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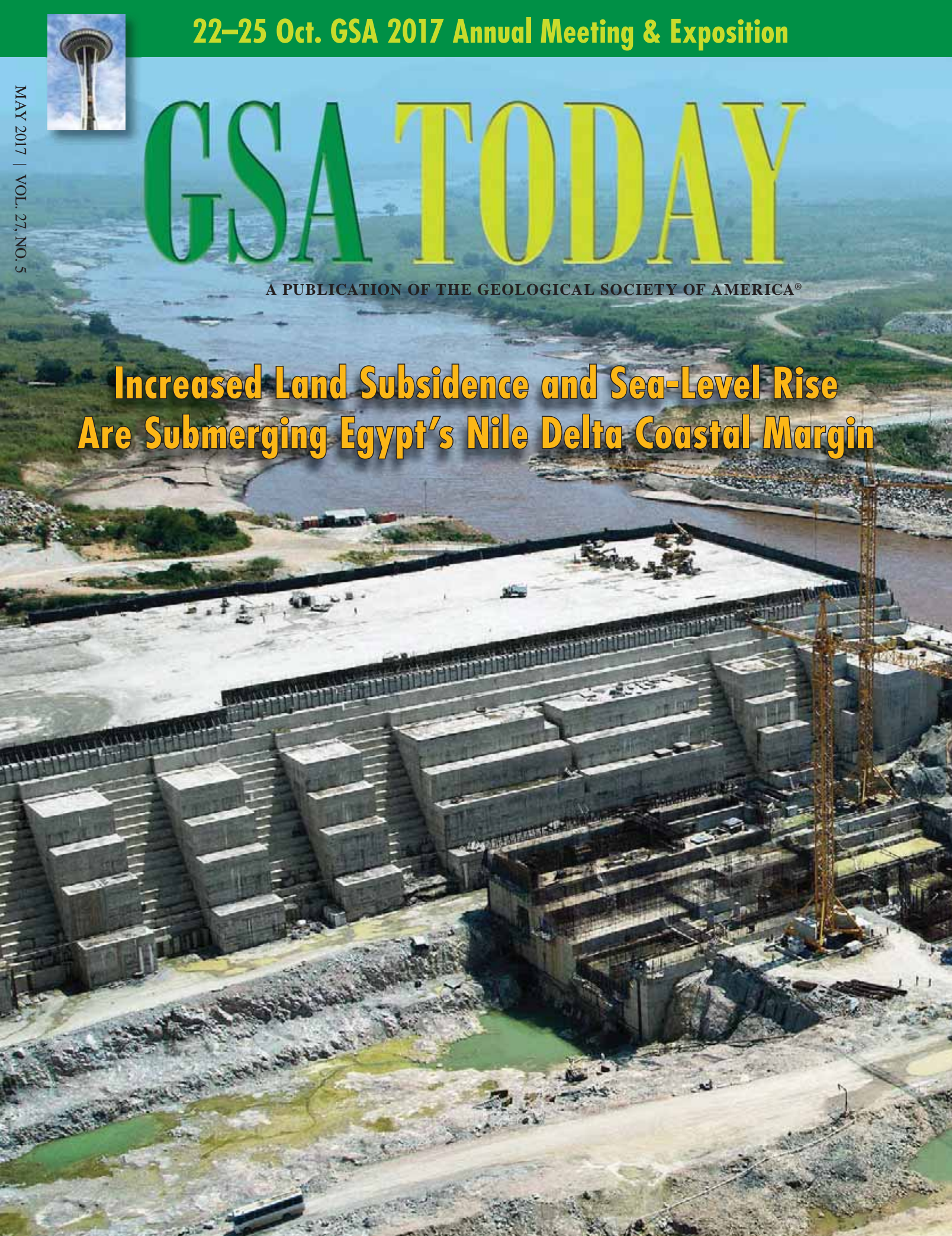


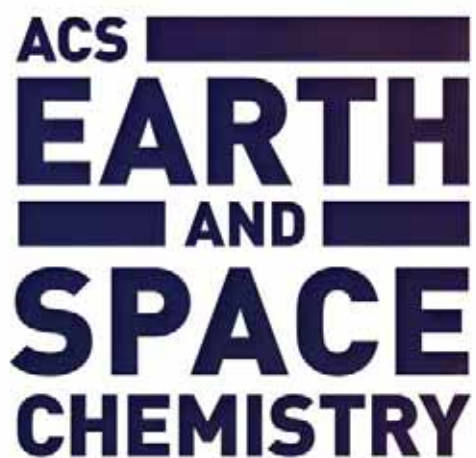
# GSA TODAY

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**Increased Land Subsidence and Sea-Level Rise  
Are Submerging Egypt's Nile Delta Coastal Margin**

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## SCIENCE

### 4 Increased Land Subsidence and Sea-Level Rise Are Submerging Egypt’s Nile Delta Coastal Margin

Jean-Daniel Stanley and Pablo L. Clemente

**Cover:** Grand Ethiopian Renaissance Dam (GERD) under construction on the Blue Nile in northern Ethiopia, near the Sudan border. This will be the largest hydroelectric power plant in Africa. The large reservoir to be placed behind the dam will be filled during a 5–7-year period during which it is expected that the amount of northward Nile flow to the Sudan and Egypt will be substantially reduced. See related article, p. 4–11.



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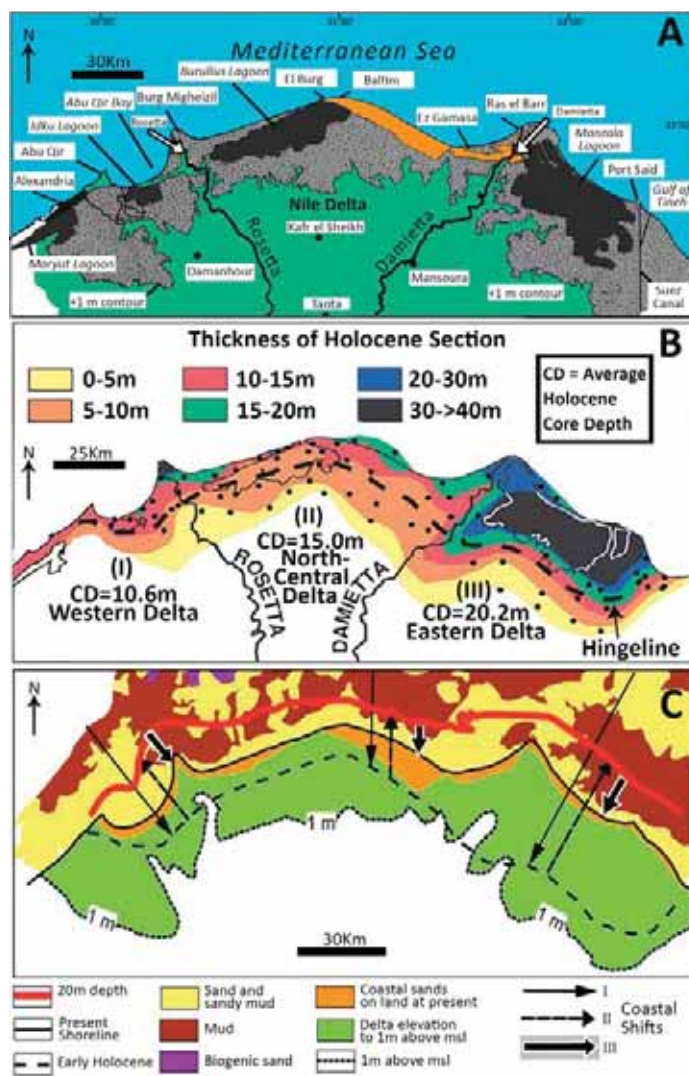
Cover inset image: The Space Needle is an observation tower in Seattle, Washington. A landmark of the Pacific Northwest, and an icon of Seattle.



sequences at the delta's coastal margin (Fig. 2A) are based on stratigraphic, sedimentological, petrologic, biogenic, and geochemical analyses of >3000 samples selected from 85 radiocarbon-dated drill cores (dots in Fig. 2B). These cores and supplemental study materials were examined during the past 30 years by the Smithsonian Institution's Mediterranean Basin (MEDIBA) Program (Stanley et al., 1996; Stanley and Warne, 1998). Total core lengths range from 20 m to >50 m from the delta surface downward, with many sections radiocarbon dated to provide a chrono-stratigraphic framework. The upper part of the Late Pleistocene's largely sandy sections (Mit Ghamer Fm.) is generally recovered at most core bases; these older sections, in turn, are covered by Holocene nutrient-rich silty mud and fine sand sequences (Bilquas Fm.) that thicken northward and eastward along the coast (Fig. 2B). Core sites are distributed from east to west in a curvilinear, coast-parallel area of ~7000 km<sup>2</sup> that forms the northern third of the delta; most sites are positioned <30 km from the present arcuate shoreline at elevations to ~1 m or lower above msl.

Additional data are derived from other sources: cores obtained by others in the delta (Attia, 1954; Marriner et al., 2012); sediment grab samples and short gravity cores on the adjacent Nile delta shelf (Summerhayes et al., 1978); and dated vibro-core and seafloor data at major, now-submerged archaeological sites of Greek and Roman age seaward of the delta, including major ones in Abu Qir Bay and Alexandria's Eastern Harbor (Bernand and Goddio, 2002; Stanley, 2007; Robinson and Wilson, 2010). Also useful are published analyses of satellite surveys of delta surface and sea-level elevations, deep subsurface stratigraphic and structural data obtained in the northern delta and offshore by means of 2D and 3D geophysical surveys, and associated well core information. These data are compiled by the hydrocarbon (largely gas) companies conducting exploration in this region during the past half-century.

The distance between the delta's southern apex near Cairo and the coast is 160 km, and the delta length along its arcuate coastline is ~270 km, from Alexandria in the west to the margin south of the Gulf of Tineh in the east. Four elongate brackish lagoons, positioned from east to west adjacent to the delta coast (Manzala, Burullus,



**Figure 2.** (A) Geographic features and localities in the northern sector of the Nile delta, including those cited in the text. (B) Map showing average thickness (in m) of Holocene section (CD) in sectors I, II, and III of the northern delta. (C) Lithologic aspects and physiographic features in the delta margin and offshore sector. Arrows highlight three major coastal shifts and reversals through time: I, coastline landward retreat in post-glacial time (ca. 16,000 B.C.) to early Holocene (ca. 6000–5500 B.C.); II, coastline seaward advance from early Holocene (ca. 6000–5500 B.C.) to late Holocene (ca. 2500 B.C.); and III, coastline landward retreat, once again, from late Holocene (ca. 2500 B.C.) to present.

Idku, and Maryut; Fig. 2A), are of modest depths, ranging to little more than 1 m below msl. They are open to the sea, and their waters are brackish to saline. The delta's coastal margin sequences of Late Pleistocene to present age include Nile fluvial and desert wind-borne sediment, and also those derived from eroded marine sections from nearshore deposits. Sandy delta beaches are in part shaped by the Mediterranean's semi-diurnal microtidal and surge effects, and especially by strong winds that in winter are directed toward the SE. The present coastline's arcuate form results from powerful winter wave

surges and wave-driven coastal currents that displace sediment mostly toward the east (Frihy et al., 2002). Coastal material is preferentially eroded from seaward projecting headlands, including the two Nile distributary promontories and the bowed-out coast in the Baltim region (Fig. 2A). This displaced sediment forms the long, narrow sand barriers at the seaward margin of coastal lagoons, while landward-driven masses of wind-blown sand have accumulated as extensive dune fields along the north-central delta coast east of Baltim (Figs. 2A and 2C). A large body of published work summarizes the

results of theoretical modeling and field measurements of sediment displaced from various coastal and offshore shelf sectors and their migration patterns through time (UNDP/UNESCO, 1978; Frihy and El-Sayed, 2013). Teams studying these problems have included several international organizations, the Coastal Research Institute in Alexandria, and other Egyptian research centers and universities. Shoreline stabilization is now partially achieved, at least locally where effective protection measures have been implemented, mostly since the past half-century following closure in 1965 of the Aswan High Dam.

The much-increased role of human activity through time in this region needs to be emphasized. In Predynastic time, from ~5000 B.C. onward, hunters and gatherers in small numbers migrated to the delta from adjoining arid, sand-rich Sahara terrains. The major cultural-ecological shift to irrigation farming and urbanism on the Nile's delta plain, with its available water and organic-rich soil, occurred during the Early Dynastic to Dynastic at ca. 3000 B.C. This evolved to what Butzer (1976) defined as an early hydraulic civilization, a socio-economic system based on deliberate flooding and draining by sluice gates and use of water basins contained by dikes. The major shift in population from the Nile valley northward to the delta took place during the Hellenistic period (323–30 B.C.), a time when Egypt's total population increased to ~5 million (Butzer, 1976).

At present, the country's population has reached ~90 million, with a growth rate above 2.0%/yr. Of this number, ~45–50 million people live in the delta and its proximity and, of these, roughly 20 million are concentrated in and around Cairo at the delta's southern apex, with another 15–20 million occupying the delta's southern and central sectors. About 10 million more people inhabit the northern delta's coastal region; this number includes the 4.5 million people living in Alexandria, Egypt's second largest city and its major port and industrial center. Population densities are extremely high (to 1000 or more/km<sup>2</sup>) in much of the Nile delta and valley, two sectors that comprise areas of 22,000 km<sup>2</sup> and 13,000 km<sup>2</sup>, respectively, and that together form only ~3.5% of Egypt's total area. Due to anthropogenic stresses, the Nile delta has been modified to the extent that it no longer functions as a natural

fluvial-marine depocenter (Stanley and Warne, 1998).

## NEOTECTONIC EFFECTS

Neotectonics refers broadly to active seismicity and tectonic movements that are geologically recent, from the Tertiary onward and continuing to the present. Considerable information on seismicity and tectonics affecting the delta's surface and subsurface sequences has been published in recent years, following active exploration at the delta's hydrocarbon provinces. Data has been obtained from 2D and 3D seismic surveys, along with well core analysis, in the northern delta and offshore shelf. These and seismograph monitoring stations have helped clarify the relation between Holocene sediment deposits and their displacement by earthquakes, faults, and delta surface lineaments, the latter mapped by Landsat. Although identified as a passive margin, northern Egypt is characterized by frequent earthquake events of shallow origin and small magnitude (M of 3 or less) and of moderate quakes (M to 5) that occur less frequently (Korrat et al., 2005). Earthquake and fault patterns are interpreted as results of ongoing interactions among African, Arabian, and Eurasian plates and the Sinai subplate.

Two active linear belts cross Egypt and intersect in the delta: a SE to NW Gulf of Suez-Cairo-Alexandria trend and a NE to SW Eastern Mediterranean-Cairo-Fayum trend (Fig. 3A), with slip faults associated with these megashears (Kebeasy, 1990; Gamal, 2013). Earthquakes related to major trends include those that recently affected the Cairo area (in 1992, M = 5.9), and the Alexandria to offshore sector (in 1998, M = 6.7); the latter initiated at a depth of 28 km. Alexandria, in particular, is a high earthquake risk zone that has periodically experienced considerable damage, such as the powerful quake and associated tsunami recorded in 365 A.D. that destroyed much of the city (Guidoboni et al., 1994), and major quakes in 1303 and 1323 A.D. that damaged the famous Alexandria lighthouse. There is evidence of seismic damage and fault offset in Alexandria that have disturbed ancient construction and also recently tilted some buildings. Modern earthquakes with M ≥ 5 occur about every 23 years. Although most quakes are of lower seismicity, together

they constitute a source of seismic hazard for the many who live in the delta and its coastal margin (El-Ela et al., 2012).

An E-W-trending series of faults crosses the northern delta and form a hingeline or hinge zone (Fig. 3B) that separates a southern delta block from a northern delta block. It is defined by step faults and gravity-induced displacements associated with down-to-north rotated fault blocks that extend from deep structural offsets to the surface. Geophysical surveys show that such features mapped in subsurface on land in the northern delta block continue at depth offshore (Sharaf et al., 2014). Ground motion measurements indicate that these can affect both surface deposits of the northern delta and seafloor strata offshore (Mohamed et al., 2015).

Tectonic activity associated with reactivation of faults at depth can cause structural displacements that in some cases extend upward to Late Pleistocene and Holocene surface deposits (Fig. 3C). Surveys have shown a close relation between underlying structural patterns and some delta plain surface lineaments, faults, and earthquakes (Elmahdy and Mohamed, 2016). By offset and subsidence, in part from isostatic loading and readjustments of strata at depth, the northern delta-offshore shelf sector has accumulated up to 3500 m of underlying stratigraphic section since the late Miocene (Fig. 3C); the depth to basement rock is 9–10 km (Kellner et al., 2009). Tectonic effects in this region at times have exceeded those of eustatic factors in controlling coastline evolution (Sarhan, 2015), such as at the NE delta coast in the Manzala lagoon area. This may be caused by pull-apart basin development (Stanley, 1990) where a much thicker Holocene sequence (to ~50 m) of mud-rich deposits accumulated beneath the present shallow, elongate lagoon (Fig. 2B).

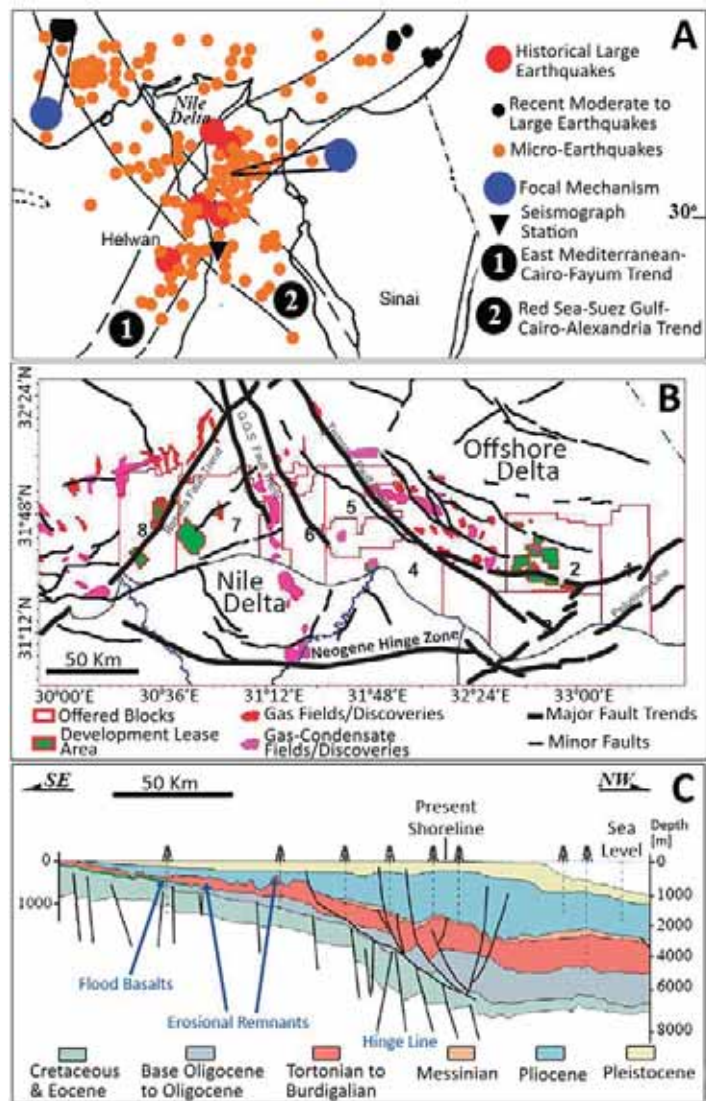
Petrologic examination of well core sections records examples of post-depositional faulting, slumping, and sediment deformation (Rizzini et al., 1978). Features such as convolute bedding of mud- and silt-rich deposits suggest processes associated with sediment dewatering and liquefaction. Likely triggers are earthquake tremors that can generate high excess pore-water pressure within unconsolidated subsurface and surface deposits. Examples of recent earthquake-triggered liquefaction were recorded at ground surface shortly following the 1992

Cairo earthquake where water-saturated silty to sandy soil had been shaken and failed near the epicenter (El-Gamal et al., 1993). Similar features at shallow depths in the delta's Holocene unconsolidated deposits near the coast (Fig. 4B), some of which probably also failed by recent neotectonic motion and liquefaction, are illustrated in the following section.

## COMPACTION AND SUBSIDENCE

Sediment compaction rates are calculated for the Holocene sections in 85 drill cores landward of the coast. Radiocarbon dates in most cores provide a temporal framework for interpreting these sediment sections. Compaction rates were determined by measuring the thicknesses of individual strata in each meter of drilled Holocene deposits between the delta surface and basal section at each core site so as to measure average thicknesses per meter and for the entire core at each site. A total of 3183 layers in cores were thus examined to determine if any systematic down-core temporal and spatial-regional thickness patterns in the northern delta could be detected (Stanley and Corwin, 2013). Thickest layers are almost always recorded in the top 1–2 m of section and dated to <1000 yr in age; the next few meters below this upper section record considerably thinner strata. This observation is attributed to expulsion of interstitial pore water by compression from sediment overburden and by evaporation in near-surface deposits in this arid setting (100–250 mm rainfall/yr). Strata thicknesses tend to decrease irregularly to depths of 5–6 m during the upper to mid-Holocene, and from those depths downward they continue to thin more gradually from mid- to basal Holocene sections. Strata thickness reduction rates, calculated by derivatives of regression curves, are treated as proxy for compaction rate (Stanley and Corwin, 2013). By mid-core depths, >50% of total Holocene core compaction is accounted for by strata thickness reduction. These patterns of down-core stratal thinning are observed all along the northern delta plain and prevail independently of original depositional environment and total thickness of Holocene section.

This strata thickness method shows that average rates of compaction (ARC) measured for total Holocene sections vary regionally along the delta margin, increasing as follows (Fig. 4A): ~3.7 mm/yr in

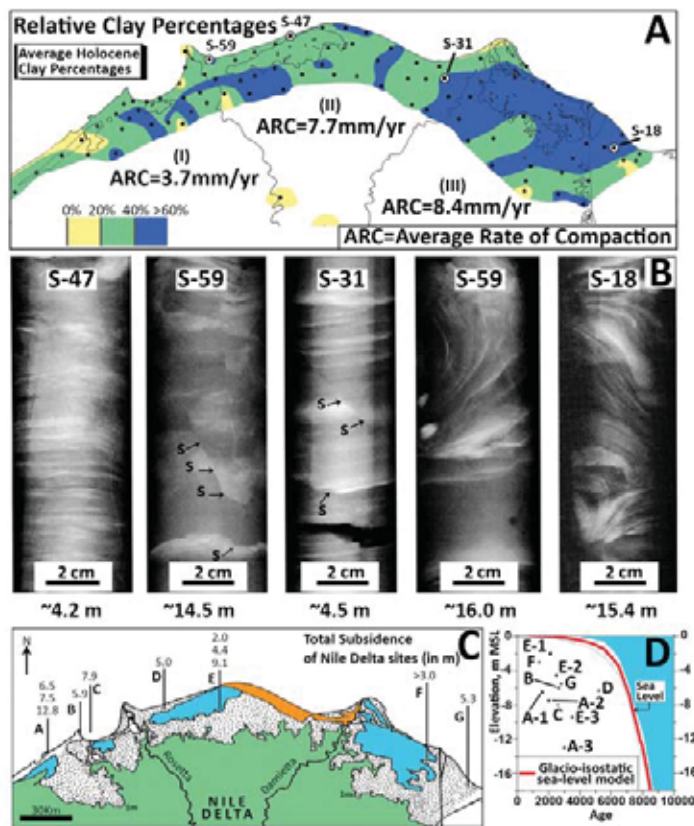


**Figure 3.** (A) Recent earthquake epicenters in the Nile delta and northern Egypt, emphasizing two active megashears discussed in text: (1) East Mediterranean-Cairo-Fayum Trend, and (2) Red Sea-Suez Gulf-Cairo-Alexandria Trend (modified after Kebeasy, 1990, and Gamal, 2013). (B) The depocenter's coastal margin showing gas field discoveries and major structural trends both on- and offshore, including the pronounced Neogene Hinge Zone trending E-W across the northern delta (after EGAS, 2015). G.O.S.—Gulf of Suez. (C) SE to NW cross section highlighting subsurface stratigraphy and major subsurface structural trends from delta to offshore shelf, including some that extend to the delta surface (after Kellner et al., 2009).

NW sector (I); ~7.7 mm/yr in the NC sector (II); and ~8.4 mm/yr in the NE sector (III). Measurement of upper strata compaction per meter provides results that parallel those of land subsidence measurements made by recent satellite surveys (El-Asmar et al., 2012). For example, high subsidence rates, to ~8 mm/yr, were measured for sectors between Baltim and Manzala lagoon (Becker and Sultan, 2009). Satellite imagery techniques (radar interferometry) identified coastal sectors of accelerated subsidence in areas of Holocene sections subject to high

depositional rates, including the Rosetta, Baltim, and Damietta headlands (Fig. 2A). To determine rates of relative sea level, ARC measurements are added to those of eustatic sea-level rise; these latter presently range from 2.6 to 3.3 mm/yr since ~2000 A.D. (cf. Shaltout et al., 2015; Hansen et al., 2016). Of note, an average eustatic rise of 3 mm/yr would account for only ~26% to 45% of total relative sea-level rise rates between NE delta sector III and NW delta sector I.

Measurement of sand, silt, and clay proportions in Holocene core samples (Stanley and Clemente, 2014) indicate that relative



**Figure 4.** (A) Map showing distribution of average relative percentages of clay in Holocene sections and average rates of compaction (ARC) in mm/yr across three northern delta sectors (I, II, III); dots indicate sites of 85 sampled drill cores (after Stanley and Clemente, 2014). (B) X-radiographs of selected drill cores sections (locations shown in A): horizontal laminations in S-47; fault-like shears(s) in S-31 and S-59; and convoluted strata units in S-18 and S-59. Scale = 2 cm. (C) Location of seven submerged sites with archaeological material; the 11 numbers indicate depths (in m) of materials below present sea level (after Stanley and Toscano, 2009). (D) Plotted age and depth of submerged materials in C show all lie well below the Eastern Mediterranean sea-level curve of Sivan et al. (2001), recording continued margin subsidence.

percentages of clay are highest (40%–60%) in the N and NE sectors (II, III) where high ARC values range from 7.7 to 8.4 mm/yr (Fig. 4A). This finer-grained sediment fraction is preferentially displaced by currents toward the NE delta margin (arrows in Fig. 5A). It is likely that water-saturated, clay-rich sediments readily expelled much of their interstitial pore water shortly after burial by successive deposits and evaporation. In X-radiographs of Holocene delta core sections, most displaying well-defined horizontal bedding (Fig. 4B, section S-47), there are examples of interbedded strata that have been extensively disturbed. Some display convolute stratification (Fig. 4B, in sections S-18 and S-59), interpreted as having failed by liquefaction and upward expulsion of interstitial water. Other disturbed strata record sharp, fault-like shear offsets (Fig. 4B, arrows and symbol S in S-31 and S-59). Because such

layers generally occur between horizontal strata above and below them, they likely record the effects of natural episodic disturbance events. Some may have formed by rapidly increased sediment accumulation and overloading. Others perhaps resulted from recent earthquake tremors and ground motion, or from tectonic shifts and reorganization of underlying strata at depth, as cited in the previous section. Similarly, human-triggered effects also occur in areas where delta surfaces have been artificially lowered to ~1 m or more and that are affected locally by liquefaction as a result of hydrocarbon and ground-water extraction.

#### DECREASED SEDIMENT REPLENISHMENT

An ample sediment supply provided regularly to a delta's margin helps minimize or moderate problems of coastal

submergence by eustatic sea-level rise and land subsidence triggered by neotectonics and/or sediment compaction as discussed above. This balance no longer occurs sufficiently at the Nile delta's coastal sector where amounts of discharged water and sediment have diminished markedly in recent time due to altered climatic conditions and much increased human impacts. Without addition of much needed superposed deposits at the coast, the youngest (earlier than 1000 A.D.), uppermost water-saturated sediment layers are now being lowered at a more rapid rate relative to sea level (Figs. 4C and 4D).

The Nile's present total flow is contributed by relatively small, isolated areas in the East African lake region and the Ethiopian highlands. The high precipitation at the headland of the White Nile is distributed between two rainfall seasons. Water of the White Nile enters the Sudd marshes and seasonally flooded areas to the north, where evaporation greatly exceeds rainfall; this results in an outflow from the wetlands that is only about half that of inflow (Sutcliffe and Parks, 1999). In marked contrast, the Ethiopian mountains, with their high rainfall in a single season and steep topography, produce larger runoffs and more concentrated flows in the Blue Nile and Atbara during shorter periods.

During much of the Holocene, amounts of sediment transported from upland Nile sources and dispersed northward to the delta margin have been largely controlled by Nile hydrologic attributes responding to major long-term climatic variations. Strong rains prevailed, especially during the latest Pleistocene-Holocene Wet Phase that, in Ethiopia, lasted ~6500 yr, between ca. 9000 B.C. and ca. 2500 B.C. (Said, 1993, his figure 2.12). The rain-front at that time shifted northward 8–10 degrees in the Nile Basin, over arid sectors of the Sahel and sectors of the Sahara in the Sudan and Egypt. Such rainfall patterns responded largely to fluctuation of the Inter-Tropical Convergence Zone (ITCZ) that induced major Nilotic hydrologic and sedimentation changes due to low-latitude isolation forcing over long periods. On a shorter (sub-millennial) scale, Nile valley climatic input by El Niño Southern Oscillations (ENSO) were also influential (Said, 1993; Marriner et al., 2012). During the African humid phase, strong boreal summer insolation produced higher rainfall in northern



Africa, which led to important tributary (wadi) input into the lower Main Nile valley that accounted for 40%–50% of total fluvial water and much-increased sediment loads.

The Wet Phase, ending at ca. 2500 B.C., was followed to the present by an Arid Phase (Said, 1993). Nile tributary input ceased, while the Main Nile received a larger proportion of Blue Nile and Atbara contributions. Ethiopian highlands presently supply by far the largest proportions of Nile water (Blue Nile: 59%; Atbara River: 13%; Sobat: 14%) and sediment transported northward across the Sudan and Egypt. The White Nile, flowing across parts of eight countries (Fig. 1), provides only 28% of the total Nile water supply, of which about half of this amount (14%) is contributed by the Sobat, one of its tributaries with a source in Ethiopia. The Blue and White Niles and Atbara join to form the Main Nile in the Sudan (Woodward et al., 2015), and this fluvial system then continues in its channel that crosses desert terrains of both the Sudan and Egypt to the delta. North of the delta's apex near Cairo, most Nile waters are now diverted into a complex irrigation system comprising hundreds of kilometers of canals and drains (Fig. 5A).

Anthropogenic pressures have increased continuously, especially during the past two centuries, and now dominate the hydrographic system. Barrages (Assyut, Naga Hamadi, Esna) emplaced on the Nile during the nineteenth century, the first dam at Aswan (Low Dam) in 1902, and water diversion systems along the Nile valley had already modified water delivery to lower Egypt by the turn of the twentieth century. Two mid-1900s dams in the northern delta, one constructed at Edfina on the Nile's Rosetta branch and the other at Faraksour Sudd on the Damietta branch, prevent water in these two now much-altered distributaries from reaching the coast (Fig. 2A). The High Aswan Dam was then constructed in 1965 to release Nile water throughout the year instead of during the short flood season in summer. It is backed by the enormous Lake Nasser reservoir (area of 5250 km<sup>2</sup>; length of 510 km), with a large water loss (12%–14% of annual input) from evaporation and seepage. Consequently, the total amount of water flowing below the High Dam and to the delta is considerably reduced. About 84 Bm<sup>3</sup> of useable fresh water remain, of which

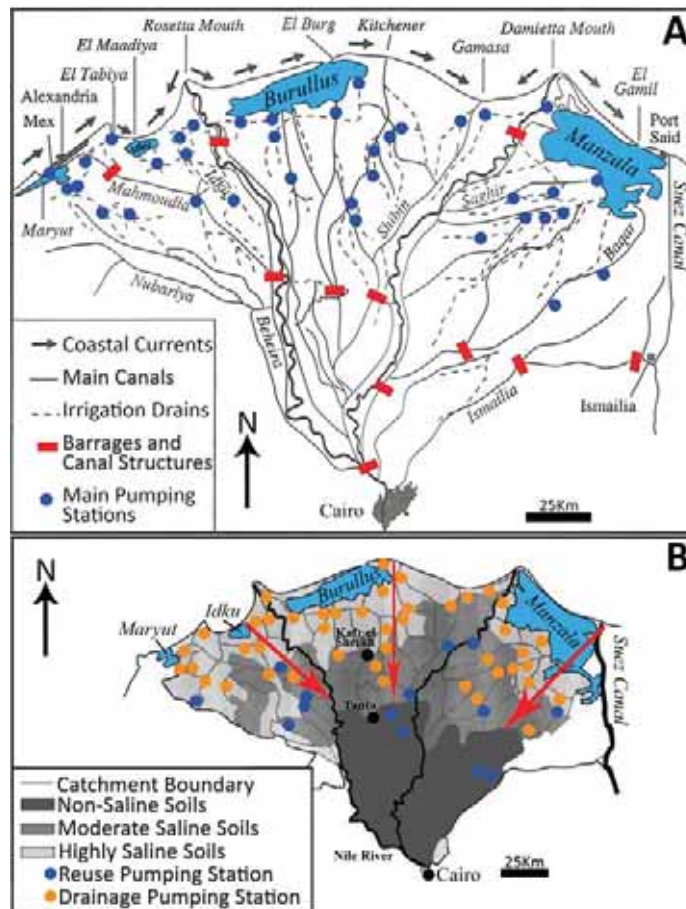
55.5 Bm<sup>3</sup> is reserved for Egypt. At present, a large fraction of Nile sediment that once accounted for ~100 million tons deposited below Aswan is now trapped in the southern part of the reservoir, where it has been forming a new lacustrine delta since the High Dam closure.

Several other large-scale projects under construction include those to divert large volumes of Nile water to convert arid, saline areas into agricultural land: one to bring water from Lake Nasser to oases in Egypt's Western Desert (Toshka–New Valley Project); another is to distribute water across the northern Sinai (Al-Salam Canal Project). Moreover, dams and barrages have been built in the Sudan and Ethiopia. Most of the now-limited volume of Nile water that reaches the delta is diverted and channeled into the complex water distribution system, most utilized for agricultural, municipal, and industrial needs. Egypt

now releases less than 10% of its water supply, a mostly saline and highly polluted aqueous mix, to the sea, with little sediment available for coastal replenishment. Egypt, the tenth and last country below Nile headwaters, presently needs much more fresh water than can be provided by the Main Nile. Without it, the delta's coastal margin, for the most part depleted of its former sediment supply for replenishment, continues to erode locally and subside.

## PROGNOSTICS

A minimal relative sea-level rise of ~100 cm is predicted between now and the year 2100 at the Nile delta's coast, where laterally variable but continued ~6.7 to ~11.4 mm/yr rates of submergence have been measured. This takes into account average rates of sediment compaction leading to subsidence of ~3.7 to 8.4 mm/yr (NW to NE delta rates) added to the



**Figure 5.** (A) Map of geographic features and network of major canals, drains, and pumping stations in the Nile delta (modified after Sestini, 1992); arrows at coast show dominant east-directed wave-driven current flow (after various authors). (B) Map of delta soil salinities (non-saline = <1000 ppm; moderate-mixed saline = 1000–35,000 ppm; highly saline = 35,000 ppm), highlighting the southward progressing saline intrusion (modified after Sefelnasr and Sherif, 2014).

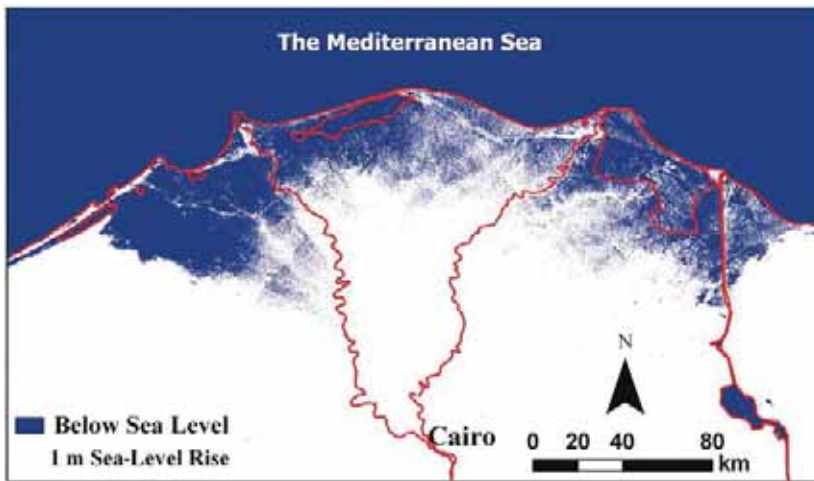


Figure 6. The present rate of relative sea-level rise as calculated in this analysis will reach ~1 m above mean sea level (msl) by 2100 A.D., with marine water (shown in blue) having advanced landward, submerging about one-third of the present Nile delta surface (after Hereher, 2010).

eustatic sea-level rise of ~3 mm/yr. A total relative sea-level rise of 1 m or more could well occur at this delta's low margin, but not by eustatic rise alone, which accounts for only ~26% to 45% of measured total estimated relative sea-level rise (~6.7 mm/yr to ~11.4 mm/yr) between the delta's NW and NE coastal margin. Total relative sea-level rise by year 2100 could be further increased locally by neotectonic lowering as has occurred sporadically and affected the delta's margin in the recent past.

Additional repercussions are envisioned from the effects of a continued decrease of Nile sediment now reaching the coast, resulting from increased anthropogenic entrapment by new up-river dams and other structures, plus increased rates of eustatic rise in sea level due to higher rates of polar ice melt that, in years ahead, may possibly accompany global warming.

Land subsidence plus eustatic sea-level rise presently affect saline water intrusion into the delta's aquifer. Highly saline soils in the northern delta become moderately saline southward from about Kafer el-Sheikh to the central delta (Fig. 5B). Non-saline soils occur primarily south of Tanta, in the central to southern delta (Kotb et al., 2000; Sefelnasr and Sherif, 2014). Egypt could help ameliorate these salinization and coastal erosion problems by constructing laterally extensive, continuous, and deeply emplaced protection structures along the delta's coastal perimeter. Present ongoing quarrying of sand dunes along the delta coast, for mineral mining and other applications, should be avoided, because it removes a natural protective barrier that

backs the low-lying shoreline. Governmental investment in establishing much-needed desalination plants and drip irrigation technology should be planned. Serious indeed is decreasing agricultural production at a time when Egypt's population continues to increase. Further Nile fresh water decrease would be grave because, at best, the river barely supplies 97% of Egypt's water needs, and now provides only 660 m<sup>3</sup>, one of the world's lowest per capita water shares. With a population expected to double in the next 50 years, Egypt is projected to reach a state of serious country-wide fresh water and energy shortage by 2025.

Additional complications include international accords with regard to the Nile's hydrology, drawn up in 1929 and amended in 1959, that attributed most Nile water to Egypt and Sudan without consulting upstream states (Waterbury, 1979; Said, 1993). To address its own conditions of drought and energy poverty, Ethiopia began construction of its Grand Ethiopian Renaissance Dam (GERD) in 2011, with completion expected this year. The dam, paid for mainly by Ethiopia, but with aid from other countries, will be Africa's largest hydroelectric power plant, producing 6000 megawatts of electricity with 16 turbines and an estimated production of 15,000 GWh per year. The reservoir behind the dam will flood 1680 km<sup>2</sup>, retain a volume of ~63 Bm<sup>3</sup>, and could take 5–7 years to reach capacity. During this period of fill, the Nile's fresh water flow to Egypt may be cut by 25%, with a loss of a third of the electricity generated by the Aswan High Dam.

In addition to the GERD, Ethiopia is proposing more dams along the Nile, and a new series of dams is also planned in the Sudan. With ~400 million people living in the 10 countries across which the Nile flows (Fig. 1), some now experiencing severe droughts and unmet energy needs, it is expected that a large proportion of Nile water now directed to Egypt (~70%; Said, 1993), will have to be reallocated up-river (Fig. 6). Already facing a multitude of economic, political, and demographic problems (Fragile States Index, 2016), in addition to hydrological and coastal protection challenges, the interdependence of the Nile Basin countries and their reliance upon the Nile's waters must be resolved immediately. It is hoped that rather than resorting to threats and military action, some form of arbitration by regional or global bodies be applied to the delicate situation, especially with regard to the three most impacted countries along the Blue Nile: Egypt, the Sudan, and Ethiopia.

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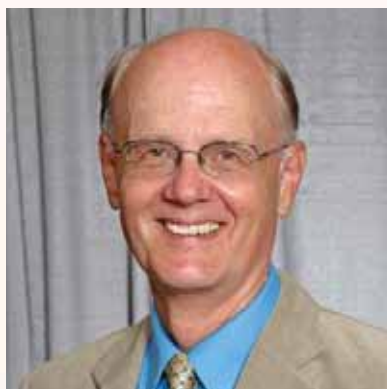
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**22-25 October**  
**Seattle, Washington, USA**

## Action Dates

Now Open	Meeting room request system (non-technical, social, and business meeting room requests)
Mid-May	Housing opens (Orchid Events is the official housing bureau)
Early June	Registration and Travel Grant applications open
6 June	Meeting room request deadline—Fees increase after this date for all submissions
Early August	Student volunteer program opens (new timing this year)
1 August	Abstracts deadline
18 September	Early registration deadline
18 September	GSA Sections travel grants deadline
25 September	Registration and Student Volunteer cancellation deadline
27 September	Housing deadline for discounted hotel rates



## You're Invited!

As Technical Program Chair for GSA's 2017 Annual Meeting in Seattle, and as a long-time GSA meeting attendee, I can say that past meetings in Seattle have been extremely popular, and this year is no exception. The Pacific Northwest provides great opportunities to experience the richness, diversity, and deep scientific understanding of the geosciences in their full splendor first-hand through 24 field trips, participating in our 25 short courses, and particularly submitting and placing your abstract(s) into one or more of our near-record 257 Topical Sessions nested within 31 geoscience disciplines.

There will be something for everyone, from hypothesis-driven basic and applied research to geoscience education, information, and communication to the public policy implications of our science. Especially important this year is how geoscience research and communication must respond to, adjust, and perhaps pursue new opportunities in a world and nation demanding a greater scientific understanding of what we do, why we do it, and the long-term impacts and implications of our work.

We intend to fill our 257 Topical Sessions, plus maintain the flexibility of creating Discipline Sessions, as well as offer numerous poster sessions, with many directly affiliated with oral sessions. We will also be offering six Pardee Keynote Sessions—diversity and the changing face of the geosciences, landscapes in the Anthropocene, the Chicxulub Impact Crater, Mesozoic-Cenozoic terranes along North America's Pacific margin, Earth anatomy revealed through geologic mapping, and a Pardee poster session on "speed dating" (featuring 10–12 geochronologists to personally interact with meeting attendees). Sound interesting? This year is an incredible opportunity to truly experience GSA's mission, "To advance geoscience research and discovery, service to society, stewardship of Earth, and the geosciences profession," and to encourage colleagues to attend, submit abstracts, and experience this great venue in Seattle.

—Dick Berg, GSA 2017 Technical Program Chair



# Call for Papers

► **ABSTRACTS DEADLINE:** 1 August

## SUBMITTING AN ABSTRACT

- **Submission deadline:** Tuesday, 1 August;
- To begin your submission, go to [community.geosociety.org/gsa2017/science/sessions](http://community.geosociety.org/gsa2017/science/sessions);
- An abstract submission fee of US\$50 for professionals and US\$25 for students will be charged;
- Please review the two-abstract rule on page 51 of this issue.

## POSTER PRESENTERS

- You will be provided with one horizontal, freestanding 8-ft-wide by 4-ft-high display board, and Velcro for hanging your display is provided at no charge.
- Each poster booth will share a 6-ft-long by 30-inch-wide table.
- Electricity is available, for a fee.
- Wi-Fi will be available in the poster hall area.
- Posters should be on display 9 a.m.–5:30 p.m. on Sunday, with authors present 3:30–5:30 p.m. On Monday through Wednesday, posters should be on display 9 a.m.–6:30 p.m., with authors present 4:30–6:30 p.m.
- Want to present your poster digitally? As a poster presenter, you will be given the opportunity to present your poster in a digital format. Information on this will be provided in the acceptance notices. Presenters are responsible for all fees associated with this type of presentation.

## ORAL PRESENTERS

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

## ABSTRACTS PUBLICATION AND MEETING PRESENTATION

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



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# Pardee Keynote Symposia



Joseph Thomas Pardee (1871–1960)

Pardee Keynote Symposia are named in honor of GSA Fellow and benefactor Joseph Thomas Pardee (1871–1960) via a bequest from Mary Pardee Kelly. Pardee is perhaps best known for his work on Glacial Lake Missoula. These symposia consist of invited presentations covering a broad range of topics.

## **P1. Challenges to the Geosciences in the 21st Century: Fostering Diversity and Inclusion to Solve Increasingly Complex Problems**

**Cosponsors:** *GSA Geology and Society Division; GSA Committee on Diversity in the Geosciences; Earth Science Women's Network; International Association for Geoscience Diversity; Geoscience Alliance; Association for Women Geoscientists*

**Disciplines:** Geoscience and Public Policy, Environmental Geoscience

**Advocate:** Barbara P. Nash

The changing face of the geosciences is a response to global challenges, climate, resources, the environment, energy and sustainability. The lack of diversity in the geosciences limits perspectives, experiences, and innovative approaches to solving critical problems that the geosciences are well poised to address. The symposium will (1) examine how the changing face of the geosciences necessitates that we develop a diverse workforce; (2) share experiences of geoscientists from diverse backgrounds who have contributed fresh perspectives and experiences to help produce scientifically effective and socially responsible solutions; and (3) examine strategies to create a geoscience workforce that leverages diversity.

## **P2. Landscapes in the Anthropocene**

**Cosponsors:** *GSA Quaternary Geology and Geomorphology Division; GSA Geology and Society Division; GSA Hydrogeology Division; GSA Geology and Public Policy Committee; Geology (journal)*

**Disciplines:** Geomorphology, Environmental Geoscience, Geoscience and Public Policy

**Advocates:** José Antonio Constantine; J. Wesley Lauer; Rónadh Cox

Intensifying pressures driven by changes in climate and land use may be pushing many of Earth's landscapes toward tipping

points. In most cases, our ability to predict this transition is being outpaced by the rates of landscape change, and we are consequently not meeting the needs of communities whose land is threatened by environmental upheaval. This symposium will bring together a trans-disciplinary group of innovative thinkers who are grappling with landscape change. Either by developing predictive models or by translating science into policy, our speakers are all working at the cutting-edge of increasingly pervasive environmental challenges typical of the Anthropocene.

## **P3. IODP-ICDP Expedition 364 to the Chicxulub Impact Crater**

**Cosponsors:** *GSA Planetary Geology Division; GSA Geophysics Division; International Continental Scientific Drilling Program (ICDP); European Consortium for Ocean Research Drilling (IODP-ECORD); Lunar and Planetary Institute (LPI)*

**Disciplines:** Planetary Geology, Geochemistry, Paleontology, Diversity, Extinction, Origination

**Advocates:** David A. Kring; Philippe Claeys

Sixty-five million years ago, the evolution of Earth was dramatically altered by the Chicxulub impact event. This icon of the impact-mass extinction hypothesis was targeted by IODP-ICDP Expedition 364 to test models of peak-ring formation, impact-generated hydrothermal systems, habitability within those systems, and the recovery of life in the vicinity of the crater. This Pardee Keynote Symposium will reveal first-year studies of a borehole that pierced the PETM, the Paleogene sediments that cover the crater, impact-melt bearing units on the floor of the crater, and the granitic core of a peak-ring that was uplifted ~10 km in a geologic instant.

## **P4. Speed Dating!: Advice on Sampling and Applications through the Lens of the Geochronologist (Posters)**

**Cosponsors:** *GSA Quaternary Geology and Geomorphology Division; GSA Archaeological Geology Division; GSA Karst Division; GSA Limnogeology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Sedimentary Geology Division; GSA Structural Geology and Tectonics Division*

**Disciplines:** Quaternary Geology, Stratigraphy, Tectonics/ Tectonophysics



**Advocates:** Tammy Rittenour; Michelle Summa Nelson; Shannon A. Mahan

Age control is an essential aspect of most geologic research. However, the first step toward obtaining accurate age estimates relies on the individual researcher to correctly select and collect suitable material for dating. For best results, researchers need to assess site and sample conditions through the lens of the dating specialist. This unique booth-style Pardee session will facilitate discussion and one-on-one interactions between geochronology specialists and users of the techniques, such as students, researchers, and other professionals in the field.

### **P5. Origin, Accretion, and Translation of Mesozoic-Cenozoic Terranes along the Pacific Margin of North America**

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

**Discipline:** Tectonics/Tectonophysics

**Advocates:** David T. Katopody; Mark T. Brandon; Bernard Housen

The Mesozoic to Cenozoic evolution of the western margin of the North American Cordillera has been the center of a long-standing controversy about the mobility of crustal fragments along continental margins. This symposium will outline the major lines of evidence for accretion and coastwise transport during the late Mesozoic and into the Cenozoic and will serve as

a forum to identify remaining problems and opportunities in Cordilleran tectonics.

### **P6. Earth Anatomy Revealed: Geologic Mapping for Our Future**

**Cosponsors:** *GSA Geology and Society Division; GSA Geology and Public Policy Committee; GSA Geoinformatics Division; Association of American State Geologists; American Geosciences Institute; American Institute of Professional Geologists; American Geophysical Union; U.S. Geological Survey*

**Disciplines:** Geoscience and Public Policy, Geoscience Information/Communication, Geoinformatics

**Advocates:** Darcy K. McPhee; Cassandra A. Rose; L. Harvey Thorleifson; Danielle N. Woodring

Our need for information on earth materials, processes, and history is escalating. Solving issues from public health to emergency preparedness, resource management, and global hydrological and tectonic modeling requires not only geologic maps at a full range of resolutions and formats, but also 3D grids of physical properties from lithology to hydraulic conductivity. This session will highlight efforts to address these ongoing and urgent challenges, including innovative applications of geologic maps to social needs, new and evolving technologies, and lessons from cutting-edge science such as extraterrestrial mapping.



Tlingit Indian totem in historic Pioneer Square. Photo by Alabastro Photography, used with permission from Visit Seattle.

# Topical Sessions

## HYDROGEOLOGY



### T1. Twenty-First Century Rock Flow Properties and Processes: 3D Printing, Digital Rock Physics, and Hydrogeophysics

**Cosponsors:** *GSA Hydrogeology Division; GSA Geoinformatics Division, GSA Karst Division*

**Disciplines:** Hydrogeology, Karst, Sediments, Carbonates

**Advocates:** Michael C. Sukop; Lee J. Florea; Franciszek Hasiuk

We encourage novel studies that employ high-tech methods (3D printing, hydrogeophysics, computed tomography, high resolution stratigraphy, etc.) to describe and interpret the processes that control flow through natural groundwater pore systems.

### T2. A Showcase of Undergraduate Research in Hydrogeology (Posters)

**Cosponsors:** *GSA Hydrogeology Division; Council on Undergraduate Research Geosciences Division*

**Discipline:** Hydrogeology

**Advocates:** Kallina M. Dunkle; Susan Swanson; Samuel J. Smidt; Christopher S. Lowry

This session is designed for undergraduates presenting research and senior theses in the field of hydrogeology. Prizes will be awarded for top presentations. Employers and graduate advisers are encouraged to attend.



### T3. Advances in Ground-Source Geothermal Energy: Monitoring and Modeling

**Cosponsors:** *GSA Hydrogeology Division; GSA Environmental and Engineering Geology Division*

**Disciplines:** Hydrogeology, Engineering Geology, Energy Geology

**Advocates:** Dave Hart; Lee J. Florea

The session includes modeling of the heat flows and sustainability of ground-source geothermal systems and methods to monitor their performance and potential impacts to groundwater.



### T4. Approaches to Applied Modeling for Industry and the Public

**Cosponsors:** *GSA Hydrogeology Division; GSA Geology and Society Division; National Ground Water Association (NGWA); GSA Environmental and Engineering Geology Division*

**Disciplines:** Hydrogeology, Geoscience and Public Policy, Engineering Geology

**Advocates:** Randy Hunt; Henk Haitjema; Jordan Read

Decision-making requires quantitative frameworks to assess cost-benefit and tradeoffs between competing societal needs. This session seeks to explore the range of applied modeling approaches brought to bear to address today's economic and environmental issues.



### T5. Arsenic and Other Geogenic Contaminants in Groundwater Resources: Linking Water Quality, Food Security, and Treatment

**Cosponsors:** *GSA Hydrogeology Division; GSA Geology and Health Division; GSA International/International Interdisciplinary Interest Group; International Society of Groundwater for Sustainable Development (ISGSD); International Medical Geology Association; GSA Environmental and Engineering Geology Division; GSA Geobiology & Geomicrobiology Division*

**Disciplines:** Hydrogeology, Geology and Health, Environmental Geoscience

**Advocates:** Prosun Bhattacharya; Abhijit Mukherjee; Saugata Datta; Mohammad Alauddin; Karen Johannesson; Jochen Bundschuh; Arslan Ahmad

The fate, transport, and effects of arsenic and other metals in groundwater and other natural water systems from regional to local scales will be discussed. This encompasses occurrence, mobility, biogeochemical cycling, epidemiological, and sustainable mitigation.



### T6. Cross-Border Community Engagement Using Geoscience Research, Education, and Outreach

**Cosponsors:** *GSA Hydrogeology Division; GSA Environmental and Engineering Geology Division; GSA Karst Division*

**Disciplines:** Hydrogeology, Environmental Geoscience, Geology and Health

**Advocates:** Peter S.K. Knappett; Kory Konsoer; Sarah Nagorsen; Peter J. Wampler

We are calling for abstracts describing geoscience and interdisciplinary studies that include cross-border engagement to develop mitigation strategies that address unsafe drinking water, poor sanitation, and natural hazards including landslides, earthquakes, floods, and hurricanes.

## INDUSTRY TRACKS

GSA's technical program offers sessions relevant to applied geoscientists. Look for these icons, which identify sessions in the following areas:



Economic Geology



Energy



Engineering



Hydrogeology and Environmental Geology

 **T7. Diffuse Recharge and Infiltration in Karst and Pseudo-Karst Terrains**

**Cosponsors:** *GSA Hydrogeology Division; GSA Karst Division; GSA Soils and Soil Processes Interdisciplinary Interest Group*

**Disciplines:** Hydrogeology, Karst, Soils

**Advocates:** Todd G. Caldwell; Marcus Gary

Climate, vegetation, soils, and geology each exert controls on groundwater recharge. The mechanisms in karst terrain can be episodic from ephemeral streams or diffuse from interfluvial soils. This session will focus on the latter.

 **T8. Fate, Effects, and Mitigation of Chemical and Fuel Releases in Surface and Subsurface Environments**

**Cosponsors:** *GSA Hydrogeology Division; GSA Environmental and Engineering Geology Division; GSA Energy Geology Division*

**Disciplines:** Hydrogeology, Environmental Geoscience, Geology and Health

**Advocates:** Michelle M. Lorah; Isabelle M. Cozzarelli; Madeline E. Schreiber

This session focuses on identifying fate, effects, and mitigation of chemical and fuel releases in the environments, including persistent releases at legacy sites, emerging contaminants, and fuel or wastes associated with oil and gas development.

 **T9. Groundwater Flow in Coastal and Marine Settings: From the Intertidal Zone to the Deep Seafloor**

**Cosponsors:** *GSA Hydrogeology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Geobiology & Geomicrobiology Division; GSA Environmental and Engineering Geology Division*

**Disciplines:** Hydrogeology, Geochemistry, Marine/Coastal Science

**Advocates:** Alicia Wilson; Evan Solomon

Huge volumes of groundwater lie beyond the boundaries of traditional watersheds. This session will explore groundwater flow and biogeochemical cycling seaward of the high tide line, including studies of submarine groundwater discharge and sub-seafloor flow.

 **T10. Groundwater Influenced Ecosystems: Springs, Gaining Streams, and Terrestrial Ecosystems**

**Cosponsors:** *GSA Hydrogeology Division; GSA Karst Division; GSA Geobiology & Geomicrobiology Division*

**Disciplines:** Hydrogeology, Karst, Geochemistry

**Advocates:** Brad David Wolaver; Laura J. Crossey; Rebecca Matthews Frus; Steven P. Loheide II

Groundwater maintains aquatic and terrestrial ecosystems in varied climates and seasons globally. Multidisciplinary advances in field and modeling techniques are needed to improve how such systems are characterized, monitored, and scientific findings conveyed to decision makers.

 **T11. Hydrogeology of Island Environments in a Changing Climate**

**Cosponsor:** *GSA Hydrogeology Division*

**Disciplines:** Hydrogeology, Marine/Coastal Science, Paleoclimatology/Paleoceanography

**Advocate:** Stephen B. Gingerich

This session will bring together hydrologists, geochemists, and climate scientists to share the diverse methods available (numerical modeling, geochemical studies, geophysics, etc.) to study the interaction of groundwater with island environments in a changing climate.


 **T12. Hydrogeology, Geochemistry, and Wetland Processes: A Session in Honor of the Career of Donald I. Siegel**

**Cosponsor:** *GSA Hydrogeology Division*

**Disciplines:** Hydrogeology, Environmental Geoscience, Geochemistry

**Advocates:** Jeffrey M. McKenzie; Laura K. Lautz

We will honor the diverse and interdisciplinary contributions of Donald I. Siegel to the fields of hydrogeology, aqueous geochemistry, and wetlands.

 **T13. In Honor of John M. (Jack) Sharp Jr.: Celebrating over 40 Years of Science, Students, and Stewardship**

**Cosponsors:** *GSA Hydrogeology Division; International Association of Hydrogeologists*

**Disciplines:** Hydrogeology, Karst, Environmental Geoscience

**Advocates:** Marcus O. Gary; Wendy M. Robertson; Brad David Wolaver; Todd Halihan

John M. (Jack) Sharp Jr. has been a pillar of hydrogeology in local, regional, national, and international circles for over 40 years. This session honors Jack and his contributions to the field of hydrogeology.

**T14. Lead Them to Water: Teaching Innovative Hydrogeology**

**Cosponsors:** *GSA Hydrogeology Division; GSA Geoscience Education Division*

**Disciplines:** Hydrogeology, Geoscience Education, Environmental Geoscience

**Advocates:** Peter E. Riemersma; Laura S. Ruhl

We encourage abstracts that highlight effective methods of teaching hydrogeology in the classroom, laboratory, and field. We solicit presentations that highlight advances in the discipline, as well as address fundamental concepts of hydrogeology.

 **T15. Monitoring the Complex Nature of Water Balances and Solute Transport at the Groundwater–Surface Water Interface**

**Cosponsors:** *GSA Hydrogeology Division; GSA Environmental and Engineering Geology Division*

**Disciplines:** Hydrogeology, Environmental Geoscience, Geochemistry

**Advocates:** Mackenzie Cremeans; J.F. Devlin

This session addresses advances in the study of groundwater–surface water interactions covering modeling, field instrumentation, and assessment of water and solute fluxes across the interface. Environments considered will include streams, lakes, wetlands, and irrigation drainage.

  **T16. Novel Approaches to Mine Remediation: Addressing the Legacy of Hardrock Mining through Innovative and Practical Methods**

**Cosponsors:** *GSA Hydrogeology Division; GSA Environmental and Engineering Geology Division*

**Disciplines:** Hydrogeology, Environmental Geoscience, Engineering Geology

**Advocates:** Kato T. Dee; William J. Walker

The legacy of hardrock mining has resulted in tens of thousands of abandoned mine sites in the Western United States. This session explores innovative and practical remediation approaches of abandoned hardrock mines.


 **T17. Polar and Alpine Changes**

**Cosponsors:** *GSA Hydrogeology Division; GSA Geobiology & Geomicrobiology Division*

**Disciplines:** Hydrogeology, Environmental Geoscience, Geomorphology

**Advocate:** W. Berry Lyons

Polar and high alpine environments are undergoing rapid changes including cryosphere loss, with important geomorphological, hydrological, biogeochemical, and ecological consequences. This interdisciplinary session will explore these changes in both the Arctic and Antarctic.

 **T18. Remote Sensing Applications in Hydrology and Geology**

**Cosponsors:** *GSA Hydrogeology Division; GSA Geoinformatics Division; GSA Geophysics Division; GSA Geology and Society Division; GSA Environmental and Engineering Geology Division*

**Disciplines:** Hydrogeology, Geophysics/Geodynamics, Geoinformatics

**Advocates:** R.H. Becker; Adam M. Milewski; Rachel R. Rotz

Recent innovations and sensors have broadened the capabilities of remote sensing, from UAV to satellite. A range of geologic, geomorphic, and hydrologic applications can be addressed. This session welcomes applications of the sensors to geologic questions.

 **T19. Springs: Providing Insights on Critical Groundwater Quality and Quantity Issues**

**Cosponsors:** *GSA Hydrogeology Division; GSA Environmental and Engineering Geology Division; GSA Geobiology & Geomicrobiology Division; GSA Karst Division*

**Disciplines:** Hydrogeology, Karst, Environmental Geoscience

**Advocates:** Brian Katz; Sue Swanson; James L. Berglund

This session will highlight research studies on springs that cover a range of topics, including water quality, geochemical and microbiological tracers for elucidating sources of anthropogenic impacts, water quantity, ecology, springs restoration, and climate change.

**T20. The Critical Zone As Heterogeneous Media: Implications for Physical, Chemical, and Biological Processes**

**Cosponsors:** *GSA Hydrogeology Division; GSA Soils and Soil Processes Interdisciplinary Interest Group; GSA Geobiology & Geomicrobiology Division; GSA Karst Division*

**Disciplines:** Hydrogeology, Soils

**Advocates:** Wendy M. Robertson; Nicole West; Zsuzsanna Balogh-Brunstad; Michael H. Young

We encourage contributions that characterize heterogeneities in the Critical Zone and their connections to hydrologic and biogeochemical processes at a range of spatial and temporal scales.


 **T21. Using Natural and Anthropogenic Tracers to Determine Recharge and Residence Times within Arid to Semi-Arid Inter-Montane Aquifer Systems**

**Cosponsor:** *GSA Hydrogeology Division*

**Disciplines:** Hydrogeology, Environmental Geoscience, Geology and Health

**Advocates:** P.S.K. Knappett; D. Kirk Nordstrom; Jurgen Mahlkecht; Hongbin Zhan

Inter-montane aquifer systems in arid regions are experiencing increased groundwater abstraction. We encourage abstracts on the hydrologic cycle in these basins to quantify groundwater recharge, groundwater quality, and discharge processes, especially with natural/anthropogenic tracers.

 **T22. Water Resources and Management in Coastal and Inland Aquifers—Emphasis on Small Island Developing States of the Caribbean**

**Cosponsors:** *GSA Hydrogeology Division; GSA International/International Interdisciplinary Interest Group; GSA Geology and Health Division; GSA Geology and Society Division; GSA Environmental and Engineering Geology Division*

**Disciplines:** Hydrogeology, Environmental Geoscience, Geology and Health

**Advocates:** Arpita Mandal; Debbie Ann Gordon Smith; Saugata Datta; Katherine K. Ellins

The session seeks presentations on current research focusing on Caribbean water resources (but not restrictive to Caribbean only,

rather similar coastal environments). Topics include water resources; water quality, and effective measures for improving wastewater treatment.

  **T23. Water Sourcing, Disposal, and Induced Seismicity Issues related to Unconventional Shale Oil and Gas Development**

**Cosponsors:** *GSA Hydrogeology Division; GSA Environmental and Engineering Geology Division*

**Disciplines:** Hydrogeology, Energy Geology, Geochemistry

**Advocates:** Kyle E. Murray; Bridget R. Scanlon; Jean-Philippe Nicot

This session will focus on water demand for hydraulic fracturing, management of produced water (e.g., disposal, reuse/recycling), and linkages to induced seismicity. Approaches to reducing water risks related to unconventional reservoir development are also important.

**KARST**

 **T24. How Nick Crawford's Vision Helped Shape Contemporary Karst Science and Education**

**Cosponsors:** *GSA Karst Division; National Cave and Karst Research Institute; GSA Hydrogeology Division; GSA History and Philosophy of Geology Division*

**Disciplines:** Karst, Hydrogeology, Geomorphology

**Advocates:** Chris Groves; George Veni; Geary Schindel; Augusto Auler

Nick Crawford is a pioneer of karst science and education. We highlight his contributions through perspectives of scientists Nick influenced, who worked with him, or who study areas of karst science that Nick helped innovate.

**T25. Karst Ecosystems and Biogeochemistry**

**Cosponsor:** *GSA Karst Division*

**Discipline:** Karst

**Advocates:** Cory W. BlackEagle; Jason Polk; Joshua Feinberg

Abstracts that deal with the study of cave and karst ecosystems, including the identification, quantification, and/or discussion of biota, flora, microbial, and related biogeochemical processes or environments in or near karst features.

**T26. Karst Hazards and Monitoring**

**Cosponsor:** *GSA Karst Division*

**Discipline:** Karst

**Advocates:** Cory W. BlackEagle; Jason Polk; Joshua Feinberg

Abstracts focused on the various hazards (sinkholes, groundwater pollution, etc.) and monitoring approaches found in karst landscapes. Topics include technical applications (e.g., LiDAR, 3D scanning, geodatabase development) and management implications (resource management, education, policy and regulation in karst areas).

 **T27. Karst Hydrology and Hydrogeology**

**Cosponsor:** *GSA Karst Division*

**Discipline:** Karst

**Advocates:** Cory W. BlackEagle; Jason Polk; Joshua Feinberg

Abstracts themed around the fundamental aspects of fluid-rock interactions within karst landscapes, including geologic, hydrogeologic, and hydrologic investigations. Appropriate topics range from dye tracing and aquifer processes to surface-subsurface hydrologic interactions and quantitative modeling.

**T28. Karst Processes and Speleology**

**Cosponsor:** *GSA Karst Division*

**Discipline:** Karst

**Advocates:** Cory W. BlackEagle; Jason Polk; Joshua Feinberg

Abstracts discussing cave and karst forming processes, including the geomorphic evolution of karst landscapes, cave system development, and cave survey studies. Carbonate weathering, hypogene processes, structural controls, and other related topics are included.

**T29. Karst Sedimentary, Paleoclimate, and Historical Records**

**Cosponsor:** *GSA Karst Division*

**Discipline:** Karst

**Advocates:** Cory W. BlackEagle; Jason Polk; Joshua Feinberg

Abstracts on cave deposits (sediments, speleothems, tufa, etc.), karst environmental records (sedimentary, underwater deposits, carbonate stratigraphy, etc.), and geoarchaeological and historical investigations to reconstruct or interpret past climates, landscapes, land use, and similar phenomena.

**ENVIRONMENTAL GEOSCIENCE**

 **T30. Asbestos: Former Highly Sought Mineral Resource Transmogrified to the Most Litigated Environmental Health Concern Known to Man, in the Geologic Blink of an Eye**

**Cosponsor:** *GSA Environmental and Engineering Geology Division*

**Disciplines:** Environmental Geoscience, Mineralogy/Crystallography, Petrology, Metamorphic

**Advocate:** Sean M. Fitzgerald

The latest in asbestos science and understanding including recent applications of geoscience, epidemiology, method developments, and regulatory approaches to asbestos and other elongate mineral particles of potential environmental health concern.



**T31. GeoCorps™ and Geoscientists-in-the-Parks Internships on Public Lands: Providing Career Development Opportunities for Students and Recent Graduates**

**Cosponsors:** *GSA Geology and Society Division; U.S. Forest Service; National Park Service*

**Disciplines:** Environmental Geoscience, Geoscience Education, Geoscience and Public Policy

**Advocates:** Johanna L. Kovarik; Lisa Norby; Matthew Dawson

GeoCorps™ America and Geoscientists-in-the-Parks Programs provide professional development and resource management opportunities on public lands for geoscience students and others pursuing careers in STEM fields. This session highlights the scientific accomplishments of these programs.



**T32. Geoscience on National Forests and Grasslands—Stewardship, Education, and Research**

**Cosponsors:** *GSA Geology and Society Division; GSA Hydrogeology Division; GSA Karst Division; U.S. Forest Service; GSA Karst Division*

**Disciplines:** Environmental Geoscience, Geoscience and Public Policy, Geoscience Information/Communication

**Advocates:** Christopher P. Carlson; Johanna L. Kovarik; Joseph T. Gurrieri; Ryan P. Mikulovsky

This session will feature geologic resources and geoscience research conducted on the National Forests and Grasslands. Topics include paleontology, geomorphology, hydrogeology, geo-ecology, geologic hazards, cave and karst resources, geologic engineering, interpretive and recreational geology, and more.



**T33. Intersections of Sustainability and Geosciences**

**Cosponsors:** *GSA Geology and Society Division; GSA Karst Division; GSA Environmental and Engineering Geology Division*

**Disciplines:** Environmental Geoscience, Geoscience Information/Communication, Geoscience and Public Policy

**Advocates:** Leslie A. North; Robert Brinkmann; Elizabeth Willenbrink

Papers are sought for a special session on Sustainability and the Geosciences. The session seeks to highlight works that combine the fields of sustainability and geoscience to examine, educate about, or manage environmental and/or societal problems.



**T34. Sigma Gamma Epsilon—Undergraduate Research (Posters)**

**Cosponsors:** *Sigma Gamma Epsilon; GSA Karst Division*

**Disciplines:** Environmental Geoscience, Paleontology, Biogeography/Biostratigraphy, Hydrogeology

**Advocates:** Aaron W. Johnson; James C. Walters

The goal of this session is to highlight recent and ongoing undergraduate research in a student-friendly forum. The session is open to students and faculty co-authors working in any area of geosciences.



**T35. Urban Geochemistry**

**Cosponsors:** *International Association of GeoChemistry; GSA Hydrogeology Division; GSA Karst Division*

**Disciplines:** Environmental Geoscience, Geochemistry, Geology and Health

**Advocates:** David T. Long; W. Berry Lyons

This session encourages presentations that qualify and quantify the geochemical and biogeochemical impacts (temporal and spatial) of urbanization and urban activities on soil, water, and air resources as well as on human and ecosystem health.

**PALEOCLIMATOLOGY/PALEOCEANOGRAPHY**

**T36. Asthenosphere to Atmosphere: Tectonics, Topography, and Climate**

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

**Disciplines:** Paleoclimatology/Paleoceanography, Tectonics/Tectonophysics, Geophysics/Geodynamics

**Advocates:** A. Alexander G. Webb; Peter D. Clift

This session focuses on climate-tectonic interactions at large scale, from asthenosphere to atmosphere. Join us to share how your research addresses key chicken-and-egg questions, critical mechanisms, or boundary conditions throughout Earth's evolution.

**T37. Cave Records from Contiguous North America: Providing Records of Hydrologic Reorganization over the Late Quaternary**

**Cosponsor:** *GSA Karst Division*

**Disciplines:** Paleoclimatology/Paleoceanography, Karst, Geochemistry

**Advocates:** Barbara E. Wortham; Alexandra Noronha

This session will examine cave records from North America to provide insight on regional hydrologic reorganization due to Northern Hemisphere climatic shifts over the late Quaternary. All cave-based records welcome.

**T38. Cenozoic Paleoclimates and Ecosystems**

**Cosponsors:** *Paleontological Society; Geochemical Society; Paleontological Research Institution; Cushman Foundation; GSA Sedimentary Geology Division*

**Disciplines:** Paleoclimatology/Paleoceanography, Paleontology, Biogeography/Biostratigraphy

**Advocates:** Alexis Licht; Caroline Stromberg; Gerard H. Roe; Guillaume Dupont-Nivet; Yannick Donnadieu; K. Christopher Beard

This session encourages contributions that address Cenozoic paleoclimate from a variety of approaches, including climate simulations, paleontological, paleobotanical, and geological studies of the marine and terrestrial records. Comparisons between data and models are particularly welcomed.

**T39. Cushman Foundation Symposium: Microfossil Mayhem—Murder, Misfortune, and More**

**Cosponsors:** *Cushman Foundation; Paleontological Research Institution; GSA Limnogeology Division; Paleontological Society; Geochemical Society; GSA Archeological Geology Division*

**Disciplines:** Paleoclimatology/Paleoceanography, Limnogeology, Archaeological Geology

**Advocates:** Miriam E. Katz; Francine M.G. McCarthy; Michelle F. Goman

Microfossils (assemblages, geochemistry) are integral to a wide range of human-related studies, from hominin evolution to murder investigation. This session highlights innovative microfossil applications to areas such as forensics, pollution, sea level, climate, anthropology, and archaeology.

**T40. Earth Life Transitions and Major Continental Biological Events of the Phanerozoic**

**Cosponsors:** *GSA Soils and Soil Processes Interdisciplinary Interest Group; GSA Sedimentary Geology Division; Geochemical Society; Paleontological Society; SEPM (Society for Sedimentary Geology)*

**Disciplines:** Paleoclimatology/Paleoceanography, Paleontology, Diversity, Extinction, Origination, Stratigraphy

**Advocates:** Lauren A. Michel; Erik L. Gulbranson; Neil J. Tabor

This session will highlight research about Phanerozoic biotic transitions in terrestrial environments. Advances made through multidisciplinary research and application of modern calibration studies made with deep-time application are welcome.

**T41. Geochemical Records of the Late Triassic to Jurassic Earth System and End-Triassic Extinction**

**Disciplines:** Paleoclimatology/Paleoceanography, Geochemistry, Paleontology, Diversity, Extinction, Origination

**Advocates:** Morgan F. Schaller; Masayuki Ikeda

Novel geochemical approaches and applications are changing our understanding of the Late Triassic Earth System. This session explores those records of paleo-environmental change as they lead up to, and through, the End-Triassic Extinction.

**T42. Glacier and Ice Sheet Grounding Lines: Contemporary and Past Observations of Grounding Line Processes, Behavior, and Landforms**

**Disciplines:** Paleoclimatology/Paleoceanography, Environmental Geoscience, Geomorphology

**Advocates:** Nicholas D. Holschuh; Lauren M. Simkins; Alexander Robel; John B. Anderson

By integrating model results with observations of both modern and paleo grounding lines, this session aims to understand the geologic, glacial, and marine processes that drive ice sheet grounding line dynamics.

**T43. High-Resolution Investigations of the Permian-Triassic Transition**

**Cosponsors:** *GSA Sedimentary Geology Division; SEPM (Society for Sedimentary Geology); Paleontological Society; Paleontological Research Institution*

**Disciplines:** Paleoclimatology/Paleoceanography, Paleontology, Diversity, Extinction, Origination, Geochemistry

**Advocates:** Thomas J. Algeo; Hugo Bucher; Kimberly V. Lau

This multidisciplinary session aims at a better understanding of interrelationships among biotic, volcanic, climatic, and oceanographic events of the latest Permian to Early Triassic through integrated high-resolution bio/chemo/chronostratigraphic studies.

**T44. Insights from Microfossils, from Traditional to Novel Approaches**

**Cosponsors:** *Cushman Foundation; Paleontological Research Institution; Paleontological Society; GSA Limnogeology Division; Geochemical Society*

**Disciplines:** Paleoclimatology/Paleoceanography, Geochemistry, Marine/Coastal Science

**Advocates:** Miriam E. Katz; Robert K. Poirier; Krystyna Kornecki; Megan K. Fung

Traditional uses of microfossils are central to many research applications, while novel geochemical approaches utilizing microfossils have expanded recently. This session highlights traditional and innovative microfossil applications in terrestrial and marine environments, including modern analogs.

**T45. Miocene-Pliocene Terrestrial Ecosystem Response to the Climate System**

**Cosponsor:** *Paleontological Society*

**Disciplines:** Paleoclimatology/Paleoceanography, Geochemistry, Paleontology, Diversity, Extinction, Origination

**Advocates:** Kevin Uno; Tammo Reichgelt

Miocene-Pliocene climatic change shaped modern terrestrial environments and holds clues for the planet's future. We encourage research on climate-biota interaction that elucidates mechanisms of ecosystem change during this period.

**T46. North Pacific Environment and Paleoclimate from the Late Pleistocene to Present**

**Cosponsors:** *GSA Sedimentary Geology Division; GSA Quaternary Geology and Geomorphology Division; GSA Archeological Geology Division; GSA Limnogeology Division*

**Disciplines:** Paleoclimatology/Paleoceanography, Quaternary Geology, Geochemistry

**Advocates:** Lesleigh Anderson; Miriam C. Jones

Marine and terrestrial reconstructions of environment and climate from the North Pacific region, including eastern Asia, Alaska, and western North America, are encouraged to explore patterns and linkages during the deglacial, Holocene, and historic periods.

**T47. Recent Developments in Cyclostratigraphy**

**Cosponsors:** *Cushman Foundation; Geochemical Society; Geologic TimeScale Foundation; Winners Academic Solutions; YES Network; GSA Sedimentary Geology Division*

**Disciplines:** Paleoclimatology/Paleoceanography, Stratigraphy, Sediments, Carbonates

**Advocates:** Chao Ma; Mingsong Li; M'bark Baddouh

This session presents recent developments in methodology and applications for the analysis of cyclostratigraphy with the twin goals of improving high-resolution geochronology and understanding paleoclimate change.

**T48. The Timing and Causes of Jurassic-Cretaceous Biological, Climatic, and Tectonic Transitions in North America**

**Cosponsors:** *GSA Sedimentary Geology Division; Paleontological Research Institution*

**Disciplines:** Paleoclimatology/Paleoceanography, Tectonics/Tectonophysics, Paleontology, Biogeography/Biostratigraphy

**Advocates:** Brady Z. Foreman; Michael D. D'Emic

We seek submissions on new age constraints, paleobiological/paleoecological analyses, provenance studies, subsidence analyses, structural data, and paleoclimatic reconstructions from Upper Jurassic and Lower Cretaceous rocks aimed at integrating major tectonic, biologic, and climatic transitions.

**PALEONTOLOGY****T49. Advances in Computational Paleobiology: Reshaping Our Understanding of the Fossil Record**

**Cosponsors:** *Palaeontological Association; Paleontological Society*

**Disciplines:** Paleontology, Diversity, Extinction, Origination, Paleontology, Biogeography/Biostratigraphy, Paleontology, Phylogenetic/Morphological Patterns

**Advocates:** Rachel C.M. Warnock; Alexander M. Dunhill; Erin E. Saupe

This session will explore the impact of computational advances in paleobiology, from novel approaches to collecting and digitizing data to the development of statistical and computational techniques for analyzing both neontological and paleontological data.

**T50. Big Forams, Big Questions: Larger Benthic Foraminifera and Climate Interactions**

**Cosponsors:** *Paleontological Society; Cushman Foundation; Paleontological Research Institution*

**Disciplines:** Paleontology, Diversity, Extinction, Origination, Paleoclimatology/Paleoceanography, Paleontology, Biogeography/Biostratigraphy

**Advocates:** Laura J. Cotton; Caitlin Keating-Bitonti

This session merges paleontological, paleoclimatic, and biological research that applies novel techniques to larger foraminifera. These studies will yield new insights into the climatic histories of shallow marine environments and their evolutionary impact on foraminifera.

**T51. Biodiversity Dynamics in the Face of Environmental Change: Integrating Paleontological and Neontological Approaches to Macroevolution**

**Cosponsors:** *Paleontological Society; Paleontological Research Institution*

**Disciplines:** Paleontology, Diversity, Extinction, Origination, Paleontology, Phylogenetic/Morphological Patterns, Paleontology, Biogeography/Biostratigraphy

**Advocates:** Shan Huang; Paul G. Harnik; Lee Hsiang Liow

This session will focus on how environmental changes have shaped Earth's biodiversity through geologic time and how these macroevolutionary relationships might be used to understand the responses of extant species to current and projected environmental conditions.

**T52. Biotic Revolutions Recorded in the Trace Fossil Record, Neoproterozoic to Recent**

**Cosponsors:** *Paleontological Society; Paleontological Research Institution*

**Disciplines:** Paleontology, Diversity, Extinction, Origination, Paleontology, Paleocology/Taphonomy, Paleontology, Biogeography/Biostratigraphy

**Advocates:** James Lehane; Leif Tapanila

Trace fossils preserve direct behavioral evidence to infer animal use of space and nutrient resources through deep time. We welcome ichnological studies of big biotic innovations for any terrestrial and aqueous environment.

**T53. Digital, Digital Get Down: Frontiers in Virtual Paleontology**

**Cosponsors:** *Paleontological Society; Paleontological Research Institution; GSA Geoinformatics Division*

**Disciplines:** Paleontology, Diversity, Extinction, Origination, Paleontology, Phylogenetic/Morphological Patterns, Paleontology, Paleocology/Taphonomy

**Advocates:** Jennifer E. Bauer; Johnny A. Waters

The objective of this session is to promote the usage of tomographic techniques in understanding morphology, phylogeny, and function of fossil forms.

**T54. Impact of Extinction Events on the Ecological and Geochemical Functioning of Marine Ecosystems**

**Cosponsor:** *Paleontological Society*

**Disciplines:** Paleontology, Diversity, Extinction, Origination, Geochemistry, Paleoclimatology/Paleoceanography

**Advocates:** William J. Foster; Peter J. Harries; Martin Aberhan

The impact of extinction events on the functioning and both the ecological and geochemical composition of the oceans will be explored. Types of studies include paleoecological, geochemical, paleobiological, ichnological, paleoclimatological, and integrated studies.



**T55. Life and Times in the Early Paleozoic**

**Cosponsor:** *Paleontological Society*

**Disciplines:** Paleontology, Diversity, Extinction, Origination, Paleoclimatology/Paleoceanography, Geochemistry

**Advocates:** Erik A. Sperling; Stephen Leslie; Matt Saltzman

This session welcomes submissions on early Paleozoic biotic radiations and extinctions and their relationship (or not) to any aspect of the evolving Earth system.

**T56. Mass Extinctions: Past, Present, and Future?**

**Cosponsors:** *Paleontological Research Institution; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; Cushman Foundation for Foraminiferal Research; Paleontological Society; Volcanic and Magmatic Studies Group*

**Disciplines:** Paleontology, Diversity, Extinction, Origination, Geochemistry, Stratigraphy

**Advocates:** David P.G. Bond; Thierry Adatte; Gerta Keller; Dougal A. Jerram

This session examines micro- and macrofaunal and floral records of extinction from deep time to the present, proxies for contemporaneous environmental changes and their ultimate drivers (e.g., large igneous province eruptions, bolide impacts, anthropogenic change).

**T57. Mercury in the Geologic Record**

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

**Disciplines:** Paleontology, Diversity, Extinction, Origination, Geochemistry, Volcanology

**Advocate:** Stephen E. Grasby

Mercury is an effective proxy for volcanism in the geologic record. This session will examine Hg across major events in Earth history, processes that influence Hg in the rock record, and stable isotope studies.

**T58. Oxygen and Ecosystems from the Proterozoic to the Paleozoic**

**Cosponsors:** *Paleontological Research Institution; Paleontological Society; GSA Geobiology & Geomicrobiology Division*

**Disciplines:** Paleontology, Diversity, Extinction, Origination, Precambrian Geology, Geochemistry

**Advocates:** Noah J. Planavsky; Devon B. Cole; Christopher T. Reinhard

This session will explore recent efforts to develop a more comprehensive understanding of coupled oxygen availability and environmental conditions with biotic evolution and ecosystem development from the Proterozoic to the early Paleozoic.

**T59. Studies in Paleobiology and Paleoecology: In Honor of Professor David J. Bottjer**

**Cosponsors:** *GSA Geobiology & Geomicrobiology Division; Paleontological Society; SEPM (Society for Sedimentary Geology); Paleontological Research Institution*

**Disciplines:** Paleontology, Diversity, Extinction, Origination, Paleontology, Paleoecology/Taphonomy, Paleontology, Phylogenetic/Morphological Patterns

**Advocates:** Thomas J. Algeo; Pedro J. Marenco; Margaret L. Fraiser; Matthew E. Clapham

This session honors Professor David Bottjer on the occasion of his stepping down as Editor-in-Chief of *Palaeogeography Palaeoclimatology Palaeoecology* after 16 years. He is a paleobiologist and paleoecologist working on organism-sediment interactions, early metazoan life, and recovery from mass extinctions.

**T60. The Onset of the Great Ordovician Biodiversity Event (GOBE): Testing Hypotheses with Diverse Data Sets**

**Cosponsors:** *Paleontological Society; GSA Geobiology & Geomicrobiology Division; GSA Sedimentary Geology Division; SEPM (Society for Sedimentary Geology); IGCP 653: Onset of the Great Ordovician Biodiversification Event; Paleontological Research Institution*

**Disciplines:** Paleontology, Diversity, Extinction, Origination, Stratigraphy, Paleoclimatology/Paleoceanography

**Advocates:** Rebecca L. Freeman; Alycia L. Stigall

We request contributions testing hypotheses concerning the Late Cambrian to Ordovician biotic and abiotic drivers of GOBE. Diverse data sets illuminate the timing, initiating conditions, stratigraphy, and paleontology of this significant event in Earth's history.

**T61. Tracking Deccan Volcanism and Biotic Change in Terrestrial Ecosystems across the Cretaceous-Paleogene of India**

**Cosponsor:** *Paleontological Society*

**Disciplines:** Paleontology, Diversity, Extinction, Origination, Geochemistry, Volcanology

**Advocates:** Gregory P. Wilson; Jeffrey A. Wilson; Paul Renne

India is central to the Cretaceous-Paleogene mass extinction and the Indo-Asian biotic interchange. This session will bring together geologists and paleontologists to highlight advances in our understanding of the Deccan traps and India's biotic changes.

**T62. Ancient Environments of South America**

**Cosponsors:** *Paleontological Research Institution; Paleontological Society; GSA Sedimentary Geology Division*

**Disciplines:** Paleontology, Paleoecology/Taphonomy

**Advocates:** Camilla Crifò; Regan E. Dunn

The aim of this session is to reunite with an integrative perspective paleontologists, paleoecologists, paleobotanists, geochemists, and sedimentologists whose main focus is the deep time paleontological, biogeographic, and geologic history of the South American continent.

**T63. Cephalopod Paleobiology and Paleoecology: A Tribute to Royal H. Mapes**

**Cosponsors:** *Paleontological Society; SEPM (Society for Sedimentary Geology); Paleontological Research Institution*

**Disciplines:** Paleontology, Paleoecology/Taphonomy, Stratigraphy, Geochemistry

**Advocates:** Corinne Myers; Thomas S. Tobin; Benjamin J. Linzmeier; Margaret M. Yacobucci

This session honors the achievements of Royal H. Mapes by convening geoscientists and biologists studying all areas of cephalopod paleontology. By presenting cutting edge cephalopod-related research we hope to foster collaborations and cross-disciplinary idea exchange.

**T64. Citizen Science in Paleontology: Harnessing Public Interest to Advance Research and STEM Education**

**Cosponsors:** *Paleontological Society; GSA Geology and Society Division; GSA Geoscience Education Division*

**Disciplines:** Paleontology, Paleoecology/Taphonomy, Geoscience Education, Geoscience Information/Communication

**Advocates:** Laura C. Soul; Terry A. Gates; Eleanor E. Gardner

Paleontologists, educators, and non-academic contributors will discuss best practices for citizen science as a viable means to achieve high quality paleontological research, and to create a valuable experience for citizens that facilitates STEM learning.

**T65. Eco-Evolutionary Dynamics in the Fossil Record**

**Cosponsors:** *Paleontological Research Institution; Paleontological Society*

**Disciplines:** Paleontology, Paleoecology/Taphonomy, Paleontology, Diversity, Extinction, Origination, Paleontology, Biogeography/Biostratigraphy

**Advocates:** Peter D. Roopnarine; Ashley A. Dineen

This interdisciplinary session will develop and expand thinking on how the complementary influences of ecology and evolution on short timescales might contribute to our understanding of macroevolutionary patterns on geological timescales.

**T66. Exceptionally Preserved Proterozoic–Early Paleozoic Fossils**

**Cosponsors:** *Paleontological Society; GSA Geobiology & Geomicrobiology Division; Paleontological Research Institution*

**Disciplines:** Paleontology, Paleoecology/Taphonomy, Paleontology, Diversity, Extinction, Origination, Geomicrobiology

**Advocates:** Ross P. Anderson; Lidya G. Tarhan; Sean McMahon

Exceptionally preserved soft-tissue fossils are essential to the reconstruction of the emergence and diversification of early complex life. Here we consider new geologically and experimentally derived insights into the taphonomy of Proterozoic–early Paleozoic Lagerstätten.

**T67. Fossils and Fossilization in Amber**

**Cosponsors:** *GSA Geobiology & Geomicrobiology Division; Paleontological Society; Paleontological Research Institution*

**Disciplines:** Paleontology, Paleoecology/Taphonomy, Paleontology, Diversity, Extinction, Origination, Paleontology, Phylogenetic/Morphological Patterns

**Advocates:** Victoria E. McCoy; Sarah E. Gabbott

This session will explore all the diverse areas of amber paleontology, from the description of exceptional specimens, to the investigation of amber taphonomy, to innovative approaches to image or chemically characterized fossils in amber.

**T68. Proxy Approaches to Determine Forest Structure in Deep Time: What Have We Learned?**

**Cosponsors:** *GSA Geobiology & Geomicrobiology Division; GSA Sedimentary Geology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; Paleontological Society*

**Disciplines:** Paleontology, Paleoecology/Taphonomy, Paleontology, Biogeography/Biostratigraphy, Geomicrobiology

**Advocates:** Richard S. Barclay; Regan E. Dunn; Heather V. Graham

We will gather a diverse set of scientists who apply cross-disciplinary approaches to fossil plants and animals, stable isotopes, biogeochemistry, and the sedimentary record to assess the structure and density of forests in deep-time.

**T69. The Role of Silica in the Earth System: From Organisms to Global Biogeochemical Cycles**

**Cosponsors:** *GSA Geobiology & Geomicrobiology Division; GSA Sedimentary Geology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; Paleontological Society*

**Disciplines:** Paleontology, Paleoecology/Taphonomy, Geochemistry, Mineralogy/Crystallography

**Advocates:** Jonathan P. Wilson; Caroline A.E. Strömberg; Patrick J. Frings

This session seeks to bring together geochemists, modelers, soil scientists, physiologists, and paleontologists to discuss state-of-the-art knowledge of the terrestrial and oceanic silica cycles, links between them, and connections with other biogeochemical cycles through time.

**T70. Paleogenomics and Geobiology**

**Cosponsors:** *Paleontological Society; Paleontological Research Institution; GSA Geobiology & Geomicrobiology Division*

**Disciplines:** Paleontology, Phylogenetic/Morphological Patterns, Paleontology, Diversity, Extinction, Origination, Geochemistry

**Advocates:** Jeffrey R. Thompson; David J. Bottjer

This session will include, though is not limited to, presentations utilizing approaches to interpret the fossil record and evolutionary trends through integration of data from the rock record with molecular biology, genomics, and developmental biology.

## GEOSCIENCE AND PUBLIC POLICY

### T71. **GeoDiplomacy: Solving Problems without Borders**

**Cosponsors:** *GSA Geology and Society Division; GSA Environmental and Engineering Geology Division*

**Disciplines:** Geoscience and Public Policy, Environmental Geoscience, Geoscience Information/Communication

**Advocates:** Gregory R. Wessel; Jeffrey K. Greenberg

This session focuses on the primacy of geology to international relations and to sustainable development and the parameters that influence such work. Examples of successful multinational research efforts, public and private, will be presented.

### T72. **Geology, Resilience, Policy, and Preparedness: How Government and Private Industry Are Preparing for Geologic Disasters (such as Cascadia Rising)**

**Cosponsors:** *Washington Division of Geology and Earth Resources; GSA Geology and Society Division; GSA Environmental and Engineering Geology Division*

**Disciplines:** Geoscience and Public Policy, Engineering Geology, Quaternary Geology

**Advocates:** Dave Norman; Maximilan Dixon

Earthquake resilience is becoming prominent in the government policy arena. With the Washington governor's directive highlighting steps to a Resilient Washington and the Cascadia Rising exercise, there has been a spotlight on policy and preparedness.

### T73. **Geoscience and the Law: Exploring the Legal and Ethical Issues of Geologic Research and Practice**

**Cosponsors:** *GSA Geology and Society Division; GSA Academic and Applied Geoscience Relations Committee; GSA Environmental and Engineering Geology Division*

**Disciplines:** Geoscience and Public Policy, Environmental Geoscience, Engineering Geology

**Advocates:** James Heller; Susan Stover

An examination of the legal and ethical concerns of academic geologic research and applied practice with discussions pertaining to FOIA, technologic innovations, new areas of exploration, and the management of risks and liabilities.

### T74. **Integrating Geohazards Data into Planning and Land-Use Management Decisions**

**Cosponsors:** *GSA Environmental and Engineering Geology Division; Washington Division of Geology and Earth Resources; GSA Geology and Society Division; GSA Geoinformatics Division; GSA Karst Division*

**Disciplines:** Geoscience and Public Policy, Engineering Geology, Geoinformatics

**Advocates:** Katherine A. Mickelson; Dave Norman; Gregory R. Wessel; Stephen L. Slaughter

This session focuses on the integration of geohazard data into land-use policy, the enhancement of public awareness, and improving communication. Examples of long-term and sustainable development, incorporating existing/future datasets, and information dissemination will be presented.

### T75. **Planetary Climate Disruption Demands Urgent Global Policy Action**

**Cosponsors:** *GSA Quaternary Geology and Geomorphology Division; GSA Energy Geology Division; GSA Environmental and Engineering Geology Division; GSA Geology and Society Division; GSA Hydrogeology Division*

**Disciplines:** Geoscience and Public Policy, Environmental Geoscience, Quaternary Geology

**Advocates:** George T. Stone; Jennifer L. Pierce

Unequivocal data document CO<sub>2</sub> and temperature rise plus problematic responses throughout the hydrosphere, cryosphere, atmosphere, and biosphere. We seek compelling arguments for public policy action to reduce greenhouse gas emissions and mitigate anthropogenic climate change.

### T76. **Scientific Freedom in 2017**

**Cosponsors:** *GSA Geology and Society Division; GSA Geology and Public Policy Committee*

**Discipline:** Geoscience and Public Policy

**Advocates:** Johan C. Varekamp; Arthur W. Snok

Scientific freedom implies open dissemination of data and interpretations, without fear of retribution. We request papers from scientists with notable research or teaching experiences in topics such as evolution, pollution science, or climate change.

## ENERGY GEOLOGY

### T77. **Characterization and Hydrocarbon Sealing Capacity of the Weathering Mud Layer in an Unconformity**

**Disciplines:** Energy Geology, Structural Geology, Stratigraphy

**Advocate:** Kongyou Wu Sr.

An unconformity can be vertically divided into top, middle, and bottom layers. The middle layer can present low porosity and permeability, and it can play a critical control on the development of unconformity-related reservoirs.

### T78. **Environmental Geology Studies of Energy Impacts**

**Cosponsors:** *GSA Energy Geology Division; GSA Environmental and Engineering Geology Division*

**Disciplines:** Energy Geology, Environmental Geoscience, Geology and Health

**Advocates:** Marc L. Buursink; Laura Ruhl; J. Fred McLaughlin; Brett J. Valentine

This session will explore research relating to environmental issues associated with energy geology, including exploration practices, extraction of resources, and waste disposal.

**T79. Geologic Energy Research**

**Cosponsors:** *GSA Energy Geology Division; GSA Environmental and Engineering Geology Division*

**Disciplines:** Energy Geology, Geochemistry

**Advocates:** Laura Ruhl; J. Fred Mclaughlin; Marc L. Buursink; Brett J. Valentine

This is the general session of the GSA Energy Division and highlights research into geologic based energy resources. Topics include coal geology, petroleum geology, geothermal, uranium, and the environmental impacts from energy utilization.

**T80. Geothermal Energy**

**Cosponsors:** *Washington Division of Geology and Earth Resources; GSA Environmental and Engineering Geology Division; GSA Structural Geology and Tectonics Division*

**Disciplines:** Energy Geology, Tectonics/Tectonophysics

**Advocates:** Corina Forson; Dave Norman

This session highlights recent geothermal exploration and development projects. Share the innovative techniques that help us find and harness geothermal resources, generating energy when the wind doesn't blow and the sun doesn't shine.

**T81. Oil and Gas Waste Waters: Characterization, Treatment, Injection, Uses, and Impacts**

**Cosponsors:** *GSA Energy Geology Division; GSA Hydrogeology Division; GSA Environmental and Engineering Geology Division*

**Disciplines:** Energy Geology, Hydrogeology, Engineering Geology

**Advocates:** Madalyn S. Blondes; Mark A. Engle; Tanya J. Gallegos

This session brings together the engineers and scientists working on treatment, injection, and uses of oil and gas waste waters with those studying their sources, composition, and impacts who can help inform these new technologies.

**T82. Pacific Northwest Energy: Resources, Opportunities, and Adaptability in a Changing Energy Environment**

**Cosponsors:** *GSA Energy Geology Division; Northwest Energy Association (NWEA); American Association of Petroleum Geologists (AAPG); GSA Environmental and Engineering Geology Division*

**Disciplines:** Energy Geology, Economic Geology, Tectonics/Tectonophysics

**Advocate:** Paul Oldaker

Presentations on interactions of geoscience with providing affordable energy to a growing population in the Pacific Northwest, including historical and emerging fossil fuel and renewable energy resources in an active convergent tectonic province.

**T83. Unconventional Energy Resources: Advances and Evolution in Tight Reservoir Assessment and Production**

**Cosponsors:** *GSA Energy Geology Division; GSA Sedimentary Geology Division*

**Disciplines:** Energy Geology, Economic Geology, Sediments, Clastic

**Advocates:** J. Fred Mclaughlin; Marc L. Buursink; Laura Ruhl; Brett J. Valentine

Unconventional oil and natural gas represent a tremendous resource in the U.S., but can be geologically complex systems to understand and develop. This session will present research as these resources move into maturity.

**SEDIMENTS, CARBONATES/CLASTIC****T84. The Dynamics of Stratigraphy and Sedimentation (Posters)**

**Cosponsors:** *GSA Sedimentary Geology Division; SEPM (Society for Sedimentary Geology)*

**Disciplines:** Sediments, Carbonates, Sediments, Clastic, Marine/Coastal Science

**Advocate:** Gary L. Gianniny

This session welcomes student scientific contributions on sedimentary geology. Topics can range broadly from studies of ancient to modern sediments, carbonates to clastics, sedimentary processes and their products in the geologic record.

**T85. Clear as Mud: Stratigraphic, Diagenetic, Sedimentologic, Geomechanical Analyses, and Modern Analogs of Ancient Mudrock Systems**

**Cosponsors:** *GSA Sedimentary Geology Division; GSA Energy Geology Division*

**Disciplines:** Sediments, Clastic, Stratigraphy, Geochemistry

**Advocates:** Bryan W. Turner; Shannon A. Dulin

New techniques enable efficient and accurate analyses of mudrock properties at fine-scales, allowing precise descriptions and interpretations of this subtle lithology. This session highlights new studies of sedimentology, stratigraphy, and diagenesis of mudrock dominated systems.

**T86. Controls, Geomorphology, and Depositional Architecture of Fluvial-Tidal Sediments through Space and Time**

**Cosponsors:** *GSA Sedimentary Geology Division; SEPM (Society for Sedimentary Geology)*

**Disciplines:** Sediments, Clastic, Geomorphology, Stratigraphy

**Advocates:** Shahin Exton Dashtgard; Stephen M. Hubbard

Presentations in this session will explore depositional, morphologic, and stratigraphic variations at the intersection of fluvial and tidal environments.

**T87. Fluvio-Deltaic Processes and Their Stratigraphic Record**

**Cosponsors:** *GSA Sedimentary Geology Division; GSA Quaternary Geology and Geomorphology Division; SEPM (Society for Sedimentary Geology)*

**Disciplines:** Sediments, Clastic, Geomorphology, Stratigraphy

**Advocates:** Brandon McElroy; Jeffrey A. Nittrouer

Advances in modern river and delta processes and their interpretation from the ancient rock record via observational, experimental, modeling, and theoretical studies.

**T88. Mudstone Facts: Deposition, Diagenesis, and Source of Basin Fluids**

**Cosponsors:** *GSA Sedimentary Geology Division; GSA Energy Geology Division; GSA Limnogeology Division*

**Disciplines:** Sediments, Clastic, Energy Geology, Limnogeology

**Advocates:** Neil Fishman; Sven Egenhoff; Dario Harazim

This session features the sedimentology and petrology of mudstones, and their role as sources of fluids in basins. Although organic-rich mudstones (marine or lacustrine) are a focal point, studies on other mudrocks are welcome.

**T89. The Dynamics of Tectono-Sedimentary Systems During Basin Formation and Fill**

**Cosponsors:** *GSA Sedimentary Geology Division; GSA Structural Geology and Tectonics Division*

**Disciplines:** Sediments, Clastic, Tectonics/Tectonophysics, Stratigraphy

**Advocates:** Eugene Szymanski; Jacob A. Covault; Daniel F. Stockli

This session will investigate the nature of sediment delivery systems that connect orogenic terranes to their associated depositional basins—over various spatiotemporal scales and tectonic settings—by exploring fundamental driving processes and multiple scaling factors.

**STRATIGRAPHY**

**T90. Advancing Seismic and Sequence Stratigraphy: Insights from Testing the Fundamentals**

**Cosponsors:** *GSA Environmental and Engineering Geology Division; GSA Energy Geology Division; GSA Sedimentary Geology Division*

**Disciplines:** Stratigraphy, Sediments, Clastic, Paleoclimatology/Paleoceanography

**Advocates:** Andrew Madof; Ashley D. Harris; Fabien J. Laugier

We encourage presenters to show their interdisciplinary and solution-driven work, which should focus on rigorously testing fundamental assumptions of sequence stratigraphy. Presentations should be aimed at evolving ideas, with the intention of advancing the science.

**T91. Chemostratigraphy: Environments, Correlation, and Time (Posters)**

**Cosponsors:** *North American Commission on Stratigraphic Nomenclature; SEPM (Society for Sedimentary Geology); International Subcommittee on Stratigraphic Classification; GSA Sedimentary Geology Division*

**Disciplines:** Stratigraphy, Geochemistry, Paleontology, Biogeography/Biostratigraphy

**Advocates:** Richard Fluegeman; Carlton E. Brett; Brian R. Pratt; Lucy Edwards

This session will focus on the use of chemical records preserved in sedimentary deposits for correlation. The conveners are interested in applications of chemostratigraphy from a variety of chronostratigraphic, environmental, and geographic settings.

**T92. Tectonics and Sedimentation, Avulsion, and Experimental Stratigraphy, and History of Western North America: A Celebration of Paul Heller's Career**

**Cosponsors:** *GSA Sedimentary Geology Division; GSA Structural Geology and Tectonics Division; GSA Quaternary Geology and Geomorphology Division; SEPM (Society for Sedimentary Geology)*

**Disciplines:** Stratigraphy, Tectonics/Tectonophysics, Geomorphology

**Advocates:** Brady Z. Foreman; Majie Fan; Elizabeth Hajek

In recognition of the late Dr. Paul Heller's influence on studies of tectonics and sedimentation, fluvial stratigraphy, and evolution of western North America, we seek submissions spanning these fields.

**LIMNOGEOLOGY**

**T93. Lacustrine Systems across Space and Time**

**Cosponsors:** *GSA Limnogeology Division; GSA Sedimentary Geology Division; Paleontological Society; SEPM (Society for Sedimentary Geology)*

**Disciplines:** Limnogeology, Stratigraphy, Paleoclimatology/Paleoceanography

**Advocates:** Scott W. Starratt; Michelle F. Goman

This session celebrates lacustrine research across the globe. Lakes are important fresh water reservoirs and their sediments are archives of global change, pollution, and ecological succession.



**22-25 October**  
Seattle, Washington, USA

**T94. Limnogeology—Progress, Challenges, and Opportunities on Earth and Beyond: A Tribute to Beth Gierlowski-Kordesch**

**Cosponsors:** *GSA Limnogeology Division; SEPM (Society for Sedimentary Geology); Paleontological Society; International Association of Limnogeology; GSA Sedimentary Geology Division; GSA Geobiology & Geomicrobiology Division*

**Disciplines:** Limnogeology, Paleoclimatology/Paleoceanography, Geochemistry

**Advocates:** David B. Finkelstein; Lisa E. Park Boush

This session explores new insights, critical thinking, and integrated analytical approaches, including sedimentology and stratigraphy, remote sensing, geophysical techniques, geomicrobiology, and geochemical studies applied to the interpretation of modern and ancient lake environments and sediments.

**T95. Monsoons and Westerlies in Asia: Quantifying Trans-Asia Hydroclimates Since the LGM**

**Cosponsors:** *GSA International/International Interdisciplinary Interest Group; GSA Limnogeology Division; GSA Quaternary Geology and Geomorphology Division; GSA Sedimentary Geology Division*

**Disciplines:** Limnogeology, Paleoclimatology/Paleoceanography, Quaternary Geology

**Advocates:** Yonaton Goldsmith; Jay Quade; Yehouda Enzel

Reconstructing trans-Asia, centennial to millennial, late Pleistocene and Holocene hydroclimates using limnology, geochemistry, paleoenvironments, paleohydrology, and modeling from lacustrine settings; all are related to Asian and Indian monsoons and westerlies.

**T96. Understanding African Environmental History through Continental Scientific Drilling: Past Successes and Future Opportunities**

**Cosponsors:** *GSA Limnogeology Division; GSA Sedimentary Geology Division*

**Disciplines:** Limnogeology, Paleoclimatology/Paleoceanography, Sediments, Clastic

**Advocates:** James M. Russell; Michael McGlue; Sarah Ivory

This session will discuss results from recent and planned continental scientific drilling projects in Africa, with a focus on understanding the evolution of African climate, environments, and sedimentary systems during the Neogene.

**T97. Will My Boat Float?—Physical and Biological Proxies for Lake Level Variability**

**Cosponsors:** *GSA Limnogeology Division; GSA Sedimentary Geology Division; American Quaternary Association (AMQUA); SEPM (Society for Sedimentary Geology); Paleontological Society*

**Disciplines:** Limnogeology, Stratigraphy, Paleoclimatology/Paleoceanography

**Advocates:** Scott W. Starratt; Bryan N. Shuman; Julie Loisel

Lake level variability is a response to climate variability and human modification of the environment. This session seeks

presentations that explore evidence for lake level change using a variety of physical and biological proxies.

**T98. Windows into the Crust: Paleo-Earthquake Records from Lacustrine Sediments**

**Cosponsors:** *GSA Limnogeology Division; GSA Sedimentary Geology Division; GSA Quaternary Geology and Geomorphology Division; GSA Structural Geology and Tectonics Division*

**Disciplines:** Limnogeology, Sediments, Clastic, Quaternary Geology

**Advocates:** Elana L. Leithold; Karl W. Wegmann; Darren Larsen

Lakes can record past earthquakes through the accumulation and preservation of distinct sedimentary deposits. We encourage research highlighting the latest techniques, common challenges, and success stories as applied to lacustrine paleo-seismology and related hazards.

**GEOSCIENCE EDUCATION****T99. Augmented and Virtual Reality in Geoscience Education**

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

**Disciplines:** Geoscience Education, Geoscience Information/Communication, Geoinformatics

**Advocates:** Rachel M. Atkins; Christine M. Clark; Shelley J. Whitmeyer

Handheld and immersive augmented and virtual reality experiences make it easier to bring more realistic, engaging experiences into our classrooms. This session will explore teaching and research applications using augmented reality (AR) and virtual reality (VR).

**T100. Barriers, Misconceptions, and Progress in Improving Climate Literacy and Strategies for Communicating about Climate Change**

**Cosponsors:** *GSA Geoscience Education Division; National Association of Geoscience Teachers, Division of Geoscience Education Research (NAGT-GER); National Association of Geoscience Teachers; Climate Literacy Network (CLEAN); GSA Geology and Society Division*

**Disciplines:** Geoscience Education, Geoscience Information/Communication, Geoscience and Public Policy

**Advocates:** Anne U. Gold; Mona Behl; Bonnie Murray

The session will focus on research and evaluation of climate literacy efforts, effective ways of communicating about climate change in general, but also in culturally relevant contexts.

**T101. Better Together: Partnerships That Facilitate or Enhance Experiential Learning in Undergraduate Geoscience Education**

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

**Disciplines:** Geoscience Education, Geoscience Information/Communication

**Advocates:** Miriam Barquero-Molina; Jonathan W. Mies

A showcase of partnerships, consortiums, and collaborations that help to overcome the challenges of providing experiential learning (student research, student service, and domestic and study-abroad field courses) in geoscience programs.

**T102. Beyond the Road-Cut: Virtual, Local, and Nontraditional “Field” Teaching and Learning Experiences**

**Disciplines:** Geoscience Education, Geoscience Information/Communication

**Advocates:** Lauren Neitzke Adamo; Kelsey S. Bitting; Patricia Irizarry-Barreto

Virtual exploration, museum-based assignments, and analysis of geoscience on campus can be more inclusive ways to enhance students’ conceptual learning and motivation. This session welcomes presentations describing nontraditional “field” experiences and evidence of their effectiveness.

**T103. Broadening The Field: Traditional Ecological Knowledge in Geoscience**

**Cosponsors:** *GSA Geoscience Education Division; GSA Diversity in the Geosciences Committee*

**Disciplines:** Geoscience Education, Geoscience Information/Communication, Environmental Geoscience

**Advocates:** Darryl Reano; Holly Pellerin; Wendy Smythe

This session focuses on coupling traditional ecological knowledge with geoscience, by providing examples of successful programs that work with various stakeholders to develop and implement culturally relevant geoscience training and curriculum within Indigenous communities.

**T104. Broader Impacts Activities as Vehicles for Filling the Geoscience Pipeline (Posters)**

**Cosponsor:** *GSA Geoscience Education Division*

**Disciplines:** Geoscience Education, Geoscience and Public Policy

**Advocates:** Michelle K. Hall; Michael Mayhew; Sharon Locke

This session will explore effective broader impact activities and recruitment strategies at the high school and early undergraduate college levels that may be effective in increasing engagement with the geosciences.

**T105. Building an Inclusive Geoscience Community Today for Tomorrow**

**Cosponsors:** *GSA Geoscience Education Division; GSA Diversity in the Geosciences Committee; National Association of Black Geoscientists*

**Disciplines:** Geoscience Education, Geoscience and Public Policy, Geoscience Information/Communication

**Advocates:** Stephen K. Boss; Aisha R. Morris; Sadredin C. Moosavi

This session examines diversity in the geosciences today relative to the inclusive geoscience community reflective of all of society the future portends. Presentations explore successful strategies for eliminating barriers against and building bridges to inclusion.

**T106. Climate Literacy in Formal and Informal Education, for Policy Makers and the Public**

**Cosponsors:** *GSA Geoscience Education Division; National Association of Geoscience Teachers; Climate Literacy Network (CLEAN); GSA Geology and Society Division*

**Disciplines:** Geoscience Education, Geoscience and Public Policy, Geoscience Information/Communication

**Advocates:** Anne Gold; Don Duggan-Haas; Carey Stanton; Larissa Johnson

The session will focus on activities in formal and informal education, and engagement with decision makers, networks, and the public that can extend the reach and effectiveness of climate literacy efforts.

**T107. Contextualized Epistemological Study of Funds of Knowledge and Natural Phenomena: Developing a Third Space for Student Success in Science (Posters)**

**Disciplines:** Geoscience Education, Environmental Geoscience, History and Philosophy of Geology

**Advocate:** Rosemary A. Millham

Identifying and integrating Funds of Knowledge in science teaching and learning can provide a foundation for building learning environments focused on equity and social justice while preserving students’ individual beliefs.

**T108. EarthCache: Engaging Students and the Public in Geoscience Education, Communication, and Outreach**

**Cosponsor:** *National Association of Geoscience Teachers*

**Disciplines:** Geoscience Education, Geoscience Information/Communication, Geoscience and Public Policy

**Advocates:** Matthew Dawson; Charles W. Carrigan

The EarthCache program is a partnership between GSA and Geocaching.com. This session explores how geoscience educators can use EarthCache sites to engage with students and the public for geoscience education, communication, and outreach.

**T109. Eat It! Using Food to Adapt Mental Models in Teaching Introductory Geoscience Education**

**Cosponsor:** *GSA Geoscience Education Division*

**Disciplines:** Geoscience Education, Geoscience Information/Communication

**Advocate:** Mindy A. Kimball

Geoscience educators often use food as a visual or conceptual model to increase cognition in introductory courses. This session encourages presentations of effective, unique, or failed food-based teaching tools.

**T110. Engaging Students through Course-Based Undergraduate Research Experiences (CURE) across the Geoscience Curriculum**

**Cosponsors:** *GSA Geoscience Education Division; Council on Undergraduate Research Geosciences Division*

**Discipline:** Geoscience Education

**Advocates:** James H. MacDonald Jr.; Jeffrey G. Ryan; Rosemary Hickey-Vargas; Mary A. Beck; Chris Vidito; Sven Holbik

Course-based undergraduate research experiences (CURE) is a proven method to provide large numbers of students the benefits of research. Presentations from CUREs across the undergraduate curriculum, and from lower to upper division courses, are encouraged.



**T111. Geology and Hydrology in the National Parks: Research, Mapping, and Resource Management**

**Cosponsors:** *GSA Hydrogeology Division; GSA Environmental and Engineering Geology Division*

**Disciplines:** Geoscience Education, Hydrogeology, Geoscience Information/Communication

**Advocates:** Jason P. Kenworthy; F. Edwin Harvey

This session addresses the roles of geology and hydrology in national parks. We encourage presentations on geologic and hydrologic research, paleontology, past research experience, and geologic and water resource management in units of the U.S. National Park System.

**T112. Geoscience Education at Two-Year Colleges**

**Cosponsors:** *GSA Geoscience Education Division; GSA Geology and Society Division; International Association for Geoscience Diversity; National Association of Geoscience Teachers; National Association of Geoscience Teachers Geo2YC Division; National Earth Science Teachers Association*

**Disciplines:** Geoscience Education, Geoscience Information/Communication, Geoscience and Public Policy

**Advocates:** Brett S. Dooley; Callan Bentley; Wendi J.W. Williams

Two-year colleges (2YCs) are important to diverse and inclusive geoscience workforce recruitment and retention of student populations pursuing STEM and teaching degrees. This session will showcase strategies, curriculum, and partnerships.

**T113. Geoscience Education Research: Implications for Undergraduate Geoscience Teaching and Learning**

**Cosponsors:** *National Association of Geoscience Teachers; GSA Geoscience Education Division; National Association of Geoscience Teachers, Division of Geoscience Education Research (NAGT-GER)*

**Disciplines:** Geoscience Education, Geoscience Information/Communication

**Advocates:** Kristen St. John; Karen McNeal; Anne Gold; Katherine Ryker

This session highlights how GER findings can be translated into teaching and identifying future directions for research with the broader geoscience community. Specific topics may include active learning, teaching with technology/modeling, diversity, and interdisciplinary collaborations.

**T114. Getting It Done: Experiences of Implementing the Framework and NGSS in Earth and Space Science**

**Discipline:** Geoscience Education

**Advocates:** Aida Awad; Ed C. Robeck; Susan Sullivan

The geoscience education community has taken action to implement the Framework for K–12 Science Education and the Next Generation Science Standards (NGSS). This session will share case studies, lessons learned, and personal reflections of implementation efforts, even unvarnished ones.

**T115. Hands-On Teaching Demonstrations that Combine Geoscience and Societal Issues: Audience Participation Requested!**

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

**Disciplines:** Geoscience Education, Environmental Geoscience

**Advocates:** Elizabeth A. Nagy-Shadman; Anne E. Egger

This is a geoscience education session that practices what it preaches. Authors present micro-demonstrations of effective teaching activities that integrate geoscience content with societal concerns. Presentations include audience participation, assessment results, and reflections on effectiveness.

**T116. How to Engage Pre-Service Teachers in Authentic NGSS-Aligned Learning in Undergraduate Geology Classrooms**

**Cosponsor:** *GSA Geoscience Education Division*

**Discipline:** Geoscience Education

**Advocate:** Susan M. DeBari

This session seeks to explore the ways that 2- and 4-year colleges and universities provide learning experiences in geoscience classrooms for future teachers. We seek presentations that provide best practices and can share measurable outcomes.



**T117. Innovation and Collaboration Supporting Undergraduates**

**Cosponsors:** *Council on Undergraduate Research Geosciences Division; National Association of Geoscience Teachers*

**Discipline:** Geoscience Education

**Advocates:** Sarah K. Fortner; Elizabeth Heise; Jennifer C. Latimer

We seek broad examples of service learning (e.g., outreach, social media engagement, science advocacy, community-based or campus research, and collaboration with non-profits, artists, and businesses). Approaches that serve diverse students and institutional settings are welcome.

**T118. Integration of Field and Laboratory-Based Experience toward Designing Pedagogically Sound Curriculum Enhancement Activities in the Geosciences (Posters)**

**Cosponsors:** *GSA Hydrogeology Division; GSA Sedimentary Geology Division; National Association of Geoscience Teachers; American Institute of Professional Geologists; GSA Environmental and Engineering Geology Division; GSA Geoscience Education Division; National Earth Science Teachers Association; GSA Quaternary Geology and Geomorphology Division; Council on Undergraduate Research Geosciences Division*

**Disciplines:** Geoscience Education, Geoscience Information/Communication, Geoscience and Public Policy

**Advocates:** Nazrul I. Khandaker; Arif M. Sikder; Stanley Schleifer

Classroom knowledge becomes understandable, relevant, and meaningful through field- and data-based information obtained through the infusion of technology, in particular, as related to sediment composition, discrete mineral phase, micro-fabric, structural anisotropy, etc. K9–16 students are highly encouraged to share their research experience.

**T119. International Field Experiences in the Digital Age, from Introductory Field Trips to Capstone Courses**

**Cosponsors:** *GSA Geoscience Education Division; GSA Geoinformatics Division; GSA Hydrogeology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Quaternary Geology and Geomorphology Division; GSA Sedimentary Geology Division; International Association for Geoscience Diversity; GSA Structural Geology and Tectonics Division*

**Disciplines:** Geoscience Education, Structural Geology, Tectonics/Tectonophysics

**Advocates:** Steven J. Whitmeyer; Ivan G. Carabajal; Martin Feely; Anita M. Marshall; Eric J. Pyle

International field experiences provide an enhanced educational experience by coupling unfamiliar geology with cultural diversity. This session will feature international field experiences that incorporate modern curricula, digital technologies, and approaches that enhance diversity and inclusion.

**T120. Making Thinking Visible: Actions and Expressions of Problem Solving and Decision Making in the Geosciences**

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

**Discipline:** Geoscience Education

**Advocates:** Eric M. Riggs; Lauren N. Holder; Angela Van Boening

This session presents evidence-based studies that aim to make thinking visible in order to understand geologic problem solving. We encourage rigorous research investigating approaches and techniques to externalize, document, and understand geologic thinking and cognition.

**T121. Natural History Museums in the 21st Century—Programming for the Future While Preserving the Past**

**Cosponsors:** *GSA Geoscience Education Division; Paleontological Society; GSA Geoinformatics Division*

**Disciplines:** Geoscience Education, Geoscience Information/Communication, Geoinformatics

**Advocates:** Lisa D. White; Caroline A.E. Stromberg; Gregory P. Wilson; Elizabeth A. Nesbitt

The role of museums in geoscience continues to evolve. This session will bring together scientists and educators to highlight the importance of natural history museums in cutting-edge research, education, and outreach to diverse audiences.

**T122. On the Cutting Edge: Fifteen Years of Impacts on Geoscience Education**

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

**Discipline:** Geoscience Education

**Advocates:** David W. Mogk; Heather Macdonald; Michael E. Wysession

This session requests contributions from geoscience educators who contributed to, or benefitted from, the *On the Cutting Edge* program, with a focus on impacts on faculty professional development, courses and curricula, assessments, student success, and diversity.

**T123. Pedagogical Applications of Point Cloud Collection and Manipulation (Posters)**

**Cosponsors:** *GSA Geoscience Education Division; UNAVCO; GSA Geoinformatics Division*

**Discipline:** Geoscience Education

**Advocates:** Jeffrey Clark; Leslie Hasbargen; Beth Pratt-Sitaula

Instructional settings present unique constraints and opportunities for the use of point cloud data. Participants will share their experiences with point cloud data collection and manipulation in the service of both topical and STEM educational objectives.

**T124. Practical Advice for In-Service and Pre-Service K–12 Earth Science Teacher Preparation and Professional Development**

**Cosponsors:** *National Earth Science Teachers Association; National Association of Geoscience Teachers, Teacher Education Division*

**Discipline:** Geoscience Education

**Advocates:** Suzanne T. Metlay; Belinda E. Jacobs; Carla McAuliffe; Sadredin C. Moosavi

K–12 earth sciences teachers, informal educators, professional development providers, and teacher preparation faculty discuss successful strategies to address teacher needs resulting from revised state science standards, NGSS, and Framework implementation nationwide.

**T125. Preparing the Next Generation of Geoscience Educators: Research on Teacher Education**

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

**Discipline:** Geoscience Education

**Advocates:** Heather L. Petcovic; Katherine Ryker

This session highlights research on current and future geoscience teacher attitudes, beliefs, knowledge, and practices across K–12 and higher education, including research on the preparation of teaching assistants and future faculty.

**T126. Professional Development Locally to Achieve Earth Science Literacy Globally: Successful Models of K–12 Teacher Professional Development Ready for Emulation in New Environments (Posters)**

**Cosponsors:** *GSA Geoscience Education Division; National Association of Geoscience Teachers; National Earth Science Teachers Association; American Geophysical Institute*

**Disciplines:** Geoscience Education, Geoscience Information/Communication, Geoscience and Public Policy

**Advocate:** Sadredin C. Moosavi

This session seeks to showcase successful K–12 earth-science teacher professional-development programs that can serve as models for use in new, underserved environments using local GSA members' talents and community/industry resources.

**T127. Supporting Geoscience Student Transfer between Institutions and Transitions into the Workforce: Pathways to Success**

**Cosponsors:** *GSA Geology and Society Division; GSA Geoscience Education Division; National Association of Geoscience Teachers; National Association of Geoscience Teachers Geo2YC Division*

**Disciplines:** Geoscience Education, Geoscience and Public Policy, Geoscience Information/Communication

**Advocates:** Norlene R. Emerson; Eric M.D. Baer; Allan Ludman

Topics might include cross-institutional collaborations including recruitment, undergraduate research, field trips, and 2YC–4YCU faculty interactions; GEOPATHS or bridge programs, advising/support strategies; career development and preparation; research on transfer; and/or impact on broadening access.

**T128. Teaching about the Earth Online**

**Discipline:** Geoscience Education

**Advocates:** Timothy J. Bralower; Ariel D. Anbar; Jonathan H. Tomkin

This session will focus on strategies to develop modern online courses including effective assessment, application of active learning including large datasets, integration of systems thinking, teaching at scale, and interdisciplinary courses.

**T129. The Challenge of Defining Student Success: Broadening Participation, Measuring Success, and Preparing 2YC and 4YC Students for a Variety of Transitions**

**Cosponsors:** *National Association of Geoscience Teachers; GSA Geoscience Education Division; National Association of Geoscience Teachers Geo2YC Division*

**Discipline:** Geoscience Education

**Advocates:** Katrien J. van der Hoeven Kraft; Peter J. Berquist; Joshua Villalobos

“Student success” is a core principle throughout academia, yet there is no one-size-fits-all approach. This session seeks presentations from individuals, institutions, and organizations that have attempted novel approaches to ensure the success of all students.

**T130. The Other Two Dimensions of NGSS: Science and Engineering Practices and Cross-Cutting Concepts in Support of Earth Science Teacher Education**

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

**Disciplines:** Geoscience Education, Geoscience Information/Communication, Geoscience and Public Policy

**Advocate:** Eric J. Pyle

This session highlights how science and engineering practices unique to earth science and cross-cutting concepts reinforce disciplinary content ideas to advance earth science in K–12 through the NGSS in teacher preparation and professional development.

**T131. Translating Professional Development Experiences into the Classroom**

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

**Discipline:** Geoscience Education

**Advocates:** Megan H. Jones; Jacquelyn Hams; Richard M. Jones

Professional development aims to share knowledge and skills with faculty, expecting that they bring their experiences into their classrooms. We welcome examples of faculty adaptations, new instructional methods, or curriculum inspired by professional development experiences.

**T132. Undergraduate Research Posters Showcasing Research by 2YC and 4YCU Geoscience Students (Posters)**

**Cosponsors:** *GSA Geoscience Education Division; National Association of Geoscience Teachers; National Association of Geoscience Teachers Geo2YC Division; International Association for Geoscience Diversity*

**Disciplines:** Geoscience Education, Geoscience Information/Communication

**Advocates:** Gretchen L. Miller; Adrienne A. Leinbach; Stephanie M. Rollins

This session is designed for two-year college (2YC) and four-year college and university (4YCU) students presenting research in any sub-discipline of geoscience. Projects supported by NSF's Improving Undergraduate STEM Education program (IUSE) are encouraged.

**T133. Victor Porter Memorial Session—Climbing out of the Fishbowl: Hands-On Public Engagement in the Geosciences**

**Cosponsor:** *GSA Geoscience Education Division*

**Disciplines:** Geoscience Education, Geoscience Information/Communication

**Advocates:** Bryan W. Turner; Matthew T. Mossbrucker; Robert T. Bakker

Museums, libraries, parks and monuments, and public lectures are critical supplements to universities for engaging and involving the general public in STEM fields. This session highlights approaches to foster public participation with the geosciences.

**GEOSCIENCE INFORMATION/COMMUNICATION**

**T134. Cascadia Disaster Resilience: Building Geohazard Literacy and Risk Awareness in Decision Makers and the Public**

**Cosponsors:** *GSA Geology and Public Policy Committee; GSA Geology and Society Division*

**Disciplines:** Geoscience Information/Communication, Geoscience and Public Policy, Geoscience Education

**Advocates:** Monica E. Gowan; John Clague

This session seeks contributions on interdisciplinary approaches for effective risk messaging on Cascadia subduction zone geohazards. Examples of hazard education and disaster resilience strategies, as well as from other geohazards and regions, are also encouraged.

**T135. Comedy in the Geosciences (Posters)**

**Cosponsor:** *GSA Geology and Society Division*

**Disciplines:** Geoscience Information/Communication, Geoscience Education

**Advocates:** Anthony D. Feig; Timothy A. Bennett-Huxtable

Exhibition of sketch, radioplay, and standup comedy with geoscientific themes. Comedic takes on teaching, research, current events, and politics related to the discipline. Performances may also include humorous storytelling, songs, and classroom teaching examples.

**T136. Discovery and Preservation of Geoscience Data and Information Resources**

**Cosponsors:** *Geoscience Information Society; GSA Geoinformatics Division; GSA Environmental and Engineering Geology Division; GSA Energy Geology Division*

**Disciplines:** Geoscience Information/Communication, Geoinformatics, Geoscience Education

**Advocate:** Chris Badurek

This session addresses access to geoscience publications, data in repositories related to publishing, and discovery of geoscience research data resources spanning mapped to remotely sensed imagery.

**T137. Geoheritage Matters (Posters)**

**Cosponsor:** *GSA Geology and Society Division*

**Disciplines:** Geoscience Information/Communication, Geoscience Education, Geoscience and Public Policy

**Advocates:** Erika C. Vye; Terri L. Cook; Benjamin van Wyk de Vries

Geoheritage, the valuation and protection of geological features and landscapes, has strong community outreach potential. The session will explore a broad variety of geoheritage-related topics, such as geoeducation, economic opportunities, and geoconservation.

**T138. Geology Rocks! A Musical Session on the Sounds of Science (Posters)**

**Cosponsor:** *GSA Geology and Society Division*

**Disciplines:** Geoscience Information/Communication, Geoscience Education, History and Philosophy of Geology

**Advocates:** Nicholas A. Sutfin; Jennifer L. Pierce

Have you written songs or poems with a geologic theme or thought of alternate, quirky lyrics? We encourage abstracts to perform spoken word or music of geologic concepts in this non-traditional session.

**T139. LiDAR Programs: Data Collection, Data Sharing, and Applications**

**Cosponsors:** *GSA Geoinformatics Division; Washington Division of Geology and Earth Resources; GSA Environmental and Engineering Geology Division*

**Disciplines:** Geoscience Information/Communication, Geoscience and Public Policy, Geoinformatics

**Advocates:** Abigail Gleason; Tom Carlson

LiDAR data are fast becoming essential to geologic mapping and research. This session will cover ways agencies are working to collect and provide that data as well as some unique applications.

**T140. New Tools in the Geologist's Toolbelt: Using Technology to Educate and Inspire Others about Geology**

**Cosponsors:** *Washington Division of Geology and Earth Resources; GSA Environmental and Engineering Geology Division*

**Disciplines:** Geoscience Information/Communication, Geoscience Education, History and Philosophy of Geology

**Advocate:** Dave Norman

Expanding capabilities in technology—interactive portals, web scripts, mobile apps, social media, video, UAVs—create effective platforms by which geologists may share geologic information with both their peers and the uninitiated.

**T141. Use of Geoscience Data and Information Resources in Education and Research (Posters)**

**Cosponsors:** *Geoscience Information Society; GSA Geoinformatics Division*

**Disciplines:** Geoscience Information/Communication, Geoscience Education, Geoinformatics

**Advocate:** Chris Badurek

This poster session examines the effective use of geoscience data and information resources in successful teaching or research activities.

**T142. What Lies Beneath: How to Build Digital Datasets and Visualize Subsurface Geology through GIS and 3D Modeling**

**Cosponsors:** *GSA Geoinformatics Division; Washington Division of Geology and Earth Resources; GSA Hydrogeology Division; GSA Environmental and Engineering Geology Division*

**Disciplines:** Geoscience Information/Communication, Geoinformatics, Engineering Geology

**Advocates:** Daniel W. Eungard; Kathy Goetz Troost

This session seeks to provide a forum in which geologists, GIS experts, and non-specialists can share experiences creating, distributing, and interpreting subsurface geologic datasets and concepts through 3D models and other tools.

**GEOINFORMATICS****T143. Curating Physical Samples in a Digital World**

**Cosponsors:** *GSA Geoinformatics Division; Paleontological Society; Society for the Preservation of Natural History Collections; Paleontological Research Institution; Cushman Foundation; Geobiology and Geomicrobiology Division; Association of American State Geologists*

**Discipline:** Geoinformatics

**Advocates:** Leslie Hsu; Megan Carter; Anders J. Noren; Lesley A.I. Wyborn

Physical samples, such as cores, fossils, and water, have unique challenges for data stewardship because they are difficult, if not impossible, to fully digitize. We will explore challenges and solutions for digitally curating physical samples.

**T144. Drones in Geoscience (Posters)**

**Cosponsors:** *GSA Environmental and Engineering Geology Division; GSA Sedimentary Geology Division*

**Disciplines:** Geoinformatics, Engineering Geology, Geomorphology

**Advocate:** James Robert Van Eerden

Drones are an increasingly accessible research tool for geoscience professionals. Learn how teams have successfully integrated drones into their research tool kit.

**T145. Geologic Maps and Their Derivatives (Posters)**

**Cosponsors:** *Association of American State Geologists; GSA Hydrogeology Division; GSA Environmental and Engineering Geology Division*

**Disciplines:** Geoinformatics, Hydrogeology, Structural Geology

**Advocates:** Richard Berg; Harvey Thorleifson

This poster session will highlight new geologic maps, mapping programs, and innovations in geological mapping, including data management, web accessibility, 3-D, and applications in water and land management.

**T146. Unmanned Aerial Vehicles and Their Use in Geologic Reconnaissance—Round 2 (Posters)**

**Cosponsors:** *GSA Environmental and Engineering Geology Division; GSA Geoinformatics Division*

**Disciplines:** Geoinformatics, Engineering Geology, Geoscience Education

**Advocates:** Thomas L. Rice; Stephen L. Slaughter; Thad A. Wasklewicz; Jessica E. Witt; Denise J. Hills

This session will highlight the burgeoning development of UAV/UAS (drone) platforms and sensors that can be utilized in geologic reconnaissance, especially in natural resource and natural hazards assessments. This is a follow-up on the 2015 session.

**T147. What Can You Do with Geoinformatics?**

**Cosponsors:** *GSA Geoinformatics Division; Geoscience Information Society; American Geosciences Institute; American Geophysical Union; GSA Environmental and Engineering Geology Division; GSA Geoscience Education Division; GSA Karst Division; Association of American State Geologists*

**Disciplines:** Geoinformatics, Geoscience Education, Geoscience and Public Policy

**Advocates:** Denise J. Hills; Chris Badurek; Christopher Keane; Shelley Stall

Many geoscientists are unfamiliar with geoinformatics, which integrates different disciplines and technologies to enable transformation of data into knowledge for geoscience. Careers in and applications of geoinformatics will be highlighted.

**ECONOMIC GEOLOGY****§ T148. System-Scale Zonation of Ore Systems: Insights into 3D Architecture from Lateral and Deep Exposures Due to Mining and Structural Deformation**

**Cosponsors:** *GSA Structural Geology and Tectonics Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; Society of Economic Geologists*

**Disciplines:** Economic Geology, Geochemistry, Structural Geology

**Advocates:** Carson A. Richardson; Simone E. Runyon; Eric Seedorff

This session focuses on recent advances in the understanding of the genesis and evolution of magmatic-hydrothermal systems and ore deposits from three-dimensional exposures due to deformation (e.g., normal faulting and tilting), drilling, and mining.

**GEOCHEMISTRY****T149. Celebrating Dr. John W. Valley's Contributions to Isotope Geochemistry and Beyond, from the Hadean to the Holocene**

**Cosponsors:** *GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Planetary Geology Division; Mineralogical Society of America; Geochemical Society; Microanalysis Society; GSA Sedimentary Geology Division*

**Disciplines:** Geochemistry, Petrology, Igneous, Petrology, Metamorphic

**Advocates:** Aaron J. Cavosie; Jade Star Lackey; William H. Peck

We seek contributions highlighting the illustrious and ongoing career of Dr. John W. Valley, who has advanced applications of isotope geochemistry in igneous, metamorphic, and sedimentary petrology, planetary science, paleoclimatology, gemology, astrobiology, and other disciplines.

**§ T150. Chemical Scene Investigations of Large Igneous Provinces II**

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

**Disciplines:** Geochemistry, Petrology, Igneous, Economic Geology

**Advocates:** Cole G. Kingsbury; Richard E. Ernst

We request abstracts that seek to investigate and fingerprint the geochemical characteristics of Large Igneous Provinces (LIPs) in order to determine, based on "forensics," the chemical processes that affect LIPs worldwide.

**§ T151. Consequences of Fluids in Subduction Zones: From Grain Scale to Plate Boundary Shear Zone**

**Cosponsor:** *GSA Hydrogeology Division*

**Disciplines:** Geochemistry, Tectonics/Tectonophysics, Geophysics/Geodynamics

**Advocates:** Alissa Kotowski; Evan J. Ramos; Thomas M. Etzel; Carolyn Tewksbury-Christle

Fluids contribute to subduction zone complexity by dynamically weakening rocks, transferring fluid-mobile elements, and influencing seismic cycles. Our session seeks geologic, geochemical, geophysical, or other studies of fluids and how they impact subduction through time/space.

**§ T152. Fluids and Melts in Geologic Systems**

**Disciplines:** Geochemistry, Petrology, Igneous, Economic Geology

**Advocates:** Pilar Lecumberri-Sanchez; Matthew Steele-MacInnis; András Fall; Rosario Esposito

Geochemical processes are commonly related, with fluid-fluid and fluid-rock interaction. This session will focus on the physicochemical evolution of melts and fluids in relationship with processes such as magmatic degassing, ore deposit formation, and oil migration.

**T153. Geochemical and Petrologic Forensics in the Study of Earth's Magmatism: A Tribute to the Distinguished Career of Jon Davidson (1959–2016)**

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

**Disciplines:** Geochemistry, Petrology, Igneous, Volcanology

**Advocates:** Shanaka de Silva; James Beard; Marjorie Wilson; Valbone Memeti; John A. Wolff

This session honors Jon Davidson as the recipient of the 2017 Distinguished Career Mineralogy, Geochemistry, Petrology, and Volcanology (MGPV) Award. Contributions are welcomed that celebrate Jon and his influence on our understanding of Earth's magmatism.

**T154. Imaging the Rock and Fluid Interactions of Geologic Carbon Sequestration**

**Cosponsors:** *GSA Hydrogeology Division; GSA Energy Geology Division; GSA Environmental and Engineering Geology Division*

**Disciplines:** Geochemistry, Hydrogeology, Mineralogy/Crystallography

**Advocates:** Laura E. Dalton; Dustin Crandall; Jennifer Druhan; Brian R. Ellis; Thomas McGuire

This session aims to exemplify how various imaging techniques can be applied to further our understanding of geochemical interactions and multiphase flow characterization in geologic carbon sequestration settings.

**T155. Improvements and Challenges in Geochronology: Organizing the Past while Planning for the Future**

**Discipline:** Geochemistry

**Advocates:** Andrew F. Parisi; Elizabeth J. Catlos

This section seeks papers examining the advancements in geochronological techniques and the challenges still to be overcome, accepting talks about new techniques being investigated, refinement of established analytical protocol, or issues encountered when performing analyses.

### T156. Into the Isotope Future: Applications and Method Development for Mineral and Fluid Carbonate Analysis with Infrared Stable Isotope Analyzers

**Cosponsor:** *GSA Environmental and Engineering Geology Division; GSA Karst Division*

**Disciplines:** Geochemistry, Economic Geology, Environmental Geoscience

**Advocates:** Gregory M. Dipple; Shaun L.L. Barker

We encourage contributions outlining novel applications and methods for using infrared analyzers to make stable isotope measurements on CO<sub>2</sub> liberated from carbonate minerals and waters, or H<sub>2</sub>O liberated from minerals.

### T157. Origin and Evolution of the Continental Crust: A Celebration of the Career of Paul Mueller

**Cosponsors:** *GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Structural Geology and Tectonics Division*

**Disciplines:** Geochemistry, Precambrian Geology, Tectonics/Tectonophysics

**Advocates:** David W. Mogk; David A. Foster; Robert Stern

Contributions are encouraged to celebrate the impacts made by Paul Mueller toward understanding the genesis and evolution of continental crust and tectonic assembly of Laurentia using the tools of geochronology, isotopic geochemistry, and whole-rock geochemistry.

## MINERALOGY/CRYSTALLOGRAPHY

### T158. Gemological Research in the 21st Century—Characterization, Exploration, and Geological Significance of Diamonds and other Gem Minerals

**Cosponsor:** *Gemological Institute of America*

**Disciplines:** Mineralogy/Crystallography, Economic Geology, Geoscience Information/Communication

**Advocates:** Caroline Nelms; James E. Shigley; Dona Dirlam; Wuyi Wang; Barbara L. Dutrow; Rodney C. Ewing; Jeffrey E. Post; Steven B. Shirey; William B. Simmons; John Valley; Lee A. Groat

Gemstones are the most recognized and highly valued of all minerals. This session focuses on aspects of gems including exploration, formation conditions, properties, means of identification, and intrinsic research value to understanding Earth's geologic evolution.

### T159. Teasing New Information out of (Old) Zircon: In Honor of Dustin Trail, 2017 MSA Award Recipient

**Cosponsors:** *Mineralogical Society of America; Collaborative for Research in Origins (CRiO), the John Templeton Foundation—FfAME Origins Program*

**Disciplines:** Mineralogy/Crystallography, Geochemistry, Petrology, Igneous

**Advocates:** Stephen J. Mojzsis; E. Bruce Watson; Calvin F. Miller; T. Mark Harrison

This session explores zircon-based advances in understanding of earth history and earth processes. Novel approaches involving a wide range of techniques; elemental and isotopic geochemistry, geochronology, textural and crystallographic studies, and others will be emphasized.

## PETROLOGY, IGNEOUS/METAMORPHIC

### T160. Coupled Evolution of Magmatic and Sedimentary Systems

**Cosponsor:** *GSA Sedimentary Geology Division*

**Disciplines:** Petrology, Igneous, Sediments, Clastic, Volcanology

**Advocates:** Amy L. Weislogel; Joshua J. Schwartz

This session encourages igneous and sedimentary petrologists to examine the temporal relationships and spatial patterns of coupled magmatic systems and associated sedimentary basins through single-crystal geochronologic data sets.

### T161. Petrology across the Inner Solar System: In Honor of Roebling Medalist Ed Stolper

**Cosponsors:** *Mineralogical Society of America; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Planetary Geology Division*

**Disciplines:** Petrology, Igneous, Planetary Geology, Mineralogy/Crystallography

**Advocates:** Paul D. Asimow; Harry Y. McSween Jr.

A special session to honor Edward Stolper, 2017 MSA Roebling Medalist, welcomes contributions exploring the ongoing influence of Ed's work throughout the petrology, geochemistry, and volcanology of Earth, Moon, Mars, and meteorite parent bodies.

### \$ T162. The Dance of Arcs: Causes of Arc Migrations, Flare-Ups, and Magmatic Focusing

**Cosponsors:** *GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Structural Geology and Tectonics Division*

**Disciplines:** Petrology, Igneous, Geochemistry, Tectonics/Tectonophysics

**Advocates:** Scott R. Paterson; Vali Memeti; Joshua Schwartz; Katie E. Ardill; Anita Grunder

This session explores the dynamic behaviors of magmatic arcs through time. We seek contributions on the spatial, temporal, and geochemical evolution of arcs and modeling investigating the causes of arc migrations, flare-ups, and internal magma focusing.

### \$ T163. Petrochronology: Advances and Applications to Petrogenesis and Tectonics

**Cosponsors:** *GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Structural Geology and Tectonics Division; Mineralogical Society of America; Geochemical Society*

**Disciplines:** Petrology, Metamorphic, Petrology, Igneous, Tectonics/Tectonophysics

**Advocates:** Matthew J. Kohn; Pierre Lanari; Martin Engi

This session welcomes advances in understanding petrogenesis, orogenesis, and/or crustal growth made using combined petrologic and geochronologic analysis of accessory and major minerals. Contributions could include analytical methods and studies ranging from (sub)grains to orogens.

**\$ T164. The Role of Sediments in Continental Magmatic Arcs: Rheologic, Petrologic, and Geochemical Evidence from the Upper Mantle to Erupted Lavas**

**Cosponsors:** *GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Structural Geology and Tectonics Division; Future of Tectonics Initiative*

**Disciplines:** Petrology, Metamorphic, Petrology, Igneous, Tectonics/Tectonophysics

**Advocates:** Kirsten B. Sauer; Barbara C. Ratschbacher

This broad session welcomes abstracts from arc systems worldwide on topics including mechanisms and time scales of sediment incorporation, rheologic consequences of sediments at all crustal levels, and magma-generating processes from surface to the subducting slab.

**VOLCANOLOGY**

**T165. Recent Advances in Understanding Volcanism of the Yellowstone Hotspot**

**Disciplines:** Volcanology, Petrology, Igneous, Geochemistry

**Advocates:** Arron R. Steiner; John A. Wolff; Martin J. Streck

This session will focus on volcanic activity associated with the Yellowstone hotspot centralizing on timing and extent, timescales of magma formation, Oligocene precursor eruptions, magma dynamics including crustal melts, and crustal modification.

**HISTORY AND PHILOSOPHY OF GEOLOGY**

**T166. Great Maps in the History of Geology**

**Cosponsors:** *GSA History and Philosophy of Geology Division; GSA Planetary Geology Division; GSA Quaternary Geology and Geomorphology Division; GSA Structural Geology and Tectonics Division; History of Earth Sciences Society (HESS)*

**Discipline:** History and Philosophy of Geology

**Advocates:** Dorothy Sack; Renee M. Clary

Maps are conceptual and visual communication tools fundamental to geology. This session examines the role that maps have played in the history of geology by exploring the notion of what makes a map great.



**T167. The History of the Petroleum Industry: Hydraulic Fracturing—The 20th and 21st Centuries**

**Cosponsors:** *GSA History and Philosophy of Geology Division; GSA Energy Geology Division; History of Earth Sciences Society (HESS); GSA Hydrogeology Division; GSA Environmental and Engineering Geology Division; History of the Geoscience Section of the Geological Society of Italy*

**Disciplines:** History and Philosophy of Geology, Energy Geology, Hydrogeology

**Advocates:** Francesco Gerali; William R. Brice

For this session, practitioners from academia and industry are encouraged to present papers on the history of hydraulic fracturing, which will contribute to an updating of the oil historiography.

**SOILS**

**T168. Advances in Terrestrial Paleoclimate Reconstructions Using Paleosols**

**Cosponsors:** *GSA Sedimentary Geology Division; GSA Soils and Soil Processes Interdisciplinary Interest Group*

**Disciplines:** Soils, Paleoclimatology/Paleoceanography, Geochemistry

**Advocates:** Rebecca M. Dzombak; Emily J. Beverly; Daniel P. Maxbauer; Gary E. Stinchcomb

This session focuses on developments and methodological applications of terrestrial paleoclimate reconstruction using paleosol-based proxies. Studies using alternative isotopic methods, novel techniques for characterizing iron oxide mineralogy, and addressing uncertainty in paleosol proxies are encouraged.

**T169. Deciphering Climate Change and Climate Variability in the Geologic Record Using Palaeosols, Loess, Paleoweathering Profiles, Pedosedimentary Sequences, and Polygenetic Soils: Their Applications and Limitations as Terrestrial Proxies in Understanding Impacts of Climatic Changes**

**Cosponsors:** *GSA Soils and Soil Processes Interdisciplinary Interest Group; GSA Sedimentary Geology Division*

**Disciplines:** Soils, Paleoclimatology/Paleoceanography, Geochemistry

**Advocate:** Mohammed Rafi G. Sayyed

A variety of approaches to obtain information about paleoclimatic conditions from terrestrial archives are welcome. It would encourage future work in unveiling the conditions during the periods of extreme geological events by critical and constructive discussions.

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



Economic Geology



Energy



Engineering



Hydrogeology and Environmental Geology

**T170. Rock Transforming to Soil—The Weathering Engine Intersects with the Carbon Cycle**

**Cosponsors:** *GSA Soils and Soil Processes Interdisciplinary Interest Group; GSA Geobiology & Geomicrobiology Division; Paleoclimatology/Paleoceanography*

**Disciplines:** Soils, Environmental Geoscience, Geochemistry

**Advocates:** Zsuzsanna Balogh-Brunstad; Marjorie Schulz

Geology and biology interact in hotspots of geochemical activity along the root rhizosphere. These reactions control soil development, nutrient availability, erosion, carbon cycling, etc. We welcome submissions from all scales, laboratory, field, and modeling studies.

**T171. Terroir**

**Cosponsor:** *GSA Soils and Soil Processes Interdisciplinary Interest Group*

**Disciplines:** Soils, Quaternary Geology, Environmental Geoscience

**Advocates:** Scott Burns; Kevin R. Pogue

Terroir is the relationship of geology, soils, and climate to wine. It is the taste of the place. We will discuss these factors related to mainly wine, but will open it up to other items.

**QUATERNARY GEOLOGY****T172. A Call to Arms: Applying Quaternary Science in the 21st Century**

**Cosponsors:** *GSA Quaternary Geology and Geomorphology Division; U.S. National Committee-International Quaternary Congress; GSA Geology and Society Division; American Quaternary Association (AMQUA); GSA Soils and Soil Processes Interdisciplinary Interest Group*

**Disciplines:** Quaternary Geology, Soils, Environmental Geoscience

**Advocates:** Julio Betancourt; Rolfe D. Mandel

This session addresses how profound environmental, technological, and societal trends, and their interactions, pose formidable consequences, requiring a repurposing and retooling of applied Quaternary science, with applications spanning disciplines, nations, and existing and emerging problems.

**T173. Change Detection Photogrammetry in Earth Science**

**Cosponsors:** *GSA Geoinformatics Division; GSA Environmental and Engineering Geology Division*

**Disciplines:** Quaternary Geology, Geomorphology, Geoinformatics

**Advocates:** Kristin E. Sweeney; Emily S. Schultz-Fellenz

As techniques for acquisition, processing, and analyses of photogrammetric datasets advance, the use of this method in a modern context permits robust and rapid change detection across a wide swath of earth science applications.

**T174. Cordilleran Ice Sheet Outburst Floods: From Glacial Lake Missoula to the Hubbard Glacier**

**Cosponsor:** *GSA Sedimentary Geology Division*

**Disciplines:** Quaternary Geology, Geomorphology, Paleoclimatology/Paleoceanography

**Advocates:** Ingrid Hendy; Joel H. Gombiner

Risks from catastrophic outburst flooding from sediment and ice dams increase as glaciers retreat. This session showcases our understanding the largest of floods with the development of new geochemical and modeling techniques, and extensive fieldwork.

**T175. Earthquakes, Faults, and Fault Systems in the Pacific Northwest**

**Cosponsors:** *Washington Division of Geology and Earth Resources; GSA Structural Geology and Tectonics Division*

**Disciplines:** Quaternary Geology, Tectonics/Tectonophysics

**Advocates:** Timothy J. Walsh; Corina Forson

New insights into active faults of the Pacific Northwest are fostered by mapping tools such as LiDAR, InSAR, temporary seismometer deployments, geologic mapping, potential field studies, and paleoseismic trenches.

**T176. Glacier-Landscape Interactions, Loess Paleoclimatology, and Interdisciplinary Quaternary Science: In Memory of Stephen C. Porter**

**Cosponsors:** *GSA Quaternary Geology and Geomorphology Division; GSA Sedimentary Geology Division*

**Disciplines:** Quaternary Geology, Geomorphology, Paleoclimatology/Paleoceanography

**Advocates:** Glenn D. Thackray; Richard B. Waitt; Zhisheng An

Stephen Porter influenced Quaternary science for several decades. We seek contributions documenting glacier-landscape interactions and chronologies, loess paleoclimatology, and interdisciplinary science, on all Quaternary time scales and regions, reflecting the breadth of Porter's work.

**T177. Ice Streams of North American Ice Sheets and Their Stratigraphic and Sedimentary Record**

**Cosponsor:** *GSA Quaternary Geology and Geomorphology Division*

**Discipline:** Quaternary Geology

**Advocates:** Michel Parent; Martin Ross; Richard Berg

While satellite imagery rapidly advanced the recognition of Late Quaternary ice streams, firm linkages with sedimentary/chronologic records, including glacial readvances, are now being established. Contributions on the North American ice stream geological record are welcomed.



**T178. Megaflood Path from Ice Lobe to Ice Lobe: Honoring the Contributions to the Ice Age Flood History by Roy Breckenridge, Gene Kiver, and Dale Stradling**

**Cosponsor:** *GSA Sedimentary Geology Division*

**Disciplines:** Quaternary Geology, Geomorphology, Paleoclimatology/Paleoceanography

**Advocate:** Linda B. McCollum

This session honors the contributions by Roy Breckenridge, Gene Kiver, and Dale Stradling in geologic mapping of the Late Pleistocene glaciolacustrine and megaflood deposits between the Purcell Trench ice lobe and the Okanogan ice lobe.

**T179. New Concepts in Glaciation of the Western Cordillera of North America**

**Cosponsor:** *GSA Quaternary Geology and Geomorphology Division*

**Disciplines:** Quaternary Geology, Geomorphology

**Advocates:** Doug Clark; Jonathan E. Cripps

Novel research and fresh insights to improve the understanding of the glacial history and processes of western North America.



**T180. Recent Advances in Seismic Hazard Characterization in the Pacific Northwest**

**Cosponsors:** *GSA Quaternary Geology and Geomorphology Division; GSA Geophysics Division; GSA Geology and Society Division; GSA Structural Geology and Tectonics Division*

**Disciplines:** Quaternary Geology, Structural Geology, Geophysics/Geodynamics

**Advocates:** Thomas M. Brocher; Brian L. Sherrod

This session showcases recent advances in seismic hazard characterization in Cascadia. Abstracts will summarize studies characterizing earthquake recurrence rates, deformation rates, fault geometries, and earthquake shaking intensities or ground motions.

**T181. The Geological Signature of Natural Hazard Events**

**Cosponsors:** *GSA Environmental and Engineering Geology Division; GSA Sedimentary Geology Division*

**Disciplines:** Quaternary Geology, Engineering Geology, Sediments, Clastic

**Advocates:** Peter Bobrowsky; David H. Huntley; Jasper Knight; Catherine Chague-Goff

This session focuses on the geologic record of natural hazards. The aim is to review challenges in recognizing products of different natural hazard events including earthquakes, wildfires, flooding, droughts, tsunamis, nuées ardentes, landslides, hurricanes, and others.

**T182. Through the Lens of the Dating Specialist: Advice on Applications, Sampling Methods, Data Interpretations, and Information on Recent Innovations (Posters)**

**Cosponsors:** *GSA Quaternary Geology and Geomorphology Division; GSA Sedimentary Geology Division; GSA*

*Archaeological Geology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Karst Division; GSA Structural Geology and Tectonics Division; GSA Limnogeology Division*

**Disciplines:** Quaternary Geology, Stratigraphy, Tectonics/Tectonophysics

**Advocates:** Tammy Rittenour; Shannon A. Mahan; Michelle Summa Nelson

This poster session provides a venue for geochronology specialists to answer questions and discuss sampling methods, technique principles, and new and innovative applications of dating techniques with interested researchers and potential users.

**GEOMORPHOLOGY**

**T183. Advances and Challenges in Quantifying Sediment Budgets for River Systems**

**Cosponsors:** *GSA Quaternary Geology and Geomorphology Division; GSA Sedimentary Geology Division*

**Disciplines:** Geomorphology, Sediments, Clastic, Environmental Geoscience

**Advocates:** Christopher Magirl; Allen C. Gellis; Jon Major

Characterizing river sediment budget is important to geologic understanding. Recent advances are producing new insights with respect to sediment sources, transport, and storage. This session requests presentations on new techniques to inform sediment budgets.

**T184. Geologic Research at Mount Rainier and Other Cascade Volcanoes: Ideal Natural Laboratories for Cutting-Edge Research with Implications to Life Safety and Infrastructure Protection in the Pacific Northwest**

**Cosponsors:** *GSA Quaternary Geology and Geomorphology Division; GSA Geology and Society Division; National Park Service; GSA Environmental and Engineering Geology Division*

**Disciplines:** Geomorphology, Volcanology, Geoscience Information/Communication

**Advocates:** Scott R. Beason; Paul Kennard; Claire E. Todd

This session explores recent cutting-edge geologic research at Mount Rainier and other Cascade volcanoes that has led to greater understanding of geologic features, especially in the context of life safety and infrastructure protection for broad areas.



**22-25 October**  
Seattle, Washington, USA

**T185. Geomorphology of Human-Altered Landscapes**

**Cosponsors:** *GSA Quaternary Geology and Geomorphology Division; GSA Archaeological Geology Division; GSA Environmental and Engineering Geology Division; GSA Soils and Soil Processes Interdisciplinary Interest Group*

**Disciplines:** Geomorphology, Archaeological Geology, Soils

**Advocates:** Anne J. Jefferson; Stephanie S. Day

Throughout history humans have shaped landscapes around them. This session explores human influences on geomorphic processes and landforms, across land uses, from pre-history to today, with the goal of identifying the fingerprints of human activity.

**T186. Heterogeneity in Landscape Evolution: Geomorphic Response to Spatially and Temporally Variable Forcings**

**Cosponsors:** *GSA Quaternary Geology and Geomorphology Division; GSA Sedimentary Geology Division; GSA Structural Geology and Tectonics Division; Future of Tectonics Initiative*

**Disciplines:** Geomorphology, Quaternary Geology, Sediments, Clastic

**Advocates:** Sarah A. Schanz; Charles M. Shobe

Landscapes adjust to spatial and temporal heterogeneity in rock and sediment properties as well as climatic and tectonic variability. We welcome field, modeling, and experimental studies that explore transient landscape response to heterogeneous drivers.

**T187. How, and Under What Conditions, Does Weathering Influence Surface Processes?**

**Cosponsors:** *GSA Quaternary Geology and Geomorphology Division; GSA Soils and Soil Processes Interdisciplinary Interest Group*

**Disciplines:** Geomorphology, Soils, Sediments, Clastic

**Advocates:** Martha Cary Eppes; Gregory S. Hancock; Greg M. Stock; Bernard Hallet

Physical and chemical weathering strongly influence subsequent landscape evolution. We request work that explores (1) mechanistic links/feedbacks between weathering and surface processes, and/or (2) driving/limiting factors (climate, rock-type, regolith thickness, etc.) controlling weathering–surface-process linkages.

**T188. Interrelationship between Tectonic Uplift and Quaternary Glaciations on the Tibetan Plateau and Its Surrounding Mountains**

**Disciplines:** Geomorphology, Quaternary Geology, Paleoclimatology/Paleoceanography

**Advocates:** Zhijiu Cui; Yingkui Li; Jonathan M. Harbor; Chaolu Yi

This session focuses on recent advances in Quaternary glaciations and landscape evolution research on the Tibetan Plateau and its surrounding mountains, and aims to discuss the interrelationship between tectonic uplift and Quaternary glaciations.

**T189. Landscapes in the Anthropocene**

**Cosponsors:** *GSA Quaternary Geology and Geomorphology Division; GSA Hydrogeology Division; GSA Sedimentary Geology Division*

**Disciplines:** Geomorphology, Quaternary Geology, Hydrogeology

**Advocates:** Rónadh Cox; José Antonio Constantine; J. Wesley Lauer

Advances in understanding landscape evolution are paving the way to successfully coupling hydrological and climate-change models with predictions of landscape adjustment. We seek abstracts investigating the relationships between various earth systems and landscape response.



**T190. Linking Physical and Ecological Processes from Source-to-Sink to Investigate Multi-Scale Response to Restoration**

**Cosponsors:** *GSA Quaternary Geology and Geomorphology Division; GSA Hydrogeology Division; GSA Environmental and Engineering Geology Division*

**Disciplines:** Geomorphology, Hydrogeology, Environmental Geoscience

**Advocates:** Andrew C. Wilcox; Amy East; Jon Major

This session will provide a forum for sharing emerging research on ecogeomorphic processes and watershed-scale response to restoration from source-to-sink, and to look ahead at future directions in this field.

**T191. Looking to the Past to Understand the Future: Glacial Chronology and Process**

**Cosponsors:** *GSA Quaternary Geology and Geomorphology Division; Paleoclimatology/Paleoceanography*

**Disciplines:** Geomorphology, Quaternary Geology, Paleoclimatology/Paleoceanography

**Advocates:** Lee B. Corbett; Paul R. Bierman; P. Thompson Davis

This session focuses on understanding Earth's glaciers through the lens of chronology and/or process, with an emphasis on using past glacier behavior to illuminate possible future glacier behavior in the face of modern climate change.

**T192. Mountain Glaciation and Climate Change of the Past and Present in the Western Americas**

**Cosponsor:** *GSA Quaternary Geology and Geomorphology Division*

**Disciplines:** Geomorphology, Quaternary Geology, Paleoclimatology/Paleoceanography

**Advocates:** Benjamin J. Laabs; Eric M. Leonard; Mitchell Plummer

Investigations of mountain glaciation in the western Americas span a broad range of latitudes and yield valuable insights into climatic change. This session brings together studies of past and present mountain glaciation.

**T193. Quantifying Geomorphic Processes and Rates of Landscape Evolution**

**Cosponsor:** *GSA Quaternary Geology and Geomorphology Division*

**Disciplines:** Geomorphology, Geochemistry, Quaternary Geology

**Advocates:** Arjun M. Heimsath; Paul R. Bierman

This session explores how methods such as cosmogenic nuclides, apatite (U-Th)/He thermochronometry, U-series geochemistry, luminescence, and chemical mass balances quantify relationships between climate, tectonics, and erosion.

**T194. The Aeolian Realm: Dunes, Dust, and Loess**

**Cosponsors:** *GSA Quaternary Geology and Geomorphology Division; GSA Sedimentary Geology Division*

**Disciplines:** Geomorphology, Sediments, Clastic, Paleoclimatology/Paleoceanography

**Advocates:** Nick Lancaster; William Johnson; Mark Sweeney

This session will explore research focused on all aspects of aeolian processes and landforms including dunes (coastal and inland), dust and loess, as well as exploring Quaternary analogs of ancient aeolian systems.

**T195. Undergraduate Research Talks: The Next Step in Student Research Projects**

**Cosponsors:** *GSA Geoscience Education Division; GSA Geoinformatics Division; GSA Structural Geology and Tectonics Division; GSA Quaternary Geology and Geomorphology Division; GSA Sedimentary Geology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Hydrogeology Division; GSA Limnogeology Division; GSA Archaeological Geology Division; GSA Karst Division*

**Disciplines:** Geomorphology, Environmental Geoscience, Structural Geology

**Advocates:** Jacqueline A. Smith; Bradley G. Johnson; Edward C. Hansen

This oral session provides a venue for undergraduate students and recent graduates to present talks on completed research projects. Students may submit abstracts for research in any subdiscipline of geology, earth science, or environmental science.

**ARCHAEOLOGICAL GEOLOGY****T196. Advances in Geoarchaeology**

**Cosponsors:** *GSA Archaeological Geology Division; GSA Soils and Soil Processes Interdisciplinary Interest Group; GSA Sedimentary Geology Division*

**Disciplines:** Archaeological Geology, Geomorphology, Soils

**Advocates:** Laura R. Murphy; Kathleen Nicoll

This session will serve as a forum for researchers to present novel approaches being developed or applied within geoarchaeology. We welcome methodological and theoretical papers that seek to push the current boundaries of the discipline.

**T197. No Dates: No Rates—Utilizing Geochronometers to Quantify Rates of Geomorphic Processes or Archaeological Development over a Wide Range of Temporal and Spatial Scales**

**Cosponsors:** *GSA Quaternary Geology and Geomorphology Division; GSA Archaeological Geology Division; GSA Karst Division*

**Disciplines:** Archaeological Geology, Quaternary Geology

**Advocates:** Shannon A. Mahan; Ronald Counts; James K. Feathers; Amanda Keen-Zebert; Kenneth Lepper; Michelle Summa Nelson; Christina Neudorf; Joel Q.G. Spencer

The intent of this session is to bring together scientists and students who have been instrumental in methodological developments for or applications of radiocarbon, optically stimulated luminescence, and cosmogenic nuclide dating.

**PLANETARY GEOLOGY****T198. Apatite as a Versatile Tool for Enabling Planetary Science**

**Cosponsor:** *GSA Planetary Geology Division*

**Disciplines:** Planetary Geology, Petrology, Igneous, Geochemistry

**Advocates:** Jessica Jane Barnes; Francis McCubbin; Jeremy W. Boyce

This transdisciplinary session focuses on solving geological problems now and in the future through investigations of the occurrence, chronology, volatile inventories, and chemistries of apatite in planetary materials (including Earth) and relevant petrologic experiments.

**T199. Basalt Weathering on Earth and Mars**

**Cosponsor:** *GSA Planetary Geology Division*

**Disciplines:** Planetary Geology, Geochemistry, Mineralogy/Crystallography

**Advocates:** Melissa S. Rice; Leslie L. Baker; Michael D. Kraft

This session explores basalt weathering processes and products under various environmental conditions on Earth and Mars. Abstracts are solicited on field studies, laboratory simulations, geochemical modeling, and/or remote sensing observations.

**T200. Boundary-Related Impact Cratering and Volcanism**

**Cosponsors:** *GSA Planetary Geology Division; Lunar and Planetary Institute (LPI); Cushman Foundation; Paleontological Research Institution*

**Disciplines:** Planetary Geology, Geochemistry, Paleontology, Diversity, Extinction, Origination

**Advocates:** Philippe Claeys; David A. Kring

Emerging studies are fueling new debate about the role of impact cratering in boundary events, such as the Triassic-Jurassic, Cretaceous-Tertiary, and Paleocene-Eocene, and, simultaneously, the role of volcanism or impact-enhanced volcanism in boundary intervals.

**T201. Comparative Analyses of Small Body Geology: Dwarf Planets, Protoplanets, Asteroids, and Comets****Cosponsor:** *GSA Planetary Geology Division***Disciplines:** Planetary Geology, Geomorphology, Mineralogy/Crystallography**Advocate:** Debra L. Buczkowski

We encourage abstracts related to geologic, spectroscopic, geo-physical, and compositional analyses of small bodies in the Solar System, including comparative studies of more than one body, or in-depth studies of a single body.

**T202. Experimental Planetary Geology: Using Laboratory and Other Experiments to Advance Our Understanding of Geology on Planetary Bodies****Cosponsors:** *GSA Planetary Geology Division; GSA Geophysics Division; GSA Sedimentary Geology Division***Disciplines:** Planetary Geology, Tectonics/Tectonophysics, Structural Geology**Advocates:** Devon M. Burr; Danielle Wyrick

This session encompasses experimental investigations that focused on geologic processes and landforms. All types of experimental work across kinematic, temperature, pressure, and chemical conditions are encouraged, especially investigations into unusual or poorly understood phenomena.

**T203. Exploring Ceres and Vesta: Continuing Discoveries of the Dawn Mission****Cosponsor:** *GSA Planetary Geology Division***Disciplines:** Planetary Geology, Volcanology, Structural Geology**Advocates:** Debra L. Buczkowski; Jennifer E.C. Scully

We encourage abstract submissions related to geologic, spectroscopic, compositional, and geophysical analyses of Ceres and Vesta. Possible topics include analyses of *Dawn* data, telescopic observations, and modeling of impact events and/or tectonic activity.

**T204. Friends of Hoth: Episode II—Bodies of the Outer Solar System****Cosponsor:** *GSA Planetary Geology Division***Disciplines:** Planetary Geology, Structural Geology, Geophysics/Geodynamics**Advocates:** D. Alex Patthoff; Emily S. Martin

We seek abstracts relating to surface, structural, and tectonic processes; interior and thermal evolution; and planetary analogs as they pertain to solid bodies in the outer solar system. This includes experimental, observational, and theoretical approaches.

**T205. Impact Cratering: From Fire to Ice—Cratering across the Solar System****Cosponsors:** *GSA Planetary Geology Division; GSA Geophysics Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Structural Geology and Tectonics Division***Disciplines:** Planetary Geology, Structural Geology**Advocates:** Christian Koeberl; Jeffrey B. Plescia

This session focuses on impact cratering processes and effects across the solar system. We solicit contributions regarding target effects, shock processes, geology, melt, airbursts, and current cratering-rates. Comparisons among different size and composition bodies are encouraged.

**T206. The G.K. Gilbert Award Session****Cosponsor:** *GSA Planetary Geology Division***Discipline:** Planetary Geology**Advocates:** James J. Wray; Danielle Wyrick

This session will honor the 2017 winner of the Planetary Geology Division's G.K. Gilbert Award, highlighting recent contributions in the awardee's field of research.

**T207. Volcanism and Tectonism across the Solar System****Cosponsor:** *GSA Planetary Geology Division***Disciplines:** Planetary Geology, Volcanology, Tectonics/Tectonophysics**Advocates:** Paul K. Byrne; Christian Klimczak

This session solicits abstracts on volcanic, tectonic, or volcano-tectonic landforms and processes on Solar System bodies, and encompasses surface geology, interior and thermal evolution, and comparative planetary studies with observational, experimental, or theoretical approaches.

**STRUCTURAL GEOLOGY****T208. Best Student Geologic Map Competition (Posters)****Cosponsors:** *U.S. Geological Survey–National Cooperative Geologic Mapping Program; Association of American State Geologists; GSA Foundation; American Geosciences Institute; American Institute of Professional Geologists; Journal of Maps; GSA Environmental and Engineering Geology Division***Disciplines:** Structural Geology, Stratigraphy, Geomorphology**Advocates:** Michael Marketti; Darcy K. McPhee

Students will present their research through geologic mapping projects that have a significant field component that addresses scientific or societal issues. The top three geologic maps will be awarded.

**T209. Challenges in Tectonics 1: Fault Zone Behavior through Time, from Earth's Surface to the Upper Mantle****Cosponsors:** *GSA Structural Geology and Tectonics Division; Future of Tectonics Initiative***Disciplines:** Structural Geology, Tectonics/Tectonophysics**Advocates:** Randolph T. Williams; Alexis K. Ault; James F. Dolan

We solicit submissions from all disciplines that focus on the grand challenge of characterizing and understanding the behavior of faults and fault systems at different spatial-temporal scales from Earth's surface to upper mantle.

**T210. Challenges in Tectonics 2: Beyond Steady State: New Developments in Understanding Strain Localization Processes and the Rheology of the Lithosphere**

**Cosponsors:** *GSA Structural Geology and Tectonics Division; Future of Tectonics Initiative*

**Disciplines:** Structural Geology, Tectonics/Tectonophysics, Geophysics/Geodynamics

**Advocates:** Seth C. Kruckenberg; Jamie S. Levine; Elena A. Miranda

We seek broad contributions from experimental rock deformation studies, numerical modeling, geophysical, geochronologic and field-based investigations, and structural and textural analyses that inform on processes of strain localization and the transient rheology of the lithosphere.

**T211. Folds: Causes and Consequences (Posters)**

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

**Disciplines:** Structural Geology, Tectonics/Tectonophysics

**Advocates:** Andreas Eckert; Amanda Hughes

We seek contributions investigating folding from plate-scale to micro-scale, including field, analytical, and modeling studies investigating the causes and consequences of folding in the contexts of tectonics, crustal deformation, rheology, landscape evolution, or fluid migration.

**\$ T212. Geologic Mapping in the Pacific Northwest and Beyond: Recent Maps, Advances, and New Insights (Posters)**

**Cosponsors:** *Washington Division of Geology and Earth Resources; GSA Quaternary Geology and Geomorphology Division; GSA Sedimentary Geology Division; GSA Environmental and Engineering Geology Division; GSA Geology and Society Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Structural Geology and Tectonics Division*

**Disciplines:** Structural Geology, Quaternary Geology, Stratigraphy

**Advocates:** Michael Polenz; Dave Norman

Geologic mapping in the Pacific Northwest and beyond: recent maps, advances, and new insights. This session presents new geologic mapping, approaches to geologic mapping, and insights from geologic mapping, mainly in the Pacific Northwest.

**\$ T213. Integrated Approaches to Deciphering Major Crustal Boundaries in Polyphase Orogenic Settings**

**Cosponsors:** *GSA Structural Geology and Tectonics Division; Society of Economic Geologists; GSA Geophysics Division*

**Disciplines:** Structural Geology, Tectonics/Tectonophysics, Geophysics/Geodynamics

**Advocates:** James V. Jones III; James J. Ryan; Jonathan S. Caine; Benjamin J. Drenth

This session seeks contributions focused on understanding major crustal boundaries within polyphase orogens and deciphering tectonic events and processes that shaped them. Contributions

investigating ties between crustal structure and regional metallogeny are encouraged.

**T214. Late Paleozoic and Early Mesozoic Tectono-Stratigraphy and Biostratigraphy of the NW Pangea Margin**

**Cosponsors:** *GSA Structural Geology and Tectonics Division; GSA Sedimentary Geology Division*

**Disciplines:** Structural Geology, Paleontology, Biogeography/Biostratigraphy, Stratigraphy

**Advocates:** Walter S. Snyder; Charles M. Henderson; Scott Ritter

Controls and timing of tectonic events that affected the late Paleozoic/early Mesozoic NW Pangea margin are still debated. Resolution demands multidisciplinary approaches and therefore this session will integrate structural geology, tectonic modeling, geochronology, and paleontology.

**T215. Scaled Physical Experiments Tell Tectonic Stories of the Earth and Beyond**

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

**Disciplines:** Structural Geology, Tectonics/Tectonophysics

**Advocates:** Mattathias D. Needle; Kathleen F. Warrell

Scaled physical experiments are a robust and quantitative way to explore geologic processes through space and time. This session will highlight research using scaled physical experiments to explore geologic questions.

**T216. Spatiotemporal Variations and the Role of Fluids in Fault-Zone Hydromechanical Processes**

**Cosponsors:** *GSA Structural Geology and Tectonics Division; GSA Hydrogeology Division; GSA Energy Geology Division; GSA Future of Tectonics Initiative*

**Disciplines:** Structural Geology, Hydrogeology, Geochemistry

**Advocates:** Elizabeth S. Petrie; Randolph T. Williams; Keith R. Hodson

This session explores the evolution of fault-fluid interactions, focusing on specific stages of fault development, long-term variability, and the effects of cumulative deformation and diagenesis. Similar studies characterizing non-fault structures are also encouraged.

**T217. Challenges in Tectonics 5: Synergies between Meeting Societal Needs and Advancing Interdisciplinary Research in Tectonics and Structural Geology**

**Cosponsors:** *GSA Structural Geology and Tectonics Division; Future of Tectonics Initiative*

**Disciplines:** Structural Geology, Tectonics/Tectonophysics, Geomorphology

**Advocates:** Kim Blisniuk; Richard W. Briggs; Frederick M. Chester; Alison R. Duvall; Peter Eichhubl; Katharine Huntington

This session focuses on fundamental research in structural geology, tectonics, and related fields that addresses topics of societal relevance, from resources to hazards, and that leverages field, laboratory, experimental, numerical, and theoretical approaches.

**§ T218. Understanding the Interplay of Structural, Metamorphic, and Magmatic Processes in the Evolution of Convergent Margins: Lessons from the Proterozoic to Present-Day South American Andean Margin**

**Cosponsors:** *GSA Structural Geology and Tectonics Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA International/International Interdisciplinary Interest Group*

**Disciplines:** Structural Geology, Tectonics/Tectonophysics, Petrology, Metamorphic

**Advocates:** Sean R. Mulcahy; Sarah M. Roeske; William C. McClelland

This session explores links and feedback mechanisms between faults, magmatism, metamorphism, and changing crustal rheology in major orogenic belts, focusing on the Andean margin from the Proterozoic to present day. Contributions from other orogens are welcome.

## TECTONICS/TECTONOPHYSICS

**T219. Challenges in Tectonics 3: Dynamic Interactions among Earth-Surface Processes, Landscape Evolution, and Tectonics**

**Cosponsors:** *GSA Structural Geology and Tectonics Division; GSA Sedimentary Geology Division; GSA Quaternary Geology and Geomorphology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; SEPM (Society for Sedimentary Geology); Future of Tectonics Initiative*

**Disciplines:** Tectonics/Tectonophysics, Geomorphology, Sediments, Clastic

**Advocates:** Roman A. DiBiase; Elizabeth J. Cassel; Majie Fan

This session seeks contributions that address connections between surface and deep-Earth processes, such as the use of sedimentary records to constrain tectonic processes and the feedbacks among tectonics, topography, climate, rock strength, and erosion.

**T220. Challenges in Tectonics 4: Planetary Evolution in Four Dimensions—The New Global Tectonics**

**Cosponsors:** *GSA Structural Geology and Tectonics Division; Future of Tectonics Initiative*

**Disciplines:** Tectonics/Tectonophysics, Geochemistry, Geophysics/Geodynamics

**Advocates:** John A. Hole; Andrew Laskowski; Robert Moucha

We seek contributions to understanding Earth's 4D evolution as a global tectonic system, from transdisciplinary datasets and numerical models, with emphasis on frontier research areas (setting or process) and new or developing analytical techniques.

**T221. Circum-Arctic Structural Events: Tectonic Evolution of the Arctic Margins and Trans-Arctic Links with Adjacent Orogens**

**Cosponsors:** *GSA Structural Geology and Tectonics Division; GSA Sedimentary Geology Division; GSA Geophysics Division;*

*GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA International/International Interdisciplinary Interest Group*

**Disciplines:** Tectonics/Tectonophysics, Structural Geology, Stratigraphy

**Advocates:** Karsten Piepjohn; Justin V. Strauss; Shawn J. Malone; William C. McClelland

We seek contributions from a broad spectrum of disciplines to advance understanding of orogenic processes responsible for circum-Arctic tectonic events, structural-magmatic-stratigraphic-geophysical links with adjacent orogens and development of the Eurasian and Amerasian basins.

**T222. Decadal to Millennial Strain Accumulation at Subduction Zones**

**Cosponsors:** *GSA Structural Geology and Tectonics Division; Future of Tectonics Initiative*

**Disciplines:** Tectonics/Tectonophysics, Geophysics/Geodynamics, Geomorphology

**Advocates:** Christine Regalla; Kristin Morell; Scott Bennett; Lucinda J. Leonard; Colin B. Amos; John P. Loveless

This session includes discussions of recent advances in understanding and quantifying the spatio-temporal evolution and mechanics of strain accumulation at subduction zones spanning decadal to geologic timescales.

**T223. Intraplate Earthquake Sources, Processes, and Hazards in Central and Eastern North America**

**Cosponsors:** *GSA Structural Geology and Tectonics Division; GSA Geophysics Division; GSA Environmental and Engineering Geology Division; GSA Quaternary Geology and Geomorphology Division; EarthScope National Office*

**Disciplines:** Tectonics/Tectonophysics, Structural Geology, Geophysics/Geodynamics

**Advocates:** J. Wright Horton Jr.; Christine A. Powell; Robert A. Williams

This session presents insights into intraplate earthquake sources, processes, and hazards in central and eastern North America from the deep lithosphere to the Earth's surface. We welcome contributions in all disciplines.

**T224. Multi-Proxy Records for Large-Scale Translation and Vertical Strain along Active and Ancient Strike-Slip Fault Systems**

**Cosponsors:** *GSA Structural Geology and Tectonics Division; Future of Tectonics Initiative; GSA Sedimentary Geology Division*

**Disciplines:** Tectonics/Tectonophysics, Structural Geology, Stratigraphy

**Advocates:** Jeff Benowitz; Jeremy Hourigan; Paul J. Umhoefer

GPS data indicate rapid slip rates on many strike-slip fault systems, yet constraints on the long-term offset history are often obscured. We welcome submissions that integrate multi-proxy datasets to document strike-slip fault evolution.

### § T225. New Perspectives on Cordilleran Tectonics, Paleogeography, and Metallogeny

**Cosponsors:** GSA Sedimentary Geology Division; SEPM (Society for Sedimentary Geology); Society of Economic Geologists; GSA Structural Geology and Tectonics Division

**Disciplines:** Tectonics/Tectonophysics, Stratigraphy, Economic Geology

**Advocates:** Luke P. Beranek; Justin V. Strauss; Stephen J. Piercey

This session welcomes new ideas on Cordilleran evolution that use the Neoproterozoic–Cenozoic rock record from Alaska to Mexico. Contributions for multidisciplinary studies in stratigraphy, petrology, structural geology, geochemistry, and geochronology are particularly welcome.

### T226. New Perspectives on Processes of Subduction Initiation and Termination

**Cosponsors:** GSA Structural Geology and Tectonics Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Geophysics Division

**Disciplines:** Tectonics/Tectonophysics, Petrology, Igneous, Geophysics/Geodynamics

**Advocates:** Sarah Roeske; Nancy Riggs; Susanne Buitert; Douwe van Hinsenberg

This session examines the formation and termination of subduction zones, whether due to passage of a triple junction, change in plate motion, or collision. Ancient and modern records and modeling studies of these processes are welcome.

### T227. Ophiolite and Ocean Plate Stratigraphy Records in Modern and Ancient Accretionary and Collisional Orogenic Belts in the Circum-Pacific Region

**Cosponsors:** GSA Structural Geology and Tectonics Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Geophysics Division; Geological Society of China; GSA Sedimentary Geology Division

**Disciplines:** Tectonics/Tectonophysics, Petrology, Igneous, Geophysics/Geodynamics

**Advocates:** Yildirim Dilek; Jingsui Yang

We encourage original contributions on the origins and emplacement mechanisms of ophiolites and remnants of ocean plate stratigraphy in the accretionary and collisional orogenic belts in the Circum-Pacific region.

### § T228. Origin, Accretion, and Translation of Mesozoic-Cenozoic Terranes along the Pacific Margin of North America

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

**Discipline:** Tectonics/Tectonophysics

**Advocates:** David T. Katopody; Mark T. Brandon; Bernard Housen

The Pacific margin of North America is the center of a long-standing controversy about terrane mobility along continental margins. This session will serve as a forum to identify remaining problems and opportunities in Cordilleran tectonics.

### § T229. Paleocene-Eocene Tectonic and Magmatic Evolution of the Pacific Northwest

**Cosponsors:** GSA Structural Geology and Tectonics Division; GSA Sedimentary Geology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division

**Disciplines:** Tectonics/Tectonophysics, Petrology, Igneous, Geophysics/Geodynamics

**Advocates:** Jeffrey H. Tepper; Eugene D. Humphreys; Robert B. Miller

Paleogene magmatism, extension, basin subsidence, and faulting spanned the Pacific Northwest, perhaps related to ridge subduction, slab breakoff, and/or Siletzia accretion. We seek contributions on this “Challis episode” from structure, tectonics, petrology, sedimentation, and geophysics.

### T230. Polygenetic Mélanges: A Glimpse on Tectono-Sedimentary Recycling in Convergent Margins

**Cosponsors:** GSA International/International Interdisciplinary Interest Group; IGCP 640 program S4SLIDE (Significance of Modern and Ancient Submarine Slope Landslides); GSA Structural Geology and Tectonics Division; GSA Sedimentary Geology Division

**Disciplines:** Tectonics/Tectonophysics, Sediments, Clastic, Structural Geology

**Advocates:** Andrea Festa; Kei Ogata; Gian Andrea Pini

This session addresses the definition of structures, fabric, and texture diagnostic of sedimentary mélanges overprinted by other processes and the estimation of their occurrence in fossil, exhumed, and present-day accretionary wedges and collisional chains.

### T231. Subduction Top to Bottom 2 (ST2B-2), Cascadia and Beyond

**Cosponsors:** GSA Structural Geology and Tectonics Division; Future of Tectonics Initiative

**Disciplines:** Tectonics/Tectonophysics, Geophysics/Geodynamics, Volcanology

**Advocates:** Gray E. Bebout; David W. Scholl; Robert Stern; Anne Trehu; Joan Gomberg; Thomas W. Sisson

Subduction zone processes and their products, including the associated natural hazards, are important to science and influence society. This session assesses geological, geophysical, geochemical, and theoretical advancements and promising directions for future research, emphasizing Cascadia.

### T232. Subduction Zone Response to Ridge and Plateau Collision: Perspectives from the Archean to the Cenozoic

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

**Discipline:** Tectonics/Tectonophysics

**Advocates:** Michael P. Eddy; Paul J. Umhoefer

Ridge-trench interaction and oceanic plateau accretion have profound effects on the geology of convergent margins. We welcome submissions that document these effects throughout Earth's history using field, geophysical, and/or modeling data.

**T233. Tectonics, Geohazards, and Morphodynamics from High-Resolution Topography and Imagery**

**Cosponsors:** *GSA Quaternary Geology and Geomorphology Division; GSA Environmental and Engineering Geology Division; GSA Structural Geology and Tectonics Division*

**Disciplines:** Tectonics/Tectonophysics, Geomorphology, Quaternary Geology

**Advocates:** Amit Mushkin; Edwin Nissen

We seek papers describing recent advances in tectonics, geohazards, morphodynamics, and associated fields that build on insights obtained from high-resolution topography and imagery, collected across the full spectrum of satellite, airborne, unmanned, and terrestrial platforms.

**T234. What Are the Conditions That Lead to Detachment Faulting?**

**Cosponsors:** *GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Structural Geology and Tectonics Division*

**Disciplines:** Tectonics/Tectonophysics, Petrology, Metamorphic, Structural Geology

**Advocates:** Thomas Hoisch; Michael L. Wells; John S. Singleton

This session will focus on the conditions that lead to detachment faulting, including studies of the pre-detachment histories of metamorphic core complexes, theoretical and rock mechanics approaches, and tectonic considerations.

**T235. Which Process Mainly Controls the Lithospheric Thinning in Extensional Terrains: Magmatic Processes or Extensional Deformation?**

**Disciplines:** Tectonics/Tectonophysics, Geochemistry, Geophysics/Geodynamics

**Advocates:** Zeynep Baran; Gokce Ustunisi; Yildirim Dilek

This session focuses on the interplay between magmatic/metamorphic processes and extensional deformation and their significance to the lithospheric thinning processes.

**GEOPHYSICS/GEODYNAMICS****T236. Characterizing Cascadia's Earthquakes—Reexamining Open Questions about Cascadia Seismic and Tsunami Hazards**

**Cosponsors:** *GSA Geophysics Division; GSA Sedimentary Geology Division; GSA Structural Geology and Tectonics Division*

**Disciplines:** Geophysics/Geodynamics, Marine/Coastal Science, Tectonics/Tectonophysics

**Advocates:** Robert C. Witter; Lydia Staisch; Joan Gombert

Uncertainty in available geological and geophysical data hampers forecasts of future Cascadia earthquakes. This session focuses on new approaches that harness multidisciplinary datasets to address open questions about Cascadia earthquake parameters, recurrence, and related hazards.

**T237. Comparative Early Evolution of the Terrestrial Planets**

**Cosponsors:** *GSA Planetary Geology Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Geophysics Division*

**Disciplines:** Geophysics/Geodynamics, Planetary Geology, Geochemistry

**Advocates:** Kent C. Condie; Charles K. Shearer

This session will focus on comparison of the early evolution of the crust, mantle, and core of terrestrial planets with emphasis on why some planets develop plate tectonics and some do not.

**T238. Geologic and Geophysical Characterization: A Key to Modeling Explosive Sources**

**Cosponsor:** *GSA Geophysics Division*

**Disciplines:** Geophysics/Geodynamics, Tectonics/Tectonophysics, Structural Geology

**Advocates:** Catherine M. Snelson; Robert Mellors; Hunter Anne Knox

The effect of geology on explosions in an observational and predictive fashion. We seek contributions from all research focus areas.

**T239. Geophysics on Ice**

**Cosponsor:** *GSA Geophysics Division*

**Disciplines:** Geophysics/Geodynamics, Environmental Geoscience, Planetary Geology

**Advocates:** Nicholas C. Schmerr; Clément Miège

This session will showcase recent advances in geophysical investigations of Earth's cryosphere and cryospheric processes. Papers will summarize geophysical characterization of ice sheets, glaciers, ice shelves, and related environments from a range of different techniques at a variety of scales.

**T240. Structure and Evolution of the North Atlantic—Arctic Realm**

**Disciplines:** Geophysics/Geodynamics, Tectonics/Tectonophysics, Geochemistry

**Advocates:** Christian Schiffer; Gillian Foulger; Randell Stephenson; Fiona Darbyshire; Hans Thybo

The goals of this session are the discussion and revision of the structure and geological-geodynamic evolution of the North Atlantic–Arctic realm. Contributions from all relevant disciplines are requested, especially reports of multidisciplinary approaches.

**T241. Volcano-Tectonic Evolution of the East African Rift System**

**Cosponsors:** *GSA International/International Interdisciplinary Interest Group; GSA Geophysics Division; GSA Sedimentary Geology Division; GSA Structural Geology and Tectonics Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division*

**Disciplines:** Geophysics/Geodynamics, Tectonics/Tectonophysics, Volcanology



**Advocates:** Kevin L. Mickus; Cynthia J. Ebinger

We seek contributions on the lithospheric evolution of the East African Rift system using geophysics, volcanology, petrology, geodynamics, sedimentology, and structural geology.

**T257. Contributions of Rock- and Paleo-Magnetism to Understanding Orogenic Processes**

**Disciplines:** Geophysics/Geodynamics, Tectonics/Tectonophysics, Structural Geology

**Advocates:** Peter A. Selkin; Daniel Pastor-Galán

Magnetic records have been valuable tools for reconstructing the formation of mountain belts. We request contributions that use paleomagnetism, rock magnetism, and anisotropy to understand orogenic processes from a broad range of perspectives.

**ENGINEERING GEOLOGY**

**T242. Current Trends in Landslide Monitoring: New Techniques, Methods, Successes, Failures, and Case Studies**

**Cosponsor:** GSA Environmental and Engineering Geology Division

**Disciplines:** Engineering Geology, Quaternary Geology, Geomorphology

**Advocates:** Peter Bobrowsky; David H. Huntley; Michael Hendry; Renato Macciotta

This session focuses on landslide monitoring techniques and methods: ground-based, remote, space-borne, real-time, methodological comparisons, new approaches, experimental efforts, reliability, instrumentation success and failures, and case study examples are encouraged contributions.



**T243. Environmental and Engineering Division Geology Student Research Competition (Posters)**

**Cosponsors:** GSA Environmental and Engineering Geology Division; Association of Environmental & Engineering Geologists

**Disciplines:** Engineering Geology, Environmental Geoscience

**Advocates:** Thad A. Wasklewicz; Jessica Witt; Stephen L. Slaughter; Anne C. Witt

We encourage students to submit poster presentations on topics related to applied research in environmental and engineering geology. Monetary awards will be given to the top presenters at the Division dinner and awards ceremony.



**T244. Landslide Inventories, Databases, Hazard Maps, Risk Analysis, and Beyond (Posters)**

**Cosponsors:** GSA Environmental and Engineering Geology Division; GSA Quaternary Geology and Geomorphology Division; GSA Geoinformatics Division

**Disciplines:** Engineering Geology, Geomorphology, Quaternary Geology

**Advocates:** Stephen L. Slaughter; Matthew M. Crawford; William J. Burns

This session will highlight landslide inventories and the changes, advances, issues, and far reaching applications that

inventories have for landslide mapping, hazard assessment, mitigation, and education.

**T245. Subduction Zone Coseismic Landslides**

**Cosponsors:** GSA Environmental and Engineering Geology Division; GSA Quaternary Geology and Geomorphology Division

**Disciplines:** Engineering Geology, Geomorphology, Quaternary Geology

**Advocates:** William J. Burns; Joshua Roering; Alison R. Duvall; Kevin M. Schmidt

This session is focused on landslides triggered by subduction zone earthquakes and is intended to explore our current knowledge base on this subject.



**T246. Weather-Induced Landslides, Debris Flows, and Rock Fall**

**Cosponsors:** GSA Environmental and Engineering Geology Division; GSA Hydrogeology Division

**Disciplines:** Engineering Geology, Geomorphology, Hydrogeology

**Advocates:** Benjamin B. Mirus; Mark E. Reid; Stephen L. Slaughter; Rex L. Baum

Contributions to this session may explore new insights into landslide processes using field and instrumental observations, analysis, and modeling techniques, or may introduce novel tools for assessing weather-induced landslide hazards.

**GEOMICROBIOLOGY**

**T247. Deciphering the Major Paleoenvironmental Crises of the Earth and Their Impact on the Marine Ecosystems and Biogeochemical Cycles**

**Cosponsors:** Paleontological Research Institution; GSA Sedimentary Geology Division; Paleoclimatology/Paleoceanography; Paleontological Society

**Disciplines:** Geomicrobiology, Geochemistry, Paleoclimatology/Paleoceanography

**Advocates:** Marcello Natalicchio; Francesco Dela Pierre; Elliot Jagniecki

This session aims to decipher the critical paleoenvironmental crises that impacted Earth's marine realm (salinity crises, anoxic events, and mass extinctions), bringing together different disciplines, including, but not limited to, geomicrobiology, geochemistry, paleontology, and sedimentology.



**22-25 October**  
Seattle, Washington, USA

**T248. Microbialite Textures and Chemical Signatures in Continental Settings: Forging the Link between the Modern and Ancient**

**Cosponsors:** *GSA Geobiology & Geomicrobiology Division; GSA Limnogeology Division; GSA Karst Division*

**Disciplines:** Geomicrobiology, Limnogeology, Planetary Geology

**Advocates:** Thomas A. Hickson; Julie K. Bartley

We seek abstracts that focus on the textures (macro- and microscopic) and geochemical signatures of microbial activity in continental settings. These abstracts should clearly forge a strong link between ancient rock sequences and modern biogeochemical processes.

**T249. New Voices in Geobiology**

**Cosponsors:** *GSA Geobiology & Geomicrobiology Division; GSA Karst Division*

**Disciplines:** Geomicrobiology, Geochemistry, Paleoclimatology/Paleoceanography

**Advocates:** Victoria A. Petryshyn; Marc Laflamme; Lydia S. Tackett; Rowan C. Martindale; Simon A.F. Darroch; Carie M. Frantz

The goal of this session is to bring together new research focusing on the interplay between geologic and biologic processes with a special emphasis on new field sites, novel materials/methods, and the development/refinement of proxies.

**T250. Perspectives on The Deep Biosphere: Twenty-Five Years of Geobiology**

**Cosponsor:** *GSA Geobiology & Geomicrobiology Division*

**Discipline:** Geomicrobiology

**Advocates:** John R. Spear; Blake W. Stamps

A critical yet little understood compartment of Earth is the life that lies beneath, the deep biosphere. Rich in geological, geochemical, and biological complexity, the subsurface continually supplies ecosystem services that maintain life on the surface.

**MARINE/COASTAL SCIENCE****T251. Tsunami Hazards: Innovations in Mapping, Modeling, and Outreach**

**Cosponsors:** *GSA Environmental and Engineering Geology Division; Washington Division of Geology and Earth Resources; GSA Geoinformatics Division*

**Disciplines:** Marine/Coastal Science, Engineering Geology, Geoscience Information/Communication

**Advocates:** Corina Forson; Timothy J. Walsh

In Washington and Oregon there is new tsunami-inundation modeling, evacuation mapping, and the first vertical-evacuation structure. Additionally, there are new regulations on designing for tsunami inundation and how to build accordingly.

**PRECAMBRIAN GEOLOGY****T252. Cratonic Assembly in the Precambrian: Forming the Core of Modern and Ancient Landmasses**

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

**Disciplines:** Precambrian Geology, Tectonics/Tectonophysics, Geophysics/Geodynamics

**Advocates:** Anthony F. Pivarunas; Joseph G. Meert; Scott R. Miller

Precambrian and younger supercontinents are composed of continents and the individual cratonic nuclei that make up those landmasses. Documenting the progressive assembly of cratons to form Rodinia and Columbia is a requirement for accurate reconstructions.

**T253. Did Earth History Repeat Itself? Turning Points at the Beginning and End of the Proterozoic That Involved Geodynamics, Surface Redox, Life**

**Cosponsor:** *Paleontological Society*

**Disciplines:** Precambrian Geology, Geochemistry, Tectonics/Tectonophysics

**Advocates:** W. Bleeker; Andrey Bekker; Ross Mitchell

Both ends of the Proterozoic eon are marked by a similar sequence of events. We hope to assemble a diverse group of speakers to address long-term patterns in the evolution of the earth system.

**T254. The Co-Evolution of Life and Its Environment during the Precambrian: The “Boring Billion” and Mid-Proterozoic Emergence of Complex Life**

**Cosponsors:** *Paleontological Society; GSA Geobiology & Geomicrobiology Division*

**Disciplines:** Precambrian Geology, Geomicrobiology, Geochemistry

**Advocates:** Roger Buick; Matthew Koehler; Charles Diamond

This session explores the middle chapter of Earth's history, which was characterized by an apparently prolonged period of biogeochemical stasis. Contributions that consider Proterozoic redox conditions, early eukaryotic evolution, long-term climatic regulation, and biogeochemical cycling are encouraged.

**T255. The Co-Evolution of Life and Its Environment during the Precambrian: The Late Proterozoic Rise of Animals; Climate, Tectonic, and Environmental Dynamics, and the Transition into the Early Paleozoic**

**Cosponsors:** *Paleontological Society; GSA Sedimentary Geology Division*

**Disciplines:** Precambrian Geology, Geochemistry, Geomicrobiology

**Advocates:** Michael Kipp; J. Alex Zumberge; Timothy W. Lyons

This session explores the dynamic transitions of the Neoproterozoic, and particularly welcomes contributions that assess marine redox heterogeneity, cause-effect relationships between tectonic, climatic and biological evolution, and the chronology of these critical events.

**T256. The Co-Evolution of Life and Its Environment during the Precambrian: The Rise of Oxygenic Photosynthesis and the Great Oxidation Event**

**Cosponsor:** GSA Geobiology & Geomicrobiology Division

**Disciplines:** Precambrian Geology, Geochemistry, Geomicrobiology

**Advocates:** Joshua Krissansen-Totton; Stephanie Olson; David C. Catling

This session explores the Archean and the Paleoproterozoic, with a particular focus on the Great Oxidation Event, the antiquity of oxygenic photosynthesis, models of Earth’s biogeochemical cycles, and novel constraints on environmental conditions.

**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 for a Pardee Keynote Symposium or a topical session, the invited abstracts do not count against the two-abstract rule.

**2017 JOINT TECHNICAL PROGRAM COMMITTEE**

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Technical Program Vice-Chair: Kevin Mickus, kevinmickus@missouristate.edu

GSA Technical Program Manager: Nancy Wright, nwright@geosociety.org

## Discipline Categories

**Can’t find a topical session that fits your abstract?** No problem! In addition to topical sessions, we offer the following discipline categories. Discipline sessions are equally vital to our technical program and are an essential addition to the fulfillment of the overall meeting. Encourage your friends to submit a discipline abstract too.

Joint Technical Program Committee Contact(s)	Discipline	Review Group
Cynthia Fadem, cfadem@earlham.edu; Richard Dunn, rdunn@norwich.edu	archaeological geology	Archaeological Geology Division
Monica Easton, monica.easton@ontario.ca	geoscience information/ communication	Association of Earth Science Editors
Marc L. Buursink, mbuursink@usgs.gov; Laura Suzanne Ruhl, lsruhl@ualr.edu	energy geology	Energy Geology Division
Jessica E. Witt, njosujwmdnc@gmail.com; Stephen Slaughter, stephen.slaughter@dnr.wa.gov	engineering geology	Environmental and Engineering Geology Division
Lydia Schiavo Tackett, lydia.tackett@ndsu.edu; Carie Marie Frantz, cariefantz@weber.edu	geomicrobiology	Geobiology & Geomicrobiology Division
Matthew Brueseke, brueseke@ksu.edu	geochemistry, geochemistry, other	Geochemical Society
Denise Hills, dhills@gsa.state.al.us; Leslie Hsu, lhsu@usgs.gov	geoinformatics	Geoinformatics Division
Saugata Datta, sdatta@ksu.edu; Thomas Darrah, darrah.24@osu.edu	geology & health	Geology & Health Division
Christopher P. Carlson, ccarlson@fs.fed.us; Bruce Clark, brucerclark@gmail.com	geoscience and public policy	Geology & Society Division
Lisa Tauxe, ltauxe@ucsd.edu; Nicholas C. Schmerr, nschmerr@umd.edu	geophysics/tectonophysics/ seismology	Geophysics Division
Natalie Bursztyn, nbursztyn@mac.com; Robyn Miek Dahl, robynmdahl@gmail.com; Shane V. Smith, shanesmi@kean.edu	geoscience education	Geoscience Education Division
Chris Badurek, cab484@drexel.edu	geoscience information/ communication	Geoscience Information Society

**GSA 2017 ANNUAL MEETING & EXPOSITION**

<b>Joint Technical Program Committee Contact(s)</b>	<b>Discipline</b>	<b>Review Group</b>
Dorothy Sack, sack@ohio.edu; Joanne Bourgeois, jbourgeo@uw.edu; Michael S. Smith, smithms@uncw.edu; Renee Clary, rclary@geosci.msstate.edu	history of geology	History and Philosophy of Geology Division
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Michael Williams, mlw@geo.umass.edu	Precambrian geology	Precambrian Geology
Glenn D. Thackray, thacglen@isu.edu; Tammy M. Rittenour, tammy.rittenour@usu.edu	geomorphology; Quaternary geology	Quaternary Geology and Geomorphology Division
Ryan F. Morgan, rmorgan@tarleton.edu; Piret Plink-Bjorklund, pplink@mines.edu	sediments, carbonates; sediments, clastic; stratigraphy	Sedimentary Geology Division
Piret Plink-Bjorklund, pplink@mines.edu	sediments, carbonates	Society for Sedimentary Geology
Garth Graham, ggraham@usgs.gov	economic geology	Society of Economic Geologists
Steven G. Driese, steven_driese@baylor.edu; Neil J. Tabor, ntabor@smu.edu	soils	Soils and Soil Processes (Interdisciplinary Interest Group)
Juliet Crider, criderj@uw.edu; Andrew P. Barth, ibsz100@iupui.edu	structural geology; tectonics	Structural Geology and Tectonics Division

# GSA 2017 Organizing Committee



**Co-General Chairs:** Alan Gillespie, University of Washington, [arg3@u.washington.edu](mailto:arg3@u.washington.edu); Darrel Cowan, University of Washington, [darrel@u.washington.edu](mailto:darrel@u.washington.edu)

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**Technical Program Vice-Chair:** Kevin Mickus, Missouri State University, [kevinmickus@missouristate.edu](mailto:kevinmickus@missouristate.edu)

**Field Trip Co-Chair:** Ralph Haugerud, U.S. Geological Survey, [rhaugerud@usgs.gov](mailto:rhaugerud@usgs.gov)

**Field Trip Co-Chair:** Harvey Kelsey, Humboldt State University, [harvey.kelsey@humboldt.edu](mailto:harvey.kelsey@humboldt.edu)

**Sponsorship Chair:** Brian Butler, Landau Associates, Inc., [BButler@landauinc.com](mailto:BButler@landauinc.com)

**K-12 Chair:** Michael O'Neal, University of Delaware, [oneal@udel.edu](mailto:oneal@udel.edu)

**Host University:** University of Washington

**Student Committee Chair:** Linnea McCann, University of Washington, [lmnn26@uw.edu](mailto:lmnn26@uw.edu)

**Student Committee Members:** Madeleine Hummer, University of Washington, [maddy.wa@gmail.com](mailto:maddy.wa@gmail.com); Michael Zackery McIntire, University of Washington, [zackmc@uw.edu](mailto:zackmc@uw.edu); Virginia Little, University of Washington, [littellvh@gmail.com](mailto:littellvh@gmail.com); Keith Hodson, University of Washington, [krhodson@uw.edu](mailto:krhodson@uw.edu)



## GSA's Associated Societies Program

GSA has a long tradition of collaborating with like-minded organizations in pursuit of mutual goals to advance the geosciences. As the Society looks to the future, it aims to build strong, meaningful partnerships with other societies and organizations across the country and around the world in service to members and the global geoscience community. National and international societies with consistent aims and missions of advancing the geosciences and/or science in general are invited to affiliate with GSA as an Associated Society.

GSA currently works with its 72 Associated Societies, two Interdisciplinary Interest Groups, and 18 specialty science Divisions to build a dynamic Annual Meeting technical program and exciting events during the meeting. We invite our Associated Societies to present their representative science and hold

customized events during the Seattle, Washington, meeting this October. GSA is looking forward to hosting our valued partners and organizations to present their science, hold meetings, and to exhibit at a booth during the meeting. Members of Associated Society organizations also receive the GSA member registration rate to the Annual Meeting.

For more information about the GSA Associated Society program and a full list of current Associated Societies, click on the "About" tab at [www.geosociety.org](http://www.geosociety.org), and then select "Who We Are."

# Seattle—It's A Numbers Game



- 1. 3** National Parks located in state, Mount Rainer, North Cascades, and Olympic are all within driving distance of the city (2.5 hours);
- 2.** Suds, suds, and more suds—with more than **200** independent breweries across the state, you may find the IPA you've been thirsting for;
- 3.** For those who have a more fruit-forward palate and want something "with legs," there are more than **850** wineries—drink local;
- 4.** Hungry? **23** prestigious James Beard award-winning restaurants;
- 5.** Whether you enjoy Jimi Hendrix, Heart, Nirvana, or Sir Mix-A-Lot, you'll find your next playlist at one of the more than **3,200** live music venues.

**GSA looks forward to going to the *nth degree* with you in Seattle!**

**25,000** members

**18** Divisions

**6** Sections

**1** Annual Meeting, where ALL are welcome!

Join us in Seattle 22–25 October for more than 48 hours of oral presentations, posters, field trips, and short courses that continue the advancement of the geosciences.



**[community.geosociety.org/gsa2017](http://community.geosociety.org/gsa2017)**

# Travel & Transportation



SeaTac. Photo by Don Wilson.

## Seattle Airport (IATA: SEA; ICAO: KSEA):

Seattle-Tacoma International Airport (or SeaTac), is the largest airport in the Pacific Northwest region of the United States. It is located 12 miles south of downtown Seattle. The airport is the main hub for Alaska Airlines and its regional subsidiary Horizon Air. It is also a hub for Delta Airlines, serving as a gateway to Europe and Asia. Multiple transportation options connect SeaTac to the metro area from rail, Prince Island Sound transit, metro bus, and taxi, [www.seattle-airport.com](http://www.seattle-airport.com).

**Amtrak** has three lines that serve Seattle. The Cascades Line travels between Vancouver, British Columbia, Canada –Seattle–Tacoma–Portland–Salem–Eugene. The Empire Builder travels between Chicago–Milwaukee–Minneapolis–Portland–Seattle. The Coast Starlight travels between Seattle–Portland –Los Angeles, [www.amtrak.com/train-schedules-timetables](http://www.amtrak.com/train-schedules-timetables).



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



**22-25 October**  
Seattle, Washington, USA

**International Attendees:** If you are visiting the United States from outside of the country and do not have United States citizenship, you may require a visa. For more information, go to <https://travel.state.gov/content/visas/en.html>. You can obtain and print out the GSA Invitation Letter to the 2017 Annual Meeting via a link at [community.geosociety.org/gsa2017/visaletter](http://community.geosociety.org/gsa2017/visaletter).



## Transform Your Tomorrow

Join more than 450 diverse students who have been funded to attend their first GSA Annual Meeting. Travel awards are available to students from underrepresented groups to attend the GSA 2017 Annual Meeting, Seattle, Washington, on 22–25 October. Students will have special opportunities to be paired with a meeting mentor and attend morning sessions connecting students with key GSA leaders. Visit the On To the Future website to apply today. **Deadline:** 26 May.

[www.geosociety.org/otf](http://www.geosociety.org/otf)



# Hotels

GSA has selected a range of hotels based on proximity to the Washington State Convention Center (WSCC), rate, and style to meet your needs and preferences. Below is the list of hotels and group rates for our block. Rates are in U.S. dollars and do not include the current applicable tax of 15.60% plus

a US\$2 fee per room per night. Complimentary basic Internet will be provided in all guest rooms booked through GSA/Orchid Events. Please check the GSA website, [community.geosociety.org/gsa2017/attendeeinfo/accommodations/hotels](http://community.geosociety.org/gsa2017/attendeeinfo/accommodations/hotels) for details.

Hotel	Rate (Single/Double)	Each Additional Adult	Distance to WSCC	Parking Daily/24 hr**
Sheraton Seattle Hotel (HQ)	\$219	\$25	0.5 blocks	\$57 Valet
Crowne Plaza Seattle Downtown	\$169	\$25	3.5 blocks	\$50 Valet
Hilton Garden Inn Seattle Downtown	\$174	\$10	5.0 blocks	\$43 Valet
Homewood Suites Seattle Convention Center-Pike Street	\$179	\$25	2.0 blocks	\$45 Valet
Paramount Hotel Seattle	\$185	\$25	1.0 block	\$39 Valet
Renaissance Seattle Hotel	\$182	\$25	5.5 blocks	\$43 Self/ \$55 Valet
Roosevelt Hotel Seattle	\$185	\$25	1.0 block	\$45 Valet
Seattle Hilton	\$189	\$25	2.5 blocks	\$45 Self
Springhill Suites by Marriott Seattle Downtown/South Lake Union*	\$184	\$10	6.0 blocks	\$26 Valet
Westin Seattle	\$185	\$30	4.5 blocks	\$45 Self/ \$57 Valet

\*Breakfast included in rate

\*\*Parking rates subject to change; additional fees for oversized vehicles



**ALERT:** The official GSA housing bureau is Orchid Events. To receive the GSA group rate at each hotel, reservations must be made through Orchid Events and not directly with the hotels. GSA and Orchid Events 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 +1-303-357-1041. Please do not make hotel arrangements or share any personal information through any means other than a trusted, reliable source.







# Take Your Annual Meeting Science on the Road

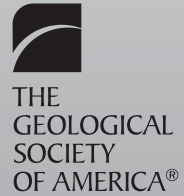
Meetings can be great catalysts for generating scientific discussions and field study ideas. The next step: Follow up with a Penrose Conference or Thompson Field Forum.

**Penrose Conferences** have a long history of bringing together multidisciplinary groups of geoscientists to facilitate open and frank discussions of ideas in an informal atmosphere and to inspire collaborative research.



**Thompson Field Forums** are designed to capture the essence of exciting discoveries and/or controversial topics via forays into the field. On-the-spot discussions of a particular geologic feature or area bring together experts on the topic at hand to exchange current knowledge, ideas, and theories.

Learn more at:  
[www.geosociety.org](http://www.geosociety.org)  
 or contact Becky Sundeen at  
[bsundeen@geosociety.org](mailto:bsundeen@geosociety.org).



E-books Now Available

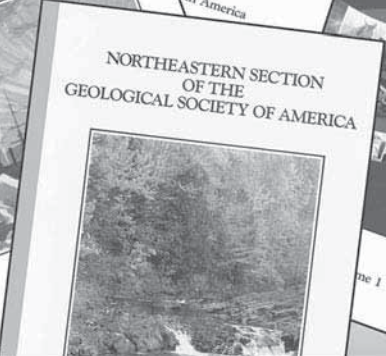
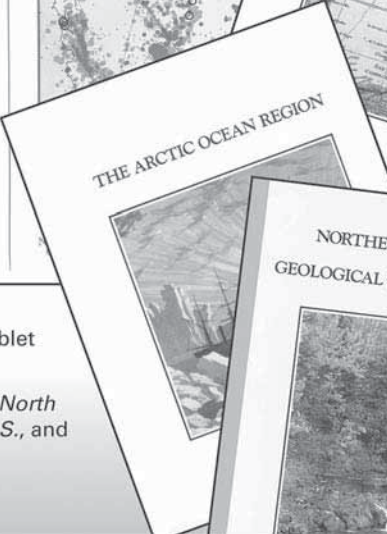
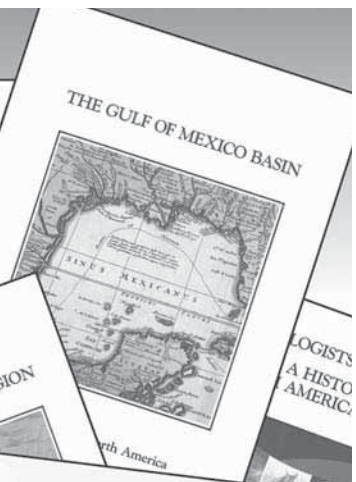
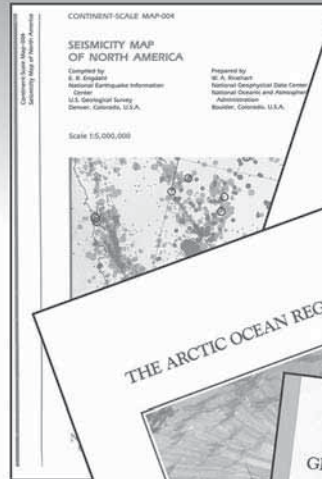
## The Decade of North American Geology DNAG

ONLY \$9.99 each

The Decade of North American Geology volumes, including the Centennial Field Guides, Continent-Scale Map Series, Continent-Ocean Transects, and all 26 volumes of the Geology of North America, are available as downloads for \$9.99 each at the GSA Store.

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

The discipline- and region-specific books include *The Geology of North America; An Overview*, *The Cordilleran Orogen: Conterminous U.S.*, and *Sedimentary Cover—North American Craton: U.S.*



Start exploring at [rock.geosociety.org/store/](http://rock.geosociety.org/store/).

# Scientific Field Trips

Descriptions and leader bios are online.

**401. Generation of the Palouse Loess: Exploring the Linkages between Glaciation, Outburst Megafloods, and Aeolian Deposition in Washington State.** Wed.–Fri., 18–20 Oct.

Cosponsor: *GSA Quaternary Geology and Geomorphology Division*. Leaders: Mark R. Sweeney, Univ. of South Dakota; Eric V. McDonald, David R. Gaylord.

**402. Late Pleistocene Glaciation and Megafloods: The Cordilleran Ice Sheet and Columbia River Valley, Drainage Diversions, and Megafloods from Glacial Lake Missoula and Glacial Lake Columbia.** Wed.–Sat., 18–21 Oct. Leaders: Jim E. O'Connor, U.S. Geological Survey; Victor R. Baker, Richard B. Waitt, Andrea Balbas.

**403. Incorporation of Sedimentary Rocks into the Deep Levels of Continental Magmatic Arcs: Links between the North Cascades Arc and Surrounding Sedimentary Terranes.** Thurs.–Sat., 19–21 Oct. Cosponsors: *GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Structural Geology and Tectonics Division*. Leaders: Stacia M. Gordon, Univ. of Nevada–Reno; Robert B. Miller, Kirsten B. Sauer.

**404. Exploring the Western Idaho Shear Zone Using the Strabo Data System.** Thurs.–Sat., 19–21 Oct. Leaders: Basil Tikoff, Univ. of Wisconsin; Z.D. Michels, Maureen Kahn, Richard M. Gaschnig, Kathy K. Davenport, Christian Stanciu.

**405. Mesozoic Terranes of the Central Cascades: Geology of the Hicks Butte Complex, Easton Metamorphic Suite, Peshastin Formation, and Ingalls Serpentinite.** Thurs.–Sat., 19–21 Oct. Leaders: James H. MacDonald, Florida Gulf Coast Univ.; Joe D. Dragovich.

**406. Tsunamis in the Salish Sea: Recurrence, Sources, Hazards.** Fri., 20 Oct. Leaders: Carrie Garrison-Laney, Univ. of Washington; Ian Miller, Brian Atwater.

**407. Geoarchaeology of the Central Puget Lowland.**

Fri.–Sat., 20–21 Oct. Cosponsors: *SWCA Environmental Consultants; Burke Museum*. Leaders: Brandy A. Rinck, SWCA Environmental Consultants; Jack Johnson.

**408. Geologic Challenges and Engineering Solutions for Major Transportation Construction Projects in Seattle.**

Fri.–Sat., 20–21 Oct. Leaders: William Laprade, Elizabeth Barnett, Shannon & Wilson, Inc.; Red Robinson, Jenn Parker, Andrew Caneday, Jeremy Butkovich.

**409. Geology of Seattle.** Fri., 20 Oct. Leaders: Ralph Haugerud, U.S. Geological Survey; Kathy Goetz Troost.

**410. Rivers Gone Wild: Extreme Landscape Response to Climate-Induced Flooding and Debris Flows, and Implications to Long-Term Management at Mount Rainier National Park.** Sat., 21 Oct. Cosponsors: *National Park Service; GSA Quaternary Geology and Geomorphology Division*. Leaders: Scott R. Beason, Mount Rainier National Park; Paul M. Kennard.

**411. Exploring the Mechanics, Frequency, and Impacts of Deep-Seated Landslides in Washington State.** Sat., 21 Oct. Leaders: Alison R. Duvall, Univ. of Washington; Sean Richard LaHusen.

**412. Glacial-Interglacial History of Whidbey Island: New Insights.** Sat., 21 Oct. Leaders: Terry Swanson, Univ. of Washington.

**413. Mount St. Helens—Its 1980 Eruption and Subsequent Hydrogeomorphic and Ecologic Responses.** Sat., 21 Oct. Leaders: Jon J. Major, Volcano Science Center; Charles M. Crisafulli.



Photo taken ca. 1970 by Link Washburn. Aerial view of Mima prairie and mounds.



Photo taken by Ron Sletten (8/3/2014) of Mount St. Helens from Johnston Ridge Observatory.

414. **Accessible Field Geology of Western Washington.** Sat., 21 Oct. Cosponsors: *Geoscience Education Division; International Association for Geoscience Diversity*. Leaders: Christopher L. Atchison, Univ. of Cincinnati; Steven J. Whitmeyer.

415. **Geology Underfoot: Helping Students Visualize the Geology of an Urban Landscape by Exploring the Glacial Geomorphology of the Greater Seattle Area.** Sat., 21 Oct. Leaders: Alecia Spooner, North Seattle College; Caroline R. Pew.

416. **The Seattle Fault and the Newcastle Anticline: The Structure and Dynamics of an Active Fold-and-Thrust Belt.** Sat., 21 Oct. Leader: John T. Figge, North Seattle College.

417. **Groundwater Remedial Activities at Department of Energy’s Hanford Site, Southeastern Washington.** Wed.–Thurs., 25–26 Oct. Cosponsor: *GSA Hydrogeology Division*. Leaders: Sunil Mehta; Bruce Williams.

419. **Glaciers, Isostasy, and Eustasy in the Fraser Lowland: Resolving Late Pleistocene Glaciation across the International Border.** Thurs., 26 Oct. Leaders: Douglas H. Clark, Western Washington Univ; John Clague.

420. **The Ultimate Washington State Terroir Tour.** Thurs.–Sat., 26–28 Oct. Leaders: Alan Busacca, Vinitas Vineyard Consultants, LLC; Kevin Pogue.

421. **Grounding Line Processes of the Southern Cordilleran Ice Sheet: Whidbey Island, Puget Lowlands.** Thurs., 26 Oct. Leaders: John B. Anderson, Rice Univ.; Lauren M. Simkins, Brian P. Demet.

422. **Structure, Neotectonics, Geophysics, and Geomorphology of the Yakima Folds: New Field Research on Fold Structure and Miocene-Present Deformation within the Backarc of the Cascadia Subduction Zone.** Thurs.–Sat., 26–28 Oct. Leaders: Harvey M. Kelsey, Humboldt State Univ.; Scott Bennett, Lydia Staisch, Brian L. Sherrod.

423. **Sedimentary, Volcanic, and Structural Processes during Triple-Junction Migration: Insights from the Paleogene Record in Central Washington.** Thurs.–Sat., 26–28 Oct. Leaders: Michael P. Eddy, Princeton Univ.; Robert B. Miller, Paul J. Umhoefer.

424. **Mima Mounds Tour and Review of Formative Hypotheses.** Thurs., 26 Oct. Leader: Ronald S. Sletten, Univ. of Washington.



## Event Space & Event Listing Requests



► **Deadline for first consideration: 6 June**

Please let us know about your non-technical events via our online event space & event-listing database (connect via community.geosociety.org/gsa2017/spacerequest). Space is reserved on a first-come, first-served basis; in order to avoid increased fees, you must submit your request for meeting rooms by 6 June. The event space/event listing submission should be used for meeting rooms to hold events (i.e., business meetings, luncheons, receptions, etc.).

- At the Washington State Convention Center (WSCC) or Sheraton Seattle Hotel—with no food/beverage minimum or room rental fee from the facility/hotel; and/or
- For off-site events (events that are not being held at the WSCC or Sheraton Seattle). Ensure that your event is listed in the meeting program book, in the personal scheduler, and the mobile app, as well as on the GSA website.

If your event is private or by “invitation only,” please indicate that and limit who has access to the information. For example, for private events, you simply check the “private” box and the information won’t be included in any of our listings. If your event is by invitation only, please indicate that in the *Notes to GSA* section.



# Short Courses

*Learn and explore a new topic.*

**Professionals** can learn about 3D hydrogeological modeling and preparing for the ASBOG Fundamentals Examination.

**Faculty and students** can explore terrestrial laser scanning, ground penetrating radar, U-Th-Pb geochronology, Structure from Motion (SfM) photogrammetry, modeling magmatic processes using MELTS, the Geochron.org database, the Magma Chamber Simulator, the Strabo Data System, and the Landlab Earth Surface Modeling Toolkit; learn global geohieritage, well log interpretation, limnogeology, tools for water data discovery, micro- and nano-imaging and analysis, petrochronology, uses and evolution of magmatic structures, and subaqueous paleoseismology methods; and gain tips for communicating geoscience research and helping students thrive in geoscience at two-year colleges.

**Students and early career professionals** can learn more about sequence stratigraphy, the structure and stratigraphy used for basin exploration, preparing for a career in the geosciences, preparing for the ASBOG fundamentals examination, and the Flyover Country Mobile App for student self-guided field experiences.

For details and course descriptions, check the upcoming June issue of *GSA Today*.



**22-25 October**  
Seattle, Washington, USA

*This is a great opportunity to earn continuing education credits!*



**22-25 October**  
Seattle, Washington, USA

## Exhibits, Advertising, and Sponsorship

Don't miss the opportunity to reach a broad cross section of geoscientists. Hosted in beautiful, breath-taking Seattle, your reach will be to industry representatives, professors, researchers, government employees, and, most importantly, our talented students. Students are our future leaders in the geoscience industry and academia. Your presence will have impact and extend your brand awareness. Your message, through an exhibit booth, sponsorship, or advertising, will be visible to a robust audience of approximately 7,000.

Not only do we have exhibit booths available, but you can amplify your presence by choosing your own adventure!

- Advertising in print and e-media
- Sponsorship at various levels
- Technical demonstrations

### **Exhibit booth inquiries:**

David Gerhardt, Exhibits Manager, +1-312-265-9664, [david@corcexpo.com](mailto:david@corcexpo.com)

### **Advertising inquiries:**

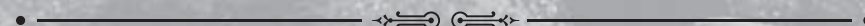
Ann Crawford, Advertising Manager, +1-303-357-1053, [advertising@geosociety.org](mailto:advertising@geosociety.org),  
[www.geosociety.org/Advertising](http://www.geosociety.org/Advertising)

### **Sponsorship inquiries:**

Debbie Marcinkowski, Director of Development, Corporate Partnerships,  
[dmarcinkowski@geosociety.org](mailto:dmarcinkowski@geosociety.org), +1-303-357-1047,  
[community.geosociety.org/gsa2017/sponsors](http://community.geosociety.org/gsa2017/sponsors)



The must-attend event in geoscience for industry representatives, academics and students, scientific organizations, and government agencies.



Second Announcement

# ROCKY MOUNTAIN SECTION

69th Annual Meeting of the Rocky Mountain Section, GSA  
Calgary, Alberta, Canada  
9–10 June 2017

[www.geosociety.org/rm-mtg](http://www.geosociety.org/rm-mtg)



Mount Allan—"The Claw" Three Sisters.

*Join Us in the Heart of the Western Canadian Sedimentary Basin, the Gateway to the Canadian Rockies*

## LOCATION

Calgary is located in the heart of the Western Canadian Sedimentary Basin within sight of the Canadian Rockies. Our technical program explores much of the geological time scale and is intended to bridge across the North American Rocky Mountains. The field trips offer opportunities to explore our local UNESCO World Heritage sites, such as the bone beds at Dinosaur Provincial Park and the Burgess Shale trilobite beds in Yoho National Park, the Royal Tyrrell Museum of Palaeontology, as well as the landscapes, geology, hot springs, and innovative carbon capture facilities of Alberta.

## REGISTRATION

**Early registration deadline:** 1 May

**Cancellation deadline:** 8 May

Please register online at [www.geosociety.org/rm-mtg](http://www.geosociety.org/rm-mtg)

**Registration fees (all fees are in U.S. dollars).** Fees for onsite registration will be collected in U.S. dollars and credit cards only (no checks).

	Standard	
	Full Mtg.	One day
Professional Member	\$335	\$175
Professional Member 70+	\$175	\$90
Professional Nonmember	\$375	\$205
Prof. Low-Income Countries	\$152	\$77
Early Career Professionals	\$175	\$95
Student Member	\$125	\$80
Student Nonmember	\$140	\$100
Student Low-Income Countries	\$52	\$27
K–12 Professional	\$125	\$80
Guest or Spouse	\$55	n/a
Field Trip/Workshop Only	\$55	n/a

## ACCOMMODATIONS

**Hotel registration deadline:** 25 May

A block of rooms has been reserved at Grey Eagles Hotel; 3777 Grey Eagle Drive, Calgary, Alberta, Canada. The meeting rate is CDN\$149.00 per night plus tax, which includes breakfast and a shuttle to campus. Reservations should be made by calling Grey Eagles Resort and Casino at +1-844-719-8777. Please mention that you are attending the GSA Rocky Mountain Section Meeting to get the discount.

**Residences deadline:** 1 May

A block of rooms has been reserved at Mount Royal University residences (West Residence Front Desk for check-in; 200 Mount Royal Circle SW, Calgary, Alberta, Canada). The meeting rate is CDN\$49.05 per night plus tax. Reservations should be made by calling Mount Royal University Residences at +1-866-264-7875 or local +1-403-440-6275. Please mention that you are attending the GSA Rocky Mountain Section Meeting to get the discount.

## TECHNICAL PROGRAM

The technical program is online at <https://gsa.confex.com/gsa/2017RM/webprogram/start.html>.

## FIELD TRIPS

For additional information, please contact the Field Trip Chair, Jean Hsieh, [jhsieh@repsol.com](mailto:jhsieh@repsol.com).

### Pre-Meeting

**FT1. Hot and Cold Running Water in the Canadian Rockies.** Thurs., 8 June. Cost: US\$100. Steve Grasby, Natural Resources Canada, [steve.grasby@canada.ca](mailto:steve.grasby@canada.ca).

**FT3. Effects of Sedimentology and Facies on Structural Styles in the Canadian Rocky Mountain Fold and Thrust Belt.** Wed.–Thurs., 7–8 June. Cost: US\$315. Byron Veilleux, Repsol Oil &

Gas Canada, Inc., bveilleux@repsol.com; Normand Bégin, Repsol Oil & Gas Canada, Inc., nbegin@repsol.com.

**FT4. Late Cretaceous Geology and Fossils of Dinosaur Provincial Park.** Wed.–Thurs., 7–8 June. Cost: US\$210. Don Henderson, Royal Tyrrell Museum, don.henderson@gov.ab.ca.

**FT11. New Looks at Old Paradigms—Semi-Radical Interpretations of Geomorphology and Cenozoic Rocks and Sediments in the Red Deer River Valley.** Thurs., 8 June. Cost: US\$150. Milovan Fustic, University of Calgary, mfustic@ucalgary.ca; Kalina Malowany, University of Calgary, kalina-malowany@gmail.com; Gerald Osborn, University of Calgary, osborn@ucalgary.ca.

#### Post-Meeting

**FT5. Biota, Brines, Sandstones, and Mines: Geology of the Early–Mid Cambrian of the Canadian Southern Rocky Mountains.** Sun.–Mon., 11–12 June. Cost: US\$375. Paul Johnston, Mount Royal University, pajohnston@mtroyal.ca; Chris Collom, MacCallum Geological Consulting, Calgary, cjcollom@shaw.ca; Patricio Desjardins, patricio.desjardins@gmail.com.

**FT6. Carbon Capture and Storage: A Trip to Visit Past and Recent Changing Environments in Alberta's Plains and Shell's World-Leading Quest CCS Project.** Sun.–Tues., 11–13 June. Cost: US\$475. Kirk Osadetz, CMC Research Institutes, Inc., kirk.osadetz@cmcghg.com; Luc Rock, Shell, luc.rock@shell.co; Alwynne Beaudoin, Royal Alberta Museum, alwynne.beaudoin@gov.ab.ca.

**FT7. Geology of the Waterton–Glacier National Parks Area.** Sun.–Tues., 11–13 June. Cost: US\$330. Brian Pratt, University of Saskatchewan, brian.pratt@usask.ca.

**FT8. Evidence for Catastrophic Subglacial Processes across Alberta, and a Refined Deglacial Chronology in the Zone of the Purported Ice-Free Corridor.** Sun.–Mon., 11–12 June. Cost: US\$260. Robert Young, University of British Columbia, Okanagan Campus, robert.young@ubc.ca.

**FT9. Montney Analogue Field Trip: The Sulphur Mountain Formation around Canmore and Kananaskis.** Sun., 11 June. Cost: US\$100. Jon Noad, Sedimental Services, jonnoad@hotmail.com.

**FT10. Canadian Rocky Mountain Fold and Thrust Belt for Geoscience Educators.** Sun., 11 June. Cost: US\$85. Glenn Dolpin, University of Calgary, glenn.dolpin@ucalgary.ca; Katherine Boggs, Mount Royal University, kboggs@mtroyal.ca.

#### WORKSHOPS

##### Pre-Meeting

**W1. Clastic Sedimentology Workshop—Applications and Examples from the Energy Industry (Students, K–12 Teachers, and Geoscience Educators).** *Cosponsored by Repsol Oil & Gas Canada Inc.* Thurs., 8 June. Cost: US\$15. Mark Radomski, Repsol Oil & Gas Canada, Inc., mradomski@repsol.com.

**W2. Digital Field Methods for Sed/Strat and Structural Geology: Use of Tablet-Based Apps for Mapping and Measurements in Undergraduate Courses.** 1–5 p.m., Thurs., 8 June. Cost: US\$30. Lawrence Malinconico, Lafayette College, malincol@lafayette.edu.

**W4. Using Virtual Field Experiences (VFEs) to Enhance Learning in Undergraduate Geology Courses.** 8 a.m.–1 p.m., Thurs., 8 June. Cost: US\$30. Glenn Dolphin, University of Calgary, glenn.dolphin@ucalgary.ca; Jon Cooper, University of Calgary, jonathan.cooper@ucalgary.ca; Alexander Dutchak, University of Calgary, alexander.dutchak@ucalgary.ca; Brandon Karchewski, University of Calgary, brandon.karchewski@ucalgary.ca.

##### Post-Meeting

**W3. Planning for the future of the Canadian Cordillera Array and EarthsCAN.** Sun., 11 June. Cost: US\$30. Dave Eaton, University of Calgary, eatond@ucalgary.ca; Jeff Freymueller, University of Alaska Fairbanks, jfreymueller@alaska.edu; Rick Aster, Colorado State University, rick.aster@colostate.edu; Katherine Boggs, Mount Royal University, kboggs@mtroyal.ca; Julie Elliott, Purdue University, julieelliott@purdue.edu; Roy Hyndman, Natural Resources Canada, roy.hyndman@canada.ca; Lucinda Leonard, University of Victoria, lleonard@uvic.ca; Kristin Morell, University of Victoria, kmorell@uvic.ca; Mike Schmidt, University of Calgary, michael.schmidt@ucalgary.ca; Derek Schutt, Colorado State University, derek.schutt@colostate.edu.

**W5. Virtual Geological Tours—3D Geological Modeling of Outcrops Utilizing Unmanned Aerial Vehicles.** Sun., 11 June. Cost: US\$30. Rudy Strobl, Executive Director, EnerFox Enterprises; Milovan Fustic, Adjunct Professor, University of Calgary; Rob Davies, Director of Field Operations, Automated Aeronautics.

#### STUDENT AND EARLY CAREER PROFESSIONAL OPPORTUNITIES

**Geoscience Career Mentoring Luncheons.** Jennifer Nocerino, jnocerino@geosociety.org.

**Roy J. Shlemon Mentor Program in Applied Geoscience.** Students and early career professionals will have the opportunity to discuss career prospects and challenges with applied geoscientists from various sectors over a FREE lunch.

**John Mann Mentors in Applied Hydrology Program.** Students and early career professionals interested in applied hydrogeology or hydrology as a career will have the opportunity to network with professionals in these fields over a FREE lunch.

**Geoscience Career Workshops.** Jennifer Nocerino, jnocerino@geosociety.org.

**Part 1: Career Planning and Informational Interviewing.** Your job-hunting process should begin with career planning, not when you apply for jobs. This workshop will help you begin this process and will introduce you to informational interviewing.

**Part 2: Geoscience Career Exploration.** What do geologists in various sectors earn? What do they do? What are the pros and cons to working in academia, government, and industry? Workshop presenters and professionals in the field will address these issues.


**Part 3: Cover Letters, Résumés, and CVs.** How do you prepare a cover letter? Does your résumé need a good edit? Whether you are currently in the job market or not, learn how to prepare the best résumé possible. You will review numerous examples to help you learn important résumé dos and don'ts.

**LOCAL COMMITTEE**

Chair: Katherine Boggs, kboggs@mtroyal.ca  
 Technical Session Chair: Jenni Scott, jescott@mtroyal.ca  
 Field Trip Chair: Jean Hsieh, jhsieh@repsol.com  
 Volunteer Chair: Susan Reid, sjreid1@mtroyal.ca

If you need special accommodations, or if you have questions about exhibits or sponsors, contact Katherine Boggs, kboggs@mtroyal.ca.

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- Virginia City and the Comstock Lode
- Frenchman Mountain's Great Unconformity
- Ruby Mountains' glacially carved Lamoille Canyon
- Berlin-Ichthyosaur State Park's fossil reptiles
- Lake Tahoe's granitic eastern shore
- Red Rock Canyon's Jurassic sandstone
- Cathedral Gorge's lakebed badlands
- Pyramid Lake's tufa towers
- Alamo's extraterrestrial impact
- Virgin Valley's fossils and opal
- Valley of Fire's bright red rock
- Tule Springs Fossil Beds
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The Development of Natural Gas from the Marcellus Shale

By Daniel J. Soeder

New technology has opened vast reserves of "unconventional" natural gas and oil from shales like the Marcellus in the Appalachian Basin, making the United States essentially energy independent for the first time in decades. Shale gas had its origins in the oil embargos and energy crises of the 1970s, which led to government research to increase domestic energy supplies. The first large-scale shale gas production was successful on the Barnett Shale in Texas in the late 1990s, followed a few years later by the Marcellus Shale in Pennsylvania. Shale gas has changed thinking about fossil energy supplies worldwide, but the development of these resources has been controversial. Activists have made claims that hydraulic fracturing may contribute to climate change, threaten groundwater resources, and pose risks to terrestrial and aquatic ecosystems, and human health. This volume explores the geology, history, technology, and potential environmental impacts of Marcellus Shale gas resources.

*"An excellent objective explanation of the history, science, technology, politics, environmental concerns, and economics of the shale gas boom. The author clearly has great practical experience of the science and technology of shale gas development and shows a deep understanding of the environmental and economic issues."*

—Andrew Stone, Executive Director, American Ground Water Trust

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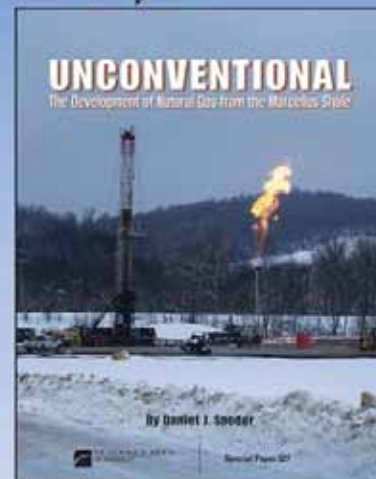


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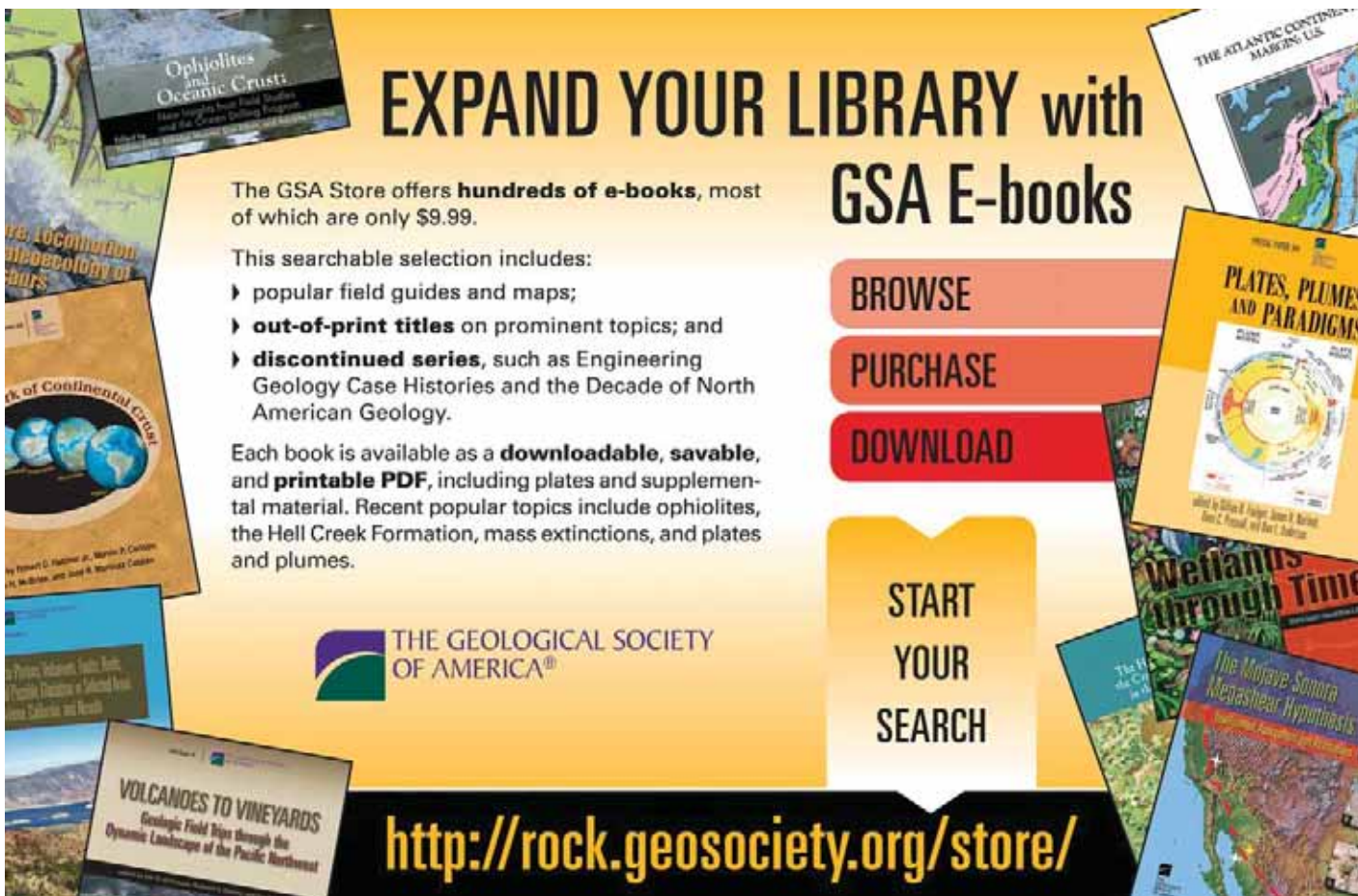
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## Announcement

# Advances in Salt Tectonics: Observations, Applications, and Perspective: In Honor of Martin P.A. Jackson

11–16 February 2018 • Dead Sea, Ein Boqeq, Israel

[www.geosociety.org/PenroseConferences](http://www.geosociety.org/PenroseConferences)

### CONVENERS

**Ram Weinberger**, Geological Survey of Israel, Jerusalem, and Department of Geological and Environmental Sciences, Ben-Gurion University of the Negev, Beer Sheva, Israel, [rami.weinberger@gsi.gov.il](mailto:rami.weinberger@gsi.gov.il)

**Ian Alsop**, Department of Geology and Petroleum Geology, School of Geosciences, University of Aberdeen, Aberdeen, UK, [ian.alsop@abdn.ac.uk](mailto:ian.alsop@abdn.ac.uk)

**Michael R. Hudec**, Bureau of Economic Geology, The University of Texas at Austin, Austin, Texas, USA, [michael.hudec@beg.utexas.edu](mailto:michael.hudec@beg.utexas.edu)

**Cosponsored by:** *GSA Foundation, Israeli Ministry of Science, Geological Survey of Israel*

### DESCRIPTION AND OBJECTIVES

Salt tectonics involves processes associated with the flow of rock salt. These processes are both scientifically and economically important, because (1) when salt is present, it typically dominates the structural style, evolution, and stratigraphic development of surrounding regions, providing a long time-scale, long length-scale record of geodynamic processes; and (2) salt governs hydrocarbon trap development and the thermal evolution of many basins, including some of the largest hydrocarbon accumulations on Earth. Great advances have been made in salt tectonics over the past 10 years, largely driven by the utilization of 3D seismic data, advanced physical and numerical modeling techniques, and application of modern geospatial technology to the study of exposed salt structures. This Penrose Conference will gather the leading academic and applied industry experts in salt tectonics in the Dead Sea (the lowest place on Earth's surface), with field trips to the Sedom salt wall, one of the most accessible and exceptional salt diapirs in the world.

The main objectives of the meeting are to present and discuss:

1. New field-based observations of salt-diapir geometries and kinematics;
2. Latest advances in understanding of diapiric structures from seismic interpretation;

3. New concepts derived from physical and mathematical modeling of salt diapirs;
4. Innovative, and perhaps controversial new concepts in salt tectonics;
5. Evolution of salt basins; and
6. A field visit to the Sedom salt wall, which provides as an outstanding outcrop example of diapiric geometry, kinematics and mechanics.

The preliminary outline of sessions is as follows:

1. Field-based studies of salt diapirs and related structures;
2. Seismic-based analysis of salt tectonic systems in Atlantic margins, Gulf of Mexico, North Sea, and elsewhere;
3. Physical and mathematical modeling of salt tectonics;
4. Mechanics of salt flow from microscale to macroscale; and
5. Interrelations between salt tectonics and hydrocarbons.

### PRELIMINARY AGENDA

This six-day meeting will start with an icebreaker on the shore of the Dead Sea, Israel, on the evening of Sunday, 11 Feb. 2018. It will end at the foot of Masada, on the afternoon of Friday, 16 Feb. 2018. The meeting will contain a balance of two days of field excursions and three days of talks and poster presentations. The field excursions will focus on the Sedom salt wall as well as the Dead Sea plate-bounding fault systems and seismically triggered deformation structures in the Dead Sea basin. We believe the Sedom salt wall to be one of the best exposed and most accessible salt diapirs in the world, with an impressive current uplift rate of about 8 mm/yr. It includes great outcrops of both halite and surrounding sediments.

All nights will be spent at the Leonardo Club Hotel, Dead Sea, which is a 15-minute drive from the Sedom salt wall and about a two-hour drive from the international airport at Tel-Aviv.

### ATTENDEES AND ESTIMATED COSTS

The registration fee is estimated at US\$750–\$850 and will cover the cost of the meeting, hotel lodging for five nights (double occupancy; single occupancy will be possible with additional fees), the icebreaker reception, all meals and coffee breaks for five days, transportation, and meals for the field trips. Airfare is not



Dead Sea, Israel. Photo by Ian Alsop.

included and participants must make their own travel arrangements.

### **APPLICATIONS AND REGISTRATION**

**Application deadline:** 15 May 2017

**Registration deadline:** 15 July 2017

The conference will be limited to 60 participants and each participant will have to commit to attending the full six days of the conference. To apply, please contact the conveners at [rami.weinberger@gsi.gov.il](mailto:rami.weinberger@gsi.gov.il) with a letter of intent that includes a brief statement of interests, the relevance of your recent work to the themes of the conference, the subject of your proposed presentation, and contact information. Interested graduate students and early career faculty are encouraged to apply. Once you have been selected to participate, you will be sent registration information.



Wadi Perazim, Israel. Photo by Ram Weinberger.



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

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

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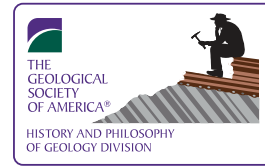


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# GSA DIVISION AWARDS



## ■ HISTORY AND PHILOSOPHY OF GEOLOGY

### History and Philosophy of Geology Student Award

**Deadline:** 15 June

This award is for the best paper in history and philosophy of geology to be submitted for presentation by the student at the annual GSA meeting. The proposed paper may be: (1) a paper in the history and philosophy of geology; (2) a literature review of ideas for a technical work or thesis/dissertation; or (3) some imaginative aspect of the history and philosophy of geology we have not thought of before. For more information, please contact Kathleen Lohff at [kathylohff@msn.com](mailto:kathylohff@msn.com) or go to [community.geosociety.org/histphildiv/awards#student](http://community.geosociety.org/histphildiv/awards#student).



## ■ LIMNOGEOLOGY

### Kerry Kelts Student Research Award

**Deadline:** 30 June

This award for undergraduate or graduate student research is named in honor of Kerry Kelts, a visionary limnogeologist and inspiring teacher. Send your application to Division Chair Joop Varekamp with "Kelts Award application" in the subject line. For more information, go to [community.geosociety.org/limnogeologydivision/awards/kerrykelts](http://community.geosociety.org/limnogeologydivision/awards/kerrykelts).



## ■ PLANETARY GEOLOGY

### Ronald Greeley Award for Distinguished Service

**Deadline:** 30 June

This award may be given to those members of the Planetary Geology Division or those outside of the Division and GSA who have rendered exceptional service to the Division for a multi-year period. For more information, go to <http://rock.geosociety.org/pgd/distinguished-service.html>.

## Why GSA Membership Is Important to Me



Szymanski at the Pan de Azúcar ash flow tuff near the town of Bagaces in the Guanacaste Province of Costa Rica.

Without a hint of hyperbole, becoming a member of GSA changed my life. From field camp to the halls of the U.S. Capitol, my journey as a professional earth scientist was made possible by the opportunities and the people of GSA. Like many geologists, my relationship with GSA began as an undergraduate student member. I learned how to navigate a section meeting, not fully understanding at the time what it meant to coauthor an abstract, much less present research to an audience that *clearly* knew more than I did about the topic. With requisite time and good mentoring, that gateway North-Central Section Meeting prepared me for my first Annual Meeting in Denver in 1996, followed by another

first: independent fieldwork in the Wasatch Mountains of Utah fully funded by a GSA Graduate Student Research Grant. It's safe to say that up to that point, I had virtually no understanding of my own potential as a scientist or citizen.

With a bit more encouragement, I went on to graduate school for igneous petrology and forensic science, applying the analytical skills of a chemist essential to both fields. I cut my teeth in science communication by testifying as an expert witness in court, convincing lawyers, judges, and juries that geology has a lot to say about the chemical composition of synthetic glass. The challenge of using science for the public good revealed the less obvious connections between geoscience and society, and once again my membership in GSA opened new doors.

In 2008, I moved to Washington, D.C., and served for a year as the GSA-USGS Congressional Science Fellow. I worked a portfolio of energy, climate, and environmental issues for Sen. Jon Tester and learned the real value of science in policymaking, wrapped up in the competing interests of economics and public opinion.

And there was the next big change. I decided to teach business students the role of science and policy in a better, more sustainable society. Over the past eight years, GSA has helped me do this, through meetings and leadership opportunities in the Geology & Public Policy Committee and the Geology and Society Division. I not only share our work at Bentley University with my geoscience community, but I also have a direct conduit to similarly passionate colleagues and an entire network of geoscience difference-makers.

### David W. Szymanski

Associate Professor of Geology, Bentley University  
GSA Member since 1997

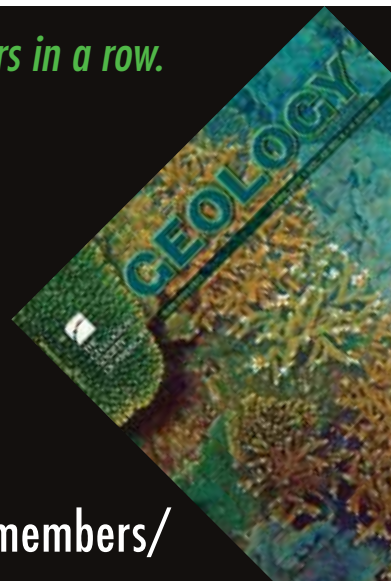
2008–2009 GSA/USGS Congressional Science Fellow  
Geology & Society Division Chair

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# In Memoriam



The Society notes with regret the deaths of the following members (notifications received between 1 Nov. 2016 and 28 Feb. 2017).

**Michele L. Aldrich**  
Hatfield, Massachusetts, USA  
Date of death: 23 Nov. 2016

**Victor C. Andresen**  
Bellingham, Washington, USA  
Date of death: 25 Jan. 2017

**C.S. Venable Barclay**  
Littleton, Colorado, USA  
Notified: 12 Dec. 2016

**James O. Berklund**  
Glen Ellen, California, USA  
Date of death: 22 July 2016

**Norma Biggar**  
Las Vegas, Nevada, USA  
Date of death: 1 Nov. 2016

**William E. Bonini**  
Bala Cynwyd, Pennsylvania, USA  
Date of death: 13 Dec. 2016

**Cynthia A. Bradbury**  
Boise, Idaho, USA  
Date of death: 1 Oct. 2016

**Howard C. Brooks**  
Baker City, Oregon, USA  
Date of death: 6 Nov. 2016

**Richard J. Cassin**  
Midland, Texas, USA  
Date of death: 8 July 2016

**Robert M. Chapman**  
Arlington, Virginia, USA  
Notified: 28 Dec. 2016

**William C. Culbertson**  
Lakewood, Colorado, USA  
Date of death: 19 Jan. 2015

**William J. Dickerson Jr.**  
Schenectady, New York, USA  
Date of death: 12 Feb. 2017

**Donald O. Doehring**  
Green Valley, Arizona, USA  
Date of death: 19 Dec. 2016

**Harold E. Gill**  
Cumming, Georgia, USA  
Notified: 6 Dec. 2016

**Keith E. Green**  
Whittier, California, USA  
Notified: 22 Nov. 2016

**George Fulford Hanson**  
Salem, Massachusetts, USA  
Notified: 28 Dec. 2016

**J. Stewart Hollingsworth**  
Grand Junction, Colorado, USA  
Date of death: 1 Jan. 2016

**Michael R. Hudson**  
Ashland, Ohio, USA  
Date of death: 22 Nov. 2016

**Bor-Ming Jahn**  
Taipei, Taiwan  
Date of death: 1 Dec. 2016

**William R. Keefer**  
Lakewood, Colorado, USA  
Date of death: 23 Dec. 2016

**Thomas S. Laudon**  
Oshkosh, Wisconsin, USA  
Date of death: 1 Jan. 2017

**Seymour Mack**  
Fresno, California, USA  
Date of death: 15 Sept. 2016

**Robley K. Matthews**  
Barrington, Rhode Island, USA  
Date of death: 30 Sept. 2015

**William G. Melson**  
Strasburg, Virginia, USA  
Date of death: 7 Oct. 2016

**Robert D. Merrill**  
Fresno, California, USA  
Date of death: 1 May 2016

**James H. Moore**  
New London, New Hampshire, USA  
Notified: 5 Dec. 2016

**Michael J. Murphy**  
Notre Dame, Indiana, USA  
Notified: 16 Dec. 2016

**Charles W. Naeser**  
Herndon, Virginia, USA  
Date of death: 1 Nov. 2016

**Matthew H. Nitecki**  
Chicago, Illinois, USA  
Date of death: 21 Dec. 2016

**Richard John Norris**  
Kapiti Coast, New Zealand  
Date of death: 1 June 2016

**Lloyd C. Pray**  
Verona, Wisconsin, USA  
Date of death: 5 April 2016

**Weldon W. Rau**  
Olympia, Washington, USA  
Date of death: 1 June 2016

**Theodore D. Sheldon**  
Cherry Hills Village, Colorado, USA  
Date of death: 8 Jan. 2017

**Margaret C. Sommer**  
San Leandro, California, USA  
Notified: 5 Dec. 2016

**Harold E. Sugden**  
Tiverton, Rhode Island, USA  
Date of death: 1 Jan. 2016

**Robert M. Swesnik**  
Dallas, Texas, USA  
Notified: 28 Dec. 2016

**David J. Thomas**  
Erie, Pennsylvania, USA  
Notified: 29 Nov. 2016

**Don E. Wade**  
Austin, Texas, USA  
Date of death: 1 Oct. 2016

**Bruce R. Wardlaw**  
Oak Hill, Virginia, USA  
Date of death: 23 March 2016

**John H. Weitz Sr.**  
Seminole, Florida, USA  
Notified: 26 Dec. 2016

**John O. Wheeler**  
West Vancouver, British Columbia,  
Canada  
Notified: 18 Jan. 2017

**H.D. Bruce Wilson**  
Winnipeg, Manitoba, Canada  
Notified: 28 Dec. 2017

**Edward L. Winterer**  
La Jolla, California, USA  
Date of death: 30 August 2016

**Thomas Lawton Wright**  
San Anselmo, California, USA  
Date of death: 17 Nov. 2016

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Committee name	No. of vacancies	Position title (special requirements)	Term (years)
<b>Academic and Applied Geoscience Relations Committee (E/M)</b>	1	Member-at-Large (Industry Related Field) <i>Professional Interest: Structural Geology/Tectonics, Sedimentary Geology, Environmental &amp; Engineering</i>	3
<b>Annual Program Committee (B/E/M)</b>	3	Members-at-Large	4
<b>Arthur L. Day Medal Award (E/T)</b>	2	Members-at-Large	3
<b>Diversity in the Geosciences (E/M)</b>	3	Members-at-Large	3
<b>Education (B/E/M)</b>	1	Graduate Educator	4
	1	Undergraduate Student	4
	1	Informal Science Educator (museum, visitor center)	2
<b>Geologic Mapping Award (E)</b>	1	Member-at-Large (Government)	3
<b>Geology and Public Policy (B/E/M)</b>	2	Members-at-Large	3
	1	Student Representative	2
<b>GSA International (E/M)</b>	1	Member-at-Large (International Associated Society)	4
	1	Member-at-Large (North America)	
	1	Member-at-Large (outside North America)	
<b>Joint Technical Program (E) (term begins December 2017)</b>	1	Member-at-Large Paleoclimatology & Paleoceanology	1
	1	Member-at-Large Precambrian Geology	1
<b>Membership (B/T)</b>	1	Member-at-Large (Government)	3
	1	Councilor/Former Councilor	3
<b>Nominations (B/E)</b>	2	Members-at-Large	3
<b>Penrose Conferences and Thompson Field Forums (E)</b>	2	Members-at-Large (convener of a past Penrose Conference or Thompson Field Forum)	3
<b>Penrose Medal Award (E/T)</b>	2	Members-at-Large	3
<b>Professional Development (E)</b>	1	Member-at-Large	3
<b>Publications Committee (B/E/M)</b>	1	Member-at-Large	4
	1	Councilor (at time of appointment)	
	1	Member-at-Large (young professional)	
<b>Research Grants (B/T)</b>	11	Members-at-Large (intensive time commitment Feb.–Mar.)	3
	1	National Science Foundation Delegate	
<b>Research Grants Alternates (B/T)</b>	10	Members-at-Large (alternates, in needed, Feb.–Mar.)	3
<b>Young Scientist Award (Donath Medal) (E/T)</b>	1	Member-at-Large (variety of discipline and experience)	3
<b>GSA Representative to the AAAS Consortium of Affiliates for International Programs (B/E)</b>	1	GSA Representative (term begins 1 Jan. 2018)	3
<b>GSA Representative to the AGI Environmental Geoscience Advisory Committee (E/M)</b>	1	GSA Representative (term begins 1 Jan. 2018)	3
<b>North American Commission on Stratigraphic Nomenclature (E/M)</b>	1	GSA Representative (term begins Nov. 2018)	3
<b>GSA Representative. to the U.S. National Committee for Soil Science (B/E)</b>	1	GSA Representative	3

*Note:* Terms begin 1 July 2018 unless stated otherwise. Nominees for Division/Section positions will come from the Divisions and Sections. B—meets in Boulder or elsewhere; E—communicates by phone or electronically; M—meets at the Annual Meeting; T—extensive time commitment required during application review period.



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### Positions Open

#### OPEN RANK FACULTY POSITION IN PETROLEUM OR SEDIMENTARY GEOLOGY AT THE UNIVERSITY OF LOUISIANA AT LAFAYETTE

The School of Geosciences at the University of Louisiana at Lafayette invites applications for an open-rank (tenured or tenure track) faculty position in Petroleum or Sedimentary Geology that is expected to begin in August 2017. The rank of this position will be determined based on qualifications. The successful candidate will be expected to put together a dynamic research program in the area of Petroleum and/or Sedimentary Geology and will mentor students at the undergraduate and graduate levels. Responsibilities will include teaching undergraduate and graduate courses such as stratigraphy, sedimentary petrology, subsurface mapping, and basin analysis. A Ph.D. is required at the time of hire. The School of Geosciences (<http://geos.louisiana.edu/>) houses the programs of Geology (B.S. and M.S. degrees) and Environmental Science (B.S. degree with a M.S. to begin in August 2017). The School includes 11 faculty members, four full time instructors, a research scientist, lab technician, and approximately 150 total undergraduate majors and 85 graduate students. There are many opportunities for collaboration with local industry, institutes, and centers, as well as within other departments and colleges.

To be considered for this position, send as a single PDF file that includes your name in the title, an application letter, CV, separate statements of teaching and research interests, and the names and contact information (post and email) of four references to [geology@louisiana.edu](mailto:geology@louisiana.edu). The review process will begin immediately and continue until the position is filled. Questions regarding this position can be directed to Dr. David Borrok ([dborrok@louisiana.edu](mailto:dborrok@louisiana.edu)). The University of Louisiana at Lafayette is an Equal Opportunity Employer and encourages applications from minority group members and women.

### Opportunities for Students

**Ph.D. Research Assistantships in Mineral-Water Interface Geochemistry, Georgia State University, Atlanta, Georgia.** Funding is available in the Kabengi research group in the Depart-

ment of Geosciences at Georgia State University in the area of mineral-water interface geochemistry. The work will lead to the degree of Ph.D. in Chemistry with a Geochemistry Specialization (coursework in geosciences) or without (coursework in geosciences & chemistry). Funded by the Department of Energy (DOE), the work will focus on studying the energetics of fundamental reactions at mineral-water interfaces. The Kabengi group has focused on experimental thermodynamics through the utilization and development of flow adsorption microcalorimetry techniques and instrumentations although other techniques (spectroscopy, computational modeling, etc.) will be equally utilized. The work will involve collaborative efforts, and opportunities to travel and work with scientists at the DOE National Laboratories. Requirements include an M.S. degree in geosciences, chemistry, physics, or any related discipline, as well as strong quantitative and communication skills. Stipends for Ph.D. candidates are \$22,500 (12 months) plus a full tuition waiver. The preferred start date is August 2017. Georgia State University is a research-intensive university in the dynamic heart of downtown Atlanta. Interested candidates should send a cover letter, CV, GRE, and TOEFL (international students) scores, and transcripts (unofficial copy OK) via email to Nadine Kabengi at [kabengi@gsu.edu](mailto:kabengi@gsu.edu). Any inquiries about the work, the opportunity, or GSU should also be sent to the email above.

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## GSA Science Communication Fellowship

**Application deadline:** 15 May 2017

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**Location:** The Geological Society of America (GSA) is headquartered in Boulder, Colo., but the Fellow may work remotely from any U.S. location (no relocation assistance is available). Work will be conducted primarily via telephone and computer, with travel to Seattle, Washington, for GSA's annual meeting, 21–25 Oct. 2017, required.

**Pay:** The Fellow will receive US\$8,000 in compensation plus paid travel to Seattle (expenses and accommodations) as noted above.

**Description:** This position is intended for journalists aspiring to increase their knowledge and skill in communicating geoscience and its value to society. The fellowship is an opportunity for an early career professional or recent graduate to gain experience and professional contacts working for a well-established and respected science organization. Read more at [www.geosociety.org/gsa/hr/1704-SciCommFellow.aspx](http://www.geosociety.org/gsa/hr/1704-SciCommFellow.aspx).

**How to apply:** Submit a résumé, cover letter, and writing sample to [communications@geosociety.org](mailto:communications@geosociety.org) (subject line: ATTN Fellowship). Interviews will be conducted by phone or video conference after the application period closes, and a hiring decision should be made by 1 July 2017.



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## Field Camp Opportunities—Where Students Discover Their Passions

While the classroom is where many undergraduates are first introduced to the geosciences, the field is where many students’ passions are kindled. When you pick up a rock or trace minerals deep into the earth, science comes alive. Since its inception, GSA has dedicated itself to enriching the geosciences by cultivating and supporting aspiring scientists. One of the most important ways GSA does this is through fieldwork opportunities, which the GSA Foundation proudly supports through its Field Camp Opportunities Fund. The importance of the field in inspiring future geoscientists cannot be overstated. As Dr. John M. Proffett, the first recipient of the Geologic Mapping Award in Honor of Florence Bascom and an avid proponent of fieldwork for geoscientists, states, “In geology, which is based primarily on interpretation and explanation of observations in the field, geologic mapping is the most important and effective method of recording and organizing these observations.” Accordingly, he argues that for students, “field courses need to be a major part of the curriculum.”

For many students, however, the financial cost of pursuing fieldwork can be a burden. The GSA Foundation’s Field Camp Opportunities Fund allows GSA to provide financial support for aspiring geoscientists so they can hone their field skills and discover their interests without financial strain.

This was true for recent University of Pittsburgh graduate, Corinne Kuebler: “Receiving the GSA/ExxonMobil Field Camp Scholarship was an incredibly rewarding and humbling experience. Since field camp was a mandatory requirement in finishing my geology degree, the burden of cost weighed heavily on me. The financial support given to me by this scholarship provided a great relief and let me fully appreciate how challenging yet valuable field camp was.”



Corinne Kuebler, 2016 GSA/ExxonMobil Field Camp Scholarship Awardee, poses under the Willwood Formation while mapping the South Fork Detachment near Cody, Wyoming.

Baylee Kushner, a recent graduate of Slippery Rock University, echoes this sentiment: “I was so relieved to have the financial burden of the latter half of summer removed and powered through the rest of camp to receive a high grade and assessment by my instructors and peers.”

For both Corinne and Baylee, these field camp experiences proved formative for their professional futures. As Corinne states, “Field camp showed me that I am passionate about geology and chemistry which changed my focus in looking for higher education programs. The opportunity granted to me due to this scholarship enriched my life and propelled me on a positive path towards my future.”

In Baylee’s case, “The financial support from this scholarship, while my driving reason for applying, has actually panned out to be the least important benefit from the experience overall. I have been overjoyed by the opportunity to complete an internship under a USGS scientist as a result of this funding. This work will greatly expand my lab experiences and professional network, as well as allow me to present the results of the research at a future GSA session.”

Please consider supporting aspiring geoscientists like Corinne and Baylee as they discover their passions in the field by contributing to the GSA Foundation’s Field Camp Opportunities Fund. Additionally, you can establish a named Field Camp Scholarship, structured similar to GSA’s popular named graduate student research grants, in honor of an important mentor in your life. Your contribution will make a lasting impact in the life of a student and to the future of the geosciences. Contact Bill Tortorici at +1-303-357-1007 or [btortorici@geosociety.org](mailto:btortorici@geosociety.org) to learn more.



Baylee Kushner, 2016 GSA/ExxonMobil Field Camp Scholarship Awardee, bags a sample from a previously unmapped unit of shale during her field camp experience at Crow Peak.

## Diverse Students Can be Attracted to Geoscience

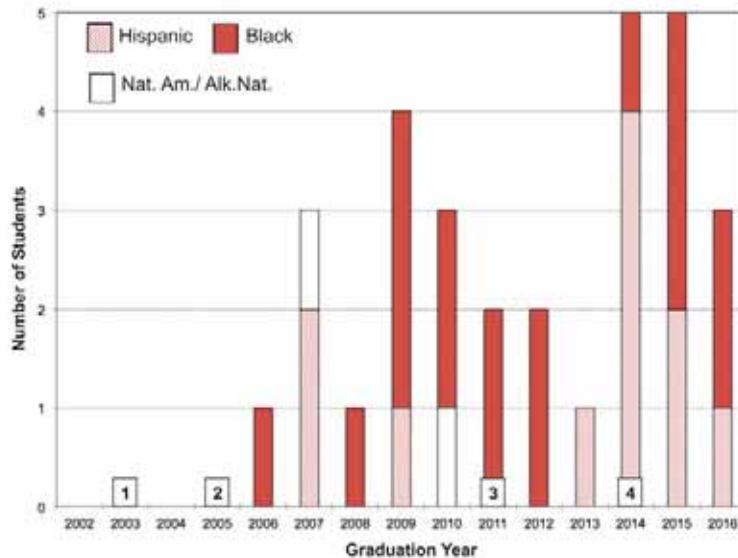
*Suzanne O’Connell\*, Martha Gilmore, Renee Johnson-Thornton, Tim Ku, Peter Patton, Phillip Resor, Dana Royer, Earth & Environmental Sciences, Wesleyan University, Middletown, Connecticut 06459, USA*

Many challenges facing humanity require geoscience expertise, yet the geoscientists addressing these challenges are predominantly white. More diversity in the profession is needed so that people with different ethnic and economic backgrounds may contribute to addressing geoscience challenges. Over the last 10 years, the geosciences have made substantial improvements in diversity (National Science Foundation, 2015), but we are far from parity with the U.S. population. However, in our department at Wesleyan University, visitors have commented on the diversity of our student body and ask how it was accomplished. Here we describe a 15-year process of changes we have made that contribute to the increased diversity (Fig. 1). During this time, we modified our curriculum, increased our outreach to underrepresented minority (URM) students, hired new faculty, and increased faculty awareness of specific issues faced by URM students.

### CURRICULUM

Many studies identify a college introductory course as an important factor in a student’s decision to major in geoscience (e.g., Stokes et al., 2015). Our department teaches a variety of introductory courses to capture student interests. To complete the Earth and Environmental Sciences (E&ES) major, a student then needs seven major-specific courses, two required seminars, and a year of at least two other science or math courses.

Our two required seminars are critical to the success of the major. They incorporate collaborative learning, peer-led team learning, and real-world problem solving, all of which have been shown to improve the retention of URM students (Conrad and Gasman, 2015).



**Figure 1. Student diversity by graduation year.** Only the number students who identified as being from one of the NSF-defined diversity groups are shown on the y axis. Numbers for students who identified as white, mixed race, Asian, or unknown are not included. Numbers on the x axis refer to departmental changes: 1—hired Asian-American professor; 2—started senior seminar; 3—started sophomore seminar; 4—hired Hispanic professor. Tenure-track faculty composition, 2001–2002: two women (1 white, 1 black) and four men (all white); 2015–2016: 2 women (1 white, 1 black) and 6.5 (half appointment in another dept.) men (4.5 white, 1 Asian, 1 Hispanic). Number of graduates varies from 8 (2004) to 24 (2015). Nat. Am.—Native American; Alk. Nat.—Alaska Native.

During sophomore seminar, students explore Connecticut’s geologic evolution. This pass/fail seminar provides students with a common background and develops a sense of community—another contributor to persistence in the major (Callahan et al., 2015).

Senior seminar lasts two semesters with a January field trip. During the fall, seniors read primary literature and collaboratively develop field-based research projects. They plan, write about, and present proposed fieldwork. In the spring, students analyze their samples and present their work at a public symposium, which will be compiled into a written report. Because of this experience, we are confident that our graduates can comprehend original literature, define a problem, conduct research,

and develop excellent oral and written communication skills.

### STUDENT OUTREACH

Geoscience suffers from a poor perception among students interested in helping the environment or society, finding a job, and making money (e.g., Hoisch and Bowie, 2010; Sherman-Morris and McNeal, 2016). Therefore, our faculty try to serve as ambassadors for the discipline both in and out of the classroom.

Student advising is important. Many E&ES faculty ask to be advisers for incoming URM students with an interest in science, thus gaining an opportunity to inform them about geoscience’s positive aspects. Many URM students are also the first-generation (FG) of their family to

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\*soconnell@wesleyan.edu

attend college. FG students and their parents are more likely to be interested in career opportunities (Engle et al., 2006). The geosciences are well-positioned to exploit this interest. The Bureau of Labor Statistics (2015) predicts that geoscience jobs will grow 10% from 2014 to 2024. Advisers and department websites can provide career information for both students and their parents.

Inviting URM geoscientists to speak and to meet with students is another great opportunity to provide role models. Any seminar is an opportunity to engage URM students. FG and URM students, in particular, need to know that URM faculty are part of a learning community.

## FACULTY AWARENESS

Faculty who understand different students' backgrounds can design a pathway for success for all students. Multiple studies have identified barriers to URM and FG students' integration into college. They are less likely to feel that they fit in, possibly not as academically well prepared (ACT/COE, 2016), and less likely to seek out a professor for help (Kuh et al., 2006). This leads them to doubt their ability to succeed in college, and especially in science (e.g., MacPhee et al., 2013). We find that professors need to initiate relationships with these students.

Faculty can invite students from an introductory class to lunch or coffee and include an upper-level student. This is an opportunity to begin to develop a relationship and for students to find out about each other, the major, and geoscience. In the E&ES department, URM students are offered part-time lab-research jobs and, if possible, a summer research experience.

In a research lab, students interact with and establish a relationship with faculty and upper-level students, becoming comfortable in a research environment. Being selected to work in a lab may also build student confidence. URM and FG students are likely to have friends with similar backgrounds, providing more engagement opportunities.

A barrier to reaching out to URM students may be faculty's implicit associations, preconceived ideas, and responses about who is best-suited to a science career (Banaji and Greenwald, 2013). Stereotype threat impedes students' success. This occurs when people internalize the negative associations about their group and do

not perform up to their capabilities (Steele, 2011). Stereotype threat increases as the difficulty of academic work increases, when the activity (e.g., test) is considered evaluative of mental ability, and in larger school settings, where anonymity exacerbates concerns about belonging. Several stereotype threat interventions have been identified (Walton and Cohen, 2011).

Imposter syndrome, the feeling of being a fraud despite a record of high achievement, can also impede students' progress.

The following are some actions we have taken that have helped diversify our department:

1. Visit and give presentations about geoscience to campus organizations that have a high percentage of diverse students.
2. Create a learning community in your classroom with non-competitive environments where students can interact with peers. This helps to counteract stereotype threat and imposter syndrome.
3. Reach out to involve URM students. Let them know you have absolute confidence that they will succeed in your class. Invite them to work in your lab.
4. Find research and experiential programs for URM students, both on and off campus (e.g., GeoCorps™ America and NSF research experiences for undergraduates).
5. Connect URM students with organizations that focus on minorities in geoscience, such as the National Association of Black Geologists and Geophysicists, Pathways to Science, and the Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS). Encourage them to apply for On To the Future (OTF) funds to attend a GSA Annual Meeting.
6. Include diverse speakers in your seminar series, and encourage them to meet with students.
7. Stay in touch with the students. Send them information about jobs and graduate school opportunities. Offer to write letters of reference.
8. Find out what helped URM students succeed at *your* institution and do more of it.
9. Don't get discouraged.

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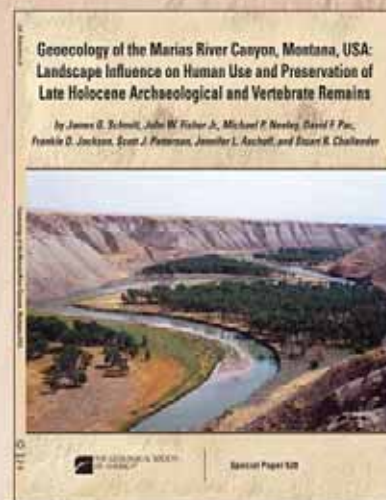


## Geocology of the Marias River Canyon, Montana, USA: Landscape Influence on Human Use and Preservation of Late Holocene Archaeological and Vertebrate Remains

by James G. Schmitt, John W. Fisher Jr., Michael P. Neeley, David F. Pac, Frankie D. Jackson, Scott J. Patterson, Jennifer L. Aschoff, and Stuart R. Challenger

The Marias River canyon in north-central Montana served during late Holocene time as a locus of human activity in an ecologically and geologically dynamic landscape. This volume presents the results of interdisciplinary research, synergistically combining geologic, ecologic, and archaeological approaches focused on examining the ways that Late Precontact peoples depended upon the animal (bison) and plant resources of a changing landscape subject to erosion and sediment transport as dominant surficial processes. Connections between erosion and deposition, plant community distribution, large mammal niches, and native peoples' place in the Marias River canyon geoecosystem, as well as the role of tributary-junction alluvial fans as repositories of archaeological materials and vertebrate faunal remains are emphasized.

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For more information, contact Jennifer Nocerino at [jnocerino@geosociety.org](mailto:jnocerino@geosociety.org).

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Honolulu, Hawaii, USA

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Mann Mentors in Applied Hydrology Luncheon: Wed., 24 May

#### **Rocky Mountain Section Meeting**

Calgary, Alberta, Canada

Shlemon Mentor Luncheon Program: Fri., 9 June

Mann Mentors in Applied Hydrology Luncheon: Sat., 10 June

## 2017 GSA Section Meetings



ALA MOANA Beach Park. Used with permission from Hawai'i Tourism Authority.

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Location: Honolulu, Hawaii, USA

Dates: 23–25 May

Meeting Chair: Craig R. Glenn, [glenn@soest.hawaii.edu](mailto:glenn@soest.hawaii.edu)

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Bow Lake, Alberta, Canada. Photo by Eric Benitez.

### **Rocky Mountain Section**

Location: Calgary, Alberta, Canada

Dates: 9–10 June

Meeting Chair: Katherine Boggs, [kboggs@mtroyal.ca](mailto:kboggs@mtroyal.ca)

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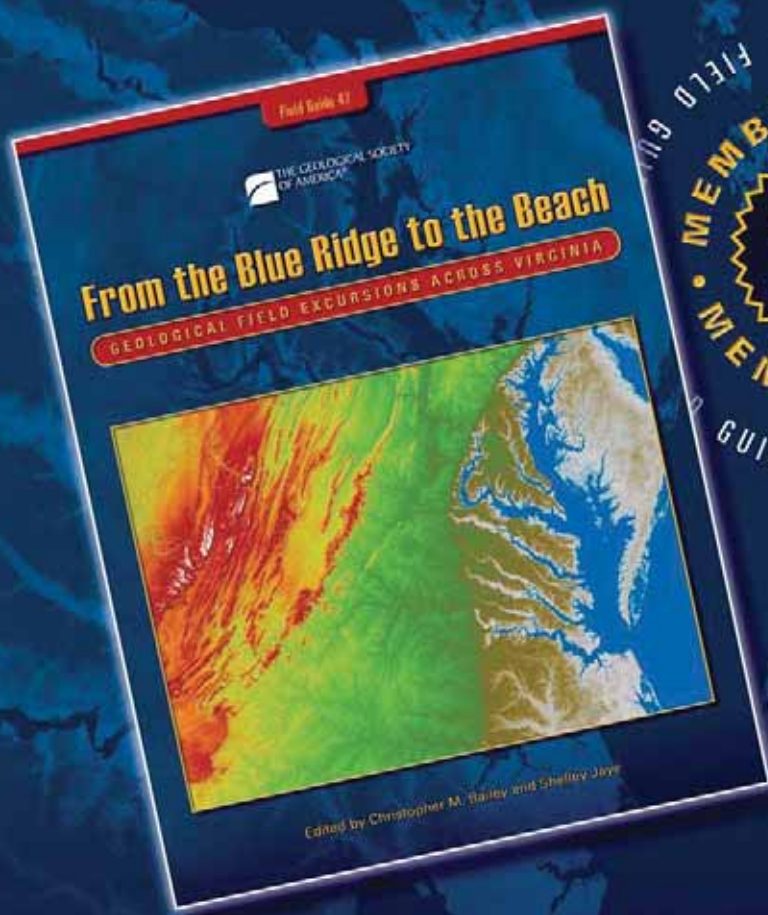
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