Granite State Geologist

The Newsletter of the Geological Society of New Hampshire,
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MESSAGE FROM THE PRESIDENT

There is a chill in the morning and evening air. Daylight hours are getting shorter. I thought that I might share "What I did on my summer vacation". For multiple reasons, I'm looking back to a trip I made during the summer of 2019.

Imagine a world, 310 to 315 million years ago, inhabited by dragon flies the size of seagulls, two-meter-long centipedes and half-meter "lizards". Riparian forests composed of twenty-meter-tall trees resembling today's club mosses and horse tail plants. Remnants from this world are preserved at the Joggins Fossil Cliffs, a UNESCO World Heritage site located approximately 500 miles from Concord, NH., on the northeast shore of the Bay of Fundy in Nova Scotia. After reading about this "coal age Galapagos", I just had to explore the cliffs for myself.

Originally studied by William Dawson and Charles Lyell in the mid-nineteenth century, there are many paleontological wonders to be seen at Joggins. My historical geology textbook (from 1978) included a reference to the oldest known reptile, Hylonomus lyelli, preserved in sand-filled lycopsid fossil tree stumps located there. No one is certain whether these and other creatures, such as the amphibian Dendrerpeton, were living in or were trapped in the hollow stumps and preserved by sediment-laden flood waters. The story of the traces of the giant arthropods Meganeura and Arthropleura found at Joggins is also fascinating. The Late Carboniferous (Pennsylvanian) atmosphere had a higher concentration of oxygen that enabled these creatures to grow to frightening proportions. For more information on Joggins fossils, I recommend viewing the Atlantic Geoscience Society YouTube. For more information on fossilized tetrapods found within the tree stumps view this video from the Nova Scotia Museum.

If you go to Joggins, be warned that the rocks are very slippery. Tidal variations in this section of the Bay of Fundy reach 13 meters (42 feet). Mud washed into the Bay from the Petitcodiac or "Chocolate" River near Moncton, NB, and other tributaries is very slick. When in the area, don't miss visiting Hopewell Rocks Provincial Park, NB to walk among the "flower pot" sea stacks when the tide is out.

I hope to see many of you at the October 13th in-person GSNH meeting at Makris. If not, do enjoy autumn in New Hampshire. Tom

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GSNH T-Shirts Available!

We have a few GSNH T-shirts still available – no XL, and we have just a couple of L and a few more M and S sizes left. Send in your order before they're gone! T-shirts will be shipped to you. See order form on second to last page (right before the renewal form).

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

Giant sinkhole with a forest inside found in China

From Stephanie Pappas, Live Science, May 11, 2022.
https://www.livescience.com/new-sinkhole-discovered-china

A team of Chinese scientists has discovered a giant new sinkhole with a forest at its bottom.

The sinkhole is 630 feet (192 meters) deep, according to the Xinhua news agency, deep enough to just swallow St. Louis' Gateway Arch. A team of speleologists and spelunkers rappelled into the

sinkhole on Friday (May 6), discovering that there are three cave entrances in the chasm, as well as ancient trees 131 feet (40 m) tall, stretching their branches toward the sunlight that filters through the sinkhole entrance.

This giant karst sinkhole, also called a tiankeng, has plants growing at the bottom in Luoquanyan Village of Xuan'en County, central China's Hubei Province. This is not the sinkhole discovered in Guangxi Zhuang Autonomous Region. (Image credit: Song Wen/Xinhua/Alamy Live News)

A site for sinkholes

The discovery is no surprise, Veni told Live Science, because southern China is home to karst topography, a landscape prone to dramatic sinkholes and otherworldly caves. Karst landscapes are formed primarily by the dissolution of bedrock, Veni said. Rainwater, which is slightly acidic, picks up carbon dioxide as it runs through the soil, becoming more acidic. It then trickles, rushes and flows through cracks in the bedrock, slowly widening them into tunnels and voids. Over time, if a cave chamber gets large enough, the ceiling can gradually collapse, opening up huge sinkholes.

This image shows a typical karst sinkhole called a tiankeng in Chongqing, China. Image credit: Eastimages/Getty Images)

"Because of local differences in geology, climate and other factors, the way karst appears at the surface can be dramatically different," he said. "So in China you have this incredibly visually spectacular karst with enormous sinkholes and giant cave entrances and so forth. In other parts of the world you walk out on the karst and you really don't notice anything. Sinkholes might be quite subdued, only a meter or two in diameter. Cave entrances might be very small, so you have to squeeze your way into them."

In fact, 25% of the United States is karst or pseudokarst, which features caves carved by factors other than dissolution, such as volcanics or wind, Veni said. About 20% of the world's landmass is made of one of these two cave-rich landscapes.

The new discovery took place in the Guangxi Zhuang Autonomous Region, near Ping'e village in the county of Leye, according to Xinhua. Guangxi is known for its fabulous karst formations, which range from sinkholes to rock pillars to natural bridges and have earned the region UNESCO world heritage site designation.

Why sinkholes matter

The sinkhole's interior is 1,004 feet (306 m) long and 492 feet (150 m) wide, Zhang Yuanhai, a senior engineer with the Institute of Karst Geology, told Xinhua. The Mandarin word for such enormous

sinkholes is "tiankeng," or "heavenly pit," and the bottom of the sinkhole did indeed seem like another world. Chen Lixin, who led the cave expedition team, told Xinhua that the dense undergrowth on the sinkhole floor was as high as a person's shoulders. Karst caves and sinkholes can provide an oasis for life, Veni said.

"I wouldn't be surprised to know that there are species found in these caves that have never been reported or described by science until now," Lixin said.

In one West Texas cave, Veni said, tropical ferns grow abundantly; the spores of the ferns were apparently carried to the sheltered spot by bats that migrate to South and Central America.

Not only do sinkholes and caves offer refuge for life, they are also a conduit to aquifers, or deep stores of underground water. Karst aquifers provide the sole or primary water source for 700 million people worldwide, Veni said. But they're easily accessed and drained — or polluted.

"Karst aquifers are the only types of aquifers that you can pollute with solid waste," Veni said. "I've pulled car batteries and car bodies and barrels of God-knows-what and bottles of God-knows-what out of the active cave stream."

The new discovery brings the number of sinkholes in Leye County to 30, according to Xinhua. The same researchers have previously discovered dozens of sinkholes in Northwest China's Shaanxi province and a cluster of interconnected sinkholes in Guangxi, China Daily reported.

New Hampshire Geological Survey Update

By Shane Csiki, State Geologist and Director; September 2022

It is hard to believe that it is fall already. But a quick check of the date on the calendar indeed shows that fall is here. Summer passed through with high speed, and the theme that probably best characterizes NHGS staff during this time has been “out and about the state” in multiple ways. Ranging from Josh Keeley’s field mapping in the Mount Moosilauke and Shelburne quadrangles to Rebecca LeCain’s outreach in local schools, everyone has been “in the field.”

During July and August, NHGS held daylong field conferences in each quadrangle being mapped this year with each geologic mapper. As described in last quarter’s update, these are part of our new “collaborative peer review” process for our geologic maps which is designed to make the quality of the final map products even more enhanced. We held five such conferences for seven mapped quadrangles, with two quadrangles being jointly mapped for surficial and bedrock geology combined

into the same day. At each field conference, not only was the mapper of the quadrangle present, but also other contract mappers and others in the geology community who served as “peer reviewers.” From NHGS, Shane Csiki, Josh Keeley, Rebecca LeCain and Mike Howley were in attendance. At each stop throughout a quadrangle, Rebecca took notes on the questions the mappers had and the feedback and questions raised by the attending peer reviewers. These notes then are becoming part of the peer review record for each map. In addition to our own suite of mappers, representatives from USGS, other units in NHDES, the Vermont Geological Survey, retired Geology professors and potential future mappers all constituted attendees throughout the series. Field discussions proved to be quite lively, engaging and educational, and our mappers have indicated that the discussions and comments have been a process improvement, and that the final maps are enhanced as a result. After the maps are digitized this fall, they will be made available to everyone who participated for the second phase of this process.

Field conference attendees examining the bedrock of Tunnel Brook, Mount Moosilauke quadrangle on August 1.

Public outreach and education has been lively. In July, Rebecca LeCain was invited by Bedford Academy to present to elementary school students about the rock cycle and fossils. The academy has a vibrant summer STEM program, and their focus includes basic geologic principles, and so the students had already learned a lot from their teachers and were very proud to put their knowledge into practice identifying rocks and fossils! Public inquiries have also been active, with several questions coming in each week about topics ranging from meteorites and gold panning to availability of our publications. Rebecca is continuing to make our maps and bulletins more accessible on our website: https://www.des.nh.gov/resource-center/publications?keys=geology

Not only has it been a busy summer, it has also been a dry summer. Drought continues to persist in New Hampshire. NHGS' Groundwater Level Monitoring Network data has been used by multiple decisionmakers within NHDES and federal agencies, as well as citizens to monitor the extent and magnitude of the drought across the State of New Hampshire. Mike Howley continues to enhance ways by which the groundwater level data can be accessed. NHGS has created a Web App for viewing the most recent data produced by the Groundwater Level Monitoring Network. The Web App is available through the NHDES Geodata Portal at https://nhdes.maps.arcgis.com or directly at https://bit.ly/3QbtJmY.

The staff of NHGS would like to thank everyone who participated in our geologic quadrangle mapping field conferences this summer, and for making the field conferences geologically engaging. This will enhance our geologic mapping products for everyone in the future.

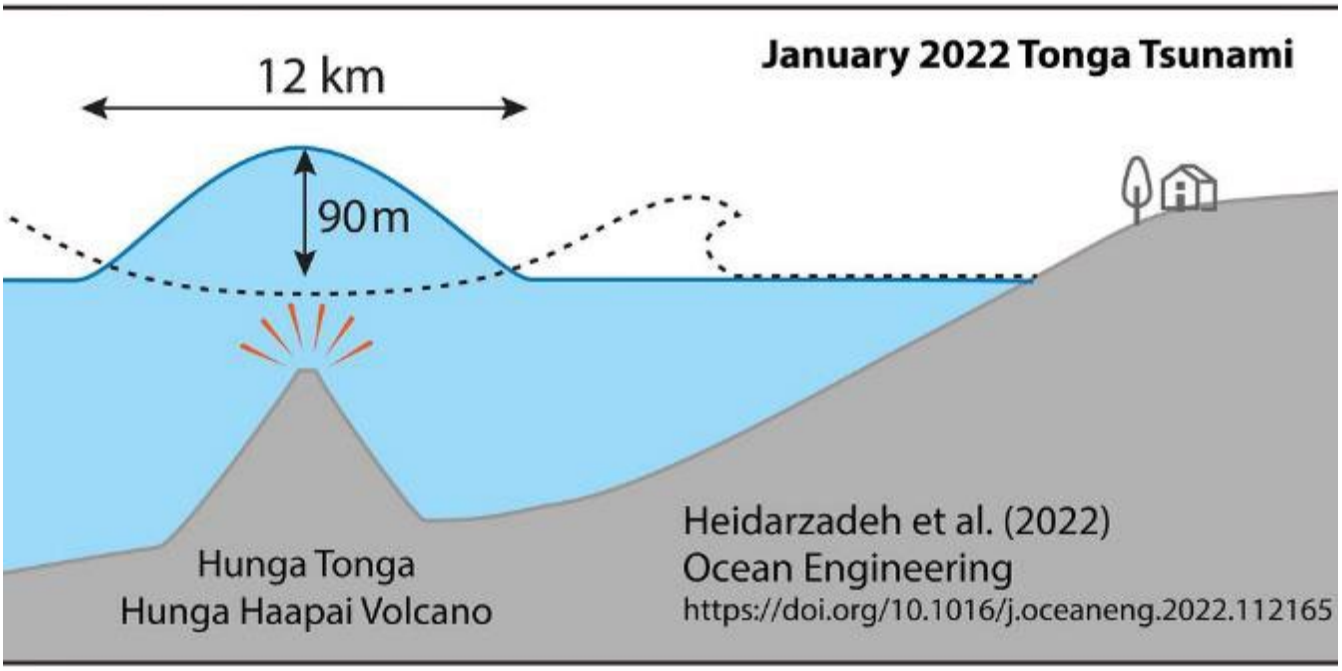
Wave created by Tonga volcano eruption reached 90 meters – nine times taller than 2011 Japan tsunami

From the University of Bath, August 19, 2022.
https://www.bath.ac.uk/announcements/wave-created-by-tonga-volcano-eruption-reached-90-metres-nine-times-taller-than-2011-japan-tsunami/

The initial tsunami wave created by the eruption of the underwater Hunga Tonga Ha'apai volcano in Tonga in January 2022 reached 90 metres in height, around nine times taller than that from the highly destructive 2011 Japan tsunami, new research has found.

An international research team says the eruption should serve as a wake-up call for international groups looking to protect people from similar events in future, claiming that detection and monitoring systems for volcano-based tsunamis are '30 years behind' comparable tools used to detect earthquake-based events.

Dr Mohammad Heidarzadeh, Secretary-General of the International Tsunami Commission and a senior lecturer in the University of Bath's Department of Architecture & Civil Engineering, authored the research alongside colleagues based in Japan, New Zealand, the UK and Croatia.



The eruption created an initial wave 90 meters high – almost the height of the Statue of Liberty

By comparison, the largest tsunami waves due to earthquakes before the Tonga event were recorded following the Tōhoku earthquake near Japan in 2011 and the 1960 Chilean earthquake, reaching 10 metres in initial height. Those were more destructive as they happened closer to land, with waves that were wider.

Dr Heidarzadeh says the Tonga tsunami should serve as a wake-up call for more preparedness and understanding of the causes and signs of tsunamis cause by volcanic eruptions. He says: "The Tongan tsunami tragically killed five people and caused large scale destruction, but its effects could have been even greater had the volcano been located closer to human communities. The volcano is located approximately 70 km from the Tongan capital Nuku'alofa – this distance significantly minimized its destructive power.

"This was a gigantic, unique event and one that highlights that internationally we must invest in improving systems to detect volcanic tsunamis as these are currently around 30 years behind the systems we used to monitor for earthquakes. We are under-prepared for volcanic tsunamis."

The research was carried out by analysing ocean observation data recordings of atmospheric pressure changes and sea level oscillations, in combination with computer simulations validated with real-world data.

The research team found that the tsunami was unique as the waves were created not only by the water displaced by the volcano's eruption, but also by huge atmospheric pressure waves, which circled around the globe multiple times. This 'dual mechanism' created a two-part tsunami – where initial ocean waves created by the atmospheric pressure waves were followed more than one hour later by a second surge created by the eruption's water displacement.

This combination meant tsunami warning centres did not detect the initial wave as they are programmed to detect tsunamis based on water displacements rather than atmospheric pressure waves.

The research team also found that the January event was among very few tsunamis powerful enough to travel around the globe – it was recorded in all world's oceans and large seas from Japan and the United States' western seaboard in the North Pacific Ocean to the coasts within the Mediterranean Sea.

The paper, co-authored by colleagues from New Zealand's GNS Science, the Association for the Development of Earthquake Prediction in Japan, the University of Split in Croatia and at London's Brunel University, was published this week in Ocean Engineering.

Dr Aditya Gusman, Tsunami Modeller at the New Zealand-based geoscience service, says: "The 2018 Anak Krakatau volcano and 2022 Hunga Tonga-Hunga Ha'apai volcano eruptions clearly showed us that coastal areas surrounding volcano islands are at risk of being hit by destructive tsunamis. Although it may be preferable to have low-lying coastal areas completely clear from residential buildings, such a policy may not be practical for some places as volcanic tsunamis can be considered infrequent events."

Co-author Dr Jadranka Šepić, from the University of Split, Croatia, adds: "What is important is to have efficient warning systems, which include both real-time warnings and education on what to do in a case of a tsunami or warning - such systems save lives. In addition, at volcanic areas, monitoring of volcanic activity should be organized, and more high-quality research into volcanic eruptions and areas at hazard is always a good idea."

Separate research led by the University of Bath atmospheric physicist Dr Corwin Wright published in June found that the Tonga eruption triggered atmospheric gravity waves that reached the edge of space.

2022 GSNH Election - Candidates

The candidates for the October 2022 elections are listed below. You may also cast a ballot for a write-in candidate of your choice. The vote will be held during the October dinner meeting; see second to last page of this newsletter for meeting details.

President - Tom Fargo

Tom received his Bachelors and Masters Degrees in geology from the State Universities of New York at Fredonia and Buffalo, respectively. He moved to Dover, NH in 1988 to pursue a Ph.D. in geology at UNH. Tom spent many years working in environmental consulting, primarily in New England, before "retiring" in 2000. During a nine-year sabbatical he engaged in many citizen volunteer pursuits, including serving in the NH House of Representatives in 2007-08. Tom returned to full-time employment with the NH Department of Environmental Services in 2009 and is currently working as a Project Manager in the Oil Remediation and Compliance Bureau. Tom is a licensed NH Professional Geologist, a long-time member of the GSNH and has served one term as President.

Council Vice President – Doug Allen

Doug is a Senior Hydrogeologist and Project Manager with Haley & Aldrich, Inc. in Bedford, specializing in environmental site investigations and remediation, application of GIS to environmental projects, engineering geology, and hydrogeological studies. He is a licensed PG in New Hampshire and New York, with a MS in geology from Lehigh University and a BA in Environmental Science from the University of Rochester. Doug has played an active role in GSNH since joining in 2002, volunteering on the membership committee (maintaining the membership database, preparing member directories, and communicating event information to members) since 2004 and previously served on the Board of Directors as Secretary, Society Vice President, and Member-at-Large prior to his current term as Council Vice President. Doug and his family live in Warner where he serves on the Town's Conservation Commission. Doug appreciates the professional fellowship that GSNH brings to the geological community of New Hampshire and looks forward to ongoing active participation.

Society Vice President – Nelson Eby

Nelson is a professor in the Department of Environmental, Earth and Atmospheric Sciences at the University of Massachusetts, Lowell. He has a BA and MS in geology from Lehigh University and Ph.D. in geology from Boston University. He is a geochemist whose research has taken him to 6 continents and a number of academic institutions and research centers. Nelson has published a number of papers and field trip guides dealing with the White Mountain magmatism of New Hampshire. He was a founding member of GSNH and many years ago (before some of you were born) served as Society VP. Nelson has a life-long interest in GSNH and the geology of New Hampshire. This will be Nelson's 2nd term as Society Vice President.

Treasurer – Abby Thompson Fopiano

Abby is a hydrologist and owner of Edgewater Strategies a firm focused on groundwater and wells. Abby has been working in New England's drinking water industry for 15 years – as a consultant, as a water system operator and as a NH DES regulator. Most recently, her focus is on source water optimization, groundwater withdrawal permitting, water use and water level monitoring, public water system operations and management and asset management. Abby is NH Professional Geologist, has a Geology degree from the University of Montana and a masters in Hydrology from the University of New Hampshire. She's been serving as the Society's webmaster for the last nine years, served two terms as a Member-at-Large and is finishing her second term as Treasurer.

Secretary – Rebecca LeCain

Rebecca is the Outreach Coordinator for the NH Geological Survey. She is in charge of marketing, and working with the public on education and inquiries for publications. Rebecca is also involved in several projects within the survey including archiving resources, groundwater monitoring, and mapping. She earned her master's degree in earth sciences from UNH, and a B.S. in geology from the University of Missouri; work in both degrees focused on paleontology and sedimentary processes. Rebecca took on the role of Secretary for GSNH to finish Shane Csiki's term when he stepped down upon becoming NH State Geologist.

Member-at-Large (Three Positions)

Sharon Lewandowski - Sharon is currently a Geologist at the NHDES in Concord, New Hampshire and is a registered P.G. in New Hampshire and North Carolina. She grew up in New Hampshire and earned her B.S. and M.S. in Geology from Bowling Green State University in Bowling Green, Ohio. Sharon started at AECOM when she moved back to New Hampshire in 2014 after working as a Hydrogeologist for eight years in Greenville, North Carolina. She has been a member of GSNH since

2015 and is excited about her continued involvement with the geological community in New Hampshire.

Mike Howley – Mike is a Hydrogeologist with the New Hampshire Geological Survey, specializing in near surface geophysics, remote environmental monitoring, geologic mapping, hydrogeological studies, and the application of GIS to geologic investigations. Prior to coming to NHGS, Mike worked for 12 years at Hager-Richter Geoscience where he conducted near-surface geophysical and geological investigations throughout the eastern US. Mike is a licensed PG in both New Hampshire and New York, and has BS and MS degrees in geology from UNH. Mike has been a member of GSNH since 2005, and lives with his family in Bradford.

Melissa Lombard – Melissa is a research hydrologist at the U.S. Geological Survey where a large part of her work is developing models in collaboration with epidemiologists to estimate drinking water exposure to contaminants. Previous employment includes environmental consulting, environmental regulation, and university research and teaching positions. Her education includes a B.A. from William Smith College, M.S. from Rensselaer Polytechnic Institute, and Ph.D. from the University of New Hampshire all in geology or earth sciences. Melissa is a licensed professional geologist in New Hampshire and resides in Antrim. She has been attending GSNH dinner meetings and field trips since at least 2007 and looks forward to contributing to the organization as an officer.

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

NH Rock Core – Free to a Good Home!

The Morgain/Higgins/Copperville/Milan drilled core is currently housed on private property and will need a new home if there is sufficient interest in saving it. The New Hampshire Geological Survey currently has stewardship of the core and its accompanying data but the survey does not have facilities to properly house the core so is working with GSNH to assess whether the geological community is interested in preserving the core itself. The core was drilled in 1992 and the data that goes along with it include assay reports, drill logs, a map and core logs with photos. If anyone in GSNH is interested in using the core for research, or would like to take on its stewardship and relocation, please contact Rebecca LeCain with NHGS at geology@des.nh.gov. See photo next page.

Example of core material looking for a new home

What's Your Board Been Doing?

By Rebecca LeCain

The GSNH Board of Directors met on Thursday September 15th via Zoom. They mostly worked on logistics for the upcoming October meeting (see second to last page of this newsletter for details) and the elections for board members!

Other matters discussed during the meeting included the following:

- It was decided that the meeting on January 19th, 2023, will be virtual so everyone can avoid going out in potentially bad weather.
- There was consideration of topics for the 2023 field trip – stay tuned for more information!

The next board meeting is planned for December 8. Please reach out to a Board member if you'd like to attend.

Volcanoes on Mars Could be Active, Raising Possibility that Planet was Recently Habitable

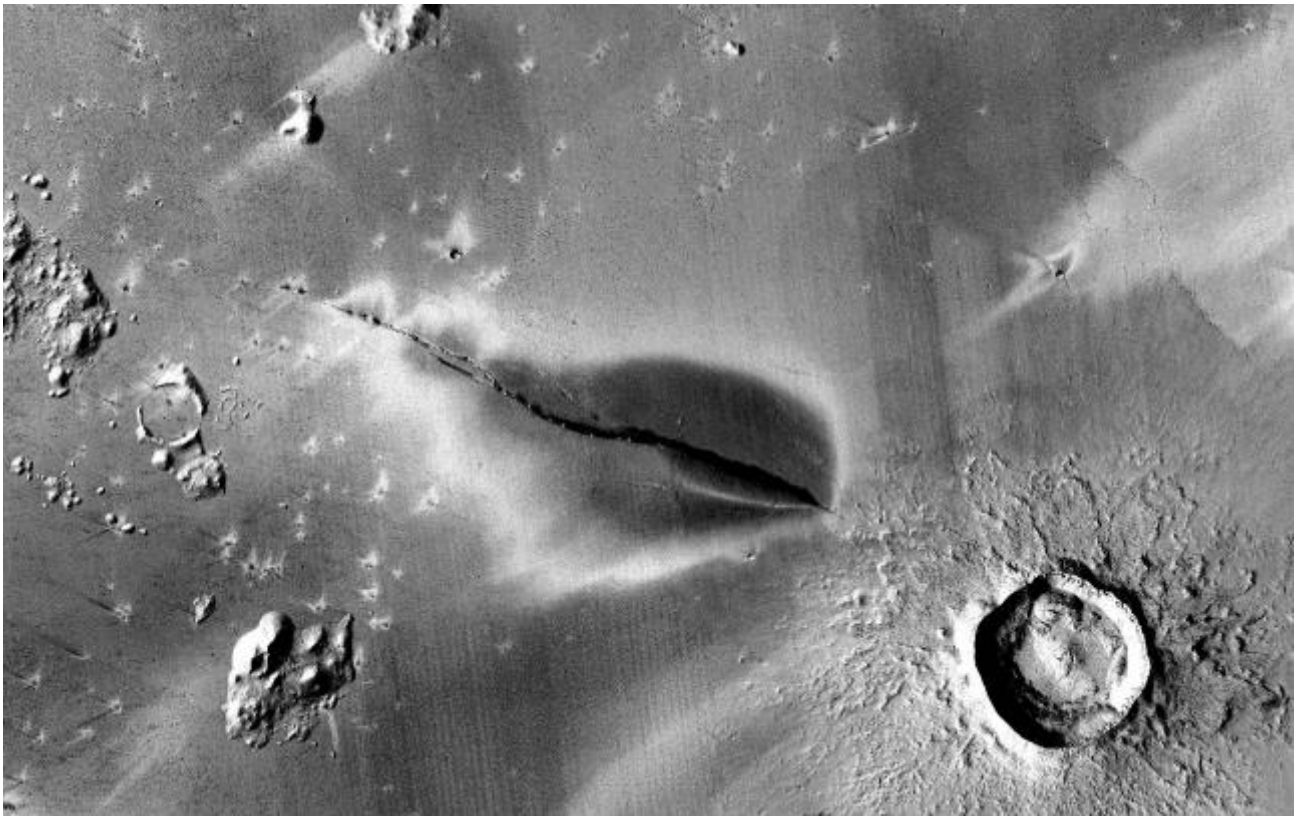
From Daniel Stolte and Alan Fischer, University of Arizona. May 6, 2022.
https://news.arizona.edu/story/volcanoes-mars-could-be-active-raising-possibility-planet-was-recently-habitable

Evidence of recent volcanic activity on Mars shows that eruptions could have taken place in the past 50,000 years, according to new study by researchers at the University of Arizona's Lunar and Planetary Laboratory and the Planetary Science Institute.

Most volcanism on the Red Planet occurred between 3 and 4 billion years ago, with smaller eruptions in isolated locations continuing perhaps as recently as 3 million years ago. But, until now, there was no evidence to indicate Mars could still be volcanically active.

Using data from satellites orbiting Mars, researchers discovered a previously unknown volcanic deposit. They detail their findings in the paper "Evidence for geologically recent explosive volcanism in Elysium Planitia, Mars," published in the journal Icarus.

"This may be the youngest volcanic deposit yet documented on Mars," said lead study author David Horvath, who did the research as a postdoctoral researcher at UArizona and is now a research scientist at the Planetary Science Institute. "If we were to compress Mars' geologic history into a single day, this would have occurred in the very last second."



Recent explosive volcanic deposit around a fissure of the Cerberus Fossae system.
NASA/JPL/MSSS/The Murray Lab

The volcanic eruption produced an 8-mile-wide, smooth, dark deposit surrounding a 20-mile-long volcanic fissure.

"When we first noticed this deposit, we knew it was something special," said study co-author Jeff Andrews-Hanna, an associate professor at the UArizona Lunar and Planetary Laboratory and the senior author on the study. "The deposit was unlike anything else found in the region, or indeed on all of Mars, and more closely resembled features created by older volcanic eruptions on the Moon and Mercury."

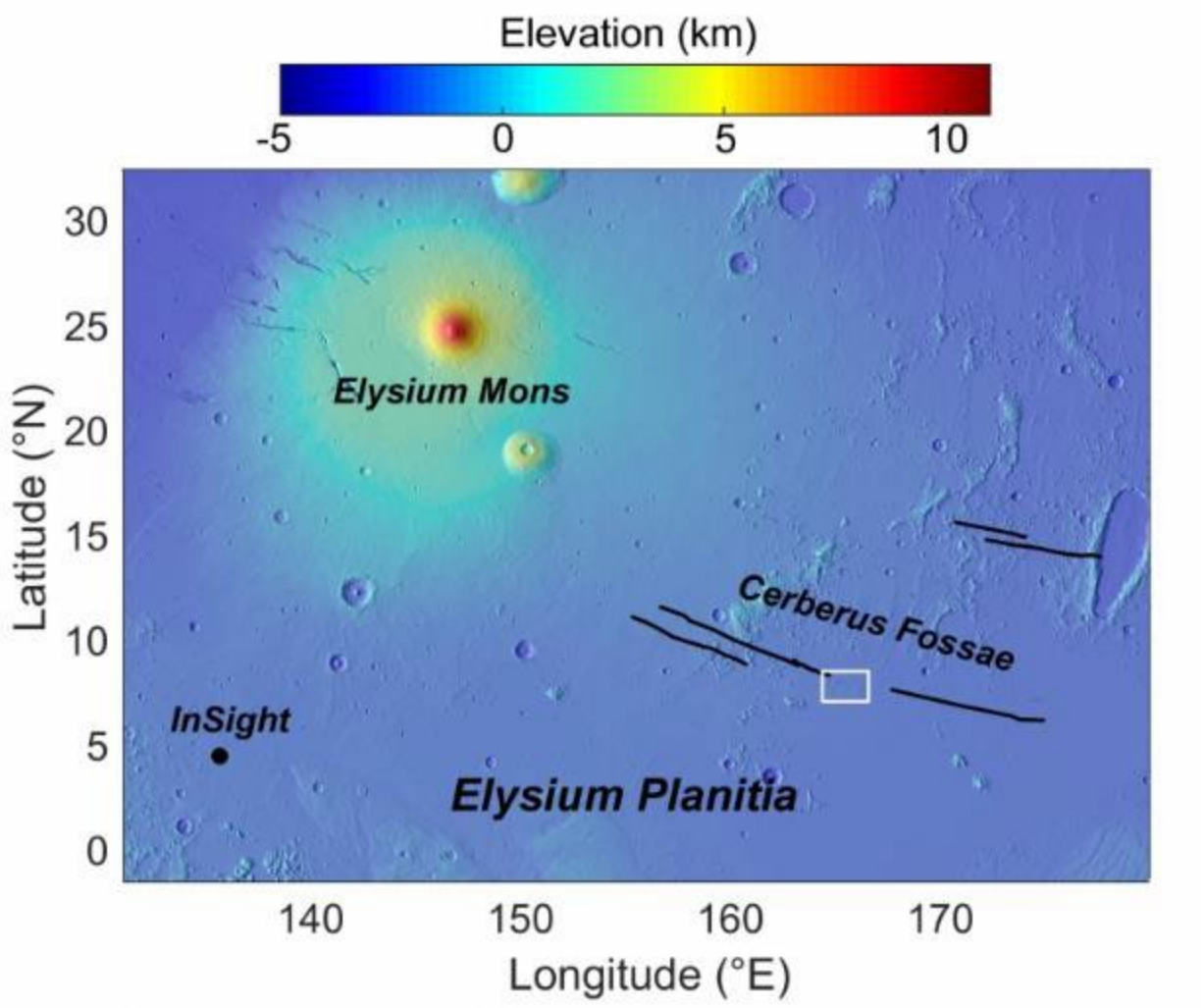
Further investigation showed that the properties, composition and distribution of material match what would be expected for a pyroclastic eruption – an explosive eruption of magma driven by expanding gasses, not unlike the opening of a shaken can of soda.

The majority of volcanism in the Elysium Planitia region and elsewhere on Mars consists of lava flowing across the surface, similar to recent eruptions in Iceland being studied by co-author Christopher Hamilton, a UArizona associate professor of lunar and planetary sciences. Although there

are numerous examples of explosive volcanism on Mars, they occurred long ago. However, this deposit appears to be different.

"This feature overlies the surrounding lava flows and appears to be a relatively fresh and thin deposit of ash and rock, representing a different style of eruption than previously identified pyroclastic features," Horvath said. "This eruption could have spewed ash as high as 6 miles into Mars' atmosphere. It is possible that these sorts of deposits were more common but have been eroded or buried."

The site of the recent eruption is about 1,000 miles (1,600 kilometers) from NASA's InSight lander, which has been studying seismic activity on Mars since 2018. Two Marsquakes, the Martian equivalent of earthquakes, were found to originate in the region around the Cerberus Fossae, and recent work has suggested the possibility that these could be due to the movement of magma deep underground.



Elysium Planitia, the region of recent explosive volcanism (white box) and NASA's InSight lander. Overlooking the plain is Elysium Mons, a volcano towering nearly 8 miles above its base.
MOLA Science Team

"The young age of this deposit absolutely raises the possibility that there could still be volcanic activity on Mars, and it is intriguing that recent Marsquakes detected by the InSight mission are sourced from the Cerberus Fossae," Horvath said. In fact, the team of researchers predicted this to be a likely location for Marsquakes several months before NASA's InSight lander touched down on Mars.

A volcanic deposit such as this one also raises the possibility for habitable conditions below the surface of Mars in recent history, Horvath said.

"The interaction of ascending magma and the icy substrate of this region could have provided favorable conditions for microbial life fairly recently and raises the possibility of extant life in this region," he said.

Similar volcanic fissures in this region were the source of enormous floods, perhaps as recently as 20 million years ago, as groundwater erupted out onto the surface.

Andrews-Hanna's research group continues to investigate the causes of the eruption. Pranabendu Moitra, a research scientist in the UArizona Department of Geosciences, has been probing the mechanism behind the eruption.

An expert in similar explosive eruptions on Earth, Moitra developed models to look at the possible cause of the Martian eruption. In a forthcoming paper in the journal Earth and Planetary Science Letters, he suggests that the explosion either could have been a result of gases already present in the Martian magma, or it could have happened when the magma came into contact with Martian permafrost.

"The ice melts to water, mixes with the magma and vaporizes, forcing a violent explosion of the mixture," Moitra said. "When water mixes with magma, it's like pouring gasoline on a fire."

He also points out that the youngest volcanic eruption on Mars happened only 6 miles (10 kilometers) from the youngest large-impact crater on the planet – a 6-mile-wide crater named Zunil.

"The ages of the eruption and the impact are indistinguishable, which raises the possibility, however speculative, that the impact actually triggered the volcanic eruption," Moitra said.

Several studies have found evidence that large quakes on Earth can cause magma stored beneath the surface to erupt. The impact that formed the Zunil crater on Mars would have shaken the Red Planet just like an earthquake, Moitra explained.

While the more dramatic giant volcanoes elsewhere on Mars – such as Olympus Mons, the tallest mountain in the solar system – tell a story of the planet's ancient dynamics, the current hotspot of Martian activity seems to be in the relatively featureless plains of the planet's Elysium region.

Andrews-Hanna said it's remarkable that one region hosts the epicenters of present-day earthquakes, the most recent floods of water, the most recent lava flows, and now an even more recent explosive volcanic eruption.

"This may be the most recent volcanic eruption on Mars," he said, "but I think we can rest assured that it won't be the last."

The volcanic deposit described in this study, along with ongoing seismic rumbling in the planet's interior detected by InSight and possible evidence for releases of methane plumes into the atmosphere detected by NASA's MAVEN orbiter, suggest that Mars is far from a cold, inactive world, Andrews-Hanna said.

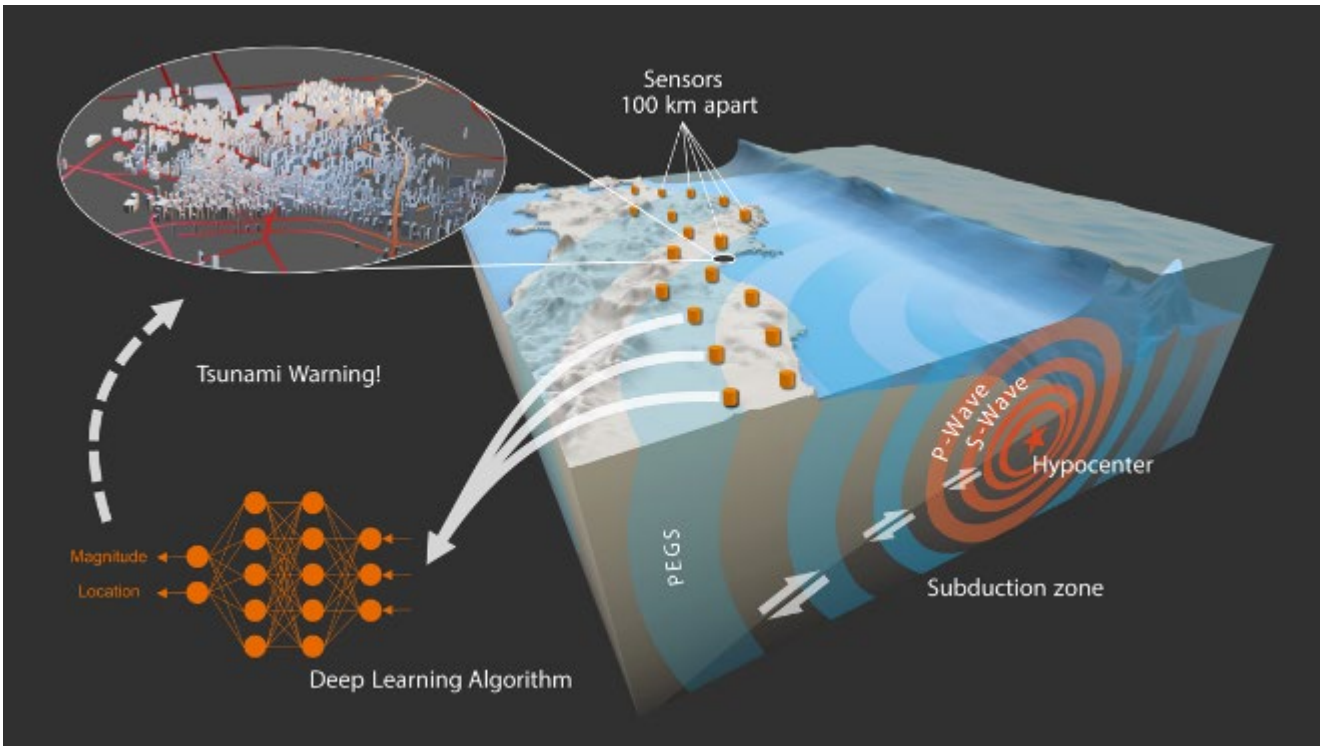
"All these data seem to be telling the same story," he said. "Mars isn't dead."

Monitoring Earthquakes at the Speed of Light

By Mohammed El-Said. Eos. Published June 2, 2022.
https://eos.org/articles/monitoring-earthquakes-at-the-speed-of-light

Earthquakes and the tsunamis they generate have caused almost a million casualties in the past 30 years. Many alert systems have been developed to limit the human and material costs of these natural disasters. However, these systems have difficulties in estimating quickly and accurately the magnitude of very large earthquakes.

Now, a study published in *Nature* has described a machine learning model that recognizes patterns in seismic data to better estimate the magnitude and location of a large earthquake.



Scientists recently developed a deep learning algorithm to estimate large earthquakes' magnitudes on the basis of prompt elastogravity signals (PEGS) traveling at the speed of light, much faster than the seismic (P and S) waves traditionally used in early-warning systems. Credit: Lina Jakaite

Using 350,000 modeling scenarios of earthquakes initiating at 1,400 potential earthquake locations in Japan, Andrea Licciardi, a geophysicist at the Université Côte d'Azur in France, and his colleagues succeed in instantaneously estimating the magnitude of large earthquakes on the basis of prompt elastogravity signals (PEGS).

PEGS are gravitational perturbations generated by the motion of large masses of rocks during an earthquake. They propagate at the speed of light, carrying earthquake information much faster than seismic waves traditionally used in early-warning systems.

Scientists have known that although in principle PEGS could help speed up earthquake warnings, their very weak amplitude has prevented their use in alert systems. The researchers in the new study overcame this limitation thanks to an artificial intelligence algorithm based on Global Navigation Satellite System data. Using the algorithm, they showed that the magnitude of large earthquakes could be accurately estimated on the basis of PEGS seconds after the earthquake starts and tracked as the earthquake grows.

"I believe that this paper is interesting. Actually, the discovery of PEGS was already done in my paper of 2016 and then confirmed in the paper of Vallée et al. in 2017," said Jean-Paul Montagner, a geoscientist at the Institut de Physique du Globe de Paris who was not involved in the new research.

“So what is innovative in this paper is the use of machine learning techniques, which makes it possible to improve the detection of these very small signals.”

Licciardi agreed. “The main advantage of our model relies on the underlying data, the elastogravity signals,” he explained. “Once an earthquake occurs, these signals travel faster than seismic waves and are strongly sensitive to the earthquake magnitude.…Because of that, our model can estimate the magnitude of the earthquake faster and more accurately than conventional early-warning systems based on P waves at least for large earthquakes (magnitude above 8.3/8.4).”

Improving Tsunami Early Warning

Licciardi pointed out that the model’s response time of about a minute can dramatically improve tsunami early-warning forecasts. In a real-time scenario, he said, the magnitude retrieved by the model can be used to quickly estimate the size of the induced tsunami wave and therefore mitigate its impact.

“Classical early-warning systems based on P waves can’t distinguish between a magnitude 8 and a magnitude 9 earthquake, while our model does not suffer from this limitation,” said Licciardi. “It provides the most accurate estimation of magnitude as a function of time.”

The new model’s strength in forecasting large earthquakes “is because the elastogravity signal is strongly sensitive to the magnitude of such large earthquakes,” Licciardi explained. “In fact, the applicability of our model is limited to such large earthquakes (magnitude above 8.3/8.4) because the signal’s amplitude for relatively smaller earthquakes is too small and buried in the background noise. This is why other tools and data are still needed in the context of early warning.”

“This is important for earthquake early-warning systems because for the largest earthquakes there is an extended time (up to minutes) in which they gather magnitude and strength,” explained Andreas Plesch, a senior Earth scientist at Harvard University who was not involved in the new work. “The authors correctly point out that during this extended time the method, especially if combined with other methods, has the operational potential to track the growth of such an earthquake earlier and more accurately.”

Plesch further noted that using the new model, tsunami alerts could be issued not only earlier (by tens of seconds or perhaps even minutes) but also more confidently and with better wave height estimates derived from improved magnitude estimates.

Mummified, baby woolly mammoth frozen over 30,000 years ago found in Canada: 'It's amazing'

By Wyatte Grantham-Philips, USA Today. Published June 25, 2022.
https://www.usatoday.com/story/news/world/2022/06/25/canada-mummified-baby-woolly-mammoth/7735393001/

Miners in Canada have found a mummified, baby woolly mammoth that scientists believe was frozen during the Ice Age over 30,000 years ago, according to a news release from the Yukon government and Tr'ondek Hwech'in First Nation.

According to the release, the woolly mammoth was uncovered while miners were excavating through the permafrost on Tuesday, in Klondike gold fields within the Tr'ondëk Hwëch'in traditional territory.

The baby was later identified to be a young, female woolly mammoth who died tens of thousands of years ago.

The mammoth calf was named Nun cho ga, meaning "big baby animal" in the Hän language, by Tr'ondëk Hwëch'in Elders.

"It's amazing. It took my breath away when they removed the tarp," Tr'ondëk Hwëch'in Elder Peggy Kormendy said in a statement. "We must all treat it with respect. When that happens, it is going to be powerful and we will heal. We must as a people."

The government news release also noted that Nun cho ga is the "first near complete and best-preserved mummified woolly mammoth found in North America." In 1948, another partial calf, Effie, was found in Alaska.

"As an ice age palaeontologist, it has been one of my life long dreams to come face to face with a real woolly mammoth. That dream came true today," stated Dr. Grant Zazula, a paleontologist in Yukon. "Nun cho ga is beautiful and one of the most incredible mummified ice age animals ever discovered in the world. I am excited to get to know her more."

According to National Geographic, woolly mammoths roamed North America, Asia and Europe from about 300,000 years ago up until around 10,000 years ago – with others estimating they disappeared

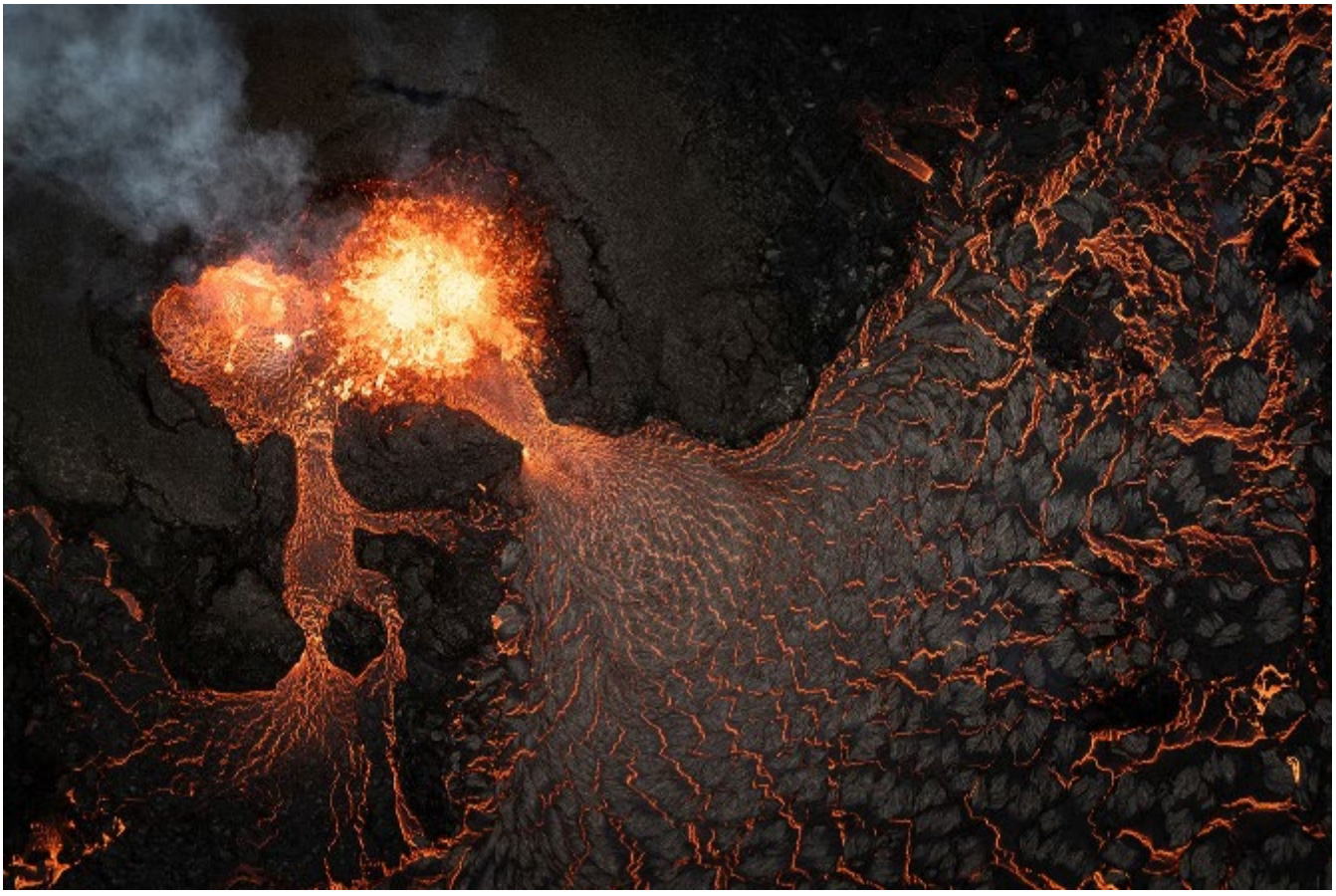
as recently as around 4,000 years ago. Their extinction has been commonly attributed to humans, but 2021 research suggests the species disappeared because of climate change.

See Iceland Aglow in Volcanic Eruptions

By Sasha Warren, Scientific American, August 24, 2022.
https://www.scientificamerican.com/article/see-iceland-aglow-in-volcanic-eruptions/

Breaking more than seven months of calm, the peninsula of Reykjanes in western Iceland has once again burst into volcanic flames. After a swarm of earthquakes in late July and early August rocked the area, lava burst forth from the Fagradalsfjall volcano into the valley of Meradalir—not far from the barely cooled lava from the same volcano's 2021 eruption—treating tourists and researchers to the vibrant red-orange glow of fresh molten rock just 20 miles from Iceland's capital of Reykjavk.

Such striking volcanic displays are relatively common in Iceland. The entire country, which is one of the geologically youngest landmasses in the world, is the product of millions of years of eruptions and is perfectly placed for ongoing volcanic activity.



Fagradalsfjall volcanic eruption in 2022. Credit: Jeroen Van Nieuwenhov

Iceland straddles the boundary between two of the earth's tectonic plates: enormous fragments of crust that fit together like puzzle pieces to form our planet's rocky outer shell. The North American and Eurasian plates are pulling away from each other at a rate of one to two inches per year, gradually unzipping the floor of the Atlantic Ocean to form a mid-ocean ridge. This divergence leaves a gap that draws up material from the earth's mantle, a hot layer of rock sandwiched between the crust (the layer we live on) and our planet's metal core).

Fagradalsfjall 2022 eruption. Credit: Jeroen Van Nieuwenhov

As it rises, this material partially melts, supplying Icelandic volcanoes with magma, but this isn't the only source of molten rock in the region. Iceland, like Hawaii, is perched above a "hotspot," a column of hot rock that rises through the mantle, driven by its own buoyancy, which adds yet more fuel to the island's volcanic fires.

In Iceland, this combination of magma sources expresses itself as several different kinds of volcanoes. The towering cone of Hekla in the south is closer to the mantle hotspot, whereas the strings of small craters and fissures now forming in Reykjanes's volcanic systems are where the plate boundary comes onshore.

Fagradalsfjall 2021 eruption. Credit: Jeroen Van Nieuwenhov

“The kind of volcanic eruptions that take place in this area [Reykjanes] are not originating from the typical cone-shaped mountain but more through openings in the crust,” says Sara Barsotti, coordinator for volcanic hazards at the Icelandic Meteorological Office (IMO). These openings occur because the area is located along a kink in the mid-ocean ridge, and the cracks form as a result of the two plates moving apart at an odd angle. Some of these cracks fill with magma, which can eventually erupt, whereas others allow chunks of crust to slide past one another, leading to earthquakes. Magma moving through the crust can also cause seismic activity as new cracks form or widen to accommodate the molten rock.

Fagradalsfjall 2021 eruption. Credit: Jeroen Van Nieuwenhov

As the mid-ocean ridge spreads, Reykjanes cycles through quiet periods, typically lasting 800 to 1,000 years, followed by two or three centuries of spectacular eruptions, which scientists studying Iceland suspect could be starting now. During the 1990s, well before the Fagradalsfjall eruption began in 2021, geophysicist Sigrun Hreinsdóttir, now at the New Zealand geoscience research and consulting company GNS Science, Te Pū Ao, set up GPS stations throughout the peninsula to monitor the area's slow shifting, bending and buckling, accompanied by small earthquakes. At the time, there were no active eruptions.

Looking back, though, Hreinsdóttir says, these measurements may have captured the first signs of new volcanic action in the region. "There was a lot of activity in [the mountain] Hengill, at the edge of Reykjanes Peninsula—lots of earthquakes," she explains. All the action led scientists to suspect a magma chamber was filling up deep below the surface, and "we were wondering if that was kind of the first sign that Reykjanes might be close to coming alive."

Fagradalsfjall 2021 eruption. Credit: Jeroen Van Nieuwenhov

Now, it seems, the peninsula is truly waking up. Since the late 2000s, magma injected beneath the surface has caused the area to periodically inflate and deflate, bulging to accommodate the movements of molten rock underground. Barsotti and her colleagues at IMO track the locations of these reservoirs using earthquakes, GPS and satellite imagery to try to anticipate which parts of Reykjanes are most primed for future eruptions. The final warning sign was a cluster of large earthquakes that shook western Iceland before the first fissures opened in 2021.

After longing to see an eruption on every day of her fieldwork on the peninsula around 30 years ago, Hreinsdóttir could only watch her dream come true from afar, as COVID kept her home in New Zealand in 2021. This August, however, she went on a pilgrimage to lay her hands on the cooled lava from last year, and her six-year-old son was knocked off his feet by a magnitude 4.5 earthquake. This August 2 quake turned out to be a warning for an eruption on the very next day that would prove to be even bigger and more spectacular than the one she had missed. “It was quite a nice feeling for me,” she says. “It felt like Fagradalsfjall was just saying, ‘Hello!’”

On August 3, Hreinsdóttir hiked out to Meradalir with her colleagues from the University of Iceland, where she was previously affiliated, and some 1,800 other visitors to see the fluorescent orange glow of lava fountaining up from between the rocks of her former study area. Like in the 2021 Fagradalsfjall eruption, volcanologists expect new lava to keep emerging here for several months.

The eruption is already a hotspot for hikers and photographers. So far it is “pretty safe,” says Barsotti, who is monitoring the volcanic activity closely for potential hazards. “But I think we also need to know there is always uncertainty in what we can anticipate to be next.” The ongoing eruption is just an hour’s drive from Reykjavík, so IMO’s volcanologists are using data and models to assess current and future risks to infrastructure, water quality and human health caused by the lava and gases emanating from the new fissure.

Although the eruption itself presents some dangers to tourists, including noxious fumes and unimaginably hot molten rock, perhaps the greatest challenge facing those who want to see it is the two-hour hike to get there. “It is important to check on the IMO website for the conditions expected because we are going toward autumn—it might be very cold; it might be very windy,” Barsotti says. As a result, children age 12 and under and pets are prohibited from entering the eruption area.

Fagradalsfjall 2021 eruption. Credit: Jeroen Van Nieuwenhov

Those that make it, though, are in for an enviable sight. “I’m jealous of myself, to be honest,” Hreinsdóttir says, although eruptions may occur as often as every few years now that Reykjanes has awakened from its roughly 800-year slumber. “How lucky was it that I was alive when this was happening?”

Fagradalsfjall 2021 eruption. Credit: Jeroen Van Nieuwenhov

Fagradalsfjall 2021 eruption. Credit: Jeroen Van Nieuwenhov

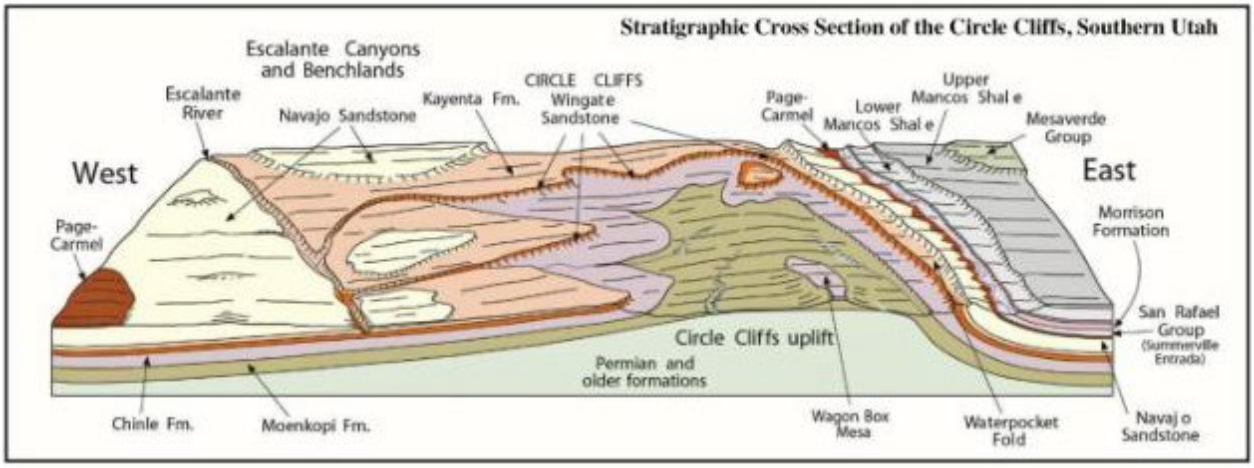
First Light on the Circle Cliffs Anticline

From Earth Science Picture of the Day, September 1, 2022.
Photographer and Summary Author: Thomas McGuire
https://epod.usra.edu/blog/2022/09/first-light-on-the-circle-cliffs-anticline.html

Baseball player Yogi Berra was famous for quotations such as “It’s so crowed, nobody goes there anymore.” Perhaps they shouldn’t.

While places such as the Grand Canyon, Yellowstone and Yosemite host crowds that often overrun the facilities, as well as overrunning the visitor experience, other scenic sites in the United States are, arguably, just as beautiful and virtually undiscovered. One such place is the Grand Staircase-Escalante National Monument in southern Utah. Both the variety of landforms and the expansive size make this a crown of the hidden jewels.

The Circle Cliffs is an anticline in which the central portion has been eroded down, while exposing the youngest layer as cliffs that surround the internal valley. This anticline encompasses hundreds of square miles of juniper, dotted high desert. In most of the Monument, facilities are non-existent. The Burr Trail is a paved road that crosses the Circle Cliffs Valley. Other roads are unpaved.



From: Geology of Grand Staircase-Escalante National Monument, Utah: Hellmut H. Doelling, Robert E. Blackett, Alden H. Hamblin, J. Douglas Powell, and Gayle L. Pollock

Grand Staircase-Escalante National Monument, Utah Coordinates: 37.4609, -111.5943

Related Links

- The Grand Staircase
- Waterpocket Fold in Capital Reef National Park (The eastern edge of the Circle Cliffs)
- Author's Earth Science Textbooks

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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.

September 30 – October 2, 2022 – **New England Intercollegiate Geological Conference**, hosted by Mt. Holyoke College. https://neigc.info/neigc-annual-conference/

October 9-15, 2022 – **Earth Science Week 2022** – For more information, see https://www.earthsciweek.org/

October 13, 2022 – **GSNH dinner meeting** – This will be our first "post-COVID" in-person meeting; see announcement on next page.

October 17-20, 2022 – **38th Annual International Conference on Soils, Sediments, Water, and Energy**, hosted by UMass Amherst. https://www.aehsfoundation.org/East-Coast-Conference.aspx

November 19-20, 2022 – **Worcester Mineral Club 45th Jewelry, Gem, Mineral and Fossil Show** – St Joseph School, Richard Nowak Gymnasium, 47 Whitcomb Street, Webster, MA. https://worcestermineralclub.org/annual-shows/

December 8, 2022 – **GSNH Board of Directors Meeting**, via Zoom.

January 19, 2023 – **GSNH meeting**, presenter TBD; this will be a virtual meeting hosted on Zoom.

April 20, 2023 – **GSNH dinner meeting**, location TBD.

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: https://www.americangeosciences.org/workforce/goli

Geological Society of New Hampshire

Topic: Facing the Forest: Human Adaptations Across the Pleistocene-Holocene Transition in Northern New England
Speaker: Dr. Nathaniel Kitchel, Postdoctoral Fellow, Dartmouth College, New Hampshire

Thursday, October 13, 2022
Location: Makris Lobster & Steak House
Route 106, Concord, NH 03301

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

RSVP by 4 pm Friday, October 7, 2022 to get the reservation price
SPACE AT THIS VENUE IS LIMITED... RESERVE EARLY!

Advance Reservations: _____Member (Dues Paid) $35.00
_____Non-member $40.00

- Students $20.00 with valid student ID card (Reservation Requested)
- Member at the Door $37.00
- Non-Member at the Door $42.00

Checks payable to: GSNH

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

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

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

Name(s) _____

Address: _____

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

MEMBERSHIP & RENEWAL APPLICATION

Geological Society of New Hampshire

PO Box 401, Concord, NH 03302

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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: _____