Granite State Geologist

The Newsletter of the Geological Society of New Hampshire,
Winter Edition – December 2022 – Issue No. 119
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In this issue:

MESSAGE FROM THE PRESIDENT

This past August I traveled to upstate New York to visit family and friends. On the way back, I stopped at the Museum of The Earth, part of the campus of the Paleontological Research Institution (PRI) located in Ithaca, New York. I was very impressed by the museum. An overview of the permanent displays can be seen in this YouTube video.

Ithaca has adopted the motto "Ithaca is Gorges", in reference to the numerous gorges and picturesque waterfalls in the area. Ithaca is located at the south end of Cayuga Lake, the longest of the Finger Lakes of central New York. A short distance from Ithaca is the valley heads moraine, marking the southernmost advance of the Wisconsin ice sheet that widened and deepened pre-existing valleys of the northern Alleghany plateau to form the Finger Lakes. Gorges in the area formed in response to this deepening. The morphology of some gorges indicate that they were initially formed during the Sangamon (?) interglacial period.

The gorges were eroded in sandstones and shales of Middle to Late Devonian age, sediments derived from the Acadian mountains and deposited by westward pro-grading Catskill Delta into the Appalachian foreland basin. The New York section is world-famous for its Devonian fossils. Exposed within some gorges are peridotite or kimberlite dikes of Cretaceous (?) age. These mantle-sourced ultra-mafic intrusions are apparently devoid of diamonds, but that are an unusual geological feature of the central New York region.

The PRI is a good source for geological reference and education materials. The PRI website is a gateway to their Earth@Home resources which include regional guides for the geology of the major physiographic provinces of the United States. I found

these guides to be a great source of information regarding state natural history museums and geological maps that I will likely use in my future travels. If you are interested in a geology-oriented get away, I'd highly recommend a trip to the Ithaca area.
I hope to "see" many of you at the January 19th GSNH on-line meeting. If not, do enjoy winter in New Hampshire. Tom

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2023 Membership Renewal – Invite a Friend!

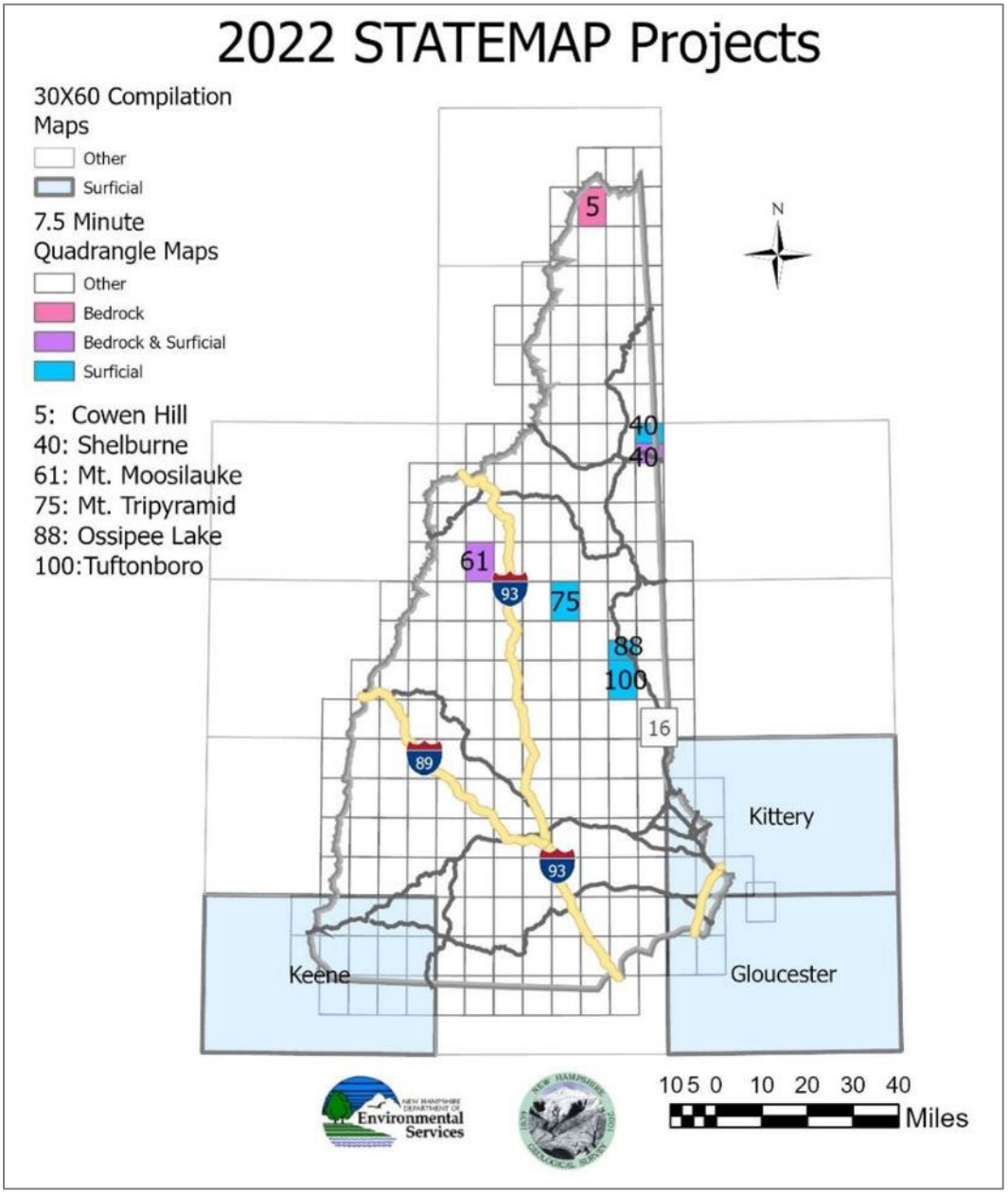
It will be 2023 soon, so consider renewing your membership for 2023! With your membership, you get a discount on dinner meetings (which will happen at some point!) and field trips, information of upcoming events of interest to the geological community, voting privileges at Society business meetings, and automatic subscription to this newsletter. Membership dues also help to support community outreach. Also, consider inviting coworkers, particularly early-career staff, to meetings and field trips – it's a great way to get involved in the greater professional community!

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

New Hampshire Geological Survey Update

By Shane Csiki, State Geologist and Director, December 2022

The holiday season is upon us, and for NHGS, that means its STATEMAP season! As most of you know, NHGS receives funding annually from the state component of the USGS National Cooperative Geologic Mapping Program (known as STATEMAP), which funds the surficial and bedrock 1:24,000-scale quadrangle mapping in New Hampshire. The structure of the program is such that the grant proposals for the following cycle, as well as the map deliverables for the cycle that you are currently finishing come due right about at the same time . . . the holidays! As a result, yours truly has been working on the grant proposal, with Josh Keeley working with our geologic mappers and providing the coordination to finalize all of this year's maps for submission to USGS. Among surficial and bedrock maps, we are submitting 6 quadrangles for final completion now, with 2 half-quads, which will be completed in 2023 (see map next page). Also included are three compilation projects to update the surficial geology of the 30' x 60' Gloucester, Keene and Kittery quadrangles with the latest information. With this many quadrangles, this has been an all-hands on deck effort to complete the projects. Mike Howley is authoring one of the compilation maps, and assisting Josh with a second. Jean Schwab, working directly with Josh, has been performing much of the GIS and cartography for the maps. Rebecca LeCain has been performing cartography and GIS work as well. And, Brian Hauschild created updated maps to support our new geologic mapping proposal. As you can see, truly an all-hands on deck effort this year.



After the first of the year, we will be entering the second phase of our new collaborative peer review process where we will engage everyone who was involved in the field review phase during the summer with an electronic review of the completed draft maps themselves. All participants will have the opportunity to review the draft map products produced during this past year's mapping activities. We are still working out the logistics of how this second phase will operate. However, any member of the geologic community is welcome to review the map products during this phase. Feel free to reach out if you are interested. We currently anticipate that this phase will take place in later January or February, 2023.

As with years past, once again this year in April, NHGS will host the annual Geologic Mappers' Workshop. We anticipate this year's workshop to be a hybrid approach, with an in-person meeting in the NHDES Auditorium, combined with an option to join remotely via Microsoft Teams. With this workshop and future workshops, and with thanks to the ability to join remotely, we seek to develop topics and talks that have relevancy to the larger geologic mapping community as it pertains to New Hampshire. We've heard already that there is an interest in a couple of methods talks given the availability of LiDAR. However, we would like this workshop to be of maximum benefit to all of you. So, if you have suggestions for workshop talk topics as they relate to geologic maps and mapping, please let me, or any NHGS staff member know, and we will investigate the possibilities. Stay tuned for more details!

Groundwater levels monitored by NHGS in the State-wide Groundwater Level Monitoring Network show slow improvements from the drought conditions and low groundwater levels observed in much of New Hampshire since June 2022. Long-term precipitation deficits and above average temperatures, along with below normal snow depths last winter all contributed to the most recent drought, although conditions are improving. In early October, NHGS completed installation of 3 replacement wells for existing groundwater monitoring wells that were either damaged or incompatible with data logger installation. The new wells, which are located in Concord, Franklin, and Colebrook, have been added to the New Hampshire Groundwater Level Monitoring Network and will be measured in parallel with the existing wells for at least 12 months.

October 2022 Meeting Presentation Recap

We had our first in-person meeting since January 2020 on October 13! This one had fewer attendees than previous meetings (32), but it was good to see all who were able to make it. The next GSNH meeting will be via Zoom; see dates to remember on page 37 for details. The plan is to keep the January meeting virtual going forward to accommodate potential weather issues and COVID/cold/flu season.

At the meeting, we first voted on the new GSNH Board members. Congratulations to the new Board!

- President: Tom Fargo
- Council Vice President: Doug Allen
- Society Vice President: Nelson Eby
- Treasurer: Abby Thompson Fopiano
- Secretary: Rebecca LeCain
- Members-at-Large: Sharon Lewandowski, Mike Howley, and Melissa Lombard

Julie Spencer announces the election results

Dr. Nathaniel Kitchel, a Postdoctoral Fellow at Dartmouth College gave a presentation entitled “Facing the Forest: Human Adaptations Across the Pleistocene-Holocene Transition in Northern New England”.

Dr. Kitchel describes the different types of fluted points found in New England (photo: Abby Thompson Fopiano)

Dr. Kitchel discusses the difficulties of fluting stone tools.

Dr. Kitchel receives the coveted speaker's gift – a section of rock core.

Large deposit of rare elements and minerals discovered in northern Maine

By Penelope Overton, Press Herald, November 26, 2022.
https://www.centralmaine.com/2022/11/27/large-deposit-of-rare-elements-and-minerals-discovered-in-northern-maine/

Geologists have discovered a large concentration of rare earth elements and trace metals highly prized by the U.S. defense, technology and alternative energy industries in 450-million-year-old volcanic rock on a remote mountainside in northern Maine.

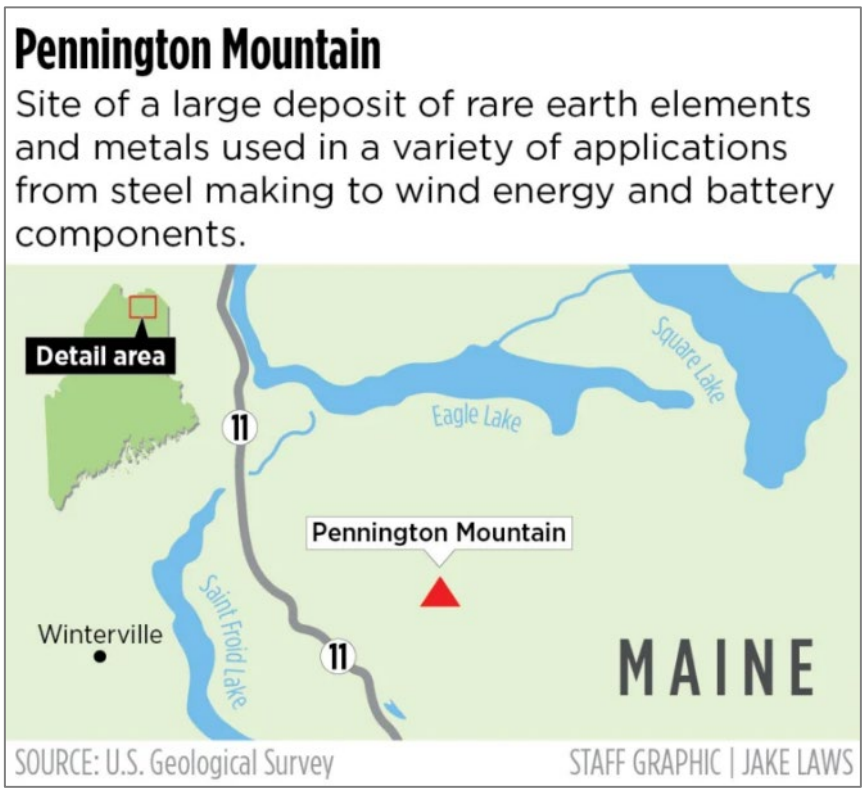
University of Maine Geology Professor Chunzeng Wang, former Maine State Geologist Robert Marvinney and Maine Geological Survey Project Coordinator Amber Whittaker during a visit to Pennington Mountain on Oct. 16. Photo courtesy of Chunzeng Wang.

It is still too early to know the exact size and composition of the deposit, or whether it should or could be mined despite strict state regulations. But geologists say it may rival similar deposits discovered in Australia and China, and one estimated the potential value of the Pennington Mountain deposit in the billions of dollars.

These rare earth elements and trace metals of niobium and zirconium can be used to make a wide range of products: from night vision goggles to stealth technology, cellphones to flatscreen TVs and solar panels, to electric vehicle batteries to wind turbine generators.

The use of rare earth elements and trace metals in renewable energy technologies has fueled tensions in Maine and around the nation between the local environmental impacts of mining and the global climate benefits achieved through the use of those mined materials.

The owner of the land, located an hour's drive northwest of Presque Isle in an unorganized territory, is Aroostook Timberlands LLC, a subsidiary of J.D. Irving, a Canadian company that has grown rich from oil, forestry and shipbuilding. With close to 1.3 million acres, it is Maine's biggest landowner.



Irving didn't respond to a request for an interview about the Pennington Mountain discovery. The company has demonstrated a willingness to mine before, seeking to tap a zinc, copper, gold and silver deposit under nearby Bald Mountain. That effort fell short of the state's strict mining and water quality laws, which it says make it virtually impossible to open a commercial metal mine in Maine.

Environmental and tribal groups claim that pit mines such as the one proposed for Bald Mountain – or a silver mine proposed east of Baxter State Park by the Wolfden Resources Corp. – could expose sulfide-rich rocks that would wind up contaminating the groundwater. The Wolfden project has been put on hold after the Ontario-based company faced rezoning challenges and some local opposition.

A Newry couple is trying to get the permits needed to mine lithium, a superconductive trace metal found in spodumene, from a large $1.5 billion deposit in western Maine, but so far the state has denied their efforts to classify the extraction as something other than metal mining. Lithium is in high demand worldwide to make rechargeable lithium-ion batteries used in electric vehicles.

The questions of whether and when mining might be appropriate at Pennington Mountain are not priorities for the researchers studying the find.

“Mining is a story for another day, a future day,” said geologist Chunzeng Wang, a University of Maine at Presque Isle professor and lead author of a paper about the discovery in Economic Geology. “For now, it’s enough to know we have something essential to economic and national security right here in Maine.”

And there may be more where that came from, Wang said with a broad smile.

The Pennington Mountain discovery showed up as a bright red, 100-acre spot of elevated radioactivity in a 2021 image taken by a low-flying airplane during a magnetic and radiometric survey of a 3,800-square-mile swath of northern Maine that is about half the size of Massachusetts.

Although the radiation levels are not high enough to pose a threat to humans, it stood out like a giant “look here” sign in the middle of nowhere in the North Woods.

Geologists have discovered rare elements and minerals in rocks on Pennington Mountain in Aroostook County, including niobium and zirconium, two Earth elements used in steel, jet engines and cellular phones. Photo by Chenzung Wang/Univeristy of Maine – Presque Isle

The aerial geophysical survey in northern Maine, which cost about $450,000, was part of the U.S. Geological Survey’s Earth Mapping Resources Initiative, or Earth MRI. It is conducted in a partnership

with state geological surveys to hunt for critical mineral resources that have a particularly vulnerable supply chain.

So far, USGS has funded three focus areas in Maine: the Oxford lithium project in 2020, Pennington in 2021 and the geologic mapping of the Aroostook district, which is in the second year of a three-year hunt for manganese. Maine is the only New England state to get Earth MRI funding to date.

Initially, USGS believed the source of the radioactivity that lit up the scan was manmade, Wang said, like nuclear waste dumped there from the now-shuttered Loring Airforce Base in Limestone. A state geologist joked that it might be space junk that had fallen from the sky. Wang immediately volunteered to check it out.

Geologists Chunzeng Wang, left, a professor at the University of Maine-Presque Isle, and Preston Bass walk through the woods at Pennington Mountain in Aroostook County. Geologists have discovered rare minerals in rocks on Pennington Mountain. Photo by Anji Shah/United States Geological Survey

Maine Geological Survey geologist Amber Whittaker called it a good example of scientific collaboration.

“Having all of us involved meant as soon as we identified the feature, Professor Wang was on-site within a day to do the recon work,” said Whittaker, who is the MGS project coordinator. In his Oct. 21 email to the group, on the day the initial geophysical survey was shared, Wang said: “I will find it out tomorrow.”

The next day, Wang set out for Pennington Mountain, equipped with a hammer and a handheld radiometric sensor, to check the anomaly and collect samples in a cold October rain. Wang had mapped the area a year earlier and even then had hoped to study the ridge more.

Samples sent to a Nevada lab for chemical analysis would eventually reveal very high levels of trace metals like niobium, which is used to manufacture gas turbines, jet engines and MRI scanners, and zirconium, a corrosive and heat-resistant metal used in superconducting magnets.

Samples also contained high amounts of even more valuable rare earth elements and metals, including dysprosium, used to make magnets for electric vehicles and wind turbine motors; gallium, used in semiconductors for smartphones, light-emitting diodes and solar cells; and lanthanum, used in hydrogen fuel cells and electric vehicle batteries.

“I’ve been a geologist for many years now and I’ve never seen anything like it before,” Wang said. “Rare earth is misleading because they’re not rare. They can be found in many places, but in very, very small amounts. What is rare is to find a sizable amount of rare earth elements in one place.”

Finding a sizable deposit doesn’t mean it can be mined, however. Rare earth finds have been identified in the U.S. but remain untapped because of water quality regulations and the high costs of compliance. As a result, the U.S. has only one active rare earth mine, Mountain Pass, in California’s Mojave Desert.

According to the USGS, China controls about 80% of the global output of processed rare earth materials. America imported an estimated 11,130 metric tons of so-called “rare earths” in 2018 valued at about $160 million, data shows. Eighty percent of that came from China, according to USGS.

“Rare earths are some of the most difficult metals to separate from a host mineral,” said USGS scientist emeritus John Slack of Farmington, who participated in the project. “You mine the ore, then crush it to get to the minerals, and then chemically separate it, sometimes multiple times, to get to the metals.”

Much of the rare earth elements mined in the U.S. is sent overseas to China to be processed before being shipped back stateside for use in domestic manufacturing. But the U.S. is trying to fix that – in 2021 and 2022, Pentagon officials announced $44.6 million in grants to build and run a U.S.-based rare earth element processing plant.

But, as Wang knows all too well, nobody in the U.S. really wants a mine built in their backyard. He told his university president and dean in a March email that Mainers should still celebrate the find, regardless of their thoughts about mining.

“Nobody likes mining in Maine, but it does not hurt if we know we have rocks that contain strategic and critical metals,” Wang said. “The rare earth elements and rare metals are all listed as USA’s strategic and critical metals/minerals, and they are essential to the economic and national security.”

The Pennington Mountain find will likely lead to more aerial surveys of northern Maine, where USGS and Whittaker believe conditions are ripe to find other mineralized rocks created by a collision of ancient land masses during a time before the Atlantic Ocean even existed.

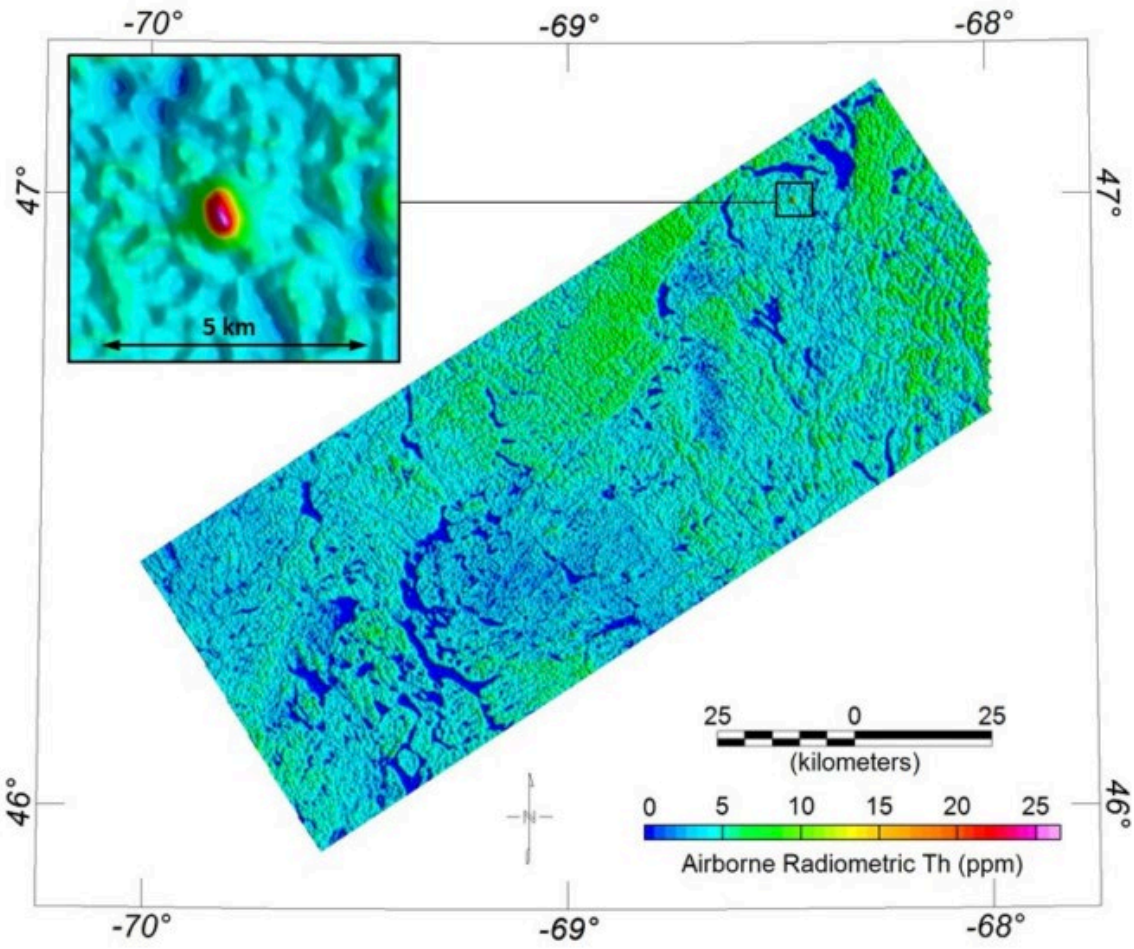
“The last time we flew over Maine was about 50 years ago, which gave us a broad-brush picture of what was there, like an impressionist painting,” USGS geophysicist Anji Shah said. Now, with GPS and high-resolution sensors, they have something more like a photograph, she said.

Wang believes the entire ridge at Pennington is rich in minerals, but Shah, who was in charge of reviewing the survey images, is more cautious. Handheld scanners only penetrate a few feet below the surface. Without digging, Wang could only sample surface-level rock outcroppings.

More study is needed at the site to determine how deep the mineral deposits run and how concentrated the rare earth elements and metals are within the mineral flakes threading through the rocks, Shah said. It would be up to the landowner or mineral exploration company to conduct such tests.

For now, the geologists are happy to celebrate the discovery that began with an unexplained red hot spot on a radiometric photograph snapped by a low-flying surveillance plane.

“This discovery shows just how much we still don’t know about the ground beneath our feet,” Shah said.



The anomaly at Pennington Mountain was first detected as a bright red mound that appeared in data collected in aerial radiometric surveys conducted in 2021. United States Geological Survey

What's Your Board Been Doing?

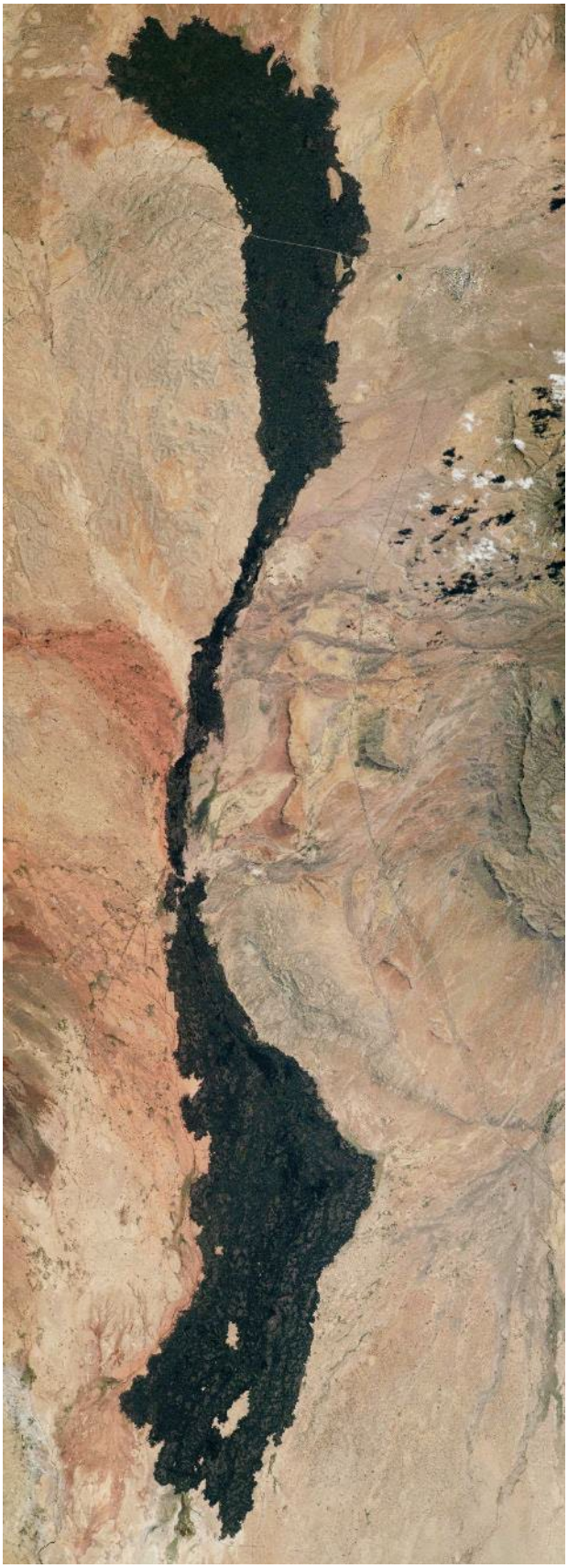
The GSNH Board of Directors met on Thursday, December 8 via Zoom. (add here)

The Board discussed plans for upcoming meetings – January is set to be a virtual meeting (see meeting announcement with details on page 36) and the plan is to have the April meeting in person but potentially to have a hybrid component. We will firm up plans for the April meeting at the March Board meeting. The Board also discussed disposition of rock core the New Hampshire Geological Survey (NHGS) has access to and logistics involved in the planned summer 2023 field trip (page 18).

The next Board meeting will be held on March 16; please reach out to a Board member if you'd like to attend.

Carrizozo Malpaís Lava Flow

From NASA Earth Observatory, September 26, 2022.
https://earthobservatory.nasa.gov/images/150388/carrizozo-malpais-lava-flow



A decades-long eruption created this long strip of basalt in the desert of New Mexico:

While in orbit over the Southwestern United States, an astronaut onboard the International Space Station took a sequence of photos of Carrizozo Malpaís, a large basaltic lava flow in central New Mexico. The four photos were then stitched together to produce a mosaic.

Little Black Peak, an inactive cinder cone located at the northern end of Carrizozo Malpaís, is the highest point on the larger shield volcano. Approximately 5,000 years ago, a vent erupted at Little Black Peak and lasted several decades. The event created the second youngest lava flow in New Mexico and one of the longest flows from the Holocene Epoch. From its northernmost to southernmost points, it stretches 50 miles (75 kilometers) across the Chihuahuan Desert.

The scattered lighter areas within the flow are different types of lava features—such as fissures, collapses, and depressions—or bare areas without lava. Desert vegetation like prickly pear cactus, perennial flowers, and juniper trees can grow within these features.

A road bisects the upper region of the lava flow, and a railway connects to the city of Carrizozo. Malpaís Spring extends from the south side of the flow, just north of the White Sands Missile Range testing site.

Astronaut photographs ISS067-E-1174535 through ISS067-E-1174538 were acquired on June 30, 2022, with a Nikon D5 digital camera using a focal length of 400 millimeters. They are provided by the ISS Crew Earth Observations Facility and the Earth Science and Remote Sensing Unit, Johnson Space Center. The images were taken by a member of the Expedition 67 crew. They have been cropped and enhanced to improve contrast, and lens artifacts have been removed. The International Space Station Program supports the laboratory as part of the ISS National Lab to help astronauts take pictures of Earth that will be of the greatest value to scientists and the public, and to make those images freely available on the Internet. Additional images taken by astronauts and cosmonauts can be viewed at the NASA/JSC Gateway to Astronaut Photography of Earth. Caption by Sara Schmidt, GeoControl Systems, JETS Contract at NASA-JSC.
will be in March; please reach out to a board member if you'd like to attend.

Quechee Gorge in East Central Vermont

From Earth Science Picture of the Day, October 4, 2022.
Photographer and Summary Author: Patti Weeks
https://epod.usra.edu/blog/2022/10/quechee-gorge-in-east-central-vermont.html

The Quechee Gorge is a 165-feet deep (50 m), 1-mile long (1.6 km) narrow chasm on the Ottauquechee River. As Vermont's deepest gorge, it is nicknamed by locals as "Vermont's Grand Canyon." It was formed following the retreat of the massive Pleistocene Laurentide Ice Sheet, which covered all of present-day Canada and much of the northern United States, between 95,000 to 20,000 years ago.

When the ice sheet began its retreat about 18,000 years ago, the Ottauquechee River re-emerged and began to flow east again, but was redirected from the Connecticut River to the newly-formed narrow Glacial Lake Hitchcock, which ran nearly 200 miles (320 km) from what is now northern Vermont to central Connecticut. A glacial terminal moraine (near present day Hartford, Connecticut) called the Rocky Hill Dam, blocked the flow of the Connecticut River for approximately 4,000 years, during which the Ottauquechee River filled the lake with 170 feet (52 m) of sand, mud and silt. When the dam eventually broke, the river made a sharp turn to the south, rapidly cutting through the soft mud. Geologist Frederick Larsen estimated that this initial erosion occurred in less than a week. The river has been slowly carving through the hard Devonian age schist and quartzite bedrock, the Gile Mountain Formation, ever since — for the past 13,000 years.

Now, the Quechee Gorge is a tourist attraction. The Ottauquechee River is also rated as a Class III+(V) whitewater river for 3.7 miles (6.0 km). According to a report by American Whitewater, the water level was low (<30 cfs) most of this past summer. Bottom photo shows whitewater details. Even at its

best whitewater level, however, there is a challenging rapid area called “Well Enough.” After a thorough scouting, you might need to leave “well enough” alone and just portage. The second photo, focusing nearly straight down into the gorge from the bridge, shows some large rocks that could make rafting navigation challenging, whether the water covers them or not. Photos taken on July 19, 2022.

Photo Details: 28mm focal length; $\mathit{f}/8$ aperture; 1/8 sec. exposure; ISO 200.

Quechee Gorge, Vermont Coordinates: 43.6374, -72.4085

Related Links

- Verdon River Gorge
- Ottauquechee River Water Level

2023 Summer Field Trip Announcement

Initial planning for the summer 2023 GSNH field trip to Franconia Notch is underway. The tentative date is Saturday, July 15 with Sunday, July 16 as a rain date.

To recognize the 20th Anniversary of the collapse of the Old Man of The Mountain (May 3, 2003), this field trip will review the status of recent and ongoing geologic research in the central and northern portions of Franconia Notch. All the stops will be located along the floor of the Notch with spectacular views of the Cannon Cliff, the westerly flanks of Mt. Lafayette, Eagle Cliff, and Profile Lake.

The trip will review the status of ongoing cosmogenic exposure dating for "glacial dipsticks," 3D thermal imaging of Cannon Cliff to establish rockfall susceptibilities, historic and current landslide events recorded in Profile Lake sediment cores, and ongoing studies of the residual rock mass stability of the “Old Man’s Stump."

The trip will include a visit to the Old Man of The Mountain Legacy Fund’s Old Man Memorial and Museum, along with ample time around Noon to enjoy your own picnic lunch in the grassy field near the base of the most recent rockslide in the Notch. This slide on the Hounds Hump section of Eagle Cliff occurred the night of 9 September 2022 and was the first such slide to be studied using the new 3D thermal imaging technology later used for Cannon cliff and talus slope study.

More detailed information and an on-line accessible "field trip guide” will be forthcoming in Spring 2023. Tentative trip leaders are Brian Fowler (Old Man of The Mountain Legacy Fund), Thom Davis (Emeritus, Bentley University), and Matt Maclay (Dartmouth College), although others may be added.

Over 510 Earthquakes at Grizzly Lake Swarm Hit the Yellowstone Volcano

By Sciencemints. Published October 6, 2022.
https://sciencemints.com/over-510-earthquakes-at-grizzly-lake-swarm-hit-the-yellowstone-volcano/

In September of this year, there were 510 earthquakes in one area of Yellowstone National Park, which is more than double the usual number.

According to the United States Geological Survey, the earthquakes were a part of an earthquake “swarm” that began in July and occurred close to Grizzly Lake in the northwest section of the park, between the communities of Norris and Mammoth (USGS).

The September earthquakes were all minor. The greatest earthquake in the entire park had a magnitude of 3.9. A tremor of this size might be felt by a human, but it is uncommon for buildings or other items to sustain more than minor damage.

One of the most seismically active regions in the nation is Yellowstone National Park, which is famous for both its numerous geothermal geysers and hot springs as well as the hundreds of minor earthquakes that take place there every year.

A stock photo shows a hot spring area at Yellowstone National Park, Wyoming. Yellowstone is one of the most seismically active areas of the U.S., experiencing hundreds of earthquakes a year. ©Getty images

In addition, the Yellowstone supervolcano is located there. This activity is a result of the park's location on a vast network of fault lines, which are cracks that allow two blocks of rock to move with respect to one another. Unprecedented energy can be released by this movement, which is what creates earthquakes.

Swarms of earthquakes frequently occur in Yellowstone as a result of volcanic fluids flowing through rock faults below ground.

Although there have been more earthquakes recently near Grizzly Lake than usual—roughly between 150 and 200 per month, according to Mike Poland, a research physicist at the USGS and Scientist-in-Charge of the Yellowstone Volcano Observatory—it is not unusual for swarms to exhibit such sudden activity.

According to Poland, “there have been many months where we’ve witnessed 800-1000 quakes.” “For instance, approximately 800 earthquakes occurred beneath Yellowstone Lake during the period of 10 days in July 2021.

The most seismically active region of the park, between Hebgen Lake and Norris Geyser Basin, had around 2400 earthquakes (max M4.4) from June to September of 2017, making it the largest/longest swarm in recent memory.

“These swarms don’t have a strong seasonality because they can happen in the winter, as happened in February 2018 when a swarm of more than 500 identified earthquakes occurred in the same general region from Hebgen Lake to Norris Geyser Basin.

There are numerous preexisting faults in this area, and when groundwater interacts with them, earthquakes result. The area was already under stress from the 1959 M7.3 Hebgen Lake earthquake, making it more vulnerable to minor incidents. It is Yellowstone’s most seismically active region as a result.

Italy’s Stromboli Volcano Eruption Spotted From Space

By James Ssengendo, October 12, 2022. From Greek Reporter: https://greekreporter.com/2022/10/12/stromboli-volcano-italy-eruption-space/

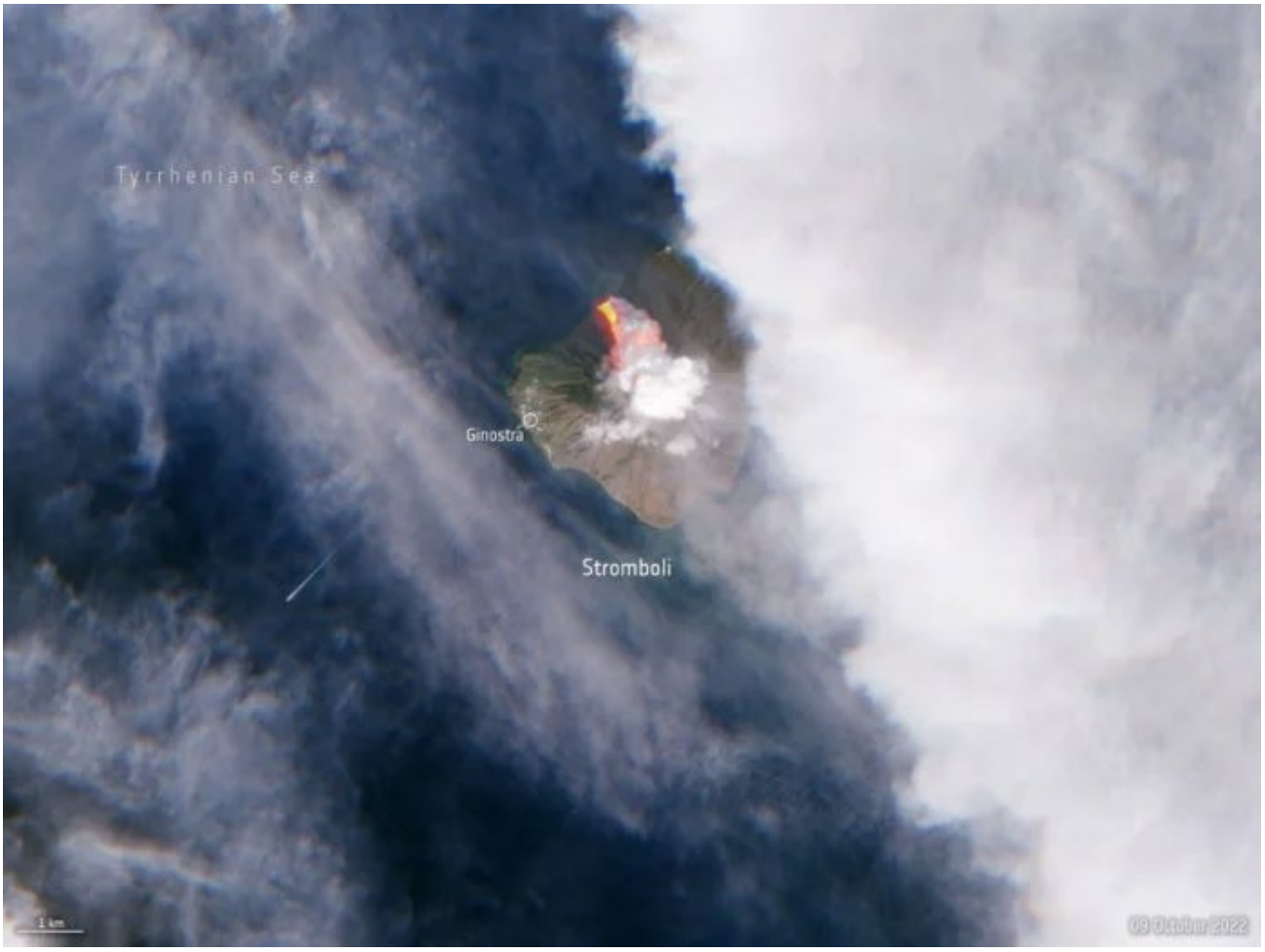
A striking image of the eruption of Italy’s Stromboli volcano was captured in space by Europe’s Sentinel-2 satellite, part of an Earth observation mission from the Copernicus Programme, shortly after it erupted.

This fissuring of magma to the Earth’s surface and the forming of lava at the Stromboli Volcano took place on October 9th, and the Sentinel-2 satellite captured an image that was processed in true colors.

The captured image shows the volcano erupting, sending a pyroclastic flow of lava pouring into the Tyrrhenian Sea with huge plumes of smoke and ash rising above the volcano.

The Stromboli volcano and its namesake, the Stromboli volcanic island, are located in southern Italy just off the northern tip of the island on the coast of Sicily in the Tyrrhenian Sea.

According to a statement from the European Space Agency (ESA), its eruption caused the partial collapse of the volcano's crater terrace, thus prompting Italian Civil Protection authorities to raise an orange alert due to the persisting "situation of enhanced volcano imbalance."



Italy's Stromboli Volcano Eruption Spotted From Space. Credit: European Space Agency (ESA)

About three hundred people permanently live on the island of Stromboli. Most of the population on the island live in the village of Ginostra, which is located to the southwest of the volcanic cone.

During the past ninety years, the Stromboli Volcano has been erupting frequently making it one of the most active volcanoes in the world.

On the same day as the Stromboli eruption, The Sentinel-2 satellite captured images of "hot areas" on the Mount Etna Volcano in Sicily. Mount Etna is located only about sixty miles (one hundred kilometers) away from Stromboli.

Although satellites have detected hot plumes on Mount Etna, which is as active as Stromboli, no lava has spewed out of the active volcano.

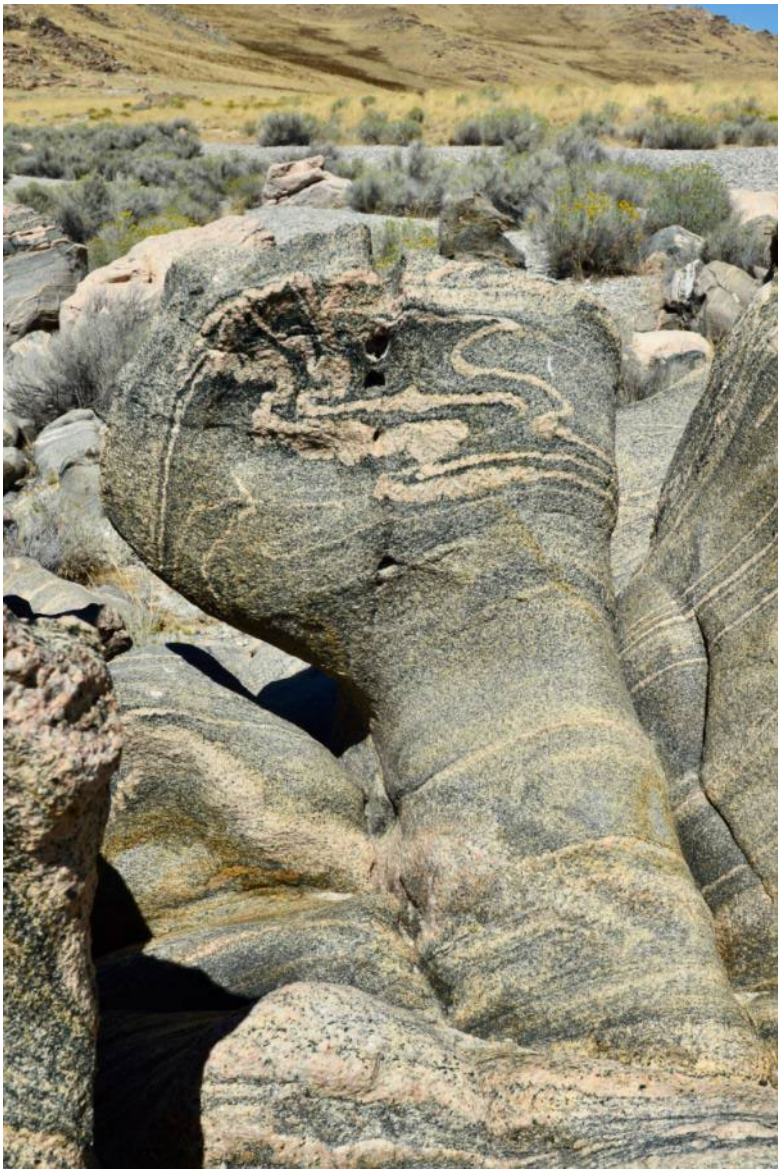
Both Stromboli and Mount Etna erupted on the same day back in May 2021, a phenomenon suggesting that a link may exist between the two volcanos.

Scientists, however, believe that the two volcanos are part of unconnected systems which each possess their own patterns of eruption and magma generation.

The Primeval Rocks of Unicorn Point

From Earth Science Picture of the Day, September 21, 2022.
Photographer and Summary Author: Ray Boren
https://epod.usra.edu/blog/2022/10/the-primeval-rocks-of-unicorn-point.html

Above the southern tip of Antelope Island — a state park, and the largest isle in Utah's Great Salt Lake — rise numerous outcrops so primordial that geologists say their stones are older than the basement rock found at the bottom of the Grand Canyon and are therefore among the oldest exposed on Earth.



The first photograph here, taken on Sept. 22, 2022 — the Autumn Equinox — presents a curious set of banded, contorted and weathered metamorphic features on the island's southernmost Unicorn Point. The second photo spotlights the outcrop's eye-catching features: A sculpted stone that looks like a fist punching skyward (or is it an abstract gargoyle of E.T. the Extra-Terrestrial's head and long neck?). Another eye-catching feature from this outcrop is shown below; a folded, intrusive "Z" that fictional Old California hero Zorro might admire. Other formations, sometimes rounded, sometimes dangerously gritty and sharp, resemble knobby pillars or upright spears, or bear intriguing striped designs and raised quartz ribbons.

Two-thirds of Antelope Island is composed of Farmington Canyon Complex stone — originally sedimentary rock that formed 2.5 billion or more years ago, which was subsequently altered approximately 1.7 billion years ago by metamorphic processes and intrusions, according to the Utah Geological Survey. These rocks and others on the island, once buried deep within the Earth, were heated at extreme temperatures, deformed, uplifted and exposed, and thus feature diverse examples of granites, gneisses, schists, quartzites, migmatites, amphiboles and pegmatites.

Antelope Island, Utah Coordinates: 40.9581, -112.2146

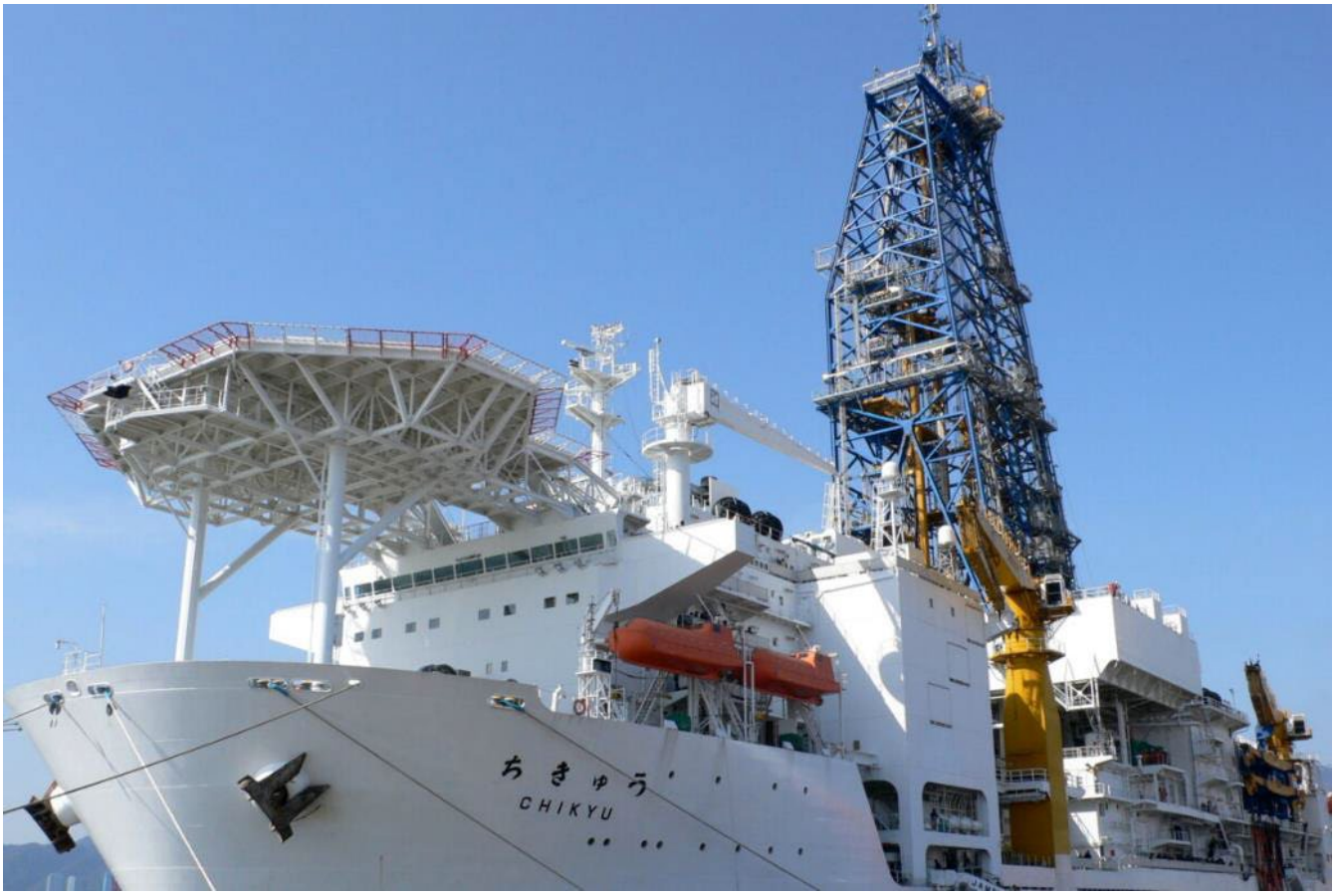
Related Links

- Antelope Island's Winter Winds

Deepest Scientific Ocean Drilling Sheds Light on Japan's Next Great Earthquake

From The University of Texas at Austin. Published September 22, 2022.
https://news.utexas.edu/2022/09/22/deepest-scientific-ocean-drilling-sheds-light-on-japans-next-great-earthquake/

AUSTIN, Texas — Scientists who drilled deeper into an undersea earthquake fault than ever before have found that the tectonic stress in Japan's Nankai subduction zone is less than expected, according to a study from researchers at The University of Texas at Austin.



The scientific drilling vessel Chikyu, which in 2018 performed the deepest drilling of a subduction zone fault. Credit: Satoshi Kaya/FlickR

The findings, published in the journal *Geology*, are a puzzle because the fault produces a great earthquake almost every century and was thought to be building for another big one.

“This is the heart of the subduction zone, right above where the fault is locked, where the expectation was that the system should be storing energy between earthquakes,” said Demian Saffer, director of the University of Texas Institute for Geophysics (UTIG) who co-led the research and scientific mission that drilled the fault. “It changes the way we’re thinking about stress in these systems.”

Although the Nankai fault has been stuck for decades, the study shows that it is not yet showing major signs of pent-up tectonic stress. According to Saffer, that doesn’t alter the long-term outlook for the fault, which last ruptured in 1946 – when it caused a tsunami that killed thousands – and is expected to do so again during the next 50 years.

Instead, the findings will help scientists home in on the link between tectonic forces and the earthquake cycle and potentially lead to better earthquake forecasts, both at Nankai and other megathrust faults such as Cascadia in the Pacific Northwest.

Demian Saffer, director of the University of Texas Institute for Geophysics (UTIG), during scientific ocean drilling at Japan's Nankai earthquake fault. Credit: Demian Saffer/UTIG

"Right now, we have no way of knowing if the big one for Cascadia – a magnitude 9 scale earthquake and tsunami – will happen this afternoon or 200 years from now," said Harold Tobin, a researcher at the University of Washington who is the first author of the paper. "But I have some optimism that with more and more direct observations like this, we can start to recognize when something anomalous is occurring and that the risk of an earthquake is heightened in a way that could help people prepare."

Megathrust faults such as Nankai, and the tsunamis they generate, are among the most powerful and damaging on the globe, but scientists say they currently have no reliable way of knowing when and where the next big one will hit.

A drilling riser aboard the scientific drilling vessel Chikyu. Dozens of risers were linked together to reach deeper into an earthquake fault than ever before. Led by researchers at the University of Texas Institute for Geophysics and University of Washington, the scientific mission revealed that tectonic stress in Japan's Nankai subduction zone was lower than expected. Credit: Demian Saffer/University of Texas Institute for Geophysics

The hope is that by directly measuring the force felt between tectonic plates pushing on each other – tectonic stress – scientists can learn when a great earthquake is ready to happen.

However, the nature of tectonics means that the great earthquake faults are found in deep ocean, miles under the seafloor, making them incredibly challenging to measure directly. Saffer and Tobin's drilling expedition is the closest scientists have come.

Their record-breaking attempt took place in 2018 aboard a Japanese scientific drilling ship, the Chikyu, which drilled 2 miles into the tectonic plate before the borehole got too unstable to continue, a mile short of the fault.

Nevertheless, the researchers gathered invaluable data about subsurface conditions near the fault, including stress. To do that, they measured how much the borehole changed shape as the Earth squeezed it from the sides, then pumped water to see what it took to force its walls back out. That told them the direction and strength of horizontal stress felt by the plate pushing on the fault.

Contrary to predictions, the horizontal stress expected to have built since the most recent great earthquake was close to zero, as if it had already released its pent-up energy.

The researchers suggested several explanations: It could be that the fault simply needs less pent-up energy than thought to slip in a big earthquake, or that the stresses are lurking nearer to the fault than the drilling reached. Or it could be that the tectonic push will come suddenly in the coming years. Either way, the researchers said the drilling showed the need for further investigation and long-term monitoring of the fault.

The research was funded by the Integrated Ocean Drilling Program and the Japan Agency for Marine-Earth Science and Technology. UTIG is a research unit of UT Austin's Jackson School of Geosciences.

Harold Tobin of the University Washington inspects drilling risers. Credit: Harold Tobin/University of Washington

Scientists just found a hidden 6th mass extinction in Earth's Ancient Past

By Joshua A. Krisch, Live Science. Published November 15, 2022.
https://www.livescience.com/1st-mass-extinction-oxygen-drop

A global drop in oxygen levels about 550 million years ago led to Earth's first known mass extinction, new evidence suggests.

Impressions of the extinct Ediacaran fossils: Dickinsonia (center) and the smaller anchor-shaped Parvancorina (left), in sandstone at the Nilpena Ediacara National Park in South Australia. (Image credit: Photo courtesy of Scott Evans)

The height of the Ediacaran period, about 550 million years ago, was a boom time for life in Earth's oceans. Petalonamids shaped like feathers sucked nutrients from the water, slug-like *Kimberella* grazed on microbial mats, and the ancestors of jellyfish were just beginning to make waves.

But then 80% of life on Earth disappeared, leaving no traces in the fossil record.

Now, a new study suggests that these missing fossils point to the earliest known mass extinction event on Earth. These first communities of large, complex animals were killed by a steep global decline in oxygen — a finding that may have implications for modern ocean ecosystems threatened by human activities.

"This represents the oldest recognized major extinction event in the fossil record of animals," said lead study author Scott Evans, a postdoctoral researcher at Virginia Tech. "It is consistent with all major mass extinctions, in being linked to climate change."

Animals have passed through the evolutionary crucible of mass extinctions at least five times. There were the Ordovician-Silurian and the Devonian extinctions (440 million and 365 million years ago, respectively), which killed off many marine organisms. Then, there were the Permian-Triassic — also known as the "Great Dying" — and Triassic-Jurassic extinctions (250 million and 210 million years ago, respectively), which affected ocean vertebrates and land animals. The most recent mass extinction, about 66 million years ago at the end of the Cretaceous period, wiped out approximately 75% of plants and animals, including nonavian dinosaurs.

Whether one more mass extinction should be added to that list has been an open question among paleontologists for some time. Scientists have long known about the sudden decline in fossil diversity 550 million years ago, but it was unclear if that was due to a sudden mass extinction event.

One possible explanation could be that early trilobites — armored and often helmet-headed marine arthropods — began competing with Ediacaran fauna, causing the latter to die out. Another possible explanation is that Ediacaran fauna lived on, but the conditions necessary for preserving Ediacaran fossils existed only until 550 million years ago. "People recognized that there was a change in biota at this time," Evans said. "But there were significant questions about what the causes might be."

To answer those questions, Evans and his colleagues compiled a database of Ediacaran fossils that other researchers had previously described in scientific literature, sorting each entry by factors such as geographic location, body size and feeding mode. The team cataloged 70 animal genera that lived 550 million years ago and found that only 14 of those genera were still around 10 million years later. They noticed no significant changes in the conditions necessary for preserving fossils, nor did they find the sort of differences in feeding modes that would suggest that the Ediacaran animals died out due to competition with early Cambrian animals, like trilobites.

Impressions of the extinct Ediacaran fossils *Dickinsonia* (left) and the related but rare form *Andiva* (right), from South Australia's Nilpena Ediacara National Park. (Image credit: Photo courtesy of Scott Evans)

But there was one common thread among the organisms that survived: body plans with high surface area relative to volume, which can help animals cope with low-oxygen conditions. That observation, combined with geochemical evidence of a decline in oxygen 550 million years ago, suggests that the Ediacaran may have ended in a mass extinction event caused by low oxygen availability in the ocean. The researchers published their findings online Nov. 7 in the journal Proceedings of the National Academy of Sciences.

"We examined the selectivity pattern — what went extinct, what survived, and what flourished after the extinction," said study co-author Shuhai Xiao, a professor of geobiology at Virginia Tech. "It turns out that organisms that cannot cope with low oxygen levels were selectively removed."

Why oxygen levels plummeted in the waning years of the Ediacaran remains a mystery. Volcanic eruptions, tectonic plate movements and asteroid impacts are all possibilities, Evans said, as are less-dramatic explanations, such as changes in nutrient levels in the ocean.

Regardless of how it happened, this mass extinction likely influenced the subsequent evolution of life on Earth and may have implications for scientists studying how animal life got started.

"Ediacaran animals are pretty strange — most don't look anything like the animals we know," Evans said. "After this extinction event, we start to see more and more animals that look like ones around today. It may be that this early event paved the way for more modern animals."

The findings may also hold lessons about human threats to aquatic life. Various agricultural and wastewater practices have introduced nutrients such as phosphorus and nitrogen into marine and river ecosystems, thus increasing the amount of algae that decompose in the water and consume oxygen. The spread of "dead zones," where oxygen levels in the water are too low to sustain life, could pose similar challenges to modern animals.

"This study helps us understand the long-term ecological and geological impacts of oxygen-deficiency events," Xiao said.

Triboluminescence Observed on Perito Moreno Glacier

From Earth Science Picture of the Day, September 21, 2022.
Photographer: Rodrigo Terren
Summary Author: Rodrigo Terren, Jim Foster
https://epod.usra.edu/blog/2022/09/photographer-rodrigo-terren-rodrigoterrengmailcom-summary-author-rodrigo-terren-rodrigoterrengmailcom.html

The photo above shows an unusual luminescent phenomenon observed during the rupture of the glacier walls in a portion of the Perito Moreno Glacier in the Province of Santa Cruz, Argentina. We were photographing this glacier one night this past August (winter in Southern Hemisphere) when hearing a very loud cracking sound, suddenly noticed that an area of the ice wall had brightened – the white blotches on glacier at lower right center. It remained illuminated for more than ten minutes. This brightening is attributed to triboluminescence. When a material, such as a quartz crystal or even a *life saver* hard candy is pulled apart, crushed, or snapped, light will sometimes be emitted. Though this phenomenon is poorly understood and rarely observed on such a large scale, it seems to be caused by the rapid separation and reunification of static electrical charges in some brittle solids.

The long exposure (several minutes) used to capture the brightening results in the star trails. Photo taken on April 29, 2022.

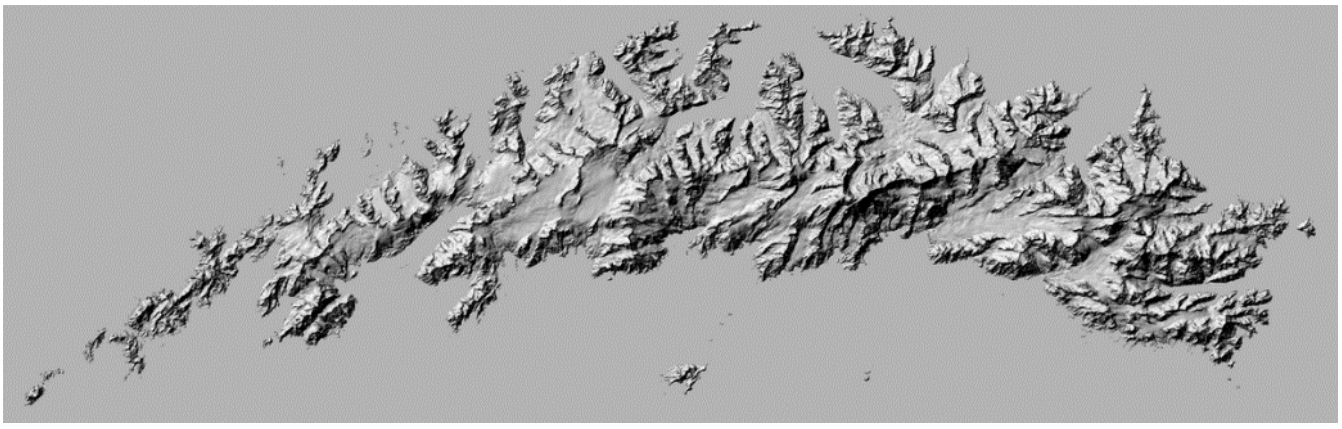
Perito Moreno Glacier, Argentina Coordinates: -50.469380, -73.029940

Related Links

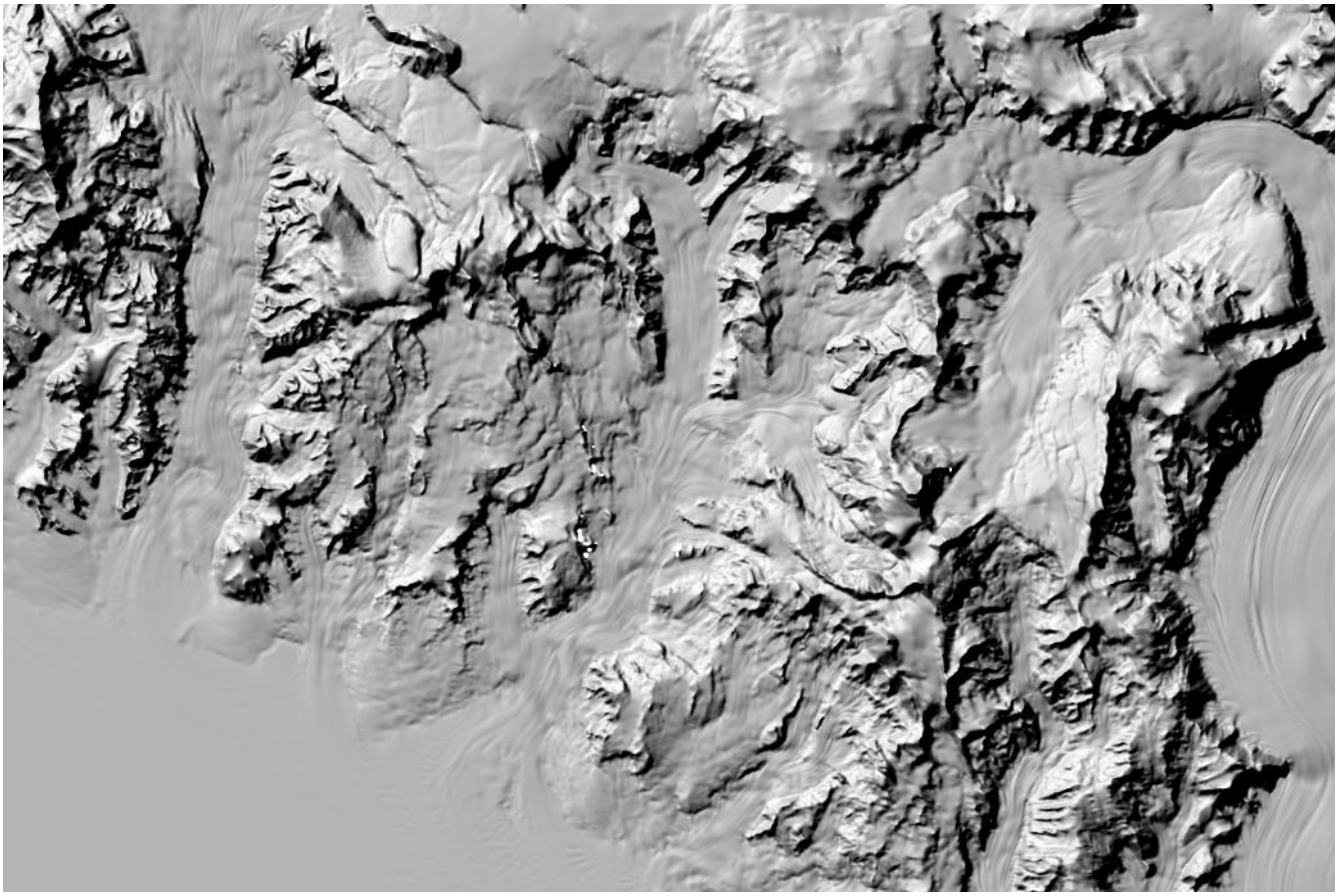
- Perito Moreno Glacier

High-res maps of entire polar regions provide new clues for climate researchers

From University of Minnesota. Published October 25, 2022.
https://cse.umn.edu/college/news/high-res-maps-entire-polar-regions-provide-new-clues-climate-researchers



MINNEAPOLIS / ST. PAUL (10/25/2022) — A team of researchers led by the University of Minnesota Twin Cities has released four more years of high-resolution imagery data, which has been added to eight years of previous data, to create the most detailed polar region terrain maps ever created. The maps use high-resolution satellite data to show the polar regions in stunning detail and will provide new insights into the effects of climate change over time.



With four more years of satellite imagery data, researchers in the Polar Geospatial Center at the University of Minnesota and their partners have now released the most detailed polar region terrain maps ever created. Credit: Polar Geospatial Center at the University of Minnesota from satellites owned by Maxar and licensed by the National Geospatial-Intelligence Agency.

The researchers have partnered with Amazon Web Services to make the high-resolution imagery data publicly available in the cloud for free.

“Our previous data resulted in more than 300 scientific publications,” said Claire Porter, acting co-director of the National Science Foundation-funded Polar Geospatial Center at the University of Minnesota Twin Cities. “With four more years of data that is even more accessible, these are transformative data sets. We’re excited to see what scientists will discover about how our Earth is changing.”

The project began with images taken from a constellation of polar-orbiting satellites about 400-700 kilometers above the Earth. The researchers at the Polar Geospatial Center created the digital elevation models based on 50-centimeter resolution images captured by the commercial satellites owned by Maxar and licensed by the National Geospatial-Intelligence Agency.

Partners at The Ohio State University and Ohio Supercomputer Center developed the software to process the images and University of Minnesota researchers put the maps together with computing resources from the University of Illinois Urbana-Champaign that provided the Blue Waters supercomputer, a leadership-class academic supercomputer. The researchers processed millions of images to create the high-resolution topographic maps.

With the newest data set they were able to fill in all the previous gaps in data to provide full coverage of the entire polar regions north of 60ºN (including most of Scandinavia, Greenland, northern Canada, Alaska, and Siberia) and south of 60ºS (including all of Antarctica). They also built a continent-wide seamless terrain map in the Antarctic, and plan to release an Arctic version this winter.

The polar regions are especially important because the effects of climate change are amplified at the poles. Using these digital elevation models, scientists can see detailed topography of the land, including individual trees, lakes, roads and buildings.

“In the past, researchers collected data using expensive airplane or land exploration at limited times of the year. Now, we are measuring the surface of the Earth at a resolution and geographic scale that no one has ever seen before, and we’ve been doing it for more than a decade,” Porter said.

“We’ve been able to see glacier change, erosion, landslides, and flooding—all in incredible detail over time,” Porter added. “That’s a game changer for everyone who is trying to protect our planet for the future.”

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JANUARY MEETING ANNOUNCEMENT

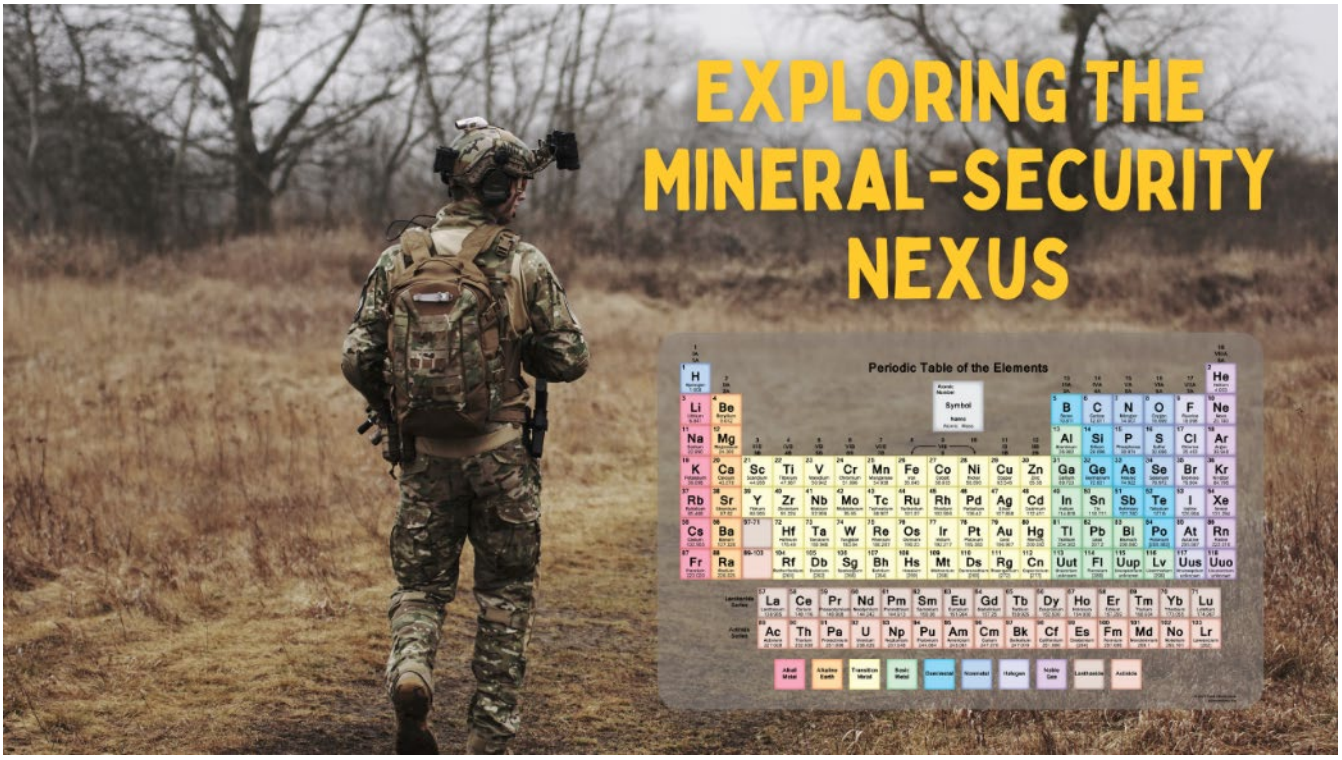
TOPIC: Mineral-Security Nexus

SPEAKER: Thomas Hale, Friends of Mineralogy Virginia Chapter

DATE/TIME: 7PM, January 19, 2023

Please send Sharon Lewandowski an email to request a Zoom invite for the January meeting: sharon.lewandowski@des.nh.gov.

Thomas Hale is a PhD student at the University of Delaware, in the Department of Geography and Spatial Sciences with a special emphasis on critical materials. He is the program assistant for the Minerals, Materials, and Society (MMS) program at UDel and host of the “A Rock & A Hard Place” podcast.



In this presentation, Mr. Hale will provide a broad overview of the nexus between minerals and national security, their impact on international affairs, and their growing role in decarbonization efforts and the energy transition. The presentation will cover core concepts such as critical minerals, conflict minerals, and rare-earth elements, including key policy challenges and great-power competition influencing the race for these critical metals. Mr. Hale will present his concept of Mineral Diplomacy as a method to view the world’s most-pressing challenges through a mineral lens; from conflict zones, critical mineral supply chains, climate change, and U.S. national security policy. Mr. Hale will also discuss his research and some key policy developments in the US surrounding critical mineral development.

Key Concepts:

- Review the fundamentals of why minerals are important to society and the basic components of global supply chains;
- Provide a brief overview of key issues and policy challenges related to critical minerals, conflict minerals, and rare-earth elements (REE's);
- Define the Mineral-Security Nexus and explore its relationship to national, human, and environmental security issues;
- Discuss the importance of visualizing data to improve our understanding of these issues.
- Explore the pathway(s) forward and political obstacles a mineral future will face;
- Describe the concept of Mineral Diplomacy as a tool to explore global issues through a mineral lens;
- Present three brief case studies on artisanal cobalt mining in the Democratic Republic of the Congo, Afghanistan's mineral resources post-US withdrawal, and mineral redevelopment of Greenland.
- Provide an overview of recent U.S. legislation and federal government announcements related to increasing domestic mining and reducing dependency on foreign supply chains.

DATES TO REMEMBER

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.

January 19, 2023 – **GSNH dinner meeting (virtual via Zoom)** – Thomas Hale, president of the Virginia chapter of Friends of Mineralogy, will give a presentation on Mineral-Security Nexus. See announcement above.

March 16, 2023 – **GSNH Board meeting** – Location TBD.

April 20, 2023 – **GSNH dinner meeting** – Location TBD.

July 15, 2023 (rain date July 16) – **GSNH Field Trip: Franconia Notch** – See announcement on page 18.

Looking for some online 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: https://www.americangeosciences.org/workforce/goli

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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: _____