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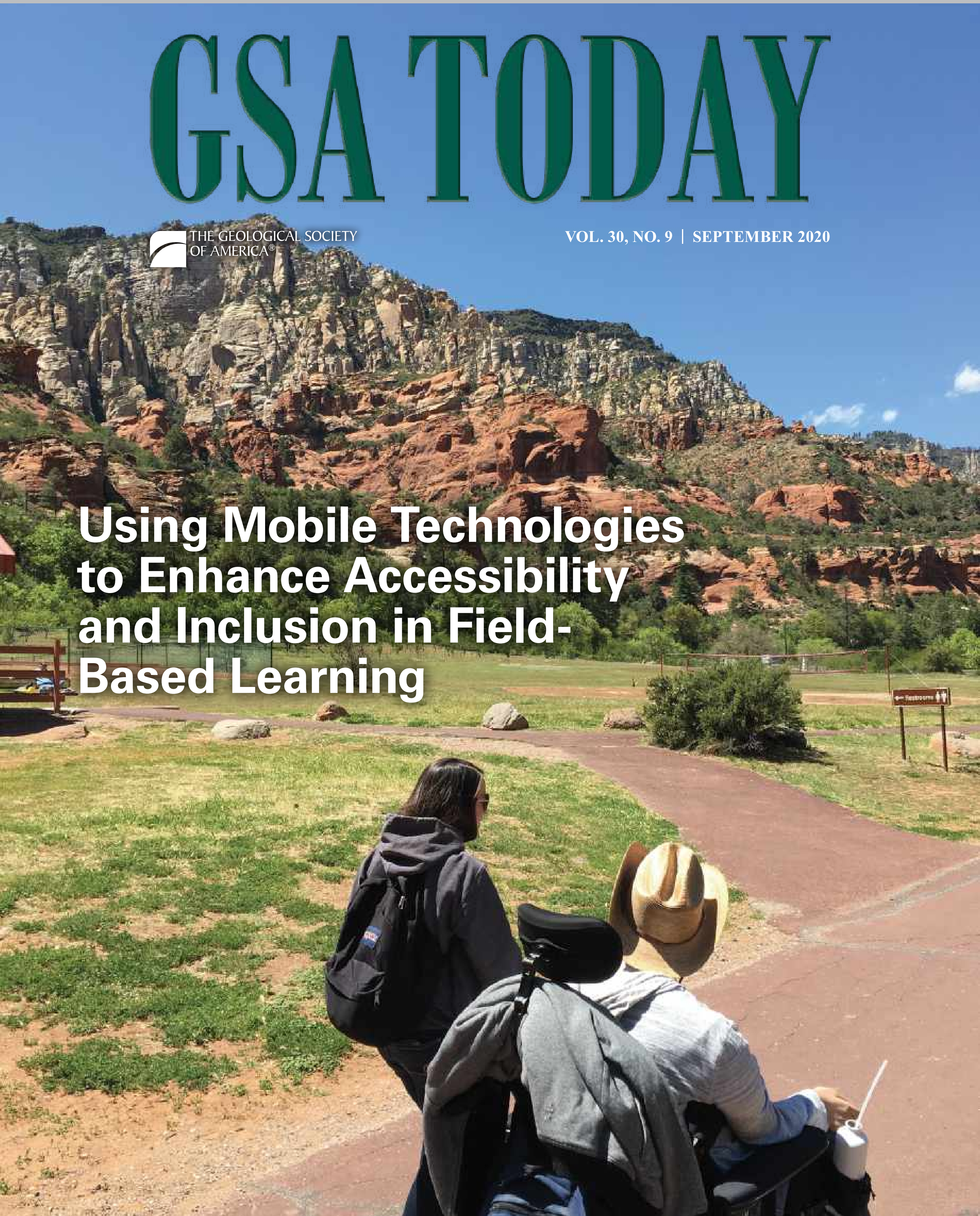
Using Mobile Technologies to Enhance Accessibility and Inclusion in Field-Based Learning



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SCIENCE

Cover: Students examining stratigraphy of the Colorado Plateau at Slide Rock State Park, Arizona, USA. For the related article, see pages 4–10.

GSA 2020 Connects Online

Using Mobile Technologies to Enhance Accessibility and Inclusion in Field-Based Learning

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ABSTRACT

The relevance of field education in the geosciences has been subject to increasing scrutiny, in part due to the exclusionary nature of traditional field practices that require independent work and physical agility. As an alternative, this article presents strategies for increasing accessibility and inclusion in collaborative field-based education through the use of mobile technologies. We present a series of examples to show how the use of mobile technologies in the field can enable collaborative observation, data collection, data sharing, and interpretation. The strategies developed in these examples provide equitable access to instruction, peer engagement, and participation in every field exercise. We suggest that technological approaches to accessibility and inclusion in the field can facilitate opportunities for all students to gain field experiences that are an important component of geoscience education.

INTRODUCTION

Field investigations are often a component of geoscience research, and consequently field-based education has been included in geoscience curricula. However, the relevance of field education has been subjected to increasing scrutiny (Drummond, 2001; Dohms, 2011), partly due to an increased focus on lab-based research. Another concern has been the "exclusivity" of traditional fieldwork, where independence (Healey et al., 2001; Maskall and Stokes, 2009) and physical conditioning (Kirchner, 1994; Maguire, 1998; Feig, 2010) were lauded (Hall et al., 2002; Atchison et al., 2019a; Stokes et al., 2019). The attributes cater to outdoor enthusiasts that may be considering a geoscience career, but it has become clear that many others are disenfranchised by these restrictions.

Field mapping and data collection are often viewed as individual experiences, where a geologist collects data in the field without much, if any, contemporaneous input from other field workers. However, field-based investigations by a group of participants have been demonstrated to build strong ties and increase morale within student peer groups through collaborative strategies that enhance learning in the field (Mogk and Goodwin, 2012; Kelley et al., 2015). In addition, collaborative fieldwork can yield high-density geologic maps, which can facilitate improved geologic interpretations (Whitmeyer et al., 2019). Thus, collaborative fieldwork can be an important approach to effective field data collection and field-based learning experiences.

Mobile devices provide new methods of communication and interaction in field settings and are now commonly used for field data collection and even data analyses (Pavlis et al., 2010; Collins, 2015; France et al., 2015; Allmendinger et al., 2017; Walker et al., 2019). In addition, mobile technologies can enhance real-time communication in the field, facilitating a level of interaction and collaboration that was previously unattainable. Real-time communication can increase participation for people with physical disabilities by enabling collaboration with peers and engagement with field locations that are remote and inaccessible (Coughlan et al., 2011; Stokes et al., 2012; Collins et al., 2016).

In this paper we outline a strategy for increasing accessibility and inclusion in field-based education and research using mobile technologies. The context of this work is presented, followed by short descriptions of field trips and a summary of the contrasting uses of technology across these trips. Opportunities and challenges with integrating technology and teaching strategies intended to improve access and inclusion are discussed, concluding with recommendations for practitioners.

APPROACH

Our approach to enhancing accessibility and inclusivity in the field focused on pairing students with physical (mobility) disabilities with students who were fully ambulatory on a variety of projects that replicated field exercises in an undergraduate geoscience curriculum. The student cohort consisted of six students who self-disclosed various mobility disabilities and six students who did not disclose any mobility disabilities. In the first year of the project, field exercises were located at several sites in Arizona, while the second year focused on sites in western Ireland. Project outcomes subsequently were disseminated on three accessible field trips at Mount St. Helens National Volcanic Monument (2017), Mammoth Cave National Park (2018), and Petrified Forest National Park (PEFO; Atchison et al., 2019b). Field trip participants (n ≈ 80) included several project participants, along with undergraduate and graduate geology students with disabilities, and geoscience instructors, some of whom had disabilities.

Mobile communication and data collection devices (see Supplemental Table SD1[1]) facilitated interaction among project students

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[1]Supplemental Material: Table SD1 and Figures SD1, SD2, and SD3. Please visit https://doi.org/10.1130/GSAT.S.12501404 to access the supplemental material, and contact editing@geosociety.org with any questions.

(during the project exercises) and field trip participants (during the dissemination field trips) across sites that were easy to access (roads, well-groomed paths, etc.) and locations with more challenging terrains. Field environments ranged from arid, dry conditions (Arizona, PEFO) to colder and wetter conditions (Ireland, Mount St. Helens).

EXAMPLE FIELD TRIPS

Arizona Field Sites, Year 1

We visited field locations in central Arizona in May 2015, including Slide Rock State Park in Oak Creek Canyon, The Trail of Time on the south rim of the Grand Canyon, and SP Crater north of Flagstaff. These trips paired undergraduate-level geoscience students with and without physical (mobility) disabilities on shorter duration (single day) field exercises. A variety of communications and technology devices enhanced collaborative inclusion and access to the field sites. Summaries of each exercise follow, including objectives, technology used, and an overview of site accessibility.

1. Slide Rock State Park

The geologic features of interest at Slide Rock State Park (see Supplemental Fig. SD1 [see footnote 1]) consist of 50–100 m cliffs of horizontal, layer-cake stratigraphy of the Colorado Plateau transition zone. This introductory exercise introduced student teams to using iPads to record observations and annotate photos of the layered stratigraphy. Goals included team-building, effective recording of observations, and interpretations of unfamiliar geology. The exercise concluded with a full group discussion of the geology, followed by discussions on the accessibility of the site and collaborations between student team members.

Technology used: iPad cameras and Evernote app.

Accessibility: Equitable access to the site; paved and packed dirt paths available for all to explore the park, but cliff outcrops were only viewable from a distance (~500 m).

2. The Grand Canyon

This exercise focused on the Trail of Time (ToT), a 1.6 km paved trail along the south rim of the Grand Canyon, with tactile exhibits that document two billion years of regional geologic history (Karlstrom et al., 2008). Students worked in teams across ability levels to visit sites along the ToT that displayed rock samples obtained from deep within the canyon, which illustrate the classic stratigraphy of the Grand Canyon. Student teams used the StratLogger app to record lithologic descriptions and construct a stratigraphic column of the Grand Canyon units.

Technology used: iPad cameras and StratLogger app.

Accessibility: Equitable access to the ToT, although the distance traveled along the ToT proved challenging for some students with disabilities. Students traveled chronologically along the ToT, starting at the Grand Canyon Village Visitor Center and heading toward the Yavapai Point Visitor Center. Traveling in this direction included a slight incline in elevation, and, depending on the number of visitors, few available benches for seating. With the exception of the powered wheelchair users, students with mobility disabilities were negatively impacted by the length and incline of the trail. Hot and dry conditions were an issue for all participants.

3. SP Crater

SP Crater is an ~1000 m cinder cone located north of Flagstaff (Fig. 1; Ulrich, 1987). Student teams were separated during this activity: those with disabilities stayed with the vehicles at the base of the mountain, while those without disabilities hiked to the summit from two approaches. One trail wrapped around the mountain and ascended the back side, and the other took a direct path up the front of the mountain. Students used two-way radios to communicate during the hike. However, students who hiked around the back of the mountain lost line-of-sight and radio contact with their partners at the vehicles, while those who took the front path to the top maintained line-of-sight and communications with the group at the base. Once at the top of the mountain, all students were able to communicate with their partners at the base using two-way radios as well as the Livestream app for real-time video broadcasts of the summit views.

Technology used: Two-way radios, GoPro video cameras, iPad cameras, and Livestream app.

Accessibility: A physically inaccessible field site where several students remained with the vehicles at the base of the mountain, while others climbed the mountain via the steep, loose-cinder front, or a longer path around the back; communication was hindered by loss of line-of-sight and a significant (1–2 min) delay in the Livestream video relay from the summit.

Western Ireland Field Sites, Year 2

Year 2 focused on field sites in western Ireland, where challenges to field access and participation were very different from Arizona. Field sites in western Ireland were typically windy, cold, and often rainy. The field exercises during the second year featured the same cohort of students and expanded on the experiences of the previous year. Exercises were longer, more involved, and often incorporated different technological solutions.

1. Kilkee, County Clare

This half-day exercise focused on describing and interpreting sedimentary structures

Figure 1. The SP Crater cinder cone that was only accessible to half of the cohort (left), the group that remained at the base used two-way radios (middle) and a Livestream video broadcast (right) to communicate with students at the top of the cinder cone.

Figure 2. Students at the exposed seaside cliffs near Kilkee (left) using the camera and Skitch application on the iPads (middle) to record and annotate the sedimentary structures and deformation features (right) to share with their peers who did not access this location.

and deformation features in rocks exposed along seaside cliffs near the town of Kilkee (Fig. 2). Most of the features, such as ripple marks, cross-beds, and soft-sediment deformation structures (Martinsen et al., 2008) were viewable by all participants from a paved path along the top of the cliffs. Some smaller-scale features, such as sand volcanoes and fault surfaces, required descending steps to an eroded cliff platform and thus were not accessible to everyone. Students used iPad cameras and the Evernote and Skitch apps to record, sketch, and describe features; remote communications were facilitated with two-way radios. A full group discussion of the exercise occurred indoors later in the evening.

Technology used: iPad cameras, Evernote and Skitch apps.

Accessibility: Paved paths did not extend onto cliff exposures, which were only accessible by stairs. Foot paths were narrow and steep in locations, inaccessible to wheelchair users. High winds made group communications difficult.

2. Lough Derryclare, Connemara

This three-day exercise focused on bedrock mapping in a boggy field area along the southern shore of Lough Derryclare in Connemara. Geological features included folded schists and quartzites of the Connemara Dalradian sequence (Leake and Tanner, 1994). Outcrops along a gravel road were accessible to all students; other outcrops required traversing boggy fields and were not accessible to students with mobility disabilities. Cell signals in the area were weak and ineffective, so a local area network (LAN) was set up to facilitate real-time communications between team members (see Network Connectivity section). Students recorded field data (lithologic descriptions and orientation measurements) with the FieldMove app in order to create a collaborative geologic map. Students with mobility disabilities mapped outcrops along the gravel road, while mobile students mapped outcrops in more distant and less accessible locations. Students communicated in real time via two-way radios and iPads using the AirBeam app. Photos were shared in near real time with the PhotoSync app. Videos were recorded asynchronously with GoPro cameras and shared between team members upon reconvening in common locations.

Technology used: Two-way radios, GoPro cameras, iPad cameras, FieldMove, AirBeam, and PhotoSync apps, with real-time communications facilitated by a LAN.

Accessibility: Outcrops along the gravel road were accessible to all students; remote outcrops were not accessible to students with mobility disabilities due to intervening uneven bogs. Rainy and cold weather negatively impacted all participants.

3. Renvyle Point, County Galway

The coastal bluff at Renvyle Point consists of an ~15 m vertical exposure of glacial till that lies unconformably on a wave cut platform of Dalradian Schist. The bluffs are not visible from the parking area and can only be reached after descending an uneven field of beach cobbles and boulders (see Supplemental Fig. SD2 [see footnote 1]). The half-day exercise focused on examining and interpreting deformation and fluidized flow features within the glacial till in order to determine the movement of the glacier. Due to the challenging terrain of the field area and the rainy weather, students with mobility disabilities remained in the vehicles and collaborated with their peers using two-way radios and iPads via a LAN.

Technology used: Two-way radios, GoPro cameras, iPad cameras, AirBeam and PhotoSync apps; real-time communications and data exchange with iPads were facilitated by a LAN.

Accessibility: Exposures of glacial till were only accessible by climbing down large, wet boulders along the shore. Rainy and windy weather made outdoor audio communications difficult.

TECHNOLOGY TO ENHANCE FIELD ACCESS AND INCLUSION

Synchronous and Asynchronous Communication

We used both synchronous (real-time sharing of audio or video) and asynchronous (delayed sharing) methods of communication while in the field. Synchronous communications were facilitated by a cell network at SP Crater to broadcast a video stream from the summit to students at the base of the hill. We used the Livestream web broadcasting app, but the 1–2-minute delay between transmitting and receiving the video stream made synchronous interactions between team members challenging. Students found the discrepancy between the faster audio communications and the slower video transmissions awkward. Students ascending the hill also used two-way radios for audio communications with team members at the base, which had no time lag as long as line-of-sight was maintained. Two-way radios typically have a strong signal across distances of 2–3 km and were frequently used by student teams when WiFi was not functional. In locations where a LAN was available, the AirBeam app was used for synchronous video streaming, and PhotoSync was used for photo sharing.

In field settings where cell signals or a LAN were not available, data sharing among participants across field sites was accomplished with asynchronous methods, although real-time communication could still be accomplished with two-way radios. Participants asynchronously recorded video with GoPro or iPad cameras and collected field data with a variety of iPad apps. Data were shared when participants were once again in close proximity. Once a cell or WiFi signal was available, participants uploaded their field data to Dropbox so that others could view and download it.

Network Connectivity

The level of connectivity between participants distributed across a field site can determine the degree of synchronicity available for interactions. Typically, cable or fiber connections are not practical in the field, cell network coverage can be unreliable, and satellite connections are expensive. A more manageable communications solution is to "bring your own network" to the field in the form of a LAN using battery-powered outdoor WiFi routers. The local topography, and the distribution and mobility of students across the site, affects the number of routers required to provide effective connectivity. Panel and omni-directional antennas are used to target the WiFi signal in a directed beam or over a local area (respectively) and moved as needed to maintain coverage across the site. The routers are configured as access points, providing connectivity for local devices, or in a chain of point-to-point links to connect field site locations (Collins et al., 2010). Some knowledge of computer networking is required, but once configured, a LAN can be used flexibly in a range of field scenarios.

The LAN was used at the Lough Derryclare and Renvyle Point field sites to stream video between iPads using the AirBeam app and share photos using the Photosync app. At Lough Derryclare, as students were distributed across the field site, up to six WiFi routers were used in a network as line-of-sight signal repeaters to maintain connectivity across the rough and hilly terrain. This configuration provided network coverage of up to two square kilometers of the field area. At Renvyle Point, access points were used at the two student locations (the car park and shoreline) connected by a 40-m network cable.

iPad Apps

Fieldwork activities were supported through a range of iPad apps (see Supplemental Table SD1 [see footnote 1]). Photos and videos were captured asynchronously using iPad or GoPro cameras. Photos were shared with the PhotoSync app, and synchronous video feeds were attempted with the Livestream and AirBeam apps. Field notes and students' reflections were recorded using the Notes, Evernote, or Notability apps, and photos were annotated with the Skitch app. Orientation measurements were collected and geologic maps were constructed using the FieldMove app. Two apps were used to construct stratigraphic sections: StratLogger was used in year one, and Strat Mobile was used at PEFO (see Atchison et al., 2019b). Dropbox was used to share files among participants and between the iPads when connected to the Internet. Flyover Country was used on the PEFO field trip to bring geologic maps and information into the field as reference materials. Many of these field mapping and data collection applications can now be accomplished with the StraboSpot app and database system (Walker et al., 2019). However, that was not available to us during the period that we conducted the project exercises.

DISCUSSION

The primary objective of this project was to determine ways to enhance collaboration across instructional activities in field sites with limited accessibility. Challenging terrain and changing environmental conditions impacted participation in field activities across a spectrum of physical abilities. We attempted to mitigate the issues of accessibility in field-based teaching and learning through the integration of technology and collaborative strategies that promote full inclusion. The sociotechnical solutions highlighted in this paper resulted from the usability of mobile technologies, levels of social and academic engagement, and environmental conditions.

Inclusion and Accessibility

Accessibility and inclusion are not synonymous terms but are often used as such (Carabajal and Atchison, 2020). In this project, accessibility and inclusion were both partially addressed through the use of technology. Participants with disabilities achieved better access to less-accessible field sites through photo and video imagery from peers and colleagues and imagery from apps such as FieldMove and Flyover Country. Inclusion, however, deals with the group dynamic, social engagement, and collaborative nature inherent in most field activities. The use of technology in this sense enables participants to collaborate through real-time video and photo sharing and two-way radios to share observations and interpretations with peers and colleagues. The opportunity for the entire learning community to draw from multiple perspectives of an individual field site (close-up, from a distance, through aerial imagery), including the ability to discuss disparate observations across distances for the purpose of developing collective interpretations, strengthened the overall understanding of the entire group (see Atchison et al., 2019a).

Inclusive Collaboration through Technology

We addressed data collection and communication in the field with both synchronous (real-time connectivity) and asynchronous (delayed) solutions. In many situations, asynchronous solutions were used as a backup when real-time solutions were ineffective—such as the time delay (buffering delay) between broadcast and reception when using the Livestream app at SP Crater, or when a WiFi network was unavailable (e.g., Kilkee). In the discussion of technology that follows we consider both successful and less successful solutions, in the hope that others can make use of, and expand on, our experiences.

Geologic Mapping and Data Collection

We used the StratLogger app for the ToT exercise at the Grand Canyon to record lithologic and stratigraphic data. After an introduction to using the app, students were fairly efficient in recording data and building their stratigraphic columns. We switched to the Strat Mobile app for the PEFO field trip after we found that StratLogger did not work with the latest operating system of the iPads. Often, the most effective software for geoscience fieldwork is developed by tech-savvy geoscientists, but it can be a challenge for geoscientist developers to keep their software compatible with continuous updates to operating systems. Commercial software solutions are usually up-to-date with operating systems but are often less effective for specialized field tasks.

We used the FieldMove app for geologic mapping in the field. FieldMove includes a digital compass that records orientation measurements and plots them in real time on a basemap of the area (road map, terrain map, or aerial photo). Alternatively, a hand-held compass can be used to take measurements and entered manually in FieldMove. Concerns have been expressed about the accuracy and precision of measurements taken by digital compasses. However, recent analyses suggest that digital compasses, such as those in FieldMove, can produce results at a similar level of accuracy and precision as analog compasses, as long as the digital compass is calibrated correctly (Novakova and Pavlis, 2017; Whitmeyer et al., 2019). We noted an advantage to using the iPads for measurements when several of the students with mobility disabilities had difficulty getting close enough to utilize a handheld compass on an outcrop surface.

Field geologists who predate the mobile technology revolution are accustomed to using paper field books for notes and sketches, and often find note-taking apps for mobile devices less intuitive to use. However, students who are accustomed to using mobile devices for communications and social interactions easily adapted to using apps like Notability, Evernote, and Skitch to record field observations. Students appreciated the capability of these apps to import pictures taken with the iPad cameras, making it easy to associate field photos with text annotations and explanations, and to draw interpretive sketches on photos.

Another advantage of mobile devices is the ability to preload data and maps on the device for later asynchronous use. Mapping apps like FieldMove allow users to preload georeferenced aerial photos or topographic base-maps for fieldwork. Geologic reference data and information can be preloaded on iPads with an app like Flyover Country. We used this app to load state-level geologic maps and information for southern and eastern Arizona for our journey from Phoenix to Holbrook during the PEFO field trip. This provided participants with background geologic and cultural information for reference as they traveled through a region of interest.

Audio and Video Communications in the Field

We experimented with video broadcasting apps that were less successful (e.g., Livestream), prior to settling on the AirBeam app for video streaming with a LAN. This facilitated video communications among team members with a minimal delay (<5 seconds). At both the Lough Derryclare and Renvyle Point field sites, students with mobility disabilities found that video communications with their partners provided a level of accessibility to remote outcrops that would not have been possible without the technology. In some situations, near real-time transfer of photos and still images between team members effectively substituted for video communications. Where weather or connectivity challenges precluded effective video links, students used the PhotoSync app to share still images and discussed the geologic features in the photos using two-way radios.

Even with our attempts to secure robust wireless signals for real-time communications, we still encountered many situations where asynchronous methods of data collection were necessary. Students always had the option of taking photos or recording videos using the iPad's native camera, which could be shared with their team members at a later time. GoPro wearable video cameras were extensively used to record traverses across a field area and to highlight important geologic features. Photos and recorded videos served as important field data that were used to both complete field exercises and to document field experiences.

Facilitating Connectivity in the Field

As with any field equipment, there is a degree of contingency planning needed when introducing mobile technology. Most crucial is the time taken to set up equipment in the field or fix problems that could impact students' learning experiences. Preconfiguring the LAN (e.g., connecting the routers, testing them, and packing them ready for deployment) helps minimize the setup time in the field. Knowledge of the field sites and the activities at each site is crucial to ensure that network coverage is sufficient (while minimizing redundancy). Revisiting known sites enables the re-use and rapid deployment of effective technology configurations. Bringing spares of essential components (e.g., batteries, cables) into the field enables faulty equipment to be easily replaced. Also important is to prepare alternate resources (e.g., two-way radios) and activities to be used in the case of technology failure.

Effective use of a LAN in larger field areas usually requires the services of a field technology expert. The expert not only configures the network, but also tests it and deploys it in the field prior to the arrival of students. Invariably, unforeseen challenges occur during a field session, and it is essential to have the tech expert available in the field to troubleshoot problems that develop. We often used two-way radios for communication between participants and the expert in order to resolve issues. Some technological challenges were not solvable in the field and necessitated the development of new solutions after returning from the field in order to mitigate future problems.

Student Engagement

This study was initially focused on evaluating learning outcomes related to geoscience field content, but soon expanded to identify overall collaborative inclusion and engagement of field activities in sites with limited physical accessibility. Engagement and overall enjoyment were palpable, mostly because a geoscience field study of this kind, which included multiple students with similar physical disabilities, was designed specifically to address student needs. All students realized they were part of a foundational study to enhance access to field learning and were aware that their personal well-being was considered in the design. The study remained flexible to enable their voices to drive the direction of the activities, especially when unavoidable changes in environmental conditions (e.g., daily weather) caused us to reevaluate our plans. Taken as a whole, students were not used to having an opportunity that was meant to include them, their strengths and abilities, which undoubtedly impacted overall engagement and enjoyment. However, not everything was enjoyable and engaging all of the time. The students without disabilities, who generally had more field experience than their disabled peers, were often left feeling as if they were only being used to collect data in sites that their colleagues could not access. Additionally, switching between technologies that were new to most of the students, and the occasional lag-time between audio communication and photo/video sharing, negatively impacted engagement and collaborative outcomes overall.

CONCLUSIONS AND IMPLICATIONS

The integration of mobile communication and data collection technologies can have a positive impact on teaching and learning in field-based activities. Increased collaborative engagement and social inclusion in the learning community is achievable, even when students are separated across field sites with variable accessibility. Real-time communication between groups enables data sharing, shared observations, and interpretations that are not commonly done when working groups are separated. This social inclusion and collaboration is important because it gives students ownership in the learning environment. However, the integration of technology can introduce additional challenges to the student field experience. Students often have varying levels of field experience, geology content knowledge, and comfort with using technology to collect data and communicate. Varying levels of confidence in the use of mobile technologies can amplify anxiety and develop an unwelcome stratified community of learning within the group.

Not everything we tried was successful, but even the small failures drove the evolution of the project through a constant attempt to overcome physical barriers to field-based teaching and learning. Outcomes of the project that demonstrate how technology can be used to enhance access to field sites and increase collaborative inclusion across all participants during field exercises include:

1. The inherent flexibility of digital tools recognizes diversity and enables personal choice (i.e., fieldwork does not have to be restrictive).
2. Specialized field apps are typically the best solutions for geoscience fieldwork but are often developed by domain specialists and not always well maintained.
3. Always have contingency plans—technologies and strategies can fail for a variety of reasons, so have back-up equipment and alternate options (e.g., asynchronous can succeed when synchronous fails).
4. Be prepared—preconfigure the technology and ensure that everyone knows how to use it before going into the field. Know how to get help when things go wrong.
5. Ensure you have adequate resources—fieldwork is unpredictable, so make sure you have the expertise to adapt (especially when technology is involved).

We have discussed our experiences with this exploratory pilot study, encompassing both successes and challenges, and some possible strategies for implementing the use of mobile technologies for enhanced fieldwork. Expanding the scope of our approaches will require a significant change in how most of us conduct research and education in the field. Doing so would not only provide improved experiences for students, but also would enhance the pedagogic toolkit available to field instructors. We envision the next phase of this work as focusing on the geoscience community as a whole, to expand the outcomes of this work and develop new strategies to make multi-day and residential field experiences accessible and inclusive of all geoscientists. In addition, now that we have identified the capabilities and potential of using various mobile technologies to increase access and engagement in a field-based inclusive learning community, we recognize the need to align the content of inclusive field experiences to typical field-camp learning objectives (e.g., collecting accurate data in the field, synthesizing data to create geologic map interpretations, synthesizing field data and interpretations to write a summary of the geologic history, among others). Evaluation of the effectiveness of the methods discussed in this paper against student learning outcomes will indicate the utility of these methods.

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26–30 October
GSA 2020
CONNECTS ONLINE

Welcome to GSA 2020 Connects Online!

Rebecca Fazzari

We are enthusiastic about launching this new platform with our trusted partners from Image Audio Visual and Conference Exchange, both of which GSA has worked with for more than 10 years.

While the official online dates of GSA 2020 Connects Online are 26–30 Oct., events will be taking place potentially as early as 14 Sept. and through 15 Nov. to accommodate the various business, committee, Division, and Associated Society meetings that typically occur during the week of the in-person annual meeting.

You can register for GSA 2020 Connects Online at any time. The meeting platform will open the week of 19 Oct., and you can sign in using your same GSA username and password. This early access will allow you to view of all the technical sessions, Pardee Symposia, Feed Your Brain talks, and so forth. You can then decide what presentations you want to attend during the live dates of the meeting and start drafting questions you want to ask the presenters. We will be putting together webinars and materials to help everyone navigate the new platform, so you will be comfortable during the dates of the live meeting.

We also will be launching our virtual GSA Resource & Innovation Center, where you'll be able to connect with some of the same organizations, universities, and GSA Divisions that you typically would in an onsite Exhibit Hall. Have questions about GSA membership, programs, or the Foundation, or want to purchase something from the GSA bookstore? No worries—we'll have a virtual GSA Headquarters booth open to connect you to the right GSA staff person without your needing to leave the platform.

We've created a new Twitter hashtag so that if you have technology issues during the live meeting you can notify our partners, and they will respond quickly and efficiently: #GSA2020help. Please continue to use #GSA2020 when tweeting anything else regarding GSA 2020 Connects Online, including scientific sessions and exhibitors to check out.

Finally, even online, GSA remains committed to offering a safe, respectful, professional environment in which participants from diverse backgrounds feel welcome and are able to participate fully. GSA requires all participants to comply with GSA's Events Code of Conduct (**https://www.geosociety.org/GSA/Events/EventConductCode/GSA/Events/Conduct.aspx**) and to refrain from harassment, bullying, or intimidation of any kind. GSA takes all such conduct concerns seriously and will take any actions deemed appropriate to ensure that our meeting is safe and inclusive, including but not limited to immediately removing alleged offenders from the meeting without warning or refund. Please contact our Ethics & Compliance Officer at ethics@geosociety.org any time if you have a question or need to report a concern.

Again, welcome to GSA 2020 Connects Online. We look forward to sharing more information with you as the meeting approaches. Please go to **https://community.geosociety.org/gsa2020/home** for the most up-to-date information.

—***Rebecca Fazzari,*** *CMP, CMM, DES, Director of Meetings & Events*

GSA 2020 Connects Online SCHEDULE*

Times in Eastern Time.

WEDNESDAY, 21 OCTOBER

Short Courses: 10 a.m.–6 p.m.

THURSDAY, 22 OCTOBER

Short Courses: 10 a.m.–6 p.m.

Field Trips: 10 a.m.–6 p.m.

FRIDAY, 23 OCTOBER

GeoCareers Webinars: 10 a.m.–3 p.m.

Short Courses: 10 a.m.–6 p.m.

Field Trips: 10 a.m.–6 p.m.

MONDAY, 26 OCTOBER

Morning Wake Up: Coffee & Conversation: 10–11 a.m.

GeoCareers Spotlight on Industry: 10 a.m.–1:30 p.m.

GSA Presidential Address: 11 a.m.–noon

Résumé/CV Clinic and Drop-in Mentoring: 1–5 p.m.

Lunch Break: noon–1:30 p.m.

Oral & Poster Technical Sessions: 1:30–5:30 p.m.

Pardee Symposium: 1:30–5:30 p.m.

Networking Events: 5:30–8 p.m.

Early Career Panel: 5:45–6:45 p.m.

TUESDAY, 27 OCTOBER

Morning Wake Up: Coffee & Conversation: 9–10 a.m.

Oral & Poster Technical Sessions: 10 a.m.–noon

GeoCareers Spotlight on Government: 10 a.m.–1:30 p.m.

GSA Resource & Innovation Center: 11 a.m.–3 p.m.

Lunch Break: noon–1:30 p.m.

Feed Your Brain: 12:15–1:15 p.m.

Résumé/CV Clinic and Drop-in Mentoring: 1–5 p.m.

Oral & Poster Technical Sessions: 1:30–5:30 p.m.

Pardee Symposium: 1:30–5:30 p.m.

Networking Events: 5:30–8 p.m.

Women in Geology Panel: 5:45–6:45 p.m.

WEDNESDAY, 28 OCTOBER

Morning Wake Up: Coffee & Conversation: 9–10 a.m.

Oral & Poster Technical Sessions: 10 a.m.–noon

GSA Resource & Innovation Center: 11 a.m.–3 p.m.

GeoCareers Spotlight on Academia and Teaching: 10 a.m.–1:30 p.m.

Lunch Break: noon–1:30 p.m.

Feed Your Brain: 12:15–1:15 p.m.

Résumé/CV Clinic and Drop-in Mentoring: 1–5 p.m.

Oral & Poster Technical Sessions: 1:30–5:30 p.m.

Networking Events: 5:30–8 p.m.

Diversity, Inclusion, and Ethics Panel: 5:45–6:45 p.m.

THURSDAY, 29 OCTOBER

Morning Wake Up: Coffee & Conversation: 9–10 a.m.

Oral & Poster Technical Sessions: 10 a.m.–noon

GeoCareers Spotlight on Non-Traditional Careers: 10 a.m.–1:30 p.m.

GSA Resource & Innovation Center: 11 a.m.–3 p.m.

Lunch Break: noon–1 p.m.

Feed Your Brain: 12:15–1:15 p.m.

Résumé/CV Clinic and Drop-in Mentoring: 1–5 p.m.

Oral & Poster Technical Sessions: 1:30–5:30 p.m.

Pardee Symposium: 1:30–5:30 p.m.

Networking Events: 5:30–8 p.m.

Accessibility in the Geosciences Panel: 5:45–6:45 p.m.

FRIDAY, 30 OCTOBER

Morning Wake Up: Coffee & Conversation: 9–10 a.m.

Oral & Poster Technical Sessions: 10 a.m.–2 p.m.

Pardee Symposium: 10 a.m.–2 p.m.

*This draft is to give you a general idea of the schedule; it is subject to change.

Feed Your Brain—*Lunchtime Enlightenment*

https://community.geosociety.org/gsa2020/program/special

Hendratta Ali

Christopher Aiden-Lee Jackson

Anita Marshall

Sherilyn Williams-Stroud

Erika Marín-Spiotta

Don Siegel

The Way Forward: Toward an Anti-Racist and Equitable Geoscience Community
Tues., 27 Oct., 12:15–1:15 p.m. Eastern Time

Geoscientists across the world are engaging and committing to intentional transformation as we aspire to end racism and achieve equity by continually reevaluating and adapting to a diverse and inclusive geoscience community. This is critical, because reports show that geoscience-related disciplines are among the least diverse of all STEM disciplines. This lack of diversity hinges on issues with inclusion, systemic racism, and different forms of discrimination. This session looks to address such questions as "What will it look like for a professional society or organization to be anti-racist and equitable?" "What will it take for us as members of these organizations to be complicit in anti-racism, anti-discrimination, and action for change?" Panelists will discuss, share experiences, and offer concrete suggestions to spur geoscientists towards ally-ship, bystander intervention, accessible practices, recognizing bias, and other anti-racist actions to improve our discipline. Panelists, facilitators, and attendees from different demographics and career stages will engage in a conversation to engage all stakeholders.

ORGANIZER

Hendratta Ali, Ph.D., Dept. of Geosciences, Fort Hays State University, @HendrattaAli, Petition leader: Call for a Robust Anti-Racism Plan for the Geosciences.

PANELISTS

Christopher Aiden-Lee Jackson, Ph.D. (he/him), Dept. of Earth Science & Engineering, Imperial College, @TIGERinSTEMM, https://www.tigerinstemm.org.
Anita Marshall, Ph.D. (she/her), Dept. of Geology, University of Florida, Director of Operations, The International Association for Geoscience Diversity, @AccessibleGEO, https://theiagd.org.
Sherilyn Williams-Stroud, Ph.D., PG, research scientist, structural geologist, Illinois State Geological Survey, GSA Diversity Committee, @geosociety, https://www.geosociety.org/.
Erika Marín-Spiotta, Ph.D., Dept. of Geography, University of Wisconsin–Madison, @ADVANCEGeo, https://serc.carleton.edu/advancegeo.
Don Siegel, Ph.D., Geological Society of America, past president, @geosociety, https://www.geosociety.org.

Other Upcoming Feed Your Brain Talks

Monday, 26 Oct., 11 a.m.–noon
GSA Presidential Address: **J. Douglas Walker,** "Doing Geology in an Online World"

Wednesday, 28 Oct., 12:15–1:15 p.m.
2020 Michel T. Halbouty Distinguished Lecture, **Tom Gleeson,** "Is Groundwater a Local and Global Resource? New Sustainability Ideas and Tools across Scales"

Thursday, 29 Oct., 12:15–1:15 p.m.
Jill Heinerth, "Science and Mapping of Underwater Caves"

Short Courses

Learn and explore a new topic!

Early registration deadline: 21 September
Registration after 21 September will cost an additional US$30
Cancellation deadline: 28 September

https://community.geosociety.org/gsa2020/program/short

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

501. **Field Safety Leadership.** Wed., 21 Oct., 10 a.m.–1 p.m. US$45 professionals; US$25 students.. Limit: 50. CEU: 0.3. **Instructors:** Kevin Bohacs, ExxonMobil (retired); Kurt Burmeister, University of the Pacific; Greer Barriault, ExxonMobil Upstream Research Company. **Endorsed by** *ExxonMobil Upstream Research Company.*

502. **Introduction to Petroleum Structural Geology.** Fri., 23 Oct., 10 a.m.–5:30 p.m. US$45 professionals; US$25 students. Limit: 50. CEU: 0.75. **Instructor:** Kellen Gunderson, Chevron Energy Technology Company. **Endorsed by** *GSA Structural Geology and Tectonics Division; GSA Energy Geology Division; AAPG Petroleum Structural Geology and Geomechanics Division.*

505. **Resistivity Surveying: Getting the Best and Making the Most from ERT and Induced Polarization Data.** Wed., 21 Oct., 10 a.m.–2 p.m. US$50. Limit: 50. CEU: 0.4. **Instructors:** Jimmy Adcock, Guideline Geo Americas; Morgan Sander-Olhoeft, Guideline Geo Americas. **Endorsed by** *Guideline Geo.*

506. **Quantitative Analysis, Visualization, and Modeling of Detrital Geochronology Data.** Thurs., 22 Oct., 10 a.m.–5:30 p.m. US$45 professionals; US$15 students. Limit: 50. CEU: 0.75. **Instructors:** Joel Saylor, University of British Columbia; Kurt Sundell, University of Arizona; Glenn Sharman, University of Arkansas; Samuel Johnstone, U.S. Geological Survey.

507. **From Airborne Electromagnetic Method Data to 3D Hydrogeological Conceptual Model.** Wed., 21 Oct., 9:30 a.m.–4 p.m. US$50. Limit: 50. CEU: 0.65. **Instructors:** Tom Martlev Pallesen, I-GIS; Mats Lundh Gulbrandsen, I-GIS. **Endorsed by** *I-GIS.*

513. **Your Thesis is Software: Tools for the Geoscientist to Help Write Better Code, from Version Control to Test-Driven Development.** Fri., 23 Oct., 10 a.m.–5 p.m. US$10. Limit: 50. CEU: 0.7. **Instructors:** Simon Goring, University of Wisconsin; Amy Myrbo, Science Museum of Minnesota.

514. **3D Printing for Geoscience and Engineering: Emerging Technology in Education, Research, and Communication.** Thurs., 22 Oct., 10 a.m.–5:30 p.m. US$50. Limit: 50. CEU: 0.75. **Instructors:** Rick Chalaturnyk, University of Alberta; Sergey Ishutov, University of Alberta; Kevin Hodder, University of Alberta; Gonzalo Zambrabo, University of Alberta. **Endorsed by** *GeoPrint; Petroleum Institute of Mexico.*

515. **Ground-Penetrating Radar—Principles, Practice, and Processing.** Thurs., 22 Oct., 10 a.m.–5 p.m. US$50. Limit: 50. CEU: 0.7. **Instructor:** Greg Johnston, Sensors & Software. **Endorsed by** Sensors & Software.

516. **Medical Geology: The Earth's Impacts on Human Health.** Fri., 23 Oct., 10 a.m.–6 p.m. US$40 professionals; US$20 students. Limit: 50. CEU: 0.8. **Instructors:** Laura Ruhl, University of Arkansas at Little Rock; Malcolm Siegel, University of New Mexico; Robert Finkelman, University of Texas at Dallas. **Endorsed by** *GSA Geology and Health Division.*

517. **A Practical Guide to Geophysics for Geotechnical Site Investigation.** Fri., 23 Oct., 10 a.m.–2 p.m. US$50. Limit: 50. CEU: 0.4. **Instructors:** Jimmy Adcock, Guideline Geo Americas; Morgan Sander-Olhoeft, Guideline Geo Americas. **Endorsed by** *Guideline Geo.*

519. **Detrital and Petrochronologic Applications of U-Pb Geochronology and Lu-Hf and Trace/REE Geochemistry by Laser Ablation Inductively Coupled Plasma–Mass Spectrometry.** Fri., 23 Oct., 10 a.m.–5:30 p.m. US$30. Limit: 50. CEU: 0.75. **Instructors:** George Gehrels, University of Arizona; Kurt Sundell, University of Arizona; Sarah George, University of Arizona.

INDUSTRY TRACKS GSA's Short Courses offer sessions relevant to applied geoscientists. Look for these icons, which identify sessions in the following areas:

Economic Geology | **Energy** | **Engineering** | **Hydrogeology and Environmental Geology**

520. **Exploring Surface Processes Using Community Surface Dynamics Modeling System Modeling Tools: How to Build Coupled Models.** Fri., 23 Oct., 10 a.m.–5 p.m. US$50. Limit: 50. CEU: 0.7. **Instructors:** Gregory Tucker, University of Colorado; Tian Gan, University of Colorado; Benjamin Campforts, University of Colorado. **Endorsed by** *National Science Foundation; Community Surface Dynamics Modeling System.*

521. **3D Hydrogeological Modeling. How to Build Them and Why?** Fri., 23 Oct., 9 a.m.–4 p.m. US$50. Limit: 50. CEU: 0.7. **Instructors:** Tom Martlev Pallesen, I•GIS. **Endorsed by** *I•GIS.*

522. **Teaching Quantitative Structural Geology.** Thurs., 22 Oct., 10 a.m.–5 p.m. US$20 (a GSA store voucher for US$20 will be given upon completion of the course). Limit: 50. CEU: 0.7. **Instructor:** David Pollard, Stanford University; Stephen Martel, University of Hawaii.

524. **NASA Data Made Easy: Getting Started with Synthetic Aperture Radar.** Thurs., 22 Oct., 10 a.m.–2 p.m.. US$10. Limit: 50. CEU: 0.4. **Instructors:** Cynthia Hall, Goddard Space Flight Center; Lisa Grant Ludwig, University of California, Irvine; Jay Parker, NASA; Heidi Kristenson, Alaska Satellite Facility; Sara Lubkin, NASA.

526. **An Introduction to Stratigraphic Data Analysis in R (SDAR), a Quantitative Toolkit to Analyze Stratigraphic Data.** Fri., 23 Oct., 10 a.m.–5 p.m.. US$40. Limit: 40. CEU: 0.7. **Instructor:** John Ortiz, Colombian Geological Survey and Corporación Geológica ARES.

528. **Geosciences and Society: A Teaching Workshop.** Thurs., 22 Oct., 2:30–5:30 p.m. US$35. Limit: 50. CEU: 0.3. **Instructors:** Anne Marie Ryan, Dalhousie University; Carl-Georg Bank, University of Toronto.

The Geological Society of America®

GEOCAREERS

If you are entering the job market, transitioning into a new career, or are supporting someone who is and want more information about career pathways in the geosciences, plan to attend one or more of the GSA 2020 GeoCareers events below. Times are Eastern Daylight Time. Sign up for drop-in mentoring and the résumé/CV review clinic in the GeoCareers Center of the GSA 2020 Connects Online platform starting Mon., 26 Oct., at 9 a.m. for our Mon.–Thurs. spots.

https://community.geosociety.org/gsa2020/geocareers

FRIDAY, 23 OCT.

Where will your career take you? If your options are open, attend these events to get a snapshot of a variety of career options.

Cover Letter Workshop, 10–11:15 a.m.
Presenters will review the fundamentals of crafting a cover letter.

Geoscience Workforce Outlook Presentation, 11:30 a.m.–12:45 p.m.
Gain an understanding of the current geoscience workforce data, including salary, employment trends, and projections.

Career Panel, 1:30–3 p.m.
Panelists from industry, government, academia, and non-traditional sectors will answer questions and offer advice in preparation for a career in these fields.

MONDAY, 26 OCT.

Are you focusing on a career in industry? Attend our Spotlight on Industry events.

Creating a Résumé for Industry, 10–11:30 a.m.
Presenters will review the fundamentals of crafting a résumé for industry.

Careers in Industry Panel, noon–1:30 p.m.
Panelists from industry will answer questions and offer advice in preparation for a career in industry.

Drop-in Mentoring with an Industry Rep., 1–5 p.m.
Mentoring will be on a first-come, first-served basis. Sign up early to secure your 30-minute consultation.

Résumé/CV Review Clinic, 1–5 p.m.
Review will be on a first-come, first-served basis. Sign up early to secure your 30-minute consultation.

Networking Event, 2–3 p.m.
Learn the importance of networking to your career and meet some professionals willing to offer advice and answer questions.

Early Career Panel, 5:45–6:45 p.m.
This panel presents representatives from several non-profits who have activities of interest to early career professionals.

TUESDAY, 27 OCT.

Are you focusing on a career with the government? Attend our Spotlight on Government events.

An Introduction to USAJOBS, 10–11:30 a.m.
Presenters will discuss how to best utilize the USAJOBS database to apply for federal employment.

Careers in Government Panel, noon–1:30 p.m.
Panelists will answer questions and offer advice in preparation for a career in government.

Drop-in Mentoring with a Government Rep., 1–5 p.m.
Mentoring will be on a first-come, first-served basis. Sign up early to secure your 30-minute consultation.

Résumé/CV Review Clinic, 1–5 p.m.
Review will be on a first-come, first-served basis. Sign up early to secure your 30-minute consultation.

Geology Club Meet-Up, 2–3 p.m.
Want to see what other Geology Clubs are up to? Join the Geology Club Meet-Up and chat with other representatives about their activities, goals, and accomplishments.

Women in Geology Panel, 5:45–6:45 p.m.
This panel will address issues faced by women in geology. Short presentations will be followed by a Q&A session.

WEDNESDAY, 28 OCT.

Are you focusing on a career in academia or teaching? Attend our Spotlight on Academia events.

Creating a Curriculum Vitae, 10–11:30 a.m.
Presenters will review the fundamentals of crafting a superior curriculum vitae (CV).

Careers in Academia and Teaching Panel, noon–1:30 p.m.
Panelists will answer questions and offer advice in preparation for a career in academia or teaching.

Drop-in Mentoring with a Faculty Rep., 1–5 p.m.
Mentoring will be on a first-come, first-served basis. Sign up early to secure your 30-minute consultation.

Résumé/CV Review Clinic, 1–5 p.m.
Review will be on a first-come, first-served basis. Sign up early to secure your 30-minute consultation.

Diversity, Inclusion, and Ethics Panel, 5:45–6:45 p.m.
This panel will address diversity, inclusion, equity, and ethics challenges in geology. Short presentations will be followed by a Q&A session.

THURSDAY, 29 OCT.

Are you focusing on a career in a museum or non-profit? Attend our Spotlight on Non-Traditional Careers events.

Creating a Résumé for Non-Traditional Employment, 10–11:30 a.m.
Presenters will review the fundamentals of crafting a winning résumé.

Non-Traditional Careers Panel, noon–1:30 p.m.
Panelists from a variety of museum, policy, and non-profit careers will answer questions and offer advice in preparation for a non-traditional career.

Drop-in Mentoring, 1–5 p.m.
Mentoring will be on a first-come, first-served basis. Sign up early to secure your 30-minute consultation.

Résumé/CV Review Clinic, 1–5 p.m.
Review will be on a first-come, first-served basis. Sign up early to secure your 30-minute consultation.

Accessibility in Geosciences Panel, 5:45–6:45 p.m.
This panel will discuss topics related to accessibility in the geosciences. Short presentations will be followed by a Q&A session.

On To the Future Update

GSA's On To the Future (OTF) program for 2020 will continue with an adapted program that allows students to experience two meetings, GSA 2020 Connects Online and the GSA 2021 Annual Meeting in Portland, Oregon, USA. This year, there are 37 OTF student awardees who will receive mentoring, professional development training, and travel awards. All financial awards will be deferred to the GSA 2021 Annual Meeting, with some students participating in this year's virtual events.

- The OTF Networking Event, Monday, 26 Oct., 5:45 p.m.
- Mentor an OTF student attending the virtual meeting; go to **https://rock.geosociety.org/mentor/** to learn more.

Financial Assistance & The Student Volunteer Program

Because GSA 2020 Connects Online will be using an online platform, there will be no student volunteer program this year. It will run again when we are able to meet face-to-face, we hope in Portland in 2021. Thanks to the generosity of our members, GSA student members will be able to register for GSA 2020 Connects Online at no cost. Not a member? Join now at **https://www.geosociety.org/GSA/Membership/join_renew/GSA/Membership/home.aspx.** Need financial assistance to cover the cost of membership? Apply for assistance at **https://form.jotform.com/193606937330057.**

Strategies for Preparing and Delivering an Effective Online Presentation

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INTRODUCTION

With the excitement of seeing old friends, the anticipation of establishing new collaborations, the buzz of new science, many of us are familiar with the fall conference season. This fall will be quite different, however, as we find ourselves facing a pandemic. To better protect geoscience communities, many professional societies and organizations are pivoting to virtual conferences for the remainder of 2020. While this may create a more accessible conference in some contexts (e.g., cost), there are other challenges to consider (e.g., technology access). As we navigate this uncertain transition, how can the vibrant exchange of knowledge facilitated by such events be best transferred to an online setting? Here, we provide a summary of best practices for presenting in these environments, many of which have the potential to be highly impactful and effective while being relatively simple to implement.

LOGISTICAL STRATEGIES

Fall conferences will likely blend live keynote talks, pre-recorded presentations, and live Q&A sessions. With these changes come adjustments to our personal preparations. For some, this may require additional planning or resolving unexpected challenges. Be proactive and be prepared: (1) review the event's code of conduct; (2) check guidelines/rules; (3) contact session chairs and organizing committees with questions; (4) download and familiarize yourself with required conference software/apps; and (5) when possible (and if applicable) upload content in advance.

VISUAL STRATEGIES

The geosciences rely on tables, figures, and animations to communicate quantitative data and qualitative observations (Carr, 2002; Libarkin and Brick, 2002). These visuals are important, as they communicate content to others and provide presentation cues for ourselves. Keep in mind that your audience may have significantly different amounts of prior knowledge, association, and inference (Dutrow, 2007). Thus, it may take time for audience members to absorb visual nuances and understand relationships. For this reason, it is critical to guide the audience through your presentation, emphasizing the various components of your visuals (e.g., data) and connecting their significance to your broader message. Below, we provide a list of recommendations (see Gallagher, 1965; Cheney, 1996, 2013; Dutrow, 2007; Schwertly, 2014; Zarnetske and Zarnetske, 2015):

1. Number presentation slides/poster sections and use titles to emphasize content (will facilitate Q&A);
2. Consider elements of design (e.g., fonts, color palettes, placement of figures/tables);
3. Eliminate distracting "chartjunk" (e.g., decorative fonts, grid-lines);
4. Consider figure resolution and size. Audience members may view your presentation from a range of devices (e.g., tablets, laptops);
5. Avoid busy backgrounds. Use white or pastel colors (reduces eye fatigue);
6. Avoid red and green fonts (~15% of the population is color blind);
7. When possible, consider simple animations to "show" rather than tell;
8. Always cite all of your sources; and
9. Above all else… KISS (keep it simple, stupid).

VISIBILITY AND AUDITORY STRATEGIES

Ninety percent of human communication occurs via nonverbal actions (e.g., facial expressions; Hansen, 2020). The extent to which face-to-face interactions traditionally occur at in-person meetings is challenging to recreate online, especially where faces and voices can be easily muted. While muting video and audio can work to support meeting access (e.g., reducing bandwidth load), it can also work to perpetuate an isolating environment. There are, however, approaches that support the attendance of others, while enhancing your own visibility online (see Hansen, 2020; Harper, 2020):

1. Do not be a faceless voice. Include a photo of yourself on your opening and closing slide;
2. Find time to practice. Be cognizant of the time allocated for your presentation and stick to it (be respectful of the audience's and attendees' time);
3. Listen to your recording and identify how you use your voice to emphasize or present content (consider tone, varying volume, projection);
4. Embrace the pause. A well-placed pause can generate anticipation and provide your audience time to process what you have discussed;
5. During live sessions (e.g., keynotes, Q&A), unless speaking, mute your microphone; and
6. As you prepare to record your presentation and/or attend the meeting, when possible, work to eliminate distractions.

CONCLUSIONS

As you prepare to present in an online environment, remember to consider why you are presenting and who your audience will be. Through presentation of your work (whether it be online or in person), you are communicating information to a broad audience with the likely aim of highlighting your research, initiating engaging dialogue, and working to facilitate future research directions.

ACKNOWLEDGMENTS

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Time for Earth

***Gregory C. Beroza,** Stanford University; **Alejandro N. Flores,** Boise State University; **Deborah Glickson,** National Academies of Sciences, Engineering, and Medicine; **Katharine W. Huntington,** University of Washington; **Carolina Lithgow-Bertelloni,** University of California, Los Angeles; **Donna L. Whitney,** University of Minnesota; **James A. Yoder,** Woods Hole Oceanographic Institution; and members of the Catalyzing Opportunities for Research in the Earth Sciences (CORES) Committee*

The *Earth in Time* report presents a vision to advance understanding of Earth and, by doing so, address urgent societal challenges. The "all hands on deck" vision and the call to invest in a diverse, inclusive, and technically skilled workforce is not only timely, but has acquired new urgency, strongly aligning with GSA's mission "to advance geoscience research and discovery, service to society, stewardship of Earth, and the geosciences profession."

In 2018, the National Science Foundation's (NSF) Division of Earth Sciences (EAR) asked the National Academies of Sciences, Engineering, and Medicine to undertake a decadal survey to provide guidance on future research priorities. The committee recruited for this effort was charged to (1) identify high-priority questions to advance earth-science research; (2) assess earth-science infrastructure; and (3) discuss partnerships that could maximize EAR's ability to address the priority questions.

A Vision for NSF Earth Sciences 2020–2030: Earth in Time (freely available at http://nap.edu/25761) views Earth as an integrated system that interacts across vast space and time scales: from bacteria and rocks to the convective and tectonic processes that build mountains, from the core to the atmosphere, and from the time of Earth's formation to the present. The embodied scientific value is made urgent by the need to understand how Earth can continue to sustain civilization and biodiversity.

The report's priority questions are poised for rapid progress. They reveal the importance of geological time, connections between Earth's surface and interior, the co-evolution of geology and life, and the effects of human activities:

1. *How is Earth's internal magnetic field generated?*
2. *When, why, and how did plate tectonics start?*
3. *How are critical elements distributed and cycled in the Earth?*
4. *What is an earthquake?*
5. *What drives volcanism?*
6. *What are the causes and consequences of topographic change?*
7. *How does the critical zone influence climate?*
8. *What does Earth's past reveal about the dynamics of the climate system?*
9. *How is Earth's water cycle changing?*
10. *How do biogeochemical cycles evolve?*
11. *How do geological processes influence biodiversity?*
12. *How can earth-science research reduce the risk and toll of geohazards?*

Progress will depend on strong disciplinary programs in EAR that support both individuals and collaborative teams. The priority questions do not exclude other areas of research. Basic research will always have the potential to lead to unanticipated, transformative results.

The committee recommended that EAR commit to funding that develops and sustains technical staff to promote collaboration, innovation, and education of the future workforce. EAR has responded through multiple initiatives to address diversity, equity, and inclusion, yet earth science remains one of the least diverse STEM fields. Addressing the science priorities of the future will require the perspectives of scientists with a wide range of experiences and identities. The committee recommended that EAR enhance existing efforts to provide leadership, investment, and centralized guidance to improve diversity, equity, and inclusion in the earth-science community.

EAR faces a challenge in keeping pace with a rapidly evolving computational landscape. The report recommends that EAR establish a standing committee to provide advice to NSF regarding cyberinfrastructure and that EAR develop a strategy to support FAIR (findable, accessible, interoperable, and reusable) data practices.

The committee identified three initiatives with years of community planning—a geochronology consortium, a very large multi-anvil press facility, and a near-surface geophysics center—that are recommended for funding. The SZ4D initiative for subduction zone processes has strong community support, and the committee recommended continued support of its development. Other possible initiatives have promise but require further community development.

EAR must be nimble and flexible to support research that crosses disciplinary, geological, and/or geographical boundaries. Boundaries between disciplines are more permeable than ever. New or strengthened partnerships with science agencies across the federal government would help EAR support collaborative and cross-disciplinary research.

The *Earth in Time* report highlights the urgency, significance, and impact of earth-science research, education, and training, which have direct benefits to the nation's health, prosperity, and security, and concludes with optimism for what earth-science researchers have accomplished and what we can do in the next decade.


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Finding and Maintaining an Effective Mentorship

Larry Collins, *Washington State University–Pullman, GSA Student Advisory Committee Member*

A good mentoring relationship can have a lasting impact on a student's academic and career success. Mentors can help you be more productive in research, publishing, and completing your undergraduate or graduate tenure. They can also introduce you to their network and point out opportunities that can help you find successful career placement.

Mentors can play several roles, including as the chair of your graduate committee, a co-author of your presentation or publication, a counselor from your university career center, or an advisor who offers course suggestions. A mentor is anyone who can offer you support—academic and/or emotional.

A mentor should lobby for you, share knowledge with you, hold you accountable so that you strive to be better, offer guidance on your professional goals when you need it, serve as a role model, and offer much-needed emotional support when things are not falling into place as you had hoped. One mentor may not meet all your needs, and you may find you rely on several individuals to inspire you to navigate necessary resources to help you reach your goals. The mentor or mentors you select should help to ensure that you graduate and are properly trained for the workforce.

Your academic mentors should prepare you to reach your goals through a series of confidential, one-on-one conversations that generally have both a start and end date. If both you and your mentor continue to benefit from your mentorship, then you continue your discussions. Your mentor should challenge and support you, not judge you. You should collaborate with your mentor to help you identify solutions for any problems you may encounter.

It takes time to build and maintain a productive relationship, so your mentor should have time to meet with you on a regular basis. That said, be aware that your mentors have other commitments, and they are volunteers. You should meet regularly, while also accommodating their schedule and providing them with lots of potential meeting times.

As you progress through your career and your needs change, so too should your mentors. To find a mentor, you should define your goals and needs, and then do your research to ensure you find someone who can help you reach those goals. Make sure you reach out to your current network for suggestions; some of the best mentors I have had are people I met through my network. Talking to your current teachers or professors is also helpful. They may have a colleague or friend who would be a great fit for you. Once you find a potential mentor, reach out to that person via email, and be sure to have an idea of what your ideal mentor relationship would look like. Share your intentions and desire for help and set up your first meeting. In that meeting, discuss your goals, what you need help with, and set up a schedule for when you and your mentor will meet. If it is a mentor for graduate school, you could begin by sharing what knowledge/expertise you already have in a given area and how you think working with them will help you expand that knowledge. It is also important to recognize that your mentors are busy people like you. If you do not hear back from them, give them a polite nudge (follow-up email) to check in with them. It is easy for mentors to miss an email. Communicate early and often. Communication is critical for a strong relationship with a mentor.

Other tips for a strong mentoring relationship include making sure your mentor is aware of your goals and objectives for each meeting and for your overall career trajectory. Be approachable, ask questions, and share your own experiences. Set expectations of what you hope to gain through the mentorship and be prepared when you meet. Have questions and any materials you might discuss handy (for example, your résumé, publications, and research outcomes). Update your mentor on your progress and have them observe your presentations and read your articles or school work. Ask your mentor about their goals, and try to observe your mentor in their career (teaching, presentations, and publications) as well.

As with any relationship, you may find your mentor/mentee relationship is not beneficial. This might be because your mentor no longer has the time to devote to mentoring you, you may feel that you are no longer compatible, you are not being heard, or because you are not making progress. If this is the case, try to identify the issue and address it with your mentor in a professional manner. If that doesn't work, it may be a good decision to talk to a trusted committee member or colleague about the situation. It is acceptable to move on to a different mentor if you cannot reconcile differences. If you think you are in an unsafe situation, never feel like you have to stay in the relationship; end the mentorship right away and seek assistance from your university if you feel ethical or professional standards were violated.

The Geological Society of America (GSA) Annual and Section Meetings are great places to look for mentors who can help you navigate the job market. GSA has operated a variety of formal and informal mentoring programs since 1996. Networking events, panel discussions, and webinars all expose you to a variety of careers in the geosciences and mentors who work in those jobs. The upcoming GSA 2020 Connects Online meeting will offer GeoCareers programming in different employment sectors, including spotlights on industry, government, academia, and non-traditional careers. View the program at **https://community.geosociety.org/gsa2020/connect/student-ecp/geocareers.**

GSA meetings can also give you the opportunity to meet prospective advisors. You may consider attending their talk or a talk that one of their current students is giving. Consider introducing yourself via email and sharing your common interests. If they are not a good fit for you, they may also suggest other people for you to meet and talk with.

Finally, GSA is excited to announce the launch of a new online mentoring program partnership with Mentoring365 (see page 23). Consider taking advantage of this new member benefit and creating your mentee profile. You will be able to search a listing of mentors from a variety of partner geoscience organizations and start your three month online mentorship. Visit **https://mentoring365.chronus.com/p/p1/membership_requests/new** to sign up.


Renew by 1 Nov. — Save 15% off dues*
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The Geological Fingerprints of Slow Earthquakes

Santa Catalina Island, California, USA | 27 June–1 July 2021
www.geosociety.org/penrose

CONVENERS

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COSPONSORS

The Geological Society of America
National Science Foundation
NSF-GeoPRISMS
Southern California Earthquake Center

DESCRIPTION AND OBJECTIVES

The discovery of slow earthquakes 20 years ago revolutionized the understanding of how plate motions are accommodated at major tectonic boundaries. Slow earthquakes are a family of events that include slow slip events (SSE), tectonic tremor, and low frequency earthquakes (LFE). In some systems, SSEs occur together with tectonic tremor. When these events occur periodically, they are known as episodic tremor and slip, or "ETS." Compared to regular earthquakes, the slip across a fault during a slow earthquake occurs slowly, but significantly faster than plate-rate creep. Slow earthquakes are observed predominantly near the plate interface of subduction zones and on transform plate boundary faults. They are often associated with "transitional" regions at the edges of seismogenic zones but occur both updip and downdip, so encompass a wide range of pressure and temperature conditions. Understanding slow earthquakes is critical to developing better constraints on regional seismic hazards and may also provide information on the physical conditions and fault-loading rates at depth.

Seismological, geophysical, and geodetic tools have been applied extensively to study the range of slow earthquake types, where they occur, their relations to each other, and the characteristics that distinguish them from regular earthquakes and creep. However, there are numerous outstanding issues regarding the basic processes that control slow earthquake characteristics. For example, what deformation processes and mechanisms are critical to their occurrence? What controls slip rates? Do all faults that host slow earthquakes share common physical characteristics? Are the multiple potential mechanisms for tremor and slow slip common among the different tectonic settings where these phenomena are observed, including subduction zones and continental transform faults?

Little Harbour, Catalina Island, California, USA. Photo by John Paul Platt.

The geological structures that formed during slow earthquakes and are preserved in exhumed systems can provide critical insights into the sources of slow earthquakes and how they interact with the regular earthquake cycle. Although different hypotheses are proposed on a regular basis in the nascent field of slow earthquake geology, there is no "smoking gun" evidence of slow earthquakes in the rock record. Reconciling the geophysical insights with geological observations is therefore an ongoing challenge, but it is increasingly clear that only field geological observations on exhumed structures can differentiate between models for slow earthquake occurrence, as geodesy and seismology cannot resolve the relevant length scales.

For this conference, we solicit contributions that use geological observations, lab measurements, or numerical models to aid in understanding the physics of slow earthquakes. We encourage researchers studying analog systems from any tectonic setting or metamorphic grade relevant to modern tremor and slow earthquakes in order to build a wide range of geological perspectives. Contributions that address outstanding questions regarding deformation mechanisms, limits on rates of deformation, and environmental conditions are encouraged. New multidisciplinary approaches are needed to define the physical controls on slow earthquakes and to develop new insights into disparate datasets. For this conference, we aim to stimulate contributions from geological-focused, particularly field-based, investigators and to engage geophysicists with a range of backgrounds to define key unknowns and debate possible models.

PRELIMINARY OUTLINE OF THEMATIC SESSIONS

1. Cutting-edge observations of slow earthquakes;
2. Current understanding of the mechanics of slow earthquakes;
3. Geological perspectives on slow earthquakes;
4. Processes and physical properties of rocks that might be relevant to slow earthquake physics;
5. Key unknowns in slow earthquake physics; and
6. The hypotheses for slow earthquake mechanisms.

Sheeted vein complex in Little Harbour, Catalina Island, California, USA. Photo by John Paul Platt.

Folded blueschist in Little Canyon, Catalina Island, California, USA. Photo by John Paul Platt.

Poster sessions will be held every evening between talks and dinner, and will continue after dinner. Group discussions and breakout sessions will accompany all of the thematic sessions to promote cross-disciplinary interactions. One of the main goals of the meeting is to provide a forum for geologists and geophysicists to discuss how the existing information from the rock record should be integrated with the geophysical insights, as well as what new geological observations are needed to develop our understanding of the physics of slow slip further.

PRELIMINARY AGENDA

This five-day meeting will be held at the University of Southern California Wrigley Institute for Environmental Studies, Santa Catalina Island, California, USA. The meeting format will be a balance of invited talks, breakout discussions, pop-up talks, and poster presentations, with a day-long field trip on day three. All nights will be spent at the Wrigley Institute. Participants will be expected to observe the GSA Code of Ethics & Professional Conduct (**https://www.geosociety.org/ethics**) throughout the meeting.

The meeting will begin with a ferry ride to Santa Catalina Island, followed by an icebreaker on the evening of day one (27 June). Day two will focus on plenary talks presenting cutting-edge observations of slow earthquake phenomena, as well as mechanical insights from geophysical and numerical modeling studies. Geological characteristics of potential slow earthquake sources will be introduced. Days four and five will involve a combination of poster presentations, talks from participants, pop-up talks, panel discussions, and breakout groups to define hypotheses regarding the geological mechanisms of slow earthquake slip and explore interdisciplinary collaborations to further our understanding of slow earthquake phenomena. A return ferry will depart for the mainland targeting arrival around 5 p.m. for evening flight departures from Los Angeles International Airport.

Day three will be an all-day field trip for all participants, taking in several exposures within about a 30–40-minute drive from the Wrigley Institute. Santa Catalina Island has extensive exposures of a metamorphic complex of Cretaceous age that is generally considered to be part of the Franciscan Complex. Protolith rock-types include graywacke, pillow basalt, chert, and serpentinite, which have been variously metamorphosed under blueschist, high-pressure greenschist, amphibolite, and eclogite-facies conditions at depths of 35–50 km and temperatures of 300–700 °C in the Mesozoic subduction zone along the western North American margin. This range of depths and metamorphic temperatures encompasses the likely range of conditions found in the source areas for slow earthquakes on active margins such as Nankai or Cascadia, and beneath the Parkfield segment of the San Andreas fault. Deformational features include block-in-matrix mélanges with sedimentary or ultramafic matrixes, as well as extensive tracts of coherent but strongly deformed rock showing polyphase folding, ductile shear zones, and a variety of deformational fabrics. On Santa Catalina Island, the complex displays a variety of structural features that have been suggested as possibly associated with slow slip, including blocks of effectively rigid rock in a viscous matrix, sheeted vein complexes, and shear zones showing evidence for solution-redeposition creep associated with microfolding and dilational cracking.

ATTENDEES AND ESTIMATED COSTS

Thanks to the generous support of the sponsoring agencies, the majority of costs for the meeting are covered. The anticipated registration fee will be US$100. The registration fee will cover four nights of lodging, meals, transportation to/from Santa Catalina Island, transportation for field trips, and facility usage. Participants will be expected to pay for travel expenses from their home to Southern California. However, we have funds to support participant travel, which will be prioritized toward participants from underrepresented groups as well as early career and student participants. All participants will be expected to make their own travel arrangements to arrive at Long Beach, California, USA, in time for a scheduled ferry to the Wrigley Institute on Santa Catalina Island.

APPLICATIONS AND REGISTRATION

Application period opens: 1 Sept. 2020
Application deadline: 8 Jan. 2021
Registration deadline: 5 Mar. 2021

GSA and the meeting conveners are committed to fostering diversity, equity, inclusive excellence, and belonging in the geoscience community. For this meeting, we welcome and encourage applications from all gender identities, Black, Indigenous, Latinx, and People of Color, people with disabilities, LGBTQIA+ individuals, and other groups that are currently underrepresented within the earth-science community. The conference will be limited to 64 participants, and each participant will have to commit to attending for the full duration of the conference, because transport to/from Catalina Island is provided at the beginning and end of the meeting but otherwise is limited. To apply, please submit your application through the form on the meeting website: **https://sites.google.com/view/penrose2021/home.**

As part of the application, we ask that you prepare a brief statement of your interests and relevance of your recent work to the conference themes (max. 300 words) as well as a tentative title for a proposed poster presentation (required) and short pop-up talk (optional). After the registration deadline, participants will be asked to write a short review that summarizes the processes and/or mechanisms they believe are important to slow slip and tremor and the supporting evidence for these mechanisms. Applicants will be notified in early February 2021.

COVID-19 contingencies: The meeting conveners are closely monitoring the ongoing pandemic and are considering how this might impact the conference. It is hoped that a vaccine will be widely available prior to the conference, which will allow for group gatherings. Additional requirements or changes may be imposed to help mitigate the risks.

2020 GSA Research Grant Recipients

The 2020 GSA Committee on Research Grants awarded US$651,145 to 360 graduate students (~55% of the 658 who applied), with an average grant of US$1,809.00. The committee also selected 10 alternate candidates in the event that any grantees return all or part of their funds due to a change in their research project or receipt of funds from another source. The GSA Graduate Student Research Grant Program is funded by GSA, the GSA Foundation, GSA Divisions, GSA Sections, and the National Science Foundation (award #1949901). Students receiving NSF funds are indicated with an asterisk.

Committee members: Cindy Palinkas (Chair), Lyndsay B. Ball, Cathy J. Busby, Gwen M. Daley, Stephanie DeSisto, Besim Dragovic, James E. Faulds, Julie C. Fosdick, Melissa Ann Foster, David L. Fox, Josh C. Galster, Andrew M. Gombos, Jr., Steven J. Hageman, Andrea D. Hawkes, Ellen K. Herman, Shichun Huang, Kenneth Stephen Hughes, Miquela Ingalls, Alexandra R. Isern, William Thomas Jackson, Jr., Brian R. Jicha, Andrew Leier, Peter J. Modreski, Roberto Stanley Molina Garza, Daniel Jones Morgan, Nathan A. Niemi, Christopher J. Potter, Michael R. Rosen, Randall J. Schaetzl, Matthew Steele-Macinnis, Daniel F. Stockli, Benjamin Michael Tutolo, Ben van der Pluijm, Gary S. Weissmann, and James D. Wright.

Alternate Committee members: Zeynep Oner Baran, Whitney M. Behr, John Bershaw, Elizabeth W. Boyer, Jason P. Briner, William C. Burton, William Burton, Mark J. Caddick, Michelle L. Coombs, Martin Goldhaber, Judith Hannah, Michelle M. Lorah, Gregory Nadon, Qinhong Hu, Jay Quade, Mohammad Hassan Rezaie-Boroon, William (Ian) Ridley, Daniel Sturmer, Ellen Thomas, and Jennifer Thomson.

THE GEOLOGICAL SOCIETY OF AMERICA®

2020 Outstanding Mentions

(proposals having exceptional merit in conception and presentation)

Alejandra Angulo*, Texas Tech University
Lydia Bailey, University of Arizona
Sam Couch, Boise State University
Michael Ferraro*, Idaho State University
Alison Hafner*, Utah State University
Kyle Henderson, McGill University
Anna Hermes, University of Colorado Boulder
Elizabeth Langdon-Lassagne, University of Nevada, Reno
Amelia Nelson, Colorado State University
Caitlin Noseworthy, Illinois State University

2020 Named Awards

Sponsored by the GSA Foundation

Michele Aldrich History and Philosophy of Geology Student Research Award

Claire Sabel, University of Pennsylvania

The Michele Aldrich History and Philosophy of Geology Student Research Award Fund supports research grants through GSA's History and Philosophy of Geology Division for students who conduct historical research within the geosciences. Preference will be given first to doctoral, then master's level students. Graduates who received their Ph.D. in the previous five years may also be considered. The recipient is determined by the History and Philosophy of Geology Division of GSA.

Marland Pratt Billings and Katharine Fowler-Billings Research Award

Stephen Oni, McGill University (graduate student)
Rebekah Kennedy, University of Connecticut (undergraduate student)

The Marland Pratt Billings and Katharine Fowler-Billings Research Award encourages and promotes geological fieldwork and related research in New England and adjacent regions.

John A. Black Award

Collin Roland, University of Wisconsin–Madison

The John A. Black Award supports graduate student field-based research on coastal processes. All field-based coastal geomorphology research should be located in the USA, Puerto Rico, or Canada. In the event there are no worthy graduate student field-based research projects in coastal geomorphology, the award may be used to support graduate student field-based research in volcanology. All field-based volcanology research should be located in the USA, New Zealand, or Iceland.

Gretchen L. Blechschmidt Award

Stephanie Rosbach, University of Missouri

The Gretchen Louise Blechschmidt Award Fund was established for women in the geological sciences who have an interest in achieving a Ph.D. in the fields of biostratigraphy and/or paleoceanography, sequence stratigraphy analysis, particularly in conjunction with research in deep-sea sedimentology, and a career in academic research.

Ian S.E. Carmichael Research Award

Hailey Mundell, Pennsylvania State University

The Ian S.E. Carmichael Research Award supports graduate student research and related activities in the fields of igneous petrology and volcanology. The recipient is determined by GSA's Mineralogy, Geochemistry, Petrology, and Volcanology Division.

Allan V. Cox Research Award

Brandon Chase, University of Alberta

The Allan V. Cox Research Award supports research grants in geophysics. The recipient is determined by the GSA Geophysics and Geodynamics Division.

John T. Dillon Alaska Research Award

Anahi Carrera, University of Southern California

The John T. Dillon Alaska Research Award honors the memory of Dr. Dillon, who was particularly noted for his radiometric age-dating work in the Brooks Range, Alaska. Two areas that serve as guidelines for selection of the award are field-based studies dealing with the structural and tectonic development of Alaska, and studies that include some aspect of geochronology (either paleontologic or radiometric) to provide new age control for significant rock units in Alaska.

Robert K. Fahnestock Award

John Kemper, Colorado State University

The Robert K. Fahnestock Award honors the memory of Dr. Fahnestock, a former member of the Research Grants Committee, who died indirectly as a result of service on the committee. The grant is awarded for the best proposal in sediment transport or related aspects of fluvial geomorphology, Dr. Fahnestock's field.

Gould Research Grant

Reid Buskirk, Texas A&M University

The Gould Research Grant supports graduate student research in the geosciences.

Robert D. Hatcher Research Award

Bibek Giri, Montana State University

The Robert D. Hatcher Research Award supports field-based research and geologic mapping through an annual award to an outstanding graduate student in the earth sciences to conduct research for that student's master's thesis or Ph.D. dissertation. Preference may be given to students working in the Appalachian orogeny broadly construed, but is not restricted to this region.

William B. & Dorothy Heroy Research Grant

Nicholas Hammond, Virginia Polytechnic Institute and State University

Rachel Hohn, California State University, Northridge

Jenny Soonthornrangsan, University at Buffalo, SUNY

The William B. & Dorothy Heroy Research Grant supports graduate student research in the geosciences.

John W. Hess Research Grant

Keegan Donovan, Northern Arizona University

The John W. Hess Research Grant in Karst Research Studies supports student research involving any aspect of cave and karst studies aimed at providing improved understanding of how caves and karst work, including how these resources can be better managed. The recipient is determined by GSA's Karst Division.

Roscoe G. Jackson II Award

Brian Beaty, Yale University

The Roscoe G. Jackson II Award funds one recipient per year in the field of sedimentology.

Lipman Research Award

Oyeleye Adeboye, Oklahoma State University
Molly Anderson, University of Florida
Marisa Barefoot, Auburn University
Robert Bogue, McGill University
Meredith Cole, University at Buffalo, SUNY
Lissie Connors, University of Oregon
Connor Frederickson, Utah State University
Lisa Hlinka, The Graduate Center, CUNY
Allison Huisa, Northern Arizona University
Junyao Kang, Virginia Polytechnic Institute and State University
Jacob Klug, University of Wisconsin–Madison
Julia McIntosh, Southern Methodist University
Carolyn Mullins, New Mexico State University
Yon-Gyung Ryuh, University of Waterloo
Rachelle Sanchez, Miami University

The Lipman Research Fund was established in 1993 and is supported by gifts from the Howard and Jean Lipman Foundation. The purpose of the fund is to promote and support student research grants in volcanology and petrology. The president of the Lipman Foundation, Peter W. Lipman, was the recipient of a GSA research grant in 1965. The recipient is determined by the GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division.

John T. and Carol G. McGill Award

Daniel Gardner, Minnesota State University, Mankato
Brandon Graham, University at Buffalo, SUNY
Charlotte Wiman, Northeastern University
The John T. and Carol G. McGill Award, which is in the memory of John T. McGill, supports graduate student scholarships and research grants in engineering geology and geomorphology.

On To the Future (OTF) Research Grant

Kim Cone*, Colorado School of Mines
The purpose of this grant is to recognize an excellent student research proposal and connect the student to GSA's On To the Future (OTF) Program. OTF is a grassroots initiative that addresses GSA's overall strategic commitment to building a diverse geoscience community by engaging groups traditionally underrepresented in the geosciences. The student chosen for this grant will be invited to participate in the On To the Future program and receive a partial travel award, full meeting registration, and be recognized at the Diversity in the Geosciences Reception.

Bruce L. "Biff" Reed Scholarship Award

Kiana Harris, Western Washington University
The Bruce L. "Biff" Reed Scholarship Fund was established to provide research grants to graduate students pursuing studies in the tectonic and magmatic evolution of Alaska, primarily, and also can fund other geologic research.

Charles A. & June R.P. Ross Research Award

Yoseph Datu Adiatma, The Ohio State University
Erin Arneson, Georgia Southern University
Abby Lunstrum, University of Southern California
Christianne Ormsby, East Tennessee State University
Ceara Purcell, Ohio University
Veronica Vriesman, University of California, Davis
The Charles A. & June R.P. Ross Research Fund is awarded to support research projects for graduate students, post-graduate students, and post-doctorate researchers in the fields of biostratigraphy (including, but not limited to, fossil age dating and the study of evolutionary faunal successions), stratigraphy and stratigraphic correlation, paleogeography and paleobiogeography, interpreting past environments of deposition and their biological significance, and the integration of these research areas into better global understanding of (1) past plate motions (plate tectonics and seafloor spreading); (2) past sea-level events, including their identification and ages; and/or (3) climate changes and effects of those climate changes on Earth's inhabitants through geologic time.

Alexander Sisson Research Award

Emma Burkett, University of New Hampshire
Family members of Alexander Sisson established a fund in his memory to promote and support research for students pursuing studies in Alaska and the Caribbean.

Parke D. Snavely, Jr., Cascadia Research Award

Alexandra Snell, Texas A&M University
The Parke D. Snavely, Jr., Cascadia Research Award Fund provides support for field-oriented graduate student research that contributes to the understanding of the geologic processes and history of the Pacific Northwest convergent margin or to the evaluation of its hazard or resource potential.

Harold T. Stearns Fellowship Award

Behnaz Hosseini, Montana State University
Dr. Stearns established the Harold T. Stearns Fellowship Award in 1973 for student research on aspects of the geology of the Pacific Islands and the circum-Pacific region.

Lauren A. Wright & Bennie W. Troxel Student Research Award

Claudia Roig, University of Wisconsin–Madison
The Lauren A. Wright & Bennie W. Troxel Student Research Fund supports two graduate students in master's or Ph.D. programs conducting field-based research (1) in the region broadly centered on Death Valley National Park or (2) in the western and southern Basin and Range Tectonic Province.

2020 GSA Graduate Student Research Grant Recipients

(listed in alphabetical order by university; asterisks indicate students receiving NSF funds)

Arizona State University
Marisol Juarez Rivera*

Auburn University
Marisa Barefoot

Baylor University
Anna Ruefer

Boise State University
Sam Couch
Thomas Farrell
Cara Piske

Boston College
Megan Kopp

Brown University
Brendan Anzures*

California State University, Los Angeles
Kirstie Rascon*

California State University, Northridge
Jeng Hann Chong
Rachel Hohn
Greg Jesmok
Brandon Page
Liselle Persad
Shaparak Salek
Erin Schmitt
David Stone

California State University, Sacramento
Jo Black

Central Michigan University
Clara Brennan

Central Washington University
Riley Blanchard
Alyssa DeMott
Ryan Hampton
Jessica Hartman
Jana Macinnis*

Colorado School of Mines
Caroline Bedwell
Daan Beelen
Kim Cone*
Sawyer McFadden
Kalen Rasmussen

Colorado State University
Johanna Eidmann
Sarah Hinshaw
John Kemper
Amelia Nelson
Julianne Scamardo
Jens Suhr
Christophe Wakamya Simbo
Celeste Wieting*

Columbia University
Jordan Abell
Sarah Giles
Jonathan Lambert

Cornell University
Corey Hensen

Dalhousie University
Julia Cantelon
Natashia Drage
Nina Golombek
Philip Sedore

Dartmouth College
Karol Faehnrich

East Tennessee State University
Matthew Harrington
Christianne Ormsby

Florida International University
Vanessa Londono*

George Mason University
Lucas Cherry

Georgia Institute of Technology
Pan Liu

Georgia Southern University
Erin Arneson

Georgia State University
Francis Muchemi

Humboldt State University
Samuel Bold
Dana Christensen

Idaho State University
Michael Ferraro*
Logan Mahoney
Stuart Parker

Illinois State University
William Andrews
Caitlin Noseworthy
Mujen Wang*

Indiana University Bloomington
Anne Kort

Instituto Politécnico Nacional
Mónica E. Aparicio

Johns Hopkins University
Naomi Becker
Mary Lonsdale

Lehigh University
James Fisher

Louisiana State University
Rachel Gnieski*
Joseph Honings*

McGill University
Robert Bogue
Catherine Crotty
Kyle Henderson
Stephen Oni
Stan Roozen

Miami University
Rachelle Sanchez
Christina Tenison

Minnesota State University, Mankato
Daniel Gardner
Luis Lepe*

Missouri University of Science and Technology
Erdoo Mongol

Montana State University
Timothy Campbell
Bibek Giri
Behnaz Hosseini
Seth Mangini

New Mexico State University
Carolyn Mullins

North Dakota State University
Jordan Dahle

Northeastern University
Charlotte Wiman

Northern Arizona University
Eva Baransky
Timothy Brickey
Keegan Donovan
Allison Huisa
Joseph Thomas

Northern Illinois University
Alyssa Graveline
James Lightner
Donald McLennan
Brittany Price
Mackenzie Wegmann

Ohio University
Ceara Purcell
Joseph Wislocki*

Oklahoma State University
Michelle Abshire
Oyeleye Adeboye
Estefanny Davalos-Elizondo

Oklahoma State University Center for Health Sciences
David Kay

Oregon State University
Julia Fleiner
Katya Jay

Pennsylvania State University
Tsai-Wei Chen
Joanmarie Del Vecchio
Victor Garcia*
Hailey Mundell

Portland State University
Cameron Greenwood*

Purdue University
Brandon Keough
Alexandria Koester

Rutgers University
Vincent Clementi
Anya Hess
Christian Rowan

Rutgers University–Newark
Christopher Terra

Saint Louis University
Carly Finegan

Southern Methodist University
Julia McIntosh

State University of New York at Binghamton
Elizabeth Skaggs
Shawn Taylor

Syracuse University
Will Fisher

Tennessee Technological University
Rachel Kaiser

Texas A&M University
Reid Buskirk
Hannah Cunningham*
Kyungwon Kwak
Alexandra Snell

Texas A&M University Corpus Christi
Adrianna Chapa*

Texas Tech University
Alejandra Angulo*
Alex Washburn

The Graduate Center, CUNY
Lisa Hlinka

The Ohio State University
Yoseph Datu Adiatma
Michael Braunagel
Jacob Clyne
Lindsey Hernandez
Emilio Mateo*
Kenneth Peterman
Karl Wilhelmsen

The University of Alabama
Shuo Chen
Bridget Murray

The University of Alabama in Huntsville
Thuy Trang Vo

The University of Chicago
Rachel Laker

The University of Tulsa
Lauren Haygood

Tulane University
Jose Silvestre*

Universidad Nacional Autónoma de México (UNAM)
Luis Abel Jimenez Galindo
Julian L Mesa Rojas

University at Buffalo, SUNY
Meredith Cole
Anissa Croft*
Brandon Graham
Kayla Hollister
Erin Schuster
Jenny Soonthornrangsan
Caleb Walcott*

University of Alaska Fairbanks
Zena Robert*

University of Alberta
Brandon Chase

University of Arizona
Lydia Bailey
Anca Barla
Emilie Bowman
Jihyun Kim
Paula Ugalde
Jordan Wang*

University of Arkansas
Kaitlyn Fitzgerald
Ryan Strickland

University of British Columbia
Sophia Leiter

University of Calgary
Juan Diaz
Jacob Forshaw
Thomas Wilson

University of California, Berkeley
Sara Kahanamoku-Snelling*
Jaemin Lee
AJ White

University of California, Davis
Dylan Vasey
Veronica Vriesman
Elaine Young*

University of California, Los Angeles
Valeria Jaramillo Hernandez
Heather Kirkpatrick

University of California, Santa Barbara
Francisco Apen*
Thomas Johnson*
Brian Penserini
Mary Ringwood*

University of California, Santa Cruz
Araceli Serrano*

University of Cincinnati
Josephine Chiarello
Andrea Corpolongo
Ezekiel King Phillips*
Catherine Nield
William Sanchez*
Emily Simpson

University of Colorado Boulder
Abigail Eckland
Anna Hermes
Lina Perez-Angel

University of Connecticut
Samantha Dow
Madison Rosen*
Jonathan Smolen
Christopher Sparacio

University of Delaware
Mark Lundine
William Vincett

University of Denver
Meghan McCarroll

University of Florida
Molly Anderson
Nicole Greco
Peng Jiang

University of Georgia
Samantha Khatri*
Anik Regan*
David Richards*
Cleveland Tarp

University of Houston
Lisabeth Arellano*

University of Idaho
David Behrens
Jonathan Erdman
Haley Thoresen

University of Illinois at Urbana-Champaign
Mingfei Chen

University of Iowa
Kenneth Horkley
Emma Kroeger
Dustin Northrup
Trent Olson

University of Kansas
Jacquelin Lee
William Swanson*

University of Kentucky
Edward Lo*

University of Louisiana at Lafayette
Elham Hosseinzadehsabeti
Nina Zamanialavijeh

University of Maine
Scott Braddock

University of Maryland, College Park
Liam Peterson

University of Massachusetts Amherst
Hanna Elston*
Aeon Russo

University of Michigan
Allison Curley
Fabian Hardy*
Heidi O'Hora
Maria Alejandra Rodriguez Mustafa

University of Minnesota, Twin Cities
John He*
Christopher Schuler
Maximillian Van Wyk de Vries

University of Missouri
Gozde Altuntas
Emily Lessner
Kimberly Moore
Stephanie Rosbach

University of Montana
Chloe Boucher

University of Nebraska–Lincoln
Kristen Guthrie
Shashank Khatri
Nicholas Richard

University of Nevada, Las Vegas
Anthony Feldman
Giuseppe Lucia

University of Nevada, Reno
Sara Holden*
Elizabeth Langdon-Lassagne
Drew Levy

University of New Hampshire
Emma Burkett

University of New Mexico
Jonathan Keller

University of New Orleans
Malcolm Cross*

University of North Carolina, Chapel Hill
Wenshuai Li
Sarah Wells

University of North Carolina, Wilmington
Julian Hooker

University of North Dakota
Chioma Onwumelu
Ogochukwu Ozotta

University of Northern Colorado
Matthew Ettsen

University of Oklahoma
Joy Foluso
Chelsey Gallagher
Karelia La Marca
Delcio Teixeira

University of Oregon
Lissie Connors
Rachel Hampton*
Dana Reuter

University of Ottawa
Renelle Dubosq

University of Pennsylvania
Claire Sabel

University of Pittsburgh
Melissa Griffore

University of Puerto Rico, Mayagüez
Edwin Irizarry Brugman*
Viridis Miranda*

University of Regina
Jordan Deane

University of Rochester
Hannah Tompkins

University of Saskatchewan
Brayden McDonald

University of South Florida
Robert Constantinescu

University of Southern California
Anahi Carrera
Ryley Collins
Reena Joubert*
Abby Lunstrum

University of Tennessee, Knoxville
Kaitlyn Gauvey*
Tyler Grambling

University of Texas at Arlington
Binqian Yin

University of Texas at Austin
Kristina Butler
Jedidiah Dale
Nicholas Meszaros
Matthew Nix
Daniel Ruiz
Natasha Sekhon
Sinjini Sinha
Leland Spangler
Alison Tune
Charlie (Yu-Chen) Zheng

University of Texas at Dallas
Ning Wang

University of Texas at El Paso
Michael Laase
Derek Scott

University of Texas at San Antonio
Thomas Varner

University of Toronto
Katie Maloney

University of Utah
Erin Bessette-Kirton
Riley Finnegan
Hannah Hartley
Otto Lang
Jory Lerback*
Joshua Marquardt
Raul Ochoa*

University of Washington
Emma Heitmann

University of Waterloo
Tong Hong
Carson Kinney
Yon-Gyung Ryuh

University of Western Ontario
James Thayer

University of Wisconsin–Madison
Jacob Klug
Claudia Roig
Collin Roland
Rachelle Turnier*

University of Wisconsin–Milwaukee
Nancy Duque*
Jiyan Hatami
Gayantha Kodikara
Jordan Ludyan
Eduardo Menozzo da Rosa

University of Wyoming
Daniel Colwell
Brandi Lawler
Claudia Richbourg
Shane Scoggin

Utah State University
Emma Armstrong
Kaitlyn Crouch
Alexandra DiMonte
Connor Frederickson
Alison Hafner*
Christina Leonard
Tomsen Reed
Caroline Studnicky
Natalie Tanski

Vanderbilt University
Jessica Raff

Virginia Polytechnic Institute and State University
Nicholas Hammond
Junyao Kang
Brenen Wynd

Washington State University
Rachelle Hart

West Virginia University
Sara Schreder-Gomes*

Western Michigan University
Karem Abdelmohsen

Western Washington University
Edward Fordham
Kiana Harris
Liam Horner
Chantel Jensen
Charles Linneman
James Robinson
Jessica Shulman
Kalieh Singleton
Delaney Todd
E.N. Worthington*

William Marsh Rice University
Sydney Allen
Jackson Borchardt
Proteek Chowdhury

Yale University
Brian Beaty
Kristy Ferraro*

2020 GSA International, GSA Division, and GSA Section Student Research Grants

GSA International, GSA Divisions, and GSA Sections have recognized the following student research grant recipients who submitted proposals of exceptionally high merit in conception and presentation in their fields.

GSA International Graduate Student Research Grants

Farouk El-Baz Student Research Grants
Harriet Cornachione, Utah State University
Howard Head, University of Cape Town
This grant is to encourage and support desert studies by students world-wide either in their senior year of their undergraduate studies or at the master's or Ph.D. level.

Division Graduate Student Research Grants

Continental Scientific Drilling Division
Continental Scientific Drilling Division Student Research Grant
Kaitlyn Crouch, Utah State University
Hannah Hartley, University of Utah
Erdoo Mongol, Missouri University of Science and Technology
Alex Washburn, Texas Tech University

Geoinformatics & Data Science Division
Geoinformatics & Data Science Division Student Research Grant
Karelia La Marca, University of Oklahoma
James Robinson, Western Washington University
Shaparak Salek, California State University, Northridge
William Swanson*, University of Kansas
Thuy Trang Vo, The University of Alabama in Huntsville
Binqian Yin, University of Texas at Arlington

Geophysics & Geodynamics Division
Allan V. Cox Research Award and Supplement
Brandon Chase, University of Alberta
Geophysics Student Research Grant Award and Supplement
Jeng Hann Chong, California State University, Northridge

Hydrogeology Division
Hydrogeology Division Student Research Grant Awards
William Andrews, Illinois State University
Julia Cantelon, Dalhousie University
Jacob Clyne, The Ohio State University
Jihyun Kim, University of Arizona
Kyungwon Kwak, Texas A&M University

Mineralogy, Geochemistry, Petrology, and Volcanology Division
James B. Thompson Jr. Graduate Student Research Grant in Metamorphic Petrology and Geochemistry
Natashia Drage, Dalhousie University
Jacob Forshaw, University of Calgary
Christopher Schuler, University of Minnesota, Twin Cities

Quaternary Geology and Geomorphology Division
Peter Birkeland Soil Geomorphology Research Award
Jason Windingstad, Illinois State University
Denton, Andrews, Porter Glacial Geology Award
Gryphen Goss, University of Calgary
Arthur D. Howard Student Research Award
Edward Fordham, Western Washington University
J. Hoover Mackin Student Research Award
Celeste Wieting*, Colorado State University
Marie Morisawa Research Award
Joanmarie Del Vecchio, Pennsylvania State University
Stanley A. Schumm Research Grant Award
Alyssa DeMott, Central Washington University

Sedimentary Geology Division
Sedimentary Geology Division Student Research Grant Award
Jessica Raff, Vanderbilt University

Structural Geology and Tectonics Division
Structural Geology and Tectonics Division Student Research Travel Grant Awards
Emma Armstrong, Utah State University
Samuel Bold, Humboldt State University
Michael Braunagel, The Ohio State University
Daniel Colwell, University of Wyoming
Alexandra DiMonte, Utah State University
Emma Heitmann, University of Washington
Valeria Jaramillo Hernandez, University of California, Los Angeles
Shashank Khatri, University of Nebraska–Lincoln
Daniel Ruiz, University of Texas at Austin
Mackenzie Wegmann, Northern Illinois University

Section Graduate Research Grants

Southeastern Section Graduate Research Grants
Matthew Banaszynski, East Carolina University
Jian Chen, The University of Alabama
Tyler Grambling, University of Tennessee, Knoxville
Can Guven, Auburn University
Nora Lopez, Auburn University
Morrison Nolan, Virginia Polytechnic Institute and State University
Md Mahfujur Rahman, Auburn University

Section Undergraduate Research Grants

Rocky Mountain Section Undergraduate Research Grants
Shannon Ahern, Stockton University
Michael Cyrier, South Dakota School of Mines
Rudolph Engel, Stockton University
Christian Laing, Winona State University
Emily Nelson, North Dakota State University
Brianna McMaster Smith, University of Wyoming

North-Central Section Undergraduate Research Grants
Jessica Patrick, Miami University
John Pogalz, University of Wisconsin–Oshkosh
Adam Schmidt, University of Wisconsin–Milwaukee
Daniel Shi, University of Missouri

2020 AGeS2 (Awards for Geochronology Student Research2) Grants

AGeS offers opportunities for graduate students to develop the scientific rationale for projects involving geochronology and then provides them with hands-on experience acquiring data in labs, all while being mentored by geochronologists. This grants program is available to GSA student members and is separate from, but complementary to, GSA's longstanding Graduate Student Research Grants program. In 2020, 69 students submitted proposals, and awards were made to 18 students. The average award amount was US$8,364. These AGeS2 awardees will participate in teleconferences with the cohort of funded AGeS students over a two-year interval. Each awardee will also receive an additional US$500 to attend an AGeS cohort workshop preceding the 2021 or 2022 GSA Annual Meeting, and will be encouraged to present their results at the meeting. For more information, see the AGeS2 homepage: **www.geosociety.org/ages.** The AGeS2 program is supported by the National Science Foundation under the following awards: EAR-1759200, EAR-1759353, and EAR-1759201.

STUDENT	PROPOSAL TITLE	INSTITUTION	TECHNIQUE
Erin Bessette-Kirton	Birth of a Bridge: Cosmogenic Nuclide Depth Profile Dating of Fluvial Terraces to Determine the Formation Age of Rainbow Bridge, Utah	University of Utah	Cosmogenics
Xenia Boyes	Dating the onset of the Iceland plume: ^{40}Ar/^{39}Ar chronology of Baffin Island basalts	California Institute of Technology	^{40}Ar/^{39}Ar
Eric Brown	Testing Potential Triggering Mechanisms of Large Holocene Rock Avalanches, Whatcom County, Washington, USA	Western Washington University	Cosmogenics
Genna Chiaro	Reassessing a Supereruption: Investigating the Eruptive Tempo of the Ora Ignimbrites (Permian, Italy) with High-Precision ^{40}Ar/^{39}Ar Sanidine Ages	Vanderbilt University	^{40}Ar/^{39}Ar
Lisa Duong	Temporal-Geochemical Transition of Miocene-Quaternary Magmatism Towards Continental Characteristics at Cerro Chirripo National Park, Costa Rica	Georgia State University	^{40}Ar/^{39}Ar
Sarah Giles	Ediacaran Detrital Zircon Provenance in South Australia: Implications for the Age of the Shuram Excursion and Ediacaran Paleogeographic Reorganization	Columbia University	U-Th-Pb
Daianne Hofig	Age Linking Middle Miocene and Anthropocene climates: Novel Insights from ^{40}Ar/^{39}Ar geochronology	Texas A&M University	^{40}Ar/^{39}Ar
Allison Huisa	Understanding Silicic Magma Storage Using ^{238}U-^{230}Th Dating of Zircon and Chevkinites in a Dominantly Mafic Intracontinental Volcanic Setting	Northern Arizona University	U-Th-Pb
Chantel Jensen	Does Forearc Erosion Mirror Short-Term Megathrust Earthquake Cycle Deformation?	Western Washington University	Cosmogenics
Mary Lonsdale	Temporally Calibrating an Early Eukaryotic Fossil Assemblage with U-Pb CA-ID-TIMS Zircon Ages	Johns Hopkins University	U-Th-Pb
Logan Mahoney	Surficial and Geomorphic History of Reynolds Creek, Idaho	Idaho State University	U-Th-Pb
Eyal Marder	Testing Tectonic and Climatic Drivers of Transient Landscape Evolution in the Colorado Front Range Using River Profile Analysis and ^{10}Be Erosion Rates	Colorado State University	Cosmogenics

(*continued*)

STUDENT	PROPOSAL TITLE	INSTITUTION	TECHNIQUE
Lyle Nelson	Radiometrically Dating the Great Unconformity and the Ediacaran-Cambrian Boundary as Expressed in the Death Valley Region	Johns Hopkins University	U-Th-Pb
Oyewande Ojo	Thermotectonic History as Recorded in Footwall Blocks of the S. Malawi Rift and N. Shire Graben Border Faults: Insights from Apatite Fission Tracks	Oklahoma State University	Fission Track
Elizabeth Patterson	Reconstructing Precipitation Variability in Mainland Southeast Asia over the Last 20,000 Years Using Stalagmites	University of California, Irvine	U-series
Nicolas Perez-Consuegra	Using Apatite ^{4}He/^{3}He and U-Th/He Thermochronology to Unravel the Timing and Mechanism of Incision of the Cauca River Canyon in the Northern Andes	Syracuse University	(U-Th)/He
Valarie J. Smith	Timing of the Onset of Accretionary Orogenesis and Metamorphism Following ~100 m.y. of a Passive Margin Setting in the Southern Appalachian Orogen	Florida State University	U-series
Elaine Young	Characterizing the Rapid Uplift and Exhumation of the Fish Creek Vallecito Basin, Southeastern California	University of California, Davis	(U-Th)/He

THE GEOLOGICAL SOCIETY OF AMERICA®

2021 GSA Section Meetings

Northeastern

14–16 March
Connecticut Convention Center
Hartford, Connecticut
https://www.geosociety.org/ne-mtg

The skyline of Hartford, Connecticut, as seen from across the Connecticut River. Image by Jimaro Morales from Pixabay.

Southeastern

1–2 April
The Hotel at Auburn University
and Dixon Conference Center
Auburn, Alabama
https://www.geosociety.org/se-mtg

William J. Samford Hall, Auburn University. The George F. Landegger Collection of Alabama Photographs in Carol M. Highsmith's America, Library of Congress, Prints and Photographs Division.

Joint North-Central/South-Central

18–20 April
University Plaza Hotel
Springfield, Missouri
https://www.geosociety.org/nc-mtg

Downtown Springfield Park Central Square. Photo courtesy of the Springfield, Missouri, Convention and Visitors Bureau.

Cordilleran

12–14 May
Whitney Peak Hotel
Reno, Nevada
https://www.geosociety.org/cd-mtg

Volcanic geology of the Virginia Mountains, Nevada. Photo courtesy of Dr. Philipp Ruprecht, UNR faculty member.

Rocky Mountain

25–27 May
Colorado State University
Fort Collins, Colorado
https://www.geosociety.org/rm-mtg

Pineridge Natural Area. Image by Jan Alexander from Pixabay.

Teaching with Digital 3D Models of Minerals and Rocks

Graham D.M. Andrews*, Gabrielle D. Labishak, Sarah R. Brown, Shelby L. Isom, Holly D. Pettus, *and* ***Trevor Byers,*** *Dept. of Geology & Geography, West Virginia University, Morgantown, West Virginia 26506, USA*

The disruption to geoscience curricula due to the COVID-19 pandemic highlights the difficulty of making mineral and rock samples accessible to students online rather than through traditional lab classes. In spring 2020, our community had to adapt rapidly to remote instruction; this transition amplified existing disparities in access to geoscience education but can be a catalyst to increase accessibility and flexibility in instruction permanently. Fortunately, a rich collection of 3D mineral and rock samples is being generated by a community of digital modelers (e.g., Perkins et al., 2019).

THE NEED

Exposing students to mineral and rock samples is an essential component of most earth-science classes. However, we lack a widely accepted and accessible method to teach basic rock and mineral description, identification, and classification other than with physical ***hand*** samples. This impedes online teaching of geoscience, and it seems obvious that this restricts the potential for growth in online classes. It discriminates against differently abled students and those unable to attend typical in-person classes (e.g., Carabajal et al., 2017). Furthermore, the emphasis on physical samples favors programs with large and diverse sample collections: often older, better-funded, and more prestigious schools.

Digital samples have the potential to address many of these problems albeit with some drawbacks. "Virtual Rocks" (De Paor, 2016) have been generated from real samples for as long as 3D scanning technology has been available but have had limited impact and application. The development of low-cost and rapid structure-from-motion photogrammetry techniques means that a model can now be made in less than an hour using a cellphone camera and free or low-cost software on a consumer-grade computer. Sharing and viewing scientific 3D models is now routine and 3D printers and virtual-reality headsets are now commonplace in schools and many homes. So why has this technology not taken off in geology programs?

IMPEDIMENTS TO ADOPTION

Major advances in making digital geoscience data available have not been distributed equally between or within specific core disciplines. For example, the teaching of petrology has digital support for intermediate and advanced classes in microscopy, petrography, and virtual field trips (e.g., Cho and Clary, 2020). However, most efforts are directed to upper-level classes for geology majors and are less useful for introductory classes where the most students will engage with rocks and minerals, often for the first and only time.

Personal experience and anecdotal evidence gathered from online discussions support the conclusion that many faculty feel that students must be able to handle mineral and rock samples to develop a complete understanding. There is no doubt that elements of mineral identification are heavily dependent on physical interaction with specimens: hardness tests, steak-plate tests, heft, and feeling the soapiness of talc, for example. But if these cannot be replicated in an online environment, is that justification to not use digital models? We say **"no"**—many important observations of minerals, and most observations of rock samples, can be and often must be made by eye. Are field photographs of outcrops undermined by not being able to "lick the rock"? Here, we describe our first-hand experiences using digital models during the migration to online instruction in March 2020.

DIVING IN

We set out to develop an online collection of digital models of volcanic rocks and textures in spring 2019 to (1) take advantage of our large and diverse sample collection, including many unique samples; (2) make models available for remote instruction; and (3) share models with geoscience educators freely. Upon recognizing that model production was straightforward, we expanded our target samples to include a small suite of minerals and rocks for "Introduction to Minerals and Rocks," a required class for geology majors. As soon as COVID-19 disruption became critical, we produced models for a representative suite of rock samples, mainly igneous and metamorphic.

MODEL CONSTRUCTION AND DISSEMINATION

Our photography set-up consists of a lightbox, turntable, LED lights, and an 18 MP digital camera on a tripod (Fig. 1A), costing less than US$100 without the camera. We use Agisoft Metashape Pro photogrammetry software (Fig. 1B; annual academic license US$559**) on graphics-accelerated PCs noting processing time scales with RAM, and processor and GPU speeds. The model is uploaded to Sketchfab.com (http://sketchfab.com/WVUpetrology; Fig. 1C) where we store and share it. A Sketchfab Pro academic license is US$100. All our models have digital object identifiers and are free to download. Our workflow

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**Correction: This original version of this article identified the software as Agisoft Metashape Basic photogrammetry software with an annual academic license price of US$59, but at press time the authors became aware that Pro is now required. The article was modified to reflect this.

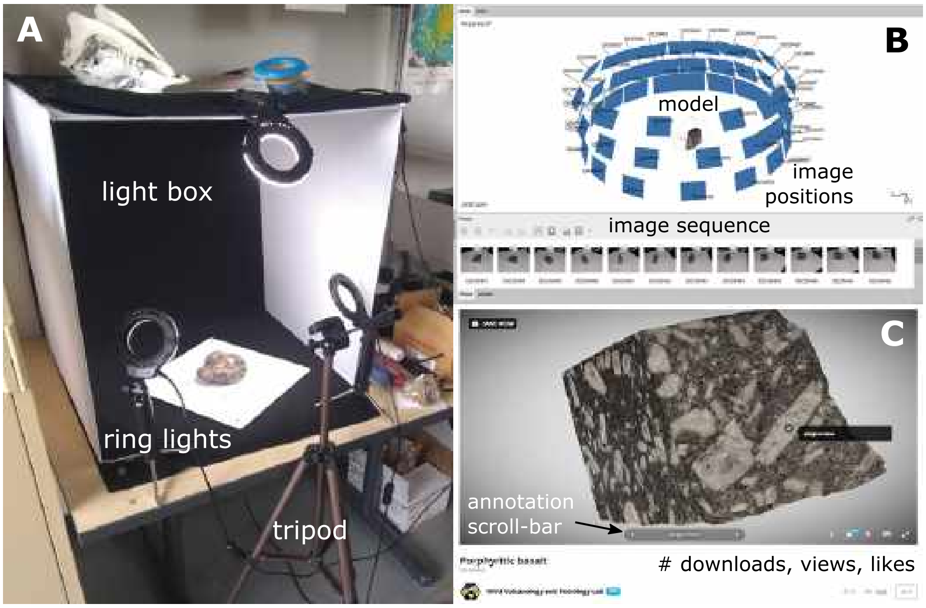

Figure 1. (A) Sample photography setup. (B) Model construction in Agisoft Metashape. (C) Finished model on Sketchfab.com.

(Supplemental Material[1]) is explained in a series of YouTube videos (currently in production; see https://www.youtube.com/watch?v=s6D6xFee7fU). Students can be trained quickly and be making models the same day. The software struggles to replicate reflective samples, those with homogeneous color, and those with complex morphologies.

CURATED SKETCHFAB COLLECTIONS

Our most novel action is to divide our samples into thematic collections on Sketchfab.com (http://sketchfab.com/WVUpetrology/collections) and to systematically add over 80 other users' models. As of June 2020, we have collections for minerals (n = 201), crystallography (53), igneous (320), metamorphic (276), sedimentary (255) and volcanic (251) rocks, meteorites (26), and fault-related rocks (28). New models are added daily. Samples range from mundane minerals and rocks essential for introductory classes through to museum-quality specimens. Samples divide into those that are labeled and those that come without information to facilitate online quizzes.

USE DURING COVID-19

Digital models cannot substitute for physical hand samples without changing the structure of lab classes. Limited assessment data indicate that students enjoy the virtual interaction and are confident with the technology (Alelis et al., 2015), and that they appreciate the flexibility it allows (Cho and Clary, 2020). However, students miss the hands-on examination and testing of specimens, and interactions with other students.

Rather than trying to substitute digital models in extant labs, we redesigned our labs around the digital models and virtual field trips. Enough models were available to introduce and apply modal mineral analyses to plutonic rocks and to allow students to reliably identify phenocrysts and porphyroblasts, for example. Students were able to distinguish between different rock types and to interpret textural information from the 3D models (e.g., bedding, etc.). Where important mineral information is not obvious (e.g., calcite reacting to HCl), we provide the necessary information in the questions.

FINAL THOUGHTS

Digital models of minerals and rocks are easy to produce and deploy in online classes, and although imperfect, they have advantages over hands-on samples when labs are redesigned accordingly. A large and growing collection of samples is being generated on Sketchfab.com, meaning that there has never been an easier time to include 3D models in your classes.

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[1]Supplemental Material: methodology. Please visit https://doi.org/10.1130/GSAT.S.12493373 to access the supplemental material, and contact editing@geosociety.org with any questions.

Learning from the Lockdown: The Silver Linings of a Virtual Conference

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BACKGROUND

Due to COVID-19, scientists and students alike moved from hallway discussions and group debates to working in isolation and participating in online classes. Academic and professional communities around the world have experienced significant cancellations of critical in-person events, including a number of scientific meetings. The University of Arizona Department of Geosciences 48th annual conference, GeoDaze, was no exception. GeoDaze was originally scheduled for April 2020, but all in-person university events were cancelled a few weeks prior. As organizers of the conference, we were initially devastated that we would not see all of our hard work come to fruition this year. Within a few days of the cancellation, our heartbreak transitioned to problem solving as we decided to redevelop the conference into an innovative virtual event. Surprisingly, there were several silver linings in the online conference that enhanced the event for attendees. As GeoDaze concluded, we wondered: What can we learn from the unprecedented pandemic lockdown to enhance scientific meeting experiences? Here we outline the benefits of transitioning a conference to an entirely virtual format, and we argue that some elements of online meetings are worth incorporating into a post–COVID-19 world.

GeoDaze is an annual university event inaugurated in 1972 that provides graduate and undergraduate students with the opportunity to present their latest geoscience research to the community. The entirely student-run conference draws in university alumni and geoscientists from industry, government, and academia. The ability for students to interact with professionals provides opportunities for career and academic growth through collaboration and guidance. This event often serves as the first opportunity for students to publicly present research, so there was a sense of urgency to maintain the annual tradition despite being met with initial hesitation and concern about moving GeoDaze to an entirely virtual format for the first time in history.

VIRTUAL CONFERENCE FORMAT

Considering that participants were uncertain about the new format, it was apparent that the website needed to be executed in a way that conveyed professionalism and reassured both participants and attendees that the virtual experience could be equally as effective as a traditional conference. In order to achieve this goal, we enlisted a GeoDaze committee member with a background in both geosciences and graphic design. This integration of multidisciplinary skills was a critical component lending to the success of the virtual conference. The culminating product, the GeoDaze 2020 website, was visually engaging and well organized (Fig. 1).

The site was built using SquareSpace, a website development platform, and CSS coding for customization. Conference attendees were able to easily navigate from the website home page, which served as a welcome platform with site navigation information and sponsor acknowledgments, to pages containing detailed conference information and scientific content. Traditional conference features, such as a welcome address, program, and conference schedule were available on the *About* page or in the linked *Program*, situated in the site navigation as a downloadable PDF. Although attendees could browse conference content at their own pace, the *Program* offered a suggested schedule to follow if the attendee wished to have a more traditional conference experience. In addition to these features, a conference *Store* was created to enable e-commerce transactions for conference merchandise, a key fundraising effort that normally takes place during traditional GeoDaze conferences.

Figure 1. Formatting and design of the GeoDaze 2020 website home page.

Presentations were organized by type on two separate webpages, titled *Posters* and *Talks*. All talks and oral poster explanations were prerecorded using Panopto, an online video platform often used in e-learning environments for managing and recording lectures. Each poster or talk session was accompanied by a live one-hour question-and-answer session hosted through Video Webinars, a feature of the teleconferencing software, Zoom. These live forums were formatted so that attendees could pose questions for individual presenters during moderated time, followed by a general discussion. Live sessions were not recorded, and presentations were only available for the duration of the conference out of respect for unpublished research. To conclude the conference, an awards ceremony was held through Zoom, paralleling the traditional GeoDaze experience. Although unexpected, the virtual GeoDaze conference highlighted several benefits that align with the American Geosciences Institute objectives, components of which are easily integrable with future in-person conferences (American Geosciences Institute, 2015).

ACCESSIBILITY

One of the major takeaways from this experience is the impact the virtual conference format had on accessibility, which also lends to overall inclusivity. Panopto allows users to prerecord, manage, and edit their

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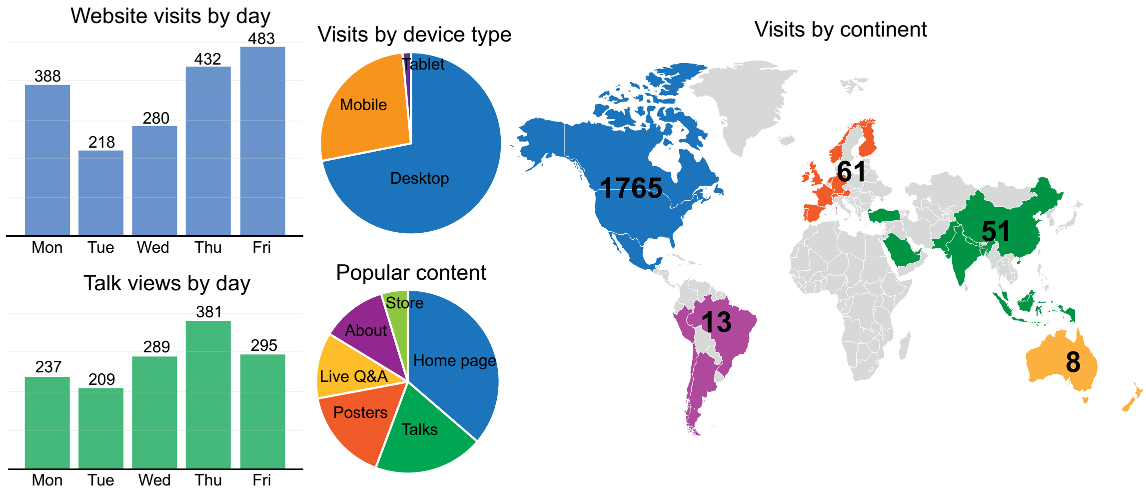

Figure 2. The virtual format made the world a smaller place, bringing people together from opposite ends of the globe to discuss science.

presentations, and recordings can be made available to a public audience or solely to those given access. The aspect of this technology that contributes the most to accessibility is the use of disability access features, such as video captioning and screen reader support, which enhance engagement of viewers with visual or auditory impairments. Many lines of evidence suggest that video captioning also improves retention of video content and viewer attentiveness for all (Gernsbacher, 2015). The additional function of variable speed playback can improve viewing for everyone, especially those with learning deficits, as it allows viewers to slow down or speed up recordings. These features, which were utilized during our virtual conference, are typically not available during in-person events, ultimately emphasizing the impact of virtually formatted scientific conferencing on accessibility.

INCLUSIVITY

The virtual format of GeoDaze made the conference available to people around the globe, compared to the normal in-person crowd of local attendees. Over the past five years, GeoDaze has averaged 130 registered attendees per year. This year the GeoDaze website had more than 1,300 unique visitors (a statistical count of non-repetitive website viewers). The *Talks* and *Posters* pages had more than 800 and 700 unique visitors, respectively. Website statistics recorded visitors from five continents (Fig. 2), providing for a much more geographically diverse audience than those of prior conferences. Additionally, website organization, formatting, and design all made it possible for people to access the conference on any device, which was ultimately beneficial considering that 27% of attendees tuned in on their mobile devices. Students and early career professionals often lack the financial resources to attend conferences, which can inhibit career and academic advancement, but virtual formatting alleviates this issue.

Under the traditional conference format, attendees must adhere to the conference schedule in order to participate. The virtual format allowed for asynchronous viewing of presentations; attendees were able to access and view prerecorded presentations at their own convenience and pace during the week that the website was live. This flexibility led to noticeably increased engagement during interactive sessions, likely because viewers could rewatch particularly complex presentations, improving comprehension, and they had time to postulate questions for the presenters. The use of a video conferencing platform gave attendees the option to ask questions vocally or to type questions in the *Chat* or *Q&A* software features. In our experience, this provided an environment that encouraged questions from all participants, including those who would normally feel too intimidated or embarrassed to ask in person. Although virtual interactions may not provide the same social gratification as face-to-face conversations, we found that the virtual *Q&A* sessions provoked interesting, and sometimes extensive, discussions that the traditional three-minute post-talk timeframe sometimes fails to encourage. On top of all of the aforementioned benefits for inclusivity, virtual conference formatting also addresses the growing concern for scientific meetings to reduce their carbon footprint.

FUTURE INTEGRATION

GeoDaze was one of many events around the globe that was disrupted by COVID-19. The goal of this piece was to highlight the fortuitous silver linings that came out of our means of adapting to the circumstances by developing a virtual conference. Given the positive takeaways outlined here, we believe that future in-person conferences could benefit from incorporating elements of virtual conferences, like ours, into the traditional format. With this suggestion, consider these key takeaways:

1. Virtual recording software, such as Panopto, offers disability features that increase accessibility for both presenters and viewers, an option that often does not exist for traditional conferences.
2. The asynchronous and virtual viewing format of our conference encouraged geographic viewer diversity, indicating that this format allows for increased accessibility and inclusivity.
3. The combination of accessibility features and self-paced conference attendance allows for better comprehension of scientific information, which can stimulate engagement during live session discussions, ultimately leading to increased scientific advancement.
4. This virtual conference serves as an example of how integrative collaboration of visual arts and science can produce innovative means for conveying scientific information that are highly effective due to the effects of enhanced visual literacy.

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Christopher G. Maples, *GSA Foundation President*

What Kind of Legacy Do You Want to Leave?

Over the past few months, COVID-19 has brought many disruptions to everyone's lives. We have all been affected to varying degrees by the ever-changing situation. However, in the midst of all the uncertainty we face, we have been inspired by the generosity of our donors.

You have continually shown your support during this time, including helping provide more than US$188,000 to students affected by COVID-19 through GSA's COVID-19 Assistance and Relief Effort for Students (GSA CARES). We started GSA CARES because one of our most valuable assets as a Society and profession is our students.

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Whether you are passionate about increasing the number of students from traditionally underrepresented groups in the earth sciences, helping students attend field camp, supporting geoscience research in a particular field or area, or ensuring that research gets a seat at the table in government policy-making decisions, we're available to discuss these options with you. There are many programs you can support and many ways you can offer that support.

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We're available at any time to discuss your plans and passions to help you leave the legacy you desire!

P. Geoff Feiss and Nancy West.

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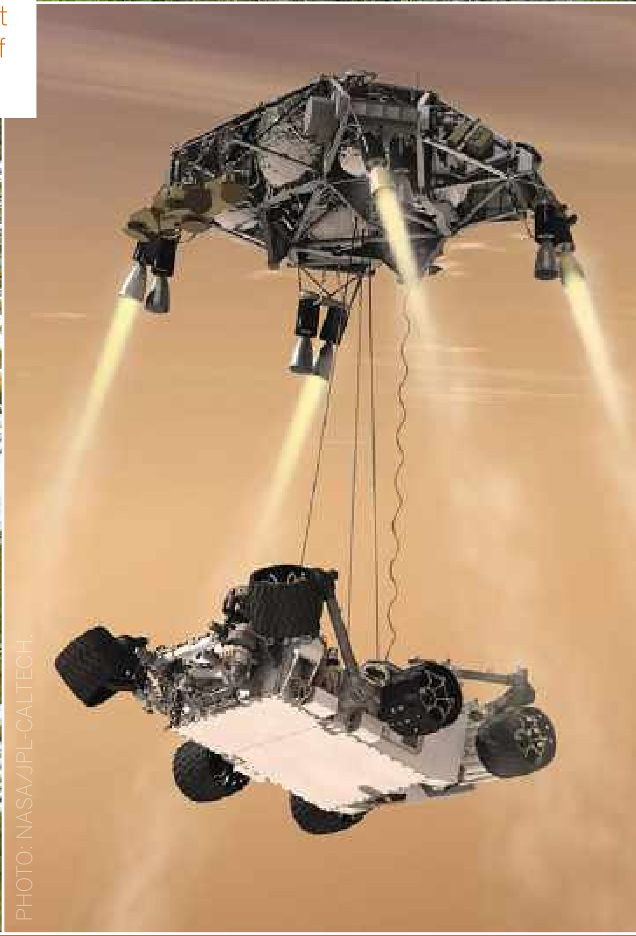
TAKING ON 21ST CENTURY CHALLENGES CREATING 21ST CENTURY LEADERS

From the Earth's core to outer space, research at The University of Texas at Austin's Jackson School of Geosciences is advancing the understanding of our world and beyond for the benefit of humankind.



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