Granite State Geologist

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MESSAGE FROM THE PRESIDENT

Personalizing Climate Change:

According to a September 2021 Washington Post analysis of federal disaster declarations, nearly 1 in 3 Americans live in a county hit by a weather disaster in the past three months. Given the recent widespread impacts from hurricane/tropical storm Ida, dire reports of water shortages across the west, and locally the wildfire smoke that blanketed NH in July, it seems appropriate to devote a column to this geologist's perspectives on climate change.

When I was an undergrad in the late 1970's, environmental science courses were offered as electives. The focus of these courses, reflective the fairly recent passages of the Clean Air Act of 1970 and the Clean Water Act of 1972, was generally local in nature, i.e., ecosystem impacts of wastewater discharges and acid rain. Concerns about the safety of nuclear power and what to do with radioactive waste reached a zenith following the Three Mile Island accident in March 1979. But the paradigm at that time remained: the earth is big, nature is powerful, and there was little that puny humans could do to upset natural systems on a global scale.

I was introduced to climate science when I started graduate studies at the University of Buffalo (UB) in the fall of 1981. At that time, UB was the US center for the Greenland Ice Sheet Project (GISP) that helped refine the record of atmospheric concentrations of CO_2. There was also on-going research chronicling the accelerating retreat of cirque glaciers in the Brooks Range of Northern Alaska. Many of fellow classmates were in involved with these projects. Their work helped the scientific community, and in a broader sense society, to recognize the inaccuracy of the paradigm. By coincidence, when I returned to graduate studies at UNH in the fall of 1988, I encountered continuing studies of the cryosphere, including the GISP-2 Project, and associated efforts to model climate change. Through the 1990s, there was growing recognition

of the problem of “global warming” and the need to address it. Then, as we all know, politics became more polarized, scientific consensus was questioned in favor of maintaining the status quo. Special-interest money flowed in to fuel debate, or at least to create gridlock.

I had the privilege to personally engage in the political debate. As a member of the NH House of Representatives in 2008, I worked to pass a bill to enter NH into the Regional Greenhouse Gas Initiative (RGGI), which is a cap-and-trade program in northeast states to limit carbon emissions from electrical power generation facilities. That program has been altered by subsequent changes in political leadership. However, carbon emissions from power generation have decreased in the US, primarily due to shifting away from coal in favor of natural gas. This shift was made possible by the work of geologists and engineers through the expanded use of hydro-fracturing in shale-gas reservoirs.

I’m mindful that geologists work on both sides of the climate change “problem”. Several of my undergraduate classmates are now retired or will soon retire from careers spent in the pursuit of fossil fuels. My current position with the NHDES Oil Remediation and Compliance Bureau is supported by sales of petroleum in NH. Are you aware that the transportation sector is the largest source of greenhouse gas (GHG) in NH? Approximately two million gallons of motor fuel are combusted in NH every day.

Based on the above-referenced Washington Post analysis, you likely know someone, perhaps even a geologist, who has been directly impacted by climate change. My college sweetheart and her family were burned out of their home on October 9, 2017 when the Tubbs wildfire swept through northwestern Santa Rosa, CA – photo below. They rebuilt their home on the same lot and moved in mid-July 2020, only to be evacuated approximately five weeks later when wildfire again threatened to take their house and all their possessions for a second time. A subsequent wildfire has not destroyed their second home, yet.

I’m trying to be optimistic, but I’m finding it difficult. The recently released Sixth Assessment Report of the United Nations Intergovernmental Panel on Climate Change details actions to mitigate future devastation. Unfortunately, what society could or should do about GHG emissions remains a battlefield.

Tom

GSNH T-Shirts Available!

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

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

New Hampshire Licensing Update

From Nikki Delude Roy, Chair

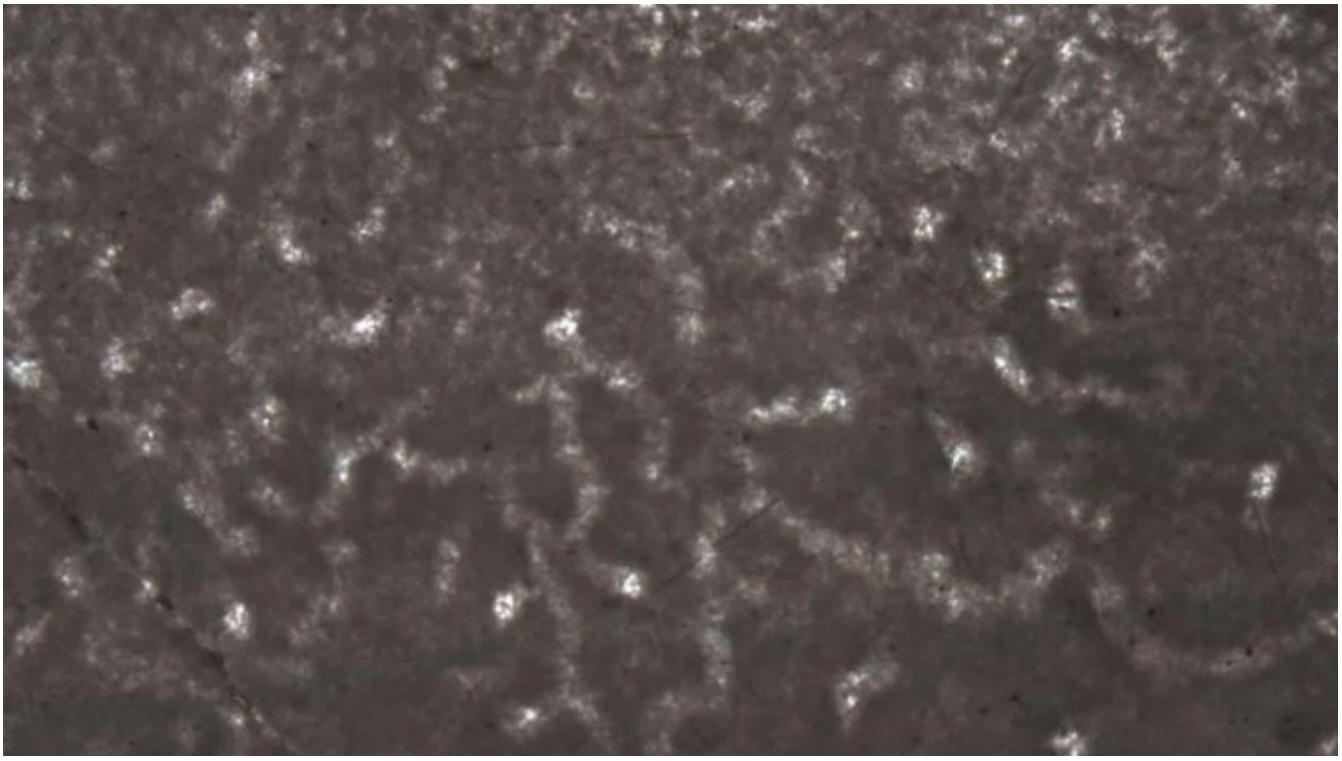
The National Association of State Boards of Geology (ASBOG) will change to computer based testing starting with the Spring 2023 Fundamentals of Geology/Practice of Geology exams. The New Hampshire Board of Professional Geologists has reviewed language in the rules to support this change and has submitted revisions for consideration.

Note that the next board meeting date is November 18, 2021 at 9:00 AM.

Canadian Arctic fossils may be the oldest animal ever found, study suggests

By Emily Chung. From CBS News, July 28, 2021.
https://www.cbc.ca/news/science/oldest-animal-fossils-sponge-1.6120659

Fossils that formed 890 million years ago in what is now the Northwest Territories may be by far the oldest evidence of animal life ever found, a controversial new Canadian study suggests.



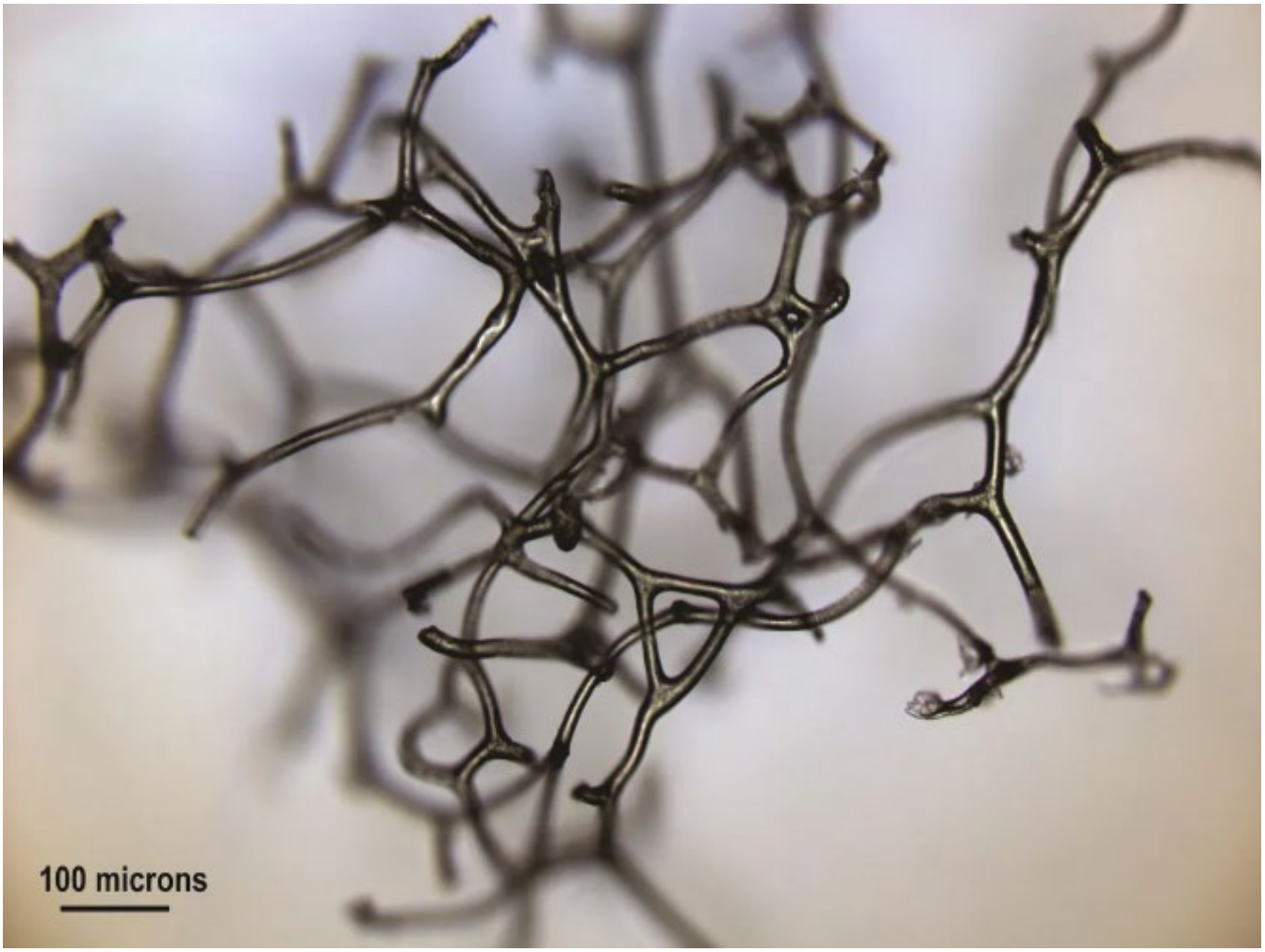
These microscopic 890-million-year-old fossils found in the Northwest Territories are thought to be the remains of an ancient sponge. If that's the case, they would be by far the oldest animal fossils ever found. (Elizabeth Turner/Laurentian University)

The tiny fossils are "possible" remains of the skeleton of an ancient sponge, says a new study by Elizabeth Turner, professor of earth sciences at Laurentian University in Sudbury, Ont., published in Nature today.

A cautious news release from the journal titled "Potential Evidence for the Earliest Animal Life" said, "the findings, if verified, may represent the earliest known fossilized animal body and may pre-date the next-oldest undisputed sponge fossils by around 350 million years."

That would also make them more than 300 million years older than the oldest confirmed animal fossil until now, 574-million-year-old fossils from Mistaken Point, N.L. [Newfoundland and Laborador] and Dickinsonia, an elliptical, leaf-like marine creature that grew up to 1.22 metres long and lived 558 million years ago.

The previous oldest confirmed sponge — widely considered to be the earliest group of animals — lived 535 million years ago.



This is the skeleton of a modern bath sponge or horny sponge from Greece seen under a microscope, which has a similar structure to the fossils. (Elizabeth Turner/Laurentian University)

Turner said she first found the fossils in pockets and crevices of ancient reefs called stromatolites built by photosynthetic microbes called cyanobacteria while studying the microbes themselves for her PhD in the 1990s.

While the ancient reefs are in the Arctic now — more specifically, their fossilized remains are limestone deposits in the Mackenzie Mountains, which are located in the Northwest Territories near the Yukon border — 890 million years ago, they were much closer to the equator in the middle of a supercontinent called Rodinia, in a shallow inland sea.

The fossils were worm-like and half the width of a human hair, branching and then rejoining. Turner was intrigued, as they were complex structures and she suspected they weren't made by microbes. She puzzled over them for decades, returning periodically to gather more samples.

Elizabeth Turner, a Laurentian University earth sciences professor, was the author of the new paper. In this photo, she does unrelated field work on northern Baffin Island in Nunavut. (C. Gilbert)

Then recently, Joachim Reitner in Germany, Robert Riding in the U.S. and Jeong-Hyun Lee in Korea, published research showing how similar fossils could be formed from horny sponges, the type of sponge used to make commercial bath sponges.

"They are truly identical to the ones that I had in my much older rocks," Turner said. "There weren't any other truly viable interpretations of the material."

The reef pockets and crevices in the Mackenzie Mountains where the worm-like sponge fossils were found are similar to the environments where sponges live today, she said.

This is one of the sites in the Mackenzie Mountains of the Northwest Territories. The mountains contain limestone from huge ancient reefs, which is where the fossils were found. (Elizabeth Turner/Laurentian University)

They were too dark for the cyanobacteria themselves to live in, so the microbes wouldn't compete with the sponges for space and other resources. But it was close enough for a sponge to capture some of the oxygen produced by the microbes, which was in short supply at that time.

The microbes might also produce a source of food in the form of slime — something their modern relatives still do, giving them their nickname, "pond scum."

What other scientists think

In an unusual move, since peer review is usually anonymous, Nature disclosed that Reitner, Riding and Lee had all peer reviewed Turner's article. Riding and Lee both confirmed they think Turner's interpretation is correct.

Riding says it's a "very interesting discovery."

"The orderliness and neatness of this pattern, I think, is very distinctive," he told CBC News in a phone interview, noting that the fossils are exceptionally well-preserved. "And if I found that pattern in younger rocks, I would say for sure that it was a sponge."

He said that sponges have long been thought to be the earliest animal and were predicted to have evolved around the time that these fossils would have formed.

That said, Riding acknowledged that the simplicity of the fossils and their extraordinary age mean some other scientists might need more convincing.

He thinks more people will start to look for these types of fossils, and may start to check them for the biochemical fingerprints left behind by sponges, which have been found in younger fossils. That would convince the doubters, he said, but added that "in my opinion, it is a sponge fossil."

Some researchers skeptical

Other researchers contacted by CBC News were more skeptical.

Jonathan Antcliffe is a paleontologist at the University of Lausanne in Switzerland who has previously disputed other "oldest sponge" fossil discoveries.

He said fossils are usually identified by unique and distinctive characteristics for that group, and there are many for sponges, including hard skeletal elements called spicules that fossilize well. Those were not found in this fossil.

While horny sponges don't have spicules, Antcliffe said they're one of the "weirdest" groups of modern sponges. He added that spicules should exist in even the earliest sponges, since they exist in a microbe that is thought to be the ancestor of sponges.

Unlike Turner and Riding, he thinks the fossils could have been made by many different kinds of microbes. "These things could be absolutely anything," he told CBC News. "There's just nothing distinctive here at all."

Qing Tang, a postdoctoral researcher at the University of Hong Kong, has previously written about the lack of really old sponge fossils being an "annoying problem for paleontologists," given that they're

thought to have evolved much earlier than the oldest fossils, and most modern sponges (but not horny sponges) have hard skeletons that should be easily fossilized.

Modern bath sponges or horny sponges don't have hard skeletons, but are supported by networks of protein. The fossils are thought to be the remains of similar networks. (Svetlana Lukienko/Shutterstock)

Some of his research has found that some very old sponges may not have had those hard skeletons.

- Oxygen not necessarily key to rise of animals, sponges suggest
- Oldest evidence of life on Earth found in Canadian rocks

But he said in this case, the fossils remind him of another fossil from between 635 million and 538 million years ago that was originally thought to be a sponge. After more detailed 3D analysis, researchers decided the fossils were more likely made by microbes.

He suggested more sophisticated 3D analyses are needed to confirm Turner's discovery.

"This discovery is overall very interesting," Qing said in an email.

"It will be a big step towards a better understanding of early animal evolution if the keratose sponge interpretation is eventually confirmed, particularly given its age… However, as is denoted in the title, these structures are best called possible sponge fossils due to relatively few characters preserved."

Mysterious Sea Bowls in La Palma

From Earth Science Picture of the Day, June 17, 2021.
Photographer: Jose F. Arozena, Summary Authors: Jose F. Arozena and Cadan Cummings
https://epod.usra.edu/blog/2021/06/mysterious-sea-bowls-in-la-palma.html

These circular or ovoid shaped holes of different sizes and depths are called sea bowls. Mysterious in nature, their origin has been hypothesized to be human made by the ancient inhabitants of the La Palma island- the so-called Awaras- since their creation has not been explained geologically. Several theories for their purpose range from serving a role in regional fishing or livestock farming to representing a part of sacred history for native populations. Located adjacent to the sea which is historically used to wash sheep and other livestock, the sea bowls could have served a role in bathing and deworming cattle in summer months. This evidence is supported by their names on marine maps stemming from livestock terms- such as “cattle tip” shown in the images above. Alternatively, their orientation on the horizon points approximately to where the Sun rises and sets during the solstices.

Whether a part of ancient livestock agriculture, marking annual astrological events, or something altogether different, these sea bowls in the volcanic basalt rock have endured the test of time as their shape remains even after being covered by hightide repeatedly for countless years.

For more about the geology and history of La Palma, see Professor Miguel Martin's videos and podcasts in the Canarian prehistory magazine Iruene.

Mazo. La Palma island, Canary Islands, Spain Coordinates: 28.605556, -17.777778

Related Links:

- Jose's Blog
- Low Bow Over La Palma
- Lava Tube on La Palma

Student Links:

- Volcanic History of La Palma

What's Your Board Been Doing? Submitted by Shane Csiki, Secretary

Well, after our great in-person Board meeting in June at Lee Wilder's "Toad Hall," it was back to meeting in cyberspace for our September Board meeting. There was no gold glow on the freshly greened trees against a blue sky, with the feel of crisp outdoor air. This time, the sun set shortly after our meeting began on the evening of September 23rd, with darkness outside the windows, a reminder that summer has past and fall is upon us. Nonetheless, the Board had a good meeting, as per usual, and took care of the business of GSNH.

Board members took some time to discuss efforts for creating some GSNH clothing items for eventual sale. Doug Allen has taken the lead on this effort for the Board. While last time, we focused on T-shirts, our focus this time will be on hats. We are currently working on the style and color. More information will follow once we have final pricing from the manufacturer.

Our next "dinner" meeting will be on October 14, for which more information is contained elsewhere in this newsletter. Unfortunately, we will not be in person for this event, but the Board is looking forward to joining you for this talk virtually once again. We continue to monitor the situation, both in terms of COVID, and attendant with that, the ability of restaurants and venues to host our gatherings. Our goal is to return to in-person meetings as we are able to do so, and we, like you, are looking forward to that

day, as the face-to-face is important for the life of GSNH. We discussed some of the technological options to possibly offer hybrid (in-person and online) meetings in the future. However, these are not without some technical hurdles. The Board will be continuing to discuss this topic at coming Board meetings.

At our meeting, we also continued our discussions toward adding electronic options for members to renew their registration each year. More information will follow in the future as that direction evolves.

Our next meeting will be on Thursday, December 14, 2021 at 6 PM, via Zoom. As always, any GSNH member is welcome to attend.

Remembering Tropical Storm Irene in New England

From the New England Water Science Center. https://www.usgs.gov/centers/new-england-water/science/remembering-tropical-storm-irene-new-england

On August 28, 2011 Tropical Storm Irene made landfall in New England, leading to coastal storm surge, significant riverine flooding, sediment transport to Long Island Sound, and major infrastructure damage and destruction. Ten years later, the USGS New England Water Science Center looks back at Irene, the data collected by our Center during the event, the response by our employees before, during and after the event, and how the event changed the way we do business.

This image shows the track of Irene and the storm's classification as it traveled northward. (Public domain.)

On August 28, 2011 Tropical Storm Irene reached the coast of New England and traversed through western Connecticut and Massachusetts and then along the New Hampshire/Vermont border and eventually exited New England through northern Maine. Irene was downgraded from a hurricane to a tropical storm prior to reaching New England as winds subsided to approximately 55 mph, and again downgraded to an extratropical storm as winds dropped to near 45 mph. Irene caused coastal damage in western Connecticut due to the storm surge associated with the high winds and significant damage to roadways, bridges, and other infrastructure due to the tremendous amounts of rainfall during the storm. The U.S. Geological Survey (USGS) New England Water Science Center responded to the storm surge and severe flooding caused by Irene before, during, and after the storm by monitoring tidal storm surge and collecting measurements of river stage and discharge. In some cases, there was record-breaking river stage elevations and associated discharge, especially in Vermont and western New Hampshire.

Leading up to the 10-year anniversary of Tropical Storm Irene the New England Water Science Center will post numerous photographs and other content to highlight the historical significance of the storm and the response by the USGS New England Water Science Center. Additionally, we are posting content on our Facebook page using the hashtag #21DaysofIrene.

We focus on the preparation for the storm and some of the coastal and riverine flooding caused by the storm. Preparation was primarily deploying storm surge sensors along New England's coastline and getting teams ready to go into the field to get discharge measurements of flooding rivers throughout the most impacted areas of New England.

We also feature continued USGS New England Water Science Center response during and after the storm, as well as lessons learned and how USGS has changed their way of responding to this type of storm event.

This photo taken on August 30, 2011 shows what used to be the parking lot where we parked our field vehicle during a previous deployment. The rocks in the forefront used to be part of the paved parking lot that was largely destroyed during Irene. (Credit: Jonathan Morrison, U.S. Geological Survey. Public domain.)

This photograph of the White River near West Hartford, Vermont (USGS station ID 01144000, gage on the left) was taken on August 29, 2011 and is looking upstream towards the USGS gage. The White River flooded Route 14 in the photo and caused significant damage and erosion along the roadway and in the town. The monitoring equipment in the gage was destroyed by floodwaters that overtopped the equipment inside the gage. (Credit: Richard Kiah, U.S. Geological Survey. Public domain.)

The impacts of Tropical Storm Irene lingered on long after the storm. This photo shows the Green River in Great Barrington, Massachusetts (USGS station ID 01198000) and was taken on May 14, 2012, almost a year after Irene. This tree was lodged under the Hurlburt Rd. bridge during Irene and was still lodged under the bridge after the storm. It was removed by the State of Massachusetts later that year. The tree caused the river to change course and it has been eroding the bank on the opposite side ever since; the property owner lost a fence due to the erosion. (Credit: Timothy Sargent, U.S. Geological Survey. Public domain.)

A debris line was left on the ground where the river reached its peak at USGS station ID 010642505 Saco River at Bartlett, New Hampshire. This is a type of High-Water Mark that was flagged for an indirect measurement of discharge. Direct measurements using a flow meter cannot be used during this type of flood event. In this case, it was a slope-area measurement that resulted in 29,100 cubic feet per second of flow, or approximately 2,182,250 gallons of water per second flowing down the channel and well over bank. (Credit: Richard Kiah, U.S. Geological Survey. Public domain.)

A High-Water Mark (HWM) at USGS station ID 01150900 Ottauquechee River at West Bridgewater, Vermont was observed at an undesirable location. It was inside the gage house and above the equipment, which was destroyed! Note the line of debris, known as a seed line, in between the two shelves, which was the peak of the river during Irene. The HWM was used to compute an indirect measurement of discharge. In this case, a contracted-opening measurement (flow through a bridge or other structure) resulted in 9,070 cubic feet per second of flow, or approximately 68,025 gallons of water passing in one second. (Credit: Richard Kiah, U.S. Geological Survey. Public domain.)

Unearthing California's Prehistoric Past

By Ashley Gebb, California State University, Chico, May 10, 2021.
https://today.csuchico.edu/unearthing-californias-prehistoric-past/

It was the find of a lifetime.

A softball-sized molar peeked out from the soft dirt, barely distinguishable except for a pearlized edge. As Russell Shapiro and the team gently began to pick away at the surrounding soil, a skull started to emerge, with more teeth jutting up from the jaw's craggy border.

Then, a gently curving tusk started teasing its way toward the sunlight.

Ever-so-carefully, they pushed forward, hoping it would be intact. By the time they reached the end of the fossilized bone, all indicators pointed to not one but two six-foot spans. Perfect mastodon tusks. Likely dating back 8 million years. And the first known species of its kind to be discovered in this part of Northern California.

“What you hope to find is a tip of a tusk,” said Shapiro, a professor of paleontology and stratigraphy in the Geological and Environmental Sciences Department. “Not only do we have the tip, but we have the entire thing. And it’s just beautiful ivory. It’s mind-blowing.”

In the months that followed, so would more phenomenal finds. Shapiro, department chair and sedimentology professor Todd Greene, several staff members, and a handful of students continue to make regular treks to the site, never failing to discover at least one fossil.

Chico State is not revealing the site location—which is on 28,000 acres of protected watershed nestled near the base of the Sierra Nevada foothills—to safeguard its security while excavation work continues. The area is owned and managed by East Bay Municipal Utility District (EBMUD) on behalf of 1.4 million people in the Bay Area.

It was EBMUD patrol ranger and naturalist Greg Francek who first stumbled upon the fossils, quite literally. In summer 2020, he was on patrol in the watershed when he spotted something strange in the soil.

He crouched down and ran his fingers along its smooth surface. It looked like wood but felt like stone. Could it be petrified, he wondered? Then he spotted another piece. And another. His curiosity kept drawing him back and within three weeks, he had found what appeared to be vertebrate fossils.

EBMUD reached out to an environmental consulting firm, which immediately called Shapiro. The firm and similar companies have worked with Shapiro for years, turning to him for finds including a 15-million-year-old whale calf found in Southern California and a 25-foot-long ichthyosaurus near Lake Shasta. With students by his side, he leads the excavations and often guides processing and storage.

Shapiro, who received the Distinguished Career Award from the Geobiology Division of the Geological Society of America in 2019, researched museum records and learned only a single horse tooth had been found near the Sierra foothills site over the years. Not optimistic, he readied himself for a lot of searching and disappointment. His visit days later was a revelation.

Within weeks, Francek and the Chico State team had discovered the head of an elephant-like mastodon, a rhino skeleton, and more than 600 fossilized trees. And from the looks of it, there is much, much more. EBMUD, stunned by the discovery, funded Shapiro to hire assistants to do the collecting, and he reached out to alumnus Dick Hilton (MS, Geology, ’75), to see if he would lend a hand.

Professors Russell Shapiro and Todd Greene search for fossils near the base of the Sierra Nevada foothills at a site that has yielded hundreds of specimens.

The first geology student to complete Chico State's graduate program decades ago, Hilton is nationally known as the authority on dinosaurs in California and for his overall expertise in field vertebrate paleontology. Now retired after a 40-year teaching career at Sierra College, he eagerly accepted the invitation.

While he's carried out paleontological digs from Montana to Wyoming, as well as led natural history trips to parts of Africa and South America, the Galapagos Islands, Baja California, and Alaska, this project, Hilton said, is an adventure all its own.

"It's my favorite thing to do," he said. "I just like to find fossils. It's the little kid in me."

In the last few months, Francek and the Chico State team have found two medium-sized mastodons, a giant tortoise, and four tusks from gomphotheres, which were elephant-like proboscideans dating to the Miocene epoch, which extended from 23 million to 5.3 million years ago.

The fossil site now spans 10.8 miles and hundreds of acres. On every visit, they tread softly, watching each step as they traverse the landscape in search of new discoveries.

Shapiro holds an unidentified bone recovered from the site.

“There! Is that part of a mastodon tooth?” Shapiro asked, laying down, peering through his magnifying glass to look for the telltale honeycomb pattern and overall density, and licking the specimen. A quick tongue test, as unconventional as it may sound, is one way to detect a fossilized object, as it should stick to your tongue. This one did not.

From 10 feet away, Hilton speaks up, “This might be part of a jaw.”

He pulls out a pocket knife and begins to scrape away at the soil. No, he determines, it’s more likely a rib. Francek takes a GPS reading, pockets the bone, scrawls RB for “random bone” in his notebook and they move on.

It goes like that for hours, as they gather every shard and every piece of bone they find, knowing that together they stitch a story of the state’s evolution. Eventually, they add a carnivore maxilla, two horse teeth, and a 3-foot-long humerus to the day’s findings.

Other exciting discoveries have included foot bones from a aepycamelus, a giant camel the size of a giraffe that would have browsed 20 feet up in the trees. The taupe-gray cannon bone is about 24 inches long and comes from the near the ankle, if that gives an indication of its gargantuan size.

Chico State is one of only a few universities federally authorized to collect and store fossils, like the mastadon molar uncovered here.

They also discovered a tapir, a pig-like mammal with long snout that typically would be found in the tropical areas of Central and South America. It appears like it was young—perhaps still nursing—based off the lack of wear on its teeth and an unerupted molar, and might even be a dwarf species.

As the drought continues to impact the watershed, new fossils reveal themselves on every visit, Francek said. A former merchant marine captain, he's taken a dozen earth science units and gone on several scientific expeditions, including recovering human remains in the Yucatan dating back 12,800 years—the oldest and most complete human skeleton ever found in North America. But little can compare to this, he said.

"It's a university-level class with these guys every day," he said. "The things that don't make sense to me, I'll show them to Dick and he'll know right away."

Their finds are slowly making their way to Chico State—one of only a few universities in Northern California that is federally sanctioned to collect and store fossils—where they will be prepared and ultimately sent to the University of California Museum of Paleontology. Chico State's own collection, now housed in the new Science Building, includes thousands of specimens owned by the US Forest Service, US Fish and Wildlife, and the Army Corps of Engineers, among others.

“We have more projects than we know what to do with,” Shapiro said. “There are lots of opportunities for new students.”

Fossil by fossil, discoveries like this help unravel the region’s geologic history, the team agrees. And what a tale it is.

“These are some of the biggest finds since Merriam,” Hilton said, with a nod to the paleontologist John C. Merriam, known for categorizing the vertebrates at the La Brea Tar Pits and the taxonomy of the saber tooth cat. “This is fantastic. I’ve never seen anything like this in California. It’s simply prolific.”

Greene’s speciality in sedimentology and stratigraphy has helped determine the origins of the fossils and the soil and rock that encases them

The geologists hypothesize that this substantial collection is the result of floods and debris flows coming from volcanoes far to the east. Unlike the scenes we see in California today, the landscape was split into largely an ocean in its south and forest highlands in the north, “a state divided,” Hilton said. Giant mammals, like the ones found here, roamed the oak forests and floodplains while ancient whales and sharks lurked in the sea’s depths.

This discovery has added detailed complexity to the story we know to be true about California, long considered one of the most geologically diverse states.

“I can look out and picture a movie reel of the lands changing,” Shapiro said. “Through the trees, I see one group of elephants peek out as another walks by, and then great horses come in.”

“You think about what that all means. I’m really envisioning how this landscape is changing,” he added.

This transformation will be on display for the public to learn from later this year. The recently discovered mastodon skull and tusks are the centerpiece of an upcoming exhibit at the University’s Gateway Science Museum, along with the Miocene whale and ichthyosaur fossils from Lake Shasta.

But people don’t have to wait until the exhibit’s September 1 opening to see them. Every Friday and Saturday, visitors can view the scientists and students as they work to reveal and preserve the fossils in the museum’s lab.

“The exhibit will take you through time and how California has changed in animals, climate, tectonics,” Greene said. “And it’s fun because we get to show off a little bit.”

The long process of creating a museum-quality reveal is a delicate dance between preservation and revelation. The mastodon skull was found upside down, its two tusks crossed over one another. Shapiro and his team slowly dug around it before draping it with burlap sacks and plaster. Then, they undercut it fully below, flipped it over, and repeated the process to protect its journey north to the lab at Chico State, scrawling “mastodon” on the casing’s side with a permanent marker.

“We call them Easter eggs,” Shapiro said, a reference to the oversized white orb’s visual similarity. The name held true weeks later, when in early April, they cut the cast open to reveal the treasure inside.

The tusks span almost six feet in length and are nearly intact. The ivory, striated with shades of grays, yellows, and tans, looks pearlescent.

As the mastodon tusks are uncovered, they are drizzled with a mix of acetone and liquid plastic to stabilize and preserve them from damage. They are estimated to be 8 million years old.

The tusks will remain partially encased in the dirt they were found in, which helps preserve them while giving context to the discovery itself. As the geologists scrape away the excess soil remnants, they drizzle the exposed bone with a mixture of acetone and liquid plastic, which helps stabilize and preserve it from damage.

Undergraduate students and instruction support technician Sean Nies, right, work to reveal and preserve the mastodon tusks and skull in the lab at Gateway Science Museum.

Junior Erica Thompson, a geology major, said one thing she's missed most during virtual learning due to the COVID-19 pandemic has been doing science firsthand. When Shapiro invited his students to take part in the fossil preservation, she leapt at the chance.

As she aspires toward a career in resource management and conservation, the chance to work on fossils from millennia ago has been nothing short of incredible, she said.

“It’s tedious, but it’s fun,” Thompson said, as she used a dental pick to nudge soil away from a horse rib bone recovered at the site. “We are unearthing something ancient and learning from it at the same time. It’s like hunting for treasure.”

Within hours of her first day in the lab, Thompson already felt she had a better grip on differentiating between bone and the surrounding matrix, as she let the texture, sound of the material, and a research textbook guide her movements. As she worked, she could not help but think about the various creatures comingling in real-life.

“It’s a nice way to let your imagination escape away from the realities of right now,” she said. “It’s like picking up a fantasy book and getting into a story someone has created. Even though you are not there, you are still connected to it.”

Instructional support technician Sean Nies (Geology, ’16) agrees. In addition to supervising the students, he helps lead the fossil preservation.

“This is what you think about when you were a kid,” he said. “It’s not often people get a call, ‘Do you want to go dig up a mastodon?’ I said, ‘Absolutely.’ And we stumbled upon this giant treasure trove.”

As a former art major, his success in a community college geology class led him to take invertebrate paleontology his first semester at Chico State. There, Nies blended his talents in drawing with an interest in science by penciling out prehistoric sketches, and he continues to find ways to combine those passions.

“I’m not making art, but there are a lot of techniques that are similar,” he said. “I’m not painting, but there is a certain level of art in prepping a fossil. It’s meditative. You kind of get lost in it.”

Armed with an array of paintbrushes of varying sizes and bristle stiffness, Nies gently sweeps away at the soil encasing the tusks, the gentle “whoosh whoosh” the only sound as he empties a small cavity. With a pick, he slowly reveals where the zygomatic arch would have been in the mastodon’s jaw, and a sinus cavity, uncovering a clam shell in the process.

“It’s kind of like the Jurassic Park stage. It’s very stereotypical removal techniques,” he said. “You want to preserve it in a way that’s visually appealing. Right now, it’s hard to tell what is bone and what is dirt.”

“I’m not making art, but there are a lot of techniques that are similar. I’m not painting, but there is a certain level of art in prepping a fossil. It’s meditative. You kind of get lost in it.” ‘— Instructional support technician Sean Nies (’16)

For Shapiro, this discipline is all about solving riddles—the more challenging, the better—and inspiring the next generation of scientists to continue the pursuit.

There are few colleges that offer these kinds of undergraduate research opportunities. He said he prioritizes including students on excavations because they demonstrate the practical use and career paths in ways students never otherwise would imagine.

Shapiro has been an incredible mentor, Nies said, especially with invitations to accompany him, whether at sites close to Chico State or a trip to France where the students were paid to examine the geochemistry of rocks.

“He’s given me a lot of opportunities and I tried to take every one,” Nies said.

That was Shapiro, decades ago. He wasn’t raised in a college-going family. But a fascination with topographic maps led him to a phonebook and a cold-call to an incredible mentor, who gave him research opportunities as a high school student that launched his future as a geology scholar.

“He once said to me, ‘The only thing you leave behind is your students,’” Shapiro said. “Now, I try to do as much mentoring as I can.”

He now dreams about teaching a class about the ancient life of California. Who knows, he said, maybe this new fossil collection could one day make that a reality, as he imagines painting tales for students of ichthyosaurus swimming around Redding and mastodons treading softly across the Sacramento Valley.

“It’s not just little kids who are into dinosaurs,” he said. “I think it would blow people’s minds, to say that you can find camels in Chico. And there’s a bit of pride in it too. If you love the area, think about what was here before.”

DATES TO REMEMBER

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

October 14, 2021 – **GSNH dinner meeting**, Virtual meeting via Zoom starting at 7 PM: please send Sharon Lewandowski an email to request a zoom invite: sharon.lewandowski@des.nh.gov. Karen Johannesson will give a presentation on Biogeochemistry of Arsenic in Groundwater Systems

October 15-17, 2021 – **Annual New England Intercollegiate Geological Conference (NEIGC)**, Grafton-Bethel region of northwestern Maine. See page 41. https://neigc.info/neigc-annual-conference/

October 18-21, 2021 – **37th Annual International Conference on Soils, Sediments, Water, and Energy**, virtual conference for 2021. https://www.aehsfoundation.org/East-Coast-Conference.aspx

December 16, 2021 – **GSNH Board of Directors Meeting**, location TBD.

January 13, 2021 – **GSNH Dinner Meeting**, location TBD.

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

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

- clu-in.org compiles webinars of interest to EPA and the environmental community here: https://clu-in.org/training/#upcoming
- The geoscience online learning initiative (GOLI) has several webinars and short courses that are free, but do include an administrative fee for continuing ed credits: https://www.americangeosciences.org/workforce/goli

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NEIGC Field Trip Announcement – October 15-17

Due to Covid-19, the 2021 NEIGC will be an informal, free weekend of fieldtrips in western Maine with a focus on recent mapping work. The traditional icebreaker and banquet gatherings will not be held, but catching up with friends and colleagues outside and socially-distanced is easy in Maine – choose your own spot or stop by Grafton Notch Campground. Trip leaders will contact participants via email before the conference with meeting locations, start times, and guide materials. Participants may reserve sites at Grafton Notch Campground (1472 Bear River Road; 207-824-2292) and there are also many hotel options in the Bethel area. We urge you to consider staying at Grafton Notch Campground so we can keep it open as a home base for the weekend. Deadline to sign up is October 8.
To sign up for trips, please visit: https://neigc-2021-maine.hub.arcgis.com/

We hope to see you in mid-October! Questions can be sent to Chris Koteas (gkoteas@norwich.edu) or Lindsay Spigel (lindsay.spigel@maine.gov).

GSNH Summer 2021 Geology Field Trip Report

By Lee Wilder

Some 15 GSNH members accompanied Dr. Nelson Eby, for a very informative trip on the Ossipee Mountain Ring Complex. His rock samples, hand-outs, and choice of trip stops, clearly explained the logic behind the current thinking on the origin of the Ossipees.

Near outcrops at the junction of NH 25 and 113 North, Whittier, NH. Photo by Muriel Robinette.

Outcrops at Cold Brook, South Tamworth, NH. Photo by Muriel Robinette.

Outcrops along Ossipee Park Road, Moultonborough, NH. Photo by Muriel Robinette

And as with any well-organized GSNH Geology Field Trip, there was good timing on the rain showers, which began as the trip ended right after this stop. The trip was appreciated by all!

More at: https://faculty.uml.edu/nelson_eby/Field%20Trip%20guides/Ossipee%20NEIGC.pdf

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Spirit Lake in the Shadow of Mount St. Helens

From Earth Science Picture of the Day, August 4, 2021.
Photographer: Robert Frost, Summary Authors: Robert Frost and Cadan Cummings:
https://epod.usra.edu/blog/2021/08/spirit-lake-in-the-shadow-of-mount-st-helens.html

Shown in the image above is Spirit Lake located at the base of Mount St. Helens in Washington. The photo was oriented looking north from directly above the volcanic crater with Mount Rainier visible in the distance. Following the eruption of Mount St. Helens in May 1980, approximately 15 billion cubic feet (430 million cubic meters) of material was deposited into Spirit Lake. This debris flow of melt water, vegetation, and volcanic ash- called a lahar- subsequently changed the natural flow of Spirit Lake by blocking its outlet to the North Fork Toutle River valley. Evidence of the debris is still present

today as thousands of felled trees from the volcanic eruption formed a log raft- the gray colored material in the image above- that covers about a quarter of the lake.

Following the eruption, Congress created the Mount St. Helens National Volcanic Monument in 1982 to allow scientific research to investigate how the surrounding landscape recovered naturally without the influences of logging or other industries. As a result, the logs in Spirit Lake and the surrounding area in the monument remains largely untouched for the past 40 years. While there has been a good regrowth of ground vegetation since the eruption, it will take a century or more for the rich forest to once again blanket the northern foothills of Mount St. Helens. Photo taken on May 29, 2021.

Spirit Lake, Washington Coordinates: 46.265940, -122.147142

Related Links:

- Looking Back at Mount St. Helens
- Monitoring Interactive Map
- Popular Science – Mount St. Helens

Student Links:

- Vegetation changes in blown-down and scorched forests 10–26 years after the eruption
- Mount St. Helens Webcam

Earth Observatory:

- Life Reclaims Mount St. Helens

GSNH Grants Available

By Lee Wilder

Attention NH Earth-Space Science Educators: Need classroom teaching materials? Want to attend a workshop or conference to enrich your subject content skills? The Geological Society of NH offers cash reimbursement for such purchases or expenses. No strings attached! See details at:

- http://www.gsnh.org/classroom-grant.html
- http://www.gsnh.org/lincoln-r-page-fund.html

New Hampshire Geological Survey Update

From Rebecca LeCain

See next page for photographs taken during New Hampshire Geological Survey (NHGS)'s visit to the Suncook River avulsion.

Suncook River old channel. Photo from R. LeCain.

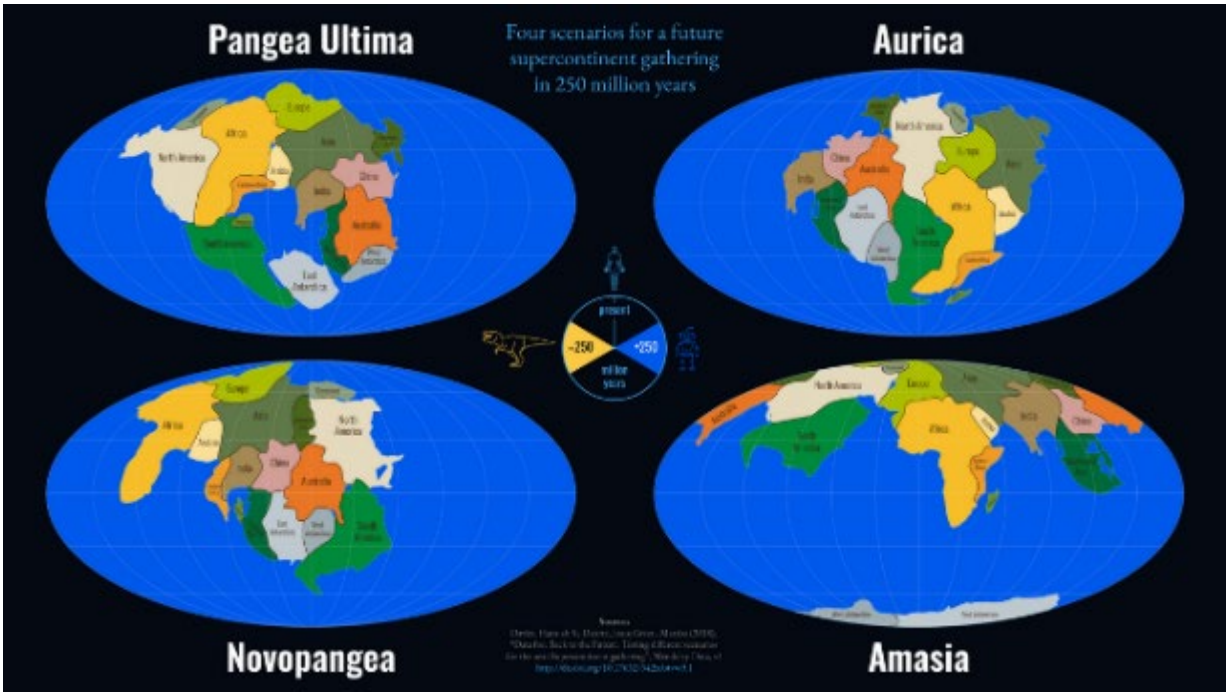
Post-avulsion work to shore up the Suncook River. Photo from R. LeCain.

NHGS interns at the Suncook River. Photo from R. LeCain.

Four scenarios for the next supercontinent

By Frank Jacobs. The Big Think, January 4, 2021.
https://bigthink.com/hard-science/next-supercontinent/

The arc of geological history is long, but it bends towards supercontinents – so, what will the next one look like?



Four plausible scenarios for the supercontinent of the future. Credit: Pilgrim-Ivanhoe.

Accelerate the film of Earth's geology, and you see the landmasses dance across the globe like islands of foam on a running bath. One peculiarity of our drifting continents is that they tend to combine, over massive amounts of time, into one single supercontinent. It helps that the Earth is round, unlike your bath.

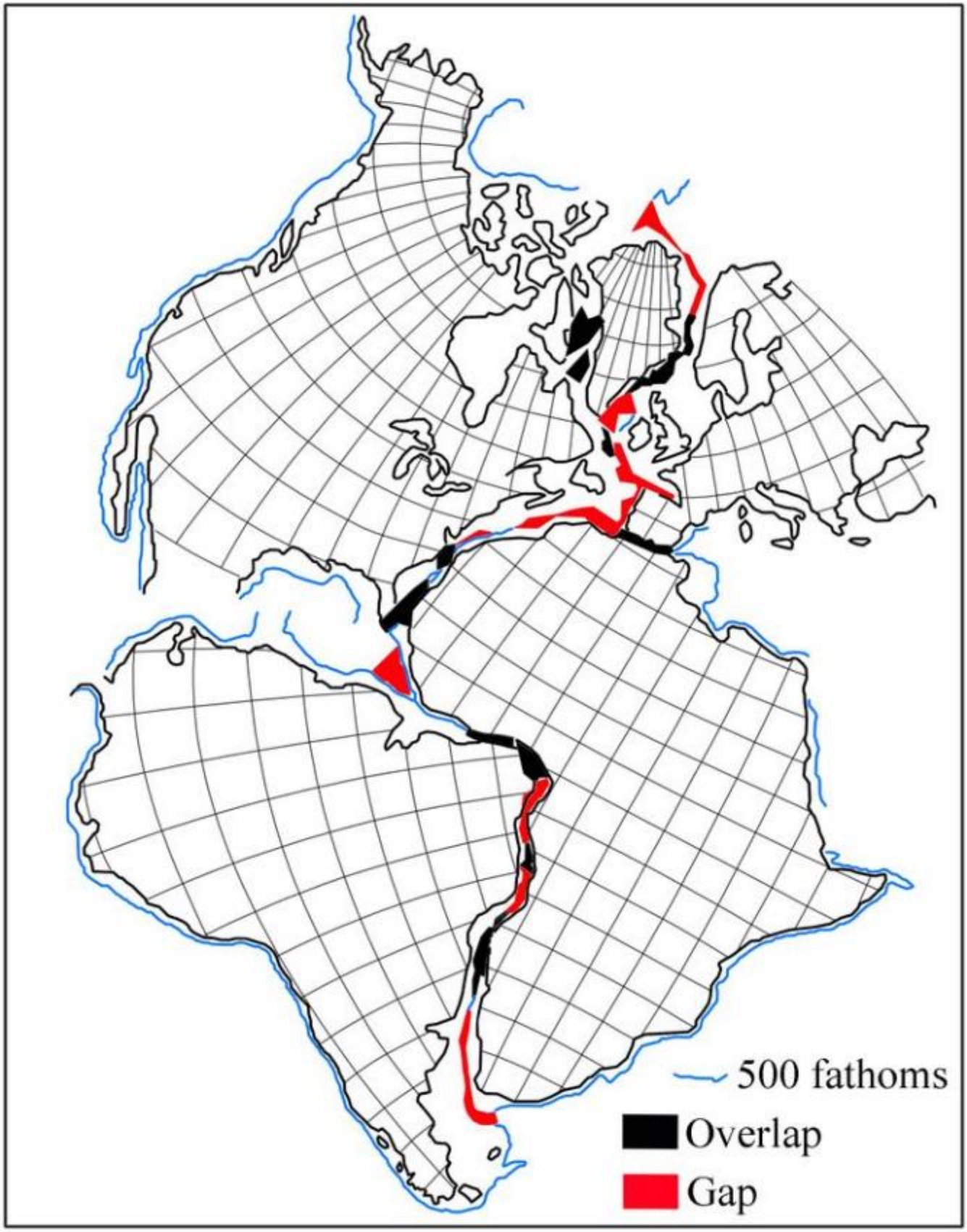
Then, millions of years later, tectonic forces cause the supercontinent to break up again – only for the individual continents to recombine much, much later. All at fingernail speed.

The usual suspects

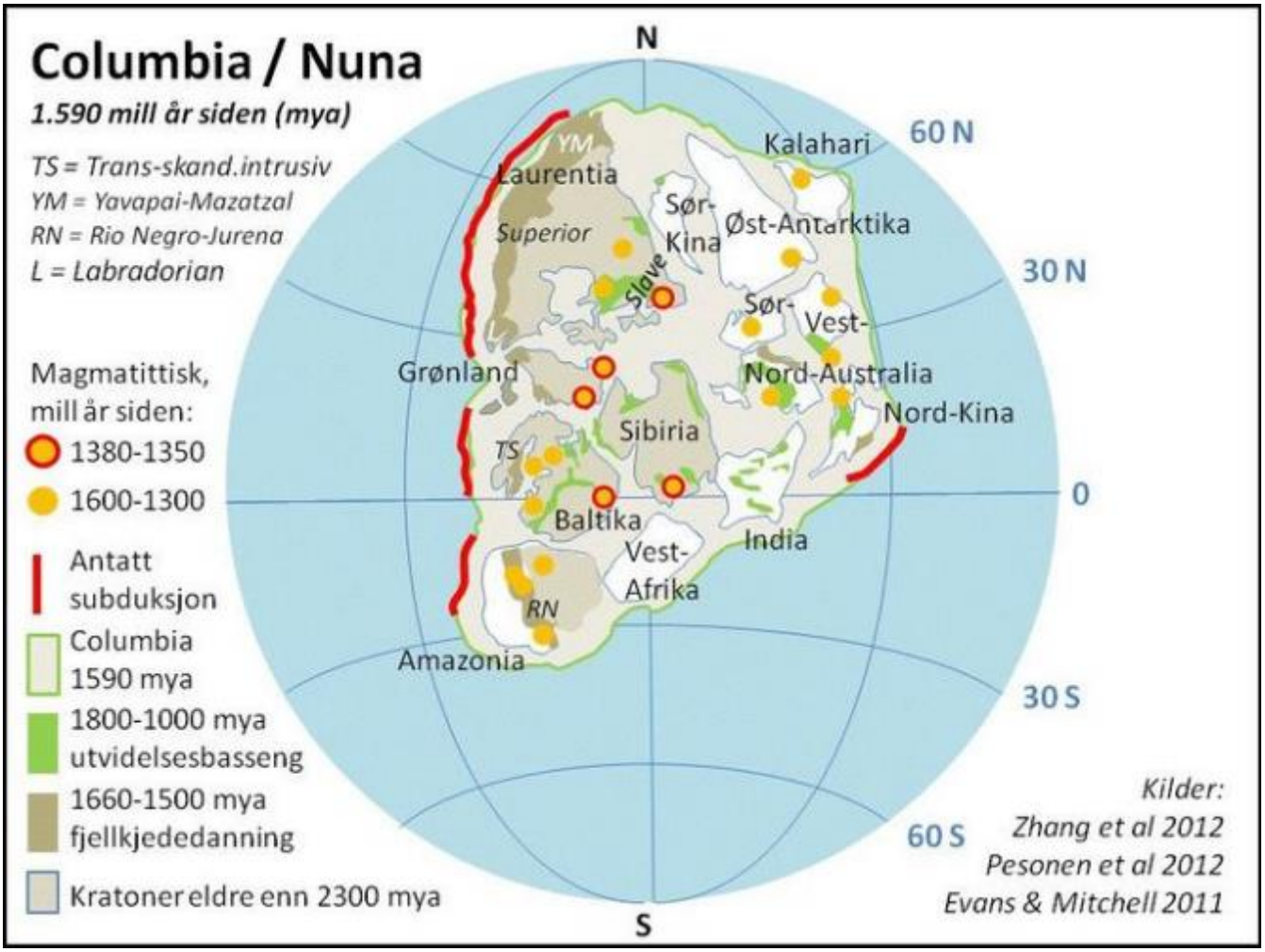
Here's one question with an un-pin-downable answer: How many supercontinents have there been in Earth's deep past? At least three or at least seven; as many as 11 or perhaps even a few more. Like the continents themselves, scientific theories diverge. Here are some of the usual suspects (most recent first, ages are approximate):

- Pangea (300-180 million years ago)
- Gondwana (600-180 mya)
- Pannotia (630-540 mya)
- Rodinia (1.1 bya-750 mya)
- Columbia, a.k.a. Nuna (1.8-1.5 billion years ago)
- Kenorland (2.7-2.1 bya)
- Ur (2.8-2.4 mya)
- Vaalbara (3.6-2.8 bya)

That's if we spool back the tape. What happens if we fast-forward? Even though Pangea, the last supercontinent, broke up almost 200 million years ago, geologists are pretty sure there will be another one, but not for some time to come. Right now, we're about halfway through a 'supercontinent cycle'. The next one will be around between 200 and 300 million years from now.



How the American, African and European continents once fit together before the Atlantic – and may one day again, if and when the local 'Wilson cycle' reverses. Credit: Jacques Kornprobst, after E. Bullard et al. (1965), CC BY-SA 4.0



Norwegian map of what the supercontinent of Columbia/Nuna may well have looked like, 1,590 million years ago. Credit: Bjoertvedt, CC BY-SA 3.0

Wilson Cycles

That brings us to the next question with an answer that's hard to pin down: What will that next supercontinent look like? That is, of course, unknowable, as no one alive today will be around to check. But one can speculate. Using what we know about the tectonic forces that power the movements of continental plates, three scientists line up four plausible scenarios for the formation of the next supercontinent.

In "Back to the future: Testing different scenarios for the next supercontinent gathering," Hannah S. Davies, J.A. Mattias Green, and João C. Duarte present four supercontinents, each the outcome of a different tectonic what-if.

Each scenario is a different combination of two basic drivers of continental conglomeration (and fragmentation): the supercontinent cycle itself, and the so-called Wilson cycle.

John Tuzo Wilson (1908-93) refined and championed the theory of plate tectonics in the 1960s, when it was still controversial. He was the first non-U.S. citizen to become president of the American Geophysical Union. Credit: UC Davis

In 1966, Canadian geologist John Tuzo Wilson proposed that the Atlantic had opened up along a zone where another ocean had previously existed. A 'Wilson cycle' therefore describes the cyclical opening and closing of ocean basins. Since those aren't necessarily in sync with supercontinent cycles, they can lead to various outcomes – supercontinents of different shapes and at different types.

The next supercontinent will take shape when at least one ocean closes. That can happen in one of two ways:

- Introversion: the 'internal', expanding ocean starts to contract and closes up again; or
- Extroversion: the 'exterior' ocean keeps expanding, closing an 'internal' ocean elsewhere.

In the first option, the Wilson cycle and the supercontinent cycle coincide, creating the possibility that the new supercontinent will have more or less the same dimensions as the old one. In the second option, the Wilson and supercontinent cycles do not coincide.

In their paper, the researchers line up and standardise the evidence for four well-known scenarios on future supercontinent formation:

- The closure of the Atlantic Ocean, leading to Pangea Ultima;
- The closure of the Pacific Ocean, giving rise to Novopangea;
- The closure of both the Atlantic and Pacific Oceans, creating Aurica; and
- The closure of the Arctic Ocean, forming Amasia.

Pangea Ultima: keystone Africa

'Ultimate Pangea' will come about via an introversion scenario, with the closing of the Atlantic and the re-formation of the 'old' Pangea – sort of. Introversion is the 'classic' scenario for supercontinent formation; in fact, Pangea itself was likely formed by introversion, with the closing of the Rheic and Iapetus Oceans.

'Ultimate' Pangea would be a remake of the 'old' Pangea, more or less. Credit: Pilgrim-Ivanhoe

Africa is the key continent here; first by colliding with Europe to form the new continent of Eurafrica, and ultimately as the keystone tying South and North America, Europe and Asia together. Remnants of the Atlantic and Indian oceans reincarnate as the 'ultimate' Mediterranean, closed off from the world ocean by East Antarctica.

Novopangea: Rift becomes Ocean

A 'classic' extroversion scenario leads to the closure of the Pacific Ocean, and to a 'new' Pangea – not just a re-forming of the old one. The East African Rift keeps growing, developing into a new ocean, replacing the Indian one. East Africa gets stuck against India's west coast.

How Novopangea might come to be: the Pacific closes and a new ocean forms along the East African Rift. Credit: Pilgrim-Ivanhoe

Aurica: America in the middle

The Aurica scenario presupposes two Wilson cycles in sync with the supercontinent cycle. Both the Atlantic and Pacific Oceans close, helping to form the supercontinent of Aurica, with the Americas in the middle.

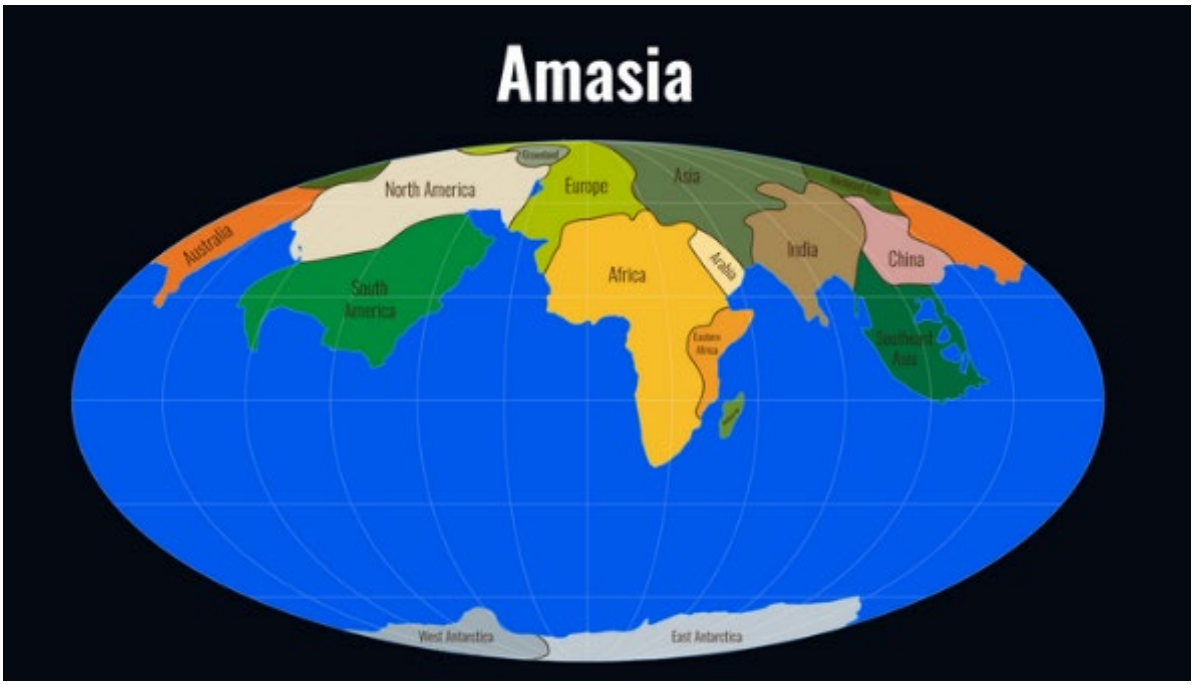
This requires the opening-up of at least one new ocean – for example, at a large rift along the present-day border between India and Pakistan. This new Pan-Asian Ocean, merged with the Indian Ocean, pushes these areas apart, turning them from next-door neighbors into lands on either side of Aurica.

Australia is now entirely landlocked, between Antarctica, East Asia, and North America. Europe and Africa have collided with the Americas from the other side. To the south, Madagascar stubbornly continues its separate course.

Two Wilson cycles in sync with a supercontinent cycle, and hey presto: Aurica. Credit: Pilgrim-Ivanhoe

Amasia, the Arctic supercontinent

The Arctic Ocean closes. Almost all continents are joined at the 'top of the world', with the exception of Antarctica, the only one not drifting northward. It'll be a short hop from North America to North Africa, with Southern Europe acting as a land bridge in between. South America has repositioned itself, with its western edge against the eastern flank of North America.

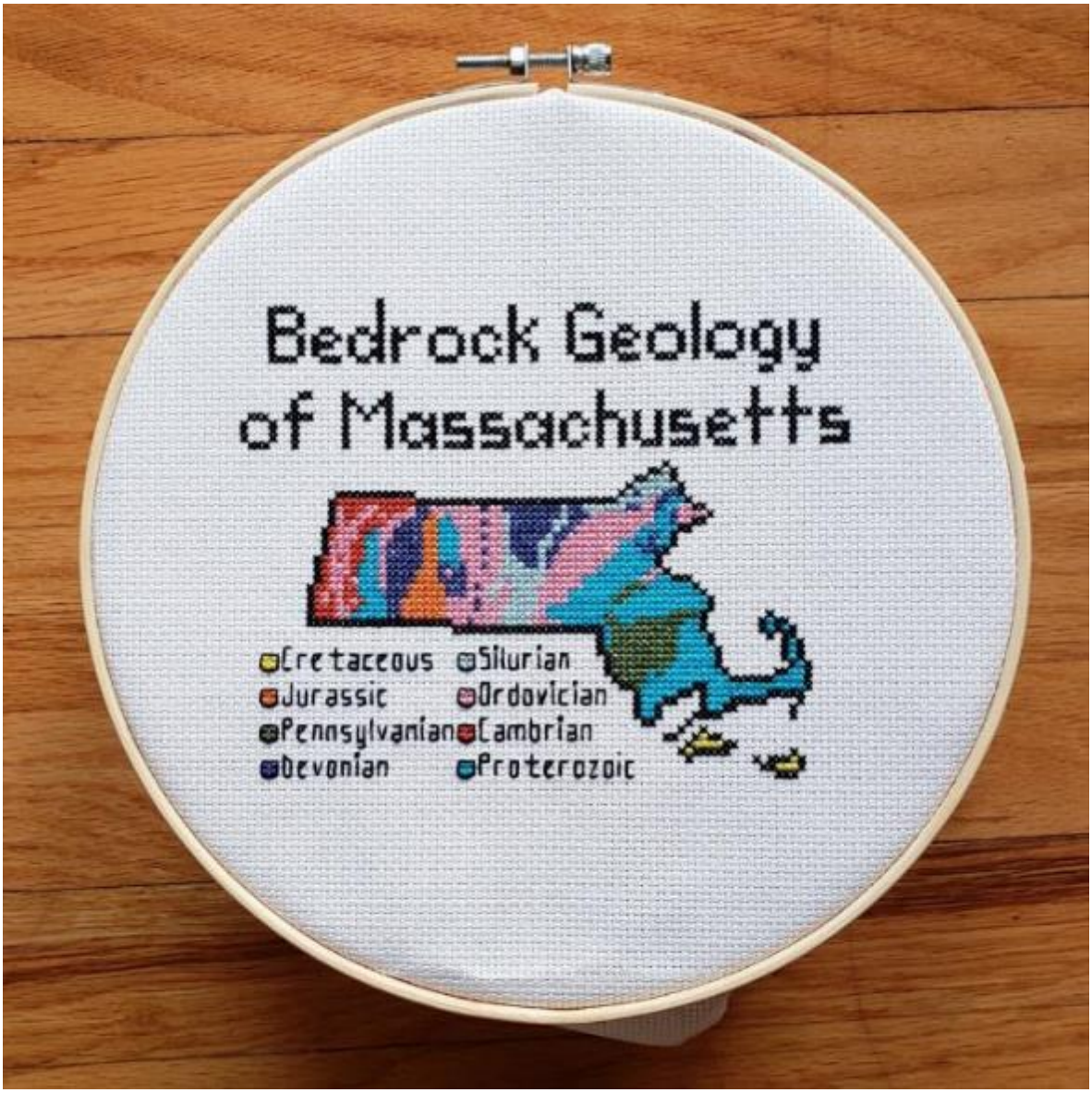


In the Amasian scenario, almost all continents would be joined 'at the top'. Credit: Pilgrim-Ivanhoe

These images produced by Pilgrim-Ivanhoe. Images based on the aforementioned article: Back to the future: Testing different scenarios for the next supercontinent gathering, by Hannah S. Davies, J.A. Mattias Green and João C. Duarte, published in Global and Planetary Change (Vol. 169, October 2018).

Geology Cross-Stitch

Kara Prior produces original cross-stitch patterns (and completed framed cross-stitch pieces, if you are don't sew) for a number of geological topics, including geologic maps for all 50 states, bathymetry, watersheds (including New Hampshire, Maine, and Vermont), and other geologic images such as a soil texture pyramid: https://www.etsy.com/shop/BlondeBoxshell?



Rock Run Conglomerate

From Earth Science Picture of the Day, July 8, 2021.
Photographer: Joshua Milden, Summary Authors: Joshua Milden and Cadan Cummings:
https://epod.usra.edu/blog/2021/07/rock-run-conglomerate.html

Found on the stream bed of Rock Run near Ralston, PA, this sample of conglomerate consists of well-rounded quartz and plagioclase feldspar clasts. Conglomerate is a sedimentary rock composed of small rock granules (~ 0.08 in or 2 mm) cemented together by a blend of calcium carbonate, iron oxide, and silica. Typically, a mixture of sand, silt, and clay fills the airspace between the rounded rocks. If the rock sample consists of angular, broken granules fragments it is instead called a breccia. The pictured conglomerate sample measures about 2 in (5 cm) thick and 5 in (13 cm) long.

Rock Run is in the McIntyre Wild Area and features many beautiful natural streams and waterfalls. The stream is a tributary to Lycoming Creek and is fed by Baumunk Lake.

Photo data:

LG Stylo 5 rear camera. ISO 50, automatic WB, focal length 3.159 mm, exposure time 1/40 sec

Ralson, PA Coordinates: 41.507028, -76.953806

Related Links:

- Conglomerate Outcrop in Stream
- Conglomerate Information

Student Links:

- Video – May the Quartz Be With You

Have you Renewed Your Membership?

If you have already renewed your GSNH membership this year, thank you! If now, please consider renewing.

With membership, you get a discount on dinner meetings and field trips (which will happen at some point!), information on upcoming events of interest, voting privileges at Society business meetings, and automatic subscription to this newsletter. Membership dues also help to support important geological outreach for the greater community.

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

GSNH T-Shirt Order Form

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

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

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

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Concord, NH 03302

MEMBERSHIP & RENEWAL APPLICATION

Geological Society of New Hampshire

PO Box 401, Concord, NH 03302

Name: _____ *(Please print clearly)*

E-mail: _____

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

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

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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: _____