PITTSBURGH GEOLOGICAL SOCIETY

May 19, 2021

Virtual Meeting Times

Board Meeting	6:00 PM
Social Gathering	7:00 PM
Presentation	7:30 PM

Pre-Registration is Required

To receive the Zoom link, PGS members and guests must RSVP at: pittsburghgeologicalsociety.org

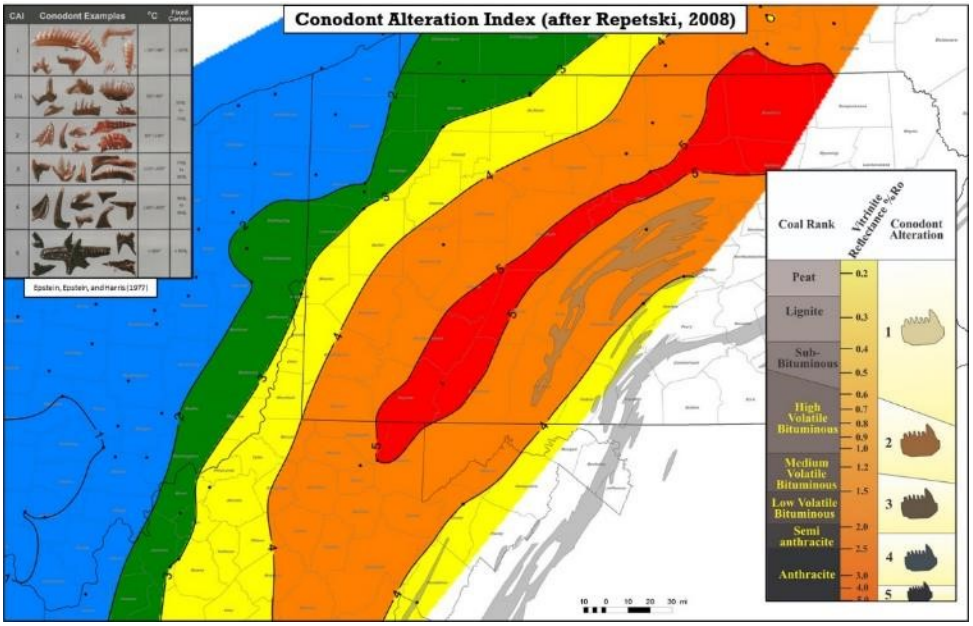
PDH Certificates are Available

Attendees can receive an emailed PDH certificate at their request. Non-PGS members are asked to kindly donate $10 to either the Pittsburgh Geological Society Endowment Fund or the PGS Galey Fund for Students when they request a certificate on the PGS website.

Online Meeting Guidelines

All attendees are encouraged to join the meeting no later than 7:20 PM when announcements will be made. PGS requests all attendees to mute their own audio and video during the presentation to avoid disruptions and to lower bandwidth.

Methods to Assess Thermal Maturity of the Utica / Point Pleasant Play in the Appalachian Basin



Thomas Bardol
Senior Geologist,
Seneca Resources Company LLC

Please RSVP by May 18 to receive the Zoom link.

Abstract

Thermal Maturity has been a key component of the Utica play since its inception. The initial focus was determining the oil, condensate, wet gas, and dry gas boundaries in Eastern Ohio and Western Pennsylvania. While that aspect of the play is now well delineated, there is still work to do determining the effective extent of the dry gas play as it extends into Central and Northeastern Pennsylvania.

Vitrinite Reflectance (VR_O %) measurements are the gold standard for assessing maturity in coals and many source rocks. The Utica and Point Pleasant are Upper Ordovician in age, so unfortunately there is no vitrinite to measure. Conodont Alteration Index (CAI) maps introduced by Epstein, Epstein, and Harris (1978) and updated by Repetski and others (2008) have helped in determining the overall maturity patterns in the Appalachian Basin. However, the author believes that more detailed thermal maturity proxies are necessary to explain production differences and estimate the extents of the deep, dry gas play.

Using logs, cuttings, core samples, and gas data collected throughout our 100+ year history in the Appalachian Basin, Seneca has undertaken several studies to further our knowledge of the extents of the deep, dry gas Utica play. These efforts include looking at bitumen and zooclast reflectance, resistivity logs, pyrolysis data, gas composition and isotopes, and Raman Spectroscopy, in addition to integrating shallower datasets from Devonian source rocks and Pennsylvanian coals. This presentation will detail the advantages, as well as issues, encountered with each of these methods and provide some applications of each.

Speaker Biography

Thomas Bardol is a Senior Geologist with Seneca Resources Company, LLC in Pittsburgh, PA, where he has worked for over 11 years. Prior to Seneca, Tom spent time with US Energy Development Corporation and Computerized Mudlogging Service. He is currently the lead Geologist for Seneca's Marcellus and Utica development in their Clermont / Rich Valley prospect in Elk, Cameron, and McKean Counties. In addition to operations Geology, Tom is involved in petrophysical reservoir characterization and the application of thermal maturity data to development and exploration of shale plays at Seneca. Tom serves as the current AAPG Delegate for the PAPG and is a past President and Treasurer of the PAPG. Tom received his BA in Geology from the State University of New York at Buffalo in 2008.

PRESIDENT'S STATEMENT

This month will mark the 41st anniversary of the eruption of Mount St. Helens. I remember where I was when the eruption occurred as many of you probably do as well. The magnificent sideways blast that resulted after a landslide unleashed the intense blow was a spectacular sight. The images captured by David Johnston, the USGS volcanologist who died while documenting the events, are timeless reminders of the events that unfolded on May 18th, 1980.

Fifty-seven people lost their lives in this natural disaster; if some had listened to the authorities and warnings by scientists, they may still be alive today. Harry Truman, who ran the Mount St. Helens Lodge at Spirit Lake, became famous after ignoring the authority's eviction orders on TV during an interview and consequently died on the mountain. The lodge was buried in ash and avalanche debris, and the logs from the blown-out trees in the lake are a visible reminder of the powerful blast that destroyed a part of the mountain. The eruption of Mount St. Helens may be one of those once-in-a-lifetime natural events that we will never forget.

Several parallels can be drawn between the eruption of Mount St. Helens and events of the past year. The COVID-19 Pandemic and the eruption of Mount St. Helens are natural events that most of us will always remember. We will remember where we were and what we were doing, either on the day of the eruption or the day you were sent home from work or school and the country essentially shut down. Similarly, there are individuals, like Harry Truman that chose not to listen to the authorities or scientists denying that COVID 19 was more than the flu. The natural world is fascinating and, occasionally, we are reminded of Earth's powerful processes, not only the geologic events (volcanism and earthquakes), but the meteorological ones such as hurricanes, tornadoes and floods and the biological ones like the pandemic we have been living with and adapting to over the past year. These natural events will be remembered and written about for decades.

I want to thank the board members and the membership for all their support over the past 3 years. I am honored to have served as the President following a long line of past presidents who worked hard to advance the society. Not growing up in this area, I have learned about the incredible history of the Pittsburgh region and the importance of geology in its economic development. Seventy-six years ago, the founders of this society built an organization that provided a venue for the exchange of ideas and the sharing of common interests. I hope to be able to eventually celebrate this milestone anniversary and interact with many of you next year at our monthly meetings. I look forward to serving in a different role as Past-President, and to volunteering on committees where needed to continue advancing the society into the future.

Have a wonderful summer and I hope to see everyone in the fall.

Tamra

The Pittsburgh Geological Society welcomes the following new members:

Regular Members
Suzanne K. Mills
Blair N. Chan
Benjamin D. Finley

Student Member:
Hannah R. McDermott, Slippery Rock University
Caleigh A. Cessna, Indiana Area Senior High School

Caleigh is this year's winner of the PGS Senior Division award at the Pittsburgh Regional Science and Engineering Fair.

Congratulations to the award winners from our April student research night:

- ASCE-GI oral: **Robert Maxwell Winn**, University of Pittsburgh, "Characterizing the Development of the Subsidence Basin Formed under the Interstate-70 Alignment over Longwall Mining of the Tunnel Ridge Mine, Washington County, PA"
- ASCE-GI poster: **Julia Jones**, University of Pittsburgh, "Is the Caney Shale Formation Brittle or Ductile?"
- AEG oral: **Margaret Kroehler**, Kent State University, "Landslide inventory and bedrock slope stability for the North Cove area, McDowell County, North Carolina"
- AEG poster: **Garrett Strittmatter**, Indiana University of Pennsylvania, "How do Scotia Sea Diatoms Relate to Climate During the Last 30,000 Years?"
- PGS oral: **Jonathan M. Brady**, West Virginia University, "Variations in Produced Water Chemistry and Relation to Regional Geology and Production in the Marcellus Shale, Northcentral West Virginia"
- PGS poster: **Natalie Odegaarden**, West Virginia University, "Vein Evolution and Intensity due to Kerogen Maturation in the Marcellus Shale"

GEOLOGICAL EVENT CALENDAR

Pennsylvania Council of Professional Geologists

May 18, 2021 **1:00 PM – 2:00 PM**

"Maximize well efficiencies in both screen wells and open hole (Bedrock wells) with proper well development techniques" by Roger E. Renner of E. H. Renner & Sons, Inc., Chairman of the Minnesota Department of Health Advisory Council on Wells and Borings. For more information or to register: https://pcpg.org/event-4137507

Geophysical Society of Pittsburgh

June 2, 2021 **12:00 PM – 1:00 PM**

2nd Annual Appalachian Basin Virtual Geophysical Symposium
Sharing geophysical knowledge to maximize unconventional resource development of the Appalachian Basin. For more information: http://www.thegsp.org/event-4181521

EVENTS OF INTEREST TO PGS MEMBERS

NORTHERN ALLEGHENIES GEOLOGICAL SOCIETY

The Alternative to Usual Mail APRIL 2021

MEETING DETAILS

MAY 27 , 2021

ARRIVE AT 5:00 PM

THURSDAY BEFORE MEMORIAL DAY WEEKEND

We will "snack" at 5:30 followed by presentation

Address:

570 Valley Brook Road
New Florence, PA

$25.00//person

1.5 PDH CREDIT

Meal to be provided by

Balance Restaurant
Johnstown, PA
See Page 2 for Details

To register for this event (whether or not you want to reserve a meal), email Abby Wess at abbyrwess912@gmail.com by May 19.

Join NAGS for on "Snacks on the Rocks" @ the scenic

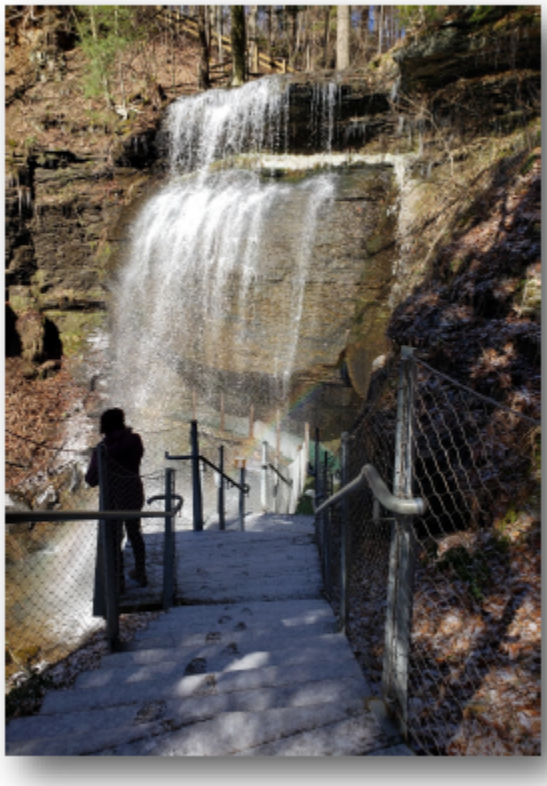
Buttermilk Falls Natural Area

New Florence, PA

The Buttermilk Falls Natural Area features an impressive 45-foot waterfall and 48-acre scenic woodland. As part of the Indiana County Parks System, this area was donated to Indiana County in 1995 by the Keystone-Conemaugh Group.

As a natural area, the site has been set aside to protect both typical and unique plant and animal communities and to protect outstanding examples of natural beauty.

Ed Patterson, from the Indiana Parks will discuss the land use history, unique salamanders, the Park's association with Fred Rodgers, and the eventual donation of the falls and woodland to the Indiana Parks and Recreation.



Joan Hawk will discuss the local geology and discuss some potential mechanisms responsible for the creation of the falls.

Jackie Hockenberry and Abby Wess will discuss vegetation.

EVENTS OF INTEREST TO PGS MEMBERS

OCTOBER 7-9, 2021: THE 85TH ANNUAL FIELD CONFERENCE OF PENNSYLVANIA GEOLOGISTS

GEOLOGY OF OHIOPYLE STATE PARK AND THE LAUREL HIGHLANDS OF SOUTHWESTERN PENNSYLVANIA

We are excited to announce that the Field Conference of Pennsylvania Geologists will be returning as an in-person conference this fall. We hope you will be able to join us on October 7-9 when we visit the Ohiopyle State Park area. All attendees are encouraged to receive their COVID-19 vaccine.

Registration Opens: August 2, 2021

Schedule: October 7-9, 2021

Location: Ohiopyle, PA

Trip Leaders: Jim Shaulis, PA Geological Survey
Frank Pazzaglia, Lehigh University
Steve Lindberg, Energy and Earth Resources Dept., University of Pittsburgh at Johnstown

Headquarters: Seven Springs Mountain Resort

GUIDEBOOK REMINDER

We are accepting submissions for the conference guidebook. We welcome articles highlighting geologic research in the state, especially projects that have been completed or are in progress in the region covered by the 2021 conference. Articles from students and early-career geoscientists are particularly welcome! Articles can be on any geoscience or related topic including geological mapping, trail guides, environmental geology, history of geology, geoarcheology, and geologic education.

For more information, please visit:
https://www.fcopg.org/

EVENTS OF INTEREST TO PGS MEMBERS

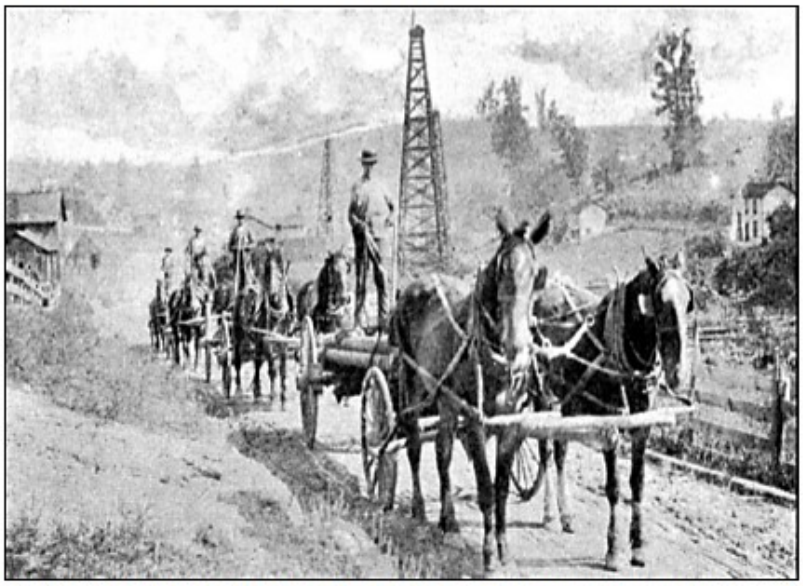
CALL FOR PAPERS

ABSTRACT DEADLINE: July 31, 2021

PETROLEUM HISTORY INSTITUTE

2021 ANNUAL SYMPOSIUM AND FIELD TRIP

September 29 – October 1, 2021; Pittsburgh, Pennsylvania



Horse teams at work in the McDonald oil field near Pittsburgh, Pennsylvania, c. 1890s.
[From C. A. Whiteshot, *The Oil-Well Driller*... (1905)]

REGISTRATION AND EVENING RECEPTION
Wednesday, September 29, 2021

PRESENTATIONS – ORAL AND POSTER – Thursday, September 30, 2021
Proceedings to be published in the *Oil-Industry History*

FIELD TRIP – Friday, October 1, 2021

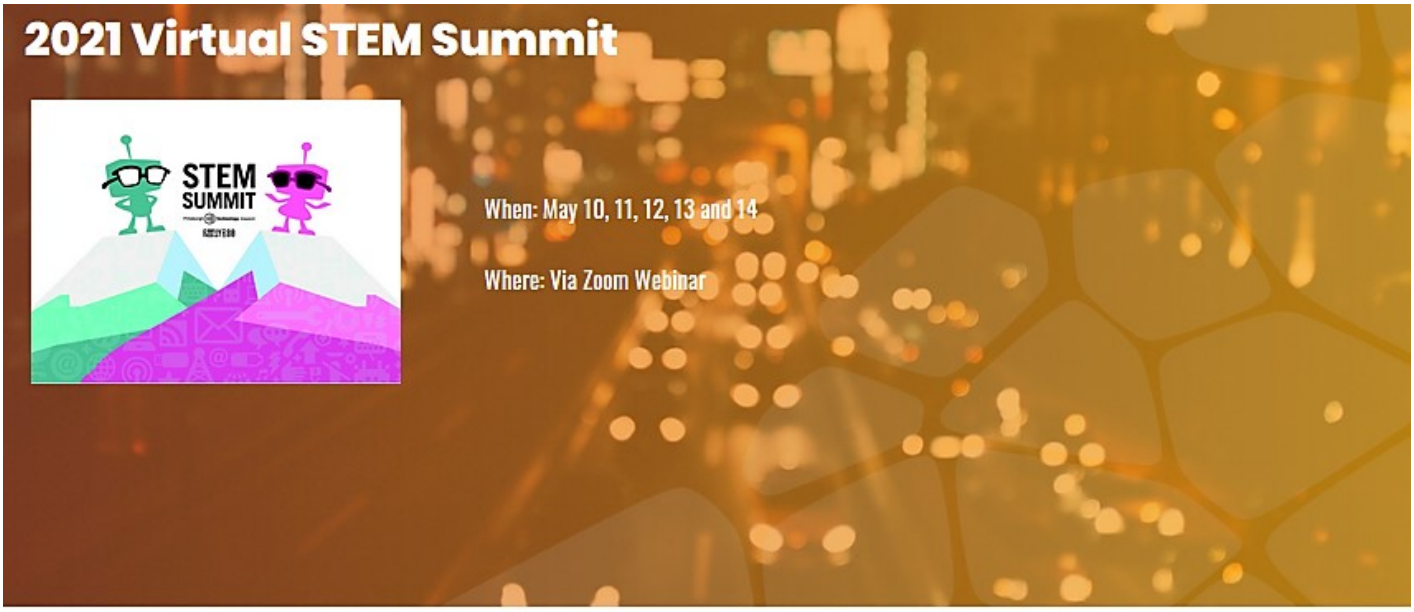
HEADQUARTERS HOTEL – DoubleTree by Hilton Pittsburgh International Airport; 8402 Univ. Blvd., Moon Township, PA 15108; 412-329-1400; for Group Rate mention "Petroleum History Institute" prior to Sept. 8.

For Symposium details including registration form, please see www.petroleumhistory.org.

ABSTRACTS BEING ACCEPTED NOW. Please send to Dr. William Brice, wbrice@pitt.edu. Or Call Marilyn Black; (814) 425-8011; marilynblack@windstream.net.

For more information, please visit:
www.petroleumhistory.org.

EVENTS OF INTEREST TO PGS MEMBERS



About Event

REGISTER HERE

2021 Virtual STEM Summit

End the school year with this 5-day, virtual work-based learning experiences in STEM with five different leaders in the STEM industry.

Join us in our innovative, student-driven event while we feature big names in the world of tech and a diverse array of science, technology, engineering and math related careers that are available in southwestern Pennsylvania.

In this virtual model, students will begin by gaining access to remarkable experiences with leaders in the STEM industry. And to add to the engagement and excitement, the students will have the unique opportunity to serve as student hosts, participate through interactive Q & A, and embark on adventures into the workings of the industry.

Who Should Attend?

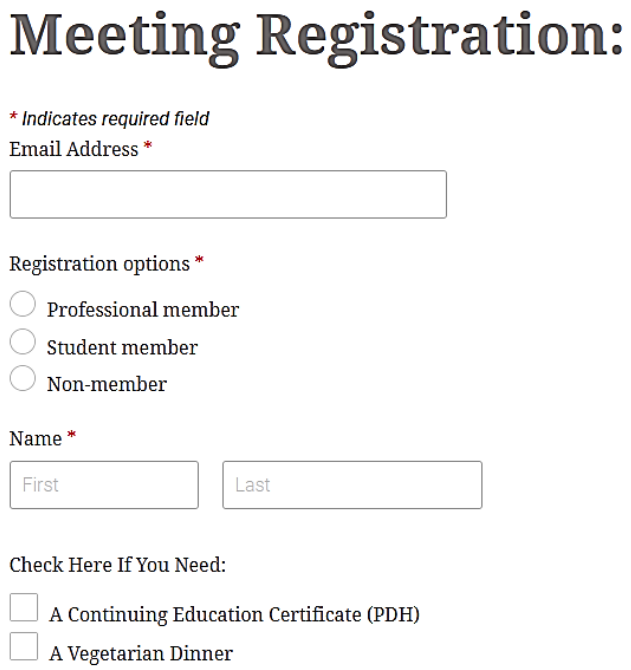
- K-12 educators, administrators and guidance counselors
- Elementary students, middle school students and high school students
- College/University educators, students, administrators and career counselors
- Business Leaders - Future Employers

To register for this event, please visit:
https://zoom.us/webinar/register/WN_gYLOAXChSUiw8CrKHi62fw

PROFESSIONAL DEVELOPMENT HOUR (PDH) CERTIFICATES

PGS issues one PDH unit for those professional geologists who attend our meetings and request a certificate. Virtual meetings complicate matters a bit. If you are a professional who needs PDH units for licensure, please be sure to enter your full name with the email address where you want the PDH certificate sent when registering to ensure accurate recordkeeping.

Don't forget to check the PDH box on the website form. →



PGS 2021-2022 ELECTION SLATE

The following nominations have been made for the officers and board of the PGS in the upcoming year. All members should have received a ballot via email. If you did not get yours, please contact membership chair John Harper at jharper.pgs@gmail.com to request one.

President: Dan Harris
Vice President: *open**

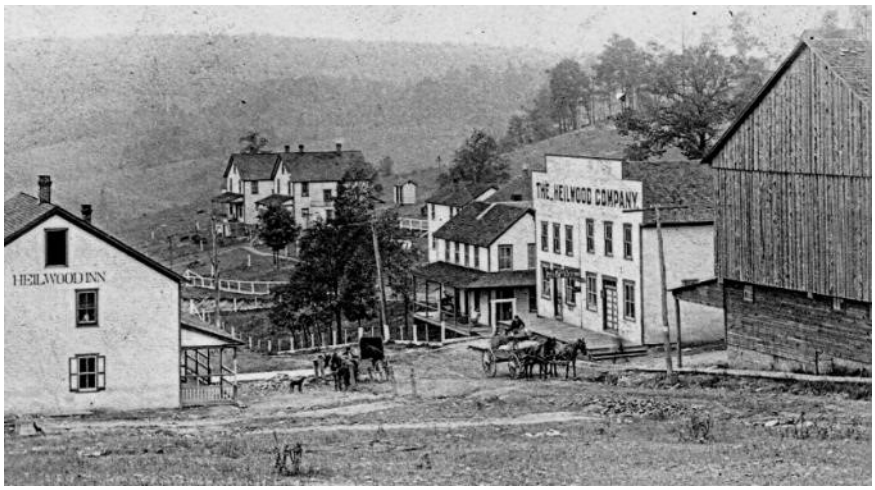
Treasurer: Kyle Fredrick
Secretary: Diane Miller

**In the event that no one is elected as vice-president for the upcoming year, a committee will be formed to take on the task of arranging monthly speakers for the society.*

Directors-at-Large (2nd year)	Directors-at-Large (1st year)
Brian Dunst	**Albert Kollar**
Ray Follador	**Wendy Noe**
Mary Ann Gross	**Nancy Slater**

THE ORIGIN OF WESTERN PENNSYLVANIA PLACE NAMES

In the 1880s, a lumberman named J. M. Guthrie established a settlement on a tract of land in Pine Township in eastern Indiana County that had once belonged to a man named Misner. The land had five houses, a storeroom, three stables, a blacksmith shop, and other out-buildings. Over time the area became known as Possum Glory because of the abundance of opossums (Possum Glory is the name officially recognized for the area by the USGS on the 1904 Indiana, Pa. 15-minute topographic map).



Historical photo of Heilwood, Indiana County, in the early 1900s when it was a coal mining town where employees of the Penn Mary Coal Company lived. On the right is the Company Store and on the left the town hotel, the Heilwood Inn.

When the lumber business began to taper off toward the end of the 1800s, Guthrie faced bankruptcy and the land was sold at sheriff's sale in 1896 to J. M. Stewart, a successful hardware store owner in Indiana, PA and grandfather of Hollywood star Jimmy Stewart. Steward sold the land to a Philadelphia coal broker named John Heisley Weaver around 1900. Four years later, Weaver, who had acquired additional coal property in the surrounding townships, began to build a "model town" he called Heilwood. The name is thought to derive from a combination of Weaver's nickname ("Heil") and the name of his first coal mine in West Virginia ("Heisleywood").

In 1906, Weaver sold all of his holdings to the Penn Mary Coal Company and by 1916 the town had about 400 houses, a dairy, a combined company store and post office, a hotel and two boarding houses, three churches, primary and secondary schools, a town hall, bowling alleys, a barber shop, and a population of about 2,400. The first hospital in Indiana County built specifically as a hospital was constructed in Heilwood in 1909, as well as the first American Legion Post formed in Indiana County in 1946. The Cherry Tree & Dixonville Railroad, a subsidiary of the Pennsylvania Railroad, ran a line through Possum Glory to service the coal industry and even had a station southeast of the town along what is now PA Route 403. The station's name was officially changed to Heilwood in 1912. Eventually the mines shut down, the railroad tracks were removed, and Heilwood became something of a bedroom community for Indiana with a population of about 700 residents.

DID YOU KNOW . . . ?

Of all the mass extinctions that Earth has sustained, the worst was what has been called "The Great Dying," the end-Permian extinction that took place 252 ma ago when approximately 81% of marine species and 70% of terrestrial species died out. Now a new study from an international group of researchers from China, Great Britain, and the U.S. showed that the end-Permian mass extinction was harsher than other such events as the result of a major collapse in diversity. In trying to understand why communities did not recover as quickly as other mass extinctions, the team found that the end-Permian extinction wiped out 19 out of every 20 species. Only 5% of species survived! Entire ecosystems had been destroyed so that ecological communities had to reassemble from scratch.

To begin an investigation of this event, Chinese researchers reconstructed food webs for 14 life assemblages spanning the Permian and Triassic periods. These assemblages offered a glimpse of how a single region on Earth responded to the crises. Building an accurate food web is important in understanding such ancient ecosystems. The food webs were consisted of plants, mollusks, and insects living in ponds and rivers, as well as the fishes, amphibians, and reptiles that ate them.

A typical Permian food web might have included herbivorous pareiasaurs and saber-toothed gorgonopsians that preyed upon them. Both groups died out at the end of the Permian.

The reptiles ranged in size from modern lizards to 1000-pound herbivores with tiny heads, massive barrel-like bodies, and a protective covering of thick bony scales. Sabre-toothed reptiles called gorgonopsians, some as large and powerful as lions with long canine teeth for piercing thick skins, occurred in the communities. When these animals became extinct, nothing took their place, and the ecosystems remained unbalanced for 10 ma, after which the first dinosaurs and mammals began to evolve in the Triassic. The first dinosaurs were small, bipedal insect-eaters about three ft long, but they soon became larger and more diversified as both carnivores and herbivores.

The researchers applied ecological modeling methods that permitted the team to look at ancient food webs and determine how stable or unstable they were. Their model disrupted the food web, killing off species, and testing for overall biotic stability. They found that the end-Permian event was exceptional in two ways: 1) the collapse in diversity was much more severe in comparison to two other mass extinctions studied, where there had been low-stability ecosystems before the final collapses; and 2) it took a very long time for ecosystems to recover, whereas recovery was rapid after the other two extinctions. Characterizing communities, especially those that recovered successfully, provided valuable insights into how modern species might fare as humans push Earth's current ecosystems to the point of no return.

Until recently, scientists could describe the food webs, but there was no way to test their stability. The research team, however, was able to combine new data sets from long rock sections in north China with cutting-edge computational methods that allowed them to get inside these ancient examples in the same way biologists can study food webs in the modern world.

https://scitechdaily.com/how-life-on-land-recovered-after-the-great-dying-mass-extinction-event/

There have been a lot of questions about when Earth's supercontinent cycle began. Geologists discovered the first of these supercontinents early in the twentieth century – Pangea, which formed late in the Paleozoic about 300 ma ago and broke up during the Age of the Dinosaurs. Geologists have since realized that at least two older supercontinents, Rodinia and Nuna, were created over the last two ga in what appears to be a 600-ma cycle.

Pangea was the first supercontinent discovered, but two older ones, Rodinia and Nuna, are also known. The question is, did any supercontinents exist before Nuna?

The question is, what happened in the first 2.5 billion years of Earth's history? Were there supercontinents then as well? A team of researchers recently answered those questions: plate tectonics operated differently before two ga ago, and the 600 ma supercontinent cycle probably started during the second half of geologic time. The shift in plate tectonics marked a regime change in the Earth System that influenced the eventual emergence of complex life and how Earth resources are formed and preserved.

The team tested two hypotheses: 1) the supercontinent cycle started prior to two ga ago, and 2) the ancient continents only managed to get together in multiple clusters called supercratons, rather than forming supercontinents. To test their hypotheses, the team visited the Yilgarn craton in Western Australia. They chose this area not only because it is old, but also because there are a series of dolerite dykes that recorded Earth's ancient magnetic field when the rocks formed. The team precisely dated the rocks and measured their paleomagnetic signatures to reconstruct their geographic position relative to magnetic north when they formed.

By analyzing the new data from Yilgarn, and comparing it with data available globally from other cratons, it became clear that the team could all but rule out the existence of a long-lived single supercontinent before two ga, although transient supercontinents may have existed. They found it more likely that there might have been two long-lived, geographically isolated supercratons prior to two ga that never formed a single supercontinent. This study is not the final word on the debate. Geologists need to collect a lot more data from many more similar rocks to further test the hypotheses.

https://scitechdaily.com/first-solid-clues-uncovered-to-start-of-earths-supercontinent-cycle/

With the current US administration's focus on climate change, more industries are becoming attracted to how to remove CO_2 from the atmosphere. Believe it or not, the concept of collecting and trapping CO_2 in valuable products is a seductive marketing strategy, especially for the global diamond trade. This industry, composed of gem companies valued at roughly $76 billion, is rife with allegations of environmental and human degradation.

Now, two of these companies are creating and selling diamonds made in laboratories from CO_2, and every carat removes 20 tons of CO_2 from the atmosphere, more than the average person produces in a year. The purchase of a 2-carat laboratory-made diamond, therefore, essentially offsets 2 ½ years of the buyer's life.

A diamond pendent, manufactured in a laboratory from carbon extracted from the atmosphere.

While Mother Nature can take as long as a billion years to make a diamond, a new patent-pending process from a New York company can make a batch of diamonds in a laboratory in only four weeks! The new process starts by subjecting CO_2 removed from the air to a chemical reaction where it is subjected to high pressure and extremely high temperatures, all of which is created using renewable energy. The company, Aether, is committed to kind of modern alchemy that is turning air pollution into precious stones. The price can be pretty high: Aether has been selling its diamonds since the beginning of 2021 at prices ranging from $7,000 for a ring to around $40,000 for earrings with sparkling stone arrangements. But that hasn't stopped them from making money. They even have a large waitlist.

The other company is a British firm called Skydiamond whose founder likes to point out that the traditional diamond industry has a history of using child labor and underpaid women and leaving nature with scarred landscapes and damaged wildlife. A lack of regulations, he pointed out, fostered numerous civil wars in Africa funded by smuggled stones called “conflict” or “blood diamonds.”

While the traditional industry began in South Africa in 1871, the alternative industry started in 1954 when an American chemist invented a process for making diamonds in a laboratory using a reactor and a press to subject powdered carbon to high temperatures and pressures. This resulted in diamonds made within a few weeks, but it required a lot of energy.

Although the global market in artificial diamonds is estimated to be worth only a small fraction of the natural diamond industry, it has been credited with driving reforms by creating competition and ethical pressures on the broader industry. This eventually resulted in 99.8% of the world’s diamonds being certified as “conflict-free,” although the market has so many different players that it’s quite easy to lose track of where the diamonds are coming from.

Such concerns led to marketing opportunities for diamonds that sparkle with the promise of addressing climate change. The major challenge for the traditional diamond industry now is that the new manufacturing process completely avoids worries about raw materials – they are getting their carbon from the air.

https://www.scientificamerican.com/article/modern-alchemists-turn-airborne-co2-into-diamonds/

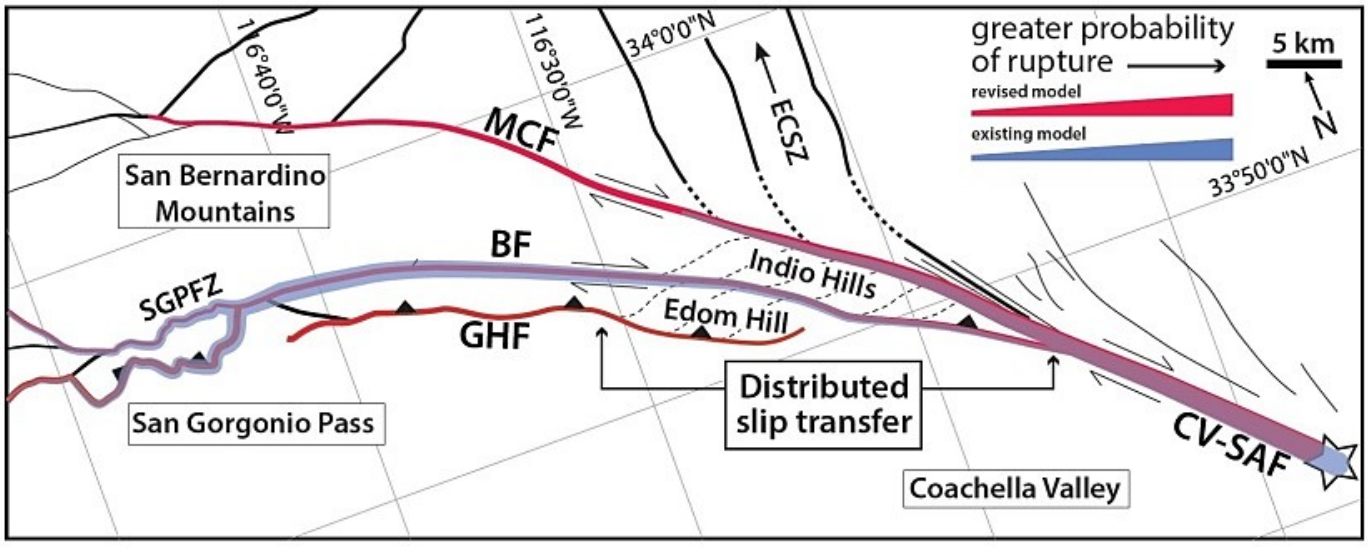
Scientists have identified a long-overlooked section of the southern San Andreas Fault that could pose the most significant earthquake risk for the Greater Los Angeles area. To make matters worse, it is approximately 80 years overdue for release. If their analysis is right, however, it is possible that when a long-predicted, greatly destructive earthquake hits, it may not do quite as much damage to the region as some previously feared. If it is true, that could mean a significant reduction in risk for the area according to seismologists.

As the Pacific and North American plates move past one another along the fault, the southern part of the San Andreas carries about half of the resulting strain from that motion, up to about 1 in per year. Eventually, the strain will be released through earthquakes. But not every part of the fault carries the strain in equal measure. In southern California, the fault system is made up of many smaller parts, and it's difficult for earthquake researchers to identify which of them most at risk of rupture. For example, the Garnet Hill, Banning, and Mission Creek fault strands cross the Coachella Valley. It was long thought much of the southern San Andreas's slip occurred along the Banning and Garnet Hill strands, and that the Mission Creek strand didn't take much of the strain at all.

Some new findings say otherwise. When a team of earthquake geologists went looking for evidence that quakes had caused landforms to move across the surface, they found their evidence at a site along the Mission Creek strand in the Little San Bernardino Mountains. Next to the water-carved canyon was a series of three long depressions in the desert that looked as though they had once been part of the original canyon before earthquakes shoved them aside, creating "beheaded channels". In each of the channels, the team dated the ages of rocks and soil.

Photo showing the northwest wall of Pushawalla Canyon exposing steeply tilted Ocotillo Formation along Mission Creek fault strand. The white line marks the channel bottom in the former canyon.

The oldest channel, which occurs about 1.25 mi away from the current canyon, was dated at roughly 80 to 95 ka. The second, about 0.8 mi away, was about 70 ka. The third channel, about 0.4 mi away, was about 25 ka. Based on these data, the team



The San Andreas Fault (SAF) system in southern California includes three major strands, including the Mission Creek Fault (MCF), Banning Fault (BF) and Garnet Hill Fault (GHF).

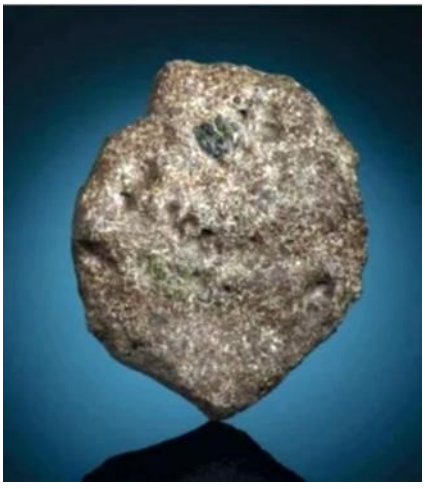
calculated that the average slip rate for the Mission Creek strand was about 0.85 in per year. That means it accounted for the majority of the strain along the southern San Andreas Fault. They also calculated the slip rate for the Banning strand at just 0.09 in per year.

The San Andreas Fault is one of the best-studied faults in the world, yet there's still so much needed to be done to understand it better. The San Andreas ruptures at an average rate of one every 215 years or so. Since the last time the southernmost segment move was in 1726, about 20 to 30 ft of elastic strain should have accumulated, so an earthquake is long overdue by about 80 years. Once the strain releases, the ground will likely shift by 20 to 30 feet, but whether that happens in a single quake or many of them is unknown. The much feared “Big One” can only be triggered by a massive rupture on a long stretch of the San Andreas Fault, something on the order of 200 miles. If the rupture traveled along the Banning strand, the east-west tilt would send energy into the San Bernardino Valley, the San Gabriel Valley, and the Los Angeles Basin. If the rupture followed the Mission Creek strand, however, its more northwesterly orientation would divert some of that energy away from the L.A. Basin. The research is one piece in an ongoing debate which likely will not be resolved until an earthquake occurs.

https://advances.sciencemag.org/content/7/13/eaaz5691

In May 2020, a meteorite was found in a remote region of the Sahara desert that turned out to be an ultra-rare piece of an embryonic planet that existed before Earth formed. The meteorite, known as Erg Chech 002 (EC 002), formed within the crust of an ancient protoplanet. Described as the oldest known lava that has ever fallen to Earth, it offers an unprecedented glimpse of planetary formation in the early solar system. The team of scientists who studied the meteorite said it belongs to the andesitic family of volcanic rocks but is unlike anything that has been seen before. Although recognized as a potentially very old rock, age was not the only point of interest to the researchers; they were also very interested in the genesis of such extraterrestrial andesitic melts and on the processes of formation of primordial crusts.

EC 002 was named after its landing site in Algeria’s Erg Chech dune sea. It consists of several fragments that collectively weigh about 70 pounds and contain stunning crystals. Although discovered in 2020, terrestrial erosion of the rocks indicates



EC 002, a meteorite found in the Sahara Desert that was once part of the andesitic crust of a protoplanet during the early Solar System.

they fell in the desert much earlier. Using analysis of magnesium and aluminum isotopes in the rock, the researchers were able to determine when the lava crystallized into solid rock – 4.566 ga ago, making it the oldest known piece of an igneous crust ever found. The next oldest igneous meteorite is about 1.24 ma younger than EC 002, and Earth is younger still; it began to develop several million years after the formation of these rocks.

Besides its advanced age, EC 002 is also notable for its unusual composition – 58% SiO2, indicating the parent body had an andesitic, rather than a basaltic crust. Andesitic crusts were probably abundant in asteroids and protoplanets during the solar system's early days. They have become extremely rare in the intervening billions of years since then. Ancient protoplanets either became assimilated into larger bodies like Earth or exploded in collisions with other rocks or protoplanets.

Remnants of primordial crusts are not only rare in the meteorite record, they are also rare today in the asteroid belt. No other known object with spectral characteristics similar to EC 002 has been identified to date. The researchers suggested that the earliest differentiated protoplanets in the solar system, as well as most of their debris, were destroyed or subsequently accreted to the growing rocky planets, making the discovery of meteorites originating from primordial crusts an exceptional occurrence. They estimated that EC 002 was ejected from its parent body during one of these encounters shortly after the protoplanet's crust cooled and crystallized.

All in all, the meteorite revealed amazing new details about the evolving embryos of planets during a time before Earth existed. The researchers currently are working to confirm the age of EC 002 using other isotopic studies, and they also want to study the crystals inside the rock, which are older than the surrounding volcanic material. Knowing the compositions of the magmas produced during the early magmatic activity of a protoplanet should help researchers understand more about how its crust was built.

https://www.vice.com/en/article/epd3qm/scientists-discover-chunk-of-protoplanet-older-than-earth-in-sahara-desert?

There was a significant rise in the level of atmospheric oxygen between about 2.43 and 2.32 ga ago that profoundly changed the chemistry of Earth's surface environments and the nature of its habitability. This was the start of the "Great Oxidation Event" (GOE), but it almost didn't endure. Researchers analyzing marine sediments from the Eastern Transvaal Basin in South Africa, which formed during the GOE discovered that early atmospheric oxygenation was short-lived. Oxygen did not become a permanent feature of Earth's atmosphere until much later.

The team's research showed that atmospheric oxygenation was highly unstable over a period of about 200 ma, and that permanent oxygenation occurred about 100 ma later that previously thought. Their results also suggested that there was a direct link between fluctuations in atmospheric oxygen concentration and greenhouse gas concentrations, which helps explain four widespread glaciations that occurred concurrent with the GOE. Some of those glaciations probably covered the entire Earth in ice for millions of years, a period known as "Snowball Earth." The new data from South Africa indicate that the permanent rise of oxygen occurred after the final major glaciation rather than before it as previously thought. These data solved a major puzzle in understanding the links between early atmospheric oxygenation and intense climatic instability.

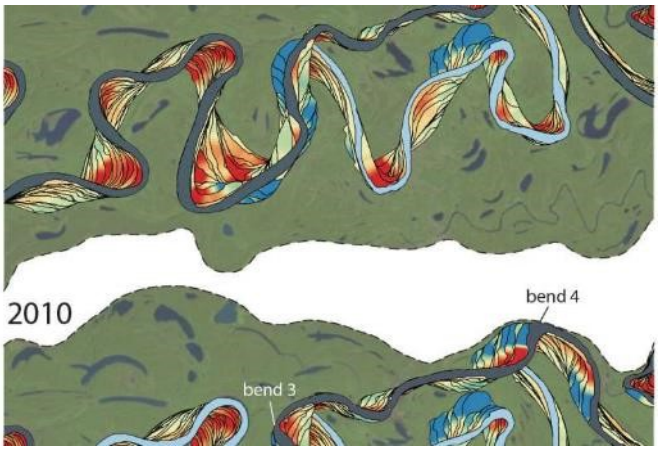
The permanent rise of atmospheric oxygenation, which was instrumental in the rise of life as we know it, did not occur until after the period of environmental instability called Snowball Earth during the Precambrian.

The researchers now refer to this period as the "Great Oxidation Episode." The episode ushered in a 1.5 ga period of subsequent climatic and environmental stability, which persisted until a second major period of rising oxygen and climate

instability at the end of the Precambrian. The researchers stated that science cannot start to understand the causes and consequences of atmospheric oxygenation if we have no idea when permanent atmospheric oxygenation actually occurred. Their research has provided a major piece of the puzzle."

http://www.sci-news.com/othersciences/paleoclimatology/permanent-oxygenation-earths-atmosphere-09528.html

Streams constantly move across the landscape. Meandering streams in particular carve out new channels and reactivate old ones as they bend and twist over time. This can be observed in stream tables in the lab, in computer simulations, and especially in nature using aerial or satellite photos taken over time. Meandering streams commonly form crescent-shaped swaths of sediment called point bars on the inner side of their channels. When the sediment deposits appear along an outer bank, they form "counter-point bars", which typically have been interpreted as anomalies. Typically, they have been interpreted as indications that something like a patch of erosion-resistant rock has interfered with the river's usual mode of deposition. Point bars and counter-point bars look quite similar but counter-point bars actually are distinct environments. Compared to point bars, they have finer sediments and lower topography, making them more prone to flooding and ponding, which create unique ecological niches along streams.

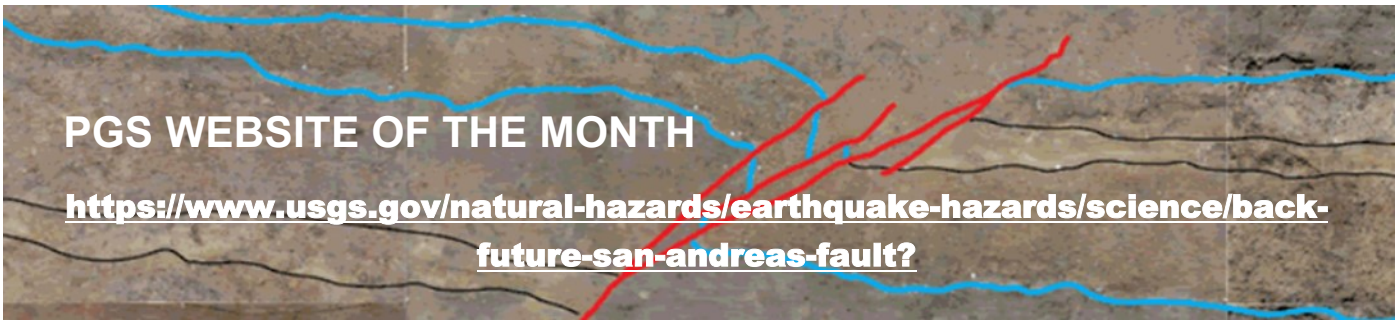


Satellite images of the Mamoré River in Bolivia colored to indicate changes in flow path.

New research, however, indicates that counter-point bars are not as odd as they might seem. In fact, they're a perfectly normal part of the meandering process. Counter-point bars can form even without a resistant substratum, which suggests that these bars and their unique geology and ecology are more common than previously thought. A team of researchers used both computer modeling and satellite photos of the Mamoré River in Bolivia, which is known for quickly changing its path, to capture how it changed over a 32-year period from 1986 to 2018. Counter-point bars appeared in both the modeling and the photos, which the researchers found were linked directly to short, high curvature bends in a river's path. These formed when the stream's course changed abruptly, as when a new oxbow lake formed through cutoff, or after reconnecting with an old oxbow lake. The sharp bends don't stay put, however. They start migrating downstream, and as they move rapidly downstream they create the right conditions for sediment to accumulate around the bend as a counter-point bar.

Geomorphologists and engineers have known for years that long-term change along a river can be described in terms of local and upstream values of curvature; places where a stream appears to wrap around a small circle have high curvatures. For the new study, the researchers used a formula that used these curvature values to determine the likelihood of a counter-point bar forming at a particular location. They were surprised at how well the formula, and the simplified models used in part to derive it, worked to explain what was thought to be a complex phenomenon. Recognizing that counter-point bars readily form in meandering stream, and having a formula for predicting where they will form, is significant. Since they are geologically important features in hydrogeology and hydrocarbon exploration as well as geomorphology, awareness of this should help geologists identify counter-point bars in subsurface formations, which would assist with understanding how they may be influencing the flow of water and hydrocarbons passing through them.

https://scitechdaily.com/meandering-rivers-naturally-create-counter-point-bars-no-matter-underlying-geology/



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Fun Fact Having Nothing to Do with Geology

Golfers take heed: The odds of making a hole in one are 1 in 12,000

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