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**The evolution of end-member continental waters: The origin of acidity in southern Western Australia**



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**Cover:** Shallow acid saline water in Gneiss Lake, near Grass Patch in Western Australia, is an example of end-member continental brines. Orange iron oxide staining and white halite and gypsum precipitate on Precambrian quartzite gravel in lake. Photo taken in January 2008, when lake water was undergoing evapo-concentration and had pH 2.0 and salinity 28% total dissolved solids. Photo by Kathleen Benison. See related article, p. 4–10.



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### Errata

On page 9 the May 2015 *GSA Today* (v. 25, no. 5) the authors of the Reply were incorrectly noted. The authors are Richard A. Becker, Basil Tikoff, Paul R. Riley, and Neal R. Iverson. The doi numbers for both the Comment and Reply were also incorrect. They should be 10.1130/GSATG239C.1 for the Comment and 10.1130/GSATG245Y.1 for the Reply. These articles are online at [www.geosociety.org/gsatoday/comment-reply](http://www.geosociety.org/gsatoday/comment-reply). *GSA Today* regrets this error.

In the GSA Foundation donors insert that accompanied the May 2015 issue, the following individuals should have been listed: Robert W. Kay and Suzanne Mahlburg Kay, donors for 19 consecutive years; and Carolyn Olson, Penrose Circle member and donor for 11 consecutive years.

# The evolution of end-member continental waters: The origin of acidity in southern Western Australia

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## ABSTRACT

The Yilgarn Craton of Western Australia hosts a regional acid saline groundwater system and hundreds of ephemeral saline lakes characterized by complex acid brines. These acid saline lakes and groundwaters have pH as low as 1.4 and salinities as high as 32% total dissolved solids. The low pH formed by a combination of processes dependent upon the host rock lithology and mineralogy, climate, weathering, organisms, and time. Although these modern acid saline environments are relatively rare, they have both ancient terrestrial and extraterrestrial counterparts. Understanding acidification processes provides enhanced understanding of hydrosphere-lithosphere-atmosphere-biosphere

interactions. These environments present evidence of new brine evolution pathways and suggest the potential for future intense acid brine environments.

## INTRODUCTION

The “wheat belt” and “gold fields” of southern Western Australia are associated with a regional acid saline groundwater system. Groundwaters have pH as low as 2.4 and salinities as high as 28% total dissolved solids (TDS) and have greatly affected bedrock and subsurface sediments. The surface expressions of these acid brine groundwaters are the hundreds of shallow, ephemeral acid saline lakes with pH as low as 1.4 and salinities as high as 32% TDS (Fig. 1) (Benison et al., 2007; Bowen and Benison, 2009). These acid lake and groundwaters are chemically complex. They are rich in Na-Cl-Mg-SO<sub>4</sub>, poor in HCO<sub>3</sub>, and have unusually high and highly variable concentrations of Al, Si, Fe, Br, and some other metals (Bowen and Benison, 2009; Gray, 2001). The

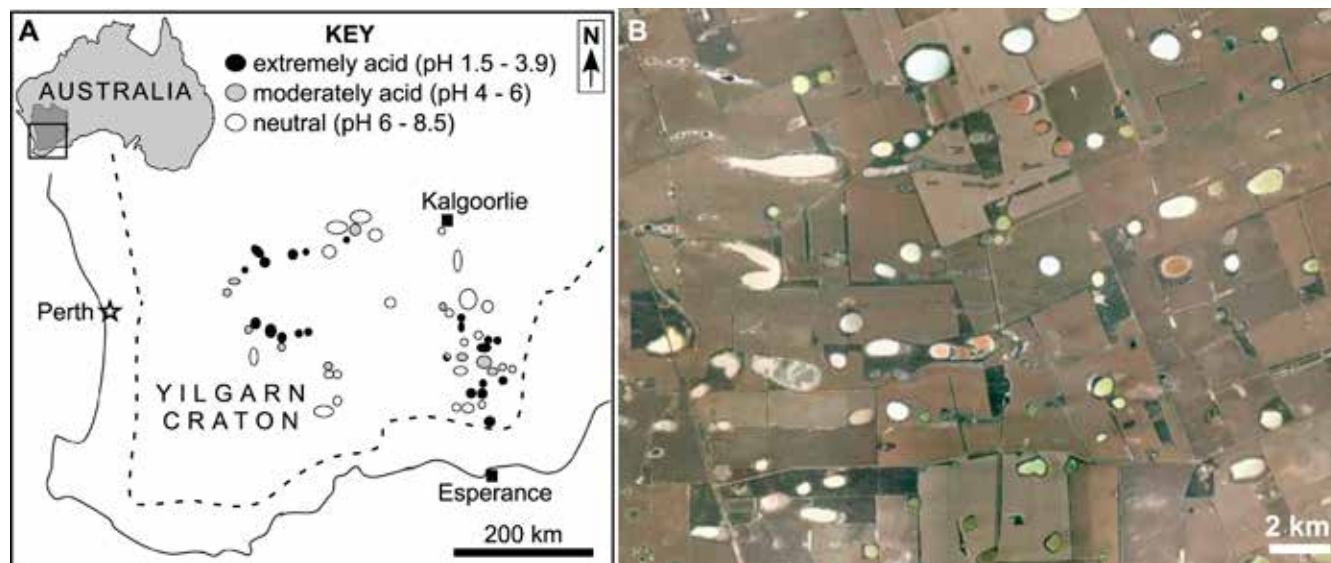


Figure 1. Yilgarn Craton in southern Western Australia. (A) Map of southern portion of Yilgarn Craton. Approximate locations and general pH range of 60 lakes studied in detail since 2001. (B) Image of “wheat belt” landscape near “gold fields,” located southwest of Salmon Gums. Note the many lakes with different colors.

origin of the acidity is likely sulfuric acid, with subsequent production of hydrochloric and bromic acids (Benison and Bowen, 2013).

The acid saline lakes and groundwaters are hosted by Archean rocks of the Yilgarn Craton and a thin, laterally discontinuous cover of sediment and sedimentary rock.

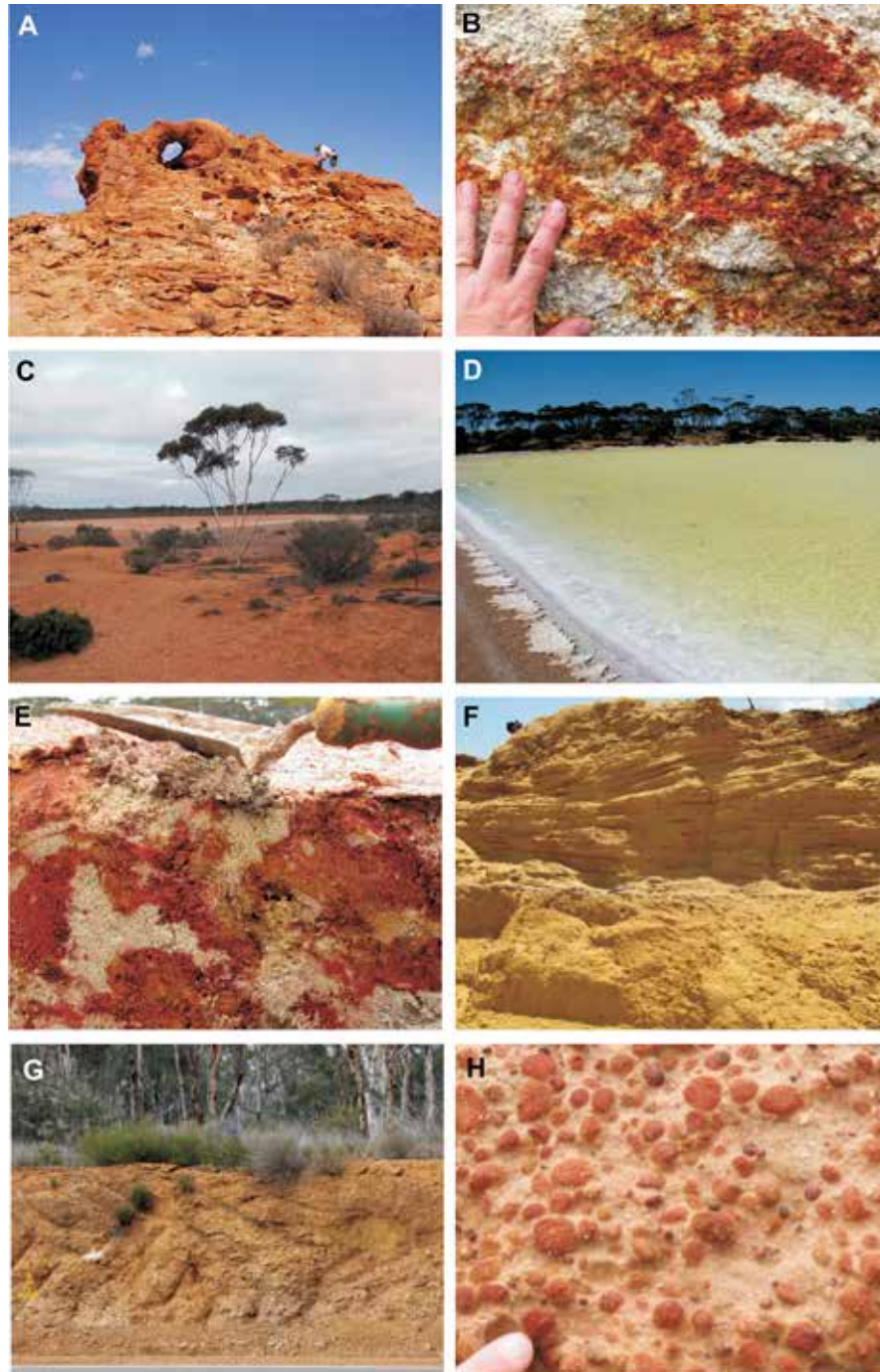


Figure 2. Photos of acid brine-influenced landscapes, rocks, and sediments in southern Western Australia. (A) Highly weathered outcrop near Leonora. (B) Altered granite in Hyden containing yellow and orange jarosite iron oxide and sulfate minerals. (C) Dry lake and surrounding sand flat east of Norseman. (D) Acid brine lake with white halite and yellow water near Salmon Gums. (E) Cross section of shallow sand flat sediment adjacent to acid brine lake southwest of Norseman. Note mottles of iron oxides, jarosite, and alunite. (F) Cross section of sand dune composed of iron oxide-coated gypsum grains near Merredin. (G) Cross section of acid sulfate soil near Toodyay. (H) Cross section of iron oxide concretions in recent sandstone near Kellerberrin.

The Yilgarn Craton contains granite-gneiss complexes and greenstone belts, which are deformed, faulted, and show a range of metamorphic alteration and various degrees of physical and chemical weathering. These rocks are mined locally for gold, iron, nickel, copper, lead, zinc, aluminum, uranium, and rare earth elements, and some ore concentrations are related to migration of the acid brines (Lawrance, 2001). Archean outcrops are found under and adjacent to some lakes and in direct contact with some modern lake water. Localized “regolith” (i.e., highly weathered Archean rock) has preserved some igneous and metamorphic textures from the precursor rock. However, its mineralogy includes Fe-oxides, kaolinite, and quartz, which are suggestive of alteration by acid saline waters (Fig. 2) (Bowen et al., 2013). Thin Eocene–Quaternary sandstones, lignites, and rare carbonates are found up to 100 m deep in paleochannel basins (Clarke, 1993, 1994; Clarke et al., 1996). Thin recent sandstones and ironstones are found along the shorelines of some acid saline lakes. Modern clastic sediments include quartz sand and reworked evaporites. Acid lake waters precipitate halite, gypsum, hematite, kaolinite/halloysite, and rare opaline silica (Fig. 2). Acid groundwaters precipitate a suite of displacive crystals and early cements in the surface and shallow subsurface sediments. These very early diagenetic minerals include halite, gypsum, hematite, goethite, jarosite, alunite, rozenite, gibbsite, kaolinite/halloysite, dickite, and hydrobasaluminite (Fig. 2) (Benison et al., 2007; Bowen et al., 2012; Story et al., 2010).

Neutral saline lakes in southern Western Australia are the anomaly here (Fig. 1). Some also have adjacent neutral groundwaters and overlie paleochannels, suggesting buffering of regional acid groundwaters by rare Eocene limestones at depth. Other neutral lakes are underlain by acid or moderately acid groundwaters. The larger neutral lakes may have a greater ratio of meteoric runoff relative to acid groundwaters, effectively making the neutral lake a perched meteoric water table.

Acid saline groundwater is widespread and seeps into most lakes to contribute to their unusual chemistry. The overarching question is: How did the extreme acidity form here?

## BACKGROUND

Hundreds of ephemeral saline lakes with changing colors in southern Western Australia were noted by Gregory (1914). The acidity of these saline lakes was recognized by Mann (1983). McArthur et al. (1989, 1991) analyzed pH, salinity, and major and minor ions in acid saline lakes and groundwaters near Salmon Gums, in particular Lakes Gilmore and Swann. Alpers et al. (1992) reported stable isotopes from two of the same samples. More recent work illustrated the spatial and temporal complexity of these dynamic systems (Benison et al., 2007; Bowen and Benison, 2009).

In southern Western Australia, the acidity has been attributed to ferrollysis, weathering, and oxidation of  $\text{Fe}^{2+}$  (Gray, 2001; McArthur et al., 1989, 1991; Mann, 1983). The abundance of secondary iron oxides in the region points to the importance of iron redox cycling in this geochemical system (Anand and Paine, 2002). McArthur et al. (1991) suggested that ferrollysis is the main source of the acidity, mainly due to the high iron content in the lowest pH waters analyzed at that time. Alpers et al. (1992) and Long et al. (1992) called for sea spray aerosols as contributors to the chemistry of acid saline waters. Long and Lyons (1990) theorized that acid saline waters might be the natural late-stage product of continental evolution. If so, the recognition of other acid saline lake systems in the rock record may not only help us to interpret local and regional climate histories of the past, it can also help us to make interpretations about large-scale processes, such as tectonic evolution and continental weathering.

## SOURCES OF ACIDITY

The most likely initial, and perhaps most important, acidification process is the oxidation of sulfides. This interpretation is supported by the presence of sulfides in host rocks, high sulfur in waters, abundant sulfate minerals, and oxidizing environment (Benison and Bowen, 2013). We have observed sulfur veins in Archean greenstone rocks from outcrops and mine tailings near Norseman. We also have observed disseminated pyrite in felsic igneous and metamorphic rock cores from the subsurface near Kalgoorlie. Disseminated sulfides, including Fe- and Cu- sulfide minerals, are found in the Archean rocks (R. Whittem, 2006, pers. comm.). There is high sulfate content (up to 35,000 ppm) and excess sulfur in waters (more S than can be accounted for with sulfate), indicating the presence of other S species (Bowen and Benison, 2009). Acid lakes and adjacent environments are characterized by abundant sulfate minerals, including gypsum, jarosite, and alunite (Benison and Bowen, 2013; Benison et al., 2007). In addition, the byproducts of ferric- and copper-sulfide oxidation are found here, including high Fe and Cu in waters and iron oxide minerals (Bowen and Benison, 2009).

Secondary acidification processes that likely occur in southern Western Australia involve combined oxidation and hydrolysis. Ferrollysis is a combined process of oxidation and hydrolysis that occurs in waters enriched with dissolved iron and yields additional  $\text{H}^+$ , causing water pH to decrease. Similar chemical reactions that influence pH occur with waters enriched with dissolved aluminum. Repeated precipitation and dissolution of hematite, jarosite, alunite, and gibbsite, as well as other Fe- and/or Al-bearing minerals, may provide varying concentrations of dissolved Fe and Al that can contribute to these pH-lowering

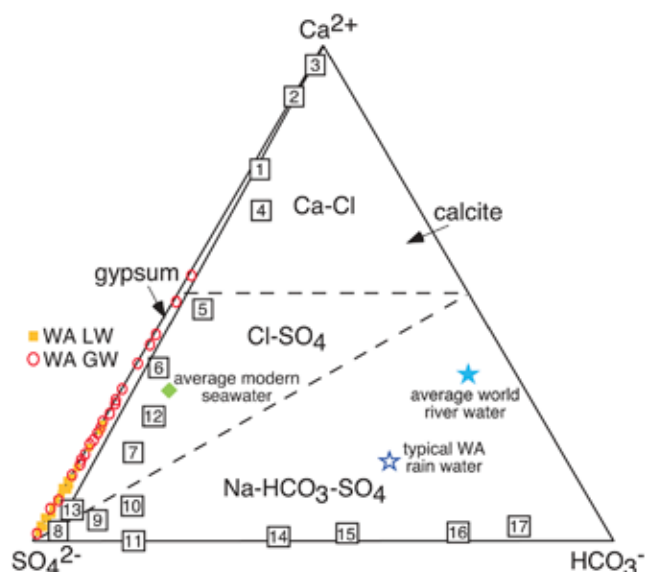


Figure 3. Ternary diagram in equivalents for  $\text{Ca-SO}_4\text{-HCO}_3$  showing the dominant carbonate and sulfate chemical divides that commonly occur as water evaporates. These types of diagrams are typically used to describe brine evolution in alkaline, neutral, or Ca-Cl type waters. The lack of  $\text{HCO}_3^-$  and calcite in the Western Australia (WA) acid lakes demonstrates that these systems are endmembers. WA lake waters are shown as orange squares and WA groundwaters are red circles (Bowen and Benison, 2009). Typical WA rain water values after Hingston and Gailitis (1976). Other examples of global extreme endmember saline systems are illustrated in comparison to the WA system. 1–3: Spring waters from China; 4–11: Surface brines from China lakes; average seawater and average river water; all after Lowenstein et al. (1989); 12: Salton Sea; 13: Great Salt Lake; 14: Deep Springs Lake; 15: Walker Lake; 16: Mono Lake; 17: Pyramid Lake; all after Spencer (2000).

reactions. Some lakes have low dissolved Fe and little Fe-minerals (Bowen and Benison, 2009), suggesting that ferrollysis is not as important as sulfide oxidation at these lakes.

Another secondary acidification process that likely occurs in southern Western Australia is due to acidophilic microorganisms. Macrofauna are noticeably absent from the acid saline lakes, and nearby vegetation is of low diversity, especially compared to nearby neutral saline lakes (Benison, 2008). However, evidence of microorganisms has been detected in the field (Benison, 2008). Molecular methods have documented diverse communities of prokaryotes in the acid saline lakes (Mormile et al., 2009). The majority of these prokaryotes are novel, but some of their closest matches are S- and Fe-oxidizing bacteria. Other microbiological studies of these acid saline lakes suggest the additional presence of eukaryotes, such as acidophilic and halophilic alga and fungi (Benison, 2012; S.S. Johnson, 2014, pers. comm.). In addition, microorganisms have been detected as solid inclusions and within fluid inclusions in halite and gypsum precipitated from these acid saline lakes (Benison et al., 2008; Conner and Benison, 2013). It is known that many acidophilic microorganisms can promote biochemical processes such as Fe- and S- oxidation, resulting in even lower pH (e.g., Langworthy, 1978; Oren, 2010). Although more work is needed to better understand the specific microbial-water geochemistry relationships in the Western Australia acid saline lakes, it is likely that the microorganisms are influencing the pH of the lakes and groundwaters.

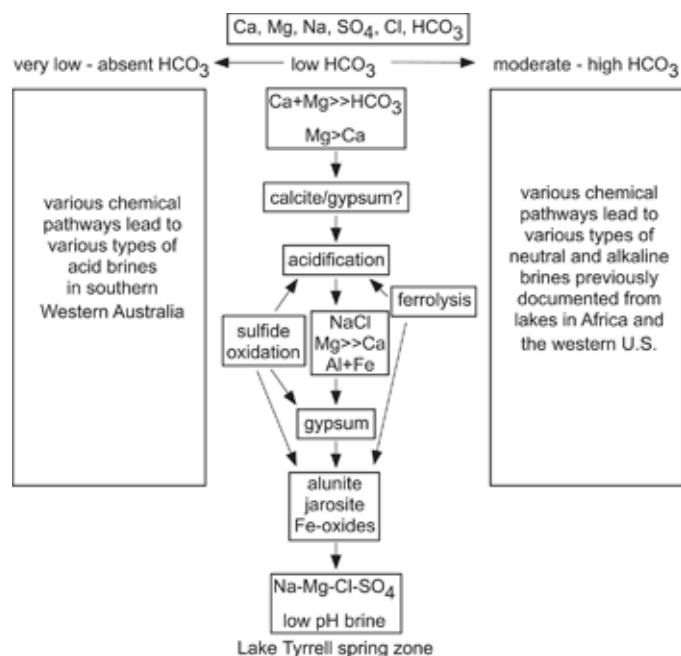


Figure 4. Brine evolution model for closed basins, featuring the Long-Lyons-Hines (2009) model for acid saline Lake Tyrrell spring zone waters, and based on the Eugster-Hardie-Jones brine evolution concept (Eugster, 1980; Eugster and Hardie, 1978; Eugster and Jones, 1979). In this variation of the model, abundance of  $\text{HCO}_3^-$  determines starting path. Several evolution pathways have been documented for specific closed lakes with neutral alkaline conditions, especially those in Africa and the western U.S.; in a complete model, these would appear to the right of the detailed Lake Tyrrell path. The more extreme and variable acid brines in southern Western Australia would appear as several complex evolution pathways to the left of the Lake Tyrrell path.

Climate and weather also play a role in acidity. In the semi-arid climate of southern Western Australia, evaporation greatly effects lake waters and, to a lesser extent, shallow groundwaters. Evaporation drives off water from the acid saline brines, resulting in more concentrated liquids. This evapo-concentration decreases pH and increases salinity. During dry times, lake waters have pH levels ~1–2 units lower than when the lakes are flooded. Likewise, shallow groundwaters have their lowest pH when the lakes are desiccated and shallow groundwater is evaporating. We have observed these lowest pHs in lakes during late stages of evapo-concentration (Benison et al., 2007; Bowen and Benison, 2009). In addition, laboratory experiments show that pH of moderately acidic water decreases several pH units upon evaporation (Foster and Benison, 2006; Long et al., 1992).

Recycling of acid waters may occur as part of flooding–evapo-concentration–desiccation cycles (Lowenstein and Hardie, 1985; Benison et al., 2007). When halite and gypsum grow in the acid lakes, they trap abundant acid fluid inclusions, which may compose up to ~30%–40% by volume halite and ~10%–20% by volume gypsum. When lakes flood and the halite and gypsum dissolve (halite at a much greater rate than gypsum), the acid fluid inclusions are released. Although this may be a small addition by volume to the water, it likely contributes to the lowering of the water pH after flooding.

The high degree of weathering of Archean rocks of the Yilgarn Craton has resulted in little buffering capacity. The result may be

the limited presence of geochemical “buffers,” such as carbonate minerals and feldspars (Bowen et al., 2013; Long and Lyons, 1990, 1992). This has allowed low pH produced by acidification processes to be maintained.

The extensive weathering of Archean rocks not only limits buffering capacity but also may yield other acids. For example, chemical weathering dissolves many minerals and yield waters rich in ions, such as Cl, Br, and Fe. The high amounts of  $\text{Cl}^-$  and  $\text{Br}^-$  in the acid waters suggest that hydrochloric and bromic acids exist here in addition to sulfuric acid.

## EXPANDING THE BRINE EVOLUTION MODEL

Hardie and Eugster (1970) and Eugster (1970) pioneered the use of evaporite minerals to trace past brine evolution and the history of evaporite sediments in closed basins. This brine evolution model has evolved through the decades to incorporate the details of chemical pathways for various neutral-alkaline brines, many of which include carbon species and carbonate minerals as important players (e.g., Eugster, 1980; Eugster and Hardie, 1978; Eugster and Jones, 1979) (Fig. 3). Long et al. (2009) added the first low pH branch to the geochemical model (Fig. 4). There are likely variations of acid brine evolution, just as variations in neutral and alkaline brines exist. More work from the range of different acid brine environments is required to build a brine evolution model that fully encompasses the compositional and mineralogical range produced by natural brines.

The Long-Lyons-Hines (2009) brine evolution model was based on the acid spring zones along the shorelines of Lake Tyrrell in northwestern Victoria. Their model suggests a geochemical evolution starting with waters enriched in Ca and Mg, but depleted in  $\text{HCO}_3^-$ . These waters precipitate gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ) and halite (NaCl), undergo sulfide oxidation and ferrolysis to become acidified, and precipitate Fe-oxides, jarosite [ $\text{KFe}_3(\text{SO}_4)_2(\text{OH})_6$ ], and alunite [ $\text{KAl}_3(\text{SO}_4)_2(\text{OH})_6$ ]. The ending waters are Na-Mg-Cl- $\text{SO}_4$  acid brines (Long et al., 2009) (Fig. 4). We note that the general water evolution is the same in southern Western Australia, as well as, perhaps, throughout the continent. However, the Yilgarn Craton acid brines present more complex compositions. For example, some lakes have  $\text{Al} + \text{Si} + \text{Fe} > \text{Ca} + \text{Mg} + \text{K}$  (Bowen and Benison, 2009). Some acid brines have unusually high Al and/or Si (up to 8,017 ppm Al and up to 13,300 ppm Si), but low Fe (0–10 ppm), and some have high Fe (up to 459 ppm), but lower Al and/or Si. There are also temporal and spatial variations in major ions at individual lakes. Because of this complexity and variability of water chemistry and mineral precipitation and dissolution, no one brine evolution pathway can be designated for the Western Australian acid brines (Fig. 4). Figure 5 presents a flow chart that depicts our general understanding of the geological and geochemical evolution for the Yilgarn Craton of Western Australia, based on observations published in Benison et al. (2007), Benison and Bowen (2013), Bowen and Benison (2009), and Bowen et al. (2013). We hypothesize that a transition from a warm and wet to a warm and dry climate promoted the early chemical weathering and late evaporation, oxidation, and acidification. Warm and wet weathering in the Tertiary would have greatly decreased the buffering minerals (Long and Lyons, 1992). Later arid climate would have decreased the water:rock ratio, as well as enhanced concentration of solutes, increasing the salinity. Laboratory experiments

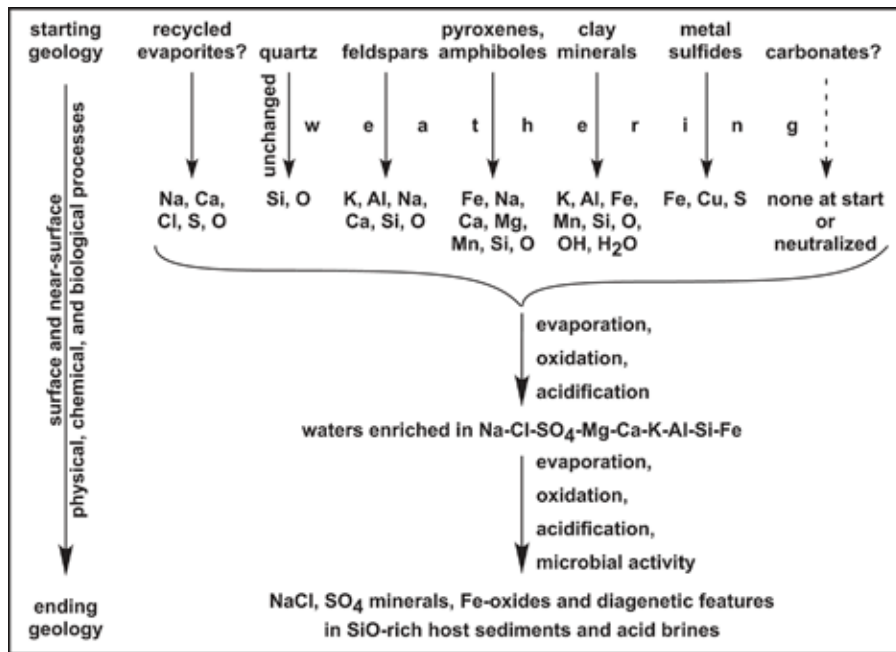


Figure 5. Flow chart showing proposed evolution of geology and geochemistry of acid brine lake waters and groundwaters in southern Western Australia.

and field observations show that evapo-concentration decreases pH if the starting solution was moderately acid (Foster and Benison, 2006).

### MAINTENANCE OF ACID BRINE ENVIRONMENTS

Geochemical cycling and physical reworking operate dynamically on both varying temporal and spatial scales on the Yilgarn Craton. An understanding of physical and chemical sedimentological processes is necessary for interpreting acid brine evolution. Flooding-evaporation-desiccation cycles controlled by local weather at individual acid saline lakes drive much of this recycling (Benison et al., 2007). For example, lake water may precipitate gypsum, halite, iron oxides, and kaolinite. When the lake dries up, winds can entrain and transport those chemical sediments, depositing them in the same lake or tens to hundreds of kilometers away. Flooding of a lake due to a rainstorm will carry sediments in sheet floods to lakes from dunes, soils, and sandflats. In addition, the meteoric water may dissolve some soluble minerals, such as halite and gypsum, releasing their ions back into the lake water. These dynamic surface processes cause the lake waters to fluctuate in pH and salinity, thus crossing geochemical divides that determine precipitation versus dissolution of specific minerals. Geochemical cycling of sulfur, as well as other elements, particularly Cl, Fe, and Al, is intense (Benison and Bowen, 2013). Changes in dissolved Fe and S, in particular, play a role in keeping the pH low. The acid brine lake water-groundwater systems seem to be maintaining themselves by these processes.

### WIDESPREAD ACID BRINES THROUGHOUT AUSTRALIA

Acid sulfate minerals, soils, and weathering profiles have been reported across Australia. Lake Tyrrell in northern Victoria is famous for its localized acid brines (e.g., Dickson and Giblin, 2009; Long et al., 1992, 2009). Thiry et al. (2006) interpreted acidic groundwater alteration in south-central Australia to have produced weathering profiles rich in kaolinite, gypsum, alunite,

and opal. Even some marginal marine environments have moderately acid (pH ~5) waters (i.e., Sammut et al., 1996). Southern Western Australia, and in particular the Yilgarn Craton, may simply be more advanced in acid brine evolution than the remainder of the continent. A combination of Australia's old cratonic rocks, relatively low tectonic activity, relatively few carbonate rocks, and long wet-to-dry climate trend, as proposed by Long and Lyons (1990, 1992) over the past tens of millions of years, has likely resulted in the acid brine development for much of the continent.

### FUTURE OF ACID BRINES IN RESPONSE TO GLOBAL CLIMATE CHANGE AND HUMAN LAND USE

In the twentieth century, both agriculture and mining had local influence on acid brine groundwater. A government-sponsored effort to turn the semi-arid eucalypt forests of inland southern Western Australia to crop and rangeland promoted the deforestation of the "wheat belt" region. With fewer trees to soak up the acid saline groundwater, the water table rose. Ranchers realized that cattle and sheep did not thrive with acid brines. Farmers found the only successful crops were grown high above the water table and irrigated with desalinated seawater piped a distance of hundreds of kilometers. Mining efforts have also used desalinated seawater pipelines. Both mining and agriculture import fresher water to the groundwater system and may be responsible for changing the volume of groundwater slightly, as well as potentially causing dissolution of some subsurface halite and other chemical sediments, and, perhaps in turn, increasing groundwater salinity. The limited volume of groundwater, in combination with its acidity, salinity, and high concentrations of some metals, make southern Western Australia a difficult place for human habitation.

Predictions for future climate suggest continued aridification in Australia due to global warming. Frederiksen et al. (2009) noted decreasing peak jet stream winds at ~30°S over southern Australia and predicted that this would cause increased temperatures, decreased autumn and winter rainfall, and prolonged droughts.



Future aridification would continue a documented drying as evidenced by termination of perennial fluvial systems and shrinking of large saline lakes in Australia during the late Tertiary and Quaternary (Cohen et al., 2011; Salama, 1994; Van de Graaf et al., 1978; Zheng et al., 1998). This predicted drier scenario for the Yilgarn Craton suggests that ephemeral acid brine lakes will exist in a desiccated stage more often than in a flooded or evapo-concentrated stages. In addition, acid brine water tables may be lower in the future. More evaporation would result in lower pH and higher salinity. Therefore, the acid brine system across the Yilgarn may become more extreme but less voluminous.

## IMPLICATIONS FOR INTERPRETATIONS OF ANCIENT ACID BRINES IN THE ROCK RECORD

Extreme acid brine environments similar to those in southern Western Australia have been recognized on Earth and Mars (e.g., Benison and Bowen, 2006; Benison et al., 1998; Kraus, 1998). In particular, some mid-Permian continental environments hosted extremely acid saline lakes and groundwaters that deposited redbeds and evaporites (Benison et al., 1998). The temporal and geographic extent of these Permian acid brine settings, and their relationship to Permian climate change and the end Permian mass extinction, are open scientific questions. Understanding the origin, evolution, and maintenance of modern natural acid brine environments may lead to more informed paleoenvironmental, paleoclimatic, and paleobiological interpretations about ancient acid brines.

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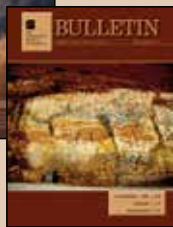
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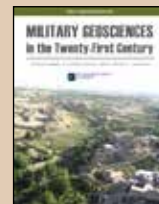
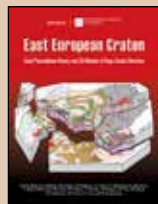
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*Geology – GSA Bulletin – Geosphere – Lithosphere*

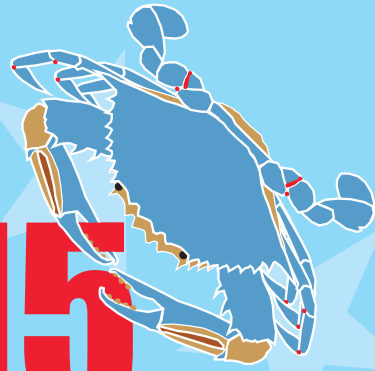
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THE  
GEOLOGICAL  
SOCIETY  
OF AMERICA®

**1-4 NOVEMBER**

**GSA 2015**



**Baltimore, Maryland, USA**

The 2015 GSA Annual Meeting will take place in vibrant Baltimore, Maryland, USA. Commonly known as Charm City, this ever-evolving, walkable city is steeped in history. In 1814, Baltimore's bombardment by the British inspired Francis Scott Key to write the lyrics for "The Star-Spangled Banner." Visit the Fort McHenry National Monument and Historic Shrine to learn more about the War of 1812, explore Baltimore's world-famous Inner Harbor, and enjoy the flavor of the city's quirky and distinct neighborhoods. Baltimore's location and geology will make for some unique field trips.

We hope you will join us 1-4 November to explore this area's geologic offerings and to forge connections with other geoscientists.



Photos courtesy of Visit Baltimore.





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BALTIMORE, MARYLAND, USA

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# Message from the Annual Meeting General Chair

The 2015 GSA Annual Meeting is coming to Baltimore, Maryland, USA. Here in “the land of pleasant living,” Baltimore is also known as “Charm City.” I invite you to come during the first week of November to discover why.

Nestled on the fall line between the Coastal Plain and the Piedmont, GSA 2015 will visit a classic passive-margin tectonic setting. But there’s nothing passive about Baltimore, or the greater Baltimore-Washington metropolitan region! Activity will abound as we kick off the meeting with a Halloween icebreaker followed by a broad selection of technical sessions. Many pre- and post-meeting field trips will be offered, along with pre-meeting short courses to provide anyone a professional development tune-up.

This year is the bicentennial of William “Strata” Smith’s revolutionary geological map of England, Wales, and portions of Scotland, published in 1815. The historical implications of this “map that changed the world” and its continuing relevance today to the success of geological investigations on Earth and across the Solar System will be highlighted throughout the meeting.

Our proximity to Washington D.C. affords opportunities for field trips to the Smithsonian Institution and the National Mall. It also positions GSA 2015 as a natural forum for exploring the interface between the geological sciences and public policy. From climate change to hydraulic fracturing, look for technical sessions and field trips that tie into this critically important theme.

Need more reasons to attend GSA 2015? How about Career Pathways events for women in geology, geology in industry, and geology in government? Or the employment interview service? What about lunchtime “Feed Your Brain” events? And don’t forget to get out of the convention center to visit the National Aquarium, Ft. McHenry, the Inner Harbor, and loads of nearby restaurants and watering holes. I look forward to your contributions to GSA 2015 in Baltimore!

**David A. Vanko**, Towson University  
*Annual Meeting General Chair*



## Organizing Committee

### GENERAL CHAIR

**David A. Vanko**, Towson University, [dvanko@towson.edu](mailto:dvanko@towson.edu)

### TECHNICAL PROGRAM CHAIR

**Patrick Burkhardt**, Slippery Rock University, [patrick.burkhardt@sru.edu](mailto:patrick.burkhardt@sru.edu)

### FIELD TRIP CHAIR

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**Jeffrey P. Halka**, Maryland Geological Survey, [jeff.halka@maryland.gov](mailto:jeff.halka@maryland.gov)

### SPONSORSHIP CHAIR

**David A. Vanko**, Towson University, [dvanko@towson.edu](mailto:dvanko@towson.edu)

### K-12 EDUCATION CHAIR

**Michael Passow**, Lamont-Doherty Earth Observatory of Columbia University, [michael@earth2class.org](mailto:michael@earth2class.org)

### SPECIAL EVENTS CHAIR

**Michael S. Kelley**, NASA Headquarters, [Michael.S.Kelley@nasa.gov](mailto:Michael.S.Kelley@nasa.gov)

### STUDENT COMMITTEE

**Hannah Susorney**, Johns Hopkins University, [hsusorn1@jhu.edu](mailto:hsusorn1@jhu.edu)

**Sophie Lehmann**, Johns Hopkins University, [slehman4@jhu.edu](mailto:slehman4@jhu.edu)

## Action Dates

▶ Abstract submission, registration & housing	Open Now
▶ Space request deadline (standard fees)	5 June
▶ Abstracts deadline	11 Aug.
▶ Speaker notifications	Early Sept.
▶ Housing cancellation fee begins	21 Sept.
▶ Early registration & housing deadline	28 Sept.
▶ Registration cancellation deadline	5 Oct.

## GSA 2015 Highlights

**1.** This year’s first scientific field trip starts on Wednesday, 28 Oct. Pre-meeting trip locations include the Central Appalachian Blue Ridge Province, Chesapeake Bay, the Gettysburg Battlefield, and the National Museum of Natural History.

**2.** Learning doesn’t wait! The popular and highly successful Short Course program has its first class on Thursday, 29 Oct. Six classes start on Friday, with several more on Saturday.

# Travel & Transportation

## Getting to Baltimore

### BY AIR

Baltimore is served by three major airports:

- (1) **Baltimore/Washington International Thurgood Marshall Airport** (BWI; [www.bwiairport.com](http://www.bwiairport.com)) in Maryland, just 15 min. from downtown Baltimore;
- (2) **Washington Dulles International Airport** ([www.metwashairports.com/dulles/dulles.htm](http://www.metwashairports.com/dulles/dulles.htm)) in Northern Virginia; and
- (3) **Ronald Reagan Washington National Airport** ([www.metwashairports.com/reagan/reagan.htm](http://www.metwashairports.com/reagan/reagan.htm)), also in Northern Virginia. Check each airport's website for ground transportation information.

### BY TRAIN

Baltimore is easily accessible by train (and is within driving distance of more than one-third of the nation's population). Erected in 1911, Baltimore's Penn Station is a major stop for **Amtrak's high-speed Acela Express service**. Learn more at [www.amtrak.com](http://www.amtrak.com). Penn Station is about three miles from the convention center.

Commuter rail service is provided by the **MARC Train**. Local areas served include Baltimore; Washington D.C.; and Martinsburg, West Virginia. Most MARC Train service lines operate Mon.–Fri., but weekend service is provided on the Penn Line, which includes Baltimore/Washington International Thurgood Marshall Airport. Learn more at [www.mtmaryland.com](http://www.mtmaryland.com).

## Getting Around

### PUBLIC TRANSPORTATION

The Maryland Transit Administration (MTA) operates bus, metro subway, light rail, and MARC train services. For fares and schedules, please call +1-888-218-2267 (locally, +1-410-539-5000) or go to [www.mtmaryland.com](http://www.mtmaryland.com). The **Charm City Circulator** ([www.charmcitycirculator.com](http://www.charmcitycirculator.com)) is a free transportation service with four routes that intersect downtown Baltimore, including a route to Fort McHenry National Monument and Historic Shrine. Shuttles run every 10 min. from early morning to late at night, seven days a week. The routes also connect to other forms of transit, such as the light rail, MARC, the metro subway, and the Baltimore Water Taxi.



**50 Free**

## Things to Do in Baltimore

From family-friendly historical sites and the bustling Inner Harbor to museums and monuments, Baltimore has a plethora of unique things to see and experience that are not only fun for everyone—they're also free! While you're planning your visit, be sure to reference these 50 free things to do in Baltimore for inspiration: [baltimore.org/article/50-free-things-do-baltimore](http://baltimore.org/article/50-free-things-do-baltimore).



**Here are GSA staff picks of additional attractions that are worth the price of admission!**

- American Visionary Arts Museum: [www.avam.org](http://www.avam.org)
- Sports Legends Museum at Camden Yards: <http://baberuthmuseum.org/sports-legends-museum>
- Ghost Tours in Fell's Point (it will be Halloween season!): [www.baltimoreghosttours.com](http://www.baltimoreghosttours.com)
- Fort McHenry: [www.nps.gov/fomc](http://www.nps.gov/fomc)
- Clipper City Brewing Co.: [www.hsbeer.com](http://www.hsbeer.com)



# Accommodations

## Make your reservation today in one of the following ways:

**ONLINE:** [community.geosociety.org/gsa2015/attendeeinfo/accommodations](http://community.geosociety.org/gsa2015/attendeeinfo/accommodations)—available 24 hours a day, 7 days a week, with immediate confirmation.

**E-MAIL:** [conventionhousing@baltimore.org](mailto:conventionhousing@baltimore.org)

**FAX:** +1-410-659-8398

**PHONE:** +1-800-282-6632 (international: +1-410-837-4636)

## Why book in the official block?

- Safeguard yourself from potential scams of unauthorized booking companies;
- Complimentary Internet in guest rooms for all reservations made through Visit Baltimore Housing Services;
- Friendly booking terms—no prepayment required and no change fees;
- Networking opportunities with a high concentration of attendees staying within the same hotels;
- Protection if hotel is oversold—rooms within the GSA block are guaranteed, and we have provisions in our hotel contracts to protect you. Contact Becky Sundeen in the GSA Annual Meeting Office if you have any issues onsite; and
- Support should any issues arise with your reservation.

We appreciate your support by staying in official GSA hotels. Your patronage of the official meeting hotels enables GSA to secure the meeting space at a greatly reduced cost, which in turn helps keep the cost of the meeting and your registration fees down. A portion of the room rate also helps to offset overall meeting costs.

## Critical Dates

**20 Sept.:** Last day to cancel rooms without a penalty.

**28 Sept.:** Room rates are guaranteed as long as there are rooms available in the GSA room block. After 28 Sept., hotel room rates and/or availability cannot be guaranteed.

**22 Oct.:** All changes, cancellations, and name substitutions must be finalized through Visit Baltimore/GSA housing by this date.

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

## GSA 2015 Highlights

**3.** You can't crash this icebreaker! All are welcome at the Baltimore Icebreaker Event on Saturday night, 5–7 p.m. Dress in your best Halloween costume!

## Annual Meeting Hotels

(details are online)

HOTEL	RATE (Single/Double)	DISTANCE to BCC
Baltimore Harbor Hotel*	US\$179	3 blocks
Baltimore Marriott Inner Harbor at Camden Yards	US\$209	1 block
Days Inn Inner Harbor	US\$139	1 block
Hampton Inn Baltimore–Downtown/Conv. Ctr*	US\$159	3 blocks
Hilton Baltimore (Headquarter Hotel)	US\$215	Connected
Holiday Inn Inner Harbor	US\$175	2 blocks
Hyatt Regency Baltimore	US\$209	Connected
Lord Baltimore Hotel	US\$179	3 blocks
Renaissance Baltimore Harborplace Hotel	US\$209	2 blocks
Sheraton Inner Harbor	US\$189	Connected

\*Breakfast included in rate.

Complimentary Internet is included with all guest rooms booked through Visit Baltimore/GSA Housing Bureau.

## Acknowledgments

Once your hotel reservations are made, Visit Baltimore Housing Services will e-mail your housing acknowledgment to you. Please review all information for accuracy. If you do not receive an acknowledgment or if you have questions, contact the Housing Bureau by e-mail at [conventionhousing@baltimore.org](mailto:conventionhousing@baltimore.org). Please refer to the GSA Annual Meeting in your subject line.

## Changes & Cancellations

The last day to cancel rooms without penalty is 20 Sept. 2015. After 20 Sept., a US\$25 per room cancellation processing fee will apply. You may continue to make changes and cancellations with the GSA Housing Bureau until 22 Oct. at 5:30 p.m. ET. Beginning 23 Oct. 2015, please contact the hotel directly for all changes and cancellations. Additionally you will be charged one night's room and tax by the hotel for any cancellations or no-shows within 72 hours of your scheduled arrival date.

*Accommodations continued on p. 16*

Accommodations continued from p. 15

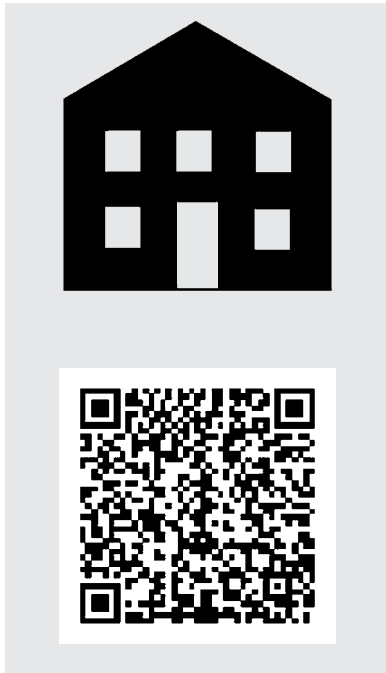
## Upgrade/Suite Raffle

To thank you for booking your hotel reservation through Visit Baltimore Housing Services, you will be entered into a raffle to win a room upgrade for your entire hotel stay. Valid for reservations booked with a three-night stay or longer. Your reservation must be made by 10 August in order to qualify for the raffle. The winners will be notified via email on 17 August.

**⚠️ ALERT:** The official housing bureau is Visit Baltimore Housing Services. Visit Baltimore Housing Services 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](mailto:meetings@geosociety.org) or call +1-303-375-1041. Please do not make hotel arrangements or share any personal information through any means other than a trusted, secure source.

## Room Sharing

Use the GSA Travel & Housing Bulletin Board at [community.geosociety.org/gsa2015/attendeeinfo/network/roommates](http://community.geosociety.org/gsa2015/attendeeinfo/network/roommates) (see QR code below) to share housing, airport shuttle, and/or carpool. You can also use this service to arrange to meet up with your colleagues.



## GSA 2015 Highlights

- 5.** Here's to the main attraction! Tech sessions start at 8 a.m. on Sunday, 1 Nov. Posters go up at 9 a.m. Talks run through 5:30 p.m. on Wednesday; posters stay up until 6:30 p.m.



The Chesapeake Bay area. Image courtesy NASA GSFC Landsat/LDCM EPO Team.



# 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 tour the city. Our tour groups are small and provide guests with an opportunity to ask questions and get off the beaten path!

## 101. Baltimore Art Museums with City Tour

Sun., 1 Nov., 9:30 a.m.–2:30 p.m. US\$135; min. 20 participants.

An exceptional tour guide will lead our small group through the Baltimore Art Museums. This personalized tour will introduce you to the American Visionary Art Museum, dedicated to the self-taught or “outsider” artist. The museum is home to seven galleries full of the most outstanding creations born of intuition and self-styled imagination. Our guide will also take you to the Baltimore Museum of Art, which includes works by Henri Matisse as well as nineteenth-century, modern, and contemporary art. This tour also includes an overview of the city of Baltimore, and our guide will be able to answer questions you have about the city and the museums. A box lunch is included.

## 102. Baltimore’s Historic Churches

Mon., 2 Nov., 8:30 a.m.–12:30 p.m. US\$45; min. 20 participants.

Discover the charm of Baltimore as reflected by its neighborhoods and traditions. The Baltimore Basilica was built from 1806 to 1821 and underwent a major renovation in 2005. The Basilica is considered America’s First Cathedral. At the Brown Memorial Park Avenue Presbyterian Church, you can view the beautiful Tiffany windows for which the church is famous. Time permitting, the last stop will be Corpus Christi, home to five Florentine mosaics on glass. When visiting these rich historical locations, you will be accompanied by our knowledgeable tour guide who can cover the historical and cultural significance of the churches not usually found in guidebooks.

## 103. Foodie Tour of Little Italy

Mon., 2 Nov., 1–4 p.m. US\$88; min. 20 participants. Walking tour—no transportation provided.

A short walk from the hotel is Little Italy, Baltimore’s own charming neighborhood, rich with history and authentic Italian culture and cuisine. Orchestrated by our personal guide, you will meet the shop owners and restaurateurs and hear their stories about what makes this neighborhood culturally significant. You will also sample Italian specialties, from limoncello to cannoli, as you stroll from shop to shop. Our guide will also take you to Jonestown, a once predominately Jewish enclave, and still home to Baltimore’s corn-beef row and numerous historic sights.

## 104. Whirlwind Tour of Washington D.C. with lunch at the Occidental

Tues., 3 Nov., 8:30 a.m.–3:30 p.m. US\$150; min. 20 participants.

This tour will take you to a part of our nation’s most historic landscape. Experience the Lincoln Memorial, the Vietnam Veterans Memorial, and the Korean War Veterans Memorial. Stop for lunch at the Occidental, the epitome of Washingtonian culture and style, for a two-course lunch. After lunch, the tour will continue with a visit to the World War II Memorial. Your professional tour guide will tell you the history of the parks, memorials, and many famous buildings that will surround you on this tour.

## 105. Baltimore Architecturally Speaking

Tues., 3 Nov., 1–5 p.m. US\$60; min. 20 participants.

On this tour of Baltimore’s architectural wonders is the Peabody Library. Within the library is the six-story chamber, which includes five stories of ornamental cast-iron balconies and 250,000 volumes dated from the sixteenth to twentieth centuries. If you have ever wondered what a 23-karat-gold bathroom would look like, you will find out in the 48-room Evergreen House. Built in the 1850s, the Evergreen House includes an extensive collection of post-impressionist paintings, Japanese art, and Tiffany glass. Comfortable walking shoes are strongly recommended.

## 106. Star Spangled Baltimore

Wed., 4 Nov., 8:30 a.m.–3:30 p.m. US\$165; min. 20 participants. Box lunch included.

On this tour, you will get a realistic glimpse into the lives of early American soldiers and what they endured for our freedom. You will visit Fort McHenry National Monument, where Francis Scott Key wrote the historic words, “Oh say, can you see, by the dawn’s early light.” As the tour winds along Charles Street, with its art galleries and mansions, your guide will offer insight into Baltimore’s history and social life. This tour includes a visit to the Star-Spangled Banner Flag House and the Maryland Historical Society, where you will see the original manuscript of Key’s Star-Spangled Banner.

## 107. Jewel of the Chesapeake

Wed., 4 Nov., 8:30 a.m.–3:30 p.m. US\$165; min. 20 participants.

Annapolis is the charming, waterfront capital of Maryland. Your guide will conduct a walking tour of the narrow, tree-lined streets of this colonial area. You will visit the Maryland State House, the oldest Capitol building still standing in America today, followed by a stop at St. John’s College, one of the oldest colleges in the United States. Your guide will give you an up-close-and-personal tour of the U.S. Naval Academy. Lunch will be provided at a local restaurant. Following lunch, you will have free time to browse through unique shops along the city’s cobblestone streets.

# Guest Program

## Penrose Guest Hospitality Suite

**Hours:** Sun.–Wed., 1–4 Nov., 8 a.m.–5:30 p.m.

We warmly welcome all members of the GSA community to Baltimore—better known as Charm City! 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 going on. 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 educational seminars, and local experts ready to answer your questions about Baltimore. 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.

## SEMINARS

### The Art of Crab Cracking

Mon., 2 Nov., 10 a.m., Penrose Guest Hospitality Suite

If there is one thing that Marylanders are universally proud of, it's Maryland blue crabs. Crab cracking is really an art in Baltimore. Wielding a mallet and a knife, watch and learn from local crab crackers on the art of getting to the succulent meat of a Maryland blue crab.

### The Life & Writings of Edgar Allan Poe

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

Famed American writer Edgar Allan Poe came from a Baltimore family and lived part of his life in and around the city. He published his second volume of poetry in 1829 and launched a literary career after winning a contest sponsored in 1833 by the *Baltimore Saturday Visitor* for the best short story. During this seminar, you will learn all about the life and writings of Poe as well as his influence in Baltimore—the most recognizable being the NFL Ravens! Various traces of Poe's life and death can still be found throughout the city of Baltimore.



## Childcare by KiddieCorp

**Location:** Baltimore Convention Center

**Hours:** Sat.–Wed., 7 a.m.–6 p.m.

**Ages:** Six months to 12 years

**Cost:** US\$9 per hour per child with a consecutive two-hour min. 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:** [www.kiddiecorp.com/parents.html](http://www.kiddiecorp.com/parents.html)

**Register securely here:** <https://www.kiddiecorp.com/gsakids.htm>

**Cancellations:** For a full refund, cancellations must be made to KiddieCorp prior to 2 Oct. Cancellations made after 2 Oct. will incur a 50% fee. No refunds after 30 Oct.

**Contact:** KiddieCorp: +1-858-455-1718, [info@kiddiecorp.com](mailto:info@kiddiecorp.com); GSA meetings dept.: [meetings@geosociety.org](mailto: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. GSA has used their service for more than 10 years. Childcare services are a contractual agreement between each individual and the childcare company. GSA assumes no responsibility for the services rendered.

### GSA 2015 Highlights

**6. Take that long lunch.** This year, the lunch break will run from noon to 1:30 to give you extra time to attend the *Feed Your Brain* lunchtime seminars and network with colleagues.

**7. Inspired to pick up a new book** or pore over the latest scientific gadgets and gifts? The Exhibit Hall opens at 2 p.m. on Sunday.

1-4 NOVEMBER

**GSA 2015**

Baltimore, Maryland, USA



# Registration

▶ **Early registration deadline:** 28 September

▶ **Cancellation deadline:** 5 October

Register online now at [community.geosociety.org/gsa2015/registration](http://community.geosociety.org/gsa2015/registration)

## REGISTRATION FEES

(in U.S. dollars—fees for onsite registration will be collected in US\$ and credit card only)

	EARLY (June–28 Sept.)	STANDARD/ ONSITE (after 28 Sept.)
Professional member, full meeting	\$365	\$445
Professional member, one day	\$235	\$265
Professional member 70+, full meeting	\$265	\$350
Professional member over 70+, one day	\$165	\$190
Professional non-member, full meeting	\$490	\$560
Professional non-member, one day	\$305	\$325
Student member, full meeting	\$120	\$155
Student member, one day	\$75	\$85
Student non-member, full meeting	\$160	\$195
Student non-member, one day	\$100	\$110
High-school student	\$40	\$40
K–12 professional, full meeting	\$55	\$65
Field Trip or Short Course only	\$40	\$40
Guest or spouse	\$85	\$90
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 hardcopy version of the registration form and mail it to GSA, P.O. Box 9140, 3300 Penrose Place, Boulder, CO, 80301-9140, USA.

## 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. A complete list of ticketed events is available on the meeting website. Ticketed events are open to everyone, and tickets can be purchased in advance when you register or at the on-site registration desk up to 48 hours prior to the event. 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](mailto:meetings@geosociety.org).

## Student Members: Volunteer!

Earn FREE meeting registration when you volunteer for ten hours, PLUS one US\$25 stipend for every five hours worked, PLUS get an insider’s view of the meeting! Sign up early for the best selection of jobs, then register for the meeting as a student volunteer.

## Grant Assistance

Need financial assistance to attend 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. Check the meeting website for application and deadline information. *Note:* Eligibility criteria and deadline dates vary by grant.

For meeting attendees who reside outside of North America, check the International Travel Grant webpage at [www.geosociety.org/sections/International/travelGrants.htm](http://www.geosociety.org/sections/International/travelGrants.htm). The deadline to apply for this grant is **27 June**.

## Student Travel Fund

▶ **Interested in helping students participate in the meeting?**

Donate to the Student Travel Fund on your registration! Every year, a large percentage of students apply for travel grants but do not receive an award due to a limited number of funds. You can help increase the number of students helped by donating as little as US\$10 via your registration form. 100% of the monies collected go to students.

**8. Come enjoy the Exhibit Hall Opening Reception** from 5:30 to 7 p.m. on Sunday. Check your nametag for complimentary drink tickets.

*Registration continued on p. 20*

Registration continued from p. 19

## Media Registration

Complimentary meeting registration is available to journalists from bona fide news organizations and to public information officers (PIOs) from geoscience-related organizations. Media registration provides access to all scientific sessions, the exhibition area, and the newsroom. Get information about eligibility and request media credentials at [community.geosociety.org/gsa2015/press/mediareg](http://community.geosociety.org/gsa2015/press/mediareg).

## Continuing Education Credits (CEUs)

The Annual Meeting offers an excellent opportunity to earn CEUs toward your general continuing education requirements for your employer or K–12 school. Credits are available for technical sessions, short courses, and field trips. Ten contact hours are required for one CEU; for example, one day (8 hours) of technical sessions = 0.8 CEUs. After the meeting, contact William Cox at [wcox@geosociety.org](mailto:wcox@geosociety.org) to receive a meeting evaluation form; return the form, and you will receive your CEU certificate within two weeks.

## Special Requirements

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 appropriate box when registering online and a GSA staff member will contact you.

### Don't forget to...

- ✓ Register for tours, special events, field trips, and workshops;
- ✓ Purchase your tickets and/or register in advance for special events;
- ✓ Bring a copy of your meeting confirmation with you;
- ✓ Be sure to apply for the Student Travel Grant program by 28 Sept.;
- ✓ Make your hotel reservation; and
- ✓ Book your travel.

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# GSA 2015 At-a-Glance

*Pre-meeting Field Trips and Short Courses, along with a variety of business meetings, will take place between Wed., 28 Oct., and Sat., 31 Oct.*

## Saturday, 31 Oct.

**Baltimore Icebreaker:** 5–7 p.m.

## Sunday, 1 Nov.

*(Daylight Savings Time ends)*

- 1 **Bridging Two Continents:** 8 a.m.–5:30 p.m.
- 2 Oral Technical Sessions: 8 a.m.–noon
- 3 Poster Sessions: 9 a.m.–5:30 p.m.
- 4 **GeoCareers in Industry:** 9 a.m.–5:30 p.m.
- 5 **Lunch Break:** noon–1:30 p.m. (**Feed Your Brain:** Lunchtime Enlightenment, *buy your food and take it in*)
- 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, 2 Nov.

- 1 **Bridging Two Continents:** 8 a.m.–5:30 p.m.
- 2 Oral Technical Sessions: 8 a.m.–noon
- 3 **Exhibits:** 9 a.m.–6:30 p.m.
- 4 Poster Sessions: 9 a.m.–6:30 p.m.
- 5 **Lunch Break:** noon–1:30 p.m. (**Feed Your Brain:** Lunchtime Enlightenment, *buy your food and take it in*)
- 6 Oral Technical Sessions: 1:30–5:30 p.m.
- 7 **Afternoon Beer Reception:** 4:30–6:30 p.m. (and a great time to meet with poster presenters)
- 8 **Alumni Receptions:** evening hours

## Tuesday, 3 Nov.

- 1 Oral Technical Sessions: 8 a.m.–noon
- 2 **Exhibits:** 9 a.m.–6:30 p.m.
- 3 Poster Sessions: 9 a.m.–6:30 p.m.
- 4 **Lunch Break:** noon–1:30 p.m. (**Feed Your Brain:** Lunchtime Enlightenment, *buy your food and take it in*)
- 5 Oral Technical Sessions: 1:30–5:30 p.m.
- 6 **Afternoon Beer Reception:** 4:30–6:30 p.m. (and a great time to meet with poster presenters)

## Wednesday, 4 Nov.

- 1 Oral Technical Sessions: 8 a.m.–noon
- 2 **Exhibits:** 9 a.m.–2 p.m.
- 3 Poster Sessions: 9 a.m.–6:30 p.m.
- 4 **Lunch Break:** noon–1:30 p.m. (**Feed Your Brain:** Lunchtime Enlightenment, *buy your food and take it in*)
- 5 Oral Technical Sessions: 1:30–5:30 p.m.
- 6 **Afternoon Beer Reception:** 4:30–6:30 p.m. (and a great time to meet with poster presenters)

*Post-meeting field trips run from Wed., 4 Nov., through Fri., 6 Nov.*



## GSA 2015 Highlights

9. **Meet your posters!** Poster presenters will be at their posters ready to talk to *you* before the Exhibit Hall Opening Reception on Sunday and during the afternoon beer receptions, 4:30 to 6:30 p.m., Monday through Wednesday.

10. **Monday night makes school cool:** Alumni receptions go all night; the Group Alumni Reception starts at 7 p.m.

# Call For Papers

## ► ABSTRACTS DEADLINE: 11 August

**DISCIPLINE SESSIONS** are created by pooling together abstracts submitted to a particular discipline category, which can create a dynamic, thought-provoking session.

**TOPICAL SESSIONS** are focused on specific topics for a motivating, interdisciplinary exchange of science. If you are interested in submitting an abstract to a particular topic, check the meeting website for a listing.

**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 is online.

## SUBMITTING AN ABSTRACT

- To begin your submission, go to [community.geosociety.org/gsa2015/science/sessions](http://community.geosociety.org/gsa2015/science/sessions).
- A fee of US\$45 for professionals and US\$25 for students will be charged for each abstract submission.
- Please review the two-abstract rule below.
- **Submission deadline:** Tuesday, 11 August.

## Two-Abstract Rule

- You may submit two volunteered abstracts, *as long as one of the abstracts is for a poster presentation*;
- Each submitted abstract must be different in content; and
- If you are invited to submit an abstract to a Pardee Keynote Symposium or a topical session, the invited abstracts do not count against the two-abstract rule.

## Poster Presenters

**Hours for poster presentations:** 9 a.m.–5:30 p.m. on Sunday, with authors present 3:30–5:30 p.m. Mon.–Wed., posters should be on display 9 a.m.–6:30 p.m., with authors present during the afternoon beer reception, 5–6:30 p.m. Authors can be available at other times throughout the day, at the presenters' preference.

- 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 will not be available this year, so please plan your presentation accordingly.
- Wi-Fi will be available in the poster hall area.

## Oral Presenters

The normal length of an oral presentation is 12 min. plus 3 min. 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.

## Request a Press Release

Each year, GSA prepares a limited number of press releases and facilitates a few Web-streamed press conferences at the meeting on presentations that may be of interest to the public through the science media. If you are presenting new research that you feel should be highlighted for the media and to the audiences they write for, please let us know. Find guidelines and request a press release or media briefing at [community.geosociety.org/gsa2015/science-careers/requestpr](http://community.geosociety.org/gsa2015/science-careers/requestpr).

## GSA 2015 Highlights

**11.** The meeting does not end on Wednesday ... at least not until after beer o'clock, 4:30 to 6:30 p.m. in the Poster Hall.

**12.** Scientific field trips run throughout the meeting; post-meeting trips include visits to Washington, D.C., the Smithsonian Institution, and Maryland's Calvert Cliffs.

**13.** Next year's meeting will be earlier than usual and in Denver: 25–28 Sept. We hope to see you there!



Joseph Thomas Pardee (1871–1960)

# Pardee Keynote Symposia

## P1. Celebrating the Genius of William “Strata” Smith: Bicentennial Anniversary of Smith’s Revolutionary Map.

Sun., 1 Nov., 8–11 a.m. & 2–4 p.m.; Mon., 2 Nov., 8 a.m.–noon.

**Advocates:** George H. Davis, Renee M. Clary.

Smith’s 1815 *Geological Map of England and Wales and Part of Scotland* stands as a milestone in the geological sciences. This session will explore “Smith fundamentals” in relationship to our science today.

## P2. Savor the Cryosphere.

Mon., 2 Nov., 1:30–5:30 p.m.

**Advocates:** Patrick Burkhardt; Greg Baker; Paul Baldauf.

This session will examine the retreat of Earth’s glaciers coupled with the perturbation of other earth systems by an intensely warming climate. Three prestigious investigators, James Balog, Richard Alley, and Lonnie Thompson, will seek to demonstrate that “seeing is believing.” The program includes a screening of *Chasing Ice*.

## P3. Earth-Life Systems at the Dawn of Animals.

Tues., 3 Nov., 8 a.m.–noon.

**Advocates:** James D. Schiffbauer; Marc Laflamme; Simon A.F. Darroch.

Geobiologists, evolutionary biologists, paleontologists, sedimentologists, geochemists, and earth-systems scientists will come

together to showcase high-impact research, identify the frontiers of current research, and present key questions to be addressed about future prospects regarding the rise of animals across the Precambrian–Cambrian transition.

## P4. Similar Information, Different Results: Fracking from State to State.

Tues., 3 Nov., 1:30–5:30 p.m.

**Advocates:** R. Laurence Davis; Christopher P. Carlson.

During this session, geologists and policy makers representing several states will outline their state’s policies and discuss how they were developed. The presentations will be followed by a panel discussion and time for Q&A.

## P5. Appalachian Geomorphology.

Wed., 4 Nov., 8 a.m.–5:30 p.m.

**Advocates:** Frank J. Pazzaglia; Gregory S. Hancock; Sean F. Gallen.

This full-day session is dedicated to new research and synoptic presentations of geomorphic processes and rates as seen through the lens of the Appalachian landscape.



# EVENTS

## The Pathway to a Successful Career: Building Value

Sat., 31 Oct., 1–4 p.m. **Instructor:** Patrick McAndless, P.Geo, FGC.

Whether you are just beginning your career or changing your path, learn how to showcase your potential value to employers and build marketing tools to help you succeed. This workshop will feature industry professionals who will offer tips and suggestions for navigating their company hiring process. Read more at [community.geosociety.org/gsa2015/science-careers/careers](http://community.geosociety.org/gsa2015/science-careers/careers).

## Connecting Students and Industry

Sun., 1 Nov., 9 a.m.–5:30 p.m.

Interested in a career in private industry or want to learn more about what it takes to get a job in industry? Plan to attend these *GeoCareers in Industry* events to interact with sponsoring representatives. Throughout the day, you will have opportunities for one-on-one time to present your research and learn about each company's unique culture and work environments, as well as the types of geoscience careers available. Midday, come learn from our *Industry Panel* luncheon. The Sunday program ends with an evening reception for student research presenters and sponsoring corporations. To register for this event, go to [community.geosociety.org/gsa2015/registration](http://community.geosociety.org/gsa2015/registration).

## Résumé Clinic

Sun., 1 Nov., 9 a.m.–5 p.m.

Plan to sign-up on-site for a private consultation with a geoscience professional to review your résumé and discuss strategies to better market yourself to potential employers.

## On To the Future: Seeking Mentors

*Are you interested in mentoring a student at GSA's Annual Meeting?*

The On To the Future Program (OTF) seeks mentors to pair with students receiving OTF awards. Mentors will assist OTF students who are underrepresented in the geosciences navigate their first meeting and answer career related questions. To learn more about this program and how to become a mentor, please visit the OTF website at [community.geosociety.org/otf/annualmeetingprogram/mentors](http://community.geosociety.org/otf/annualmeetingprogram/mentors).

## GSA Career Pathway Programs

GSA offers six programs at the Annual Meeting, all designed to develop skills and knowledge to enhance the professional and personal growth of students and K–12 teachers. These programs:

- Concentrate on employment within various sectors (*Government and Industry Panels*), specialties (*John Mann Mentors in Applied Hydrogeology* and *The Paleontological Society Career Mentors Program*) and specific issues (*Women in Geology*);
- Facilitate future career choices by sharing resources, skills, and knowledge;
- Enhance professional development (*Student Networking Luncheon*);
- Provide networking opportunities with professionals and other students; and
- Provide attendees with critical feedback (the government and industry panels are driven entirely by students' questions).

Go to [community.geosociety.org/gsa2015/science-careers/careers/mentor](http://community.geosociety.org/gsa2015/science-careers/careers/mentor) to learn more.

## GSA Professional Development: Be Heard & Be Interesting

*Science communication strategies for interacting with the public, policymakers, and social media*

Sat., 31 Oct., 8 a.m.–noon. Professionals: US\$35; students: US\$25; includes continental breakfast. Limit: 30. Sign up when you register or call GSA Sales & Service, +1-800-443-4472, to add the workshop.

Have you ever struggled to explain your research to a friend? Would you like to be able to tell your Senator your views on policy? Are you interested in using Twitter but aren't sure how? Learn from experts and each other as you hone your public communication and outreach skills, and practice in a safe and comfortable setting.

You will leave knowing how to create clear and concise messages that are targeted to your audience, as well as how to prepare for a media interview. You will learn strategies for using social media, identify opportunities for interacting with laypersons in your community, and gain an understanding of how to approach policy makers on scientific issues.

Communication skills are key to a successful career and important in all aspects of life. Give yours the attention they deserve.





# The Next Step for Your Annual Meeting Science: PENROSE CONFERENCES and THOMPSON FIELD FORUMS

You'll be networking with 6,000+ colleagues in Baltimore, and this can be a great catalyst for generating intriguing scientific discussions and field study ideas. That's what GSA's Penrose Conferences and Thompson Field Forums are for.

Penrose Conferences have a long history of bringing together multi-disciplinary groups of geoscientists to facilitate open and frank discussions of ideas in an intimate, informal atmosphere and to inspire individual and collaborative research.

Thompson Field Forums are designed to capture the essence of exciting discoveries or controversial topics via forays into the field for on-the-spot discussions of a particular geologic feature or area. This is both an opportunity to get out into the field and to bring together experts on the topic at hand to exchange current knowledge, ideas, and theories.



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# Scientific Field Trips

Descriptions and leader bios are online.

## ExxonMobil

Thanks to generous support from ExxonMobil, 10 field trips (marked with an asterisk) are now offered at a discounted rate for students. Registration for each of these trips is on a first-come, first-served basis, and student discount space is limited.

### 401. Holocene Barrier Island Geology and Morphodynamics along the Maryland and Virginia Open-Ocean Coasts: Fenwick, Assateague, Chincoteague, Wallops, Cedar, and Parramore Islands.

Wed.–Sat., 28–31 Oct. US\$475.

**Leaders:** Randolph A. McBride, George Mason University; Michael S. Fenster; Christopher Seminack. **Cosponsors:** GSA *Sedimentary Geology Division*; GSA *Quaternary Geology and Geomorphology Division*.

### 402. Geomorphology, Active Tectonics, and Landscape Evolution in the Mid-Atlantic Region.\*

Wed.–Sat., 28–31 Oct. US\$425; limited student price: US\$300.

**Leaders:** Frank J. Pazzaglia, Lehigh University; Mark W. Carter; Gregory S. Hancock; David J. Harbor; G. Richard Whittecar; Paul Bierman; James A. Spotila. **Cosponsor:** GSA *Quaternary Geology and Geomorphology Division*.

### 403. From the Freezer to the Fire: Neoproterozoic Tectonics, Glaciation, and Volcanism in the Central Appalachian Blue Ridge Province.\*

Thurs.–Sat., 29–31 Oct. US\$275; limited student price: US\$140.

**Leaders:** Christopher Bailey, College of William & Mary; Callan Bentley; Scott Southworth; Alan J. Kaufman. **Cosponsors:** GSA *Structural Geology and Tectonics Division*; GSA *Sedimentary Geology Division*; EGU *Structural Geology & Tectonics Division*.

### 404. William Smith's Map and Other Treasures of the History of Geology at the Academy of Natural Sciences, American Philosophical Society, and Library Company, Philadelphia.

Fri., 30 Oct. US\$99.

**Leaders:** Gary D. Rosenberg, Indiana University–Purdue University; Sally Newcomb; Hugh Torrens. **Cosponsor:** GSA *History and Philosophy of Geology Division*.

### 405. Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island.

Fri., 30 Oct. US\$85.

**Leaders:** Justin Callahan, U.S. Army Corps of Engineers, Baltimore District; Maria Orosz. **Cosponsors:** U.S. Army Corps of Engineers, Baltimore District; Maryland Port Administration; Maryland Environmental Service.

### 407. Cambrian-Ordovician of the Central Appalachians: Correlations and Event Stratigraphy of Carbonate Platform and Adjacent Deep-Water Deposits.\*

Fri.–Sat., 30–31 Oct. US\$220; limited student price: US\$110.

**Leaders:** David K. Brezinski, Maryland Geological Survey; John F. Taylor; John E. Repetski; James D. Loch.

### 408. Appalachian Stratigraphy, Tectonics, and Eustasy from the Blue Ridge to the Allegheny Front, Virginia and West Virginia.\*

Fri.–Sat., 30–31 Oct. US\$230; limited student price: US\$115.

**Leaders:** John T. Haynes, James Madison University; Alan Pitts; Richard J. Diecchio; Daniel H. Doctor.

### 409. Cenozoic Stratigraphy and Structure of the Chesapeake Bay Region.

Fri.–Sat., 30–31 Oct. US\$180.

**Leaders:** David S. Powars, USGS; Lucy E. Edwards; J. Stephen Schindler; Susan M. Kidwell.

### 410. Coastal and Wetland Ecosystems of the Chesapeake Bay Watershed: Applying Palynology to Understand Impacts of Changing Climate, Sea Level, and Land Use.

Sat., 31 Oct. US\$85.

**Leaders:** Debra A. Willard, USGS; Christopher Bernhardt; Cliff R. Hupp. **Cosponsor:** AASP - *The Palynological Society*.

### 411. Geology, Engineering, and the Chesapeake & Ohio Canal (A William Smith Bicentenary Activity).

Sat., 31 Oct. US\$90.

**Leaders:** Robert W. Krantz, ConocoPhillips; Katharine M. Loughney; John Tudek. **Cosponsors:** *William Smith Bicentenary Committee*; GSA *History and Philosophy of Geology Division*.

### 413. Field Geology of the Baltimore Mafic Complex, Pennsylvania–Maryland State Line.\*

Sat., 31 Oct. US\$90; limited student price: US\$50.

**Leaders:** Stephen G. Shank, Pennsylvania Geological Survey; L. Lynn Marquez; Christopher R. Hardy. **Cosponsor:** *Pennsylvania Geological Survey*.

### 414. Geologic Investigation of the Impact of a Subsurface Coal Fire: Centralia, Pennsylvania.

Sat., 31 Oct. US\$99.

**Leaders:** Jennifer M. Elick, Susquehanna University; J. Fred McLaughlin.

### 415. The Tectono-Thermal Evolution of the Central Appalachian Orogen: Accretion of a Peri-Gondwanan(?) Ordovician Arc.\*

Sat., 31 Oct. US\$87; limited student price: US\$47.

**Leaders:** Howell Bosbyshell, West Chester University; LeeAnn Srogi; William S. Schenck; Gale C. Blackmer. **Cosponsor:** GSA *Structural Geology and Tectonics Division*.

**416. Kirk Bryan Field Trip: Great Falls of the Potomac and the Evolution of a Decay-Phase Orogen, the Appalachian Mountains.**

Sat., 31 Oct. US\$125.

**Leaders:** Paul Bierman, University of Vermont; Eric Kirby; William B. Ouimet; Eric W. Portenga; Frank Pazzaglia; Gregory S. Hancock. **Cosponsor:** *GSA Quaternary Geology and Geomorphology Division.***417. The History of Stone Quarrying in the Baltimore Area, Including a Visit to the Historic Cockeysville Marble Quarry.**

Sat., 31 Oct. US\$49.

**Leaders:** Joseph T. Hannibal, Cleveland Museum of Natural History; Page Herbert. **Cosponsor:** *Heritage Stone Task Force of the IUGS.***418. Hydrology and Geomorphology of Urban Streams and Riparian Zones in the Baltimore Metropolitan Area.**

Sat., 31 Oct. US\$95.

**Leaders:** Andrew Miller, Univ. of Maryland Baltimore County (UMBC); Claire Welty; Robert J. Shedlock; Edward J. Doheny. **Cosponsors:** *Andrew Miller (UMBC); Claire Welty (UMBC); Ed Doheny (USGS).***419. The Lost Springs of Washington, D.C., Late Tertiary and Quaternary Sediments of D.C., and the Baltimore LTER: The Hydrogeology of Urbanization.**

Sat., 31 Oct. US\$90.

**Leader:** John M. Sharp, The University of Texas Jackson School of Geosciences.**420. K–12 Earth Science Educators Trip to the National Museum of Natural History.**

Sat., 31 Oct. US\$28.

**Leaders:** Michael J. Passow, Smithsonian Institution National Museum of Natural History; Adam Blankenbicker. **Cosponsors:** *Smithsonian Institution National Museum of Natural History; National Earth Science Teachers Association.***421. Rockin' D.C.: A Geological Overview of the National Mall and Its Building Stones.**

Sat., 31 Oct. US\$85.

**Leaders:** Kenneth Rasmussen, Northern Virginia Community College; Victoria Martin. **Cosponsors:** *GSA Geoscience Education Division; GSA Sedimentary Geology Division.***422. The Geology of the Gettysburg Battlefield and Its Influence on Military History.**

Sat., 31 Oct. US\$130.

**Leaders:** Roger J. Cuffey, Pennsylvania State Univ.; Vincent L. Santucci. **Cosponsors:** *Penn State University; National Park Service Geologic Resources Division; Gettysburg National Military Park.***423. The Delmarva Peninsula: A Field Laboratory for Studies of Shallow Groundwater Flow and Quality.**

Sat., 31 Oct. US\$90.

**Leaders:** Robert J. Shedlock, Maryland–Delaware–District of Columbia Water Science Center; Judith M. Denver; Jeff P. Raffensperger; Ward E. Sanford.**424. Building Stones of Downtown Baltimore.**

Sat., 31 Oct. US\$36.

**Leaders:** David W. Bolton, Maryland Geological Survey; Joseph T. Hannibal. **Cosponsor:** *Heritage Stone Task Group of the International Union of Geological Sciences.***425. A Billion Years of Deformation in the Central Appalachians: Orogenic Processes and Products.\***

Wed.–Fri., 4–6 Nov. US\$250; limited student price: US\$125.

**Leaders:** Steven J. Whitmeyer, James Madison University; Christopher M. Bailey; David B. Spears. **Cosponsor:** *GSA Structural Geology and Tectonics Division.***426. The Shale Hills Critical Zone Observatory.**

Thurs., 5 Nov. US\$95.

**Leaders:** Don Duggan-Haas, The Paleontological Research Institution; Susan L. Brantley; Tim White. **Cosponsors:** *GSA Geoscience Education Division; National Association of Geoscience Teachers.***427. Experience Capitol Hill: Geoscience and Public Policy in Washington, D.C.**

Thurs., 5 Nov. US\$49.

**Leaders:** Kasey S. White, Geological Society of America; Jeffrey Rubin; David Robert Wunsch; Jonathan G. Price. **Cosponsor:** *GSA Geology and Public Policy Committee.***428. USGS: Then and Now.**

Thurs., 5 Nov. US\$75.

**Leaders:** Susan G. Stover, University of Kansas; Suzette Kimball; David Applegate; Virginia Burkett; Scott Southworth. **Cosponsors:** *GSA Geology and Public Policy Committee; USGS.***429. Acoustic Seafloor Mapping of the Baltimore Harbor.**

Thurs., 5 Nov. US\$95.

**Leaders:** Stephen VanRyswick, Coastal & Estuarine GeoSciences Program; Katherine Offerman. **Cosponsor:** *Maryland Geological Survey.***430. Stream Restoration in Geologic Regions of Maryland.**

Thurs., 5 Nov. US\$105.

**Leaders:** Eric Dougherty, Maryland State Highway Administration Engineering Geology Division; Todd Nichols. **Cosponsor:** *Maryland State Highway Administration.***431. Late Devonian Climate Change and Glaciogenic Facies in the Central Appalachians.**

Thurs., 5 Nov. US\$110.

**Leaders:** David K. Brezinski, Maryland Geological Survey; Blaine Cecil; William DiMichele.**432. The Building Stones of the National Mall.**

Thurs., 5 Nov. US\$20.

**Leaders:** Richard A. Livingston, University of Maryland; Carol A. Grissom. **Cosponsors:** *University of Maryland; Smithsonian Institution.*

**433. Smithsonian Museum of Natural History—Fossil Collections and Exhibitions.**

Thurs., 5 Nov. US\$30.

**Leaders:** Scott L. Wing, Smithsonian Institution; Kathy Hollis; Siobhan Starrs. **Cosponsor:** *Smithsonian Institution Museum of Natural History.***434. Tour of the Smithsonian Meteorite Collection.**

Thurs., 5 Nov. US\$10.

**Leader:** Cari Corrigan, Smithsonian Institution. **Cosponsor:** *GSA Planetary Geology Division.***435. Miocene Stratigraphy and Paleoenvironments of the Calvert Cliffs, Maryland.\***

Thurs.–Fri., 5–6 Nov. US\$160; limited student price: US\$85.

**Leaders:** Susan M. Kidwell, Univ. of Chicago; Lucy E. Edwards; David S. Powars; Peter R. Vogt.**436. Biology and Geology of Cranesville and Finzel Swamps in Garrett County, Western Maryland.**

Thurs.–Fri., 5–6 Nov. US\$225.

**Leaders:** Dan Feller, Maryland Dept. of Natural Resources; Sunshine Brosi; Katherine Offerman.**437. Karst of the Mid-Atlantic Region in Maryland, West Virginia, and Virginia.\***

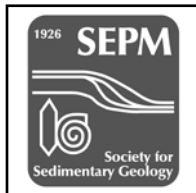
Thurs.–Sat., 5–7 Nov. US\$380; limited student price: US\$200.

**Leaders:** Daniel H. Doctor, USGS; David J. Weary; David K. Brezinski; Randall C. Orndorff; Lawrence E. Spangler. **Cosponsors:** *GSA Karst Division; GSA Hydrogeology Division; Karst Waters Institute; National Cave and Karst Research Institute.***438. Cretaceous Stratigraphy and Palynology of the Maryland Coastal Plain.\***

Thurs., 5 Nov. US\$120; limited student price: US\$65.

**Leaders:** Peter P. McLaughlin, University of Delaware; Heather Quinn. **Cosponsor:** *AASP - The Palynological Society.*

## GSA Associated Society Field Trips



Society for Sedimentary Geology (SEPM)

**Geology and Paleontology of Calvert Cliffs (Chesapeake Group), Calvert County, Maryland.**

Sun., 1 Nov. Fee: \$25. Restricted to students only; max.: 35.

**Leaders:** Stephen Godfrey, Calvert Marine Museum; Peter Vogt, Marine Science Institute, University of California, Santa Barbara; John Nance, Calvert Marine Museum. Sign up at <http://sepm.org/pages.aspx?pageid=384>.

Society of Economic Geologists (SEG)

**Registration opens** 1 Aug. 2015 via the SEG website, [www.segweb.org/events](http://www.segweb.org/events). Early registration: 1 Aug.–28 Sept. SEG reserves the right to cancel these trips should minimum attendance numbers (min. 12, max. 20) not be met by 28 Sept. Late registration pricing begins after 28 Sept.

## PRE-MEETING TRIP

**The Historic Sykesville Ultramafic Rock-Associated, Fe-Cu-Co-Zn-Ni Mineral District: Tailings and Core.**

Sat., 31 Oct.

**Leaders:** Philip A. Candela, University of Maryland; Philip M. Piccoli, University of Maryland; Ann G. Wylie, University of Maryland. **Fees:** SEG members: early: US\$135/late: US\$195; non-SEG members: early: US\$195/late: US\$255; SEG student members: early: US\$65/late: US\$95; non-SEG member students: early: US\$95/late: US\$125.

## POST-MEETING TRIP

**Placer Deposits of the Atlantic Coastal Plain: Stratigraphy, Sedimentology, Mineral Resources, Mining and Reclamation.**

Thur.–Fri., 5–6 Nov.

**Leaders:** C. Richard Berquist, College of William and Mary; Adam Karst, Iluka Resources, Inc.; Anjana K. Shah, USGS. **Fees:** SEG members: early: US\$325/late: US\$395; non-SEG members: early: US\$395/late: US\$465; SEG student members: early: US\$155/late: US\$195; non-SEG member students: early: US\$195/late: US\$235.

# Short Courses

- ▶ **Early registration deadline:** 28 September
- ▶ **Registration after 28 September** costs an additional US\$30.
- ▶ **Cancellation deadline:** 5 October

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

### 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) 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 non-registrant fee.

**Continuing Education Units (CEUs):** These courses offer CEUs; one CEU comprises 10 hours of participation.

Check the website or contact Jennifer Nocerino, [jnocerino@geosociety.org](mailto:jnocerino@geosociety.org), for course abstracts and additional information.

### 501. Springs Inventory and Assessment.

Fri.–Sat., 30–31 Oct., 8 a.m.–5 p.m. US\$685; includes hotel, transportation, and all meals. Limit: 17. CEU: 1.6.

**Instructors:** Abraham Springer, Northern Arizona University; Lawrence Stevens, Springs Stewardship Institute; Dorothy Vesper, West Virginia University

**Cosponsors:** U.S. Fish & Wildlife Service; National Park Service; GSA Hydrogeology Division

### 502. Sequence Stratigraphy for Graduate Students.

Fri.–Sat., 30–31 Oct., 8 a.m.–5 p.m. US\$25; includes lunch. Limit: 55. CEU: 1.6. **Extra!** Upon completion of the course, participants will receive a US\$25 coupon redeemable at GSA's onsite bookstore.

**Instructors:** Bob Stewart, ExxonMobil; Bret Dixon, Anadarko; Art Donovan, BP; Morgan Sullivan, Chevron; Kirt Campion, Marathon

**Cosponsors:** ExxonMobil; Anadarko; BP; Chevron; Marathon; GSA Sedimentary Geology Division

### 503. Field Safety Leadership.

Fri.–Sat., 30–31 Oct., 8 a.m.–5 p.m. US\$25; includes lunch. Limit: 24. CEU: 1.6. **Extra!** Upon completion of the course, participants will receive a US\$25 coupon redeemable at GSA's onsite bookstore.

**Instructors:** Kevin Bohacs, ExxonMobil Upstream Research Co.; David Story, ExxonMobil Upstream Research Co.; Pam Collins, ExxonMobil Upstream Research Co.

**Cosponsor:** ExxonMobil Upstream Research Co.

### 504. Introduction to Petroleum Structural Geology.

Fri.–Sat., 30–31 Oct., 8 a.m.–5 p.m. US\$25; includes lunch. Limit: 30. CEU: 1.6. **Extra!** Upon completion of the course, participants will receive a US\$25 coupon redeemable at GSA's onsite bookstore.

**Instructors:** J. Steve Davis, ExxonMobil Upstream Research Co.; Garrett Vice, ExxonMobil Upstream Research Co.

**Cosponsors:** ExxonMobil Exploration Co.; ExxonMobil Upstream Research Co.; GSA Structural Geology and Tectonics Division

### 505. Structural and Stratigraphic Concepts Applied to Basin Exploration.

Fri.–Sat., 30–31 Oct., 8 a.m.–5 p.m. US\$25; includes lunch. Limit: 30. CEU: 1.6. **Extra!** Upon completion of the course, participants will receive a US\$25 coupon redeemable at GSA's onsite bookstore.

**Instructors:** Bob Stewart, ExxonMobil Exploration Co.; Lori Summa, ExxonMobil Upstream Research Co.

**Cosponsors:** ExxonMobil Exploration Co.; ExxonMobil Upstream Research Co.; GSA Sedimentary Geology Division

### 506. Dynamics of the Subsurface Flow of Groundwater, Hydrocarbons, and Sequestered CO<sub>2</sub>: Physics and Field Examples.

Fri.–Sat., 30–31 Oct., 8 a.m.–5 p.m. US\$165. Limit: 40. CEU: 1.6.

**Instructor:** K. Udo Weyer, WDA Consultants Inc.

### 507. Near-Surface Geophysics for Non-Geophysicists.

Sat., 31 Oct., 8 a.m.–5 p.m. US\$83; includes course materials. Limit: 30. CEU: 0.8.

**Instructor:** Gregory Baker, University of Kansas

### 508. Making a GeoFabLab: How to Combine 3D Scanning, 3D Modeling and 3D Printing for Education and Research.

Sat., 31 Oct., 8 a.m.–5 p.m. US\$100. Limit: 30. CEU: 0.8.

**Instructors:** Franek Hasiuk, Iowa State University; Ian Saginor, Keystone College; Aaron Wood, Iowa State University

### 509. Introduction to Story Maps: Workshop and Hands-On Session.

Sat., 31 Oct., 8 a.m.–5 p.m. US\$108. Limit: 40. CEU: 0.8.

**Instructors:** Lee Bock, ESRI; Jon Bowen, ESRI; Allen Carroll, ESRI; Suzanne O'Connell, Wesleyan University

**Cosponsors:** Environmental Systems Research Institute (ESRI); GSA Geology and Society Division; GSA Geoscience Education Division; and GSA History and Philosophy of Geology Division

**510. Introduction to Terrestrial Laser Scanning (Ground-Based LiDAR) for Earth Science Research and Education.**

Sat., 31 Oct., 8 a.m.–5 p.m. US\$45. Limit: 25. CEU: 0.8.

**Instructors:** Marianne Okal, UNAVCO; Christopher Crosby, UNAVCO; Carlos Aiken, The University of Texas at Dallas

**Cosponsor:** UNAVCO

**511. Three-Dimensional Geologic Mapping.**

Sat., 31 Oct., 8 a.m.–5 p.m. US\$84; includes lunch. Limit: 70. CEU: 0.8.

**Instructors:** Richard Berg, Illinois State Geological Survey; Harvey Thorleifson, Minnesota Geological Survey; Hazen Russell, Geological Survey of Canada; Kelsey MacCormack, Alberta Geological Survey

**Cosponsor:** Association of American State Geologists

**512. Statistical Treatment of Structural Geology Data.**

Sat., 31 Oct., 8 a.m.–5 p.m. US\$100. Limit: 40. CEU: 0.8.

**Instructors:** Basil Tikoff, University of Wisconsin–Madison; Davis Joshua, Carleton College; Sarah Titus, Carleton College

**Cosponsor:** GSA Structural Geology and Tectonics Division

**513. Applications of Commercial Satellite Imagery for Polar Science.**

Sat., 31 Oct., 8 a.m.–5 p.m. US\$109. Limit: 25. CEU: 0.8.

**Instructors:** Lucas Winzenburg, University of Minnesota; Paul Morin, University of Minnesota; Claire Porter, University of Minnesota; Mark Salvatore, Arizona State University

**Cosponsor:** National Science Foundation Polar Geospatial Center

**514. Ground-Penetrating Radar: Principles, Practice, and Processing.**

Sat., 31 Oct., 8 a.m.–5 p.m. US\$50. Limit: 24. CEU: 0.8.

**Instructors:** Greg Johnston, Sensors & Software Inc.; Troy De Souza, Sensors & Software Inc.

**Cosponsor:** Sensors & Software Inc.

**515. Building Teaching Skills for Future Faculty.**

Sat., 31 Oct., 8 a.m.–5 p.m. US\$100. Limit: 40. CEU: 0.8.

**Instructors:** Anne Egger, Central Washington University; David McConnell, North Carolina State University

**Cosponsor:** National Association of Geoscience Teachers

**516. Medical Geology: How the Natural Environment Gets Away with Murder.**

Sat., 31 Oct., 8:30 a.m.–5 p.m. US\$81. Limit: 50. CEU: 0.75.

**Instructors:** Robert Finkelman, The University of Texas at Dallas; Thomas Darrah, Ohio State University; Laura Ruhl, University of Arkansas at Little Rock; Jose Centeno, The Joint Pathology Center

**Cosponsors:** International Medical Geology Association (IMGA); GSA Geology and Health Division

**517. Digital Evolutionary Trees: Create Exciting Evolutionary Trees, Packed with Images and Information and Integrated with a Comprehensive Earth History Database.**

Sat., 31 Oct., 9 a.m.–4 p.m. US\$40. Limit: 30. CEU: 0.6.

**Instructors:** Barry Fordham, The Australian National University; James Ogg, Purdue University

**Cosponsor:** Geologic TimeScale Foundation

**518. U-Th-Pb Geochronology and Hf Isotope Geochemistry Applied to Detrital Minerals.**

Sat., 31 Oct., 9 a.m.–5 p.m. US\$45. Limit: 40. CEU: 0.7.

**Instructor:** George Gehrels, University of Arizona

**519. Digital Geologic Mapping: Flat Map Data Collection with QGIS and Introduction to 3D Mapping Techniques.**

Sat., 31 Oct., 9 a.m.–5 p.m. US\$109. Limit: 25. CEU: 0.7.

**Instructors:** Terry Pavlis, The University of Texas at El Paso; Richard Langford, The University of Texas at El Paso; Jose Hurtado, The University of Texas at El Paso; Steven Whitmeyer, James Madison University

**520. Digital Field Mapping and Model Building.**

Sat., 31 Oct., 9 a.m.–5 p.m. US\$25. Limit: 25. CEU: 0.7.

*Extra!* Upon completion of the course, participants will receive a US\$25 coupon redeemable at GSA's onsite bookstore.

**Instructor:** Peter Rourke, Midland Valley

**Cosponsor:** Midland Valley

**521. Time Series Data Publication with the CUAHSI Water Data Center.**

Sat., 31 Oct., 8 a.m.–noon. US\$50. Limit: 25. CEU: 0.4.

**Instructor:** Jon Pollak, Consortium of Universities for the Advancement of Hydrologic Science Inc. (CUAHSI)

**Cosponsor:** Consortium of Universities for the Advancement of Hydrologic Sciences Inc. (CUAHSI)

**522. Geochemical Modeling for Students and Teachers.**

Sat., 31 Oct., 8 a.m.–noon. US\$43. Limit: 50. CEU: 0.4.

**Instructors:** Craig Bethke, University of Illinois at Urbana–Champaign; Brian Farrell, Aqueous Solutions LLC; Katelyn Zatwarnicki, Aqueous Solutions LLC

**Cosponsor:** Aqueous Solutions LLC

**523. William “Strata” Smith and Geo-Education: Using the History of Geology for Teaching Mapping, Scientific Practices, and the Nature of Science.**

Sat., 31 Oct., 8 a.m.–noon. US\$20. Limit: 30. CEU: 0.4.

**Instructors:** Renee Clary, Mississippi State University; Glenn Dolphin, University of Calgary; Brenda Kirkland, Mississippi State University

**Cosponsors:** GSA History and Philosophy of Geology Division; GSA Geoscience Education Division; History of Earth Sciences Society

**524. Teaching Controversial Issues 1: Climate and Energy.**

Sat., 31 Oct., 8 a.m.–noon. US\$35. Limit: 35. CEU: 0.4.

**Instructors:** Don Duggan-Haas, Paleontological Research Institution and Its Museum of the Earth; Scott Mandia, Suffolk County Community College; Glenn Dolphin, University of Calgary; Richard Kissel, Yale Peabody Museum of Natural History; Minda Berbeco, National Center for Science Education; Robert Ross, Paleontological Research Institute and its Museum of the Earth

**Cosponsors:** National Association of Geoscience Teachers; GSA Geoscience Education Division

**525. Quantitative Optical Mineralogy.**

Sat., 31 Oct., 8 a.m.–noon. US\$45. Limit: 30. CEU: 0.4.

**Instructor:** James Nicholls, University of Calgary

**Cosponsor:** GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division

**526. Using Geodetic Data in Introductory Courses: Ice Mass and Sea-Level Changes Module for Intro-Level Undergraduates.**

Sat., 31 Oct., 8 a.m.–noon. US\$30. Limit: 30. CEU: 0.4.

**Instructors:** Becca Walker, Mt. San Antonio College; Beth Pratt-Sitaula, UNAVCO

**Cosponsors:** GEodetic Tools for Societal Issues Project (GETSI); UNAVCO

**527. Teaching Geoethics across the Geoscience Curriculum.**

Sat., 31 Oct., 8 a.m.–noon. US\$50. Limit: 50. CEU: 0.4.

**Instructors:** David Mogk, Montana State University; John Geissman, The University Texas at Dallas

**Cosponsor:** National Association of Geoscience Teachers

**528. Professional Geoscience Ethics: Fundamentals and Case Histories.**

Sat., 31 Oct., 1–5 p.m. US\$70. Limit: 50. CEU: 0.4.

**Instructors:** David Abbott Jr., American Institute of Professional Geologists

**Cosponsor:** American Institute of Professional Geologists; GSA Committee on Professional Development

**529. Teaching Controversial Issues 2: Evolution of Life and Earth.**

Sat., 31 Oct., 1–5 p.m. US\$35. Limit: 35. CEU: 0.4.

**Instructors:** Don Duggan-Haas, Paleontological Research Institution and Its Museum of the Earth; Scott Mandia, Suffolk County Community College; Glenn Dolphin, University of Calgary; Richard Kissel, Yale Peabody Museum of Natural History; Minda Berbeco, National Center for Science Education; Robert Ross, Paleontological Research Institute and Its Museum of the Earth.

**Cosponsors:** National Association of Geoscience Teachers; GSA Geoscience Education Division

**530. Groundwater–Surface Water Interactions: Concepts Every Geoscientist Should Know.**

Sat., 31 Oct., 1–5 p.m. US\$95. Limit: 30. CEU: 0.4.

**Instructor:** Judson Harvey, U.S. Geological Survey

**Cosponsor:** U.S. Geological Survey

**531. Interactive Strategies for the Classroom: A How-to Guide Using Examples about Igneous Rocks.**

Sat., 31 Oct., 1–5 p.m. US\$20. Limit: 40. CEU: 0.4.

**Instructors:** Karen Kortz, Community College of Rhode Island; Jessica Smay, San Jose City College

**Cosponsors:** National Science Foundation; National Association of Geoscience Teachers (NAGT); Geo2YC Division of NAGT

**532. Supporting Student Success in Geoscience Departments and Programs.**

Sat., 31 Oct., 1–5 p.m. US\$50. Limit: 40. CEU: 0.4.

**Instructors:** Diane Doser, The University of Texas at El Paso; James Ebert, SUNY College at Oneonta; Virginia Peterson, Grand Valley State University

**Cosponsor:** National Association of Geoscience Teachers

**533. Welcome to the Anthropocene: Teaching Resources for a New Epoch.**

Sat., 31 Oct., 1–5 p.m. US\$25. Limit: 50. CEU: 0.4. *Extra!* Upon completion of the course, participants will receive a US\$25 coupon redeemable at GSA's onsite bookstore.

**Instructors:** Mark Nielsen, The Howard Hughes Medical Institute; Missy Holzer, Rutgers University Graduate School of Education

**Cosponsors:** The Howard Hughes Medical Institute; National Earth Science Teachers Association

**534. Using Geodetic Data in Majors-Level Courses: Analyzing Active Tectonics with LiDAR, InSAR, and GPS Data Applied to Critical Societal Issues.**

Sat., 31 Oct., 1–5 pm. US\$30. Limit: 30. CEU: 0.4.

**Instructors:** Bruce Douglas, Indiana University; Beth Pratt-Sitaula, UNAVCO; Vince Cronin, Baylor University

**Cosponsors:** GEodetic Tools for Societal Issues Project (GETSI); UNAVCO

**535. How to Talk to Strangers: Selling Yourself and Your Science, for Students.**

Sat., 31 Oct., 2–4 p.m. US\$10. Limit: 50. CEU: 0.2.

**Instructor:** Beth Bartel, UNAVCO; Gifford Wong, Dartmouth College

**Cosponsor:** UNAVCO

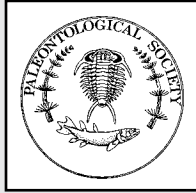
1-4 NOVEMBER

**GSA 2015**

Baltimore, Maryland, USA



# GSA Associated Society Course



GSA does not handle registration for this course. Please use the contact information provided online to learn more and to register.

## PALEONTOLOGICAL SOCIETY

### Reading and Writing of the Fossil Record: Preservational Pathways to Exceptional Fossilization.

Sat., 31 Oct., 9 a.m.–6 p.m. FREE, with no registration needed and no course attendance limit.

**Instructors:** Marc Laflamme, University of Toronto; James Schiffbauer, University of Missouri; Simon Darroch, Yale University

**Cosponsor:** The Paleontological Society

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The NASA Postdoctoral Program offers scientists and engineers unique opportunities to conduct research in multiple disciplines at all NASA Centers.  
 Apply at <http://nasa.orau.org/postdoc>

THE CLAY MINERALS SOCIETY

1-4 NOVEMBER  
**GSA 2015**  
 Baltimore, Maryland, USA

an international organization devoted to the study of clays and clay minerals  
**VISIT US AT BOOTH #1014**  
<http://clays.org>

ASSOCIATION OF EARTH SCIENCE EDITORS

1-4 NOVEMBER  
**GSA 2015**  
 Baltimore, Maryland, USA

A group of individuals involved in selection, editing, and publication of manuscripts, books, journals, reports, and maps pertaining to the earth sciences.  
**VISIT US AT BOOTH #964**  
<http://aese.org>  
 Annual Meeting: 6-9 October  
 Lawrence, Kansas

MINERALOGICAL ASSOCIATION OF CANADA

1-4 NOVEMBER  
**GSA 2015**  
 Baltimore, Maryland, USA

to promote and advance the knowledge of mineralogy and the allied disciplines of crystallography, petrology, geochemistry and mineral deposits  
**VISIT US AT BOOTH #1026**  
<http://mineralogicalassociation.ca>



# Sponsorship

**Help bring your company into the spotlight as a supporter of the geosciences!**

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## BENEFITS INCLUDE

- Contact with thousands of the best and brightest geoscience students soon to be entering the workforce—the Annual Meeting provides a convenient place to visit with students from numerous schools outside your company's usual recruiting areas;
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- Awareness of your company as a partner supporting GSA programs and doing business in our members' communities.

**Does your company employ geoscientists? Do you provide goods and services important to the work of geoscientists?** If so, please learn more at [community.geosociety.org/gsa2015/sponsors/brochure](http://community.geosociety.org/gsa2015/sponsors/brochure) or contact Debbie Marcinkowski at +1-303-357-1047, [dmarcinkowski@geosociety.org](mailto:dmarcinkowski@geosociety.org), for help in selecting the best fit for your company.

## Exhibit Hall Hours

**SUNDAY**  
 Exhibits Open: 2–7 p.m.  
 Exhibits Opening Reception:  
 5:30–7 p.m.

**MONDAY & TUESDAY**  
 Exhibit Hall Open: 9 a.m.–6:30 p.m.  
 Afternoon Beer Reception:  
 4:30–6:30 p.m.

**WEDNESDAY**  
 Exhibit Hall Open: 9 a.m.–2 p.m.  
 Afternoon Beer Reception: 4:30–6:30 p.m.  
 (posters area only)

EXHIBITS & SPONSORSHIP



Photo courtesy of Visit Baltimore.

## Event Space Requests

You still have time to reserve a room for your business meeting, luncheons, award ceremonies, parties, alumni receptions, and more. Please complete and submit the Event Space request form at [community.geosociety.org/gsa2015/spacerequest](http://community.geosociety.org/gsa2015/spacerequest) along with your payment. Your event space 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 those that are being held at a local restaurant or other venue in Baltimore!



*Back for an encore in 2015 is the highly successful workshop for early-career geoscientists on the process of preparing and publishing papers.*

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

► **When:** Sunday, 1 Nov., 11:30–2 p.m.

FREE (but an application is required) — *Lunch is provided.*

**Publishing your work is important, but how do you go about it?** This workshop, led by experienced GSA science editors, will focus on the process of preparing your research for submission to scholarly journals. Presentations by the editors will be followed by roundtable discussions, with time set aside for Q&A.

### Before You Begin

**You have a big pile of data and lots of good ideas. How do you parse all that into discrete, coherent papers?** Knowing how to frame and structure your work for publication is fundamental. Find out what editors and reviewers look for, such as whether the paper fits the scope of the journal to which it is submitted, and whether the stated aims of the paper match the results and interpretations reported.

### Writing and Revising

**The aim of this workshop isn't to address the writing process itself, but to focus on the bigger creative picture.** How do you frame your paper to meet the journal's aims and the reviewers' expectations? Find out what makes a well-prepared manuscript—including an attention-getting cover letter, an introduction that serves its purpose, and well-thought-out figures and tables that communicate your ideas.

- Get advice on what to include, what to leave out, and how best to structure your manuscript;
- Learn how to avoid frustrating your paper's reviewers; and
- Learn how to submit your paper online and what to expect during the review and publication process.

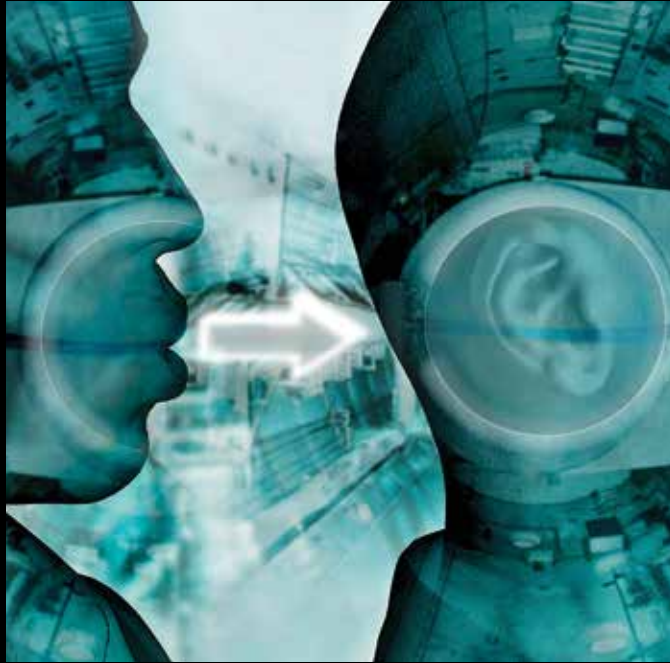
### Reviewing: Be a Part of the Scholarly Community

**Peer review is integral to publishing, so both reviewing and being reviewed are essential parts of your role as a scientist.** As an early-career author, what kind of criticism should you expect, and how should you respond to critical reviews? Reviewing the work of others is also a great way to discover what works in a paper and what does not, and it teaches you the things to avoid in your own writing. Hear from experts on what constitutes a good review and how you would benefit from being a reviewer.

### Apply to Attend

Space is limited for this class. Please e-mail [editing@geosociety.org](mailto:editing@geosociety.org) for an application. Applications are welcome from anyone interested in participating, but preference will be given to graduate students nearing completion who are actively working on manuscripts for publication, post-docs, early-career faculty and researchers, and people getting back into research after a hiatus.

# Be Heard *and* Be Interesting



*Science communication strategies for interacting with the public, policymakers, and social media*

**Saturday, 31 Oct., 8 a.m.–noon.**

**PROFESSIONALS:** US\$35; **students:** US\$25; includes continental breakfast.

**LIMIT:** 30. Sign up when you register or call GSA Sales & Service, +1-800-443-4472, to add this course.

Have you struggled to explain your research to a friend? Would you like to be able to tell your Senator your views on policy? Are you interested in using Twitter but aren't sure how? Learn from experts and each other as you hone your public communication and outreach skills, and practice in a safe and comfortable setting.

You will leave knowing how to create clear and concise messages targeted to your audience, as well as how to prepare for a media interview. You will learn strategies for using social media, identify opportunities for interacting with laypersons in your community, and gain an understanding of how to approach policy makers on scientific issues.

**Communication skills are key to a successful career and important in all aspects of life. Give yours the attention they deserve.**



**Did you catch GSA TV at GSA 2014?  
Would you like to be featured in 2015?**

GSA is pleased to have partnered with WebsEdge for professional, quality filming at recent GSA Annual Meetings. WebsEdge does an excellent job producing GSA TV—an onsite conference television program reporting on the latest research and discoveries in the geosciences.

GSA TV features a new episode daily, screened around the meeting venue, on a dedicated channel in some guest hotel rooms, and online. The programs combine onsite interviews and news around key conference themes alongside pre-recorded documentary-style reports highlighting geoscience advances at institutions like yours.

Your organization is invited to take advantage of this opportunity to profile the hard work and commitment of your earth scientists and their leading research, and support GSA in its mission to promote research to understand earth systems.

As with any professional video production project, there is a cost for organizations that choose to participate. To find out more, contact **Mark Rose at mark@websedge.com**.



Photo by Bret Webster.

## Meet Us in the Social Media–Sphere



Twitter: <https://twitter.com/geosociety>  
Follow hashtag #GSA2015

Facebook: <https://www.facebook.com/GSA.1888>

LinkedIn: <https://www.linkedin.com/company/geological-society-of-america>

GSA's Connected Community:  
[community.geosociety.org](http://community.geosociety.org)

## CALL FOR NOMINATIONS

# GSA DIVISION AWARDS

### MINERALOGY, GEOCHEMISTRY, PETROLOGY, AND VOLCANOLOGY (MGPV)

Nominations due 15 July

Submit nominations to J. Alex Speer, Mineralogical Society of America, 3635 Concorde Pkwy, Suite 500, Chantilly, VA 20151-1110, USA; [jaspeer@minsocam.org](mailto:jaspeer@minsocam.org). For more information, go to [www.geosociety.org/divisions/mgpv/awards.htm](http://www.geosociety.org/divisions/mgpv/awards.htm).

#### MGPV Distinguished Geologic Career Award

This award goes to an individual who, throughout his or her career, has made distinguished contributions in one or more of the following fields of research: mineralogy, geochemistry, petrology, and volcanology, with emphasis on multidisciplinary, field-based contributions.

#### MGPV Early Career Award

This award will go to an individual near the beginning of his or her professional career who has made distinguished contributions in one or more of the following fields of research: mineralogy, geochemistry, petrology, and/or volcanology, with emphasis on multidisciplinary, field-based contributions. Nominations are restricted to those who are within eight years past the award of their final degree. Extensions of up to two years will be made for nominees who have taken career breaks for family reasons or because of serious illness.

# STUDENT GRANTS, AWARDS & SCHOLARSHIPS

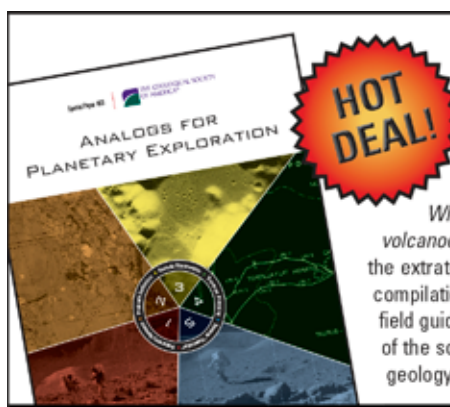
### Kerry Kelts Award

**Application deadline:** 31 July, 12 a.m. EST

Applications are invited for the Kerry Kelts Research Awards of the GSA Limnogeology Division. This year, 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 file 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 Joop Varekamp, [jvarekamp@wesleyan.edu](mailto:jvarekamp@wesleyan.edu). Please include "Kelts Award application" in the subject line.

GSA and the Limnogeology Division hope to increase the number of Kelts awards, named for visionary limnogeologist and inspiring teacher Kerry Kelts, in the future. If you can help support this award, please send your donation, labeled "Kerry Kelts Research Awards of the Limnogeology Division," to GSA at P.O. Box 9140, Boulder, CO 80301-9140, USA.



**ANALOGS FOR PLANETARY EXPLORATION**  
Edited by W. Brent Garry and Jacob E. Bleacher

*Where on Earth is it like Mars? How were the Apollo astronauts trained to be geologists on the Moon? Are volcanoes on Earth just like the ones on other planets? Geologic sites on this planet are used to better understand the extraterrestrial worlds we explore with humans, robots, and satellites. *Analogs for Planetary Exploration* is a compilation of historical accounts of astronaut geology training, overviews of planetary geology research on Mars, field guides to analog sites, plus concepts for future lunar missions. This Special Paper provides a great overview of the science, training, and planning related to planetary exploration for students, educators, researchers, and geology enthusiasts. | SPE483, 567 p., ISBN 9780813724836 | original list \$100.00 | now \$20.00*

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THE GEOLOGICAL SOCIETY OF AMERICA®

# *Help Shape the Future of Geoscience— Serve on a GSA Committee!*

**2016–2017 COMMITTEE VACANCIES**

**Deadline to apply or submit nominations:** 15 June 2015

If you are looking for the opportunity to work toward a common goal, a way to give back to GSA, networking opportunities, or a place to make a difference, then you should volunteer (or nominate a fellow GSA member) to serve on a Society committee or as a GSA representative to another organization.

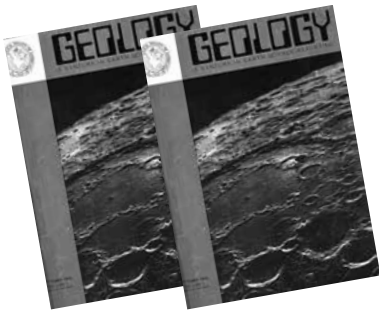
To learn more about the committees and access the nomination form, visit [www.geosociety.org/aboutus/committees/](http://www.geosociety.org/aboutus/committees/). You can also download the form and send a hardcopy nomination to Pamela Fistell, GSA, P.O. Box 9140, Boulder, CO 80301-9140, USA; fax: +1-303-357-1074; phone +1-303-357-1044 or +1-800-472-1988, ext. 1044; [pfistell@geosociety.org](mailto:pfistell@geosociety.org). **Terms begin 1 July 2016** (unless otherwise indicated).

COMMITTEE	Number of Vacancies	Length of Term
Academic and Applied Geoscience Relations (E, M)	two	3 years
Arthur L. Day Medal Award (E)	two	3 years
Diversity in the Geosciences (E, M)	three	3 years
Education (B, E, M)	one	2 years
Geologic Mapping Award (E)	two	3 years
Geology and Public Policy (B, E, M)	one; one	3 years; 2 years
GSA International (M, E)	two	4 years
Joint Technical Program (E)	three	2 years, starts 1 Dec. 2015
Membership (B) Academia	two	3 years
Nominations (B, E)	two	3 years
Penrose Conferences and Thompson Field Forums (E)	two	3 years
Penrose Medal Award (E)	two	3 years
Professional Development (E)	one	3 years
Research Grants (B, T)	seven	3 years
Young Scientist Award (Donath Medal) (E)	one	3 years
GSA REPRESENTATIVES TO OTHER ORGANIZATIONS		
	Number of Vacancies	Length of Term
GSA Representative to the AAAS Consortium of Affiliates for International Programs (CAIP)	one	3 years, starts 1 Jan. 2016
North American Commission on Stratigraphic Nomenclature (NACSN) (M, possibly B)	one	3 years, starts 1 Nov. 2015

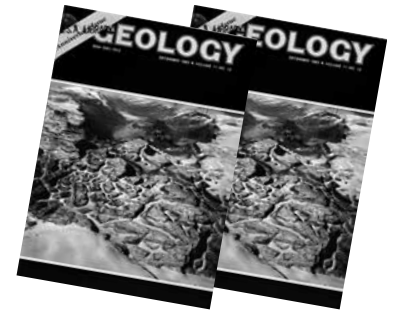
B—Meets in Boulder or elsewhere  
 E—Communicates by phone or electronically  
 M—Meets at the Annual Meeting  
 T—Extensive time commitment required during application review period (15 Feb.–15 Apr.)

Committee, Section, and Division Volunteers:  
***Council Thanks You!***

GSA Council acknowledges the many member-volunteers who, over the years, have contributed to the Society and to our science through involvement in the affairs of the GSA. Your time, talent, and expertise help build a solid and lasting Society.



## Geology—Past & Future REVISITED



**Editor's note:** The following is the tenth installment of our encore presentation of articles that highlighted the 10th anniversary of the first issue of *Geology*, as published in *Geology* in Dec. 1983 [v. 11, no. 12, p. 679–691, doi: 10.1130/0091-7613(1983)11<679:GAF>2.0.CO;2]. Each section was written by a different author (author affiliation notations are as originally published in 1983). See the August 2013 *GSA Today* (v. 23, no. 8, p. 18–19, <ftp://rock.geosociety.org/pub/GSAToday/gt1308.pdf>) for the first installment and table of contents. In this issue: article 20: “**Environmental geology**,” by John W. Rold; and article 21: “**Science publishing**,” by Henry Spall.

## Environmental Geology

**John W. Rold, Colorado Geological Survey, Denver, Colorado 80203**

In 1973 environmental geology provided an exciting frontier for geologists. Although many still argued whether the term defined a new specialty in the science or simply the practical application of geology to the normal activities of humans, Peter Flawn's book by that title was being used as a text for adult education and courses for both majors and nonmajors, ranging from freshman level to graduate seminars. Land-use-control laws with geologic emphasis and legal definitions of geologic hazards were being debated and passed in many states. A federal land-use control law was being discussed. Interdisciplinary planning was the fad. Ian McHarg's book *Design with Nature* inculcated planners, architects, and decision makers with the realization that geology could play an important role in planning and development. Professional societies such as AIPG and AEG were attempting to ensure that geologists played their proper role in the interdisciplinary environmental crusade. Practical advances in geomorphology and geotechnology were providing the scientific basis for a shift in geologic-hazard philosophy from “acts of God” to that of predictable occurrences of ongoing geologic processes. State surveys and the USGS were educating planners, legislators, and decision makers to the need for and use of geologic information and then striving to satisfy that demand with data that could and would be properly used by nongeologists.

Gas-station lines and mineral shortages generated intense exploration and massive development schemes. Determining the interaction between geologic factors, development activities, and the biosphere sparked a surge of environmental-geology employment in governmental agencies, companies, and consulting firms.

A cursory review of the 1973 literature indicates major concerns for integrating geologic information into the decision-making process, solving energy and mineral shortages, mitigating hazards, achieving mined-land reclamation, handling solid waste, and preventing water pollution. Deriving, compiling, interpreting, and distributing adequate geologic information for this burgeoning application of the science perplexed many in the profession. Complying with the letter and the spirit of the National Environmental Protection Act and the rapidly multiplying other federal, state, and local environmental laws and regulations required the attention of geologists in industry and government alike.

By 1983 each problem has been addressed but none totally solved. Federal, state, and local laws now provide a pattern for industry, government, and the public to address the problems. The frontier feeling of the 70s has been replaced with an institutionalization, accommodation, and consolidation of conflicts. Public interest confrontations and the involved geologists commonly move from the hearing room to the court room.

Now the world faces recession. High interest rates, mineral oversupply, shrinking governmental agency budgets, and high unemployment in geology (as well as other sectors) provide different restrictive parameters for facing the new challenges in applying our science toward solving our problems. In the 1980s geologists face the challenges of working within the institutionalized framework to solve the old problems and devise new or better ways of using geology in everyday planning and decision making, as well as addressing the arising awareness of toxic wastes, acid rain, hazard mitigation, shrinking ground-water supplies, increased water degradation, and the disposal of high-level radioactive waste. The wellbeing of the profession and humankind itself may depend on geologists' skills in addressing these serious world-wide problems.

Send brief comments to [gsatoday@geosociety.org](mailto:gsatoday@geosociety.org). Should this article spark a longer comment, please consider writing a *GSA Today* Groundwork or science article; learn more at [www.geosociety.org/gsatoday/](http://www.geosociety.org/gsatoday/).

# Science Publishing

**Henry Spall, U.S. Geological Survey, Reston, Virginia 22092**

One of the factors we did not consider when *Geology* began publication in 1973 was the important and inevitable changes in the publication process. Clearly, even more significant changes will take place by the end of this decade in the way we communicate scientific information.

The production of more and more information every year has led to greater incentive to speed up the publishing process. Word processors have had an enormous effect on publishing. Manuscripts keyboarded by an author on a floppy (or hard) disc can now be teletransmitted through *all* the publication stages—submission to the journal, journal review, author's revision, journal editing, typesetting—without the need for a hard (paper) copy. Other input devices available are optical character recognition (OCR) devices that will eventually be able to scan any kind of typed or typeset font. These convert the printed material to digital form that can be manipulated by a word processor or by phototypesetting equipment. In addition, greater use of computer graphics will allow not only a speedier and more standardized presentation of illustrations but, ultimately, publication of an entire package of text and graphics solely by electronic methods.

Some societies, notably the American Chemical Society, have been engaged in electronic publishing for a long time. In the U.S. Geological Survey, we are moving steadily toward processing our book publications solely by means of word-processing and telecommunications equipment. An obvious prediction for the next decade is that society journals will move in this direction too.

Traditionally, primary journals have been of great benefit to individuals, despite the fact that the individual is usually interested in only a small part of the contents of such a journal. This fact, as well as the burgeoning amount of information and the cost to publish it, means that much attention will be paid in the next 10 years to finding alternative ways of getting the information to the audience in a manner that is both efficient and cost effective.

Microform publication, which offers immense space- and money-saving advantages, is one way of doing this. Of all the alternatives to traditional journals, microform offers perhaps the best opportunity for reader browsing, although the courageous but ill-fated attempt by the Geological Society of America to introduce microfiche in the *GSA Bulletin* shows that most readers prefer the printed page. Nevertheless, libraries are steadily moving toward microfilm browsing files (as indeed they are moving steadily toward computerized systems for many library functions). A second alternative to the primary journal is the use of laser-encoded video discs to store and display scientific information. Video discs can store enormous amounts of information—one side of a disc can carry more than 40,000 pages of text, the equivalent of 4,000 journal articles or 200 books. The advantages of such compressed storage systems to libraries, plagued by chronic space shortages, are self-evident; in addition, any of the images on a disc can be displayed on a video screen within a matter of seconds. A third alternative that we will see in the next decade is the increased storage of information in computer-readable form and its retrieval by on-line access, usually through video-display units. Variations of this, now, include journals that are available both in paper copy and through on-line magnetic tape or floppy disc.

Experience indicates that the initial reaction to alternatives to primary journals will not be favorable or positive, not the least because operating these systems requires some commitment to unfamiliar technology. Nevertheless, computers and such have made enormous inroads into today's society. (Anyone who has watched teenagers in a video arcade realizes how enthusiastic this generation is about manipulating information on a video screen; remember that these people are tomorrow's users of scientific data and will expect to see familiar technology.) Within the next 10 years, aided by the momentum toward personal computers, immediate access and exchange of information by means of video screens and telecommunications links will increase significantly. As the hardware becomes faster and more efficient and the software systems are made more "user friendly," the sheer volume of information that will be produced demands that we be receptive to alternative ways of communicating the results of our research.

## Recent, Rare, and Out-of-Print Books

Geoscience Books; Paleontology Books and Fine Fossil Specimens; Ore Deposit Books, Mineral and Ore Specimens; USGS and USBM Publications



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## 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. To estimate cost, count 54 characters per line, including punctuation and spaces. Actual cost may differ if you use capitals, boldface type, or special characters. Rates are in U.S. dollars.

Classification	Per Line for 1st month	Per line each add'l month (same ad)
Positions Open	\$9.15	\$8.90
Fellowship Opportunities	\$9.15	\$8.90
Opportunities for Students		
First 25 lines	\$0.00	\$5.00
Additional lines	\$5.00	\$5.00

### Position Open

#### TENURE-TRACK ASSISTANT PROFESSOR IN IGNEOUS PETROLOGY/GEOCHEMISTRY DEPARTMENT OF GEOLOGICAL SCIENCES AND ENGINEERING

##### UNIVERSITY OF NEVADA, RENO

The Department of Geological Sciences and Engineering at the University of Nevada, Reno seeks an earth scientist for a tenure-track faculty position at the Assistant Professor level in high-temperature earth processes. We seek an outstanding scientist who combines field, laboratory and modeling investigations and will establish an innovative, world-class, externally funded research program in the petrological and/or geochemical evolution of Earth's crust and/

or mantle. The applicant will be expected to direct graduate student research at the M.S. and Ph.D. levels and contribute to both undergraduate and graduate education. The specific field of interest is open, but preference will be given to candidates who would complement and interact with our existing strengths in the structural and metamorphic evolution of the lithosphere, economic geology, geothermal systems, and natural hazards. Interested applicants must have a doctorate in geology or a related geoscience field by the time of hire. The department is part of the Mackay School of Earth Sciences and Engineering, which also includes two state-funded Earth Science units, the Nevada Bureau of Mines and Geology and the Nevada Seismological Laboratory. More information about the Department can be found at <http://www.unr.edu/geology>.

Applications are due by August 15th, 2015 and review will begin shortly after. All interested applicants should view the application and submit their materials at <http://www.unrsearch.com/postings/17132>.

Materials that will need to be uploaded include a cover letter, CV, statement of research, statement of teaching philosophy, and complete contact information for at least three letters of reference. We are hoping to fill the position by January 1st, 2016. Questions regarding the search may be addressed to the head of the search committee, Dr. Stacia Gordon, at [staciag@unr.edu](mailto:staciag@unr.edu). The University of Nevada, Reno, is an Equal Opportunity/Affirmative Action Employer. Women and underrepresented groups are encouraged to apply.

### CALL FOR PAPERS:

# GSA TODAY

The Geological Society of America's science & information magazine, *GSA Today*, is seeking science and Groundwork articles for publication in late 2015–early 2016.

- **GET NOTICED:** *GSA Today* is open-access online ([www.geosociety.org/gsatoday/](http://www.geosociety.org/gsatoday/)) and has a circulation of ~25,000. Its science articles, with just one featured each month, are among the most widely read in earth science, and this consequently provides an unparalleled opportunity for disseminating the results of research projects to the widest possible audience.
- **MAKE AN IMPACT:** *GSA Today* is ranked twelfth in the world among geoscience journals in the latest report from SCImago Journal & Country Rank ([www.scimagojr.com/journalrank.php?category=1907](http://www.scimagojr.com/journalrank.php?category=1907)), which measures a journal's influence and prestige.
- **HIT THE GROUND RUNNING:** The time from receipt to acceptance averages 80 days; acceptance to publication for these articles averages 183 days, but for hot-topic papers, the turnaround time can be as short as a month (see the July 2008 science article).
- **TOP SCIENCE EDITORS:** Steven J. Whitmeyer of James Madison University and Gerald (Jerry) Dickens of Rice University.
- **GO HERE TO LEARN MORE:** [www.geosociety.org/pubs/gsgatguid.htm](http://www.geosociety.org/pubs/gsgatguid.htm).



**S<sup>4</sup>SLIDE**  
Significance of Modern and Ancient Submarine Slope LandSLIDES



Submarine Mass Movements and Their Consequences  
7th International Symposium  
Wellington, New Zealand  
1-4 November 2015



### CALL FOR ABSTRACTS

The 7th International Symposium on Submarine Mass Movements and Their Consequences will be hosted by NIWA in Wellington, New Zealand on November 1st-4th, 2015 and a post conference fieldtrip on November 5th – 7th. This symposium is part of an initiative of the International Geoscience Programme (IGCP-640), a joint endeavor of UNESCO and the International Union of Geological Sciences (<https://sites.google.com/a/utexas.edu/s4slide/home>). The main objective of this conference is to bring a world perspective of submarine mass movements and their consequences by assembling excellent contributions from active international researchers, academic institutions and the oil and gas industry thus providing full coverage of the many scientific and engineering aspects of this type of marine and coastal geo-hazard.

Conference Themes:

1. Fluids in slope instability
2. Submarine mass movement in margin construction and economic significance
3. Geotechnical aspects of mass movement
4. Failure dynamics from landslide geomorphology
5. Tsunami generation from slope failure
6. Mass transport deposits in outcrop
7. Innovative techniques for studying mass movements
8. Earthquakes and submarine slope instabilities: preconditioning, triggering and paleo-seismology
9. Monitoring mass failure processes

Please submit 300 word abstracts for poster presentation on the conference website ([submarinemassmovements2015.co.nz/](http://submarinemassmovements2015.co.nz/)) by 1 September 2015

Student/Researcher grants are available to help cover registration and partial travel cost. Details of this are also on the SubmarineMassMovements2015 website.

S4SLIDE / IGCP-640  
Assessing Geohazards, Environmental Implications and Economic Significance of Submarine Landslides across the World's Continental Margins



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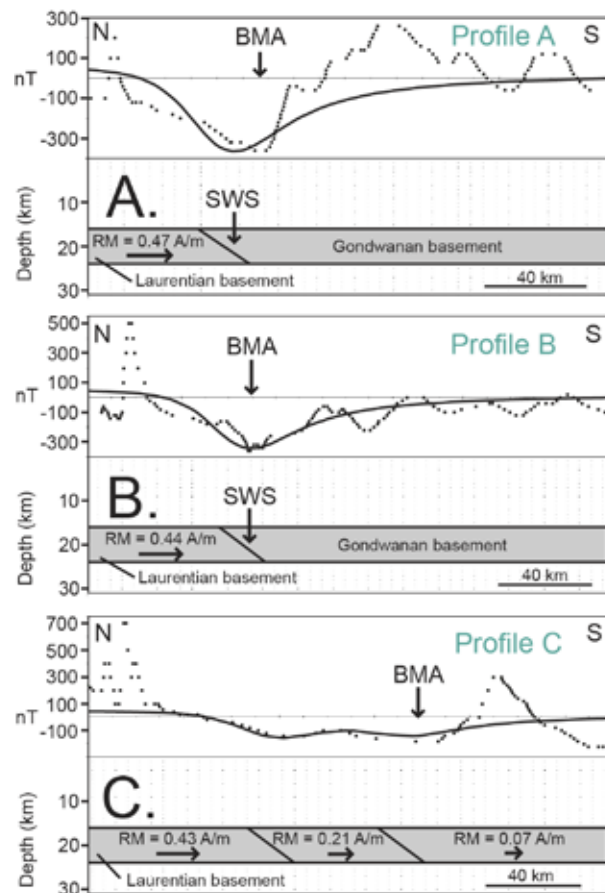


# CORRECTION

**“Crustal magnetism, tectonic inheritance, and continental rifting in the southeastern United States,”** by E.H. Parker Jr., *GSA Today*, v. 24, no. 4/5, p. 4–9, doi: 10.1130/GSAT-G192A.1.

An error has been found in the modeling used to generate magnetic anomalies in Figure 3 (*in* Parker, 2014, p. 6). During construction of crustal models, the coordinates of the polygons used to represent Gondwanan crust were entered incorrectly (counterclockwise). This resulted in two errors: (1) it reversed the polarities of the computed anomalies, which then necessitated a reversal in magnetic polarity (assignment of a 180° declination) for remanent magnetization, in order to match the overall pattern of the observed anomalies; and (2) it generated an unintended lateral variation in the contribution to the magnetic anomaly from induced magnetization. The second error was small, because of the small value for susceptibility ( $k = 0.01$  SI) assigned to all polygons, but the first resulted in a 180° error in the orientation of the contrast in remanent magnetization between Gondwanan and Laurentian crust.

The accompanying figure shows the corrected anomalies. The changes in the overall shapes of the anomalies are relatively minor, but the remanent magnetization is now shown as localized and reversed in Laurentian rather than Gondwanan crust. This is equivalent to reversed magnetization for both crustal blocks, where (e.g., for profile A) the value of 0.47 A/m then represents the contrast due to slightly stronger magnetization for Laurentian crust. This is consistent with the original interpretation that magnetization was acquired during the Kiaman superchron (320–263 Ma) and Alleghanian collision, while the region was near the equator.



## The Origin, Evolution, and Environmental Impact of Oceanic Large Igneous Provinces

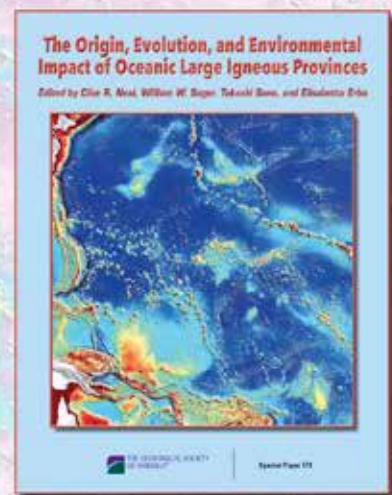
Edited by Clive R. Neal, William W. Sager, Takashi Sano, and Elisabetta Erba

The origin, evolution, and environmental impact of large igneous provinces (LIPs) represents a topic of high scientific importance because the magmatism associated with these features cannot be directly related to plate tectonics, and because the eruption of flood basalts may have global environmental consequences. Oceanic LIPs are even more poorly understood due to their relative inaccessibility. This volume takes a multidisciplinary approach to understanding LIP origin, evolution, and environmental impact in ocean basins. Papers that focus on plate tectonic reconstructions, petrologic and geophysical investigations of various LIPs, and sedimentological and micropaleontological evidence of syn-LIP sediments are presented. Precious materials and data from dredging cruises and scientific ocean drilling expeditions have made this volume possible.

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# Moving lithospheric modeling forward: Attributes of a community computer code

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We live on a planet with an active surface that is modified and deformed at multiple temporal and spatial scales owing to diverse processes occurring at plate boundaries and plate interiors. The processes of mid-ocean-ridge spreading, mountain building, subduction of tectonic plates, mantle drag, intra-continental deformation, earthquakes, and volcanism cross traditional disciplinary boundaries (Fig. 1A). Understanding these lithospheric processes is valuable not only for intellectual curiosity and to refine our working knowledge of plate tectonics, but also for understanding threats to life, property, and infrastructure. Computer modeling and simulation are increasingly powerful tools that researchers employ to better understand lithospheric deformation and unravel the complex feedbacks that drive the evolution of Earth's surface. The field is poised for a significant advance to take advantage of recent expansions in computing power, improved representation of idealized processes, increased data availability, and better communication between software developers and geoscientists.

To move forward as a community, we must address key scientific drivers motivating present and future lithospheric deformation research. The scientific processes to incorporate include melting and melt transport, strain localization and de-localization, surface processes (e.g., erosion and deposition), and mantle-lithosphere interaction. Understanding these requires the integration of results from seismic imaging, the earthquake cycle, plate boundary evolution, and more realistic Earth-like rheologies

into numerical models that are reliable, portable, and computationally efficient.

Lithospheric modelers are confronted with a broad range of challenges to address these drivers. Scientifically, crucial geological processes lack theoretical or empirical descriptions (e.g., variable fault dip at depth, spacing in shear bands, localization of deformation, and coupled deformation with melting and melt migration). Incorporating the vast quantity of new data available through such initiatives as the National Science Foundation's EarthScope and data compilations such as Gplates (Qin et al., 2012) and PetDB (Lehnert et al., 2000) requires both the development of new data-handling methods and an understanding of their interrelationships. Added to these challenges are the difficulties in implementing the numerical methods required to run the desired simulations, including modeling systems with large-magnitude variations in material properties occurring over short spatial scales; maintaining discrete material boundaries as the model evolves; and incorporating realistic fault evolution and faulting behavior. Lastly, extending models to three dimensions increases the numerical and model complexity, an area that has seen limited development.

Modeling complex systems requires validation and verification of software. Establishing and running benchmarks and test suites not only "proves" a code, it also provides important insight to the researcher. Limits in parameter space and trade-offs between different model specifications become better known. Benchmarking performance helps to inform the use of computational resources and to understand numerical uncertainty.

The heterogeneity of the lithosphere translates to a heterogeneous approach to modeling lithospheric processes. Computational approaches employed to address the key scientific interests of the community tend to be based either in continuum, analytical, or discontinuous methods (Fig. 1B). Usage of these different mathematical methods, several of which may be deployed in any one code, depends on the maturity of the research area and the specifics of the research question. Individual researchers will often develop numerical techniques and modeling software capable of solving specific geologic problems. While these efforts often result in numerical codes that are powerful and apt for the problem at hand, they often do not translate into a more universal modeling tool.

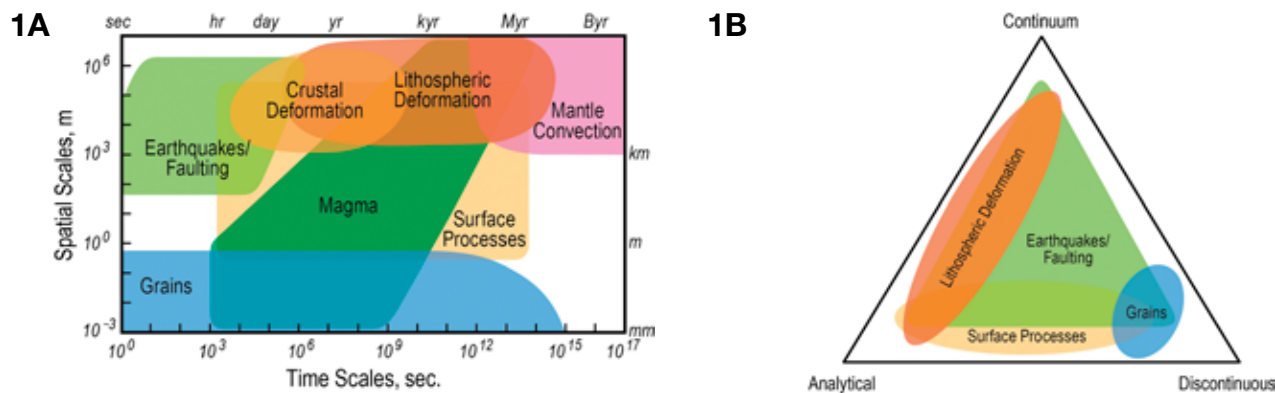


Figure 1. (A) The study of how the lithosphere deforms spans disciplines to help us understand earth processes on a subatomic to global scale and from microseconds to hundreds of millions of years. The wide range of scales in space and time are challenging to accommodate using today's computation resources (after Hwang et al., 2014). (B) Mathematical techniques commonly used in geophysics research can be classified as continuum, analytical, or discontinuous methods, posing computational and numerical challenges for multidisciplinary research.

For example, while one technique might be optimal for understanding the evolution of ocean basins and localized faulting at a mid-ocean ridge, it may not be applicable for regional-scale subduction dynamics. Similarly, techniques used to model stress/strain fields over the earthquake cycle may not be optimal for understanding stress/strain fields generated during continental collision. In addition, while grain-scale processes are critical in understanding how rocks deform, it may not be necessary to include these small-scale effects when trying to understand continental scale deformation. Furthermore, we understand that the lithosphere behaves as an elasto-visco-plastic material, but many of the governing characteristics of this rheologic behavior are not well defined and thus not easy to incorporate into numerical models. Large-scale geophysical observatories, such as EarthScope's real-time seismological and geodetic data streams (Williams et al., 2010, [http://www.earthscope.org/assets/uploads/pages/es\\_sci\\_plan\\_hi.pdf](http://www.earthscope.org/assets/uploads/pages/es_sci_plan_hi.pdf)), coupled with the breadth of research questions (both basic and applied) focusing on the structure and evolution of the North American continent provide a great interpretive challenge that requires a broad range of lithospheric dynamics modeling capabilities.

Therein lies the challenge of modeling lithospheric processes: *Can we build a community code (or suite of codes) that can span the breadth of lithospheric processes while maintaining the required numerical rigor to solve such problems and that is offered at a level that is accessible to users with a wide range of experiences?*

The ideas in this article emerged from the 2014 CIG EarthScope Institute for Lithospheric Modeling workshop (<http://geodynamics.org/cig/events/calendar/2014-cig-earthscope-institute-lithospheric-modeling-workshop/meeting/>), a joint workshop of the Computational Infrastructure for Geodynamics' (CIG) long-term tectonics community and the EarthScope National Office. This was the first dedicated workshop within North America for the modeling of lithospheric deformation in more than a decade; the topic has previously been wrapped into larger workshops and national meetings with a broader scope, diluting many of the discussions pertinent to lithospheric deformation modeling. The workshop highlighted the complexity and variety within the discipline, suggesting that a "one size fits many"—that is, a single community code that fits most researchers' needs—might not be the best approach. Rather, a move

toward a common core or engine that researchers can build upon or modify to suit their specific research problems might be a more realistic and fruitful endeavor. Community-developed scientific codes can build on established numerical methods (which are ideally benchmarked, documented, and open-source) while taking advantage of state-of-the-art techniques. As a community of user-developers is established, a shared expertise emerges that in turn leads to improved computational tools.

To begin this journey, we must build a community vision. The workshop articulated the following as needs: to (1) continue the conversations, either in person at meetings or via online forums; (2) establish the means to collate best practices and known successful numerical techniques; (3) develop benchmarks and use cases—specific examples of scientific or technical problems or questions, with identified goals, key users, and outcomes; and (4) collectively begin a community-wide benchmark exercise in order to assess current computing capabilities and guide the development of the next generation of models. Through these efforts, the community as a whole can move lithospheric deformation modeling into the next frontier. This requires your involvement; please consider visiting the CIG website ([www.geodynamics.org](http://www.geodynamics.org)) and joining the list-serves and online community.

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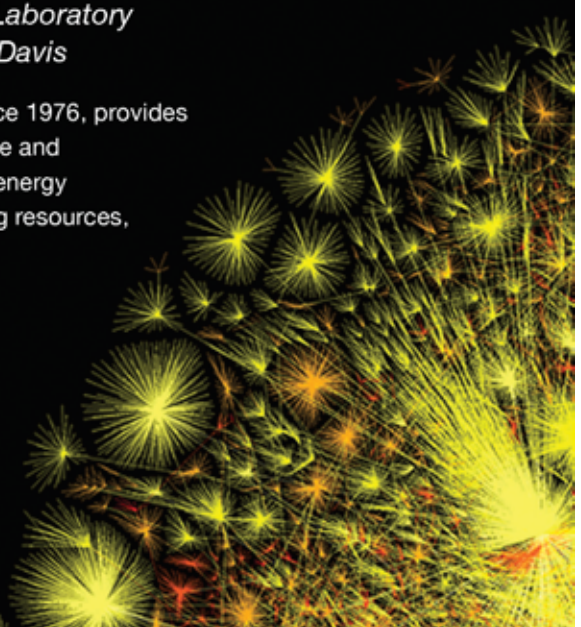
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A generous gift by Candace E. Walker, daughter of former GSA member George W. Walker (1921–2014), will provide significant ongoing support for the recently established GSA Geologic Mapping Award in Honor of Florence Bascom. The gift honors Walker’s 43-year career (1943–1986) with the U.S. Geological Survey. Employing a “rapid reconnaissance”\* approach to mapping, Walker contributed significantly to the *Geologic Map of Oregon*, among the first produced in digital format. “Walker’s maps remain important despite, in some cases, nearly 50 years of progress. Subsequent detailed mapping has improved our knowledge but has not changed the broad understanding first imparted by George’s work.”\* Walker also served as USGS Bureau Chief, Western Minerals Resources Branch (1972–1976), in Menlo Park, California, USA. More information about George W. Walker’s career, publications, and tributes can be found on the GSA Foundation website at [www.gsafweb.org/news-events/](http://www.gsafweb.org/news-events/).



*Geological Map of Oregon* by George W. Walker and Norman S. MacLeod, 1991.



### About the GSA Geologic Mapping Award in Honor of Florence Bascom

This award recognizes distinguished geoscientists whose outstanding geologic mapping has led to a greater understanding of fundamental geological processes and concepts.

Florence Bascom (1862–1945) was a woman of firsts in the geosciences: the first woman hired by the U.S. Geological Survey (1896), the first woman to present a paper to the Geological Society of Washington (1901), and the first woman officer of GSA (vice president, 1930). Bascom’s Ph.D. dissertation showed petrographically that rocks previously considered sediments were metamorphosed lava flows. An expert on the crystalline rocks of the Appalachian Piedmont, Bascom created excellent geologic maps from field observations made on horseback. Recruited by Bryn Mawr in 1895, she developed the geology program and trained many women who became professional geoscientists, including Louise Kingsley and Katherine Fowler-Billings, among many others. Bascom was recognized as a four-starred geologist in the first edition of *American Men of Science* (1906). Bascom’s contributions to Piedmont geology are still utilized by geologists working in that area.

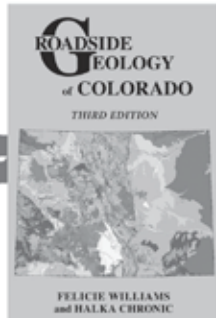
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\*Quotes from *Field Guide to Geologic Processes in Cascadia*: Oregon Dept. of Geology and Mineral Industries Special Paper 36, edited by George W. Moore, Oregon State University, 2002.

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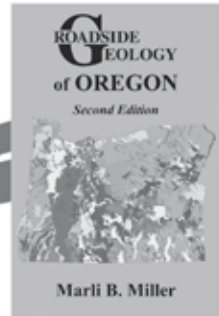
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