 9–11 a.m., ICC, Room 206-207

Diversity in the Geosciences and On To the Future Alumni Reception
Tues., 6 Nov., 5:30–7 p.m., ICC, Room 211

All are welcome to this reception to share ideas and celebrate diversity with the geoscience community. The 2018 On To the Future awardees and Minority Scholarship recipients will be recognized with a special keynote from the 2018 Bromery Awardee. Appetizers and a cash bar provided.

LBGTQ Social
Tues., 6 Nov., 7:30–11 p.m., Yard House

GSA RISE

Respectful Inclusive Scientific Events

Harassment Resistance and Bystander Intervention

Tues., 6 Nov., 9–11 a.m., Indiana Convention Center, Mentoring Center, Room 206-207

Learn how to address unwelcome behavior whether you are the target of, or a witness to, bullying and harassment. You'll practice how to set and hold a clear boundary and how to communicate clearly when a behavior is unwanted, as well as learn options for responding to harassment in different settings and circumstances. Come ready to participate—there will be lots of interactive practice and discussion in this lively session.

No registration required. All are welcome—join the discussion.

GSA Meetings RISE to The Top

GSA supports **Respectful Inclusive Scientific Events** and is committed to ensuring a safe and welcoming environment for all participants. By registering for the meeting, you are agreeing to abide by the events code of conduct (**www.geosociety.org/conductcode**) in all venues at our meetings, including ancillary events, field trips, and official and unofficial social gatherings.

Notice of GSA Council Meetings

GSA Headquarters Hotel

- **Day 1:** Saturday, 3 Nov., 8 a.m.–noon, White River Ballroom, Section G
- **Day 2:** Wednesday, 7 Nov., 8 a.m.–noon, Room 101-102

GSA Headquarters Hotel: JW Marriott
10 S. West Street, Indianapolis, Indiana 46204, USA

All GSA members are invited to attend the open portions of these meetings.

THE GEOLOGICAL SOCIETY OF AMERICA®

The Geological Society of America®

GEOCAREERS

Career Development Events for Students and Early Career Professionals

Geocareers Day

Sunday, 4 November, 8 a.m. – 1 p.m.,
All GeoCareers Day events held in Indiana Convention Center (ICC), Sagamore Ballroom 4

All-inclusive Fee: $25, registration strongly suggested and space is limited. This event is targeted towards undergraduate students but all students and early career professionals are welcome.

8 – 9 a.m. **Geoscience Career Workshop**
Before you jump into the job search process, gain an understanding of the current geoscience workforce data, including salary, employment trends, and projections. Presenters will also review the fundamentals of crafting a winning résumé and how to best utilize the USAJOBS database for applications for federal employment.

9 – 11 a.m. **Company and Agency Information Session**
Agency and company booths will be set up to answer your career questions. Learn about each unique work culture and types of internships and careers available.

10 – 11:30 a.m. **Career Mentor Roundtables**
Mentors from non-profit, industry, government, and academia will answer your career questions at table stations around the room.

12 – 1 p.m. **Career Pathways Panel**
Representatives from government and industry sectors will answer questions and offer advice in preparation for a career in these fields. Lunch provided.

The following GeoCareers Day events may be attended separately:
Career Workshop: $10 fee if attending separately. Registration strongly suggested. Contact GSA Sales & Service, +1-800-443-4472.

Career Pathways Panel: Free. Lunch is included but limited to first come, first served. All-day participants receive priority.

NETWORKING AND PANEL EVENTS

Women in Geology Career Pathways Reception

Sunday, 4 November, 5:30–7 p.m.
ICC, Mentoring Center, Rooms 206-207
This informal gathering begins with remarks from a few key women speakers who will address issues faced by women in geology. A networking session follows, providing time for sharing ideas and getting to know other women geoscientists. No registration required.

Early Career Professionals Coffee
Monday, 5 November, 9:00–10:00 a.m., ICC, Mentoring Center, Rooms 206-207

This informal gathering will include remarks from representatives of several non-profits who have activities of interest to early career professionals. There will be time for networking and sharing ideas on how these organizations can best serve you. No registration required.

Networking Reception, Monday, 5 November, 11:30 a.m.–1 p.m., ICC, Mentoring Center, Rooms 206-207

This reception provides students and early career professionals with an exciting opportunity to network with more than 40 geoscience professionals. The mentors will answer questions, offer advice about career plans, and comment on job opportunities within their fields.

The Paleontological Society Mentors in Paleontology Careers Luncheon

Monday, 5 November, noon–1 p.m., Weber Grill Restaurant
This student luncheon features a panel of mentors representing a variety of colleges, universities, museums, and government agencies.

Women Rising Post-Pardee Professional Networking Mixer
Monday, 5 November, 5:30–7 p.m., ICC, Room 204

An informal social to extend the discussions and connections from the Pardee Session *Women Rising: Removing Barriers and Achieving Parity in the Geosciences.* Professionals, students, department chairs and program managers working to be inclusive of all talent are encouraged to attend.

Hydrogeology Division Careers and Networking Event,
Tuesday, 6 November, 2:30–4:30 p.m., ICC, Sagamore Ballroom 4
In a relaxed and welcoming atmosphere, this gathering will begin with remarks from hydrogeologists in a variety of career fields, including government, industry, and academia. A roundtable mentoring session follows, providing time for individuals to network, share ideas, ask questions, and discuss careers in hydrogeology.

The Geological Society of America®

GEOCAREERS

MORE WORKSHOPS

Social Media for Scientists Workshop – Lecture, Sunday, 4 November, 2-3 p.m., ICC, Mentoring Center, Rooms 206-207
This workshop is open to all and free of charge, but advanced registration is preferred. Select event(s) 603A and/or 603B in the GeoCareers section of the Events page, or contact GSA Sales & Service to add to your existing registration, +1.888.443.4472.
Want to learn more about using social media to communicate your science? We will discuss the current social media landscape as well as best practices, tips, guidelines, and inspirations for multiple social media platforms. We'll also talk about how you can utilize social media to build public trust in science and scientists. Designed for scientists, ideal for beginners, but helpful for everyone!

Social Media for Scientists Workshop – Lab, Sunday, 4 November, 3-4 p.m., ICC, Mentoring Center, Rooms 206-207
This workshop is open to all and free of charge, but advanced registration is preferred. Select event(s) 603A and/or 603B in the GeoCareers section of the Events page, or contact GSA Sales & Service to add to your existing registration, +1.888.443.4472. Participate in breakout sessions with experts on specific social media platforms including Reddit, LinkedIn, Twitter, Facebook and Instagram. Learn how to use or improve your game on these different platforms to communicate science with different demographics using different types of media. All levels welcome; attendance in the lecture portion not required.

Career Short Courses

Saturday, 3 November **(https://community.geosociety.org/gsa2018/science-careers/courses)**

- Short Course 521: 8 a.m.-noon. Unconscious Bias and Active Bystander Intervention Training to Promote Positive Work Climates
- Short Course 525: 2-4 p.m. Ready to Engage: Selling Yourself at GSA 2018 and Beyond, for Students

EMPLOYMENT ASSISTANCE

Résumé Clinic

Monday and Tuesday, 5-6 November, 9 a.m.–5 p.m., Mentoring Center, ICC, Rooms 206-207
Stop by the Resume Clinic for a private consultation with a geoscience professional to review your résumé and discuss strategies to better market yourself to potential employers. Please bring a copy of current résumé. First come, first served basis. Space is limited.

Geoscience Job Board

Stop by the Mentoring Center in the convention center to post or browse jobs, internships, or other opportunities. Also, check the online Geoscience Job Board (www.geosociety.org/jobs) for employment, fellowship, and student opportunities.

Visit community.geosociety/gsa2018/workshops for details.

The Geological Society of America®

GEOCAREERS

Mentoring Activities at the Meeting

Indiana Convention Center, Mentoring Center, Rooms 206-207

GSA has a tradition of offering a variety of mentoring opportunities at the meeting, whether you are a student, early career professional, professional, or retiree. Consider being a mentor or a mentee at the upcoming Annual Meeting.

Short-term Mentoring Options

Mentor groups of students and early career professionals at specific events. These require at least a one-hour commitment from mentors.

- Drop-In Mentorship. Work with one student or early career professional on a first come, first served basis to provide academic and career pathway advice.
- GeoCareers Table Mentor. Attend a portion of the GeoCareers Day events which focus on careers in the industry and government sectors. Help students answer questions in a small group format.
- Networking Reception Mentor. Address questions posed by students and early career professionals, offer advice about career plans, and comment on job opportunities within your geology employment sector.
- Resume Mentor. Review student resumes, and provide advice and guidance on building a winning resume.
- Women in Geology Mentor. Mentor students and early career professionals as they navigate key topics women face in the geosciences.

Learn more and sign up for one or more of these one-on-one and/or short-term mentoring activities (bit.ly/2GlBenV).

GSA Mentoring Center

Stop by the new Mentoring Center in the Indiana Convention Center, Rooms 206-207, which will be open Monday - Tuesday, 9 a.m.-5 p.m., and Wednesday, 9 a.m.-3 p.m. Check the Mentoring Center schedule on-site to participate in the following events and activities:

- Post or view jobs – Bulletin boards will be available to post jobs, internships, and opportunities for students and early career professionals.
- Résumé Review Clinic – If your resume needs a good review, bring it with you and have a professional look it over.
- Career workshops – A variety of topics including successfully applying to GSA student opportunities, applying to graduate school, and exploring a variety of geology careers will be just some of the presentations offered.
- Drop-in mentoring – If you have questions that you would like answered one-on-one, stop by and receive mentoring advice from a variety of geology professionals.
- Networking events – GSA's popular Networking Reception, Early Career Coffee, and Women in Geology Programs will all be held in this space.
- Exhibitor presentations – Exhibitors will answer questions on employment with their company and the day to day of their careers.

GSA 2018

4–7 November

Indianapolis, Indiana, USA

Learn and explore a new topic.

Don't forget to sign up for a GSA Short Course!

- Go to **community.geosociety.org/gsa2018/attendeeinfo/registration** to sign up. If you've already registered and want to add a course, please contact GSA Sales & Service, +1-888-443-4472.
- For full course descriptions, go to **community.geosociety.org/gsa2018/science-careers/courses.**
- Earn continuing education credits (CEUs): All courses offer CEUs, and most are at low or no cost.

Short Course questions?

Contact Jennifer Nocerino, **jnocerino@geosociety.org**.

The Best of AAPG at GSA 2018

Oil & gas related presentations by the following authors are happening during GSA's Annual Meeting! Come to sessions T33: Geologic Energy Research, and T34: Unconventional Energy Resources, on Tuesday, to hear these peer-judged talks selected as the best from AAPG:

Geologic Energy Research (T33)

ANASTASIO, David, Lehigh University

DURCANIN, Michael A., Sierra Oil and Gas

GOSWAMI, Antara, ION Geoventures

MOHAPATRA, Gopal, Hess Corporation

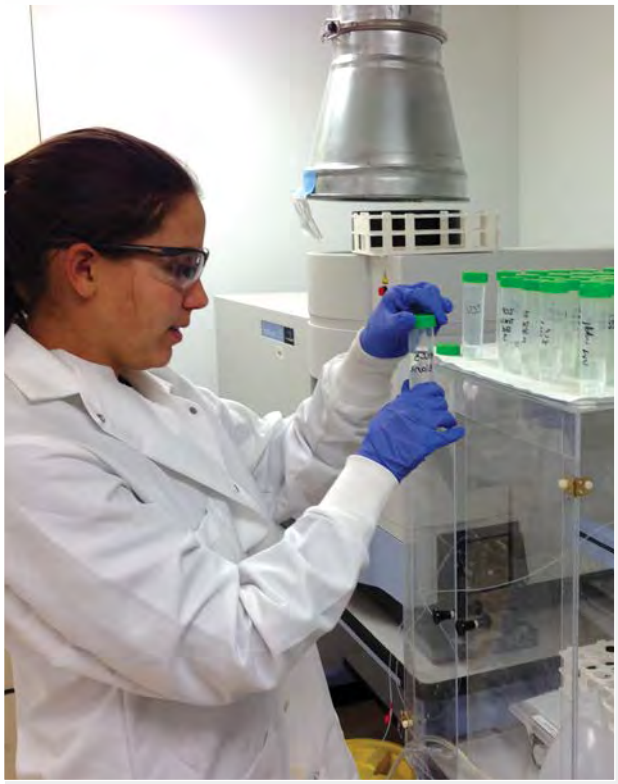
SHUMAKER, Niven, Noble Energy

Unconventional Energy Resources (T34)

GONG, Changrui, Imperial College London

GRAMMER, G. Michael, Oklahoma State University

GSA Junior Geologist Program



Advancing geoscience research and discovery one junior geologist at a time!

The Geological Society of America welcomes geologists of all ages to the 2018 Annual Meeting & Exposition. The Junior Geologist program will focus on bringing a little bit of geology to the novice geologists. Activity books can be picked up at registration or the GSA Headquarters booth in the Exhibit Hall. This fun packet will bring introductory geology to your mini rock star and keep them engaged at the Annual Meeting. Participants will receive a certificate and Junior Geologist Badge. Reminder: All children under the age of 18 should be accompanied by a parent or guardian at all times unless in the care of KiddieCorp childcare services.

THE GEOLOGICAL SOCIETY OF AMERICA®

Call For Field Trip, Short Course, and Technical Session Proposals

It's already time to plan for our 2019 Annual Meeting in Phoenix, Arizona, USA. Help ensure that your area of research and expertise is represented at next year's annual meeting. Any individual or geoscience organization is welcome to submit proposals. The proposal form is online at **www.geosociety.org/amnext**.

Show the geology by leading a Scientific Field Trip.

Field Trip proposal deadline: 3 Dec. 2018

Trips can be anywhere from a half day to five days long. Field trip proposals may be submitted by any member of GSA, its affiliated societies, or anyone else.

Exchange the geology by organizing and chairing a Technical Session.

Technical Session deadline: 1 Feb. 2019

Proposals are being taken for both Pardee Keynote and Topical Sessions.

Share the geology as an instructor through a Short Course.

Short Course proposal deadline: 1 Feb. 2019

Courses run the Friday and Saturday before the Annual Meeting and are typically a half day to two full days.

THE GEOLOGICAL SOCIETY OF AMERICA®

www.geosociety.org/meetings/

In Memoriam

The Society notes with regret the deaths of the following members (notifications received between 1 May 2018 and 31 July 2018).

Kenneth R. Aalto
Trinidad, California
Date of death: 15 June 2018

Arthur B. Arnold
Rio Rancho, New Mexico
Date of death: 1 February 2018

Wolfgang H. Berger
La Jolla, California
Notified: 19 July 2018

Gordon A. Clopine
Beaumont, California
Date of death: 17 May 2018

Frank B. Couch, Jr.
Arrington, Tennessee
Date of death: 31 January 2017

Declan G. De Paor
Galilea, Spain
Date of death: 31 May 2018

George M. Essington
Kenner, Louisiana
Date of death: 27 April 2018

Robert L. Folk
Austin, Texas
Date of death: 14 June 2018

Nicholas Hood
Auburn, Alabama
Date of death: 30 June 2018

Benjamin F. Howell, Jr.
State College, Pennsylvania
Date of death: 12 May 2018

Frank H. Kilmer
Florence, Oregon
Date of death: 12 April 2018

Joanne Kluessendorf
Menasha, Wisconsin
Date of death: 1 June 2018

Daniel N. Leavell
Granville, Ohio
Notified: 1 June 2018

Victoria E. Mitchell
Moscow, Idaho
Date of death: 13 April 2017

Michael W. Morgans
Helston, Cornwall,
United Kingdom
Date of death: 1 January 2018

Siegfried Muessig
Pomona, California
Notified: 12 July 2018

Raymond C. Murray
Missoula, Montana
Date of death: 8 April 2018

A. Thomas Ovenshine
Palo Alto, California
Date of death 2 June 2018

Tom L. Phillips
Urbana, Illinois
Date of death: 12 July 2018

Robert J. Pruett
Milledgeville, Georgia
Date of death: 25 July 2017

Rebecca A. Rhodes
Belleville, New York
Date of death: 17 June 2018

A. F. Spilhaus, Jr.
Potomac, Maryland
Date of death: 30 April 2018

Richard R. Thompson
Bethlehem, Pennsylvania
Date of death: 1 February 2018

Karen Wiese
Alliance, Ohio
Notified: 25 May 2018

2019 GSA Section Meetings

Northeastern

17–19 March
Portland, Maine, USA
Meeting Chair: Steve Pollock, spollock@maine.rr.com
www.geosociety.org/ne-mtg

Joint South-Central/North-Central/ Rocky Mountain

25–27 March
Manhattan, Kansas, USA
Meeting Chairs: Matthew Kirk, matthew.f.kirk@gmail.com; Tina Niemi, niemit@umkc.edu; Shannon Mahan, smahan@usgs.gov
www.geosociety.org/sc-mtg

Southeastern

28–29 March
Charleston, South Carolina, USA
Meeting Chairs: Scott Harris, HarrisS@cofc.edu; Katie Luciano, LucianoK@dnr.sc.gov
www.geosociety.org/se-mtg

Cordilleran

15–17 May
Portland, Oregon, USA
Meeting Chairs: Martin Streck, streckm@pdx.edu; Jim O'Connor, oconnor@usgs.gov
www.geosociety.org/cd-mtg

Northeastern image: Portland waterfront, Portland, Maine, USA. Photo courtesy Maine Office of Tourism. Joint Meeting image: Manhattan, Kansas, USA. Photo courtesy K-State Photo Services. Southeastern image: Beach boardwalk, Charleston, South Carolina, USA. Photo courtesy Meetcharleston.com. Cordilleran image: Chanticleer Point, Portland, Oregon, USA. Photo by Martin Streck.

Geoscience Jobs & Opportunities

Ads (or cancellations) must reach the GSA advertising office no later than the first of the month, one month prior to the issue in which they are to be published. Contact advertising@geosociety.org, +1.800.472.1988 ext. 1053, or +1.303.357.1053. All correspondence must include complete contact information, including e-mail and mailing addresses.
Online: www.geosociety.org/jobs.

Rates are in U.S. dollars.

Classification	Per Line for 1st month	Per line each addt'l month (same ad)
Positions Open	$9.30	$9.25
Fellowship Opportunities	$9.30	$9.25
Opportunities for Students		
First 25 lines	$0.00	$5.00
Additional lines	$5.00	$5.00

Positions Open

GIS/REMOTE SENSING SPECIALIST & GEOSPATIAL CENTER DIRECTOR DEPT. OF EARTH AND SPACE SCIENCES LAMAR UNIVERSITY, BEAUMONT, TEXAS

Posting Number: 201121583. Position Number: 499699.

The GIS/Remote Sensing Specialist and Center Director will support the Lamar Geospatial Center (LGC) by developing and teaching remote sensing classes and workshops, as well as GIS and GPS classes including those supporting GIS Certification, a Minor in GIS when required; and, eventual development of a Masters in Geospatial Science. This person will lead the day-to-day operations of the LGC and projects associated with it, including database management, submission of reports, and the writing of grant proposals pertaining to the LGC. Note that funded research and presentations/publications are also expected duties of the successful candidate. A track record of funded projects is desirable.

Essential Job Functions:

1. Develops and teaches workshops related to remote sensing and geospatial technology.
2. Develops and teaches academic remote sensing and GIS classes offered for credit toward GIS Certification, a GIS Minor, and Masters in Geospatial Sciences through Lamar University.
3. Manages people responsible for the collection of data, data entry, data conversion and data organization of LGC geospatial products.
4. Performs data verification and QA/QC for LGC geospatial projects.
5. Generates reports, maps and other technical documents in support of LGC geospatial projects.
6. Writes research proposals, makes presentations, and publishes research results.
7. Promotes the Lamar Geospatial Center to the community.

Minimum Qualifications:

1. Knowledge of multiple operating systems and remote sensing/geospatial software applications, particularly the ESRI suite of ArcGIS software products and common extensions on a Windows operating system.
2. Ability to provide technical support to clients for remote sensing, GIS and GPS related hardware and software issues.
3. Highly skilled in collecting, processing, editing and manipulating geospatial data.
4. Excellent oral and written communication skills.
5. Ability to effectively lead a team of geospatial specialists.

Education: A Geoscience or Planetary Science related Ph.D. degree specializing in Remote Sensing, or GIS/Geospatial Science is required.

Work Experience: Applicant must have at least 3 years of increasingly responsible Remote Sensing and GIS project management experience. Field experience with GPS units, and post-processing knowledge, is important. Thorough knowledge of Remote Sensing, GIS and GPS computer applications is expected.

Application Process: Please access Human Resources' job application page at https://jobs.lamar.edu and click on Faculty Positions. Find this position in the list and click on it. This will take you to the posting details and the Apply for this Job tab. Please include (1) Letter of Interest, (2) Curriculum Vitae, (3) Statement of Teaching Philosophy. Also requested are the names and contact information for at least three references and letters from them if available, as well as unofficial transcripts and other miscellaneous information you would like to include. Alternatively, you can send this information to Lamar University, Human Resources, 4400 MLK Pkwy, P.O. Box 10009, Beaumont, Texas 77710. However, the online application process is preferred.

Salary: Commensurate.

Lamar University is an Equal Opportunity/Affirmative Action Employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, disability or protected veteran status.

Lamar University is proud to provide employment preference to veteran applicants in accordance with Texas 805 Government Code, Section 657.003.

This position is security-sensitive and thereby subject to the provisions of the Texas Education Code §51.215, which authorizes the employer to obtain criminal history record information.

FACULTY, GEOLOGICAL SCIENCES (FIELD GEOLOGY), FULL-TIME TENURE-TRACK, FALL 2019 SALEM STATE UNIVERSITY

The geological sciences department at Salem State University invites applications for a full-time, tenure-track faculty position beginning September 2019. We seek a field geologist with expertise in earth materials, mineralogy, and petrology who is committed to collaborative undergraduate teaching and research. Our department has a strong commitment to the inclusion and engagement of our growing population of diverse students. We seek candidates who will successfully serve as mentors and role models for students belonging to groups that are traditionally underrepresented in geological sciences. Teaching assignments will include: mineralogy/petrology/earth materials for majors; summer field courses in Montana and/or New England; introductory general education courses in the geosciences; upper-level applied geoscience and major elective courses in the candidate's area of expertise; and advising senior research.

Please apply online to https://salemstate.edu/campus-careers and attach curriculum vitae, cover letter and transcripts. Completed application materials submitted by November 9, 2018, will receive full consideration, and evaluation will continue until the position is filled. For those attending, we plan to meet with interested candidates at the 2018 GSA Annual Meeting in Indianapolis, Indiana.

ASSISTANT PROFESSOR OF GEOSCIENCES SMITH COLLEGE

The Dept. of Geosciences at Smith College invites applications for a tenure-track position at the rank of Assistant Professor, to begin July 1, 2019. Candidates should have a strong foundation in "hard rock" geology, and we are especially interested in applicants with expertise in and/or who can teach courses in mineral resources and sustainability. Teaching responsibilities for this position will regularly include mineralogy and petrology, and other courses in the candidate's field of specialization. The successful candidate is also expected to establish an active research program and to engage undergraduate students in their scholarship. A Ph.D. in Geosciences is expected by the time of appointment. Candidates from groups underrepresented in STEM are strongly encouraged to apply. Details about the Dept. of Geosciences may be found at https://www.smith.edu/academics/geosciences. For more information and to apply, visit https://apply.interfolio.com/53297. Review of applications will begin on November 1. We will accept applications until December 10, 2018. EO/AA/Vet/Disability Employer.

FACULTY POSITION IN STRATIGRAPHY AND SEDIMENTOLOGY GEORGIA SOUTHERN UNIVERSITY

Georgia Southern University's Dept. of Geology and Geography invites applications for the position of Assistant Professor of Geology, specializing in stratigraphy and sedimentology. The full text advertisement, including information about the department, faculty, and the complete position announcement with all qualifications and application instructions, is available at https://cosm.georgiasouthern.edu/geo/. Screening of applications begins October 15th and continues until the position is filled. Georgia is an open records state. Georgia Southern is an AA/EO institution. Individuals who need reasonable accommodations under the ADA to participate in the search process should contact the Vice Provost.

TENURE-TRACK ASSISTANT PROFESSOR POSITION WESTERN WASHINGTON UNIVERSITY

The Dept. of Physics/Astronomy and the Geology Dept. at Western Washington University invite applications for a tenure-track assistant professor of planetary science position, split evenly between both departments with Physics/Astronomy as the administrative home department, starting September 2019. Applicants must hold a Ph.D. in geophysics,

physics, geology, astronomy or closely related field by time of appointment.

A successful applicant will be expected to pursue an externally-supported research program in planetary science that will actively involve undergraduate students. Post-doctoral research or equivalent experience is strongly preferred. Candidates should also have the potential for teaching excellence at all levels of the undergraduate curriculum in the physics and geophysics program. Experience in teaching undergraduate STEM courses and interest in the use of student-centered teaching techniques is preferred. Candidates must demonstrate ability and commitment to promoting diversity and inclusion, as well as excellent communication and interpersonal skills. Preference will be given to candidates whose research specialization complements existing strengths in remote sensing, planetary geology, seismology, magnetism, and tectonics, and who have the potential to mentor graduate student research in the Geology M.S. program.

Applications must include (1) a detailed cover letter describing the applicant's background and addressing the required and preferred qualifications, (2) a statement of philosophy and interest in teaching, (3) a statement outlining proposed research plans, specifically addressing plans for student involvement in both departments, (4) a statement detailing how teaching, service and/or scholarship has prepared the applicant to support the success of students with backgrounds or identities that are underrepresented in STEM fields, (5) unofficial transcripts of undergraduate and graduate course work, and (6) a full curriculum vitae including the names, addresses, e-mail addresses, and telephone numbers of three professional references. Do not send letters of recommendation; they will be requested only for semi-finalists. Review of applications will begin on November 30, 2018 and the position will remain open until filled. All application materials must be uploaded as a single pdf to: Assistant Professor of Planetary Science (http://employment.wwu.edu/cw/en-us/job/496058/assistant-professor-of-planetary-science). Inquiries may be addressed to the search committee chair, Dr. Melissa Rice, at melissa.rice@wwu.edu or (360) 650-3592

Western Washington University is a a is a public university with over 15,000 students in Bellingham, WA, centrally located between Seattle, WA and Vancouver, B.C. in the beautiful Pacific Northwest. The Dept. of Physics and Astronomy offers a B.S. degree in physics and a B.A. degree in math/physics education. The Geology department offers B.S. degrees in geophysics and geology, and a M.S. degree in geology. More information can be found at https://cse.wwu.edu/physics and https://cse.wwu.edu/geology.

WWU is an AA/EO employer.

TECTONOPHYSICIST, TENURE-TRACK DEPT. OF GEOLOGICAL SCIENCESCALIFORNIA STATE UNIVERSITY FULLERTON (CSUF)

The Dept. of Geological Sciences at CSUF invites applications for a tenure-track, Assistant Professorship in the broad field of tectonophysics beginning August 2019. We are seeking an Earth scientist who integrates field and geophysical techniques to investigate tectonic questions, demonstrates a strong commitment to teaching excellence and shows evidence of an existing or developing active, externally funded, student-centered, research program. A Ph.D. in Geological Sciences or related field is required at the time of appointment. We seek scholars who will teach introductory geophysics (bi-annually) and regularly participate in the teaching geologic field techniques, summer field camp, upper-division or graduate courses their area of specialization as well as general education courses. Preference will be given to candidates who can occasionally teach structural geology. The successful candidate will contribute to the diverse CSUF campus. To apply, please go to: https://apps.fullerton.edu/facultyrecruitment to view all job listings and select 10499BR to begin the application process. To ensure full consideration, submit all application materials by November 16, 2018.

TENURE-TRACK FACULTY POSITION GEOCHEMISTRY OF NEAR-SURFACE PROCESSES, BOSTON COLLEGE

The Dept. of Earth and Environmental Sciences at Boston College invites qualified candidates to apply for a tenure-track faculty position at the rank of Assistant Professor. We seek candidates with expertise in low-temperature geochemistry with application to Earth's near-surface environment in the context of global change. The successful candidate will be expected to develop a vigorous externally funded research program integrated with excellence in teaching within the Earth and Environmental Sciences curriculum at both the undergraduate and graduate levels. The candidate should have research interests compatible with those of the current faculty in the Dept. of Earth and Environmental Sciences, including, but not limited to: understanding modern processes related to the exchange of water, carbon, and pollutants between the atmosphere, the oceans, the terrestrial hydrosphere, land surface, and urban systems, or reconstructing/understanding ancient environments and climates. We particularly encourage applicants whose research uses stable isotopes, integrates field-based research, and/or crosses traditional disciplinary boundaries in the sciences, thereby having the potential to also conduct innovative research within the forthcoming Schiller Institute for Integrated Science and Society at Boston College (https://www.bc.edu/bc-web/schools/mcas/sites/schiller-institute.html). Information on the department, its faculty and research strengths can be viewed at http://www.bc.edu/eesciences.

Applicants must hold a Ph.D. in the geosciences or a related field at the time of appointment. Complete applications should be submitted online at: https://apply.interfolio.com/53801 and must include a curriculum vitae, statements of teaching and research interests, and the names and contact information of at least three references. Review of applications will begin on November 1, 2018. Inquiries may be directed to Prof. Jeremy Shakun, Search Committee Chair (jeremy.shakun@bc.edu), or Ethan Baxter, Department Chair (ethan.baxter@bc.edu).

RICE | EEPS
Earth, Environmental and Planetary Sciences

WIESS AND PAN POST-DOCTORAL RESEARCH FELLOWSHIPS
Department of Earth, Environmental and Planetary Sciences

The Department of Earth, Environmental and Planetary Sciences at Rice University is inviting applications for the Wiess and the Pan Postdoctoral Research Fellowships. We are seeking candidates with independent research interests that intersect with one or more faculty within our department. Both domestic and international applicants are welcome, but applicants must have a Ph.D. awarded within three years of the time of appointment.

The research fellowships will be supported for two years, pending satisfactory progress during the first year, and covers an annual stipend of $60,000 with a benefits package and an additional annual discretionary research allowance of $3,500.

Applicants are requested to develop a proposal of research to be undertaken during the fellowship period. The principal selection criteria are scientific excellence, a clearly expressed research plan to address questions at the forefront of their field of study, and research synergies with at least one faculty. The proposed research should, however, encompass independent research ideas and explore new directions beyond the applicant's Ph.D. Preference will be given to applicants whose proposals demonstrate independence and originality, and also the potential for collaboration with one or more faculty in the Department of Earth, Environmental and Planetary Sciences.

The application for both fellowships is due on 1 November, 2018. Applicants are required to submit one application only at http://jobs.rice.edu/postings/15058. The application should include the following documents:

(1) A cover letter.
(2) A research proposal of no more than 3 pages (not counting references) of single-spaced text and figures.
(3) A current CV, including a list of publications.

As part of the online application, the applicant will also have to provide the names and contact information of three or more people who will be asked to submit reference letters by the same deadline.

The highest ranked applicants will be invited to visit Rice in early 2019. Following acceptance, the appointment may begin anytime before 1 January, 2020. For further information or questions contact the chair of the search committee at esci-postdoc@rice.edu.

Rice University is located in Houston, Texas, and is a private, coeducational, nonsectarian university that aspires to path-breaking research, unsurpassed teaching, and contributions to the betterment of our world. Rice fulfills this mission by cultivating a diverse community of learning and discovery that produces leaders across the spectrum of human endeavor.

Rice University is an Equal Opportunity Employer with commitment to diversity at all levels, and considers for employment qualified applicants without regard to race, color, religion, age, sex, sexual orientation, gender identity, national or ethnic origin, genetic information, disability or protected veteran status.

https:/earthscience.rice.edu/open-positions/

Boston College is an Affirmative Action/Equal Opportunity Employer and does not discriminate on the basis of any legally protected category including disability and protected veteran status. To learn more about how BC supports diversity and inclusion throughout the university please visit the Office for Institutional Diversity athttp://www.bc.edu/offices/diversity.

ASSISTANT PROFESSOR GEOSCIENCES, TOWSON UNIVERSITY

The Jess and Mildred Fisher College of Science and Mathematics, Department of Physics, Astronomy and Geosciences

Applications are invited for a tenure-track, 10-month Assistant Professor of Geosciences position at Towson University in the Dept. of Physics, Astronomy and Geosciences starting August 2019. A PhD in a relevant area is required and postdoctoral experience is preferred. This position supports the Geology program and the interdisciplinary graduate and undergraduate programs in Environmental Science and Studies. Preference will be given to candidates with research and teaching interests in the areas of sedimentology and stratigraphy and/or paleobiology. Candidates with a background in hydrogeology, in environmental or low-temperature geochemistry, or in geophysics and whose interests overlap with the priorities already listed will also be considered. Teaching responsibilities will include introductory and upper-level geology courses and will likely include a graduate-level environmental geology course. Research responsibilities include establishment of a productive research program that involves students and pursuit of external funding. Electronic applications should be submitted as a single PDF file that includes a cover letter, CV and 2-page teaching and research statements. Three letters of reference should also be submitted by email. All materials should be sent to Dr. David Schaefer, GEOLsearch@towson.edu. Review of applications will begin on October 5, 2018 and will continue until the position is filled. Additional information can be found at http://www.towson.edu/physics.FCSM-N-3212.

ASSISTANT PROFESSOR OF EARTH AND ATMOSPHERIC SCIENCES (HYDROGEOLOGY/GROUNDWATER MODELING), UNIVERSITY OF NEBRASKA–LINCOLN

Applications are invited for a tenure track position as Assistant Professor in the Dept. of Earth and Atmospheric Sciences at the University of Nebraska–Lincoln. The position forms part of a cluster hire (Climate Change: Impacts, Adaptation, and Mitigation) that involves multiple departments in the College of Arts and Sciences. The successful candidate will be expected to participate in teaching and curricular development of undergraduate and graduate courses, to advise and direct graduate students, and to develop a rigorous research program that is supported by external funding. It is expected that the research program will focus on relationships between the hydrosphere and climate. The ability to contribute to multidisciplinary water and climate research efforts in the department and college will be considered as an advantage. The candidate should demonstrate strong potential for research and teaching and must hold a Ph.D. in Geology, Hydrogeology, or a related field at the time of appointment.

The Dept. of Earth and Atmospheric Sciences offers B.S. degrees in Geology and Meteorology-Climatology, as well as M.S. and Ph.D. degrees in Earth and Atmospheric Sciences. Additional information about our department can be found on our web site: http://eas.unl.edu.

To apply, go to http://employment.unl.edu/postings/60181 and complete the "faculty/administrative form". Applicants must attach a cover letter, curriculum vitae, statements of research and teaching interests, and names of at least three references via the above website. We will begin to review applications on November 23, but the position will remain open until it is filled.

As an EO/AA employer, qualified applicants are considered for employment without regard to race, color, ethnicity, national origin, sex, pregnancy, sexual orientation, gender identity, religion, disability, age, genetic information, veteran status, marital status, and/or political affiliation. See http://www.unl.edu/equity/notice-nondiscrimination.

For further information, contact Dr. Richard Kettler, Search Committee Chair by email, phone, or mail at: rkettler1@unl.edu, 1-402-472-0882; Dept. of Earth & Atmospheric Sciences, University of Nebraska–Lincoln, 126 Bessey Hall, Lincoln NE 68588-0340.

ASSISTANT PROFESSOR HYDROGEOSCIENTIST, WEST VIRGINIA UNIVERSITY DEPT. OF GEOLOGY AND GEOGRAPHY

(Job No. 09825)

The West Virginia University Dept. of Geology & Geography invites applications for a tenure-track position in geology at the Assistant Professor level starting in August 2019. A Ph.D. or equivalent degree in Geoscience or a broadly related field is required at the time of appointment. We seek applications from individuals with interests in basic and applied aspects of water science. The successful applicant will possess demonstrable expertise applicable to competitively funded research problems. Relevant specialties might include physical hydrogeology; fluid flow modeling; hyporheic or vadose zone processes; groundwater-surface water interaction; flow in fractured media; hydrogeology of energy-related activities; groundwater supply and sustainability; contaminant transport; watershed dynamics; ecohydrology; or karst hydrogeology.

Candidates will be evaluated based on their potential to establish a vigorous externally funded research program, publish scholarly work, mentor graduate students, and to teach at the undergraduate and graduate levels, including a junior-senior level physical hydrogeology course.

Research on fresh water resources is a strategic focus at WVU, as demonstrated by a newly established interdisciplinary Institute of Water Security and Science (https://iwss.wvu.edu/), a National Science Foundation funded multi-state Appalachian Freshwater Initiative (https://iwss.wvu.edu/projects/appalachian-freshwater-initiative), and many other water focus areas located in WVU colleges and centers.

WVU (http://www.wvu.edu) is a comprehensive land-grant university that enrolls 29,000 students. It is classified as "highest research activity" by the Carnegie Foundation. WVU is located in Morgantown (https://www.morgantownwv.gov/), ranked as a most preferred small city in America. The immediate region has a diverse population of about 200,000 residents. The community lies within a high technology corridor that includes several federal research facilities, as well as resource-based industries. The city is readily accessible to Pittsburgh and Washington, DC.

To apply for this position, visit https://careers.wvu.edu, navigate to the position title listed above, and submit (1) a single PDF file including a statement of research interests, a statement of teaching philosophy, and a current curriculum vitae; (2) a list of names and e-mail addresses for at least three individuals who can provide prompt letters of recommendation; and (3) pdf files of up to four publications.

Review of applications will commence on December 3, 2018 and continue until the position is filled. For additional information, please see http://pages.geo.wvu.edu/hydrogeo or contact search chair Steve Kite at steve.kite@mail.wvu.edu. WVU is an EEO/Affirmative Action Employer and welcomes applications from all qualified individuals, including minorities, females, individuals with disabilities, and veterans.

GEOCHEMISTRY OF NEAR SURFACE ENVIRONMENTS, UNIVERSITY OF MINNESOTA–TWIN CITIES

The Dept. of Earth Sciences at the University of Minnesota–Twin Cities invites applications for a tenure-track faculty position in Isotope Geochemistry and/or Analytical Geochemistry of Near Surface Environments at the assistant professor level. Exceptional candidates at the associate professor level will also be considered. We seek a colleague who creatively uses isotopic and/or analytical approaches to understand processes and changes in near surface environments in modern and ancient systems, including the atmosphere, hydrosphere, cryosphere, biosphere, and/or the upper crust. Successful applicants will be expected to contribute to a diverse research and teaching community in the Dept. of Earth Sciences through the development of a vigorous, internationally recognized and externally funded research program, through teaching courses at the undergraduate and graduate levels, and through service in the department, college, and university. The Dept. of Earth Sciences is part of the College of Science and Engineering and houses research programs as well as state-of-the-art analytical facilities spanning a broad spectrum of Earth Science disciplines (further information is available at: http://www.esci.umn.edu).

Applicants must have a Ph.D. in the geosciences or a related field at the time of appointment. Applicants should submit a cover letter, curriculum vitae, research statement, teaching statement, names and contact information of three references, and, if applicable, a list of any planned presentations at conferences in fall of 2018. These materials must be submitted online: https://human-

resources.umn.edu/jobs Search for Requisition Number 325790.

Appointment may begin as early as August 2019. Review of applications will begin on Oct. 15, 2018, and continue until the position is filled. For further information or questions, please contact R. Lawrence Edwards, Chair of the Search Committee at edwar001@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 a diverse student body. 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. The University supports the work-life balance of its faculty.

TENURE-TRACK GROUNDWATER HYDROGEOLOGY, SAN JOSÉ STATE UNIVERSITY

The Dept. of Geology at San José State University invites applications for a tenure-track position in groundwater hydrogeology. A Ph.D. degree in the Earth Sciences is required, postdoctoral experience is desirable, and a proven record of excellence in teaching or evidence of promise for excellence in teaching is expected. Research should complement departmental strengths in tectonics/structure, sedimentology/stratigraphy/paleontology, geomorphology, petrology/geochemistry, and field geology. The successful candidate must have the interest and ability to teach Hydrogeology and Environmental Geology, will develop undergraduate and graduate courses in their area of expertise, and will contribute to a growing departmental emphasis on Earth Systems. Teaching non-majors is also expected. Research involving masters and undergraduate students is required, and external funding must be sought. Apply by Nov. 12, 2018 for full consideration. SJSU is a national leader in graduating URM students and has achieved both HSI (Hispanic Serving Institution) and AANAPISI (Asian American and Native American Pacific Islander Serving Institution) status; 40% of our student population are first-generation and 38% are Pell-qualified. SJSU ranks #4 nationally in increasing student upward mobility (http://socialmobilityindex.org/). See the official job announcement at the SJSU website: http://www.sjsu.edu/up/careers/faculty_jobs/index.html. SJSU is an Affirmative Action/Equal Opportunity Employer committed to the core values of inclusion, civility, and respect for each individual. A background check (including criminal records check) must be completed satisfactorily before any candidate can be offered a position with the CSU.

TENURE TRACK ASSOCIATE PROFESSOR IN GEOCHEMISTRY AND DIRECTOR OF THE ENVIRONMENTAL SCIENCE PROGRAM, SAN DIEGO STATE UNIVERSITY

The Dept. of Geological Sciences and the Environmental Sciences Program invites applications for a new tenure-track role, Director of the Environmental Science Program and Associate Professor in Geochemistry. The Department seeks to enhance its areas of expertise by adding a faculty member with a focus in applications of geochemistry to understand earth systems, earth system processes, climate, petrology, water quality/quantity and/or environmental issues. The successful candidate will demonstrate a high capacity for developing and maintaining an externally-funded research program in their area of excellence, advise undergraduate research, supervise graduate students, possess a desire to deliver high-quality and innovative teaching and a willingness to engage in the shared governance model at all levels. The candidate will work closely with the Department Chair to advance all aspects of the Environmental Science Program including course development, curricular revisions, student advising, and promotion of the program. In addition to directing the program, the candidate will be expected to develop and teach courses for the department related to the Environmental and Geological Sciences at the undergraduate and graduate level within their discipline. A PhD in Geology or related field is required for the position. Demonstrated success in research, teaching and service/outreach at a level appropriate for the rank of Associate Professor is required. Offers are contingent on verification of academic qualifications.

Apply via Interfolio at https://apply.interfolio.com/53560. Review of applications will begin 15 October, 2018, and will continue until the position is filled. Please direct questions about the position to the search committee chair, Dr. Thomas Rockwell, trockwell@sdsu.edu.

SDSU is a Title IX, equal opportunity employer.

CHAIR, DEPARTMENT OF GEOSCIENCES TENURE-TRACK FACULTY, MIDDLE TENNESSEE STATE UNIVERSITY

The Middle Tennessee State University (MTSU) Dept. of Geosciences invites applications for an innovative leader to chair the Dept. of Geosciences. The department offers baccalaureate programs in geology, physical geography, and environmental science, and master's programs in geospatial analysis and environmental geosystems. Responsibilities of the chair will include providing strong academic leadership for the Department, budgetary coordination, faculty/staff hiring and evaluations, facilitating planning and assessment, community advancement, fundraising, facilitating the acquisition and implementation of external grants, teaching and mentoring students, and providing leadership in the development and oversight of instructional programs, research, and service commitments. The successful candidate must have a distinguished record of teaching, research, and service in the geosciences, environmental sciences, or closely related area. Candidate must also have excellent communication and interpersonal skills; demonstrated vision, leadership, administrative experience and ability to work productively with faculty and students from diverse backgrounds.

Applicants must be eligible for the rank of associate professor or full professor, with tenure upon appointment possible. Start date for the position is negotiable but not later than August 1, 2019.

MTSU Geosciences offers BS degrees in Geoscience with concentrations in Geology, Physical Geography, Environmental Science, and a MS concentration in Geosciences. The Department is comprised of 12 faculty and research staff, approximately 100 undergraduate majors, and 20 graduate students. In 2017, the Department moved into new teaching and research facilities, including specialized laboratories in GIS, remote sensing, hydrology and geochemistry. The Department emphasizes excellence in teaching, while also supporting the development of new and innovative research programs at both the undergraduate and graduate levels.

Required documents for application include a cover letter, curriculum vita, and statements of teaching philosophy, research experience and interest, and administrative philosophy. Three letters of recommendation and official university transcripts (not issued to applicant) of all degrees received will be required of all applicants selected for an interview. Please contact Dr. Wendy Beckman (Wendy.Beckman@mtsu.edu, 615-494-8755) with questions.

To apply for this position, go to http://mtsujobs.mtsu.edu and follow the instructions on how to complete an application, attach documents, and submit online. Review of applications begins September 3 and continues until position is filled. Rank and salary are commensurate with education and experience. Proof of U.S. citizenship or eligibility for U.S. employment will be required prior to employment (Immigration Control Act of 1986). Clery Act crime statistics for MTSU available at http://police.mtsu.edu/crime_statistics.htm. or by contacting MTSU Public Safety at 615-898-2424. EO/AA employer.

SEDIMENTARY GEOLOGY AND PALEONTOLOGY, ALBION COLLEGE

The Albion College Dept. of Geological Sciences invites applications for a tenure-track Assistant Professor of Sedimentary Geology and Paleontology who is excited about teaching and conducting research with a diverse student body. The successful candidate will have a Ph.D. prior to starting in August 2019. The department has five FTE faculty positions and two technicians.

Candidates should expect to teach two lectures and two labs per semester, including introductory and advanced undergraduate courses in sedimentary geology, paleontology, and an area of specialization that will enhance and complement the undergraduate geology curriculum. The department offers a nationally recognized biennial Summer Field Camp in the Rockies and offers annual regional geology field trips. Candidates with interests in interdisciplinary collaborations and field-based research and teaching are particularly desirable. Interest in curricular innovation and increasing diversity and inclusion in geology both in the classroom and field are also valued. Candidates are expected to conduct research that includes undergraduate students, participate in co-curricular departmental activities, and contribute to interdisciplinary programs in the college community.

The institution and department have well-funded undergraduate and faculty research initia-

tives that support faculty travel, teaching, and scholarship. The department has excellent teaching and research facilities and is well equipped with analytical instruments, and field and laboratory equipment. The department maintains extensive rock, fossil, and equipment storage and sample preparation facilities, along with exceptional curated collections of invertebrate fossils and sedimentary rocks.

Candidates should submit a vita, official academic transcripts, documentation of teaching excellence and experience, a statement of undergraduate teaching and research philosophy and objectives, and three references to https://apply.interfolio.com/53141. Applications completed by October 19, 2018 will receive full consideration. **We will talk with selected candidates in November at the 2018 GSA Annual Meeting in Indianapolis or by video conference.** Please contact Dr. Carrie Menold, chair, with any questions at cmenold@albion.edu.

Albion College is a private liberal arts college of approximately 1400 students. It is situated in a culturally diverse community in south-central Michigan within an hour's drive of the University of Michigan, Michigan State University, and Western Michigan University. Albion is dedicated to the highest quality in undergraduate education and committed to diversity as a core institutional value. Albion College is committed to a policy of equal opportunity and nondiscrimination on the basis of sexual orientation, race, color, ethnicity, national origin, religion, sex, gender identity, gender expression, age, disability, marital status, or veteran status as protected by law, in all educational programs and activities, admission of students, and conditions of employment. We are especially interested in candidates who will contribute to a campus climate that supports equality and diversity. Visit www.albion.edu.

ASSISTANT OR ASSOCIATE PROFESSOR GEOLOGY, COLORADO COLLEGE

MISSION: At Colorado College our goal is to provide the finest liberal arts education in the country. Drawing upon the adventurous spirit of the Rocky Mountain West, we challenge students, one course at a time, to develop those habits of intellect and imagination that will prepare them for learning and leadership throughout their lives.

Colorado College is seeking applications for a tenure-track faculty position at the rank of Assistant or Associate Professor beginning in August 2019. We seek a dynamic scientist and teacher with the following characteristics:

(1) Expertise in a subfield(s) of geomorphology/surface processes that includes, but is not limited to: fluvial geomorphology, glacial/Quaternary geomorphology, critical zone geomorphology, or tectonic geomorphology.

(2) An educational and/or research program that emphasizes field observations in conjunction with laboratory and/or modeling analyses. Experience with geologic investigations in the Rocky Mountains/western United States, and acquaintance with the geologic evolution of the Colorado Rocky Mountains are desirable.

(3) A strong background in and ability to teach geospatial and quantitative approaches such as GIS, numerical models, or geoinformatics, and to utilize novel measurement techniques, models, and datasets.

The successful candidate is expected to have research and teaching interests that can strengthen departmental connections with other science programs at Colorado College (e.g. environmental science, biology, chemistry, mathematics, and physics). The candidate is also expected to spend extended time in the field and the classroom engaging with highly motivated undergraduate students as both a teacher and mentor.

The College actively promotes an engaging and inclusive environment in which students and employees of diverse backgrounds, cultures, and perspectives can learn and work. Applicants should describe the ways in which they can contribute to this goal in their cover letter. Applications should also include a curriculum vitae, a statement of research interests and teaching philosophy, a sample of scholarly publications, three letters of recommendation, and a graduate school transcript. A Ph.D. is required. One distinguishing feature of Colorado College is its Block plan, in which professors teach, and students take, one course at a time. Each block is three and a half weeks long, and professors teach six of the eight blocks in an academic year. Applicants should provide evidence of teaching effectiveness, if available.

Please submit application materials to http://employment.coloradocollege.edu/postings/3473 by October 15, 2018. For more information, direct questions to geology@coloradocollege.edu.

Colorado College is an equal opportunity employer committed to increasing the diversity of its community. We do not discriminate on the basis of race, color, age, disability, national origin, religion, gender, sexual orientation, gender identity or expression in our educational programs and activities or our employment practices.

ASSISTANT PROFESSOR, TENURE TRACK MINERALOGY AND GEOCHEMISTRY DARTMOUTH COLLEGE

The Dept. of Earth Sciences at Dartmouth College invites applications for a tenure- track assistant professor of mineralogy and geochemistry. Particular attention will be given to candidates with research interests in applied mineralogy related to mineral-microbe or water- rock interactions. We are especially interested in candidates who focus on understanding fundamental processes through a state-of-the-art field and laboratory research program that provides synergy with existing research activities within the department and elsewhere at Dartmouth, including the Department's core research areas: earth and planetary evolution, surface processes, and ice and climate systems. The successful candidate will continue Dartmouth's strong traditions in graduate and undergraduate research and teaching. Teaching responsibilities consist of three courses spread over four ten-week terms. One or more of these courses will have a core focus on the fundamentals of mineralogy.

The Dept. of Earth Sciences is home to 11 tenured and tenure-track faculty members in the School of Arts and Sciences and enjoys strong Ph.D. and M.S. programs and outstanding undergraduate majors. To create an atmosphere supportive of research, Dartmouth College offers new faculty members grants for research-related expenses, a quarter of sabbatical leave for each three academic years in residence, and flexible scheduling of teaching responsibilities. Dartmouth College has undergraduate and graduate student populations that are diverse by many measures. We seek applicants with a record of successful teaching and mentoring of students from all backgrounds (including first-generation college students, low-income students, racial and ethnic minorities, women, LGBTQ, etc.). Dartmouth provides opportunities to participate in undergraduate diversity initiatives in STEM research, such as our Women in Science Program, E. E. Just STEM Scholars Program, and Academic Summer Undergraduate Research Experience (ASURE).

To learn more about Dartmouth College and the Dept. of Earth Sciences, visit http://www.dartmouth.edu/~earthsci.

To submit an application, upload a cover letter, curriculum vitae, statements of teaching and research interests and objectives, reprints or preprints of up to three(3) of your most significant publications, and the name, address (including street address), e-mail address and fax/phone numbers of at least three(3) references to: http://apply.interfolio.com/53423

Application review will begin November 1, 2018 and continue until the position is filled. Applicants must hold a PhD or be ABD with degree anticipated by July 1, 2019.

Dartmouth College is an equal opportunity/affirmative action employer with a strong commitment to diversity and inclusion. We prohibit discrimination on the basis of race, color, religion, sex, age, national origin, sexual orientation, gender identity or expression, disability, veteran status, marital status, or any other legally protected status. Applications by members of all underrepresented groups are encouraged.

ASSISTANT PROFESSOR OF GEOSCIENCES SEDIMENTOLOGY/STRATIGRAPHY, DENISON UNIVERSITY

Denison University invites applications for a tenure-track assistant professor position in the Dept. of Geosciences, to begin in August 2019. We seek a broadly-trained scientist engaged in the study of sedimentology and/or stratigraphy that complements our department's current strengths in paleontology, petrology/volcanology, process geomorphology, and structural geology. Successful candidates should demonstrate potential to be an outstanding teacher, active scholar, and contributor to the continued growth of the Department and University. Candidates must have a Ph.D. at the time of appointment.

We seek a colleague who is committed to teaching excellence in the liberal arts tradition. Ideal candidates will have broad interests beyond their individual specialties and will provide a balance of classroom, field and laboratory experiences for our students. Candidates must have the desire and ability to teach courses across all levels of the curriculum. The typical teaching load is three lab courses per year. In addition, successful candidates are expected to maintain a vibrant and productive

research program that actively incorporates undergraduate students.

Denison University is an academically rigorous liberal arts college with an increasingly diverse campus community. It offers a competitive salary and a comprehensive benefits package. Denison is located in the village of Granville, 30 minutes from Columbus, Ohio, the state capitol, which hosts a wide range of cultural and artistic opportunities. Granville also offers an excellent public school system and easy access to outdoor activities.

All application materials will be handled electronically at https://employment.denison.edu. Applications must include: (1) a letter of application addressing the position requirements listed above; (2) a current curriculum vitae; (3) academic transcripts of undergraduate and graduate courses (unofficial acceptable); (4) a statement of teaching philosophy and experience; and (5) a statement of your research program in a liberal arts context. In addition, please list the contact information for three persons who know your teaching and scholarship well who will then be requested to upload reference letters. Completed application materials submitted by October 22, 2018 will receive full consideration. Evaluation will continue until the position is filled. For those attending, we will meet with selected candidates at the 2018 GSA Annual Meeting in Indianapolis and the 2018 AGU Fall Meeting in Washington DC. Please contact Dr. Erik Klemetti, chair, with any questions at klemettie@denison.edu.

To achieve our mission as a liberal arts college, we continually strive to foster a diverse campus community, which recognizes the value of all persons regardless of religion, race, ethnicity, gender, color, gender identity and or expression, sexual orientation, family configuration, disability, socioeconomic status, religion, national origin, age, or military status. For additional information and resources about diversity at Denison, please see our Diversity Guide at http://denison.edu/forms/diversity-guide. Denison University is an Affirmative Action, Equal Opportunity Employer.

FACULTY POSITION GEOPHYSICS AND GEOCHEMISTRY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY (MIT)

The Dept. of Earth, Atmospheric, and Planetary Sciences at the Massachusetts Institute of Technology (MIT), Cambridge, MA 02139, invites qualified candidates to apply for a tenure-track faculty position. The search is in the broad area of geophysics and geochemistry encompassing the Earth and other planetary bodies in the solar system. We seek candidates who use theory, observation, and/or experimentation and particularly encourage applicants whose work crosses traditional disciplinary boundaries. Candidates should have the potential for innovation and leadership in research and a commitment to teaching at the undergraduate and graduate levels.

Applicants must hold a Ph.D. in geoscience or related field by the start of employment. Our intent is to hire at the assistant professor level, but more senior appointments may also be considered. A complete application must include a cover letter, curriculum vitae, one- to two-page descriptions each of research and teaching plans, and three letters of recommendation. We request that in their cover letter, applicants explicitly commit to our department's code of conduct: https://eapsweb.mit.edu/about/code-conduct

Applications are being accepted at Academic Jobs Online: https://academicjobsonline.org/ajo/jobs/11380

To receive full consideration, complete applications must be received by November 1, 2018.

Search Contact: Ms. Karen Fosher, HR Administrator, EAPS, 54-924, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139-4307, email: kfosher@mit.edu

MIT is an equal employment opportunity employer. All qualified applicants will receive consideration for employment and will not be discriminated against on the basis of race, color, sex, sexual orientation, gender identity, religion, disability, age, genetic information, veteran status, ancestry, or national or ethnic origin.

ASSISTANT PROFESSOR, TENURE-TRACK MULTIPLE DISCIPLINES DEPARTMENT OF GEOLOGY AMHERST COLLEGE

The Amherst College Dept. of Geology invites applications for a tenure-track appointment at the rank of Assistant Professor with expertise in one of the following broadly defined fields:

- Climate Science and Paleoclimate; or
- Mineralogy, Petrology, and High-Temperature Geochemistry; or
- Structural Geology, Tectonics, and Geophysics.

We seek a colleague who is committed to excellence in earth science education in a liberal arts context with a record that demonstrates the promise of high-quality research and who is excited about involving undergraduate students in research projects. Today, Amherst College comprises a profoundly diversified student body; nearly one-quarter of Amherst's students are Pell Grant recipients and 45 percent of our students identify as domestic students of color. The College is committed to cultivating a challenging and inclusive educational environment, therefore we seek candidates who can teach, mentor, and inspire students of different sexual orientations, genders, races, ethnicities, nationalities, and religious and socioeconomic backgrounds. Amherst College is an equal opportunity employer and encourages persons of all genders, persons of color, and persons with disabilities to apply. The college is committed to enriching its educational experience and its culture through the diversity of its faculty, administration, and staff. We encourage applications from those who will offer rigorous, integrated classroom, field, and laboratory experiences for our students. Geology faculty teach three courses with labs per year, supervise students in independent research leading to honors theses, serve as academic advisor to geology majors and underclass students in general, support the activities of the Geology Department, and participate in the life of the College through service. The appointee to this position will regularly teach courses at the introductory level that engage a broad range of students and more advanced courses within their area of expertise for students majoring in Geology. Opportunities for teaching interdisciplinary courses are also available. The ability to direct writing, quantitative analysis, and research at all undergraduate levels is necessary. The successful candidate will be expected to sustain a dynamic and productive research program that is grounded in original observations and analysis of Earth materials and is conducive to substantive undergraduate participation. Start-up funds and other forms of institutional support are available. This appointment will begin July 1, 2019. Candidates must have completed the Ph.D. at the time of appointment; post-doctoral experience is beneficial. Applications should be submitted electronically via Interfolio https://apply.interfolio.com/51958. We request a cover letter, curriculum vita, contact information for three references who have agreed to provide letters of recommendation, and a statement in which you describe your current research agenda, what you would like to teach to undergraduate students and how you envision doing so, and the background, experience, or interests that position you to support Amherst's commitment to diversity and inclusion. Review of applications will begin on September 14, 2018, and continue until the position is filled. Applications completed by September 14, 2018 will be assured of full consideration. For more information about Amherst College and the Geology Department please visit our websites: http://www.amherst.edu and https://www.amherst.edu/academiclife/departments/geology. Questions should be addressed to Professor Anna Martini, Search Committee Chair: ammartini@amherst.edu.

ASSISTANT OR ASSOCIATE PROFESSOR HYDROGEOLOGY, FORT LEWIS COLLEGE

The Dept. of Geosciences at Fort Lewis College invites applications for a full-time, tenure-track position in the field of Hydrogeology at the Assistant or Associate Professor level commencing in the fall semester of 2019. Responsibilities include teaching courses in groundwater and introductory geology, contributing to the new Environmental Science program, and advising undergraduate research within the Dept. of Geosciences. Applicants must have a complete Ph.D. by August 2019, potential for excellence in undergraduate teaching, and interest in research involving undergraduate students.

In Fall 2018, Fort Lewis College welcomes our first cohort of first-time freshman where the majority of students identify as a member of an underrepresented group. Fort Lewis College's regional commitment to Southwestern Colorado and historical commitment to serve Native American and Alaska Native students makes us proud to have such a diverse incoming cohort of students. This year, Fort Lewis College will launch a diversity hiring initiative. The goal of this program is to attract faculty committed to designing courses around equity, closing achievement gaps, improving retention, and empowering students of all backgrounds.

For more information and to apply, please visit: https://www.fortlewis.edu/Portals/71/Assistant-Associate%20Professor%20of%20Hydrogeology.pdf.

Review of applications will begin on November 1, 2018, and will continue until the position is filled.

Fort Lewis College does not discriminate on the basis of race, age, color, religion, national origin, gender, disability, sexual orientation, gender identity, gender expression, political beliefs, or veteran status. Accordingly, equal opportunity for employment, admission, and education shall be extended to all persons. The College shall promote equal opportunity, equal treatment, and affirmative action efforts to increase the diversity of students, faculty, and staff.

Opportunities for Students

Graduate Student Opportunities at Case Western Reserve University. Students with backgrounds in geology, physics, chemistry, biology, engineering, and related fields are encouraged to apply for our Ph.D. and MS programs in Earth, Environmental, and Planetary Sciences. Areas of active research in the Department include planetary geology and geodynamics, planetary materials, high-pressure mineral physics and geochemistry, core and mantle processes, sedimentary geology, and sediment transport. For more information, please visit http://eeps.case.edu or write to eeps-gradinfo@case.edu. Financial assistance is available. Application deadline: 1/15/2019.

The Environmental Geochemistry group in the Dept. of Geology at Kent State University is inviting applications for MS and Ph.D. students. Dr. Elizabeth Herndon is seeking graduate students for an NSF-funded project on manganese biogeochemistry and impacts on carbon cycling in terrestrial ecosystems. Candidates may also be considered for other ongoing projects related to metal biogeochemistry in arctic environments or human-impacted streams. Applicants should have a solid academic record in earth and environmental sciences, preferably with a strong background in chemistry and prior research experience. We are committed to building a diverse and inclusive research group and strongly encourage applicants who contribute to the diversity and excellence of the academic community. Interested students should contact Dr. Herndon (eherndo1@kent.edu) this fall to discuss opportunities to discuss opportunities. Please indicate your research interests and include a current resume. Successful applicants will join the Dept. of Geology in August 2019, or in some circumstances, summer 2019. Support will be a combination of research and teaching assistantships and includes tuition. The Dept. of Geology has over 30 active graduate students and maintains analytical facilities for comprehensive water and soil/rock analysis (https://www.kent.edu/geology/facilities).

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John W. (Jack) Hess, *GSA Foundation President*

A Forward-Thinking Investment in Undergraduate Field Experiences

Geoscience professionals and employers often state that undergraduate field work is a critical training experience. This is particularly true for students interested in pursuing careers in the energy industry, where field-experienced geologists are vital. The GSA Foundation is proud to announce our new **Petroleum Geoscientists Fund for Undergraduate Field Experience and Research** to ensure that aspiring geoscientists have support for the field training necessary to succeed.

The Petroleum Geoscientists Fund was started by professional geologists in the energy industry who understand how important it is for undergraduate geoscience students to hone their field skills and discover their geoscience passion by participating in a field camp or related field training opportunity. The fund provides undergraduate students interested in pursuing careers in industry an opportunity to learn the skills necessary to contribute meaningfully to corporate and industry efforts. Through supported attendance of a field camp of their choice, students develop relationships and networks that will foster and sustain their career trajectory.

The establishment of this fund comes at a critical time. Only 40% of 2016 geoscience bachelor's candidates participated in a field camp – and attendance is decreasing. Rising costs and dramatically reduced corporate funding for field camp scholarships makes attending a camp increasingly prohibitive for many students. The Petroleum Geoscientists Fund was founded to begin addressing these issues while underscoring the value of undergraduate field experience, and it is one of a small number of sources for field camp financial support currently available.

Finally, the fund provides a way for industry career geologists across companies, whether active or retired, to give back to their field. Throughout its history, GSA has developed partnerships with individuals and corporations in the oil and gas industry that have proven fruitful. Students have been able to interact with industry employees in order to learn more about their sector and how to prepare for industry careers, while corporate partners can engage with, and draw interns and employees from, GSA's robust student membership. This fund allows us to strengthen our partnerships and provide more opportunities for students to explore and prepare for these careers.

Will you join us in supporting undergraduate field experiences and research? If you or your company would like to discuss in-depth ways to support the Petroleum Geoscientists Fund for Undergraduate Field Experience and Research, please contact Debbie Marcinkowski at +1-303-357-1047 or dmarcinkowski@geosociety.org. To make an immediate gift please visit: https://gsafweb.org/fund/petroleum-geoscientists-fund/.

Field camp participants during a session at Bighorn Basin.

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GSA PUBLICATIONS HIGHLIGHTS

Tour Indiana with This Free GSA Field Guide

To coincide with GSA's 2018 Annual Meeting & Exposition in Indianapolis, we're offering free digital access to the field guide, *From the Cincinnati Arch to the Illinois Basin: Geological Field Excursions along the Ohio River Valley,* so you can make the most of your visit to the region.

Topics include Pennsylvanian stratigraphy in southwestern Indiana; the use of filled-fracture features as indicators of seismicity within the lower Wabash valley; hydrogeology of an abandoned mine site in Newburg; analysis and correlation of Silurian depositional sequences across the region; how source-area expansion is documented in the time-oriented array of buildings in Evansville; as well as chapters that explore the history of New Harmony and the pioneering naturalists who worked to map this country's interior.

Available now through the end of November.

Visit the GSA Bookstore at ***http://rock.geosociety.org/Store/*** and search "FreeIndiana" to download your copy today!
The exploration begins at ***https://pubs.geoscienceworld.org/gsa.***

Geology and Tectonics of Subduction Zones: A Tribute to Gaku Kimura

Edited by Timothy Byrne, Michael B. Underwood, Donald Fisher, Lisa McNeill, Demian Saffer, Kohtaro Ujiie, and Asuka Yamaguchi

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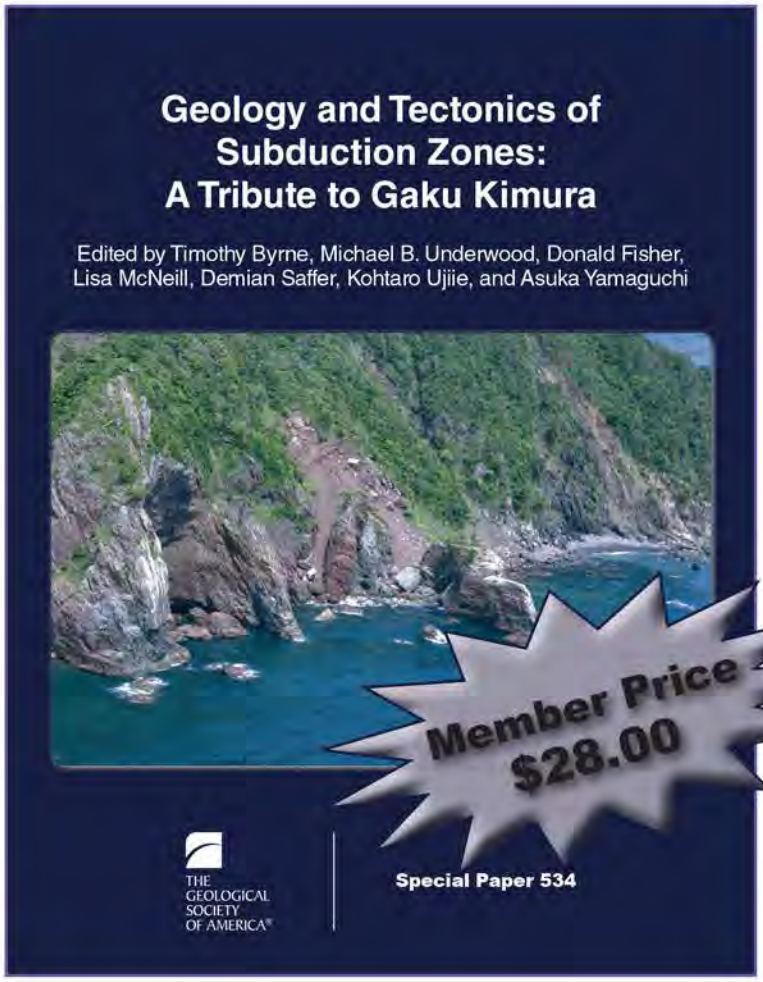
Special Paper 534

This volume highlights the career of Dr. Gaku Kimura, professor emeritus of geosciences at the University of Tokyo, by showing the spectrum of research required to understand these dynamic environments and the range of research he has inspired. The first three chapters provide context for the growth of accretionary prisms by examining the thermal structure of the ocean crust, and the sedimentary facies and potential fluid pathways in the Shikoku Basin. Next, two chapters look at the regional-scale structure of the plate boundary and the rheology and hysteresis of the hanging wall of the subduction zone in SW Japan. The following five chapters discuss the progressive deformation and thermal maturation of sediments along accretionary margins from Japan to New Zealand to western North America. The final two chapters look at the deformation processes near the subducting plate interface with the last chapter proposing a link between outcrop-scale observations and seismic slip.



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