



Granite State Geologist

The Newsletter of the Geological Society of New Hampshire,
Winter Edition –December 2015 – Issue No. 91

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In this issue:

- Jon C. Boothroyd
- Magnetic reversals
- Dinner speaker - State Archaeologist Dick Boisvert
- Coral Bleaching
- What your Board is doing
- Mt. Etna erupting
- Next meeting date – April 21
- Upcoming Events and Much More!

MESSAGE FROM THE PRESIDENT

2015 is winding down. I never really got to fly my new kite this year and now I've taken down the Indian corn and hung up a Christmas wreath on my front door, marked my driveway edges, and stacked my snow shovels by the door. November sprinted past in a blur. Despite the warm temperatures, winter is coming. So I finished raking the leaves and replaced the screens with storm windows in my doors.

I hope you're prepared for winter and for the January 14 dinner meeting. We'll be at Makris (a new menu is planned) to hear a presentation by State Archeologist Dick Boisvert, who will describe the recent (geologically speaking) glaciation and climate change. The Board suggests that members bring a friend to the meeting to support the Society's mission of advancing the science of geology. (See examples in the articles inside about Abbie Fopiano's outreach to a class of young girls and the Society's award of a Classroom Enhancement Grant for a water cycle activity set.) If not to this meeting, then ask someone to come with you to the April 21 meeting.

I saw a Mad magazine recently on the news stand and started getting excited. I remember when the price was \$1 and under the price, the cover said CHEAP. But, I looked at the \$13.95 price and noticed the cover no longer said CHEAP. I guess some things don't stay cheap. Anyway, this is your reminder that the year is up and it's time to pay your dues -- \$20 (CHEAP!)

This October's meeting will be an election meeting. If you're interested in running for a position, then attending a board meeting is a good way to discover the type of work your board is doing (and also by reading Lea Anne Atwell's "What Your Board Is Doing" articles in each issue.) Our next board meeting will be March 10 at 6pm at the offices of NH Dept. of Environmental Services in Concord. Get in touch with me if you're interested in attending.

I hope you're all prepared for the coming winter, the holidays, and for our next year as a Society. It's going to be a good one!

JON BOOTHROYD, RHODE ISLAND STATE GEOLOGIST, DIED OCTOBER 15, 2015



Jon C. Boothroyd, Ph.D. 1938-2015 on a walking tour of Narragansett Beach in 2012

Rhode Island's state geologist, research professor emeritus at the University of Rhode Island, and long-time CRMC advisor and colleague, Dr. Jon Boothroyd, died October 15, 2015 at 77. Primarily a field geologist specializing in coastal, braided river, and various glacial environments, Dr. Boothroyd received his Ph.D. in geology from the University of South Carolina-Columbia in 1974, and had taught geology at the University of Rhode Island (first as an assistant professor, then as professor) since 1975.

"The State of Rhode Island has lost a staunch supporter and tremendous advocate for our environment," said Michael Tikoian, former Coastal Resources Management Council chair. "Jon Boothroyd was always supportive and committed to the work of the CRMC. His professionalism, knowledge and commitment to the preservation of our environment will be solely missed."

Grover Fugate, executive director of the state Coastal Resources Management Council, said Boothroyd's impact on their operations was nearly impossible to calculate. Fugate said it was Boothroyd's ability to float between the academic world and the general public that made him invaluable.

"Jon didn't get caught up in the jargon," Fugate said. "He didn't try to impress people with that. He could speak it as well as anybody else, but he tried to talk in ways that they could understand. He could walk into a room of everyday people and start explaining these processes, or he could walk into a geological conference and talk to them as well. He could talk to the gamut of individuals."

More at http://www.independentri.com/independents/ind/article_227993a9-7c51-5649-9e38-39258a25844b.html; <http://www.narrowriver.org/Boothroyd>; and <http://ripr.org/post/state-geologist-passes-away>

CHILDHOOD MEMENTO BELONGING TO FAMOUS FOSSIL COLLECTOR, Mary Anning, DISCOVERED ON UK COASTLINE NOVEMBER 18, 2015



Researchers have been studying a childhood token believed to have belonged to the pioneering paleontologist Mary Anning, recently discovered on a beach in Lyme Regis, Dorset. According to Michael Taylor, at the University of Leicester's School of Museum Studies, the token, a metal disc found by a detectorist on Church Cliff beach, Lyme Regis, in southwest England may have belonged to the famous fossil collector, who passed away on 9 March 1847.

In a new paper by the University of Leicester's Michael Taylor and Lyme

Mary Anning Token. Courtesy of University of Leicester

Regis Museum's Richard Bull examines the high likelihood that the token belonged to Mary Anning. The token has "MARY ANNING MDCCCX" (1810) on the obverse of the disc and "LYME REGIS AGE XI" (eleven) on the

reverse. In 1810 Mary Anning would have been eleven years old and had yet to find the first ichthyosaur—or the plesiosaur which made her famous.

Mary Anning was a self-educated, working class woman from Lyme Regis and the greatest fossil hunter ever known. Mary Anning's discoveries were some of the most significant geological finds of all time. They provided evidence that was central to the development of new ideas about the history of the Earth. Her opinions were sought and she was acknowledged as an expert in many areas, including the rather unglamorous coprolites (fossil feces.) She played a key role in informing the work of her learned, male contemporaries, notably William Buckland, Henry de la Beche and William Conybeare. By the time of her death, geology was firmly established as its own scientific discipline.

Taylor said: " Its [the token's] importance is that it's such a very personal little thing and a real addition to the Museum's collection which doesn't have many items from Anning."

One explanation for how Mary came to acquire the disc could be that her father, Richard Anning, made it for his daughter as an eleventh birthday token. As a cabinet maker, Richard likely had the tools to impress a metal disc as he would have made metal labels for his furniture. Richard Anning died in November 1810, so making the disc for his daughter may have been one of his last actions, and perhaps a way of showing affection for the daughter despite the little he could do for her because of his poverty and ill health.

The token is a metal disc, possibly brass, about 25mm in diameter and 1mm thick. It was found on the beach below Church Cliffs which is where Mary could well have lost it during a fossil collecting expedition. The token is now on display at Lyme Regis Museum, Dorset.

<http://www.sciencedaily.com/releases/2015/11/151118131906.htm> and <http://www.lymeregismuseum.co.uk/in-the-museum/mary-anning>

Don't forget to pay your dues this month. Membership renewal is January 1st.

DEADLY WORLDWIDE CORAL BLEACHING EPISODE UNDERWAY--EARTH'S 3RD ON RECORD

By: Bob Henson , 12:47 PM GMT on October 09, 2015

<http://www.wunderground.com/blog/JeffMasters/comment.html?entrynum=3151>

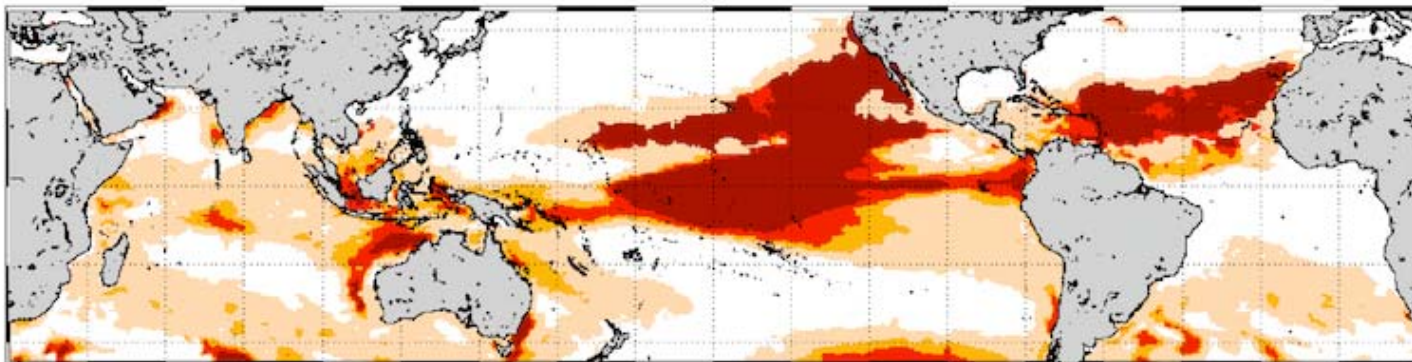
Earth is entering its third worldwide coral bleaching event of the last 20 years--a disturbing example of how a warming planet can harm vital ecosystems--NOAA announced on Thursday. NOAA also released an eight-month outlook that projects even more bleaching to come in 2016. The only other global-scale bleachings in the modern era of observations happened in 1998 and 2010. Global bleaching is defined as an event that causes bleaching in each of the planet's major coral-reef areas. "We may be looking at losing somewhere in the range of 10 to 20 percent of the coral reefs this year," NOAA coral reef watch coordinator Mark Eakin said, in an interview with Associated Press. Florida started getting hit in August. The middle Florida Keys aren't too bad, but in southeast Florida, bleaching has combined with disease to kill corals, Eakin said. It has also hit Cuba, Haiti and the Dominican Republic and is about to hit Puerto Rico and the Virgin Islands, he said, adding, "you kill coral, you destroy reefs, you don't have a place for the fish to live."

The current global bleaching is the culmination of regional problems that began in mid-2014, when very warm conditions emerged in several parts of the tropics. Hawaii is one of those areas: as Jeff Masters reported in July, Hawaii experienced its worst bleaching on record in 2014 when record-warm ocean temperatures caused 50 - 70% of the corals sampled in Northeast Oahu's Kāneʻohe Bay to bleach. Another hard-hit area was the coral-rich Papahānaumokuākea Marine National Monument, which extends hundreds of miles northwest of the main Hawaiian Islands. "Last year's bleaching at Lisianski Atoll was the worst our scientists have seen," said Randy Kosaki, NOAA's deputy superintendent for the monument. "Almost one and a half square miles of reef bleached last year and are now completely dead." This year, the same warm waters that have fed record numbers of tropical storms and hurricanes have laid the foundation for additional bleaching in and near Hawaii. "Hawaii is getting hit with the worst coral bleaching they have ever seen, right now," Eakin said. "It's severe. It's extensive. And it's on all the islands." In one part of northwestern Hawaii, "the reef just completely bleached and all of the coral is dead and covered with scuzzy algae."



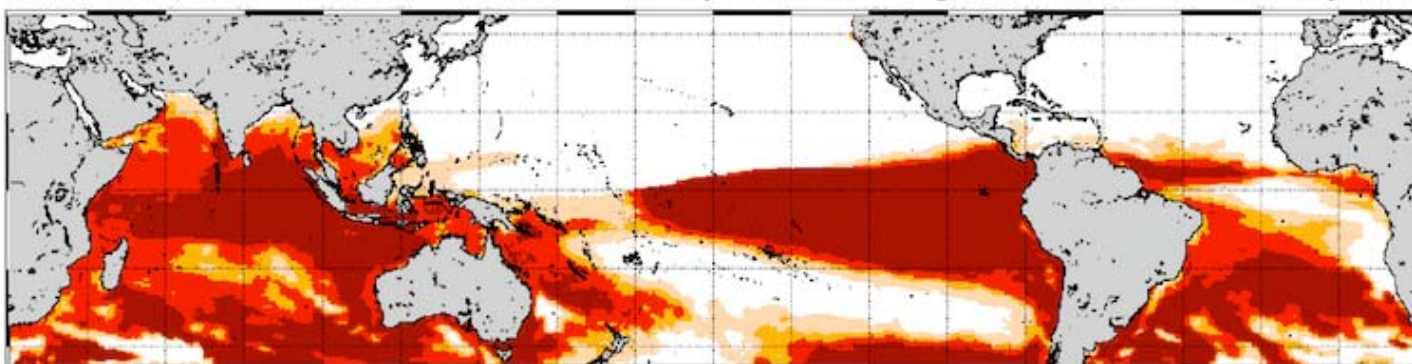
Extensive stand of severely bleached coral at Lisianski Island in Papahānaumokuākea Marine National Monument (Hawaii) documented during an August 2014 NOAA research mission. (Credit: NOAA)

2015 Oct 6 NOAA Coral Reef Watch 60% Probability Coral Bleaching Thermal Stress for Oct-Jan 2016



Potential Stress Level: Watch Warning Alert Level 1 Alert Level 2

2015 Oct 6 NOAA Coral Reef Watch 60% Probability Coral Bleaching Thermal Stress for Feb-May 2016



Potential Stress Level: Watch Warning Alert Level 1 Alert Level 2

Figure 1. NOAA's four-month bleaching outlook (top) shows a threat of bleaching continuing. An extended bleaching outlook (bottom) showing the threat of bleaching. Corals experiencing "Alert Level 2" conditions (dark red colors) can expect widespread mortality due to severe bleaching. Image credit: NOAA.

El Niño isn't helping Rising global temperatures are increasing the likelihood of bleaching, but it is often El Niño that pulls the trigger for the most widespread events. A strong El Niño can suppress upwelling and raise sea-surface temperatures across much of the central and eastern tropical Pacific and other low-latitude areas. Because the algae embedded in coral depend on photosynthesis to survive, coral reefs are limited to the uppermost reaches of the ocean, where sunlight can filter through. When the sea surface temperature is 1°C warmer than the highest monthly mean temperature corals usually experience, coral polyps will expel the symbiotic algae that live in their tissues, exposing the white skeleton underneath and resulting in a "bleached" appearance. Death can result if the stress is high and long-lived—for instance, if unusually warm ocean temperatures persist for months.

We may see major areas of bleaching in 2016 well beyond the period covered in the latest NOAA announcement. It is looking increasingly possible that a significant La Niña event will occur later in 2016 in the wake of the current El Niño event (see below). A recent study led by Joanie Klepyas (National Center for Atmospheric Research) examined heat stress in the [Coral Triangle of the tropical Northwest Pacific](#). This is one of the world's most expansive regions of coral reefs with nearly 600 varieties of coral and more than 2000 species of reef fish. Thanks to El Niño, much of the Coral Triangle is now experiencing sea-surface temperatures (SSTs) a bit below average, but the SSTs could rise quickly if El Niño segues into a moderate to strong La Niña. In 1998, this sequence of events led to the region's worst bleaching event on record.

CORAL BLEACHING

Have you ever wondered how a coral becomes bleached?

HEALTHY CORAL

1 Coral and algae depend on each other to survive.



Corals have a symbiotic relationship with microscopic algae called zooxanthellae that live in their tissues. These algae are the coral's primary food source and give them their color.

STRESSED CORAL

2 If stressed, algae leaves the coral.



When the symbiotic relationship becomes stressed due to increased ocean temperature or pollution, the algae leave the coral's tissue.

BLEACHED CORAL

3 Coral is left bleached and vulnerable.



Without the algae, the coral loses its major source of food, turns white or very pale, and is more susceptible to disease.

WHAT CAUSES CORAL BLEACHING?



Change in ocean temperature
Increased ocean temperature caused by climate change is the leading cause of coral bleaching.



Runoff and pollution
Storm generated precipitation can rapidly dilute ocean water and runoff can carry pollutants — these can bleach near-shore corals.



Overexposure to sunlight
When temperatures are high, high solar irradiance contributes to bleaching in shallow-water corals.



Extreme low tides
Exposure to the air during extreme low tides can cause bleaching in shallow corals.



Figure 2. Healthy corals play host to microscopic algae that live in their tissues (panel 1). The coral reef helps protect the algae and provides the plants with carbon dioxide and key nutrients. At the same time, the algae serve as food for the coral and are the source of coral reefs' often-spectacular colors. During stressful conditions (panel 2), algae leave the coral tissue. If the stress continues for weeks to months, the food-deprived corals experience bleaching: they lose their color and become more susceptible to disease or death (panel 3). Image credit: NOAA.

When bleaching occurs year after year. Coral reef experts have warned that multi-year bleaching events could become increasingly common as our climate continues to warm in the 21st century. The possibility of two or more consecutive years of bleaching in Hawaii may be a harbinger of this future. Bleaching occurred from 2010 to 2013 in the Arabian/Persian Gulf, following widespread coral disease unrelated to bleaching in 2009. This was the first time four consecutive years of mass mortality have been observed in any coral reef on Earth. In a study published this spring, Bernhard Riegl and Sam Purkis (National Coral Reef Institute) took a close look at this four-year disaster and found what they call a "degradation cascade." About two-thirds of the coral cover in the area studied was lost during the four-year event. Disease outbreaks often followed bleaching, and the corals that survived tended to shrink. Disease fostered by warmer temperatures is a major threat to coral reefs in its own right, as explored in a 2015 study led by Jeffrey Maynard (Cornell University).

<http://www.noaanews.noaa.gov/stories2015/100815-noaa-declares-third-ever-global-coral-bleaching-event.html>

WHAT IS YOUR BOARD DOING? By Lea Anne Atwell

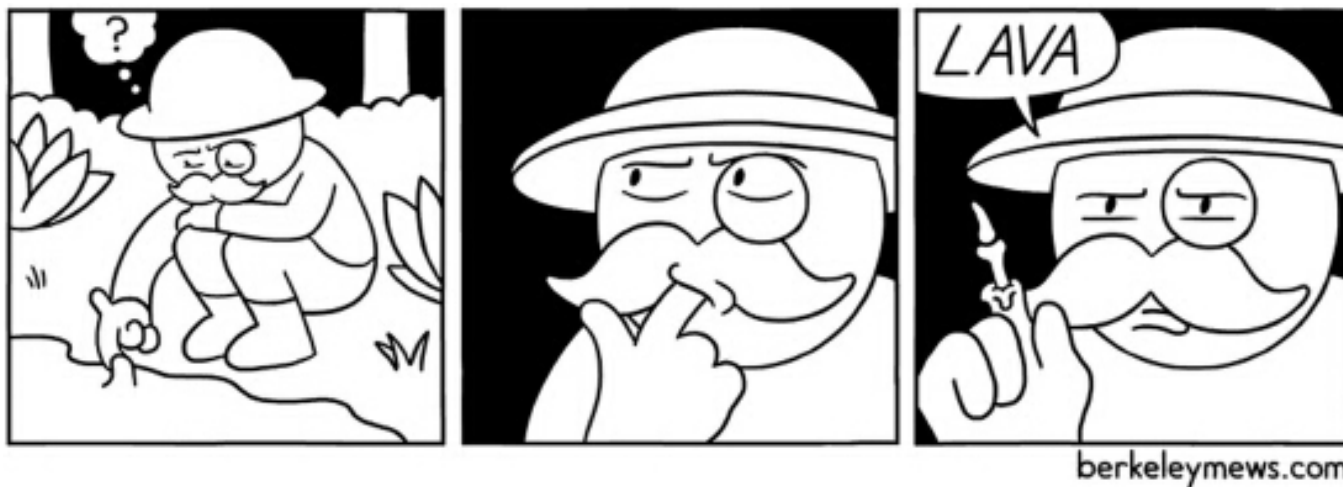
On December 10th, Thor Smith hosted the quarterly Board meeting at the USGS offices in Pembroke, NH. Key items discussed at our meeting are summarized below.

- We discussed upcoming dinner meeting locations and speakers. If you know someone who may be interested in giving a talk at an upcoming meeting, or who would be interested in being on our “stand-by” list in case of a last minute speaker cancellation, please contact Erin Kirby. Also, we are moving ahead with plans for having the April 21, 2016 dinner meeting at the Puritan in Manchester. If you have any feedback about the venue, let a Board member know.
- Potential ideas for a summer 2016 field trip were discussed, including the Mount Washington Observatory, Ossipee ring dyke area, and a tour of water supply systems in the Seacoast area. We will also be reaching out to the geological societies in nearby states to see if anyone is interested in a combined field trip.
- So far, we’ve sold 31 GSNH t-shirts, the proceeds of which are going to our Charles Spaulding Speaker’s Fund. We still have plenty of t-shirts available for \$18 each; t-shirts can be purchased at our upcoming dinner meeting in April.
- We discussed hiring a contractor to help with re-designing our website. Stay tuned for details.

Our next meeting will be on Thursday, March 10, 2016 at the NHDES offices in Concord, NH. All members are welcome to attend our meetings. Please let a Board member know if there is something you would like added to our agenda!

GSNH ROCK AND MINERAL TALK BOXES

Need some nice rock or mineral specimens for a presentation? GSNH Members may borrow the rock and mineral kits for use in talking with civic, school or scout groups. Kits contain a nice variety of mostly NH samples, ID sheets, etc. Reserve by contacting the GSNH Education and Outreach Committee through Lee Wilder at geology@des.nh.gov.



Q: Why did the geologist take his girlfriend to the quarry?

A: He wanted to get a little boulder.

DON WILHELMS' GEOLOGIC HISTORY OF THE MOON

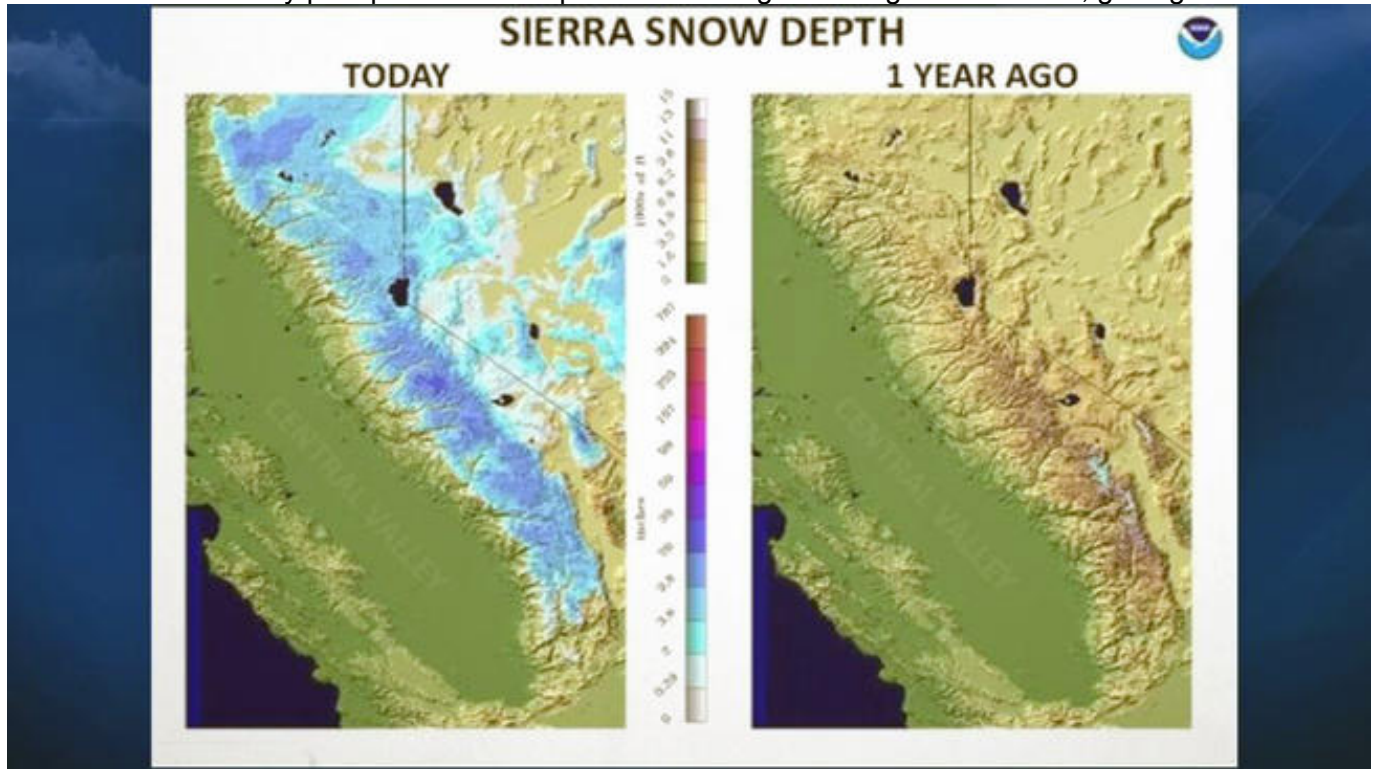
Since 1987 *The Geologic History of the Moon* ([D. Wilhelms](#)) has remained the cornerstone reference for all lunar geologists, and was originally published as United States Geological Survey Professional Paper 1348. Unfortunately this volume has long been out of print.

Northwestern University Center for Planetary Sciences has disassembled a copy and scanned each page at a resolution of 200 dpi on a Lanier LD 060 production scanner. Available here <http://ser.sese.asu.edu/GHM/>.

IN GOOD SIGN FOR CA DROUGHT, IMPROVING SIERRA NEVADA SNOWPACK

Snowpack in the Sierra Nevada is well ahead of last year, indicating California might see improved drought conditions after a record dry spell.

Moderate to heavy precipitation was reported in the region during the last week, getting the snow



NOAA images show Sierra Nevada snowpack depth in November 2015 (left) and November 2014.

season off to a promising start. Snow in the Sierra Nevada melts during the spring, providing water for millions of Californians and replenishing the state's water reservoirs, which are well below normal due to four years of drought.

"We're off to a good start with about 30 inches at the highest peaks," said NBC4 forecaster Crystal Egger. The snowfall comes after record low snowpack measurements during 2015 in the Sierra Nevada.

THE NH GEOLOGICAL SURVEY GROUND WATER LEVEL NETWORK SUMMARY

Submitted by Lee Wilder of the NHGS

August 2015 NH Groundwater level measurements were collected by the NH Geological Survey staff and volunteers from August 26 – August 31, 2015. Interesting to note that at the Concord NH Weather Station (official site for NH) we finished last year down in average precipitation. To date this year we are also down -3.4" in average precipitation. Local showers at sites other than Concord, give different data. The statewide August 2015 average groundwater level for **wells in the overburden** (in soils on top of the bedrock) showed a decrease of -0.58 feet from July 2015. When compared with August 2014, the statewide average groundwater level for August 2015, in these wells, also decreased -1.25 feet. The August 2015 average groundwater level in the new **bedrock wells** showed a decrease of -0.74 feet when compared with July 2015. When compared with August 2014, the bedrock wells showed a decrease of -1.64 feet for August 2015.

September 2015 NH Groundwater level measurements were collected by the NH Geological Survey staff and volunteers from September 21 – September 30, 2015. The statewide September 2015 average groundwater level for **wells in the overburden** (in soils on top of the bedrock) showed a decrease of -0.25 feet from August 2015. When compared with September 2014, the statewide average groundwater level for September 2015, in these wells, also decreased -0.65 feet. The September 2015 average groundwater level in the new **bedrock wells** showed a decrease of -0.96 feet when compared

with August 2015. When compared with September 2014, the bedrock wells showed a decrease of -1.26 feet for September 2015.

October 2015 NH Groundwater level measurements were collected by the NH Geological Survey staff and volunteers from October 27 – November 2, 2015. The statewide October 2015 average groundwater level for **wells in the overburden** (in soils on top of the bedrock) showed an increase of 0.45 feet from September 2015. When compared with October 2014, the statewide average groundwater level for October 2015, in these wells, decreased -0.74 feet. The October 2015 average groundwater level in the new **bedrock wells** showed an increase of 0.92 feet when compared with September 2015. When compared with October 2014, the bedrock wells showed a decrease of -0.93 feet for October 2015.

November 2015 NH Groundwater level measurements were collected by the NH Geological Survey staff and volunteers from November 23 – November 30, 2015. The statewide November 2015 average groundwater level for **wells in the overburden** (in soils on top of the bedrock) showed an increase of 0.21 feet from October 2015. When compared with November 2014, the statewide average groundwater level for November 2015, in these wells, decreased -0.48 feet. The November 2015 average groundwater level in the new **bedrock wells** showed an increase of 0.71 feet when compared with October 2015. When compared with November 2014, the bedrock wells showed a decrease of -0.51 feet for November 2015.

The groundwater level measurements for the deeper of the two Concord bedrock wells (CVWB-1) are **not** presently available in real-time. Past data are on the USGS website at: http://waterdata.usgs.gov/nh/nwis/uv/?site_no=431034071340501&PARAMeter_cd=72019.

The data for all of the wells in the NH Groundwater Level Network are shared with and posted on the USGS website at: <http://groundwaterwatch.usgs.gov/statemap.asp?sc=33&sa=NH>.



Q: Where do geologists like to relax?

A: In a rocking chair

Don't forget to pay your dues this month. Membership renewal is January 1st.

MAGNETIC POLE REVERSAL

Geologists understand that Earth's magnetic field has flipped its polarity many times. The magnetic north pole has been creeping northward – by more than 600 miles (1,100 km) – since the early 19th century, when explorers first located it precisely. It is moving faster now, scientists estimate the pole is migrating northward about 40 miles per year, as opposed to about 10 miles per year in the early 20th century.

Every few years, scientist Larry Newitt of the Geological Survey of Canada goes hunting. He grabs his gloves, parka, a fancy compass, hops on a plane and flies out over the Canadian arctic. His quarry is Earth's north magnetic pole.

James Ross located the pole for the first time in 1831 after an exhausting arctic journey during which his ship got stuck in the ice for four years. No one returned until the next century. In 1904, Roald Amundsen found the pole again and discovered that it had moved—at least 50 km since the days of Ross.

The pole kept going during the 20th century, north at an average speed of 10 km per year, lately accelerating "to 40 km per year," says Newitt. At this rate it will exit North America and reach Siberia in a few decades. "We usually go out and check its location once every few years," he says. "We'll have to make more trips now that it is moving so quickly."

The movement of Earth's north magnetic pole across the Canadian arctic, 1831--2001.
Credit: Geological Survey of Canada.

Earth's magnetic field is changing in other ways, too: Compass needles in Africa, for instance, are drifting about 1 degree per decade. And globally the magnetic field has weakened 10% since the 19th century. When this was mentioned by researchers at a recent meeting of the American Geophysical Union, many newspapers carried the story. A typical headline: "Is Earth's magnetic field collapsing?"

Probably not. As remarkable as these changes sound, "they're mild compared to what Earth's magnetic field has done in the past," says University of California professor Gary Glatzmaier.

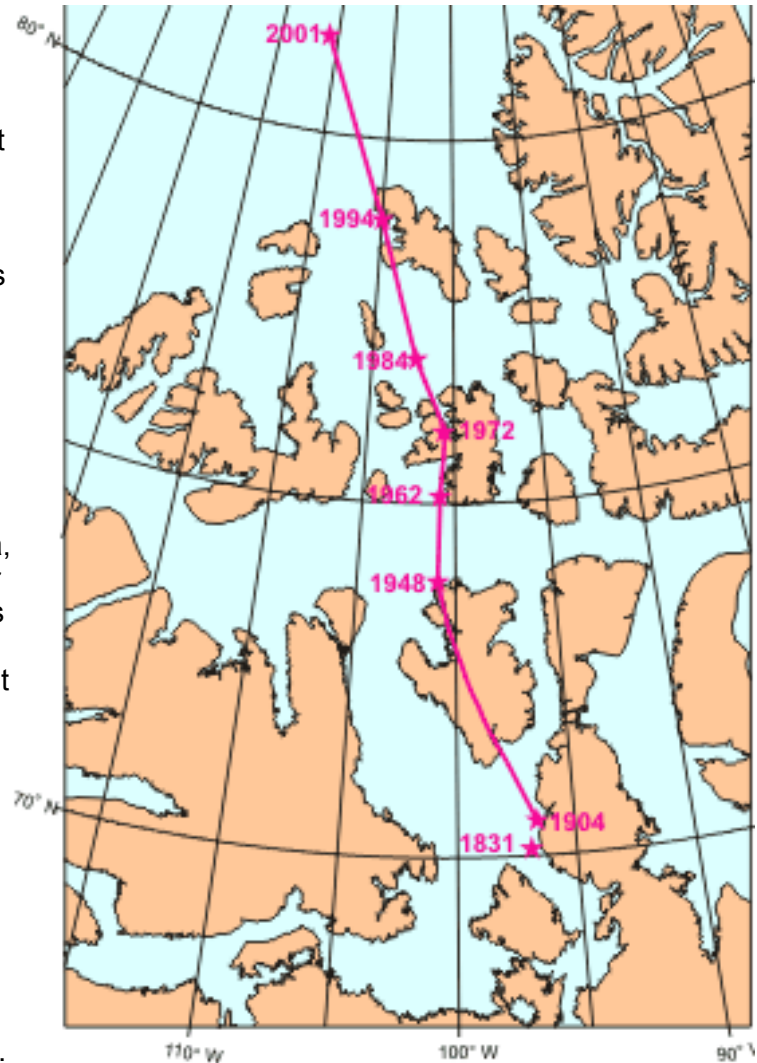
Sometimes the field completely flips.

The north and the south poles swap places.

Such reversals, recorded in the magnetism of rocks, are unpredictable. They come at irregular intervals averaging about 300,000 years; the last one was 780,000 years ago.

But there is something strange in the South Atlantic. The [South Atlantic Anomaly](#) is a dent in Earth's shield against cosmic radiation, 124 miles above the ground (200 kilometers). It may be the most dangerous place in the Earth's sphere for satellites and spacecraft to traverse, because anything electronic traveling through it is vulnerable to strong radiation from space and tends to malfunction.

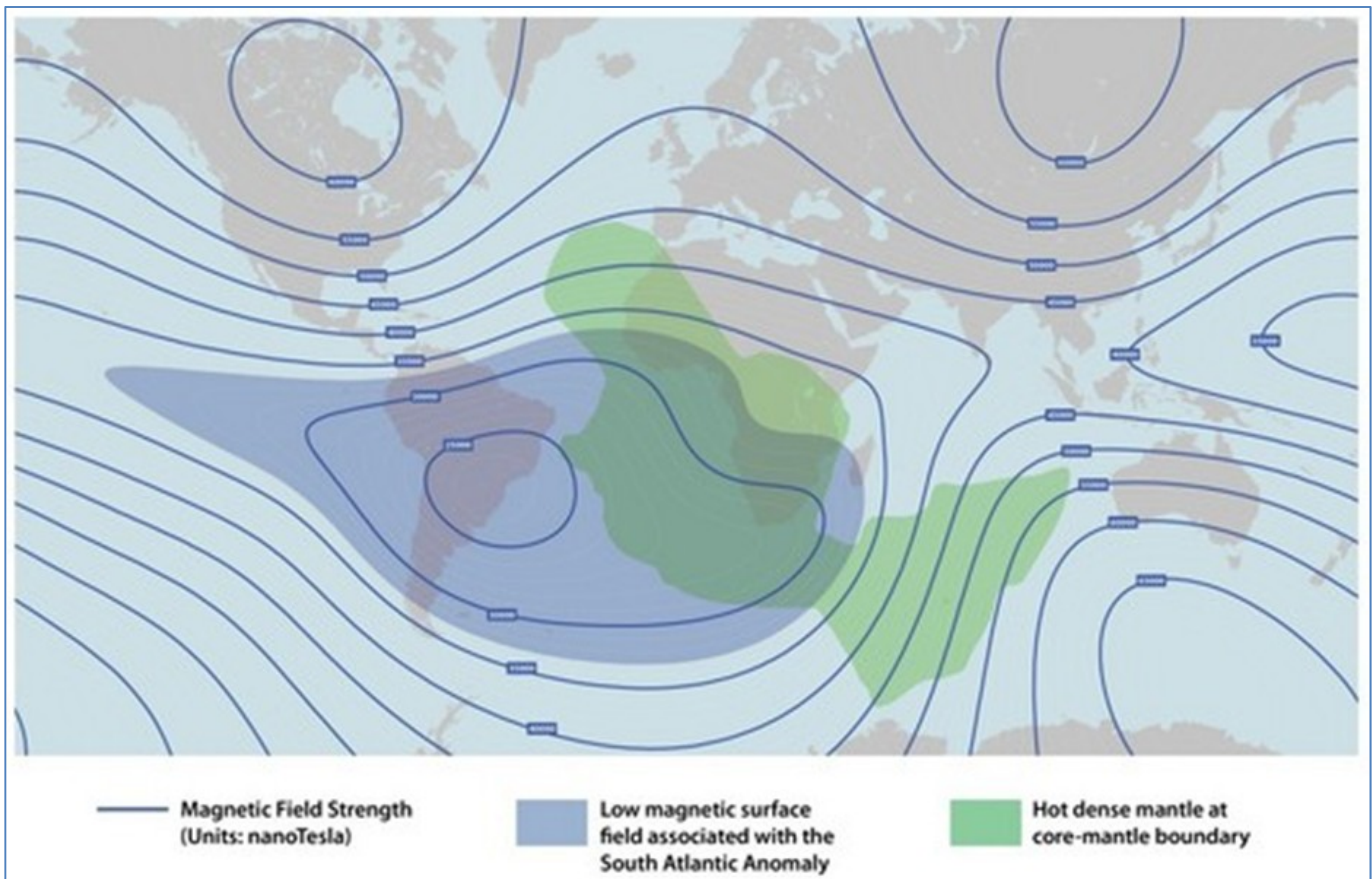
Even the Hubble Space Telescope takes no measurements when passing over the anomaly. It's an area where, instead of pointing outward, part of the Earth's magnetic field actually ushers energetic particles down instead of repelling them, weakening the overall field in the area. And it has been growing.



Mr. John Tarduno, professor of geophysics at the University of Rochester said: The earth's magnetic field "has been decreasing for at least 160 years at an alarming rate, leading some to speculate that we are heading toward a reversal." To Tarduno's group, that consistently recurring spot of weakening suggests that a permanent feature deep below the Earth's surface may be generating the South Atlantic Anomaly and might therefore play a role in the reversal of the Earth's magnetic field.

That feature is a section of particularly hot and dense mantle rock just above the Earth's outer core. The section is 1,860 miles (3,000 km) below southern Africa and the Atlantic, and it's about as wide as the distance between New York and Paris. Scientists call it the Large Low Shear Velocity Province, and Tarduno's group suspects that its sharp boundaries might disrupt the flow of iron within the Earth's core, creating a strange, field-weakening eddy that could lead to reversals time and time again.

"Some have postulated that the Earth's magnetic field is leaking out the wrong way at that particular spot," Rory Cottrell, a geologist also at the University of Rochester and co-author of the new paper, said. "One theory is that changes in the South Atlantic Anomaly could be responsible for the decrease in the overall magnetic field that we're seeing, because these patches are growing or changing over time."



This map depicts the lower strength of the Earth's protective magnetic field over the Southern Atlantic Anomaly, overlaid with the hot, dense mantle rock of an underlying feature deep below. John Tarduno and other researchers think the irregularity below may cause the weakened field above. Credit: Michael Osadciw/University of Rochester

Archeology in Africa is providing historical data about the weak spot magnetic field. Modern magnetic records only stretch back for the past 150 years or so, and within that time frame, researchers have seen the Earth's magnetic field rapidly decrease in intensity. But the researchers used the Iron Age remnants of African villages to extend their view even further back, from A.D. 1,000 to A.D. 1,850 — and the record reveals that the South Atlantic Anomaly was going strong at that time, too.

Throughout that time, the inhabitants of ancient African villages would burn down the huts and grain bins in their villages on a regular basis, giving scientists key, consistent data throughout that time period.

"They had this ritualistic burning of villages," Tarduno says.-The process was intended to cleanse the village, their collaborator archaeologist Thomas Huffman, from Witwatersrand University in South Africa, said in the statement. The burning villages would reach temperatures of over 1,800 degrees Fahrenheit (1,000 degrees Celsius), which would melt the magnetic compounds like magnetite in the clay floors. The magnetite would become remagnetized by the Earth's magnetic field at the precise instant it cooled, ready to be analyzed centuries later.



Grain bins much like these modern ones, photographed in southern Africa, were ritually burned down during Africa's Iron Age. The scorched ground beneath them conserved rare clues about the Earth's magnetic field. Credit: John Tarduno/University of Rochester

Researchers had obtained very little historical data in the southern hemisphere, and none in southern Africa before these findings. The new baked-clay records revealed an eerily familiar

picture of the Earth's magnetic field: Just like today, the Earth's magnetic field at the time was steadily weakening, with a focus on that same South Atlantic Anomaly. The effect did not appear to be continuous, but rather seemed to be a recurring event in that part of the globe, whose weakening power comes and goes over time.

The researchers' model is only one of many theories about magnetic pole reversal, and they're focusing on refining the mathematics and gathering more, even earlier data from southern Africa to further track the weak spot.

Some fear a reversal of the planet's magnetic field will lead to the end of the human race.

Jean-Pierre Valet, who conducts research on geomagnetic reversals at the Institute of Earth Physics of Paris, said: "The most dramatic changes that occur when the poles reverse is a very large decrease of the total field intensity." Mr. Valet finished research last year which concluded the extinction of Neanderthal around 55,000 years ago coincided with a dramatic weakening of the magnetic field, which nearly, but didn't end up leading to a flip.

The most dramatic changes that occur when the poles reverse, is a very large decrease of the total field intensity," said Jean-Pierre Valet. Some fear if the Earth's magnetic field is dangerously weakened the earth would be subject to radiation and X-rays during solar storms. When the magnetic field gets weakest, as ours should continue to do so, is when we are at most risk from solar flares. John Tarduno, professor of geophysics at the University of Rochester, said: "Coronal mass ejections (CMEs) occasionally occur on the Sun, and sometimes hurtle directly toward Earth. "Some of the particles associated with CMEs can be blocked by Earth's magnetic field. With a weak field, this shielding is less efficient."

Bruce Jakosky, MAVEN principal investigator at the University of Colorado, Boulder, said when the switch does take place, the Earth's magnetic field which prevents the Sun's dangerous radiation getting through, would be neutralized for around 200 years. He revealed the detail during an historic announcement about how Mars lost 99% of its atmosphere and its oceans that could have housed early life. Mr. Jakosky explained that Mars had been blasted by solar winds, which had stripped it of its atmosphere, for billions of years since the beginnings of our solar system. He said: "When the polar shift happens the Earth will have no magnetic field for about 200 years." During that time the Sun's solar blasts are expected to strip away at our atmosphere as they did on Mars billions of years ago. But he thankfully added that 200 years would not be long enough for the Sun to significantly reduce the atmosphere for life to die out.

Without a magnetic field, or with a significantly reduced one it could destroy global communications facilities, power supplies, and lead to fires and rioting on the streets. Skin cancer levels are also likely to soar as our natural UV screen, the ozone layer, would be lost.

Some scientists disagree that a flip and weakened magnetic field would mean species extinctions. While the conditions that cause polarity reversals are not entirely predictable – the north pole’s movement could subtly change direction, for instance – there is nothing in the millions of years of geologic record to suggest that any of the doomsday scenarios connected to a pole reversal should be taken seriously.

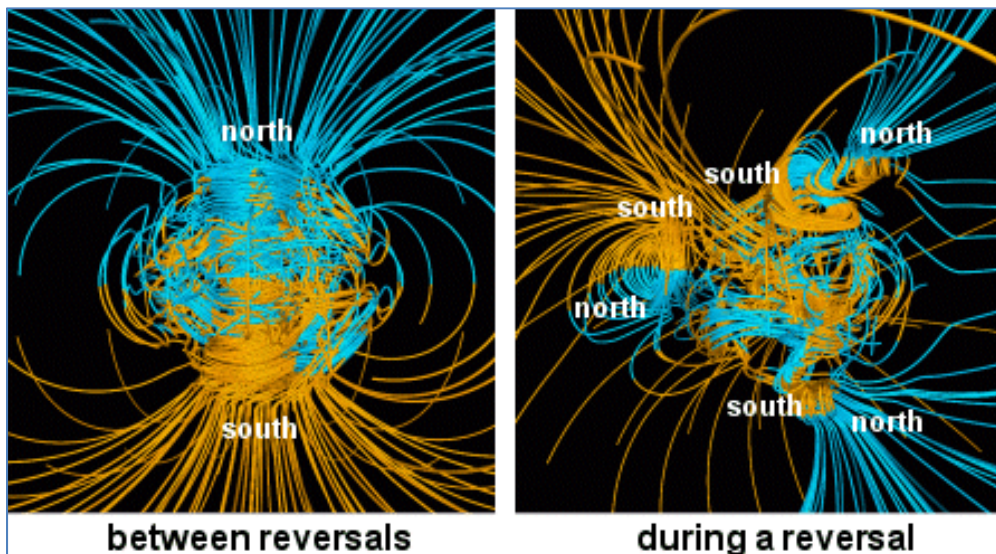
Experts aren't convinced that there's a connection between pole reversals and species extinctions. "Even if the field becomes very weak, at the Earth's surface we are shielded from radiation by the atmosphere. Similarly as we cannot see or feel the presence of the geomagnetic field now, we most likely would not notice any significant change from a reversal," Ms. Monika Korte, the scientific director of the Niemeck Geomagnetic Observatory at GFZ Potsdam in Germany said. Michael Myer, lead scientist for the NASA Mars mission, added that the Sun had been much more powerful in the early stages of the solar system when Mars had been continually blasted, and, even then the stripping of its atmosphere had taken billions of years and still one per cent of it remains.

How long might a reversal take? The rock record shows that magnetic pole reversal is – in terms of geologic time scales – a common occurrence that happens gradually over millennia. Korte said: "It's not a sudden flip, but a slow process, during which the field strength becomes weak, very probably the field becomes more complex and might show more than two poles for a while, and then builds up in strength and [aligns] in the opposite direction."

Some 41,000 years ago, a complete and rapid reversal of the geomagnetic field occurred. Magnetic studies of the GFZ German Research Centre for Geosciences on sediment cores from the Black Sea show the magnetic reversal during this period, during the last ice age. Moreover, data obtained by the research team formed around GFZ researchers Dr. Norbert Nowaczyk and Prof. Helge Arz, together with additional data from other studies in the North Atlantic, the South Pacific and Hawaii, prove that this polarity reversal was a global event. Their results are published in the latest issue of the scientific journal *Earth and Planetary Science Letters*.

What is remarkable is the speed of the reversal: "The field geometry of reversed polarity, with field lines pointing into the opposite direction when compared to today's configuration, lasted for only about 440 years, and it was associated with a field strength that was only one quarter of today's field," explains Norbert Nowaczyk. "The actual polarity changes lasted only 250 years. In terms of geological

time scales, that is very



Supercomputer models of Earth's magnetic field. On the left is a normal dipolar magnetic field, typical of the long years between polarity reversals. On the right is the sort of complicated magnetic field Earth has during the upheaval of a reversal.

fast." During this period, the field was even weaker, with only 5% of today's field strength.

As a consequence, Earth nearly completely lost its protection shield against hard cosmic rays, leading to a significantly increased radiation exposure. This is documented by peaks of radioactive beryllium (¹⁰Be) in ice cores from this time, recovered from the Greenland ice sheet. ¹⁰Be as well as radioactive carbon (¹⁴C) is caused by the collision of high-energy protons from space with atoms of the atmosphere.

Glatzmaier and Roberts have modeled what happens during a magnetic flip. Using the equations of magnetohydrodynamics, a branch of physics dealing with conducting fluids and magnetic fields, Glatzmaier and colleague Paul Roberts have created a supercomputer model of Earth's interior. Their model heats the inner core, stirs the metallic ocean above it, then calculates the resulting magnetic field.

They run their code for hundreds of thousands of simulated years and watch what happens. Reversals take a few thousand years to complete, and during that time--contrary to popular belief--the magnetic field does not vanish. "It just gets more complicated," says Glatzmaier. Magnetic lines of force near Earth's surface become twisted and tangled, and magnetic poles pop up in unaccustomed places. A south magnetic pole might emerge over Africa, for instance, or a north pole over Tahiti. Weird. But it's still a planetary magnetic field, and it still protects us from space radiation and solar storms.

Compiled from the following sources

http://www.nasa.gov/vision/earth/lookingatearth/29dec_magneticfield.html

<http://www.livescience.com/18426-earth-magnetic-poles-flip.html>

<http://www.express.co.uk/news/science/617587/Defenceless-Earth-200-YEARS-solar-radiation-blasts-magnetic-poles-shift>

<http://www.space.com/30070-ancient-huts-earth-magnetic-reversal.html>

<http://www.express.co.uk/news/science/597607/Sunrise-WEST-Scientists-warn-magnetic-poles-SWITCHING-North-become-south>

SOLAR WINDS DRIED UP MARS By: Joe Joyce after 11/24/2015 NASA feature story

We finally have an understanding of how Mars transformed from a once habitable, Earth-like planet into the dry world we see today. NASA researchers have just announced that Mars' once rich atmosphere was stripped away by solar winds in the early days of the Solar System, causing the planet to dry out.

Using the Mars Atmosphere and Volatile Evolution (MAVEN) spacecraft, which has been orbiting Mars since 2014, measurements have provided some insight into the gases that were lost from the Martian atmosphere, which include hydrogen, oxygen, and carbon dioxide – all things needed to create a livable world.

NASA researchers believe that around 4.3 billion years ago, Mars had incredibly deep oceans that held more water than the Arctic Ocean here on Earth.

The big question is could this happen to Earth? These powerful energized Solar winds blast out from the Sun at around a million miles per hour. Fortunately, a big magnetic field shields us from brunt of the solar winds, so we don't need to panic...unless our planet core begins to cool down...then we may have a problem!

From <http://www.nh1.com/news/joe-knows-solar-winds-dried-up-mars/>. See a more detailed discussion in <http://mars.nasa.gov/news/whatsnew/index.cfm?FuseAction=ShowNews&NewsID=1873>.



MADISON BOULDER UPDATE by Lee Wilder

The Friends of the Madison Boulder have been busy making improvements at the Madison Boulder Natural Area, including improving access and installing a gate and a kiosk.

The Madison Boulder was mentioned in the press twice this summer, with articles in both the Union Leader and The Hippo.

GSNH visited the Madison Boulder Natural Area on our summer field trip in 2010 and has been partnering with the Friends of the Madison Boulder to promote access, maintain the area, and educate the public about the boulder. For more information, visit www.nhstateparks.org/explore/state-parks/madison-boulder-natural-area.aspx.

GSNH LEGISLATIVE TRACKING 2015 BILLS Submitted by Russ Wilder

These are the 2015 Bills as of December 10, 2015 that may be of interest to members. Next status report: March 2016

<p>HB626</p>	<p>This bill authorizes the site evaluation committee to approve proposals for energy infrastructure development and designates energy infrastructure corridors. The bill also establishes a commission to study the designation of energy infrastructure corridors.</p> <p>7/8/2015 H Minority Committee Report: Ought to Pass with Amendment #2015-2326h</p> <p>(Prime)Suzanne Smith</p>
<p>HB227</p>	<p>This bill requires the approval of the appropriate legislative body before acquisition of land acquired with public funds or land donated to a public entity</p> <p><i>House Status:</i> PASSED / ADOPTED WITH AMENDMENT</p> <p><i>Senate Status:</i> IN COMMITTEE</p> <p><i>Next/Last Comm:</i> SENATE PUBLIC AND MUNICIPAL AFFAIRS</p> <p><i>Next/Last Hearing:</i> 04/08/2015 at 10:00 AM LOB 102 – Inexpedient to Legislate</p> <p>(Prime)James Belanger</p>
<p>HB572</p>	<p>Relative to taking land by eminent domain for high pressure gas pipelines and requiring payment of the land use change tax when land is taken by eminent domain to build energy infrastructure;</p> <p>I. Requires rules to be adopted governing the siting of high pressure gas pipelines and provides guidelines for such rules.</p> <p>II. Requires the site evaluation committee to consider intervention in Federal Energy Regulatory Commission proceedings involving siting of high pressure gas pipelines.</p> <p>III. Allows terms and conditions contained to a certificate of site and facility to include the authority to require bonding.</p> <p><i>G-Status:</i> SENATE</p> <p><i>House Status:</i> PASSED / ADOPTED</p> <p><i>Senate Status:</i> Enrolled</p> <p>7/21/2015 Signed by the Governor on 7/20/2015; Chapter 264; Effective Date 7/20/2015</p> <p>(Prime)James Belanger</p>
<p>HB 233</p>	<p>This bill clarifies the scope of local approval requirements for mining activity. This bill also modifies requirements for pre-application meetings.</p> <p><i>G-Status:</i> SENATE</p> <p><i>House Status:</i> PASSED / ADOPTED</p> <p><i>Senate Status:</i> PASSED / ADOPTED WITH AMENDMENT</p> <p>Signed by the Governor on 6/26/2015; Chapter 162; Effective Date 8/25/2015</p> <p>(Prime)John Hunt</p>
<p>HB 113</p>	<p>designating the mastodon as the official state fossil.</p> <p><i>G-Status:</i> HOUSE</p> <p><i>House Status:</i> INEXPEDIENT TO LEGISLATE</p> <p><i>Senate Status:</i></p> <p><i>Next/Last Comm:</i> HOUSE EXECUTIVE DEPARTMENTS AND ADMINISTRATION</p> <p><i>Next/Last Hearing:</i> 02/17/2015 at 02:00 PM LOB 306</p>

	(Prime)David Borden
HB 216	<p>This bill provides for a procedure for the recovery of an occupational board or commission's investigatory costs from persons subject to disciplinary orders. This bill also requires that the general administration provisions of RSA 332-G be applicable to the mechanical licensing board.</p> <p><i>G-Status:</i> SENATE <i>House Status:</i> PASSED / ADOPTED REREFERRED - <i>Senate Status:</i> 5/28/2015 S Sen. Bradley moved to Rerefer to Committee, RC 14Y-7N, MA; SJ 16</p>
	(Prime)Carol McGuire
HB 431	<p>relative to the placement of all new elective electric transmission lines in New Hampshire.</p> <p><i>G-Status:</i> HOUSE <i>House Status:</i> INEXPEDIENT TO LEGISLATE <i>Senate Status:</i> <i>Next/Last Comm:</i> HOUSE SCIENCE, TECHNOLOGY AND ENERGY <i>Next/Last Hearing:</i> 02/19/2015 at 11:00 AM LOB 304</p>
	(Prime)Laurence Rappaport
HB 244	<p>relative to the permissible level of methyl tertiary butyl ether (MTBE) in drinking water</p> <p><i>G-Status:</i> HOUSE <i>House Status:</i> INEXPEDIENT TO LEGISLATE <i>Senate Status:</i> <i>Next/Last Comm:</i> HOUSE ENVIRONMENT AND AGRICULTURE <i>Next/Last Hearing:</i> 02/10/2015 at 10:30 AM LOB 303</p>
	(Prime)Jim McConnell
HB 248	<p>directing the university system of New Hampshire to conduct a study of prolonged human consumption of and exposure to methyl tertiary butyl ether (MTBE).</p> <p><i>G-Status:</i> HOUSE <i>House Status:</i> INEXPEDIENT TO LEGISLATE <i>Senate Status:</i> <i>Next/Last Comm:</i> HOUSE ENVIRONMENT AND AGRICULTURE <i>Next/Last Hearing:</i> 02/10/2015 at 01:00 PM LOB 303</p>
	(Prime)Jim McConnell
HB 208	<p>This bill changes the allocation of proceeds received from allowance sales under the New Hampshire regional greenhouse gas initiative program.</p> <p><i>G-Status:</i> SENATE - 6/18/2015 S Conference Committee Report; Not Signed Off; SJ 19</p>
	(Prime)Richard Barry
HB 451	<p>Mining activities exempt from departmental permitting by RSA 12-E:1, IX(a) shall be subject to local ordinances, including site plan review under RSA 674.</p> <p>Signed by the Governor on 7/6/2015; Chapter 193; Effective 9/4/2015</p>
	(Prime)Franklin Sterling
HB 462	<p>repealing an increase in the fuel oil discharge cleanup fund fee.</p> <p><i>G-Status:</i> HOUSE <i>House Status:</i> INEXPEDIENT TO LEGISLATE</p>

	<p><i>Senate Status:</i></p> <p><i>Next/Last Comm:</i> HOUSE WAYS AND MEANS</p> <p><i>Next/Last Hearing:</i> Time not specified LOB 202</p>
	(Prime) James Spillane
HB 272	<p>(New Title) designating the Ham Branch River watershed in Easton as a protected river, and exempting portions of the Ham Branch River watershed from the shoreland water quality protection act.</p> <p><i>G-Status:</i> SENATE</p> <p><i>House Status:</i> PASSED / ADOPTED WITH AMENDMENT</p> <p><i>Senate Status:</i> INEXPEDIENT TO LEGISLATE</p> <p><i>Next/Last Comm:</i> SENATE ENERGY AND NATURAL RESOURCES</p> <p><i>Next/Last Hearing:</i> 04/15/2015 at 09:45 AM SH 100</p>
	(Prime) Susan Ford
HB 368	<p>relative to the selection of engineers used as part of the planning board review process.</p> <p><i>G-Status:</i> HOUSE</p> <p><i>House Status:</i> INEXPEDIENT TO LEGISLATE</p> <p><i>Senate Status:</i></p> <p><i>Next/Last Comm:</i> HOUSE MUNICIPAL AND COUNTY GOVERNMENT</p> <p><i>Next/Last Hearing:</i> 02/05/2015 at 10:00 AM LOB 301</p>
	(Prime) Edward Butler
SB196	<p>Appropriating funds to the department of environmental services for the purpose of funding eligible water supply land protection costs under the state aid grant program. Prime sponsor: Martha Fuller Clark. Introduced and Referred to Senate Energy and Natural Resources. Ought to Pass: MA, VV; Sen. Bradley Moved Laid On Table, MA, VV</p>
	(Prime) Martha Fuller Clark , Judith Spang , Thomas Bucu , Suzanne Smith
SB38	<p>Establishing a commission to develop a land conservation plan. Signed by the Governor on 7/6/2015; Chapter 193; Effective 9/4/2015</p>
	(Prime) Martha Fuller Clark , Jeanie Forrester , Gerald Little , Dan Feltes , Judith Spang , Suzanne Smith
HB 376	<p>Appropriating funds to the department of environmental services for the purpose of funding eligible and completed drinking water, wastewater, and landfill closure projects under the state aid grant program.</p> <p>11/12/2015 H Committee report: Inexpedient to Legislate (Vote 15-10; RC)</p>
	(Prime) Thomas Bucu , Suzanne Gottling , Peter Leishman , Laura Pantelakos , Jeb Bradley , Martha Fuller Clark , Karen Umberger , Richard Ames , Karen Ebel , David Danielson
HB278	<p>relative to town clerk fees for fill and dredge permit applications.</p> <p><i>G-Status:</i> HOUSE</p> <p><i>House Status:</i> INEXPEDIENT TO LEGISLATE</p> <p><i>Senate Status:</i></p> <p><i>Next/Last Comm:</i> HOUSE WAYS AND MEANS</p> <p><i>Next/Last Hearing:</i> 01/28/2015 at 10:30 AM LOB 202</p>
	(Prime) David Danielson
SB168	<p>Relative to the duties of the commissioner of the department of environmental services.</p> <p><i>G-Status:</i> SIGNED BY GOVERNOR</p> <p><i>House Status:</i> PASSED / ADOPTED</p> <p><i>Senate Status:</i> PASSED / ADOPTED WITH AMENDMENT</p>

	<p><i>Next/Last Comm:</i> HOUSE RESOURCES, RECREATION AND DEVELOPMENT <i>Next/Last Hearing:</i> 04/07/2015 at 11:00 AM LOB 305</p> <p>(Prime)David Watters , Martha Fuller Clark, Russell Prescott, Judith Spang, Adam Schroadter, Peter Bixby, Carol Bush</p>
HB377	<p>Establishing a commission to study the establishment of a state geographic information system office and the position of state geographic information officer.</p> <p>11/12/2015 H Committee Report: Ought to Pass with Amendment #2015-2506h (NT) (Vote 11-0; CC)</p> <p>(Prime)Alfred Baldasaro , Edith Hogan, Robert Theberge, Daniel Itse, Daniel Tamburello, Timothy Twombly, Jeanine Notter, Leon Rideout</p>
HB281	<p>This bill defines exotic aquatic species of wildlife and adds to the duties of the exotic aquatic weeds and species committee. Signed by the Governor on 6/26/2015; Chapter 164; Effective Date 8/25/2015</p> <p>(Prime)Suzanne Gottling , Judith Spang, Chris Christensen, Martha Fuller Clark, Jeb Bradley, Gerald Little, James Grenier, Suzanne Smith</p>
HB 498	<p>This bill revises the radon notice required prior to the sale of real property and establishes a similar notice requirement regarding arsenic. Signed by the Governor on 6/26/2015; Chapter 171; Effective Date 1/1/2016</p> <p>(Prime)John Hunt , Sam Cataldo</p>
HB349	<p>This bill requires the department of environmental services to consider impacts to wetland buffers before granting permits for filling and dredging in wetlands.</p> <p>3/12/2015 H Lay on Table (Rep C. Christensen): MA VV; HJ 26, PG. 1258</p> <p>(Prime)Judith Spang , Suzanne Gottling, Jane Beaulieu, Martha Fuller Clark, David Watters, Lee Oxenham</p>
HB 609	<p>Relative to hydraulic fracturing. <i>G-Status:</i> HOUSE <i>House Status:</i> INEXPEDIENT TO LEGISLATE <i>Next/Last Comm:</i> HOUSE ENVIRONMENT AND AGRICULTURE <i>Next/Last Hearing:</i> 02/17/2015 at 02:30 PM LOB 303</p> <p>(Prime)Timothy Horrigan , Gladys Johnsen</p>
HB 664	<p>Consolidating existing oil pollution funds. Signed by the Governor on 6/12/2015; Chapter 142; Sections 3, 5, 8, & 16 Effective 12:01 AM 7/1/2025, Remaining Effective Date 7/1/2015</p> <p>(Prime)Chris Christensen , Adam Schroadter, Karen Ebel</p>
HB306	<p>Relative to membership of the wetlands council and the water council. Signed by the Governor on 6/2/2015; Chapter 67; Effective Date 8/1/2015</p> <p>(Prime)Suzanne Gottling , Judith Spang</p>
SB 97	<p>Authorizing municipalities to adopt ordinances to regulate stormwater to comply with federal permit requirements. This bill authorizes municipalities to regulate stormwater in order to comply with federal and state laws and regulations. This bill also authorizes planning boards to advise governing bodies as to whether proposed ordinances and bylaws regarding the maintenance and operation of stormwater systems comply with the master plan. Signed by the Governor on 07/13/2015; Chapter 0247; Effective 09/11/2015</p>

THE GSNH DINNER MEETING

MAKE YOUR RESERVATION NOW!

JANUARY 14, 2016

AT MAKRIS LOBSTER HOUSE

SOCIAL HOUR START AT 5:30, DINNER AT 6:30

Email reservations to Erin Kirby at EKirby@Geosyntec.com or

Mail to: Erin Kirby, GSNH Dinner Meeting, PO Box 401, Concord, NH 03302.

Checks payable to: GSNH.

DATES TO REMEMBER

March 10, 2016 – GSNH BOD meeting 6pm at NHDES

March 21–23, 2016 - GSA Northeastern Section 51st Annual Meeting, Empire State Plaza Convention Center, Albany, NY <http://www.geosociety.org/Sections/ne/2016mtg/>

March 21-23, 2016 - National Ground Water Association short course - Environmental Geochemistry of Metals: Investigation and Remediation (#576), Dallas, Texas, <http://www.ngwa.org/Events-Education/shortcourses/Pages/576mar16.aspx>

April 21, 2015 – GSNH Spring Dinner Meeting

June 26-29, 2016 - 50th US Rock Mechanics/Geomechanics Symposium to be held in Houston, Texas. For information on the symposium, accommodations and sponsorship, visit www.armasymposium.org.

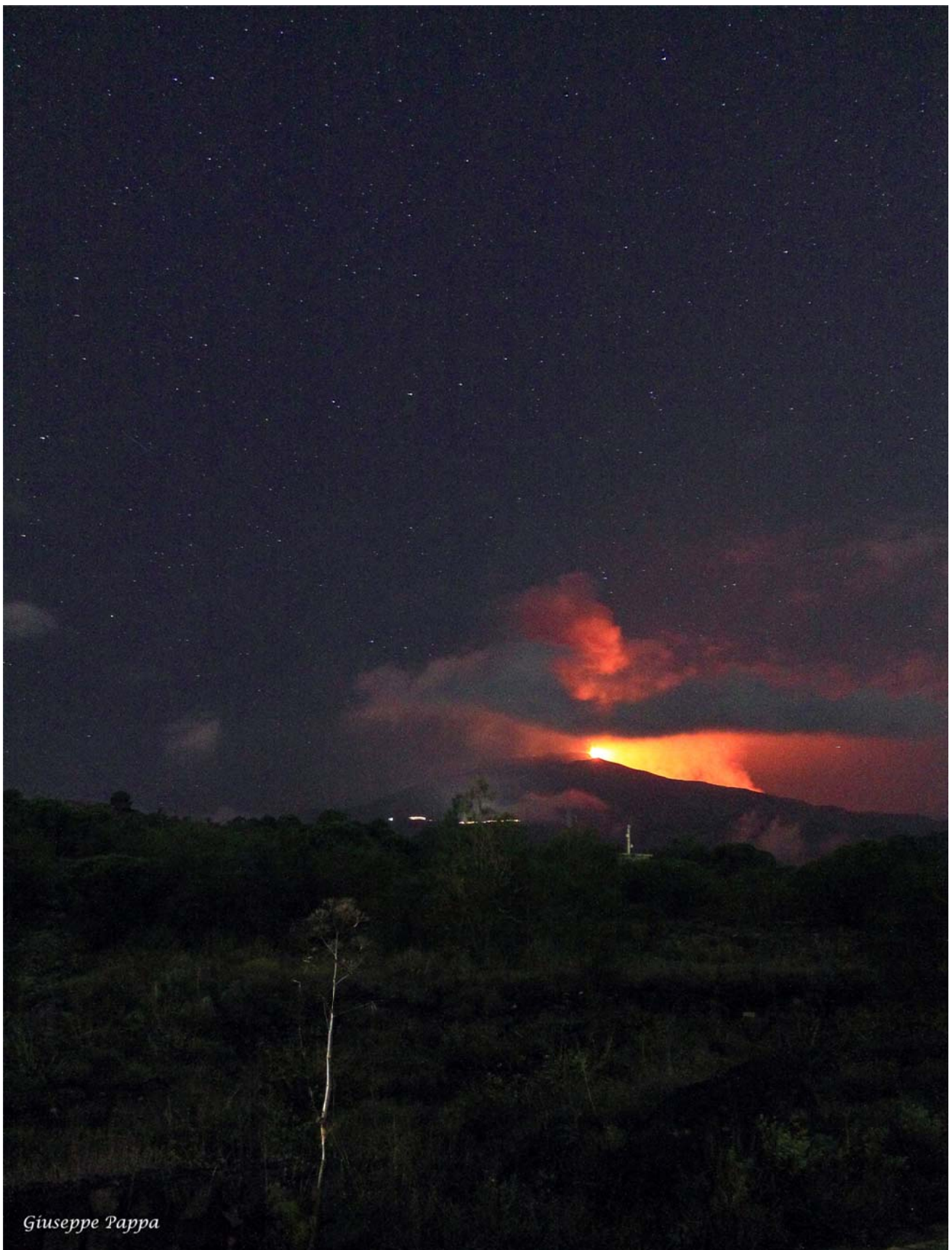
1986 BAN ON NH NUCLEAR WASTE BURIAL WAS REPEALED IN 2011 from NH Business Review

The law that was passed 30 years ago prohibiting an underground radioactive waste dump in New Hampshire had been quietly repealed as part of the 2011 state budget bill. It was repealed so quietly that it never made the news, unlike the thousands of headlines generated by the 1986 protests that prompted its passage.

Several New Hampshire lawmakers said they either don't recall how the 1986 law was repealed in 2011 or insist it was part of a broader budget item that was proposed at the beginning of the process. It first shows up in 2011 as a simple line in then-Gov. John Lynch's proposed budget. "224:120 Repeal. RSA 125-G, relative to the high-level radioactive waste act, is repealed." Republican Peter Bragdon, who was formerly Senate president, said there was nothing secretive about the repeal. "The repeal was a part of the budget introduced into the House on day one, so it was not some item that was slipped in when nobody was looking. It was there from the beginning," said Bragdon. Bragdon said the repeal appears to have been part of a revision of the duties of the state Office of Energy and Planning. <http://www.nhbr.com/December-25-2015/1986-ban-on-NH-nuke-waste-burial-was-repealed-in-2011/>

CLASSROOM ENHANCEMENT GRANT AWARDED TO THE LEDGE STREET SCHOOL

The Society awarded a grant to the Ledge Street School in Nashua, NH for the purchase of a Water Cycle Activity Set from American Education Products. The activity set will be used by 80-90 fifth grade students and their teacher and shared with other grades. The Nashua school system starts their science curriculum in kindergarten and this activity set will enhance the students understanding of weather and the water cycle. The Board awarded the grant October 27 and reimbursed the school for \$101.64 after the set was purchased and received. The Classroom Enhancement Grant and the Lincoln R. Page Professional Development Fund are described at <http://www.gsnh.org/outreach/outreach.shtml>.



Giuseppe Pappa

This photo of [Mount Etna](#) was captured from [Nicolosi](#), Catania, Sicily on December 6, 2015, at about 7:00 p.m. Mount Etna is once again erupting, ejecting fountains of gas and ash nearly 2 mi (3.2 km) above its approximately 10,925 ft (3,330 m) summit and pasty lava up to about 0.5 mi (0.9 km) into the air. Historically one of the most active volcanoes on our planet, it last erupted in 2013.
<http://epod.usra.edu/blog/2015/12/2015-mountain-etna-eruption.html>

ABBY FOPIANO SPEAKS TO GIRLS, INC.

In mid-November your GSNH President received an online inquiry to have a geologist visit the Girls Inc. Day School in Concord NH and educate their students about local geology. One of the Missions of GSNH is to “contribute to the public education and understanding of the geology of New Hampshire, including the dissemination of knowledge of New Hampshire geology to interested professions, groups and individuals”. Therefore, we greatly appreciate these types of inquiries and are happy to help. The day before Thanksgiving, Abby Fopiano, a GSNH Board Member-At-Large and Hydrogeologist with Epping Well and Pump Company lead a discussion on geology to a classroom of elementary school



children, ranging from 1st to 5th grade. In total, 22 students and four teachers took part in the hour-long lesson.

Abby began the discussion asking the students what they thought geology was and how geology affects the world around them. The students had recently learned about the rock cycle and right away had a lot of input. Hands were popping up all over the room, commenting about the volcanoes, earthquakes and floods they see on television and about the rocks they have found in their backyards and summer trips they took to the top of Mount Washington or Hampton Beach.

Abby talked about the age of Earth and some of the major events and processes that have occurred over time – and how much time it takes. Rock and fossil specimens such as granite, talc, garnets, basaltic sands, corals, and dinosaur bones were as passed around. The discussion lead to the formation and erosion of the Appalachian Mountains and the types of rocks, minerals and landscapes that we New Englanders see around us every day. And finally, how drinking water gets to our tap, whether on a private well or town water system. The students were engaged for the whole hour. This impressed the teachers considering a full Thanksgiving meal was being served just after, and the smells of stuffing and turkey were filling the classroom.

It was a very successful and fun visit. One of the 5th grade students was particularly thankful; as she was able to share a few stories about rocks she has in her own collection, telling where she found them and why they are so interesting.

If you know a teacher that may benefit from a geologist visiting their school, please contact your GSNH President, Wayne at wayne.ives@des.nh.gov or Abby Fopiano at abby@eppingwell.com.

NEW GEOLOGY MAPS OF NH from NH Geological Survey

The NH Geological Survey recently completed its 2015 field mapping season. Three 1:24000 scale Surficial Geology maps of NH were field mapped:

1. The **Melvin Village Quadrangle** (Geo-099-024000-SMOF) by Brooks, J.A. and Tinkham, D.A.
2. The **Squam Mtn. Quadrangle** (Geo-085-024000-SMOF) by Thompson, W.B.
3. The **Mt. Dartmouth Quadrangle** (formally Mt. Wash West) (Geo-046-024000-SMOF) by Fowler, B.K. and Barker, G.A.

And two new 1:24000 scale Bedrock Geology maps of NH:

1. The **Hanover Quadrangle** (Geo-091-024000-BMOF) by Peter J. Thompson.
2. The **Mt. Dartmouth Quadrangle** (formally Mt. Wash West) (Geo-046-024000-SMOF) by Eusden, J.D. Jr., Devoe, M.C., Oxman, G.O., Xiao, S.M.

HIPSTER EARTH



LIDAR COVERAGE IN NEW HAMPSHIRE from NH Geological Survey

Under a cooperative LiDAR Project between the State of New Hampshire, the USGS, National Forest Service, FEMA and the NRCS, much of western and central NH was flown in the Fall 2015 (some 5,200 square miles). Once this data is processed, 85% of New Hampshire will have LiDAR at a DEM of 1 meter resolution. The data will become available late summer 2016 through the state's GIS clearinghouse, GRANIT. <http://www.granit.unh.edu/>

WORLD'S MOST ACTIVE VOLCANOES

Ever wonder where the world's most active volcanoes are? Check here for many kinds of information on active volcanoes.

<http://www.volcanolive.com/active2.html>

CALCITE OR ARAGONITE: WHICH FORMS WHEN? By Andrew Alden at About.com

Aragonite and calcite are polymorphs having the same chemical formula, CaCO_3 , but their atoms are stacked in different configurations. [Aragonite](#) has an orthorhombic structure and [calcite](#) a trigonal structure.

Calcite is more stable in general than aragonite, although as temperatures and pressures change one mineral may convert to the other. At surface conditions, aragonite spontaneously turns into calcite over geologic time, but at higher pressures aragonite, the denser of the two, is the preferred structure.

High temperatures work in calcite's favor. At surface pressure, aragonite can't endure temperatures above around 400°C for long. High-pressure, low-temperature rocks of the blueschist metamorphic facies often contain veins of aragonite instead of calcite. The process of turning back to calcite is slow enough that aragonite can persist in a metastable state. Sometimes a crystal of one mineral converts to the other mineral while preserving its original shape as a pseudomorph: it may look like a typical calcite knob or aragonite needle, but the petrographic microscope shows its true nature.

Calcium carbonate minerals in water will commonly crystallize out of solution. Neither mineral is highly soluble, and the presence of dissolved carbon dioxide (CO_2) in water pushes them toward precipitating. In water, CO_2 exists in balance with the bicarbonate ion, HCO_3^- , and carbonic acid, H_2CO_3 , all of which are highly soluble. Changing the level of CO_2 affects the levels of these other compounds, but the CaCO_3 can't dissolve quickly. The one way process of CaCO_3 precipitation is a major driver of the geological carbon cycle.

Whether calcite or aragonite forms depends on conditions in the water. In clean fresh water, calcite predominates, especially in cool water. Cave formations are generally calcite. Mineral cements in many limestones and other sedimentary rocks are generally calcite. In the ocean, calcium carbonate comes directly out of solution to form mineral layers on the tiny round particles called ooids and to form the cement of seafloor mud. Which mineral crystallizes, calcite or aragonite, depends on the water chemistry.

Seawater is full of ions that compete with calcium and carbonate. Magnesium (Mg^{2+}) slows the growth of calcite and forcing itself into calcite's molecular structure, but it doesn't interfere with aragonite. Sulfate ion (SO_4^-) also suppresses calcite growth. Warmer water and a larger supply of dissolved carbonate favor aragonite by encouraging it to grow faster than calcite can.

Over geologic time the ocean has shifted between "aragonite seas" and "calcite seas." Today we're in an aragonite sea that is high in magnesium—it favors the precipitation of aragonite plus calcite that's high in magnesium. A calcite sea, lower in magnesium, favors low-magnesium calcite.

The secret is fresh seafloor basalt, whose minerals react with magnesium in seawater and pull it out of circulation. When plate tectonic activity is vigorous, we get calcite seas. When it's slower and spreading zones are shorter, we get aragonite seas. There's more to it than that, of course. The important thing is that the two different regimes exist, and the boundary between them is roughly when magnesium is twice as abundant as calcium in seawater.

The Earth has had an aragonite sea since roughly 40 million years ago (40 Ma). The most recent previous aragonite sea period was between late Mississippian and early Jurassic time (about 330 to 180 Ma), and next going back in time was the latest Precambrian, before 550 Ma. In between these periods, Earth had calcite seas. More aragonite and calcite periods are being mapped out farther back in time. It's thought that over geologic time, these large-scale patterns have made a difference in the mix of organisms that built reefs in the sea.

<http://geology.about.com/od/minerals/fl/calcite-vs-aragonite.htm>

TEACHERS WORKSHOP HELD by Lee Wilder

GSNH, along with the NH Geological Survey, and the Capital Mineral Club, sponsored a mineral identification workshop for teachers on September 22nd. Participants received a mineral kit and dichotomous key for attending. The NH Mining Products display at the NHDES offices was also recently updated.

ANCIENT HUMAN-SIZE FISH BREATHED WITH LUNGS BY LAURA GEGGEL, LIVE SCIENCE

Before the dinosaur age, the coelacanth — a hefty, mysterious fish that now breathes with its gills — sported a well-developed lung, a new study finds. This lung likely helped the fish survive in low-oxygen, shallow waters hundreds of millions of years ago, the researchers said. During the Mesozoic era, more commonly known as the dinosaur age, it's likely that some species of coelacanth moved to deeper waters, stopped using their lungs and began relying exclusively on their gills to breathe, the researchers said. This adaptation to deep water likely helped coelacanths survive the asteroid that slammed into ancient Earth and killed the nonavian dinosaurs, the researchers said. The fish's gill- and lung-breathing relatives were not as lucky; during the Late Cretaceous period, about 66 million years ago, coelacanths living in shallow waters disappear from the fossil record, they said.

The hulking 6.5-foot-long fish has long baffled scientists. Fossils of the predatory fish date back to the early Devonian period, about 410 million years ago. The fish was thought to have gone extinct after the dinosaur-killing asteroid hit Earth, but living coelacanths were discovered off the coast of South Africa in 1938.

Today, there are two known species of living coelacanths that live in the deep waters near Mozambique and Indonesia. Scientists have collected and preserved entire specimens of these fish (which give birth to live young) over the decades, allowing researchers to study how the fish change from embryos to adulthood.



At a 427-foot depth off Sodwana Bay in South Africa, the extant coelacanth *L. chalumnae* swims in its natural environment. Laurent Ballesta / Andromede Oceanology Ltd

In the new study, researchers examined the curious lungs of one species of coelacanth (*Latimeria chalumnae*) at five different stages of growth. They scanned each specimen with X-ray tomography, a method that allows researchers to take multiple X-rays of an

object, compile them and create a 3-D image. "Our results demonstrate the presence of a potentially functional, well-developed lung in the earliest known coelacanth embryo," the researchers wrote in the study. However, as the embryo grows, its lung development slows, and it eventually becomes a vestigial (functionless) organ in the fish, they observed. The new findings were published on Tuesday in the journal *Nature Communications*.

Interestingly, adult *L. chalumnae* have small, hard, flexible plates scattered around their vestigial lungs. It's possible that these plates are similar to the "calcified lung" of fossil coelacanths, said Paulo Brito, one of the study's researchers and a professor of zoology at Rio de Janeiro State University in Brazil. "In fossil coelacanths, these plates surrounding the lung most probably had a function in lung volume regulation, moving over each other to accommodate volumetric changes," Brito told Live Science in an email. "In extant [living] coelacanths, it represents a rudimentary anatomical structure."

As the lung shrank and became useless, a fatty organ that the fish uses for buoyancy control in deep waters grew and took over the space once occupied by the lung.

This is a condensed version of an article that appeared on Live Science. Read the entire story [here](#). Follow Laura Geggel on Twitter [@LauraGeggel](#). <http://www.nbcnews.com/science/weird-science/ancient-human-size-fish-breathed-lungs-n428416>



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