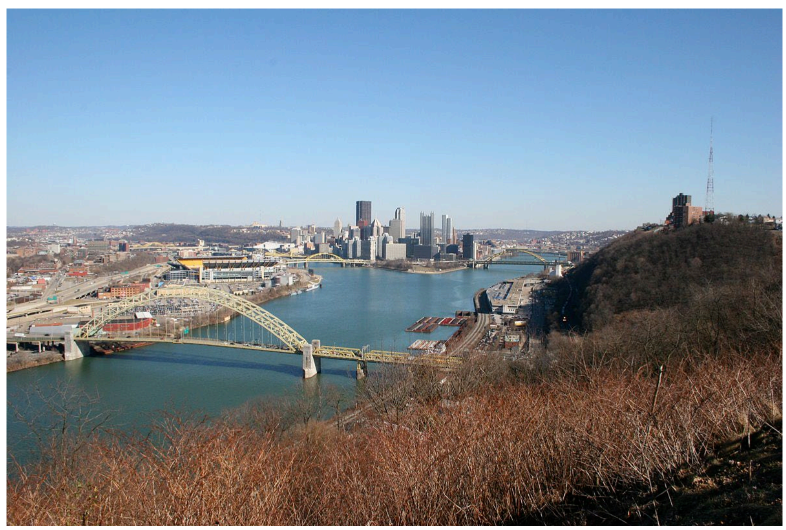
PITTSBURGH GEOLOGICAL SOCIETY

Of Ice and Waters Flowing:

The Geologic History of Pittsburgh's Three Rivers



John A. Harper

Retired Manager, Geologic Resources Division
Pennsylvania Geological Survey

Please RSVP by Wednesday, September 14

September 21, 2022

MEETING TIMES

Social Hour	5:30 PM
Dinner	6:30 PM
Speaker	7:30 PM

DINNER COSTS

$35.00 regular member
$15.00 student member
$40.00 non-member

RESERVATIONS

Email your name and number of attendees to:
pgsreservations@gmail.com

Or reserve and use PayPal:
https://www.pittsburghgeologicalsociety.org/

MEETING LOCATION

Cefalo's Banquet & Event Center, Carnegie PA

COVID19 POLICY

See page 3 for current guidance.

Speaker Abstract

Pittsburgh's landscape, including its famous rivers, is the product of about 600 ma of plate movement, structural deformation, sedimentation, glaciation, and erosion. The geologic history of the Pittsburgh area began with the main phase of the breakup of the supercontinent Rodinia along the eastern margin of Laurentia between about 620 ma and 550 ma ago, creating a series of transform faults and reactivating existing thrust faults that, during the Middle Cambrian, became normal faults. These latter resulted in the Rome Trough, a failed rift within eastern Laurentia that passes through western and north-central Pennsylvania. The Rome Trough and the transform faults, which now have names like Tyrone-Mt. Union lineament, affected structure, stratigraphy, and landscape development in western Pennsylvania throughout geologic time. By the beginning of the Pleistocene, the stage was set. The Appalachian Plateau of western Pennsylvania was dominated by gently rolling topography exhibiting low relief between the hill tops and the bottoms of stream valleys. Drainage was mainly northwest through western Pennsylvania, Ohio, and New York to the ancestral Great Lakes basin and eventually out to the Atlantic Ocean. Initiation of continental glaciation sometime before 770 ka blocked the stream channels, backing up the streams to form an enormous lake of ponded water called Lake Monongahela. As the water level rose, it eventually crested drainage divides, allowing the water to drain backward down pre-existing channels, changing the direction of western Pennsylvania drainage from northwest to southwest, carving deeper channels into the landscape, and stranding some older channel segments as remnant terraces. Four additional episodes of continental glaciation during the Pleistocene recreated Lake Monongahela, each time at a lower level, followed by additional deepening of the stream channels as the lakes drained. The result was Pittsburgh's and western Pennsylvania's iconic three rivers and the landscape that is more about valleys than hills.

Speaker Biography

John Harper, a native of the Pittsburgh area, became interested in geology and paleontology after receiving a set of toy dinosaurs for Christmas when he was nine years old. Maintaining that interest over the years led to a B.A. in Geography and Earth Science from Indiana University of Pennsylvania, an M.S. in Geology from the University of Florida, and a Ph.D. in Paleontology and Paleoecology from the University of Pittsburgh. Upon graduating from Pitt, he joined the staff of the Pittsburgh office of the Pennsylvania Geological Survey and served 35 years, during which he spent all but three years of it managing the staff and helping research Pennsylvania's petroleum and subsurface geology. While there, he took an active role in informing the public about Pennsylvania's oil and gas, the geology of western Pennsylvania, the history of geology, fossil collecting, geological hazards, and other topics. Upon his retirement in 2012, John maintained his interests in part by volunteering two days a week at the Survey where he participated in research on geological sequestration of carbon dioxide and on the stratigraphy and geology of oil and gas from the organic-rich shales of the Marcellus and Utica formations. John has also been a Research Associate in the Section of Invertebrate Paleontology at the Carnegie Museum of Natural History since 1983, so he has been spending two days a week in the Section researching fossil gastropods and assisting with curation of the collections. During both his working and retirement years, he has published numerous professional and popular articles on many aspects of geology, paleontology, and petroleum history. And he still loves those dinosaurs!

Please note that PGS is monitoring the COVID-19 situation closely and will continue to modify policy based on the recommendation of national and local experts. We ask that our members please consult and follow the US Centers for Disease Control and Prevention (CDC) recommendations for Allegheny County as shown here: https://www.cdc.gov/coronavirus/2019-ncov/your-health/covid-by-county.html

UPCOMING PGS MONTHLY MEETINGS

Meeting Date	***Scheduled Speaker***	***Presentation Topic***
September 21, 2022	John Harper *(retired)* Pennsylvania Geological Survey	Of Ice and Waters Flowing: The Geologic History of Pittsburgh's Three Rivers
October 19, 2022	Scott Burns, Portland State	Terroir of Wine*
November 16, 2022	Richard Smozna & Kathy Bruner, West Virginia University	Prehistoric Cave Art of Northern Spain
December 14, 2022	Craig Eckert	Geology of the Appalachian Trail
January 19, 2023	Joint AEG-ASCE Meeting	
February 15, 2023	Darcy Lecture	
March 15, 2023	Peter Dodson University of Pennsylvania	Collecting Dinosaurs on Four Continents
April 19, 2023	Student Night	
May 10, 2023	AAPG Section Winner	

❖ **October meeting to be held at Narcisi Winery**

The Pittsburgh Geological Society welcomes our new members:

New Regular Members:

Alex H. Hayes, Staff Geologist, Geosyntec Consultants
Bethany Carney, LEED AP, CEM, Retired Energy Engineer
Cheryl Kestner, Teacher, Mary Queen of Apostles School
Shaun J. Donmoyer, GIT, Geosyntec Consultants

New Recent Graduate Member:

Daniel A. Cross, BS Geology, IUP

New Student Members:
Jonathon Gannon, Pennwest California University (formerly CalU)
Johnna Green, Metropolitan State University of Denver
Phoebe Sobotta, University of Pittsburgh

PRESIDENT'S STATEMENT

Hello all and welcome to the 2022-2023 PGS program year! I hope that you all have had a relaxing summer and are ready for some nice weather this fall. We had a great 2021-2022 program year and I'm glad to be back for another round in 2022. Let's start the 2022-2023 program with a summary of how things went in 2021.

PGS was fortunate enough to return to in-person meetings last year, featuring eight speakers organized by the Program Coordinator, Pete Hutchinson. Meetings held from September through April were held at Cefalo's Banquet and Event Center in Carnegie and the May meeting was held at Penn Brewery on Pittsburgh's North Side, though it was determined to be unsuitable as a venue due to the acoustics. PGS was also able to return to pre-COVID operations by offering an in-person field trip in March along with a virtual option, the two-day professional development and environmental drilling workshop, and the April student research meeting. A new social event involving a tour of the Wigle distillery was also organized in December. PGS awarded the Frank Benacquista scholarship to two students through a generous donation by PGS Board member Pete Hutchinson, and supported several other educational endeavors through financial contributions and volunteer activity. All prior corporate sponsors were contacted to request continued support and all those that renewed their support were sent letters of appreciation and a list of potential benefits to their organization. These benefits include incentives such as advertising space on the website and a designated location to post active job positions, and their corporate names and web addresses in all nine newsletters. A new merchandise store was also added to the website.

One goal for the 2022-2023 program year is an exploration of more accessibility options (virtual or hybrid meetings and alternate venues more attractive to membership), with October's meeting scheduled to be held at the Narcisi Winery. Other goals include development of subcommittees specific to organization of special events, and demonstration of value to membership and sponsors through social events, merchandise sales, and advertising opportunities.

PGS memberships are going completely digital this year, so don't forget to renew for the 2022-2023 year. You can access and fill out the new formats for applications and renewals by going to the PGS membership website at: (https://pittsburghgeologicalsociety.org/membership.html)

I look forward to seeing you all again soon!!

. Dan

LOCAL GEOLOGICAL EVENTS

THE OHIO GEOLOGICAL SOCIETY OGS 2022 ANNUAL GOLF OUTING

September 1, 2022 **Arrive – 9:30 AM ; 10:30 AM – Shotgun**

18 Hole Golf Scramble, sponsored by Ergon Oil Purchasing, Inc.

Details and registration: https://www.ohiogeosoc.org/events/2022-ogs-annual-golf-outing/

Chapel Hill Golf Course, Mount Vernon, OH

HARRISBURG AREA GEOLOGICAL SOCIETY (HAGS)

September 8, 2022 **6:30 PM – 7:30 PM**

"Water Under the Bridge: A Practical Introduction to Hydrography in Pennsylvania" by Ellen Fehrs, Pennsylvania Geological Survey

In-person or Virtual – Details and registration: https://bit.ly/3dFK45u

PGH PETROLEUM GEOLOGISTS / GEOPHYSICAL SOCIETY PGH (PAPG & GSP)

September 15, 2022 **social hr @ 11:15 AM – talk @12:00 PM**

"A deep dive into the Hydrogen resource; framework, chemistry, geophysics and possible paths forward" by William Harbert, PhD, Professor of Geophysics, University of Pittsburgh

Details and registration: https://www.papgrocks.org/ or https://www.thegsp.org/event-4942013

Cefalo's Banquet and Event Center, Carnegie, PA

PENNSYLVANIA COUNCIL OF PROFESSIONAL GEOLOGISTS (PCPG)

September 15, 2022 **2:00 PM - 3:00 PM**

"Predictability and Practicability of attaining Pennsylvania's Proposed MCLs for PFOS and PFOA in Groundwater" by Jeffrey R. Hale, P.G., Senior Principal Professional, Kleinfelder

Details and registration: https://pcpg.wildapricot.org/event-4776439

MERRILL LINN CONSERVANCY'S COMMUNITY FOSSIL DIG

September 25, 2022 **11:00 AM – 3:00 PM**

Bucknell University professor Jeff Trop and students will guide exploration and identification of ~390 million year old marine fossil finds. See flyer for details.

Shale Pit Road, Beaver Springs, PA **GPS coordinates: 40.45.695N, 77.13.724W**

INTERNATIONAL INSTITUTE OF MINERAL APPRAISERS (IIMA) 2022 EASTERN FALL CONFERENCE

October 11-12, 2022

Day 1: Seven hour refresher course on appraisals (needed for IIMA certification)

Day 2: Eight speakers discuss aspects of appraising minerals-oil-gas-coal-limestone-ores in workshop sponsored by Ayers Petroleum Consulting, see flyer for details Registration: https://ai.appraisalinstitute.org/eweb/DynamicPage.aspx?webcode=EventInfo&Reg_evt_key=2293DD0C-AF61-4B78-9000-7FCCFBD91515&goback=0

Southpointe Golf Club, Canonsburg, PA

INTERNATIONAL CLIMATE SYMPOSIUM *hosted by* DICKINSON COLLEGE

October 24-26, 2022

"Science-Based Choices for Climate Action, Insights from the IPCC 6th Assessment Report" an in-person and livestreamed symposium hosted by Dickinson College, Carlisle, PA.

Details & pre-registration: https://www.dickinson.edu/climatesymposium

Join the Merrill Linn Conservancy's
Community Fossil Dig - September 25
11AM – 3PM
Shale Pit Road, Beaver Springs, PA

Discover and collect ancient fossils from a site containing a rich trove of ancient life.

Who will help us identify fossils?

- Bucknell Univ. professor Jeff Trop and students will guide exploration and identification of fossil finds.
- Examples of common fossils will be displayed.

What can we expect to find?

- ~390 million year old marine fossils
- Abundant brachiopods and crinoids
- Less abundant trilobites, bivalves, gastropods, cephalopods, corals, and bryozoans

What to wear:

- Clothing and footwear that can get dirty.
- Shoes should have good tread; no flip-flops.

What to bring:

- Fossils that you would like to have identified
- Water, snacks (there is **no food/water** near the site)
- Sunscreen
- Camera
- Hammer, chisel or flathead screwdriver, safety glasses or sunglasses (optional aids for fossil extraction; limited supply of equipment will be available to borrow)

Directions to Shale Pit Road, Beaver Springs, PA.

From Mifflinburg, take PA-104 south ~4 miles to Penn's Creek.

- Turn right onto Troxelville Road, continue ~8.5 miles to Troxelville.
- Bear left, continue on PA-235 for ~2.5 miles.
- After Beaver Springs Dragway, turn right onto Middle Creek Road, continue ~1.5 miles.
- Turn left onto Shale Pit Road, continue ~0.5 miles. Fossil quarry and parking will be on your right.

From Middleburg, take PA-522 west 9.3 miles to Beaver Springs.

- After Beaver Creek Tractor, turn right onto Ridge Road, continue ~1 mile.
- Turn right onto Stage Road, continue ~ 1 mile.
- Turn sharp right to Shale Pit Road, continue ~1.2 miles. Fossil quarry and parking will be on your left.

Linnconservancy.org * 570 524-2959 * info@linnconservancy.org

EASTERN FALL CONFERENCE 2022

October 11-12, 2022

Southpointe Golf Club | Canonsburg, PA

October 11th

USPAP Refresher Course

8:30 AM - 4:30 PM
Instructor: Mark Smeltzer

Member Price: $250
(Discount Code: NCMT521028)

Non-Member Price: $265

Happy Hour 5-7 PM
Hilton Garden Inn Southpointe

Happy Hour Sponsored By: TRUEMAPPING GIS & MAPPING

SCAN QR CODES TO REGISTER!

October 12th

Mineral Appraisal Workshop

9:00 AM - 5:00 PM
8 Presentations + Lunch

Member Price: $100

Non-Member Price: $125

Conference Sponsored By: AYERS PETROLEUM CONSULTING

Questions? Contact Betsy Suppes (bsuppes@atlanticbb.net)

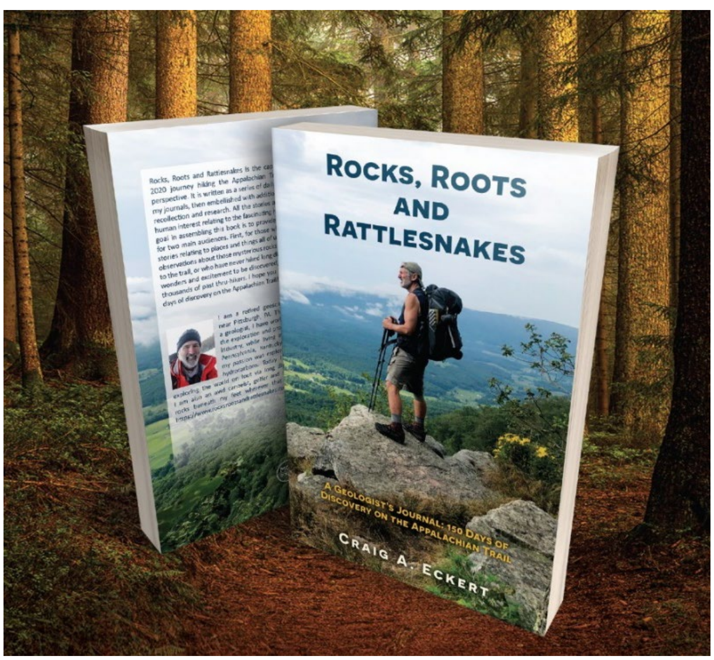
YOU CAN STILL ORDER YOUR OWN PGS SWAG!

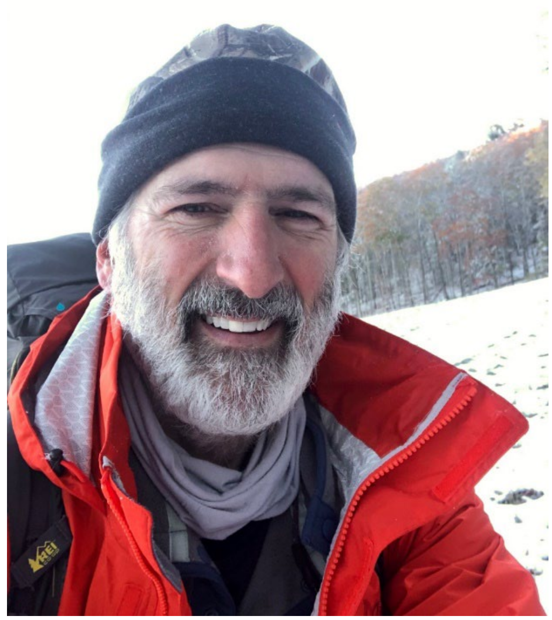
Show off your PGS Membership by purchasing a hoodie, t-shirt, or bumper sticker at the new PGS merchandise store. All proceeds support geology student participation in PGS society meetings!

https://apparelnow.com/pittsburgh-geological-society-apparel

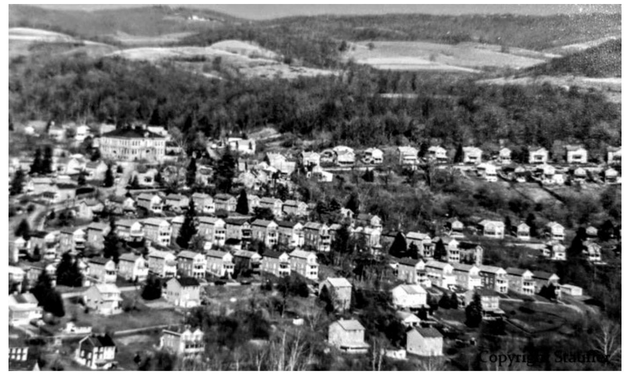
READ A BOOK WITH A LOCAL GEOLOGY CONNECTION!

In June of 2020, Pittsburgh-based geologist and former PGS President Craig Eckart set off on a thru-hike of the Appalachian Trail, a journey which took him past numerous rocks and scenic landscapes. He decided to keep a daily log about the geologic observations he made along the way. In *Rocks, Roots, and Rattlesnakes*, Craig reflects on the sedimentary, igneous, metamorphic and tectonic history of our favorite local mountain chain, weaving an assortment of published data with his own geologic observations. His book makes a great gift for a geologist or a future trail hiker. You can purchase it now at Craig's website: https://www.rocksrootsandrattlesnakes.com/.





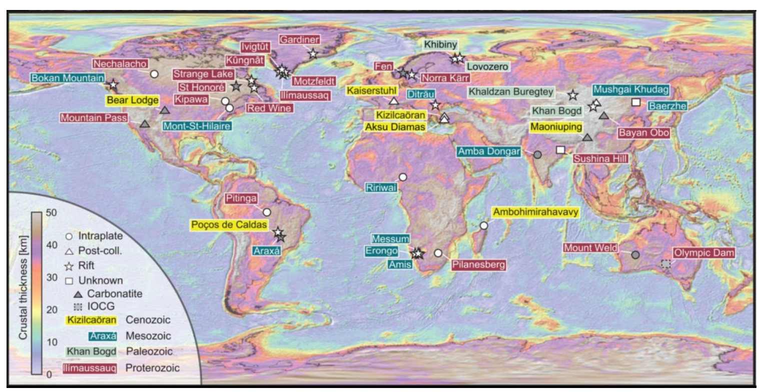
THE ORIGIN OF WESTERN PENNSYLVANIA PLACE NAMES



Historical photograph of the old mining town of Marianna, situated in Washington County on the hill above Ten Mile Creek at the border with Greene Countv.

Marianna, a coal-mining community in West Bethlehem Township in southern Washington County, is located on the hill above the northern bank of Ten Mile Creek, the border between Washington and Greene counties. The area was originally home to Native Americans who called Ten Mile Creek *Cusuthee*. European settlers arrived in the early 1700s, and by the mid-1700s the area was primarily farmland. Then, in the late 1800s, the coal companies came to the area and offered $10 to $150 per acre for the rights to mine the great Pittsburgh coal. In 1907, Pittsburg-Buffalo Company, who had purchased about 6,000 acres of coal rights, built a mining town that became incorporated as a borough three years later. It was named for Mary Ann Feehan Jones, the wife of the secretary/treasurer of Pittsburgh-Buffalo Company. The company did well for its employees: the houses were constructed of brick and designed with indoor bathrooms, fenced yards, and other amenities that were mostly missing in other small communities at that time. Today it is considered Washington County's best-preserved example of a company-built coal-mining town.

DID YOU KNOW . . . ?



- **A team of European researchers generated a map of the world that shows deposits of rare earth elements (REE) and alkaline-silicate complexes.**

A team of scientists from Europe has developed a new 3D geological model intended to help in the exploration of rare earth elements (REE) by targeting alkaline igneous systems, the type of rocks that typically host many of Earth's deposits of REE. As the researchers pointed out, despite the growing importance of these essential raw materials in so many strategic and manufacturing fields, exploration models for REE have been less developed relative to those for major and precious metals such as iron, copper, and gold. In order to address this problem, the research team chose to use both geophysical and geochemical approaches to create their model. Their model, therefore, was based on a combination of map compilations, geophysical and geochemical data, and petrological interpretations of alkaline igneous systems known worldwide. Groups of these alkaline igneous rocks having a common geological history occur at many localities around the world and are common hosts of REE deposits. As a result of demand for the REEs having been historically low, the processes involved in their production and distribution have been dominated by only a few countries who invested early. The team's understanding of the geology of REE deposits was based largely on detailed studies of individual occurrences, involving a host of complex local nomenclature. This, of course, had been a barrier to exploration relative to more mature commodities such as copper or gold. Therefore, the aim of the new research was to generate a multiscale REE exploration guidebook of alkaline-silicate systems that would allow geologists to locate prospective regions and REE deposits more efficiently. The researchers synthesized diverse observations from maps, geophysical models, and geochemical indicators to generate a workflow scheme for explorers that would be relevant from continental scale to the scale of a specific deposit. Their report included a schematic 3D model that showed the position of various types of critical mineral deposits. This 3D model has been specially directed at geologists inexperienced with alkaline rocks that will allow them to learn key points quickly and guide them in their search for REEs.

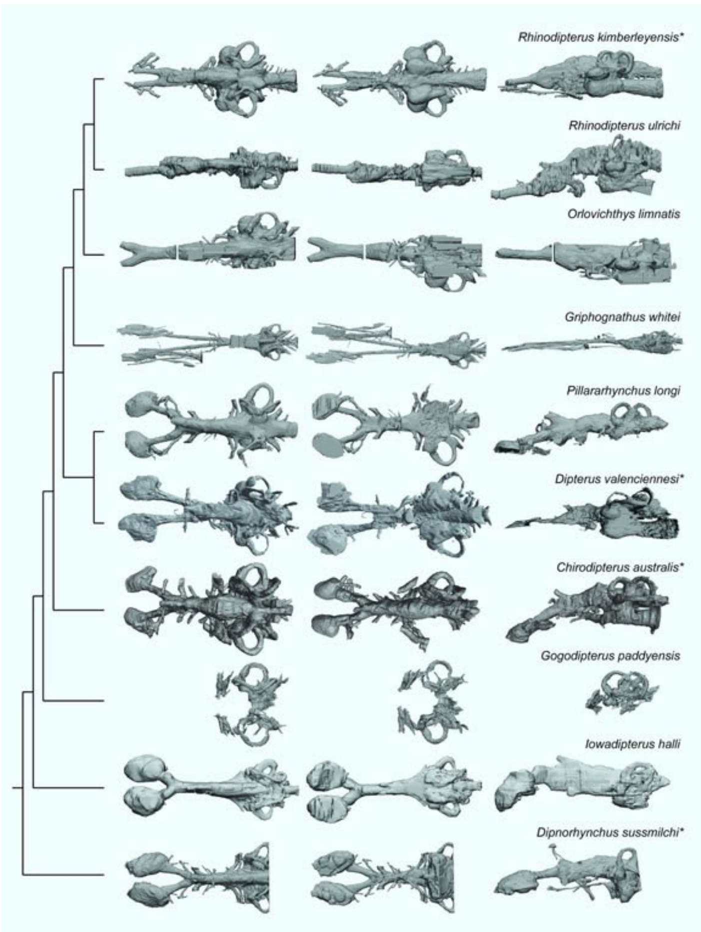
https://www.mining.com/new-3d-geological-model-expected-to-help-guide-exploration-of-rare-earth-elements/

And speaking of REE, researchers from the Lawrence Livermore National Laboratory (LLNL) and their collaborators have been using naturally occurring and engineered proteins and bacteria to separate and purify REE so they can be used for the nation's defense. This would be for the Defense Advanced Research Projects Agency (DARPA) Environmental Microbes as a BioEngineering Resource (EMBER) program (let's hear it for acronyms!). For Phase 1 of the project, the research team received $4 million in R&D funding with an option for as much as $9 million more based on program performance. The team will use advances in microbial and biomolecular engineering to develop a biologically-based strategy for separating and purifying REE using under-developed sources available in the U.S. So far, the chemical processes required to extract and purify REE have been complex and environmentally harmful. Thus, remining or recycling REE from sources such as low-grade ores and mine tailings while using natural products should be significantly advantageous for obtaining REE supplies. Although the U.S. has sufficient domestic REE resources, the nation is dependent on foreign countries to separate and purify them. Biomining, an available technology that has been using microbes to extract or separate metals such as gold or copper from a variety of sources, had not been found to have a role in REE production until recently. In the new project, the LLNL team plans on applying the environmental microbiology, synthetic biology, and protein engineering to allow new biomining methods for producing REE in manufacturing-ready forms. The team also expects to conduct a bioprospecting campaign to identify new REE-associated microorganisms that display REE-use capacity, as well as expanding the range of REE-biomining hosts and REE-binding biomolecules. By the end of the project, the team hopes to deliver this type of biotechnology with high commercial potential to the country's REE industry. If the project is successful, the new biomining process will have the potential to help improve the current REE supply susceptibility.

An REE-bearing core sample from a drill hole in Arizona.

https://cleantechnica.com/2022/07/09/separating-purifying-rare-earth-elements-with-microorganisms/

Lungfish, those freshwater vertebrates best known for having lobed fins, a well-developed skeleton, and, especially, the ability to breathe air, have persisted for 400 ma from the Devonian to present day. They represent the closest living relatives of the tetrapods. Although the evolution of their skull and dentition is relatively well understood, this is not the case for the central nervous system. The brain is essentially unknown in fossil lungfish because their preservation quality is often damaged by crushing or breaking, and the brain itself has very poor preservation potential. There is a considerable amount of indirect information about it and associated structures, however, that can be obtained from 3D representations of the space within the cranial cavity, called endocasts. Recent discoveries now allow paleontologists to describe and illustrate the braincases of six Paleozoic lungfish species from excellently preserved fossil material, which is very informative for the understanding of brain evolution in the Dipnoi, the order to which lungfishes belong. The discovery, by researchers from Australia and Scotland, indicates that lungfish brains have been evolving constantly throughout the 400 ma of their existence. The researchers used synchrotron and computed tomography to create the 3D models of the cranial endocasts of six Paleozoic species, including *Iowadipterus halli, Gogodipterus paddyensis, Pillararhynchus longi, Griphognathus whitei, Orlovichthys limnatis, and Rhinodipterus*



The evolution of Paleozoic lungfish can be determined by cranial endocasts shown in, from left to right, dorsal, ventral, and left lateral views.

ulrichi. This has doubled the number of known lungfish endocasts. Their research suggests these animals probably have always relied on their sense of smell rather than vision to survive within their environments, unlike other fish that use sight much more effectively. By understanding how lungfish brains have changed throughout their evolutionary history, researchers can also understand what the brains of the first tetrapods might have looked like. This in turn can give us an idea about which senses were more important than others, for example vision versus smell. The ongoing work is significant in terms of broad evolutionary and paleontological science. By studying lungfish we can continue to understand how fish first left the water some 350 ma ago and started to become terrestrial animals and much later, humans. It is possible that some of their nervous system traits remain in us still.

http://www.sci-news.com/paleontology/paleozoic-lungfish-endocasts-10990.html

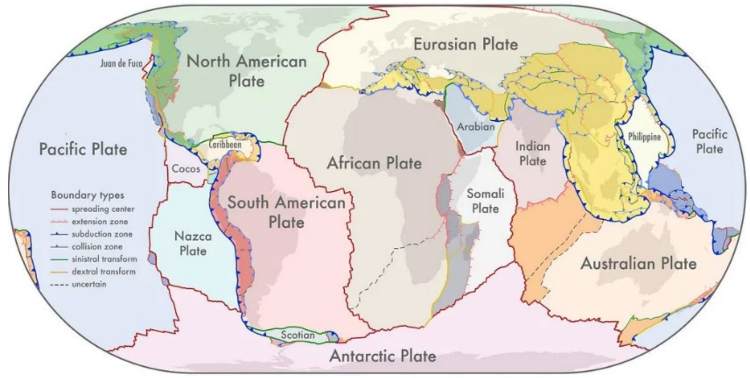
Geologists have discovered 1.2-ga-old groundwater about 1.9 mi. below Earth's surface in Moab Khotsong, a gold and uranium mine located in the Witwatersrand Basin, within the Kaapvaal Craton, South Africa. Uranium and other radioactive elements occur naturally in the host rock that contains other mineral and ore deposits. These elements hold new information about the groundwater's role as a power generator for chemolithotrophic groups of microorganisms that are known to occur within the deep subsurface.

A geologist collects a sample of Precambrian-age groundwater from the Moab Khotsong mine in South Africa.

When elements such as uranium, thorium, and potassium decay in the subsurface, the resulting alpha, beta, and gamma radiation has ripple effects, triggering what are called radiogenic reactions in the surrounding rocks and fluids. At Moab Khotsong, researchers found large amounts of radiogenic helium, neon, argon, and xenon, and the discovery of krypton-86, which is a tracer of this powerful reaction history that has never been seen before. The radiation also breaks apart water molecules through radiolysis, thereby producing large concentrations of hydrogen, which is an essential energy source for subsurface microbial communities deep underground where they can't use photosynthesis. Due to their extremely small masses, helium and neon are especially valuable in the identification and quantification of transport potential. Although the extremely low porosity and permeability of crystalline basement rocks means the groundwater is basically isolated and rarely mixes, diffusion can still take place. Even solid materials like plastic and stainless steel can eventually be penetrated by diffusing helium, as anyone who has ever watched a helium-filled mylar balloon deflate can testify. The researchers' results indicate that diffusion has provided a way for 75-82% of the helium and neon originally produced by the radiogenic reactions to be transported through the overlying crust. Because the radiogenic reactions produce both helium and hydrogen, scientists can learn about helium reservoirs and transport as well as calculate hydrogen energy flux from the deep Earth that can sustain subsurface microbes on a global scale. This discovery has implications for the space program as well. While these calculations are important in understanding how subsurface life is maintained on Earth, they will also be important in determining what energy might be available from radiogenic-driven power on other planets and moons in the Solar System and beyond. This would be important for informing upcoming missions to Mars, Titan, Enceladus, and Europa.

http://www.sci-news.com/geology/moab-khotsong-groundwater-10972.html

New models showing the configuration of tectonic plates are providing fresh insights into the history of the Earth, and will provide a better understanding of earthquakes, volcanoes, and other natural hazards. The research, by scientists in Australia, Tasmania, and the U.S., began with an investigation of how the current configuration of plate boundary zones and continental crust were assembled. That was done like a jigsaw puzzle, a few pieces at a time. When the puzzle was completed, however, it was chopped up and rearranged to produce a new picture. The new



A new model of the Earth's tectonic plates in color, showing the boundary zones in darker shading.

study helped clarify the various elements so the scientists could piece together the previous images. The team created three new geological models, including a plate model, a province model, and an orogeny model. There are 26 orogenies that have left an imprint on the present-day architecture of the crust, many of which are related to the formation of supercontinents (e.g., the relationship of the Alleghanian orogeny to the formation of Pangea). The new plate model includes several new microplates, including the Macquarie microplate situated south of Tasmania and the Capricorn microplate that separates the Indian and Australian plates. The researchers added more accurate information about the boundaries of deformation zones to further enrich the model, where previous models showed them as discrete areas rather than wide zones. The greatest changes in the new plate model occur in western North America, where the boundary with the Pacific plate has been drawn as the San Andreas and Queen Charlotte faults. The newly delineated boundary is much wider than the previously drawn narrow zone, however, at about 930 mi. Another large change is in central Asia where the new model includes all the deformation zones north of India as the plate bulldozed its way into Eurasia. The team's work provides a more accurate representation of the Earth's architecture and has other important applications. The plate model shows that plate boundary zones account for nearly 16% of the Earth's crust and 27% of continents. It provides a better explanation of the spatial distribution of 90% of earthquakes and 80% of volcanoes from the past 2 ma, whereas the existing models only explain about 65% of earthquakes. Thus, the new model can be used to improve information on the risks from geohazards. The orogeny model will help us understand the geodynamic systems and provide better models of Earth's evolution. And the province model can be used to improve prospecting for minerals.

https://scitechdaily.com/new-understanding-of-earths-architecture-updated-maps-of-tectonic-plates/

A team of scientists from Australia found a stalagmite in Yonderup Cave in Western Australia that has preserved a record of fire events and climate conditions on that continent. The largest fire event recorded by the stalagmite occurred in about 1897 CE, and coincided with a decades-long drought period known as the Australian Federation drought, leading to speculation that the intensity of the fire was probably at least partially caused by those dry conditions. The fire occurred a few decades after Indigenous cultural burning would have been suppressed by Europeans, so the fire most likely was worsened by a build-up of understory vegetation and dry combustible material on the forest floor due to removal of Indigenous land management practices. The researchers interpreted the pre-European period encapsulated in the stalagmite record as characterized by regular, low-intensity fires, whereas its post-European record suggests infrequent but high-intensity fires. They proposed these changes were due to management practices. They found trace metals and nutrients such as phosphorus in bushfire ash, which theoretically can dissolve into waters that eventually infiltrate underground caves. This research provides the first evidence that water containing high concentrations of dissolved ash-derived elements can alter the chemistry of speleothems (cave ornaments), thereby resulting in the preservation of geochemical signals from past fire events. The question arises: why hadn't speleothems been discovered as archives of past fires previously? The researchers realized they needed to use the highest resolution geochemical techniques available, as stalagmites grow very slowly. A stalagmite increases in height in one year only by the thickness of a sheet of paper, but the geochemical trace left by a fire is even thinner.

Speleothems in Yonderup Cave in Western Australia. One stalagmite from the cave has preserved a record of fire events and climate conditions.

Stalagmites record the annual accumulation of years, similar to tree rings. In regions with high seasonality, wet winters can lead to a flush of organic matter into the dripwaters that form stalagmites. This causes annual dark bands alternating with light calcite bands in summer, meaning that, like tree rings, they can be easily and precisely dated by counting back the annual layers. While the particular portion of the Yonderup stalagmite is relatively young, allowing scientists to peer back just 260 years, the range of time promised by other stalagmites and other speleothems, or cave ornaments, stretches back much further, thousands or even tens of thousands of years. The technique potentially provides the possibility of speleothems to describe historical fires and climatic events anywhere caves occur, which could provide new perspectives on climate change because speleothems record increasing or decreasing rainfall rates and changes in evaporation and their potential influence on local fire events, whether they're becoming more or less frequent through time.

http://www.sci-news.com/othersciences/geoscience/yonderup-cave-stalagmite-10721.html

A new study has found evidence of surprisingly rapid upward movement of earth's crust on the island of Taiwan. During about 500 ka, the Coastal Range of east Taiwan rose at a rate of 0.35 to 0.55 in. per year. Although this might seem imperceptibly slow, it is actually quite fast for mountains. Much of the spectacular topography on Earth's surface was formed by vertical movements of less than 0.04 in. per year. The research, performed by scientists from Taiwan and Oregon, found the measurements of extreme rates to be unprecedented, challenging ideas about the millions of years timescales supposedly needed for the rise and fall of a mountain. Geologists have ways of estimating the ages of rocks and reconstructing their movements over time, but Taiwan's rapid vertical crustal movement previously had gone undetected by more traditional techniques. Taiwan sits at the boundary of two tectonic plates and formed from a series of collisions between the plates. It is in a geological zone where volcanic islands from an oceanic plate are crushing together and merging into a continent. Mountains occur there as a result of intense deformation and movement of the rocks near Earth's surface. The researchers analyzed sedimentary rocks from sites around the island. These rocks recorded the history of sediment accumulation and erosion as the crust moved up and down. The researchers looked at microscopic fossils embedded in the rock layers to determine when they formed, and also looked at their paleomagnetic signatures. The researchers used this information to calculate the unexpectedly fast rate at which the mountains were rising. Their discoveries also challenge a long-standing hypothesis for the geological origin story of Taiwan. Previously, geologists thought that Taiwan's mountains emerged gradually along the boundary of the two plates, from north to south, over 5 or 6 ma. The new data, however, show that the whole Coastal Range has been popping up at the same time along the plate boundary, within only 500 ka. So now geologists need to rethink about what was actually occurring during this mountain-building event and how to reconcile and reinterpret data from earlier research. Although the research focused on a specific part of Taiwan, similarly spectacular movements also could have helped shape places like the Talkeetna-Chugach Mountains in Alaska and Klamath Mountains in Oregon. The research suggests similar kinds of crust motions are probably underdetected by previous studies.

https://www.geologyin.com/2022/05/taiwans-crust-is-moving-at-extreme-speed.html

Taiwan's crust is moving upward at "extreme" speed.

WEBSITE OF THE MONTH

https://www.americangeosciences.org/critical-issues/faq/what-are-rare-earth-elements-and-why-are-they-important

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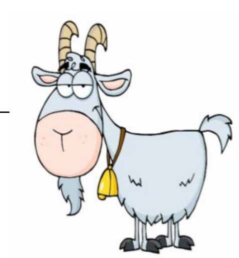

Fun Fact Having Nothing to Do with Geology

Billy goats urinate on their own heads to smell more attractive to females.

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