

Bulletin

of the Eastern Section of the National Association of Geoscience Teachers

Volume 73, Issue 2: Spring / Summer 2023



Taughannock Falls—Mike O'Donnell

enjoyed an afternoon at one of the fine wineries before heading home.)

Steve Lindberg has graciously stepped in to host the meeting next May in Berkeley Springs, WV at the famous Country Inn. Details will trickle out over the next couple of months. The following year, Mike and Amy Baer are looking at hosting the meeting near Erie, PA. I encourage the membership to attend as both spots have a lot of geology of interest.

Our section is one of the stronger ones in NAGT because of you the membership. I hope everyone continues to do what they do, especially as it concerns the education of our youth in earth sciences. Until we can develop hyperdrive spaceships, we really just have the one planet!

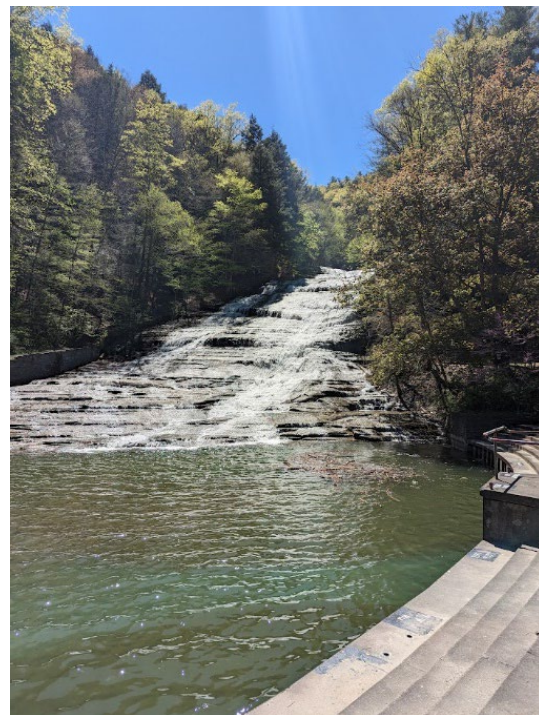


From the Past President

By Mike O'Donnell

Blue Ridge Community and Technical College

Well, I survived a year of being the president of the Eastern Section, and several years of staying in that position because of the COVID lockdowns. We had a wonderful meeting in Ithaca, NY in May. It was awesome to see most everyone again in person. Don Haas and his staff were phenomenal in providing a behind the scenes tour of The Museum of the Earth and all that they do to support and enhance geoscience education for New York, the US and beyond. As always, the field trips were exciting, especially to Taughannock and Buttermilk falls, and to an esker to see the effects of the Pleistocene glaciation. (As an aside, my wife and I



Buttermilk Falls – Mike O'Donnell

New OER texts

The Open Education Initiative at Virginia Tech is pleased to announce a newly-adapted work by Dr. Laura Naser, an Instructor in the Department of Geosciences at Virginia Tech. *Introduction to Earth Science* is a 530+ page textbook designed for introductory-level undergraduate Geoscience courses. It can be freely accessed online, read offline, printed, or purchased as a print-on-demand book.

The main landing page for the book is <https://doi.org/10.21061/introeearthscience>. The text is available in HTML format (<https://pressbooks.lib.vt.edu/introeearthscience>), PDF, and low-res PDF for faster downloading.



The text includes various features designed to enhance the student learning experience. These include a multitude of high-quality figures and images within each chapter that help to clarify key concepts and are optimized for viewing online. Self-test assessment questions are embedded in each chapter to help focus student learning. QR codes are provided for each assessment to allow students using PDF or print versions to easily access from an internet-capable device of their choice.

While we're announcing free, online text "books," I want to call your attention to *Historical Geology*, a relatively recent addition to the suite of free textbooks at opengeology.org. *Historical Geology* was written by Callan Bentley, Karen Layou, Russ Kohrs, and Shelley Jaye (NAGT-Eastern Section members) with Matt Affolter (Utah) and Brian Ricketts (New Zealand). Its URL is: <https://opengeology.org/historicalgeology/>

This text is not a downloadable PDF, but rather a nested series of webpages, interlinked to one another. The authors elected to pursue the "website" format so they could maximize embedded interactive media, such as videos, 3D models, and GigaPans. The text is organized into "chapters" that pursue general themes, "case studies," which examine particular places or questions, "tools of the trade," which are instructional pages on practical skills, a set of "virtual field experiences" to various interesting places, and finally a suite of "virtual sample sets," showing off various minerals, rocks, structures, etc. Instructors can pick and choose which readings they assign, or adapt them as they see fit for their own classes. The "book" is Creative Commons licensed, so there are no copyright issues for remixing its content to be more useful.



The authors continue to add new content and fix typos as time goes by; If there is any content you would particularly like to see included, email lead author Callan Bentley (cbentley@pvcc.edu) with your suggestions.

Also available on opengeology.org are an Introductory / Physical Geology text, a mineralogy text, and a petrology text.



Ithaca Was Gorges; and A “Hat-Trick”

by **Steve Lindberg**

Pitt-Johnstown

Eastern Section President

What does a walk through the corridors of Earth’s geologic history, an esker, kimberlite dike, and a 215 foot waterfall all have in common? All these remarkable geologic attractions brought us back together for the first in-person eastern section meeting in over three years. The Ithaca region and the Museum Of The Earth - Paleontological Research Institution exceeded all expectations in providing an exceptional venue for our May, 2023 meeting! The three day gathering was hosted by the Museum Of The Earth, which served as the centerpiece and “home base” for our excursions to numerous field sites in and around the Ithaca, Tompkins County region of New York. The meeting was well attended, with 35 NAGT members, several non-members, and students being present for all or part of the weekend event. The fifty dollar flat rate registration fee was sufficient to cover all expenses with the exception of the rental fee and donation to the Museum Of The Earth, which totaled \$2,300.



A sincere thank you to the entire staff, directors, and coordinators from the Museum Of The Earth-Paleontological Research Institution for providing your facility to the eastern section; Warren D. Allmon, director, Brendan Anderson, postdoctoral fellow, Robert Katz, community engagement coordinator, Robert Ross, associate director for





But wait, what is the reference to the “hat-trick” in the article title? I now have the privilege of serving as the eastern section president for the third time; 2000-2001, 2011-2012, and 2023-2024. I very much appreciate this opportunity to once again represent the eastern section as the president, and I look forward to a productive and rewarding year. I have already begun to make plans for our spring 2024 meeting to be held in

outreach, and Don Haas, director of teacher programming. I also want to thank our eastern section members for all your support and enthusiasm for the geosciences, which continues to make the eastern section of NAGT one of the most successful sections in the organization; Thank you! Ithaca Is Gorges, it certainly was!

Berkeley Springs, West Virginia the weekend of May 2,3,4. I hope to have an ambitious agenda of activities and field trips that will include the U.S. Silica



Mine and production facility located right in Berkeley Springs, as well as several nearby geologic sites that include the historic C&O Canal. Once again, Thank you for making the Ithaca, New York meeting successful; and our eastern section a leader in geoscience education. I hope to see you in Berkeley Springs next May.





Dinosaur Footprints at Luck Stone Quarry, Stevensburg, VA

by Sharon Lyon
Howard Community College

In the Triassic period, 210 million years ago, the Supercontinent of Pangea was pulling apart, forming fault-bounded rift valleys. Swampy lakes within these basins attracted dinosaurs, both herbivores and carnivores. With thanks to Luck Stone Quarry in Stevensville, Virginia, last year I was able to view some of the dinosaur trackways found in the Culpeper Triassic Basin. Over 4800 prints have been uncovered in two levels of the quarry. Paleontologists have identified the species based on their footprints, and calculated their size and speed. The theropod genus *Kayentapus*, with its razor-sharp claws, sprinted up to 10 miles per hour. Crocodile-like phytosaurs left belly prints in the mud, and plant-eating aetosaurs walked with a quadrupedal gait.

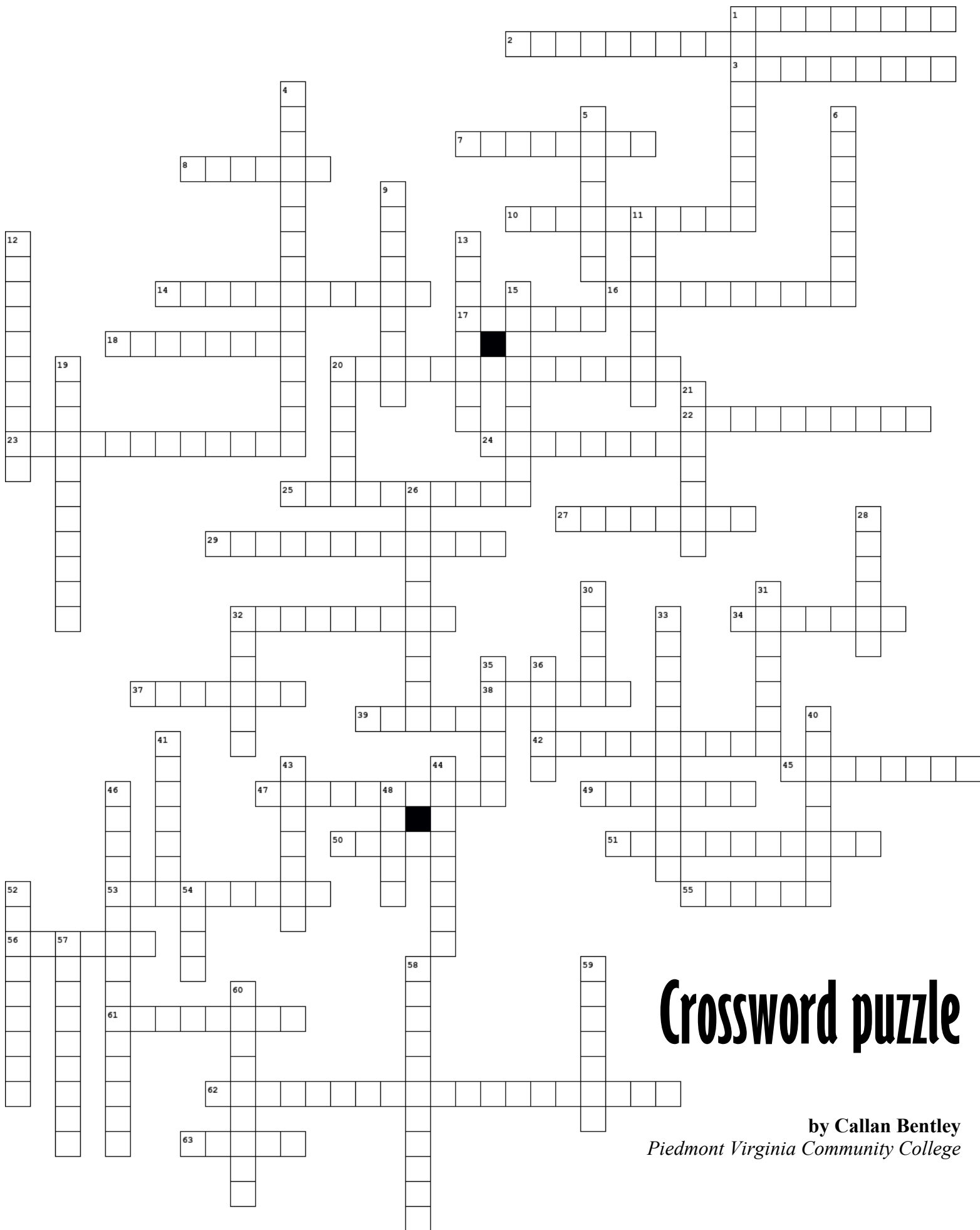
Once a year, the quarry coordinates with The Museum of Culpeper History to make the footprints available to the public. This year, the quarry will be



open on September 22-23. You must purchase tickets for the event. The tickets will go on sale in July (date not yet posted). If you are interested in the event, watch the museum's website for the ticket sale date and purchase them immediately as they go on sale. Last year's event sold out in minutes.

<https://culpepermuseum.com/dino-walk/>





Crossword puzzle

by Callan Bentley
Piedmont Virginia Community College

ACROSS

1. meteoritic jewelry
2. a swamp's deepest aspiration?
3. turbid clay/sand mix
7. named by Charles Lapworth for exposures near Loch Eriboll, Scotland
8. makes up the Vietnam Veteran's Memorial, despite what the Park Service will tell you
10. sub-Moho greenery
14. odd lava erupted from Ol Doinyo Lengai
16. named for a town in ZA
17. red and bubbly, a favorite for landscapers
18. nature's pottery
20. widespread fossil fuel
22. evaporite with a soft touch
23. hot, wet, sheared mantle (the south tower of the Golden Gate Bridge is "anchored" in it)
24. hot stuff for a young planet
25. so welded, it bears a glassy texture
27. finely felsic
29. rounded gravel that has finally stopped tumbling
32. on a lithofacies map, you'll find it between "fss" and "sh"
34. Europeans call it dolerite
37. fine lime, as from Solnhofen
38. fine-grained late-stage intrusion in many batholiths
39. red cryptocrystalline silica
42. banded and spongy, freshwater derived
45. named for a prominent mountain range
47. popular belts during the Archaean
49. brown, low-grade successor to peat
50. coccoliths suitable for scrawling
51. "zebra" stripes that indicate orogeny shearing a plutonic protolith
53. a seafloor sediment to make garden pests shudder
55. Pele's meringue
56. roe, roe, roe beneath your boat?
61. mafic + named for a U.S. state
62. extinct chemical sediment, indicative of an anoxic ocean
63. dark and conchoidal, good for axes

DOWN

1. some of its crystals can reach the size of a house
4. petrified beach or dune
5. might be mistaken for salt & pepper
6. dense enough to drive delamination?
9. recrystallized beach or dune
11. dry or rapidly-quenched, it's glass
12. cool under pressure
13. felsic + named for a U.S. state
15. its main mineral name derives from an Italian range
19. main constituent of the lunar highlands
20. upper crust, in the ocean at least
21. shards fused not far from home
26. "zebra" stripes that indicate orogeny shearing a sedimentary protolith
28. sediment with a rifted flavor
30. silica so fine
31. signature of old ice
32. flakey and scaly
33. shelly sand
35. sugary and fizzy, but not a soda pop
36. you can wipe it clean
40. a granite sans K-spar
41. smashed shells
43. most continental crust is taken for it
44. incredible, edible rock
46. a "fossil earthquake"
48. muddied waters might drop this signature
52. lithified cosmic dust
54. sitting on its ash
57. makes up the highest-elevation outcrop on this planet
58. pyroxene-bearing granitoid
59. a granite sans quartz
60. source from which granite flows




You can contribute to the *Bulletin*!

Consider writing up your recent teaching triumphs, field trip locations, geoscience-themed travels, or essays. This issue offers a wealth of examples you might emulate for future editions of **our** newsletter.

Outcrops

by **Steve Lindberg**
U-Pitt Johnstown

The May meeting in Ithaca included a brief search along Six Mile Creek to find one of the main Kimberlite Dikes mentioned in several publications. After a .3 mile hike along the stream through the Mulholland Wildflower Preserve, eastern section member Callan Bentley and several of his students located the elusive intrusion! Kimberlite is named for the occurrence of the diamond bearing mica peridotites at Kimberley, South Africa. Kimberlite is an ultrabasic igneous rock composed of olivine with accessory minerals that include mica (phlogopite), serpentine, garnet, and calcite. Here in Ithaca, New York the Kimberlite dikes were first described by Cornell University Professor Orville Derby. The main dike visible in the photograph measures about 20 centimeters in width and forms a near vertical intrusion through the Devonian period shales. The Ithaca region is host to numerous Kimberlite dikes for which emplacement dates range from 144.8 to 147.5 million years. 



The Spring 2024 Eastern Section Meeting To Be Held On May 2,3,4 at the Country Inn, Berkeley Springs, West Virginia

The meeting room at the Country Inn has already been reserved for the three day eastern section meeting! Although still in the very early stages of planning; our activities will include a Thursday evening informal reception with a “share-a-thon and swap” to exchange your education lessons and other items, a Friday field trip to the U.S. Silica Plant and Mine in Berkeley Springs, Geo-Auction, and Saturday field trip to Round Top Hill and other geological locations!

Mark your calendars for the spring 2024 meeting!

- Steve Lindberg
2024 Meeting Coordinator



Friends Of Mineralogy Pennsylvania Chapter

The Energy and Earth Resources Dept. at the University Of Pittsburgh At Johnstown is excited to announce that we will be hosting the fall 2023 Friends Of Mineralogy, Pennsylvania Chapter Symposium to be held here on the Pitt-Johnstown campus the weekend of November 10-12, 2023. The symposium includes presentations on Pennsylvania geology and minerals, a silent auction, Sunday field trip, mineral dealers and sales, give-away and swap table along with other events to be announced. The description below is copied from the FOM web site. Registration forms and further details will be available soon on both the web site and Facebook page. You can contact Steve Lindberg (slindber@pitt.edu) for more details.

The 2023 Friends of Mineralogy Symposium will be held in Heritage Hall at the University of Pittsburgh at Johnstown on Saturday November 11, 2023. A Meet and Greet is planned for Friday night, November 10. The Symposium Field Trip location will be the New Paris Quarry, a fluorite locality, on Sunday November 12. Stay tuned for further details. Friends of Mineralogy - Pennsylvania Chapter's annual Symposium serves the goal of advancing serious interest in minerals and related activities. The audience includes mineral collectors, professional mineralogists and geologists, and curators of public and private collections. The bond uniting these people is a love of mineral specimens and a desire to spread appreciation and knowledge of minerals. Some have an extensive background in mineralogy, and some do not. If you can make a presentation on a topic of interest to this mixed audience, please submit a short abstract to Chapter President Bill Stephens [bstephens@stephensenv.com]. Topics on Pennsylvania mineralogy are of particular interest.

Time slots are approximately 45 minutes including time for questions. This is a hybrid symposium including attendees both in person and via Zoom. Accepted speakers can provide an abstract of up to two illustrated pages for the printed program. We can provide an honorarium of \$100 per presentation.





**FRIENDS OF MINERALOGY - Pennsylvania Chapter
SYMPOSIUM November 11, 2023 Johnstown, PA
FIELD TRIP November 12**

For newsletters and field trips during the year, please join our chapter!
See "Join FM" on the web site

Symposium for mineral collecting enthusiasts
Friday evening Nov. 10: Meet & Greet - bring your mineral specimens to talk about.
Saturday Nov. 11: Hybrid Symposium - **ONLINE or IN PERSON**
8:30 a.m. to 5:00 p.m. at University of Pittsburgh - Johnstown
Talks by knowledgeable **SPEAKERS** on **Pennsylvania Mineralogy and Geology**
Expanded Sales by Select Dealers - Silent Auction - Give-away Table - Conversation
Professional Geologists: Five Professional Development Hour credits available for full lecture attendance
Sunday Nov. 12: Field Trip to New Paris Quarry. Open only to symposium registrants.

Watch for details, **registration form**, changes and updates on our **web site:**
www.rasloto.com/FM or **Friends of Mineralogy Pennsylvania** on Facebook

A Geoscience Education and Communication Division

by Lesley Hymers
Mining Matters

The Geological Association of Canada (GAC®) has launched a Geoscience Education and Communication Division. Officially announced at the 2023 GAC-MAC Conference held in Sudbury in May, the role of the Division is to cultivate interest in the theory and practice of Geoscience Education and Communication among its members and support the diverse and inclusive growth and development of the disciplines and the community, across Canada. Intended for both Geoscience



Education and Communication researchers and practitioners, the Division will serve to advance the research and practice of the disciplines; raise their profiles; and honour those who laid their foundations. The principal

activities of the Division include providing support to Conference Local Organizing Committees; hosting Geoscience Education and Communication Special Sessions and Workshops as part of annual Conferences and providing an article annually for publication in *Geoscience Canada*, the main technical publication of the Geological Association of Canada.

The Division is currently in the process of being established and a microsite will soon be hosted on the GAC website (<https://gac.ca/about/divisions/>)

Contact Lesley Hymers (lhymers@miningmatters.ca) for more information about the Division.

Canadian Geoscience Education Network Revitalization

by Lesley Hymers
Mining Matters

The Canadian Geoscience Education Network (CGEN) is the education arm of the Canadian Federation of Earth Sciences and is concerned with all levels of geoscience education in Canada. Founded in the 1990's, CGEN provides a forum, encourages activities designed to increase public awareness of geoscience, supports the development of geoscience awareness activities in Canada; and coordinates the efforts of the Canadian geoscience community in matters related to geoscience education and public awareness of geoscience. The principal activities of CGEN include supporting educator professional learning workshops, public education, and publications. The EdGEO program is coordinated by CGEN and was initiated in the early 1970's to support local Earth science workshops for Canadian teachers.



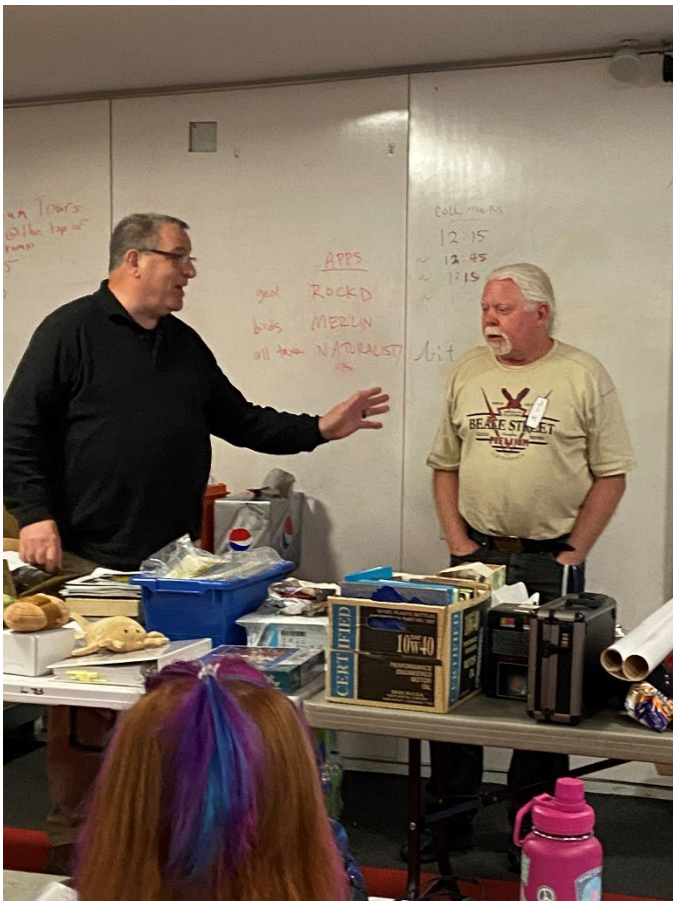
CGEN is currently undergoing a process of renewal and is seeking new volunteer Executive. For more information about the opportunities available, please contact Beth McLarty Halfkenny (BethMcLartyHalfkenny@cunet.carleton.ca) EdGEO is seeking a National Committee Chair and invites anyone with interest to contact Lesley Hymers (lhymers@miningmatters.ca) for more information.



Some photos from the Ithaca meeting

by Renee Aubrey





bulletin

NATIONAL ASSOCIATION OF GEOLOGY TEACHERS EASTERN SECTION



"FROM THE ARCHIVES"

Summer, 2023

Here are two geoscience product advertisements that appeared in our eastern section winter, 1988 Bulletin. Pretty sure these are no longer available at this price. Enjoy! *Steve Lindberg, Eastern Section Archivist.*



ANNOUNCING A NEW WAY TO LOOK AT A CLASSIC OLD MAP Landforms of the United States by Erwin Raisz as a JIGSAW PUZZLE



Tested in the classroom and livingroom to be a delightful pastime, while serving the added benefit of a teaching aid.

An exciting assignment that will be welcomed by your students, as well as, a great gift idea for family, friends, and colleagues.

Designed as a teaching aid for students of Earth Science, Geology, and Geography from Junior High to College Level

Separate puzzles (550 pieces, 18" x 24") of Eastern U.S. and Western U.S.

\$14.95
plus \$3.00

Shipping & Handling
(CA, OR, WA add 50¢)

10% discount for lots of 12

Make checks payable to
MAP PUZZLES

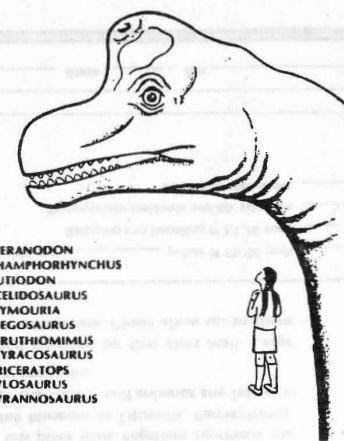
Send orders to:
Map Puzzles
89 Elm Street
Oneonta NY 13820



Dinosaurs

33 Posters of Dinosaurs and their relatives

ALLOSAURUS	DIPLODOCUS	PTERANODON
ANKYLOSAURUS	EDAPHOSAURUS	SHAMPHORHYNCHUS
BRACHIOSAURUS	ELASMOSAURUS	RUTIODON
BRONTOSAURUS	EOGYRINUS	SCOLIDOSAURUS
CAMPTOSAURUS	ERYOPS	SEYMOURIA
COELOPHYSIS	HESPEROSUCHUS	STEGOSAURUS
CORYTHOSAURUS	ICHTHYOSAURUS	STRUTHIOMIMUS
CYNONATHUS	IGUANODON	STYRACOSAURUS
DIADECTES	MONOCLONIUS	TRICERATOPS
DIMETRODON	PLATEOSAURUS	TYLOSAURUS
DIPLOCAULUS	PROTODON	TYRANNOSAURUS



Set of posters includes technically accurate drawings of thirty-three restored dinosaurs reptiles and amphibians. Each animal was drawn to a scale of 1:25. The sample reflects the adaptive diversity of the Mesozoic Era, including representatives from most environments and members of major family trees. Each poster is color coded to geological age. Mouths are open to display teeth when present. Animals are not embellished with characteristics for which there is no direct evidence of existence. Sizes range from 107 cm. x 48 cm. to 21.5 cm x 28 cm. Posters are printed on eighty pound glossy stock. Each set includes a forty-page teachers' guide which provides data on each animal and activity ideas for using the sets. A set also contains one page of scale drawings of a one meter high girl which can be used as a frame of reference for size comparison.

\$22.50 (3 lbs.)

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Recommended for elementary grades

The *Bulletin* is edited by Callan Bentley, Piedmont Virginia Community College. Please get in touch with your feedback, contributions, or if you would be interested in helping with editing.

Nominate your peers!

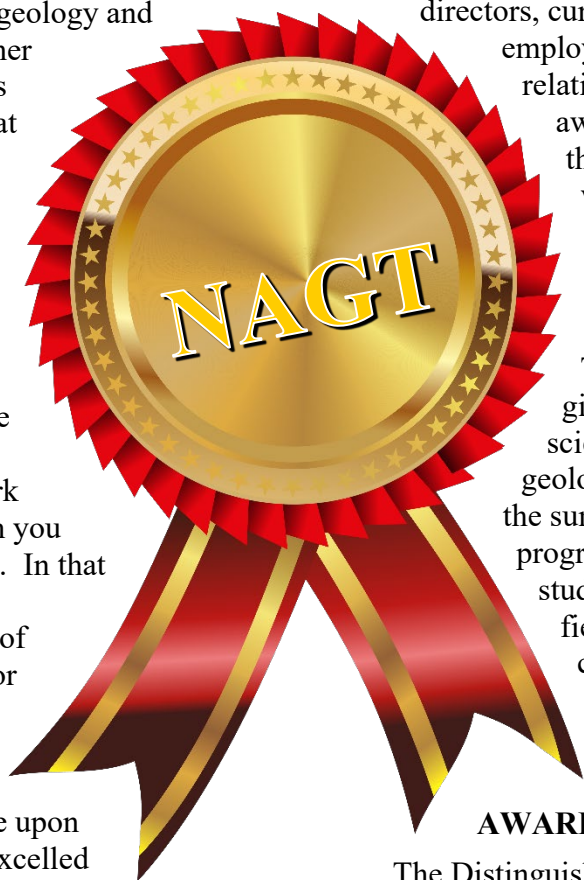
(Nominate yourself!)

by **Christopher Roemmele**
West Chester University

Greetings to all educators of geology and earth science. I am Christopher Roemmele, your new Awards Chair for NAGTES. I teach at West Chester University in West Chester, Pennsylvania, and taught high school/middle school earth science for 15 years in New Jersey. I know how hard we all work as teachers and getting a proverbial pat on the back and thank you is nicely motivating. Perhaps you work with or know someone whom you feel deserves this recognition. In that case, I strongly urge you to nominate this person for one of our Eastern Section awards, or one of the National NAGT awards. The Eastern Section meeting is a wonderful time to heap praise upon those individuals who have excelled in the work and promoted geoscience education.

Information about all our Eastern Section awards can be found on our section website. Please note the deadline is being/has been changed to February 1! So start thinking and get those forms filled out now! Completed nomination forms should be sent to me at croemmele@wcupa.edu. However, you must place your nomination via the online forms found on the National NAGT web site at <http://nagt.org/nagt/programs/oest.html>

Here is a list of our awards. Perhaps there is one with your (or a colleague's) name on it!



OUTSTANDING EARTH SCIENCE TEACHER

The OEST Awards program was adopted by NAGT in 1971. Its purpose to honor pre-college teachers of earth science, their excellence and commitment to teaching and teaching earth science

DIGMAN AWARD FOR EXCELLENCE IN GEOSCIENCE EDUCATION

The Digman Award is designed to recognize an individual who works to bring geoscience to the general public. We look for individuals who are not teachers, but work in a capacity that educates the general public in areas of the geosciences. Museum directors, curators and assistants, state survey employees, mine and quarry public relations people would all qualify for this award. The nomination information for this award is also on our section website.

JAMES O'CONNOR MEMORIAL FIELD CAMP SCHOLARSHIP

The James O'Connor scholarship is given to a college geology or earth science major who is attending a geologic field camp course (typically over the summer) as part of their college degree program. The \$500 scholarship assists the student in covering the expenses of their field camp. Nominate a student currently enrolled in your geology program. Nomination information appears on the section website.

DISTINGUISHED SERVICE AWARD FOR THE EASTERN SECTION

The Distinguished Service Award is given to a member of the Eastern Section (still actively teaching or retired) who has, over the years, contributed to the growth and activities of the Eastern Section. This person should have a history of continued service to the Eastern Section. Nomination information appears on our website.

JOHN MOSS AWARD FOR OUTSTANDING COLLEGE TEACHING

The John Moss award is reserved for instructors and professors who, at the college level, model and promote outstanding teaching in the geosciences. Nomination information appears on section website.



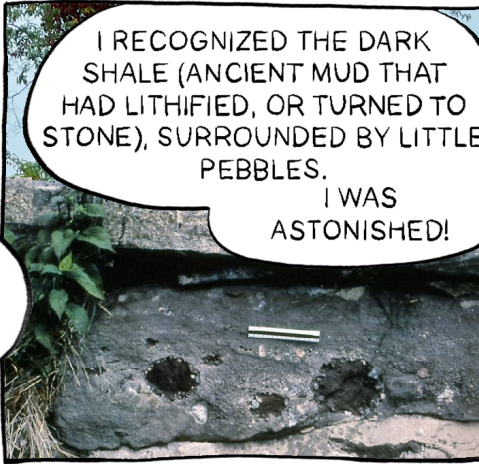
ARMORED MUD BALLS IN FRANKLIN COUNTY, MASSACHUSETTS

IN 1970, I DISCOVERED
LITHIFIED ARMORED MUD BALLS
IN THE QUARRIED STONE
SUPPORTS OF AN OLD BRIDGE
IN TURNER'S FALLS, MA.

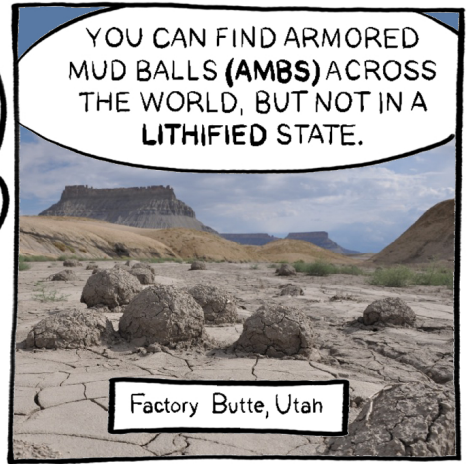


RICHARD LITTLE
Professor Emeritus,
Greenfield Community College

I RECOGNIZED THE DARK
SHALE (ANCIENT MUD THAT
HAD LITHIFIED, OR TURNED TO
STONE), SURROUNDED BY LITTLE
PEBBLES.
I WAS
ASTONISHED!

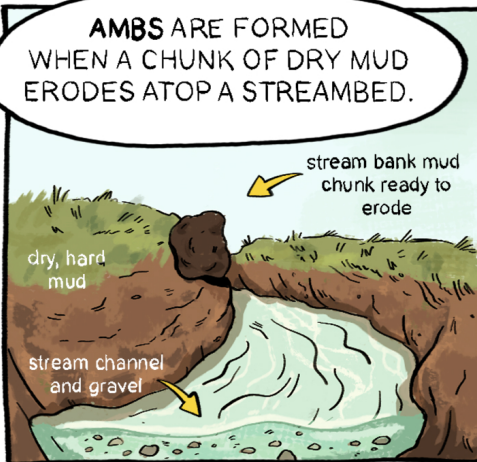


YOU CAN FIND ARMORED
MUD BALLS (**AMBS**) ACROSS
THE WORLD, BUT NOT IN A
LITHIFIED STATE.



Factory Butte, Utah

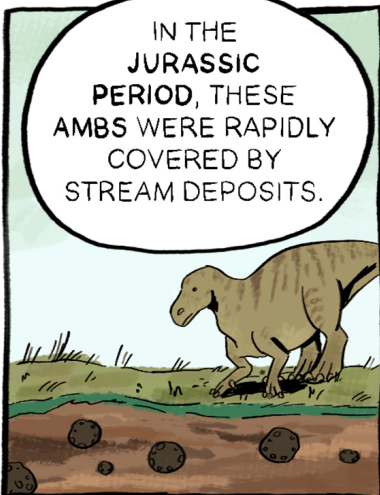
AMBS ARE FORMED
WHEN A CHUNK OF DRY MUD
ERODES ATOP A STREAMBED.



CHUNKS OF STICKY MUD
ROLL DOWNSTREAM AND
PICK UP A COATING OF
PEBBLES, CALLED "**ARMOR**"!



IN THE
JURASSIC PERIOD, THESE
AMBS WERE RAPIDLY
COVERED BY
STREAM DEPOSITS.



ANY
UNCOVERED
AMBS QUICKLY
FELL APART.



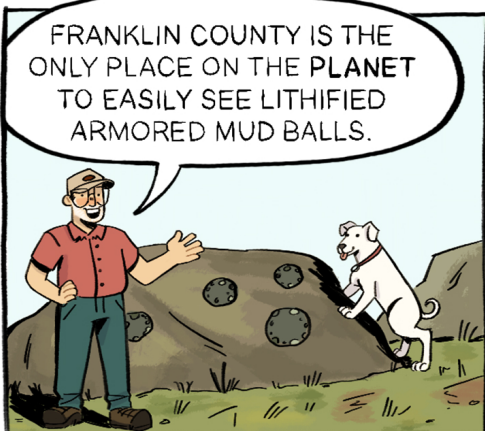
IT TOOK MILLIONS OF
YEARS FOR THE **AMBS**
TO LITHIFY AND THERE
MAY BE MANY HIDDEN
UNDERGROUND.



I FOUND THE **AMBS**
BECAUSE THEY HAD
BEEN QUARRIED FROM
A NEARBY HILL AND
USED TO BUILD THE
BRIDGE.



FRANKLIN COUNTY IS THE
ONLY PLACE ON THE **PLANET**
TO EASILY SEE LITHIFIED
ARMORED MUD BALLS.



art by LILY DANDROW
ldandrowart.com



IN 2023, A BILL WILL BE PRESENTED
IN THE STATE LEGISLATURE TO START
THE PROCESS OF **AMBS** BECOMING
AN OFFICIAL STATE "**SEDIMENTARY
STRUCTURE**".

YOU CAN
HELP SPREAD
THE WORD BY
CONTACTING YOUR
STATE SENATOR
AND STATE REP.

edited by
NICK BERTOZZI
nickbertozzi.com

THANK YOU
FOR YOUR
HELP!

Frequently Asked Questions.....

ARE THESE THE ONLY LITHIFIED ARMORED MUD BALLS IN THE WORLD? Maybe. These are *definitely* the only “easily seen” lithified armored mud balls in the world. There are about 10 other locations where lithified armored mud balls have been noted in the geological literature. They are all in locations that are remote, hard to find, and probably not seen today due to erosion, soil cover, etc. Those other locations from Greenland to Trinidad, are listed and described on the ArmoredMudBalls.rocks web site. *Photo to right: Turners Falls AMB with dime for scale (GCC Geology Path)*



WHY ARE THE FRANKLIN COUNTY AMBs THE BEST IN THE WORLD? + **Best Armor, Color, & Sizes:** The dark mudrock of the ball contrasts with the “puddingstone” conglomerate of the old stream deposited sand and pebbles. The balls are very easy to see. Also, these AMBs’ armor have a diverse mix of colorful streambed pebbles eroded from nearby Jurassic mountains. Some other lithified AMBs from ocean environments are just sand-coated and the color of the ball matches the surrounding rock, making them hard to see. The great size range of the Franklin County examples, from basketball to golf balls, is unlike any other geological location. + **Geological “stratigraphy”:** The Franklin County AMBs are found sedimentary strata of *two different geological time periods from two different quarries and rock outcrops* -- Jurassic (Turners Falls Sandstone*, where most of the AMBs are from) and also about 500,000 years earlier, Triassic Period (Sugarloaf Arkose*). It is extremely rare to have AMBs formed and preserved. It is exceedingly rare to have AMBs formed over such a large time period in the same spot on earth. And, even more amazing: *after* the formation of the Triassic Sugarloaf Arkose AMBs (found in Greenfield and Deerfield) a 200’ thick lava flow (Deerfield Basalt) covered the region, followed by a Jurassic lake. Then, in the Jurassic Turners Falls Sandstone, AMBs rolled into the old Connecticut Valley once again. And, of course, in both cases, in different towns and geologic ages, these rare forms had to be exposed and discovered!

WHY ARE LITHIFIED ARMORED MUD BALLS SO RARE? There are 7 essential events that must happen.

1. Lake beds are needed to deposit mud**. This usually is related to wetter climate conditions.
2. Dry climate conditions*** and / or land uplift are needed for the mud layer(s) to become dry and hard. Then stream erosion, typically due to flash floods common in dry climates. The hard mud chunks fall into the stream. They get round, sticky, and roll along picking up pebbles from the stream bed. That is the armor.
3. Quick burial as the flood subsides, and with geological time, lithification -- turning to stone.

4. Uplift and erosion to expose the rock with AMBs
5. A quarry is needed to remove those specific sedimentary layers with the AMBs.
6. Those quarried blocks have to be placed so that someone can see the round balls.
7. Now, someone has to discover, identify, publicize, and save the rare AMBs.

You can also help! Contact your State Legislators. Sign the petition on the ArmoredMudBalls.rocks web site.

*Turners Falls Sandstone and Sugarloaf Arkose are official geology-mapped names of the rock formations. A “formation” is a geological term (noun) for a mapped rock unit. “Arkose” is a type of sandstone that was deposited close to mountain source areas and so is mostly composed of weaker minerals, like feldspar. ** Some AMBs form from ocean and coastal mud deposits, but not in the Jurassic Connecticut Valley.

*** Dry climates are needed because wetter climates have longer continuous stream transport that destroys AMBs. Dry climates and flash floods make quick burial of AMBs a possibility. Mud balls do not survive very long during stream transport.

*Please note: **unlithified, “recent” armored mud balls** are occasionally found in a number of places. They are very rare, but being so unusual and interesting, there are many photos online. The Factory Butte, UT examples as seen in the cartoon were discovered by noted artist Will Sillin in 2015. A revisit several years later revealed none had survived.*

MORE INFORMATION:

www.ArmoredMudBalls.rocks

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Many thanks to the creativity and talents of graphic artists: Nick Bertozzi (nickbertozzi.com) and Lily Dandrow (ldandrowart.com).

Utah photo thanks to Will Sillin (willsillin.com).

THE BEST PLACE IN THE WORLD

TO SEE THE LITHIFIED AMBs IS

GREENFIELD COMMUNITY COLLEGE’S GEOLOGY PATH
(front of Main Bldg).

For other nearby locations, see the AMBs website.

