Granite State Geologist

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MESSAGE FROM THE PRESIDENT

I was glad I could make the GSNH Summer Field Trip this year. (It helps when you are one of the leaders.) We held it after blueberry season near the end of August and it was a beautiful, cool, sunny day with a nice group in attendance. Charlie Kerwin of Keene State College led about thirty of us as we traipsed around on the trails and dirt roads of Pawtuckaway State Park to pound on outcrops of the various rocks forming the Pawtuckaway ring dike. A fine view from the fire tower after a brief hike capped the morning session. In the afternoon we stopped at two of the dams that form and control Pawtuckaway Lake and discussed how the State's dam operations affect the lake and the rivers downstream. Pawtuckaway Lake is one of the lakes used by the State to manage Lamprey River stream flow.

Another field trip opportunity with the New England Intercollegiate Geological Conference is coming right up. It starts Friday, October 11 and runs through the weekend. Norwich University in Northfield, VT will host it this year. According to the Geological Society of Maine Newsletter: "Trips will predominantly focus on areas in central and southern Vermont and immediately adjacent parts of New Hampshire." The conference webpage is at http://w3.salemstate.edu/~lhanson/NEIGC/Conference.html where you can read the trips scheduled. (I found out reading the history page that the NEIGC began in 1901. William Morris Davis led its first field trip that year to the terraces of the Westfield River in south-central Massachusetts.) Anyway, I've already registered for this year's field trip. (I plan to take the Mt. Ascutney trip: the last time I was there was a sledding trip that ended with a broken finger, a bloody nose, and a broken sled – only the last was mine.) Don't miss Vermont in the fall!

We plan to have a very different speaker's event at our October meeting. Dr. Robert Gastaldo will be speaking on the terrestrial record of the end-Permian mass extinction in South Africa, and he will add to his presentation an opportunity to do some armchair geology with virtual reality gear. [Of course, VR will never replace field geology, and who would want it to? Who wants to miss out on the bugs and poison ivy and slips and falls of field work?] This meeting is coming up soon, October 17, and is bound to be a hit, so sign up early before we reach our maximum attendance.

2020 GSNH Election: Consider Joining the GSNH Board!

Several positions on the Board of Directors have terms expiring in 2020, and voting will take place during the Fall (October) 2020 dinner meeting. These include the following: President, Society Vice President, Council Vice President, Secretary, and one Member-at-Large position.

GSNH Needs You!
Several current positions are term-limited and expiring in 2020, so the Board is particularly looking for the following:

President: Duties include the following:

1. Preside at meetings of GSNH and serve as chairman of the Board of Directors.
2. Direct all committees, especially the Membership and Communications Committee, excepting the nominating committee.
3. Determine the duties of the Vice Presidents.
4. Coordinate the work of the Board of Directors and committees, in order that the objectives of the GSNH may be promoted.
5. Submit an annual report to the membership at the Annual Meeting.
6. Represent GSNH at public meetings to promote the purpose and mission of the society, or appoint another GSNH Board or Committee member to do the same.
7. Approve all disbursal of funds.

Member-at -Large (one position): Duties include the following:

1. Attend and provide input at GSNH Board Meetings
2. Serve as a liaison for the GSNH membership.

If interested in joining the Board of Directors, please reach out to a current Board member. For more details about all the positions, see http://www.gsnh.org/gsnh-constitution-and-bylaws.html.

Call for Articles

Have a geological story you want to share with your fellow geologists? Did you go on a field trip or just see a cool geological feature in your travels? Feel free to submit to the GSNH newsletter, published quarterly. The submission deadlines are March 1, June 1, September 1, and December 1, but content can be submitted any time for inclusion in the next newsletter article. Send to jlambert@nobis-group.com. For more details, see the submission guidelines at the GSNH website: http://www.gsnh.org/submission-guidelines.html.

Asteroid That's Nearly the Height of the World's Tallest Building Is Flying by Earth Soon

By Laura Geggel, Live Science: https://www.livescience.com/asteroid-fly-by-september-2019.html

A monster of an asteroid that nearly rivals the height of the Burj Khalifa — the world's tallest building, located in Abu Dhabi — is cruising by Earth in less than a month, according to NASA.

An artistic depiction shows a huge asteroid about to slam into Earth. (Image: © Shutterstock)

The asteroid 2000 QW7 is incredibly bulky, measuring anywhere between 951 and 2,132 feet (290 and 650 meters) in diameter, and just a tad shorter than the 2,716-foot-tall (828 m) Burj Khalifa.

This asteroid is so immense, it's nearly twice the height of the 1,250-foot-tall (381 m) Empire State building. It's expected to whiz by our blue planet on Sept. 14, according to the Center for Near Earth Object Studies (CNEOS), a part of the Jet Propulsion Laboratory in Pasadena, California.

However, asteroid 2000 QW7 isn't exactly in a position to drop in for tea. First off, it will be going incredibly fast — 14,361 mph (23,100 km/h) — as it zooms by Earth, CNEOS reported. Second, even though it's considered a near-Earth object, it will still be quite far away. Asteroids and other space

materials are considered near-Earth objects if they pass within 1.3 astronomical units of our planet (an astronomical unit is the distance from Earth to the sun, or 92.9 million miles (149.6 million kilometers)).

As CNEOS notes, 2000 QW7 will pass within 0.03564 astronomical units of Earth, which is equivalent to about 3.3 million miles (5.3 million km). Put another way, that's 13.87 times the distance between Earth and the moon.

Just like Earth, asteroid 2000 QW7 orbits the sun. However, it only sporadically crosses paths with Earth. The last time it approached our planet was Sept. 1, 2000. After Sept. 14, the next time it's expected to pass by is Oct. 19, 2038, according to the Jet Propulsion Laboratory.

2019 GSNH Summer Field Trip: Pawtuckaway State Park

by Jenny Lambert

The 2019 GSNH summer field trip took place on August 24 at Pawtuckaway State Park. More than 30 field trip participants enjoyed the beautiful summer weather. We had a two-part field trip, with Charlie Kerwin (Keene State College) leading the group through the outcrops of the Mt. Pawtuckaway ring dike complex and Wayne Ives (Instream Flow Program, Watershed Management Bureau of NHDES) taking over to visit the Dolloff Dam and Drowns Dam and discuss the water management issues at Pawtuckaway Lake.

Tom Fargo assists trip leader Charlie Kerwin at the start of the GSNH summer field trip on August 24, 2019 as he describes the geology of the Pawtuckaway ring dike. Photo by Wayne Ives.

Trip leader Charlie Kerwin collects a fresh outcrop sample at the GSNH summer field trip on August 24, 2019. Photo by Jenny Lambert.

Field trip participants on syenite at the top of South Mountain during the 2019 GSNH Field Trip to Pawtuckaway State Park, Nottingham, NH on August 24, 2019. Photo by Wayne Ives.

View of the top of South Mountain (and more outcrops!) to the southwest. Photo by Jenny Lambert.

Lunch break on Dolloff Dam at the southern outlet of Pawtuckaway Lake during the 2019 GSNH Field Trip to Pawtuckaway State Park, Nottingham, NH on August 24, 2019. Photo by Wayne Ives.

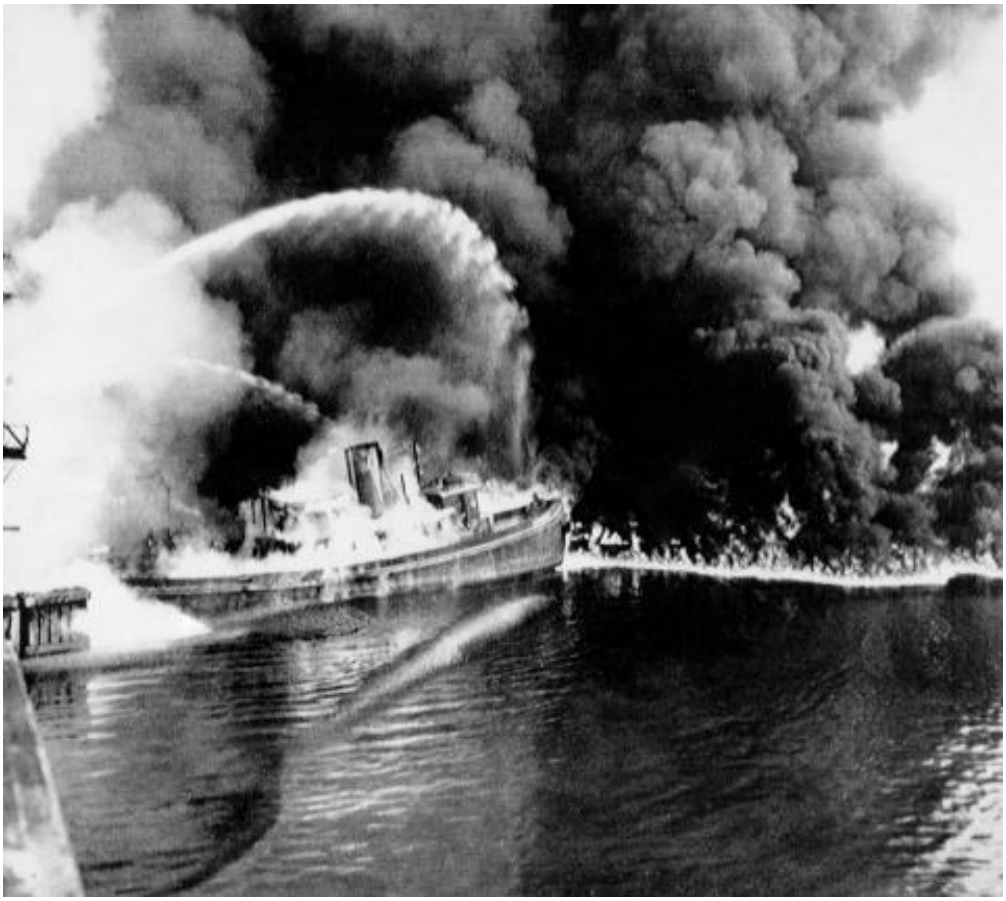
Wayne Ives describes the data collection and history of Pawtuckaway Lake at the Dolloff Dam during the 2019 GSNH Field Trip to Pawtuckaway State Park, Nottingham, NH on August 24, 2019. Photo by Jenny Lambert

Wayne Ives discusses watershed management and phosphorus at the Drowns Dam on the northern edge of Pawtuckaway Lake during the 2019 GSNH Field Trip to Pawtuckaway State Park, Nottingham, NH on August 24, 2019. Photo by Jenny Lambert

50th Anniversary of the Cuyahoga River Fire by Jenny Lambert

June 22, 1969 was the last time the heavily polluted Cuyahoga River in Cleveland caught fire.

The state of the river wasn't a secret; there were at least 13 fires in the river starting in 1868, with the largest in 1952 causing over $1 million in damages. However, by the late 1960s, environmental concern was growing and the city had started trying to clean up the river. *Time* magazine published an article on the fire that sparked an outcry, and local environmental advocates including local university students (who held the first Earth Day in 1970), Cleveland Mayor Carl Stokes, and US Representative Louis Stokes used the publicity to advocate for river cleanups. Their efforts resulted in the creation of the US Environmental Protection Agency (1970) and the passage of the Clean Water Act (1972).



Firefighting on the Cuyahoga River near Downtown Cleveland, June 25, 1952 (AP Images, from https://time.com/3921976/cuyahoga-fire/)

For more, see:

Smithsonian Magazine: https://www.smithsonianmag.com/history/cuyahoga-river-caught-fire-least-dozen-times-no-one-cared-until-1969-180972444/

Cuyahoga River Restoration: http://cuyahogariver.org/the-cuyahoga.html

Cuyahoga50: https://www.cuyahoga50.org/

Color Vision Deficiency and the Geosciences by Jenny Lambert

From GSA Today, June 2017:
https://www.geosociety.org/gsatoday/groundwork/G322GW/GSATG322GW.pdf

Geologists frequently read and produce color charts, annotated maps, and other visual ways of conveying important information. An important consideration when producing visual information is color vision deficiency (CVD). While the most common form of CVD is red-green, CVD may also include blue and monochromatic variants. There are several ways to improve legibility for viewers with CVD:

- Use color-checking software such as color-blindness.com or colorbrewer2.org
- Use line weight and dash type to distinguish between lines
- If using colors for areas, use different hues (such as light green and dark red) as an additional marker to distinguish color values
- Distinguish items by more than color
- Label items directly if possible

Note that color images that are designed to be clearly visible to people with CVD will look better to everyone, and will also better survive being scanned/copied!

July 2019 Magnitude 7.1 Ridgecrest Earthquake Sequence from USGS

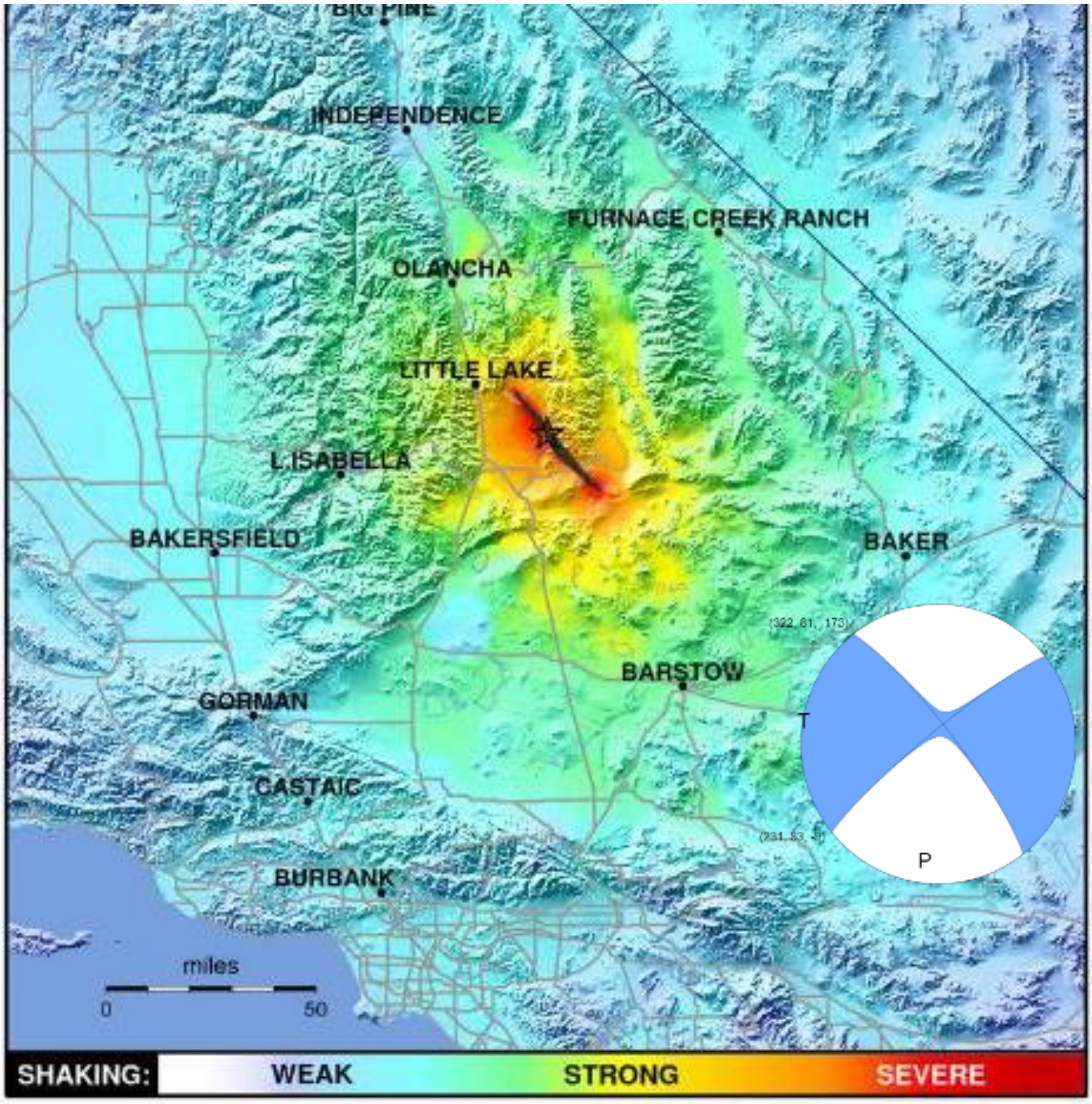
See: https://earthquake.usgs.gov/earthquakes/eventpage/ci38457511/executive

The July 6th, 2019, 03:19 UTC (July 5th 20:19 locally) Mw 7.1 earthquake in eastern California, southwest of Searles Valley, occurred as the result of shallow strike slip faulting in the crust of the North America plate. Focal mechanism solutions for the earthquake indicate rupture occurred on a steeply dipping fault as the result of either right lateral slip on a plane striking NW-SE, or as left lateral slip on a plane striking SW-NE. At the location of this earthquake, approximately 150 km northeast of San Andreas Fault - the major plate boundary in the region – the Pacific plate moves to the northwest with respect to the North America plate at a rate of approximately 48 mm/yr. The location of the earthquake falls within the Eastern California shear zone, a region of distributed faulting associated with motion across the Pacific:North America plate boundary, and an area of high seismic hazard. More detailed studies will be required to precisely identify the causative fault associated with this event, though seismic activity over the past 2 days has been occurring on two conjugate fault structures in the Airport Lake Fault Zone.

This earthquake occurs approximately 34 hours after and 11 km northwest of a M 6.4 event in the same region, on July 4th, 2019, at 17:33 UTC. The July 4th event was preceded by a short series of small foreshocks (including a M4.0 earthquake 30 minutes prior), and was followed by a robust sequence of aftershocks, including almost 250 M 2.5+ earthquakes (up until the M 7.1 event). Those events aligned with both nodal planes (NE-SW and NW-SE) of the focal mechanism solution of the M 6.4 event, which was very similar in faulting style to today's M 7.1 earthquake. The sequence includes two other M5+ earthquakes, one of which occurred 20 seconds before the M 7.1 event. The M 7.1 earthquake occurred at the NW extension of the prior sequence.

While commonly plotted as points on maps, earthquakes of this size are more appropriately described as slip over a larger fault area. Strike-slip-faulting events of the size of the July 6, 2019, earthquake are typically about 70x15 km (length x width).

This region of eastern California has hosted numerous moderate sized earthquakes. Over the past 40 years, prior to the July 4th event, 8 other M5+ earthquakes have occurred within 50 km of the July 6th, 2019 earthquake. The largest of these was a M 5.8 event on September 20, 1995, just 3 km to the west of today's event, which was felt strongly in the China Lake-Ridgecrest area, and more broadly from Los Angeles to Las Vegas.



Shake Map and Moment Tensor (inset) for the Ridgecrest earthquake sequence

GSNH T-SHIRTS STILL AVAILABLE!

The GSNH t-shirts have been a popular item. We have about a dozen each in sizes small, medium and large. Ask Julie Spencer about buying a t-shirt at the next dinner meeting! T-shirts are $18 each.

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

Northeastern Friends of the Pleistocene: 2019 Cape Cod Field Conference

by Woody Thompson, NEFOP Secretary

On May 31-June 2, 2019, the Northeast (original) Friends of the Pleistocene (NEFOP) held their 82nd annual trip on Cape Cod, Massachusetts. It was 51 years ago that the Friends last visited the Cape. There has been a vast amount of research since then on the Quaternary geology of the area! The trip was led by Byron Stone of the U. S. Geological Survey along with colleagues working on the onshore, coastal, and offshore geology of the Cape. There were about 90 Friends on the trip, making it the best attended NEFOP conference in many years. A small selection of photos from the weekend are included here.

Figure 1. Walking along Highland Light Sea Cliff to Stop 8

Figure 2. Buried peat with tree stump in growth position, at Stop 12 on Coast Guard Beach, Eastham.

Figure 3. Doane Rock in Eastham (Stop 13) is the largest known glacial erratic boulder on Cape Cod.

Figure 4. Sand beds in the proximal Mashpee Pitted Plain, deformed by overriding glacial ice and now part of the Sandwich Moraine (Stop 21). The overlying till has been removed here. Photo by Dan Tinkham.

This was the first in-depth Cape Cod geology trip for many of us, and over the 3-day weekend we were treated to a succession of informative stops that laid out the glacial and marine processes that formed today's Cape. I was floundering on how to summarize all of this, including the detailed field trip guidebook. Luckily, Byron's guide starts with a great overview of what we saw, so I'm taking the liberty of quoting this section from Page 1 of his Introduction:

"The bared-arm shaped peninsula of Cape Cod consists of three parts: from 'shoulder to elbow', the landscape is formed by interlobate recessional moraines of the last ice sheet and their associated glaciodeltaic outwash plains that were graded to a lake in Nantucket Sound. From just past the 'elbow' [northward] to the 'wrist', the land is formed by deltas that were built into a glacial lake in Cape Cod Bay; these deltas were sourced from the margin of a long-lingering ice lobe in the Gulf of Maine. And from the 'wrist to the curving fingertips', there lies a massive marine spit and dune complex of late Holocene age. On days 1 and 2 of the field tips, we will examine sea cliff exposures, morphologic features, and a sand and gravel excavation in the elbow to fingertips section of Cape Cod (also called the lower Cape). On day 3, we will visit sand and gravel excavations in the recessional moraines, and outwash plains of the shoulder to elbow section of Cape Cod (also called the upper Cape)."

Much of this year's FOP was based on years of detailed geologic mapping by the USGS and their collaboration with the Massachusetts Geological Survey (MGS). Stephen Mabee, State Geologist, was editor of the guidebook, which is MGS Open-File Report 19-01. The trip was also co-sponsored by the Massachusetts Geological Society. The 2019 guidebook will be posted on the NE FOP website, where it will join the readily accessible files of nearly all past guides since 1934:

https://www2.newpaltz.edu/fop/

On To New Hampshire!

On the weekend of June 6-7, 2020, the Friends will meet in central New Hampshire for the first time. We will visit the Lakes Region and neighboring areas, for which there is new detailed surficial mapping by the New Hampshire Geological Survey through the USGS STATEMAP program. The trip will examine the glacial and deglacial history of the region, including ice-flow directions, the mode of ice retreat, glacial stratigraphy and geomorphology, and revelations from LiDAR imagery. Dan Tinkham (Emery & Garrett Groundwater Investigations in Meredith, A Division of GZA) will be leading the trip, along with several other mappers and colleagues working in New Hampshire, under the auspices of the NHGS.

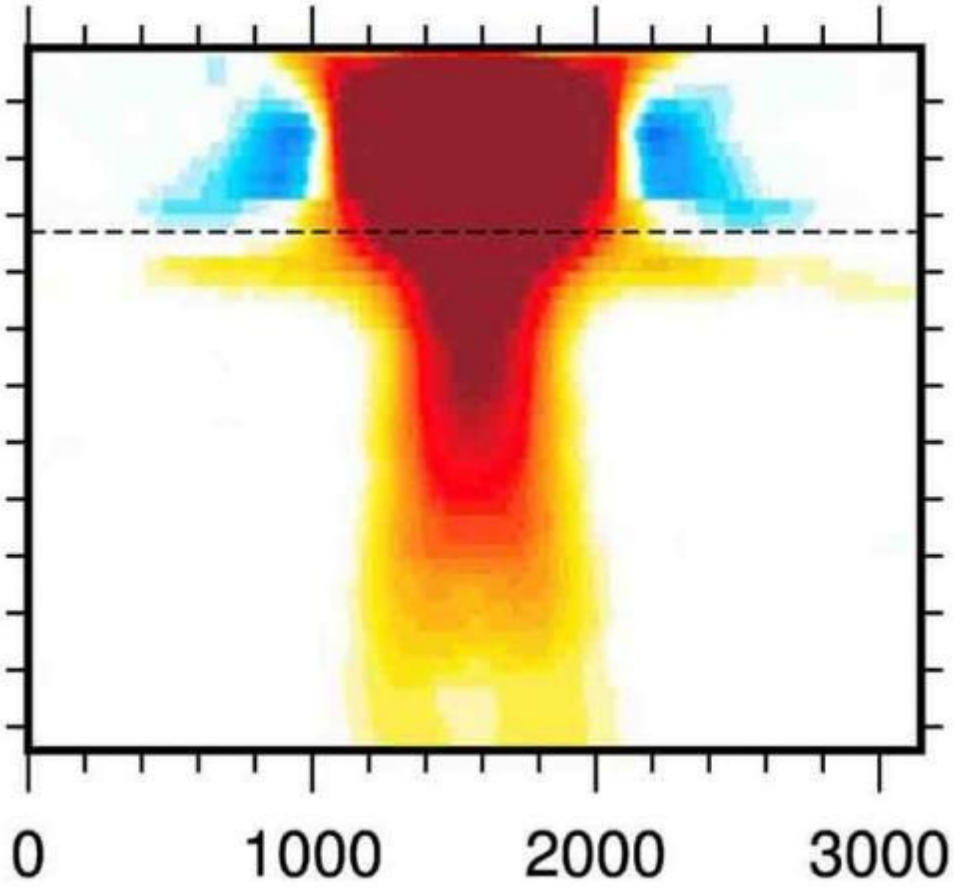
Watch the NEFOP website this winter for a preliminary announcement of the 2020 trip, with registration details to follow when available.

Catching Mantle Plumes by their Magma Tails

From GeologyPage:
https://www.geologypage.com/2018/04/catching-mantle-plumes-by-their-magma-tails.html

Hawaii's volcanos stand as silent sentinels. They guard the secret of how they formed, thousands of miles away from where the edges of tectonic plates clash and generate magma for most volcanos. A 2017 Nature study by Jones et al. found the best clues yet of the origin of Hawaii's volcanos through simulation of a shift in the Pacific plate three million years ago. What remains elusive is conclusive evidence that mantle plumes exist.

The plumes are hypothesized, mushroom-shaped upwellings of hot rock from the deep Earth. They are hypothesized to form within the thermal boundary layer at the base of the mantle and are thought to carry heat from the Earth's core that generates a volcano's magma. Scientists have now made the best computational modeling yet of mantle plumes, according to a study made available online in January of 2018 ahead of its peer-review and publication November of 2017 in the American Geophysical Union's Journal of Geophysical Research, Solid Earth.



Scientists have now made the best computational modeling yet of mantle plumes, hypothesized, mushroom-shaped upwellings of hot rock from the deep Earth. They [sic] plumes are hypothesized to form within the thermal boundary layer at the base of the mantle and are thought to carry heat from Earth's core that generates a volcano's magma. Credit: Ross Maguire

The international science team showed through supercomputer simulations, for the first time, details of how plumes decelerate seismic waves and how plumes appear in seismic tomographic images of the Earth's mantle, the layer beneath the crust. What's more, the researchers say their work could help guide future experiments on the ocean floor with deep Earth imaging and help get to the bottom of mysteries like the origin of Hawaii's volcanos.

"We found that mantle plumes are likely to be more challenging to seismically image than we previously recognized," said study lead author Ross Maguire, formerly a PhD student who has recently graduated from the department of Earth and Environmental Sciences at the University of Michigan. "Our current picture of deep mantle plumes might be lacking," Maguire said, pointing to a lack of seismic data coverage.

Seismic imaging can see rock structures thousands of kilometers below ground by listening to the echos of earthquakes. Networks of seismic stations sit on the ocean floor and measure differences in the travel time of seismic waves through rock, in essence taking a CT scan of the deep Earth.

“In order to constrain the role of mantle plumes in Earth dynamics as well as to understand the causes of hot spot volcanism, we need to focus on increasing the global coverage of seismic sensors, particularly in the oceans, which currently only have sparse coverage,” Maguire said. Oceanic deployments of seismic sensors are costly and tough to plan and execute, he added.

“In our study, we used computer modeling to find optimal imaging scenarios, so that we can recover the most detail of mantle plumes at the lowest cost,” Maguire said. “We hope that our results will help guide the design of future seismic deployments aimed at imaging the mantle beneath hotspots.”

“The thing that is probably new in this work is that we combine, maybe for the first time, actual numerical models of how plumes form and how they rise in the Earth with estimates of their seismic structure” said study co-author Jeroen Ritsema, a professor in the Department of Earth and Environmental Sciences at the University of Michigan.

“Secondly,” he added, “we’ve also explored how various network configurations might change the way that we are imaging plumes. We’ve done extensive tests to figure out the optimal configurations of seismometers on Earth to see plumes. This is particularly important for Hawaii,” Ritsema said. “Hawaii is a place where we believe there is a plume responsible for volcanism on the Hawaiian islands. We’ve determined what might be optimal offshore deployments on the seafloor that could lead to best images of the deep mantle beneath Hawaii.”

“It is a big computational challenge to simulate wave propagation through mantle plumes,” Maguire said. They needed numerical codes that solve the elastic wave equation in Earth’s mantle at high frequencies and in three dimensions. “What that does is it allows us to accurately account for the effects of wave propagation phenomena such as wave diffraction around plume tails, which is very important for imaging plumes,” Maguire said.

XSEDE, the eXtreme Science and Engineering Discovery Environment, funded by the National Science Foundation, provided computational resources to the science team through access to supercomputers and experts in how to use them best. “We would not be able to do this type of work without supercomputing resources like those that are provided by XSEDE,” Maguire said. “They allowed us to run our wave propagation simulations on hundreds or sometimes thousands of computer cores in parallel.”

The science team tackled the challenges imposed by their modeling requirements and used a seismology software package called SPECFEM 3D (GLOBE), which is a spectral element code developed by Jeroen Tromp of Princeton and his team that simulates wave propagation in the Earth’s interior. They used the Stampede1 supercomputer of the Texas Advanced Computing Center through an XSEDE allocation that ran over 1.2 million core hours on Stampede1 and continues with the Stampede2 system. “We ran that code mostly on Stampede1, and it was actually quite easy to get the code configured on Stampede1, since all the modules and tools we needed to compile it were immediately available,” Maguire said.

The workflow management proved daunting, with many simulations that produced hundreds of gigabytes of data. “The XSEDE team was really helpful in answering all my questions about how I can optimize my workflow, for example how I can spend the least amount of time waiting in the queue for my jobs to run; or how I can efficiently transfer large amounts of from Stampede onto my local machine,” Maguire said.

The researchers also took advantage of the XSEDE Campus Champions program, campus information technology faculty and staff that are trained by and maintain close ties to XSEDE. “XSEDE Campus Champion Brock Palen of the University of Michigan helped us answer questions about what type of resources are available through XSEDE, and how we can get access to them,” Maguire said.

Another useful resource, said Maguire, was access to an allocation on XSEDE Science Gateways through the Computational Infrastructure for Geodynamics with the help of Lorraine Wang. “Science Gateways enabled us to test our code and really figure out how computationally demanding our project would be,” Maguire said.

The researchers used a computationally demanding technique called synthetic tomography, which Maguire explained was essentially a reliability test of how well scientists can trust the accuracy of images of the Earth’s interior. “What we do is we simulate seismic wave propagation through a digital Earth model, which in our case contains a mantle plume,” Maguire said. They do that with virtual seismograms, which are processed like actual seismic data to get an image of recovered plume structure. “It really allows us to test how a mantle plume would be imaged tomographically and how its features would either be blurred or distorted, depending on the imaging configuration,” Maguire said.

“Our study focuses primarily on lower mantle plume tails because it’s really one of the only ways forward in terms of settling the debate on the existence of mantle plumes,” Maguire said. This relates to hotspot volcanism, caused by an anomalously hot mantle away from plate boundaries. Mantle plumes that rise from the core boundary interest geoscientists because they play a role in Earth’s total heat budget by moving heat from the core to the surface.

“Whole mantle plumes, meaning plumes that rise from the core-mantle boundary, are also the most challenging to image seismically because our resolution is very poor in the deep mantle and deep plume conduits are likely to be thin,” Maguire said.

Supercomputers might finally be starting to catch up with long-standing scientific questions and help provoke new questions. “I think that the challenge remains in understanding exactly what we are looking for,” said Ritsema. “In Maguire’s work, we have defined a mantle plume as a purely thermal upwelling in the deep Earth. In this particular case, the plume is a fairly narrow structure—it has a fairly narrow tail, with its complications in imaging. But there has been other work by other groups who have in fact argued that plumes might be much thicker than what we have investigated in our work. The very nature of plumes, whether plumes are purely thermal or temperature-driven, or whether there is also a compositional component to their formation, are issues that are now being addressed in geophysics,” Ritsema said.

The computational demands of simulations in this study of wave propagation limited the number of plume structures, which can be more varied in shape, size, composition, and temperature than the solely thermal plume cases they considered.

“Our study is also the first to model wave propagation through plumes at frequencies as high as one-tenth of a hertz,” Maguire said. “But we’d like to be able to push that even further to go to higher frequencies. And that means that it’s going to be even more of a computational challenge. As the numerical tools that we use become more efficient, and as more high-performance computing clusters become available, that’s something that we might be able to achieve in the future.”

Said Maguire: “Understanding Earth dynamics is of fundamental importance, because we all live here and are affected by what goes on beneath our feet. The existence of mantle plumes and the role that they play in our planet is still a big question mark. Additionally, plumes have been linked to some of the biggest volcanic eruptions in the history of the Earth. And they’re thought to potentially play a role in the largest mass extinction events that we have on geologic record. There’s still a lot that we don’t

understand about them. Doing research into probing the nature of mantle plumes is of fundamental importance."

The study, "Evaluating the Resolution of Deep Mantle Plumes in Teleseismic Traveltime Tomography," was published in January of 2018 in the American Geophysical Union's Journal of Geophysical Research: Solid Earth.

Reference:
Ross Maguire et al, Evaluating the Resolution of Deep Mantle Plumes in Teleseismic Traveltime Tomography, Journal of Geophysical Research: Solid Earth (2017). DOI: 10.1002/2017JB014730

N.H Becomes Second State to Sharply Lower Arsenic Limit in Drinking Water

by Annie Ropeik, NHPR.org, July 15, 2019:
https://www.nhpr.org/post/nh-becomes-second-state-sharply-lower-arsenic-limit-drinking-water#stream/0

Governor Chris Sununu on Friday signed a bill adopting a stricter limit on arsenic in the state's drinking water.

The new standard will require local water systems, landfills and others to limit how much arsenic they allow in the water supply to 5 parts per billion – half the federal default.

New Hampshire is only the second state in the country to make such a change, after New Jersey.

The Department of Environmental Services based the new law partly on a recent UNH study, which says the change will help state residents avoid dozens of cancer cases, a handful of deaths and other negative health and economic outcomes in the coming decades.

New Hampshire gets most of its drinking water from groundwater that can contain high levels of naturally occurring arsenic. Past research from Dartmouth College suggests this is one reason the state has some of the nation's highest rates of certain cancers, such as bladder cancer.

This research also suggests arsenic exposure may be linked to heart disease and diabetes.

New Hampshire's new arsenic standard must take effect within two years. The state says it'll cost municipal and school district water systems about $2.6 million overall to adopt in the first year, and about $1.4 million each year after.

About half of New Hampshire residents use private wells, which aren't required to follow the new regulation. Officials say those private well users are still strongly encouraged to test their water regularly and follow state guidance for treatment.

A DES fact sheet says as of 2010, 20% of the state's many public and private drilled wells – the most common source for drinking water – had arsenic levels above 10 parts per billion, which is the state's old standard.

Dartmouth research says about a third of the public water systems in New Hampshire contain detectable levels of arsenic.

Deep-Sea Sediments Reveal Solar System Chaos: An Advance in Dating Geologic Archives

by Marcie Grabowski, University of Hawai'i at Manoa, School of Ocean and Earth Science and Technology, August 29, 2019:
https://www.soest.hawaii.edu/soestwp/announce/news/deep-sea-sediments-reveal-solar-system-chaos-an-advance-in-dating-geologic-archives/

Research vessel JOIDES Resolution off the coast of Hawaii. Credit: International Ocean Discovery Program.

A day is the time for Earth to make one complete rotation on its axis, a year is the time for Earth to make one revolution around the Sun — reminders that basic units of time and periods on Earth are intimately linked to our planet's motion in space relative to the Sun. In fact, we mostly live our lives to the rhythm of these astronomical cycles.

The same goes for climate cycles. The cycles in daily and annual sunlight cause the familiar diel swings in temperature and the seasons. On geologic time scales (thousands to millions of years), variations in Earth's orbit are the pacemaker of the ice ages (so-called Milanković cycles). Changes in orbital parameters include eccentricity (the deviation from a perfect circular orbit), which can be identified in geological archives, just like a fingerprint.

The dating of geologic archives has been revolutionized by the development of a so-called astronomical time scale, a "calendar" of the past providing ages of geologic periods based on astronomy. For example, cycles in mineralogy or chemistry of geologic archives can be matched to cycles of an astronomical solution (calculated astronomical parameters in the past from computing the

planetary orbits backward in time). The astronomical solution has a built-in clock and so provides an accurate chronology for the geologic record.

However, geologists and astronomers have struggled to extend the astronomical time scale further back than about fifty million years due to a major roadblock: solar system chaos, which makes the system unpredictable beyond a certain point.

In a new study published in the journal Science, SOEST oceanography professor Richard Zeebe and Lucas Lourens from Utrecht University now offer a way to overcome the roadblock. The team used geologic records from deep-sea drill cores to constrain the astronomical solution and, in turn, used the astronomical solution to extend the astronomical time scale by about 8 million years. Further application of their new method promises to reach further back in time still, one step and geologic record at a time.

On the one hand, Zeebe and Lourens analyzed sediment data from drill cores in the South Atlantic Ocean across the late Paleocene and early Eocene, ca. 58-53 million years ago (Ma). The sediment cycles displayed a remarkable expression of one particular Milanković parameter, Earth's orbital eccentricity. On the other hand, Zeebe and Lourens computed a new astronomical solution (dubbed ZB18a), which showed exceptional agreement with the data from the South Atlantic drill core.

"This was truly stunning," Zeebe said. "We had this one curve based on data from over 50-million-year-old sediment drilled from the ocean floor and then the other curve entirely based on physics and numerical integration of the solar system. So the two curves were derived entirely independently, yet they looked almost like identical twins."

Zeebe and Lourens are not the first to discover such agreement — the breakthrough is that their time window is older than 50 Ma, where astronomical solutions disagree. They tested 18 different published solutions but ZB18a gives the best match with the data.

The implications of their work reach much further. Using their new chronology, they provide a new age for the Paleocene-Eocene boundary (56.01 Ma) with a small margin of error (0.1%). They also show that the onset of a large ancient climate event, the Paleocene-Eocene Thermal Maximum (PETM), occurred near an eccentricity maximum, which suggests an orbital trigger for the event. The PETM is considered the best paleo-analog for the present and future anthropogenic carbon release, yet the PETM's trigger has been widely debated. The orbital configurations then and now are very different though, suggesting that impacts from orbital parameters in the future will likely be smaller than 56 million years ago.

Zeebe cautioned, however, "None of this will directly mitigate future warming, so there is no reason to downplay anthropogenic carbon emissions and climate change."

Regarding implications for astronomy, the new study shows unmistakable fingerprints of solar system chaos around 50 Ma. The team found a change in frequencies related to Earth's and Mars' orbits, affecting their amplitude modulation (often called a "beat" in music).

"You can hear amplitude modulation when tuning a guitar. When two notes are nearly the same, you essentially hear one frequency, but the amplitude varies slowly — that's a beat," Zeebe explained. In non-chaotic systems, the frequencies and beats are constant over time, but they can change and switch in chaotic systems (called resonance transition). Zeebe added, "The change in beats is a clear expression of chaos, which makes the system fascinating but also more complex. Ironically, the change in beats is also precisely what helps us to identify the solution and extend the astronomical time scale."

FALL LEGISLATIVE COMMITTEE REPORT by Tom Fargo

At this writing, the 2019 session of NH General Court (State Legislature) is returning to work after a two-month summer recess. Legislative Study Commissions and Committees have been formed and are initiating their work toward recommendations for further legislation.

During 2019, the GSNH Legislative Committee tracked 21 bills of interest. A tabulation of these bills was included in the June Newsletter and is also posted on the GSNH website. Four of these bills have been voted by the full House or Senate as "Inexpedient to Legislate" (ITL), killing the bill.

Ten bills tracked by GSNH were either tabled, retained by or re-referred to House or Senate policy committees for further work. As of this writing, only one bill HB-543, relative to protection of wetlands, has work sessions scheduled in the House Committee on Resources Recreation and Development.

Governor Sununu vetoed one of the bills tracked by GSNH, that being HB326, relative to the definition of prime wetlands.

Since the June 2019 legislative update, Governor Sununu signed five additional GSNH-tracked bills into law. These bills included:

- HB-261 - Requiring the NHDES to revise the ambient groundwater quality standard (AGQS) for arsenic to not exceed 5 micrograms per liter (parts per billion), effective no later than July 1, 2021.
- HB- 443 - Allowing the local governing body to restrict the use of water for outdoor watering during periods of drought. This bill also provides exemptions for turf grass on recreation fields, golf courses and fields used for production of sod.
- HB-495 - Establishing a thirty-four-member Legislative Commission on drinking water. This Commission is to plan for long term goals and requirements for drinking water on the seacoast. The Commission activities will run through November 1, 2029.
- HB-617 - Establishing a four-member Legislative Committee to study recycling streams and solid waste management in New Hampshire.
- HB-737 – Establishing a twenty-member Legislative Commission to investigate and analyze the environmental and public health impacts relating to releases of perfluorinated chemicals in the air, soil, and groundwater in Merrimack, Bedford and Litchfield.

As indicated by the descriptions above, Legislative Commissions are comprised of several members of the General Court (NH House and Senate) as well as numerous stakeholders specified by the law. Legislative Committees are comprised of only members of the NH General Court, who often request expert testimony from knowledgeable individuals during the course of their investigations. Most study Committees and Commissions must issue an interim or final report their findings by November 1st.

DATES TO REMEMBER

September 14-17 – **American Institute of Professional Geologists (AIPG) 2019 National Conference:** Geology in the Green Mountains: scenic beauty and economic engine https://aipg.org/page/2019NationalConference

September 23-24, 2019 – **National Groundwater Association (NGWA) Conference on Fractured Rock and Groundwater**, Burlington, VT https://www.ngwa.org/detail/event/2019/09/23/default-calendar/5017sep19

October 11, 2019 – **7th Annual Pedro De Alba Lecture in Geotechnical Engineering.** Dr. Jeffrey R. Keaton will deliver a lecture on "Engineering Geology: Fundamental Input or Random Variable?". University of New Hampshire, Huddleston Hall Ballroom. Networking hour starts at 5:30; lecture starts at 6:30. For more information or to register, please contact Jean Benoît at 603-862-1419 or jean.benoit@unh.edu

October 11-13, 2019 – **New England Intercollegiate Geological Conference (NEIGC)**, Norwich University, Northfield VT http://w3.salemstate.edu/~lhanson/NEIGC/Conference.html

October 17, 2019 – **GSNH Dinner Meeting:** Makris Lobster & Steak House, Route 106, Concord, NH. Speaker: Dr. Robert A. Gastaldo, Whipple-Coddington Professor of Geology, Colby College, Waterville, Maine, will discuss "The Terrestrial Record of the End-Permian Mass Extinction – Karoo Province, South Africa" The presentation includes a virtual reality rendering of drone-imaged Bethel Valley; ground zero for the end-Permian extinction model. See GSA Article Here.

October 21-24, 2019 – 35th **Annual International Conference on Soils, Sediments, Water and Energy**, UMass Amherst, Amherst, MA https://www.aehsfoundation.org/East-Coast-Conference.aspx

December 12, 2019 **GSNH Board of Directors meeting** at Haley & Aldrich, Inc, Bedford, NH

January 23, 2020 – **GSNH Dinner Meeting:** Makris Lobster & Steak House, Route 106, Concord, NH Speaker: Elizabeth Burakowski, UNH

What is your Board doing? By Jenny Lambert

On Thursday, September 12, Wayne Ives hosted a meeting of the GSNH Board of Directors at the Department of Environmental Services in Concord. The Board discussed adding a georeferenced map (using google maps) of sites of geological interest (that are publicly accessible) to the GSNH website. Other planned website additions are archives of previous field trip handbooks and GSNH newsletters. Other items discussed include the 2020 Board elections (see article in this newsletter), education grants, a report on the 2019 summer field trip (see article in this newsletter), and arrangements for the next few dinner meetings, which will be on October 17 and January 23 (see Dates to Remember above). We also have a potential speaker (Diane Foster at UNH and students) and potential date for the April 2020 meeting which is awaiting confirmation.

The next Board of Directors meeting will be held on Thursday, December 12 at Haley & Aldrich, Inc. at 6PM. All members are welcome to attend; please let a Board member know if you would like to attend or add an item of interest to the agenda.

Geological Society of New Hampshire

Topic: The Terrestrial Record of the End-Permian Mass Extinction – Karoo Province, South Africa

Presentation includes a virtual reality rendering of drone-imaged Bethel Valley; ground zero for the end-Permian extinction model.

Speaker: Dr. Robert A. Gastaldo, Whipple-Coddington Professor of Geology, Colby College, Waterville, Maine

Thursday, October 17, 2019

Location: Makris Lobster & Steak House
Route 106, Concord, NH 03301

5:30 pm Social Hour - 6:30 pm Dinner - 7:15 pm Speaker Presentation

RSVP by 4 pm Friday, October 11, 2019 to get the reservation price
SPACE AT THIS VENUE IS LIMITED T0 80...RESERVE EARLY!

Advance Reservations: _____Member (Dues Paid) $27.00
_____Non-member $30.00

- Students $10.00 with valid student ID card (Reservation Requested)
- Member at the Door $29.00
- Non-Member at the Door $32.00

Checks payable to: GSNH.

_____**Please indicate special food issues – leave blank for none.**

GSNH will also accept dinner reservations by e-mail, which will then allow you to pay at the door.
Reply via e-mail to: Sharon.Lewandowski@des.nh.gov or
Mail to: **Sharon Lewandowski , GSNH Dinner Meeting,**
PO Box 401,
Concord, NH 03302.

Please note that e-mail reservations constitute an agreement with the Society for which you will be responsible to pay, whether you are able to attend or not, unless you cancel your reservation by noon the Tuesday before the dinner.

Name(s) _____

Address: _____

Your phone or e-mail: _____

The dinner and lecture program counts as 2.0 hours of CEU contact hour credit.

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
__ *Regulations Committee*
__ *Education Committee*
__ Events Committee
__Communications Committee (Newsletter or Website, circle preference)
__ Other:

Membership Category:

_____ 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: _____