Granite State Geologist

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Newsletter Editor: jlambert@nobis-group.com **Website:** http://www.gsnh.org/

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MESSAGE FROM THE PRESIDENT

Hello Friends,

For Christmas last year, my daughter gave me the book: "101 American Geo-Sites You've Gotta See" by Albert B. Dickas. I was amazed that, so far, I've been to 29 (nominally one-third) of the sites listed. By the way, Mr. Dickas only included one site in New Hampshire, that being Flume Gorge, for which his write-up includes a diagram and description of the fallen Old Man of the Mountain. This book got me thinking about what would be on my geological bucket list, or more precisely my must-see wish list. For a long time, I've been interested in exploring the copper mines in Michigan's Upper Peninsula (UP for short). The former building for the Geology Department at SUNY Fredonia (where I earned my BS) was Houghton Hall, named after a local who left western New York to seek his fortune in the copper mines of the UP. Mr. Dickas included the Quincy Mine in Hancock, MI. in his book. But copper is not the only geological attraction for me in the UP, there's the banded iron formations too. My supplemental investigations of must-see geological sites to visit, using guidebooks available on-line from the Institute on Lake Superior Geology, have only heightened my interest in visiting the UP and northern Minnesota region.

Unfortunately, my wife is not as enthusiastic as I am for exploring this vast and far-away place. Perhaps I could convince her that a trip there would be worthwhile for the food. We both grew up in the Buffalo, NY area where many restaurants specialize in Friday-night beer-batter fish fries, and slow-roasted prime rib on Saturday evening. I'm pretty sure that restaurants in the Lake Superior region would have a similar tradition. The Buffalo area also has a fair number of Polish and German restaurants. Man, I miss that food. Frankenmuth, MI is on the way to the UP, right?

Regarding banded iron formations, I had mistakenly assumed that steel production in the US was pretty much a thing of the past. I've been watching Duluth Harbor webcam videos on YouTube. I have been amazed by how much processed iron ore (taconite) gets shipped out of the Duluth, MN/Superior, WI port, on an almost daily basis. You might be amazed too by videos of the thirteen 1,000-foot long, 105-foot wide lake freighters arriving and departing the harbor. The largest, the MV Paul R. Tregurtha, is capable of carrying 68,000 tons of iron ore. These "iron boats" are too big for the Welland Canal to ship the ore beyond the upper Great Lakes. Therefore, it's all being made into steel in the US and Canada. I've added the Duluth/Superior Harbor to my personal must-see list.

And finally, regarding must-see geological sites, several members of the GSNH are working on an on-line guide to significant geological sites in New Hampshire. To be in the guide, the sites need to be accessible to the public. If you have suggestions for sites to be included in this guide, please send you suggestions to: Wayne Ives, CHRISTOPHER.W.IVES@des.nh.gov.

Hey, and reach out to someone who you haven't talked to in a while. You will both feel better because of your effort.

Tom

GSNH T-Shirts Still Available!

We have GSNH t-shirts available in size small, medium and large (sorry, sold out of extra large). T-shirts will be shipped to you – no need to wait until the next in-person meeting! See order form on second to last page (right before the renewal form).

Front (left photo) and back (right photo) of GSNH t-shirt.

April GSNH Meeting Recap

For our spring meeting (held via Zoom on April 15), Charlie Kerwin of Keene State College gave a presentation on “New Hampshire Geology and the Massabesic Gneiss Complex – What we Know”. He discussed the origins of the igneous rocks present in the Massabesic Gneiss Complex (MGC), as well as the issues that can make classification of these rocks more complicated.

Similar to the previous virtual meetings, we had a half hour of open social time prior to the meeting – it was nice to see all the attendees virtually!

Flights Above Northern Maine to Map Geology

From U.S. Geological Survey (USGS), release date May 12, 2021.
https://www.usgs.gov/news/media-alert-flights-above-northern-maine-map-geology

USGS Editor: In the public interest and in accordance with Federal Aviation Administration regulations, the USGS is announcing this low-level airborne project. Your assistance in informing the local communities is appreciated.

A low-flying airplane will be visible to residents of northern Maine beginning in mid to late May and lasting potentially through August 2021.

Cessna 208B Grand Caravan, airplane used to conduct low-level flights. Image courtesy Sander Geophysics Limited (SGL). **(Credit: Mike McManus)**

The low-level flights are being coordinated by U.S. Geological Survey and Maine Geological Survey scientists to image geology at the surface and below ground. The effort is part of the Earth Mapping

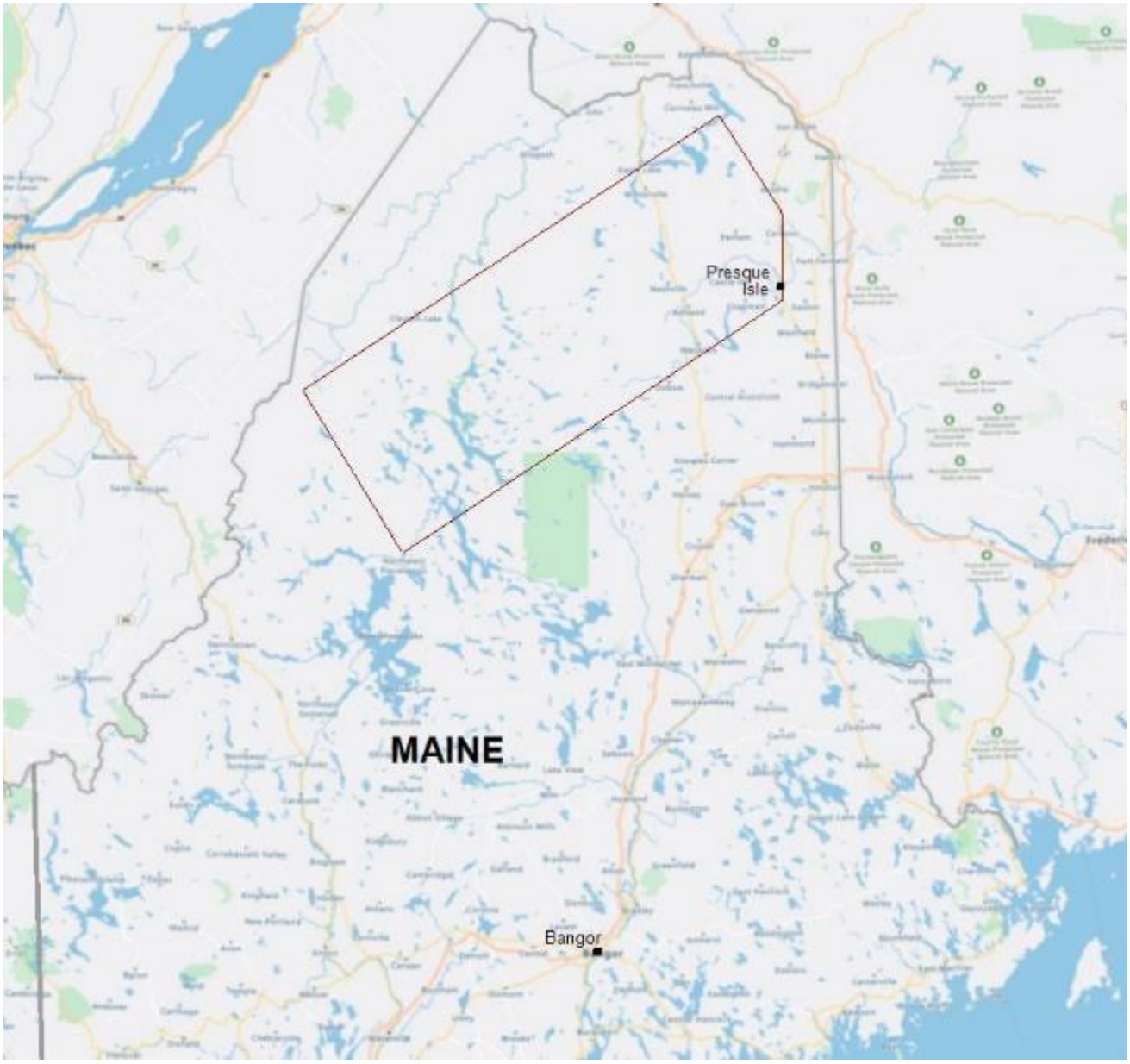
Resources Initiative (Earth MRI), a nationwide collaboration between the USGS and state geologists initiated in 2019 to better understand geology in particular areas.

“It has been more than 60 years since a public high-resolution survey was flown in northern Maine, and we are excited about the new information that the data will provide,” said Amber Whittaker with the Maine Geological Survey.

Instruments on the airplane will measure variations in the Earth’s magnetic field and natural low-level radiation created by different rock types up to several miles beneath the surface. This information will help researchers develop geologic maps in three dimensions, which can provide scientists with the framework needed to better evaluate natural resources, groundwater or earthquake hazards. The scientific instruments on the airplane are completely passive and do not pose a risk to humans, animals or plant life.

Cessna 208B Grand Caravan, airplane used to conduct low-level flights. Image courtesy Sander Geophysics Limited (SGL). **(Credit: Mike McManus)**

This survey will be flown at an altitude of 300 to 1,000 feet above ground by contractor Sander Geophysics Limited. Experienced pilots who are specially trained and approved for low-level flying will operate the aircraft. All flights will occur during daylight hours and are coordinated with the FAA to ensure accordance with U.S. law. The flights will be based out of Saint-Georges Airport (Saint-Georges Aerodrome) in Quebec, potentially moving to Presque Isle International Airport later in the survey. Parts of Aroostook, Penobscot, Piscataquis and Somerset Counties will be covered.



The USGS low-level airplane survey will take place within the polygon on the map, which covers several counties in northern Maine. (Public domain.)

Have you Renewed Your Membership?

If you have already renewed your GSNH membership this year, thank you! If now, please consider renewing. With membership, you get a discount on dinner meetings and field trips (which we are starting to prepare for!), information on upcoming events of interest, voting privileges at Society business meetings, and automatic subscription to this newsletter. Membership dues also help to support important geological outreach for the greater community.

See last page of this newsletter for a membership renewal application.

Kasha-Katuwe Tent Rocks National Monument, New Mexico

From Earth Science Picture of the Day, March 30, 2021.
Photographer and Summary Author: Brian Sauls
https://epod.usra.edu/blog/2021/03/kasha-katuwe-tent-rocks-national-monument-new-mexico.html

The unusual landforms seen above are located in the Kasha-Katuwe Tent Rocks National Monument, located about 20 miles (32 km) west of Santa Fe, New Mexico. Kasha-Katuwe means white cliffs in the Keresan Pueblo language. The materials composing these cone-shaped rock formations, or hoodoos, were deposited 6-7 million years from pyroclastic flows associated with violent volcanic eruptions in the nearby Jemez volcanic field. The total thickness of this volcanic layer, consisting of distinct layers of boulder-sized rock fragments, pumice, ash and tuff, exceeds 1,000 feet (300 m). As the rocks eroded over the millennia, spires were created by differential weathering and erosion, with the relatively soft pumice and tuff layers capped by more resistant boulders which have since toppled off. The whole array of tall pillars, which can reach 90 feet (27 m) in height, has left a series of deep, winding and slot-like recesses almost too narrow to walk through.

Kasha-Katuwe Tent Rocks National Monument, New Mexico Coordinates: 35.660278, -106.408333

Related Links:

- Bryce Canyon Hoodos
- Little Red Canyon Hoodoo

Student Links:

- Pyroclastic Flow
- Weathering, Erosion, and Sedimentary Rocks

Earth Observatory: Valles Caldera, New Mexico

What's Your Board Been Doing?

Submitted by Shane Csiki, Secretary
June 2021

For the first time in over a year, the Board met in person for its quarterly meeting on June 17th. It was great to see everyone face-to-face instead of as electron images on a computer screen, and to discuss the affairs of GSNH together in the same physical place! As usual for our June meeting, Lee Wilder hosted us at "Toad Hall" by the Contoocook River in Hopkinton. It was a beautiful evening, and I personally enjoyed watching the gold glow of the late afternoon sun against the fresh greenery gracing the trees on the other side of the adjacent field . . . all framed against a crystal clear blue sky.

As for the business of GSNH, the Board spent time discussing the logistics of an upcoming summer field trip and our future dinner meetings in the post-COVID-19 world. Presently, although our dinner meetings are lined up, and we have speakers for them, questions remain as to the feasibility (from the restaurant's side of things) of an in-person dinner meeting for October. The Board's goal is to return to in-person meetings as soon as practicable, so that everyone can interact personally once again. Stay tuned for further communications from the Board on these logistics as they are worked out. Though not ideal, GSNH has discovered Zoom from our recent experience and that can always serve as a fallback if necessary.

In other business, the Board discussed membership renewals, which have been difficult because we have not had in-person meetings. The Board also discussed possibilities for other avenues for members to renew memberships for consideration in the future. The project to develop a site of New Hampshire geologic sites of interest continues to evolve, and Wayne Ives presented a template to the Board for the online site descriptions as this project continues to develop.

Our next meeting will be on Thursday, September 16, 2021 at 6 PM. Alas, this meeting will be via Zoom once again. But, as shown in the photo on the next page, our June meeting was a great one in the beautiful New Hampshire outdoors!

June 17 GSNH board meeting. Photo by Lee Wilder.

Are You a K-12 Teacher? GSNH Has Grant Money Available!

GSNH has an on-going public outreach program for K-12 students and their teachers. GSNH has two separate funds to support K-12 teachers: The Lincoln R. Page Professional Fund reimburses teachers up to $300 for expenses related to their continuing education in the earth sciences, while the classroom enhancement grant reimburses teachers up to $500 to support the purchase of earth science teaching equipment or supplies for use in the classroom. See:

- Lincoln R. Page Professional Development Fund: http://www.gsnh.org/lincoln-r-page-fund.html
- Classroom Enhancement Grant: http://www.gsnh.org/classroom-grant.html

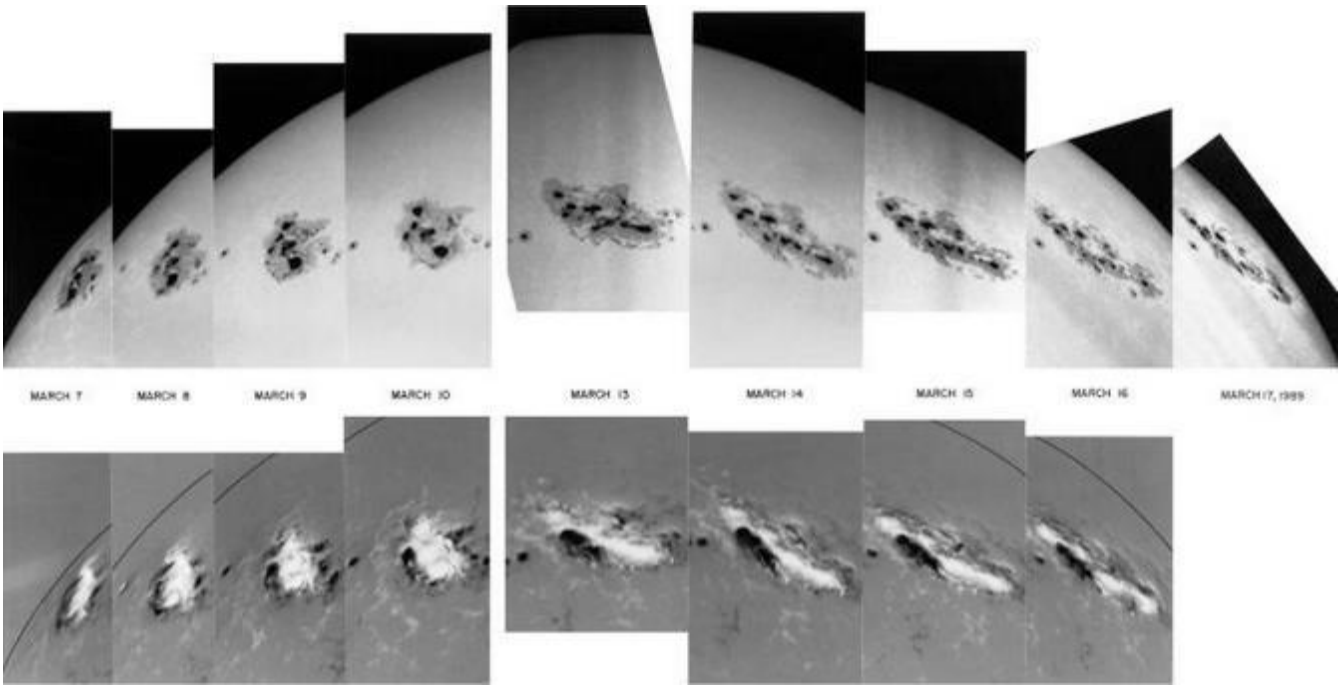
GSNH also maintains a list of volunteers to give Earth Science presentations to schools, so if interested, please reach out to Tom Fargo (Thomas.R.Fargo@des.nh.gov) to be added to the list.

The Great Québec Blackout

By Dr. Tony Phillips, spaceweather.com, March 12, 2021.
https://spaceweatherarchive.com/2021/03/12/the-great-quebec-blackout/

They call it “the day the sun brought darkness.” On March 13, 1989, a powerful coronal mass ejection (CME) hit Earth’s magnetic field. Ninety seconds later, the Hydro-Québec power grid failed. During the 9 hour blackout that followed, millions of Quebecois found themselves with no light or heat, wondering what was going on?

“It was the biggest geomagnetic storm of the Space Age,” says Dr. David Boteler, head of the Space Weather Group at Natural Resources Canada. “March 1989 has become the archetypal disturbance for understanding how solar activity can cause blackouts.”



Sunspot 5395, source of the March 1989 solar storm. From “A 21st Century View of the March 1989 Magnetic Storm” by D. Boteler.

It seems hard to believe now, but in 1989 few people realized solar storms could bring down power grids. The warning bells had been ringing for more than a century, though. In Sept. 1859, a similar CME hit Earth’s magnetic field–the infamous “Carrington Event“–sparking a storm twice as strong as March 1989. Electrical currents surged through Victorian-era telegraph wires, in some cases causing sparks and setting telegraph offices on fire. These were the same kind of currents that would bring down Hydro-Québec.

“The March 1989 blackout was a wake-up call for our industry,” says Dr. Emanuel Bernabeu of PJM, a regional utility that coordinates the flow of electricity in 13 US states. “Now we take geomagnetically induced currents (GICs) very seriously.”

What are GICs? Freshman physics 101: When a magnetic field swings back and forth, electricity flows through conductors in the area. It’s called “magnetic induction.” Geomagnetic storms do this to Earth itself. The rock and soil of our planet can conduct electricity. So when a CME rattles Earth’s magnetic field, currents flow through the soil beneath our feet.

Auroras over Pershore, England, during the March 13, 1989, geomagnetic storm. Credit: Geoffrey Morley.

Québec is especially vulnerable. The province sits on an expanse of Precambrian igneous rock that does a poor job conducting electricity. When the March 13th CME arrived, storm currents found a more attractive path in the high-voltage transmission lines of Hydro-Québec. Unusual frequencies (harmonics) began to flow through the lines, transformers overheated and circuit breakers tripped.

After darkness engulfed Quebec, bright auroras spread as far south as Florida, Texas, and Cuba. Reportedly, some onlookers thought they were witnessing a nuclear exchange. Others thought it had something to do with the space shuttle (STS-29), which remarkably launched on the same day. The astronauts were okay, although the shuttle did experience a mysterious problem with a fuel cell sensor that threatened to cut the mission short. NASA has never officially linked the sensor anomaly to the solar storm.

Grey areas indicate regions of igneous rock where power grids are most vulnerable to geomagnetic storms.

Much is still unknown about the March 1989 event. It occurred long before modern satellites were monitoring the sun 24/7. To piece together what happened, Boteler has sifted through old records of radio emissions, magnetograms, and other 80s-era data sources. He recently published a paper in the research journal Space Weather summarizing his findings — including a surprise:

“There were not one, but two CMEs,” he says.

The sunspot that hurled the CMEs toward Earth, region 5395, was one of the most active sunspot groups ever observed. In the days around the Quebec blackout it produced more than a dozen M- and X-class solar flares. Two of the explosions (an X4.5 on March 10th and an M7.3 on March 12th) targeted Earth with CMEs.

“The first CME cleared a path for the second CME, allowing it to strike with unusual force,” says Boteler. “The lights in Québec went out just minutes after it arrived.”

Among space weather researchers, there has been a dawning awareness in recent years that great geomagnetic storms such as the Carrington Event of 1859 and The Great Railroad Storm of May 1921 are associated with double (or multiple) CMEs, one clearing the path for another. Boteler's detective work shows that this is the case for March 1989 as well.

The March 1989 event kicked off a flurry of conferences and engineering studies designed to fortify grids. Emanuel Bernabeu's job at PJM is largely a result of that "Québec epiphany." He works to protect power grids from space weather — and he has some good news.

"We have made lots of progress," he says. "In fact, if the 1989 storm happened again today, I believe Québec would not lose power. The modern grid is designed to withstand an extreme 1-in-100 year geomagnetic event. To put that in perspective, March 1989 was only a 1-in-40 or 50 year event–well within our design specs."

Some of the improvements have come about by hardening equipment. For instance, Bernabeu says, "Utilities have upgraded their protection and control devices making them immune to type of harmonics that brought down Hydro-Québec. Some utilities have also installed series capacitor compensation, which blocks the flow of GICs."

Other improvements involve operational awareness. "We receive NOAA's space weather forecast in our control room, so we know when a storm is coming," he says. "For severe storms, we declare 'conservative operations.' In a nutshell, this is a way for us to posture the system to better handle the effects of geomagnetic activity. For instance, operators can limit large power transfers across critical corridors, cancel outages of critical equipment and so on."

The next Québec-level storm is just a matter of time. In fact, we could be overdue. But, if Bernabeu is correct, the sun won't bring darkness, only light.

Additional reading:

"A 21st Century View of the March 1989 Magnetic Storm" by David Boteler, head of the Space Weather Group at Natural Resources Canada.

"Geomagnetically induced currents: Science, engineering, and applications readiness" by Antti Pulkkinen (NASA/GSFC), Emanuel Bernabeu (PJM) and many others.

An Ancient Meltwater Pulse Raised Sea Levels by 18 Meters

By Tim Hornyak (@robotopia), Eos, June 2, 2021.
https://eos.org/articles/an-ancient-meltwater-pulse-raised-sea-levels-by-18-meters

Meltwater pulse 1A, a period of rapid sea level rise after the last deglaciation, was powered by melting ice from North America and Scandinavia, according to new research.

Data from Scottish isolation lakes like Loch Camas Drollaman, above, were used in a study of meltwater pulse 1A. Credit: Ian Shennan, Department of Geography, Durham University

The period of time when sea levels shot up at the end of the last glacial period, roughly 14,600 years ago, is known as meltwater pulse 1A (MWP-1A). Ever since this pulse was identified from coral records in 1989, the origins of the meltwater have been the subject of debate. Some researchers have hypothesized that Antarctica was the major source of the meltwater, whereas other scientists have suggested that it came from the Northern Hemisphere.

A new study in *Nature Communications* has concluded that melting ice sheets in North America, followed by Scandinavia, were the dominant drivers of MWP-1A and that the world's mean sea level rise was 17.9 meters over 500 years.

Sea Level Fingerprinting

To arrive at their conclusion, the international team of researchers used a technique known as sea level fingerprinting. The method stems from the knowledge that when ice sheets lose mass, their gravitational attraction also decreases. Nearby waters move away from the ice sheets, causing regional sea levels to rise faster farther away from the ice. Thus, different regions of the globe have different fingerprints.

Previous studies of MWP-1A have looked at sea level records in Barbados, Tahiti, and the Sunda Shelf in Southeast Asia. Authors of the new study added sea level data from other sites—the Great Barrier Reef and northwestern Scotland—to give a more robust spatial and temporal perspective on deglaciation. Their analysis of the new sites suggested that seas rose significantly more in the Southern Hemisphere, indicating that 65%–80% of MWP-1A's meltwater came from the Northern Hemisphere.

"In this case, the observed low sea level rise in the Northern Hemisphere supports a major northern contribution with a relatively minor Antarctic contribution," said coauthor Yucheng Lin, a researcher in the Department of Geography at Durham University. "Also, during the past 10 years, more and more Antarctic field-based glaciological evidence suggests the Antarctic Ice Sheet was relatively stable during MWP-1A," he added.

Insights on Climate Change Today

Yusuke Yokoyama, a professor at the University of Tokyo's Atmosphere and Ocean Research Institute who was not involved in the study, said the new research is a possible answer to the question of meltwater sources for MWP-1A, but that the debate is far from over.

Previous studies that analyzed data from Tahiti, Barbados, and the Sunda Shelf are reliable, according to Yokoyama, because they are based on uranium series dating. Data in the new study that came from the Great Barrier Reef and Scotland are based on a radiocarbon dating method, which "requires caution in interpreting the timing, particularly during the deglaciation," Yokoyama said.

The study's researchers said they were careful to use the updated method of calibrating the radiocarbon timescale. "This process will produce some complicated uncertainties regarding the dating

results, and we have used some statistical techniques to fully capture those uncertainties. In this case, our results considered those uncertainties carefully," said Lin.

In the future, the researchers want to study more sea level sites to better understand MWP-1A. They also want to see how they can use their results to replicate climate changes during the event, said Pippa Whitehouse, one of the study's coauthors and an associate professor of geography at Durham University. A better understanding of MWP-1A could yield insights into global ocean circulation behavior under rapid freshwater discharge and could provide better predictions of future climate change.

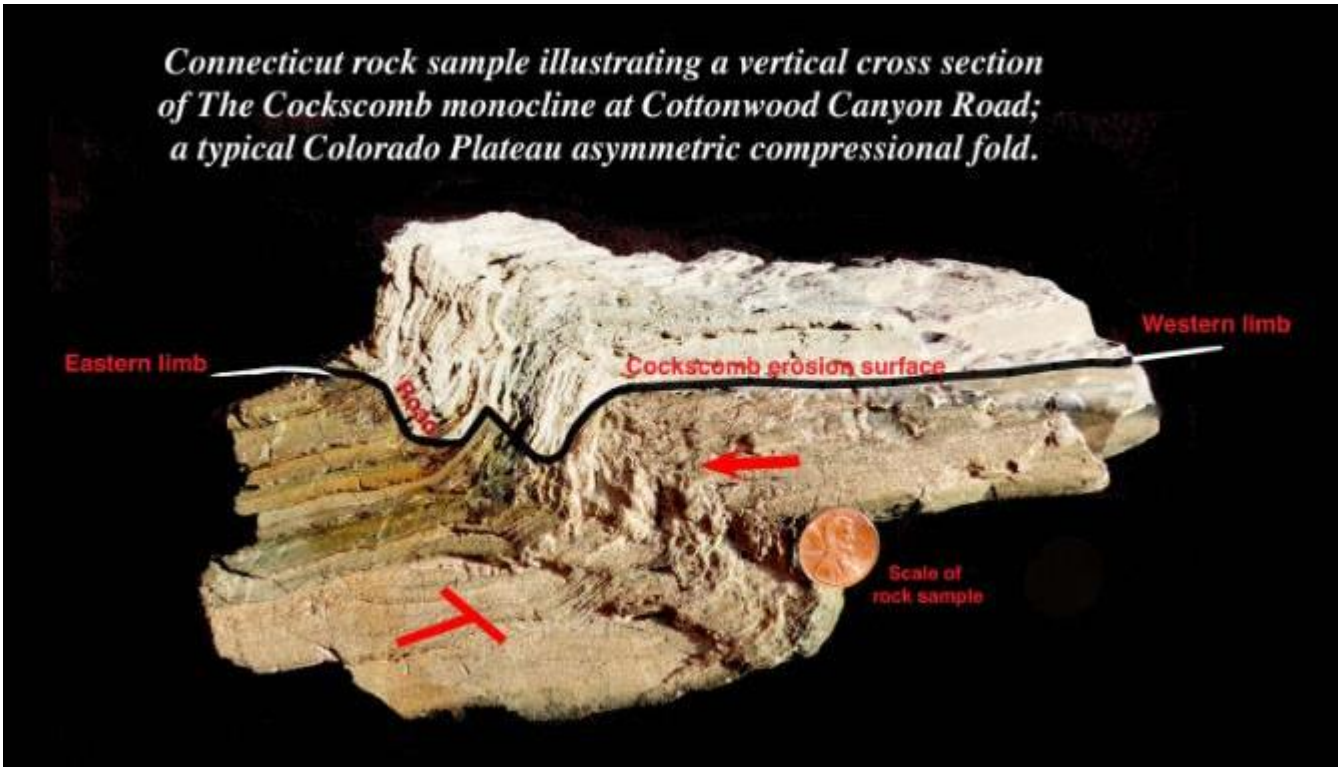
"We hope that our study will help climate modelers and paleoscientists piece together the impact of this event, with clear parallels for understanding the impact of increasing melt from the Greenland Ice Sheet today," said Whitehouse.

Citation: Hornyak, T. (2021), An ancient meltwater pulse raised sea levels by 18 meters, Eos, 102, https://eos.org/articles/an-ancient-meltwater-pulse-raised-sea-levels-by-18-meters. Published on 02 June 2021.

The Colorado Plateau and a Small Model of a Subduction Compression

From Earth Science Picture of the Day, June 4, 2021.
Photographer and Summary Author by: Thomas McGuire
https://epod.usra.edu/blog/2021/06/the-colorado-plateau-and-a-small-model-of-subduction-compression.html

The cause of uplift and the compressional features on the Colorado Plateau during the Laramide Orogeny (mountain building roughly 60 million years ago) were not understood until it was proposed that the Farallon Tectonic Plate is subducting at a low angle beneath the North American Plate. This is what raised the whole plateau. Additionally, compressional folding, including dozens of asymmetric folds (Cockscomb, San Rafael Swell, Comb Ridge, Raplee Anticline, Waterpocket Fold, and many others) was caused by frictional drag with the remains of the subducting Farallon plate. Many of the folds are also related to sub-surface compressional faulting.



Small scale rocks often reflect larger regional features. The top image is The Cockscomb monocline along Cottonwood Canyon Road in Arizona. The second image is a rock from Connecticut. What is

now western New England was an area of subduction in the closing of the Ordovician Pre-Atlantic Iapetus Ocean (about 400 million years ago), which created the Pangea land mass. This rock is a smaller-scale model of the Colorado Plateau's asymmetric compressional folds, like The Cockscomb. My drawing on the image shows how this smaller rock represents The Cockscomb (a penny is used for scale).

Cottonwood Canyon Road Arizona Coordinates: 37.306608, -111.886410

- Related links:
- Signature Features of the Colorado Plateau
- San Juan River at Raplee Monocline
- T. McGuire's Geology Books and Related Works

Amateur Radio Operators Help Fill Earthquake Donut Holes

By David J. Wald, Vincent Quitoriano, and Oliver Dully. From Eos, Science News by AGU., February 22, 2021.
https://eos.org/science-updates/amateur-radio-operators-help-fill-earthquake-donut-holes

If you've ever seen tall antennas rising from everyday residences in your community and wondered what they are for, it could be that those homes belong to ham radio enthusiasts who enjoy communicating with each other over the airwaves. In addition to having fun with their radios and finding camaraderie, many ham radio operators are also prepared to help neighbors and authorities communicate during disasters. One such group of radio enthusiasts is poised now to serve yet another important role: They will be contributing to a more robust delivery mechanism for critical seismic intensity reports after major earthquakes through the U.S. Geological Survey's (USGS) Did You Feel It? (DYFI) system.

Twenty Years, Millions of Reports

DYFI is a popular way for the public to help document macroseismic shaking intensity—if your answer to "Did you feel it?" is yes, it was macroseismic shaking—and contribute to earthquake science. The magnitude 5.1 earthquake that hit rural North Carolina on 9 August 2020, for example, resulted in more than 100,000 responses submitted to the DYFI system from people residing in more than 15 states.

DYFI involves a user answering a questionnaire about their experience and observations—from which USGS determines the shaking intensity at that person's location—and has been in operation for 2 decades (1999–2020) in the United States and for nearly 15 years globally. In that period, USGS has amassed more than 5 million individual DYFI intensity reports, spanning wide ranges of intensities and

felt distances. In addition to the scientific value of this collection, studies have shown that this type of civic engagement by the public improves awareness of natural hazards [Celsi et al., 2005]. For example, DYFI engagement can help clarify the difference between earthquake intensity (the effects and strength of shaking at a specific location) and magnitude (related to the area and distance of slip on a fault).

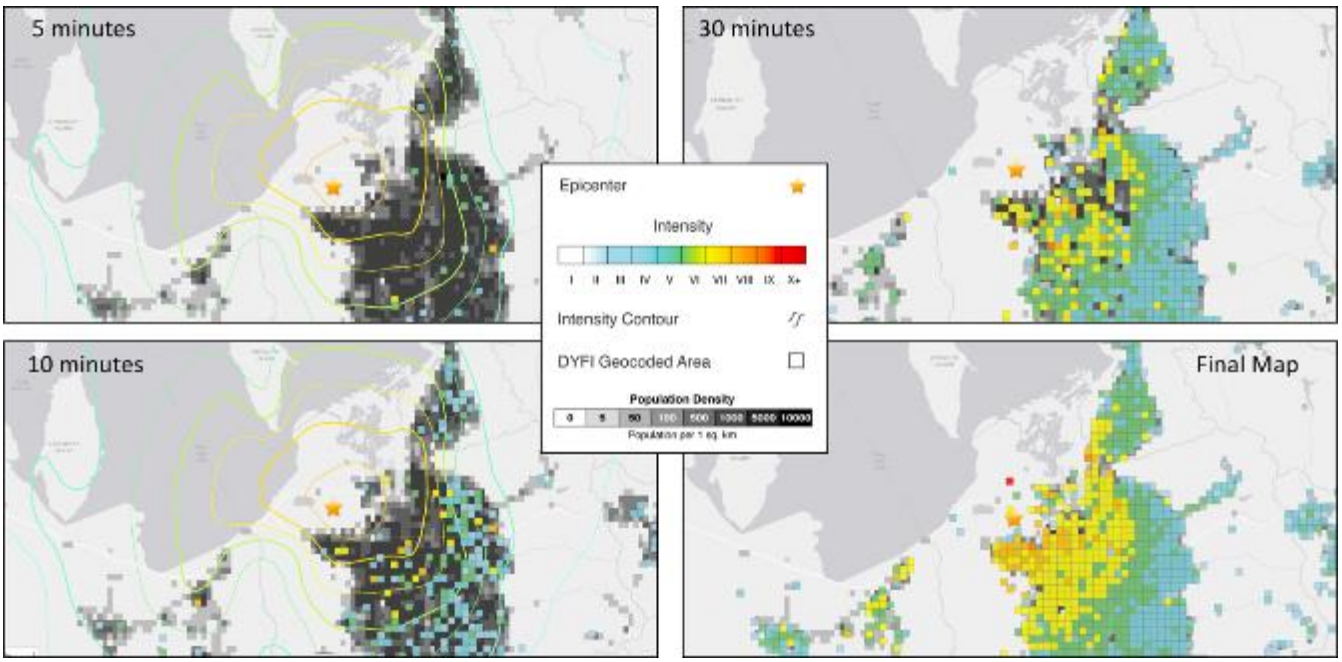
DYFI is also used to help constrain USGS ShakeMap, an important tool for situational awareness and emergency management widely used to depict an earthquake's shaking distribution and its likely effect on communities. For instance, the U.S. Federal Emergency Management Agency (FEMA) uses ShakeMap (and thus DYFI) to estimate losses immediately following damaging earthquakes in the United States to guide and expedite state and national disaster declarations.

Macroseismic intensity data collected through the DYFI system have proven to be accurate time and time again. At lower intensity levels, answers to the online questionnaire allow scientists to quantify the fraction of observers that felt an earthquake and where they felt it. At higher intensities, objective observations—such as whether objects fell off shelves—are prime indicators of absolute shaking levels. Other indices, such as qualitative felt levels (e.g., not felt, weak, mild, moderate, strong, violent), are categorized, as is often done in social science surveys, so that consistent numerical scores can be assigned to such perceptions [e.g., Goltz et al., 2020].

Scores of scientific papers rely on DYFI data to study earthquake shaking [e.g., Atkinson and Wald, 2007; Quitoriano and Wald, 2020, and references therein]. The reliability of these studies is due in part to the high quality of DYFI data and in part because DYFI can fill gaps where instrumental data are lacking but residents have access to cell phones and the Internet. In fact, DYFI data are often more accurate than seismometers for assessing damage because they provide actual reports (say, of chimney damage), whereas data from seismic instruments require inference to determine the likelihood of such damage. Naturally, the more DYFI reports that come in, the more robust intensity assignments become because many observations can be better analyzed statistically.

Unlike social media sourcing, which can provide useful first-person accounts during disasters, DYFI reports provide immediate, specific, and quantifiable intensity values deemed authoritative by the U.S. government. Critically, social media content requires careful curation, especially when large volumes of indiscriminate content are produced during a crisis situation. Twitter and online posts are informative but are more difficult to parse and use quantitatively or in an official capacity [e.g., Earle et al., 2011].

By contrast, DYFI, as a targeted questionnaire aimed at answering specific questions about shaking and damage, can be automatically processed and sent to ShakeMap to convey shaking and potential impacts. Remarkably, rates of DYFI responses sometimes exceed 70 submissions per second, and typically, about 90% of DYFI reports are acquired within 60 minutes of an earthquake.



The Did You Feel It report donut hole for the 2020 magnitude 5.7 Magna, Utah, earthquake that affected Salt Lake City. Color-coded shaking intensities (each block represents 1 square kilometer) atop population density estimates (gray scale shading) indicate an early gap in DYFI reporting from the most strongly shaken area. The final map shows DYFI reports after 8 hours

Sampling the "Donut Hole"

A potential problem with the DYFI system is that public access to it may be compromised as a result of strong earthquake shaking. Those affected may experience electrical power outages and limited Internet and cellular access, or they may have other immediate priorities, such as checking on those around them. USGS and other global seismic network operators have witnessed felt report "donut holes" in areas of strong shaking due to loss of Internet communication [Bossu et al., 2018], most recently during the M5.7 earthquake that hit near Salt Lake City in March 2020 (Figure 1). Alternative pathways are thus needed to gather important ground truth shaking data with minimal delay. To this end, we have recently come up with a plan B.

We now expect to sample the donut hole with the help of amateur radio groups worldwide. These groups, which already provide emergency communications capabilities to government agencies, hospitals, and other critical users during emergencies and disasters, can mobilize a significant number of licensed radio operators after a strong earthquake, especially near large population centers, ensuring a baseline level of macroseismic intensity reporting even in heavily affected areas.

To take advantage of this capability, USGS has partnered with Winlink, a radio email platform with more than 28,000 users worldwide, and with members of the Amateur Radio Emergency Service (ARES). In June 2020, Winlink experts adapted the USGS DYFI questionnaire to their software platform, and this version is now available to all licensed amateur radio operators. During a major earthquake, Winlink users can send their responses via radio to faraway receiving stations if their local Internet connectivity is compromised. These unaffected, out-of-area stations, or gateways, can then forward data via the Internet to USGS for immediate analysis.

Disaster Response, Past and Future

Amateur radio provides robustness and redundancy in the event of major communications failures, such as those experienced during the devastating 2017 Puebla, Mexico, earthquake and during Hurricanes Katrina, Irma, and Maria. During these events, Twitter and other social media platforms were unavailable locally. But amateur radio operators in the affected areas sent email via radio without local telecommunications infrastructure, often over hundreds or thousands of kilometers to unaffected gateways.

The ARES system is built to operate under such dire conditions: ARES responders are preregistered, have precise location information, and have verifiable identities. They also have training in other duties during emergency situations, such as facilitating communications among hospitals to help triage incoming patients and share resources, so they are more likely to submit high-quality data during an emergency.

The donut hole observed after the 2020 Salt Lake City earthquake (which was actually shaped more like a croissant) was small in scale, and although residents inside that area lost electrical power, the effects of the shaking were limited overall, and only light damage was reported [e.g., Kleber et al., 2021]. In contrast, effects will be far heavier over much larger areas during a major event.

The United States has not yet experienced a large earthquake domestically in the age of social media and has not experienced an event with devastating consequences for roughly a century (e.g., the direct metropolitan hits by the 1906 magnitude 7.8 Great San Francisco earthquake and the 1933 magnitude 6.3 Long Beach earthquake, which greatly affected Los Angeles). In such events in the future, scientists and emergency planners anticipate large-scale, complex, and unpredictable losses in communications. Amateur radio operators can bridge gaps and provide reliable on-the-ground observations from affected areas in a timely manner when other means of communications are offline.

Send in the COWs

Amateur radio is also uniquely flexible when it comes to choosing communications paths. In addition to their more traditional very high frequency (VHF) and high-frequency (HF; i.e., radio frequency) networks, operators have also built local high-speed data-voice (mesh) networks, which can interface with satellite-connected cells on wheels (COWs).

Communications companies use COWs at sporting events to provide additional network capacity, but they can be used similarly during disasters, as was demonstrated during the 2017 Thomas Fire and the 2018 Camp Fire, both in California. Other organizations, like FEMA and the Salvation Army, have their own COWs.

ARES has leveraged mesh networks to provide local Voice over Internet Protocol (VoIP) and video feeds in addition to Winlink (which works on these networks just as well). Most recently, ARES provided these services for the Monterey Park Fire Department in California during the 2019 ShakeOut earthquake scenario exercise. However, email and voice communications amateur radio frequencies on VHF and HF are more than sufficient for most situations, and DYFI for Winlink has been designed to be sent via VHF, HF, and mesh.

Standing By to Help

To develop backup plan B for DYFI, Winlink worked with USGS to implement the DYFI questionnaire with a DYFI-compatible ARES form. The questionnaire is now available to all ARES users, and the ARES/Winlink/DYFI connection has been widely tested in earthquake exercises and recent real events. The ARES/DYFI reports fit seamlessly with standard entries submitted via the Internet to the DYFI system.

ARES has promoted the new global radio email DYFI protocol through various media and has created a training video for ARES users. The organization has also set up training sessions and exercises among various radio operator communities in California, Washington, Arizona, Hawaii, and Mexico to test and promote the new form.

Internet-based access to DYFI as well as social media platforms may be compromised after a major seismic event. But the widely dispersed members of ARES are now standing by to help in the case of consequential earthquakes anywhere in the world. In such an event, those antennas towering above your neighbor’s home may just be a lifeline that helps emergency personnel come to the rescue.

Acknowledgments

The development of this Winlink DYFI form was made possible through a collaboration between USGS, the Winlink Development Team, and ARES LAX (Amateur Radio Emergency Service, Los Angeles). Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. government.

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Author Information

David J. Wald (wald@usgs.gov), U.S. Geological Survey, Golden, Colo.; Vincent Quitoriano, U.S. Geological Survey, San Diego, Calif.; and Oliver Dully, Amateur Radio Emergency Service, Pasadena, Calif.

DATES TO REMEMBER AND CANCELLATIONS

Please check online or the contact info below to confirm the status of these events. The list is current as of publication date but may change.

June 26-27, 2021 – **Gilsum Rock Swap & Mineral Show** – **CANCELLED** for 2021; next Rock Swap planned for June 25-26, 2022.

July 2021 – **Champlain Valley Gem, Mineral and Fossil Show** – **CANCELLED** for 2021; next show planned for July 23-24, 2022. http://www.burlingtongemandmineralclub.org/show.html

July 16-17, 2021 – **21st Annual Seek the Peak Adventure Expo** supporting the Mount Washington Observatory. https://secure.qgiv.com/event/stp2021/

August 13-15, 2021 – **East Coast Gem, Mineral and Fossil Show** – Better Living Center, Eastern States Exposition, West Springfield, MA: https://www.easternstatesexposition.com/events/2021/east-coast-gem-mineral-fossil

August 21, 2021 (rain date August 22, 2021) – **GSNH Summer Field Trip** – Nelson Eby will lead a half-day field trip in the Ossipee ring complex. Site access will be limited, and attendees will need to carpool to access the stops. The field trip fee will be $10. Details will be provided in a later email notification.

August 28-29, 2021 – **Capital Mineral Club Show** – Everett Arena, Concord, NH

September 16, 2021 – **GSNH board meeting**, virtual meeting

October 14, 2021 – **GSNH dinner meeting**, location TBD; Dr. Karen Johanesson at UMass Boston to give a presentation on arsenic in groundwater

October 23-24, 2021 – **Southeastern New Hampshire Mineral Club Show** – Dover Elks Lodge #184, 282 Durham Road, Dover, NH

Friends of the Pleistocene Summer Field Trip – **POSTPONED** to early June 2022. Look for more details in future issues.

Looking for some continuing ed credits? Some webinar series are below:

- clu-in.org compiles webinars of interest to EPA and the environmental community here: https://clu-in.org/training/#upcoming
- The geoscience online learning initiative (GOLI) has several webinars and short courses that are free, but do include an administrative fee for continuing ed credits: https://www.americangeosciences.org/workforce/goli
- Mineral Talks Live is a weekly webinar series produced by BlueCap Productions, the Mineralogical & Geological Museum at Harvard University, and the Society of Mineral Museum. The series is on YouTube: https://www.youtube.com/playlist?list=PLYUSEUgiTprl9Vh7ZLXu8x_hHp0dN_TDJ

Perseverance's Robotic Arm Starts Conducting Science

NASA Science Mars Exploration Program:
https://mars.nasa.gov/news/8944/perseverances-robotic-arm-starts-conducting-science/

NASA's newest Mars rover is beginning to study the floor of an ancient crater that once held a lake.

Mastcam-Z Views 'Santa Cruz' on Mars: NASA's Perseverance Mars rover used its dual-camera Mastcam-Z imager to capture this image of "Santa Cruz," a hill about 1.5 miles (2.5 kilometers) away from the rover, on April 29, 2021, the 68th Martian day, or sol, of the mission. The entire scene is inside of Mars' Jezero Crater; the crater's rim can be seen on the horizon line beyond the hill.
Credit: NASA/JPL-Caltech/ASU/MSSS.

NASA's Perseverance rover has been busy serving as a communications base station for the Ingenuity Mars Helicopter and documenting the rotorcraft's historic flights. But the rover has also been busy focusing its science instruments on rocks that lay on the floor of Jezero Crater.

Perseverance's Mastcam-Z Images Intriguing Rocks: NASA's Perseverance rover viewed these rocks with its Mastcam-Z imager on April 27, 2021. Credit: NASA/JPL-Caltech/ASU/MSSS.

What insights they turn up will help scientists create a timeline of when an ancient lake formed there, when it dried, and when sediment began piling up in the delta that formed in the crater long ago.

Understanding this timeline should help date rock samples – to be collected later in the mission – that might preserve a record of ancient microbes.

A camera called WATSON on the end of the rover's robotic arm has taken detailed shots of the rocks. A pair of zoomable cameras that make up the Mastcam-Z imager on the rover's "head" has also surveyed the terrain. And a laser instrument called SuperCam has zapped some of the rocks to detect their chemistry. These instruments and others allow scientists to learn more about Jezero Crater and to home in on areas they might like to study in greater depth.

One important question scientists want to answer: whether these rocks are sedimentary (like sandstone) or igneous (formed by volcanic activity). Each type of rock tells a different kind of story. Some sedimentary rocks – formed in the presence of water from rock and mineral fragments like sand, silt, and clay – are better suited to preserving biosignatures, or signs of past life. Igneous rocks, on the other hand, are more precise geological clocks that allow scientists to create an accurate timeline of how an area formed.

One complicating factor is that the rocks around Perseverance have been eroded by wind over time and covered with younger sand and dust. On Earth, a geologist might trudge into the field and break a rock sample open to get a better idea of its origins. "When you look inside a rock, that's where you see the story," said Ken Farley of Caltech, Perseverance's project scientist.

While Perseverance doesn't have a rock hammer, it does have other ways to peer past millennia's worth of dust. When scientists find a particularly enticing spot, they can reach out with the rover's arm and use an abrader to grind and flatten a rock's surface, revealing its internal structure and composition. Once they've done that, the team gathers more detailed chemical and mineralogical information using arm instruments called PIXL (Planetary Instrument for X-ray Lithochemistry) and SHERLOC (Scanning for Habitable Environments with Raman & Luminescence for Organics & Chemicals).

"The more rocks you look at, the more you know," Farley said.

And the more the team knows, the better samples they can ultimately collect with the drill on the rover's arm. The best ones will be stored in special tubes and deposited in collections on the planet's surface for eventual return to Earth.

More About the Mission

A key objective for Perseverance's mission on Mars is astrobiology, including the search for signs of ancient microbial life. The rover will characterize the planet's geology and past climate, pave the way for human exploration of the Red Planet, and be the first mission to collect and cache Martian rock and regolith (broken rock and dust).

Subsequent NASA missions, in cooperation with ESA (European Space Agency), would send spacecraft to Mars to collect these sealed samples from the surface and return them to Earth for in-depth analysis.

The Mars 2020 Perseverance mission is part of NASA's Moon to Mars exploration approach, which includes Artemis missions to the Moon that will help prepare for human exploration of the Red Planet.

JPL, which is managed for NASA by Caltech in Pasadena, California, built and manages operations of the Perseverance rover.

For more about Perseverance:

- mars.nasa.gov/mars2020/
- nasa.gov/perseverance

Archive – Schunemunk Mountain Conglomerate

From Earth Science Picture of the Day, May 29, 2021.
Photographer, Summary Author and copyright by: Dan Brownstein
https://epod.usra.edu/blog/2021/05/archive-schunemunk-mountain-conglomerate.html

Every weekend we present a notable item from our archives. This EPOD was originally published May 29, 2004.

This is an outstanding example of a puddingstone conglomerate from Schunemunk Mountain in New York. Schunemunk Mountain is an isolated Devonian-age ridge in a sea of Ordovician-age Martinsburg Shale. Note the exceptionally large quartz cobbles. Conglomerates form in near-shore environments, similar perhaps to what beaches look like today in Northern California. The Schunemunk puddingstone was also extensively polished during the last glacial period, which further reveals the unique texture of this rock. [See photograph next page.]

Related Links:

- Puddingstone
- Schunnemunk State Park
- Conglomerate

Memorial Spot – Jason Fopiano

In memory of fellow geologist Jason Fopiano, his family has placed a granite bench at the Scenic Vista in Intervale, New Hampshire (3654 White Mountain Highway). Jason's bench overlooks the valley right up to the peak of Mount Washington - he loved our White Mountains and his family believes his spirit is there now. When you drive through North Conway in the future, please stop and take a seat for a while.

Abby and Roslyn Fopiano with Jason's memorial bench. Photo from Abby Fopiano.

The text on the bench is:

THE MOUNTAINS ARE CALLING AND I MUST GO - John Muir

For Jason Fopiano, and avid hiker and skier whose heart is forever in the White Mountains.

Loved and remembered by his wife, daughter, family and friends.

August 10, 1977 – November 13, 2020

Thousands of abandoned Ohio oil and gas wells may be hidden. Drones could help find them.

By Kathiann M. Kowalski. May 10, 2021. https://energynews.us/2021/05/10/thousands-of-abandoned-ohio-oil-and-gas-wells-may-be-hidden-drones-could-help-discover-them/

After successful trials using drones to discover abandoned oil and gas wells, Ohio authorities are looking to expand their use and to speed up remediation at hundreds of sites across the state.

This abandoned oil well, dating back to the early 1900s, was finally plugged in September 2020. Credit: Ohio Department of Natural Resources

Ohio has roughly 1,000 sites on its orphan well inventory. There likely are “many more,” said Eric Vendel, chief of the Ohio Department of Natural Resources’ Division of Oil and Gas Resources Management. The hope is that drones equipped with magnetometers could help locate wells that are not yet on the state’s radar.

Workers plug a natural gas well at an elementary school in Lorain, Ohio in 2015. The recently constructed school had to be evacuated when the well, located underneath the gym floor, began leaking gas. Credit: Ohio Department of Natural Resources

Orphan wells matter because they can continue to emit methane, a health and fire risk if not properly contained. Methane also is 84 times more potent as a greenhouse gas than carbon dioxide is over a 20-year time span. Abandoned oil and gas wells have also contaminated soil and groundwater.

Orphan wells in Ohio are a subset of the larger group of abandoned oil and gas wells, where no legally responsible owner can be found. Until wells are identified, however, it's unclear whether they should be fixed by the state under its orphan well program.

Until now, there haven't been good tools to systematically identify which of the quarter-million wells drilled in the state since the mid-19th century have been properly plugged or should be deemed orphan wells. In many cases, wells have come onto Ohio's orphan well list only after people reported problems. In one case, for example, a well was found under the gym floor at a Lorain County grade school. Nor has any systematic on-the-ground survey been done to check whether recorded wells were properly plugged.

Magnetometers have been used to find wells and other geological anomalies for decades. The equipment looks for specific changes in the ground's magnetic field that signal the presence of a vertical well casing. Walking sites with equipment is time-consuming, however, so it hasn't been done in a systematic manner statewide.

The growing popularity of remotely piloted aerial vehicles, or drones, within the last 20 years has paved the way for surveys to be done efficiently over larger areas. The magnetometer itself looks like a yard-long white surfboard. It hangs from a remote-controlled drone with a wingspan of 4 to 5 feet.

"It's a pretty big piece of equipment," said Rob Lowe, a survey section manager at the Ohio Department of Natural Resources's Division of Oil and Gas Resources Management. His section was formally established in 2016.

Work by a team from the National Energy Technology Laboratory, ODNR and others confirmed the technology's viability at last June's Unconventional Resource Technology Conference. The team's report showed that the drones found known wells and some that hadn't been reflected in official records.

In one instance, Lowe and others flew the drone over an area of roughly one square mile in Hancock County's Eagle Township, about 6 miles southwest of Findlay. Historical records indicated the presence of 39 wells, Lowe said. Data from the drone's magnetometer suggested there could be nearly 90. The wells would be more than a century old.

An aerial survey identified dozens of leaking wells in Hancock County, Ohio. Credit: Ohio Department of Natural Resources

In most nonmilitary cases, drones can currently fly only where their operators have a clear line of sight. That presents problems for forested areas. Those include large parts of eastern Ohio, where fracking and horizontal drilling technology have led to thousands more oil and gas wells in the last decade. The equipment likewise doesn't work as well in heavily populated areas. Buildings and other structures can interfere with readings.

Not all wells have original metal casings, either. Steel was in short supply during World War II, so many casings were ripped out, said Jason Simmerman, an engineer in ODNR's orphan well program. A remote sensing technology called LIDAR — for LIght Detection And Radar — might help. It uses pulsed laser beams and other data to detect small changes in topography.

“It’s going to give us a really detailed surface model of the ground,” Simmerman said. Small depressions or old roads could suggest places to look more closely for old wells.

Expanding the program

A 2018 law effectively doubled the money earmarked for orphan wells by bumping it from 14% to 30% of the state’s oil and gas severance taxes. Now the state hopes to use the technology on a broader scale, although the timetable isn’t firm. The state also is looking to increase its pace for plugging problem wells.

A review of ODNR data by FracTracker researchers Ted Auch and Matt Kelso found fewer than 80,000 plugging dates for 238,216 oil and gas wells across the state. That left more than 158,000 wells. By comparison, McGill University researchers estimated Ohio has 183,090 abandoned oil and gas wells in a January 2021 study in Environmental Science & Technology.

“We just have horrible data on the location and condition of our oil and gas wells,” Auch said.

“The problem is massive,” said Scott Peterson, executive director at the Checks and Balances Project. He wants to see a comprehensive statewide survey with the drones done as soon as possible. “The state needs to step up.”

Vendel wouldn’t guess at the total number of orphan wells. He thinks the drone technology could help locate “hundreds, if not thousands, more wells,” based on results from the trial work. “Regardless of those numbers, it’s going to take us a long time to catch up,” he said.

ODNR awarded contracts to plug 131 wells in fiscal year 2020. The agency has stated a goal of plugging at least 200 wells per year for each of the next few years. If the number of orphan wells is even half the FracTracker estimate, remediation could take nearly 400 years at that pace.

Earlier this year, ODNR put out a call for contractors to do more plugging work. Many companies that can do remedial well work also can work on drilling sites, Vendel noted.

More use of the magnetometers and other high-tech tools would ideally let ODNR batch plugging jobs together, Vendel said. For example, a project to plug a high-priority well could add on several nearby wells, saving time and providing economies of scale. That includes the contracting process, gaining

site access, mobilizing equipment and so on. Larger jobs would likely be more attractive for companies to bid on.

Workers performed an emergency plugging of a gas well in the village of Coal Grove, Ohio, in March 2020 after neighbors reported a natural gas odor.

Yet site conditions often present surprises. “We could find cannonballs down these. We could find trees shoved down them,” Vendel said. Some stream beds also have shifted over the last century and a half, so that some sites might well be under water.

An April 2021 report from the Ohio River Valley Institute estimates that a comprehensive plugging program for more than 150,000 abandoned wells could provide the equivalent of 8,331 jobs over a 20-year period. The report estimated the costs to plug roughly half a million wells in Ohio, Pennsylvania, Kentucky and West Virginia likely would be around $25 billion, but could go as high as $34 billion.

“Plugging these wells and cleaning up the sites can also improve the public safety, health, air quality, property values and economic development in the region,” said report author Ted Boettner.

Advocates hope President Joe Biden's proposed infrastructure plan or other federal legislation will provide a chunk of money for such work. In any case, the Ohio River Valley Institute report noted, comprehensive clean-up probably would be cost-effective, due to the social costs of greenhouse gas emissions, as well as ecosystem benefits and likely job creation.

Meanwhile, critics such as FracTracker and the Checks and Balances Project say Ohio's current severance tax levels of 10 cents per barrel of oil and 2.5 cents per thousand cubic feet of natural gas are too low.

"You take the long-term externalities and environmental costs, and you force them onto the state when this should be an industry pay-as-you-go kind of thing," Auch at FracTracker said. "That's not happening."

Archive – LaCrosse Ice Falls

From Earth Science Picture of the Day, April 17, 2021.
Photographer, Summary Author and copyright by: P. Riemer
https://epod.usra.edu/blog/2021/04/archive-lacrosse-ice-falls.html

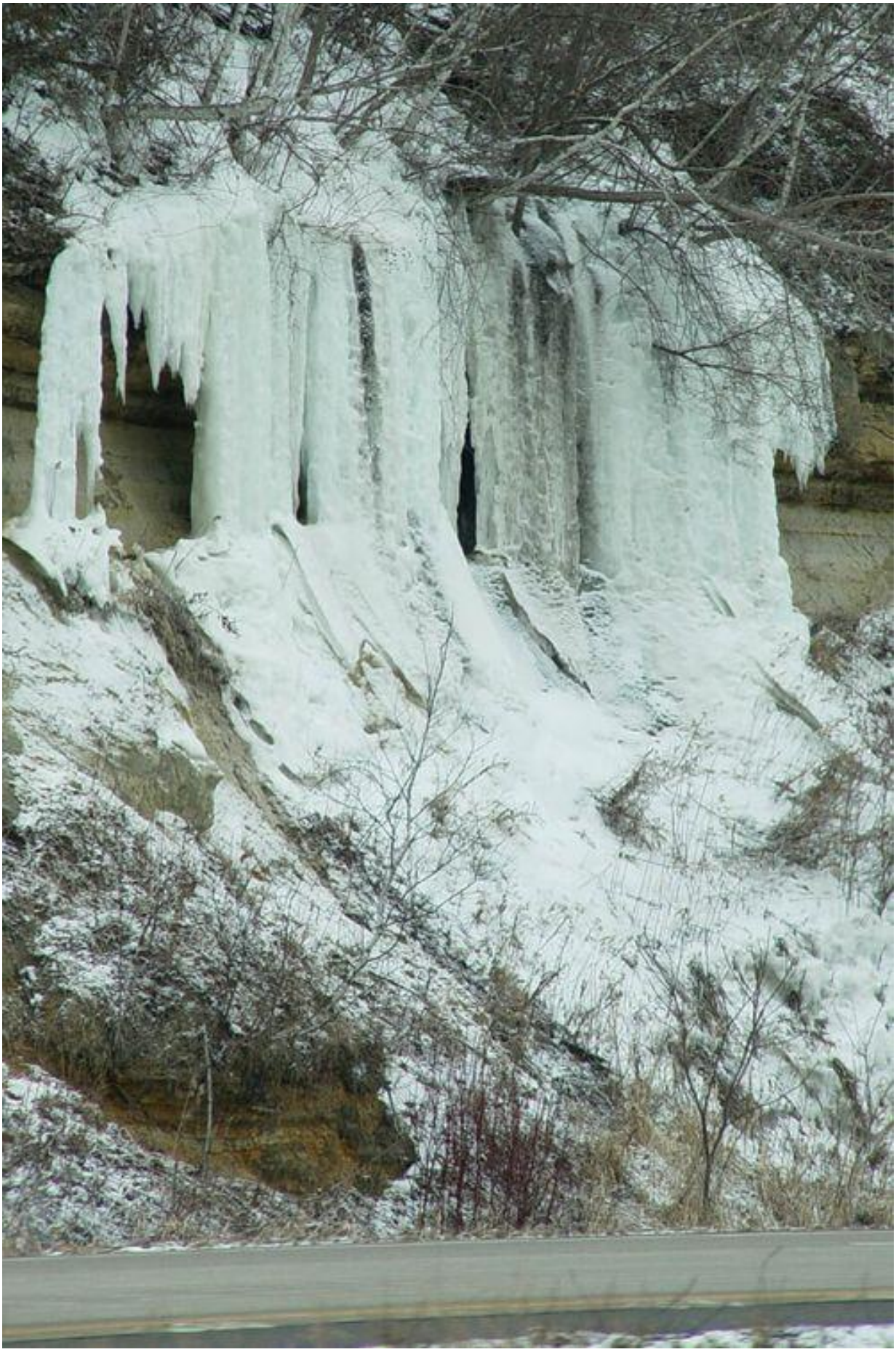
Every weekend we present a notable item from our archives. This EPOD was originally published April 16, 2004.

The photo of this roadside waterfall [next page] was taken in early March in southeastern Minnesota. Water seeping out of the high bluffs above the Mississippi River along Highway I-90, across the river from LaCrosse, Wisconsin, has frozen to form this dramatic ice fall, only a few feet from the shoulder of the roadway.

The Mississippi River probably did not occupy its present course before the Pleistocene Epoch. Pleistocene ice advances tied up millions of cubic kilometers of water in the form of glacial ice, but during each ice retreat, the Mississippi River valley was scoured with huge discharges of meltwater. These floods are responsible for the steepness of the bluffs, which consist of Prairie du Chien dolostone and are capped with Cambrian sandstone. Icings such as this are examples of aufeis.

Related Links:

- Pleistocene Epoch
- Dolostone
- The Blufflands Subsection
- Aufeis
- The Geology of the New Richmond Sandstone



June Legislative Committee Report by Tom Fargo

Below is a list of 2021 NH General Court (House and Senate) Bills that are potentially relevant to members of the Geological Society of New Hampshire. This table lists bills identified by keyword searches completed on March 1, 2021. **Status of these bills was current as of noon on June 10, 2021.**

Bill No.	Title	Bill Description	Legislative Action – Bill Status
Key Word "**Environ**"			
HB141-FN	requiring the Department of Environmental Services to maintain a public registry of where certain fire suppressants have been used	This House bill requires the Department of Environmental Services to maintain a public registry of where certain fire suppressants have been used. Note: The FN designation indicates the bill contains a fiscal note describing the impact of the bill on the State budget. In this case the cost was described and an indeterminable increase in expenses. This bill is a re-introduction of HB-1569 from 2020.	**This bill no longer appears in its original form. The bill now allows a county to exempt its chief administrator from participating in the NH retirement system.**
HB-256	adding members from Londonderry to the commission to investigate and analyze the environmental and public health impacts relating to releases of perfluorinated chemicals into the air, soil, and groundwater in Merrimack, Bedford, and Litchfield.	This House bill amends RSA 126-A:79-a, that in 2019 established a commission to study the impacts of emissions of PFAS chemicals in the vicinity of the Saint Gobain Performance Plastics facility in Merrimack. Without an extension, the commission's activities conclude with issuance of a final annual report by November 1, 2024.	Signed into law by Governor Sununu May 6, 2021.
HB-398	making an appropriation to the Department of Environmental Services for funding eligible wastewater projects	This House bill appropriates to the Department of Environmental Services the sum of $5,735,248 for the fiscal year ending June 30, 2022 and $6,919,115 for the fiscal year ending June 30, 2023, which shall be nonlapsing, for the purpose of funding eligible wastewater projects under RSA 486	This bill was retained by the Finance Committee March 23, 2021.
HB-412	making an appropriation to the Department of Environmental Services for the purpose of funding public water system projects	This House bill appropriates to the Department of Environmental Services the sum of $500,000 for the fiscal year ending June 30, 2022 and $500,000 for the fiscal year ending June 30, 2023, which shall be	This bill was retained by the Finance Committee March 23, 2021.

		nonlapsing, for the purpose of funding public water system projects under RSA 486-A.	
SB146-FN	adopting omnibus legislation relative to the environment	This Senate bill aggregates proposed legislation regarding: I. Establishing the coastal program administered by the Department of Environmental Services. II. Establishing a statewide solid waste disposal reduction goal. III. Prohibiting incineration of PFAS in New Hampshire. IV. The prevention of zoonotic disease transmission. V. Tidal waters. VI. Establishing a surcharge on certain saltwater licenses and establishing a fund for derelict fishing gear and coastal cleanup. VII. The acquisition and preservation of agricultural land for food producing in the land and community heritage program. VIII. Class 2 obligations under the electric renewable portfolio standards. IX. Public use of coastal shorelands.	Senate passed this bill on 3/18/2021. House made substantial amendments and passed it on 6/4.2021. Senate did not concur with House amendments. Committee of Conference was established June 10, 2021 to potentially reconcile differences.
Key Word "**Water**"			
HB-135	requiring parties responsible for pollution of a drinking water supply to be financially responsible for certain consequences of that pollution.	This House bill the polluter, as determined by the Commissioner of NHDES, to connect the water user to a municipal system or to provide water filtration and to pay for that corrective action.	The House passed this bill with amendments on 4/8/2021. Bill was re-referred to Senate Energy and Natural Resources Committee 5/20/2021.
HB-235	relative to community small groundwater withdrawal	This House bill requires Community Water Systems with groundwater withdrawals less than 57,600 gallons over any 24-hour period from a new source to meet many of the requirements for large groundwater withdrawals as specified in RSA 485-C. Note this bill appears to be in response to groundwater withdrawals in the Town of Hampstead that resulted in private wells running dry.	The House passed this bill with amendments on 4/7/2021. The Senate passed this bill with amendments on 5/13/2021. House did not concur with Senate amendments. Committee of Conference was established June 7, 2021 to potentially reconcile differences.
HB-265 and HB-335	requiring bottled drinking water sold to the public to meet the same maximum contaminant levels established for public drinking water.	These two identical House bills require bottled water manufactured and sold in NH to meet state drinking water quality standards	HB-265 was voted Inexpedient to Legislate. HB-335 was retained in the House Commerce and Consumer Affairs Committee on 3/9/2021.
HB-271	relative to standards for per and polyfluoroalkyl substances (PFAS)	This House bill establishes in Statue the maximum contaminant levels and ambient groundwater quality	The House passed this bill with amendments on 4/7/2021. The Senate

	in drinking water and ambient groundwater.	standards for four PFAS compounds previously adopted in rules by NHDES.	passed this bill with amendments on 5/27/2021. House did not concur with Senate amendments. Committee of Conference was established June 7, 2021 to potentially reconcile differences.
HB-478	relative to treatment of PFAS contaminants in the drinking water of the Merrimack Village Water District.	This House bill requests Saint Gobain Performance Plastics commit to provide for the design, installation, operation, maintenance and monitoring of all water treatment system(s) necessary to effectively treat and remove PFC contamination from all affected public water systems to meet NHDES standards and to pay for the required upgrades.	This bill was retained in the House Resources, Recreation and Development Committee on 3/16/2021.
HB-611-FN	abolishing fluoridation in water	This House bill amends RSA 194.3 relative to school districts, and repeals five existing RSAs relative to public water systems, to abolish the addition of fluoride to drinking water in New Hampshire. Note that this or similar bills have been introduced in each General Court session for decades. The fiscal note describes the impact of the bill on the State budget as an indeterminable increase in expenses.	This bill was retained in the House Resources, Recreation and Development Committee on 3/11/2021.
Key Word "**Waste**"			
HB-413	establishing a solid waste working group on solid waste management planning and relative to compost.	This House bill establishes a solid waste working group on solid waste management planning and also requires the Department of Environmental Services to make certain rules regarding compost. The working group would include sixteen members listed in the proposed statute and designated by the Commissioner of NHDES. The working group shall issue reports on November 1, 2021 and 2024.	Both House and Senate passed this bill with amendments. House concurred with Senate amendments on 6/10/2021. Bill will be sent to the Governor.
Key Word "Professional" as potentially related to Geologists			
SB-58	relative to the administration of occupational regulation by the office of professional licensure and certification	This bill makes amends RSA 310-A:1-d relative to actions of the Office of Professional Licensure and Certification. Changes proposed for the Board of Professional Geologists include: 1. Designation of Board Members by the Governor and Council 2. Requirements for recordkeeping and applications for licensure would be in accordance with policy established by the Office of Professional Licensure and Certification	Senate passed the bill with amendments on 3/11/2021. House passed the bill with amendments on 6/3/2021. As of June 10, 2021, Senate has not yet concurred with House amendments.

Key word searches with no returns: **geology, mineral, rock, soil**

GSNH T-Shirt Order Form

	Number of Shirts	Price per Shirt	Total
GSNH Small T-Shirt		$18.00	
GSNH Medium T-Shirt		$18.00	
GSNH Large T-Shirt		$18.00	
~~**GSNH Extra Large T-Shirt**~~		~~$18.00~~	
		Subtotal	
		Shipping & Handling	
		Total	

Shipping & Handling costs	
One Shirt	$4.00
Two Shirts	$7.00

Ship to:

Name	
Street Address	
City, State, Zip Code	
Phone # (in case of questions about your order)	

Please make checks payable to "GSNH" and mail with this completed order form to:

GSNH
P.O. Box 401
Concord, NH 03302

MEMBERSHIP & RENEWAL APPLICATION

Geological Society of New Hampshire

PO Box 401, Concord, NH 03302

Name: _____ *(Please print clearly)*

E-mail: _____

***Renewing Members**: Only update this section if you have changes to your contact information (including email) or educational history.*
***New applicants:** please complete this section.*

Preferred address/email to receive GSNH Communication: ___Home or ___Business

Home Address:

_____

_____

_____

Business Address:

(Employer): _____

_____

_____

Home Telephone: _____

Office Telephone: _____

New Hampshire PG # (if applicable) _____

Education: Degrees received or in progress:

Year	Degree	Major	College or University

I volunteer to help with one of the following committees or tasks:

__ Membership Committee
__ Legislative Committee
__ Giving a talk at a meeting

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(Newsletter or Website, circle preference)
__ Other:

_____ Regular Member (Annual Dues $20.00)

_____ Student Member (Annual Dues $10.00)…Please complete **Education** section above.

Make checks payable to **"Geological Society of New Hampshire."** Note that GSNH dues are not deductible as a charitable contribution, but may be deductible as a business expense. Please return this completed application form with any necessary corrections and a check for the appropriate dues to the GSNH at the address above. The Society's membership year runs from January 1 to December 31.

Signature: _____ Date: _____