Granite State Geologist

~ 30 Years of GSNH! ~

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

I have been working from home for well over a hundred business days at this point. Month after month of purposely avoiding people. To quote Pink Floyd, "Is there anybody … out there?" We have learned to talk to pictures on computer screens like Dick Tracy on his wrist radio. It's not just a little isolating missing our dinner meetings and field trips with their opportunities to hobnob with all of you.

But the picture isn't all bleak. The Board is planning for both real and virtual dinner meetings, as early as next January, just in case, and we have hopes for a real 2021 field trip.

So what should you envision for the near future from GSNH? Here's the picture of Society events for at least this meeting. GSNH will hold a virtual Annual Meeting on October 15 at 7pm. (Not the same Bat station, not the same Bat time.) Well, the good news is that you can get CEHs for FREE! But drinks and dinner are on your own.

The meeting will start with a vote on changing to our bylaws and constitution to allow these virtual meetings. Then we will open up the election for the new Board of Directors. We will still have updates and announcements as well as a forecast of future meetings and field trips. If you have job openings or are looking, we'll have time for that, too.

And our first virtual presentation. Our presenter, Mike Wimsatt, the Director of the NHDES Waste Management Division will give a presentation on where New Hampshire is and where it is going with the PFAS problem.

Finally, this is my last column as GSNH president and the virtual Annual Meeting will be the last time I coordinate a GSNH dinner meeting. Virtually isn't at all the way I had pictured passing the gavel. So I'll take this opportunity to thank the members of the Board, past and present, who have made my job so easy. I frequently marveled at how they never failed to step up to do what needed to be done. Both on the Board and Society levels. Each one of them has shouldered a portion of the load and taken responsibility for one or more tasks making this Society function. I thank you. I encourage you all to give them a 'well done' – they deserve it.

So wind up your Dick Tracy watch and tune in to our Zoom conference call to join our Annual Meeting, vote, get updates and hear a fascinating presentation. Get the picture?!?

The October Meeting is Going Virtual!

Our October meeting will be held on October 15, 2020 as a virtual meeting, so you'll need to arrange for your own dinner this time. The meeting will start with a vote on the changes to the GSNH constitution and bylaws (starting on page 4 below). Michael Wimsatt, PG, Director of the NHDES Waste Management Division, will give a presentation on New Hampshire's response to PFAS contamination, and attendees will receive a continuing education form. We will also have our 2020 election at this meeting; see page 14 below for the slate of candidates who are running for positions on the GSNH Board. You will need to be a member in good standing in order to vote; that means you'll need to be up to date with your dues! See membership and renewal application form at the end of this newsletter.

Please keep an eye out for an upcoming email providing registration and other details. You will need to register in order to receive the Zoom invitation; you can register by emailing Sharon Lewandowski (Sharon.A.Lewandowski@des.nh.gov). Folks who have registered will receive a zoom link for the meeting a few days before. The meeting will start at 7PM. Hope to see you there!

GSNH Milestones

By Jenny Lambert

We have a few major milestones this year: GSNH was incorporated 30 years ago, on October 24, 1990! The first newsletter was produced in March 1992 and has been running more or less quarterly ever since.

GSNH start and early years

The organization originally called the New Hampshire Geological Society (NHGS) was started by a group of geologists including Ray Talkington, Tom Shevenell, Brian Fowler, Gary Smith, John Cotton, and Dick Lane (first president). It was modeled after the Maine and Vermont geological societies. The

first general meeting took place in September 1990, and was attended by approximately 30-40 geologists. Attendees who paid the initial dues received a certificate stating that they were charter members of the organization – some still have the certificates!

Early meetings were held at the Wayfarer Inn and Restaurant in Bedford and later, the Cat 'n Fiddle in Concord. Presentations were a standard part of the meeting early on, and the schedule of three meetings plus a summer field trip was established early as well. The first newsletter was produced in March 1992 and has been running more or less quarterly ever since.

NHGS, NHCPG, and licensing

At the January 1998 NHGS meeting, John Regan of the New Hampshire Department of Environmental Services (NHDES) mentioned that NHDES would start to enforce their existing administrative rules requiring licensed professionals to sign reports. At the time, only professional engineers (PEs) could sign those reports. This provided the spark to work toward licensing geologists in the state.

NHGS members were concerned that the NHGS' tax free status would be jeopardized by getting involved with lobbying and politics. Therefore, a separate organization was established to work toward licensing geologists: the New Hampshire Council of Professional Geologists (NHCPG), which was modeled after a similar group in New York. NHCPG raised money from individual and corporate sponsors and hired a lobbyist. In June 2020, Governor Jeanne Shaheen signed the legislation establishing the New Hampshire licensure for professional geologists (PGs). Dorothy Richter and John Cotton were issued PG numbers 1 and 2 to recognize their efforts in working through the legislative process.

After the bill was signed, the NHCPG dissolved and folded back into the NHGS, as both groups had similar interests. As part of the reorganization, two representatives were incorporated into the society: a Society Vice President and a Council Vice President to keep an eye on the legislature and issues with PG licenses.

At around the same time, the society changed its name to the Geological Society of New Hampshire at the request of the State Geologist, David Wunsch, who wanted to prevent confusion with the New Hampshire Geological Survey.

The first New Hampshire Board of Professional Geologists was appointed by Governor Shaheen in 2001 and consisted of four geologists (Dorothy Richter, John Cotton, Paul Sanborn, and Timothy

Allen) and one public member (attorney Ronald Cook). All five board members were appointed for initial 5-year terms but staggered renewal terms. The State geologist was later added as an *ex officio* member of the board. The first group of PG applicants were grandfathered in based on references, educational requirements, and years of experience; they were not required to take the Association of State Boards of Geology (ASBOG) exam. In the past 20 years, the PG board has issued more than 900 licenses, more than 500 of which are currently active.

Special thanks to Dorothy Richter, Tina Cotton and Lee Wilder for help with filling in the early days of GSNH.

Concord Monitor – drought impacts on drinking water wells

Abby Fopiano, GSNH Treasurer, was quoted on a September 16 front-page Concord Monitor article about the impact of the current drought on water levels (online publication 9/15). See: https://www.concordmonitor.com/drought-wells-concord-new-hampshire-nh-36255123

Changes to GSNH Constitution and Bylaws – October 2020

Below is the existing text of the GSNH Constitution and By-Laws, with proposed edits and alterations as shown in red underlined and crossed out text. These proposed changes were discussed and unanimously approved by the Board of Directors to bring to the membership for consideration at the September 17 Board meeting. Based on guidance from the Attorney General's office nonprofit staff, the purpose of these changes is to amend the Constitution to provide GSNH the official authorization to hold any of its meetings in an electronic, virtual format, if deemed necessary by the Board. The proposed amendments to the By-Laws are to clarify the procedure for ballot voting at a virtual meeting when needed, and to clarify how the method of a virtual meeting will be conveyed to the membership and that such method (i.e., Zoom) provides the ability of the members to communicate with each other.

We encourage you to review these prior to the October 15 meeting. The proposed changes will be briefly explained at the meeting, and members will have the opportunity to comment or ask questions at the meeting prior to the vote.

CONSTITUTION

ARTICLE 1: NAME AND FORM

The name of the organization shall be the Geological Society of New Hampshire, Inc., a non-profit, non-capital stock corporation. The organization hereafter shall be referred to as the GSNH.

ARTICLE II: PURPOSE AND MISSION.

The purpose and mission of the GSNH shall be to:

1. Advance the science of geology and its related fields by encouraging education, research, service, and public awareness through the holding of meetings, exchange of information, and providing a common union of its members.

2. Contribute to the public education and understanding of the geology of New Hampshire, including the dissemination of knowledge of New Hampshire geology to interested professions, groups and individuals.

3. Strengthen the role and importance of geology to the environmental concerns of New Hampshire and advance the geologic sciences as a profession through the support of the practice of licensed professional geologists in New Hampshire.

4. Promote the protection of public health, safety and welfare, and the environment through the support of high standards of ethical conduct within the professional and educational practices of geologic science.

ARTICLE III: MEMBERSHIP.

1. Membership in GSNH may be obtained through submittal of a membership form to the Treasurer and payment of annual dues, as provided in Article III of the Bylaws.

2. All members have full voting rights when present at the Annual Meeting or other membership meetings.

ARTICLE IV: MANAGEMENT.

The affairs of GSNH shall be managed by the Officers and Board of Directors, elected at regular terms, by the voting membership. The Officers and Board of Directors constitute the managing body.

ARTICLE V: MEETINGS.

GSNH shall hold one Annual Membership Meeting every even numbered year for the sole purpose of electing a Board of Directors. Other business as may properly come before the meeting may be raised during any Annual Meeting. The Annual Meeting shall be held at such time and place as the Board of Directors may from time to time prescribe. Other membership meetings and Board meetings may also be held as deemed desirable by the Board of Directors. The Board of Directors may convene the Annual Meeting, other membership meetings and Board meetings in person and/or by audio and/or by video teleconference, referred to as a "virtual meeting."

ARTICLE VI: OFFICERS & BOARD OF DIRECTORS.

The officers of GSNH shall be an elected President, Vice President (Society Branch), Vice President (Professional Geologist Branch), Secretary, and Treasurer. The Board of Directors shall consist of the five (5) officers, the immediate Past-President, and the three (3) elected Members-at-Large.

ARTICLE VII: DISPOSITION OF CORPORATE ASSETS.

Dissolution of the GSNH will require a two-thirds vote of the GSNH members present and voting at a membership meeting of the GSNH. In the event the GSNH dissolves after paying or making provision for the payment of any outstanding debts, the Board of Directors shall distribute all remaining assets to one or more New Hampshire not-for-profit educational organizations. The assets are to be used by the receiving organization(s), expressly to promote and enhance the public knowledge and understanding of Geology and/or the Earth Sciences.

ARTICLE VIII: BYLAWS

Bylaws, not inconsistent with this Constitution or with the Certificate of Incorporation, shall be adopted at the time of adoption of this Constitution and may be amended as therein provided.
Amendments to Bylaws to this Constitution may be initiated by the Board of Directors, or by a written request signed by 10 members of the GSNH.
Bylaws and Amendments to Bylaws to the Constitution shall become effective upon approval by a two-thirds majority of members voting at the Annual Meeting, provided due notice having been given each member of such proposed changes at least three (3) weeks before the Annual Meeting.

ARTICLE IX: AMENDMENTS.

Amendments to this Constitution may be made at any Annual Meeting of GSNH by a two-thirds vote of the members voting at the Annual meeting, provided due notice having been given each member of such proposed Amendments at least three (3) weeks before the Annual Meeting.

Amendments to this Constitution may be initiated by the Board of Directors, or by a written request signed by 10 members of the GSNH.

BYLAWS

ARTICLE I: MEMBERSHIP.

A. Geological Society of New Hampshire (GSNH) membership is open to all having an interest in Geology or other Earth Sciences, who submit a membership form and pay annual dues as provided in Article III of these Bylaws.

B. Members in good standing shall have the right and privilege to vote at membership meetings when present, as well as the right to serve on boards and committees.

ARTICLE II: FISCAL YEAR.

The fiscal year of the GSNH shall be the same as the calendar year.

ARTICLE III: DUES.

A. Annual dues for members shall be $20.00 for each fiscal year.

B. Annual dues for student members shall be $10.00 for each fiscal year.

C. Annual dues shall be due on the first day of January of the fiscal year.

D. Changes in dues shall be recommended by the Board of Directors, but shall not become effective until voted and approved by a majority of the members present and voting at the Annual Meeting.

E. The Board of Directors will have the power to establish additional fees and seek additional funds for program and committee activities, as needed.

F. Any member whose dues remain unpaid for six (6) months shall be dropped from membership.

ARTICLE IV: OFFICERS.

A. The officers of GSNH shall be a President, Vice President (Society Branch), Vice President (Professional Geologist Branch), Secretary, and Treasurer. These officers, together with the Past-President and three (3) elected Members-at-Large shall constitute the Board of Directors. The Professional Geologist Vice President and at least one of the Members at Large, must be currently licensed New Hampshire Professional Geologists. In the event the Past-President is unable to fulfill his/her position, an individual will be elected to take the Past Presidents place. The election shall be by majority vote of the members present and voting at the Annual Meeting.

B. The officers shall be elected for a term of two (2) years each. They may not serve more than three (3) consecutive terms in the same office. The Members-at-Large of the Board of Directors shall not serve for more than two (2) terms in that office.

C. No person shall be eligible to serve as an officer or as a member of the Board of Directors who has not been a GSNH member for at least one full year.

ARTICLE V: ELECTIONS.

A. A committee on nominations, consisting of at least two (2) members shall be appointed annually by the Board of Directors no later than the GSNH Board meeting prior to the Annual Meeting. Members of the nomination committee shall serve until the next GSNH Board Meeting following the Annual Meeting.

B. The nomination committee shall solicit nominations for the five (5) elected officers and the three (3) members at large; but not the Past President. The deadline for nominations being four (4) weeks before the Annual Meeting. The nomination committee shall publish a list of nominees at least three (3) weeks prior to the Annual Meeting.

C. Voting shall be by a written ballot vote at the Annual Meeting, when convened in person. The candidate with the highest number of votes shall be declared elected.

D. Voting shall be conducted remotely at the Annual Meeting, when convened through the use of audio and/or video teleconferencing, referred to as a "virtual meeting." The Board shall send the published list of nominees to all members in good standing at least three (3) weeks before the Annual Meeting. Each member in good standing and present at the "virtual meeting" will be provided instructions on how to vote during the meeting, and the vote shall constitute a written ballot for the "virtual meeting." The candidate with the highest number of votes shall be declared elected.

~~D~~E. The Board of Directors shall assume their duties at the first Board of Directors meeting following their election.

~~E~~F. A vacancy in any office, except the Presidency, shall be filled for the unexpired portion of the term by a person elected by the Board of Directors. A two-thirds vote of the Board of Directors shall constitute an election. In the event of the resignation or inability of the President to complete the term of office, the Board of Directors shall call for a special election within two (2) months of such vacancy. Voting shall be by a written ballot vote from the membership. In the event such a special election is held at a virtual meeting, the procedure provided in Section D of this article shall be utilized for the conductance of voting. The candidate with the highest number of votes shall be declared elected.

ARTICLE VI: DUTIES OF THE BOARD OF DIRECTORS.

A. President

The President shall:

1. Preside at meetings of GSNH, and serve as chairman of the Board of Directors.
2. Direct all committees, especially the Membership and Communications Committee, excepting the nominating committee.
3. Determine the duties of the Vice Presidents.
4. Coordinate the work of the Board of Directors and committees, in order that the objectives of the GSNH may be promoted.
5. Submit an annual report to the membership at the Annual Meeting.
6. Represent GSNH at public meetings to promote the purpose and mission of the society. or the President may appoint another GSNH Board or Committee member to do the same.
7. Approve all disbursal of funds.

B. Vice Presidents

The Society Branch Vice President shall:

1. Perform the duties of the President in the event that the President is unable to serve, until such time as a new President is duly elected.
2. Promote membership in GSNH.
3. Coordinate the work of the committees as so directed by the President, especially the Education and Events Committee.
4. Assist the Secretary and Treasurer with their GSNH duties.

The Professional Geologist Branch Vice President shall:

1. Perform the duties of the President in the event that the President or the Society Vice President is unable to serve, until such time as a new President is duly elected.
2. Promote membership in GSNH.
3. Coordinate the work of the committees as so directed by the President, especially the Regulations and Legislative Committee.
4. Assist the Secretary and Treasurer with their GSNH duties.

C. Secretary

The Secretary shall:

1. Record the minutes of all meetings of the GSNH and the Board of Directors.
2. Be responsible for providing each member of the Board of Directors a copy of the minutes of all meetings of GSNH and the Board of Directors.

3. Conduct such correspondence as the Board of Directors may direct.

4. See that notification of all GSNH meetings and the election of candidates is distributed to all members, in a timely manner.

D. Treasurer

The Treasurer shall:

1. Collect and record funds in accordance with the approved budget and/or upon direction of the Board of Directors.

2. Present a financial statement at the Annual Meeting and at other times as requested by the President.

3. Disburse funds and pay all bills by check as approved by the President.

4. Close the books at the end of the fiscal year and submit them for audit to the Board of Directors.

5. Send dues notices to members at least three (3) weeks prior to the date they are due.

E. All Board of Directors

All Board of Directors shall:

1. Perform the duties prescribed in the GSNH Constitution, Bylaws, other statutes and as directed by the Board of Directors, in a legal and reasonable manner.

2. Deliver to their successors all official material, no later than the Board of Directors Meeting following the election.

ARTICLE VII: MEETINGS.

A. Membership meetings shall be held a minimum of three times a year. The Annual Meeting shall be considered a membership meeting.

B. A special meeting of the membership may be called by the Board of Directors as needed.

C. The date, time and place of each meeting shall be determined by the Board of Directors.

D. The method by which meetings are convened by audio and/or video teleconference shall be provided to all members in good standing at least three (3) weeks before the date of the meeting.

E. In the event a meeting is held via audio and/or video teleconference, the method selected must provide members the opportunity to hear and speak to each other.

~~D~~F. The Annual Meeting shall be the governing body of GSNH.

ARTICLE VIII: VOTING BODY.

A. The voting body of any membership or Annual Meeting shall consist of all GSNH members in "good standing" (their annual dues are current), who are present and voting.

B. Each member present shall have but one vote.

C. At the Annual Meeting, those voting members present shall constitute a quorum, five (5) of whom shall be members of the Board of Directors. All meetings shall be announced no less than three (3) weeks prior to the meeting date.

ARTICLE IX: BOARD OF DIRECTORS.

A. Membership and Meetings

1. The Board of Directors shall be comprised of the five (5) officers, the Past-President, and the two (2) Members at Large.

2. The Board of Directors shall meet at the call of the President or upon written request of two of its members.

3. A majority of the current Board of Directors shall constitute a quorum at Board meetings.

B. Duties

The Board of Directors shall

1. Perform the duties delegated to it under these Bylaws.

2. Transact business referred to it by the membership.

3. Receive and pass upon plans of work of chairpersons of committees. Create, authorize, direct, and dissolve all committees and their members.

4. Select the time and place of all meetings, including the Annual Meetings.

5. Submit to the membership such recommendations, as it deems advisable.

6. Take no action in conflict with that of the GSNH Constitution, Bylaws, statute or majority of the GSNH membership.

ARTICLE X: COMMITTEES.

A. Standing Committees

There shall be Standing Committees appointed by the Board of Directors. Current standing committees are Legislative, Regulations, Membership, Communication, Education, and Events. Standing Committees will be made up of a Chairperson who will be appointed by the Board of Directors and an adequate number of members to accomplish the committee goals as directed by the Board of Directors. The Committee Chairpersons of the Legislative and Regulations Standing Committees must be a currently licensed New Hampshire Professional Geologist. The Standing Committees shall report to the Board of Directors at Board meetings.

1. Ad Hoc Committees

1. May be created or dissolved by the Board of Directors as deemed necessary to promote the purpose and mission and carry out the work of the GSNH.

2. Shall consist of a chairperson and such other persons as may be appointed by the Board of Directors.

This constitution and bylaws of the GSNH were developed by the Constitution/Bylaws Committee and represent the final products of drafts prepared on: March 13, 2000; August 28, 2002; August 30, 2002; September 3, 2002; September 4, 2002; September 10, 2002; September 17, 2002, and October 13, 2011.

Progress at the Old Man of the Mountain Plaza at Profile Lake, Franconia Notch State Park, Franconia, NH

From Lee Wilder, OMMLF

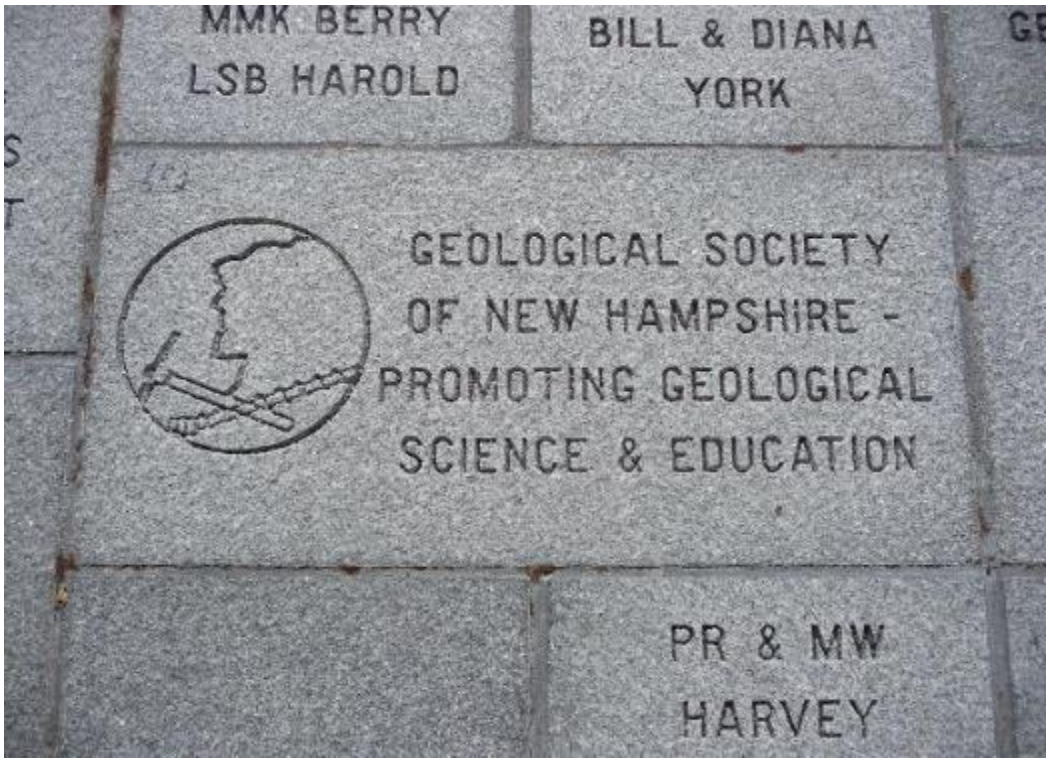
Shortly after the fall of the Old Man on May 3, 2003, then Governor Craig Benson appointed a commission to make recommendations on how to honor the famous New Hampshire Landmark and State symbol. Thus, the Old Man of the Mountain Legacy Fund (OMMLF) was formed. After countless meetings and numerous suggestions and ideas. The Legacy Fund, with the support of hundreds of people and private donations, created the Profiler Plaza in Franconia Notch as a lasting monument to honor the Old Man. http://www.oldmanofthemountainlegacyfund.org/

Recently, as part of the Plaza project, several wooden bridges were built over the inflow and outflow streams of Profile Lake so that Plaza visitors could access the Old Pemi Trail and the Notch's bicycle path and thus walk around profile Lake. This one plus mile path provides spectacular views of Franconia Notch, Profile Lake and the Plaza. Also as part of this project phase, a shorter path leads to a shoreline fishing platform providing handicapped access to Profile Lake.

On Saturday, September 12, 2020, Governor Chris Sununu was present for a ribbon cutting ceremony opening the trail and fishing platform. Partial funding for the trail, bridges, trail map kiosk and fishing platform came from the State's Department of Cultural and Natural Resources (DNCR) / New Hampshire Division of Parks. The Plaza and trail will now be turned over to the New Hampshire Division of Parks and they will maintain them.

The OMMLF will now transition into a "Friends Group" under the DNCR Group Volunteer Program. This Friends Group will also include the Friends of the Madison Boulder. This is important because the residual funds from the improvement of the Madison Boulder Geological Wayside (which the Geological Society of NH has been holding) can now be easily transferred by the GSNH into the Friends of the Old Man and the Madison Boulder, because of their nearly identical missions. https://www.des.nh.gov/organization/commissioner/pip/publications/geologic/documents/madison-boulder-brochure.pdf

In addition, placing these two Friends Groups under the DNCR "umbrella" will bring New Hampshire's only two National Natural Landmark Sites (as recognized by the National Park Service) under more efficient single management. The role of the Friends Group will be to have flexible funds available to see that the Plaza and Boulder continue to serve the best interests of the visiting public.



Your GSNH Board purchased an Old Man Plaza paver. Funds raised by paver sales and public contributions were the sole source of funding for the Plaza's construction.

2020 GSNH Election – Candidates for election

The candidates for the October 2020 elections are listed below. You may also cast a ballot for a write-in candidate of your choosing.

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 two terms as Council Vice 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. 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. Doug is finishing his second term as Society VP and looks forward to serving as Council VP.

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.

Treasurer – Abby Fopiano

Abby Fopiano is the Water Well Program Manager at NH DES. Abby has extensive experience from work as a consultant developing and permitting public water supply wells in MA and NH. She also has expertise in the private sector managing operations associated with an analytical laboratory, water system operations, water well pump installation and well drilling. Abby is a 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 six years, served two terms as a Member-at-Large and is finishing her first term as Treasurer.

Secretary – Shane Csiki

Shane serves as the Fluvial Geomorphologist, and Administrator of the Flood Hazards Program in the New Hampshire Geological Survey. He earned his Ph.D. in Geography from the University of Illinois at Urbana-Champaign in 2014, and a Master's of Public Administration from the University of New Hampshire at Manchester in 2018. Shane's professional interests include river processes, flood hazards and water resources issues. He is enthusiastic about the mission of state geological surveys and in organizations dedicated to a healthy earth science community, as GSNH fulfills in New Hampshire. His personal interests include books, and studying the history of places and our nation's roads and highways. Shane has served two terms as Secretary.

Member-at-Large (Three Positions)

Bill Abrahams-Dematte - Bill is a Project Hydrogeologist/Scientist for AECOM Environment in Chelmsford, MA and Manchester, NH, where he has worked for the last 20 years. Prior to AECOM, Bill worked for Continental Placer in Laconia, NH, as a private consultant in Williston, VT, and for the Vermont Association of Conservation Districts in Montpelier, VT. Bill specializes in environmental site investigations, site characterization and remediation, hydrogeological studies, data management, GIS, and geotechnical work. Bill has been a member of the GSNH for the last 19 years and has held several positions with the Board of GSNH: Council VP for a 1-1/2 year term (2010-2011), Webmaster for the GSNH website (2011-2013), Treasurer (2013-2018) and is finishing his first term as Member-at-Large. His other professional associations include the GSA, NGWA, and AIPG societies as well as being a New Hampshire, Tennessee, & New York licensed PG. Bill lives in Wilton, NH and appreciates the GSNH for providing a means to being more connected with the New Hampshire geological

community, for the excuse to go out and hike around on a bunch of rocks, and for the opportunity to meet new people.

Jennifer Lambert - Jenny is a Senior Hydrogeologist with the Nobis Group in Concord, New Hampshire, working primarily on issues related to contaminant transport in groundwater. She has a B.A. from Hamilton College and a M.Sc. from the University of Waterloo, both in geology. She worked in environmental consulting in Massachusetts and then in Pennsylvania before moving to New Hampshire in 2012. Jenny is a licensed Professional Geologist in Pennsylvania and New Hampshire. She has been a member of GSNH for 7 years, is the current editor of the Granite State Geologist and has served as Member-at-Large for one term.

Leland Wilder - Lee Wilder, BA Geology, 1964, University of New Hampshire. M.Ed. in Administration and Supervision, 1993, University of New Hampshire. Retired from teaching Earth-Space Science after 35 years in NH public schools; an adjunct professor in Earth-Space Science at Colby-Sawyer College for 10 years and Public Outreach Coordinator for the NH Geological Survey for 17 years. Member and officer of the Hopkinton Conservation Commission for 37 years. Past President, and formerly a Director of the NH Science Teachers Association. Past Secretary and President of the GSNH. Friend of the Madison Boulder and serving on the board of the Old Man of the Mountain Legacy Fund since its inception in 2003.

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

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

With the continuance of COVID-19, the GSNH Board of Directors has been continuing to conduct its meetings electronically, like many organizations around the world. Our last meeting on Thursday, September 17 continued this trend, and our meeting was held via Zoom.

Although we would prefer to resume a sense of normalcy and have our October dinner meeting in person with all of you, the current circumstances do not make this possible. However, it has been January since we all last met. So, like many other organizations, the Board has decided to move forward (hopefully temporarily!) with our October "dinner" meeting to be held virtually! More information is contained elsewhere in the newsletter, and you will be receiving additional information soon in your e-mail. Because this will be the first time GSNH will be meeting together since January, the Board plans to provide a series of updates and the ability to interact in order to maintain as close to a sense

of normalcy as possible. Despite this, the Board is planning for normalcy to resume in the not too distant future, and has currently reserved space at the Makris for our January dinner meeting, and the Puritan for our April dinner meeting. In the meantime, however, the Board decided to give our next meeting, as a virtual one, a go! This will be a bit of an experiment, but the Board, with all of you, is going to see how this goes.

As a result, much of our Board meeting on September 17 consisted of discussions on how to bring a usual GSNH dinner meeting into cyberspace to make this as smooth of an evening as possible. As part of this effort, the Board received some counsel from the Attorney General's office nonprofits staff regarding the holding of virtual meetings, and also, how to conduct our election for the new Board in this environment. Based on that guidance, elsewhere in this newsletter, you will find draft proposed changes to the GSNH Constitution and By-Laws to "officially" provide us the room to meet virtually into the future, should the need arise. The Board discussed and approved the language as drafted at our meeting to bring to you for consideration on October 15, and this will be an item that we will be asking you to vote upon at the start of our meeting.

The Board would much rather interact with everyone in person, and looks forward to the day that we can all safely do that! Outside of COVID-19, the Board continues its work to provide education awards to deserving individuals in the education system, and to develop a website on geological sites of interest in the state.

The next GSNH Board meeting is tentatively planned to be held on Thursday, December 10, 2020, at a place (physical or virtual!) yet to be determined.

New Hampshire Adopts Aggressive PFAS Drinking Water Bill

By John Gardella, CMBG3 Law. From the National Law Review, Volume X, Number 206 (July 24, 2020): https://www.natlawreview.com/article/new-hampshire-adopts-aggressive-pfas-drinking-water-bill

On July 23, 2020, Governor Sununu of New Hampshire signed into law a bill that sets maximum contaminant levels (MCLs) for four types of perfluoroalkyl substances (PFAS) in drinking water. The bill also sets aside $50 million in state funds for cleanup of sites contaminated by PFAS. The New Hampshire law is a significant development, as it sets MCLs that are stricter than both the EPA's health advisory levels and also many other state regulations for the same chemicals. Many states, like New Hampshire, have begun regulating PFAS on their own under pressure to do so from both its citizens and media, as the EPA continues its lengthy review process before setting MCLs of its own.

The New Hampshire bill (H.B. 1264 (2020)), sets limits for the following PFAS:

- PFOA: 12 parts per trillion
- PFOS: 15 parts per trillion
- PFNA: 11 parts per trillion
- PFHxS: 18 parts per trillion

The MCLs take effect on June 30, 2020, giving townships, municipalities and water commissions two years to implement changes so that they are in compliance with the new limits.

As part of the bill, the New Hampshire Department of Environmental Services (DES) is required to provide low interest loans to communities that began remediation efforts after September 30, 2019 and whose water sources show PFAS that exceed the MCLs. The state set aside $50 million for such loans. However, if DES identifies a "responsible party" for some or all of the contamination, the loan amount that the state must give from taxpayer money can be reduced by the amount collected by the responsible party. This provision will naturally have the effect of the DES increasing the number of PFAS violations that it issues to private parties (largely, industrial companies) so that the remediation costs can be shouldered more by industry than by taxpayer money.

Two other important provisions of the bill are language that requires insurance companies to cover blood tests for people potentially impacted by PFAS, and an agreement to extend the state's Seacoast Cancer Cluster Investigation until June 30, 2022. The Seacoast Cancer Cluster Investigation Task Force was established by the Governor in 2016 with the purpose of bringing together numerous entities to study a reported cancer cluster, believed to be caused by PFAS, along the New Hampshire coastline. The Task Force's purpose is to review progress by state agencies in investigating the cancer cluster, establish roles and responsibilities for municipalities and state agencies based on the findings, and ensure local coordination and cooperation with informing the public.

The bill was originally proposed several years ago, but many questions were raised during the public comment period regarding the method by which the MCLs were set, as well as the proper balance between using state taxpayer money for site cleanups versus fining parties allegedly responsible to fund some or all of the cleanup. The bill was the subject of litigation in state court for some time by companies concerned that the bill failed to follow proper administrative and procedural steps. Despite the concerns and delays, the bill passed the state Senate 23-1 and the state House 210-116.

The Explosive Secret Hidden Beneath Seemingly Trustworthy Volcanoes

From Trinity College Dublin, July 28, 2020.
tps://www.tcd.ie/news_events/articles/scientists-reveal-an-explosive-secret-hidden-beneath-seemingly-trustworthy-volcanoes/

An international team of volcanologists working on remote islands in the Galápagos Archipelago has found that volcanoes which reliably produce small basaltic lava eruptions hide chemically diverse magmas in their underground plumbing systems – including some with the potential to generate explosive activity.

Many volcanoes produce similar types of eruption over millions of years. For example, volcanoes in Iceland, Hawai'i and the Galápagos Islands consistently erupt lava flows – comprised of molten basaltic rock – which form long rivers of fire down their flanks.

The 2015 eruption at Wolf volcano in the Galapagos Archipelago, credit Gabriel Salazar, La Pinta Yacht Expedition.

Although these lava flows are potentially damaging to houses close to the volcano, they generally move at a walking pace and do not pose the same risk to life as larger explosive eruptions, like those at

Vesuvius or Mt. St. Helens. This long-term consistency in a volcano's eruptive behaviour informs hazard planning by local authorities.

The research team, led by Dr Michael Stock from Trinity and comprising scientists from the US, UK and Ecuador, studied two Galápagos volcanoes, which have only erupted compositionally uniform basaltic lava flows at the Earth's surface for their entire lifetimes. By deciphering the compositions of microscopic crystals in the lavas, the team was able to reconstruct the chemical and physical characteristics of magmas stored underground beneath the volcanoes.

The results of the study show that – in contrast with the monotonous basaltic lavas erupted at the Earth's surface – magmas beneath the volcanoes are extremely diverse and include compositions similar to those erupted at Mt. St. Helens.

The team believes that volcanoes consistently erupt compositionally uniform basaltic lavas when the amount of magma flushing through the ground beneath the edifice is high enough to "overprint" any chemical diversity. This can occur when volcanoes are located close to a "hot spot" – a plume of hot magma rising towards the surface from deep within the Earth.

However, the chemically diverse magmas which the team discovered could become mobile and ascend towards the surface under certain circumstances. In this case, volcanoes that have reliably produced basaltic lava eruptions for millennia might undergo unexpected changes to more explosive activity in the future.

Dr Stock, from Trinity's School of Natural Sciences, and lead author on the paper just published by leading international journal, Nature Communications, said:

"This was really unexpected. We started the study wanting to know why these volcanoes were so boring and what process caused the erupted lava compositions to remain constant over long timescales. Instead we found that they aren't boring at all – they just hide these secret magmas under the ground.

"Although there's no sign that these Galápagos volcanoes will undergo a transition in eruption style any time soon, our results show why other volcanoes might have changed their eruptive behaviour in the past. The study will also help us to better understand the risks posed by volcanoes in other parts of the world – just because they've always erupted a particular way in the past doesn't mean you can rely on them to continue doing the same thing indefinitely into the future."

The 2015 eruption at Wolf volcano in the Galapagos Archipelago, credit Gabriel Salazar, La Pinta Yacht Expedition.

Dr Benjamin Bernard, a volcanologist involved in monitoring Galápagos volcanoes at Instituto Geofísico and co-author on the paper, added:

"This discovery is a game-changer because it allows us to reconcile apparently divergent observations, such as the presence of explosive deposits at several Galápagos volcanoes. It also allows us to better understand the behaviour of these volcanoes, which is essential for volcano monitoring and hazard assessment."

This work was published in the leading international journal *Nature Communications* and was funded by the Charles Darwin and Galápagos Islands Fund at Christ's College, University of Cambridge, and the US National Science Foundation. It was conducted with support from the Ecuadorian Instituto Geofísico, Galápagos National Park and Charles Darwin Foundation.

Is Your Membership up to Date?

In order to vote in the upcoming election and to vote for revised GSNH bylaws and constitution (all in the October meeting), you need to be a "member in good standing". That means that you need to be current on your dues! See last page of this newsletter for a renewal form.

Iceland's Basalt Columns: Nature's Artwork

From Earth Science Picture of the Day, May 11, 2020
Photographer and summary author: Patti Weeks
https://epod.usra.edu/blog/2020/05/icelands-basalt-columns-natures-artwork.html

Drive north from Iceland's capital city of Reykjavík for about 75 mi (121 km) on Highway 54 to the eastern border of the Snæfellsnes Peninsula, then a short distance east, and you'll encounter a geological marvel that's stunning and looks almost man-made. This impressive natural phenomenon is referred to as the Gerðuberg basalt columns, a 1,640 ft (500 m) long cliff of hundreds of evenly-sized basalt columns, hugging each other closely. They range in height from 40–46 ft (12–14 m), and each pillar is about 5 ft (1.5 m) in diameter.

These cliffs were formed by flowing basaltic lava that originated within the Ljósufjöll volcanic system in the Snæfellsnes Volcanic Belt. Iceland's 130 volcanoes have been erupting periodically over millions of years, but only 30-40 remain active, including Ljósufjöll. The Ljósufjöll system is classified as an alkalic rock series, which is found outside the active systems of the spreading central Mid-Atlantic Ridge. The Gerðuberg cliffs consist of a coarse-grained basalt called dolerite (also called diabase.)

Lava flows, such as the one that formed the Gerðuberg cliffs, are cooled rapidly by the sea, and as the lava solidifies, vertical cracks are formed by the stress of the rock's cooling and contracting. The growth of the fractures, or joints, are perpendicular to the surface of the flow, and as they continue to grow, they form a closely-spaced regular array of columns or polygonal prisms. This process is called columnar jointing. The individual prisms can have 3 to 8 sides; the Gerðuberg columns have the more typical hexagonal shape. These relatively straight, vertical sets of columns are referred to as a colonnade. The horizontal surface bands, or chisel marks, develop due to the cooler exterior temperature of the column during its formation. Fallen blocks of stone, as seen in the photos near the base of the cliffs, have succumbed to erosion at weakened areas.

The bottom photo (next page) was taken on the steep, rugged southwestern coast of the Snæfellsnes Peninsula, about 60 mi (37 km) west of the Gerðuberg columns. This oceanside cliff, of the Snæfellsjökull volcanic system, reveals columnar jointing but with an irregular array of columns. Columns with smaller diameters are thought to have cooled faster than those with larger ones. Iceland, made of about 90 percent volcanic rock, may have the largest collection of basalt columns in the world. Photos taken September 4, 2018.

Photo Details: Camera: SONY DSC-HX400V;

1. Exposure Time: 0.0025s (1/400); Aperture: f/3.5; ISO equivalent: 80; Focal Length: 13.3mm.

2: Same except - Exposure Time: 0.0016s (1/640); Aperture: f/4.0; Focal Length: 14.7mm.

3. Exposure Time: 0.0040s (1/250); Aperture: f/5.0; ISO equivalent: 160; Focal Length: 39.6mm.

Gerðuberg, Iceland Coordinates: 64.8607, -22.3589

Related links:

Mid-Atlantic Ridge in Iceland: https://epod.usra.edu/blog/2010/08/mid-atlantic-ridge-in-iceland.html

Stuðlagil – The Magical Basalt Column Canyon: https://iceland-photo-tours.com/photo-guides/einar-pall-svavarsson/studlagil-the-magical-basalt-column-canyon

More About Iceland's Geology:

https://www.academia.edu/1217780/Introduction_to_the_Nature_and_Geology_of_Iceland

Student links:

Volcanoes and Iceland: https://storymaps.arcgis.com/stories/3c8d7d9085014a28bf0aa2cf4c5d4726

Rocks Lesson #10: http://volcano.oregonstate.edu/rock-lesson-works

Types of volcanic rock: https://www.sciencelearn.org.nz/resources/650-types-of-volcanic-rock

Earth Observatory

Eruption of Eyjafjallajökull Volcano, Iceland:

https://earthobservatory.nasa.gov/images/43252/eruption-of-eyjafjallajakull-volcano-iceland

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Tomanowos, the meteorite that survived mega-floods and human folly

By Daniel Garcia-Castellanos, Instituto de Ciencias de la Tierra Jaume Almera (ICTJA-CSIC).
From The Conversation, April 24, 2020. Originally published in Spanish.
https://theconversation.com/tomanowos-the-meteorite-that-survived-mega-floods-and-human-folly-134213

The rock with arguably the most fascinating story on Earth has an ancient name: Tomanowos. It means “the visitor from heaven” in the extinct language of Oregon’s Clackamas Indian tribe.

The Clackamas revered the Tomanowos – also known as the Willamette meteorite – believing it came to unite heaven, earth and water for their people.

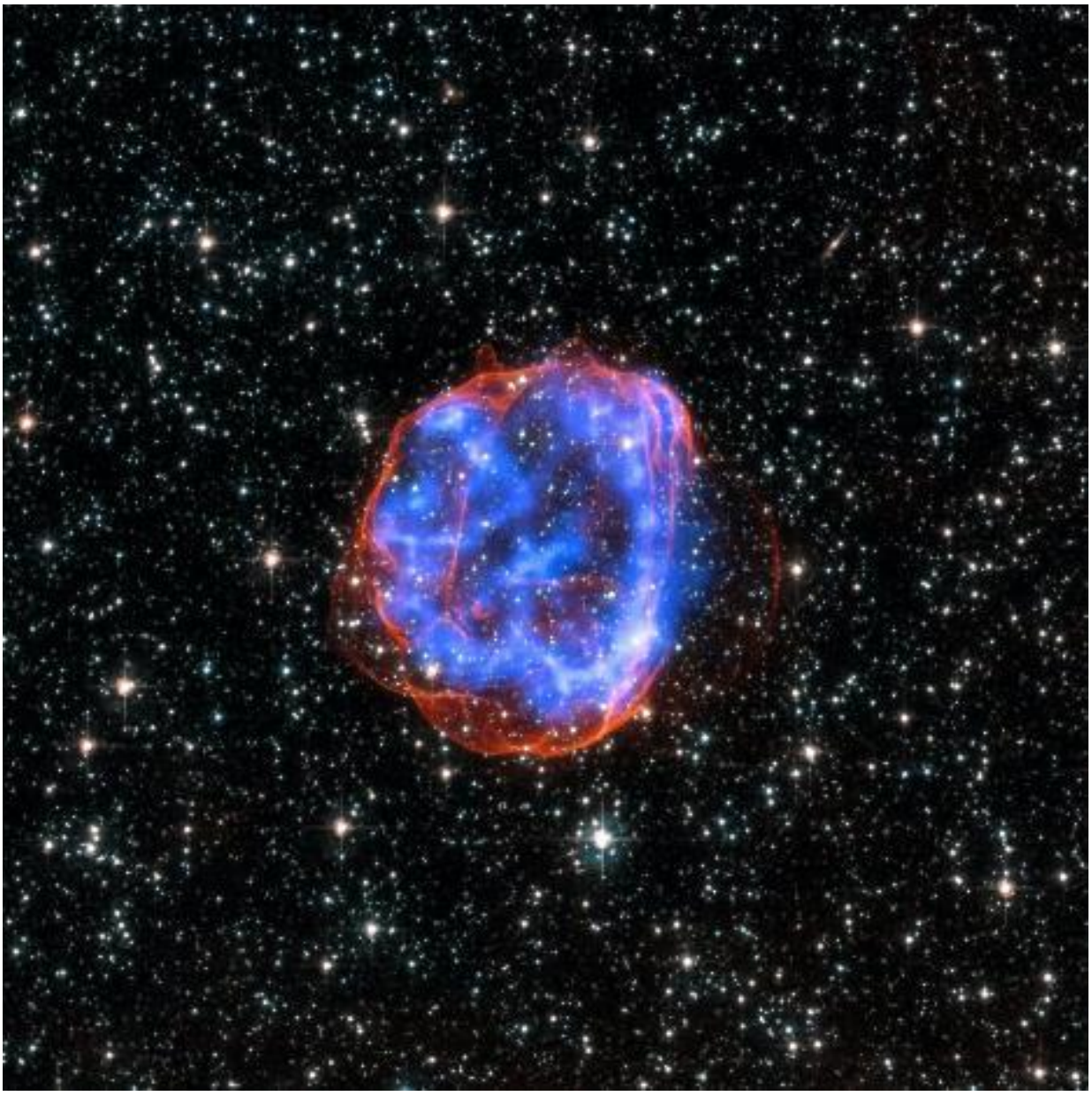
Rare extraterrestrial rocks like Tomanowos have a kind of fatal attraction for us humans. When European Americans found the pockmarked, 15-ton rock near the Willamette River more than a century ago, Tomanowos went through a violent uprooting, a series of lawsuits and a period under armed guard. It’s one of the strangest rock stories I’ve come across in my years as a geoscientist. But let me start the tale from its real beginning, billions of years ago.

History of a Rock

Tomanowos is a 15-ton meteorite made, as most metal meteorites are, of iron with about 8% nickel mixed in. These iron and nickel atoms were formed at the core of large stars that ended their lives in supernovae explosions.

Those massive explosions spattered outer space with the products of nuclear fusion – raw elements that then ended up in a nebula, or cloud of dust and gas.

Eventually the elements were forced together by gravity, forming the earliest planet-like orbs, or protoplanets of our solar system.



Supernovae disperse the iron produced in heavy stars. NASA.

Some 4.5 billion years ago, Tomanowos was part of the core of one of these protoplanets, where heavier metals like iron and nickel accumulate.

Some time after that, this protoplanet must have collided with another planetary body, sending this meteorite and an unknowable number of other chunks back out into space.

Riding the flood

Subsequent impacts over billions of years eventually pushed Tomanowos' orbit across that of the Earth. As a result of this cosmic billiards game, the Tomanowos meteorite entered Earth's atmosphere around 17,000 years ago and landed on an ice cap in Canada.

Over the following decades, flowing ice slowly transported Tomanowos southwards, towards a glacier in the Fork River of Montana in what is now the United States. This glacier had created a 2,000-foot-high ice dam across the river, impounding the enormous Lake Missoula upstream.

The ice dam crumbled when Tomanowos was nearing it, releasing one of the largest floods ever documented: the Missoula Floods, which shaped the Scablands of Washington State with the power of several thousand Niagara Falls.

Trapped in ice and rafted down river by the flood, Tomanowos crossed modern-day Idaho, Washington and Oregon along the swollen Columbia River at speeds sometimes faster than 40 miles per hour, according to simulations by modern geologists. While floating near what's now the city of Portland, the meteorite's ice case broke apart, and Tomanowos sank to the river bottom.

It is one of hundreds of other "erratic" rocks – rocks made of elements that do not match the local geology – that have been found along the Columbia River. All are souvenirs from the cataclysmic Missoula floods, but none is as rare as Tomanowos.

A rock worth suing for

As flood waters ebbed, Tomanowos was exposed to the elements. Over thousands of years, rain mixed with iron sulfide in the meteorite. This produced sulfuric acid that gradually dissolved the exposed side of the rock, creating the cratered surface it bears today.

Several thousand years after the Missoula floods, the Clackamas arrived to Oregon and discovered the meteorite. Did they know it came from the heavens, despite the lack of a crater? The name Tomanowos, or Visitor from the Sky, suggests that they may have suspected the rock's extraterrestrial origins.

Millennia of peaceful rest in the Willamette valley ended in 1902 when an Oregon man named Ellis Hughes secretly moved the iron rock to his own land and claimed it as his property.

Hauling a 15-ton rock on a wooden cart for nearly a mile without being noticed wasn't easy, even in the Wild West. Hughes and his son labored for three back-breaking months. Once the meteorite was on his land, he began charging admission to view the "Willamette Meteorite."

In fact, however, the legitimate owner of the iron rock turned out to be the Oregon Iron and Steel Company, which owned the land where Hughes had found the meteorite and sued for its return. While the suit worked its way through the courts, the company hired a guard who sat atop Tomanowos 24 hours a day with a loaded gun. They won the case in 1905, and sold Tomanowos to the American Museum of Natural History in New York a year later.

Children sitting in pits of the Willamette Meteorite at the American Museum of Natural History, 1939. Bettman Archive/Getty Images

Floods

Today Tomanowos can be seen in the museum's Hall of the Universe exhibition, which still refers to it as the Willamette Meteorite. In 2000 the museum signed an agreement with descendants of the Clackamas tribe, recognizing the meteorite's spiritual significance to the Native people of Oregon.

The Confederated Tribes of Grand Ronde hold an annual ceremonial visit with the ancient rock that, as their ancestors so aptly observed, brought the sky and the water together here on Earth. In 2019 several fragments of the meteorite that had been held separately were returned to the tribe.

But the museum's written display tells only some of the rock's long story. It omits the Missoula Floods, despite the significance of this event for modern earth science.

Present display of the Tomanowos meteorite, American Museum of Natural History. Daniel Garcia-Castellanos, CC BY-ND

Decades after geologists J. Harlen Bretz and Joseph T. Pardee separately posited the theory of the Missoula floods in the early 20th century, their research was used to explain how Tomanowos reached Oregon, where it was found. Their work also triggered one of the most significant paradigm shifts in recent geoscience: the recognition that catastrophic flooding events significantly contribute to the erosion and evolution of landscape.

Previously, scientists had followed Lyell's principle of uniformitarianism, which held that Earth's landscape was sculpted by regular, natural processes distributed evenly over long times. Normal floods fit into this theory, but the notion of swift, catastrophic events like the Missoula Floods were somewhat heretic.

The idea of huge Ice Age floods helped geologists a century ago prevail over pre-scientific, religious explanations for unusual finds – such as how marine fossils could be found at high elevation, and how a giant metal rock from outer space came to rest in Oregon.

Have News? Let us Know!

We've had a few months without any face-to-face interactions, since we missed our spring meeting and summer field trip. Please let the newsletter editor (jlambert@nobis-group.com) or another member of the Board know if you have any news you'd like to share with the greater geological community.

USGS releases first-ever comprehensive geologic map of the Moon

US Geological Survey, April 32, 2020.
https://phys.org/news/2020-04-usgs-first-ever-comprehensive-geologic-moon.html

Have you ever wondered what kind of rocks make up those bright and dark splotches on the moon? Well, the USGS has just released a new authoritative map to help explain the 4.5-billion-year-old history of our nearest neighbor in space.

For the first time, the entire lunar surface has been completely mapped and uniformly classified by scientists from the USGS, in collaboration with NASA and the Lunar Planetary Institute.

The lunar map, called the "Unified Geologic Map of the Moon," will serve as the definitive blueprint of the moon's surface geology for future human missions and will be invaluable for the international scientific community, educators and the public-at-large. The digital map is available online now and shows the moon's geology in incredible detail (1:5,000,000 scale).

"People have always been fascinated by the moon and when we might return," said current USGS Director and former NASA astronaut Jim Reilly. "So, it's wonderful to see USGS create a resource that can help NASA with their planning for future missions."

To create the new digital map, scientists used information from six Apollo-era regional maps along with updated information from recent satellite missions to the moon. The existing historical maps were redrawn to align them with the modern data sets, thus preserving previous observations and interpretations. Along with merging new and old data, USGS researchers also developed a unified description of the stratigraphy, or rock layers, of the moon. This resolved issues from previous maps where rock names, descriptions and ages were sometimes inconsistent.

New Unified Geologic Map of the Moon with shaded topography from the Lunar Orbiter Laser Altimeter (LOLA). This geologic map is a synthesis of six Apollo-era regional geologic maps, updated based on data from recent satellite missions. It will serve as a reference for lunar science and future human missions to the Moon. Credit: NASA/GSFC/USGS

"This map is a culmination of a decades-long project," said Corey Fortezzo, USGS geologist and lead author. "It provides vital information for new scientific studies by connecting the exploration of specific sites on the moon with the rest of the lunar surface."

Elevation data for the moon's equatorial region came from stereo observations collected by the Terrain Camera on the recent SELENE (Selenological and Engineering Explorer) mission led by JAXA, the Japan Aerospace Exploration Agency. Topography for the north and south poles was supplemented with NASA's Lunar Orbiter Laser Altimeter data.

For more details about the map, read the abstract or download it directly at the Unified Geologic Map of the Moon website.

The Beaver's Tale

From Earth Science Picture of the Day, July 9, 2020
Photographer and summary author: James Van Gundy
https://epod.usra.edu/blog/2020/07/the-beavers-tale.html

I recently came across this somewhat whimsical carving of a beaver in an antique shop. It looked odd to me and as I picked it up, I was struck by its weight that seemed unusually heavy for an object its size. As I looked more closely, it appeared that the statue was carved from some sort of metallic sulfide mineral that again was unusual as such materials are usually too brittle to carve.

A label on the underside of the base identified it as a creation of stone carver Peter Ellero of Sudbury, Ontario. With a little research, I learned that Mr. Ellero was an Italian immigrant who worked for a while in International Nickel Corporation's Creighton Mine at Sudbury. The material used to carve the beaver probably came from that mine. The Sudbury district is home to one of the world's richest mineral deposits and has produced over $100 billion worth of nickel, copper, gold, platinum, palladium, and silver over its 100+ year history.

The statue is actually carved from nickel ore that consists of a mixture of metallic sulfide minerals including pentlandite - (Fe,Ni)9S8, pyrrhotite - Fe(1-x)S, and chalcopyrite - $CuFeS_2$. The polished base

appears to be an igneous rock called gabbro that contains a large number of inclusions of the same minerals. Pyrrhotite is one of the few minerals that are naturally magnetic, and indeed, the ore deposit was initially discovered by a surveyor who noticed a magnetic distortion in his compass readings.

It's now understood that the Sudbury ore deposits lie within an impact crater that was originally about 155 miles (250 km) in diameter and resulted from the impact of a 6 to 10 mile (10-15 km) diameter comet approximately 1.8 billion years ago. The Sudbury ores are derived from the impact melts produced by that comet's interaction with the Earth's crust and upper mantle. Since it was originally formed, the crater has been much deformed by subsequent tectonic activity.

So, it turns out that this little beaver has a number of tales to tell. One, of an immigrant seeking a better life. Another of a wandering compass needle pointing towards almost unimaginable mineral wealth, and finally, a story of an ancient cataclysmic natural catastrophe. Note that the statue's base is 9.5 by 4.5 inches (24.1 by 11.4 cm) and it weighs 7.2 pounds (3.27 kg).

Sudbury, Ontario Coordinates: 46.492217, -80.993300

Related links:
Nickel Mine Slag
Student links:
Very Attractive Minerals
Fireball FAQs
Earth Observatory:
Mapping Fireballs

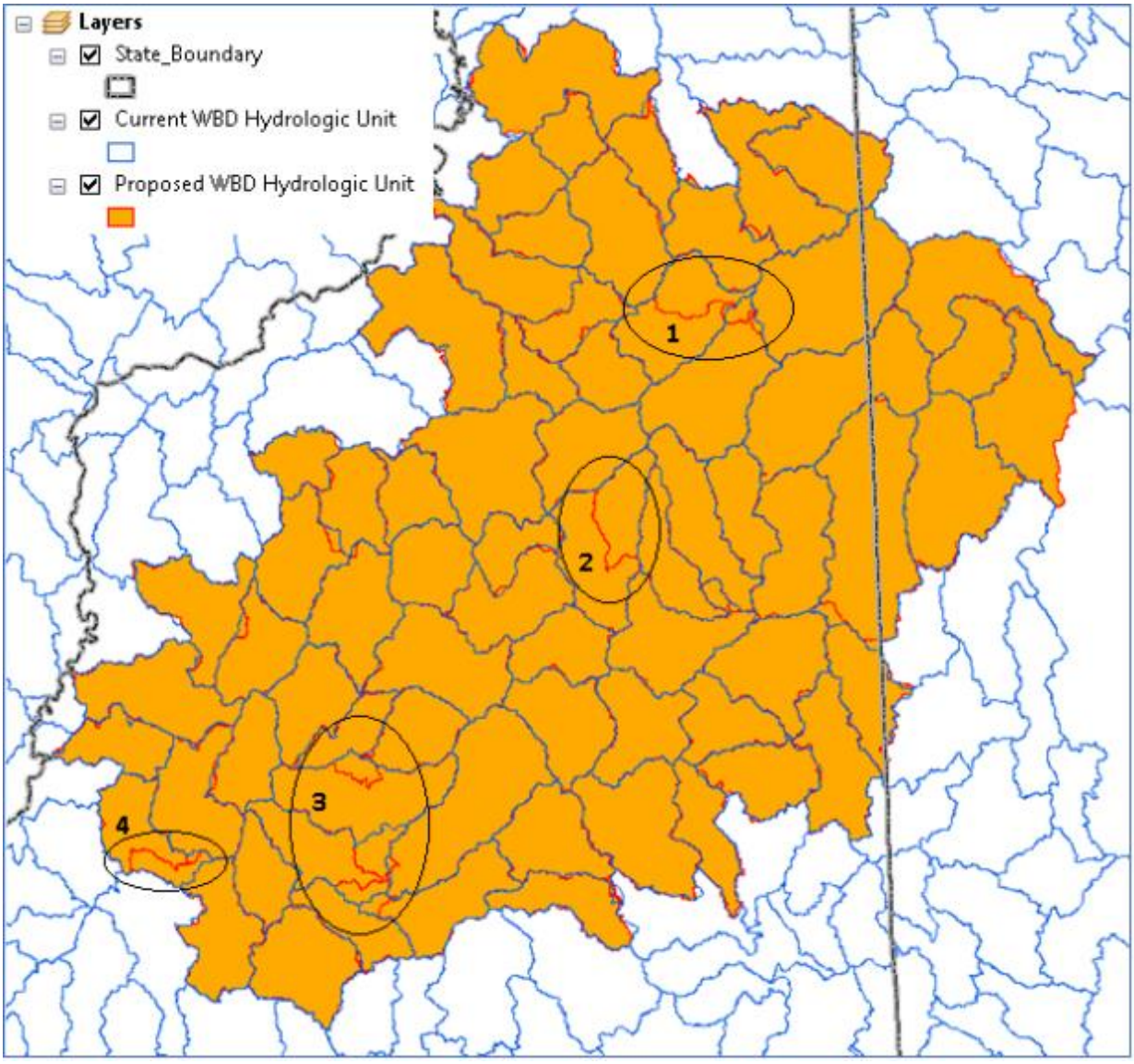
Proposed Changes to the Watershed Boundary Dataset (WBD) in New Hampshire

From the New Hampshire Geological Survey, July 28, 2020.

In cooperation with the New Hampshire Geological Survey (NHGS), The White Mountain National Forest (WMNF) is proposing changes to the WBD in the White Mountain region in order to reduce the number of hyphenated watersheds and isolate main brooks or rivers as their own watershed. Based on the proposal, the following water bodies would have their own twelve-digit hydrologic unit code (HUC12): Beebe River, West Branch Brook, Peabody River, Pond Brook, Dry River, and Moose River.

The WMNF HUC12s have been re-delineated using lidar and stream extraction tools developed by NHGS. This work is an important first step in generating an elevation-aligned WBD. As part of the delineation, 2 new HUC12s have been broken out: Dry River and Moose River, for a total of 72 HUC12s in the New Hampshire portion of the WMNF. Five additional name changes have also been proposed. All of the re-delineations have edge refinements based on lidar data.

The figure below highlights four zones with significant changes. Zone 1 shows the new delineation of the Moose River and Moose Brook-Androscoggin River HUC12s and the subsequent change to the Peabody River-Androscoggin River HUC12. Zone 2 shows the splitting of the Saco Headwaters to create a new HUC for Dry River. Zone 3 shows outlet shifts in the Mill Brook, Beebe River, and West Branch Brook HUCs. Zone 4 shows an upstream shift of the Pond Brook outlet to excise the Baker River from its HUC. Some outlet shifts have caused several name changes.



Overview of improved HUC12 delineations showing significant changes in zones 1-4.

The table below summarizes some of the larger proposed WBD name and HUC changes. Small to moderate spatial changes are not listed.

Original HUC Name	Original HU Code	Proposed HU Name	Proposed HU Code	Change(s)
Headwaters Saco	010600020101	Dry River	010600020107	New name and HUC, modified outlets
Moose River-Androscoggin River	010400020101	Moose River	010400020104	New name and HUC, Modified outlets
Moose River-Androscoggin River	010400020101	Moose Brook-Androscoggin River	010400020101	New name, Modified outlets
Beebe River-Pemigewasset River	010700010402	Beebe River	010700010402	Modified outlet, name change
Bog Brook-Pemigewasset River	010700010403	Bog Brook-Pemigewasset River	010700010403	Modified outlets
Mill Brook-Pemigewasset River	010700010205	Mill Brook-Pemigewasset River	010700010205	Modified outlets
Peabody River-Androscoggin River	010400020102	Peabody River	010400020102	New name, Modified outlets
Pond Brook-Baker River	010700010303	Pond Brook	010700010303	New name, Modified outlets
West Branch Brook-Pemigewasset River	010700010206	West Branch Brook	010700010206	New name, Modified outlets

Note that the watershed changes that *will* be made by USGS were described in the previous GSNH newsletter (issue #109).

For additional information, please contact Joshua Keeley at the NHGS: Joshua.Keeley@des.nh.gov

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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.

October 15, 2020 – **GSNH Meeting** – Virtual meeting via Zoom starting at 7PM: look from an email from Doug Allen to register. See page 2 for details.

October 2020 – **New England Intercollegiate Geological Conference** – **Cancelled for 2020**

October 19-23, 2020 – **36th Annual International Conference on Soils, Sediments, Water and Energy** – changed to virtual meeting: https://www.aehsfoundation.org/East-Coast-Conference.aspx

October 25-28, 2020 – **Geological Society of America Annual Meeting** – changed to virtual meeting https://community.geosociety.org/gsa2020/home

December 10, 2020 – **GSNH Board of Directors Meeting** – location TBD

January 21, 2021 – **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 National Academies of Sciences, Engineering and Medicine is providing a series of workshops Fall-Winter 2020 regarding America's geoheritage: https://www.nationalacademies.org/our-work/americas-geoheritage-ii-a-workshop
- The geoscience online learning initiative (GOLI) has several webinars and short courses that are free, but do include an administrative fee for continuing ed credits: https://www.americangeosciences.org/workforce/goli

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Researchers Find Younger Age for Earth's Moon

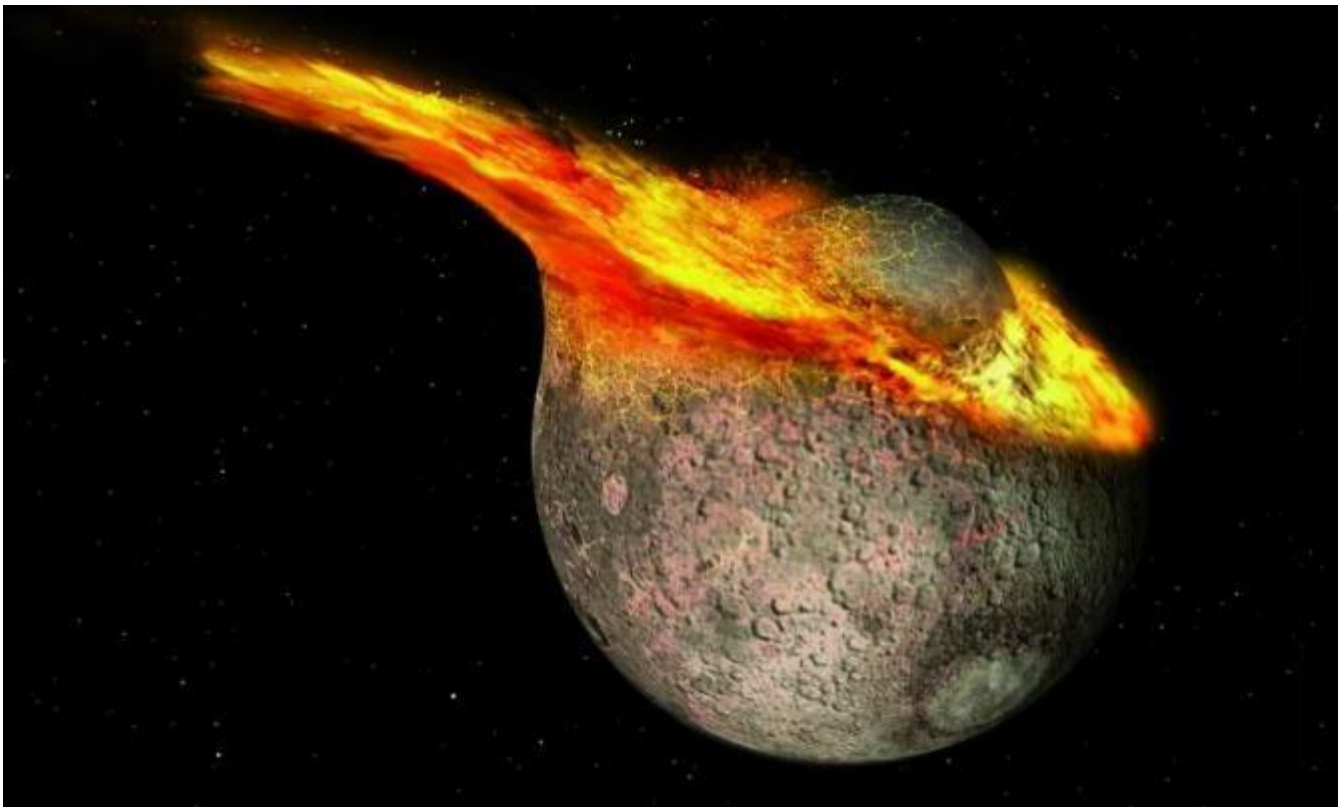
By DLR, Phys.org. From July 13, 2020.
https://phys.org/news/2020-07-younger-age-earth-moon.html

The moon formed a little later than previously assumed. When a Mars-sized protoplanet was destroyed in a collision with the young Earth, a new body was created from the debris ejected during this collision, which became the moon. Planetary geophysicists at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR), led by Maxime Maurice, together with researchers at the University of Münster, have used a new numerical model to reconstruct the time at which the event occurred—4.425 billion years ago. The previous assumptions about the formation of the moon were based on an age of 4.51 billion years—that, is 85 million years earlier than the new calculations reveal. The scientists have reported their findings in Science Advances.

Four and a half billion years ago, the solar system was still chaotic. Earth was still growing to its present size, collecting matter in the form of what are referred to as planetesimals. These had previously formed in the disc of dust and gas orbiting the early sun. The young Earth consolidated, becoming ever hotter inside. Increasingly, large parts of the rocky mantle melted and formed a magma ocean. It is at this time that Earth gained the natural satellite that continues to orbit around it to this day. A massive cosmic collision between Earth and a protoplanet ejected rock from the young Earth. Eventually, this debris agglomerated to form a new planetary body—the moon.

In principle, most scientists agree about how the moon formed, but not about the details of the process, and especially not about the time at which it occurred. "The results of our latest modeling

suggest that the young Earth was hit by a protoplanet some 140 million years after the birth of the solar system 4.567 billion years ago," says Maxime Maurice, summarizing the team's investigations. "According to our calculations, this happened 4.425 billion years ago—with an uncertainty of 25 million years—and the moon was born."



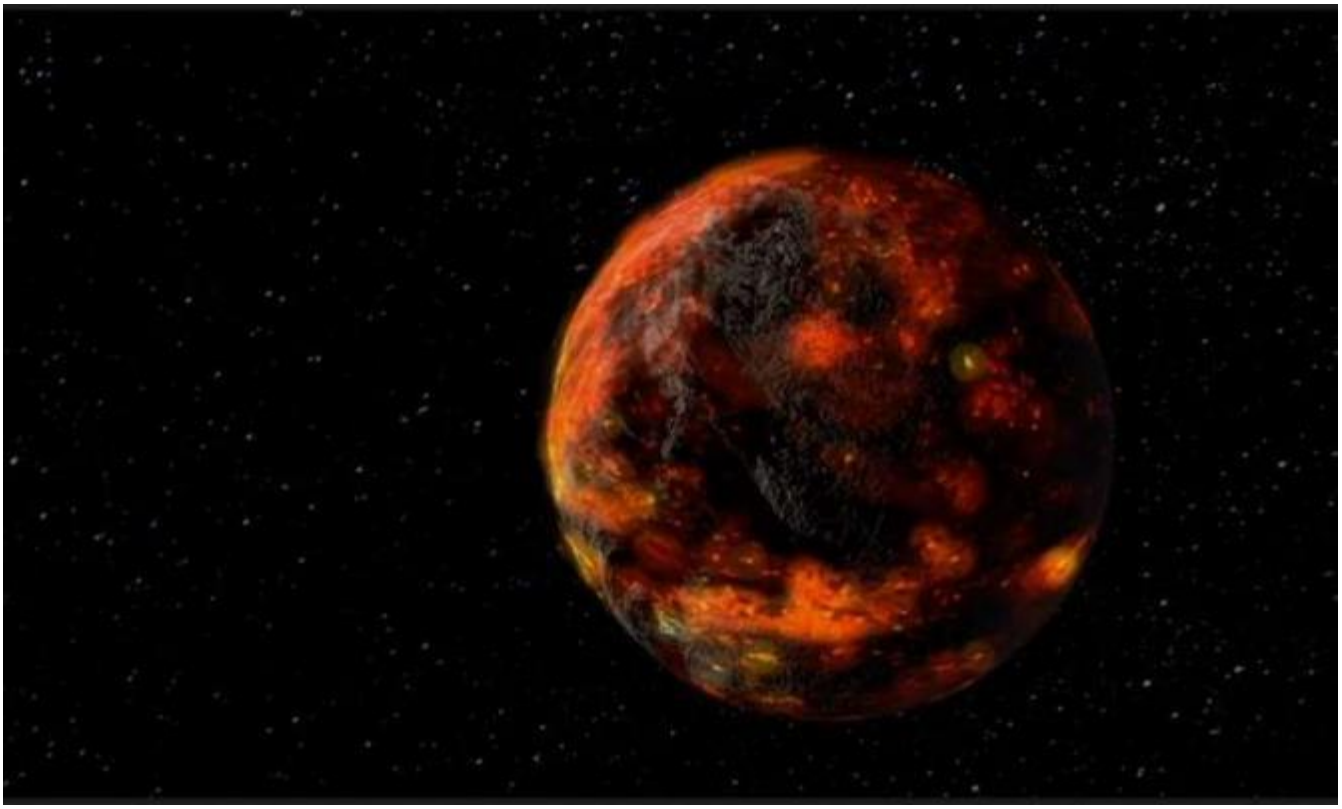
The moon is born. Credit: Ron Miller

At that time, Earth had just developed into a planet. During this development, the heavy metallic components sank to its center and formed a core of iron and nickel, which was surrounded by a thick mantle of silicate rocks. The mantle rocks became increasingly hot due to the process of accretion and the decay of radioactive elements. This allowed the separation of metals and silicates to take place in Earth's interior within a few tens of millions of years.

A planetary bullseye caused the formation of the moon

At this stage, Earth was hit by Theia, a protoplanet that was perhaps the size of Mars. Theia was one of the Titans in Greek mythology, and the mother of the moon goddess Selene. In the early days of the solar system, there would have been many bodies of this kind. Some were ejected from the solar system, while others were destroyed by collisions with other bodies. Theia, however, hit Earth and caused the ejection of such a large amount of material from the planet's mantle that the moon was

able to form from it. During this violent impact, a several-thousand-kilometer-deep magma ocean formed. Today, no traces of Theia remain following this collision.



Magma ocean and first rocky crust on the moon. Credit: NASA/Goddard Space Flight Center

Reconstructing how the formation of the moon was triggered by this event requires a great deal of imagination and creativity. The collision of the two bodies, with its enormous energy, also vaporized a large amount of rock from Earth's early mantle. This was ejected and collected in a ring of dust around Earth before it reassembled there to form rock. "From this, the moon was formed in a short time, probably in just a few thousand years," explains Doris Breuer, Head of the Planetary Physics Department at the DLR Institute of Planetary Research and a co-author of the study.

The oldest moon rock is not old enough

Scientists largely agree about the history of the moon's formation. However, they have not been able to date it exactly, as none of the moon rocks brought to Earth by the astronauts of the six Apollo missions and the three Soviet Luna robotic missions directly record the age of Earth's natural satellite. Researchers from DLR and the University of Münster have determined when the moon was formed using a new, indirect method. "Our calculations show that this most likely happened at the very end of

Earth's formation," says Sabrina Schwinger, another co-author of the study, describing the chronological sequence of events.

One of the oldest moon rocks. Credit: NASA/JSC/AACO

It was not only Earth that had an ocean of magma in its early youth. Energy gained from accretion also led to the formation of a magma ocean on the moon. The moon melted almost completely and, similarly to Earth, was covered by a magma ocean over 1000 kilometers deep. This magma ocean quickly began to solidify and formed a crust of floating, lightweight crystals at the surface—its 'interface' with the cold space. But under this insulating crust, which slowed down the further cooling and solidification of the magma ocean, the moon remained molten for a long time. Until now, scientists were unable to determine how long it took for the magma ocean to crystallize completely, which is why they could not conclude when the moon originally formed.

To calculate the lifetime of the moon's magma ocean, the scientists used a new computer model, which, for the first time, comprehensively considered the processes involved in the solidification of the magma. "The results from the model show that the moon's magma ocean was long-lived and took almost 200 million years to completely solidify into mantle rock," says Maxime Maurice. "The time scale is much longer than calculated in previous studies," adds DLR colleague Nicola Tosi, second

author of the study and advisor of Maxime Maurice's Ph.D. thesis, which was the base for this condensed scientific report. "Older models gave a solidification period of only 35 million years."

Solidification models reveal the age of the moon and Earth

To determine the age of the moon, the scientists had to go one step further. They calculated how the composition of the magnesium- and iron-rich silicate minerals that formed during the solidification of the magma ocean changed over time. The researchers discovered a drastic change in the composition of the remaining magma ocean as solidification progressed.

This finding is significant because it allowed the authors to link the formation of different types of rock on the moon to a certain stage in the evolution of its magma ocean. "By comparing the measured composition of the moon's rocks with the predicted composition of the magma ocean from our model, we were able to trace the evolution of the ocean back to its starting point, the time at which the moon was formed," explains Sabrina Schwinger.

The results of the study show that the moon was formed 4.425 ± 0.025 billion years ago. The moon's exact age is in remarkable agreement with an age previously determined for the formation of Earth's metallic core with the uranium-lead method, the point at which the formation of planet Earth was completed. "This is the first time that the age of the moon can be directly linked to an event that occurred at the very end of the Earth's formation, namely the formation of the core," says Thorsten Kleine from the Institute of Planetology at the University of Münster.

More information:

M. Maurice et al. A long-lived magma ocean on a young moon, *Science Advances* (2020). DOI: 10.1126/sciadv.aba8949

Calcite Crystals and Microbial Activity Within the Earth's Crust

From Earth Science Picture of the Day, September 18, 2020 (originally published May 18, 2017)
Photographer and summary author: Henrik Drake
https://epod.usra.edu/blog/2020/09/epod-20th-calcite-crystals-and-microbial-activity-within-the-earths-crust.html

The photo on the next page features calcite crystals precipitated in response to microbial activity deep within the Earth's crust -- shown in fractured granitic rock in Sweden. These crystals (about 5 mm in height) act to provide an archive for tracking ancient microbial activity. The tweezers are included for scale.

Methane-munching microbes, an analog for extraterrestrial life, have been living in the deep biosphere for some 400 million years. The knowledge about ancient life in the environment deep under our feet is extremely scarce. In numerous cracks down to depths of 1700 m (5,577 ft) that have been partly sealed by crystals growing within them, an international team of researchers led by Dr. Henrik Drake from Linnaeus University, Sweden, have traced fundamental, ancient microbial processes, including the production and consumption of the greenhouse gas, methane. This is thus far the most extensive study on ancient microbial activity in the continental crust, and findings suggest that microbial methane formation and consumption are widespread in the bedrock here.

This new knowledge of a deep source and sink for methane calls for a re-evaluation of the carbon cycling within the vast continental crust and may even be significant in a long-term global warming perspective. Dr. Christine Heim of the University of Göttingen, Germany, a co-author of the study, states that it's intriguing to find biomarkers of ancient organic remains having surface origins (land plants) preserved within calcite at such great depth. The nutrient source for the microbes at least partly seems to have been coming from the surface. This connection to the surface biosphere may explain why the marks of microbial activity abruptly disappear at around 700 to 800 m in depth. So in essence, cracks in the Earth's crust and on other planets, believed to be omnipresent, may be the perfect graveyards for past biologic activities.

Photo Details: Camera: SONY DSC-RX10; Lens: 24-200mm F2.8; Focal Length: 8.8mm (35mm equivalent: 24mm); Aperture: f/2.8; Exposure Time: 0.017 s (1/60); ISO equiv: 125; Software: Adobe Photoshop Lightroom 6.8 (Windows).

Related Links:

Dodecahedron Geode

Stromatolites in Hamlin Pools

Isotopic evidence for microbial production and consumption of methane in the upper continental crust throughout the Phanerozoic eon in Earth and Planetary Science Letters (published in May 2017)

Earth Photo of the Day Archives

New Hampshire Geological Survey – Fieldwork

From Joshua Keeley, New Hampshire Geological Survey (NHGS)

The photograph below shows the bedrock well in Pawtuckaway State Park in Deerfield, which is conveniently located next to several blackberry bushes. This well is monitored by a University of New Hampshire volunteer each month. See the NGS groundwater level monitoring program website: https://www.des.nh.gov/organization/commissioner/gsu/gwlmp/index.htm

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