Granite State Geologist

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Newsletter Editor: jlambert@nobis-group.com **Website:** http://www.gsnh.org/

In this issue:

MESSAGE FROM THE PRESIDENT

Who would have guessed it? In our Board meeting in March we knew this COVID thing wasn't good. In the March newsletter I questioned our future as we faced a spate of cancellations. No dinner meeting. No summer field trip. No conferences or workshops.

But what do geologists and Army Rangers do in the face of adversity? Improvise. Adapt. Overcome. Here we are three months later and the Board held its first virtual Board meeting. That which seemed daunting when we first discussed it, is now commonplace. It was quite successful even though at the beginning, we thought the platform would require our meeting be very short. But we were prepared to address only critical near-term topics. The GSNH Board is working around the limitations of quarantining and now have plans for holding our Annual Fall Meeting and Elections as scheduled – just not as we've ever held them before.

The Election will happen on time and by electronic ballot. Dues-paying members will get ballots by email. [A none too subtle reminder for any who have forgotten in the coronavirus commotion.] The election results will be announced at the 'meeting.' We have a full slate, but don't let that hold you back if you are interested in being a Board member - we welcome your candidacy. Contact a friendly Board member and throw your virtual hat in the virtual ring. Candidate snapshots will be in the September newsletter.

So what about the October 15 Annual Dinner Meeting??? Well, dinner is at your house! Nothing we can do about virtual dinners, but we are setting up a live, virtual presentation (Yes, with CEHs!) for the meeting. More info will be sent to you and in the September newsletter.

We are looking forward optimistically to getting back together in one physical space as soon as ever we may. So we have reserved restaurant spaces for the January and April meetings. If it makes sense to meet in person, we will be there and hope you will be, too. The plan for the April presentation is to lay down the detailed geology for the 2021 summer field trip. Cross your fingers. Take care and see you soon!

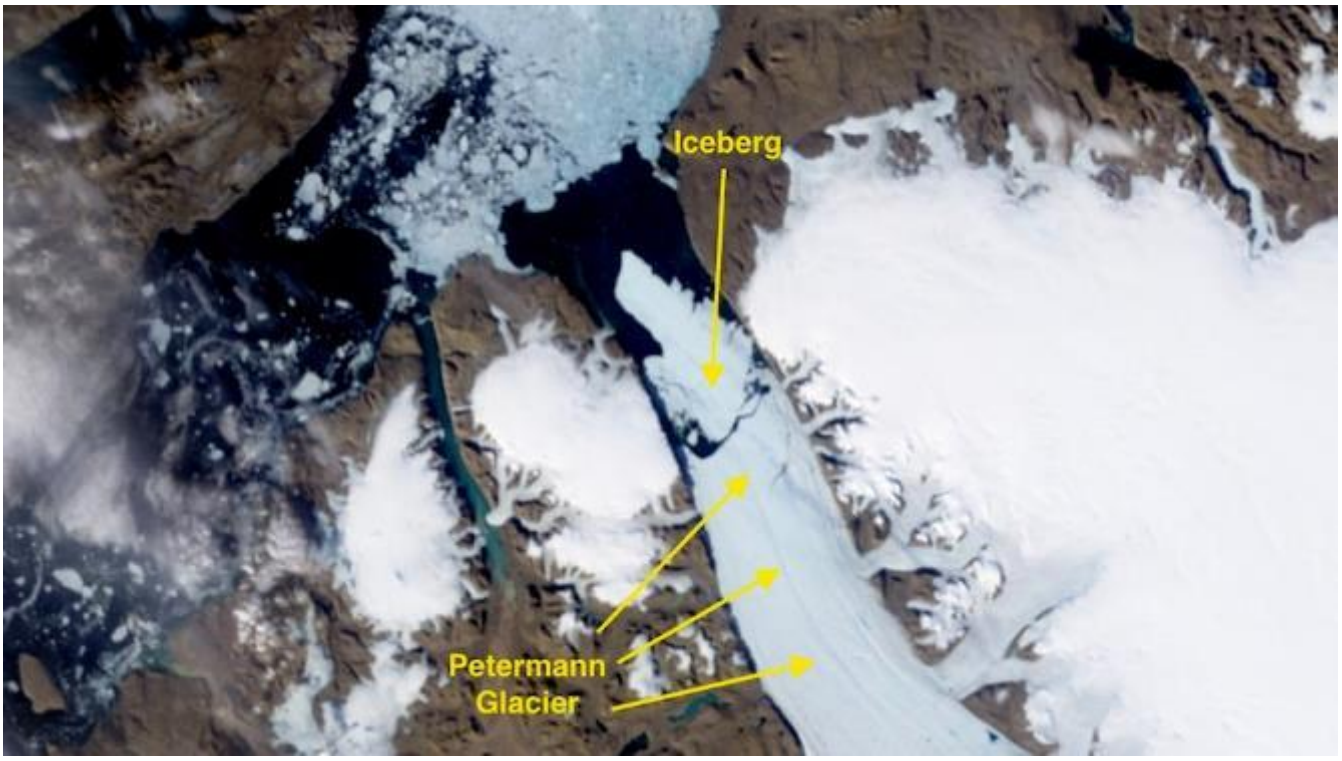
Growlers, Bergy Bits, and Behemoths: The Many Types of Icebergs and How They Are Predicted

From Tom Niziol, Weather Underground, April 14, 2020.
https://www.wunderground.com/cat6/growlers-bergy-bits-and-behemoths-the-many-types-of-icebergs-and-how-they-are-predicted

Above: Icebergs and ice float in the Ilulissat Icefjord on August 04, 2019, near Ilulissat, Greenland. (Sean Gallup/Getty Images)

Icebergs – the huge chunks of ice that peek above the surface of the ocean water—are the stuff of legend. One of the greatest nautical disasters, the sinking of the HMS Titanic back on April 14-15, 1912, was a result of a collision with an iceberg. But did you know there is an iceberg season, and there are “iceberg alleys”?

There are favored locations at high latitudes in both the Northern and Southern Hemisphere where icebergs are “born” and begin their journey in the world’s oceans. For the region along the east coast of North America from Greenland to Newfoundland, the ice season runs from about February 1 through July 3. That region, including the west coast of Greenland, is the birthplace of most of the icebergs that find their way to the main transatlantic shipping lanes between North America and Europe.



On August 5, 2010, an iceberg broke off the edge of the Petermann Glacier on the northwest coast of Greenland. The Petermann "ice island" was one of the largest icebergs on record in the Northern Hemisphere.

Before I delve further into all of that. however, let's review what an iceberg is. According to the U.S. Coast Guard, "an iceberg is a floating mass of fresh water ice extending more than 5 m [16.4 feet] above the sea surface. It may originate from a glacier flowing directly to the sea, such as the tidewater glaciers of Greenland, or from an ice shelf, such as those found in Antarctica." Icebergs are different from sea ice. The most basic difference is that sea ice forms from salty ocean water, whereas icebergs and their parent glaciers form from fresh water or snow.

The life cycle of an iceberg is fascinating. It begins with snowfall that builds up on an ice cap like the one over Greenland. Over several decades the snow gets compressed by layer upon layer that accumulate to form very dense ice. As a result of all of that weight, the ice begins to move under the forces of gravity, from the high plateau toward the sea through the various mountains passes. That slow flow of ice toward the sea is what we know as a glacier. At the edge of the glacier is where the birthing process or calving of the iceberg occurs, as it breaks off the edge and drops into the sea. This entire process may take as much as 3000 years.

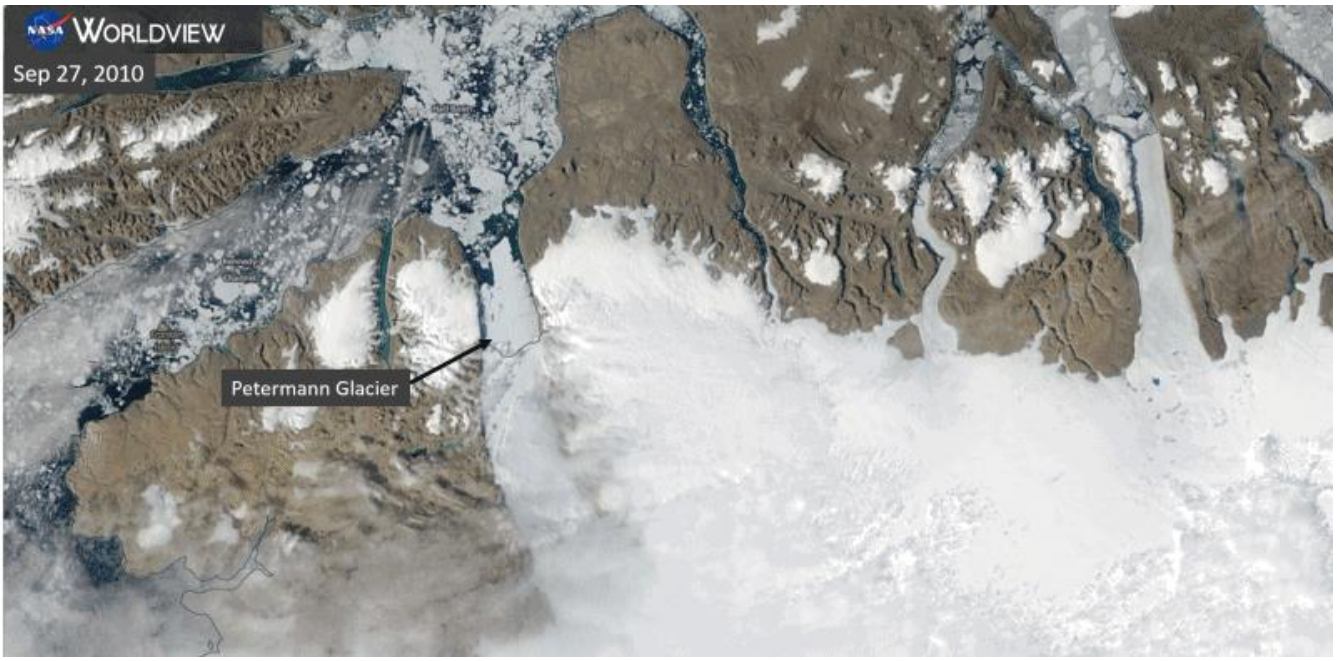
Icebergs are part of the big picture of ice balance for the Greenland Ice Sheet. Huge amounts of ice are lost from Greenland by calving as well as melting, and huge amounts are added by snowfall. It's

the balance between these that determines how much ice is gained or lost in a given year. A project led by NASA and the European Space Agency called IMBIE (Ice Sheet Mass Balance Inter-comparison Exercise) used data from 13 NASA and ESA satellite missions from 1992 to 2018 to create the most accurate measurements of ice loss to date. NASA reported in December that "half of the loss is tied to surface ice melting in warmer air. The rest of the loss is the result of factors such as warmer ocean temperatures, iceberg calving, and the ice sheet shedding ice into the ocean more quickly."

The range of iceberg size

Icebergs cover a huge spectrum of sizes, from the tiny “growlers” (less than 3 ft tall and 15 ft across) and “bergy bits” (up to the size of a small cottage) to very large icebergs that can be as bigger than a Caribbean island. Back in August 2010, a huge piece of the Greenland's Petermann Glacier broke off. This iceberg, or ice island as it was called, was over 4 times the size of Manhattan Island, with an area of about 95 sq mi. It gradually moved and eventually broke into several pieces over the course of the next six weeks.

Below I have an animation of MODIS polar orbiter satellite Arctic Mosaic images on days when it was clear enough to see the huge iceberg. The August 2010 Petermann Glacier calving event created the largest iceberg observed in the Arctic since 1962, when the Ward Hunt Ice Shelf on the north coast of Canada's Ellesmere Island calved off a massive 230-sq-mi chunk.



[still from] Animation of the breakoff of a huge iceberg from Petermann Glacier in August 2010. (NASA)

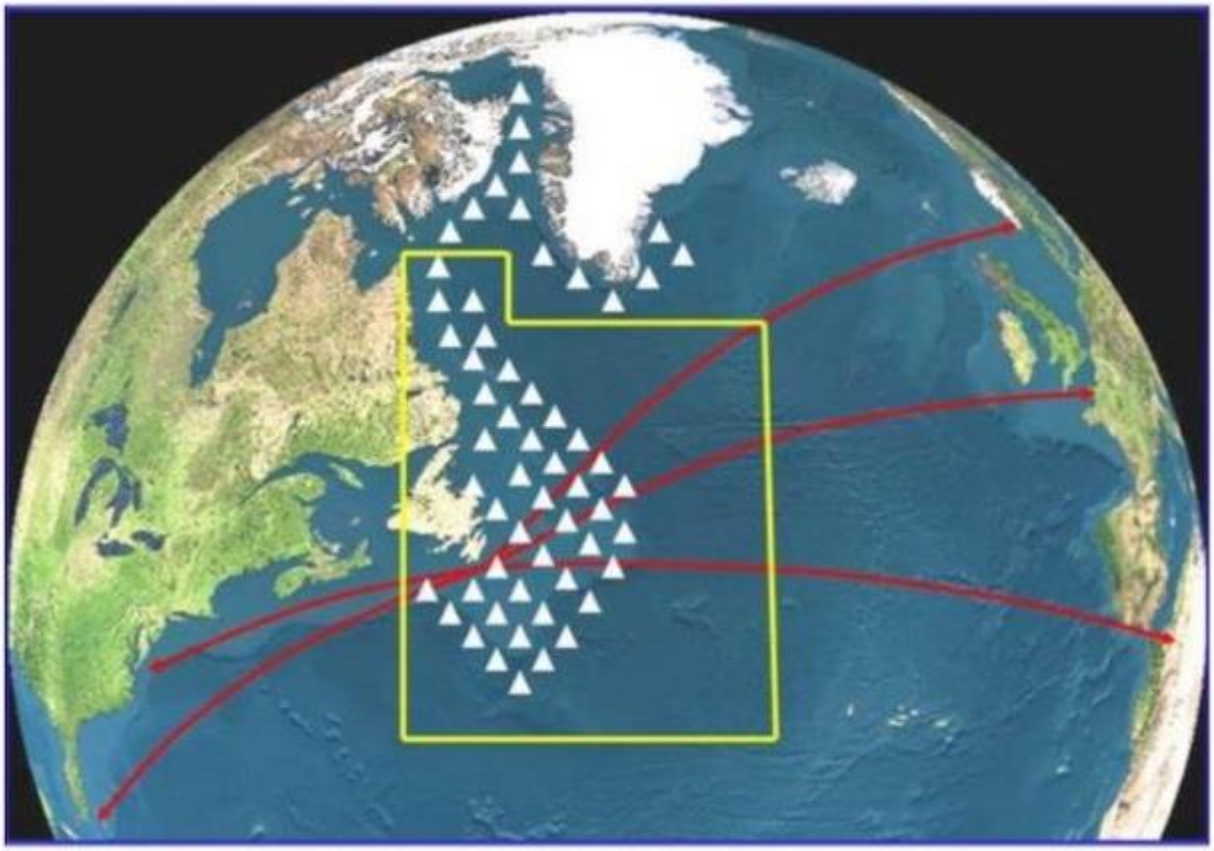
Antarctic icebergs are often much bigger than those in the Arctic. The iceberg referred to as B15 calved from the Ross Ice Shelf in 2000 and was estimated to have an area of roughly 4000 sq. mi. (about twice the size of Delaware). The largest iceberg on record, however, was an Antarctic iceberg in November 1956 that encompassed an area of roughly 12,000 sq mi—larger than Belgium. This iceberg was sighted in the South Pacific Ocean in November 1956 by the aptly named USS Glacier!

Left: Satellite image of the world's largest recorded iceberg, B15, as it broke away from the Antarctic Ice Shelf in May 2000. Right: Photograph of B15, which covered an area over 4000 square miles. (Josh Landis, NSF, US Antarctic Program)

Once an iceberg enters the ocean, its journey is driven primarily by ocean currents. This occurs because roughly 7/8 of a typical iceberg's mass is below the waterline. The other 1/8 of the iceberg sits above the surface, and therefore winds have much less effect on its movement compared to the ocean currents.

When you observe an iceberg, it typically looks white in color. It takes on that color because sunlight is scattered by the millions of air bubbles frozen into the ice itself. Sunlight can't penetrate very far into the iceberg before all of those bubbles scatter the light through all of its visible wavelengths, resulting in the white appearance to the human eye. However, icebergs can appear in shades of blue or even green, especially older icebergs, often composed of ice that has been under pressure for some time. The pressure removes any air bubbles in the ice that could reflect sunlight. As a result, the solid ice absorbs the red color of the visible light spectrum and greens and blues are reflected back to the human eye.

There are favored paths that icebergs traverse as they calve from glaciers on both the Northern and Southern Hemisphere and head to warmer ocean waters where they eventually melt. Scientists refer to these areas as "iceberg alleys." In the Northern Hemisphere, Iceberg Alley refers to the region of the Atlantic that runs from the coastal waters off Labrador south through Newfoundland and further south into the region known as the Grand Banks, which coincidentally runs right through the major transatlantic shipping lanes from North America to Europe.



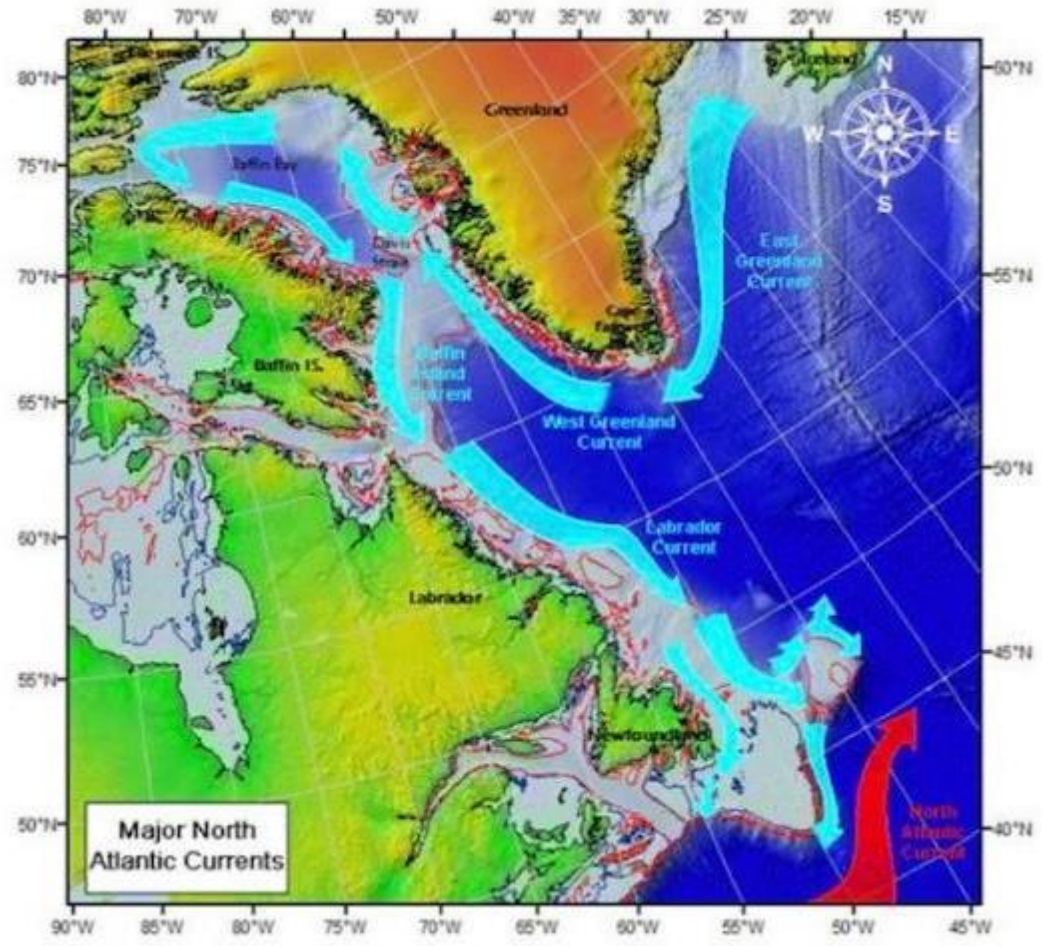
Common iceberg locations (white triangles) overlaid onto the major transatlantic shipping lines (red line). (US Coast Guard International Ice Patrol)

Many of the icebergs that calve off the Greenland glaciers take a very interesting, and often long-lived, journey before they end up off Canada's Newfoundland Coast and into the major transatlantic shipping lanes. Off the west coast of Greenland they are first steered northward by the West Greenland Current. Then they reverse course through the Davis Strait toward Baffin Island, as shown below, and continue south along the east coast of Labrador, steered by the aptly named Labrador Current toward Newfoundland and those major transatlantic shipping lanes.

The overall trip from Greenland down to the shipping lanes can take up to three years to complete. It's an arduous journey as well. Many icebergs break up in churning sea long before they make it to the shipping lanes, grinding against sea ice and shorelines and melting at an accelerating pace as they get farther south. According to the U.S. Coast Guard Navigation Center (NAVCEN), "It has been estimated that of the 15,000 to 30,000 icebergs produced annually by the glaciers of Greenland, only one percent (150 to 300) ever make it to the North Atlantic shipping lanes."

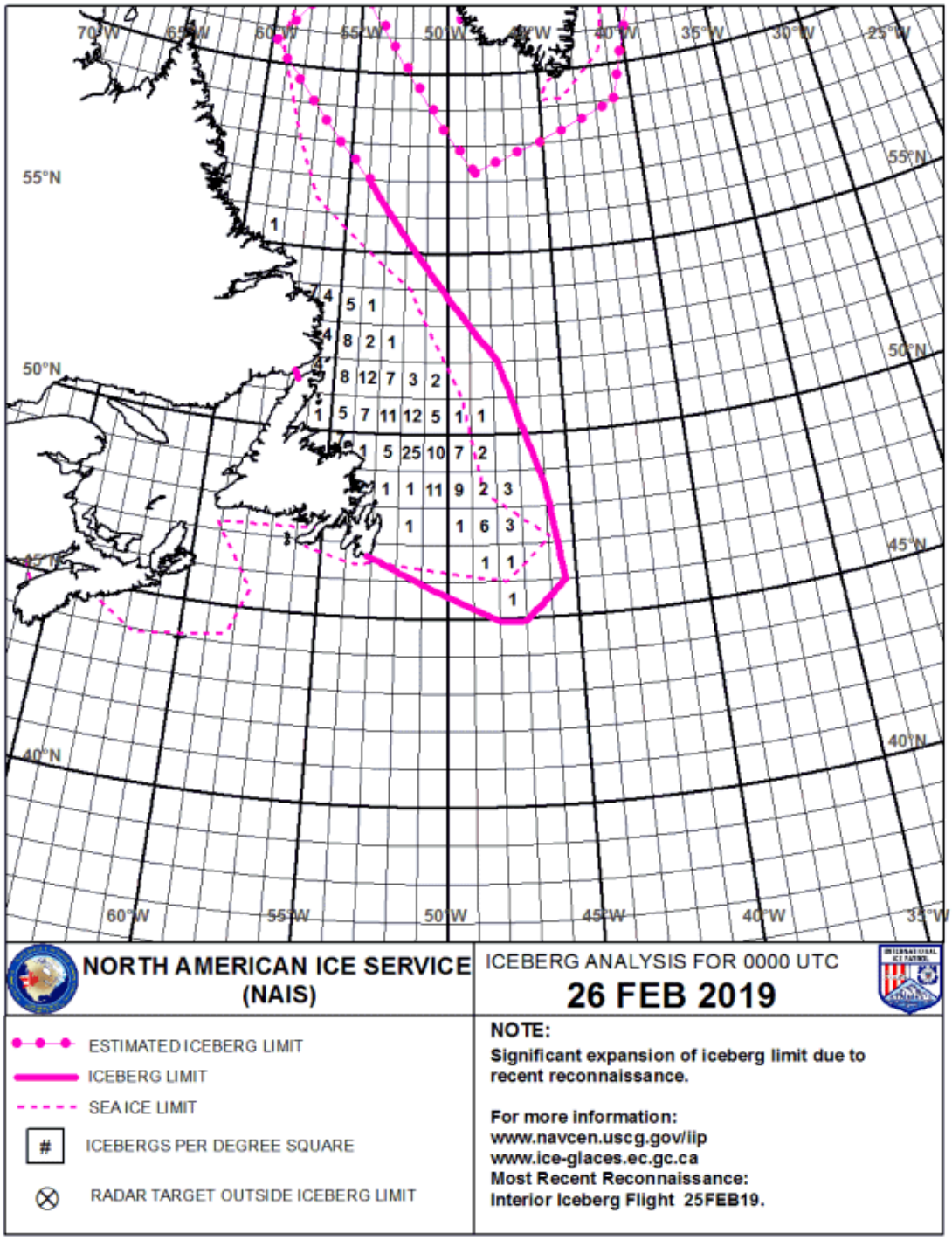
As noted above, those glaciers in the Northern Hemisphere's Iceberg Alley that move from Greenland past Newfoundland and to the transatlantic shipping lanes follow an "ice season". The Newfoundland ice season runs from February 1 through July 31. During this time the U.S. Coast Guard International

Ice Patrol monitors the area of the Grand Banks of Newfoundland for icebergs. The story of the beginnings of the International Ice Patrol goes back to that cold, moonless night of April 14–15, 1912, when the Titanic sailed into the path of an iceberg about 400 miles south of Newfoundland. Soon after the Titanic sank, the International Ice Patrol (IIP) was established to track icebergs and warn ships, and that patrol continues today.



Schematic showing the major ocean currents on the North Atlantic responsible for the long path icebergs take when they calve off the northwest coast of Greenland. (US Coast Guard International Ice Patrol)

The IIP uses a combination of observations from satellites and Coast Guard aircraft to monitor the movement of icebergs. The North American Ice Service (NAIS)—a partnership comprised of the IIP, the Canadian Ice Service, and the U.S. National Ice Center—provides safety information on iceberg and sea ice conditions in the North Atlantic Ocean. This includes a chart of the daily NAIS Iceberg Limit as well as a text Iceberg Bulletin and a graphic Iceberg Chart to advise mariners of the estimated iceberg extent within the region.

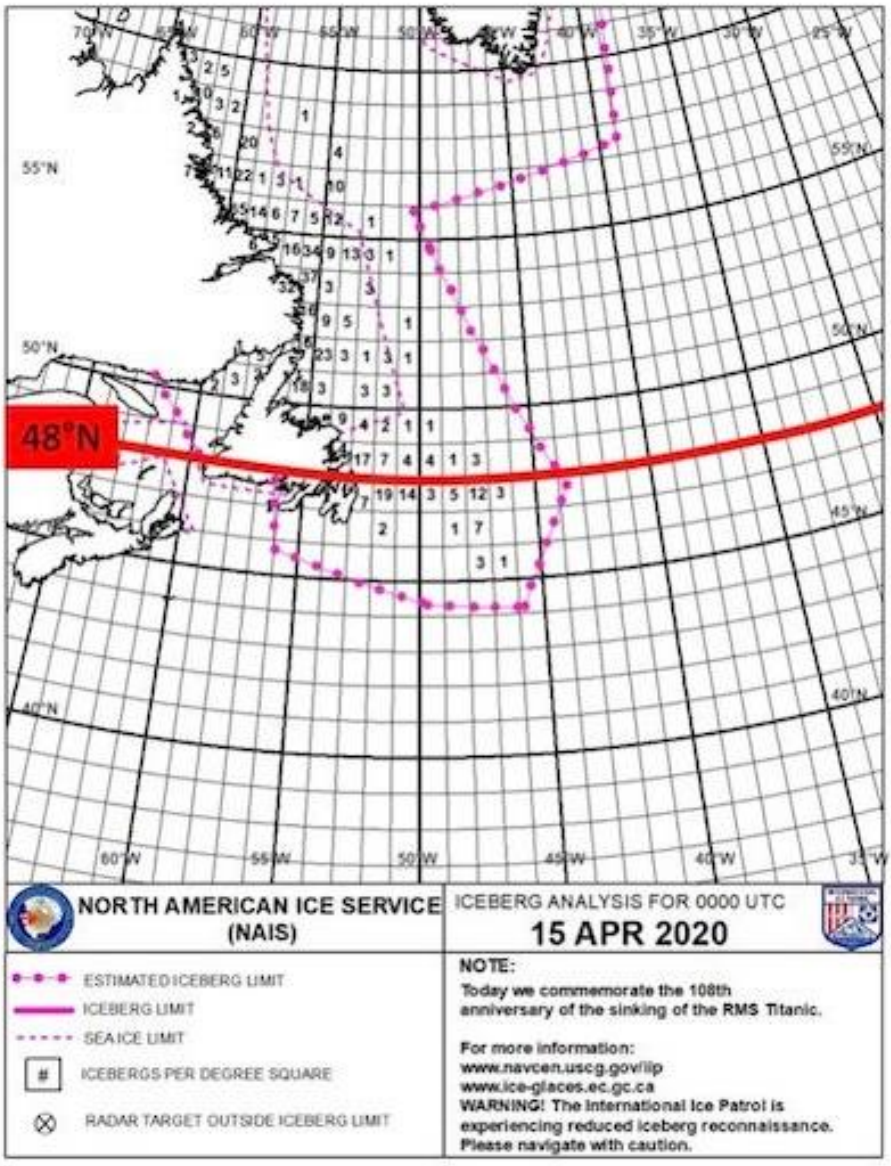


Animation of NIAC iceberg analyses for 2019. (NAIC)

On the charts [above], numbers within each grid sector inside the Iceberg Limit show the relative density of icebergs along with a host of other information. You can find these charts at the NAVCEN website. The animation below, showing the ice charts during the 2019 season on a weekly basis from February through June, shows the evolution of the iceberg migration and subsequent drop-off as the season moves into summer.

Forecasting icebergs

The number of icebergs that make it south across the Grand Banks and into the transatlantic shipping lanes varies significantly from one year to the next. In fact, in some years virtually no icebergs will cross 48°N, which is a rough demarcation for the shipping lanes, yet in others over 1000 icebergs cross that latitude. In fact, in 2014 the Coast Guard estimated that over 1,500 icebergs made it into the shipping lanes. It is imperative, therefore, to strive to develop method to predict these seasonal hazards.



NAIS Iceberg Analysis for April 15, 2020, showing the southern extent of the iceberg field, stretching south of the 48N latitude. (NAIS)

The year-to-year variations in iceberg migration rely on several parameters. These include the rate of calving of icebergs from Greenland's ice sheet, as well as ocean currents, prevailing winds, and air and sea temperatures.

Researchers have shown that calving rates from Greenland are directly related to the number of icebergs that drift south of 48°N, as one might expect, but there are many other important factors as well. If those icebergs get chewed up by the rocky shorelines of Labrador, or move too slowly, or if the water is too warm to keep them from melting, then they may not complete the journey south to the shipping lanes.

An aerial photo taken on August 15, 2019, shows icebergs as they float along the eastern cost of Greenland near Qulusuk. (Jonathan Nackstrand/AFP via Getty Images)

With 7/8 of a typical iceberg below the surface of the ocean, the strength of the Greenland, Baffin, and eventually the Labrador Currents steers them and determines how quickly they reach the shipping lanes.

On a lesser but still important scale, the prevailing wind direction plays a similar role, also steering the icebergs. Strong northwest to west (offshore) winds such as those during the winters of 2013–14 and 2014–15 resulted in significant cooling across much of the area icebergs traversed on their way south. The anomalously strong offshore flow was associated with a particular phase of the North Atlantic Oscillation (NAO). The NAO quantifies a pattern that can produce significant impacts to winter weather in Eastern North America and the adjacent ocean.

The NAO fluctuates between negative and positive phases. In the negative phase, persistent onshore (easterly) winds and warmer maritime air often occur during the winter along the coast of Labrador.

This results in less buildup of sea ice, which in turn exposes icebergs to wave-induced deterioration, and the onshore wind moves them toward the shallower waters near the coast, where they can run aground or become trapped in bays. In contrast, positive NAO phase is often accompanied by strong, persistent northwest winds along the Labrador coast during the winter. The cold offshore flow builds up more sea ice, protecting icebergs during the journey south toward the shipping lanes, and that journey is also aided by the long-shore wind.

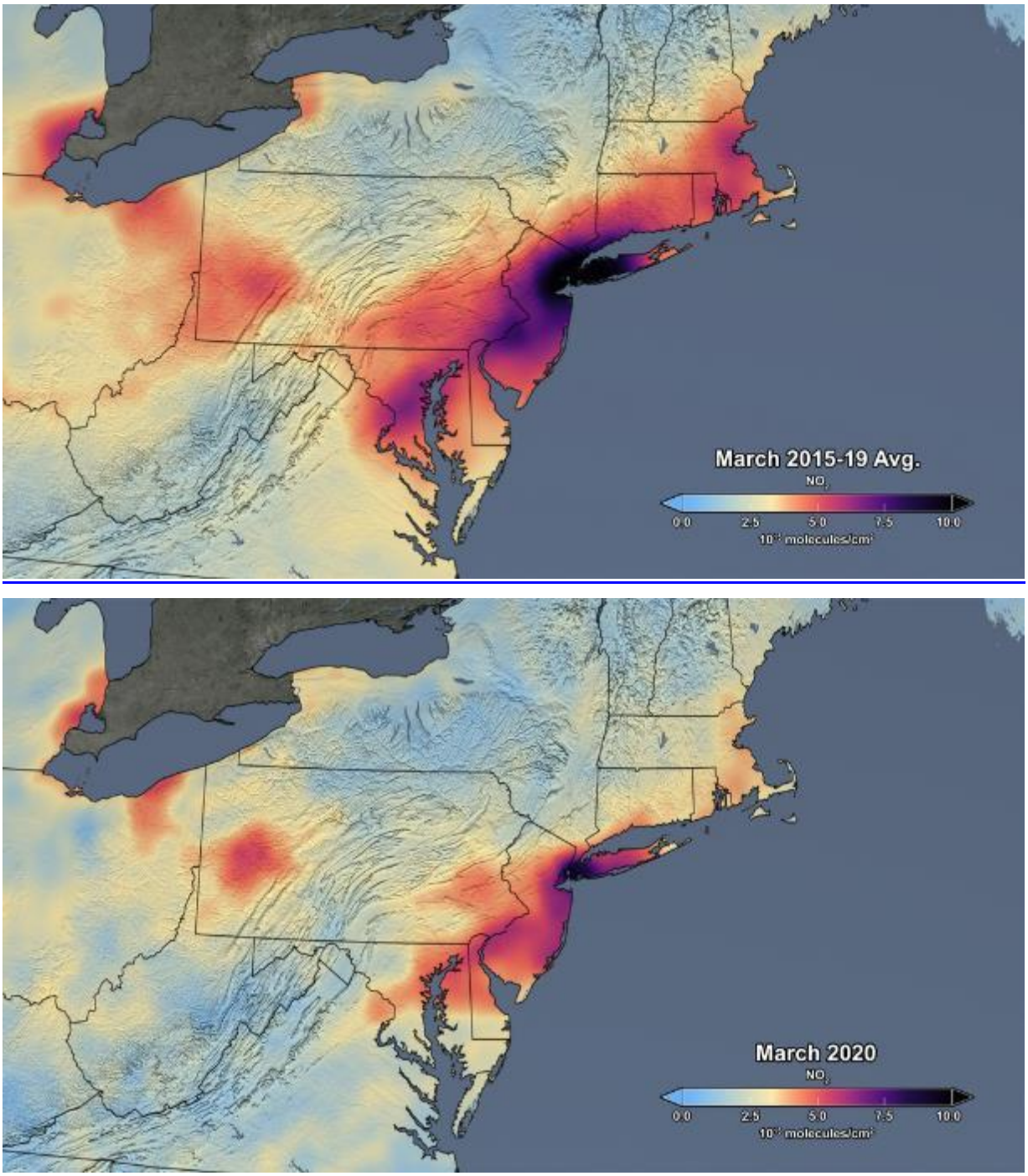
The trajectory that icebergs take in their long journey from Greenland to Newfoundland is also related to the air and sea surface temperatures, which modulate the melting of the icebergs. Observations suggest that heavier iceberg conditions are associated with colder surface temperatures and stronger northwesterly winds, so iceberg conditions are closely linked to the state of the climate on a seasonal timescale. Therefore, if one can forecast the overall state of the NAO, there may be some skill in tying that to the forecast of iceberg conditions. Furthermore, researchers may soon look forward to useful seasonal forecasts for spring/summer iceberg conditions in the northwest Atlantic.

The winter of 2019-20 brought mostly positive NAO conditions. This would imply a greater-than-usual chance of plentiful icebergs, all else being equal. However, the other factors I outlined above are also important. Recently, researchers from the University of Sheffield in England have developed a computer model using artificial intelligence analysis to predict the iceberg season for the northwest Atlantic. The results of their modelling are sent to the IIP to help them gauge the potential for just how busy the iceberg season may get. The group has issued seasonal forecasts since 2018, but this year will be the first time they have used artificial intelligence to help predict the total number of icebergs passing 48°N and the rate of change in this number across the season. The Sheffield group's seasonal outlook for 2020, issued in January, is for a relatively low number of icebergs. They predict that between 479 and 1,015 icebergs will move south of 48°N in 2020, compared with 1,515 last year. The group's modeling will be taken into account by IIP when they issue their weekly iceberg forecasts.

NASA Satellite Data Show 30 Percent Drop in Air Pollution Over Northeast U.S

From NASA, April 9, 2020:
https://www.nasa.gov/feature/goddard/2020/drop-in-air-pollution-over-northeast

Over the past several weeks, NASA satellite measurements have revealed significant reductions in air pollution over the major metropolitan areas of the Northeast United States. Similar reductions have been observed in other regions of the world. These recent improvements in air quality have come at a high cost, as communities grapple with widespread lockdowns and shelter-in-place orders as a result of the spread of COVID-19.



The image above shows the average concentration March of 2015-19, while the image below shows the average concentration measured in March of this year. Website has a single image slider for comparison.
Credits: NASA

Nitrogen dioxide, primarily emitted from burning fossil fuels for transportation and electricity generation, can be used as an indicator of changes in human activity. The images below show average concentrations of atmospheric nitrogen dioxide as measured by the Ozone Monitoring Instrument (OMI) on NASA's Aura satellite, as processed by a team at NASA's Goddard Space Flight Center, Greenbelt, Maryland. The left image in the slider shows the average concentration in March of 2015-19, while the right image in the slider shows the average concentration measured in March of this year.

Though variations in weather from year to year cause variations in the monthly means for individual years, March 2020 shows the lowest monthly atmospheric nitrogen dioxide levels of any March during the OMI data record, which spans 2005 to the present. In fact, the data indicate that the nitrogen dioxide levels in March 2020 are about 30% lower on average across the region of the I-95 corridor from Washington, DC to Boston than when compared to the March mean of 2015-19. Further analysis will be required to rigorously quantify the amount of the change in nitrogen dioxide levels associated with changes in emissions versus natural variations in weather.

If processed and interpreted carefully, nitrogen dioxide levels observed from space serve as an effective proxy for nitrogen dioxide levels at Earth's surface, though there will likely be differences in the measurements from space and those made at ground level. It is also important to note that satellites that measure nitrogen dioxide cannot see through clouds, so all data shown is for days with low cloudiness. Such nuances in the data make long-term records vital in understanding changes like those shown in this image.

For more information on NASA's air quality research, visit airquality.gsfc.nasa.gov.

The visual in this article can be downloaded at NASA's Scientific Visualization Studio.

Impact of Covid-19 on New Hampshire Professional Geologist Licensure

On May 11, Tom Fargo reached out to the Chair (Muriel Robinette) and Secretary (Rick Chormann), of the NH Board of Professional Geologists with two questions:

1. Has the Board considered conditional approval of waivers or extensions for continuing education requirements relative to license renewal?

2. Have any Executive Orders issued by Governor Sununu, in response to COVID-19, addressed the continuing education requirements for professional licensure, including those for NH Professional Geologists?

On May 22, Dawn Couture at the Office of Professional Licensure provided responded with the following information:

At their May 14 meething, the Board voted to issue a Standing Order where licensees may renew their license on a conditional basis that they complete the 24 hours of continuing education within 6 months.

However, on May 19, the Governor issued an executive order (Emergency Order, 29, Exhibit H) that waived all continuing professional education requirements for all Boards, Councils and Commissions in the state for those renewing between March 13, 2020 and December 31, 2020. This executive order superseded the Board's order.

See the following link for details:

https://www.governor.nh.gov/sites/g/files/ehbemt336/files/files/inline-documents/emergency-order-29-ex-h.pdf

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What is your Board Doing?

Submitted by Shane Csiki, Secretary, June 2020

Since the advent of COVID-19, organizations across the country have been continuing to seamlessly conduct their business operations, despite having to function remotely. This is a feat made possible by platforms such as Zoom, GoToWebinar, and WebEx. And, GSNH is no different. On Thursday evening, June 18th, the Board conducted its business via an online Zoom meeting.

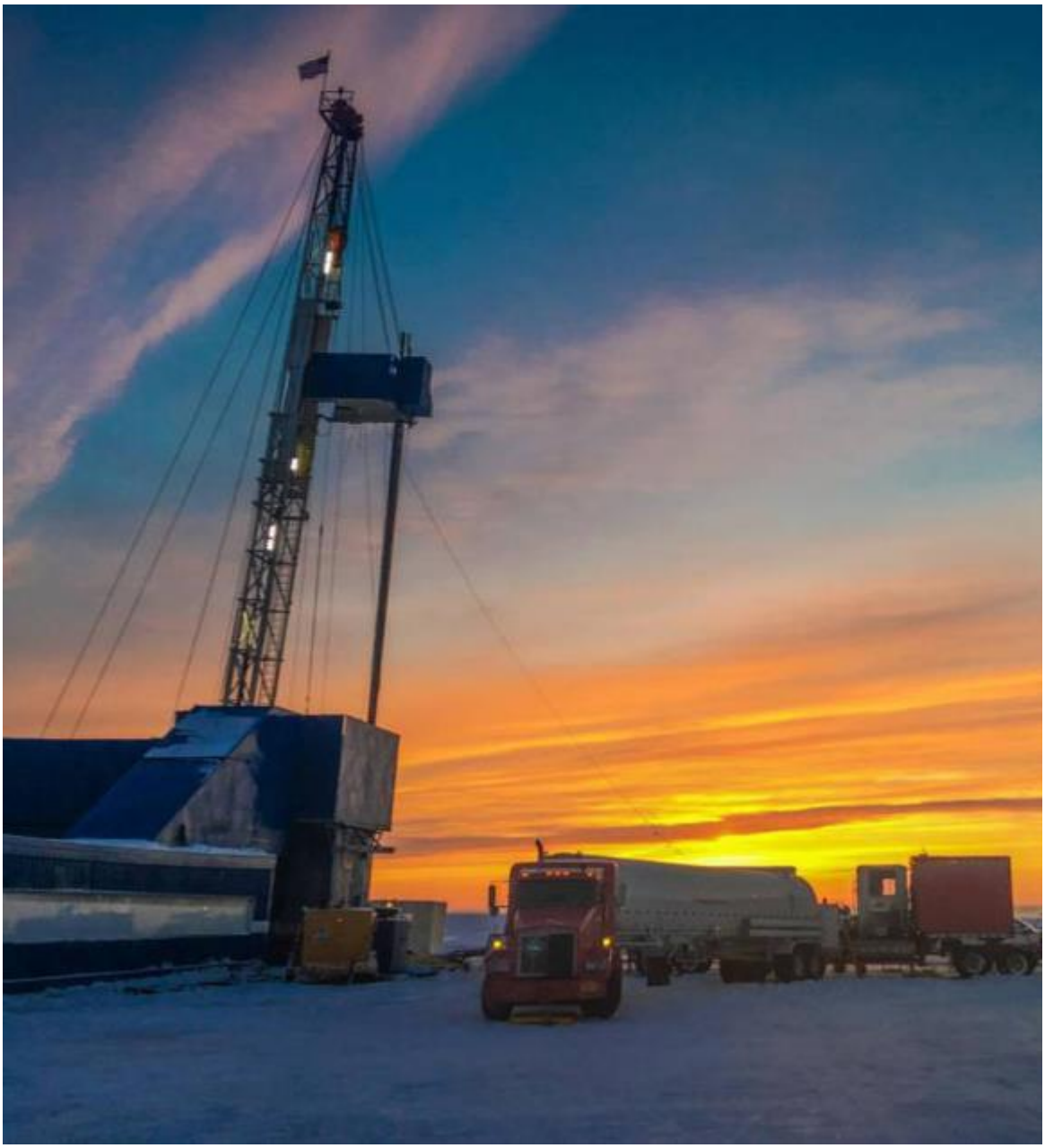
Continuing the functionality of GSNH, in a time when planning to come together in one room is very difficult, poses a challenge that comprised the majority of discussion at our Board meeting. For our upcoming October dinner meeting, the Board is currently faced with the challenge of having no current guarantee at that dining venues will have the capacity to house a meeting of the size and format that all who are a part of GSNH are accustomed to. The Board spent time to discuss these challenges, while also seeking to ensure that GSNH continues to provide opportunities to discuss and learn about Geology. As a result, the Board has decided to try our next "dinner meeting" in October (October 15) in a virtual format, via a Zoom meeting. Further details will be forthcoming as the date gets closer. However, given the sheer number of planning unknowns at this point, the Board thought this would be the best option to plan for. At this point in time, the Board is still planning on returning to in-person dinner meetings in January, and is actively working with the restaurants on this planning.

The next GSNH Board meeting will be held on Thursday, September 17, 2020, at a place (physical or virtual!) yet to be determined.

New data and an old well add up to a major North Slope oil find, company says

By Elwood Brehmer, Anchorage Daily News, April 9, 2020
https://www.adn.com/business-economy/energy/2020/04/09/new-data-and-an-old-well-add-up-to-a-major-north-slope-find-company-says/

With one unique North Slope oil discovery already in hand, a small group of explorers claims to have found another prospect on par with one of the state's largest oil fields that is worth developing even at near rock-bottom prices.



A drill rig is seen working at the Alkaid-1 well operated by London-based Pantheon. The company believes it can access the prospect directly from a turnout on the Dalton Highway and may even be able to eventually send oil directly into the Trans-Alaska Pipeline System from the location about 20 miles south of Pump Station 1. (Pantheon Resources)

Leaders of London-based Pantheon Resources said in an interview that a modern evaluation of an old exploration well along with information gleaned from recent nearby drilling gives them the confidence to say they have a roughly 1.8 billion-barrel discovery south of Prudhoe Bay along the Dalton Highway and Trans-Alaska Pipeline System corridor.

Pantheon CEO Jay Cheatham said the prospect, dubbed Talitha, could ultimately produce approximately 500 million barrels of oil with peak production nearing 90,000 barrels per day, which would make it comparable to ConocoPhillips' large Alpine field to the northwest.

If the resource estimates prove out, Talitha would be the latest in a series of big North Slope oil discoveries over roughly the past five years, which has led many within the industry to conclude there is a "renaissance" occurring in what was once the country's premier oil basin.

However, while the economics of large North Slope prospects are routinely challenged by remote locations and a lack of infrastructure, Talitha and Pantheon's nearby Greater Alkaid project avoid those multibillion-dollar hurdles, according to Cheatham.

ConocoPhillips and Oil Search, two of the companies advancing major new North Slope oil projects, recently announced a collective $270 million pullback of previously forecasted investments.

"We are so advantaged because of our location — being able to be right there along the Dalton Highway," Cheatham said.

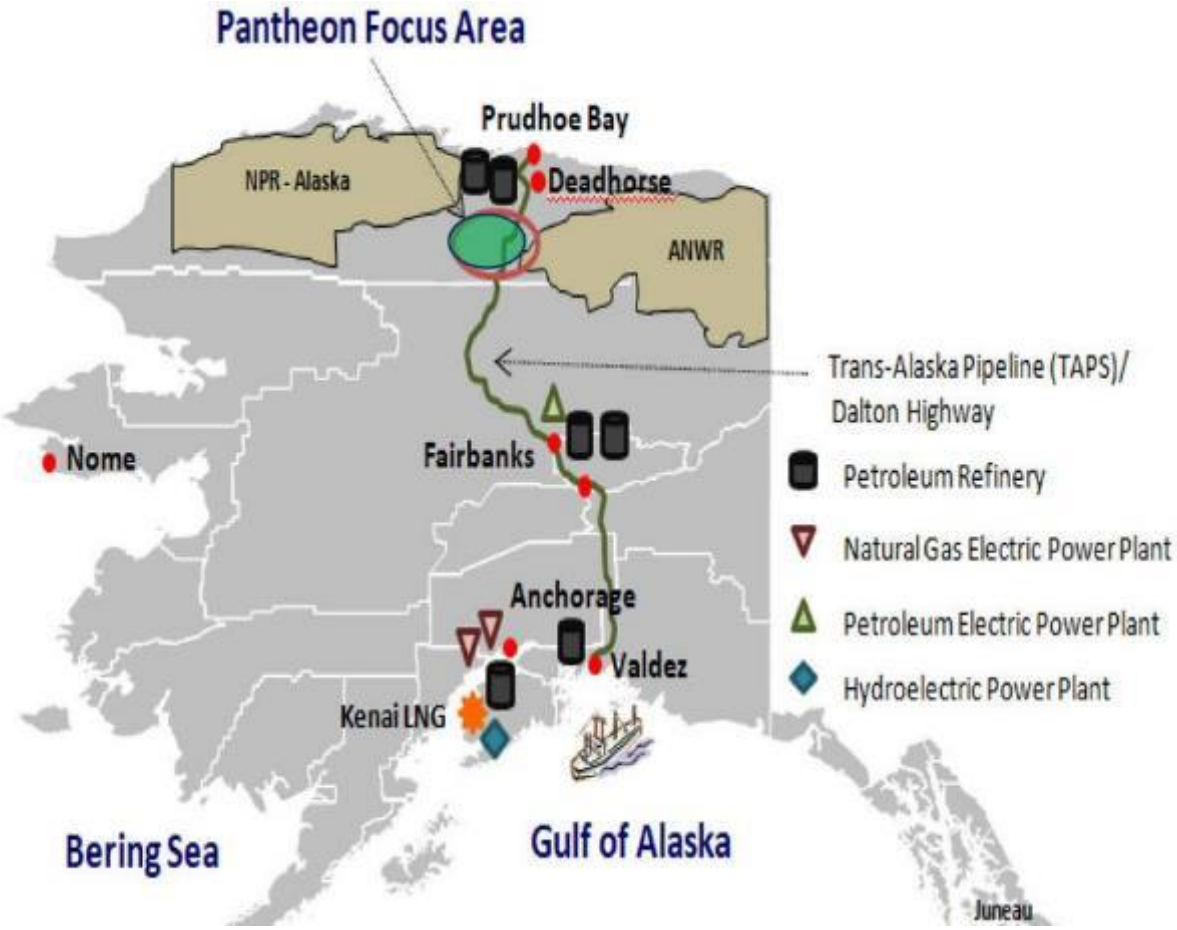
The company has estimated the Greater Alkaid prospect, which is believed to hold 76 million barrels of recoverable oil, could produce up to 30,000 barrels per day.

The Alkaid-1 well was drilled in 2015 by Anchorage-based Great Bear Petroleum, Pantheon's predecessor firm on the project. It is just east of the Dalton and about 20 miles south of Prudhoe.

Pantheon bought Great Bear and its roughly 200,000 acres of North Slope leases in January 2019. Results from the Pipeline State-1 exploration well drilled by Arco in 1988 also helped form the basis of geologic data that led Pantheon leaders to conclude they have a very large resource.

The Pipeline State well is also just east of the haul road and about 6 miles south of the Alkaid prospect. Pantheon Technical Director Rob Rosenthal, a founding member of Great Bear, said the well

data from Greater Alkaid was combined with the old Pipeline State well test results and data from a modern 3D seismic shoot of the whole area to give a better picture of what lies beneath.



Courtesy Pantheon

“It’s essentially in the same rocks, in the same stuff, in the same play,” as the Alkaid well, Rosenthal said of the Talitha prospect.

He added that even though the 10,000-foot vertical Pipeline State-1 well has a roughly 2,200-foot oil-bearing column over four reservoirs, with the technology and oil prices of the late 1980s it did not add up to a viable prospect at the time.

“There would have been no call back at $10 oil to go out and shoot 300-400 square miles of 3D (seismic), but today with the drilling technology, the completion technology, we can make this commercial,” Rosenthal said.

Pantheon is so far focusing on the shallowest reservoir.

Cheatham stressed the “dual advantage” that being adjacent to the haul road and TAPS provides the company. First, it allows Pantheon to avoid the massive up front costs of installing miles of remote gravel roads, drilling pads and pipelines and the corresponding multi-year environmental reviews that North Slope operators routinely face. It also makes it much easier for Pantheon to produce oil — and cash flow — early to help support full development of Talitha.

“It’s not like you’ve got to put in your whole facility. We can get (the wells) online virtually as we drill them,” Cheatham said.

Rosenthal added that the location also allows Pantheon to work year-round, while other companies are forced to limit appraisal drilling and early project development to the ice road season.

It all adds up to projects that are viable at oil prices in the $30 per barrel range, according to Cheatham.

The price for Alaska North Slope crude hovered near $30 per barrel in the second week of April as Saudis and Russian officials worked to end their production and price war that added downward pressure to oil markets already flooded with supply after the severe COVID-19-induced drop in demand started a month ago.

Full development is currently envisioned as about 170 wells split roughly evenly between water injectors and producers, a high-level plan similar to what was used to develop Alpine, he said.

Company leaders are hopeful development could begin in 2022 or 2023 if the global pandemic and subsequent economic shutdown do not persist for many months.

Cheatham and Rosenthal told the Journal in January that they planned to drill one or two more wells this year around Alkaid-1 and initiate a long-term production test, but that work is on hold at least until travel restrictions ease.

They acknowledged that Pantheon will need to find a partner to help finance large-scale development and that is challenged right now as well.

However, when Pantheon begins in earnest its search for financing for its projects, Rosenthal said he does not believe the company will be hampered by the decisions numerous investment banks have

made in recent months to stop funding Arctic oil developments because Greater Alkaid and Talitha aren't in sensitive or otherwise controversial areas.

"When they say 'Arctic' they mean offshore or ANWR or things like that," Rosenthal said. "I don't think there's necessarily a blanket 'we're not going to fund anything in Alaska,' but it's up to us to send out a positive message about what we're doing."

Cheatham said the project economics — and again, location along existing infrastructure — will be the ultimate deciding factor in whether or not Pantheon gets the money it needs for its work.

"We are economic really at prices that are so low that if any large projects get new funding we believe that ours would be right at the top of the list," Cheatham said.

Rock of Rattlesnake Hill

By James W. Spain, The Concord Insider, April 22, 2020
https://www.theconcordinsider.com/2020/04/22/rock-of-rattlesnake-hill/

The largest block of granite ever quarried in New Hampshire was cut and loaded by the New England Granite Company on August 7, 1894, in Concord. This granite block was cut from Rattlesnake Hill and weighed 38 tons and was sold for the price of $50,000. Once cut from New England Quarry the block was transported down Rattlesnake Hill to the cutting shed near the railroad tracks on North State Street, across from the present-day Blossom Hill Cemetery.

When this massive granite block left Concord, it was transported by the railroad to Westerly, Rhode Island, for processing and preparation for a grand mausoleum.

The mausoleum was constructed in Woodlawn Cemetery in New York for William Foster, a very wealthy gentleman that made a fortune manufacturing kid skin gloves.

The structure is canopied with a cruciform footprint and one of the first constructed in this era with an "open air" concept void of doors and windows. The Rattlesnake Hill block provided a granite base weighing just shy of 40 tons and measures 42 by 24 feet. Under the slab there are catacombs constructed for eight additional burials. The mausoleum is finished with a double sarcophagus containing William Foster's remains. There is a total of 16 Tuscan columns and over 1,100 tons of granite used in the structure which is 52 feet high.

William Foster tomb at Woodlawn Cemetery in New York

To this day, there is almost 40 tons of granite from Rattlesnake Hill, Concord, resting alongside some of the most famous Americans, such as Duke Ellington, Herman Melville and many more.

Earth may have been a 'Waterworld' without continents 3 billion years ago, study suggests

By Joshua Bote, USA Today, March 3, 2020
https://www.usatoday.com/story/news/nation/2020/03/03/earth-waterworld-3-b-years-ago-iowa-state-colorado-study/4937921002/

Around 3 billion years ago, Earth may have been covered in water – a proverbial "waterworld" – without any continents separating the oceans.

That's according to a new study published Tuesday in the peer-reviewed scientific journal Nature Geoscience by a pair of researchers from the University of Colorado-Boulder and Iowa State University.

They uncovered an ancient piece of marine sediment in the Western Australian outback that may have some answers for the evolution of life on Earth.

Around 3 billion years ago, Earth may have been covered in water without any continents separating the oceans, a new study suggests. Alekseystemmer, Getty Images/iStockphoto

Benjamin W. Johnson, an assistant professor of geological and atmospheric sciences at Iowa State, worked in conjunction with Boswell Wing at the University of Colorado to examine a nearly 3.2-billion-year-old piece of oceanic crust.

Johnson told USA TODAY that one of the biggest suggestions of the research is that "without significant continental crust above sea level," the ocean would be the only place where early life existed.

The crust, found in the Panorama district of the Pilbara Craton, provides a clear "isotope archive" for the ocean – or history of the different variants of a specific element in the ocean.

What that means, according to the researchers, is that the composition of the water at the time contained more oxygen-18 than oxygen-16, the latter of which is more common in the modern ocean and is a slightly lighter isotope.

The most plausible explanation for that is as the continents formed, the land ended up "sequestering" oxygen-18 from the oceans.

This doesn't mean there was no land on Earth, Johnson said. Wing explains it as if Earth was like the Galapagos Islands "from the West," with vast expanses of ocean and tiny islands dotting the ocean.

"Our work doesn't mean there was zero dry land, just that it must have been much, much smaller in extent than today, with only small island chains emergent above the ocean," Johnson told USA TODAY.

It may also prove the possibility that other, water-heavy planets outside the galaxy could evolve into what Earth looks like now.

"If the Earth was a waterworld for the first quarter or so of its history, then perhaps other Earth-like planets elsewhere in the galaxy would undergo a similar evolution," he said.

Follow Joshua Bote on Twitter: @joshua_bote

GSNH Legislative Committee Update

Submitted by Thomas Fargo, June 1, 2020

The NH General Court (House of Representatives and Senate) last met in a pre-COVID-19 session on March 12, 2020. This was the last scheduled session date prior to “Cross-Over” when remaining bills originating in the House must be acted on by the full House, and bills originating in the Senate must be acted on by the full Senate. The March 12th House session ended up being 19 hours long. It started at 9:00 AM, and finished voting on all pending bills just before 4:00 AM on Friday March 13th. Because my wife is a House member from Dover, I was present in Representatives Hall from 10:00 PM to the end of this session. Partisan disputes over House Rules contributed to the length of this session, but by the end, all required votes on bills were completed.

On March 12th, due to growing concerns associated the COVID-19, the House passed a resolution to allow the Speaker to undertake safeguards to protect the health of members prior to re-convening. The full House did meet on June 11 in the Whittemore Arena at the University of New Hampshire where members could social distance. Partisan disagreements over rules changes necessary to conduct business outside of pre-established deadlines resulted on only one bill being passed, that enabling restaurants to sell beer in growlers. House committees were unable to meet to act on additional Senate bills following Cross-Over.

NH Senate committees have met remotely to consolidate many House bills into “omnibus” bills that were voted on when the full Senate met in session in Representatives Hall on June 16th. As of this

writing, the Senate is scheduled to meet on June 29th and the House is scheduled to meet at UNH on June 30th in the last sessions for the 2019-2020 term. Due to the bundling of bills with divergent partisan support, it seems likely that few will receive the Governor's signature. Therefore, expectations are for few new laws to be enacted following the remaining 2019-2020 General Court term.

Arsenic Standard for Drinking Water Going Down to 5 ppb

From Supply Lines with the Source, Newsletter of the NHDES Drinking Water and Groundwater Bureau, Spring US 2020.
https://www.des.nh.gov/organization/commissioner/pip/newsletters/dwgb/documents/2020-spring-supply-lines2.pdf

Effective July 1, 2021, if adopted as proposed, the new arsenic maximum contaminant level (MCL) in New Hampshire will be 5 ppb (parts per billion – equivalent to micrograms per liter).

The new standard, which implements House Bill 261, enacted in July 2019, will apply to community and nontransient, non-community public water systems. HB 261 directs NHDES to change both the MCL and the ambient groundwater quality standard (AGQS) for arsenic to "a value not to exceed 5 micrograms per liter." The change will make New Hampshire the second state to adopt an arsenic MCL lower than the federal level of 10 ppb. New Jersey has been enforcing its 5 ppb standard since 2006.

HB 261 followed from HB 1592, enacted in 2018, which directed NHDES to review the 10 ppb AGQS (and effectively the MCL) to determine whether it should be lowered, considering the extent of occurrence, the ability to detect it in water, the ability to remove it from water, impact on public health, and the costs and benefits of establishing a lower standard.

When EPA set the limit at 10 ppb in 2001, it was already known that a 10ppb limit would present a health risk that was orders of magnitude higher than what was allowed for other cancer-causing drinking water contaminants. The agency's cost-benefit analysis indicated that at a level below 10 ppb the costs of treatment would be greater than the willingness of water customers to pay for the reduction in the known risk of bladder and lung cancers. NHDES' review found that more recent research into the health risks associated with low levels of arsenic indicated additional harmful effects including adverse pregnancy outcomes, increased illnesses during infancy, increased risk of death from cardiovascular disease, and neurocognitive effects, including potentially reduced childhood IQ.

NHDES has started contacting water systems that are likely to be affected by the lower MCL. For the vast majority of water systems currently in the 5-10 ppb range, compliance will involve adding adsorption treatment or replacing existing adsorbers more frequently, although some systems may

choose iron-arsenic co-precipitation either with naturally occurring iron or addition of an iron salt. Point-of-use arsenic adsorption cartridges are also a good treatment strategy, especially for daycares and small businesses. For more information on treatment options, contact Cindy Klevens at cynthia.klevens@des.nh.gov or (603) 271-3108.

DATES TO REMEMBER and CANCELLATIONS

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.

June 27-28, 2020 – **Gilsum Rock Swap & Mineral Show** – **Cancelled for 2020**

July 17-18, 2020 – **20th Annual Seek the Peak Hike-a-Thon** supporting the Mount Washington Observatory. https://secure.qgiv.com/event/stp2020/ – **Changed to a virtual event**

July 24-25, 2020 – **Champlain Valley Gem, Mineral and Fossil Show** – **Cancelled for 2020**

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

August 7-9, 2020 – **East Coast Gem, Mineral, and Fossil Show** – Better Living Center, Eastern States Exposition, West Springfield, MA: https://www.easternstatesexposition.com/events/2020/east-coast-gem-mineral-fossil

August 29-30, 2020 – **Capital Mineral Club Gem, Mineral, Fossil & Jewelry Show** – Everett Arena, 15 Loudon Road, Concord, NH: https://www.capitalmineralclub.org/57th_annual.php

September 17, 2020 – **GSNH Board of Directors meeting** – virtual meeting via Zoom.

October 15, 2020 – **GSNH Dinner Meeting** – Virtual meeting via Zoom; additional information to follow

October 26-30, 2020 – **Geological Society of America Annual Meeting** – changed to virtual meeting https://community.geosociety.org/gsa2020/registration

Looking for 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

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How Catastrophic Outburst Floods May Have Carved Greenland's 'Grand Canyon'

UMass Amherst, April 30, 2020. Contact: Benjamin Keisling
https://www.umass.edu/newsoffice/article/how-catastrophic-outburst-floods-may-have

AMHERST, Mass. – For years, geologists have debated how and when a network of canyons under the Greenland Ice Sheet formed, especially one that is so deep and long it's called 'Greenland's Grand Canyon.' Its shape suggests it was carved by running water followed by glaciation, but until now, "the

genesis of this canyon, and similar features in northern Greenland, remain(ed) unknown," authors of a new paper say.

Scientists at the University of Massachusetts Amherst and the University of Copenhagen's Centre for Ice and Climate now propose a new mechanism for how the megacanyon formed – from a series of catastrophic 'outburst' floods that suddenly and repeatedly drained lakes of melting ice sheet water over time. Based on ice-sheet model simulations of the early ice sheet's history, they show that climate and bedrock topography have "exerted strong controls" on the ice sheet since its beginning.

First author Benjamin Keisling, now a postdoctoral fellow at Columbia University's Lamont-Doherty Earth Observatory in Palisades, New York, did the work as a graduate student with senior author and advisor Rob DeConto at UMass Amherst. He collaborated with colleagues in Denmark, where Keisling had a National Science Foundation GROW fellowship. Details appear now in the journal Geology.

Keisling explains that before now, repeated outburst floods appeared to be the mechanism by which the Columbia River and other North America canyon networks formed, but they had not been considered as having played a role in forming the tortured landscape under the Greenland Ice Sheet.

He says, "If the floods we propose occurred, they could have influenced ocean circulation, causing abrupt climate changes with regional and perhaps global significance. The megacanyon beneath northern Greenland also influences how ice and water flow in the subglacial environment today, which affects present-day ice-sheet stability."

He recalls that in most Greenland studies, researchers use the modern ice sheet as a starting point for understanding how it has changed over time. But Keisling and his co-authors took a different approach, investigating what Greenland looked like before widespread glaciation. "We wanted to better understand the dynamics of "glacial inception – how, where, and why the ice sheet first grew on an ice-free island," he says.

The team also wanted to gain a better understanding of how the ice sheet grew back after melting. "We know from prior work this has happened multiple times in the past and could again in the future, given enough global warming," says Keisling.

They used coupled ice-sheet and climate models to simulate the Greenland Ice Sheet's evolution over many glacial-interglacial cycles in the last few million years. They found that following long periods with stable temperatures, an exceptionally warm period could cause the ice sheet to rapidly retreat. This led

to large, ice-dammed lakes forming in areas where the bedrock was still depressed from the old ice sheet's weight.

Keisling in Northeast Greenland at the East Greenland Ice Core Project (EGRIP) camp. The dome in the background is where researchers gather for meals. Photo courtesy: UMass Amherst/B Keisling

Their simulations show the ice dams eventually giving way as large outburst floods. "Over time," says Keisling, "it appears that the filling and draining of these lakes as the ice repeatedly retreated and advanced carved Greenland's megacanyons." Similar floods have been documented at the edge of other retreating ice sheets, he says.

Comparing Greenland with modern outburst floods, the researchers estimate that as many as hundreds of floods carved its Grand Canyon. Results suggest testable hypotheses for future research that could settle the long-standing debate about whether the ice sheet's stability has changed over time, they point out.

"Knowing the history of Greenland's bedrock provides context for understanding the ice sheet's long-term behavior," Keisling says. "This helps paint a picture of what happened during past warm periods

when the melting ice sheet caused global sea levels to rise – a phenomenon we are also seeing today."

This work was supported by NASA, an NSF grant and a GROW Fellowship, and the Danish National Research Foundation.

Archive – Spotted Lake, British Columbia

From Earth Science Picture of the Day, May 3, 2020
Photographer and summary author: Teena Della
https://epod.usra.edu/blog/2020/05/archive-spotted-lake-british-cloumbia.html

Each Sunday we present a notable item from our archives. This EPD was originally published May 3, 2003.

The photo above shows the appropriately named Spotted Lake, which is located a few miles west of Osoyoos, British Columbia, Canada -- off of Highway 3. The lake covers 38 acres and has one of the world's highest concentrations of minerals. It's therapeutic and easily harvested waters contain; magnesium sulfate (Epsom salts), calcium and sodium sulfates, plus eight other minerals and traces of four more, including silver and titanium. In the summer, as water evaporates in the desert heat of Osoyoos, the lake's mud forms white, pale yellow, green and blue circles, depending on its mineral concentrations.

Related links:

- Mrs. Della's Facebook page
- Canada's Spotted Lake
- kɬlilx'w Spotted Lake

2020 GSNH Election – Last Chance to Consider Joining the GSNH Board!

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

GSNH Needs You!

Two positions are term-limited and expiring in 2020, so the Board is particularly looking for the candidates for President and Member-at-Large (one position):

If interested in joining the Board of Directors, please contact a member of the Nominating Committee:
Julie Spencer (julie.spencer@comcast.net)
Abby Fopiano (abigail.fopiano@des.nh.gov)

For more details about all the positions, see http://www.gsnh.org/gsnh-constitution-and-bylaws.html.

Girl Scout creates program to teach children the value of nature

By Ginger Kozlowski, Manchester Ink Link, April 19, 2020
https://manchesterinklink.com/girl-scout-creates-program-to-teach-children-the-value-of-nature/

[Ed note: Society and Outreach committee member Joe Schmidl represented GSNH for this project]

Chloe Gross of Deerfield

DEERFIELD, NH – Chloe Gross believes that if any generation is motivated to see that climate change and biodiversity issues are addressed this Earth Day and all year round, it will be the youngest among us. This Deerfield 18-year-old has earned the Girl Scout Gold Award – the highest honor available to a Girl Scout in grades 9-12 – by creating a program that anyone can use to get kids outdoors, spark an interest in nature, and involve experts in teaching them about the value of a healthy environment.

Chloe Gross, far right, stands with a group of children who hiked to the top of Mount Kearsarge last July as part of her program to interest kids in nature and preserving our environment. She earned the Girl Scout Gold Award for her work, which resulted in a program people everywhere can use. Courtesy photo

Her project, EcoKids Environmental Program, is designed to be used as a six-hour day camp or summer camp plan, or used in pieces as an after-school program for children in grades 4-6. Available on her website, ecokidsnational.org, activities can be mixed and matched or substituted for visits from experts. While she tested the plan by running a weeklong program through Deerfield Parks and Recreation, she points out that the program can be used in the city, suburbs, woods, deserts, or plains – anywhere.

“Adaptability is the main goal of EcoKids,” she wrote in the program introduction, “so that every child has the opportunity to connect to the natural world and create a lifelong stewardship to protect our Earth.”

Incredibly, Chloe created and ran the program, created a website, and designed a curriculum available as a PDF for all to use while sick first with mononucleosis and then Lyme disease during her junior into senior years at St. Thomas Aquinas High School in Dover.

“She’s amazing!” said Ellen O’Donnell, Chloe’s former teacher at Deerfield Community School and Gold Award project advisor. “She took on quite a big task. She wanted to share her love of the outdoors and come up with curriculum.”

Ellen O'Donnell taught the children in Chloe Gross's pilot program how to identify trees by their leaves. Each person had a nature journal to keep a record of their leaves and other activities through the week. Courtesy Photo

Once Chloe conferred with O'Donnell, she took her advisor's suggestions and ran with them, finding experts on her own and becoming skilled at communicating with adults and organizing a huge number of tasks to create her program. She ran her weeklong program last July in Deerfield, keeping children in grades 3-5 engaged and active. They hiked locally, exploring trails in Pawtuckaway State Park with rescue and geology experts, had a wetlands lesson from an environmental teacher from Vermont, talked about water quality and native plants on the Dowst-Cate Trail, went bird watching and did other activities at Bear Brook State Park, and finished the week with hike up Mount Kearsarge in Warner.

O'Donnell said Chloe didn't want the children she was working with to know how tired she was during her recovery, powering through presentations and hikes. "She's a really thoughtful girl, a hard worker," she said. "She's one of those bright lights that you remember for the rest of your life."

Chloe now looks to the future with great confidence.

“When I was compiling my report I was thinking of all things I didn’t even know I learned,” she said. “All these ‘adulting’ memes! But I can write a professional email! That’s one of those things I didn’t even realize I learned. This is so big! Whatever project that is thrown at me, I’ll be able to handle it. It just hit me, if I could make it through last year, being as sick as I was, and still have it be a raging success – not only for myself but the kids who loved it, and the adults. If I really want it, I can put my mind to it, and it can happen!”

O’Donnell agreed. “She’s going to make a mark on the world!”

Chloe is looking forward to starting college in the fall. She plans to attend the University of New Hampshire, studying environmental conservation and sustainability with possible minor in forestry, education, or communications.

Beth Heckman taught the kids how to geocache, a method of using GPS data to find hidden boxes in the woods that have trinkets and a small journal. This was part of a hike in Bear Brook State Park, where they practiced staying on the trail, navigating junctions, and of course, geocaching. Courtesy Photo

Gold Award Girl Scouts don’t just change the world for the better, they change it for good. The Gold Award is earned by girls in grades 9–12 who demonstrate extraordinary leadership in developing sustainable solutions to local, national, and global challenges. Since 1916, Girl Scouts have answered

the call to drive lasting, impactful change. They earn college scholarships, demonstrate high educational and career outcomes, and are active in their communities.

Chloe Gross has answered the call to drive lasting, impactful change, and her Gold Award is a testament to her remarkable dedication to improving her community and the world. The Gold Award is the mark of the truly remarkable.

About the Girl Scout Gold Award:

- Gold Award Girl Scouts on average spend one to two years on their project.
- A Gold Award project must be sustainable after the girl's involvement ends.
- The average age of Gold Award Girl Scouts is 17.
- Since 1916, more than 1 million girls have earned the Gold Award or its equivalent.
- Gold Award Girl Scouts are entitled to enlist at a higher pay grade when they join the military.
- University research indicates that noting you are a Gold Award Girl Scout on a college application is influential in the admissions decision-making process.
- Twelve young women from New Hampshire and Vermont earned their Gold Award in the 2018-19 membership year as part of Girl Scouts of the Green and White Mountains.
- The Girl Scout Gold Award is the mark of the truly remarkable!

Colleagues celebrate Hal Borns' legacy of friendship, vision, scientific discovery

University of Maine Climate Change Institute, March 26, 2020
https://climatechange.umaine.edu/2020/03/26/colleagues-celebrate-hal-borns-legacy-of-friendship-vision-scientific-discovery-2/

Harold "Hal" W. Borns Jr., University of Maine professor emeritus of Earth and Climate Sciences and former director of the Institute for Quaternary Studies (now the Climate Change Institute), died Tuesday, March 17, 2020.

Borns was an internationally acclaimed glacial geologist and professor. But he almost became an engineer.

After serving in the U.S. Coast Guard in World War II, Borns worked as an electronics technician for Bell Telephone. Eventually heeding his father's advice, he utilized the GI Bill to study electrical engineering at Tufts University.

There, an elective course in geology altered Borns' life and career. He was fascinated by the sequence of rock layers in the Grand Canyon, and by the fact that the layers represented changing environments through time.

After earning his bachelor's degree at Tufts University, Borns earned graduate degrees from Boston University. His post-doctoral education was at Yale University, the University of Bergen in Norway, and the Natural History Museum in London.

Borns was among the first to help UMaine become a modern research university. He was proud to have been the first Maine scientist awarded a grant from the U.S. National Science Foundation (in 1960).

Beginning in 1968, Borns helped to develop an appropriate research focus for the recently formed Department of Geology. In 1972, after four years of careful planning and with the strong support of UMaine administration, he became the founding director of the Institute for Quaternary Studies, the nation's first multidisciplinary research institute created to study Earth's long-term climate variability.

Harold W. Borns, Jr.

The institute included faculty members from geology, biology, history, anthropology, archaeology, computer science and oceanography — an assemblage that was highly unusual at the time and remains so to this day. His efforts ultimately led to today's Climate Change Institute (CCI) becoming one of the most accomplished and respected climate research institutes in the world.

CCI director Paul Mayewski says Borns displayed intuitive and creative vision when he created the multidisciplinary Institute for Quaternary Studies that has lasted nearly 50 years.

"Personally, I was fortunate enough to serve as a field assistant to Dr. Borns many years ago as I was starting my career," says Mayewski. "His supportive counsel and friendship provided a role model for many of us."

Steve Norton, professor emeritus in Earth and Climate Sciences, called Borns "the most supportive, thoughtful, and kind person in our program — to the students and faculty."

"He worked tirelessly and selflessly for the betterment of the University of Maine for over 60 years," says Norton, who joined the Department of Geology in 1968.

Borns was an expert in glacial geology, and especially the glacial history of Maine. He established strong connections among UMaine researchers and the Maine Geological Survey.

Among his many contributions: the 1985 State Geological Survey map of Maine's Surficial Geology that synthesized previous work in the state and is still the standard reference.

In 2006, Borns and cartographer Michael Hermann produced the award-winning Maine's Ice Age Trail: Down East, Map and Guide. The colorful and detailed map and subsequent phone app highlight 46 unique glacial landscape features that were revealed between 16,000 and 13,000 years ago as the Laurentide Ice Sheet retreated northward.

Borns' geological fieldwork included sites on all continents except Australia. He had 28 field seasons in Antarctica, where the Borns Glacier was named for him. From 1988 to 1990, Borns served as director of the Polar Glaciology Program for the U.S. National Science Foundation.

Borns estimated that he taught and advised about 3,000 students during his career. He did it with wisdom, warmth, wit and a large measure of love for geology and for UMaine.

A group of faculty peers called Borns “a true living treasure of the University of Maine.”

The Climate Change Institute annually holds the Harold Borns Symposium, which features scientific presentations by present and former graduate students, faculty and staff. The discussions include current research projects from around the world, and from many disciplines.

Three months before his death, Borns met with UMaine President Joan Ferrini-Mundy to share insights about the history of research at the university.

“Last year, Hal sent me a letter detailing the impact of his first NSF grant on his research, on the university and on Maine,” says Ferrini-Mundy.

“When we got together three months ago, he shared how excited he was to be doing data collection with high school students in the Machias area. Hal was the quintessential professor and researcher in the true spirit of a land grant university.

“His internationally and nationally recognized research put the University of Maine on the global map, and impacted the state’s understanding of its ice age history. He was an educator at heart, widely sharing his expertise for glacial and ice age geology with students of all ages, colleagues and the community. We will miss his passion for learning and science.”

Former CCI director George Jacobson notes, “Those of us who had the good fortune to interact with Hal over the years found a friend and mentor who encouraged our interests in research and helped to further our careers. His own great enthusiasm for science continued to the end, and even in the last few months of his life he mentioned plans for next summer’s fieldwork in gravel pits in Downeast Maine.”

Watershed Boundary Dataset (WBD) changes in New Hampshire

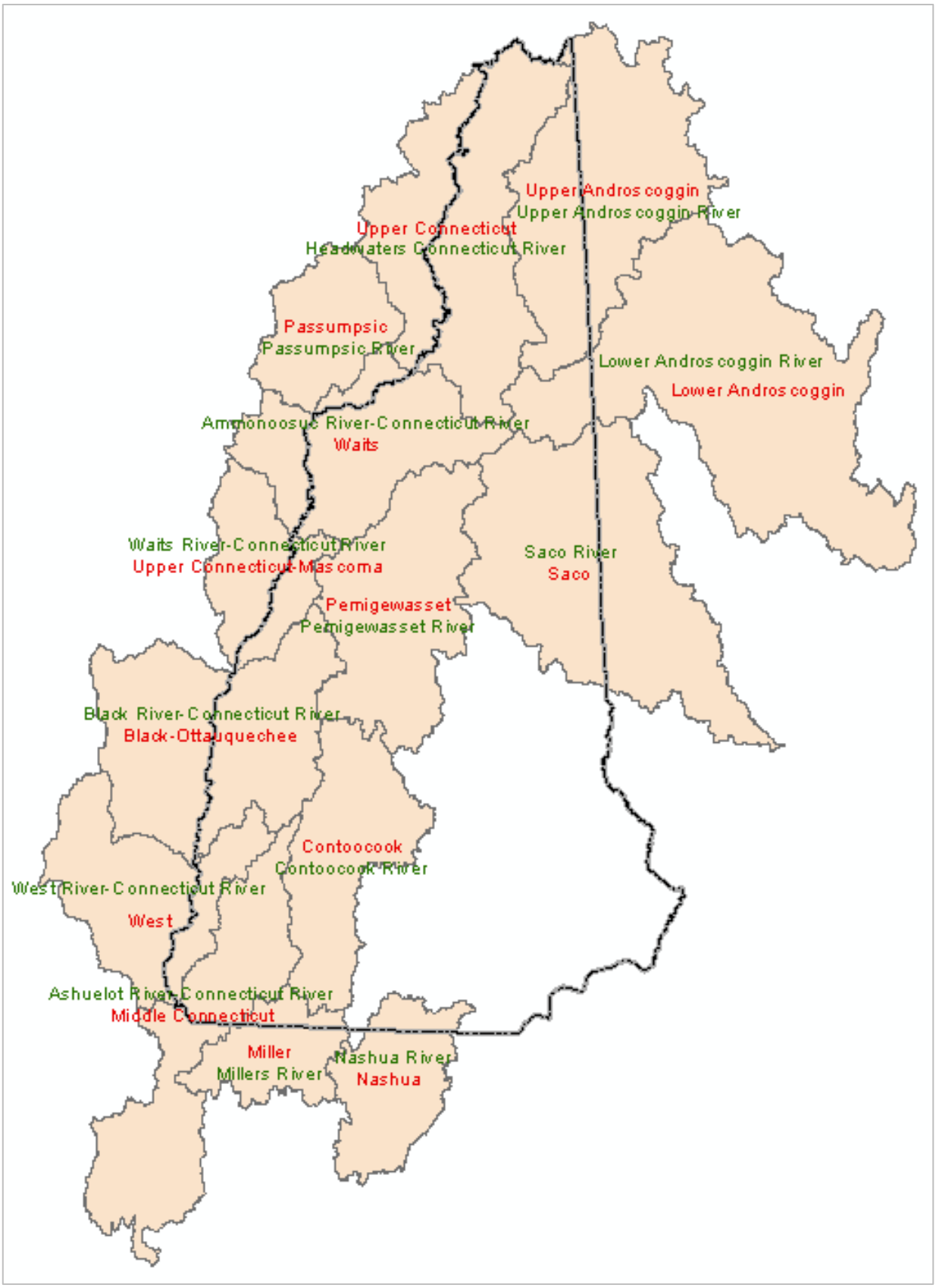
By Joshua Keeley, New Hampshire Geological Survey

The WBD is a companion dataset to the National Hydrography Dataset (NHD) and both are components of the National Map, a public USGS product. In partnership with the USGS, the New Hampshire Geological Survey (NHGS) updates and helps maintain both the WBD and NHD in NH. The following name changes will be applied to watersheds at the hydrologic unit code 8 (HUC8) level by USGS in order to correct existing errors. Specifically, the purpose is to rename hydrologic units

according to the actual rivers within them and to add 'River' to the official names. There will be no spatial changes in this update. Please contact Joshua.Keeley@des.nh.gov for more information.

Summary of WBD name changes in Region 1 of the National Map

STATES	HUC8	NAME	New Name	Comments
NH	1070001	Pemigewasset	Pemigewasset River	Added River to name to match GNIS name
NH	1070003	Contoocook	Contoocook River	Added River to name to match GNIS name
CN,ME, NH	1040001	Upper Androscoggin	Upper Androscoggin River	Added River to name to match GNIS name
ME,NH	1060002	Saco	Saco River	Added River to name to match GNIS name
NH,VT	1080103	Waits	Ammonoosuc River-Connecticut River	Added Connecticut River as it is the mainstem and should be included in name. Waits River is not in this unit, suggest updating to feature in unit
NH,VT	1080104	Upper Connecticut-Mascoma	Waits River-Connecticut River	Added River to name to match GNIS name. Mascoma is not in this unit, selected prominent feature in unit for name. Swapped name order as Connecticut River is the mainstem and should come second in name.
NH,VT	1080106	Black-Ottauquechee	Black River-Connecticut River	Added River to name to match GNIS name. Added Connecticut River as it is the mainstem and should be included in name. Selected most prominent of suggested features for name.
NH,VT	1080107	West	West River-Connecticut River	Added River to name to match GNIS name. Added Connecticut River as it is the mainstem and should be included in name
CN,ME, NH, VT	1080101	Upper Connecticut	Headwaters Connecticut River	Added River to name to match GNIS name. Updated to Headwaters as Upper cannot be used alone
NH,VT	1080102	Passumpsic	Passumpsic River	Added River to name to match GNIS name
MA,NH	1070004	Nashua	Nashua River	Added River to name to match GNIS name
MA,NH	1080202	Miller	Millers River	Added River to name to match GNIS name
MA,NH, VT	1080201	Middle Connecticut	Ashuelot River-Connecticut River	Added River to name to match GNIS. Selected prominent hydro feature and updated to hyphenated name
ME,NH	1040002	Lower Androscoggin	Lower Androscoggin River	Added River to name to match GNIS name



HUC8 watershed name changes in NH showing old names in red and new names in green

MEMBERSHIP & RENEWAL APPLICATION

Geological Society of New Hampshire

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

Signature: _____ Date: _____