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**A More
Informative
Way to Name
Plutonic Rocks**

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SCIENCE

4 **A More Informative Way to Name Plutonic Rocks**
 A.F. Glazner et al.

Cover: Polished slab of "Texas Pearl," a countertop rock from the Llano uplift of central Texas. By the standard classification this rock plots near the common corner of the syenogranite/monzogranite/quartz syenite/quartz monzonite fields. By the method proposed in this issue this is biotite 16,40,25 granite. Slab is 15 × 20 cm. See related article, p. 4–10.



- 12 **GSA 2018 Annual Meeting Wrap-Up**
- 13 **Thank You Sponsors**
- 14 **Thank You to All the Mentor Volunteers Who Served at the GSA 2018 Annual Meeting!**
- 16 **2018 GSA Presidential Address: Robbie R. Gries:**
 Navigating "Me, too" in the Geosciences
- 20 **Call for Nominations:** GSA Scientific Division Awards
- 22 **Get into the Field with These GSA Awards**
- 24 **2018 Outstanding Earth Science Teacher Awards**
- 25 **2019 GeoCareers Section Meeting Programs**
- 26 **Second Announcement:** GSA Cordilleran Section Meeting
- 30 **Call for GSA Committee Service**
- 31 **Elections:** GSA Officers & Councilors
- 31 **Student Funding to NEGSA 2019**
- 32 **Geoscience Jobs & Opportunities**
- 35 **GSA Foundation Update**
- 36 **Groundwork:** eRock: An Open-Access Repository of Virtual Outcrops for Geoscience Education
- 38 **2020 GSA Calendar Photo Search**
- 39 **2019 GSA Section Meetings**



A More Informative Way to Name Plutonic Rocks

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ABSTRACT

The International Union of Geological Sciences (IUGS) system for rock classification, introduced more than 40 years ago, has served geologists well but suffers from the problem of dividing a continuum of rock compositions into arbitrary bins. As a result, closely related rocks can be given unrelated names (e.g., granodiorite and tonalite), and the names themselves, which were generally derived from the names of places or people, rarely contribute to understanding the processes that generate the diversity of igneous rocks. Here we propose a quantitative modification to the IUGS system that reduces the number of distinct names but more effectively communicates the inherent variability of plutonic rocks. The system recognizes that mapped plutonic rock units are characterized by recognizable textures and mineral assemblages, but that mineral proportions within those units can be highly variable. Adding quantitative data to rock names is an important step toward moving geologic field observations into quantitative digital form and preparing them for advanced data mining and analysis.

One thing quarks do have going for them: all their names are simple—something chemists, biologists, and especially geologists seem incapable of achieving when naming their own stuff. —Neil deGrasse Tyson, *Astrophysics for People in a Hurry*

INTRODUCTION

Why do we bother to name rocks? One answer among many is that rock categories can efficiently convey important information about a geologic setting just as biological categories can convey the same for ecosystems. Say “zebra” to a biologist and they will likely think “African savanna”; say “granodiorite” to a geologist and they will likely think “subduction zone.” However, the sheer number of igneous rock names presents

a formidable entry barrier to students of the field. In a recent undergraduate textbook, Winter (2010, p. 32) lists 157 common igneous rock names, many of them unknown to practicing petrologists. Say “kugdite” to a geologist and you will likely get a puzzled stare.

Classification of igneous rocks has occupied and irritated petrologists for centuries. Unlike biological classifications, which can place organisms into discrete categories, rock classifications place sharp boundaries between objects that are completely gradational. A biologist can classify something definitively as a dog or cat, knowing that there are no doggish cats or cattish dogs, but a petrologist cannot do so—there are plenty of granodioritic granites and granitic

granodiorites (Fig. 1). Thus, any classification based on discrete categories will split continuously variable rock compositions at arbitrary boundaries.

An international effort to systematize the nomenclature of plutonic igneous rocks was started in the 1960s under the leadership of Swiss petrologist Albert Streckeisen, and summaries of this work (e.g., Streckeisen, 1974, 1976; LeBas and Streckeisen, 1991) are the standard references for current nomenclature. The principal classification is based on a double triangle (Fig. 2); this diagram, appropriate for rocks with 10% or more quartz or feldspathoid minerals plus feldspars, uses the modal (volume) proportions of quartz (Q), alkali feldspar (A), plagioclase (P), and feldspathoids (F) to name rocks.

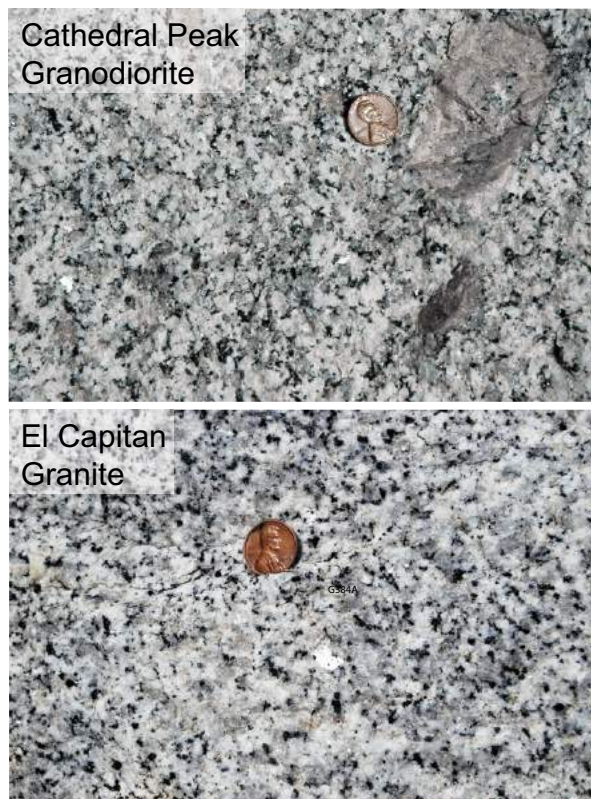


Figure 1. Outcrop photographs of the Cathedral Peak Granodiorite and El Capitan Granite, Yosemite National Park, California, USA. In spite of largely equivalent mineral proportions, one is termed a granite and the other a granodiorite. This confusion is lessened if name boundaries are considered fuzzy rather than sharp. Pennies are 2 cm in diameter.

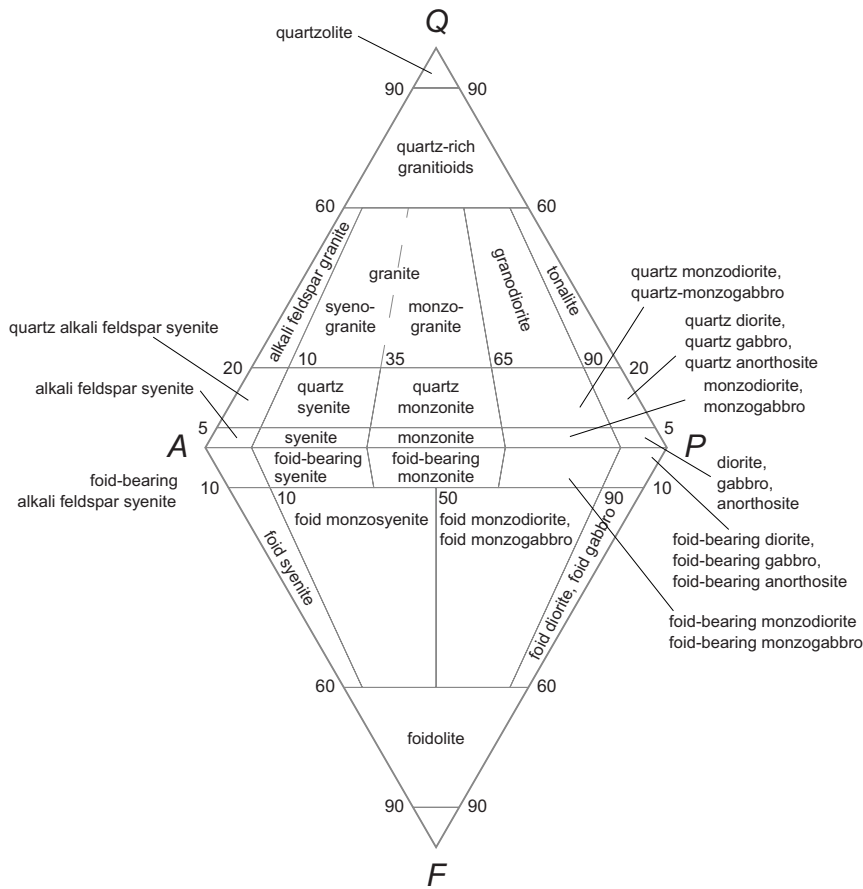


Figure 2. The International Union of Geological Sciences classification double triangle. Field boundaries are arbitrary and not designed to follow petrologic processes, so closely related rocks can scatter across several fields. The plethora of names and positions of boundary lines are difficult to remember, particularly because they mean little in terms of process. They also serve to carve up related rocks (e.g., one map unit) into several different rock types.

The International Union of Geological Sciences (IUGS) commission aimed to simplify the nomenclature, eliminate synonymic terms (e.g., adamellite = quartz monzonite), and come up with fields and corresponding names that are consistent with general usage. The IUGS method relies on two parameters, the modal percentage of quartz or feldspathoid minerals (horizontal lines), and the ratio of alkali feldspar to plagioclase (lines radiating from the quartz and feldspathoid apices). These values are easy to estimate in thin section, although less so in the field, where the plagioclase/alkali feldspar distinction can be subtle. In contrast, the modal proportions of mafic minerals and their sum (color index) are generally easy to estimate in the field and diagnostic of a given rock unit, although these are not used in the IUGS system. The IUGS diagram provides a convenient way to assign a standardized name once the mode has been estimated, and this is both a strength and a significant problem.

As an example of the problems that this kind of classification can cause, consider the data in Figure 3, taken from Bateman (1992). Modal data from the well-known Cathedral Peak Granodiorite of Yosemite National Park in California, USA (Fig. 1), are split rather evenly between the granite and granodiorite fields. Thus, any random hand sample or outcrop of the Cathedral Peak pluton might be a granite or a granodiorite or straddle the arbitrary boundary between them. This unit was designated a granodiorite because one or the other name had to be chosen, even though the pluton includes both. The nearby El Capitan Granite (Fig. 1) is also more-or-less evenly divided between the granite and granodiorite fields (with several points in the tonalite field), but it is officially a granite. Rocks of the Kuna Crest suite, a set of medium-grained rocks with high color index, scatter over the granodiorite, tonalite, quartz monzodiorite/quartz monzogabbro, and quartz diorite/quartz gabbro fields. This sort of artificial

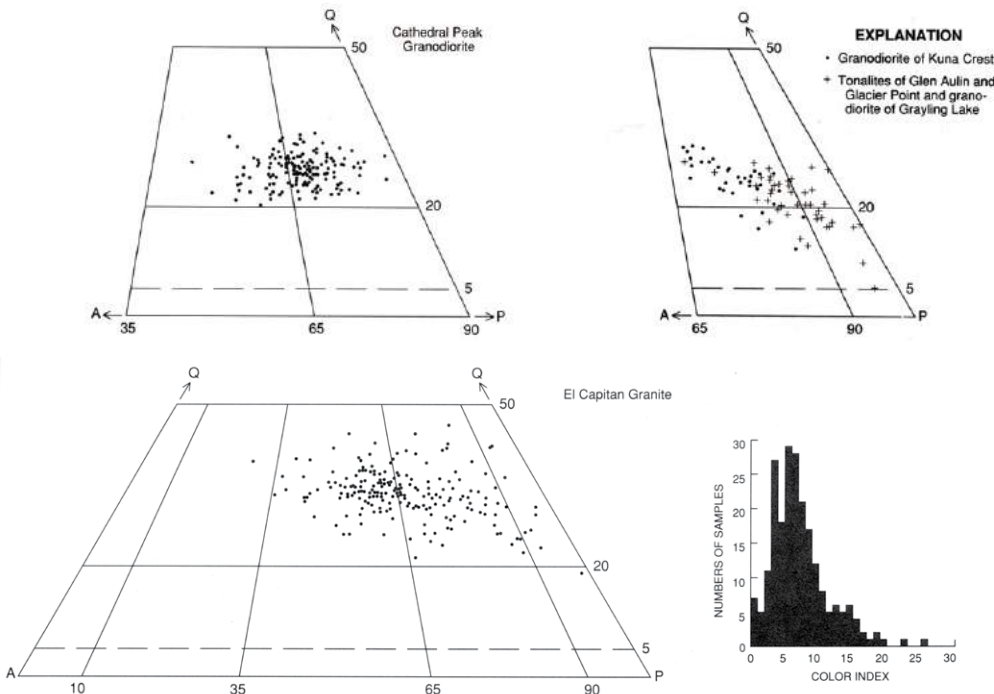


Figure 3. Modal data for plutonic units from Yosemite National Park, California, USA, from Bateman (1992). Many of the main units scatter evenly across the granite (monzogranite) and granodiorite fields, and petrologic variability in the granodiorite of Kuna Crest crosses the common point of four fields, meaning that the rock could be called any of the four (really, six; see text). Q—quartz; A—alkali feldspar; P—plagioclase.

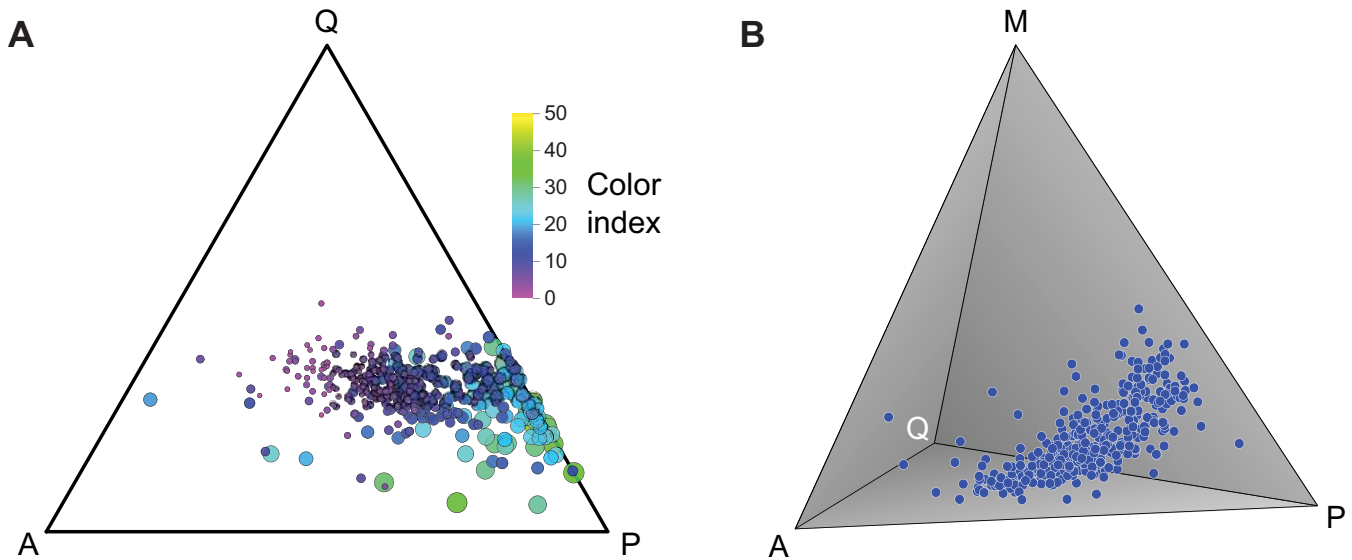


Figure 4. Modal data for 403 quartz-bearing plutonic rocks from the Sierra Nevada batholith, plotted on the quartz-alkali feldspar-plagioclase (QAP) triangle and in a tetrahedron whose base is QAP and whose apex M represents mafic minerals. It is clear that the proportion of mafic minerals (color index) increases dramatically away from the center of the QAP triangle, toward the QP sideline. This trend is neglected by the International Union of Geological Sciences classification. Data from Bateman et al. (1984) and Bateman et al. (1988).

separation-by-name of closely related rocks is an unfortunate consequence of fitting observations into arbitrarily defined boxes.

Figure 3 also shows that the color indices of rocks called El Capitan Granite range from near zero to more than 20, an important point to which the name “granite,” as defined by the IUGS system, gives no indication. In general, color index increases moving away from the center of the quartz-alkali feldspar-plagioclase (QAP) triangle, toward plagioclase (Fig. 4). The abundances and identities of the mafic phases (e.g., biotite, hornblende, titanite) are typically where the geochemical action is, and yet the IUGS classification has no provision for this.

Thus, the current system of igneous rock nomenclature suffers from several shortcomings: (1) it conceals the variability of igneous rocks at the map unit scale with restrictive names; (2) it lacks important information about the mineralogy of the rocks at scales ranging from pluton to hand sample; (3) it is burdened by unnecessary names that, by themselves, tell nothing; and (4) the quantitative data used to derive a name are largely discarded once the name is applied. This last point must be addressed if we are to move field observations from “dark data” (Heidorn, 2008), buried in field notebooks, into sharable digital form (Walker et al., in press).

Bowen (1928) foresaw the problems with using mineral abundances as a basis

of classification. Noting an analogy between mineral assemblages and life assemblages, he said:

How artificial a classification of faunas would be which was based on the ratio of foxes to hares, of hares to moles and so on! To be sure it is by no means accidental that the ratio of hares to foxes is 10 in a certain area and only 2 in another, but as compared with the broad factors controlling life in the two areas it is relatively accidental... So it is not accidental that a rock is nearly pure olivine here and only 75 per cent olivine a few feet distant, but it is relatively accidental and should not be made a fundamental factor in classification.

Bowen clearly recognized the problems inherent in classifications based on mineral proportions, and yet that is the system with which we live. We contend that an improved system could address the shortcomings of the IUGS system by:

- using a more restricted set of names, because restricting the subdivision of names allows each name to encompass greater modal variation;
- allowing for overlap between rock categories; and
- including quantitative information about modal mineralogy at scales for which quantification is appropriate.

ROCK NAMES, NECESSARY AND SUPERFLUOUS

There are thousands of igneous rock names (e.g., Johannsen, 1932, and accompanying volumes), but most samples

described in the literature are covered by just one or two dozen. We compiled the number of citations in GeoRef mentioning 19 of the most common IUGS names over the period 1970–2018. “Granite” made up just under half of the total number of citations (~223,000) in this list, and the names were distributed as in Figure 5. The first nine names account for 90% of the citations (allowing for multiple counting of citations listing more than one name).

As is common with textual data, rock names roughly obey Zipf’s Law (Aitchison et al., 2016), which states that the frequency of a given word is inversely proportional to its frequency rank. There are ~50,000 rock names in the North American Volcanic and Intrusive Rock

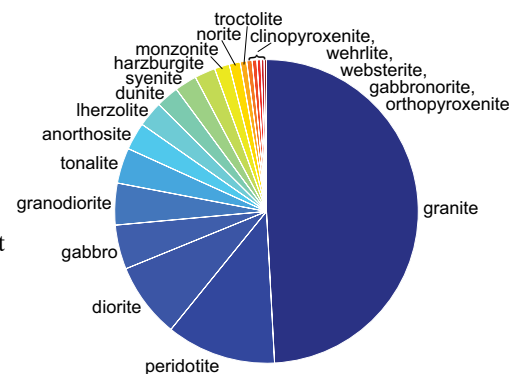


Figure 5. Frequency distribution of documents using the given rock names in the GeoRef database, 1970–2018. The ten most common names account for more than 90% of the citations.

database (NAVDAT) of western North American igneous rocks (Walker et al., 2006), 105 of them unique. The first 18 names make up 90% of the samples; the remaining 87 names are rarely applied. We contend that these surplus names (e.g., sannaite, malignite), although locally useful, are largely noise that obscures the signals of petrologic processes.

It is somewhat bewildering that petrologists have used modal mineralogy to classify plutonic rocks for a century, and yet these data are rarely recorded in digital databases. In NAVDAT, only ~5% of the analyses have associated modal data, and one-third of those are from just two sources.

A SIMPLER, QUANTITATIVE APPROACH

We propose the following classification methods for three major groups of rocks: quartz/feldspathoid- + feldspar-bearing, ultramafic, and gabbroic. We do not propose equivalent schemes for other igneous rock groups (e.g., lamprophyres, carbonatites, agpaites), but a similar approach could be applied to all plutonic rocks, and the same reasoning could be applied to chemical classifications (e.g., total alkalis-silica) for volcanic rocks.

Our approach borrows conceptually from the International Union for Pure and Applied Chemistry (IUPAC) system for naming organic compounds. In the 1950s, nomenclature for organic compounds was bloated and tangled. Names and properties of thousands of known organic compounds were compiled originally by Beilstein (1881), much as names and properties of igneous rocks were compiled by Johannsen (1938, and accompanying volumes). The Beilstein compilation includes the name of the compound and assigns it a unique number. However, the common name and Beilstein number provide limited information about the nature of a compound.

IUPAC therefore set out to create a nomenclatural scheme that would be more systematic and informative. The IUPAC system consists of a set of root names that correspond to chemically and structurally simple organic molecules (e.g., the alkanes methane, ethane, propane, etc.), preceded by modifiers that identify and describe the spatial arrangement of atoms added to the root molecule to form a particular compound. For example, the compound on which the octane rating system of gasoline is based, isooctane, is 2,2,4

trimethylpentane in the IUPAC system. When decoded, this provides a complete description of the molecule.

Plutonic rocks are a chemical continuum rather than a collection of discrete compounds; therefore, a system that is analogous to IUPAC organic nomenclature cannot be constructed. However, a broadly similar approach can achieve much the same goals.

We suggest that an optimal system of plutonic rock names will use a small number of root names along with the modal proportions of the minerals used in the classification. Each root name corresponds to a particular combination of major minerals and thus indicates the relevant classification triangle or tetrahedron. The absolute minimum number of root names is four: “granite” for rocks classified on the basis of quartz, alkali feldspar, and plagioclase; “foid syenite” or some other moniker for those dominated by feldspathoids, alkali feldspar, and plagioclase; “peridotite” for olivine, orthopyroxene, and clinopyroxene; and “gabbro” for plagioclase, olivine, orthopyroxene, and clinopyroxene. In this extreme rendering of our approach, the 27 fields in the Streckeisen double triangle are replaced by two root names, granite for the upper triangle and foid syenite for the lower triangle.

The simplicity of the extreme approach is appealing, but we see reasons for a less radical trimming of the list of recognized rock names. First, some combinations of names trace a process; e.g., lherzolite, harzburgite, and dunite trace the composition of the mantle residue of basalt extraction. Second, a small number of root names can provide a convenient shorthand for differences between related rocks that are awkward to express by differences in the mineral proportions. Finally, allowing a given set of mineral components to map into more than one rock name permits the boundaries between the rock names to be fuzzy, reflecting the real variability of the rocks noted by Bowen (1928). This inherent flexibility can allow the rock names that are retained to emerge from their actual usage rather than being imposed by a committee.

We therefore propose an approach to naming rocks that consists of a root name preceded by a vector of mineral abundances. As this is a new system, we do not claim to know the optimal balance

between reducing the number of root names for simplicity and retaining root names because they are sufficiently useful to warrant it. The following examples of our approach therefore are meant to be illustrative rather than definitive; if the system is adopted, optimal names will arise organically rather than by fiat.

Finally, there are many reasons that root names alone should continue to be used to name map-scale bodies of plutonic rock. Addition of a numerical vector to a root name is intended only to be used at the scale of individual samples from a map-scale body. Indeed, by making the boundaries around rock names fuzzy, usage in pluton names and rock names becomes more consistent.

Modified IUGS Method for Classification of Plutonic Rocks

The following procedure involves the same observations needed to classify a rock with the IUGS method, and thus the full IUGS name can always be applied. All percentages are modal (volume %).

Rocks with Quartz + Feldspars >10% (Upper Half of IUGS Diamond)

1. Estimate the proportions of quartz (Q), alkali feldspar (A), plagioclase (P), and mafic minerals (M), and the identities of mafic minerals and accessories (*example: 20,20,50,10; biotite, hornblende, titanite*).
2. Assign a root name based on where the QAP estimate, normalized to 100, falls on the upper triangle in Figure 6 (*example: granodiorite*).
3. Prefix the rock name with unnormalized QAP; e.g., 20,20,50. The proportion of mafic minerals (color index) is implicit in these numbers as 100 minus their sum (*example: 20,20,50 granodiorite; color index is 10*).
4. Prefix the resulting name with relevant mafic minerals, using defined abbreviations if desired. The prefix should list these in increasing abundance so that the most abundant is closest to the root name (Shelley, 1993, p. 7) (*example: hbl-bio 20,20,50 granodiorite*).
5. Important accessory minerals can be denoted by, for example, *titanite-bearing* or *ttn-bearing* (*example: ttn-bearing hbl-bio 20,20,50 granodiorite*).

Note that these steps are identical to the IUGS method except that there are

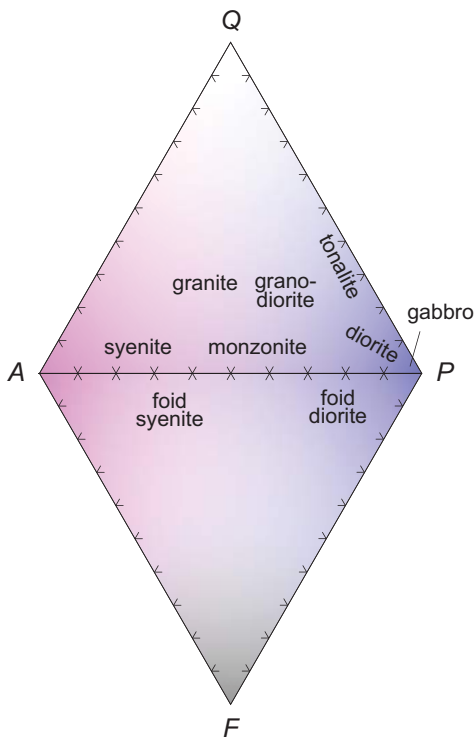


Figure 6. Proposed simplified names for rocks in the International Union of Geological Sciences (IUGS) diamond. Boundaries are fuzzy, fields overlap, and names are redundant of the numeric values, which can be converted into formal IUGS names if desired.

far fewer bins in which to put the rocks (six versus sixteen). The bins simply indicate broad QAP proportions. For example, granites and granodiorites are quartz-rich and distinguished broadly by alkali feldspar > plagioclase or plagioclase > alkali feldspar, respectively. Syenites are rich in alkali feldspar and poor in plagioclase + quartz. Diorites are rich in plagioclase and poor in alkali feldspar + quartz, and so on.

For map scale, nomenclature likely skips Step 3 because the modal variation at that scale is too variable for quantification. Accordingly, the Cathedral Peak Granodiorite mentioned earlier would be just that, or the Cathedral Peak Biotite Granodiorite to reflect the dominant mafic mineral. This does not directly address the fact that the Cathedral Peak body includes both granodiorites and granites as defined by IUGS boundaries. However, the recognition that a granodiorite is defined as a quartz-rich rock, with generally (but not necessarily exclusively) plagioclase > alkali feldspar, is an improvement in representing the nature of the pluton. Addition of the mafic mineralogy to the name significantly advances one's knowledge of what to expect in the field.

A particular hand sample of the Cathedral Peak pluton might be called a hornblende-biotite 30,20,45 granodiorite, indicating a color index of 5 with biotite > hornblende. The variation in mineralogy in the El Capitan pluton could be described as a range from biotite 30,50,20 granite to hornblende-biotite 25,10,55 granodiorite. This expresses the variations observed in the felsic and mafic mineralogy and color index far better than the unqualified names.

Rocks with Feldspathoid(s) + Feldspars >10% (Lower Half of IUGS Diamond)

Classification of feldspathoid-bearing rocks is the same as with quartz-bearing rocks except that the identity of the feldspathoid(s) replaces “foid” (e.g., nepheline syenite rather than foid syenite).

Ultramafic Rocks

Olivine-pyroxene rocks with <10% felsic minerals are named via the olivine-orthopyroxene-clinopyroxene (OOC) triangle (Fig. 7). The same simplification principles apply to these rocks: estimate mineral proportions and then name the rock with these numbers and the simplified, blurred boundary classification in Figure 7. Preface the name with other important minerals such as garnet or spinel; their proportion is 100 minus the sum of OOC.

Gabbroic Rocks

Gabbroic rocks can be classified using a tetrahedron with apices of plagioclase, olivine, orthopyroxene, and clinopyroxene (POOC; Fig. 8). The base of the tetrahedron is the OOC triangle of Figure 7; the apices are anorthosite, dunite, orthopyroxenite, and clinopyroxenite; troctolite lies along the plagioclase-olivine edge, and the interior is gabbro or norite depending on whether the dominant pyroxene is clinopyroxene or orthopyroxene. Hybrid names, such as gabbro-norite, and qualified names, such as olivine gabbro, are unnecessary (but can be used if desired) when the defining mineralogy is given in the name (e.g., 50,10,20,20 gabbro).

Examples

1. A rock has 20% quartz, 20% K-feldspar, 50% plagioclase, with the remainder (10%) mafic minerals consisting of biotite > hornblende. The root name would be

granodiorite, and the rock would be a *hbl-bio 20,20,50 granodiorite*.

2. A shonkinite (Johannsen, 1932, p. 355) contains 3% quartz, 8% orthoclase, 22% plagioclase, 65% hornblende, and 2% accessories. This would be a *hbl 3,8,22 monzonite*. The sum of Q, A, and P is only 33, implying a large amount of hornblende ± other phases.
3. A “leucolithfieldite” from Johannsen (1938, p. 181) contains 16% microcline, 55% plagioclase, 18% nepheline, 8% muscovite, and 1% each magnetite and biotite. This would be an *18,16,55 nepheline syenite* or a *musc 18,16,55 nepheline syenite*.
4. Boyd and McCallister (1976) gave a peridotite mode as 59% olivine, 11% orthopyroxene, 20% clinopyroxene, and 10% garnet. This rock would be a *garnet 59,11,20 lherzolite*.
5. Boudreau (1988) listed modal mineralogy of rocks from the Stillwater Complex as Table 1.

Complications

There are many details. For example, it is common in granitoids that the feldspars are difficult to distinguish in the field; in such cases they can be lumped, with only two numbers reported, as *biotite 35,60 granite*. Modal data can be determined with varying levels of precision. Field estimates might be good to only the nearest 10%, whereas microscopic estimates can be good to a percent; the approximate precision should always be stated. A feldspathoidal rock might contain two or more important feldspathoids, as in 30,20,40 sodalite-nepheline syenite, indicating sodalite + nepheline = 30 and sodalite < nepheline.

SUMMARY

There are several advantages to this method of naming plutonic rocks.

- It allows for overlap of names such as “granite” and “granodiorite.” These names are redundant of the quantitative information and merely serve as a guide to the appropriate classification triangle or tetrahedron and to the overall rock type.
- The abundances of the determinative minerals are given directly in the name, and the QAP/FAP/OOC/POOC parameters can be calculated from the name.
- Thus, everything needed to derive the standard IUGS classification is in the name.

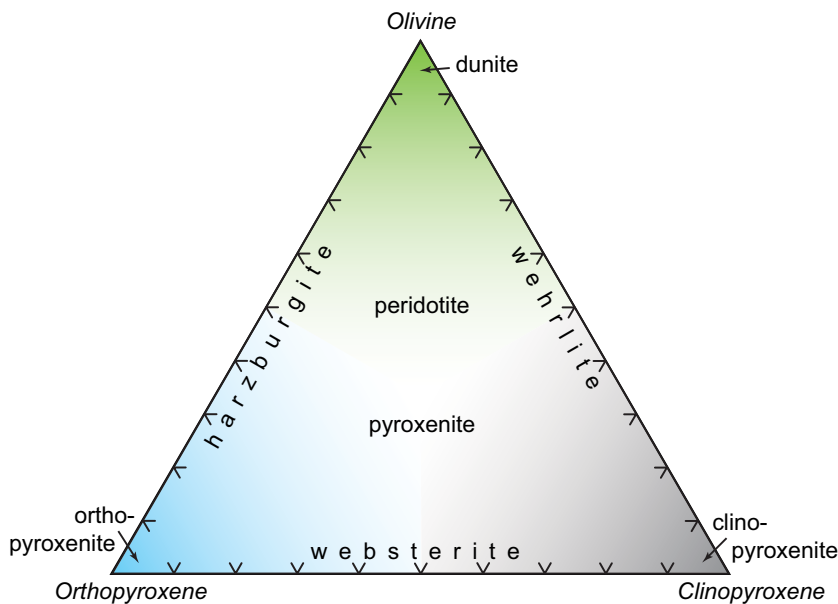


Figure 7. Proposed fuzzy classification of ultramafic rocks in the olivine-orthopyroxene-clinopyroxene (OOC) triangle.

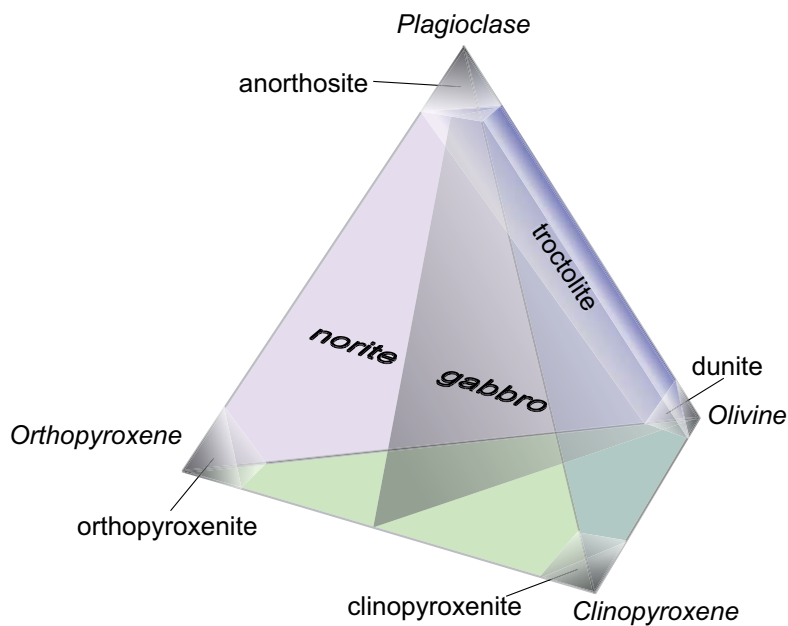


Figure 8. Proposed fuzzy classification of gabbroic rocks in the plagioclase-olivine-orthopyroxene-clinopyroxene (POOC) tetrahedron. All boundaries are meant to be fuzzy. The base of this tetrahedron is the OOC triangle of Figure 7, and plagioclase-poor rocks can be named using either one (see examples). Names in the base of the tetrahedron are omitted for clarity.

TABLE 1. MODAL MINERALOGY OF ROCKS FROM THE STILLWATER COMPLEX

Sample	Plagioclase	Olivine	Orthopyroxene	Clinopyroxene	Other	Name
MA203	90.7	0	2.0	7.0		91,0,2,7 anorthosite
MA208	82.8	14.4	2.4	0.4		83,14,2,0 norite
MA161	68.6	0	24.7	6.6		69,0,25,7 norite
MA190	64.9	1.5	9.7	23.9		65,2,10,24 gabbro
5104EX	2.4	66.5	20.0	0.6	phlogopite 10.1	plag-phlog 66,20,1 harzburgite or phlog 2,66,20,1 harzburgite

- For quartz/feldspathoid rocks, the color index is implicit in the name; for gabbros, this gives the proportion of minerals other than plagioclase, pyroxenes, and olivine; for ultramafic rocks, this exercise gives the proportion of minerals other than olivine and pyroxene, such as garnet or spinel. Such information is neglected by the IUGS naming scheme.
- There are many fewer rock names and field boundaries to commit to memory, freeing the mind to think about processes rather than classification.
- Freight trains of syllables in hybrid names such as *quartz monzodiorite* are avoided. We contend that *10,20,60 diorite* is both less cumbersome and more informative than *quartz monzodiorite*.
- Quantitative modal and mineralogical data become part of the rock name, allowing for more complete and easily accessible information in databases, which in turn allows for new scientific opportunities in data mining (e.g., Hazen et al., 2011).

We hope that this modification of the venerable IUGS scheme will be adopted in order to simplify and take the stress out of naming plutonic rocks, with the added benefit of adding significant quantitative information that can be easily assimilated in digital form.

ACKNOWLEDGMENTS

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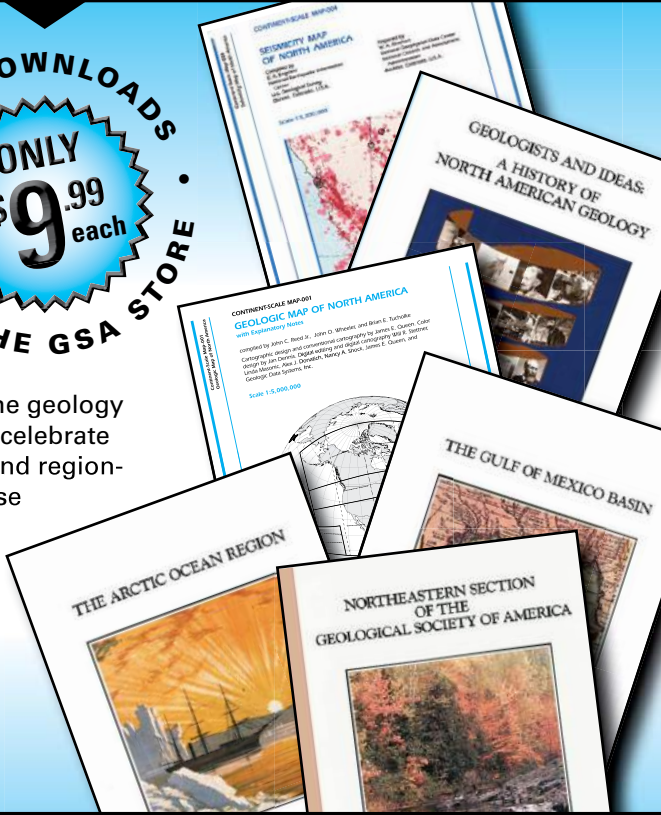
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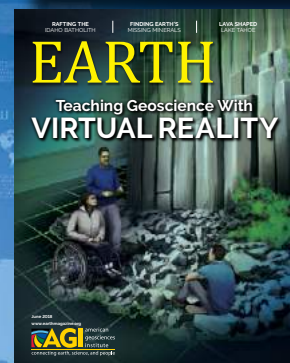
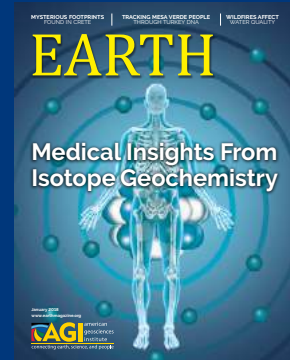


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GSA 2018 Annual Meeting Wrap-Up

I wish to sincerely thank all our attendees, sponsors, Divisions, Associated Societies, and exhibitors for making the 2018 Indy meeting a memorable event. I especially thank all the volunteers involved in bringing this meeting together. It is with your involvement that GSA is able to create these scientific meetings, which are enjoyed by many.

If you felt there was some science missing from the Indy meeting, I challenge you to make it happen at some GSA meeting in the near future. You can help shape all our meetings by proposing a session, a Field Trip, a Pardee Symposium, or a Short Course or by presenting your science during the meeting. We hope to see you in Phoenix!

Vicki S. McConnell, GSA Executive Director

By the Numbers

Attendees: 5,628	Abstracts presented: 3,554 (1,474 posters, 2,080 talks)
Professionals: 2,041	Field Trips: 17 trips with 383 participants
Early career professionals: 505	Short Courses: 18 courses with 297 participants
Students: 2,294	Exhibiting companies: 206
K-12 teachers: 62	Amount donated by attendees toward the GSA Student Travel Fund: US\$6,340
Members of the media: 11	
Countries represented: 54	
Sessions: 287	

A **Special Thank You** goes to the International Association for Geoscience Diversity (IAGD) members Amanda Haddock, Caroline Pritchard, Leah Miller, Sean Thatcher, and Sumant Jha for their assistance in reviewing the meeting.

In case you missed it, these can still be viewed:

GSA Presidential Address and Awards Ceremony:

<https://livestream.com/accounts/7595903/events/8386444>

Late Breaking Session: Kīlauea 2018: Geoscience and Communication During a High Profile Natural Event:

<https://livestream.com/accounts/7595903/events/8462334>

Feed Your Brain—The Resources of The Moon:

<https://livestream.com/accounts/7595903/events/8386530>

Women Rising: Removing Barriers and Achieving Parity in the Geosciences: <https://livestream.com/accounts/7595903/events/8386539>

Plate Tectonics Paradigm 50 Years after the Seminal Work of Morgan, Mckenzie, and Le Pichon: <https://livestream.com/accounts/7595903/events/8386543>

Feed Your Brain—James Reilly, USGS Director:

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Human Evolution and Environmental History in Africa:

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Thank You to All the Mentor Volunteers Who Served at the GSA 2018 Annual Meeting!

Mentors are integral to GSA's meeting and are a source of motivation and support for students and early career professionals as they seek advice and information related to their academic and career pathways. Below are the programs mentor volunteers participated in and some comments from mentees:

- Annual Meeting Mentors
- Drop-in Mentors
- GeoCareers Roundtable Mentors
- On To the Future Mentors
- Résumé Mentors
- Student Networking Mentors
- Women in Geology Roundtable Mentors

"My mentor was fantastic; he provided excellent advice about how to make effective and informative posters, how to meet new people and who to talk to, and introduced me to some of the students that he worked with in the past."

—On To the Future Mentorship

"I thought that the résumé mentor was very thoughtful and informative, and I appreciated all of his feedback."

—Résumé Mentorship

"I had a very good experience with my mentor. They were very insightful and thoughtful. When they couldn't answer my questions, they put me in contact with people who could."

—On To the Future Mentorship

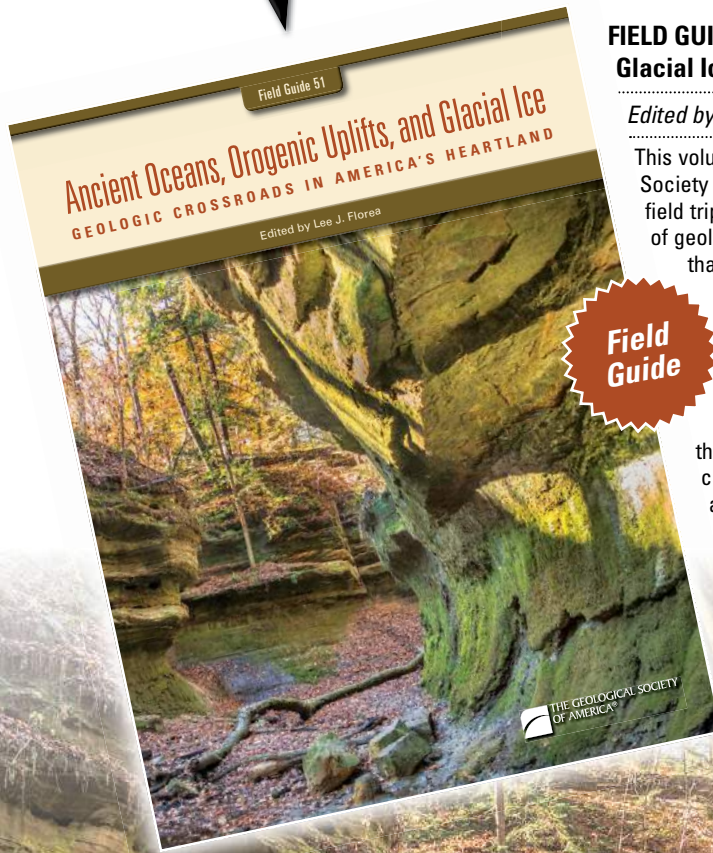


*"Loved the mentoring
roundtable and booths."*

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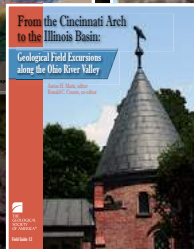
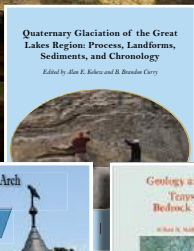
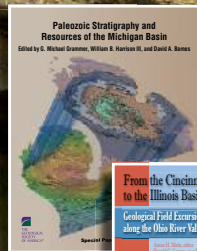
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2018 GSA Presidential Address: Navigating “Me, too” in the Geosciences



Robbie Gries

Delivered at the GSA Annual Meeting in Indianapolis, Indiana, USA, on 4 November 2018

Robbie Gries, Priority Oil & Gas LLC, Denver, Colorado 80227, USA

We have seen the “Me, too!” movement expand across all aspects of humankind. From Hollywood, where it grew legs, to Congress, state legislatures, the White House, huge corporations, small businesses, sports, television personalities, the military, the Olympics, religions, and, yes, to GSA.

Before Harvey Weinstein—before something hit the proverbial fan—GSA was already receiving and addressing complaints from members who experienced harassment (ranging from bullying to sexual assault, but most commonly, gender harassment). We launched a review of our ethics position, our obligations, and our Code of Conduct to ensure our Society has the means to effectively deal with unprofessional behavior at GSA meetings, field trips, and other sponsored events. GSA recognized the absence of good definitions and effective procedures and made moves to correct that. GSA’s initiative was timely and good strides have been made. We are taking “proactive measures.”

I believe people in the geosciences have excellent skills to address harassment, prejudice, and gender issues. *We have* the scientific skills and intellect to address many societal problems and we are good at using these skills. We routinely gather data, review published studies, and conduct in-depth conversations with experts. This is second nature to the professional geoscientist.

What is not second nature to us is how to employ these skills in our *interpersonal relationships*, including our interactions with colleagues, staff, students, and even our families. And this can make a big difference.

So, first, let’s look at facts. The Facts. Data. The scientist’s friend and staple for sound analysis.

The National Academies of Sciences, Engineering, and Medicine published in the summer of 2018 a report, “Sexual harassment of women: Climate, culture, and consequences.” Though mostly about women, because they are the target of most harassment, it includes substantial data on men, too.

Incredibly, studies on sexual harassment from the 1980s through today continue to show that sexual harassment of women is widespread in workplaces and that **the rates of sexual harassment have not significantly decreased**. This is a disturbing finding.

Let’s look first at how sexual harassment was defined in the National Academies study: Sexual harassment is a form of discrimination that consists of three types of behavior:

- “1. ‘Gender harassment’ means using verbal and nonverbal behaviors that convey hostility, objectification, exclusion, or second-class status. The use of derogatory terms, inappropriate jokes, pictures, etc.;
- “2. ‘Unwanted sexual attention,’ including unwelcome verbal or physical sexual advances; and
- “3. ‘Sexual coercion’...favorable professional treatment is conditioned on sexual activity.”

Most people may think of sexual harassment as just unwanted sexual attention or sexual coercion—however, this study defines gender harassment (the use of verbal and nonverbal behaviors) as a form of sexual harassment, and it is the most common form. Sexual harassment can be either direct (targeting an individual) or ambient (generalized over a larger group or population). Both are harmful and create a hostile environment.

The National Academies study referred to a University of Texas System ARC3 Campus Climate Survey (Swartout, 2018) that found that 17% of science students (including geosciences) experience sexist hostility. Surprisingly, it was found that 13% of the male science students experience sexual harassment, compared to 17% of the women. AND, populations with multiple marginalities (female, people of color, and gender non-conformist minorities) experience a greater rate of harassment. Corroborating the Texas study, a Pennsylvania State University System study completed in 2015 found that 30%–40% of all science students (not just geoscience) experience sexist hostility from faculty/staff. The variation in percent depends on the campus and the discipline. In the sciences (excluding engineering and medical), 12%–18% experience crude behavior and 4%–5% unwanted sexual attention. Sexual coercion is, fortunately, low, at ~1%. It is little comfort to read that 50% of medical students have experienced sexist hostility. In fact, across the board, medical student stats were terrible, including a large percentage of male students who experienced harassment.

Top-down harassment has the most harmful impact, and, fortunately, it is much less frequent in the sciences than peer harassment—80% of reported harassment is by peers. But, again, all reports of harassment are exacerbated when involving a person of color or gender diversity.

The largest contributor to sexual harassment is organizational environment. **This puts the geosciences in jeopardy because geoscience inherently has many of these organizational hazards.** These are:

1. Institutions where men outnumber women;
2. Where there is an absence of organizational sanctions—meaning complaints not taken seriously;
3. Where leadership provides a model for inappropriate behavior; and
4. Where there are large power differentials.

There are, however, some easy solutions to propagating LOW rates of sexual harassment:

1. *Establish a zero-tolerance climate;*
2. *Develop a staff that is less male-dominated, with a larger expression of female leadership.*

Many geoscientists think, “Oh, we covered this a long time ago.” “We have lots of women on our staff, therefore we are finished with this.” This cannot be “assumed.” This is a question that needs to be regularly revisited. Gather fresh data. Reevaluate. And, importantly, use valid methodologies established by social science research. We, as scientists, know that when working on a geoscience problem, valid methodologies are crucial. This is equally true for data-gathering regarding harassment and institutional environments.

One important aspect of our regular evaluations is to recognize and confront our biases. Most of us think that we do not have a bias, but when we do the actual research, we find we do harbor unconscious biases. Both men and women.

Jackson Katz, a football star turned women’s studies student and author of the *Macho Paradox* (2006), likes to get data from his classes. He says, “I draw a line down the middle of a chalkboard, sketching a male symbol on one side and a female symbol on the other. Then I ask just the men: What steps do you guys take, on a daily basis, to prevent yourselves from being sexually assaulted? At first there is a kind of awkward silence as the men try to figure out if they’ve been asked a trick question. The silence gives way to a smattering of nervous laughter. Occasionally, a young guy will raise his hand and say, ‘I stay out of prison.’ This is typically followed by another moment of laughter, before someone finally raises his hand and soberly states, ‘Nothing. I don’t think about it.’ Then I ask women the same question. What steps do you take on a daily basis to prevent yourselves from being sexually assaulted? Women throughout the audience immediately start raising their hands. As the men sit in stunned silence, the women recount safety precautions they take as part of their daily routine. Here are some of their answers: Hold my keys as a potential weapon. Look in the back seat of the car before getting in. Carry a cell phone. Don’t go jogging at night. Lock all the windows when I sleep, even on hot summer nights. Be careful not to drink too much. Don’t put my drink down and come back to it; make sure I see it being poured. Own a big dog. Carry mace or pepper spray. Have an unlisted phone number. Have a man’s voice on my answering machine. Park in well-lit areas. Don’t use parking garages. Don’t get on elevators with only one man, or with a group of men. Vary my route home from work. Watch what I wear. Don’t use highway rest areas. Use a home alarm system. Don’t wear headphones when jogging. Avoid forests or wooded areas, even in the daytime. Don’t take a first-floor apartment. Go out in groups. Own a firearm. Meet men on first dates in public places. Make sure to have a car or cab fare. Don’t make eye contact with men on the street. Make assertive eye contact with men on the street.” Creating awareness in men of what women face each day helps to build empathy and helps men put aside their personal bias.

So, just as in a geoscience investigation, don’t ASSUME. Survey your employees, faculties, students: Get the data. Refresh the data.

Another question that always enters into this discussion: “Why don’t women report? We aren’t wimps, for god’s sake!”

Characteristically, women have learned to go along to get along. They are much more likely to try to ignore or even try to appease the harasser. They are non-confrontational. Women often mentally diminish the experience—saying to themselves that it wasn’t all that serious. They choose not to attract negative attention; they don’t want to *get the aggressor in trouble or are afraid of retaliation*. Only ~25% report incidents. Or worse. In the University of Texas study, only 2% were found to report. Women of color report even less than whites. Fear of blame, disbelief, inaction, retaliation, humiliation, ostracism, and damage to career and reputation reign. These reactions affect women’s careers—where they might leave a leadership track to avoid a perpetrator, or, leave the institution, or, even leaving their career. Getting labeled a complainer is feared the most and harms or ends careers.

Older generations—my generation, generations before me—basically “lived with” abuse problems, developed defenses, succumbed, shut up, deferred, and tolerated. It was just the way it was. We definitely ignored or appeased. The risk for negatively impacting our careers was too high to “stick our necks out.”

Probably some of you remember going to geologic conventions where there were two registration lines labeled “Geologists” and “Ladies.”

And, we sat in on sessions where photos of scantily clad women were used jokingly for “scale” or to make some point. The audience would giggle or laugh or even applaud, whether comfortable or not. Many men were not comfortable, lots of women (of course, there were NOT lots of women) were uncomfortable. But our reaction was governed by our need to fit in, to be accepted, and being “one of the boys,” and accepting “boys will be boys” overruled our sensitivity. Our convention floors were populated with sexy, scantily clad women showing off the latest in drill bits or geochemical measuring tools. Those days are well behind us, it appears. But the changes in our meeting environment have still not eliminated sexual harassment.

I recall a couple of my own experiences and reactions. Twice at different times, male candidates for president of a large international geological association were inappropriate with me. One would not keep his hands off me in a darkened meeting room. Then he followed me to my room that night and tried to force his way in. Did I show outrage and anger? Not at all. My first reaction was to worry about HIS feelings as I said no, over and over. I was trying not to hurt his feelings! It never occurred to me to put myself first. I tried to be polite, to be gentle. It could have sent a message of weakness to him. Therefore, I *understand* that the act of saying no, expressing outrage, or reporting is indeed complex.

Knowing that young men, even today, can be the subject of harassment makes me more chagrined to recall 40 years ago when I let my frustration about being asked inappropriate questions with job interviews get the best of me. I had recently had an interview with the president of a small oil company where he asked, “I see that you are divorced. If you remarry, do you plan to quit?” Never mind that he, too, was divorced at that time. I just smiled and answered, “No, of course not.” But I found it upsetting. So, my frustration got the best of me later in the week when a young man that I had employed to do summer fieldwork appeared at my office door. Two weeks prior,

2018 GSA PRESIDENTIAL ADDRESS

I had sent him off to the San Juan Basin with a company car, expense account, and instructions for acquiring samples and measuring sections. I asked what he was doing back in Denver so soon and he replied that he had gotten married in May and his new bride did not want him gone all summer. Without batting an eye, I said, “Well, that’s why we don’t like to hire young men. They just get married and quit!” Oh, wherever you are today, young man, I apologize.

How I admired a Houston woman, Deborah Sacrey, who told me about going up to a rig floor to start her duties as a well-site geologist in the 1970s. She was greeted by an imposing rough-neck who told her that there were only two kinds of women who came to rigs. Wives or women who provide “other” services. She handed him her business card and said, “Well, here is a third kind of woman you can expect on a rig—the kind that will fire your sorry ass if you give her any crap!” Oh, my! Where does that deep self-confidence come from? Can we learn it? Can we teach it?

Another female geologist I know fought hard to be able to do her share of well-site work in the jungles of Central America. When she was brutally raped by a gang of armed locals, she hid the fact from the well-site team (explaining her bruises and wounds as resulting from falling down the rig stairs) and did not tell anyone because she was afraid that (A) they would not believe her, and (B) very important—she feared she would ruin the opportunity for other women in the company to do well-site work.

Two years ago, a GSA initiative was developed to ensure a safe and welcoming environment for meeting participants: RISE = Respectful Inclusive Scientific Events. This promotes “mindfulness”—being aware of your own behavior and the behavior of others to promote the best of experiences for participants, including “bystander intervention training.” Other societies have used GSA’s model for their own meetings.

Many of our fellow geologists have written to GSA leadership with irritation, “Aren’t we beyond this!” No. We are not. Get the data.

Last year, 2017, was full of news events about transgressions—but 2018 is seeing mixed repercussions and some backsliding.

Only about half of the states in the U.S. have followed through with promised bills and training for legislators and staffs, according to Associated Press News (Lieb, 2018).

The “Congressional Accountability and Harassment Reform Act: S. 2872” passed the Senate but has not yet passed in the House. And it does not look optimistic for passing. A big issue is lawmakers’ *objection to holding themselves personally responsible* for paying any settlement—they are accessing taxpayers’ money out of a little-known account in the U.S. Treasury or they’re using the Office of Compliance to pay. It has paid out more than US\$17 million over the past 20 years handling workplace complaints and settlements. This is not made public.

But we can’t fix the problems of the world today, or this year, but we can address the problem in the geoscience world. Let’s bring this home to GSA again.

Besides establishing our RISE program—two more recent GSA initiatives:

Under the leadership of Monica Gowan, GSA developed a new position paper, approved in May: “Removing Barriers to Career Progression for Women in the Geosciences.”

This position statement:

1. **Affirms the pressing need** for a change in professional culture so that all people are welcomed, supported, and can thrive in the geoscience profession; and for policies that aspire to the highest standards of conduct as a professional society;
2. **Advocates for** resolving implicit and explicit biases and the elimination of harassment, including bullying and sexual misconduct in the workplace; and
3. **Recommends** elevated personal and professional responsibility and evidence-based policies that extend beyond civil and legal remedies, to promote inclusive, safe, and productive environments in the geoscience classroom, office, laboratory, and field. GSA, under the leadership of immediate past president, Isabel Montañez, set up an ad hoc committee to review and make recommendations for GSA’s Code of Ethics. Neil Fishman chaired the committee, and recommendations were presented to Council in May 2018. These included:
 1. Add enforcement to our code of conduct;
 2. Create a standing committee for ethics;
 3. Accept no statute of limitations for a breach of the GSA code;
 4. Provide training for leadership and staff; and
 5. GSA engage a “compliance officer” with a large emphasis on proactive efforts.

In the geoscientist’s world, opportunities are abundant in our world for misbehavior, whether it is as a victim or as a person accused. We are often in isolated settings. “In the field,” “traveling,” “office hours,” “beer parties,” “late nights in the lab,” “conventions.” Those are the real circumstances of our lives that other professionals might not have to navigate.

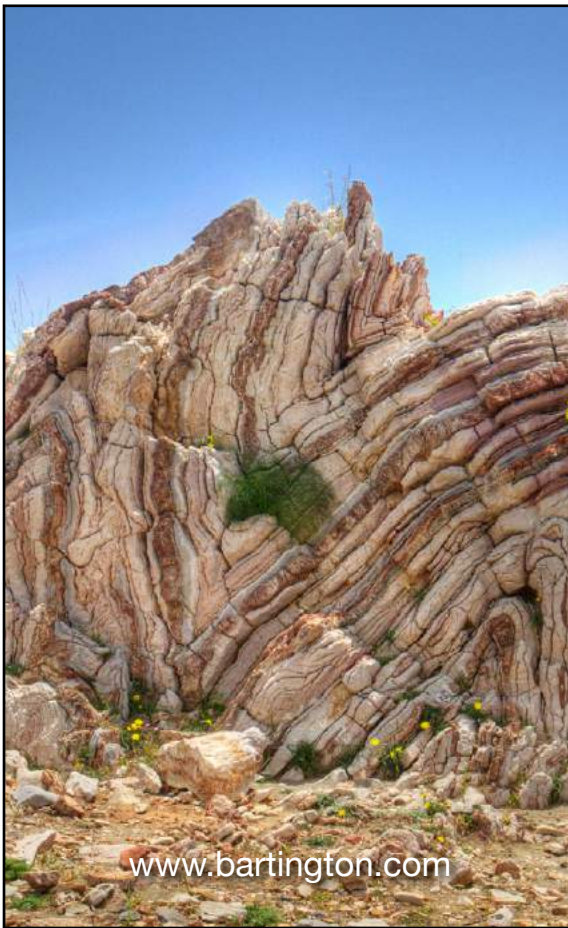
And these are parts of our professional life that we want to keep. These are activities and situations we love and value. They are important relationship- and career-building activities. Fieldwork. Having a beer together. Being mentored by a prominent geoscientist. These things help make geoscience fun, exciting, and rewarding. It is what makes a geoscience career unique and collegial. We cherish these aspects of our student and professional life. How do we keep these priceless interactions in the “Me, too” world? How do we navigate our unique and potentially dangerous landscape?

I believe those of us in the geosciences have excellent skills to address harassment, just as we address a geologic problem. We get the data, study the data, and then promote sensitivity and sensibility. We are capable. We can do this.

We will navigate from “Me, too” to “Not Us!”

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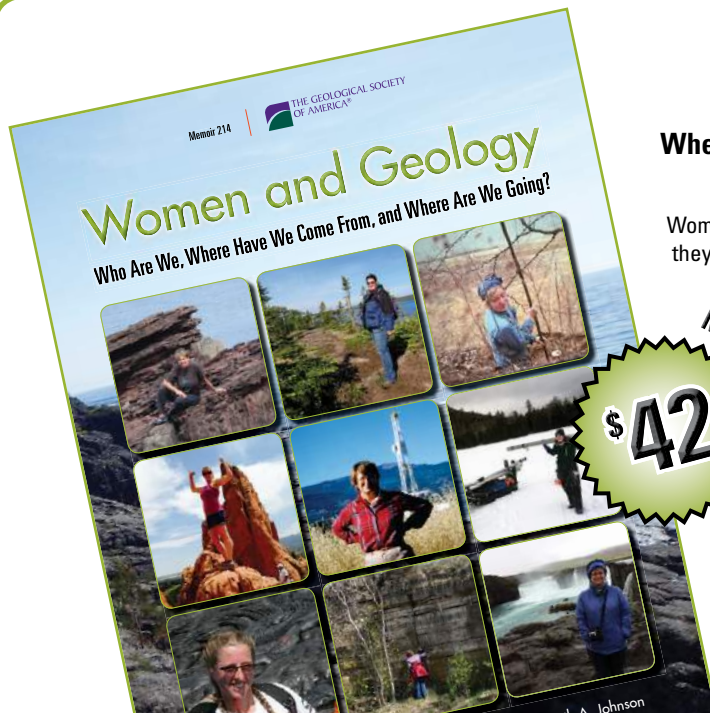
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MEMOIR 214



Women and Geology: Who Are We, Where Have We Come From, and Where Are We Going?

Edited by Beth A. Johnson

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

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Richard Hay Student Paper/Poster Award

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Gerald M. and Sue T. Friedman Distinguished Service Award

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KARST DIVISION

Division Meritorious Contribution Award

Nominations due 1 Mar.

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Young Scientist Award

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MGPV Distinguished Geologic Career Award

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Nominations due in August

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Ronald Greeley Award for Distinguished Service

Nominations due 30 June

community.geosociety.org/pgd/awards/greeley

QUATERNARY GEOLOGY AND GEOMORPHOLOGY DIVISION

Farouk El-Baz Award for Desert Research

Nominations due 1 Apr.

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Sedimentary Geology Division and Structural Geology and Tectonics Division Joint Award

Stephen E. Laubach Structural Diagenesis Research Award

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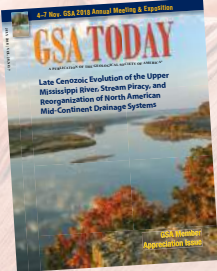
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Get into the Field with These GSA Awards

GSA Field Camp Scholar Award

Who should apply? Undergraduate students

Deadline to apply: 5 April

This year's field award will provide US\$2,000 to undergraduate students so they can attend the summer field camp of their choice. These scholarships are based on diversity, economic/financial need, and merit.

The importance of field schools to practicing geologists is unquestionable, yet the opportunities to experience field geology are dwindling. Through the Field Camp Opportunities Fund, the GSA Foundation gives students the opportunity to experience the wonder of the geosciences and learn something new about the world.



Supported by

GSA FOUNDATION

GSA, in cooperation with ExxonMobil, offers two programs to support and encourage field geology. This collaboration has proven very successful; in 2018, hundreds of geology students and professors applied for these awards.

The GSA/ExxonMobil Bighorn Basin Field Award

Who should apply? Undergraduate and graduate students and faculty

Deadline to apply: 5 April

Camp dates: 5–12 August 2019

This award is a one-week field seminar that offers 20 undergraduate and graduate students and five faculty members a high-quality educational experience in the spectacular Bighorn Basin of north-central Wyoming. The course is free to accepted participants, and all transportation, meals, and living expenses are covered.

GSA/ExxonMobil Field Camp Excellence Award

Who should apply? Anyone, but the award must be used toward field camp operations

Deadline to apply: 5 April

One field camp instructor/director will receive an award of US\$10,000 to assist with his or her summer field season. This award will be based on safety awareness, diversity, and technical excellence.

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Dalila A. de Jesus

My field camp experience was a very rewarding and empowering one. I'm very grateful for the opportunity I had to be there and be part of such a great course and team. I'm even more thankful for all the generous support from GSA, which surely contributed to the amazing and successful experience I had over the summer.

—Dalila A. de Jesus, 2018 GSA Field Camp Scholar Award Winner

To apply for these awards, go to <https://bit.ly/2AL9fKI>. Students and recent graduates must submit an online application form, two letters of recommendation, and a cover letter.

Questions? Contact Jennifer Nocerino, jnocerino@geosociety.org, +1-303-357-1036.

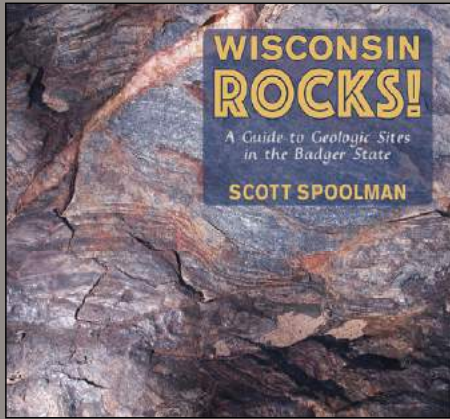
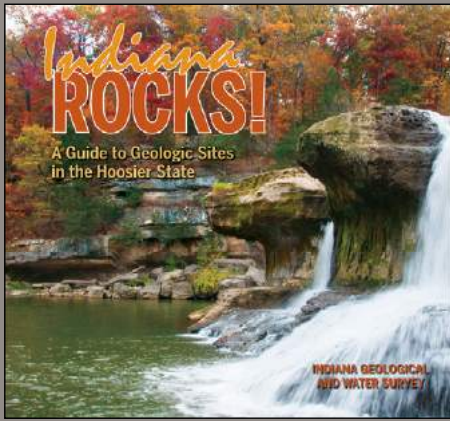


The Bighorn Basin Field Award was a great opportunity to learn about both basic oil and gas exploration concepts and what companies value in terms of student field knowledge and experiences. The course has resulted in me redesigning/focusing my own courses to the types of concepts/approaches that were covered and provided a great networking opportunity for students/faculty and industry professionals.

—Brian Currie, 2011 GSA/ExxonMobil Bighorn Basin Field Faculty Award Winner

The Bighorn Basin Field Course has played a big part in my career development to this point. It provided valuable exposure to geoscience in the oil and gas industry and to geoscience field work, exploratory basin analysis, well log interpretation, stratigraphic principles, and petroleum systems, all of which have been valuable skills I have relied on in both technical work and interview settings.

—Hamilton Goodner, 2015 GSA/ExxonMobil Bighorn Basin Field Award Winner



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2018 Outstanding Earth Science Teacher Awards

The National Association of Geoscience Teachers (NAGT) has announced the 2018 Outstanding Earth Science Teacher (OEST) Awards. This annual award recognizes excellence in earth-science teaching at the pre-college level. GSA awards the section recipients US\$500 in travel money to attend a GSA meeting, or US\$500 for classroom supplies, and complimentary membership in GSA for three years. State winners receive a one-year complimentary GSA membership.

SECTION WINNERS

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Ames High School
Ames, Iowa, USA

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Seymour, Wisconsin, USA



The National Association
of Geoscience Teachers (NAGT)

2019 GeoCareers Section Meeting Programs

Geoscience Career Workshops

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 of 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 to help you learn important résumé dos and don'ts.

Mentor Programs

Enjoy a free lunch while meeting with geoscience mentors working in applied sectors. The popularity of these programs means that space is limited, so plan to arrive early, because lunch is first-come, first-served.

Northeastern Section, Portland, Maine, USA

Mann Mentors in Applied Hydrology Luncheon: Sunday, 17 March

Shlemon Mentor Luncheon Program: Monday, 18 March

Joint Section Meeting (Rocky Mountain, South-Central, North-Central), Manhattan, Kansas, USA

Shlemon Mentor Luncheon Program: Monday, 25 March, and Tuesday, 26 March

Mann Mentors in Applied Hydrology Luncheon: Wednesday, 27 March

Southeastern Section, Charleston, South Carolina, USA

Shlemon Mentor Luncheon Program: Thursday, 28 March

Mann Mentors in Applied Hydrology Luncheon: Friday, 29 March

Cordilleran Section, Portland, Oregon, USA

Shlemon Mentor Luncheon Program: Wednesday, 15 May

Mann Mentors in Applied Hydrology Luncheon: Thursday, 16 May

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



Second Announcement

CORDILLERAN SECTION

**115th Annual Meeting,
Cordilleran Section, GSA
15–17 May 2019
Portland, Oregon, USA**

www.geosociety.org/cd-mtg



Portland, Oregon, USA, at night; photo courtesy Portland Travels.

Converging on Cascadia

LOCATION

Portland, Oregon, USA—the City of Roses—is located in the heart of one of the most dynamic geologic environments in the West, having been affected by megathrust earthquakes, giant flood-basalt eruptions, catastrophic glacial floods, continuing fluvial and hillslope processes, and human influences on the landscape. Founded along the banks of the Columbia and Willamette rivers, Portland is nestled between the magnificent volcanic arc of the Cascade Range to the east and the Coast Range to the west. Building on the exceptional local and regional geological features of the Cordillera, we have devised a diverse program reflecting fundamental and applied aspects across earth science disciplines.

REGISTRATION

Early registration deadline: 8 April

Cancellation deadline: 15 April

Registration fees

	Early		Standard	
	Full Mtg	One day	Full Mtg	One day
Professional member	US\$300	US\$220	US\$330	US\$260
Professional member 70+	US\$190	US\$160	US\$240	US\$200
Professional nonmember	US\$350	US\$255	US\$380	US\$295
Early career professional member	US\$200	US\$150	US\$240	US\$180
Early career professional nonmember	US\$230	US\$170	US\$260	US\$200
Student member	US\$130	US\$90	US\$150	US\$115
Student nonmember	US\$160	US\$110	US\$180	US\$135
K–12 Professional	US\$130	US\$90	US\$130	US\$115
Guest	US\$130	n/a	US\$130	n/a
Field trip/workshop only	US\$70	n/a	US\$100	n/a

ACCOMMODATIONS

A block of rooms has been reserved at the DoubleTree by Hilton at 1000 NE Multnomah Street, Portland, Oregon 97232, USA, which is a few blocks from the Oregon Convention Center, where the conference will be held. The meeting room rate is US\$199 per night plus tax. Reservations can be made at bit.ly/2CK7LVw. Reservations can also be made by calling the hotel directly at +1-503-281-6111 or by calling the toll-free reservations hotline at +1-800-996-0510. Refer to group code **MCS**.

THEME SESSIONS

- T1. Cordilleran Tectonics from the Basin and Range to Alaska and the Arctic: A Celebration of Elizabeth Miller's Career (2018 GSA Structural Geology and Tectonics Division Career Contribution Award).** Jeff Lee, Central Washington Univ., jeff@geology.cwu.edu; Victoria Pease, Stockholm Univ., vicky.pease@geo.su.se.
- T2. Advances in Seismic Hazard Assessment through Paleoseismic and Tectonic Geomorphic Fault Studies: In Honor of Ray J. Weldon II for His Career and Contributions to the Field.** Ashley Streig, Portland State Univ., streig@pdx.edu; Kate Scharer, U.S. Geological Survey, kscharer@usgs.gov; Scott Bennett, U.S. Geological Survey, sekbennett@usgs.gov.
- T3. A Simple Twist of Plate: In Honor of the Career Contributions of the Dynamic Duo—Rick Blakely and Ray Wells—to Understanding Plate Interactions and Deformation in Cascadia.** Andrew Meigs; Oregon State Univ., meigsa@geo.oregonstate.edu; Scott Bennett, U.S. Geological Survey, sekbennett@usgs.gov; Peter Haeussler, U.S. Geological Survey, pheuslr@usgs.gov.
- T4. Recent Advances in Cordilleran Tectonic Evolution—1: Paleozoic to Mesozoic.** Jamie MacDonald, Florida Gulf Coast Univ., jmacdona@fgcu.edu; Joe Dragovich, Associated Earth Sciences Inc., jdragovich@aesgeo.com; Megan Anderson, Washington Dept. of

- Natural Resources, megan.anderson@dnr.wa.gov; Peter Davis, Pacific Lutheran Univ., davispb@plu.edu; Jeffrey Tepper, Univ. of Puget Sound, jtepper@pugetsound.edu.
- T5. **Recent Advances in Cordilleran Tectonic Evolution—2: Cenozoic.** Jamie MacDonald, Florida Gulf Coast Univ., jmacdona@fgcu.edu; Joe Dragovich, Associated Earth Sciences Inc., jdragovich@aesgeo.com; Megan Anderson, Washington Dept. of Natural Resources, megan.anderson@dnr.wa.gov; Peter Davis, Pacific Lutheran Univ., davispb@plu.edu; Jeffrey Tepper, Univ. of Puget Sound, jtepper@pugetsound.edu.
- T6. **Tectonic Development of the Coast Mountains, British Columbia and Alaska.** Margi Rusmore, Occidental College, rusmore@oxy.edu; M. Robinson Cecil, California State Univ.–Northridge, robinson.cecil@csun.edu; George Gehrels, Univ. of Arizona, ggehrels@gmail.com; Harold Stowell, Univ. of Alabama, hstowell@ua.edu.
- T7. **Constraints on Insular Superterrane Collision and Translation: Current Thinking on the Baja-BC Hypothesis.** Basil Tikoff, Univ. of Wisconsin, basil@geology.wisc.edu; Darrel S Cowan, Univ. of Washington, darrel@uw.edu; Paul Umhoefer, Northern Arizona Univ., paul.umhoefer@nau.edu.
- T8. **Paleogene Tectonic Setting of the Greater Pacific Northwest before Cascadia: From Siletzia to the Challis Belt.** Paul Umhoefer, Northern Arizona Univ., paul.umhoefer@nau.edu; Robert Miller, San Jose State Univ., robert.b.miller@sjsu.edu; Jeff Tepper, Univ. of Puget Sound, jtepper@pugetsound.edu.
- T9. **Tectonic Processes in Cordilleran Arcs.** Stacia Gordon, Univ. of Nevada–Reno, staciag@unr.edu; Robert Miller, San Jose State Univ., robert.b.miller@sjsu.edu.
- T10. **Crystal Windows into Igneous Processes.** Anne Fulton, Univ. of Oregon, afulton2@uoregon.edu; Michelle Muth, Univ. of Oregon, mmuth@uoregon.edu; Nicole Rocco, Oregon State Univ., roccon@oregonstate.edu.
- T11. **Advances in the Formation, Storage, Eruption, and Emplacement of Evolved Magma Bodies.** Madison Myers, Montana State Univ., madison.myers@montana.edu; Laura Waters, Sonoma State Univ., watersla@sonoma.edu; Jim Watkins, Univ. of Oregon, watkins4@uoregon.edu; Nathan Andersen, Univ. of Oregon, nla@uoregon.edu; John Wolff, Washington State Univ., jawolff@wsu.edu.
- T12. **Field, Petrological, and Geochemical Constraints on Magmatic Systems in the Cordillera.** Wendy Bohrson, Central Washington Univ., bohrson@geology.cwu.edu; Anita Grunder, Oregon State Univ., grundera@geo.oregonstate.edu.
- T13. **The Yellowstone Hotspot Province: Prehistory, Timing, Extent, Volcanic Products, and Hydrothermal Consequences.** Arron Steiner, Washington State Univ., arron@wsu.edu; John Wolff, Washington State Univ., jawolff@wsu.edu; Martin Streck, Portland State Univ., streckm@pdx.edu.
- T14. **Magmatism of the Columbia River Flood Basalt Province.** Seth Burgess, U.S. Geological Survey, sburgess@usgs.gov; Michael Sawlan, U.S. Geological Survey, msawlan@usgs.gov.
- T15. **Magmatism in the Cascades: Variations in Space and Time.** Adam Kent, Oregon State Univ., adam.kent@geo.oregonstate.edu; John Dilles, Oregon State Univ., grunderdilles@gmail.com; Anita Grunder, Oregon State Univ., grundera@geo.oregonstate.edu.
- T16. **Landscape Evolution and Tectonic Geomorphology in the Greater Pacific Northwest.** Matthew Morriss, Univ. of Oregon, mmorris9@uoregon.edu; Phil Schoettle-Greene, Univ. of Washington, philip.greene@gmail.com; Will Struble, Univ. of Oregon, wstruble@uoregon.edu; Lydia Staisch, U.S. Geological Survey, lstaisch@usgs.gov.
- T17. **Landscape Changes at Various Temporal and Spatial Scales.** Allen Gontz, San Diego State Univ., agontz@sdsu.edu; Josh Kelly, San Diego State Univ., jtkelly@sdsu.edu.
- T18. **Interactions between Water and Volcanic Terranes.** Erick Burns, U.S. Geological Survey, eburns@usgs.gov; Gordon Grant, U.S. Forest Service, gordon.grant@oregonstate.edu; Steven Ingebritsen, U.S. Geological Survey, seingebr@usgs.gov.
- T19. **The Evolution of the Columbia River: Fluvial, Volcanic, and Tectonic Interactions from Miocene to Modern Time.** Lydia Staisch, U.S. Geological Survey, lstaisch@usgs.gov; Jim O'Connor, U.S. Geological Survey, oconnor@usgs.gov.
- T20. **Glaciers of the North American West.** Andrew G. Fountain, Portland State Univ., andrew@pdx.edu; Claire Todd, Pacific Lutheran Univ., toddce@plu.edu; Erin Whorton, U.S. Geological Survey, ewhorton@usgs.gov.
- T21. **Understanding Sediment Transport Dynamics in Mountain Environments.** Scott W. Anderson, U.S. Geological Survey, swanderson@usgs.gov; Kristen Jaeger, U.S. Geological Survey, kjaeger@usgs.gov.
- T22. **New Insights into River Processes and Implications for Floodplain Management and Restoration.** Mackenzie Keith, U.S. Geological Survey, mkeith@usgs.gov; Laurel Stratton, U.S. Geological Survey, lstratton@usgs.gov.
- T23. **Landslides: Hazards and Agents of Landscape Evolution.** Adam Booth, Portland State Univ., boothad@pdx.edu; Susan Shaw, Weyerhaeuser Co., susan.shaw2@weyerhaeuser.com; Dan Shugar, Univ. of Washington–Tacoma, dshugar@uw.edu; Scott Burns, Portland State Univ., burnss@pdx.edu.
- T24. **Geologic Maps: Essential Framework Tools Used to Solve Practical Earth-Science Problems (Posters).** Jason McClaghry, Oregon DOGAMI, jason.mcclaghry@oregon.gov; Carlie Duda, Oregon DOGAMI, carlie.duda@oregon.gov.
- T25. **Geologic Hazards: Hazard Maps, Risk Analysis, and Risk Reduction.** William Burns, Oregon DOGAMI, bill.burns@oregon.gov; Nancy Calhoun, Oregon DOGAMI, nancy.calhoun@oregon.gov; Christina Appleby, Oregon DOGAMI, christina.appleby@oregon.gov.
- T26. **Groundwater Resources of Oregon: Celebrating the Scientific Curiosity of Ken Lite and Marshall Gannett.** Esther Pischel, U.S. Geological Survey, epischel@usgs.gov; Amanda Garcia, U.S. Geological Survey, cgarcia@usgs.gov; Walter Burt, GSI Water Solutions Inc., wburt@gsiws.com.
- T27. **Hydrogeology of Coastal Basins of the Western United States.** Donald Sweetkind, U.S. Geological Survey,

dsweetkind@usgs.gov; Geoffrey Cromwell, U.S. Geological Survey, gcromwell@usgs.gov.

- T28. **Lakes across the West: Archives of Climate Change and Storehouse of Economic Resources.** Scott W. Starratt, U.S. Geological Survey, sstarrat@usgs.gov.
- T29. **Hydrogeology of Springs in the Great Basin.** Hank Johnson, U.S. Geological Survey, hjohnson@usgs.gov; Steve Gingerich, U.S. Geological Survey, sbginger@usgs.gov; Nick Corson-Dosch, U.S. Geological Survey, ncorson-dosch@usgs.gov.
- T30. **Undergraduate Research (Posters).** Jeff Marshall, Cal Poly Pomona, marshall@cpp.edu.
- T31. **Hands-On Teaching Demonstrations in Introductory Geoscience Courses: Audience Participation Requested!** Daina Hardisty, Mt. Hood Community College, hardistd@mhcc.edu; Andrew Hilt, Portland Community College, andrew.hilt@pcc.edu; Eriks Puris, Portland Community College, eriks.puris@pcc.edu.
- T32. **Where the Next Generation Science Standards Meet Place-Based and Outdoor Learning.** Nancy Price, Portland State Univ., naprice@pdx.edu.
- T33. **Geoscience Education Research and Practice.** Robyn Mieke Dahl, Western Washington Univ., robyn.dahl@wwu.edu; Natalie Bursztyn, Quest Univ., natalie.bursztyn@questu.ca; Katrien van der Hoeven Kraft, Whatcom Community College, kkraft@whatcom.edu.
- T34. **Keep the Anthropocene Weird: Where Have We Come From, What Are We Doing, and How Will We Proceed?** Sammy Castonguay, Treasure Valley Community College, scastonguay@tvcc.cc.

FIELD TRIPS

See the website for trip descriptions. For additional information, please contact the Field Trip chair, Jason McClaughry, at jason.mcclaughry@oregon.gov.

- FT1. **Flood Basalts, Rhyolites, and Pre- to Post-Dating Volcanism of the Columbia River Province in Eastern Oregon.** Sat.–Tues., 11–14 May. Cost: US\$481 (includes all lunches, hotels, van transportation, handouts, possibly one dinner). Max.: 23. Martin J. Streck, Portland State Univ., streckm@pdx.edu; Mark L. Ferns, Eastern Oregon Univ., mferns@eou.edu; Emily Cahoon, Portland State Univ., ecahoon@pdx.edu.
- FT2. **The Columbia River Basalt in the Western Columbia Basin and Columbia River Gorge.** Mon–Tues., 13–14 May. Cost: US\$235 (includes all lunches, handouts, hotel, van transportation). Max.: 24. Michael Sawlan, U.S. Geological Survey, msawlan@usgs.gov; Ray Wells, U.S. Geological Survey, rwells@usgs.gov; Jon Hagstrum, U.S. Geological Survey, jhag@usgs.gov; Seth Burgess, U.S. Geological Survey, sburgess@usgs.gov.
- FT3. **Volcanism, Sedimentation, and Tectonics in the Hood River Graben: A Pliocene to Quaternary Intra-Arc Half Graben in the Northern Oregon Cascade Range.** Mon.–Tues., 13–14 May. Cost: US\$278 (includes two lunches, overnight stay at the historic Balch Hotel in Dufur, Oregon, van transportation, handouts). Max.: 17. Jason D. McClaughry, Oregon DOGAMI, jason.mcclaughry@

oregon.gov; Joshua A. Hackett, Oregon Water Res. Dept.; Clark Niewendorp, Oregon DOGAMI; Richard M. Conrey, Hamilton College.

- FT4. **Landslides in the Columbia River Gorge.** Tues., 14 May. Cost: US\$117 (includes lunch, snacks, bus transportation, handouts). Max.: 50. William J. Burns, Oregon DOGAMI, bill.burns@oregon.gov; Nancy Calhoun, Oregon DOGAMI, nancy.calhoun@oregon.gov; Trevor Contreras, Washington Geological Survey, trevor.contreras@dnr.wa.gov; Kara Jacobacci, Washington Geological Survey, kara.jacobacci@dnr.wa.gov; Kate Mickelson, Washington Geological Survey, kate.mickelson@dnr.wa.gov; Will Gallin, Washington Geological Survey, william.gallin@dnr.wa.gov.
- FT5. **Columbia River Basalt Hydrology and Management Solutions in the Mosier Basin, Oregon.** Sat., 18 May. Cost: US\$76 (includes lunch, van transportation, handouts). Max.: 30. Kenneth E. Lite, Jr., Oregon Water Resources Dept., kenneth.e.lite@oregon.gov; Robert B. Perkins, Portland State Univ., rperkins@pdx.edu; Erik A. Thomasser, Oregon Water Resources Dept., erik.a.thomasser@oregon.gov; Jonathan L. LaMarche, Oregon Water Resources Dept., jon.l.lamarche@oregon.gov; Aurora C. Bouchier, Oregon Water Resources Dept., aurora.c.bouchier@oregon.gov.
- FT6. **Mount St. Helens—Its 1980 Eruption and 39 Years of Post-Eruption Recovery.** Sat., 18 May. Cost: US\$141 (includes lunch, snacks, bus transportation, and entry fee to Johnston Ridge Observatory, rental fee for Coldwater Science and Learning Center, handouts). Max.: 50. Jon Major, U.S. Geological Survey, jjmajor@usgs.gov.
- FT7. **Terroir of Wine: Relationship of Wine to Soils, Geology, and Climate.** Sat., 18 May. Cost: US\$141 (includes lunch, snacks, minibus transportation, tasting fees, handouts). Max.: 26. Scott Burns, Portland State Univ., burnss@pdx.edu.
- FT8. **Rice Museum of Rocks and Minerals.** Sat., 18 May. Cost: US\$105 (includes lunch, van transportation). Max.: 22. Julian Gray, executive director, julian@ricenorthwestmuseum.org; Garret Romaine, board secretary.
- FT9. **Active Tectonics and Bedrock Geology of the North American Plate at the Latitude of the Columbia River: A Field Trip to Recognize the Contributions of Ray Wells and Rick Blakely—The Dynamic Duo of Pacific Northwest Geology and Geophysics.** Sat.–Sun., 18–19 May. Cost: US\$455 (includes all lunches, handouts, hotel, van transportation). Max.: 27. Andrew Meigs, Oregon State Univ., meigsa@geo.oregonstate.edu; Ray E. Wells, U.S. Geological Survey, rwells@usgs.gov; Scott Bennett, U.S. Geological Survey, sekbennett@usgs.gov.

SHORT COURSE

- SC1. **Assessing Contaminant Sources/Release Ages and Aquifer Continuity in Soil/Groundwater Systems Using Stable Radiogenic Isotopes of Strontium (Sr) and Lead (Pb).** Sat., 18 May, 9 a.m.–4 p.m. Fee: Minimal cost for printouts. Portland State University, Dept. of Geology, Cramer Hall S17. Richard Hurst, California Lutheran University, rhurst@callutheran.edu.

OPPORTUNITIES FOR STUDENTS AND EARLY CAREER PROFESSIONALS

Mentor Programs

Learn more at www.geosociety.org/mentors.

Roy J. Shlemon Mentor Program in Applied Geoscience.

Wed., 15 May, noon–1:30 p.m., Oregon Convention Center, Room B112. 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. Thurs., 16 May, noon–1:30 p.m., Oregon Convention Center Room, B112. 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 Careers Workshop

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 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 résumés helping you to learn important résumé dos and don'ts.

Best Student Posters and Papers

Awards for the best student posters and papers are supported by the GSA Cordilleran Section. To be eligible, students must be lead authors and presenters and should be capable of answering detailed questions about their research. Judging will take place during the conference, and awards will be announced after the meeting.

ORGANIZING COMMITTEE

General Chairs: Martin Streck, streckm@pdx.edu; Jim O'Connor, occonnor@usgs.gov

Technical Program: Matt Brunengo, mbruneng@pdx.edu; Erick Burns, eburns@usgs.gov

Field Trips: Jason McCloughry, jason.mccloughry@oregon.gov; Clark Niewendorp, clark.niewendorp@oregon.gov; Bob Houston, robert.houston@mlrr.oregongeology.com

Workshops: Frank Granshaw, fgransha@pdx.edu

Student Volunteers, Exhibits: Frank Granshaw, fgransha@pdx.edu

Sponsorships: Scott Burns, burnss@pdx.edu



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Call for GSA Committee Service

Nominations due 15 June

Learn more at www.geosociety.org/Committees, or contact Dominique Olvera at dolvera@geosociety.org.

Terms begin 1 July 2020 unless otherwise noted.

COMMITTEE NAME	NO. OF VACANCIES	POSITION TITLE	TERM (years)
Academic and Applied Geoscience Relations (E, M)	1	Member-at-Large Industry	3
Arthur L. Day Medal Award (E, T)	2	Members-at-Large	3
Bascom Mapping Award (E, T)	1	Member-at-Large Government	3
	1	Member-at-Large Industry	
Diversity in the Geosciences (B, E, M)	2	Members-at-Large	3
	1	Member-at-Large Industry	3
	1	Member-at-Large Student	2
Education (B, E, M)	1	Undergraduate Student Representative	2
Geology and Public Policy (E, M)	2	Members-at-Large North America	3
	1	Member-at-Large Student	2
GSA International (E, M)	2	Members-at-Large	4
	1	Member-at-Large Outside North America	4
	1	Member-at-Large Student	2
Joint Technical Program (B, E) Term begins December 2019	1	Member-at-Large Precambrian Geology	2
	1	Member-at-Large Paleoclimatology & Paleooceanology	2
Membership and Fellowship (B, T)	1	Member-at-Large Industry	3
	1	Member-at-Large Student	3
Nominations (B, E)	2	Members-at-Large	3
North American Commission on Stratigraphic Nomenclature	1	Committee Representative	3
Penrose Medal Award (E, T)	2	Members-at-Large	3
Professional Development (E)	2	Members-at-Large	3
Public Service Award (E)	1	Member-at-Large	3
Publications (B, E, M)	1	Geoscience Information Society Library Representative	4
Research Grants (B, T)	12	Members-at-Large	3
Young Scientist Award (Donath Medal) (E, T)	2	Members-at-Large	3
	1	Member-at-Large (Councilor, former Councilor)	3

Note: Terms begin 1 July 2020 unless stated otherwise. B—Meets in Boulder or elsewhere; E—Communicates by phone or electronically; M—Meets at the Annual Meeting; T—Extensive time commitment required during application review period.

Elections: GSA Officers and Councilors

GSA Elections Will Open on 14 March 2019

GSA's success depends on you—its members—and the work of the officers serving on GSA's Executive Committee and Council.

Members will receive instructions for accessing an electronic ballot via our secure website, and biographical information on the nominees will be online for review at that time. Paper versions of both the ballot and candidate information will also be available upon request.

Please help continue to shape GSA's future by voting on these nominees. The election will open for voting on 14 March 2019. To be included in the count, ballots must be submitted electronically, faxed to GSA Headquarters (+1-303-357-1070), or postmarked before midnight on **13 April 2019**.

2019 Officer Nominees

PRESIDENT

(July 2019–June 2020)

Donald I. Siegel

Syracuse University
Syracuse, New York, USA

We congratulate our incoming president!

PRESIDENT-ELECT | PRESIDENT

(July 2019–June 2020)

(July 2020–June 2021)

J. Douglas Walker

University of Kansas
Lawrence, Kansas, USA

TREASURER

(July 2019–June 2020)

Richard C. Berg

Illinois State Geological Survey
Champaign, Illinois, USA

2019 Council Nominees

COUNCILOR POSITION 1

Divisions Liaison

(July 2019–June 2023)

Steven Driese

Baylor University
Waco, Texas, USA

Glenn Thackray

Idaho State University
Pocatello, Idaho, USA

COUNCILOR POSITION 2

(July 2019–June 2023)

Margaret Eggers

Eggers Environmental, Inc.
Oceanside, California, USA

Harvey Thorleifson

University of Minnesota
Minnesota Geological Survey
Minneapolis, Minnesota, USA

COUNCILOR POSITION 3

(July 2019–June 2023)

Julia Baldwin

University of Montana
Missoula, Montana, USA

Katharine Huntington

University of Washington
Seattle, Washington, USA

STUDENT FUNDING TO NEGSA 2019

Students nationwide who work full-time or care for dependents while earning their undergraduate or graduate degree are eligible to apply for a travel award to attend the GSA Northeastern Section Meeting, 17–19 March, in Portland, Maine, USA. Funding will cover meeting registration, lodging, transportation, food, and dependent care.

Apply at bit.ly/2AB3xi0 by 22 Feb.

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GEOSCIENCE JOBS & OPPORTUNITIES

Ads (or cancellations) must reach the GSA advertising office no later than the first of the month, one month prior to the issue in which they are to be published. (Note: Combined March/April issue releases on March schedule). Print ads will also appear on the Geoscience Job Board to coincide with the month of print issue. **Contact: advertising@geosociety.org, +1-800-472-1988 ext. 1053, or +1-303-357-1053.** Email correspondence should include complete contact information (including phone and mailing address). Rates are in U.S. dollars.

Classification	Per Line for 1st month	Per line each add'l month (same ad)
Positions Open	\$9.35	\$9.30
Fellowship Opportunities	\$9.35	\$9.30
Opportunities for Students		
First 25 lines	FREE	\$5.00
Additional lines	\$5.00	\$5.00

POSITIONS OPEN

Chair and Professor, Dept. of Geological Sciences, University of Alabama

The Dept. of Geological Sciences at the University of Alabama seeks an individual with an outstanding record of proven leadership, teaching, research, and service, to be hired at the rank of Full Professor with tenure for the 12 month position of Department Chair. The successful candidate must be internationally recognized within the field, have an active research program that includes external funding, and be able to advance the research goals and stature of the faculty. This candidate should be able to forge a dynamic vision for the department by working with the faculty, and communicate that vision to the Dean of the College of Arts and Sciences and the Provost of the University.

We seek a chair who can build upon our strong foundation to increase the quality of our B.S., M.S., and Ph.D. students' experience and advance the Department's research productivity and profile. The Department's 22 faculty conduct research that spans the geosciences and collaborates with the Alabama Water Institute, the National Water Center, the Center for Sedimentary Basin Studies, and are establishing new energy industry consortia. The applicant should possess proven leadership abilities, with a minimum of three years of significant administrative experience, and have an enthusiasm for the University's teaching and research missions. The candidate must hold a Ph.D. in Geology or a closely-related field and have expertise which complements that of existing faculty.

In addition, the successful candidate should demonstrate a proven record in the following areas:

- vigorous advocacy on behalf of faculty, staff, and students;
- excellent leadership, particularly promoting collegiality in implementing change and coordinating diverse approaches to teaching and research;
- innovative curriculum and program maintenance and development;
- excellent budget oversight and facilities management;
- experience with program assessment plan implementation and assessment data interpretation; and
- inspirational mentoring of colleagues and students.

Details regarding existing department research programs, equipment, and facilities can be found

at: www.geo.ua.edu. Questions should be directed to Dr. Kim Genareau (kdg@ua.edu), Chair of the Search Committee. Applicants should submit a cover letter, curriculum vitae, vision statement, and names and contact information for at least three references through the UA Jobs Website at: <https://faculty.jobs.ua.edu/postings/44323>. Review of applications will begin 1 March 2019 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.

Assistant or Associate Professor, Economic Geologist (Hydrothermal Geochemistry), Nevada Bureau of Mines and Geology

Description of Position: The Nevada Bureau of Mines and Geology (NBMG) at the University of Nevada, Reno, seeks applicants for a tenure-track faculty position at the Assistant or Associate Professor level with expertise in Economic Geology focused on the hydrothermal geochemistry of mineral deposits. Position responsibilities and expectations include: (1) working independently as well as collaborating with NBMG faculty-staff, faculty in other geoscience units at UNR and UNLV, and others in industry and government in developing funded projects and conducting research; (2) focusing research on mineral deposits in Nevada, though some research can be conducted outside Nevada; and (3) supervising graduate students and teaching courses related to hydrothermal geochemistry. The position will be a tenure-track faculty appointment with an academic-year base salary (9 months) that is competitive with other research universities. Starting date will be July 1, 2019, or shortly thereafter, depending on availability of the successful candidate.

Required Qualifications: Interested applicants must have a doctorate in geology or a related geoscience field by the time of hire and a demonstrated record of research on topics related to hydrothermal mineral deposits as indicated by dissertation research or peer-reviewed publications. Excellent communication skills, as demonstrated in written application materials; commitment to public service; potential for, or established record of publications; and ability to attract funding are essential. Previous research must include one or more of the following disciplines: economic geology or hydrothermal geochemistry with a focus on mineral deposits.

Preferred Qualifications: Preference will be given to candidates with: (1) academic experience in hydrothermal minerals deposits, particularly research that blends both quantitative analytical and field-based approaches; (2) demonstrated research productivity with publications in the peer-reviewed literature; and (3) achievable plans for funded research on Nevada-focused topics in economic geology, as described in the applicant's letter of interest. Additional preferred fields of expertise include: (1) geochemistry of metal solubility and transport; (2) geochemical modeling, (3) fluid inclusions, (4) stable isotopes, and/or (5) geochemical microanalyses.

Department Information: NBMG is a research and public service unit of the University of Nevada,

Reno (UNR) and serves as the state geological survey of Nevada. Managed as part of the Mackay School of Earth Sciences and Engineering in the College of Science at UNR, NBMG functions as both an academic unit and statewide agency. Its principal scientists are tenure-track faculty members. Nevada is one of the most exciting regions in the world to do research in the geosciences and the best in the U.S. for the study of hydrothermal mineral deposits. For further information about NBMG, please consult our website (<http://www.nbmgs.unr.edu>).

Contact information for this position: Dr. John Muntean, Search Chair, munteanj@unr.edu.

To express interest, please apply online at: https://nshe.wd1.myworkdayjobs.com/en-US/UNR-external/job/University-of-Nevada-Reno--Main-Campus/Assistant-or-Associate-Professor--Economic-Geologist_R0113408-1.

Please attach the following attachments to your application:

1. Resume/CV
2. Statement expressing your interest in the position and research plans
3. Name, e-mail, postal address, and telephone number of at least three professional references
4. A Word document containing links to at least three of your publications
5. Please write a brief statement (one page maximum) about how you would contribute toward our mission of creating a culturally inclusive environment in the role for which you are applying.

Posting Close Time: This posting will close at 12:00 am on the date listed below. The posting will no longer be available to apply to after 11:59 pm the day prior.

Posting Close Date: 02/22/2019

EEO/AA: Women, under-represented groups, individuals with disabilities, and veterans are encouraged to apply.

Applied Geoscientist with GIS and/or Remote Sensing Capability, Eastern Kentucky University

The Dept. of Geosciences (www.geoscience.eku.edu) of Eastern Kentucky University invites applications for a tenure-track position at the Assistant Professor level beginning August 2019. We seek a colleague with academic training that includes practical and research expertise in Earth Science, GIS, and remote sensing to complement the department's environmentally-focused geosciences programs. We offer a B.S. in Geographic Information Science and a B.S. in Environmental and Applied Geology, the latter with two concentrations: an ASBOG-based professional concentration, or an academic concentration to prepare students for graduate school. We also offer a 24-hour university certificate in GIS. Preference will be given to candidates with experience in state-of-the-art field techniques utilizing geophysics, geotechnical skills, and/or programming in Python/R with current research or future interest in developing research in Kentucky.

Candidates must exhibit a commitment to excellence in teaching at the general education and undergraduate levels, and to actively involving undergraduate students in their research.

Teaching expectations include general education courses in geology and/or physical geography, and upper-level elective courses for our Geographic Information Science and Environmental and Applied Geology programs.

Review of applications will begin on January 2, 2019 and continue until March. To be considered, applicants must apply through ECU's employment site at <https://jobs.ecu.edu/>; search for posting # F00068P.

Instructional Assistant Professor, Texas A&M University

The Dept. of Geology and Geophysics at Texas A&M University invites applications for a full-time non-tenure track Instructional Assistant Professor. This is a 9-month appointment for an initial three-year term, renewable contingent on performance and continued funding. We seek an energetic educator to lead efforts to develop cutting-edge fundamental Earth science courses and expand our catalog of online courses. The successful candidate will teach two courses per semester using effective pedagogical techniques in a combination of classroom and online settings, coordinate lab scheduling for undergraduate courses, and develop new online course materials. Teaching opportunities also include field, high impact learning, and study abroad courses.

The successful candidate may augment the 9-month appointment with research funding or by teaching undergraduate research and field courses and/or other courses in their area of expertise. In addition to teaching, the successful candidate is expected to make contributions to either research or departmental service and will have opportunities to explore cutting-edge teaching technologies or practice. This appointment includes the ability to seek extramural funding, conduct collaborative research with other members of the faculty, use department facilities, and publish research results. At the time of employment, candidates must have a Ph.D. in geology, geophysics, geological education or a related discipline in addition to higher education teaching experience with a minimum of 4 semesters as a Teaching Assistant or 2 semesters as instructor of record.

The College of Geosciences at Texas A&M University is a unique institution committed to fundamental Earth systems research across four Departments: Atmospheric Sciences, Geography, Oceanography, and Geology and Geophysics. The College hosts the Texas Sea Grant, the Geochemical and Environmental Research Group (GERG), and the International Ocean Discovery Program (IODP). The college has established a teaching/research facility in Costa Rica and a teaching facility near San Miguel de Allende, Mexico. This appointment includes the opportunity to work across departments and programs in the College and lead international coursework to maximize educational opportunities for our undergraduates.

The Texas A&M System is an Equal Opportunity/Affirmative Action/Veterans/ Disability Employer committed to diversity. The University is dedicated to the goal of building a culturally diverse and pluralistic faculty and staff committed

to teaching and working in a multicultural environment. We strongly encourage applications from women, underrepresented ethnic groups, veterans, and individuals with disabilities. Texas A&M University also has a policy of being responsive to the needs of dual-career partners (<http://dof.tamu.edu/Faculty-Resources/dual-career-partner-placement>). The College of Geosciences is committed to creating a diverse and inclusive climate for faculty, graduate students and undergraduate students. We actively work to recruit and retain a diverse cohort of undergraduate students. We seek a colleague with a track record that will complement our education mission to train a diverse pool of students for future success in applied, academic, and government positions as geoscientists.

Interested candidates should submit electronic applications to: <https://apply.interfolio.com/57482> and must include the following: curriculum vita, statement of teaching philosophy, statement of research interests, and the names and addresses of at least three references. Screening of applications will begin November 15, 2018, and will continue until the position is filled.

Questions regarding the position may be directed to the Chair of the Instructional Assistant Professor Search Committee by emailing: InstructionalAsstProfessorsearch@tamu.edu.

Associate Director for Research, Kansas Geological Survey (KGS), University of Kansas, Lawrence

Full-time position to provide strategic collaborative research leadership that supports the KGS mission. The Associate Director for Research (ADR) will report to the Director and interact with Senior-rank academic staff; oversee approximately 14 Kansas Geological Survey (KGS) Assistant and Associate-rank academic and scientific research staff, and their research programs; align the unique strengths of current KGS research programs with research trends and new innovative research opportunities. The ADR also will be expected to lead an externally funded, active research program in an area relevant to Kansas. The KGS is a research and service division of the University of Kansas, and the successful candidate will have the opportunity to collaborate with KU faculty and students in other departments and research groups. Complete announcement/application info at www.kgs.ku.edu/General/jobs.html. Review of applications will begin Jan. 15, 2019.

Apply online at <http://employment.ku.edu/academic/13077BR>. For further information about the position contact Rolfe Mandel, mandel@ku.edu, 785-864-2171. For further information about other aspects of the position, contact Annette Delaney, HR, at adelaney@ku.edu or 785-864-2152. KU is an EO/AAE, <http://policy.ku.edu/IOA/nondiscrimination>.

Hydrogeochemist, Geohydrology Section, Kansas Geological Survey, University of Kansas, Lawrence

Full-time position to lead KGS hydrogeochemical investigations. Faculty-equivalent, sabbatical-eligible position at the rank of Assistant or entry-

level Associate Scientist. Requires Ph.D. with an emphasis on aqueous geochemistry related to water resources and scientific leadership potential. Emphasis on state-of-the-science field studies and complementary theoretical research. Complete announcement/application info at www.kgs.ku.edu/General/jobs.html. Review of applications will begin March 4, 2019; <http://www.kgs.ku.edu/General/jobs/100008370.html>.

Apply online at <http://employment.ku.edu/academic/13299BR>. For further information contact Geoff Bohling (geoff@kgs.ku.edu) or Don Whittemore (donwhitt@kgs.ku.edu). For further information about other aspects of the position, contact Annette Delaney, HR, at adelaney@kgs.ku.edu or +1-785-864-2152. KU is an EO/AAE, <http://policy.ku.edu/IOA/nondiscrimination>.

Lecturer in Geology, Specializing in Environmental Geospatial Sciences, Dept. of Geology, University of Dayton

The Dept. of Geology invites applications for a nine month, annually renewable, non-tenure-track lecturer position. This is a full time and benefit-eligible position. The successful candidate will be expected to teach four courses per semester. These courses include introductory lectures and labs in geography, geology, Geographic Information Systems (GIS), and environmental geology. Candidates will also mentor undergraduate students in GIS-related capstone projects. The position begins August 16, 2019.

Required qualifications: A Ph.D. in geography, geology, environmental geoscience, or a closely related field is required at the time of application, with an emphasis in geo-spatial information technology. Applicants must be able to teach introductory and advanced GIS courses using the ESRI ArcGIS software. They must also possess effective written communication skills.

For a complete list of qualifications and to apply, go to <http://jobs.udayton.edu/postings/27666>. A complete application consists of a cover letter of interest addressing the required and preferred qualifications, a complete CV, a statement of teaching philosophy, a sample syllabus for an introductory course in GIS; a copy of graduate transcripts, and three letters of recommendation, at least one of which should discuss the applicant's potential as a teacher. Optional materials include evidence of teaching effectiveness (i.e. summary of teaching evaluations).

Application deadline: February 15, 2019.

The Dept. of Geology offers BS degrees in Geology and Environmental Geology and a graduate certificate in Geographic Information Systems (GIS). It is also actively involved in the University's Sustainability Studies Program. For more information on the department, please visit <http://www.udayton.edu/artsscience/geology/index.php>.

The University of Dayton, founded in 1850 by the Society of Mary, is a top ten Catholic research university. The University seeks outstanding, diverse faculty and staff who value its mission and share its commitment to academic excellence in teaching, research and artistic creativity, the development of the whole person, and leadership and service in the local and global community.

GEOSCIENCE JOBS & OPPORTUNITIES

To attain its Catholic and Marianist mission, the University is committed to the principles of diversity, inclusion and affirmative action and to equal opportunity policies and practices. As an Affirmative Action and Equal Opportunity Employer, we will not discriminate against minorities, females, protected veterans, individuals with disabilities, or on the basis of sexual orientation or gender identity.

Assistant Professor, Field-Oriented Sedimentology, Structural Geology, or Volcanology, Nevada Bureau of Mines and Geology (NBMG), University of Nevada, Reno

The Nevada Bureau of Mines and Geology (NBMG) at the University of Nevada, Reno, seeks applicants for a tenure-track academic faculty position in field-oriented research in structural geology, volcanology, or sedimentology. NBMG is a public service unit of UNR and serves as both the state geologic survey of Nevada and as a research department in the UNR College of Science. Faculty at NBMG have tenure-track academic appointments, with both research and teaching obligations.

Position Responsibilities: The primary responsibilities of this position will be to develop broad programs in research and education in Sedimentology, Structural Geology, or Volcanology. Research will focus on the geologic framework and tectonic evolution of Nevada, utilizing innovative approaches to detailed geologic mapping, sedimentologic analysis, structural analysis, geochronology (e.g. U/Pb, detrital zircons, or $^{40}\text{Ar}/^{39}\text{Ar}$), and/or paleomagnetism. Position responsibilities and expectations include: (1) utilizing detailed geologic mapping to conduct basic and applied research; (2) working independently as well as collaboratively with NBMG faculty-staff, faculty in other geoscience units in the Nevada system of higher education, and others in industry and government in developing funded research projects; (3) contributing to the understanding of natural resources and geologic hazards in the region; (4) supervising graduate students and teaching courses in the successful candidate's area of expertise.

Qualifications: Applicants must have a doctorate in geology or a related geoscience field by the time of hire and a demonstrated record of research on topics related to sedimentology, structural geology, tectonics, and/or volcanology as indicated by dissertation research, industry experience, or peer-reviewed publications. The successful candidate must also have experience in field-oriented research and a desire to conduct detailed geologic mapping on future projects in Nevada. Excellent communication skills, as demonstrated in written application materials; commitment to public service; potential for, or established record of publications; and ability to attract funding are essential. Doctoral research must include one or more of the following disciplines: structural geology, sedimentology, or volcanology. We encourage candidates to explain achievable plans for funded research on Nevada-focused topics in their area of expertise in the letters of interest.

Salary and Date of Appointment: The position will be a tenure-track faculty appointment at the assistant professor level with an academic-year base salary that is competitive with other research universities. Starting date will be July 1, 2019 or shortly thereafter, depending on availability of the successful candidate.

For more detailed information about the position and to apply, please visit <https://is.gd/pgqdbK>. Application deadline is **March 1, 2019**. For further information about NBMG, please consult our website <http://www.nbmng.unr.edu>.

The University of Nevada, Reno, is committed to Equal Employment Opportunity/Affirmative Action in recruitment of its students and employees and does not discriminate on the basis of race, color, religion, sex, age, creed, national origin, veteran status, physical or mental disability, and sexual orientation. The University of Nevada employs only United States citizens and aliens lawfully authorized to work in the United States.

EEO/AA Women and under-represented groups, individuals with disabilities, and veterans are encouraged to apply.

Tenure-Track Assistant Professor, Igneous Petrology/Mineralogy, University of Georgia

The Dept. of Geology at the University of Georgia seeks to fill a position for a tenure-track assistant professor in the field of igneous petrology/mineralogy. We encourage applications with strong backgrounds in chemistry and physics who may employ unconventional and interdisciplinary approaches to address big-picture questions including aspects of planetary evolution involving core, mantle, and/or crustal processes. A Ph.D. in Geology, Earth or Planetary Science or other related discipline is required by August 1, 2019. The hire must be comfortable teaching undergraduate core curriculum classes in petrology, a graduate course in their specialty, and introductory geology courses. The hire will be expected to establish an externally funded research program, attract outstanding graduate students, and give oversight to an electron microprobe facility with long standing technical support staff. Applicants should submit a cover letter, curriculum vitae, statements of research and teaching interests, and contact information for 3 references. Application should be made to <http://www.ugajobsearch.com/postings/58518>. To ensure full consideration all materials should be submitted by 5 PM EST February 15, 2019. The University of Georgia is an Equal Opportunity/Affirmative Action employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, ethnicity, age, genetic information, disability, gender identity, sexual orientation or protected veteran status. Persons needing accommodations or assistance with the accessibility of materials related to this search are encouraged to contact Central HR (hrweb@uga.edu). Please do not contact the department or search committee with such requests.

FELLOWSHIP OPPORTUNITIES

Roger E. Deane Postdoctoral Fellow, Dept. of Earth Sciences, University of Toronto. The Dept. of Earth Sciences (<http://www.es.utoronto.ca/>) at the University of Toronto invites applications for the Roger E. Deane Postdoctoral Fellowship, a highly competitive fellowship in any field of Earth Science. The department is interested in supporting innovative research and outstanding young geoscientists to work in collaboration with one or more faculty members. Applicants are expected to contact potential hosts in advance to discuss areas of common interest and to develop proposal ideas.

Salary: The Deane Postdoctoral Fellowship has an annual salary of CAD\$55,000 and is awarded for a one-year period, with an anticipated extension for a second year.

Application Instructions: A complete application includes: a curriculum vitae, three references sent by referees directly to geol_sec@es.utoronto.ca (subject line: Deane Postdoctoral Fellowship), an innovative research proposal written by the applicant (2 pages maximum excluding references), and a cover letter with the potential host's name clearly stated (1 page max).

The selection committee will evaluate research proposals for original thinking and to determine a candidate's ability to develop a research project that can be accomplished in the department.

Deadline: Applications are due March 8, 2019. Decisions will be made mid-May 2019.

Expected Start Date: September 1, 2019.

Term: 1 year minimum, 2 year maximum.

FTE: 100%.

Submit electronic PDF applications to: Ampy Tolentino, geol_sec@es.utoronto.ca (subject line: Deane Postdoctoral Fellowship).

Employment as a Postdoctoral Fellow at the University of Toronto is covered by the terms of the CUPE 3902 Unit 5 Collective Agreement.

This job is posted in accordance with the CUPE 3902 Unit 5 Collective Agreement.

The University of Toronto is strongly committed to diversity within its community and especially welcomes applications from racialized persons / persons of colour, women, Indigenous /Aboriginal People of North America, persons with disabilities, LGBTQ persons, and others who may contribute to the further diversification of ideas.

OPPORTUNITIES FOR STUDENTS

Lindahl Ph.D. Scholarships, The University of Alabama. The Dept. of Geological Sciences seeks Ph.D. students with specializations that complement faculty research interests. Exceptional students will receive Research or Teaching Assistantships and a Lindahl Scholarship totaling \$22,000 for a nine month appointment, and the cost of non-resident tuition is covered. Funding is renewable for 4 years if expectations are met. Other fellowships are available from the Graduate School. Further details are at <http://www.geo.ua.edu/>. Applicants should contact Dr. Geoff Tick (gtick@ua.edu) to express interest. Review of applications for Fall 2019 admission will begin January 15, 2019.



GSA's Policy Office—Working for the Geosciences in Washington, D.C.

Geoscience offers more than an explanation of how our world was shaped—through it, scientists can, in turn, shape our world. Since its founding, the Geological Society of America has committed itself to facilitating the open exchange of scientific research and expertise within the geoscience community. Concurrently, the Society seeks to communicate our science to the public at large and, most importantly, to policymakers in Washington, D.C. To better enable this aim, GSA's Policy Office was established in our nation's capital to serve the needs of our community and advance the application of the geosciences.

GSA's Washington office has a threefold mission—to bring geoscience and geoscientists into the policy process, to advocate for the use of scientific information in decision making in the public-policy arena, and to work on behalf of GSA membership concerns in D.C. As Kasey White, GSA's Director for Geoscience Policy, notes, "Many of the issues at the forefront of policy discussions have a geoscience component—natural hazard mitigation, climate change, mineral, energy, and water resource management, to name a few. GSA's policy office brings forward the geoscience research underpinning these important issues to increase science in decision making."

The office fulfills this mission in a variety of ways, primarily by engaging the GSA community to increase member involvement in public-policy development activities and providing them with the tools and information necessary to advocate for science. It achieves this through events such as Geosciences Congressional Visits Day, where participants receive practical

training in legislative procedure and relationship-building before meeting with congressional members and committee staffers. Additionally, GSA established the Science Policy Fellowship as an opportunity for recent M.S. and Ph.D. graduates to experience science policy and increase communication between the office and GSA members. This exists in tandem with GSA's longstanding GSA-USGS Congressional Science Fellowship program, which places a GSA member on Capitol Hill for one year to work as staff for a member of Congress.

These efforts—in addition to providing testimony, drafting letters, and cosponsoring congressional briefings—aid GSA's Washington office in advocating for GSA's priorities to policymakers, especially on policy issues that directly affect members. White describes one of the foremost among these to be increasing federal research and development funding. At a time when geoscience has enormous potential to shape society, geoscience research has been specifically targeted for funding cuts in multiple pieces of legislation—making GSA's efforts more critical than ever.

We need your help in maintaining a strong presence in Washington, D.C., through GSA's Policy Office. Your generous support will help us to continue advocating for the inclusion of science in policy decisions and, most importantly, continue the fight to increase funding for geoscientific research. To learn more about how you can make a significant gift to this cause, please contact Cliff Cullen at +1-303-357-1007 or ccullen@geosociety.org. You can make an immediate gift to GSA's Policy Office at gsa-foundation.org/fund/policy-office.



From left: GSA Section-sponsored students Sylvia Nicovich, Vanessa Swenton, and Kendall FitzGerald meet with Rep. Suzanne Bonamici (D-OR) during the 2018 Geoscience Congressional Visits Day. GSA's Director for Geoscience Policy Kasey White presents the 2018 USGS Coalition Leadership Award to Rep. Vicente Gonzalez (D-TX).

eRock: An Open-Access Repository of Virtual Outcrops for Geoscience Education

Adam J. Cawood¹, Clare E. Bond, Dept. of Geology & Petroleum Geology, University of Aberdeen, AB24 3UE, UK

Visualizing objects and structures in 3D is a task that most people, including geologists, find difficult. Geoscience educators and students often find field-based exercises the most effective medium for understanding complex geological concepts and visualizing relationships in 3D (e.g., Elkins and Elkins, 2007). Unfortunately, field-based training is not available to everyone. Traditional barriers to this field-based training include physical disabilities, lack of financial resources, and geographical restrictions. Recent advances in data acquisition and processing have the potential to circumvent these traditional barriers to access and open up a vast number of field sites to a diverse range of people.

3D RECONSTRUCTIONS FOR RESEARCH AND COMMUNICATION

Advances in computer technology and increased availability of affordable acquisition tools mean that 3D reconstructions of outcrop and landscapes are increasingly used by the geoscience community as a research tool. Virtual outcrops derived from LiDAR and digital photogrammetry can provide a wealth of detailed geological information (e.g., Cawood et al., 2017) and as such, these 3D realizations are gaining traction as an accessible means of communicating geoscience within industry and academia. In spite of these developments, little has been done to leverage this technology as a tool for education in the geosciences. We attribute this to (1) the requirement, until recently, for specialist software packages to render 3D digital objects, and (2) the widespread use of inaccessible, proprietary data banks to store virtual outcrops used in applied research.

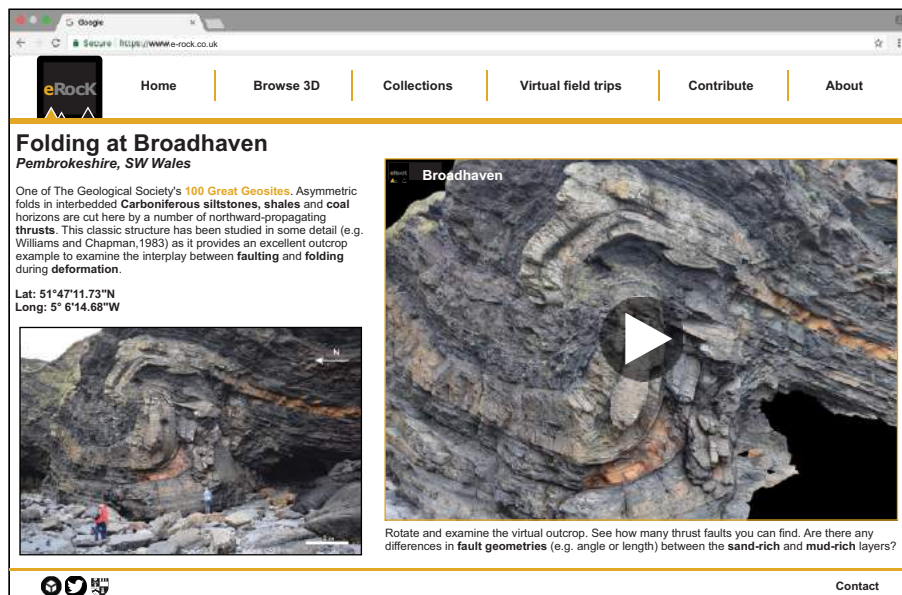


Figure 1. Example of a virtual outcrop page at eRock (www.e-rock.co.uk/broadhaven).

PUBLIC-DOMAIN DIGITAL ARCHIVES: FROM 2D TO 3D

The past two decades have seen a surge in the number of open-access digital archives available online, such as curated collections of public-domain art (e.g., www.metmuseum.org). Sculptures and objects in these digital collections are typically shown in pseudo-3D by capturing them through a series of images from different viewpoints. Recent advances in 3D rendering, however, mean that these objects can now be digitally reconstructed and made available online in true 3D format through online viewers. Sketchfab (www.sketchfab.com), a resource originally made for the gaming and computer animation community, is the best known of these viewers.

Sketchfab is being used by a growing number of educators, scientists, and archivists: examples include 3D anatomical

models for e-learning in medical sciences, digitally reconstructed archaeological sites, and digital versions of culturally important objects (e.g., The Rosetta Stone; www.sketchfab.com/britishmuseum). This variety of content suggests that 3D rendering has great potential as a tool in a wide variety of applications, from digitally preserving cultural heritage to helping students understand the 3D structure of objects. Currently, however, this resource has not yet been systematically developed in the geoscience community—there remains a lack of efficiently collated, open-access 3D material online.

eROCK: AN OPEN-ACCESS REPOSITORY OF VIRTUAL OUTCROPS

eRock (www.e-rock.co.uk) is an online resource that presents virtual outcrops through an accessible, geoscience-focused

GSA Today, v. 29, <https://doi.org/10.1130/GSATG373GW.1>. Copyright 2018, The Geological Society of America. CC-BY-NC.

¹Email: adam.cawood@abdn.ac.uk

platform (Fig. 1). By embedding Sketchfab-hosted models directly into eRock, curated collections can be presented in a focused, easy-to-follow format: Users can view virtual outcrops without the need for searching through large amounts of irrelevant material, with little associated data or context. 3D models can currently be browsed in eRock by location (through a map interface), by theme (e.g., metamorphic or sedimentary), or by virtual field trip (e.g., the geology of the NW Highlands, Scotland). Concise outcrop descriptions are provided with key information, links to references, metadata, and other relevant resources for each 3D model (Fig. 1). All eRock models are open access, free to download, and 3D viewable through a standard web browser, with no need for specialist software packages.

Current demographic data for the site show that the largest user group is the 35–44 age group, followed by 25–34-year-olds. The 18–24 age group currently only accounts for 11% of visitors (Fig. 2A) but spends the longest average time at the site per visit (Fig. 2B), suggesting that they visit multiple pages and virtual outcrops per session. Unfortunately, both women and those from low- and middle-income countries are underrepresented as a proportion of total visitors to the site (Fig. 2). As the aim of the project is to build eRock into a collaborative educational tool for users across the spectrum of educational background and needs, our future efforts need to be directed at widening the range and diversity of people who visit the site.

VIRTUAL OUTCROPS FOR EDUCATION

Field-based exercises have been shown to enhance geological understanding. We suggest that digital realizations of outcrops may improve visualization and understanding in much the same way, *but only if virtual outcrops are provided in context*. Unstructured collections of data devoid of geological description or linked reference material are unlikely to provide much benefit. 3D visualizations must be provided with appropriate material to contextualize the object—in this way, students can understand the scale of the object they are looking at, its geological significance, and how it relates to the surrounding landscape

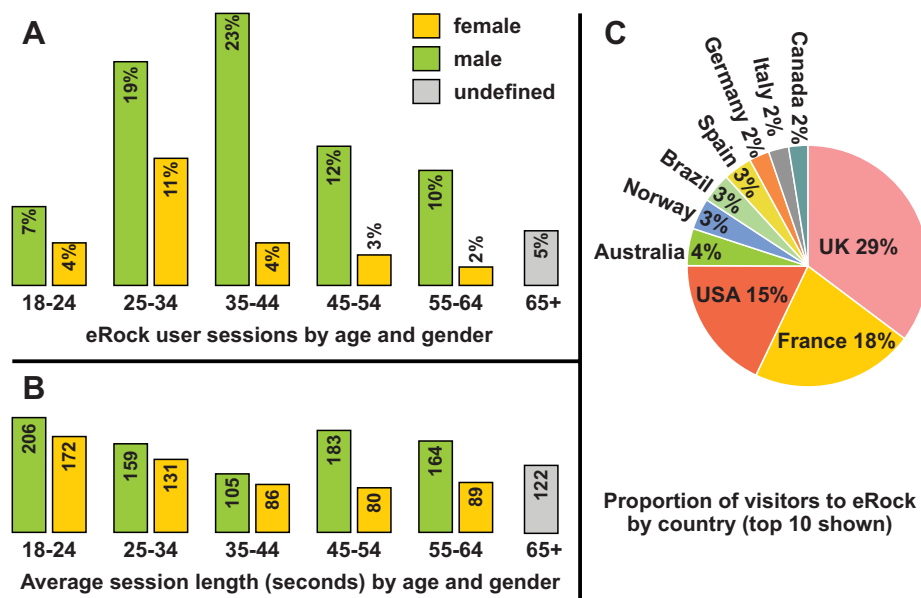


Figure 2. User demographic data for www.e-rock.co.uk.

and subsurface. The strength of eRock lies in its integrated approach: Many models are provided as part of a suite of educational materials, including geological maps, cross sections, field photographs, and text.

At the time of this writing, preliminary studies by the authors suggest that undergraduate students find a combination of traditional fieldwork and digital visualization useful: Students report an improvement in both their perception of 3D landscapes and their visualization of complex geological structures compared to field-based studies alone. Further, students appear to be strongly in favor of the use of virtual outcrops as part of the undergraduate geoscience curriculum.

LOOKING FORWARD: FUTURE OBJECTIVES

1. eRock is in the early stages of development, with roughly 40 virtual outcrops available online. We encourage others to help the project grow by providing 3D models, images, site descriptions, and metadata. Structured, contextualized content is critical to ensure eRock is a useful tool—we need help from the wider community to achieve this.
2. It is important to represent a wide variety of outcrops, both in terms of location

and geological theme. We want a diverse range of people to use this resource—a repository that showcases outcrops from around the world is more likely to attract visitors from a variety of countries and backgrounds.

3. We are currently running a series of trials that assess the relative merits of virtual outcrops versus traditional teaching materials and field-based exercises. If this approach genuinely improves students' geological understanding, the next stage will be to incorporate the technology into structured curricula. The success of this project depends on collaboration. Get in touch, and give us your input to help the project grow.

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MANUSCRIPT RECEIVED 3 APR. 2018

REVISED MANUSCRIPT RECEIVED 31 OCT. 2018

MANUSCRIPT ACCEPTED 10 NOV. 2018

2020 GSA Calendar PHOTO SEARCH

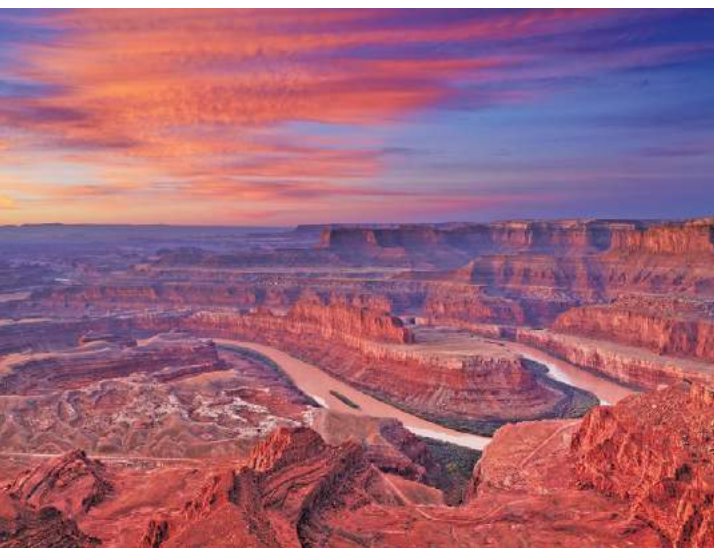
Each year, we enjoy seeing how you connect with the natural world through your camera lens. If you have a remarkable or noteworthy geologic image that's sure to wow us, enter the 2020 GSA calendar photo search. Send up to three of your best images in landscape orientation, using the following categories as a guide:

Iconic Landscapes—Striking or notable geologic landscapes and features.

Abstract Images—The patterns of geology at any scale, photomicrographs to satellite images.

Geologic Processes Past and Present—Process or feature resulting from a specific process.

For example: An erupting volcano or volcanic rocks that represent ancient eruptions.



How to Enter

Email the following to editing@geosociety.org with a subject line of "calendar submission":

- Your name, email, and mailing address.
- A caption describing the image(s), plus a photo credit, including a one-sentence bio. Feel free to include information on how you captured the image.

- Up to three images in landscape orientation, in jpeg format, and no larger than 1 MB each (if your image is chosen, we'll ask for a high-resolution file).
- Name your file using your initial and last name (e.g., FBascom_image1.jpg).

Deadline: 25 March



Go to www.geosociety.org/GSA/Publications/GSA/Pubs/Photos.aspx for more information.

2019 GSA Section Meetings



Northeastern

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



Joint South-Central/North-Central/ Rocky Mountain

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



Southeastern

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



Cordilleran

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

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

Field Volcanology:

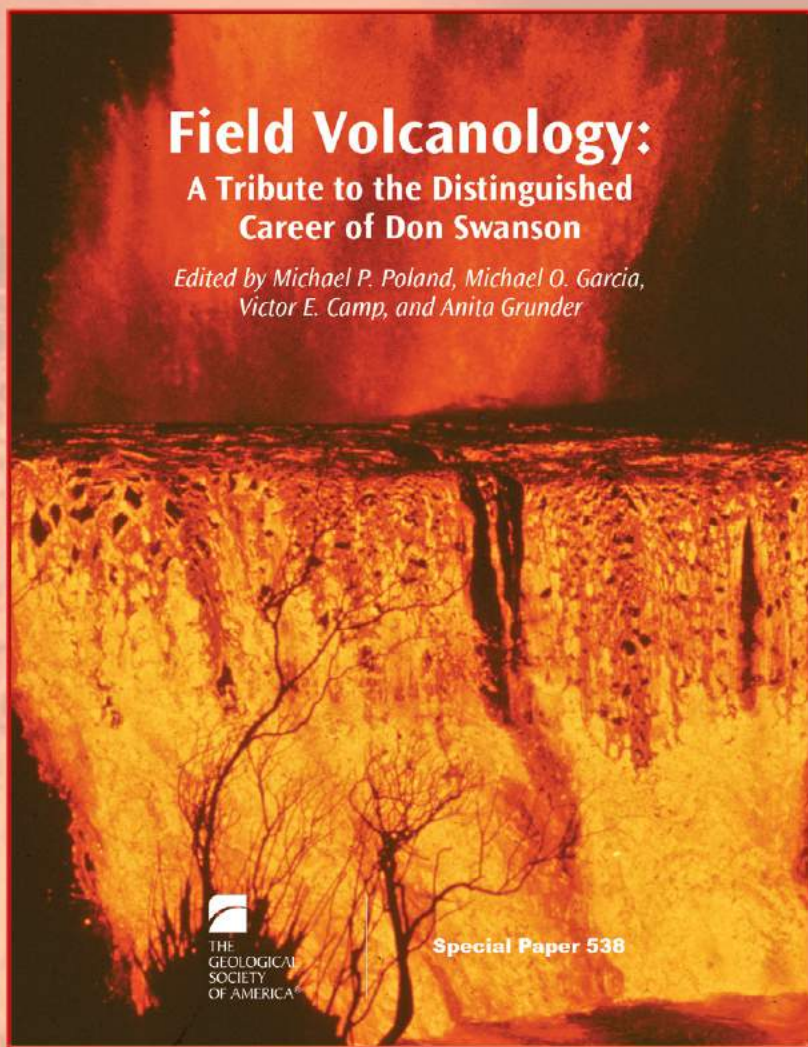
A Tribute to the Distinguished Career of Don Swanson

**Member Price
\$42.00**

*Edited by Michael P. Poland, Michael O. Garcia,
Victor E. Camp, and Anita Grunder*

Don Swanson, who received the GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division's Distinguished Geologic Career award in 2016, has adopted a detailed, field-oriented approach to studying problems of great volcanologic importance across a range of compositions and spatio-temporal scales. Swanson's work has resulted in a series of fundamental contributions that have advanced understanding of the Columbia River flood basalts, Cascade volcanic arc, and Hawai'i, and his insights have been applied not only around the world, but across the solar system. This volume emphasizes the role of field volcanology as a window into better understanding volcanic processes past and present, and highlights, in particular, those places and processes where Swanson's insights have been particularly impactful.

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