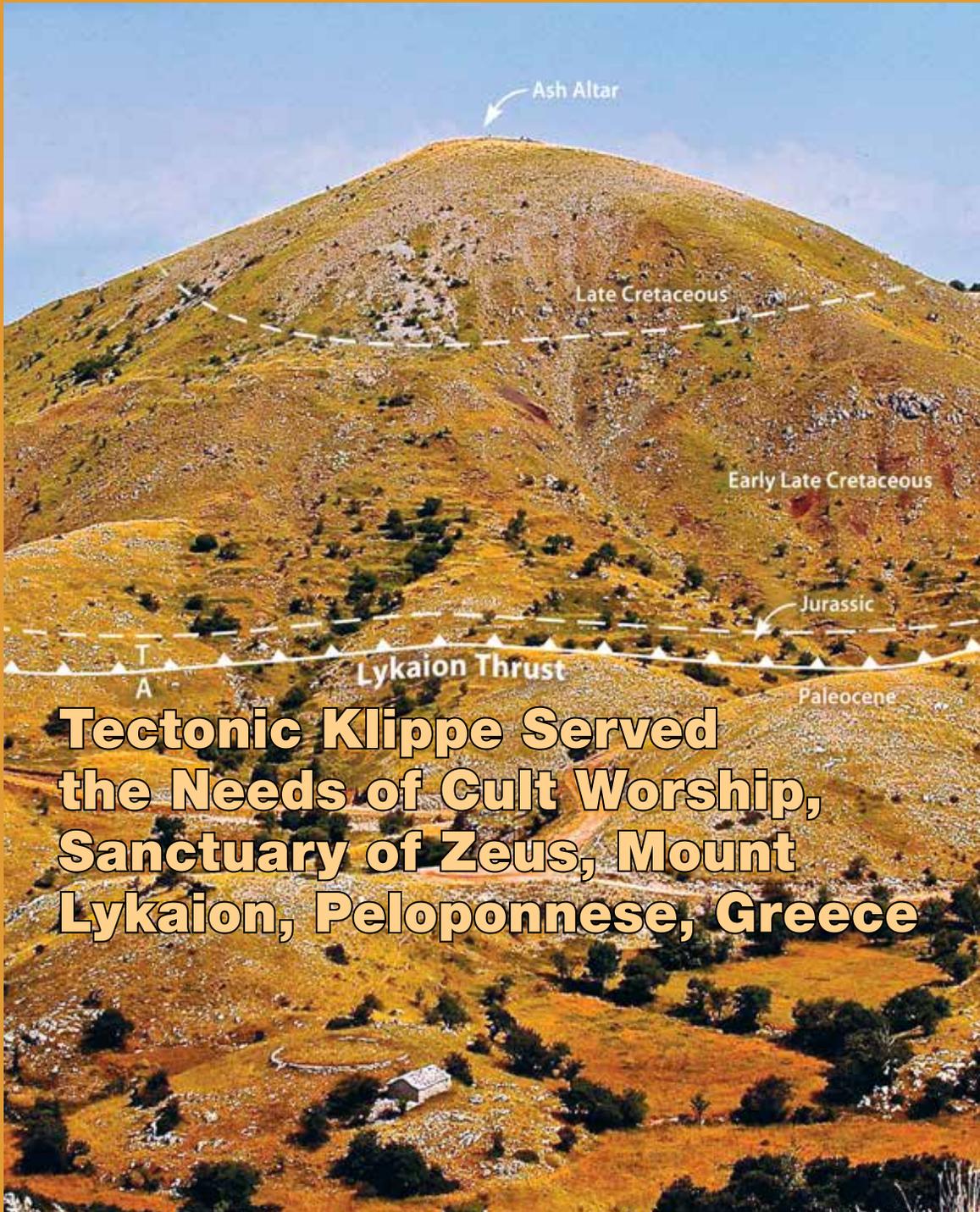


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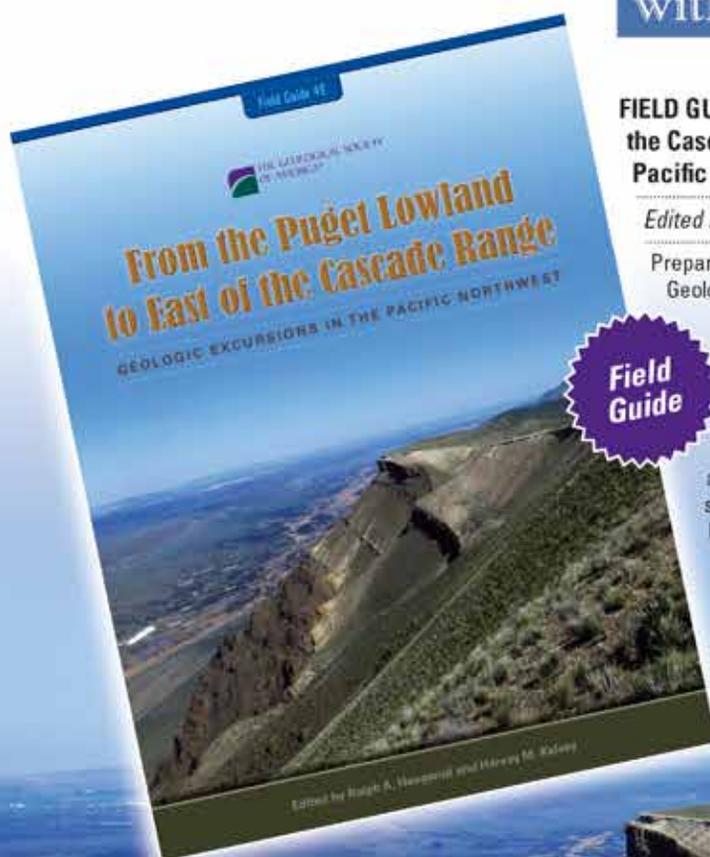
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Tectonic Klippe Served the Needs of Cult Worship, Sanctuary of Zeus, Mount Lykaion, Peloponnese, Greece

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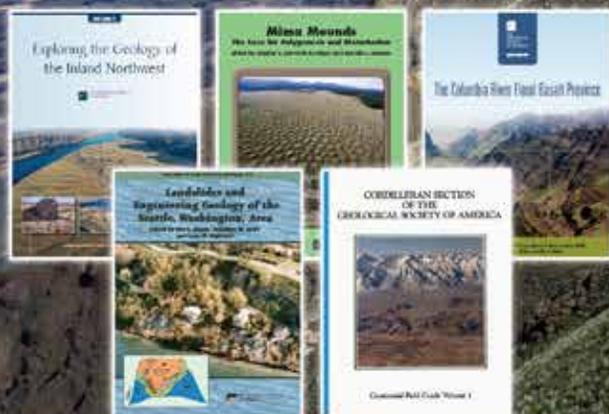


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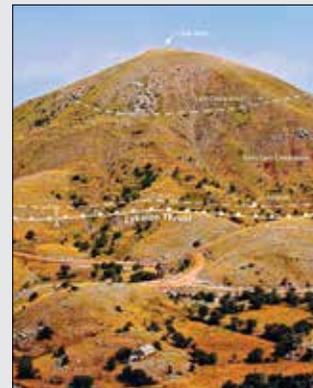
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SCIENCE

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George H. Davis

Cover: East-directed photograph of smooth conical summit region of the Sanctuary of Zeus, Mount Lykaion, Arcadia, Greece. At the very top is the only extant Late Bronze Age mountaintop ash altar. The summit “cone” is a thrust klippe, composed of Jurassic/Cretaceous strata faulted atop Paleocene strata. In the foreground is an abandoned shepherd’s hut and threshing circle. Photograph by George H. Davis. See related article, p. 4–9.



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Erratum: The In Memoriam section of the Nov. 2017 issue of *GSA Today* (p. 22) listed Jon C. Avent of Lopez Island, Washington, USA, as deceased. This is not the case, and GSA deeply regrets this error.

Tectonic Klippe Served the Needs of Cult Worship, Sanctuary of Zeus, Mount Lykaion, Peloponnese, Greece

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ABSTRACT

Mount Lykaion is a rare, historical, cultural phenomenon, namely a Late Bronze Age through Hellenistic period (ca. 1500–100 BC) mountaintop Zeus sanctuary, built upon an unusual tectonic feature, namely a thrust klippe. Recognition of this klippe and its physical character provides the framework for understanding the coupling between the archaeology and geology of the site. It appears that whenever there were new requirements in the physical/cultural expansion of the sanctuary, the overall geologic characteristics of the thrust klippe proved to be perfectly adaptable. The heart of this analysis consists of detailed geological mapping, detailed structural geologic analysis, and close cross-disciplinary engagement with archaeologists, classicists, and architects.

INTRODUCTION

In the second century AD, Pausanias authored an invaluable description of the Sanctuary of Zeus, Mount Lykaion, located at latitude 37° 23' N, longitude 22° 00' E, in the Peloponnese (Fig. 1). Pausanias' accounts were originally written in Greek and are available in a number of translations and commentaries, including Habicht (1999). Pausanias described the physical setting, built structures, athletic games, and nature of the cult activity taking place there in ancient times, calling attention to the presence of two distinct though linked precincts (Romano and Voyatzis, 2014, 2015). The upper level of the sanctuary resides on the summit of Agios Elias and includes an open-air ash altar, which today is represented by an ~2-m-thick blanket of bone ash surviving from animal sacrifice going back as far as the Late Bronze Age, ca. 1500 BC. The lower level comprises foundations and

residual worked blocks of built structures and activity areas, including a hippodrome and stadium used for athletic games in ancient times (see Romano and Voyatzis, 2014, 2015).

In 2004, I signed on as geologist for the Mount Lykaion Excavation and Survey Project, directed by David Gilman Romano and Mary Voyatzis (see *Acknowledgments*). My objective was to evaluate, through detailed geologic mapping (Fig. 2), the ways in which the geology and archaeology of the sanctuary were interconnected. What became clear is that the geology of the sanctuary perfectly fulfills the integrated pragmatic, athletic, spiritual, and ritual requirements of the Zeus cult, which, according to Romano and Voyatzis (2014, 2015), functioned between at least as far back as 1500 BC to 100 BC.

The critical geologic emphasis here is that Mount Lykaion is a thrust klippe. Thrusting was achieved during tectonic inversion of Jurassic to early Cenozoic Pindos Basin stratigraphy (Degnan and Robertson, 2006; Doutsos et al., 1993; Skourlis and Doutsos, 2003). The 3D exposure of the thrust klippe has been achieved through erosional exploitation of the active normal faults being produced by crustal-stretching collapse of the Aegean region (Cocard et al., 1999; Goldsworthy and Jackson, 2000; Jackson, 1994; McClusky et al., 2000).

NATURE OF THRUST KLIPPEN

Thrust klippen are remnant masses of far-traveled thrust sheets, which through regional erosion become isolated from the main sheets with which they were formerly contiguous (Heim, 1922; Quereau, 1895;

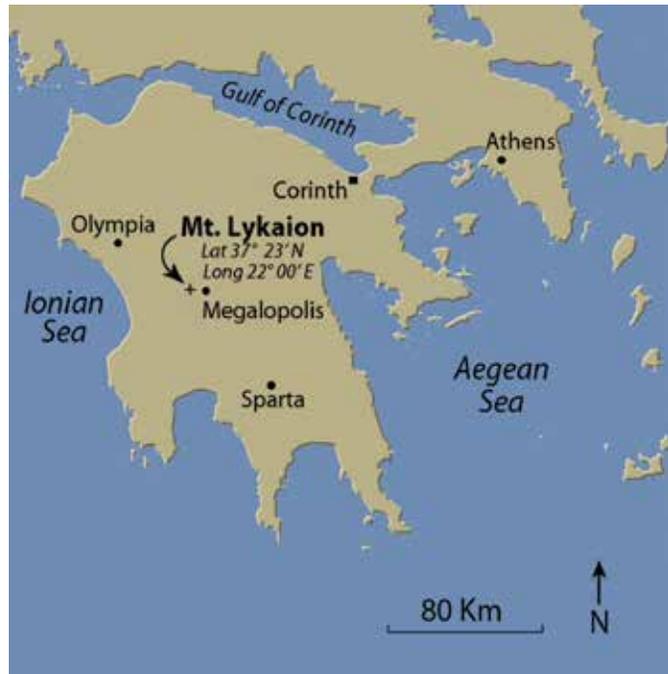


Figure 1. Location of the Sanctuary of Zeus, Mount Lykaion, Peloponnese, Greece.

Trümpy, 2006). Low-angle regional thrust faulting places older, deeper rock formations on top of younger, shallower ones, and it is this inverted stratigraphic succession that is an essential “smoking gun” for recognizing thrust klippen.

Many large, expansive klippen have attracted historical and cultural attention, in part because they can be strikingly anomalous in topography, landscape, and aesthetics compared to their surroundings. A klippe that particularly stands out is the Mythen klippe, which overlooks Lake Lucerne (Central Switzerland) (Wissing and Pfiffner, 2002) (Fig. 3A). The bedrock of Mythen is mainly Upper Jurassic strata, which rest in low-angle thrust contact upon dominantly Cretaceous strata (Bertrand, 1887). As early as the eighteenth century the Mythen seized the philosophical, artistic, poetic, and scientific attention of Johann Wolfgang von Goethe. Goethe’s passion for the Mythen influenced his friend Friedrich Schiller to use the Mythen as the backdrop of Schiller’s drama, *William Tell* (1804).

Yet another example of klippen influencing history and culture is Chief Mountain, which is located along the eastern border of Glacier National Park, Montana, USA (Mudge and Earhart, 1980) (Fig. 3B). Chief Mountain is known as *Ninaistako* to the Blackfoot people. Bailey Willis (1902) identified Chief Mountain as a thrust klippe, recognizing that Precambrian basement rocks were faulted up and over Cretaceous strata along the Lewis overthrust. According to Blackfoot tradition, *Thunder* resides there, and Thunder is considered to be an agent of renewal to the Blackfoot people (National Park Service, 2006).

AGIOS ELIAS KLIPPE: HOW IT MAY HAVE LOOKED TO THE ZEUS CULT

Whereas *Ninaistako* is home to Thunder, Agios Elias (St. Elijah), the klippe hosting the Sanctuary of Zeus, is home to Lightning. Epithets for Zeus in the ancient literature include *Lightning Wielder* and *Shepherd of the Clouds*. Agios Elias (elevation 1381 m) is technically the *second*-highest summit of Mount Lykaion proper (elevation 1421 m) (Fig. 3C). The assets of its natural setting must have been particularly obvious to the ancient peoples who frequented the site. Pausanias (8.38.7; see Habicht, 1999) recorded that on a clear

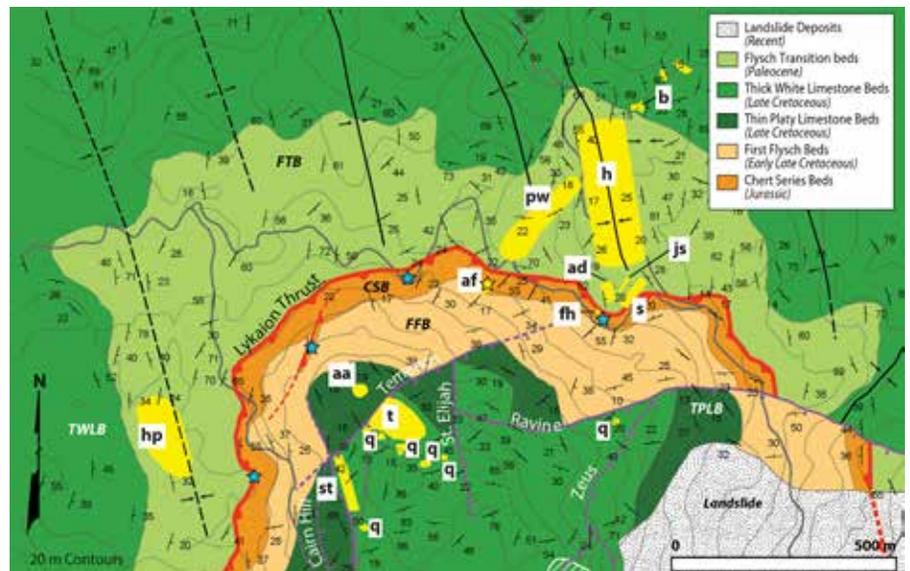


Figure 2. Geoarchaeological map of the Sanctuary of Zeus, Mount Lykaion. Archaeological features: aa—ash altar; ad—administration building; af—Agnos fountain; b—bath; fh—fountain house; h—hippodrome; hp—horse pasture; js—j-seats; pw—processional way; st—proto-stadium; q—quarry; s—stoa; t—temenos; CSB—Chert Series Beds Formation; FFB—First Flysch Beds Formation; TPLB—Thin Platy Limestone Beds Formation; TWLB—Thick White Limestone Beds Formation; FTB—Flysch Transition Beds Formation.

day most of the entire vast expanse of the Peloponnese could be seen from the very top of the sanctuary. Moreover, Mount Lykaion and environs reside within a dynamic setting marked by rock falls, landslides, fissuring, and earthquakes (Ambraseys and Jackson, 1990, 1998; Jackson, 1994). The ancient connection of earthquake-related phenomena to the action of gods is clear in the Late Bronze Age archaeological record, from which period onward Poseidon was known as *the Earth Shaker*. The association of Poseidon and earthquakes is revealed first in the Linear B clay tablets preserved at Pylos (Budin, 2004).

When Agios Elias began to be considered and/or used as a cult place in honor of Zeus, it would have appeared as a steep-sloped, smooth, 200-m-high conical mountaintop summit that gives way below to an encircling bench-like bedrock apron of more modest topographic relief (~40 m) (Fig. 4A; also see Fig. 3C). It would have been obvious that springs feed from the interface between the conical summit and bench-like platform upon which Agios Elias rests. Over time the sanctuary was expanded with the addition of built structures and activity areas (Fig. 4B). The upper level of the sanctuary was largely established between the fifteenth and seventh centuries BC, whereas the lower level was developed and used between the

seventh century BC and first century BC (Romano and Voyatzis, 2014, 2015). The main archaeological features in the upper level include the open-air mountaintop ash altar, where animals were sacrificed and dedicatory objects offered to Zeus; a temenos, i.e., religious precinct where no one except priests could enter without meeting their death within a year (Pausanias, 8.38.6; see Habicht, 1999); and possibly a proto-stadium, where the earliest athletic races are thought to have been held (Romano and Voyatzis, 2015). The main archaeological elements of the lower sanctuary include the Agno fountain (a notable ancient spring), stoa (covered, detached portico with stalls), fountain house, administrative building, corridor, seats, hippodrome, stadium, baths, and a processional way (Romano and Voyatzis, 2015) (see Figs. 2 and 4B).

AGIOS ELIAS KLIPPE: HOW IT LOOKS IN RELATION TO THE GEOLOGY

A draping of my geologic map and the archaeological elements of the Sanctuary of Zeus over the modern landscape (Fig. 5) creates an image that underscores the premise of this paper: the Sanctuary of Zeus exploits in a variety of specific ways the geology of the Agios Elias klippe, and especially the major thrust fault that defines the base of the klippe. In fact, it is

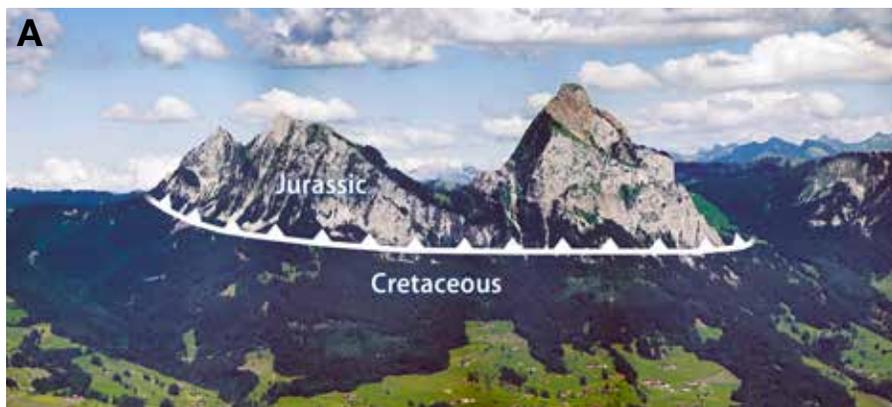


Figure 3. (A) Mythen klippe, Central Switzerland. (The author thanks H. Röst and M. Steiner for permission to reproduce their Mythen image.) (B) Chief Mountain klippe, Glacier National Park, Montana. To the Blackfoot people this mountain is *Ninaistako*. (The author thanks Marc Adamus for permission to reproduce his Chief Mountain photograph.) (C) South-directed photograph of the Agios Elias klippe, Sanctuary of Zeus, Mount Lykaion.

the trace of this thrust fault, which I have named the Lykaion thrust, that is the archaeological boundary between the upper and lower levels of the sanctuary. This thrust was identified as one among many within a regional system of thrust faults discovered during the 1:50,000 mapping carried out by Lalechos (1973) and Papadopoulos (1997).

In carrying out geological mapping of the sanctuary and its surroundings (1:2500-scale), I expanded the four-unit Pindos Group stratigraphy of Lalechos (1973) and Papadopoulos (1997) into the

five formations shown in the map explanation (Davis, 2009) (see Fig. 2). The oldest Pindos Group formation (Chert Series Beds Formation, Jurassic) rests in thrust-fault contact atop the youngest (Flysch Transition Beds Formation, Paleocene). The Jurassic Chert Series Beds serve as a décollement into which the Lykaion thrust soles, which is also the case for most parts of the Pindos fold and thrust belt (Degnan and Robertson, 1998; Skourlis and Doutsos, 2003). Décollement favorability of the Chert Series Beds derives from its inherent quasi-plastic mechanical

character, composed of very thin radiolarian chert beds intercalated with soft claystone and mudstone. Beneath the Lykaion thrust fault the rocks are marked by a system of large upright to slightly overturned anticlines and synclines, which control the geologic map relationships (Davis, 2009, 2014) (see Figs. 2 and 5).

Limestone and interbedded siltstone of the Flysch Transition Beds Formation (Paleocene) crop out immediately below the klippe and have eroded to an open, relatively smooth landscape forming the bedrock bench. Directly beneath is the Thick White Limestone Beds Formation (Late Cretaceous), composed of resistant, sharp weathering, brush- and bush-surmounted limestone. In combination with the underlying Thin Platy Limestone Beds Formation (Late Cretaceous), the Thick White Limestone Beds Formation supports the steep imposing cliffs that mark the west and north faces of Mount Lykaion. Moreover, the Thick White Limestone Beds Formation has been heavily attacked by karst processes as revealed in the more than 150 sinkholes within its map-area distribution of just 10 km². Today it is difficult to overstate the impenetrability of some of this karst-modified terrain where not agriculturally terraced.

The cone-shaped, smooth-weathering klippe landscape above the thrust is much different from that below because of the presence of relatively soft sandstones of the First Flysch Beds Formation (early Late Cretaceous) and the mudstones and radiolarian chert layers of the Chert Series Beds Formations (Jurassic) (see Fig. 5). Normal faults conspicuously cut and offset the bedrock within the klippe (see Figs. 2 and 5), and this faulting has had a particularly profound effect on the landscape character of the top of the klippe (Davis, 2009). The normal faulting postdates the late Cretaceous to Eocene folding and thrusting. The clearest expression of this faulting marks the eastern margin of the Agios Elias klippe, where major, *active*, east-dipping, NNE-striking normal faults of the “Zeus” active fault system have cut into the plateau-like upper surface of the Agios Elias klippe, producing structural platforms that step down to the east. The edge is so precipitous that rock falls are frequent, and a very large landslide complex has accrued on the eastern flank of the klippe (see Figs. 2 and 5). Closely associated with the trace of this normal fault

system is an active fissure field marked by hummocky, disrupted landscape.

On Agios Elias proper there are three normal fault zones that intimately connect to the geoarchaeology. The Cairn Hill fault strikes north-south, dips eastward, and cuts and offsets the Lykaion thrust fault at the south end of the klippe (see Fig. 2). The north end of the trace of this fault coincides with the location of the proto-stadium. A second normal fault trace (the Temenos fault) trends east-west close to the very summit of the klippe, and separates the ash altar area from the temenos. A third normal fault (the Ravine fault), striking northwest/southeast, dips eastward, and cuts and offsets the Lykaion thrust fault near the northeastern “corner” of the klippe.

CONNECTIVITY OF THE ARCHAEOLOGY, GEOLOGY, AND TECTONICS

Upper Level of the Sanctuary

On the Agios Elias summit (see Figs. 2 and 5), the normal-fault displacements have resulted in Thin Platy Limestone Beds being perched, as a faulted block, at the very top, structurally above the stratigraphically younger Thick White Limestone Beds Formation. The Thin Platy Limestone Beds Formation weathers to smooth grassy slopes, creating a landscape conducive to carrying out ceremonial functions, and for which the Thick White Limestone Beds would have been completely unsuitable. Moreover, the combination of bed thickness and joint spacing in the Thin Platy Limestone Beds Formation delivers nearly perfectly sized and shaped portable limestone blocks (resembling cinder blocks), which could readily be moved around, piled, and shaped into built structures, such as walls and ascent ways, for ritual purposes.

The northern boundary of the temenos trends east-west and was located at the very base of the ash altar summit “cone,” at the break in slope from nearly 30° to flat. Thus the northern boundary of the temenos lies right along the trace of the Temenos fault, which appears to be active (see Fig. 2). One of the best upper-level examples of the *hand-in-glove* fit of the geology and archaeology is the location and orientation of the proto-stadium. It trends north-south, and is located on the trace of the Cairn Hill fault (see Fig. 2). This trace is marked by an 8-m-wide

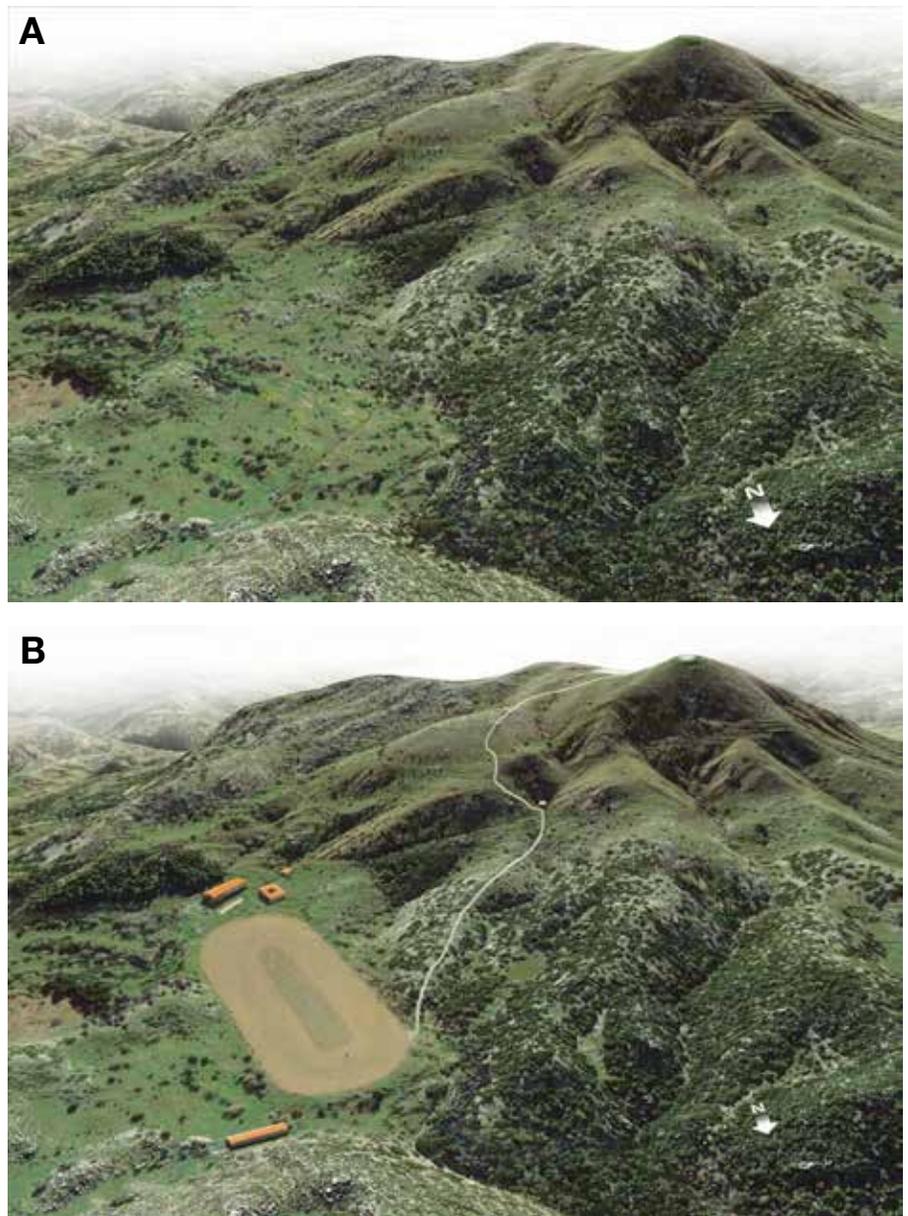


Figure 4. South-directed interpretive renderings of the landscape of Agios Elias, imagining the way the landscape may have appeared (A) in ca. 3000 BC before the Zeus cult exploited the resources of this landscape, and (B) in ca. 300 BC when built structures and activity areas were prominent additions to the landscape. Bath building and hippodrome are in foreground. Path ascends processional way, passes next to Agno foundation, and then may have continued as shown, entering the temenos just below the ash altar on the summit. At south end of Hippodrome are stoa (largest), seats (white), administrative building (square), and fountain house (small).

fault-growth deposit of alluvium (clay and silt) that accumulated at the intersection of westerly back-tilted limestone beds on the hanging-wall, and the east-dipping Cairn Hill fault. Thus this straight and alluvium-padded swath of ground was an obvious choice for competitive racing.

Lower Level of the Sanctuary

In the lower level of the Sanctuary of Zeus there is an intimate relationship between the archaeological elements and

the trace of the 10°E-dipping Lykaion thrust. Immediately above the trace of the thrust is the Agno fountain, which was described by Pausanias as flowing like the Danube (i.e., year-round) (Book 38, see Habicht, 1999), and a second spring marked by the location of the ancient fountain (spring) house. These springs, and others (see Figs. 2 and 5), coincide with locations just above the outcrop trace of the clay-gouge smear of quasi-plastic Chert Series Beds Formation, which formed

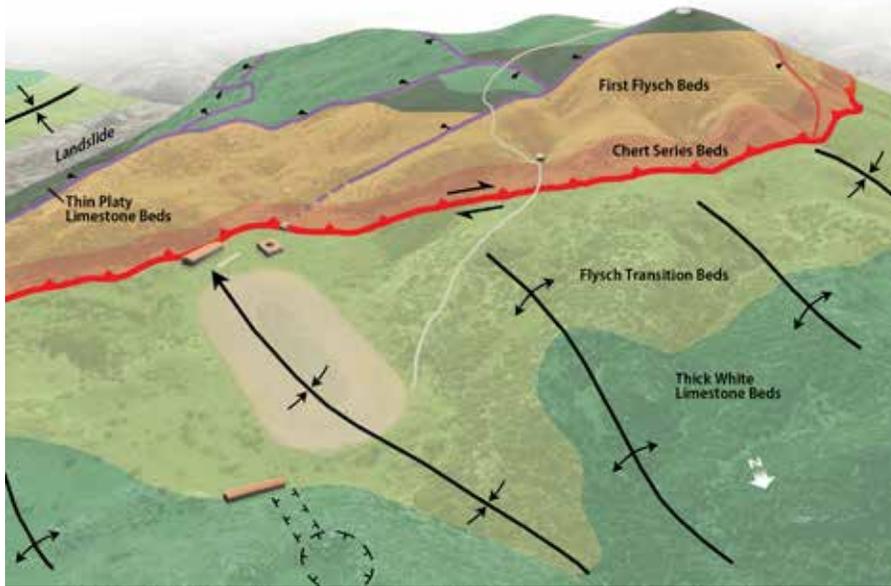


Figure 5. A draping of the author’s geologic map of Mount Lykaion onto the modern landscape of Agios Elias. The archaeological elements are pictured stylistically, for only the excavated remains of foundations and spilled building blocks can be seen today. The exact location of the pathway above the Agno fountain is speculative.

along the base of the upper plate of the Lykaion thrust. Precipitation falling on the upper reaches of the Agios Elias klippe creates meteoric water that seeps into the underlying porous, permeable bedrock, including both the fractured, karst-attacked limestone and the jointed sandstone. Upon encountering the clay seal, the flow of this descending meteoric water is forced to shift laterally, “day-lighting” just meters above the trace of the Lykaion thrust.

The stoa was placed immediately adjacent to the trace of the Lykaion thrust (see Figs. 2 and 5). The long dimension of the stoa (70 m) is not only oriented perfectly parallel to the trace of the Lykaion thrust, but the back wall of the stoa physically abuts against the fault. The limestone blocks for the back wall of the stoa are set against a scarp-like face that was excavated through easily removed clayey-gouge materials (sheared Chert Series Beds Formation) in the uppermost part of the lower plate of the thrust fault. The limestone-block foundation of the stoa was placed just a few meters below the trace of the Lykaion thrust, and built upon a limestone bedrock foundation of the flat-lying Flysch Transition Beds Formation, the uppermost unit of the lower plate of the thrust.

The hippodrome (for horse racing and chariot races) and stadium (located within or just next to the hippodrome) constitute

another illustration of the tight connection between archaeology and geology (see Figs. 2 and 5). The hippodrome of the sanctuary measures $\sim 250 \text{ m} \times 100 \text{ m}$, with its long dimension oriented 348° (Romano and Voyatzis, 2015). The flat space it occupies is starkly anomalous to the steep slopes and cliffs of the overall sanctuary and environs! Mapping and analysis discerned that the flat space owes its existence, geologically, to a fortuitous intersection of structural geology and stratigraphy. The hippodrome resides along a broad, open, 12° -plunging syncline whose hinge line is oriented *exactly* parallel to the trend of the hippodrome. Moreover, the landscape surface of the hippodrome coincides with the interface between the Thick White Limestone Beds Formation (below) and the Flysch Transition Beds Formation (above) (see Figs. 2 and 5). The strata of the relatively thin-bedded and incompetent Flysch Transition Beds Formation has been almost entirely eroded away at the hippodrome site, thus creating a stripped structural platform along and/or near the top of the Thick White Limestone Beds Formation. The added touch was partial infilling of the shallow synclinal basin by runoff-derived silt and clay alluvium eroded from the flanks of the Agios Elias klippe to the immediate south. The fine-grained alluvial blanket imparted softness to the track, amenable for the horse racing and running races. Of course none of these

interpretive geological details would have been known to the local people in charge of the site, but it would have been obvious that this soft flatland would have been perfect for the athletic games envisioned.

A bath complex lies just beyond the northeast corner of the hippodrome. This location is remote from the built structures of the lower level (see Figs. 2 and 5). Yet mapping reveals that its positioning is perfectly suited to tapping a local water source. A sinkhole lies 120 m upslope from the baths, and a collapse sinkhole corridor connects the sinkhole to the back of the baths. Outcrops between the back of the bath and the sinkhole are marked by conspicuous solution fluting.

DISCUSSION

On the tectonic scale, the geology, seismology, and geomorphology of Mount Lykaion combine to exert grandeur and power to the sanctuary. Its elevation is a testimony to the residual crustal buoyancy achieved through the presence of anomalously thick crust fashioned by tectonic inversion and crustal shortening of the Pindos basin. Its topographic relief is a product of the active normal faulting that is causing collapse of basins and severe downcutting by drainages. Its earthquake activity, active faulting, fissuring, and landsliding are derived from contemporary crustal stretching. On the scale of the Agios Elias klippe, there is an intimate relationship between archaeology, structural geology, stratigraphy, and geomorphology.

I introduced and framed this article with an emphasis on tectonic klippen, even though the salient cult-suited geologic resources of Agios Elias can be presented without much reference to klippen (Davis, 2009, 2014). But recognizing Agios Elias as a klippe, i.e., as an *outlier*, is fundamental to understanding the *provenance* of the Sanctuary of Zeus. Provenance can be defined as “the beginning of something’s existence.”

Interpreting the beginning of the existence of the Late Bronze Age Zeus-cult worship on Mount Lykaion is very challenging, because so many factors and variables must be taken into consideration. I simply wish to add another consideration to that list. From a regional tectonic perspective, I believe that Agios Elias likely attracted attention for ritual activity in honor of Zeus because it

departed substantively from the “standard” landscape of the region. I think of Goethe’s fascination with the Mythen klippe as an analogue. Like the worshippers of Zeus, Goethe was well-traveled regionally and challenged himself in trying to understand natural phenomena in a way grounded in direct experience (Miller, 1995; Seamon and Zajonc, 1998). Goethe wrote: “Natural objects should be sought and investigated as they are ... not to suit observers, but respectfully as if they were divine beings” (Matthaei, 1971, p. 57; Seamon and Zajonc, 1998). In a similar manner, Ninaistako stood out to a well-traveled Blackfoot people who were intimately connected to the land and who undoubtedly recognized that Ninaistako was exotic when viewed in the overall backdrop of the larger Cordillera. Such a perspective may have played a part in Agios Elias being chosen as the sanctuary for homage to and celebration of Zeus. This landform would have been recognizable as an outlier, for it is an exception to the rule of north-south-trending mountain ridges forming the Pindos backbone of Greece. After all, an *outlier* is “a thing detached from the main body or system”; “a thing differing from all other members of a particular set.” There *must* have been a sense that Zeus would not have settled for the norm.

ACKNOWLEDGMENTS

I am indebted to David Gilman Romano and Mary Voyatzis, co-directors of the Mount Lykaion Excavation and Survey Project, for inviting me to serve as geologist on the project. This project would not have been possible without the generous permission and support of the Ephorate of Antiquities of Arcadia, directed by Anna Karapanagiotou, Greek Ministry of Culture, and the American School of Classical Studies at Athens. I wish to express my gratitude to field assistants Tom Fenn (2004 and 2005), Randy Goosen (2007), Phil Nickelson (2008), Karl Yares (2009), Kyle Maloney (2010), George Faidon Papakonstantinou (2011), and Alex Weber (2015, 2016). For ArcMap GIS management I depended on the expertise of Tom Fenn, Meridith Reifschneider, and Katherine Guns. I always benefit from the enormous skill of scientific illustrator, David Fischer, who prepared the virtual landscapes for this manuscript. I want to thank H. Röst and M. Steiner for permission to reproduce their Mythen image, and Marc Adamus for his Chief Mountain photograph. I wish to acknowledge the helpful input from three formal reviewers, two of whom remained anonymous and one of whom was Walter Alvarez. Mary Voyatzis and David Gilman Romano provided very useful improvements leading to the final

version. Steve Whitmeyer, *GSA Today* science editor, efficiently guided my manuscript through the review process.

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MANUSCRIPT RECEIVED 6 JULY 2017

REVISED MANUSCRIPT RECEIVED 5 SEPT. 2017

MANUSCRIPT ACCEPTED 8 SEPT. 2017

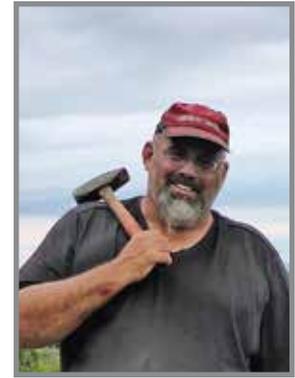
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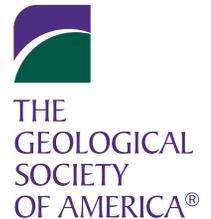
Steven J. Whitmeyer, professor of structural geology and tectonics at James Madison University, rotates off as *GSA Today* science editor at the end of this month. He is primarily interested in tectonic evolution through time and uses structural and geospatial analyses to develop and visualize tectonic reconstructions. He has co-edited two GSA Special Papers and one GSA Field Guide.



Incoming science editor **Mihai N. Ducea** is a professor of geology at the University of Arizona and also holds a courtesy appointment at the University of Bucharest. He received a Ph.D. at the California Institute of Technology. Ducea's research is aimed at understanding the links between igneous and metamorphic petrologic processes and the tectonic evolution of continents. He is interested in continental margin processes and conducts fieldwork at various locations in the western North American Cordillera, the central Andes, the Carpathians, and southern Tibet. He runs a geochemical and radiogenic isotope laboratory at the University of Arizona. Ducea is a GSA Fellow who has published 31 papers in GSA journals (*Geology*, *GSA Today*, *GSA Bulletin*, *Geosphere*, and *Lithosphere*) over the past 16 years and has co-edited a GSA Memoir (2015) and a GSA Special Paper (2005).



Gerald (Jerry) Dickens continues his term through December 2018. He is a professor in the Department of Earth Science at Rice University. His research interests range from Cenozoic cycling, mixed siliciclastic-carbonate margins, and sediment-hosted ore deposits. He previously was chief editor of AGU's *Paleoceanography*.



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William M. Turner, doi: 10.1130/GSATG360C.1.

REPLY:

Reply to the comment by Dr. William Turner

Terry Pavlis and Kelsey Mason, doi: 10.1130/GSATG365Y.1

ORIGINAL ARTICLE:

The New World of 3D Geologic Mapping, *GSA Today*, v. 27, no. 9, p. 4–10. doi: 10.1130/GSATG313A.1.



Upcoming

Award Deadlines



For details, see the October *GSA Today* or go to www.geosociety.org/awards/aboutawards.htm.

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

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

2018 GSA Medals and Awards

Nomination deadline: 1 Feb. 2018

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- Day Medal
- Honorary Fellow
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- GSA Public Service Award
- Randolph W. “Bill” and Cecile T. Bromery Award for Minorities
- GSA Distinguished Service Award
- Doris M. Curtis Outstanding Woman in Science Award
- Geologic Mapping Award in Honor of Florence Bascom

Nomination deadline: 1 Mar. 2018

- GSA International Distinguished Career Award
- GSA James B. Thompson, Jr., Distinguished International Lectures

John C. Frye Environmental Geology Award

Nomination deadline: 31 Mar. 2018

In cooperation with the Association of American State Geologists and supported by endowment income from the GSA Foundation’s John C. Frye Memorial Fund, GSA makes an annual award for the best paper on environmental geology published either by GSA or by a state geological survey.

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

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

OTHER AWARDS

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

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

For a listing of other national awards and links information and nomination forms, visit www.geosociety.org/awards/national.htm. If you know of an award not listed, please send the details to gsatoday@geosociety.org.

2017 Honorary Fellows

GSA is pleased to announce the selection of the Society's 2017 Honorary Fellows.



Zvi Garfunkel, Hebrew University of Jerusalem, Israel

Zvi Garfunkel was born in Kaunas, Lithuania, in 1938. He survived the Holocaust and immigrated to Israel in 1948. He is married and has one daughter.

Garfunkel earned a Ph.D. in geology in 1970 from the Hebrew University of Jerusalem. Since 1972, he has been a member of the faculty of the Institute of Earth Sciences there (full professor in 1986; emeritus since 2007). From 1988 to 2007, he served as the R. Kravis Chair in geology. He also served as president of the Geological Society of Israel. He was a member of the academic board of Azrieli, the Jerusalem College of Engineering, from 2000 to 2006. In 2006, Garfunkel was awarded the EMET prize for Science, Art, and Culture, which was bestowed upon him by the Prime Minister of Israel.

Garfunkel's research dealt with major geologic, mainly tectonic and geodynamic, processes. He contributed to the early study of the retreat of subducted slabs (roll-back or retrograde subduction) and its importance for mantle circulation. Most of his work focused on processes that shaped the Middle East and adjacent basins: Cenozoic rifting and continental breakup in the Middle East, focusing on the Dead Sea Transform (DST)—the plate tectonic framework, history and structure, relation to flank uplifting, seismic activity, and the influence of vertical motions accompanying the DST formation on landscape evolution. He recognized that the DST was a “weak” plate boundary before this concept was applied to other major strike-slip faults. Garfunkel structures are associated with major strike-slip faults, especially pull-aparts, and the geometry of deformation by sets of such faults and associated block rotations on vertical axes (including the Mojave Desert). Other work dealt with the setting of igneous activity and its relations with young rifts, the associated changes in lithospheric geotherms, and how deep intrusions may influence uplifting and subsidence. He documented a large uplift produced by Early Cretaceous activity in the Levant, a feature rarely reported for pre-Cenozoic volcanism, and noted that this marked the beginning of an age progression of volcanics extending to Sudan—one of the few known continental hot spot traces.

An author or co-author of more than 100 refereed papers, Garfunkel also studied the formation of the East Mediterranean basin and its relation to rifting and changes of vertical motions in adjacent lands, and the subsequent development of the Levant continental margin. He found that the Neogene development of the Eastern Mediterranean was dominated by still active large-scale slumping and deformation of the Messinian evaporates and the overlying sediments. Other works clarified the history of the Pan-African basement next to the Northern Red Sea, and analyzed the large-scale structure and plate tectonic setting of the Pan African and the fringing Cadomian orogens. He also studied the relationships between flood volcanism and to the lithosphere, and the formation foreland basins.

THE GEOLOGICAL SOCIETY OF AMERICA
ISSN 0091-7613
FEBRUARY 2018 • VOL. 44 NO. 2 • P. B1-176

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2017 Honorary Fellows



Augusto Neri, Istituto Nazionale di Geofisica e Vulcanologia, Italy

Augusto Neri received his master's degree in chemical engineering from the University of Pisa and his Ph.D. from the Illinois Institute of Technology of Chicago. Since 2003, he has been the research director in physical volcanology at the Istituto

Nazionale di Geofisica e Vulcanologia (INGV), Italy, and since 2014, full professor of volcanology and earth physics. Since 2016, he has served as director of the Volcanoes Department of INGV. He is the author of more than 90 scientific papers and has been the principal investigator of many international and national projects. In 2017, he was awarded the Sergey Soloviev Medal of the European Geophysical Union for his pioneering research in modeling volcanic processes and his effort worldwide to mitigate explosive eruption risks.

Neri's research has been devoted to the development of physical-mathematical models of volcanic processes and phenomena as well as to their application to the assessment of volcanic hazards and risks. His studies were focused on the Italian active volcanoes although they extended to several other volcanoes worldwide.

Trained as an engineer, Neri employs principles of physics and engineering to develop numerical multiphase flow models able to quantitatively describe the processes governing volcanic phenomena. Volcanic plumes, collapsing columns, pyroclastic density currents, ash cloud dispersal and ash fallout, magma ascent in conduits, and magma chamber evolution were the main phenomena investigated. Several complex and non-intuitive processes were highlighted through these models, which conveyed a more robust understanding of the dynamics of volcanic eruptions. For instance, the application of these models to well-observed events, such as the 18 May 1980 Mount St. Helens volcanic blast and the 1997 Vulcanian explosions of Soufrière Hills volcano, Montserrat, allowed for better elucidation of the internal dynamics of these phenomena as well as the recognition of their controlling mechanisms.

Neri has also made important contributions to the assessment of volcanic hazards by applying transient and multidimensional models to the simulation of expected volcanic scenarios and the production of volcanic hazard and risk maps. Applications of these models at high-risk Italian volcanoes, such as Vesuvio and Campi Flegrei, significantly helped civil protection authorities to better delineate the hazards and design proper mitigation measures. These models were also applied during volcanic crises at Mount Etna, Stromboli, Soufrière Hills Montserrat, La Soufrière of Guadeloupe, Redoubt, Merapi, Eyjafjallajökull, Grímsvötn, and Santorini to produce quantitative hazard scenarios and maps that supported government decisions on risk mitigation.

Augusto Neri's remarkable work in these areas has undoubtedly promoted a new field of study in volcanology and inspired numerous research activities and young generations on these subjects.

Honorary Fellowship is presented to an international geoscientist who has distinguished him or herself in geoscience investigations, promoting environmental awareness, linking science and society, providing notable service to implementing public policy in natural resource managements, or otherwise making outstanding contributions to science. These awards were presented at the GSA Presidential Address and Awards Ceremony during the 2017 GSA Annual Meeting in Seattle in October.

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GSA Section Meetings

2018



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12–13 March
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Photo by Oliver Beland.



Northeastern Section

18–20 March
Burlington, Vermont, USA
Meeting Chairs: Charlotte Mehrtens, cmehrtens@uvm.edu;
Andrea Lini, alini@uvm.edu
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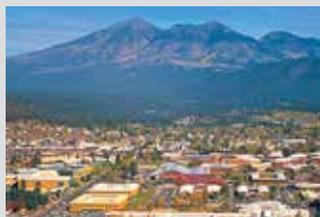
Southeastern Section

12–13 April
Knoxville, Tennessee, USA
Meeting Chair: Colin D. Sumrall, csumrall@utk.edu
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North-Central Section

16–17 April
Ames, Iowa, USA
Meeting Chair: William Simpkins, bsimp@iastate.edu
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Rocky Mountain/Cordilleran Joint Section Meeting

15–17 May
Flagstaff, Arizona, USA
Meeting Chair: Paul Umhoefer, paul.umhoefer@nau.edu
Meeting Co-Chair: Dennis Newell, dennis.newell@usu.edu
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Second Announcement

SOUTH-CENTRAL SECTION

**52nd Annual Meeting of the South-Central
Section, GSA
Little Rock, Arkansas, USA,
12–13 March 2018
www.geosociety.org/sc-mtg**



Photo by Oliver Beland.

Geology in the Natural State

LOCATION

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REGISTRATION

Early registration deadline: 5 Feb.

Cancellation deadline: 12 Feb.

Registration fees (all fees are in U.S. dollars)

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	Early Full Mtg. One Day	Standard Full Mtg. One day		
Professional Member	\$175	\$130	\$235	\$185
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Early Career Professional Member	\$125	\$90	\$180	\$130
Early Career Professional Non-Member	\$140	\$100	\$190	\$140
Student Member	\$60	\$45	\$120	\$75
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Field Trip/Workshop Only	\$45	n/a	\$60	n/a

ACCOMMODATIONS

Reservation Deadline: 19 Feb.

A block of rooms has been reserved at the Little Rock Marriott, 3 Statehouse Plaza, Little Rock, Arkansas 72201, USA, and the meeting rate is US\$139 per night plus tax. Reservations should be made by calling the Little Rock Marriott at +1-877-759-6290 (toll free) or +1-501-906-4000 (local). Please be sure to mention that you are attending the GSA South-Central Section meeting.

CALL FOR PAPERS

Abstract deadline: 5 Dec.

Submit online at www.geosociety.org/sc-mtg

Abstract submission fee: US\$18 for students and US\$30 for all others. If you have any questions about submitting an abstract online, please contact Heather Clark, +1-303-357-1018, hclark@geosociety.org.

TECHNICAL PROGRAM

Please direct questions related to the following sessions to Technical Program Chair Laura Ruhl, lsruhl@ualr.edu.

Theme Sessions

- T1. Late Paleozoic Tectonic Framework of the South-Central USA and the Evolution of the Ouachita Orogen.** Principle organizer: Robert Stern, Univ. of Texas at Dallas, rjstern@utdallas.edu. Co-organizers: Daniel Rains, Arkansas Geological Survey, daniel.rains@arkansas.gov; Majie Fan, Univ. of Texas at Arlington, mfan@uta.edu.
- T2. Groundwater Resources of the Mississippi Embayment.** Principal organizer: Katherine Knierim, USGS, kknierim@usgs.gov. Co-organizer: Samantha Wacaster, USGS.
- T3. Paleontology of the South-Central Region.** Principal organizer: Joseph Daniel, PaleoAERIE, paleoaerie@gmail.com. Co-organizer: René Shroat-Lewis, Univ. of Arkansas at Little Rock, rashroatlew@ualr.edu.
- T4. Petroleum-Produced Water: Safe Disposal and Beneficial Use.** Principal organizer: Javier Vilcaez, Boone Pickens School of Geology, Oklahoma State Univ., vilcaez@okstate.edu. Co-organizer: Antonio Cardona, San Luis Potosi Univ., acardona@uaslp.mx.

- T5. **Structure and Stratigraphy of the Mid-Continent Region: Mountain Building and Related Sedimentation.** Principal organizers: Keith Gray, Wichita State Univ., k.gray@wichita.edu; Xiangyang Xie, Texas Christian Univ., x.xie@tcu.edu. Co-organizers: William Parcell, Wichita State Univ., william.parcell@wichita.edu; Matthew McKay, Missouri State Univ., matthewmckay@missouristate.edu.
- T6. **Karst Development and Karst Hydrogeology in the Mid-Continent Region of the United States.** Principal organizer: Phillip Hays, USGS and Univ. of Arkansas, pdhays@usgs.gov. Co-organizer: Matthew Covington, Univ. of Arkansas, mcoving@uark.edu.
- T7. **Insight from Planetary Remote Sensing.** Principal organizer: Suniti Karunatillake, Louisiana State Univ., sunitiw@lsu.edu.
- T8. **Carbon in the Geosphere.** Principal organizer: Omar Harvey, Texas Christian Univ., omar.harvey@tcu.edu.
- T9. **Geologic Mapping in the South-Central Region of the United States (Posters).** Principal organizer: Richard Hutto, Arkansas Geological Survey, richard.hutto@arkansas.gov. Co-organizer: Garrett Hatzell, Arkansas Geological Survey, garrett.hatzell@arkansas.gov.
- T10. **Holistic Approaches to Coping with Induced Seismicity in the Mid-Continent.** Principal organizer: Casee Lemons, Texas Bureau of Economic Geology, casee.lemons@beg.utexas.edu. Co-organizers: Tandis Bidgoli, Kansas Geological Survey, tbidgoli@kgs.ku.edu; Jake Walter, Oklahoma Geological Survey, jwalter@ou.edu; Scott Ausbrooks, Arkansas Geological Survey, scott.ausbrooks@arkansas.gov.
- T11. **Demography and Geosciences: Addressing the Growing Diversity Gap.** Principal organizer: Stephen K. Boss, Univ. of Arkansas, sboss@uark.edu.
- T12. **Drivers and Impacts to Water Quality throughout the Mid-Continent Region of the United States.** Principal organizer: Ralph Davis, Univ. of Arkansas, ralphd@uark.edu. Co-organizers: Brian Haggard, Arkansas Water Resources Center, Univ. of Arkansas, haggard@uark.edu; Phillip Hays, Department of Geosciences, Univ. of Arkansas, pdhays@uark.edu.
- T13. **Cretaceous Igneous Activity in the South-Central United States.** Principal organizer: Robert Stern, Univ. of Texas at Dallas, rjstern@utdallas.edu. Co-organizers: Adriana Potra, Univ. of Arkansas, potra@uark.edu; Michael G. Davis, Arkansas Tech. Univ., mdavis@atu.edu.
- T14. **Geological Survey Support to Emergency Management.** Principal organizer: Brian Blake, Central United States Earthquake Consortium (CUSEC), bblake@cusec.org. Co-organizer: Martha Kopper, martha.kopper@arkansas.gov.
- T15. **Effects of Carbon-Cycle Perturbations on Marine Ecosystems.** Principal organizer: Hannah-Maria Brame, Univ. of Texas at Austin, hmrbrame@utexas.edu. Co-organizer: Anna Weiss, Univ. of Texas at Austin, anna.weiss@utexas.edu.
- T16. **Geology and Health Research on Trace Elements in Drinking Waters and Outreach and Education Activities.** Principal organizer: Saugata Datta, Kansas State Univ., sdatta@ksu.edu. Co-organizers: Robert Finkelman, Univ. of Texas at Dallas, bobf@utdallas.edu; Darcia Routh, Arkansas Dept. of Health, darcia.routh@arkansas.gov.
- T17. **Continuous Improvement, Assessment, and Accreditation of Geology Programs.** Principal organizer: Margaret (Beth) McMillan, Univ. of Arkansas at Little Rock, memcmillan@ualr.edu. Co-organizers: Jeffery Connelly, Univ. of Arkansas at Little Rock, jbconnelly@ualr.edu; Nickolas Jovanovic, Univ. of Arkansas at Little Rock, nsjovanovic@ualr.edu.
- T18. **Earth and Space Science K–Higher Education.** Principal organizer: Margaret (Beth) McMillan, Univ. of Arkansas at Little Rock, memcmillan@ualr.edu. Co-organizers: Wendi Williams, Univ. of Arkansas at Little Rock and Northwest Arkansas Community College, wjwilliams@ualr.edu; Michele Snyder, Arkansas Department of Education, michele.synder@arkansas.gov.
- T19. **Undergraduate Student Research (Posters).** Principal organizer: Joshua Spinler, Univ. of Arkansas at Little Rock, jxspinler@ualr.edu.

FIELD TRIPS

Please direct questions related to the following sessions to the Field Trip Chair: Angela Chandler, angela.chandler@arkansas.gov, contact the trip leaders, or check the meeting website. All trips depart from the Little Rock Marriott unless otherwise noted.

Pre-Meeting

- Lithostratigraphy and Sequence Stratigraphy of the Mississippian across Northern Arkansas.** *Cosponsored by the GSA Sedimentary Division.* Fri.–Sat., 9–10 March, 8 a.m.–6 p.m. US\$130 (includes transportation, lodging, and meals). Trip departs from the University of Arkansas–Fayetteville. Principal organizer: Walter Manger, Univ. of Arkansas, wmanger@uark.edu. Co-organizers: Angela Chandler, Arkansas Geological Survey, angela.chandler@arkansas.gov; Richard Hutto, Arkansas Geological Survey, richard.hutto@arkansas.gov.
- Minerals and Geologic History of Magnet Cove.** Sat., 10 Mar., 9 a.m.–4 p.m. US\$40 (includes transportation, lunch, and a snack). Principal organizer: Corbin Cannon, Arkansas Geological Survey, corbin.cannon@arkansas.gov. Co-organizers: Lea Nondorf, Terracon, lea.m.tipton@gmail.com; Christopher DeGarmo, Arkansas Natural Resources Commission, christopher.degarmo@arkansas.gov.
- Educators in the Field: Bringing Earth and Space Science into Context.** *Cosponsored by the National Association of Geoscience Teachers Geo2YC Division; The International Association for Geoscience Diversity.* Sat., 10 Mar., 1–5 p.m. US\$20 students/US\$30 all others (includes transportation and snacks). Principal organizer: Wendi Williams, Univ. of Arkansas at Little Rock and Northwest Arkansas Community College, wwilliams@nwacc.edu, wjwilliams@ualr.edu. Co-organizer: Keith Harris, Arkansas Partnership for STEM Education at Univ. of Arkansas at Little Rock, krharris@ualr.edu.
- Healing Springs of Arkansas.** Sat. and Sun., 10–11 Mar., 8:30 a.m.–5 p.m. US\$98 (includes transportation, lodging, and meals). Principal organizer: John Svendsen, Univ. of

Arkansas–Little Rock, docnlr@sbcglobal.net. Co-organizer: Van Brahana, Univ. of Arkansas, brahana@uark.edu.

5. **Hot Springs National Park and Finding Quartz Crystals.** Sun., 11 Mar., 7:30 a.m.–5 p.m. US\$40 (includes entrance fees and transportation; participants are responsible for meals). Principal organizer: Doug Hanson, Arkansas Geological Survey, doug.hanson@arkansas.gov. Co-organizer: Ty Johnson, Arkansas Geological Survey, ty.johnson@arkansas.gov.
6. **Lake Ouachita Geofloat.** Sun., 11 Mar., 9 a.m.–4:30 p.m. US\$36 (includes transportation and meals). Principal organizer: Ty Johnson, Arkansas Geological Survey, ty.johnson@arkansas.gov. Co-organizers: Garrett Hatzell, Arkansas Geological Survey, garrett.hatzell@arkansas.gov; Doug Hanson, Arkansas Geological Survey, doug.hanson@arkansas.gov.

Post-Meeting

7. **Crater of Diamonds State Park.** Wed., 14 Mar., 7:30 a.m.–5 p.m. US\$50 (includes transportation, entrance fees, and meals). Principal organizer: Doug Hanson, Arkansas Geological Survey, doug.hanson@arkansas.gov. Co-organizer: Danny Rains, Arkansas Geological Survey, danny.rains@arkansas.gov.

WORKSHOPS/SHORT COURSES

- W1. **Earth and Space Sciences in the High School Integrated Approach.** *Cosponsored by the National Association of Geoscience Teachers Geo2YC Division; The International Association for Geoscience Diversity.* Sat., 10 Mar., 8 a.m.–noon. US\$20 students/US\$30 all others (includes snacks and course materials). Principal organizer: Keith Harris, Arkansas Partnership for STEM Education at Univ. of Arkansas–Little Rock, krharris@ualr.edu. Co-organizers: Michele Snyder, Arkansas Department of Education, michele.snyder@arkansas.gov; Wendi Williams, Univ. of Arkansas at Little Rock and Northwest Arkansas Community College, wwilliams@nwacc.edu, wjwilliams@ualr.edu.
- W2. **High-Resolution Geophysical Imaging: An Aid for Geological Mapping.** Sun., 11 Mar., 8 a.m.–5 p.m. US\$100 students/US\$250 all others (includes lunch, snacks, and course materials). Principal organizer: Ahmed Ismail, Boone Pickens School of Geology, Oklahoma State University, ahmed.ismail@okstate.edu.
- W3. **Basic Seismic Attributes.** Sun., 11 Mar., 1–5 p.m. US\$50 (includes snacks and course materials). Principal organizer: Robert Schneider, Texas A&M Univ.–Kingsville, robert.schneider@tamuk.edu. Co-organizer: Gary Jones, Yosh Geophysical, gljones@sbcglobal.net.

OPPORTUNITIES FOR STUDENTS AND EARLY CAREER PROFESSIONALS

Presentation Awards

Awards for the best student posters and papers are supported by the GSA South-Central Section. To be eligible, students must be lead authors and presenters and should be capable of answering

detailed questions about their research. These awards will be announced during the Tuesday afternoon posters/exhibits reception.

Student Travel Grants

Deadline: 5 Feb. 2018

Students who are GSA members and who register for the meeting are eligible to apply for student travel grants. For further information, check the Section website.

Mentor Programs

For more information, contact Jennifer Nocerino at jnocerino@geosociety.org.

Roy J. Shlemon Mentor Program in Applied Geoscience Luncheon.

Monday 12 Mar., noon–1:30 p.m. 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 Hydrogeology Program.

Tuesday 13 Mar., noon–1:30 p.m. 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

For more information, contact Jennifer Nocerino at 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. This section is highly recommended for freshmen, sophomores, and juniors. The earlier you start your career planning the better.

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 when possible, 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 market for a job 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

General Chair: Michael DeAngelis, mtdeangelis@ualr.edu

Technical Session Chair: Laura Ruhl, lsruhl@ualr.edu

Field Trip Chair: Angela Chandler, angela.chandler@arkansas.gov

Workshop/Short Course Chair: Kathy Knierim, kknierim@usgs.gov

Student Volunteer Coordinator: René Shroat-Lewis, rashroatlew@ualr.edu

Exhibits Coordinator: Joshua Spinler, jxspinler@ualr.edu

Sponsorship Chair: Beth McMillan, memcmillan@ualr.edu

SCIENCE EDITOR

OPENINGS FOR 2019

GSA is soliciting applications and nominations for science co-editors with **four-year terms beginning 1 January 2019**. Duties include: ensuring stringent peer review and expeditious processing of manuscripts; making final acceptance or rejection decisions after considering reviewer recommendations; and maintaining excellent content through active solicitation of diverse and definitive manuscripts.

POSITIONS AVAILABLE If applicable, research interests that complement the continuing editors are listed.

ENVIRONMENTAL & ENGINEERING GEOSCIENCE Hydrogeology, low-T geochemistry, geomorphology, and/or environmental geophysics.

GSA BOOKS Editor duties include soliciting high-quality book proposals and ensuring proper peer review procedures. The successful candidate will have a wide range of interests and expertise, prior editing experience, and a strong publication record.

LITHOSPHERE Tectonics and structural geology; geomorphology and neotectonics; metamorphic geology.

GSA BULLETIN Deformation; geochemistry; paleoclimatology; Precambrian geology; seismology; stratigraphy; structural geology; volcanology.

GSATODAY, one of the most widely read earth science publications in the world, seeks an editor who has a wide range of interests and expertise, the ability to identify research topics of both high quality and broad appeal, a strong publication record, and prior editing experience.

GEOSPHERE Deformation, geodynamics, geophysics, marine geophysics, seismology, structural geology, tectonics, geodesy, tectonophysics

Note that candidates should not feel they must have expertise in every area listed; however, editors will sometimes need to handle papers outside of their main disciplines.

INTERESTED?

- ▶ Submit a curriculum vitae and a letter describing why you (or your nominee) are suited for the position to Jeanette Hammann, jhammann@geosociety.org.

Editors work out of their current locations at work or at home. The positions are considered voluntary, but GSA provides an annual stipend and funds for office expenses. **DEADLINE:** First consideration will be given to nominations or applications received by **15 February 2018**.

E&EG ▶ 1 position

GSA Books ▶ 1 position

Lithosphere ▶ 1 position

GSA Bulletin ▶ 1 position

GSA Today ▶ 1 position

Geosphere ▶ 1 position

A SUCCESSFUL EDITOR WILL HAVE

- ▶ a broad interest and experience in geosciences, including familiarity with new trends;
- ▶ international recognition and familiarity with many geoscientists and their work;
- ▶ a progressive attitude and a willingness to take risks and encourage innovation;
- ▶ experience with online manuscript systems and the ability to make timely decisions; and
- ▶ a sense of perspective and humor.



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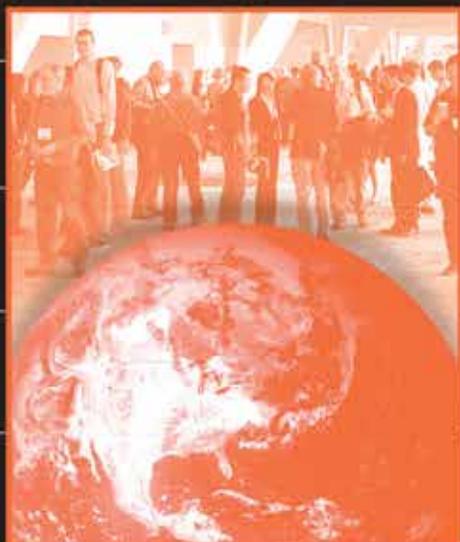
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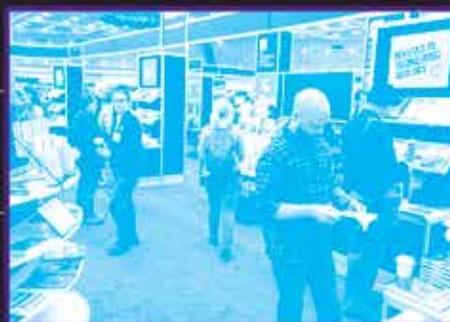
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Second Announcement

NORTHEASTERN SECTION

53rd Northeastern Section Annual Meeting, GSA
Burlington, Vermont, USA
18–20 March 2018

www.geosociety.org/ne-mtg



Lake Champlain and New York's Adirondack Mountains from Burlington, Vermont, USA.

Mountains to Lakes

LOCATION

Burlington, Vermont, USA, is a dynamic college town located on the shore of Lake Champlain between the Adirondack Mountains to the west and the Green Mountains to the east. Home to wonderful restaurants, boutiques, and microbreweries, Burlington is centrally located to many Vermont attractions, such as the Shelburne Museum, the ECHO science museum, the Ben and Jerry's Factory, and geological sites of interest such as the Champlain Thrust at Lone Rock Point and the Chazy Reef on Isle la Motte.

REGISTRATION

Early registration deadline: 13 Feb. 2018

Cancellation deadline: 20 Feb. 2018

For more information or if you have special requirements, please contact the local committee chairs: Andrea Lini, andrea.lini@uvm.edu, and Charlotte Mehrtens, charlotte.mehrtens@uvm.edu.

Registration fees (all fees are in U.S. dollars)

	Early		On-Site	
	Full	One-Day	Full	One-Day
Professional Member	\$195	\$145	\$240	\$165
Professional Member (70+)	\$115	\$95	\$145	\$115
Professional Non-member	\$215	\$165	\$265	\$200
Early Career Professional	\$150	\$115	\$215	\$180
Student Member	\$75	\$65	\$95	\$85
Student Non-member	\$85	\$75	\$105	\$95
K–12 Professional	\$80	\$65	\$100	\$75
Guest or Spouse	\$65	\$60	\$75	\$65
Workshop Only	\$55	n/a	\$60	n/a

CALL FOR PAPERS

Abstract deadline: 12 Dec. 2017

Submit online at www.geosociety.org/ne-mtg

Abstract submission fee: US\$18 for students and US\$30 for all others. If you have questions about submitting an abstract online, please contact Heather Clark, +1-303-357-1018, hclark@geosociety.org.

THEME SESSIONS

- T1. Practical Applications of Engineering Geology.** Krystle Pelham, New Hampshire Dept. of Transportation, krystle.pelham@dot.nh.gov.
- T2. Applications of Geoscience to Government and Community Issues.** Marjorie Gale, State Geologist, Vermont Geological Survey, marjorie.gale@vermont.gov; Gale Blackmer, State Geologist, Pennsylvania Geological Survey, gblackmer@pa.gov; Frederick Chormann, State Geologist, New Hampshire Geological Survey, frederick.chormann@des.nh.gov.
- T3. Stories of Resilience: River Restoration and Recovery in the Northeast.** Kristen Underwood, University of Vermont, southmountain@gmavt.net; John Field, Field Geology Services, jfield@field-geology.com.
- T4. Engineering and Environmental Applications in a Post-Glacial Northeast.** Kristen Underwood, University of Vermont, southmountain@gmavt.net; John Field, Field Geology Services, jfield@field-geology.com.
- T5. Critical Zone Processes, Function, and Resiliency: Challenges and Opportunities.** Julia Perdril, University of Vermont, jperdril@uvm.edu; Tim White, Penn State University, tsw113@psu.edu.
- T6. Emerging Contaminants in Fractured Bedrock Aquifers in the Northeast.** Jon Kim, Vermont Geological Survey, jon.kim@vermont.gov; Peter Ryan, Middlebury College, pryan@middlebury.edu; Ed Romanowicz, SUNY Plattsburgh, romanoea@plattsburgh.edu; Tim Schroeder, Bennington College, tschroeder@bennington.edu.
- T7. Biogeochemical Cycling in Natural and Human-Altered Landscapes.** Jamie Shanley, USGS, jshanley@usgs.gov; Doug Burns, USGS, daburns@usgs.gov.
- T8. Private Wells—Current Challenges and Opportunities.** Sille Larsen, Vermont Department of Health, sille.larsen@vermont.gov; Liz Royer, Vermont Rural Water Association,

- Iroyer@vtruralwater.org; Paul Susca, New Hampshire Department of Environmental Services, paul.susca@des.nh.gov; Patti Casey, Vermont Agency of Agriculture, patti.casey@vermont.gov.
- T9. **Geological Characterization of Mudstones: Applications to Hydrocarbon Exploration and Production.** David R. (Randy) Blood, EQT Production, rblood@eqt.com; Ashley S.B. Douds, EQT Production, adouds@eqt.com.
- T10. **Lake Champlain Research and Management.** Patricia Manley, Middlebury College, manley@middlebury.edu; Andrea Lini, University of Vermont, andrea.lini@uvm.edu.
- T11. **Current Research in Coastal and Marine Processes.** Mark Borrelli, University of Massachusetts–Boston, mark.borrelli@umb.edu; Bryan A. Oakley, Eastern Connecticut State University, oakleyb@easternct.edu.
- T12. **Paleolimnological Records of Landscape Change.** Laurie D. Grigg, Norwich University, lgrigg@norwich.edu; Timothy L. Cook, Worcester State University, tcook3@worcester.edu.
- T13. **Deglaciation and Late-Glacial Climate Research, Northeastern U.S. and Eastern Canada.** Organizer(s): Woodrow B. Thompson, Maine Geological Survey (retired), iceagemaine@myfairpoint.net; P. Thompson Davis, Bentley University, pdavis@bentley.edu; Brian K. Fowler, New Hampshire Geologic Resources Advisory Committee, b2fmr@metrocast.net.
- T14. **Glacial Lakes: New Understandings of Their Extent, History, and Internal Dynamics.** John Rayburn, SUNY New Paltz, rayburnj@newpaltz.edu; Stephen Wright, University of Vermont, swright@uvm.edu.
- T15. **Fire Geomorphology.** Jennifer Callanan, William Paterson University, callananj@wpunj.edu.
- T16. **Pleistocene to Anthropocene Surficial Processes in the Northeastern U.S.** Will Ouimet, University of Connecticut, willouimet@gmail.com; Noah Snyder, Boston College, noah.snyder@bc.edu.
- T17. **The Class that Time Forgot: Best Practices in Teaching Earth History.** Joseph F. Reese, Edinboro University of Pennsylvania, jreese@edinboro.edu; Eric C. Straffin, Edinboro University of Pennsylvania, estraffin@edinboro.edu.
- T18. **Geolore: Local Geology Field Trips Merge Geology and History to Motivate Students, Teachers, and Community Members to Explore Natural Areas.** Tarin Weiss, Westfield State University, tweiss@westfield.ma.edu; Lori Weeden, University of Massachusetts–Lowell, lori_weeden@uml.edu; Melissa Lombard, Fitchburg State University, melissalombard@alum.rpi.edu.
- T19. **From Plane Tables to Drones: A Topography of Geologic Mapping in a Digital Landscape.** John Van Hoesen, Green Mountain College, vanhoesenj@greenmtn.edu; Rick Chormann, New Hampshire Geological Survey, frederick.chormann@des.nh.gov.
- T20. **The Devonian Terrestrial Realm: Current Perspectives and New Research.** Charles Ver Straeten, New York State Museum, charles.verstraeten@nysed.gov; William Stein, Binghamton University, stein@binghamton.edu; Rose-Anna Behr, Pennsylvania Topographic and Geologic Survey, rosbehr@pa.gov.
- T21. **Stratigraphic Studies along the Western Margin of the Appalachian Orogens.** Paul Washington, Marietta College, pw005@marietta.edu; James Ebert, SUNY Oneonta, james.ebert@oneonta.edu.
- T22. **The Adirondack Mountains and the Grenville Orogenic Cycle: New Results and Syntheses Regarding the Timing and Nature of Deformation, Metamorphism, Intrusion, and Formation of Ore Deposits.** Tim Grover, Castleton University, tim.grover@castleton.edu; Greg Walsh, USGS, gwalsh@usgs.gov; Mike Williams, University of Massachusetts, mlw@umass.edu; Sean Regan, USGS, sregan@usgs.gov; Marian Lupulescu, New York State Museum, marian.lupulescu@nysed.gov; and Peter Valley, SUNY Potsdam, pvvalley@gmail.com.
- T23. **Application of Strain, Fabric, and Textural Analyses to Ductile Fabrics in Investigations of Orogenic Processes (Posters).** Jeffrey R. Webber, Stockton University, jeffrey.webber@stockton.edu; Keith A. Klepeis, University of Vermont, keith.klepeis@uvm.edu; Michael L. Williams, University of Massachusetts–Amherst, mlw@geo.umass.edu.
- T24. **Orogenic Sutures—Recognition, Characterization, and Tectonic Implications.** Alain Tremblay, University of Quebec at Montreal, tremblay.a@uqam.ca; Laura Webb, University of Vermont, lewebb@uvm.edu.
- T25. **Post-Rift Tectonism and Landscape Evolution in Eastern North America.** Will Amidon, Middlebury College, wamidon@middlebury.edu; Dave West, Middlebury College, dwest@middlebury.edu; Ryan McKeon, Dartmouth College, ryan.e.mckeon@dartmouth.edu.
- T26. **Evolution of the Taconic Foreland: Insights into Active Margins and Global Climate Change.** Charles E. Mitchell, SUNY Buffalo, cem@buffalo.edu; Robert D. Jacobi, SUNY Buffalo, 1rdjacobi@gmail.com; Francis A. Macdonald, Harvard University, fmacdon@fas.harvard.edu; Jeff Pietras, SUNY Binghamton, jpietras@binghamton.edu.
- T27. **New Perspectives on the Evolution of Brittle and Ductile Fault Zones: A Session Honoring the Work of Robert D. Jacobi.** Keith Klepeis, University of Vermont, keith.klepeis@uvm.edu; Jon Kim, Vermont Geological Survey, jon.kim@vermont.gov; Jean Crespi, University of Connecticut, jean.crespi@uconn.edu.
- T28. **Petrologic, Structural, and Tectonic Interpretations in Northern New England: A Session Honoring the Work of Jo Laird and Peter J. Thompson.** Ian W. Honsberger, Carleton University, ian.honsberger@carleton.ca; Wallace A. Bothner, University of New Hampshire, wally.bothner@unh.edu; Peter Robinson, Geological Survey of Norway, peter.robinson@ngu.no.
- T29. **Petrologic Insights on Modern and Ancient Plate Margins I: The Volcanic and Plutonic Record.** Sara Mana, Salem State University, smana@salemstate.edu; Emily Peterman, Bowdoin College, epeterma@bowdoin.edu; Alicia M. Cruz-Uribe, University of Maine, alicia.cruzuribe@gmail.com.
- T30. **Petrologic Insights on Modern and Ancient Plate Margins II: The Metamorphic Record.** Emily Peterman, Bowdoin College, epeterma@bowdoin.edu; Howell

Bosbyshell, West Chester University; hbosbyshell@wcupa.edu; Victor Guevara, Skidmore College, vguevara@skidmore.edu.

- T31. **Igneous Processes in the Shallow Crust: A Session Honoring the Work of David Scott Westerman.** Christopher Koteas, Norwich University, gkoteas@norwich.edu.
- T32. **Combining Geology and Geophysics in the Appalachians.** Maureen D. Long, Yale Univ., maureen.long@yale.edu; Yvette D. Kuiper, Colorado School of Mines, ykuiper@mines.edu.
- T33. **Lake Research and Monitoring Networks in the Northeast.** Kiyoko Yokota, SUNY Oneonta, kiyoko.yokota@oneonta.edu; David Richardson, SUNY New Paltz, richardsond@newpaltz.edu; Lisa Borre, Cary Institute of Ecosystem Studies, borrell@caryinstitute.org.

FIELD TRIPS

No NEGSA-sponsored field trips will be offered; however, there will be field guides to local geologically significant sites available at the meeting.

WORKSHOPS

1. **Core Tools: Techniques and Software for Collection and Analysis of Core Samples.** Sat., 17 Mar., 9 a.m.–3 p.m., 331 Delehanty Hall, University of Vermont. Fee: US\$35. Anders Noren, Continental Scientific Drilling Coordination Office/LacCore Facility, University of Minnesota, noren021@umn.edu.
2. **Science Practice Integration for Your Classroom.** Sat., 17 Mar., 10 a.m.–3 p.m., 219 Delehanty Hall, University of Vermont. Fee: US\$20 (bring your lunch; coffee and tea provided.). Melissa Lombard, Fitchburg State University, melissalombard@alum.rpi.edu; Lara Gengarelly, University of New Hampshire, lara.gengarelly@unh.edu.
3. **Turning Drone Data into Information.** Sat., 17 Mar., 12:30–4:30 p.m., Spatial Analysis Laboratory, 205 George Aiken Center, University of Vermont. Fee: US\$50. Jarlath O'Neil-Dunne, University of Vermont Spatial Analysis Laboratory, jarlath.oneil-dunne@uvm.edu.

OPPORTUNITIES FOR STUDENTS AND EARLY CAREER PROFESSIONALS

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 Hydrogeology 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

Part 1: Career Planning and Informational Interviewing. Your job hunting process should begin with career planning, not when you apply to jobs. This workshop will help you begin this process and will introduce you to informational interviewing. This section is highly recommended for freshmen, sophomores, and juniors. The earlier you start your career planning the better.

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 market for a job or not, learn how to prepare the best résumé possible. You will review numerous examples, helping you to learn important résumé dos and don'ts.

STUDENT VOLUNTEERS

The committee and officers of the Northeastern Section rely on student volunteers to help meetings run smoothly, and we are pleased to offer student volunteers complimentary registration for the meeting in return for ~7 hours of work. Contact student volunteer coordinator David West (dwest@middlebury.edu) for more information.

NORTHEASTERN SECTION STUDENT TRAVEL GRANT

Application deadline: 13 Feb. 2018

Find information on student travel grants on the Section website. Please review the eligibility guidelines and application procedures.

ACCOMMODATIONS

A block of rooms has been reserved at the Sheraton Hotel and Conference Center in Burlington at US\$139 per night single or double, with US\$20 extra for the third and fourth occupants. This convention rate is guaranteed until Fri., 23 Feb. 2018. Parking is included.

LOCAL COMMITTEE

Co-Chairs: Andrea Lini, andrea.lini@uvm.edu; Charlotte Mehrtens, charlotte.mehrtens@uvm.edu

Technical Session Co-Chairs: Jon Kim, jon.kim@vermont.gov; George Springston, gsprings@norwich.edu

Workshop Chair: Larry Becker, becklrb@comcast.net

Sponsorship Chair: Craig Heindel, cheindel@gmvat.net

Student Volunteer Coordinator: Dave West, dwest@middlebury.edu

Special Events/Speakers: Dave Franzi, franzida@plattsburgh.edu; Tony Fowler, afowler@uottawa.edu

2018 GeoCareers Section Meeting Programs

GSA's Mentor Programs are designed to connect students and early career professionals with professionals in a variety of sectors so that you are able to make informed choices on your career trajectory. Don't miss these popular luncheons!

John Mann Mentors in Applied Hydrogeology

Roy J. Shlemon Mentor Program in Applied Geoscience

Whether you are close to graduating, a young professional, or seeking a change in direction, use tips from these workshops to guide you on your way. The following three workshops will be offered at each of the GSA Section Meetings.

Geoscience Career Workshop Part 1: Career Planning and Informational Interviewing

Geoscience Career Workshop Part 2: Geoscience Career Exploration

Geoscience Career Workshop Part 3: Cover Letters, Résumés, and CVs



New K-12 Field Workshops Coming for 2018



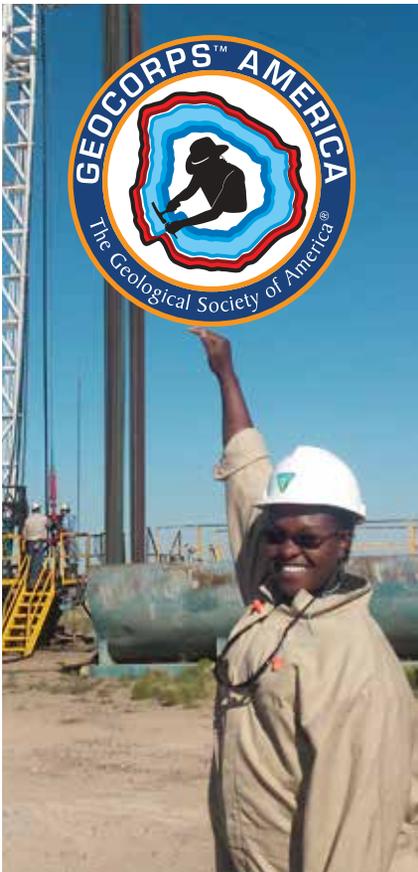
GSA is revising its GeoTeachers program to reach more teachers at less cost with a series of annual professional development workshops in states around the country. The workshops will be designed for teachers to

- Focus on the local geology, geoscience processes, and hazards;
- Explore sites where geologic resource extraction, refining, and waste mitigation can be observed;
- Learn from geologists in academia, industry, and government providing career insights for classroom use;
- Participate in activities tied to classroom needs and local standards presented by master teachers;
- Obtain field guides, hand samples, and other resource materials for classroom use;
- Earn continuing education/graduate credit for professional development purposes; and
- Join a community of practice with follow-up webinars and activities designed to assist classroom implementation.

Teachers interested in participating in these workshops should register their interest at <http://bit.ly/2eHUssk>.

Geoscience educators, scientists, and practicing geologists interested in helping develop and implement these workshops either by sharing their expertise, field knowledge, or contacts should register their interest at <http://bit.ly/2wqqWPI>.

For more information contact Dean Moosavi, smoosavi@geosociety.org, +1-303-357-1015, or go to www.geosociety.org/geoteachers.



GSA GeoCorps™ America Program

Use your geoscience skills to serve your public lands, while spending the summer in an amazing place!

Summer 2018 GeoCorps Positions—Apply by 2 Feb. 2018

GeoCorps will provide dozens of exciting geoscience opportunities on federal public lands. Project areas include a wide variety of topics, such as paleontology, hydrology, geohazards, caves/karst, GIS/mapping, and more.

www.geosociety.org/geocorps

www.facebook.com/GeoCorps



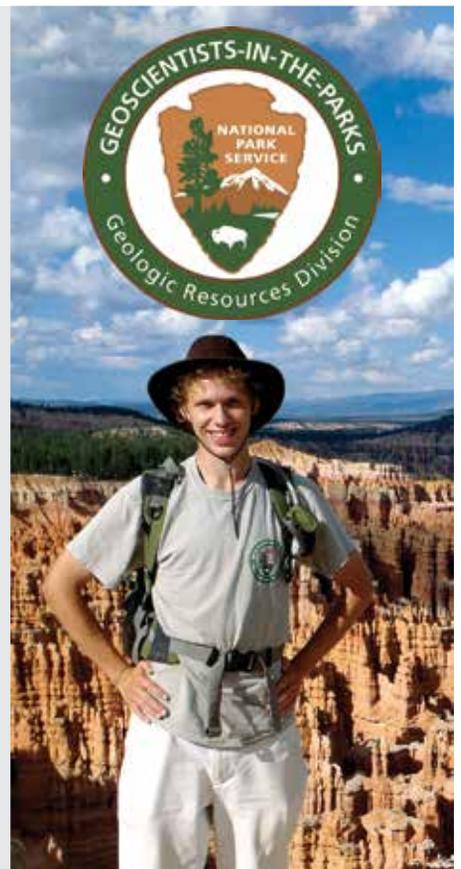
National Park Service Geoscientists-in-the-Parks (GIP) Opportunities

Summer Geoscience Projects in Beautiful National Parks across the United States

Summer 2018 Positions—Apply by 2 Feb. 2018

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 the Stewards Individual Placement Program.

www.geosociety.org/gip





GeoCorps Enterprise

GeoCorps is now accepting industry partners too! Use GSA to find the best students for your short-term projects, during the summer, and other times of the year. You focus on the geoscience and we'll take care of the administration. Contact Matt Dawson for more information, +1-303-357-1025, geocorps@geosociety.org.

www.geosociety.org/geocorpsenterprise

FIELD CAMP Scholarships

GSA and the GSA Foundation are proud to announce that Field Camp Scholarships will be available to undergraduate geology students for the summer of 2018. These scholarships will provide students with US\$2,000 each to attend the field camp of their choice. Applications are reviewed based on diversity, economic/financial need, and merit. Applications will be due in February 2018. Questions? Contact Jennifer Nocerino at jnocerino@geosociety.org.

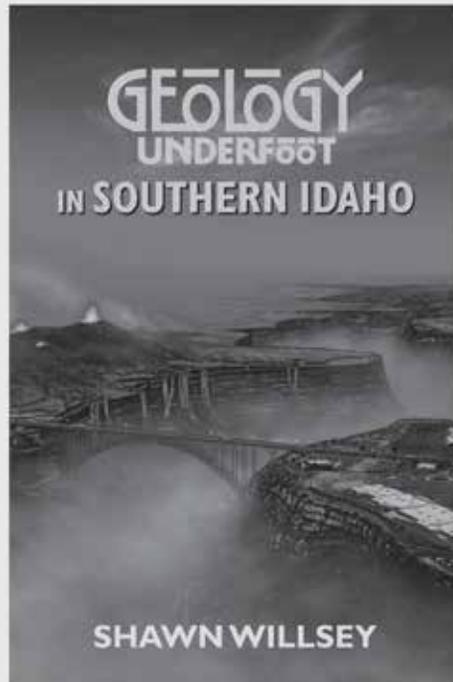


GSA FOUNDATION

SOME OF THE GEOLOGIC HIGHLIGHTS COVERED IN THIS BOOK

- Bruneau Sand Dunes State Park
- Hagerman Fossil Beds National Monument
- Box Canyon State Park
- Shoshone Falls and the Snake River Canyon
- Sculpted Rock at Black Magic Canyon
- Redfish Lake and the Sawtooth Range
- Malm Gulch's Fossilized Forests
- Beaverhead Meteor Impact at Leaton Gulch
- Fissure Eruption at Kings Bowl
- City of Rocks National Reserve
- Spencer Opal Mines
- Henrys Fork Caldera
- Volcanic Vents of North Menan Butte
- Soda Springs Geyser and Travertine
- Minnetonka Cave

Southern Idaho is a Geologic Jackpot!



Within its rugged mountains, youthful lava fields, and steep-walled canyons lies compelling evidence of amazing geologic events. Join author Shawn Willsey as he uses clear prose, concise illustrations, and dramatic photographs to tell the stories of 23 amazing geologic sites. Learn how Ice Age floods sculpted the Snake River Canyon, how tree molds and lava tubes formed at Craters of the Moon, where the land surface ruptured during the 1983 Borah Peak earthquake, and much more.

6 x 9 • 304 pages • \$24.00, paper
140 color photos • 60 color illustrations
Item no. 288 • ISBN 978-087842-678-2

MP Mountain Press
PUBLISHING COMPANY
P.O. Box 2399 • Missoula, MT 59806 • 406-728-1900
800-234-5308 • info@mtnpublishing.com
www.mountain-press.com

Why GSA Membership Is Important to Me



Nazrul Khandaker and Elizabeth Wuyep. As a GSA International travel grant recipient, Wuyep deeply appreciated funding that enabled her to come all the way from Nigeria to present research and build international collaboration. GSA Annual Meeting, Minneapolis, 2011.

With ~25,000 members worldwide and several core-discipline-based Divisions, Sections, Interdisciplinary Interest Groups (IIGs), and globally connected Associated Societies, GSA, being a multi-faceted organization, is meeting numerous expectations relevant to disseminating cutting-edge science, encouraging fundamental and applied research, connecting with societal needs, advocating the dire need to enhance the knowledge base and allow effective communicating at the congressional level, educating next generations of working geoscientists and educators, and fostering international collaborations.

Membership with GSA opens up a plethora of geoscience-related opportunities and, given the current status of the interdisciplinary nature of the discipline, finding the right resource at the right time—GSA is becoming the cornerstone for scientific resource retrieval. Members are exposed to a variety of online resources via the Member Community and online posting of timely and strategic topics relevant to their needs.

As part of the scientific exchange of knowledge-sharing, Annual, Section, and specialty meetings (Penrose, international meetings, etc.) are welcoming meeting of minds internationally and domestically. Spreading GSA's global mission is ensuring rapid assimilation of cultural and geoscientific information for wider usage. GSA is promoting fundamental research focusing on basic geologic processes, natural resource development, and environmental aspects.



Jubilant geology students from Dhaka University, Bangladesh, were enjoying field investigation. The participation of an astounding number of female students (almost half) highlighted this trip and broke the gender barrier. Deformed Tertiary clastics and carbonates in the background. Sylhet, Bangladesh, 6 Jan. 2016. Photo credit: Nazmus Sakib.

Serving society and science with validated and established data and connecting congressional members to keep them aware of the pivotal role geosciences play in terms of combating present-day extreme weather-related events and preparing a well-informed and trained workforce to undertake future tasks are significantly aligned with GSA's mission, vision, and objectives.

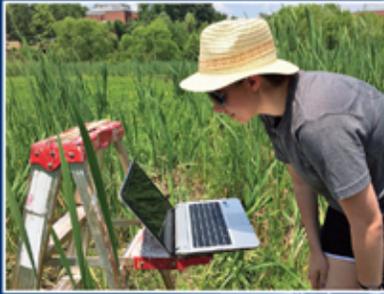
Aside from dissemination of sound geological knowledge, the outreach involving mentoring, supporting students' research, travel to the Annual/Section meetings, providing students representation at the Division level, etc., are importantly becoming a normal mode of operation. K–16 educators, preservice teachers, and caregivers find themselves immersed with pedagogically sound lesson plans much needed for generating motivation, interest, and curiosity and creating pipelines for college-bound geoscience students both in urban and non-urban setting.

Nazrul I. Khandaker

Professor, York College (City University of New York)

GSA Member since 1985

GSA International Secretary



GOLI

Geoscience Online Learning Initiative

<https://www.americangeosciences.org/workforce/goli>

The Geoscience Online Learning Initiative (**GOLI**) is an effort by the American Geosciences Institute, started in cooperation with the American Institute of Professional Geologists (AIPG) to bring to the profession a platform for asynchronous, life-long learning and continuing education opportunities. These online courses are available to learners who desire the flexibility to complete their continuing education on their own time. Asynchronous courses do not have a set schedule as do traditional semester-based courses. This enables learners to actively self-pace their progress. Brought to you via the OpenEdX Learning Management System (LMS), learners are able to browse course descriptions, enroll in specific courses, access content, and complete any course completely free of charge. All learners who complete courses offered through the **GOLI** program with a passing grade of 70% or higher are eligible to purchase Continuing Education Units (CEUs) for a nominal charge.

Sample courses:

- **Assessing, Mitigating, and Communicating Flood Risk**
- **Communicating Cascadia's Earthquake Risk**
- **Desalination as a Source of Fresh Water**
- **Planning for Coastal Storm and Erosion Hazards**
- **Best Practices in Mineral Resource Estimation & Reporting**

GOLI consists of live webinar courses and self-paced asynchronous online courses. Continuing education units (CEUs) are granted by AIPG to individuals completing the course. For more information about the Geoscience Online Learning Initiative visit <https://www.americangeosciences.org/workforce/goli> or contact Heather Houlton at hrh@agiweb.org.



Background: ©Shutterstock.com/Sergey Nivens. Insets, left: Megan Amanatides; center: Zsuzsanna Toth (both submitted to AGI's 2016 Life as a Geoscientist contest); right: ©iStock.com/Chris Gramly



THE
GEOLOGICAL
SOCIETY
OF AMERICA

REPORT

Catastrophic Mega-Scale Landslide Failure of Large Volcanic Fields

16–22 September 2017
Cedar City and Bryce Canyon City, Utah, USA

CONVENERS

Robert F. Biek, *Utah Geological Survey, Salt Lake City, Utah, USA*

David B. Hacker, *Department of Geology, Kent State University, Kent, Ohio, USA*

Peter D. Rowley, *Geologic Mapping Inc., New Harmony, Utah, USA*

FIELD TRIPS AND ANALYSIS

This six-day Thompson Field Forum investigated the concept of exceptionally large catastrophic collapse of volcanic fields using the distinguishing features of the newly discovered Markagunt (MGS) and Sevier (SGS) gravity slides, Marysvale volcanic field, southwest Utah, USA. Large landslides are known from hundreds of volcanoes and increasing numbers of laccoliths around the world, yet the mega-scale failure of volcanic fields themselves, producing gravity slide structures so large that they blur the boundary between gravitational and tectonic processes, has not received widespread attention. This was a transformative week of (1) redefining the physical limits of what is possible; (2) investigating evidence—on the outcrop—to identify unique characteristics of structures and deposits indicative of mega-slide deformation and of fast versus slow processes; and (3) planning for future collaborative studies.

First, some background. The MGS and SGS exhibit the full range of structural features commonly seen in modern landslides, but on a gigantic scale; they are among Earth's largest terrestrial landslides. The MGS remained undiscovered for so long precisely because of its gigantic size (>5000 km², >95 km long, >35 km runout, estimated volume 3000 km³ [dimensions revised from D.B. Hacker et al., 2014, *Geology*, v. 42, no. 11, p. 943–946]) and its initially confusing mix of extensional, translational, and compressional structures overprinted by post-MGS basin-range tectonism. In comparison, the 1980 Mount St. Helens debris avalanche was only about 3 km³. Preliminary mapping of the SGS, discovered in 2015, shows it to be smaller (likely at least 1500 km² in size) and slightly older than the MGS. Both slides are composed of large contiguous sheets of andesitic lava flows, volcanoclastic rocks, and intertonguing ash-flow tuffs that record southward catastrophic transport of the southern flank of the Oligocene to

Miocene Marysvale volcanic field, preceded by gravitational spreading on the Paunsaugunt thrust fault system. MGS emplacement is currently constrained between 22 to 21 Ma, whereas SGS emplacement is between 25 to 23 Ma. That features as large as the MGS and SGS can remain undetected despite decades of geologic mapping and research in a well-exposed area suggests to us that other volcanic fields around the world may hold evidence of as-yet-undiscovered exceptionally large gravity slides.

This field forum brought together 27 participants, including nine students, who represented disciplines including rock mechanics, landslides, volcanology, petrography, paleomagnetism, sedimentology, isotope geochemistry, structure, and tectonics. We began the forum with a half-day meeting to introduce the MGS and SGS and hear participant research presentations on their relevant interests, then spent five days viewing and discussing exceptionally instructive outcrops. The meeting concluded with a session that summarized the group's findings and planned for collaborative research, student involvement, and funding opportunities. In early 2018, the conveners will submit a field guide and participant abstracts for publication in the GSA Field Guide series.

Using the MGS and SGS as examples, the conference emphasized the following:

- Different lines of evidence diagnostic of large to small catastrophic gravity slides;
- Cross-disciplinary assessment of extreme deformation recorded by basal layers and associated injectites (clastic dikes), ultracataclastic shear zones, pseudotachylyte, fragmented clasts, and main and sidewall breakaways;
- Fabrics and rock types developed by rheomorphic versus tectonic versus debris-avalanche modes of emplacement;
- Factors contributing to volcanic landslide initiation and transport—why and how did these slides happen?;
- The role of magmatic intrusions in inflation of volcanic fields and slope destabilization;
- Gravitational basement spreading of volcanic fields prior to catastrophic failure;

- Relationship to other large landslides and volcanic provinces throughout the world and on other planets;
- Understanding paleoclimate and its relationship to deeply weathered volcanoclastic strata at the base of the volcanic field; and
- Public education opportunities highlighting unique features of the slides and evolution of the Marysvale volcanic field, which are adjacent to several of Utah's national and state parks and monuments.

Importantly, there was significant debate about structures and features diagnostic of catastrophic failure versus those produced by (1) slow, episodic tectonic processes such as low-angle, non-rooted or rooted normal faults; or (2) volcanic processes, such as those that produce autobreccia—distinctions that are critical in identifying mega-scale landslides in volcanic fields elsewhere. The MGS and SGS provide significant research opportunities on these and other questions. Already, several student theses are under way, as is preliminary lab work to support future funding proposals.

ACKNOWLEDGMENTS

We thank GSA for their generous financial support of this Thompson Field Forum, and gratefully acknowledge support from the Utah Geological Association, Utah Geological Survey, Kent State University, Geologic Mapping Inc., and over a dozen Panguitch ATV enthusiasts (who transported participants to remote outcrops). Nicole Dillon and Becky Sundeen at GSA Headquarters made planning the forum a breeze.



Participants gathered at the base of the 22-Ma Harmony Hills Tuff, one of the regionally extensive ash-flow tuffs that constrain emplacement parameters and timing of the MGS and SGS. From left to right: Shannon Hunter, Bill Lund, Chris Rowan, Julia Morgan, Grant Willis, Nic Barth, Lee Siebert, Jay Melosh, Eric Ferré, Bob Biek, Kevin Rafferty, Sam Thiele, Mike Hozik, Mark Anders, Zach Smith, Ashley Griffith, Scott Giorgis, Majie Fan, Troy Barber, Melanie Ray, Jeff Keith, Dave Malone, Pete Rowley, Mike Braunagel, David Hacker, and Collin Jensen (Amy Hughes is not pictured). Photo courtesy Lance Weaver, Utah Geological Survey.



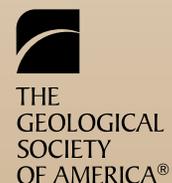
Call for Proposals: Penrose Conferences and Thompson Field Forums

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 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 under the events tab at www.geosociety.org or contact Becky Sundeen at bsundeen@geosociety.org.



Geoscience Jobs & Opportunities

Positions Open

TENURE TRACK ASSISTANT PROFESSOR IN PETROLOGY TULANE UNIVERSITY

The Dept. of Earth and Environmental Sciences at Tulane University invites applications for a tenure track faculty position in petrology, at the rank of Assistant Professor. We seek a broad-based Earth scientist who complements current faculty expertise and will build an externally funded research program that will attract high caliber Ph.D.-level graduate students. Possible areas of core expertise include, but are not limited to: igneous petrology, volcanology, high-temperature geochemistry, metamorphic petrology and thermochronometry. Applicants must hold a doctorate in an appropriate field and have a demonstrated ability to conduct outstanding research. We seek applicants committed to mentoring undergraduate and graduate students; teaching duties are at both the graduate and undergraduate levels. For full consideration, applications should be received by January 15, 2018, but the position will remain open until filled. Applications should include a curriculum vitae, research and teaching statements that articulate how the mission of the department would be enhanced, and the names and contact information of at least three references. Applications must be submitted electronically via the following link: apply.interfolio.com/46806. Any inquiries may be directed to Dr. Nancye Dawers, Dept. of Earth and Environmental Sciences, Tulane University, 6823 St. Charles Ave., New Orleans, LA 70118-5698 (ndawers@tulane.edu). Further information about the department and university can be obtained at <http://tulane.edu/sse/eens>. Tulane University is an EEO/ADA/AA employer.

TENURE-TRACK FACULTY POSITION SEDIMENTOLOGY/SEDIMENTARY PETROLOGY, UNIVERSITY OF HOUSTON

The Dept. of Earth and Atmospheric Sciences at the University of Houston invites applicants for a faculty appointment at the Assistant Professor level in the broad areas of sedimentology and sedimentary petrology. We encourage applicants with a research focus on any aspect of modern or ancient sedimentary systems who integrates field, laboratory, theoretical, and/or modeling approaches to the study of sedimentary deposits.

The successful candidate will join a department of 32 tenure-track faculty with diverse expertise in tectonics, petroleum geology, exploration geophysics, isotope geochemistry, remote sensing, and anticipated growth in the study of sedimentology/sedimentary petrology. The successful candidate will be expected to build a vigorous externally funded research program and demonstrate productivity via peer-reviewed publication. Candidates will also be expected to teach at both the undergraduate and graduate levels as well as to mentor M.S. and Ph.D. students. We expect to fill this position by August, 2018. Candidates must have a Ph.D. in Earth Science or a related field at the time of the appointment. We will begin reviewing applications by December 1, 2017.

Application Procedures: Candidates should submit: (1) a letter of application including statement of teaching and research interests, (2) a curriculum vitae, (3) a list of possible references. Applications should be submitted online through: <https://jobs.uh.edu/>. A background check is required prior to interviewing. Further information can be obtained on the departmental web page at <http://www.eas.uh.edu> or by calling +1-713-743-3399.

The University of Houston is an Equal Opportunity/Affirmative Action Employer. Minorities, women, veterans, and persons with disabilities are encouraged to apply.

The University of Houston is responsive to the needs of dual career couples.

The University of Houston, with one of the most diverse student bodies in the nation, seeks to recruit and retain a diverse community of scholars.

FACULTY POSITION ASSISTANT OR ASSOCIATE PROFESSOR IN GEOLOGY SUBDUCTION ZONE INITIATIVE UNIVERSITY OF WASHINGTON

The University of Washington (UW) seeks a geologist with a compelling vision for subduction zone research and the collaborative leadership skills to contribute to a new subduction zone initiative at UW. This faculty position is in the Dept. of Earth & Space Sciences (ESS) of the College of the Environment, and is expected to be at the rank of Assistant Professor (tenure track) or Associate Professor (with tenure). This position is a full-time position with an indefinite term and 9-month service period.

The new faculty member will be a geologist who studies the evolution of subduction systems through the interpretation of the rock record. Candidates should use geological field observations to establish context for interpreting the rock record, and combine these approaches with other analytical, theoretical, or experimental techniques. We particularly encourage applicants who examine high-temperature processes, and who complement existing strengths in ESS. We seek a colleague whose research will connect with other scientists in ESS and across the College. Candidates hired at the Assistant Professor level should demonstrate strong potential for collaborative, cross-disciplinary leadership contributing to a subduction zone initiative; candidates hired at the Associate Professor level should have a record of leadership.

Applicants should demonstrate the potential for or a track record of externally funded internationally recognized research, commensurate with experience, and show potential for high quality teaching in our undergraduate and graduate programs. Specifically, the faculty member must contribute to the undergraduate curriculum in Earth Materials/Mineralogy and Field Geology, and should demonstrate the ability to attract and effectively advise excellent research students. Applicants must hold a Ph.D. or foreign equivalent.

The UW promotes diversity and inclusivity among our students, faculty, and staff and the public. We seek applicants who are committed to these principles. Applicants should demonstrate the potential to support ESS's collegial, collabora-

tive culture and to fulfill our strong commitment to equity and inclusion through their research, teaching, and/or service.

The University of Washington (UW) is located in the greater Seattle metropolitan area, and offers one of the most exceptional research and teaching environments in the United States. Seattle is a region of explosive growth, global trade, and technological advancement. It is also a cultural metropolis surrounded by the natural beauty of the Pacific Northwest. Seattle offers a quality of life that is among the highest in the country, with lakes and parks, walkability, bike lanes, and a lively music and cultural scene. The UW serves a diverse population of 80,000 students, faculty and staff, including 25% first-generation college students, over 25% Pell Grant students, and faculty from over 70 countries. The UW is a recipient of a National Science Foundation ADVANCE Institutional Transformation Award to increase the advancement of women faculty in science, engineering, and math (seewww.engr.washington.edu/advance).

The Dept. of Earth and Space Sciences, located in the College of the Environment, has four broad and overlapping focus areas: the solid earth, surface processes, geobiology, and space/planetary studies. The departmental community includes 41 research and teaching faculty, 110 graduate students, and 200 undergraduate majors. The department is home to USGS employees who study natural hazards in the Pacific Northwest. Several centers and programs, closely linked to the department, allow for unparalleled interdisciplinary educational and research opportunities. These include the School of Oceanography and other units in the College of the Environment; Departments of Civil Engineering and Applied Mathematics; Quaternary Research Center (QRC); and Pacific Northwest Seismic Network (PNSN).

Application Instructions: <https://ap.washington.edu/ahr/academic-jobs/position/aa25938/>

To apply, please send a letter of interest, curriculum vitae with publication list, and the contact information of 3 references. Applicants should also send three statements (1-2 pages each): (1) A statement addressing research accomplishments, as well as future research plans. (2) A statement discussing teaching and mentoring philosophy, teaching effectiveness, and potential contributions to teaching field geology and earth materials. (3) A statement on their past or potential contributions to diversity, equity, and inclusion ([seehttp://www.washington.edu/diversity/diversity-blueprint/](http://www.washington.edu/diversity/diversity-blueprint/)), including advocacy for identity groups other than their own.

Electronic materials (.pdf) should be sent to essasst@uw.edu with "Subduction Zone Faculty Search: [Your Name]" in the subject line. Consideration of applications will begin immediately and continue until the position is filled. Preference will be given to applications received prior to January 2, 2018. Questions pertaining to the application process or potential disability accommodations can be addressed to Scott Dakins (essasst@uw.edu). Questions about the position can be addressed to

Associate Professor Katharine Huntington, search committee chair (kate1@uw.edu).

This position is a full-time position with an indefinite term and 9-month service period. Applicants must hold a Ph.D. or foreign equivalent. All University of Washington faculty engage in teaching, research and service. The University of Washington is an affirmative action and equal opportunity employer. All qualified applicants will receive consideration for employment without regard to race, religion, color, sex, sexual orientation, gender identity, gender expression, national origin, age, protected veterans or disabled status, or genetic information.

**ASSISTANT PROFESSOR IN
POTENTIAL FIELDS GEOPHYSICS
THE UNIVERSITY OF ALABAMA**

The Dept. of Geological Sciences at The University of Alabama (UA) invites applications for a tenure-track faculty position in potential fields geophysics. This position will begin August 2018 and will be filled at the Assistant Professor level. Candidates who specialize in potential fields (gravity, magnetics, electricity, and/or electromagnetism), including data acquisition, processing, and interpretation, with research interests in near-surface, environmental, hydrologic, exploration, and solid-earth geophysics are invited to apply. It is expected that this position will enhance UA research focused on water, energy, and the environment with an emphasis on hydrogeology, petroleum systems, and/or tectonics. Candidates must have a strong record of research and teaching, and they must have received a Ph.D. in geology, geophysics, or a related field by the time of their appointment. The successful candidate will be expected to establish a vigorous, externally funded research program and to attract and advise high-quality graduate students. Teaching responsibilities will include undergraduate and graduate courses in his/her specialty and introductory geology. The department has a broad range of geophysical and computational facilities, in addition to University-shared facilities. Details regarding existing research programs, equipment and facilities, and departmental activities can be found at <http://www.geo.ua.edu>.

Questions should be directed to Dr. Fred Andrus (fandrus@ua.edu). Applicants should go to <https://facultyjobs.ua.edu/postings/41543> to electronically apply for this position. When submitting an application, candidates must provide a cover letter, CV, research and teaching statements, and a list with the contact information for at least three references. Applications will be reviewed starting December 1, 2017 and will continue until the position is filled. The University of Alabama is an Equal Opportunity Affirmative Action Employer and actively seeks diversity in its employees.

**HYDROLOGY AND WATER RESOURCES
ASSISTANT/ASSOCIATE PROFESSOR
UNIVERSITY OF NEVADA, LAS VEGAS**

The University of Nevada, Las Vegas Geoscience Dept. seeks to recruit an Assistant or Associate Professor in the field of Hydrology and Water Resources [18545] as a tenure-track or tenured appointment. The successful candidate is expected

to develop (Assistant-level), or expand upon (Associate-level) a rigorous, externally funded research program, supervise graduate students at both the master's and doctoral levels, and teach both graduate and undergraduate classes. Preference will be given to applicants with research interests in one or more of the following sub-disciplines: hydroclimatology; interactions among groundwater, surface water and atmosphere; hydrogeochemistry; innovative means of characterizing water resources; and/or ecohydrology and geobiologic impacts on water resources. Research approaches may include analytical, numerical, field, remote sensing and/or experimental techniques. The position requires a Ph.D. in an appropriate earth science discipline from a regionally accredited college or university. Salary will be competitive with those at similarly situated institutions. Position is contingent upon funding.

Application materials must include a cover letter, curriculum vitae, proposed research plans (five page limit), statement of teaching philosophy and interests (two page limit), and contact information for at least five referees. Review of candidates' materials will begin on January 10, 2018. Materials should be addressed to Dr. Elisabeth Hausrath, Search Committee Chair, and submitted at <https://hrsearch.unlv.edu>. For assistance with UNLV's online applicant portal, contact UNLV Employment Services at (702) 895-3504 or applicant.inquiry@unlv.edu.

EEO/AA/Vet/Disability Employer.

**AFFILIATE PROFESSOR, GEOLOGY
GRAND VALLEY STATE UNIVERSITY**

The Geology Dept. at Grand Valley State University invites applications for an affiliate faculty position to begin in the Fall 2018. For more information about the responsibilities of the position, please visit <http://jobs.gvsu.edu/cw/en-us/listing/>. At least an M.S. in Geosciences with teaching experience is required.

Apply online at jobs.gvsu.edu. Attach a letter of application, vitae, statement of teaching philosophy and the names and contact information of at least three references familiar with your teaching. Review of applications to begin December 18, 2017, and continue until the position is filled. Contact Figen Mekik (mekikf@gvsu.edu) with any questions. The Geology department website may be found at www.gvsu.edu/geology. Grand Valley is an affirmative action, equal opportunity institution.

**NUTRIENT BIOGEOCHEMISTRY
CATCHMENT HYDROLOGY
AND LIMNOLOGY POSTDOC
UNIVERSITY OF VERMONT**

Vermont EPSCoR is recruiting a postdoctoral associate to join our cutting-edge NSF-funded research on Basin Resilience to Extreme Events (BREE). We are continuing a five-year interdisciplinary research project, which studies Lake Champlain Basin landscape, watershed and lake condition responses to extreme weather events. Policy scenarios for enhancing resilience are tested using our comprehensive Integrated Assessment Model (IAM). As a member of the BREE team, the successful candidate will benefit from unique

learning and professional development experiences including science communication through our program with the Alan Alda Center for Communicating Science, grant writing through workshops, and undergraduate mentorship through our summer internship program.

Please visit <http://epscor.w3.uvm.edu/2/node/3223> for a complete description of the job and how to apply.

**TENURE-TRACK, ASSISTANT
OR ASSOCIATE PROFESSOR
MINERALOGY & PETROLOGY**

UNIVERSITY OF ALASKA FAIRBANKS

University of Alaska Fairbanks Dept. of Geosciences is seeking an Assistant/Associate Professor of Mineralogy & Petrology. This position is a 9 month, tenure track position to begin in August 2018.

We encourage applications from mineralogists and/or petrologists with experience in igneous petrology. Specific areas of research and teaching focus can include, but are not limited to: intrusive igneous rocks and structures; economic geology; petrology and/or geochemistry of volcanic arcs; and/or geochronology. We seek a colleague who will complement and collaborate with existing faculty in the department who specialize in volcanology, structural geology, metamorphic petrology, and economic geology.

The successful candidate is expected to show strong interest in and aptitude for teaching at the undergraduate and graduate levels. The position will include teaching, mineralogy, petrology, and introductory courses as part of our undergraduate geoscience curriculum, the opportunity to contribute to the UAF Geology Field Camp, and the potential to teach other courses in the candidate's area of specialty. Establishment of an externally funded research program and attraction of excellent graduate students to attend UAF is an important component of the position. Development of a research program in Alaska is strongly encouraged. Candidates with field research experience and expertise in analytical research methods utilizing the electron microprobe and other instruments housed by our Advanced Instrumentation Lab are strongly encouraged to apply.

Candidates will hold a Ph.D. in geosciences or a related field with commitment to excellence in teaching and research involving undergraduates, and who will maintain an active research program.

Applicants must provide statements of research and teaching interests; curriculum vitae; an example of their published research; and the names and contact information of three people who can provide letters of recommendation. For complete position information and to apply visit our UA Careers site (posting 508082). <http://careers.alaska.edu/cw/en-us/job/508082?ApplicationSubSourceID=>

Please visit us at the Fall AGU meeting. Applicants are encouraged to visit us on the web <http://cnsm.uaf.edu/> to learn more about the College of Natural Science & Mathematics and the Geosciences program. Review of applications will begin December 21, 2017. For more information,

please contact Rhonda McKay at rlmckay2@alaska.edu.

UA is an AA/EO employer and educational institution and prohibits illegal discrimination against any individual: www.alaska.edu/nondiscrimination.

**TENURE-TRACK FACULTY POSITION
NEAR-SURFACE GEOPHYSICS OR
SEDIMENTARY PETROLOGY
UTAH VALLEY UNIVERSITY**

OREM, UTAH. The Dept. of Earth Science at Utah Valley University (UVU) invites applications for a tenure-track position to begin August 2018. We seek a talented and committed educator with expertise in sedimentary petrology, near-surface geophysics, or geophysics applied to engineering geology. The successful candidate must have a Ph.D. in geology or a closely related field at the time of appointment. Responsibilities will include teaching introductory level geoscience courses, supervision of undergraduate research, possible development of new upper division course(s) in the successful applicant's area of expertise, and service to the institution. Excellent teaching skills and a strong commitment to effective teaching and undergraduate research are necessary.

UVU, located in Orem, Utah, is a fast-growing comprehensive state institution of higher education with over 36,000 students and strong support for engaged learning. The university sits at the western front of the Wasatch Mountains, with superb opportunities for field-based teaching and research. The Dept. of Earth Science has a 13-member faculty with a strong record of mentoring undergraduate research and offers B.S. programs in Geology, Environmental Science & Management, and Earth Science Education. It has excellent facilities, including a GEODE seismograph, XRF, ICP-OES, SEM (EDX and CL-capable), petrographic teaching microscopes, electrical resistivity and magnetometer instruments, as well as a range of other geochemical, remote sensing, surveying, and computing resources. The department also has strong ties to the University of Utah, Brigham Young University, Utah State University, local industry and governmental organizations.

UVU is located in the Provo-Orem metropolitan area, which has a population of over 500,000 and excellent access to numerous outdoor recreational activities such as snow sports, hiking, mountain biking, kayaking, fishing, and hunting. Salt Lake City is 45 minutes north by high-speed commuter rail and has a major airport and a vibrant cultural scene including highly acclaimed ballet, outdoor concert series, professional sports and more (see www.slcgov.com/arts and www.visitsaltlake.com). In addition, Utah boasts world famous National Parks and Monuments. For more information, please see <http://www.uvu.edu/earth-science/> or contact Michael Bunds at michael.bunds@uvu.edu.

To apply, please visit <https://www.uvu.jobs/postings/3579>. Applications will be evaluated beginning 1/5/18.

Utah Valley University is an Equal Opportunity Employer/Veterans/Disabled/Equal Access Employer. Utah Valley University is committed to

an inclusive hiring process and the welcoming of diverse candidates.

**TENURE-TRACK FACULTY
PHYSICAL GEOGRAPHY
UTAH VALLEY UNIVERSITY**

OREM, UTAH. The Dept. of Earth Science at Utah Valley University (UVU) invites applications for a full-time, tenure-track position in Physical Geography, to begin August 2018. The successful candidate will have a Ph.D. in physical geography, expertise in remote sensing, applied research projects in physical geography, and a demonstrated commitment to excellence in teaching. Responsibilities will include teaching introductory geography courses and upper division courses in the candidate's area of expertise, including remote sensing, as well as engaging in scholarship, supervision of undergraduate research, activity in professional organizations, and service.

UVU is a growing comprehensive state university with over 30,000 students and strong support for undergraduate research. The Dept. of Earth Science consists of a 13 full-time faculty, excellent facilities, and new Geography programs, including a Certificate of GIS starting in the fall of 2017 and B.S. degree submitted to the State Board of Regents. The department also offers B.S. programs in Geology, Environmental Science & Management, and Earth Science Education. UVU is located at the foot of the Wasatch Mountains, 45 minutes south of downtown Salt Lake City. The area offers outstanding outdoor recreation opportunities and a vibrant cultural scene including highly acclaimed ballet, symphony and outdoor concert series.

For more information, please visit www.uvu.edu/earthscience and/or contact the search committee co-chairs, Hilary Hungerford (hilary.hungerford@uvu.edu) and Nathan Toké (Nathan.Toke@uvu.edu). To apply and for details on application requirements, please visit www.uvu.jobs. Applications will be evaluated beginning 12/17/17. Utah Valley University is an Affirmative Action/ Equal Opportunity/ Equal Access Employer. Employment decisions are made on the basis of an applicant's qualifications and ability to perform the job without regard to race, color, religion, national origin, sex, sexual orientation, gender identity, gender expression, age (40 and over), disability, veteran status, pregnancy, childbirth, or pregnancy-related conditions, genetic information, or other bases protected by applicable federal, state, or local law.

**TWO-YEAR POST-DOCTORAL POSITION
LOW TEMPERATURE GEOCHEMISTRY
KANSAS STATE UNIVERSITY**

The Dept. of Geology at Kansas State University invites applications for a post-doctoral position for up to two years beginning in August 2018. The successful candidate's research will emphasize Low temperature aqueous geochemistry. Anticipated areas of specialization could include at least one of the following: Application of Stable Isotope Systematics in Hydrochemistry, Rare Earth Element Geochemistry in Groundwater Flow Systems, Use of inorganic and organic tracers to bet-

ter understand provenance of groundwater solvent and solute sources and processes, Environmental Geochemistry, Contaminant Hydrology, Groundwater Contaminant Geochemistry, and Critical Zone Geochemistry. Research that interfaces with the broad area of biogeochemistry and chemical hydrogeology is highly desirable. Along with post-doctoral research this position also requires teaching 2 sections of Introductory Geology course per semester. A detailed advertisement for the position is located: <http://careers.k-state.edu/cw/en-us/job/502098/fellow-post-doc-geology>

Screening of applications begins Feb 1, 2018 and continues until the position is filled. Full consideration will be given to applications received by Feb 15, 2018. Kansas State University is an EOE of individuals with disabilities and protected veterans. Kansas State University actively seeks diversity among its employees. Background check required.

**TENURE-TRACK FACULTY POSITION
GEOLOGY AND/OR GEOSCIENCE
EDUCATION, CALIFORNIA STATE
UNIVERSITY, SACRAMENTO**

The Geology Dept. in the College of Natural Sciences and Mathematics at California State University, Sacramento invites applications for a tenure-track Assistant Professor of Geology and/or Geoscience Education to begin August 2018. Applicants must hold a Ph.D. in geology or related field by August 2018. The ideal candidate will be a specialist in geodesy, earth materials, engineering geology, soils, or surface water. We will consider other specialties that fit the needs of the department. The successful candidate will embrace the opportunity to teach general education courses to a diverse student population, conduct a research program that involves undergraduate and graduate geology students, and be a fully engaged participant in a small, collegial department. Enthusiasm and a commitment to teaching and mentoring are essential. Salary will be dependent on qualifications and professional experience. Screening of applications will begin January 15, 2018; position open until filled. For the full vacancy announcement, please visit <http://csus.peopleadmin.com/postings/2162>.

**FACULTY POSITIONS
DEPARTMENT OF GEOSCIENCES
NATIONAL TAIWAN UNIVERSITY**

The Dept. of Geosciences at NTU is seeking active scientists to fill two faculty positions starting from August 1st, 2018. The positions are open to candidates from all fields in geosciences, but those who have strong background in the fields of petrology and geochemistry, geo-resources, energy exploration, stratigraphy, sedimentology, structural geology and hydro- and applied geology will receive more favorable consideration. Applicants are requested to submit the following documents: CV, list of publications, statements of teaching and research interests, names and contact information of three referees, and three to five articles published within the last seven years (one of which need to be designated as representative paper and must be published after August 1st, 2013). Application materials should be sent by email to Profes-

sor J. Bruce H. Shyu, the Chair of the Searching Committee, at jbhs@ntu.edu.tw.

Deadline for application: December 15th, 2017. For more information, please refer to the website: <http://web.gl.ntu.edu.tw/>.

**ASSISTANT PROFESSOR
STRUCTURAL GEOLOGY
TARLETON STATE UNIVERSITY**

The Dept. of Chemistry, Geosciences, and Physics at Tarleton State University, in Stephenville, Texas, invites applications for an Assistant Professor tenure-track position in structural geology to start Fall 2018. The successful candidate will support the geosciences program through engaging, student-centered teaching, develop an active research program that involves undergraduates, and actively contribute to service and outreach initiatives that advance the department, college, and university. Candidates will be expected to instruct the following courses: Structural Geology, Plate Tectonics, Basin Analysis, Physical Geology, Natural Disasters, and other courses as deemed fitting. All submissions must be made electronically through Tarleton's employment site, <https://jobs.tarleton.edu>. Review of applications will begin February 1, 2018, and continue until the position is filled. Tarleton State University is an Equal Opportunity/Affirmative Action/Veterans/Disability Employer. As a member of The Texas A&M System, Tarleton will provide equal opportunity for employment to all persons regardless of race, color, sex, religion, national origin, age, disability, genetic information, veteran status, sexual orientation or gender identity and will strive to achieve full and equal employment opportunity through The Texas A&M System.

Required Qualification: Candidates must hold a Ph.D. in structural geology or a related field. ABD status may be considered as long as all degree requirements, including dissertation, defense of dissertation, and comprehensive examinations, have been successfully completed by time of appointment- September 1, 2018. Candidates must have the ability to apply and teach in a dynamic field environment. In addition, candidates must demonstrate potential for outstanding teaching, potential to develop an active research program that involves students, and strong verbal and written communication skills.

Preferred Qualifications: Ability to teach additional courses from wider background is preferred, but not essential. A candidate whose research complements a growing concentration in petroleum geology, particularly those focusing on regional or basin-scale tectonics, petroleum exploration, or subsurface fracturing and fluid flow is ideal.

Opportunities for Students

Doctoral Fellowship in Transdisciplinary Tectonics at Utah State University. The Dept. of Geology at USU seeks outstanding Ph.D. applicants for a Presidential Doctoral Research Fellowship pursuing research in tectonics, starting fall 2018. This selective fellowship provides four years of support in the form of a competitive stipend, tuition, and health benefits. Two research themes in tectonics within the department are:

1. What controls fault zone and plate boundary behavior through time? Critical to understanding these processes are constraints on earthquake process, timing, and physics, characterization of Earth material properties and petrology, the role of fluids in fault slip, and the rheological evolution of the lithosphere.
2. What are the interactions among tectonics, surface processes, and landscape evolution? Research in tectonic geomorphology and geodynamics involves deep-Earth and near-surface/critical zone processes, drainage analysis, and natural hazards.

The Dept. of Geology at USU is field oriented, has a dynamic graduate program, and is located in northern Utah surrounded by excellent outdoor opportunities.

Visit <http://geology.usu.edu> for more information about our program and possible faculty mentors, and contact tammy.rittenour@usu.edu for questions. Applications are due January 8, 2018, at <http://www.usu.edu/graduateschool/>.

Graduate Student Opportunities at Case Western Reserve University. Students with backgrounds in geology, physics, chemistry, biology, engineering, and related fields are encouraged to apply for our Ph.D. and MS programs in Earth, Environmental, and Planetary Sciences. Areas of active research in the department include planetary geology and geodynamics, planetary materials, high-pressure mineral physics and geochemistry, core and mantle processes, sedimentary geology, and sediment transport. For more information, please visit <http://eeps.case.edu> or write to eeps-gradinfo@case.edu. Financial assistance is available. Application deadline: 1/15/2018.

Ph.D. Student, Antarctic Geosciences and Remote Sensing, Northern Arizona University. Satellite imagery is rapidly transforming the way we see the planet, including our ability to study the most remote parts of the Arctic and Antarctic. Satellite imagery can help us map networks of rivers, study changes in the flow and thickness of glaciers, identify rock and soil types, and even find animals like penguins and seals. Because the availability of imagery in polar areas has increased rapidly over the last decade, we are now faced with a challenge: How do we scale-up the scientific discoveries that have been enabled by satellite imagery to larger spatial scales? Moving from small pilot-studies to pan-Arctic or pan-Antarctic analyses of geological and biological processes requires new infrastructure to link scientists, satellite imagery, and high performance computers. This new imagery-computing superhighway will make it easier for scientists to study processes at much larger spatial scales than has been previously possible. Our project, called ICEBERG—Imagery Cyberinfrastructure and Extensible Building-Blocks to Enhance Research in the Geosciences, aims to build the cyberinfrastructure required to make the most of satellite imagery for geosciences.

Dr. Mark Salvatore is seeking applications for a Ph.D. student to start in the Fall of 2018. The student will work with high-resolution multispectral satellite data to identify, characterize, and map

geologic units throughout the ice-free regions of Antarctica. As part of a large collaborative and federally funded project, the student will also work closely with researchers, computer programmers, and students at collaborating institutions. A successful candidate will have a strong background in surface geology, remote sensing, geographic information systems, and/or geologic mapping. Prior research experience and computer programming skills are preferred.

The student will become a member of the dynamic and evolving Dept. of Physics & Astronomy at Northern Arizona University. With a growing emphasis on planetary sciences, students in this program develop a deep understanding of planetary formation and evolution, remote sensing, spectroscopy, and planetary surface processes. Ph.D. students benefit from a full tuition waiver, a competitive stipend, and have the opportunity to participate in the campus healthcare plan. Northern Arizona University is located in beautiful Flagstaff, Arizona, a four-season town located at the base of the San Francisco peaks and 70 miles from the Grand Canyon. The Dept. of Physics & Astronomy is home to a friendly, engaging, and welcoming environment for individuals of all races, ethnicities, sexual orientations, and world views.

Applications are due by December 15, 2017. Interested students should contact Dr. Salvatore directly (mark.salvatore@nau.edu) prior to submitting an application.

MS Graduate Student Opportunities, Ohio University. The Dept. of Geological Sciences at Ohio University invites applications to its graduate program for the Fall of 2018. The department offers thesis and non-thesis MS degrees in Geological Sciences with areas of emphasis in three research clusters: paleobiology and sedimentary geology, solid earth and planetary dynamics, and environmental and surficial processes. Prospective students are encouraged to contact faculty directly to discuss potential research topics. Qualified students are eligible to receive teaching or research assistantships that carry a full tuition scholarship and a competitive stipend. For additional program and application information, visit the department website at <http://www.ohio.edu/cas/geology> or contact the graduate chair, Dr. Daniel Hembree (hembree@ohio.edu). Review of applications begins February 1, 2018.

Graduate Research Opportunities at Purdue University. The Dept. of Earth, Atmospheric, and Planetary Sciences (EAPS) at Purdue University is looking for enthusiastic and self-motivated graduate students for a variety of research projects in Geology and Geophysics, and Planetary, Environmental, and Atmospheric Sciences. As a multidisciplinary department within the College of Science, EAPS draws students from a variety of STEM backgrounds. We offer 4 years of guaranteed financial support and a variety of fellowships. Students with demonstrated academic and research excellence are invited to explore funded graduate opportunities at <http://www.eaps.purdue.edu/gradresearch>. Come see our booth (905) at AGU.

Northwestern University Graduate Student Opportunities The Dept. of Earth and Planetary Sciences at Northwestern University invites applications for fall 2018 from prospective doctoral candidates interested in the fields of planetary science, climate change, geobiology, paleolimnology, sedimentary geochemistry and earth system history, radiogenic and stable isotope geochemistry, stratigraphy and paleoecology, geophysics and natural hazard, carbon biogeochemistry and stratigraphy. Our program guarantees five years of competitive financial support. The deadline for applications is December 20, 2017, but consideration after the deadline will continue for candidates with excellent credentials. Applicants should visit www.earth.northwestern.edu for submission instructions. AA/EOE. Northwestern University is an Equal Opportunity, Affirmative Action Employer of all protected classes including veterans and individuals with disabilities. Women and minorities are encouraged to apply.

Hiring?

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URBAN METRO TRAVEL GRANT TO NEGSA 2018

Application deadline: 23 Feb.

Do you work full-time or care for dependents while earning your undergraduate degree? You may be eligible to apply for a travel award to attend the Northeastern Section Meeting (NEGSA), 18–20 March 2018 in Burlington, Vermont, USA. Check the student tab on the Northeastern Section website (www.geosociety.org/ne-mtg) for eligibility guidelines and an application. If you have questions, please email Tahlia Bear at tbear@geosociety.org.



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The GSA Foundation is extremely thankful to all of our friends and donors who have contributed time, resources, ideas, and financial support toward the Geological Society of America’s programs in 2017.

Your contributions helped provide graduate students with a means to pursue their research: This year, a record-setting 785 student research proposals resulted in 395 awards totaling nearly US\$700,000.

Your support of GSA’s On To the Future program enabled 73 students to attend their first GSA Annual Meeting in Seattle this past October, with nearly US\$52,000 distributed for travel support, meeting registrations, and one year of GSA membership for participants.

Thanks to you, GSAF and GSA will be able to provide field camp scholarships next spring, which help students attend a field camp of their choice. In light of continuing challenges for some of our supporting industries, this was a remarkable response from many of you to continue an invaluable program that propels aspiring geologists

forward on their career paths. Field camp is considered indispensable to many employers and is a foundational experience in developing necessary skills. **Your support is the sole reason we can provide this important assistance next year.** This is perhaps the year’s proudest display of GSA members’ dedication and commitment to ensuring the next generations of geoscientists, and we thank you for making this possible.

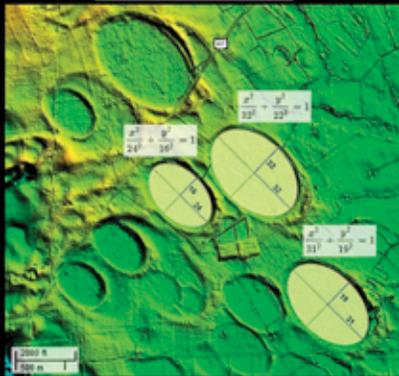
If you have not yet, please consider making a year-end contribution to a program that is important to you. For every 15 people who make a US\$100 year-end gift, we can offer another On To the Future scholarship next year. If just 10 people contribute US\$200 each before the new year, we can offer one more field camp scholarship. Perhaps you have the good fortune to be able to contribute the full amount for either of these, but your collective participation with any contribution amount can make a tremendous difference. You can also set up recurring monthly donations. Go to <https://gsafweb.org/donate/> to make your year-end gift to GSA programs by 31 December in time for a 2017 charitable tax deduction.

www.gsafweb.org

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$$\sin(\theta) = W/L \quad d = \frac{v^2 \sin(2\theta)}{g}$$



Antonio Zamora

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GEOLOGY

ISSN 0091-7613

NOVEMBER 2017 • VOL. 45 NO. 11 • P. 961-1056

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Call for Short Course and Technical Session Proposals

GSA 2018 Indianapolis Meeting



4-7 November

Indianapolis, Indiana, USA



Photo courtesy of VisitIndy.com.

It's time to plan for our 2018 Annual Meeting in Indianapolis, Indiana, USA. Help ensure that your area of research and expertise is represented at next year's annual meeting. Any individual or geosciences organization is welcome to submit proposals.

Exchange the geology by organizing and chairing a technical session.

Technical Session deadline: 1 Feb. 2018

Proposals are being taken for both Pardee Keynote and Topical Sessions. The proposal form is online at <https://gsa.confex.com/gsa/2018AM/cfs.cgi>.

Share the geology as an instructor through a Short Course.

Short Course proposal deadline: 1 Feb. 2018

Courses run the Friday and Saturday before the Annual Meeting and are typically half a day to two full days. The proposal form is online at <https://gsa.confex.com/gsa/2018AM/shortcourse/cfs.cgi>.



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