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On the Numbers and Areas of Tectonic Plates

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Edited by Richard D. Law, J. Ryan Thigpen, Arthur J. Merschat and Harold Stowell

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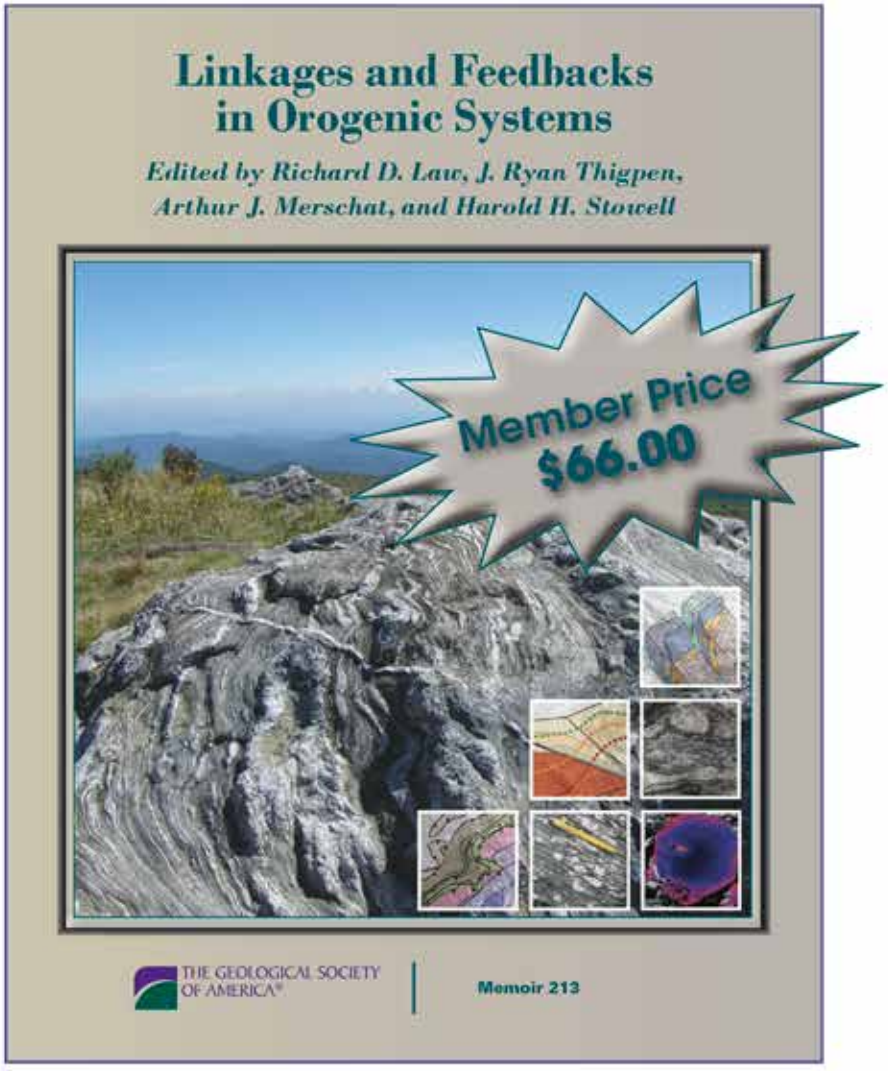

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THE GEOLOGICAL SOCIETY OF AMERICA®

Broken Sheets—On the Numbers and Areas of Tectonic Plates

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ABSTRACT

The sizes and numbers of tectonic plates are thought to record the importance of plate division, amalgamation, and destruction at divergent and convergent margins. Changes in slope apparent on log area versus log frequency plots have been interpreted as evidence for discrete populations of plate sizes, but the sizes of lithospheric plates are also closely approximated by a continuous density function in which diameters of individual plates are exponentially distributed; such size frequencies are dependent only on the total area and number of designated elements. This implies that the spatial locations of plate boundaries are controlled by a myriad of complicated and interrelated processes such that the geographic occurrence of any particular boundary is largely indeterminate and thus spatially independent of the proximity of other plate boundaries. Observed breaks in slope on linearized size versus frequency plots are merely coincidental and of themselves do not support an interpretation of discrete tectonic processes operating over distinct length scales. Although a purely random distribution of plate boundaries also implicates a similar chance distribution of plate sizes, some smaller plates are indeed clustered along convergent boundaries in the southwestern Pacific. Such association of plates of similar (small) sizes suggests that locations of plate boundaries are best described as reflecting nonhomogeneous Poisson processes wherein probabilities of reaching some plate boundary vary along any Earth-surface transect. Size frequencies of continents, calderas, and many other geologic entities where dimensions are expressed as areal extent exhibit similar size-frequency distributions, suggesting that lateral occurrences of their boundaries are also largely unpredictable, thus reflecting the inherently complicated nature of processes associated with their formation.

INTRODUCTION

The outer brittle layer of the Earth consists of lithospheric plates that move over the relatively weak asthenosphere. Larger-scale aspects of plate movement are the surficial manifestations of mantle convection in the deeper Earth, but local processes of deformation may be only indirectly related to regional stress fields. Because size frequencies from brittle fragmentation might be manifest as self-similar (fractal) power laws (e.g., Davydova and Uvarov, 2013), it is important to know the relationships between lithospheric rheology and degree of fragmentation, as well as the degree to which the breakup of the lithosphere reflects the dynamics of mantle convection versus local interactions along plate boundaries. This is particularly so as models of the evolution of tectonic plates are extended over ever-increasing spans of geologic time (e.g., Domeier and Torsvik, 2014; Matthews et al., 2016; Merdith et al., 2017).

One approach to this question derives from considerations of the numbers and sizes of the tectonic plates. Anderson (2002), for example, noted that fracture patterns tend to self-organize such that mud cracks, frozen ground, basalt columns, and other natural features exhibit similar patterns. He argued that tectonic plates therefore might consist of semi-rigid larger polygons separated by (at times diffuse) boundary zones of deformation surfaced by smaller elements. Bird (2003) presented a global data set interpreted as embodying several fractal subpopulations of plate sizes, each manifest as an approximately linear trend in log area versus log occurrence–frequency space. Sornette and Pisarenko (2003) argued that plate sizes comprise a single continuous power law distribution of size frequency, but with the proviso that a finite Earth surface area imposes an upper limit on larger plate areas. Like Bird (2003), Morra et al. (2013) concluded that plate sizes consist of large and small populations, and that this difference in plate areas persists back in time at least several tens of millions of years. Mallard et al. (2016) employed spherical models of mantle convection to examine the geodynamical processes that drive the tessellation of the Earth's lithosphere and concurred with Bird (2003) and Morra et al. (2013) that plate areas comprise several distinct populations. Harrison (2016) proposed an additional 107 plates as subdivisions of the 52 plates proposed by Bird (2003); he also interpreted several changes of slope in log-log plots of plate number versus area as reflecting the presence of several size populations.

While the designation of any particular region as a discrete "plate" is somewhat of an evolving enterprise (e.g., Zhang et al., 2017), the actuality of either single (Sornette and Pisarenko, 2003) or multiple (Anderson, 2002; Bird, 2003; Mallard et al., 2016; Harrison, 2016) populations of plate sizes is important to interpreting the manifestation of causative tectonic processes. If sizes of tectonic plates are readily characterized by a single frequency distribution, be it fractal or otherwise, an interpretation of multiple processes operating at distinct length scales is not supported. Conversely, if plate area-frequencies are best described by multimodal distributions, then interpretations linking populations of large plates to processes occurring at convective length scales (e.g., Lenardic et al., 2006) and populations of smaller plates to the generation of lithospheric fragments at the edge of plate boundaries are entirely reasonable.

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NUMBERS AND AREAS OF TECTONIC PLATES

Detailed data on major tectonic boundaries and areas of enclosed plates are summarized by Bird (2003), who presented the characteristics and locations of 6,048 points that serve to define 229 boundary segments delineating 52 lithospheric plates. The relationship between plate area and frequency of occurrence is most conveniently represented as a cumulative frequency distribution in which plate area is plotted relative to size exceedance—the number of plates equal to or larger than any size in question; the Y-intercept defines the total number (e.g., 52) of data values (Fig. 1).

THE BROKEN SHEET FUNCTION

The general curvilinear form of log-log plate area frequency distributions is similar to size-frequency distributions for some other area mosaics that include regions of like sediment (lithotopes) across depositional surfaces (Wilkinson and Drummond, 2004), regions on global geologic maps (Wilkinson et al., 2009), sizes of geopolitical subdivisions (McElroy et al., 2005), and taxonomic divisions of organismal morphospace (Wilkinson, 2011). Size-frequency distributions for these tessellations reflect the partitioning of the total area into mosaics of sub-elements wherein locations of boundaries, and therefore the sizes of these elements, are statistically independent.

Conceptually, if the sizes of sub-elements are represented by linear distances across them rather than areas, the distribution of distances between boundaries is the same as that arising from the classic one-dimensional "broken stick" model of random linear subdivision proposed by MacArthur (1957), who suggested that ecological niches within a resource pool could be broken up like a stick, with each piece of the stick representing a niche occupied in the community. This one-dimensional style of division comprises an exponential distribution of separation magnitudes, the same as that arising from differences between a series of ordered random numbers. In the two-dimensional manifestation of random division, a scenario that herein we refer to as the "broken sheet" model, area-frequency distributions are those that would result when linear distances between each boundary are

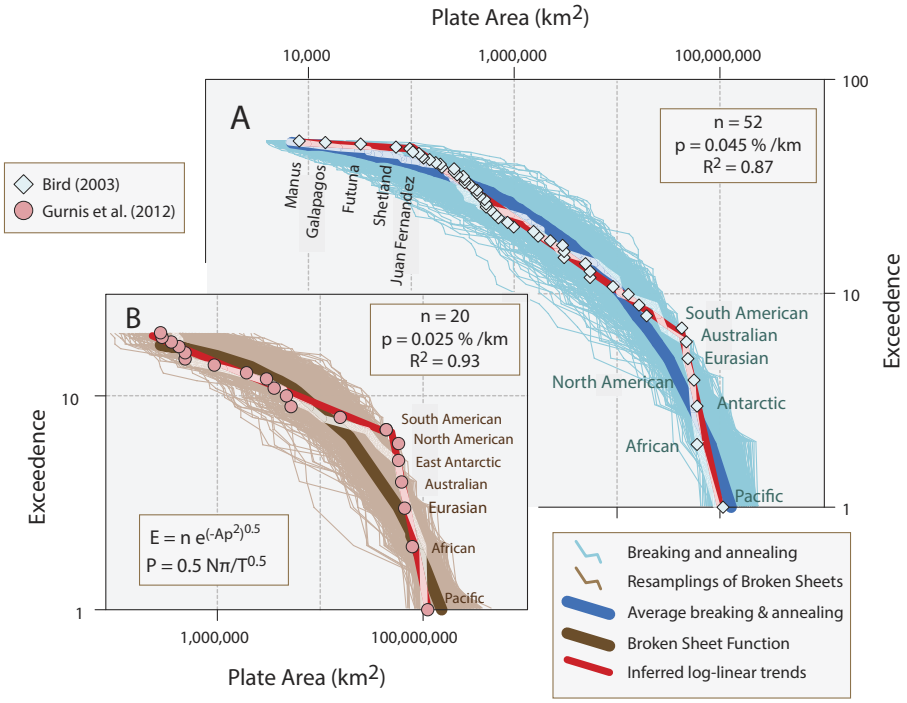

Figure 1. Areas of tectonic plates relative to exceedance, the number of plate areas equal to or greater than the *x*-axis values. (A) Plate areas from Bird (2003). (B) Areas from Gurnis et al. (2012). Division into three apparent subpopulations in (A) (*n* = 52) and two subpopulations in (B) (*n* = 20) is based on seemingly linear trends (straight red lines). Light blue lines in (A) are 500 sets of plate areas (*n* = 52) resampled from a stable model time series wherein two random plates are annealed and another two randomly divided over thousands of iterations (see text). Heavy blue line in (A) is the average area of many realizations of such annealed and broken plates. Light brown lines in (B) are 500 sets of plate areas (*n* = 20) resampled from the broken sheet density function. Heavy brown line in (B) is the ideal broken sheet size frequency distributions predicated by the number of designated plates (20) and the total area of the sphere on which they exist (4 π steradians; ~510 × 10^6 km^2). White lines in (A) and (B) are the two series whose areas, by chance, are closest to observed sizes. Since there is no inherent division of sizes in these models, any subdivision based on the perception of differing slopes for straight-line segments is spurious.

exponentially distributed. The broken sheet distribution (e.g., Fig. 1) is the form that results when sizes of randomly partitioned sub-elements are plotted as areas, rather than distances. The surface of the Earth can therefore be described as being subdivided into tectonic plates such that plate sizes, as measured by the linear distances across them, are exponentially distributed and, hence, like the broken stick, are consistent with random subdivision.

In the broken sheet size-frequency distribution, size exceedance (E, the number of plates with areas greater than or equal to some value) of any entity with some area (A) is defined by the relation in Equation (1),

$$E = n\, e^{(-Ap^2)^{0.5}}, \quad (1)$$

where n is the total number of entities, p is the incidence of boundary occurrence—the probability of crossing some boundary per unit length of transect, itself expressed as Equation (2),

$$p = 0.5\, n\pi/A^{0.5}, \quad (2)$$

and A is the total surface or "sheet" area being divided (for Earth, ~510 × 10^6 km^2).

Comparisons to the 52 plate areas from Bird (2003) and the 20 plate areas from Gurnis et al. (2012) yield R^2 values of 0.87 and 0.93, respectively (Fig. 1); values of p, which correspond to the probability of crossing a plate boundary, are ~0.045% and 0.025% per kilometer, respectively.

VARIATION IN PLATE SIZE

If a broken sheet distribution describes the sizes of lithospheric plates more effectively than the multi-fractal (e.g., Bird, 2003; Morra et al., 2013; Harrison, 2016) systems proposed earlier, then this system should also: (1) largely account for differences between these theoretical size

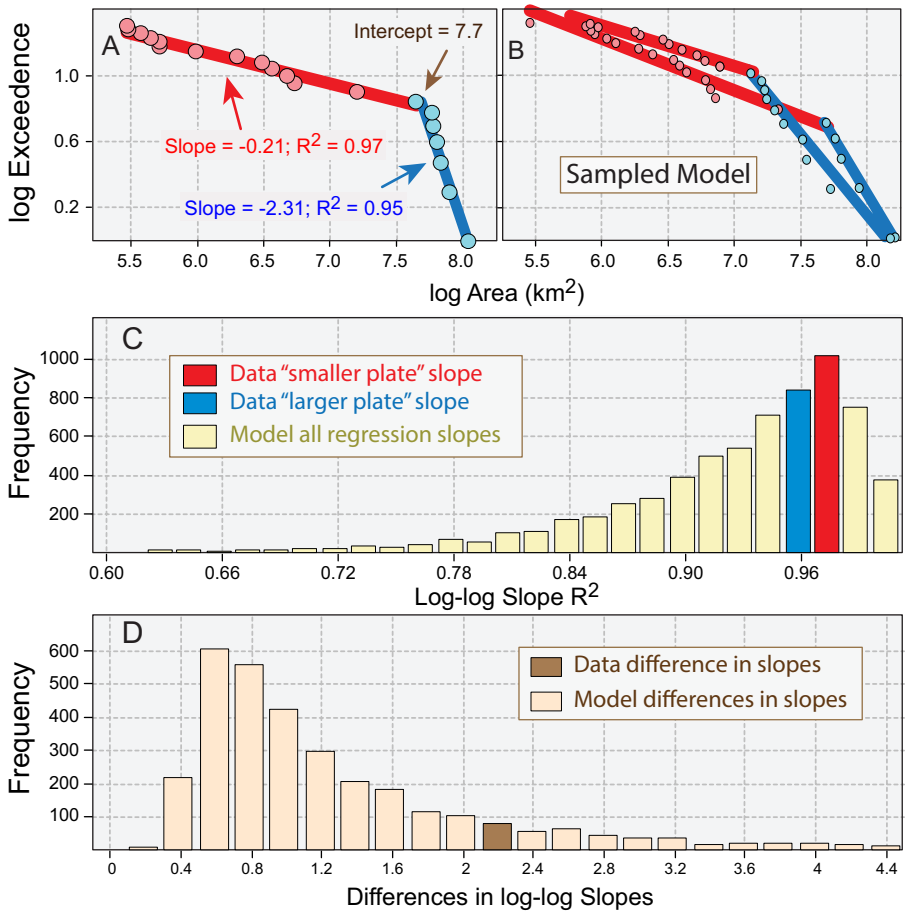

Figure 2. Correlations and slopes of apparent linear trends in measured and model plate area frequencies. (A) Plate areas from Gurnis et al. (2012) exhibiting an apparent inflection in slope at log area ~7.7 (~50 × 10⁶ km²); slope difference is 2.11. (B) Two model area frequency distributions, each comprising 20 randomly delimited plate areas with a total of 510 × 10⁶ km²; red and blue lines represent the two best-fit log-linear regressions that account for the largest amount of plate size variance. (C) Frequency distribution of R^2 values of 1,000 models of 20 randomly delimited plate areas (light yellow bars) compared to R^2 values of smaller (red bar, red line in [A]) and larger (blue bar, blue line in [A]) "populations" in the Gurnis et al. (2012) data. (D) Frequency distribution of apparent differences in slopes of "smaller" (e.g., red lines in [B]) and "larger" (e.g., blue lines in [B]) plate areas among 1,000 models of 20 randomly delimited plate areas (tan bars) compared to that defined by smaller (red line in [A]) and larger (blue line in [A]) plate "populations" in the Gurnis et al. (2012) data (brown bar). Note that area-exceedance correlations of "small" and "large" plate areas in the observed data as well as differences in these slopes all fall well within the range of values expected for the sparse sampling of a continuous broken sheet distribution of plate areas.

frequency distributions and those observed among measured plate areas; and (2) yield results that are in agreement with the apparent grouping of plate areas into the several subpopulations based on apparent linear trends in log-log plot of area versus exceedance (e.g., Fig. 1). With respect to differences between theoretical and observed plate areas, it seems apparent that increases in the size of any particular plate might occur fairly continuously through marginal accretion during seafloor spreading or more abruptly during the development of tectonic sutures at convergent margins, and that decreases might occur continually during subduction, or relatively episodically during the development of rifted or transform boundaries. Modern plate size frequencies are a snapshot of the time-integrated geologic histories of the growth and decline in the numbers and sizes of all constituents of the global plate population (e.g., Morra et al., 2013).

A straightforward model of such processes might simply presume that the observed lithospheric plate area frequency distribution is a natural consequence of both the random division and random annealing of members of some initial population of plate areas. We effect such a simulation with a population of $n = 52$ plates (e.g., Bird, 2003), each with an initial area of 9.8×10^6 km² ($A = 510 \times 10^6$ km²). From this group, one pair is selected at random and annealed into a single composite; another element is then selected and randomly divided. Because some minimum area should serve to separate lithospheric "plates" and smaller structural elements, we assume a minimum area of 4,000 km², about half the size of the smallest (Manus, 8,117 km²) plate in the Bird (2003) database. Moreover, owing to constraints imposed by length scales of mantle convection (e.g., Lenardic et al., 2006), we assume a maximum plate area of 200×10^6 km², about twice the area of the largest (Pacific, 104×10^6 km²) plate. Given these two constraints, repeated annealing and division of members of the population rapidly results in model size frequencies that are both stable with respect to numbers of iterations and indistinguishable from the observed frequency distribution of modern plate areas (Fig. 1A). The range of permissible area frequencies afforded by this simple model of repeated random annealing and fragmentation completely overlaps the observed sizes of Bird's (2003) 52 plates.

VERACITY OF PLATE SUBPOPULATIONS

A single "broken sheet" hypothesis for the generation of a continuum of plate sizes must also account for the widely held perception that plate areas somehow comprise two or more subpopulations, each scaled to some distinct tectonic processes. We suggest that what appear to be "population-specific" segments in log-size versus log-exceedance plots (Fig. 1) are no more than coincidental trends in a sparsely sampled continuum of plate areas. Two issues are relevant to the veracity of dividing and interpreting curvilinear log-log data arrays on the basis of apparent straight line segmentation. First, any model that includes a greater number of subdivisions and a greater number of parameters (each line segment being described by some slope and intercept) will certainly result in better agreement with data than one with fewer parameters (only the number of plates and total area comprise the broken sheet representation). However, benefits from increases in goodness-of-fit are balanced by costs in model complexity (e.g., Akaike, 1974), and greater numbers of model parameters run counter to the heuristic perception that simpler is better. Furthermore, any array representing some sparsely sampled curvilinear distribution will unavoidably exhibit

runs of apparent linearity (e.g., Fig. 2). Are the several subpopulations of plate areas suggested by Bird (2003), Morra et al. (2013), Harrison (2016), and Mallard et al. (2016) statistically distinct from apparently linear runs manifest in the sparse sampling of a broken sheet?

In order to address that question, we consider the tabulation of 20 plate areas from Gurnis et al. (2012) used by Morra et al. (2013) to define two subpopulations of plate sizes (Figs. 1B and 2A). As noted, these plate sizes are closely approximated by areas in which diameters are exponentially distributed—the broken sheet function (Fig. 1B). If we randomly draw a sample of 20 areas from such a theoretical population, by chance the resultant array will exhibit some number of apparent linear runs in log plate area versus log exceedance space (Fig. 2B). In order to quantify the degree of spurious linearity apparent in such randomly sampled populations, we repeatedly calculate the slopes and correlation coefficients for the two linear trends that most closely match the sample areas in such a model array, determine the sample (plate) number and area where the intersection between these two linears occurs, and calculate the differences in their slopes. Based on this exercise, it becomes apparent that the R^2 values of all spurious linear arrays (Fig. 2C), as well as the differences between their slopes (Fig. 2D), comprise populations that completely overlap similar parameters derived from the Gurnis et al. (2012) data. Because we cannot reject the null hypothesis that all of these areas were drawn from the same size-frequency distribution, any proposition that they somehow exemplify several distinct subpopulations of plate areas becomes untenable. Proposed linear runs of plate areas are entirely consistent with the sparse sampling of a broken sheet.

GEOGRAPHIC CLUMPING OF TECTONIC PLATES

Given that a broken sheet model of plate fragmentation, wherein geographic locations of plate boundaries are randomly distributed across the Earth's surface, is in good agreement with observed areas of plates (Fig. 1), we might then ask if the Earth's plates also exhibit random geographic dispersal. If the distribution of plate boundaries was laterally homogeneous, then it follows that the areas of those plates should be spatially

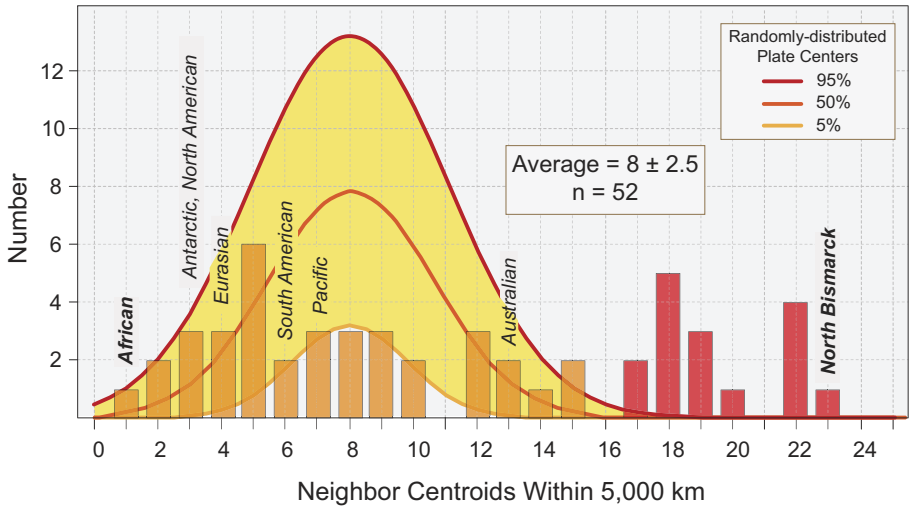

Figure 3. Number of neighbor plate centers within 5,000 km of plate centroids (bars) and Monte Carlo simulation of numbers of neighbors apparent among 500 model sets of randomly distributed plate centers (yellow envelope). Names of several larger plates and those with fewest (African) and most (north Bismarck) neighbors are above appropriate bars. Note that 16 plates have 17 or more neighbors (darker red bars), a density that reflects a spatial association of smaller plates; all of these occur in the southwestern Pacific.

homogeneous as well; that is, the numbers of plates within some distance of the centroid of any other plate might exhibit a unimodal distribution. Conversely, if plates were geographically associated by size, then numbers of neighbors within some distance of any plate center might exhibit some sort of multimodal frequency distribution, with smaller distances separating smaller plate centroids, and larger distances separating larger. Among the Bird (2003) data, the closest pair of centroids is that of the North Bismarck and Manus plates off Papua New Guinea (235 km); no plates have any neighbors within a smaller distance. Conversely, the most widely separated centers are those of the South American and Philippine Sea plates (19,412 km); at that (or any greater) distance, all centroids have 51 neighbors. Taking 5,000 km as a working distance, the frequency of so-defined neighbors for any one of the Bird (2003) plates ranges from 1 to 23 (Fig. 3). Moreover, Monte Carlo simulations show that the number of neighbors within 5,000 km of randomly distributed centroids in fact does comprise a Gaussian distribution with a mode of ~8 neighbors, the modal number expected for the centroids of 52 plates haphazardly dispersed across ~510 × 10^6 km^2 of the Earth's surface (Fig. 3). Because several plates exhibit numbers of neighbors that fall well above 95% confidence limits for randomly placed centroids, we can reject the null hypothesis that the distribution of plate sizes is truly random. Those observed plates with 17 or more neighbors within 5,000 km (Fig. 3) are located exclusively in the southwestern Pacific; no other part of the Earth exhibits a statistically significant concentration of tectonic plates.

DISCUSSION

Numbers and Sizes of Tectonic Plates

In general, the numbers and areas of modern tectonic plates are closely replicated by the distributions expected when locations of boundaries are largely independent; to a first approximation, the Earth's lithospheric surface is randomly subdivided. That several smaller plates exhibit geographic association also suggests that actual fragmentation is more accurately characterized as a spatially heterogeneous Poisson process; the probability of crossing some plate boundary varies with geographic position, being higher across the southwestern Pacific.

Understanding the reasons for differing numbers and sizes of tectonic plates is important from a number of perspectives. As noted, difference in plate areas might implicate different processes in their evolution, with larger plates being carried and transported by mantle convection and smaller ones undergoing greater amounts of brittle deformation along regions of convective convergence. The greatest

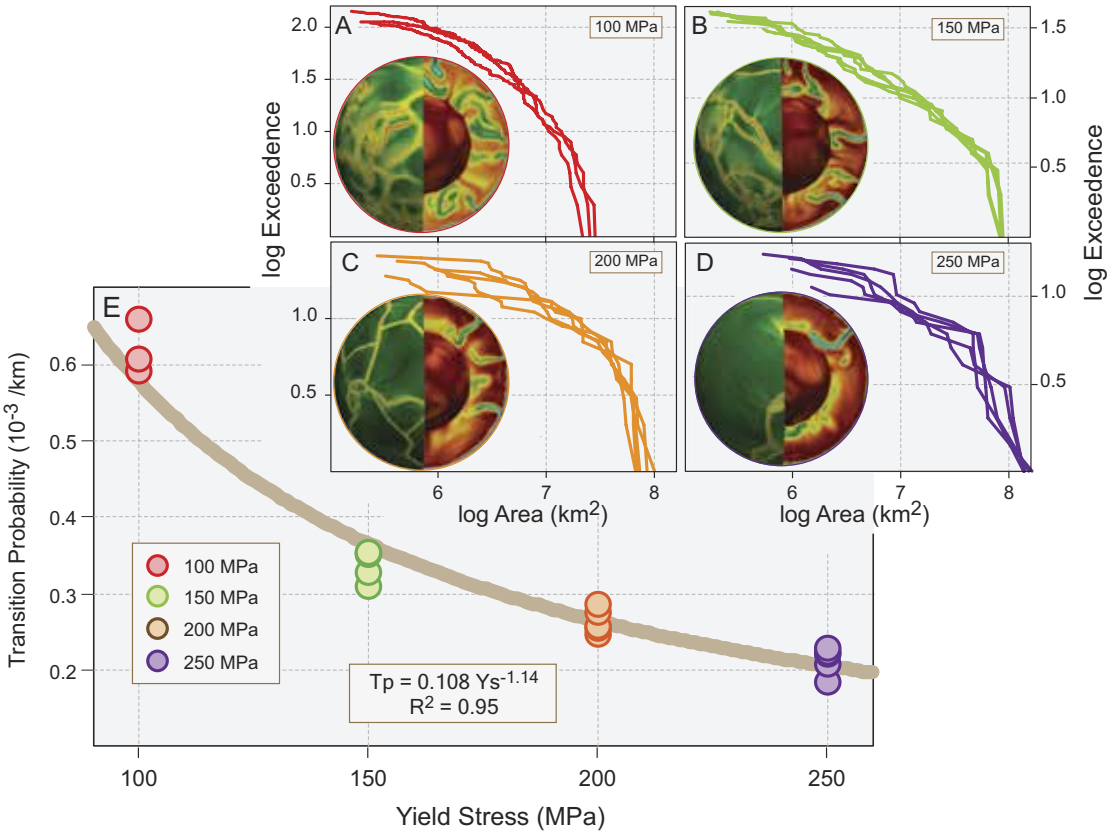

Figure 4. (A–D) Convection in 3D spherical models of mantle convection (inset Earth models) and the logarithm of plate size versus log exceedance (cumulative count) (colored lines) for yield stresses of 100, 150, 200, and 250 MPa from Mallard et al. (2016). (E) Transition probabilities for broken sheets calculated for the 18 arrays of plate area and number (colored lines in [A–D]). Relations between model yield stresses and transitions probabilities defined an approximate power law relation between stress at model plate boundaries and degree of plate fragmentation.

clustering of plates is around the equatorial North Bismarck plate off Papua New Guinea (23 neighbors within 5,000 km). Association of smaller plates in the southwestern Pacific could reflect a greater importance of such processes of plate fracture, particularly when overriding plates are oceanic lithosphere, in ways that are not associated with convergence when the overriding plate is continental lithosphere, as is found along the eastern Pacific. However, fragmentation alone is a unidirectional process that serves to abruptly decrease plate sizes and somewhat obviates considerations of size changes that might arise through subduction, spreading, or suturing.

Although identification of "populations" of large and small plates defined by apparent linear runs in log size versus log exceedance space may indeed be spurious, this does not preclude an interpretation that plate-center convection and plate-margin tectonism have differentially influenced plate size histories. There is much support for the premise that the mechanisms of plate formation and destruction might exhibit a degree of variation along a theoretical length scale. At a longer scale, it is generally accepted, for example, that larger plates bearing continental crust tend to aggregate over cold downwellings, leading to overheating of the mantle, which in turn gives rise to the tensional fragmentation of continents (e.g., Gurnis, 1988). Conversely, at a shorter scale, subduction zones may tend to produce smaller plates (e.g., Mallard et al., 2016), particularly when subduction-related back-arc volcanism develops into oceanic spreading centers (e.g., Bird, 2003); microplates may also be produced along seafloor spreading centers when propagating rifts pass by each other (e.g., Hey et al., 1985). Other processes of plate generation and destruction are less sensitive to length scale; plates of any size can be amalgamated during continental collision and/or destroyed by subduction.

That plate areas are in general agreement with the premise that the Earth's lithosphere is randomly fragmented, yet there is geographic association of larger and smaller plates, merely enforces the supposition that those factors responsible for the generation of differing plate numbers, sizes, and locations, both in time and in space, must reflect a concatenation of many complex processes, but that these processes also operate with differing geographic and/or temporal intensity across the Earth's surface.

IMPLICATIONS

As a first approximation, the Earth's lithosphere generally comprises a randomly broken sheet wherein the occurrences of plate boundaries are spatially independent but somewhat geographically clustered across the southwestern Pacific. This suggests that the processes of spreading, suturing, fragmentation, and subduction, which ultimately result in differing plate areas as well as contiguous areas of granitic crust (i.e., continents), are irreconcilably complex while also exhibiting some degree of spatial and temporal heterogeneity across the Earth's

surface. The Earth's evolving tectonic state, particularly with respect to continental fragmentation, serves to influence ocean currents, atmospheric composition, and circulation, as well as balances of incoming and outgoing radiation; the location of elevated terrain suitable for the development of glacial ice forces climate change, which in turn serves to modulate rates of geochemical cycling through atmospheric and oceanic reservoirs (e.g., DeConto, 2009). Wilson cycle–scale changes in degree of continental amalgamation and dispersal have been invoked as causal drivers for a wide variety of large-scale processes ranging from changes in continental freeboard (e.g., Whitehead and Clift, 2009) to climatic and biogeochemical cycling (e.g., Nance and Murphy, 2013) to global marine animal diversity (e.g., Zaffos et al., 2017). As such, the broken sheet model serves as a first-order metric for the quantification of changes in extents of continental aggregation over geologic time.

From a practical point of view, the broken sheet function or a derivative thereof can serve as a useful metric in describing size frequencies in many systems where entity size is measured as some area, and where log size versus log exceedance (cumulative count) comprise curvilinear arrays in log-log space, as is the case with respect to some compilations of calderas (e.g., Geyer and Martí, 2012), impact craters (e.g., Hergarten and Kenkmann, 2015), and earthquake magnitudes (e.g., Kagan, 2002). With respect to lithospheric plates, Mallard et al. (2016) have recently noted that specifics concerning how plate sizes relate both to properties of the lithosphere and processes of underlying mantle convection are poorly understood. In order to address these questions, they employ three-dimensional spherical models of mantle convection that combine pseudo-plasticity and variations in viscosity in order to generate plate-like behavior (Fig. 4A). Pseudo-plasticity is realized through a yield stress that characterizes the plastic limit at which concentrated strain produces plate boundaries. Their models produce plate size–frequency distributions that serve to more intimately relate styles of lithosphere fragmentation to processes of mantle convection. Perhaps not surprisingly, lower values of yield stress correspond to greater degrees of fragmentation. But this relation is more readily quantified when transition probabilities are determined for degrees of fragmentation at differing yield stresses. Specifically, transition probability (*Tp*) decreases (lithosphere fragmentation increases) with increasing yield stress (*Ys*) as: $Tp = 0.108\ Ys^{-1.14}$; $R^2 = 0.95$ (Fig. 4). From a utilitarian perspective, the broken sheet function therefore appears to effectively capture degrees of lithospheric tessellation under differing rheological conditions and therefore affords a potentially useful metric for describing the evolution of crustal deformation over the entire span of Earth's geologic history.

From a more philosophical point of view, understanding the nature of size frequencies of tectonic plates, continents, and other entities is perhaps of more than just academic interest. The study of many geologic features commonly generates quite dissimilar interpretations, and these disagreements often arise from inherently different perceptions of our world. On the one hand, a deterministic view links the origins of observed phenomena to unique and discernable causes in an explainable way, while on the other, a more stochastic perspective argues that the concatenation of multiple intricate geologic processes gives rise to a large degree of randomness and generally unresolvable levels of complexity in the natural world. Where one falls on this spectrum bears directly on how one interprets the numbers and sizes of tectonic plates and the reality of proposed linkages between a rather deterministic understanding of regional motions of the asthenosphere and those more complex and decidedly less predictable processes of local deformation.

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Annual Meeting & Exposition

GSA 2018

4–7 November

Indianapolis, Indiana, USA

Pedal boats and gondolas offer different ways to explore the Central Canal. Photo courtesy of Lavengood Photography, Visit Indy.
Postcard: Top to bottom, left to right: Donaldson Cave, Spring Mill State Park, Indiana. Photo by Lee Florea. Indiana Dunes National Lakeshore. Photo by Todd Thompson. Grist Mill, Spring Mill State Park, Indiana. Photo by Lee Florea. Indy Skyline photo courtesy of Rich Clark, Visit Indy.

THE GEOLOGICAL SOCIETY OF AMERICA®

Action Dates

Now Open	Meeting room request system (non-technical, social, and business meeting room requests)
Now Open	Housing (VisitIndy is the official housing bureau)
Now Open	Abstract Submission Form
Early June	Registration and Travel Grant applications open
6 June	Meeting room request deadline—fees increase after this date
Early August	Student volunteer program opens
14 August	Abstracts deadline
1 October	Early registration deadline
1 October	GSA Sections travel grants deadline
8 October	Registration and student volunteer cancellation deadline
10 October	Housing deadline for discounted hotel rates

Organizing Committee


Todd Thompson


Kevin Mickus


Amy Brock-Hon


Lee Florea


Polly Root Sturgeon

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Host Organization: Indiana Geological & Water Survey

IGS INDIANA GEOLOGICAL & WATER SURVEY INDIANA UNIVERSITY

Indiana skyline. Photo courtesy of Jason Lavengood, Visit Indy.

Message from the GSA 2018 General Chair

Todd Thompson

Set in the middle of the great Midwest, Indianapolis is the site of GSA's 130th Annual Meeting & Exposition. Known as the "Crossroads of America" and the home of the Indy 500, Indianapolis is a vibrant city that welcomes you with Hoosier hospitality and will surprise you with its diversity, multi-culturalism, and cosmopolitan ambiance. GSA staff and the local organizing committee are planning an exciting week packed with 26 pre- and post-meeting field trip offerings, 29 short courses, and a wide variety of technical sessions. Also, local universities, museums, and institutions will enhance the meeting with displays and activities for all attendees.

If you want to sample Indy's cultural offerings, there are many to choose from. Take a stroll downtown through the White River State Park and ride in a gondola down the Central Canal. Along the canal, visit the Indiana State Museum and its geological collections. The adjacent Eiteljorg Museum of American Indians and Western Art houses one of the finest collections of Native American contemporary art. Elsewhere in town, the Indianapolis Children's Museum is the largest of its kind in the nation and is home to a world-class dinosaur exhibit and vertebrate paleontology lab. You can explore the history of the Indianapolis Motor Speedway and auto racing in the Hall of Fame Museum at the "Greatest Race Course in the World," and then refresh yourselves at the diverse dining and brewery options across the city.

Indianapolis, situated near the margin of Pleistocene glaciation, is a prime venue for exploring the geology of the Midwest. Repeated glacial cycles have left fantastic exposures of Quaternary sediments from classic glacial moraines and eskers to relict shorelines and dunes along the Great Lakes. Underlying these sediments, and exposed south of the city, are Paleozoic strata in a sequence of escarpments and plateaus that are home to classic outcrops and fossil locations, scenic waterfalls and deep gorges, and world-class karst landscapes and caves. Further southwest in the Illinois Basin are economically important coal seams and oil fields that have fueled the nation. And along the banks of the Wabash River in southwestern Indiana, a utopian town from the 1800s, named New Harmony, was the birthplace of geological exploration in the United States, giving rise to the Owen brothers, who served as state geologists in Indiana, Kentucky, and Arkansas, and whose geologic mapping and exploration was the underpinning of American geology for almost 200 years.

We look forward to welcoming you to Indianapolis this November!

Todd Thompson
GSA 2018 General Chair
Director and State Geologist, Indiana Geological & Water Survey

Annual Meeting Engagement Opportunities

Elevate your company's image and engage with GSA Annual Meeting attendees from all sectors onsite.

EXHIBIT
Put your company in the spotlight to a host of earth scientists from the academic, government, business, and industry sectors.

ADVERTISE
Reach GSA Members and meeting attendees and be visible in the meeting program book, *GSA Today*, and the GSA Connection e-newsletter.

SPONSOR
Be a leader in giving back to your community through meeting sponsorships.

SHOWCASE TECH PRODUCTS
Give attendees hands-on time with your products in the *GEO.SCI Technology Demonstration Theater.*

BUILD YOUR BRAND
Be seen throughout the convention center (escalator signage, banners, wraps).

We are happy to help determine your interests and create a discounted package that will best meet your needs.

GSA 2018

4–7 November
Indianapolis, Indiana, USA

More information is available at
community.geosociety.org/gsa2018

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

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Indianapolis, Indiana, USA

Registration

- **Registration opens early this month**
- **Early registration deadline:** Midnight MDT, 1 October
- **Cancellation deadline:** Midnight MDT, 8 October

GSA strives to create a pleasant and rewarding experience for every attendee. Let us know in advance of the meeting if you have needs that require further attention. Most dietary considerations can be met without any extra charge. Be sure to check the box when registering online and describe your need in the space provided.

REGISTRATION FEES

	Early Registration (June–1 Oct.)	Standard/Onsite Registration (after 1 Oct.)
Professional Member Full Meeting	US$420	US$499
Professional Member 1 Day	US$255	US$295
Professional Member >70 Full Meeting	US$295	US$380
Professional Member >70 1 Day	US$195	US$220
Professional Nonmember Full Meeting	US$610	US$690
Professional Nonmember 1 Day	US$360	US$435
Early Career Professional Member Full Meeting	US$270	US$340
Early Career Professional Member 1 Day	US$165	US$199
Student Member Full Meeting	US$135	US$170
Student Member 1 Day	US$90	US$105
Student Nonmember Full Meeting	US$190	US$225
Student Nonmember 1 Day	US$125	US$145
High School Student	US$50	US$50
K–12 Professional Full Meeting	US$60	US$70
Field Trip or Short Course Only	US$40	US$40
Guest or Spouse	US$90	US$99
Low Income Country*	50%	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" registrants. Please fill out a printable version of the registration form and mail it to GSA, 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301, USA.

Don't forget to...

- Register for tours, special events, field trips, and short courses
- Bring a copy of your meeting confirmation with you
- STUDENTS: Be sure to apply for the travel grant program by 1 October
- Make your hotel reservation
- Book your travel

Check the meeting website for more information.

Travel Grants

Need assistance getting to the Annual Meeting?
GSA Sections, Divisions, and Associated Societies are ready to help!

Various groups are offering grants to help defray your costs for registration, field trips, travel, etc., at the GSA Annual Meeting & Exposition. Check out the meeting website for application and deadline information. **Note**—Eligibility criteria and deadline dates may vary by grant.

For meeting attendees who reside outside of North America, check the International Travel Grant webpage at **www.geosociety.org/Intl_TravelGrant.** The deadline to apply is **5 July.**

Help a member participate in the GSA Annual Meeting by donating to the Student Travel Fund on your registration.

Interested in helping students participate in the meeting? Every year, a large percentage of students apply for travel grants for the meeting but do not receive an award due to a limited number of funds. You can help reduce this number by donating as little as US$10 via your registration form. **100% of funds collected go to students.**

Travel & Transportation

Indianapolis International Airport. Photo courtesy of IM Imagebank, VisitIndy.com.

Photo by Peterhuocean11 at Wikipedia public domain, via Wikimedia Commons.

By Air

Indianapolis International Airport (IND)

The LEED-certified Indianapolis International Airport is a short, low-traffic, 15-minute drive from downtown. One of the country's most environmentally friendly airports is the most passenger-friendly as well. Air travelers receive a rousing greeting to the city when they arrive at Indianapolis International Airport. The US$1.1 billion Col. H. Weir Cook Terminal opened in 2008 as the first airport terminal designed after 9/11. It combines state-of-the-art security measures with soaring, smart design and public artwork. The Indianapolis International Airport has been consistently named the best airport in North America.

By Bus

Megabus

Megabus offers city-to-city bus tickets for as low as US$1 for your travel around North America. The Megabus model was designed with the customer in mind, with luxury double-deckers offering free Wi-Fi, at-seat power outlets, panoramic windows, and a green alternative way to travel. Travel to Indianapolis from Atlanta, Chattanooga, Chicago, Cincinnati, Louisville, and Nashville.

Greyhound

Greyhound's iconic brand is synonymous with affordable long-distance travel in North America and a unique national network. The Indianapolis Bus Station is less than a five-minute walk from the Indiana Convention Center.

By Train

Amtrak

Amtrak offers a unique travel experience. Enjoy wide seats, plug-in power, big windows, and plenty of room to get up and stretch your legs. Amtrak has two routes stopping in Indianapolis: The Cardinal route and the Hoosier State route.

By Car

Driving

Known as the Crossroads of America, Indy is within a day's drive of more than half of the country's population. Traffic congestion is a rarity in Indianapolis, and visitors find the city's street layout straightforward and easy to navigate. Downtown features more than 70,000 parking spots. (Reserve your spot now with Spot Hero—see next page.)

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International Attendees: If you are visiting the United States from outside of the country and do not have United States citizenship, you may require a visa. For more information, go to https://travel.state.gov/content/visas/en.html. You can obtain and print out the GSA Invitation Letter to the 2018 Annual Meeting via a link at **community.geosociety.org/gsa2018/visaletter.**

Guaranteed Parking Reservations

GSA has partnered with SpotHero to allow attendees to purchase parking passes at many convenient locations within easy walking distance of the Indiana Convention Center for GSA 2018. Inventory is limited and garages will fill up prior to the meeting, so it is strongly recommended that you purchase parking passes for the meeting in advance.

To reserve your parking spot today, visit the GSA Annual Meeting SpotHero Parking Page at **https://spothero.com/indianapolis/indiana-convention-center-parking/gsa-annual-meeting-11-04-2018** and book a spot with rates up to 50% off drive-up. The SpotHero app is available on both Android and iPhone.

https://spothero.com/indianapolis/indiana-convention-center-parking/gsa-annual-meeting-11-04-2018

Notice of GSA **Council Meetings**

2018 GSA Annual Meeting & Exposition
Indianapolis, Indiana, USA

- **Day 1:** Sat., 3 Nov., 8 a.m.–noon
- **Day 2:** Wed., 7 Nov., 8 a.m.–noon

The meetings will be held at the JW Marriott*, GSA's headquarters hotel, 10 S. West Street, Indianapolis, Indiana 46204, USA. All GSA members are invited to attend the open portions of these meetings.

*Meeting room to be announced. Updates will be posted on the GSA website.

THE GEOLOGICAL SOCIETY OF AMERICA®

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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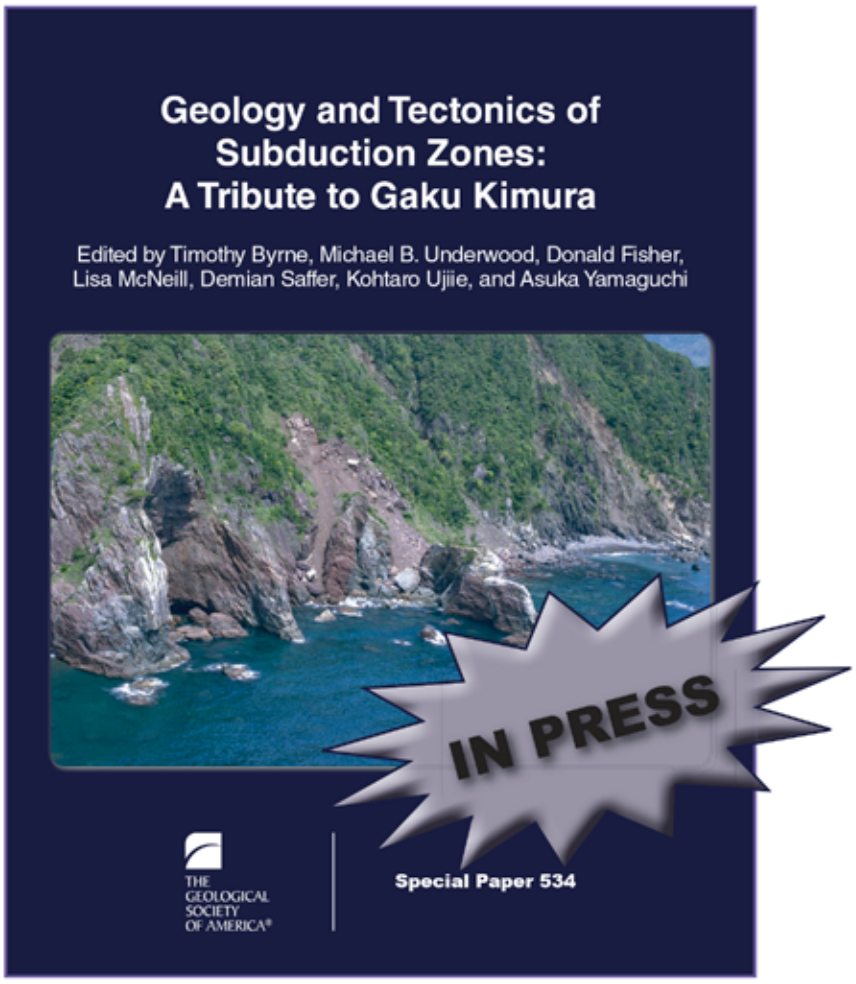
Special Paper 534

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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Hotels

Reservation Information

Reservation deadline: 10 October

GSA has negotiated special hotel rates for GSA 2018 Indianapolis attendees. We appreciate your support by staying in the official GSA hotels; your patronage enables GSA to secure the meeting space at a greatly reduced cost, which in turn helps lower the cost of the meeting and your registration fees.

VisitIndy is GSA's only official housing company for this meeting—to be included in the GSA room block and receive GSA rates, you must make your reservation through VisitIndy. Reservations are taken on a first-come, first-served, space-available basis. We recommend that you make your reservation early for the best opportunity to get the hotel of your choice.

Booking through VisitIndy means you will receive:

- An immediate e-mail acknowledgment of your hotel assignment;
- Free access to Internet in your guest room; and
- Protection if the hotel has oversold guest rooms.

When rooms are booked at hotels that are not within GSA's official hotel block and/or you do not use VisitIndy:

- GSA is exposed to penalties for not fulfilling our room block commitments;
- GSA risks losing the ability to re-book preferred meeting hotels and receive reduced rates in the future; and
- GSA could possibly lose its qualification for the amount of space allowed at the convention center.

Critical Dates

1 Oct.: The last day to cancel rooms without a penalty;

10 Oct.: Reservations must be received by this date in order to guarantee rooms at special meeting rates;

24 Oct.: All changes, cancellations, and name substitutions must be finalized through VisitIndy; and

After 24 Oct.: You must contact the hotel directly with any changes or for new reservations.

Reservation Options

Online: community.geosociety.org/gsa2018/hotels (for new reservation, modifying an existing reservation, or cancelling);

Phone: Agents available 8:30 a.m.–5 p.m. EDT, Mon.–Fri.: +1-317-262-8191; or

Print: Download the form and fax (+1-317-262-8270)—do not mail after faxing—or mail the completed form to VisitIndy, 200 S. Capitol Ave., Suite 300, Indianapolis, IN 46225, USA.

Special Requests

Please contact VisitIndy at +1-317-262-8191 or housing@visitindy.com if you have special requests, including if you need to book a hotel suite. Some requests are not guaranteed and hotels will assign specific room types upon check-in, based on availability.

Acknowledgments

VisitIndy will send reservation acknowledgments within 24 hours via email if you booked online or by telephone; fax and mail acknowledgments will be sent within 72 hours of receipt. If you do not receive your acknowledgment in this time frame, contact VisitIndy. You will not receive a written confirmation from the hotel.

Deposits, Cancellations, and Changes

All reservation requests must be accompanied by a credit card guarantee or check equaling the amount of one night's room and tax for each room reserved. Reservations cancelled after 1 Oct. OR prior to 72 hours of your scheduled arrival will be subject to a US$25 fee for each room cancelled. You will be charged one night's room and tax if you cancel within 72 hours of your arrival date. Through 24 Oct., please send requests for changes and cancellations via email to VisitIndy (housing@visitindy.com) or in writing by fax to +1-317-262-8270. After 24 October, contact hotels directly to make changes and cancellations.

Upgrade/Suite Raffle

To thank you for booking your hotel reservation through VisitIndy, you will be entered into a raffle to win a room upgrade for your entire hotel stay. This is valid for reservations booked with a three-night stay or longer. Your reservation must be made by 25 July in order to qualify for the raffle. The winners will be notified via email within 7–10 days.

Room Sharing

Use the GSA Travel & Housing Bulletin Board at community.geosociety.org/gsa2018/roomates to share housing, airport shuttle, and/or carpool. You can also use this service to make arrangements to meet up with your colleagues.

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ALERT: The official GSA housing bureau is VisitIndy. To receive the GSA group rate at each hotel, reservations must be made through VisitIndy and not directly with the hotels. GSA and VisitIndy will NOT contact attendees directly to solicit new reservations. If you are contacted by a vendor who claims to represent GSA, please notify the GSA Meetings Department at meetings@geosociety.org or +1-303-357-1041. Please do not make hotel arrangements or share any personal information through any means other than a trusted, reliable source.

Hotel Details

Below is the list of hotels and group rates for our block. Rates are in U.S. dollars and do not include the current applicable tax of 17% per room per, per night. Complimentary basic Internet will be provided in all guest rooms booked through GSA/VisitIndy.

When making your hotel reservation, please check the type of room you are reserving. Some hotels will only offer "run of house" inventory. Run of house means you can request the type of room you want (room with one bed or room with two beds) but ultimately the hotel will determine which room you receive based on their availability at the time of check-in. Other hotels will offer a specific bed type when reserving a room (room with one bed or room with two beds). If you want to make sure you have a specific number of beds in your room, make your reservation at a hotel that offers room inventory with a specific number of beds and not just "run of house." Please check the GSA website for details.

Hotel	Rate (tax not included)	Each Additional Adult (3rd & 4th person)	Distance to ICC	Parking Daily/ 24 hr**
JW Marriott (HQ)	US$199	US$25	Skywalk	US$48 Valet / US$43 Self
Courtyard by Marriott Indianapolis Downtown	US$179	US$25	Skywalk	US$35 Valet / US$32 Self
Crowne Plaza Indianapolis Downtown	US$184	US$25	Skywalk	US$38 Valet / US$28 Self
Embassy Suites Indianapolis–Downtown*	US$180	US$25	Skywalk	US$22 Self
Fairfield Inn & Suites by Marriott Downtown*	US$169	US$25	Skywalk	US$35 Valet / US$32 Self
Hampton Inn Downtown*	US$150	US$20	2 blocks	US$28 Valet
Hilton Indianapolis Hotel & Suites	US$165	US$25	3 blocks	US$44 Valet / US$38 Self
Hilton Garden Inn Downtown	US$141	US$10	5 blocks	US$29 Valet / US$26 Self
Holiday Inn Downtown	US$142	US$10	6 blocks	US$20 Self
Holiday Inn Express & Suites Downtown–Convention Center*	US$142	US$10	1 block	US$18 Self
Indianapolis Marriott Downtown	US$189	US$25	Skywalk	US$48 Valet / US$43 Self
Omni Severin Hotel	US$170	US$20	Skywalk	US$40 Valet
Springhill Suites by Marriott Indianapolis Downtown*	US$179	US$20	Skywalk	US$35 Valet / US$32 Self
Staybridge Suites Indianapolis Downtown–Convention Center*	US$153	US$10	2 blocks	US$18 Self

*Breakfast included in rate (check hotel website for specifics regarding breakfast menu)
**Parking rates subject to change; additional fees for oversized vehicles
ICC—Indiana Convention Center.

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

Event Space Requests

There is still time to reserve a room for your business meetings, luncheons, award ceremonies, parties, alumni receptions, and more. Please complete and submit the event space request form via the link at **community.geosociety.org/gsa2018/spacerequest** along with your payment (if applicable). Your request will also allow GSA to include your event listing on the personal scheduler and mobile app. Please let us know about your event—even if it's being held at a restaurant or other venue in the city.

Events Requiring Tickets/ Advance Registration

Several GSA Divisions and Associated Societies will hold breakfasts, lunches, receptions, and awards presentations that require a ticket and/or advance registration (see the meeting website for a complete list). Ticketed events are open to everyone, and tickets can be purchased in advance when you register. If you are not attending the meeting but would like to purchase a ticket to one of these events, please contact the GSA Meetings Department at meetings@geosociety.org.

GSA 2018

4–7 November
Indianapolis, Indiana, USA

Childcare by KiddieCorp

Location: Indiana Convention Center

Hours: Sat.–Wed., 7 a.m.–6 p.m. daily

Ages: Six months to 12 years

Cost: US$9 per hour, per child, with a one-hour minimum per child. At least one parent must be registered for the meeting.

Late pick-up fee: US$5 per child for every five minutes the parent is late

More info: https://kiddiecorp.com/parents-guide/

Register securely at: https://form.jotform.com/KiddieCorp/gsakids

Cancellations: For a full refund, cancellations must be made to KiddieCorp prior to 3 Oct. Cancellations made after 3 Oct. will incur a 50% fee. No refunds after 3 Nov.

Contact: KiddieCorp, +1-858-455-1718, info@kiddiecorp.com

GSA Meetings: meetings@geosociety.org

About: KiddieCorp is a nationally recognized company that provides onsite children's activities for a comfortable, safe, and happy experience for both kids and parents. Childcare services are a contractual agreement between each individual and the childcare company. GSA assumes no responsibility for the services rendered.

Contact: KiddieCorp
+1-858-455-1718
info@kiddiecorp.com

KIDDIE CORP

Local Tours

The following local tours are open to all registered GSA Annual Meeting attendees and guests. For short visits and historical tours, it is valuable to have an experienced and knowledgeable tour guide to assist you as you explore the city. Our tour groups are small and provide guests with an opportunity to ask questions and get off the beaten path!

101. Mimosas & a Masterpiece

Sun., 4 Nov., 9 a.m.–1 p.m. US$89; min. 20 participants.

Mimosa and a Masterpiece is an innovative and inspiring art class that allows you to paint while sipping on a cocktail. A local artist will guide you stroke-by-stroke through the process of completing a featured painting. The class is fun and energetic with frequent breaks, lots of laughs, and no experience needed. Afterward, attendees will enjoy retail therapy or dining options on Mass Ave. with unique and historic shops, such as Silver in the City, Sage Clothing Boutique, Arts A Poppin, and much more!

102. Indy Sampler

Mon., 5 Nov., 9 a.m.–noon. US$68; min. 20 participants.

Guests will enjoy an in-depth sightseeing tour of Indianapolis, including a bit of history and information on the city's main attractions, restaurants, and citizens. Throughout the tour, guests will be given an opportunity to ask questions of the well-trained guides, who love interacting with attendees.

The Indy Sampler Tour includes one stop allowing guests a stretch break and to experience one of Indy's unique attractions. The planned stop for GSA will be at the Indianapolis Motor Speedway, where guests will get a glimpse into the rich racing history at this famed venue—home of the annual Indy 500, the largest one-day sporting event in the world.

Indianapolis Motor Speedway. Photo courtesy of Visit Indy.

Jammin' on the Avenue Public Art. Photo courtesy of Drew Endicott Photography, Visit Indy.

103. Wine and All That Jazz

Tues., 6 Nov., 1–3:30 p.m. US$59; min. 20 participants.

Surprising to many, Indianapolis has a deep jazz heritage, along with roots and history of the Underground Railroad that went right through the heart of the city. Guests will learn more about this heritage along Indiana Avenue in the near downtown area en route to the winery. WINE… Nothing is so simply satisfying, yet so deliciously complex. For more than 25 years, the Chateau Thomas Winery has been celebrating this duality by crafting some of the most delightful wines in the country. Guests will take a cellar tour and participate in a wine tasting where they will experience the wines of Indiana's own Chateau Thomas Winery while nibbling on fruit and cheese.

104. A True Tea Experience

Wed., 7 Nov., 12:30 p.m.–4:30 p.m. US$85; min. 20 participants.

With a thirst for more customized experiences and a drive to share the love of blending tea, HoiTEA ToiTEA has created an opportunity for you to create your very own blend. Get educated and be entertained. Take home your very own blend! You could make multiple visits and leave with a different brew each time. Never pretentious but always the proper amount of fun and blending guidance to create a tea that steeps to you! Smell the aromas, taste the flavors, feel the warmth of your cup, and chat with other tea lovers. Afterward, guests will enjoy the trendy, eclectic shops and eateries in Broad Ripple Village, just steps away.

Guest Program

Penrose Guest Hospitality Suite

Hours: Sun.–Wed., 4–7 Nov., 8 a.m.–5:30 p.m.

We warmly welcome all members of the GSA community to Indianapolis! As part of that welcome, we offer registered guests and Penrose Circle Invitees a comfortable Hospitality Suite for rest and relaxation while technical sessions are happening. As a registered guest, you are welcome to attend your companion's technical session(s), and you will also have admittance to the Exhibit Hall. Activities in the suite include complimentary refreshments, entertaining and complimentary educational seminars, and local experts ready to answer your questions about Indianapolis. Local tours and activities will also be offered for an additional fee. We hope that you take advantage of the tours to learn about the area from one of the knowledgeable tour guides.

Other Indy attractions include the children's museum. Photo courtesy of Lavengood Photography, Visit Indy.

Seminars

Fiber Art

Sun., 4 Nov., 10 a.m., Penrose Guest Hospitality Suite

Each guest will select a variety of colors from a huge assortment of wool fibers. These colorful wool fibers are pulled, by the guest, into various shapes and dimensions, positioned on a backing and ironed to fuse them into place. This creates a one-of-a-kind piece of art that can be inserted into a cardboard frame to create a card to send to a loved one or friend or taken home and framed.

Entrance Sign of Eiteljorg Museum of American Indians and Western Art, in Indianapolis, Indiana. Photo by Nick Juhasz.

Eiteljorg Museum of American Indians and Western Art

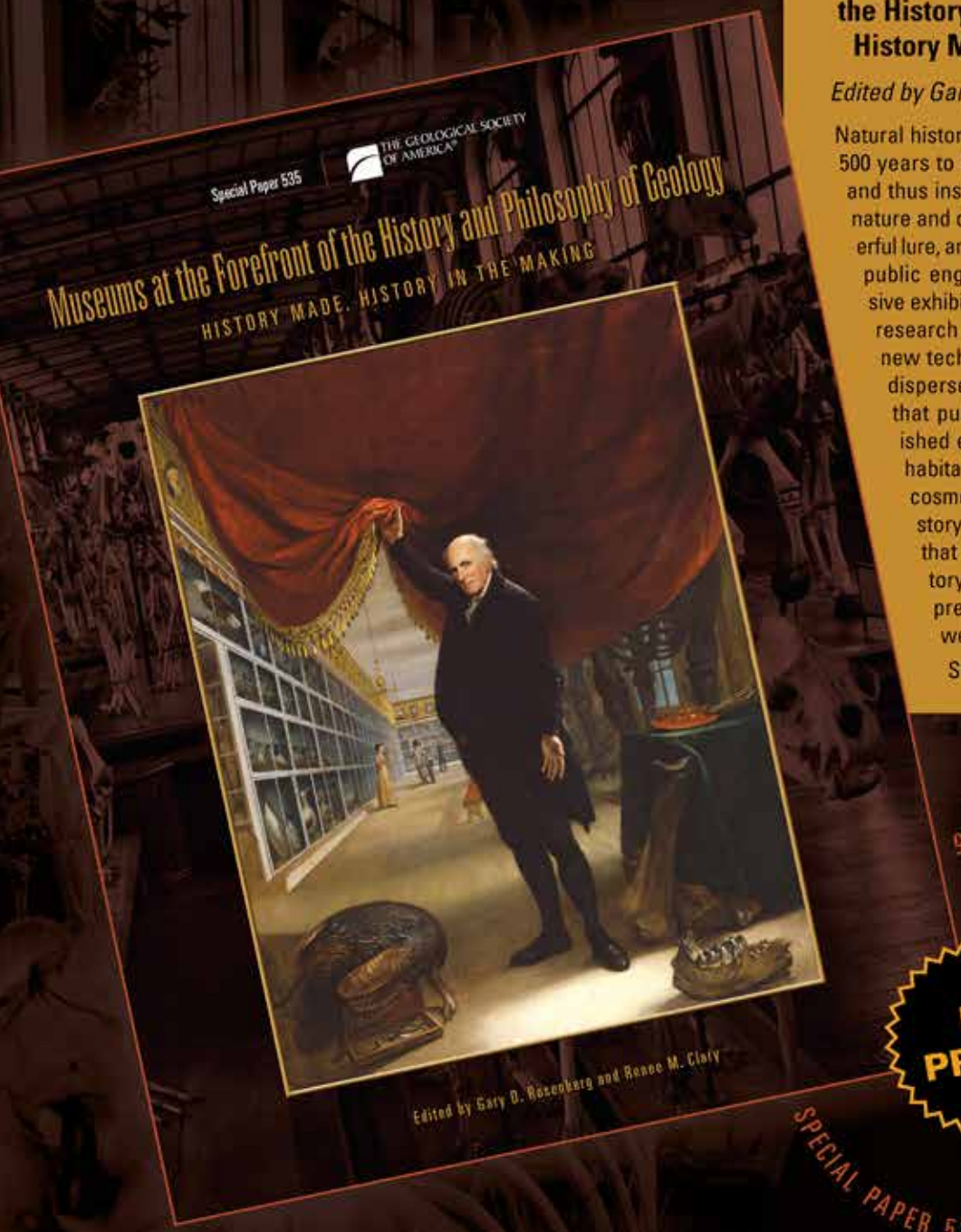
Mon., 5 Nov., 10 a.m., Penrose Guest Hospitality Suite

Guests will hear the history of how and why this fantastic museum is located in Indy as well as learn about its many collections, special exhibits, and heritage.

Smart Shopping and Nutrition

Tues., 6 Nov., 10 a.m., Penrose Guest Hospitality Suite

Grocery store and merchandise marketers use all kinds of psychological techniques to entice us to buy what they want us to buy. Learn ways to avoid some of these subtle traps, better understand product labels, and become more educated on overall nutrition.



Museums at the Forefront of the History and Philosophy of Geology: History Made, History in the Making

Edited by Gary D. Rosenberg and Renee M. Clary

Natural history museums have evolved over the past 500 years to become vanguards of science literacy and thus institutions of democracy. Curiosity about nature and distant cultures has proven to be a powerful lure, and museums have progressively improved public engagement through increasingly immersive exhibits, participation in field expeditions, and research using museum holdings, all facilitated by new technology. Natural history museums have dispersed across the globe and demonstrated that public fascination with ancient life, vanished environments, exotic animals in remote habitats, cultural diversity, and our place in the cosmos is universal. This volume samples the story of museum development and illustrates that the historical successes of natural history museums have positioned them to be preeminent facilitators of science literacy well into the future.

SPE535, 22 chapters, ISBN 9780813725352

SPECIAL PAPER 535 • SPECIAL PAPER 535 • SPECIAL PAPER 535

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Discover Indianapolis—Be Surprised, Be Welcomed, Enjoy Hoosier Hospitality

Cultural Trail. Photo courtesy of Lavengood Photography, Visit Indy.

Indianapolis Cultural Trail

City planners from Portland to Paris have traveled to Indy to see how the city managed to take away a lane of car traffic to make way for a US$63 million, eight-mile bicycle and pedestrian-friendly Cultural Trail. The decorative brick path connects visitors to hotels, restaurants, attractions, and cultural districts. Also lined with art and landscaping, it has garnered international attention as a model for urban revitalization.

The Canal & White River State Park: Discovery Runs through It

Located in the heart of downtown, White River State Park offers 250 acres of green space and attractions all connected by a glimmering canal walk and art-lined pedestrian pathways. Bicycles, Segways, kayaks, pedal boats, and Venetian gondolas enliven the Central Canal, which is also home to three prominent memorials. Colorful murals and giant sculptures decorate paths leading to an outdoor concert venue, top-10 zoo, award-winning baseball stadium, towering IMAX theater, and world-class museums.

White River State Park. Photo courtesy of Lavengood Photography, Visit Indy.

Monument Circle. Photo courtesy of Lavengood Photography, Visit Indy.

Indianapolis Monumental Marathon

A unique opportunity awaits us in the running of the Indianapolis Monumental Marathon on Saturday, 3 Nov. The starting line will be one block from the Indiana Convention Center where the GSA Annual Meeting & Exposition will take place.

The Indianapolis Monumental Marathon is one of the 20 largest marathons in the U.S. and is an ideal fall marathon for everyone from the first-time marathon runner to elite athletes. Starting and finishing at the Indiana State Capitol, the course highlights landmarks and historical neighborhoods throughout Indianapolis. Not a full marathon runner? A half-marathon, 5K, and kids fun run are also planned. Learn more at www.monumentalmarathon.com.

GSA Events

CODE OF CONDUCT

Approved by GSA Council on 24 September 2016

GSA is a premier, international scientific society whose goals and mission are to advance geoscience research and discovery, to provide service to society and to promote stewardship of Earth, within and beyond the geosciences profession. In fulfilling its goals and mission, and in keeping with its Diversity Position Statement, GSA meetings foster the exchange of scientific ideas, through open and respectful dialogues at oral and poster sessions, field trips, short courses, mentorships and other GSA-supported programs. GSA promotes, provides, expects, and endorses a professional and respectful atmosphere and values a diversity of views and opinions.

All registrants, guests, volunteers, exhibitors, GSA staff, service providers, and others in attendance are expected to abide by this GSA Events Code of Conduct, which outlines specific expectations for participants at GSA-supported events and is in addition to the provisions of the GSA Code of Conduct.

To read the full GSA Events Code of Conduct, go to

www.geosociety.org/GSA/Events/EventConductCode/GSA/Events/Conduct.aspx.

Photo by Bret Webster.

Get Connected …

"What a great discussion." —Andrew Cullen

"Thank you for joining in. I believe this type of discussion is exactly what was intended by GSA for this open forum." —Michael Tarullo

"I would like to add to this very interesting discussion." —Georges Pardo

… in the Community

GSA Members:
Lend your voice to your community

community.geosociety.org

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Meet With Us On Social Media

Twitter:
twitter.com/geosociety

Instagram:
www.instagram.com/geosociety

Follow hashtag #GSA2018

Facebook:
www.facebook.com/GSA.1888

GSA's Member Community:
community.geosociety.org

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Back for its sixth year!

What's Your Problem; What's Your Point?

Publishing your work is important, but how do you go about it?

Led by experienced GSA science editors, this workshop focuses on the bigger creative picture. Learn how to:

- frame and structure your work for publication,
- write an attention-getting cover letter,
- choose the right journal for your work,
- and more!

Plus, hear from experts on what constitutes a good review and how you would benefit from being a reviewer.

This highly successful workshop for early career geoscientists on the process of preparing and publishing papers will be held at the 2018 GSA Annual Meeting in Indianapolis, Indiana, USA. More information and a link to the application is at **www.geosociety.org/GSA/Publications/GSA/Pubs/writersResource.aspx.**

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Follow us on

Submitting an Abstract

Discipline Sessions

Discipline sessions are created by pooling together abstracts submitted to a particular discipline category. These sessions are formed in order to establish a very stimulating session. Start your abstract submission by going to **community.geosociety.org/gsa2018/discipline.**

Topical Sessions

Topical sessions are topically focused for a motivating exchange of science. If you are interested in submitting an abstract to a particular topical session, you can review the list at **community.geosociety.org/gsa2018/topical.**

Pardee Keynote Symposia

Pardee Keynote Symposia represent leading-edge, interdisciplinary science and address broad, fundamental geoscience issues and/or areas of public policy. Speakers in these sessions are of high standing in their fields. More information on these sessions can be found at **community.geosociety.org/gsa2018/pardee.**

Key Things to Know

Submitting an Abstract

▶ **Submission deadline:** Tuesday, 14 August.

- To begin your submission, go to **community.geosociety.org/gsa2018/abstracts.**
- A non-refundable abstracts submission fee of US$50 for professionals and US$25 for students will be charged during the submission process.
- Abstracts are editable until the 14 August submission deadline.
- When submitting an abstract to a discipline session, a list of possible topical sessions may pop up during the submission process. This list is provided as an option for you, in case you feel your abstract might fit well into one of those sessions.
- ***Please be patient.*** When submitting an abstract, the first page is slow to load. We thank you for your patience while the page is loading.

GSA 2018

4–7 November

Indianapolis, Indiana, USA

The Two-Abstracts Rule:

(A) You may submit two volunteered abstracts, *as long as one of the abstracts is for a poster presentation;*

(B) Each submitted abstract must be different in content; and

(C) If you are invited to submit an abstract in a Pardee Keynote Symposium or a topical session, the invited abstracts do not count against the two-abstracts rule.

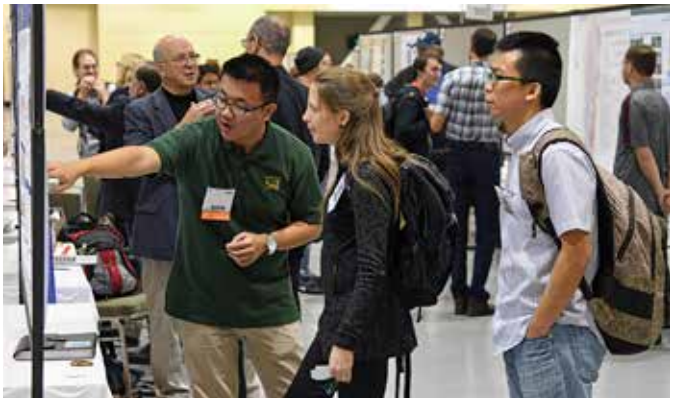
Abstract Content and Presentation

- Please familiarize yourself with and adhere to the GSA Code of Ethics for abstract publication and meeting presentation (see p. 33).
- Abstracts must describe recent findings in the realms of science, pedagogy, or their applications.
- All abstracts undergo peer review. Common reasons for rejection include dubious conclusions, questionable methodologies, poorly written prose, and incomplete or outdated information.
- The Joint Technical Program Committee (JTPC) will attempt to honor the authors' designations of topical session, discipline, or presentation mode (oral or poster). Final assignments remain at the discretion of the technical program chair. Session scheduling and presentation modes are firm once assigned.

Authors

- Please adhere to the Code of Ethics describing content, authorship, and scholarship (see p. 33).
- PRESENTERS: Presenting authors can deliver two (2) abstracts during the meeting, which can consist of one (1) volunteered oral presentation and one (1) volunteered poster presentation, or two (2) poster presentations. The only exemption to this policy occurs when the presenter is also invited to give a presentation in either a Pardee Keynote Symposium or a topical session, as invited abstracts are not counted. Invited topical session presenters will receive a PIN to exempt that abstract. If the session to which a presenting author is invited is canceled, that abstract will lose its exempted status.

- CO-AUTHORS: You may be listed on additional abstracts as a non-presenting co-author. There is no limit to the number of abstracts one can co-author.
- All presenting authors, including invited speakers, are responsible for paying their abstract submission fee. All authors must pay their registration fees, plus any other expenses they might incur associated with the GSA meeting.
- Acceptance notifications are delivered three to four weeks after the abstract deadline to allow sufficient time to make travel arrangements.
- Enhance your professional reputation by submitting a refined abstract. Then, deliver an admirable presentation.



Poster Presenters

- Hours for poster presentations: Posters should be on display from 9 a.m. to 5:30 p.m. on Sunday, with authors present 3:30–5:30 p.m. On Monday through Wednesday, posters should be on display from 9 a.m. to 6:30 p.m., with authors present 4:30–6:30 p.m.
- You will be provided with one horizontal, freestanding 8-ft-wide by 4-ft-high display board, and Velcro for hanging your display is provided at no charge.
- Each poster booth will share a 6-ft-long by 30-inch-wide table.
- Electricity is not available, so please plan your presentation accordingly.
- Wi-Fi will be available in the poster hall area.
- Want to present your poster digitally? As a poster presenter, you will be given the opportunity to present your poster in a digital format. If you are interested, contact Nancy Wright, nwright@geosociety.org. Presenters are responsible for all fees associated with this type of presentation.

Oral Presenters

- All oral presentations should be prepared using 16:9 screen ratio.
- The normal length of an oral presentation is 12 minutes, plus three minutes for questions and answers.
- You must visit the Speaker Ready Room at least 24 hours before your scheduled presentation.
- All technical session rooms will be equipped with a PC using MS Office 2013.

GSA Code of Ethics for Abstracts Publication and Meeting Presentation

When submitting an abstract, the abstracts process will ask for your agreement to the following Code of Ethics.

Working together as a community of geoscientists, we will continue to advance the finest science in a respectable, professional manner. Authors will display integrity in disseminating their research. Presentations will adhere to the content and conclusions of abstracts as submitted and reviewed. Listed co-authors will have made a bona fide contribution to the project. Conversely, the presenter should remain gracious by offering collaborators the opportunity for recognition as co-authors. All co-authors must be aware of their inclusion and have accepted that recognition. Presenters must be diligent in preparing a polished product that conveys high-quality scholarship. Submission of an abstract implies a sincere intent to attend the meeting.

GSA RISE
Respectful Inclusive Scientific Events

GSA Meetings **RISE** to the top.

We support **R**espectful **I**nclusive **S**cientific **E**vents and are committed to ensuring a safe and welcoming environment for all participants.

We expect all meeting participants to abide by the GSA Events Code of Conduct Policy (see p. 30) in all venues at our meetings, including ancillary events, field trips, and official and unofficial social gatherings.

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GEOCAREERS

Events and activities to help students and early career professionals prepare for their careers.

MENTORING CENTER

Visit the NEW Mentoring Center, open Sunday–Wednesday

- Résumé review clinic
- Post or view jobs
- Career workshops
- Drop in mentoring
- Networking events
- Company presentations

GEOCAREERS DAY

Sunday, 4 Nov.
US$25, registration required and space is limited

- Résumé & USAJOBS Workshop
- Company and Agency Information Booths
- Mentor Roundtables
- Career Pathways Panel

NETWORKING AND PANEL EVENTS

- Women in Geology Career Pathways Reception, Sunday, 4 Nov.
- Early Career Professionals Coffee, Monday, 5 Nov.
- Networking Reception, Monday, 5 Nov.
- Women Rising Networking Social, Monday, 5 Nov.
- The Paleontological Society Mentors in Paleontology Careers Luncheon, Monday, 5 Nov.
- Hydrogeology Division Careers and Networking Event, Tuesday, 6 Nov.

MORE WORKSHOPS

- Publishing: "What's Your Problem; What's Your Point?" Sunday, 4 Nov.
- Short Course 521: Unconscious Bias and Active Bystander Intervention Training to Promote Positive Work Climates
- Short Course 525: Ready to Engage: Selling Yourself at GSA 2018 and Beyond, for Students
- Social Media for Scientists Lecture & Lab

Visit community.geosociety/gsa2018/workshops for details.

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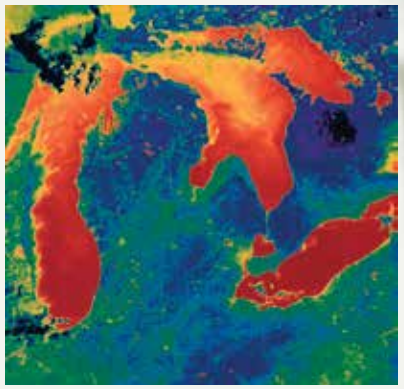
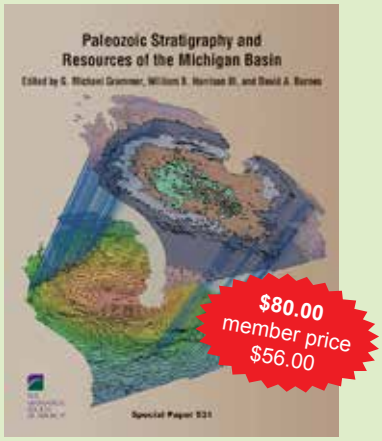
Attending the GSA Annual Meeting in Indianapolis?

Extend your trip to the Michigan Basin and Great Lakes region (even if only from your armchair or airplane seat) with these GSA volumes.





Paleozoic Stratigraphy and Resources of the Michigan Basin

Edited by G. Michael Grammer, William B. Harrison III, and David A. Barnes

The Michigan Basin is a classic intracratonic basin that has played a significant role in the fundamental understanding of geological processes in such basins, and has been an important resource for oil and gas, economic minerals, groundwater, and coal. Current utilization of high-resolution sequence stratigraphy and three-dimensional geostatistical modeling have led to a new and more comprehensive understanding of the Paleozoic sedimentary packages of the Michigan Basin. This volume provides significant insights into the Michigan Basin to both academic and applied geoscientists; its papers discuss various aspects of the sedimentology and stratigraphy of key units within the basin and analyze the diverse distribution of natural resources present in this basin.

SPE531, 339 p., ISBN 9780813725314
$80.00, member price $56.00

Quaternary Glaciation of the Great Lakes Region: Process, Landforms, Sediments, and Chronology

Edited by Alan E. Kehew and B. Brandon Curry

Taking advantage of new technological advances in Quaternary geology and geomorphology, this volume showcases new developments in glacial geology. Honoring the legacy of Frank Leverett and F.B. Taylor's 1915 USGS monograph of the region, this book covers diverse topics ranging from hydrogeology, near-surface geophysics, geotectonics, and vertebrate paleontology to glacial geomorphology and glacial history. Several papers make use of detailed, nuanced shaded relief maps of digital elevation models of LiDAR data; these advances are brought into historical perspective by visiting the history of geologic mapping of Michigan. Looking forward, interpretations of the shaded relief maps evoke novel processes, such as regional evolution of subglacial and supraglacial drainage systems of receding glacial margins. The volume also includes assessment of chronological issues in light of greater accuracy and precision of radiocarbon dating of plant fossils using accelerator mass spectrometry versus older techniques.

SPE530, 244 p., ISBN 9780813725307
$60.00, member price $42.00

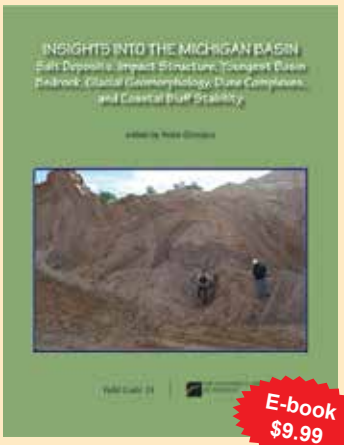
NOW $10.00
original list price
$66.00

Coastline and Dune Evolution along the Great Lakes

edited by Timothy G. Fisher and Edward C. Hansen

The 17,500 km of Great Lakes' shoreline—North America's "third coast"—has been the setting for a number of classic studies in coastal geomorphology and Quaternary geology, especially on the subjects of coastal dunes and the effects of deglaciation and isostatic rebound on lakes and coasts. Speaking to a recent revival of interest in these processes along the Great Lakes, this volume includes an interdisciplinary mix of papers spanning a variety of temporal scales and offering a substantive overview of this recent research. The majority of the papers investigate the relationship between dune activity, lake levels, and climate. In addition to offering insights into coastal processes in general, the data presented here could help inform decisions on how to manage and mitigate the human impact on this fragile natural environment.

SPE508, 228 p., ISBN 9780813725086
Now $10.00; (original list price: $66.00)



E-book
$9.99

Insights into the Michigan Basin: Salt Deposits, Impact Structure, Youngest Basin Bedrock, Glacial Geomorphology, Dune Complexes, and Coastal Bluff Stability

Edited by Robb Gillespie

This volume is a compilation of field excursions from the 2013 GSA North-Central Section meeting held in Kalamazoo, Michigan. Early depositional events within the Michigan Basin are examined deep underground in the Detroit Salt Mine. The Kentland Quarry (northwest Indiana), the site of a Cretaceous-aged meteorite impact, permits surface examination of a similar impact event that occurred in now-buried Ordovician-aged rocks in Cass County, Michigan. A trip near Grand Ledge, Michigan, examines Mississippian-aged fluvial deposits traditionally classified as the youngest bedrock exposed in Michigan. Younger, recently identified, Pennsylvanian rocks are the subject of a core workshop at the Michigan Geological Repository for Research and Education in Kalamazoo. Three trips showcase the surficial geology of southwest Michigan: One trip details the glacial landforms and sedimentary features formed by the differing dynamics of the Laurentide Ice Sheet's Michigan and Saginaw lobes. The other trips follow the eastern Lake Michigan shoreline and examine sand-dune complex development and coastal bluff stability and erosion issues.

FLD031P, 148 p., ISBN 9780813700311
E-book: $9.99

GSA's archive of e-books includes lots of other Special Papers, Field Guides, and maps on topics from the Indiana-Ohio-Kentucky-Michigan area and beyond. All are available at the GSA Store and most are only $9.99.

From the Cincinnati Arch to the Illinois Basin: Geological Field Excursions along the Ohio River Valley
Edited by Anton H. Maria and Ronald C. Counts
FLD012P, 180 p., ISBN 9780813700120
$9.99

On and around the Cincinnati Arch and Niagara Escarpment: Geological Field Trips in Ohio and Kentucky for the GSA North-Central Section Meeting, Dayton, Ohio, 2012
Edited by Michael R. Sandy and Daniel Goldman
FLD027, 130 p., ISBN 9780813700274
$9.99, print (limited quantities) or e-book

Geology and Hydrogeology of the Teays-Mahomet Bedrock Valley System
Edited by Wilton N. Melhorn and John P. Kempton
SPE258P, 128 p., ISBN 0813722586
$9.99

Early Sedimentary Evolution of the Michigan Basin
Edited by Paul A. Catacosinos and Paul A. Daniels, Jr.
SPE256P, 248 p., ISBN 081372256X
$9.99

Late Quaternary History of the Lake Michigan Basin
Edited by Allan F. Schneider and Gordon S. Fraser
SPE251P, 123 p., ISBN 0813722519
$9.99

Lake Michigan Area—Bouguer Gravity Map and Total Magnetic Intensity Map
Compiler: Norbert W. O'Hara
MCH038P, 2 sheets plus 12 p. text
$9.99

Michigan Basin Area—Bouguer Gravity Map and Total Magnetic Intensity Map
Compiler: Norbert W. O'Hara
MCH040P, 2 sheets plus 12 p. text
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Scientific Field Trips

Trip descriptions and leader bios are online at **community.geosociety.org/gsa2018/fieldtrips.**

401. **Crossroads of Geology in New Harmony, Indiana.** Thurs.–Sat., 1–3 Nov. US$370. **Cosponsors:** *Historic New Harmony; Indiana Geological and Water Survey; Indiana State Museum; Rapp Granary-Owen Foundation; Working Men's Institute*. **Leader:** William S. Elliott, University of Southern Indiana.

402. **Coastal Dune Environments of Southeastern Lake Michigan: Geomorphic Histories and Contemporary Processes.** Fri.–Sat., 2–3 Nov. US$250. **Leaders:** Edward C. Hansen, Hope College; Timothy G. Fisher; Suzanne J. DeVries-Zimmerman.

403. **Accessible Cave and Karst Geology of the Mammoth Cave National Park Region.** Fri.–Sat., 2–3 Nov. **Cosponsors:** *The International Association for Geoscience Diversity; GSA Geoscience Education Division; GSA Karst Division; GSA Diversity Committee; Mammoth Cave National Park; National Cave and Karst Research Institute*. **Leaders:** Christopher L. Atchison, University of Cincinnati; Brett H. Gilley; Rickard S. Toomey. Apply on the website.

404. **Geoarchaeology of the Eastern Indiana Glacial Plain.** Sat., 3 Nov. US$182. **Cosponsors:** *GSA Geoarchaeology Division; GSA Quaternary Geology & Geomorphology Division; GSA Geology & Society Division; GSA Hydrogeology Division; GSA Soils & Soil Processes Interdisciplinary Interest Group; GSA History and Philosophy of Geology Division; Society for American Archaeology Geoarchaeology Interest Group; American Quaternary Association*. **Leaders:** Cynthia M. Fadem, Earlham College; Laura R. Murphy; Edward W. Herrmann.

$ 405. **The Kentland Impact Structure (Newton County, Indiana Stone Quarry): Structure, Stratigraphy, Age, Paleomagnetism, and Shock Metamorphism.** Sat., 3 Nov. US$170. **Leaders:** John Weber, Grand Valley State University; Andrew D. Alder; Christian Koeberl; Michael C. Pope; R. Douglas Elmore.

406. **The Pleistocene at Your Fingertips: Glacial Lake Outburst Flood Deposits and Patterned Ground in the Central Wabash Valley.** Sat., 3 Nov. US$75. **Cosponsors:** *GSA Soils and Soil Processes IIG; GSA Geosciences Education Division*. **Leaders:** Darrell Schulze, Purdue University; Darryl E. Granger; Carolyn Olson; Michael Konen.

407. **Kirk Bryan Field Trip: At the Edge of the Laurentide Ice Sheet: Stratigraphy and Chronology of Glacial Deposits in Central Indiana.** Sat., 3 Nov. US$85. **Cosponsor:** *GSA Quaternary Geology & Geomorphology Division*. **Leaders:** Henry Loope, Indiana University; José Luis Antinao; G. William Monaghan.

408. **Geology of the Falls of the Ohio.** Sat., 3 Nov. US$199. **Leaders:** Stephen F. Greb, Kentucky Geological Survey; Alan Goldstein; William Andrews.

409. **Karst Geology and Hydrogeology of the Spring Mill Lake and Lost River Basins in South-Central Indiana.** Sat., 3 Nov. US$99. **Cosponsor:** *Indiana Geological and Water Survey*. **Leaders:** Lee J. Florea, Indiana Geological and Water Survey, Indiana University; Richard L. Powell; Samuel S. Frushour.

410. **Pleistocene Fluvial Systems, Extent of Quaternary Glacial Maximums, and Historical Significance in Northern Kentucky.** Sat., 3 Nov. US$140. **Cosponsor:** *GSA Quaternary Geology & Geomorphology Division*. **Leaders:** Matthew A. Massey, University of Kentucky; William Andrews; Steven L. Martin; Maxwell Hammond; Antonia Bottoms.

411. **Shorelines and Dunes along the Southern Shore of Lake Michigan: Examining Coastal Geology in the Context of Lake-Level Change.** Sat., 3 Nov. US$138. **Leaders:** Erin P. Argyilan, Indiana University Northwest; John W. Johnston; G. William Monaghan; Kenneth Lepper; Todd A. Thompson.

$ 412. **The Rise of Pinnacle Reefs: Islands of Diversity in Seas of Despair.** Sat., 3 Nov. US$99. **Cosponsor:** *Indiana Geological and Water Survey*. **Leaders:** Patrick I. McLaughlin, Indiana Geological & Water Survey; Alyssa M. Bancroft; Carlton E. Brett; Poul Emsbo; Jonathan J. Havens.

413. **Among the Dinosaurs at the Children's Museum: The Lanzendorf Collection of Dinosaur Art, Cretaceous Dinosphere, and Polly Horton Hix Paleo Prep Lab.** Sat., 3 Nov. US$75. **Cosponsors:** *GSA History and Philosophy of Geology Division; Paleontological Research Institute; Cushman Foundation; History of Earth Sciences Society*. **Leaders:** Gary Rosenberg, Milwaukee Public Museum; Renee Clary; Dallas Evans.

INDUSTRY TRACKS—Look for these icons, which identify sessions in the following areas:

$ **Economic Geology**

Energy

Engineering

Hydrogeology and Environmental Geology

414. **Caving to Buckner Cave.** Sat., 3 Nov. US$74. **Cosponsors:** *Richard Blenz Nature Conservancy Inc.; National Speleological Society.* **Leader:** Anmar Mirza.

415. **Legacy Deposits, Mill Dams, and Long-Term Monitoring of Sediment and Nutrient Budgets on Four Mile Creek in Southwestern Ohio.** Sat., 3 Nov. US$90. **Leaders:** Jason A. Rech, Miami University; William H. Renwick; Bartosz Grudzinski.

416. **Geology of the Salem Limestone.** Mon., 5 Nov. US$10. **Cosponsor:** *Department of Earth Sciences, Indiana University–Purdue University Indianapolis.* **Leader:** Thomas J. Rossbach, Indiana University–Purdue University Indianapolis.

417. **Monuments, Museums, and Skyscrapers: The Stones of Downtown Indianapolis.** Wed., 7 Nov. US$25. **Cosponsor:** *Heritage Stone Subcommission of the International Union of Geological Sciences.* **Leaders:** Joseph T. Hannibal, Cleveland Museum of Natural History; Ann Holstein.

418. **The Maumee Megaflood and the Geomorphology, Environmental Geology, and Silurian-Holocene History of the Upper Wabash River Valley and Vicinity, North-Central Indiana.** Wed.–Fri., 7–9 Nov. US$450. **Cosponsor:** *GSA Hydrogeology Division*. **Leaders:** Anthony H. Fleming; James O. Farlow.

419. **Middle Paleozoic Stratigraphy and Paleontology of the Greater Louisville, Kentucky Area.** Wed.–Fri., 7–9 Nov. US$279. **Cosponsors:** *Ohio Geological Survey; Indiana Geological and Water Survey; North American Commission on Stratigraphic Nomenclature*. **Leaders:** Carlton E. Brett, University of Cincinnati; Patrick McLaughlin, Indiana Geological & Water Survey; Christopher B. Waid; Katherine V. Bulinski.

420. **Salem Limestone (Valmeyeran, Mississippian)—A High-Energy Carbonate Shoal Model.** Thurs., 8 Nov. US$99. **Cosponsor:** *Heritage Stone Subcommission of the International Union of Geological Sciences*. **Leaders:** Brian D. Keith, Indiana University; Todd A. Thompson.

421. **Watch What You Drink: Midwestern Alluvial-Outwash Aquifers and the CV Theis Groundwater Observatory.** Thurs., 8 Nov. US$140. **Leaders:** Amy Townsend-Small, Univ. of Cincinnati; David Nash.

422. **Lower and Middle Pennsylvanian Coal Geology in the Illinois Basin.** Thurs., 8 Nov. US$180. **Leaders:** Cortland Eble, University of Kentucky; Stephen F. Greb.

423. **A Day at the Museum: Behind-the-Scenes Tour of Collections, Exhibits, and Programming at Indianapolis Museums.** Thurs., 8 Nov. US$115. **Leaders:** Polly Sturgeon, Indiana University; Peggy Fisherkeller; Eloise Batic; Becky Wolfe.

424. **The Quaternary Geology of the Southern Chicago Metropolitan Area: The Chicago Outlet, Morainic Systems, Glacial Chronology, and Kankakee Torrent.** Thurs.–Fri., 8–9 Nov. US$190. **Leaders:** B. Brandon Curry, University of Illinois at Urbana-Champaign; Olivier Caron.

425. **Devonian Black Shales of the Appalachian and Illinois Basin.** Thurs.–Sat., 8–10 Nov. US$275. **Cosponsors:** *Juergen Schieber; Zalmai Yawar; Zhiyang Li*. **Leader:** Juergen Schieber.

426. **Hydrogeology of the Mammoth Cave Region, Kentucky.** Thurs.–Sat., 8–10 Nov. US$280. **Cosponsor:** *Mammoth Cave National Park*. **Leader:** Ralph Ewers, Eastern Kentucky University.

Assorted fossils.

Granary. Photo by William Elliot.

Short Courses

Learn and explore a new topic!

Early registration deadline: 1 October
Registration after 1 October will cost an additional US$30
Cancellation deadline: 8 October

Can I take a short course if I am not registered for the meeting? YES! You're welcome to—just add the meeting nonregistrant fee (US$40) by 1 Oct. to your course enrollment cost. Should you then decide to attend the meeting, your payment will be applied toward meeting registration.

GSA K–12 teacher members: You are welcome to take short courses without registering for the meeting or paying the nonregistrant fee.

Continuing education units (CEUs): Most professional development courses and workshops offer CEUs. One CEU comprises 10 hours of participation in an organized continuing education experience under responsible sponsorship, capable direction, and qualified instruction.

See **community.geosociety.org/gsa2018/science-careers/courses** or contact Jennifer Nocerino, jnocerino@geosociety.org, for course abstracts and additional information.

The following short courses are open to everyone. Early registration is highly recommended to ensure that courses will run.

501. **High Resolution Topography and 3D Imaging I: Introduction to Terrestrial Laser Scanning.** Fri., 2 Nov., 8 a.m.–5 p.m. US$52. Limit: 24. CEU: 0.8. **Instructor:** Chris Crosby, UNAVCO. **Cosponsor:** *UNAVCO.*

502. **Field Safety Leadership.** Fri.–Sat., 2–3 Nov., 8 a.m.–5 p.m. US$25. Limit: 24. CEU: 1.6. **Instructors:** Kevin Bohacs, ExxonMobil Upstream Research Company (retired); Greer Barriault, ExxonMobil Upstream Research Company. **Cosponsor:** *ExxonMobil Upstream Research Company.*

503. **Structural and Stratigraphic Concepts Applied to Basin Exploration.** Fri.–Sat., 2–3 Nov., 8 a.m.–5 p.m. US$25. Limit: 30. CEU: 1.6. **Instructors:** Órla McLaughlin, ExxonMobil Exploration Company; Bob Stewart, ExxonMobil Exploration Company. **Cosponsors:** *ExxonMobil Exploration Company; GSA Sedimentary Geology Division.*

504. **Sequence Stratigraphy for Graduate Students.** Fri.–Sat., 2–3 Nov., 8 a.m.–5 p.m. US$25. Limit: 55. CEU: 1.6. **Instructors:** Bret Dixon, Anadarko; Morgan Sullivan, Chevron; Órla McLaughlin, ExxonMobil Exploration Company. **Cosponsors:** *ExxonMobil Exploration Company; Anadarko; Chevron.*

505. **A User's Guide to Micropaleontology and Biostratigraphy: Applications in Research and Industry.** Sat., 3 Nov., 8 a.m.–5 p.m. US$65. Limit: 40. CEU: 0.8. **Instructors:** Thomas Demchuk, Louisiana State University/RPS Group Inc.; Ryan Weber, PaleoData Inc. **Cosponsors:** *AASP - The Palynological Society; SEPM (Society for Sedimentary Geology); The Cushman Foundation; Paleontological Research Institute; Chevron Corp.*

506. **Ground Penetrating Radar—Principles, Practice and Processing.** Sat., 3 Nov., 8 a.m.–5 p.m. US$75. Limit: 24. CEU: 0.8. **Instructors:** Greg Johnston, Sensors & Software Inc.; Troy De Souza, Sensors & Software Inc. **Cosponsor:** *Sensors & Software Inc.*

507. **Detrital Zircon Geochronology: Best Practices, Current Challenges, Future Opportunities.** Sat., 3 Nov., 8 a.m.–5 p.m. US$40. Limit: 40. CEU: 0.8. **Instructors:** George Gehrels, University of Arizona; Kurt Sundell, University of Arizona.

508. **The Changing Face of Limnogeology—Tools and Methods for Analyzing Lacustrine Systems.** Sat., 3 Nov., 8 a.m.–5 p.m. US$10 students; US$25 professionals. Limit: 40. CEU: 0.8. **Instructors:** Scott Starratt, USGS; Lisa Park Boush, University of Connecticut; Michelle Goman, Sonoma State University; David Finkelstein, Hobart and William Smith Colleges. **Cosponsor:** *GSA Limnogeology Division; RCN EarthRates.*

509. **Geological Mapping.** Sat., 3 Nov., 8 a.m.–5 p.m. US$115. Limit: 40. CEU: 0.8. **Instructor:** Harvey Thorleifson, Minnesota Geological Survey. **Cosponsors:** *Association of American State Geologists; GSA Geoinformatics Division.*

510. **High Resolution Topography and 3D Imaging II: Introduction to Structure from Motion (SfM) Photogrammetry.** Sat., 3 Nov., 8 a.m.–5 p.m. US$52. Limit: 24. CEU: 0.8. **Instructors:** Chris Crosby, UNAVCO; Ramon Arrowsmith, Arizona State University. **Cosponsor:** *UNAVCO.*

511. **Earth History Visualization and Integrated Databases: TimeScale Creator Suite.** Sat., 3 Nov., 8 a.m.–5 p.m. US$90 students; US$123 professionals. Limit: 30. CEU: 0.8. **Instructors:** James Ogg, Purdue University; Gabi Ogg, Geologic TimeScale Foundation. **Cosponsors:** *Geologic TimeScale Foundation; SEPM (Society for Sedimentary Geology) North American Micropaleontology Section (NAMS).*

512. **Introduction to Drones (sUAS) in the Geosciences.** Sat., 3 Nov., 8 a.m.–5 p.m. US$110. Limit: 24. CEU: 0.8. **Instructor:** Greg Baker, University of Kansas. **Cosponsors:** *GSA Geoarchaeology Division; GSA Hydrogeology Division;*

GSA Quaternary Geology and Geomorphology Division; GeoAvatar LLC.

513. **Using Sketch Comedy & Standup in Geoscience Teaching & Informal Communication.** Sat., 3 Nov., 8 a.m.–5 p.m. US$97. Limit: 20. CEU: 0.8. **Instructors:** Anthony Feig, Central Michigan University and STEMpunks Comedy Research Group; Tim Huxtable, Screen Actors Guild; and STEMpunks Comedy Research Group. **Cosponsor:** *GSA Geology and Society Division.*

514. **Supporting Diversity in Two-Year College Geoscience Programs: Broadening Participation of Underrepresented Groups.** Sat., 3 Nov., 8:30 a.m.–4:30 p.m. US$45. Limit: 40. CEU: 0.7. **Instructors:** Heather Macdonald, College of William & Mary; Norlene Emerson, University of Wisconsin–Richland; Eric Baer, Highline College. **Cosponsors:** *National Association of Geoscience Teachers (NAGT); Geo2YC Division of NAGT; GSA Geoscience Education Division; SAGE 2YC.*

515. **New Approaches to Date Brittle and Ductile Deformation.** Sat., 3 Nov., 8 a.m.–noon. US$35. Limit: 40. CEU: 0.4. **Instructor:** Yu Wang, China University of Geosciences (Beijing). **Cosponsor:** *China University of Geosciences* (*Beijing*).

$ ⌖ 🔥 516. **Active Learning and Digital Geoscience Education: Update and Upgrade.** Sat., 3 Nov., 8 a.m.–noon. US$60. Limit: 25. CEU: 0.4. **Instructors:** Lev Horodyskyj, Arizona State University; Don Bratton, Smart Sparrow; Steve Semken, Arizona State University; Ariel Anbar, Arizona State University. **Cosponsor:** *Smart Sparrow.*

$ ⏻ ⌖ 🔥 517. **Writing Workshop for Geologists Whose Native Language is Not English.** Sat., 3 Nov., 8 a.m.–noon. US$84. Limit: 40. CEU: 0.4. **Instructor:** Patricia Bobeck, Geotechnical Translations.

518. **If We Build It: Tips and Techniques in Dynamic Content.** Sat., 3 Nov., 1–5 p.m. US$25, and earn a US$25 coupon for the GSA Bookstore. Limit: 40. CEU: 0.4. **Instructors:** Craig Jones, University of Colorado; Shan de Silva, Oregon State University. **Cosponsor:** *Geosphere.*

519. **Building Mobile Apps for Geoscience.** Sat., 3 Nov., 8 a.m.–noon. US$175. Limit: 20. CEU: 0.4. **Instructors:** Shane Loeffler, University of Minnesota; John Czaplewski, University of Wisconsin–Madison. **Cosponsor:** *GSA Geoinformatics Division.*

$ ⏻ ⌖ 🔥 520. **Data Science for Geosciences: Latest Successful Stories and Hands-on Practice.** Sat., 3 Nov., 8 a.m.–noon. US$80. Limit: 40. CEU: 0.4. **Instructors:** Peter Fox, Rensselaer Polytechnic Institute; Anirudh Prabhu, Rensselaer Polytechnic Institute; Fang Huang, Rensselaer Polytechnic Institute. **Cosponsor:** *GSA Geoinformatics Division.*

$ ⏻ ⌖ 🔥 521. **Unconscious Bias and Active Bystander Intervention Training to Promote Positive Work Climates.** Sat., 3 Nov., 8 a.m.–noon. US$10. Limit: 40. CEU: 0.4. **Instructors:** Blair Schneider, University of Kansas; Moses Milazzo, USGS. **Cosponsors:** *ADVANCEGeo Partnership; Association for Women Geoscientists; Earth Science Women's Network.*

522. **Creating Meaningful Experiences in School Settings.** Sat., 3 Nov., 8 a.m.–noon. US$25. Limit: 24. CEU: 0.4. **Instructor:** Adam Blankenbicker, American Geosciences Institute. **Cosponsor:** *American Geosciences Institute.*

$ ⏻ 523. **Petroleum Systems Fundamentals.** Sat., 3 Nov., 1–5 p.m. US$25. Limit: 40. CEU: 0.4. **Instructor:** Keith Mahon, Anadarko. **Cosponsor:** *Anadarko.*

$ ⏻ ⌖ 🔥 524. **Mobile Mapping on Android Devices in Offline Environments.** Sat., 3 Nov., 1–5 p.m. US$105. Limit: 40. CEU: 0.4. **Instructors:** Ciarán Doyle, Takor Group; Darren Smith, Takor Group. **Cosponsor:** *Takor Group.*

525. **Ready to Engage: Selling Yourself at GSA 2018 and Beyond, for Students.** Sat., 3 Nov., 2–4 p.m. US$5. Limit: 50. CEU: 0.2. **Instructors:** Beth Bartel, UNAVCO; Wendy Bohon, IRIS. **Cosponsors:** *GSA Geology and Society Division; UNAVCO; IRIS.*

526. **Taking Students into the Field on Their Own Time: Design and Assessment of Student Self-Guided Field Experiences Using the Free, NSF-Funded Flyover Country Mobile App.** Sat., 3 Nov., 1–5 p.m. US$138. Limit: 40. CEU: 0.4. **Instructors:** Avery Shinneman, University of Washington–Bothell; Amy Myrbo, University of Minnesota; Shane Loeffler, University of Minnesota.

$ 527. **Introduction to AMiGEO (Analytical Methods in Geosciences): Online Open-Access Modules for Teaching Laboratory Techniques.** Sat., 3 Nov., 1–5 p.m. US$25. Limit: 20. CEU: 0.4. **Instructors:** Elizabeth Johnson, James Madison University; Juhong Christie Liu, James Madison University.

Short Courses continued on p. 42

INDUSTRY TRACKS—Look for these icons, which identify sessions in the following areas:

$ **Economic Geology**

⏻ **Energy**

⌖ **Engineering**

🔥 **Hydrogeology and Environmental Geology**

Short Courses continued from p. 41

528. **Strengthening Students' Spatial Thinking Skills.** Sat., 3 Nov., 1–5 p.m. US$95. Limit: 40. CEU: 0.4. **Instructors:** Carol Ormand, SERC, Carleton College; Nicole LaDue, Northern Illinois University; Thomas Shipley, Temple University. **Cosponsors:** *NAGT; GSA Geoscience Education Division.*

529. **Design, Implementation, and Evaluation of Course and Curriculum-Based Undergraduate Research Experiences (CUREs) Using an Integrated Mixed Methods Approach.** Sat., 3 Nov., 1–5 p.m. US$25. Limit: 40. CEU: 0.4. **Instructors:** Joseph Allen, Concord University; Elizabeth Creamer, Virginia Tech; Stephen Kuehn, Concord University. **Cosponsors:** *Council on Undergraduate Research; GSA Geoscience Education Division; AGU Heads and Chairs Program; Mixed Methods International Research Association.*

GSA 2018

4–7 November

Indianapolis, Indiana, USA

The Geological Society of America® ON TO THE FUTURE

GSA has supported more than 500 students from diverse backgrounds to attend their first GSA Annual Meeting & Exposition through the On To the Future program (OTF). Mentorships are instrumental in helping shape the careers of the next generation of geoscientists. Five years into the program, here is a sampling of where some OTF students are working:

AECOM
Apache Corporation
Bureau of Land Management
Chesapeake Energy
Colorado Parks and Wildlife
Comprehensive Nuclear-Test-Ban Treaty Organization
Florissant Fossil Beds National Monument
Halliburton
Horizon Well Loggins LLC
Mewbourne Oil Company
NASA Langley Research Center
Nebraska Department of Environment Quality
New Jersey Department of Environmental Protection
Paleontological Research Institute and Museum of Earth
Quantum Spatial
Radar Solutions International Inc.
Roux Associates
San Diego Natural History Museum
Terra Firma Construction
University of Arizona
URS Corporation
U.S. Army Corps of Engineers
Weston Solutions Inc.
Willow Elementary School

Learn more about OTF and how you can help mentor a student at **www.geosociety.org/otf.**

K–12 GSA Experience Comes to Indy!

How do we recruit the next generation of geoscience students to our field?

Get' em while they're young!

Building on our success in Seattle, GSA is pleased to announce that we will be inviting K–12 teachers from the Indianapolis area to bring their classes to the GSA Annual Meeting & Exposition this November for the K–12 GSA Experience. In our pilot project in 2017, ~150 students representing five classes from four different high schools got their first taste of a professional scientific meeting by visiting the exhibit and poster halls. The students interacted directly with working scientists from government agencies, non-profits, and industry and spoke to exhibitors in booths from NASA to NOAA, the IRIS Consortium to UNAVCO, and GEOSEP Services to Isomass Scientific Inc. The last destroyed a cell phone as part of their demonstration of elemental analysis, to the great delight of their young audience. The students also explored the poster session confirming connections to topics in their own curriculum and engaging in scientific conversations with presenters. Students walked away with a sense of the diversity of geoscientists, an improved understanding of how science actually occurs, and their connections to that process in their current studies and future college and career choices.

The K–12 GSA Experience will be available to classes on Monday, Tuesday, and Wednesday, 5–7 Nov. 2018, between 10 a.m. and 3 p.m. (2 p.m. on the 7th). Interested teachers should complete the form at **https://goo.gl/forms/w5ODAtljtIGfp2hp2** by 30 Sept. Class pre-registration is ***required.*** Exhibitors with demonstrations or content specifically of interest to a K–12 audience should complete the form at **https://goo.gl/forms/W0qiYujiD1UF47yi1** (for businesses, agencies, and universities).

For more information, contact Dean Moosavi at smoosavi@geosociety.org, +1-303-357-1015.

GSA 2018

4–7 November

Indianapolis, Indiana, USA

Make a Difference, Be a Mentor

GSA is looking for mentors at the Annual Meeting to help students and early career professionals understand the breadth of careers available and to provide advice as they navigate their next steps, academically and professionally. Mentoring opportunities range from one-on-one pairings while you and your mentee are at the meeting to one-hour consultations. Early career professionals, professionals, and retirees are welcome to serve as mentors.

One-on-One Mentoring

- Annual Meeting Mentor
- On To the Future Mentor

Short-Term Mentoring

- Drop-in Mentor
- GeoCareers Table Mentor
- Networking Reception Mentor
- Résumé Mentoring
- Women in Geology Mentor

Learn more about becoming a mentor at the GSA Annual Meeting at **https://bit.ly/2GlBenV.**

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WOMEN AND GEOLOGY: Who Are We, Where Have We Come From, and Where Are We Going?

Edited by Beth A. Johnson

Women have been a part of the story of geology from the beginning, but they have struggled to gain professional opportunities, equal pay, and respect as scientists for decades. Some have been dismissed, some have been forced to work without pay, and some have been denied credit. This volume highlights the progress of women in geology, including past struggles and how remarkable individuals were able to overcome them, current efforts to draw positive attention and perceptions to women in the science, and recruitment and mentorship efforts to attract and retain the next generation of women in geology. Topics include the first American women researchers in Antarctica, a survey of Hollywood disaster movies and the casting of women as geologists, social media campaigns such as #365ScienceSelfies, and the stories of the Association for Women Geoscientists and the Earth Science Women's Network and their work to support and mentor women in geology.

MWR214, 128 p., ISBN 9780813712147
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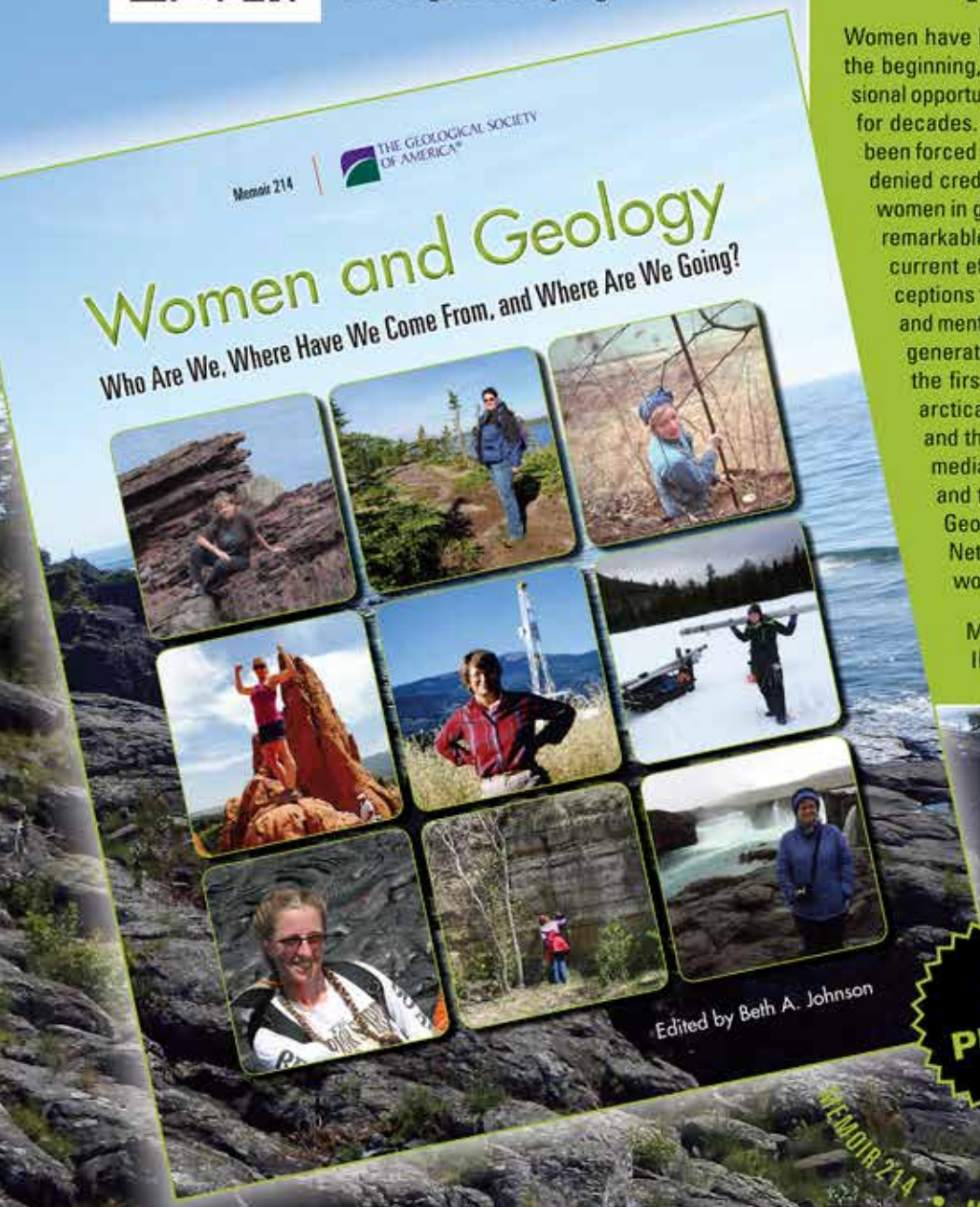

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GSA Division Awards

ARCHAEOLOGICAL GEOLOGY

Richard Hay Student Paper/Poster Award

Application deadline: 20 September

The Richard Hay Award is a travel grant awarded to a student presenting a paper or poster in archaeological geology at the annual GSA meeting. The application and referee forms must be emailed as an attachment. Note: you will receive an automatic response after submitting the application materials.
rock.geosociety.org/arch/studentawards.html

GEOSCIENCE EDUCATION

Student Travel Grants

Application deadline: 1 September

The Geoscience Education Division (GED) is offering several travel grants up to US$250 to GED student members who are presenting their work in a geoscience education session at the 2018 Annual Meeting. Grants will be awarded based on merit and financial need.
community.geosociety.org/gedivision/travelgrants

HISTORY AND PHILOSOPHY OF GEOLOGY

History and Philosophy of Geology Student Award

Proposal deadline: 15 June

The History and Philosophy of Geology Division is soliciting proposals for a student award for the amount of US$1000 for a paper to be given at the national GSA meeting. Consideration will be given to both undergraduate and graduate students. While both oral and poster presentations are acceptable, oral presentations are preferred. Faculty advisors may be listed as second author, but not as the lead author of the paper. The proposed paper may be (1) on the history or philosophy of geology; (2) a literature review of ideas for a technical work or thesis/dissertation; or (3) some imaginative aspect of the history or philosophy of geology we have not thought of before.
community.geosociety.org/histphildiv/awards/student

LIMNOGEOLOGY

Kerry Kelts Student Research Award

Application deadline: 30 June, midnight EDT

One award of US$1,000 for undergraduate or graduate student research related to limnogeology, limnology, or paleolimnology is available. Prepare your application as a PDF (or PDFs) with your last name in all file names. The application files should contain a research summary and a short CV (two pages max.). The research summary must include a description of the proposed research, its limnogeological significance, why the award funds are needed for the project, and a brief description of the student's other funding sources. Be sure to include a title. The maximum length for the summary is five pages, including figures and captions; the list of references cited is not included in this limit. Send your application to Division Chair Scott W. Starratt, sstarrat@usgs.gov. Please include "Kelts Award application" in the subject line.
rock.geosociety.org/limno/Kelts_Award.html

MINERALOGY, GEOCHEMISTRY, PETROLOGY, AND VOLCANOLOGY (MGPV)

Student Travel Grants

Application deadline: 5 October, midnight EDT

MGPV travel grants support student travel to the GSA Annual Meeting. Applications are restricted to graduate or undergraduate students who are the presenting authors of an accepted abstract at the meeting. Applicants must be members of the Geological Society of America and of the Division.
community.geosociety.org/mgpvdivision/awards/studenttravelgrants

PLANETARY GEOLOGY (PGD)

Ronald Greeley Award for Distinguished Service

Nomination deadline: 30 June

This award may be given to those members of the PGD, and those outside of the Division and GSA, who have rendered exceptional service to the PGD for a multi-year period. Nominations for the award, which should include a description of what the nominee has given to the PGD community, may be made by any PGD member to the management board.
rock.geosociety.org/pgd/distinguished-service.html

National Park Service Geoscientists-in-the-Parks (GIP) Opportunities

Fall/Winter 2018–2019 GIP Positions

Apply by 15 June 2018

The National Park Service GIP program places college students and early career professionals (18–35 years old) in National Park Service units for three months to one year to assist with geology and integrated science projects. This program is a partnership between the National Park Service, the Geological Society of America, and the Stewards Individual Placement Program.

www.geosociety.org/gip

National Park Service

Stewards Individual Placement Program

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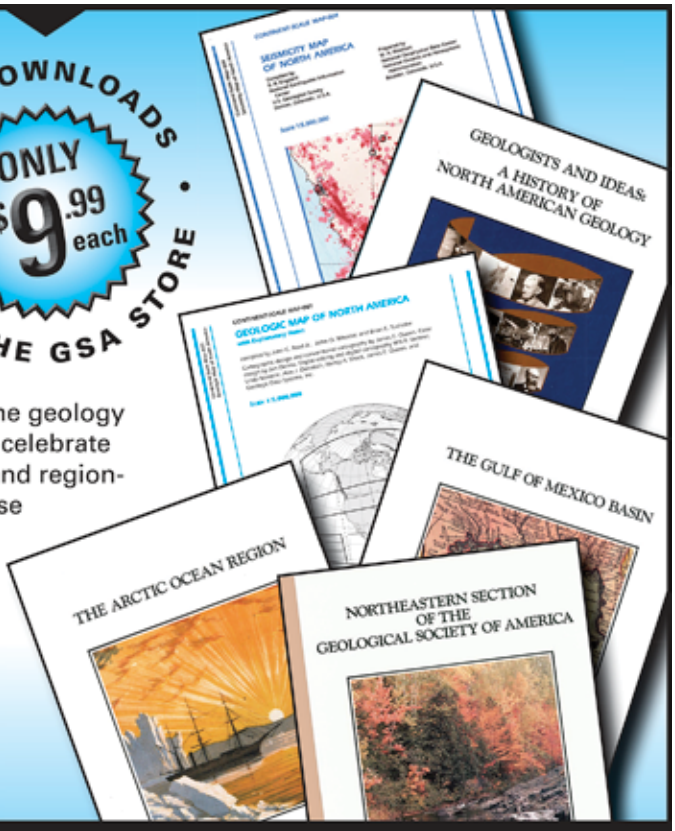
www.geosociety.org/geocorps

The Decade of North American Geology DNAG

E-BOOK DOWNLOADS ONLY $9.99 each AT THE GSA STORE



This monumental project, describing and illustrating the geology and geophysics of North America, was created to help celebrate GSA's 100th anniversary. The collection of discipline- and region-specific books that once filled a floor-to-ceiling bookcase can now be read on your tablet or computer.

Volumes include:

- Centennial Field Guides
- Continent-Scale Map Series
- Continent-Ocean Transects
- Geology of North America Series

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GeoTeachers K–12 Teacher Professional Development Workshops for 2018

Workshop	Registration Status
Arizona: Flagstaff, 23–27 July	OPEN until 18 June
Colorado: Colorado Springs, 30 July–3 Aug.	OPEN until 18 June
Indiana: Indianapolis, Annual Meeting Mini-Workshop, 2–4 Nov.	OPENS 1 JULY

Garden of the Gods and Pikes Peak, Colorado, USA. Photo by Dean Moosavi.

Big Stump, Florissant National Monument, Colorado, USA. Photo by Dean Moosavi.

Highlights of the Colorado Workshop

Three days of field trips, including

- Garden of the Gods
- North and South Cheyenne Canyon
- Florissant National Monument
- Guffey Volcanic Field
- Cripple Creek Mining District Past and Present

… *Plus* three rounds of short courses.

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For workshop details, price, and registration please visit the GeoTeachers website at **www.geosociety.org/geoteacherspd.**
Questions? Contact Dean Moosavi, smoosavi@geosociety.org, +1-303-357-1015.

Why GSA Membership Is Important to Me

Jeff Rubin (right) with Senator Jeff Merkley (D-OR).

I joined GSA as a new graduate student on a "conventional" geoscience career path. That path has been distinctly unconventional, and I've stayed with GSA because I consider membership itself valuable. As an emergency manager with a large fire district in Oregon, I apply and "translate" geoscience information for my co-workers, the public, and policymakers. I've appreciated that GSA has had room for me, and that I could contribute regardless (or because) of my job title.

My four years on the Geology and Public Policy Committee (GPPC), including one as chair, allowed me to be part of, and learn from, a motivated, opinionated, and productive group. We were in anything but lockstep, but always were able to move from discussion to decision, even on controversial topics—and there were plenty. Between GPPC and my time on the Geology and Society Division Management Board, I've developed an ongoing interest in the business side of GSA, and am honored to be part of our strategic planning process.

Whether via GPPC, Congressional Science Visits Day, Climate Science Day on the Hill, or just periodic interaction with GSA's staff in D.C., our policy programs have made me a more effective policy voice—not just in D.C., but in Oregon. Our growing commitment to public policy and science communication is emblematic of the role that we can play—as an organization and as individuals. I see my continuing involvement at GSA as a good way to stay connected with geoscience and to share some of its applications.

Jeff Rubin
Emergency Manager, Tualatin Valley Fire & Rescue
GSA Member since 1983
GSA Fellow since 2016

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.

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The Department of Geology at Stephen F. Austin State University invites applications for a tenure-track position at the assistant (or associate) professor level. Applicants must have a doctoral degree in geology or a related field with emphasis on structural geology and field camp, a strong commitment to excellence in teaching and a willingness to direct Master of Science geology students in research. Preference will be given to candidates with structural geology and field camp teaching and/or research experience. Teaching responsibilities for structural geology will include introductory courses, upper-level and graduate courses in the applicant's specialty, and occasional weekend field-trip courses. Teaching responsibilities for field camp will include teaching or co-teaching field methods in the spring semester and co-teaching summer field camp. Other expectations include research, university service and continuing professional development.

To apply and submit required documents, please visit http://careers.sfasu.edu/postings/2803.

Review of applications will begin on September 3, 2018, and will continue until the position is filled. SFA is an equal opportunity employer. This is a security-sensitive position and will be subject to a criminal history check.

GSA Committee Vacancies Available for Nominations by 15 June 2018

Note: Terms begin 1 July 2019 unless stated otherwise. Nominees for Division/Section positions will come from the Divisions and Sections.

B—Meets in Boulder or elsewhere; **E**—Communicates by phone or electronically;
M—Meets at the Annual Meeting; **T**—Extensive time commitment required during application review period.

COMMITTEE NAME	NUMBER OF VACANCIES	POSITION TITLE / SPECIAL REQUIREMENTS	TERM (YEARS)
Annual Program Committee (B/E/M)	3	• Members-at-Large • Member-at-Large Student	4 2
Arthur L. Day Medal Award (E/T)	2	• Members-at-Large	3
Diversity in the Geosciences (E/M)	2	• Members-at-Large	3
Education (B/E/M)	3	• Member-at-Large • Graduate Student Representative • 4-Year College Faculty	4 2 4
Geologic Mapping Award (E)	2	• Member-at-Large • Member-at-Large Student	3 3
Geology and Public Policy (B/E/M)	1	• Member-at-Large	3
GSA International (E/M)	4	• Member-at-Large • Secretary • IIG, Chair • Chair	4 4 4 4
Joint Technical Program (E) Terms begin December 2018	2	• Member-at-Large • Member-at-Large (Marine/Coastal Geology)	2 2
Membership and Fellowship (B/T)	2	• Members-at-Large Academia (intensive time commitment in February–March)	3
Nominations (B/E)	2	• Members-at-Large	3
Penrose Conferences and Field Forums (E)	2	• Members-at-Large (convener of a past Penrose Conference or Field Forum)	3
Penrose Medal Award (E/T)	2	• Members-at-Large	3
Professional Development (E)	2	• Former Councilor • Member-at-Large Student	3
Publications Committee (B/E/M)	1	• Member-at-Large	4
Research Grants (B/T)	9	• Members-at-Large (intensive time commitment in February–March)	3
Young Scientist Award (Donath Medal) (E/T)	2	• Member-at-Large • Member-at-Large (Councilor, former Councilor)	3 3

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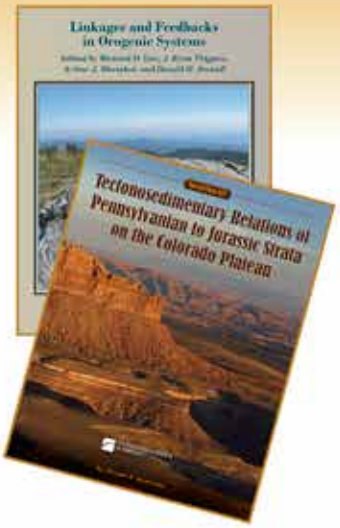

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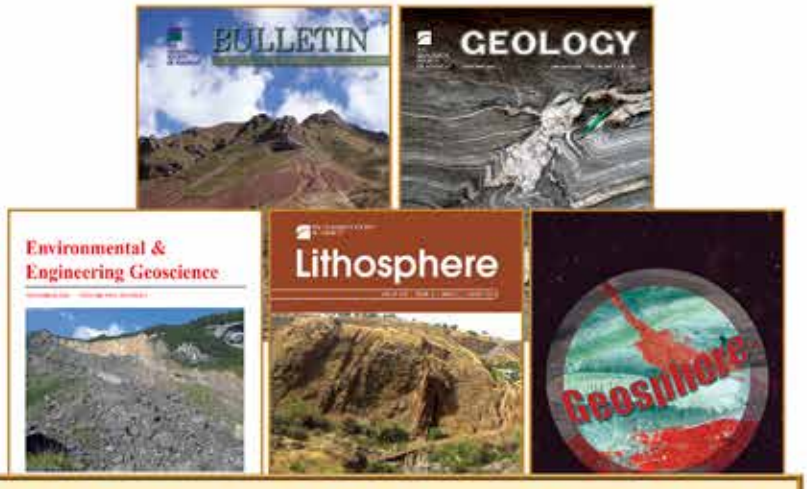

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John W. (Jack) Hess, *GSA Foundation President*

On To the Future Mentorship—Impacting Students and Mentors

In speaking with many geoscientists over the years, it is quite clear—there is a strong tradition of mentorship. Through their time and dedication, from research guidance and support to important academic and corporate networking, mentors help shape careers, and by extension, the geosciences. GSA's On To the Future (OTF) program continues this tradition of mentorship—one that has proven critical to its success. While there are many stories we can tell, we are fortunate to share the experience of Dr. Lina Patino, Acting Division Director for the Division of Earth Sciences at the National Science Foundation, and her 2017 OTF mentee, Alba Mar Rodriguez Padilla, a senior at the College of the Atlantic.

While those who serve as OTF mentors come from a wide variety of backgrounds and careers, they choose to volunteer because of their experiences of mentorship and desire to give back. This is true for Dr. Patino: "I was drawn to be an OTF mentor because of the role that mentors have played in my career. In particular, those mentors were crucial when I attended my first professional meeting. It was because of these engaged mentors that I felt like I belonged at the conference." Indeed, OTF mentors play a crucial role—for many OTF students, the GSA annual meeting is their first major scientific conference. Mentors provide support and a sense of inclusion by helping students navigate the annual meeting. For Alba, Dr. Patino's guidance enriched her meeting experience: "The entire time I felt that Lina wanted me to have a rich but easy-going experience at the conference: she introduced me to her colleagues at the NSF booth, attended multiple oral sessions of topics that were pertinent to my research and interests with me, and invited me to oral presentations related to her work."

OTF mentorship goes beyond meeting support, however—students and mentors are free to explore their shared research interests, professional goals, as well as backgrounds and experiences. For Alba, this aspect was particularly powerful. Dr. Patino was able to offer expert advice on a variety of topics, including the graduate school application process and potential funding opportunities. However, the greatest impact came from hearing Dr. Patino's story, "Since the moment we met, Lina was very honest and generous in providing advice and sharing her own experiences. I was very inspired by Lina's career, rooted in perseverance. Being an international student in this country myself, and with Spanish being my first language as well, helped me connect with Lina at a deeper level. I found that Lina's advice applied not only to my beginning scientific career as an undergraduate senior with an interest in academia, but also to my personal life."

In the end, the impact of this mentorship experience enriches both mentor and mentee. For Dr. Patino, the annual meeting is now an opportunity to learn about the latest research, as well as "to get to know young scientists from diverse backgrounds. Their excitement is inspiring and their energy is contagious; OTF is building a network of mentees and mentors who care about understanding the Earth and also care about building a community where individuals from diverse backgrounds feel like they belong in the geoscience profession." For Alba, the annual meeting was just the beginning of the mentorship experience: "After GSA, Lina and I have stayed in touch and she has continued to be a person I look up to and trust. I look forward to connecting with her in future meetings, and feel grateful to have been given the opportunity to be mentored by her through OTF."

Will you help us to ensure that On To the Future continues providing mentorship opportunities for students like Alba? Your contribution will make a lasting impact in the life of a student and on the future of the geosciences. Contact Clifton Cullen at +1-303-357-1007 or ccullen@geosociety.org to learn more. If you are interested in mentoring an OTF student, go to **http://bit.ly/2q0iCCT,** or see page 43 of this issue.

GSA President Isabel P. Montañez addresses participants and mentors during the 2017 *On to the Future* welcome gathering.

In the Field

The GSA Bookstore has the tools you need to head into the field.

GSA's newest field guide, *Geology at Every Scale*, contains nine field trips that highlight the spectacular sedimentary and structural geology in and around Knoxville, Tennessee, USA. From East Tennessee's marble industry to the geological curiosities of the Great Smoky Mountains, *Geology at Every Scale* will help you explore the region.

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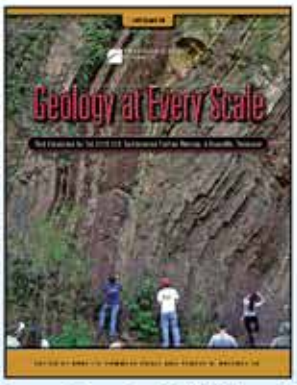

Geology at Every Scale: Field Excursions for the 2018 GSA Southeastern Section Meeting in Knoxville, Tennessee
edited by Annette Summers Engel and Robert D. Hatcher Jr.
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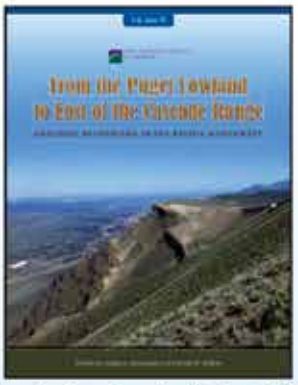

From the Puget Lowland to East of the Cascade Range: Geologic Excursions in the Pacific Northwest
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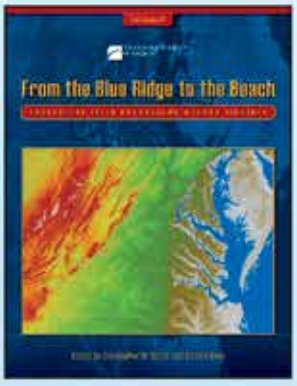

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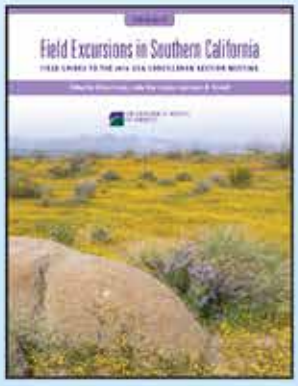

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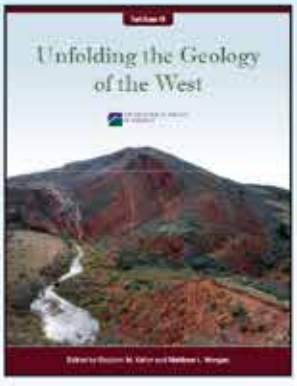

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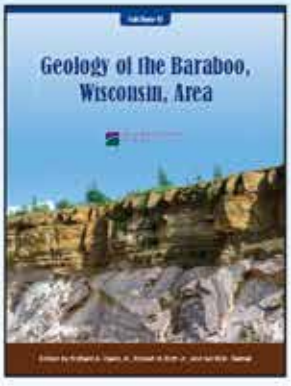

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