Granite State Geologist

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MESSAGE FROM THE PRESIDENT

Earlier this week I began to wonder what will become of our geology meetings and field trips if a virus determines that we cannot associate in crowds without fear of infection? Will this fear be the end of events like the upcoming Gilsum Rock Swap (June 22-23)? Will geologists no longer end their field days in the camaraderie and amber glow at the bar?

Heartbreakingly, at our March meeting the Board was forced to CANCEL our April 16 dinner meeting at Puritan and our summer field trip. Many, if not all institutions and businesses, are curtailing all optional meetings. We found that our speakers will not be allowed to attend our April meeting. We also learned that the summer field trip that we had been supporting with the Friends of the Pleistocene has been cancelled for the same reason.

With springtime comes hope. One of my hopes is that one of you will step up and run for the positions in the Board of Directors. I will be stepping down as president after three terms put me at the end of the term limit. It's been fun and there is a solid core of board members. So get your feet wet in one of the other positions or committee work. We do plan to meet as usual in June on the 18th. The election will be at the October Annual Meeting at Makris.

There's a rumor that the Massachusetts Geological group may be recovering. Their renewal may be set back because the plans for a summer field trip are likely going to be canceled too, but we can all hope that they can jump start the dormant group into another energetic society.

The NH Society will be coming out with boonie hats with embroidered GSNH logos. We expect these to be ready for sale later this year and at a very reasonable price. There may be a few choices of hat colors. Also, this year we hope to have a prototype of an interactive map of geologic features of NH.

The map will show publicly accessible locations of NH's interesting geology.

Anyway, the Society will be more active on our website. We plan to post a link to an alternate source of continuing education hours and whatever else we can find to fill the void. Keep well, keep busy, and we'll meet again in October. See you then!

January Dinner Meeting Recap

By Jenny Lambert

The January dinner meeting was held at Makris Lobster and Steakhouse. We had 62 attendees, including 52 members. Our presenter, Dr. Elizabeth Burakowski, described the results of her research on trends in snowpack and timing of both melt-out and canopy cover. The presentation also included a discussion of potential impacts of warming trends under moderate and worst-case scenarios, both on the snowpack itself and the industries (such as winter sports) that depend on sufficient snow.

Dr. Burakowski discusses climate trends during her presentation. Photo from Abby Fopiano.

Several exciting minerals were included as raffle prizes at the meeting:

- 1st prize: Indicolite, "Chrome Tourmaline" (won by Shane Csiki): This is a complex boron-aluminum silicate variety of green tourmaline that owes its vivid green hue to trace amounts of chromium and vanadium. Transparent specimens are a valuable gemstone.

- 2nd prize: Apatite, $Ca_5(PO_4)_3F$ (won by Sean Gannon): This is a hexagonal crystal of fluorapatite, which can be cut as a gemstone. Massive apatite deposits are used to make fertilizer.
- 3rd prize: Radiating crystal of pectolite ($NaCa_2Si_3O_8[OH]$) growing on a prehnite ($Ca_2Al[AlSi_3O_{10}][OH]_2$) crystal mass, from Route 80, Paterson, NJ (won by Ken Milender). Pectolite is a unique mineral known for its interesting crystal habits. This was from the collection of Bob Whitmore.
- 4th prize: "Gemmy" beryl, $Be_3Al_2Si_6O_{18}$ (won by Stefanie Lamb). This specimen is from Rice Mine in North Groton, NH, from the collection of Bob Whitmore.
- 5th prize: Magnesite ($MgCO_3$) crystal with talc (won by Crystal Pringle). Magnesite is used to produce magnesium oxide (MgO), which serves as a refractory material for the steel industry. From the collection of Bob Whitmore.

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7 Billion-Year-Old Stardust is Oldest Material Found on Earth

From Mindy Weisberger, LiveScience, January 13, 2020.
https://www.livescience.com/oldest-material-on-earth.html

Scientists recently identified the oldest material on Earth: stardust that's 7 billion years old, tucked away in a massive, rocky meteorite that struck our planet half a century ago.

This ancient interstellar dust, made of presolar grains (dust grains that predate our sun), was belched into the universe by dying stars during the final stages of their lives. Some of that dust eventually hitched a ride to Earth on an asteroid that produced the Murchison meteorite, a massive, 220-lb. (100 kilograms) rock that fell on Sept. 28, 1969, near Murchison, Victoria, in Australia.
New analysis of dozens of presolar grains from the Murchison meteorite revealed a range of ages, from about 4 million years older than our sun — which formed 4.6 billion years ago — up to 3 billion years older than our sun, researchers reported in a new study.

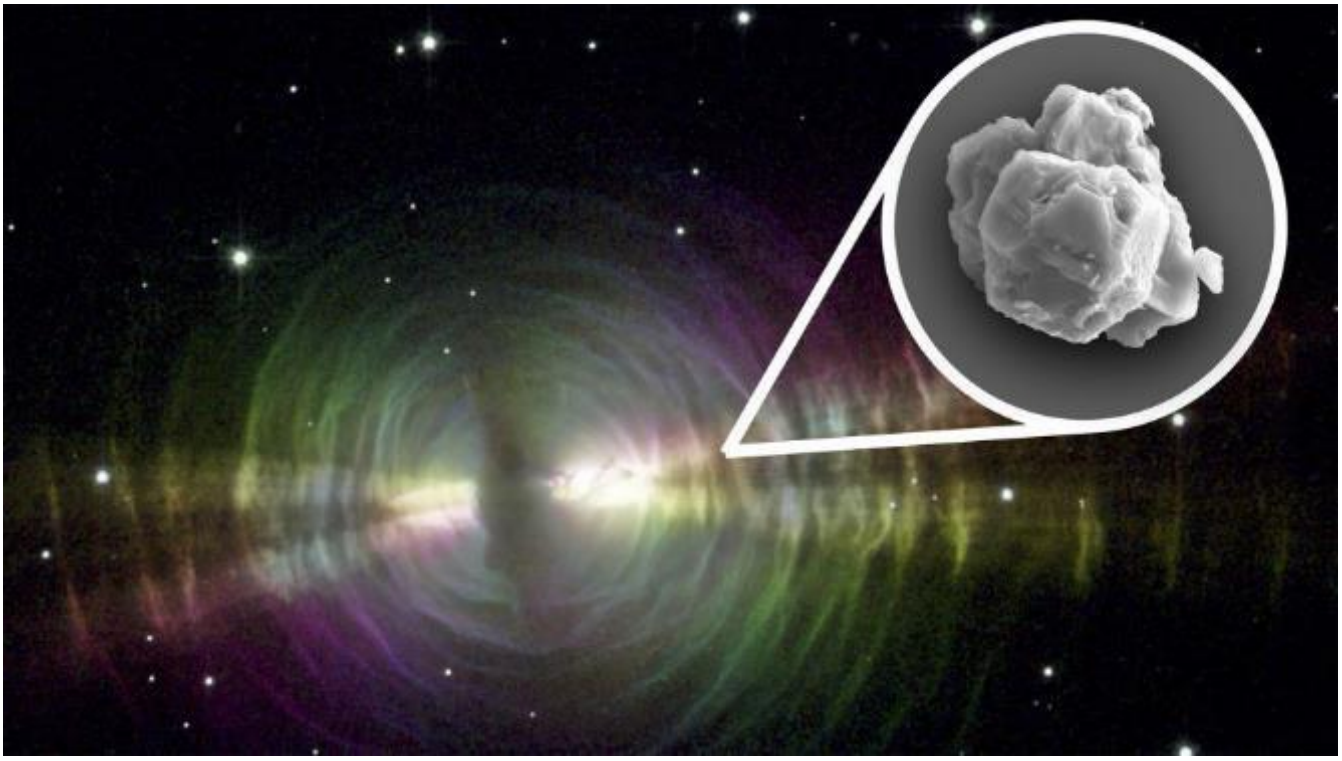
Though the universe abounds with floating stardust, no presolar grains have ever been found in Earth's rocks. That's because plate tectonics, volcanism and other planetary processes heated and transformed all the presolar dust that may have collected during Earth's formation, said lead study author Philipp Heck, the Robert A. Pritzker Associate Curator of Meteoritics and Polar Studies at the Field Museum of Natural History in Chicago.

When large, orphan space rocks form — such as the asteroid that produced Murchison — they, too, can pick up ancient, interstellar dust. But unlike dynamic planets, Murchison's parent asteroid is "an

almost-inert piece of rock that formed from the solar nebula and hasn't changed since then," so the presolar grains haven't been cooked down into another type of mineral, Heck told Live Science.

Most presolar grains measure about 1 micron in length, or are even smaller. But the grains the scientists analyzed for the study were much bigger, ranging from 2 to 30 microns in length.

"We call them 'boulders,'" Heck said. "We can see them with an optical microscope."



Dust-rich outflows of evolved stars similar to the pictured Egg Nebula are plausible sources of the large presolar grains found in meteorites like Murchison.
(Image: © NASA, W. Sparks (STScI) and R. Sahai (JPL). Inset: SiC grain with ~8 micrometers in its longest dimension. Inset image courtesy of Janaína N. Ávila)

Stellar “baby boom”

For the study, Heck and his colleagues examined 40 of these so-called boulders from Murchison, grinding up bits of the meteorite and adding acid, which dissolved minerals and silicates and revealed the acid-resistant presolar grains.

"I always compare it to burning down the haystack to find the needle," Heck said.

The researchers used a dating technique that measured the grains' exposure to cosmic rays during their interstellar journey over billions of years. In space, high-energy particles emanate from different

sources, bombarding and penetrating solid objects that pass by. Those cosmic rays react with rock to form new elements that accumulate over time. By measuring the quantity of different elements in presolar grains, scientists can estimate how long the dust has been bathing in cosmic rays.

Think of it this way: Imagine putting a bucket outside during a rainstorm. As long as the rain falls at a steady rate, you could calculate how long the bucket had been outside based on the amount of rain that it collects, Heck explained.

Most of the grains — about 60% — dated to around 4.6 billion to 4.9 billion years ago. One possible explanation for why there were so many grains of this age is that they were all the product of a "little baby boom" of star birth in our galaxy that took place around 7 billion years ago.

"And then it took about two to two-and-a-half billion years for those stars to become dust producing," Heck explained. "When a star forms, it doesn't produce dust. During most of its life, the star doesn't produce dust. The stars only produce dust at the end of their lives."

This discovery supports findings by other astronomers that indicate a dramatic spike in star formation around 7 billion years ago, the researchers reported.

What's more, many of the grains weren't traveling through space alone; they journeyed as clumps, "almost like granola clusters," according to Heck. Though it's uncertain what bound these grains, other studies have shown that some presolar grains are coated with a sticky film of organic matter, which could have cemented these clusters together, Heck said.

Smells like science

Grinding and analyzing bits of space rock also presented the researchers with an unusual by-product — a strong and very pungent smell. The paste of ground-up meteorite released a stench "like rotten peanut butter," study co-author Jennika Greer, a graduate student at the Field Museum and the University of Chicago, said in a statement.

"I've never smelled rotten peanut butter," Heck told Live Science. "But it did smell really strong."

Another meteorite that was recently added to the Field Museum's collection, the Aguas Zarcas from Costa Rica, or "cosmic mudball meteorite," was said to smell like cooked Brussels sprouts. Volatile organic compounds in rocky meteorites that are abiotic — not formed by living organisms — produce these distinctive smells when they are heated or dissolved, Heck said.

And Murchison was an especially smelly meteorite, Heck said. When he visited the town of Murchison in 2019 for the 50th anniversary of the meteorite's landing, he spoke with people who had witnessed the event or collected fragments of the space rock. Many of them had tales to tell about the meteorite's distinctive aroma.

"They said the whole town smelled like methylated spirits, a very strong organic smell," Heck said. "Even those who hadn't seen the meteorite themselves — they smelled it."

The findings were published online in the Journal *Proceedings of the National Academy of Sciences:*

Lifetimes of interstellar dust from cosmic ray exposure ages of presolar silicon carbide: Philipp R. Heck, Jennika Greer, Levke Kööp, Reto Trappitsch, Frank Gyngard, Henner Busemann, Colin Maden, Janaína N. Ávila, Andrew M. Davis, and Rainer Wieler. Proceedings of the National Academy of Sciences Jan 2020, 117 (4) 1884-1889; DOI: 10.1073/pnas.1904573117

Remember: Renew Your GSNH Membership! by Jenny Lambert

Did you miss the January dinner meeting? Get distracted by the holidays? You still have time to renew your 2020 membership with GSNH! With membership, you get a discount on dinner meetings and field trips, information on upcoming events of interest, voting privileges at Society business meetings, and automatic subscription to this newsletter. Membership dues also help to support important geological outreach for the greater community.

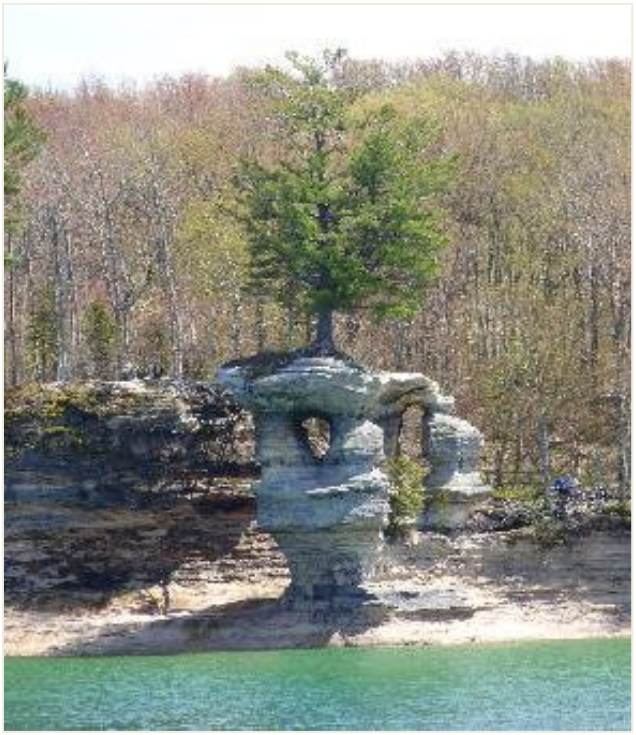
There's a membership and renewal application at the end of this newsletter. Please send dues and your membership/renewal form (along with any information updates) to GSNH, PO Box 401, Concord, NH 03302.

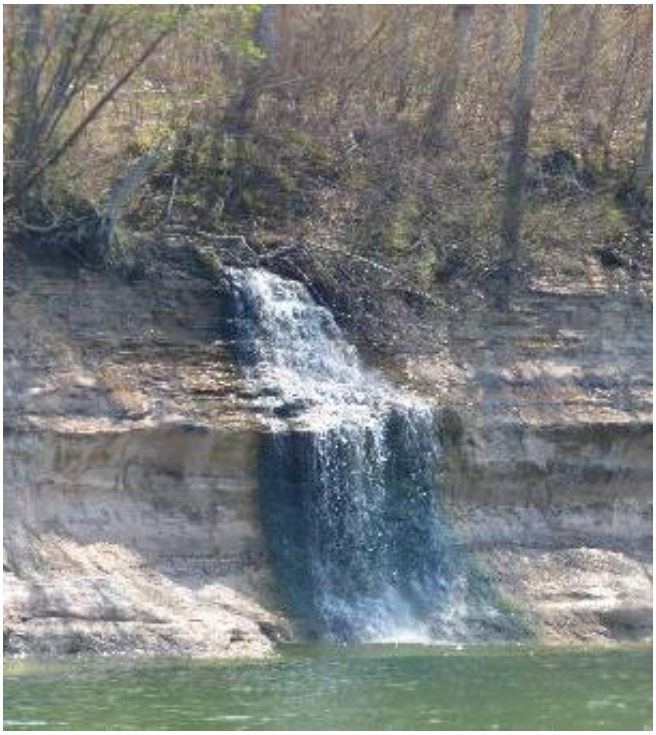
Geological Travel – Pictured Rocks National Lakeshore

The Pictured Rocks National Lakeshore is located in Michigan's Upper Peninsula along Lake Superior, between the towns of Munising and Grand Marais. It was formally established on October 6, 1972 and consists of 71,397 acres. The park boundary extends ¼ mile out over Lake Superior along the length of the park and includes sand dunes, transitional deciduous and coniferous boreal forests, and 15 miles of sandstone cliffs that are 50-200 feet high. The cliffs include, from oldest to youngest (bottom to top):

- Jacobsville Formation (Late Precambrian): feldspar-rich quartz sandstone (deep red with white mottling); only the upper few feet are visible above the lake surface
- Munising Formation (Mid to Late Cambrian): contains three members: basal conglomerate, Chapel Rock sandstone, and Miners Castle sandstone (very easily eroded)
- Au Train Formation (Early Ordovician): light brown-white dolomitic sandstone (resistant to weathering).

The cliffs are famous for their colorful staining from groundwater and waterfall mineral deposition: iron for reds and oranges, copper for blue and green, and manganese for brown and black.





Photos by Peter Whittlesey

Other local activities:

Waterfalls: The Upper Peninsula is famous for its waterfalls, including easily accessible falls around Munising. The Tahquamenon Falls are notable for their size (3rd largest by volume east of the Mississippi River) and dark brown water from tannins leached from the local cedar swamps.

Shipwrecks: Hundreds of shipwrecks are located along the southeastern shore of Lake Superior. Glass-bottom shipwreck cruises are available in Munising, and Whitefish Point, known as “the Graveyard of the Great Lakes”, has an excellent shipwreck museum.

Paddling: Kayak tours and rentals are available. The water is cold and weather can be changeable; only sea kayaks are recommended in the area.

Lighthouses: The southeastern Lake Superior shoreline is dotted with lighthouses. Lighthouses at Marquette Harbor, Au Sable Point and Whitefish Point are open to the public.
Wildlife: Seney National Wildlife Refuge and the Whitefish Point Bird Observatory are notable viewing areas.
Other: Kitch-iti-kipi is a large spring (240 feet across, 40 feet deep) that flows at more than 10,000 gallons per minute. The high flow rate and constant temperature (45°) ensures that it never freezes. It has a glass-bottom observation raft that visitors can pull across the pool.

Suggested reading:

William L. Blewett, 2012. Geology and Landscape of Michigan's Pictured Rocks National Lakeshore and Vicinity. Wayne State University Press.

Gilsum Rock Swap and Mineral Show to be held June 27-28, 2019

By Robert Mitchell, President, Gilsum Recreational Committee

Gilsum, NH -- The town of Gilsum, located in the scenic Monadnock Region in southwestern NH, will once again host thousands of people from all over the U.S. who will attend the Gilsum Rock Swap and Mineral Show. Here more than 65 dealers, swappers, distributors, wholesalers and collectors can buy, sell, or swap beryl, quartz crystals, semi-precious stones, and rocks and minerals of all sorts. Displays range from newly found specimens in the rough to fossils, prized collector's pieces and hand-crafted jewelry.

The event takes place at the Gilsum Elementary School grounds, Route 10 in Gilsum, just north of Keene, NH, and is about 2 hours from Boston. Show hours are 8:00 AM to 6:00 PM Saturday and 8:00 AM to 4:00 PM Sunday.

This year's event includes a special presentation by geologist Paul Brandes, "From Paleo to Present: A Brief History of Mining." Humans have been mining since the Paleolithic Era more than 60,000 years ago, from chert used for tools to precious metals and gems. Join Brandes, the "Indiana Jones of Geology," for a walk through time as he explains what people mined in each era and how mining techniques gradually evolved, then accelerated in the 19th century. This presentation is free.

Gilsum's many mines operated until the 1940s and yielded feldspar, mica and beryl. Most are now abandoned, although one, the Beauregard mine, is available to mineral clubs through prior

arrangement. Today collectors prize other minerals such as beryl. Maps showing locations of local mines are available during the show.

Since the show's inception, the town of Gilsum has opened its doors for the event. Activities include a presentation on prospecting Saturday, daily pancake brunch, bake sale, book sale, a traditional Saturday night New England ham and bean supper with homemade pies and a chicken barbeque dinner Sunday afternoon.

Admission is free, although donations are graciously accepted. All proceeds go to youth recreation and community programs.

For more information please contact Robert Mitchell at the Gilsum Recreation Committee, P.O. Box 76, Gilsum, NH, 03448; call 603.357-9636; or send e-mail to gilsumrocks@gmail.com. More information can be found at the Gilsum rock swap website: http://gilsum.org/rockswap/

Lucara Cuts Deal to Cut Diamond with Louis Vuitton

By Nelson Bennett, BIV.com, January 16, 2020
https://www.nationalgeographic.com/science/2019/10/huge-new-shark-toothed-dinosaur-siamraptor-found-in-thailand/

Vancouver's Lucara Diamond Corp. (TSX:LUC) has struck a deal with the luxury house Louis Vuitton to cut and polish the world's largest uncut diamond, and second largest ever found.

Under the deal, Louis Vuitton and HB Company, a diamond manufacturer in Antwerp, will cut and polish the 1,758-carat Sewelo diamond.

Lucara isn't saying how much the deal will be worth. The company will retain 50% of the diamonds that are cut from the massive Sewelo.

The Sewelo was unearthed at Lucara's Karowe mine in Botswana in April 2019, bumping a previous find – the 1,109-carat Lesedi La Rona – to third place.

When Lucara unearthed the Lesedi La Rona in 2015, it was the second largest diamond ever recovered. But in April 2019, the Sewelo became the second largest diamond ever unearthed.

The Sewelo is the world's largest uncut diamond.

In 2017, Lucara sold the Lesedi La Rona diamond to Graff Diamonds for US$53 million.

Photo by Louis Vuitton.

DATES TO REMEMBER and CANCELLATIONS

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

April 4, 2020 – **Saving Special Places 2020:** https://savingspecialplaces.org/ - **Cancelled**

April 9, 2020 – **NHGS Mappers Workshop,** NHDES - **Postponed to after September 15**

April 16, 2020 – **GSNH Dinner Meeting:** - **Cancelled**

April 18 and 19, 2020 – **Southeastern New Hampshire Mineral Club Show:** https://www.senhmc.org/ - **Cancelled**

June 5-7, 2020 – **Friends of the Pleistocene Field Trip** – **Postponed to 2021**

June 27-28, 2020 – **Gilsum Rock Swap & Mineral Show,** Gilsum Elementary School & Community Center, 640 Route 10. Contact gilsumrocks@gmail.com.

August 5-6, 2020 – **Fate of PFAS: From Groundwater to Tap Water,** National Groundwater Association (NGWA), Durham, NH. https://www.ngwa.org/detail/event/2020/08/05/default-calendar/20aug5010

Looking for some continuing ed credits? Many professional organizations and vendors have online webinars. For example, clu-in.org compiles webinars of interest to EPA and the environmental community here: https://clu-in.org/training/#upcoming

Geologist turns to paper models to help students think in 3D

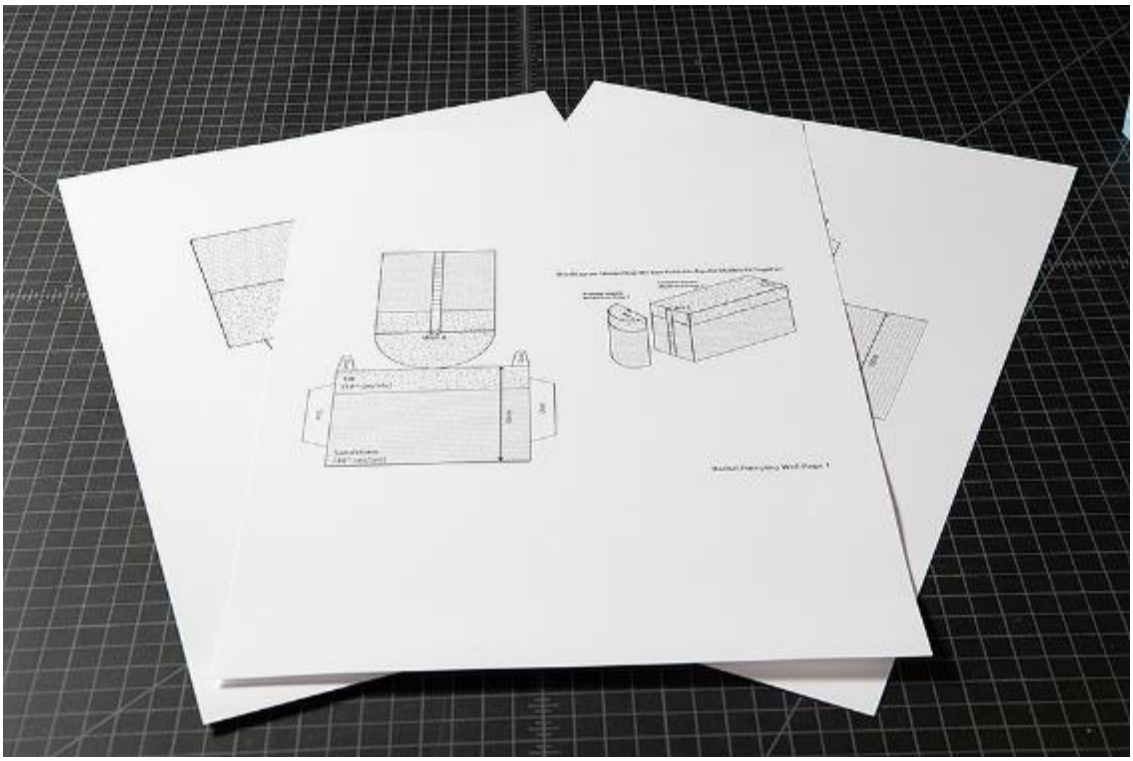
By Charlotte Hsu, UBNow, February 20, 2020
http://www.buffalo.edu/ubnow/stories/2020/02/foldable-aquifers.html

Scissors. Purple glue sticks. Paper designs to cut out and fold.

Chris Lowry teaches advanced geology college courses at UB. But some of the tools he brings to class evoke the joy of grade school.

Lowry is creator of the Foldable Aquifer Project — a series of 3D paper models of aquifers, which (in real life) consist of layers of permeable rock, sand and gravel that hold water underground.

Each paper aquifer helps students understand a specific problem tied to subterranean water storage, such as how pumping water out of a well affects neighboring wetlands. Lowry has designed about 20 of the models so far, all available to download for free on the project website.



A paper design of an aquifer to cut out and fold. Photo: Douglas Levere

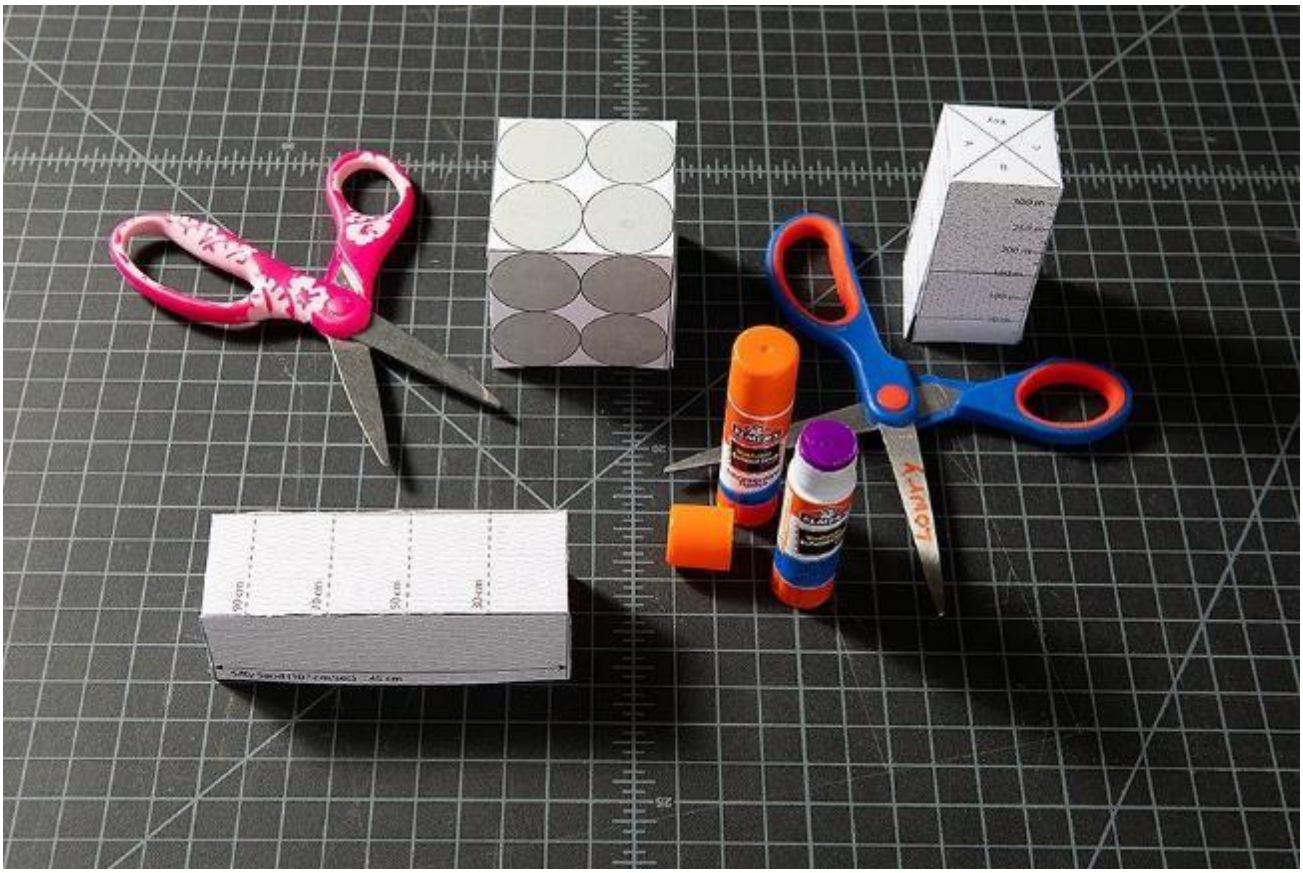
"Geology is a 3D science, but everything we give to students is on a 2D piece of paper," says Lowry, associate professor in the departments of Geology and Environment and Sustainability in the College of

Arts and Sciences. “With the foldable aquifers, students don’t have to imagine what a 2D drawing looks like in 3D.

“I used the aquifers in class this year, and students seem to be pretty pumped on it,” Lowry says, no pun intended. “Not everyone took the time to fold the models, and there are some students who don’t need that; they can do it in their mind. But there are other students who had problems on a homework assignment, and when I gave them the folded model, immediately they had this lightbulb kind of moment. They were like, ‘Oh. I see what you’re talking about now.’”

Thinking outside the box

Lowry started designing the models while on sabbatical in 2019. He set aside an hour a day to work on them and write corresponding homework assignments.

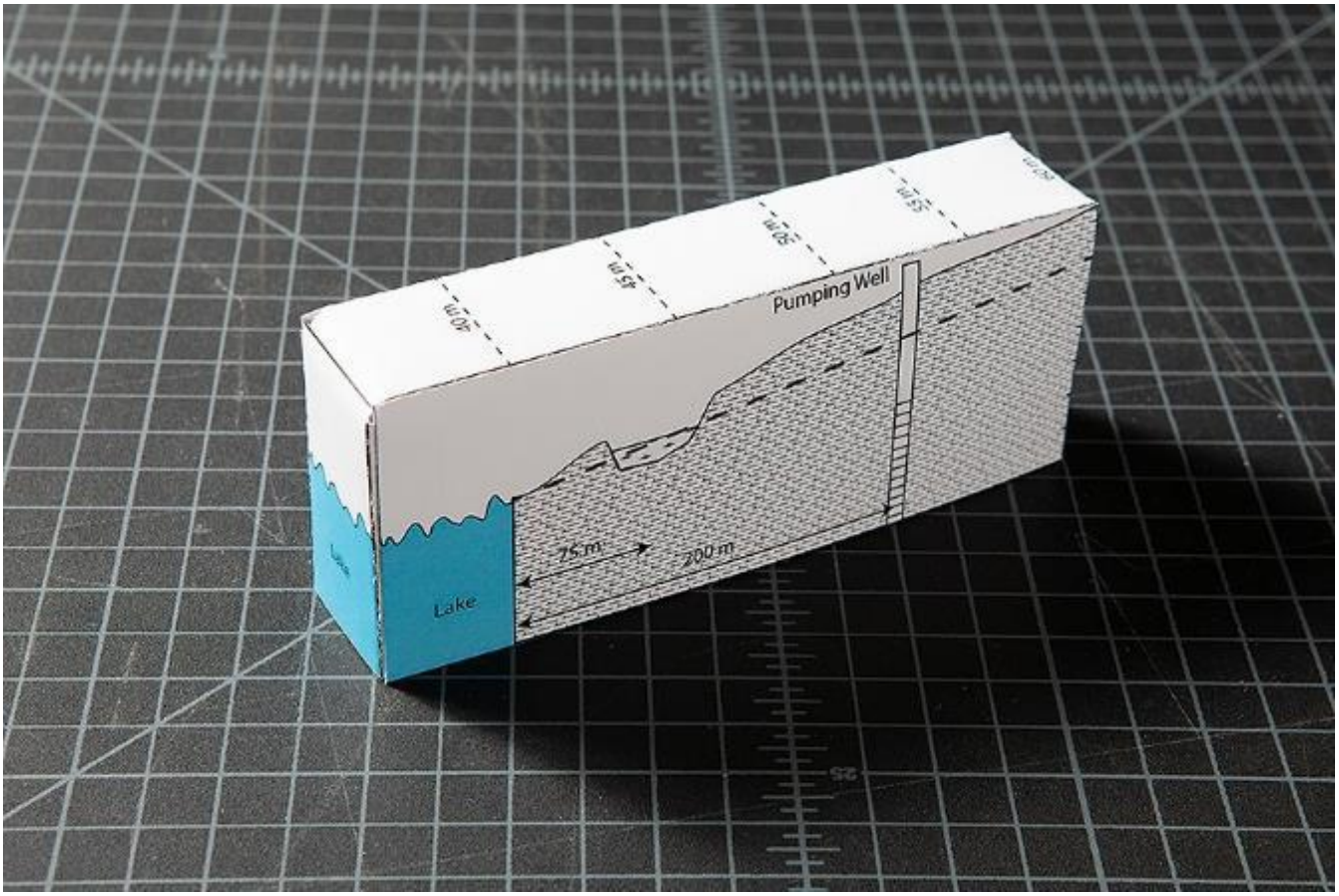


Cut, fold, glue! UB hydrology researcher Chris Lowry hopes that constructing paper aquifers will help students understand concepts related to groundwater. Photo: Douglas Levere

But the project’s inspiration — like the scissors and glue sticks — draws from childhood.

Lowry remembers going to a restaurant called the Old Spaghetti Factory when he was a boy. Kids got paper trolleys to fold during the meal, and he was reminded of that tactile experience one day during office hours.

“I had this problem I gave in class where the handout showed what the aquifer would look like from the side, the top and the other side,” he recalls. “I folded the paper in office hours. And when I folded that paper in half, I was like, these were totally like those trolleys I made when I was a kid.”



Each foldable aquifer helps students understand concepts related to groundwater. This one focuses on how drawing water from a well could affect a wetland. Photo: Douglas Levere.

Jeremy Stock, a geology master’s student and professional artist and caricaturist, says he loves the foldable aquifer concept. He and Lowry discussed the models when Lowry was developing them. Later, Stock took a class in which Lowry gave students assignments involving the aquifers.

“It’s this kind of old-school mini project — a little art you can do while you’re doing your hydrogeology homework,” says Stock, who teaches art to high school students in Buffalo. “You can hold it in your hand and turn it around, which is helpful because one of the challenges in teaching is to get people to think in three dimensions.”

The foldable aquifers seem “totally like a Chris thing,” Stock adds. “He likes to think outside the box.”

Homework assignment – and keepsake?

Lowry got a great response from colleagues when he shared the project on Twitter and at a recent conference. His website doesn’t yet track downloads, so he isn’t sure how many people are using his designs. But he hopes that other educators will discover and utilize the paper aquifers.

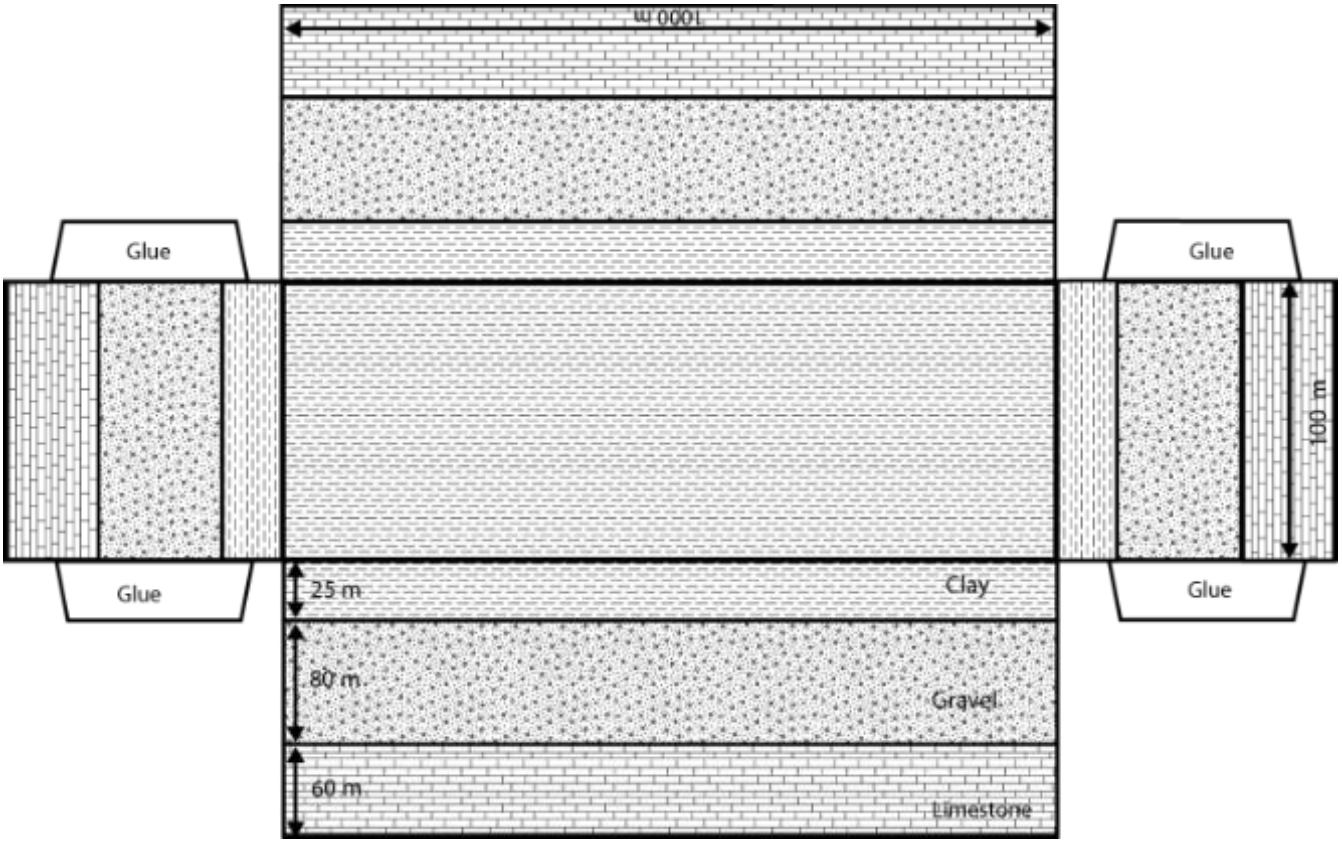
“Faculty members need tools in their classroom, yet they don’t have time to fully develop all of these tools,” he says. “These foldable aquifers are meant to be a plug-and-play kind of thing. If you’re doing a lecture on Darcy’s law, which has to do with water flow, you could just go to the Darcy’s law problem and give the aquifer and homework assignment to your students.”

It’s a creative way, Lowry says, to make classes interesting and engage students in thinking about water.

“Maybe you absolutely hated my class and you’re going to burn your aquifer at the end of the semester, but I think these things might sit on students’ desk for a while,” Lowry says. “They might look at their aquifer later on. Now, I’ve touched them one more time and made them think about hydrogeology.”

UB hydrology researcher Chris Lowry has created numerous foldable aquifers to help students visualize how water is stored underground. Photo: Douglas Levere

(editor's note: A basic foldable model of an aquifer is included below. You can print and put together your own aquifer model!)



Earth Day: 50-Year Anniversary on April 22

By Jenny Lambert

April 22, 2020 marks the 50th anniversary of Earth Day, which is considered to be the birth of the modern environmental movement. Earth Day was started by Gaylord Nelson, a U.S. senator from Wisconsin, after witnessing the impacts of an oil spill in Santa Barbara, California, in 1969. He took inspiration from the on-campus anti-war movement and envisioned a large scale, grassroots movement to put environmental protection on the national political agenda. Nelson announced the Earth Day concept in the fall of 1969, sparking a wave of interest across the country. The date was selected to be April 22 to fall between spring break and final exams.

The first Earth Day, on April 22, 1970, was marked by an estimated 20 million Americans, with thousands of colleges and universities organizing protests against environmental degradation. Earth

Day united various groups that had been fighting against oil spills, loss of wilderness and wildlife, dangerous chemicals, and other individual issues. The political energy started with Earth Day lead to the creation of the Environmental Protection Agency (EPA), Clean Air Act, Clean Water Act, and Endangered Species Act by the end of 1970.

See EarthDay.org (https://www.earthday.org/earth-day-2020/) for more information, including local events and more details on the history and impact of Earth Day. The website lists events in Concord, Hampton, Hanover, Holderness, Jefferson, and Rindge, with more to come.

Also, the National Informal STEM Education (NISE) Network (https://www.nisenet.org/earth50) has a long list of suggested hands-on activities, posters, images, library resources, citizen science opportunities, online workshops, and additional resources for planning programs at events.

Earth's got a new 'moon' – here's what to expect

By David Rothery, The Conversation, February 26, 2020
https://theconversation.com/earths-got-a-new-moon-heres-what-to-expect-132554

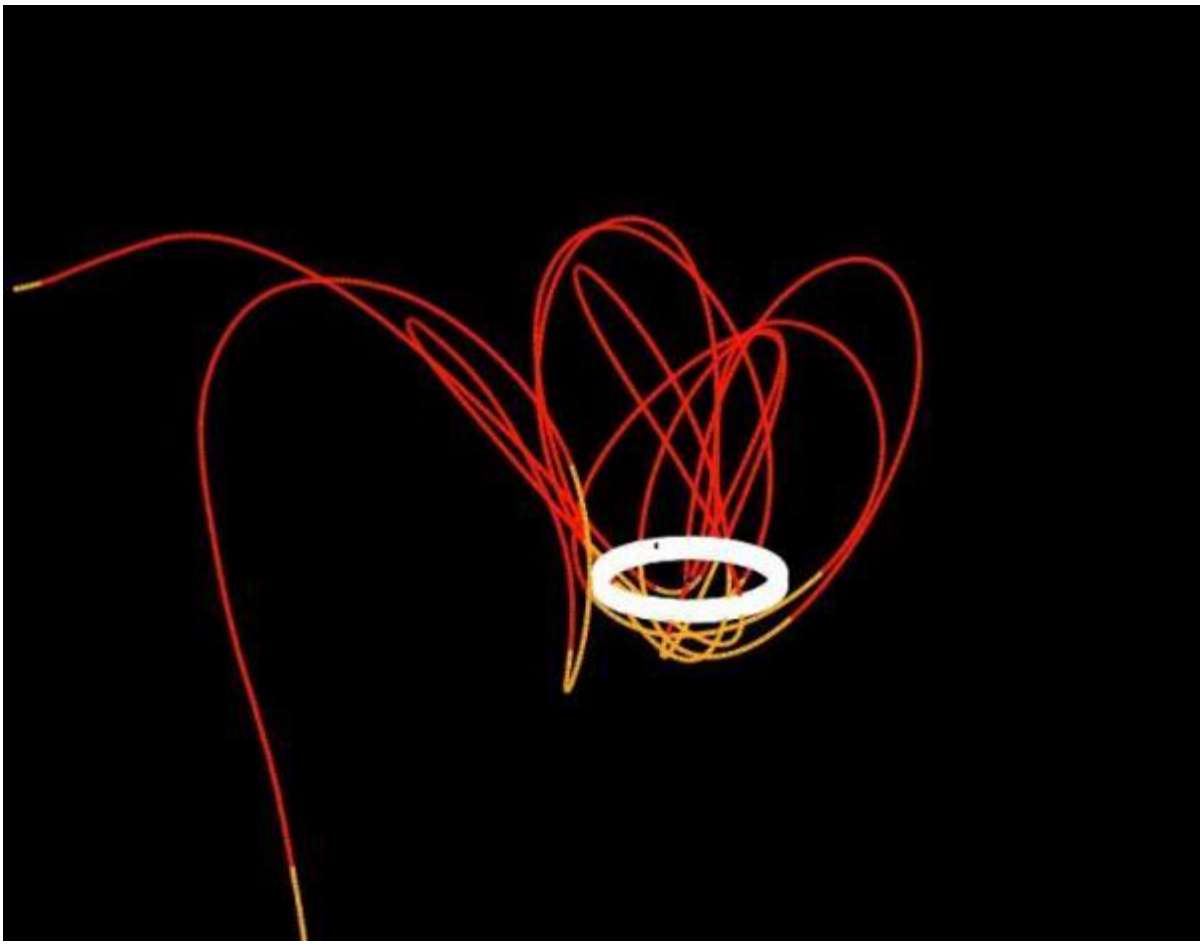
The Minor Planet Centre has just announced that the Earth has been orbited by a second moon for the past three years or so. But while excitement about the discovery is growing, it is important to keep in mind that this moon isn't as impressive as our main satellite. It is extremely faint – it is estimated to be only between one and six metres across – and won't be with us for much longer.

The body was first spotted by US astronomers Theodore Pruyne and Kacper Wierzchos using a 1.52-metre (60 inch) telescope at Mount Lemmon Observatory near Tuscon, Arizona on February 15.

Subsequent observations enabled its orbit to be calculated, and at 22:53 Universal Time (UT) on February 25, the Minor Planet Center announced the discovery, designating it as 2020 CD_3 and confirming that it is temporarily bound to the Earth.

The object 2020 CD_3 is essentially just a tiny member of a class of asteroids whose orbits cross the Earth's orbit. Occasionally, they come near or collide with the Earth, but in this case a collision would not have been a catastrophe for us because 2020 CD_3 is so small that it would have broken up in the atmosphere before reaching the ground.

Instead of colliding with our planet, however, the initial approach of 2020 CD_3 towards the Earth meant that it was captured into orbit at a somewhat greater distance than our much larger, permanent moon.



Perspective view of the orbit of 2020 CD3 about the Earth. The white band is the orbit of Earth's main, permanent, moon. Tony873004

So-called "mini-moons" like this one come and go, and 2020 CD_3 is probably already on its final loop before breaking free. One study has suggested that at any one time, the Earth is likely to be accompanied by at least one temporary mini-moon greater than one metre in size that makes at least one loop around the Earth before escaping.

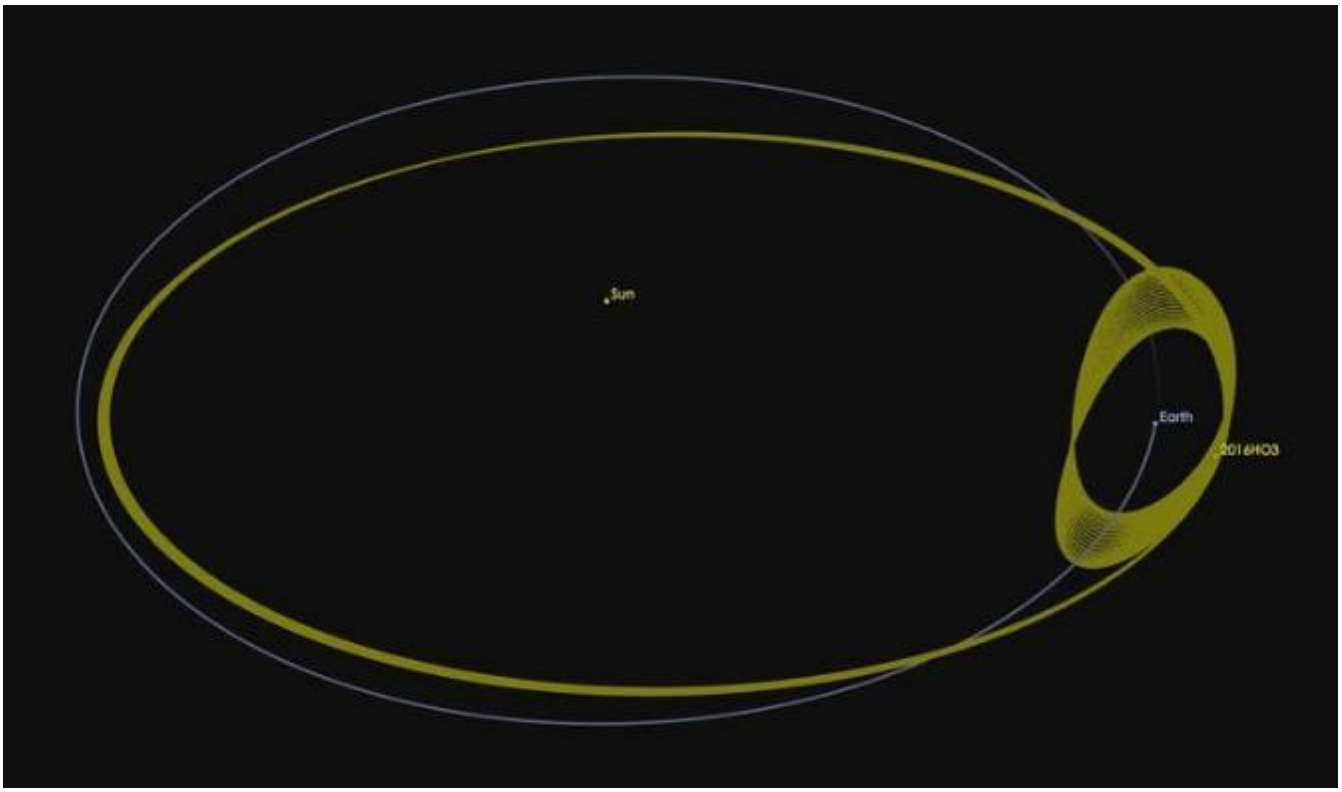
None of these stays long, because gravitational tugs from our much larger permanent moon and the Sun make their orbits unstable. After being captured, they typically orbit the Earth for no more than a few years before breaking free to reclaim an independent orbit about the Sun.

Hard to Predict

Once a mini-moon has been discovered, its orbit is impossible to predict exactly because bodies this small are pushed perceptibly by the Sun's radiation, and we know too little about their sizes, shapes and reflectivity to calculate the resulting effect. A previous visitor designated 2006 RH_{120} made four orbital loops around the Earth between September 2006 and June 2007 before proceeding on its way. By now it will have travelled to the far side of the Sun, but will pass close to Earth again in 2028.

Other claimed "moons" of the Earth are asteroids whose orbital period about the Sun averages out at exactly one year. So while they appear to have a relationship with Earth, they are actually just orbiting the Sun in company with, but independently of, the Earth.

These are known as "quasi-satellites" of the Earth. One of those, 1991 VG seems to have made at least one genuine orbit of the Earth in 1992, and could well do so again in the future.



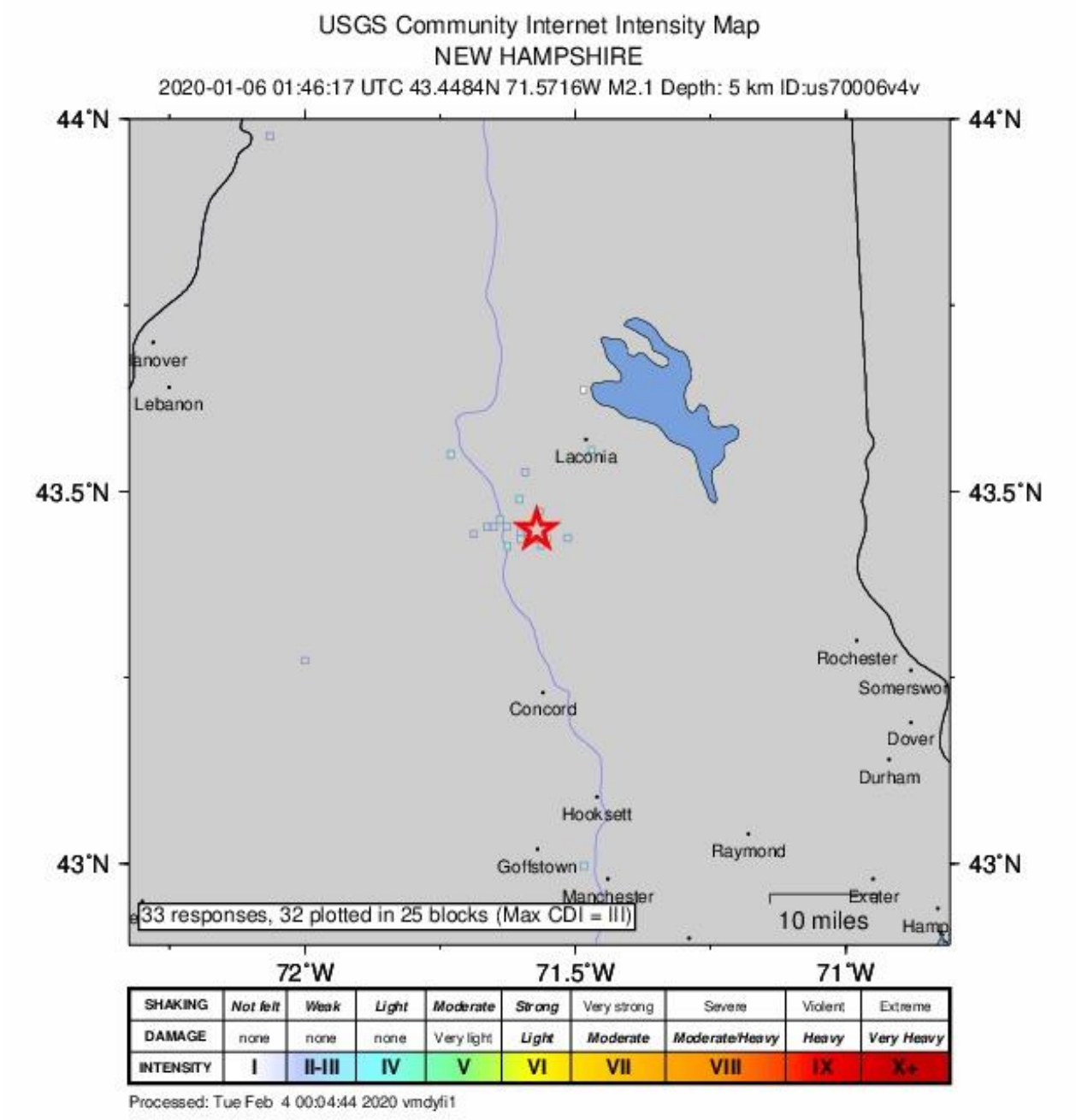
The orbit of asteroid 2016 HO3 relative to the Sun (big loops) and relative to the Earth (small loops). NASA/JPL-Caltech

So while 2020 CD_3 is an interesting new discovery, don't expect a catastrophic collision or extra moonlight for that evening stroll. Nevertheless, for a while at least, our main moon has a very tiny cousin.

Tilton NH Earthquake – January 6, 2020

From the U.S. Geological survey:
https://earthquake.usgs.gov/earthquakes/eventpage/us70006v4v/executive

We don't get big earthquakes frequently in New Hampshire, but you may have felt a small one in January. A magnitude 2.1 earthquake was registered 1 km east-northeast of Tilton at a depth of 5.0 km on January 6 at 1:46 UTC (8:46 PM EST).



Note that as this newsletter was going to press, another magnitude 2.1 earthquake was felt near Tilton: see https://earthquake.usgs.gov/earthquakes/eventpage/us60008fw6/executive

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Rare ice volcanoes captured erupting on Lake Michigan beach but may not stick around

By Bisma Parvez, Detroit Free Press, February 17, 2020
https://www.freep.com/story/news/local/michigan/2020/02/17/rare-ice-volcanoes-lake-michigan/4783878002/

The recent cold front has brought an interesting phenomenon to Lake Michigan: first ice balls, now ice volcanoes.

National Weather Service meteorologist Ernie Ostuno was able to capture some amazing photos of erupting ice volcanoes at Oval Beach in Saugatuck Sunday.

An ice volcano is a cone-shaped mound of ice formed over a terrestrial lake by the eruption of water and slush through an ice shelf.

'Ice volcanoes' erupt on Lake Michigan on Sunday Feb. 16 (Photo: National Weather Service Grand Rapids)

"Ice volcanoes occur in locations in which waves hit accumulated ice on the shoreline with some force," said Cort Spholten, a meteorologist with the National Weather Service of Grand Rapids.

"We were cold enough to form ice on the shore of Lake Michigan and water had broken the surface of that ice," Spholten said. "The waves ... were strong enough so the water channels through, it squeezes water upwards and tosses the floating ice up. As it happens, over the course of hours or days, it forms a cone and it resembles a volcano."

According to Spholten, there have to be very specific conditions for the ice volcanoes to form.

"It needs to stay cold enough to keep the ice around and waves need to be large enough to force water upwards against the ice shelf," he said.

'Ice volcanoes' erupt on Lake Michigan (Photo: National Weather Service Grand Rapids)

How long will it last?

"Today, winds from the southeast should diminish the waves. It's unlikely ice volcanoes will be seen today compared to yesterday, but it's not impossible," Spholten said.

However, ice volcanoes can also be dangerous especially when people climb on them. There may be no way to get out of the icy water if someone slips down the side of one of the mounds.

The ice volcanoes formed after another rare phenomenon on Lake Michigan.

On Friday, thousands of ice balls rolled up onto the lake shore. According to experts the weather conditions have to be just right: The temperatures are just below freezing along shallow beaches. Slush collects into round shapes and the waves sculpt ice chunks into orbs.

Ice balls, a rare phenomenon on Lake Michigan, rolled up on the beaches Friday at Holland State Park. (Photo: Sean Mulligan, Michigan DNR)

How Earth Climate Models Help Scientists Picture Life on Unimaginable Worlds

By Lonnie Shekhtman, NASA's Goddard Space Flight Center, January 24, 2020
https://www.nasa.gov/feature/goddard/2020/how-earth-climate-models-help-scientists-picture-life-on-unimaginable-worlds

In a generic brick building on the northwestern edge of NASA's Goddard Space Flight Center campus in Greenbelt, Maryland, thousands of computers packed in racks the size of vending machines hum in a deafening chorus of data crunching. Day and night, they spit out 7 quadrillion calculations per second. These machines collectively are known as NASA's Discover supercomputer and they are tasked with running sophisticated climate models to predict Earth's future climate.

But now, they're also sussing out something much farther away: whether any of the more than 4,000 curiously weird planets beyond our solar system discovered in the past two decades could support life.

Scientists are finding that the answer not only is yes, but that it's yes under a range of surprising conditions compared to Earth. This revelation has prompted many of them to grapple with a question vital to NASA's

search for life beyond Earth. Is it possible that our notions of what makes a planet suitable for life are too limiting?

The next generation of powerful telescopes and space observatories will surely give us more clues. These instruments will allow scientists for the first time to analyze the atmospheres of the most tantalizing planets out there: rocky ones, like Earth, that could have an essential ingredient for life — liquid water — flowing on their surfaces.

For the time being, it's difficult to probe far-off atmospheres. Sending a spacecraft to the closest planet outside our solar system, or exoplanet, would take 75,000 years with today's technology. Even with powerful telescopes nearby exoplanets are virtually impossible to study in detail. The trouble is that they're too small and too drowned out by the light of their stars for scientists to make out the faint light signatures they reflect — signatures that could reveal the chemistry of life at the surface.

In other words, detecting the ingredients of the atmospheres around these phantom planets, as many scientists like to point out, is like standing in Washington, D.C., and trying to glimpse a firefly next to a searchlight in Los Angeles. This reality makes climate models critical to exploration, said chief exoplanetary scientist Karl Stapelfeldt, who's based at NASA's Jet Propulsion Laboratory in Pasadena, California.

"The models make specific, testable predictions of what we should see," he said. "These are very important for designing our future telescopes and observing strategies."

Is the Solar System a Good Role Model?

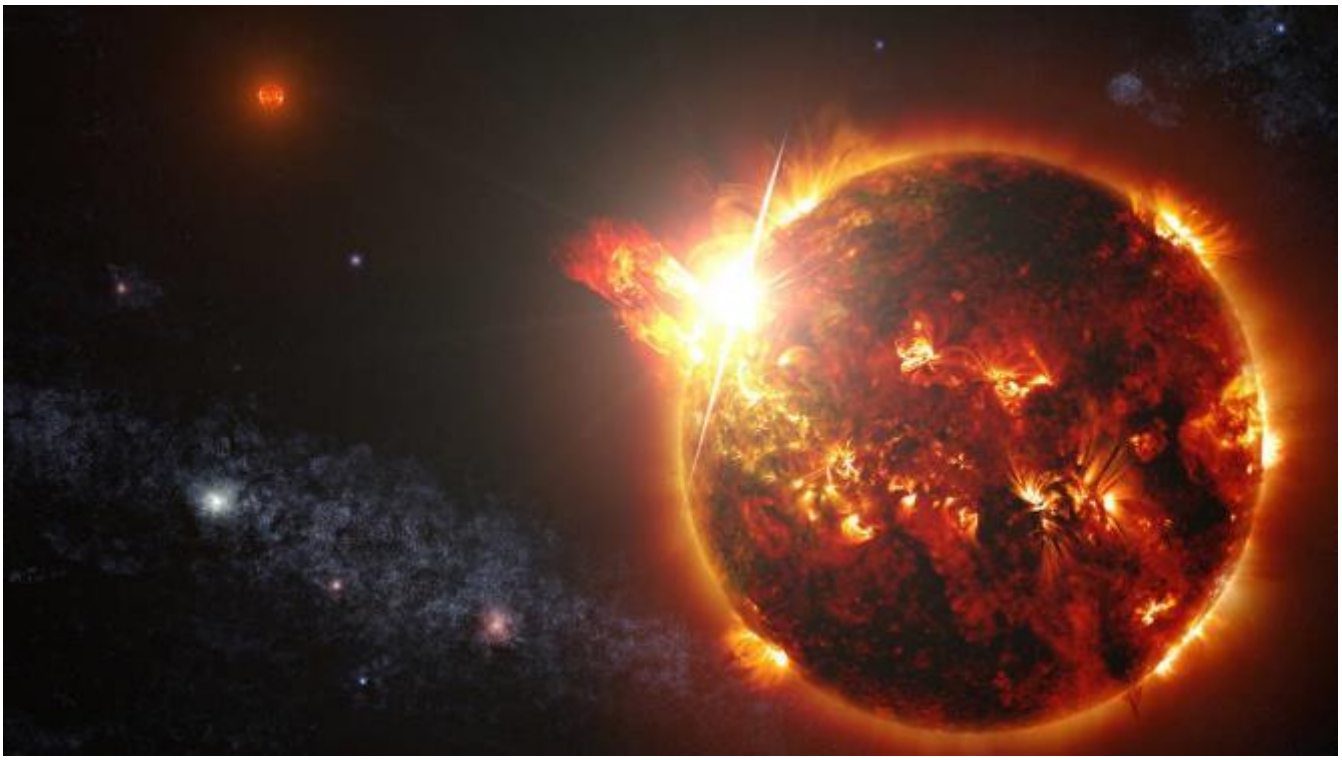
In scanning the cosmos with large ground-based and space telescopes, astronomers have discovered an eclectic assortment of worlds that seem drawn from the imagination.

"For a long time, scientists were really focused on finding Sun- and Earth-like systems. That's all we knew," said Elisa Quintana, a NASA Goddard astrophysicist who led the 2014 discovery of Earth-sized planet Kepler-186f. "But we found out that there's this whole crazy diversity in planets. We found planets as small as the Moon. We found giant planets. And we found some that orbit tiny stars, giant stars and multiple stars."

Indeed, most of the planets detected by NASA's Kepler space telescope and the new Transiting Exoplanet Survey Satellite, as well as ground-based observations, don't exist in our solar system. They fall between the size of a terrestrial Earth and a gaseous Uranus, which is four times bigger than this planet. P

lanets closest in size to Earth, and most likely in theory to have habitable conditions, so far have been found only around "red dwarf" stars, which make up a vast majority of stars in the galaxy. But that's likely because red dwarfs are smaller and dimmer than the Sun, so the signal from planets orbiting them is easier for telescopes to detect.

Because red dwarfs are small, planets have to lap uncomfortably close — closer than Mercury is to the Sun — to stay gravitationally attached to them. And because red dwarfs are cool, compared to all other stars, planets have to be closer to them to draw enough heat to allow liquid water to pool on their surfaces.



In 2014, NASA's Swift mission detected a record-setting series of X-ray flares unleashed by DG CVn, a nearby binary consisting of two red dwarf stars, illustrated here. At its peak, the initial flare was brighter in X-rays than the combined light from both stars at all wavelengths under normal conditions.
Credits: NASA's Goddard Space Flight Center

Among the most alluring recent discoveries in red dwarf systems are planets like Proxima Centauri b, or simply Proxima b. It's the closest exoplanet. There are also seven rocky planets in the nearby system TRAPPIST-1. Whether or not these planets could sustain life is still a matter of debate. Scientists point out that red dwarfs can spew up to 500 times more harmful ultraviolet and X-ray radiation at their planets than the Sun ejects into the solar system. On the face of it, this environment would strip atmospheres, evaporate oceans and fry DNA on any planet close to a red dwarf.

Yet, maybe not. Earth climate models are showing that rocky exoplanets around red dwarfs could be habitable despite the radiation.

The Magic is in the Clouds

Anthony Del Genio is a recently retired planetary climate scientist from NASA's Goddard Institute for Space Studies in New York City. During his career he simulated the climates of Earth and of other planets, including Proxima b.

Del Genio's team recently simulated possible climates on Proxima b to test how many would leave it warm and wet enough to host life. This type of modeling work helps NASA scientists identify a handful of promising planets worthy of more rigorous study with NASA's forthcoming James Webb Space Telescope.

"While our work can't tell observers if any planet is habitable or not, we can tell them whether a planet is smack in the midrange of good candidates to search further," Del Genio said.

Proxima b orbits Proxima Centauri in a three-star system located just 4.2 light years from the Sun. Besides that, scientists don't know much about it. They believe it's rocky, based on its estimated mass, which is slightly larger than Earth's. Scientists can infer mass by watching how much Proxima b tugs on its star as it orbits it.

The problem with Proxima b is that it's 20 times closer to its star than Earth is to the Sun. Therefore, it takes the planet only 11.2 days to make one orbit (Earth takes 365 days to orbit the Sun once). Physics tells scientists that this cozy arrangement could leave Proxima b gravitationally locked to its star, like the Moon is gravitationally locked to Earth. If true, one side of Proxima b faces the star's intense radiation while the other one freezes in the darkness of space in a planetary recipe that doesn't bode well for life on either side.

But Del Genio's simulations show that Proxima b, or any planet with similar characteristics, could be habitable despite the forces conspiring against it. "And the clouds and oceans play a fundamental role in that," Del Genio said.

Del Genio's team upgraded an Earth climate model first developed in the 1970s to create a planetary simulator called ROCKE-3D. Whether Proxima b has an atmosphere is an open and critical question that will hopefully be settled by future telescopes. But Del Genio's team assumed that it does.

With each simulation Del Genio's team varied the types and amounts of greenhouse gases in Proxima b's air. They also changed the depth, size, and salinity of its oceans and adjusted the ratio of land to water to see how these tweaks would influence the planet's climate.

Models such as ROCKE-3D begin with only grains of basic information about an exoplanet: its size, mass, and distance from its star. Scientists can infer these things by watching the light from a star dip as a planet crosses in front of it, or by measuring the gravitational tugging on a star as a planet circles it.

These scant physical details inform equations that comprise up to a million lines of computer code needed to build the most sophisticated climate models. The code instructs a computer like NASA's Discover supercomputer to use established rules of nature to simulate global climate systems. Among many other factors, climate models consider how clouds and oceans circulate and interact and how radiation from a sun interacts with a planet's atmosphere and surface.

When Del Genio's team ran ROCKE-3D on Discover they saw that Proxima b's hypothetical clouds acted like a massive sun umbrella by deflecting radiation. This could lower the temperature on Proxima b's sun-facing side from too hot to warm.

Other scientists have found that Proxima b could form clouds so massive they would blot out the entire sky if one were looking up from the surface.

"If a planet is gravitationally locked and rotating slowly on its axis a circle of clouds forms in front of the star, always pointing towards it. This is due to a force known as the Coriolis effect, which causes convection at the location where the star is heating the atmosphere," said Ravi Kopparapu, a NASA Goddard planetary scientist who also models the potential climates of exoplanets. "Our modeling shows that Proxima b could look like this."

In addition to making Proxima b's day side more temperate than expected, a combination of atmosphere and ocean circulation would move warm air and water around the planet, thereby transporting heat to the cold side. "So you not only keep the atmosphere on the night side from freezing out, you create parts on the night side that actually maintain liquid water on the surface, even though those parts see no light," Del Genio said.

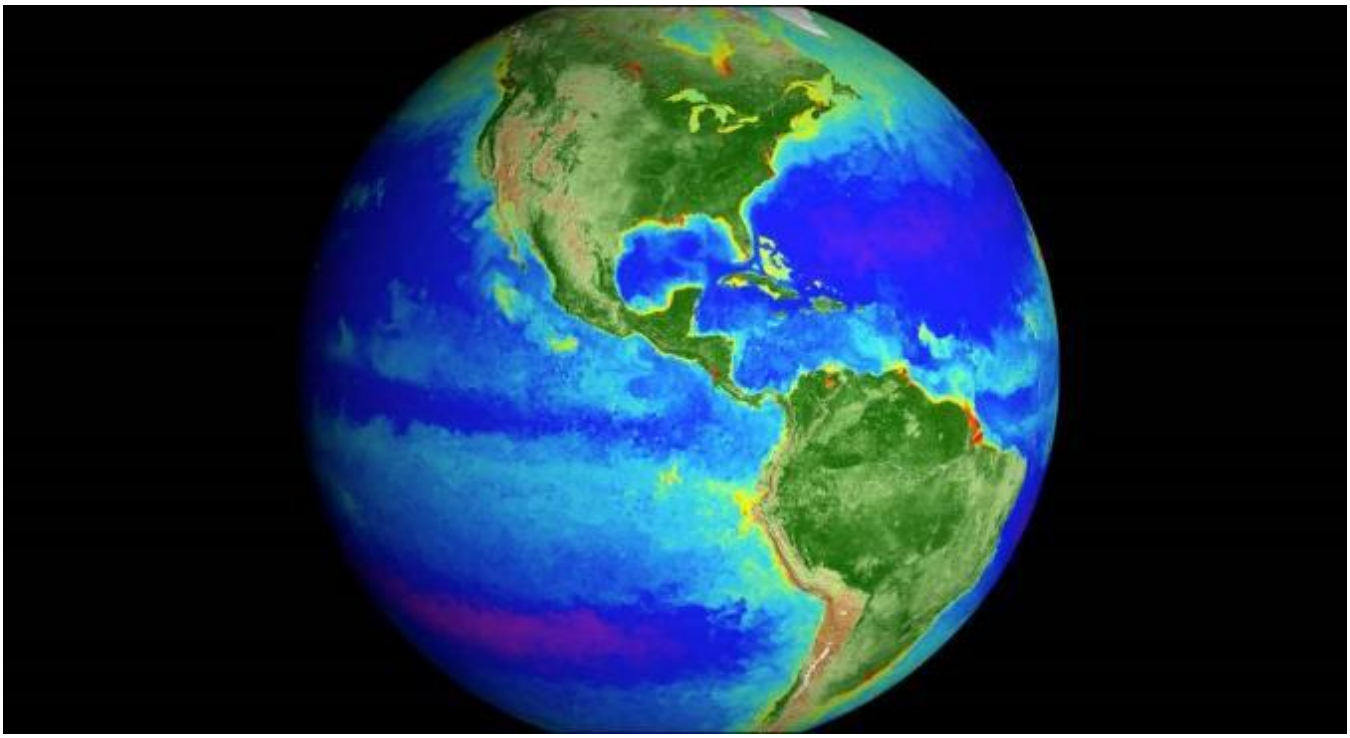
Taking a New Look at an Old Role Model

Atmospheres are envelopes of molecules around planets. Besides helping maintain and circulate heat, atmospheres distribute gases that nourish life or are produced by it.

These gases are the so-called "biosignatures" scientists will look for in the atmospheres of exoplanets. But what exactly they should be looking for is still undecided.

Earth's is the only evidence scientists have of the chemistry of a life-sustaining atmosphere. Yet, they have to be cautious when using Earth's chemistry as a model for the rest of the galaxy. Simulations from

Goddard planetary scientist Giada Arney, for instance, show that even something as simple as oxygen — the quintessential sign of plant life and photosynthesis on modern Earth — could present a trap.



NASA scientists now have the most complete global picture of life on Earth to date. From the unique vantage point of space, NASA observes not only Earth's landmasses and oceans but also the organisms that live among them. Credits: NASA's Goddard Space Flight Center

Arney's work highlights something interesting. Had alien civilizations pointed their telescopes toward Earth billions of years ago hoping to find a blue planet swimming in oxygen, they would have been disappointed; maybe they would have turned their telescopes toward another world. But instead of oxygen, methane could have been the best biosignature to look for 3.8 to 2.5 billion years ago. This molecule was produced in abundance back then, likely by the microorganisms quietly flourishing in the oceans.

"What is interesting about this phase of Earth's history is that it was so alien compared to modern Earth," Arney said. "There was no oxygen yet, so it wasn't even a pale blue dot. It was a pale orange dot," she said, referencing the orange haze produced by the methane smog that may have shrouded early Earth.

Findings like this one, Arney said, "have broadened our thinking about what's possible among exoplanets," helping expand the list of biosignatures planetary scientists will look for in distant atmospheres.

Building a Blueprint for Atmosphere Hunters

While the lessons from planetary climate models are theoretical — meaning scientists haven't had an opportunity to test them in the real world — they offer a blueprint for future observations.

One major goal of simulating climates is to identify the most promising planets to turn to with the Webb telescope and other missions so that scientists can use limited and expensive telescope time most efficiently. Additionally, these simulations are helping scientists create a catalog of potential chemical signatures that they will one day detect. Having such a database to draw from will help them quickly determine the type of planet they're looking at and decide whether to keep probing or turn their telescopes elsewhere.

Discovering life on distant planets is a gamble, Del Genio noted: "So if we want to observe most wisely, we have to take recommendations from climate models, because that's just increasing the odds."

The researchers and science profiled in this story are part of the Sellers Exoplanet Environments Collaboration, or SEEC, at NASA's Goddard Space Flight Center. The multidisciplinary collaborative brings together experts from planetary and Earth sciences, with those from astrophysics and heliophysics, to build the most comprehensive and sophisticated computer models of exoplanets in order to better prepare for current and future exoplanet observations. To learn more, visit: https://seec.gsfc.nasa.gov/index.html.

What is your Board Doing? Submitted by Shane Csiki, Secretary

The Board of Directors held its most recent meeting at the offices of Nobis Engineering in Concord on March 12, 2020.

At this meeting, the Board was faced with the task of cancelling the April 2020 Dinner Meeting because of logistical issues and concerns posed by the current Coronavirus outbreak. However, the Board is currently looking ahead positively to the Fall Dinner Meeting in October, and is actively planning for that event, when we will be able to come together again. On a more positive note, GSNH member Lea Anne Atwell is currently working with Abby Fopiano to put together information on publicly accessible geological sites of interest in New Hampshire. They have made considerable progress. At this point, it appears that the end product will be linked from the GSNH web page. The Board is very excited about this project, and spent time at our recent meeting discussing some of the logistics, and is looking forward to seeing it come to fruition.

The next GSNH Board meeting will be held on Thursday, June 18, 2020, in Hopkinton, starting at 6:00 PM. All GSNH members are welcome to attend.

March Legislative Committee Report by Tom Fargo

Below is a list of 2020 NH General Court (House and Senate) Bills that are potentially relevant to members of the Geological Society of New Hampshire. This table lists bills identified by keyword searches completed in March 2019. Bill descriptions have been abridged.

Bill No.	Title	Bill Description	Legislative Action – Bill Status
Key Word "**Environ**"			
HCR-10	urging Congress to grant states broader authority to set higher environmental standards than those established in federal law	This concurrent resolution urges Congress to grant states broader authority to set higher environmental standards than those established in federal law.	On 3/11/2020 calendar Committee on State-Federal Relations vote was split:11-9 Majority: Ought to Pass (OPT) Minority: Inexpedient to Legislate (ITL)
HB-1310	relative to authorizing the state to set higher environmental standards than those established in federal law	This bill authorizes the state to set higher environmental standards than those established in federal law.	Full House voted ITL on 3/11/2020
HB-1664	(New Title) establishing greenhouse gas emission reduction goals for the state and establishing a climate action plan.	This bill establishes greenhouse gas emission reduction goals for the state and gives the department of environmental services (DES) the authority to develop and update regularly a climate action plan.	Full House voted OTP w/ Amendment on 02/19/2020. Referred to ED&A Committee. Referral waived 3/3/2020
HB-1538	creating a commission to develop and implement environmental education, outreach, and training programs and initiatives for qualified health care professionals relative to environmental toxins and health	This bill creates a commission to develop and implement environmental education, outreach, and training programs and initiatives for qualified health care professionals relative to environmental toxins and health.	Full House voted Refer to Interim Study on 3/11/2020
HB-1569	requiring DES to maintain a public registry of where certain fire suppressants have been used	This bill requires DES to maintain a public registry of where certain fire suppressants have been used.	Full House voted OTP w/ Amendment on 02/19/2020.
SB-728	establishing the coastal program administered by DES	This bill establishes a coastal program to be administered by DES. This bill is a request of the department of environmental services.	Full Senate voted OTP on 03/05/2020.
SB-583	relative to the addition of climate and environmental sciences to the criteria for an adequate education	This bill adds climate and environmental science to the criteria for an adequate education.	Full Senate voted OTP on 01/09/2020. Referred to House E&WD Committee.
SB-517	relative to the public information and permitting functions of the office of the commissioner in DES.	This bill changes the functions of the public information and permitting office of the commissioner of DES. This bill is a request of DES.	Full Senate voted OTP on 02/06/2020. Referred to House ED & A Committee.
Key Word "**Water**"			

LSR 2020-2119	abolishing fluoride in water	This LSR was withdrawn	
HB-1274	(New Title) requiring bottled drinking water sold to the public meet the same maximum contaminant levels established for public drinking water.	This bill requires bottled water to be tested for the presence of certain chemicals and labeled with certain results of such tests	Full House voted OTP with Amendment on 3/11/2020
HB-1120	requiring periodic water tests of rental property	This bill requires the landlord to make certain water tests for residential property available to the tenant. The bill also requires the landlord to install a water treatment system if the property has a well and the water does not meet water quality standards established by DES.	On 3/11/2020 calendar Judiciary Committee vote on 3/4/2020 was split 12-8. Majority OTP with Amendment; Minority: ITL
HB-1252	relative to large groundwater withdrawals from replacement wells	This bill adds to the requirements for an application for an exemption for large groundwater withdrawals from replacement wells.	Full House voted OTP 03/11/2020.
HB-1347	addressing impacts to other water users from new sources of water for community water systems.	This bill requires DES to adopt rules concerning small groundwater withdrawals from new sources of water.	Full House voted OTP 03/11/2020.
HB-1537	relative to standards for perfluorochemicals in drinking water and ambient groundwater	This bill directs the department of environmental services to set maximum contaminant limits for per and polyfluoroalkyl substances (PFAS).	Full House voted OTP with Amendment 03/11/2020.
SB-599	relative to testing for lead in water in schools and childcare facilities	This bill requires testing for lead in water in schools and childcare facilities.	Hearing in Senate Health, Human Services Committee held on 02/20/2020.
SB-496	(New Title) establishing a PFAS fund and programs and making an appropriation therefor.	This bill: 1) Establishes the PFAS fund. 2) Establishes a low interest loan program for certain water and wastewater systems affected by PFAS contamination. 3) Makes an appropriation to DES for the remediation of PFAS contamination. 4) Allows DES to borrow money.	Senate Energy and Natural Resources Committee voted OTP with Amendment on 02/13/2020 Senate Finance Committee voted OTP on 03/9/2020
SB-641	establishing a state assistance to public drinking water systems program and fund.	This bill establishes the PFAS fund and enables DES to make grants, loans, contracts, and reimbursements from the fund for projects related to PFAS remediation.	Senate Finance Committee voted Refer to Interim Study on 03/9/2020
Key Word “Wetland”			
HB-1124	relative to the definition of prime wetland	This bill further defines prime wetland for local protection in fill and dredge permits.	On 3/11/2020 calendar Resources Recreation and Development Committee vote on 3/5/2020 was split 11-9. Majority OTP with Amendment; Minority: ITL
Key Word “Shoreland”			

SB-491	relative to shoreland water quality	This bill clarifies the definitions of shoreland frontage, structure, and pervious surface and makes changes to the minimum shoreland protection standards regarding such subjects.	Senate Energy and Natural Resources Committee voted on 03/05/2020 to Lay on Table
Key Word "Waste"			
HB-1422	establishing a moratorium on the issuance of permits for new landfills or the expansion of existing landfills for the purpose of studying the creating of municipal waste districts	This bill establishes a 2-year moratorium on the issuance of permits for new landfills or the expansion of existing landfills for the purpose of studying the creating of municipal waste districts.	Full House voted on 3/12/2020 Refer to Interim Study
SB-591	establishing a statewide solid waste disposal reduction goal	This bill establishes a statewide solid waste disposal reduction goal.	Full Senate voted on 03/12/2020 OTP with Amendment
SB-629	establishing the solid waste management fund and establishing a solid waste disposal surcharge	This bill: I. Establishes the solid waste reduction management fund. II. Establishes a solid waste disposal surcharge. III. Repeals the existing surcharge on out-of-state waste.	On calendar for 3/19/2020 Senate Energy and Natural Resources Committee voted on 03/04/2020 OTP with Amendment.
HB-1702	establishing a solid waste working group on solid waste management planning	This bill establishes a solid waste working group on solid waste management planning at the request of the study committee on recycling and solid waste, established pursuant to 2019, 265 (HB 617).	Full House voted OTP on 03/11/2020.
HB-1706	establishing a committee to study the solid waste practices of state agencies	This bill establishes a committee to study the solid waste practices of state agencies at the request of the 2019, HB 617 study committee on recycling and solid waste.	Full House voted OTP on 02/19/2020.
Key Word "Soil"			
HB-1562	including soil health and soil conservation in the state soil conservation plan	This bill amends current provisions relative to soil conservation to include soil health and climate change mitigation and adaptation.	On 3/11/2020 calendar. Committee of Environment and Agriculture voted unanimously OTP with Amendment on 3/3/2020
Key Word "Professional" as potentially related to Geologists			
HB-1538	creating a commission to develop and implement environmental education, outreach, and training programs and initiatives for qualified health care professionals relative to environmental toxins and health.	This bill creates a commission to develop and implement environmental education, outreach, and training programs and initiatives for qualified health care professionals relative to environmental toxins and health.	Full House voted Refer to Interim Study on 03/11/2020.
SB-568	establishing an oversight committee on the office of professional licensure and certification.	This bill establishes a permanent statutory oversight committee to promote efficiency and effectiveness in professional licensing and certification administered by the office of professional licensure and certification.	Full Senate voted ITL on 03/05/2020

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:

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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

Membership Category:

__ *Regulations Committee*
__ *Education Committee*
__ Events Committee

__Communications Committee
(Newsletter or Website, circle preference)
__ Other:

_____ Regular Member (Annual Dues $20.00)

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

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

Signature: _____ Date: _____