SEPTEMBER 2018 PGS NEWSLETTER VOL LXXI NO 1

PITTSBURGH GEOLOGICAL SOCIETY

September 12, 2018

Social hour	**6:00 PM**
Dinner	**7:00 PM**
Program	**8:00 PM**

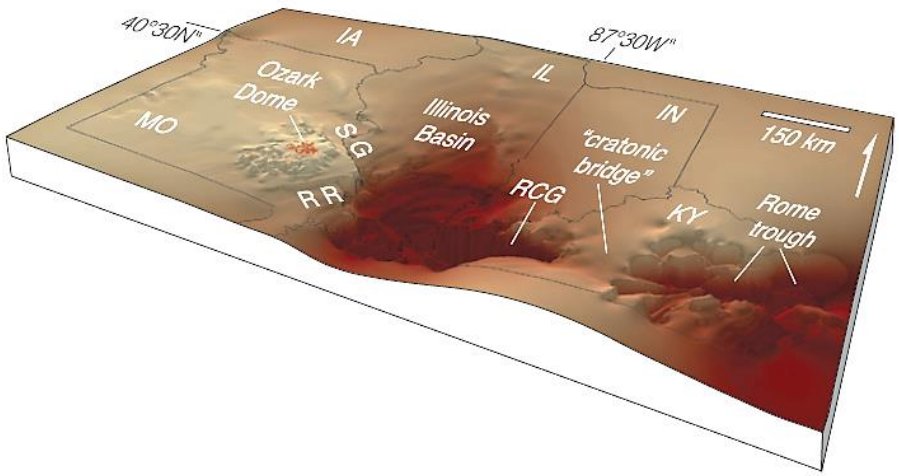
Dinner costs
$30.00 per person
$10.00 student member

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

You can also reserve and pay via PayPal at:
https://www.pittsburghgeologicalsociety.org/

Location
Foster's Restaurant
Foster Plaza Bldg. 10
Green Tree PA

Tectonics of the Midcontinent: Looking West (Geologically) from Pittsburgh Across the Craton



Dr. Stephen Marshak

University of Illinois, Urbana-Champaign

Deadline for reservations is noon on Monday, Sept. 10.

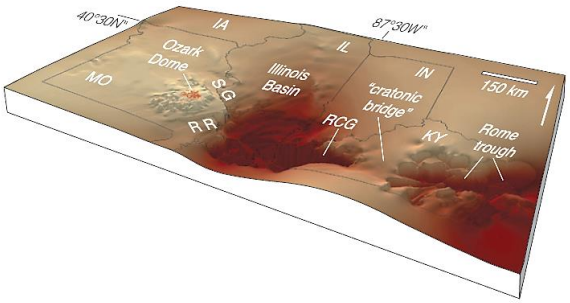
Speaker Abstract

Geologists have long held a fascination with mountain belts, because of their scenic beauty, and because they offer cross sections that provide access to rocks once deep in the crust. Datable igneous and metamorphic rocks in mountain belts provide a basis for developing a chronology of tectonism. The USA Midcontinent region doesn't display such drama. These interior plains, which extend from Pittsburgh west to the Rockies, are part of North America's cratonic platform, a region in which crust that formed over 1 billion years ago lies buried beneath a veneer of nearly flat-lying Phanerozoic sedimentary strata. This region has been relatively stable, tectonically, through the Phanerozoic. But it has not been completely stable. Because of the lack of relief and the lack of outcrops, our direct knowledge of tectonic activity in the Midcontinent has remained limited. Fortunately, new data sources are providing glimpses into the tectonic history of the Midcontinent (and the rest of the cratonic platform), and are laying a foundation for understanding how such continental lithosphere behaves geodynamically.

In this presentation, I will summarize the tectonic features of the cratonic platform (epeirogenic basins, domes, and arches; localized fault-and-fold zones), and will provide: 1) selected observations from the EarthScope project (including seismic arrays and magnetotelluric arrays) that serve to characterize variations in crustal thickness, the intensity of faulting, and the relationship of seismicity to structure; 2) structure-contour maps that help characterize the nature of displacement in fault-and-fold zones; 3) subsidence curves that constrain the timing of basin subsidence; 4) a digital elevation model (DEM) of the Great Unconformity (the contact between Precambrian and Paleozoic strata), that gives a clearer image of structural relief between basins and domes; 5) results from a thermochronologic study of the Great Unconformity that reveals times during which exhumation (uplift and erosion) of North America took place.

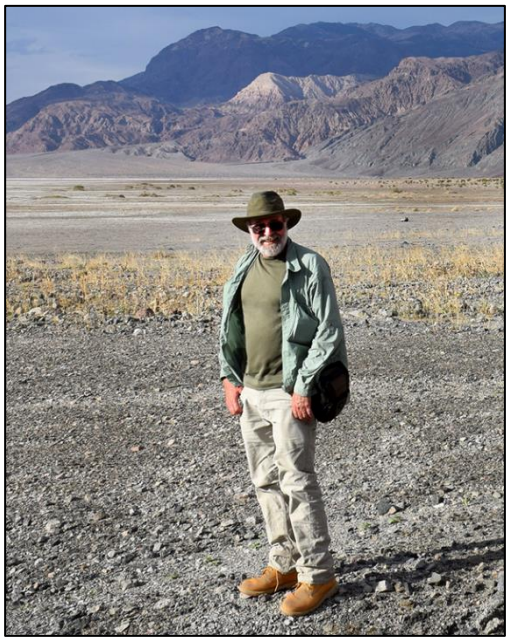
Taken together, the above results emphasize that the cratonic platform holds the record of a complex, though subtle, tectonic history. Subsequent to Proterozoic rifting, which established a rectilinear network of permanently weak upper-crustal faults, stress transmitted into the interior during Appalachian orogenic events caused transpressional and transtensional fault reactivation. Just prior to supercontinent breakup, delamination of the lithospheric mantle may have caused up to 6 km of uplift across the entire continent. Differential movements prior to the Mesozoic probably continue to affect subtle differential uplift, and therefore the distribution of intracratonic plateaus, today.

About the Cover Image



This illustration of cratonic structure comes from a 2017 paper in *Geology* by Steve Marshak and colleagues. *The basement revealed: Tectonic insight from a digital elevation model of the Great Unconformity, USA cratonic platform* and other research papers from Steve Marshak's group can be downloaded from his ResearchGate page: **https://www.researchgate.net/scientific-contributions/73572629_Stephen_Marshak**

Speaker Biography



Dr. Stephen Marshak served as a professor of structural geology and tectonics at the University of Illinois, Urbana-Champaign, for 35 years. He began his career at Illinois, in 1983, after receiving degrees from Cornell (A.B), the University of Arizona (M.S.), and Columbia University (Ph.D.). While at Illinois, he also served as the Head of the Department of Geology (for 8 years) and as the Director of the School of Earth, Society, & Environment (for 10 years).

Steve continues to participate in research projects domestically and internationally, with a focus on tectonics of cratonic lithosphere, structure of fold-thrust belts, development of rock fabrics, and Precambrian tectonics. Most recently, he was involved in an EarthScope project (OIINK) focused on the Midwest. Steve served as Chair of the Division of Structural Geology and Tectonics of the Geological Society of America, sat on NSF panels for Structure and Tectonics and for Continental Dynamics, and was an associate editor for Geology and for Tectonophysics.

Steve particularly enjoys teaching and has received college-level and campus-level instructional awards at the University of Illinois, as well as the Neil Miner Award of the National Association of Geoscience Teachers. He shares his passion for geoscience education in college textbooks that he authors or co-authors (including: *Earth—Portrait of a Planet*, *Essentials of Geology*, *Earth Science*, *Earth Structure*, *Basic Methods of Structural Geology*, and *Laboratory Manual for Introductory Geology*) and through a Massive Open Online Course (MOOC) called *Planet Earth . . . and You*.

Next month's PGS Dinner Meeting will be held on October 17, 2018.

Dr. Graham Andrews

Assistant Professor

WVU Volcanology & Petrology Lab

Department of Geology and Geography

West Virginia University

PRESIDENT'S STATEMENT

Welcome to the 2018-2019 PGS season! After a summer of field work, traveling, vacationing and enjoying the warmer temperatures, I hope you are ready to engage and participate at our monthly meetings. These are times to connect with our colleagues in an informal setting, talk with each other while enjoying a meal and learning about some aspect of the local or regional geology.

I want to start off the year expressing my sincere gratitude to all the board members for their continued commitment to PGS. Thank you for your years of volunteer service and the time and effort involved in running a professional society. PGS would not exist without your commitment. I would like to welcome our recently elected Directors-at-Large: Brian Dunst, returning for another 2-year term, Albert Kollar, and Ray Follador. The latter two both have served as Past Presidents and their combined knowledge and experience will be invaluable. They join Wendell Barner, Erica Love, and Mary Ann Gross, our continuing Directors-at-Large, and Counselors Chuck Shultz and John Harper on the PGS board.

Kyle Fredrick and Ken LaSota will continue to serve as Treasurer and Secretary. Dan Harris has stepped in to serve as Vice President, in charge of organizing the speakers for the monthly meetings. Dan has worked hard to arrange an excellent speaker lineup for the year, so I hope to see you at our monthly meetings. If you have any ideas for future speakers or wish to make a presentation, please feel free to share with any board member or post a comment on our website.

Speaking of the website, I would like to express my sincere gratitude to Karen Rose Cercone for upgrading the PGS website and producing, along with John Harper, our monthly newsletter. If you have not had the opportunity to visit the new PGS website, check it out at https://www.pittsburghgeologicalsociety.org/ and let us know what you think.

Lastly, I would like to thank Diane Miller, who has completed her term as Director-at-Large. Diane was instrumental in setting up our Twitter feed and assisted with other social media initiatives. Please consider following us if you are a regular Twitter user. If you prefer LinkedIn for your professional news and networking, consider joining the PGS Group on that site, moderated by board member Wendell Barner. And of course, our Facebook page is kept current by board member Erica Love.

One of my goals this year is to try to increase the participation of young professionals in our monthly meetings. We would love to have you share your stories of employment successes or dilemmas and to speak with the many student members as they begin to plan their careers. I would like to encourage the young professionals to become mentors for the numerous students looking for someone to provide guidance as they transition from the world of academia to the workplace. Look for notices in future newsletters for specific events geared toward enticing young professionals to come back and be a part of the society.

I would like to remind you to renew your membership early. As you are renewing your membership please consider donating an extra dollar or two to the Galey Fund to help support the student meals at our monthly meetings.

I am looking forward to working with the board this year and the members of PGS. See you at the meetings.

Tamra

IN MEMORIAM

PGS Honorary Member

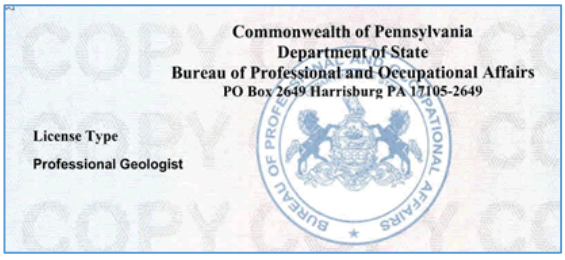
TOM STURGES

It is with great sadness that we announce that Tom Sturges PE, long-time PGS Honorary Member, former Corporate Member of the Society, and Chairman of the Board of Pennsylvania Drilling Company, passed away on June 6 of this year at age 73, from complications of a brain tumor.

Tom grew up in Whitehall, PA, the son of Frank and Hazel Sturges, with his sister, Mary Lee Sturges Clark. He attended the Kiski School and graduated from Bucknell University with a degree in Civil Engineering. He worked for the Newport News Shipbuilding and Dry Dock Company, then moved back to Pittsburgh to join Pennsylvania Drilling Company, a family company founded in 1900, specializing in exploratory and environmental drilling. Tom eventually became Chairman, expanded PennDrill Manufacturing, and added another manufacturing facility in Winchester, VA.

Tom was an active alumnus of both Kiski and Bucknell throughout his life and received “The Distinguished Alumni Award” for his service to Kiski. He was deeply involved in nonprofit boards, including the boards of The Early Learning Institute for 43 years and Conservation Consultants. He volunteered for the Carnegie Science Center, and was a member and leader of many professional organizations, including the National Drillers Association, American Society of Civil Engineers, and Association of Environmental and Engineering Geologists, in addition to his work with the Pittsburgh Geological Society. He will be missed by his colleagues and friends throughout the tri-state area.

PGS Professional Development Hours for PGs


Commonwealth of Pennsylvania
Department of State
Bureau of Professional and Occupational Affairs
PO Box 2649 Harrisburg PA 17105-2649

License Type

Professional Geologist

Licensed Professional Geologists may use PGS monthly lectures as a one-hour credit toward their state requirement for continuing education to renew their licensure. If you attend dinner before the talk, your certificate of attendance is provided at no cost to you.

If you plan to attend only the talk, rather than the full meeting with dinner, we ask for a $10 contribution to cover the costs of printing the certificate. It would be a great help to our treasurer if you could pay in advance using PayPal. To reserve and pay for a talk-only certificate, please see our website reservation form or email PGS Treasurer Kyle Fredrick at pgsreservations @gmail.com

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UPCOMING CONFERENCES AND WORKSHOPS

Click on graphics for registration links.

47TH ANNUAL 2018 AAPG-SPE EASTERN SECTION JOINT MEETING

EVENT DETAILS...

Join us in Pittsburgh, PA for the 2018 annual joint meeting of the AAPG-SPE Eastern Section. The Pittsburgh Section of the Society of Petroleum Engineers will be collaborating with Eastern Section of AAPG to host this meeting with the Pittsburgh Association of Petroleum Geologists and the Pittsburgh Geological Society. The meeting will be held at the Wyndham Grand Hotel, downtown Pittsburgh. Our workshops, field trips and technical sessions will comprise an ambitious program addressing many of the resource opportunities and challenges in the Appalachian, Illinois and Michigan Basins. We invite you to save these dates, October 7 to 11, 2018, and join us.

SUNDAY, OCTOBER 7

Field Trips and Short Courses (AAPG and SPE)

MONDAY OCTOBER 8

Field Trips and Short Courses (AAPG and SPE)
Student Expo
YP Event: Ducky Tour and Incline to Mt Washington
DPA Ethics Luncheon #1
Opening Session and Awards Ceremony (AAPG)
Icebreaker followed by Jammin Geologists

TUESDAY OCTOBER 9

Speaker and Judges Breakfast
AM Technical Program: Talks and Posters (SPE and AAPG)
All Convention Luncheon with Keynote Speaker (SPE and AAPG)
PM Technical Program: Talks and Posters (SPE and AAPG)
Core Workshop and Networking Event

WEDNESDAY, OCTOBER 10

Speaker and Judges Breakfast
ES-AAPG Future Meetings Breakfast
AM Technical Program: Talks and Posters (SPE and AAPG)
ES-AAPG Council Luncheon
DPA Ethics Luncheon #2
DEG Luncheon *
PM Technical Program: Posters only (AAPG)
Sundowner *

THURSDAY, OCTOBER 11

Field Trips and Short Courses (AAPG and SPE)

HOME
ABOUT PCPG
JOIN PCPG
COURSES & EVENTS
NEWSLETTERS
GOVERNMENTAL AFFAIRS
SHALE GAS
GEO LINKS
COLLEGES & STUDENTS
STAY IN TOUCH WITH PCPG
CONTACT PCPG

Back

Add to my calendar

The Big Picture: Geologic and Environmental Applications of Drones (420 mins.)

When September 28, 2018
7:30 AM - 5:00 PM
Location Chester County Public Safety Training Campus, Coatesville, PA
Spaces left 13

Registration

- Instructors
- PCPG Member Rate – $299.00
  Registration closes on Friday, September 19, or when sold out.

VISA MasterCard DISCOVER AMERICAN EXPRESS

Register

PCPG Member registration opens Wednesday, August 15.
Non Member registration opens Thursday, August 23.

Registration is strictly limited to 24 enrollments, and we do not maintain a wait list.

Chester County Public Safety Training Campus
137 Modena Rd.
Coatesville, PA 19320 DIRECTIONS

7:30 Registration Opens

8:00 - **5:00** Seminar, with breaks/lunch provided.

Prerequisite:
Prior drone flight experience is highly recommended but not required. Attendees may consider purchasing an inexpensive (less than $50) microdrone to fly before this course.

Agenda/Instructor Bios: Download

LOCAL GEOLOGICAL EVENTS

NORTHERN ALLEGHENIES GEOLOGICAL SOCIETY

August 28, 2018
"Center for Coalfield Justice and Sierra Club vs. Commonwealth, DEP, and Consol: Implications for Permitting and Remediation of Longwall Mining Subsidence Damage" by Tom Schuster, Sierra Club.

Windber Hotel, Windber PA

GEOPHYSICAL SOCIETY OF PITTSBURGH

September 11, 2018
"Seismic reservoir characterization of Utica-Point Pleasant shale – a case study" by Satinder Chopra, TGS-NOPEC Geophysical Company.

Cefalo's Banquet & Event Center, Carnegie PA

SOCIETY OF PETROLEUM ENGINEERS

September 12, 2018
"SPE Distinguished Lecture: Global Climate Change Wars & Fossil Energy; Current & Future Realities" by George Stosur, formerly US Dept. of Energy.

Cefalo's Banquet & Event Center, Carnegie PA

PITTSBURGH ASSOCIATION OF PETROLEUM GEOLOGISTS

September 20, 2018 (lunch meeting)
"Spatial distribution of chlorite in the Marcellus Formation and its relationship with static reservoir properties and well production" by Jennifer Rothfuss of Chevron Appalachian Mountain Business Unit.

Cefalo's Banquet & Event Center, Carnegie PA

ASCE – PITTSBURGH

September 22, 2018
"100th Anniversary Celebration of ASCE-Pittsburgh"

Hotel Monaco, Pittsburgh PA

The Pittsburgh Geological Society is happy to welcome the following new members:

Joe A. Biaglow, PG
Senior Geologist, RETTEW Associates, Inc.
1988 MS in Hydrogeology, Wright State

Wayne A. Cook
Marketing, Seitel
2001 BA in History, Southeastern Louisiana Univ.

Elizabeth M. Dwyre, PE
Senior Geotechnical Engineering Manager, WSP
1981 M.Eng. in Civil Engineering, Cornell Univ.

Alexander T. Edmonds
Geologist, Intertek PSI
2016 BS in Geology, Slippery Rock Univ.

Eric T. Hirschfeld
Recent Graduate
2018 BS in Environmental Geology/BA in Environmental Studies, Univ. of Pittsburgh

Peter R. Lamont, PG
Principal Geologist, Groundwater and Environmental Services, Inc.
1993 MS in Environmental Sciences, Indiana Univ.

Connor A. Nitti
Corrosion Control Technician, Lake Superior Consulting
2017 BS in Geology, California State University at Chico

Joao Silveira Meyers
Graduate Student, Shippensburg University
2013 BS in Petroleum Engineering, Monte Serrat University in Brazil

Benjamin R. Staudt
Operations Manager, Vibra-Tech Engineers
2018 BS in Geology, University of Pittsburgh

PGS SPRING FIELD TRIP TO FAYETTE COUNTY, PA

Many thanks go out to John Harper and Albert Kollar, for guiding 14 PGS members on a tour of historic sites in Fayette County related to the geology of the early iron industry there.
In this picture, the group is standing in front of Wharton Furnace, a restored charcoal iron blast furnace on the east side of Chestnut Ridge not far from Laurel Caverns. The brown thing in front of the group is a slab of cast iron, supposedly one of the last "ingots" produced at the furnace.

If you would like to learn more about the stops made on this field trip, you can download the guidebook from our updated PGS publication page. Just surf to: https://www.pittsburghgeologicalsociety.org/pgs-publications.html

Share your summer geology adventures with PGS. Send photos with captions to Erica Love @ ericalove.pgs@gmail.com

Head for the Shetland Island of Northmavine if you want to see a geologic cross-section made from the very rocks it is depicting. Located at Mavis Grind (a place where wooden boats were hauled overland from one side of the island to the other), it contains gray Silurian sandstone intruded by pink granite, in fault contact with an ophiolite slab. Photo taken by Karen Rose Cercone in May 2018.

THE ORIGIN OF WESTERN PENNSYLVANIA PLACE NAMES

In 1784, John Woods, son of Pittsburgh's first surveyor, Colonel George Woods, built an estate east of the city overlooking the Monongahela River. He called it Hasell Hill, named for the hazelnut trees that were plentiful in the woodlands. When others began moving into the area, they referred to it as Hazel Woods, not for John Woods, but for the forest of hazelnut trees. In the 1850s, the Wiley family cleared most of the forest. Then, in 1869, the land became part of the City of Pittsburgh. Hazelwood, as it is now known, was home to the sprawling Hazelwood Works of the Jones & Laughlin (or J&L) Steel Co., later called LTV Steel.

Top: 1950s-era photo of the J&L Steel plant in Hazelwood. Bottom: The same site today, known as Hazelwood Green.

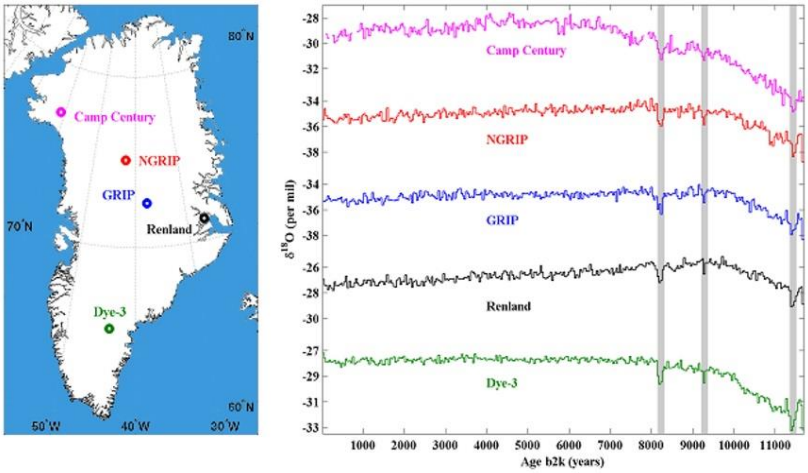
J&L Steel dominated Hazelwood's industrial might for over 100 years with, among other features, coke ovens that remained in operation until the early 1990s. The largest department at J&L Steel, the hot and cold mills, operated on more than 42 acres under a single roof and was capable of rolling strip or sheet steel 2,000 feet or longer. But the decline in America's steel industry hit Hazelwood hard. By 1989, most of the LTV Steel facilities had been closed and the mills demolished.

By 2005, one of Pittsburgh's leading manufacturing icons had been replaced largely by the Pittsburgh Technology Center, located along Second Avenue below Oakland. The remaining 178 acres of land along the Monongahela River, called Hazelwood Green, is Pittsburgh's last urban brownfield and largest remaining riverfront tract. Civic leaders envision the site as a model for sustainable development encompassing a mix of offices, research and development, light manufacturing, housing, and retail, with public open spaces and trails. A collaborative effort seeks to ensure that the site remains closely knit to the Hazelwood community by offering walkable and bikeable connections within the site, and to the riverfront and connecting city trails, and by contributing to the revitalization of the neighborhood.

DID YOU KNOW . . . ?

International Commission on Stratigraphy (ICS), the group responsible for standardizing the Geologic Time Scale, has ratified three new Holocene stages. The ICS's parent organization, the International Union of Geologic Sciences (IUGS) then unanimously ratified them. This is a key achievement for the International Union of Geological Sciences and particularly for its

Commission on Stratigraphy. The Holocene now includes the Greenlandian Stage (Lower Holocene). The lower boundary of each is placed at a carbon isotope excursion that defines the respective climatic event. The proposals were developed by a dedicated, international team of Holocene scientists led by Mike Walker of University of Wales. Many years of scientific research and international collaboration, followed by intense scrutiny of the proposals as they were evaluated at several levels in the IUGS organization, give legitimacy to the new units as global standards.



Map of Greenland drill sites with data from five ice cores that penetrated the entire Holocene. Notice that $\delta^{13}C$ shifts (indicating cold events) match at three time periods (gray lines) in all 5 cores.

Two of the new stages were defined using ice cores and the third was defined using a cave speleothem. The Greenlandian Stage/Age stratotype is the NorthGRIP2 ice core from Greenland, dated at 11,700 years before AD 2000 (written as "yr b2k"). The Northgrippian Stage stratotype is the NorthGRIP1 ice core from Greenland, dated at 8,326 yr b2k. The Meghalayan Stage stratotype is the Mawmluh Cave speleothem from India, dated at 4,250 yr b2k.

http://iugs.org/uploads/E-Bulletin/IUGS-E-bulletin-June-143.pdf

A team of paleontologists from California and Australia recently discovered the fossils of two soft-bodied creatures that lived in shallow marine water in South Australia during the Ediacaran Period (latest Neoproterozoic Era) about 550 ma. The scientists named the fossils *Obamus coronatus, in* honor of former President Barack Obama and his passion for science, and *Attenborites janeae*, in honor of the English naturalist and broadcaster Sir David Attenborough and his advocacy and support of science, especially paleontology.

Obamus coronatus was a disc-shaped creature that measured between ½ and 2 cm across. It had raised spiral grooves on its surface. It probably did not move around, but instead seemed to be embedded in the thick layer of organic matter that covered the early ocean floor. *Attenborites janeae* was a tiny ovoid creature having internal grooves and ridges. It was less than a centimeter across and resembled a raisin.

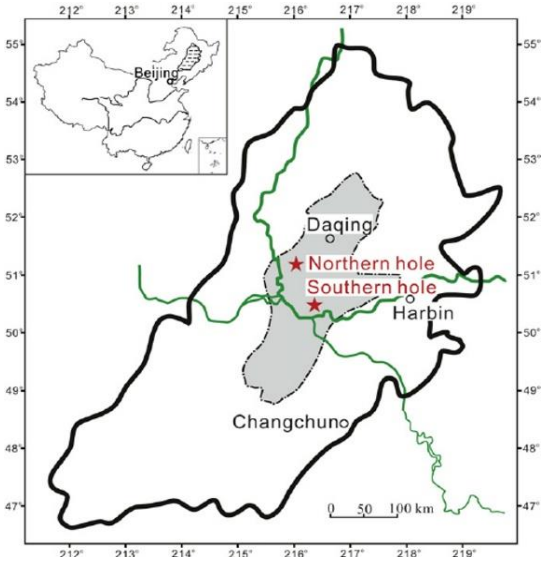
They have not been classified further than genus and species because Ediacaran biota are so unlike modern fauna and flora that they have not yet been organized into the hierarchical taxonomic classification system where other fossil and living creatures fit. Very little is known about how they relate to modern life. Paleontologists have described about 50 genera so far, many of which have only one recognized species.

Left - Obamus coronatus; right – Attenborites janeae. Two new Ediacaran fossils from South Australia.

Both of the new fossils represent new body plans, unlike anything else that has been described previously. Paleontologists have seen evidence for these creatures for some time, but it took time to verify that they represented whole life forms and not just parts of others.

http://www.sci-news.com/paleontology/ediacaran-period-fossils-australia-06135.html

In May of this year, the Songliao Basin Drilling Project (SBDP), a project dedicated to drilling through continental Cretaceous rocks, completed its Songke II borehole at a depth of 23,025 feet in Heilongjiang Province, northeastern China. This is the first time a scientific drilling project has penetrated an entire Cretaceous terrestrial formation anywhere in the world. The successful drilling of the borehole developed key technologies and equipment for deep earth exploration and experimental research, both opening a new space for clean energy prospecting in the Songliao Basin and contributing to global efforts on Cretaceous terrestrial paleoclimate research.



Map of the Songliao Basin in north-eastern China showing the locations of two continental Cretaceous drill holes.

The drilling project started in April 2014 and was jointly funded by the International Continental Scientific Drilling Program (ICDP) and the Chinese government. Recovered in the project was a nearly complete Cretaceous terrestrial sedimentary record. In addition, the core should provide the geosciences community unique opportunities to understand the response of terrestrial environments to geological events related to the carbon cycle and greenhouse climate change during the Cretaceous. This should be of help in informing the scientific community an understanding of modern global warming.

http://iugs.org/uploads/E-Bulletin/IUGS-E-bulletin-June-143.pdf

Those who felt the magnitude 5.8 earthquake centered in Virginia in 2011 that shook much of the eastern US, including Pittsburgh, probably wonder why it affected places more than twice the distance from the epicenter than a similar-sized earthquake in California would have done. The answer is one that many people may not realize – earthquakes east of the Rocky Mountains can cause noticeable ground shaking at much farther distances than comparable-sized earthquakes out west.

The Virginia earthquake was felt up to 600 miles from the epicenter. By comparison, a 2014 California earthquake of magnitude 6.0 was only felt up to 250 miles from the epicenter, despite releasing almost twice as much energy as the Virginia earthquake and causing much more damage near the epicenter. Another example is a magnitude 4.1 earthquake that shook Delaware in December 2017. It was felt about 200 miles from the epicenter. That's the same size area as was affected by a much larger earthquake in California event that released about 700 times more energy.

Map showing earthquakes above magnitude 4.0 in the eastern US since 1973. Circle size corresponds to magnitude, ranging from 4.0 to 5.9.

Why? Some of the reasons have to do with the underlying tectonic plates and their geologic history, whereas others have to do with the size and age of buildings. Eastern North America has older rocks, some that formed hundreds of millions of years before those out west. These older rocks have

been exposed to metamorphic processes that made them harder and denser. Faults in these rocks have had more time to heal, allowing seismic waves to cross them more effectively when an earthquake occurs. In contrast, rocks in western North America generally are younger and broken up by faults that have not had time to heal. When an earthquake does occur, more of the seismic wave energy is absorbed by the faults and the energy doesn't spread as efficiently.

Many of the older bridges and buildings in the eastern US were built before the 1970s, and so were not designed to endure earthquakes. In the western US, older structures often are retrofitted and new structures are designed to withstand strong shaking. Fortunately, many modern buildings on our side of the continent are being constructed to newer design standards, and there has been progress in retrofitting many of the older buildings.

The geology of the eastern US, and the relatively sparse history of earthquakes, has made it difficult to assess how frequently earthquakes will occur and how large they can be. Eastern earthquakes are more of a mystery because they do not take place at a plate boundary where most western earthquakes originate. Scientists do not fully understand the state of stress within tectonic plates, and they are studying how stresses accumulate and evolve and how earthquakes are triggered. Scientists also don't have a precise location of most of the faults located in the eastern US. Most of those faults have not had major earthquakes or movement in the past few million years, and the faults that are active may only have earthquakes every few thousand or tens of thousands of years. In addition, most of the surficial evidence of past earthquakes in the eastern US is obscured by vegetation or erosion. In contrast, in the western US, more active faults and large areas of sparse vegetation mean earthquakes can leave clear markings that help researchers document the history, size, and effects of earthquakes.

https://www.usgs.gov/news/east-vs-west-coast-earthquakes?utm_source=jkfitzpatrick&utm_medium=email&utm_campaign=East-vs-West-Coast-Earthquakes

Artist's hypothetical rendition of a small-bodied, ground-dwelling Late Cretaceous bird fleeing a burning forest following the end-Cretaceous bolide impact.

One of the more puzzling aspects of the end-Cretaceous extinction event has been the survival of birds. If, as many scientists believe, the extinction event was the result of a bolide impact in the Yucatan Peninsula of Mexico that set off massive wildfires around the globe, why did birds survive into the Paleogene when their close cousins, the dinosaurs all went extinct? Now an international research team thinks they have found the answer. They pieced together evidence from the plant fossil record and ecology of ancient and modern birds, and found that the only birds that survived the extinction were ground-dwellers.

Analysis of the plant fossil record from New Zealand, Japan, Europe, and North America confirmed that global forests collapsed in the wake of the asteroid's impact. After extensive study, the team concluded that the temporary elimination of forests by wildfires following the impact explains why tree-dwelling birds failed to survive into the Paleogene (there were no trees to dwell in!). Following the destruction of forests, there was a mass colonization of "disaster plants" like ferns whose spores were able to survive the asteroid hit. These germinated rapidly to fill the habitats emptied

by the extinction of the trees. Back then, the ancestors of modern arboreal birds were ground dwellers that adapted to tree-dwelling only after the forests had recovered. The scientists used the evolutionary relationships of extant birds and their ecological habits to track how bird ecology has changed over the course of their evolutionary history. Their analyses suggested that the most recent common ancestor of all living birds probably lived on the ground before and during the extinction event. In contrast, many birds that lived with *T. rex*, *Triceratops*, and other Late Cretaceous dinosaurs exhibited tree-dwelling habits. Those birds, the scientists insist, didn't survive the extinction event to give rise to any known modern-day birds. Today, there are nearly 11,000 living species of birds, resulting from evolutionary adaptation and dispersal from a handful of ancestral bird lineages that succeeded in surviving the extinction event. In the future, the research team plans to continue to explore the precise timing of forest recovery and the early evolutionary radiation of birds.

http://www.sci-news.com/paleontology/dinosaur-killing-asteroid-impact-forests-tree-dwelling-birds-06049.html

Niels Steenson was born 380 years ago (1638) in Denmark. "So what?" you ask. If that name doesn't mean anything to you, perhaps latinizing his name to Nicolaus Stenonius will help. No? How about Nicolas Steno? Does that sound familiar?

Steno, of course, is the scholar who defined what we now call the Law of Superposition, which states that layers of rock are arranged in a time sequence, with the oldest on the bottom and the youngest on the top, unless later processes disturb this arrangement. It is Steno's most famous contribution to geology and one of the most fundamental principles of stratigraphy.

Steno studied anatomy in Leiden in the Netherlands before he moved to Florence where Galileo did most of his most prominent work. Steno became quite famous for his first publications in anatomy, soon was elected to the *Accademia dei Cimento*, and came to the attention of the Duke of Tuscany. In 1666, fishermen caught an enormous shark off the coast and the Duke, an ardent supporter of the arts and sciences, asked Steno to study it.

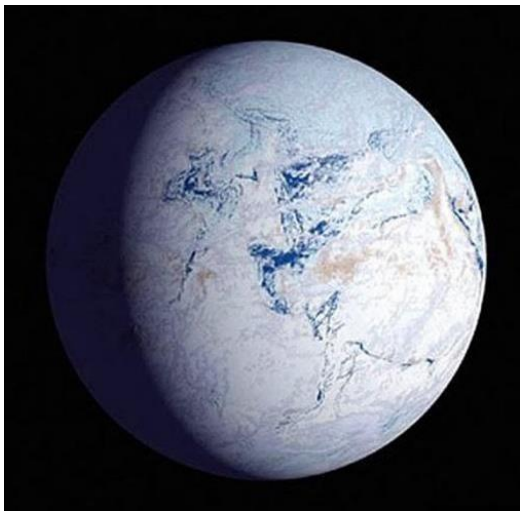
Although he was most concerned with the contraction of the shark's muscular systems, Steno began comparing its teeth with what at the time were called "tongue stones". These were objects that ancient scholars thought had fallen from the sky or from the moon; some of Steno's contemporaries instead thought they grew within rocks. Steno used causal explanations and a focus on observed facts to demonstrate that the "tongue stones" were, in fact, fossils.

Illustration from Steno's 1667 paper comparing a tooth from a shark's head with a fossil tooth.

Although Fabio Colonna had already demonstrated this fact 50 years earlier, Steno's scientific method attracted more attention and more discussion on the subject. Thus, the combination of serendipity and a well-trained scholar pushed science further, resulting in noteworthy results. The history of science emphasizes Steno's strategy of making a distinction between his observations and his conclusions. He avoided merely compiling previous opinions and favored, instead, empirical observation, the hallmark of a true scientist.

http://iugs.org/uploads/Anniversaries_INHIGEO_Nicolas_Steno.pdf

A team of geologists from the University of Texas recently hypothesized a link between the beginnings of plate tectonics and “Snowball Earth”, the period of climate change during the Neoproterozoic that sent Earth into a deep freeze lasting millions of years. Although scientists generally consider the start of plate tectonics to have occurred about three billion years ago, during the late Mesoarchaean Era, the new hypothesis puts the process in the Neoproterozoic, only about one billion years ago.



An artist’s depiction of Snowball Earth.

The Earth currently is the only planet known to have plate tectonics. It is much more common for planets, especially in our solar system, to have an outer solid, unfragmented shell, known as “single lid tectonics”. Plate tectonics is one of the most fundamental Earth processes that shaped – and continues to shape – the planet. Most researchers believe it has been active for most of Earth’s 4.5 billion-year history.

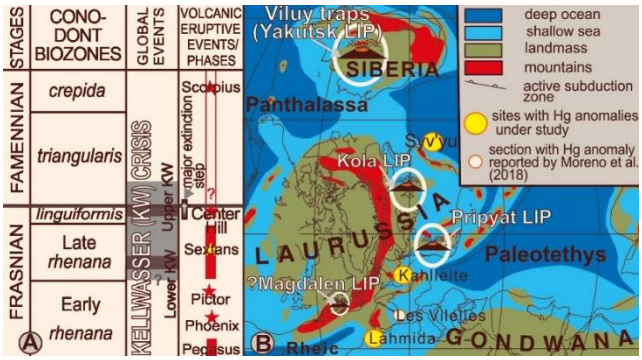
The Texas researtch team insists, however, that a variety of traces occur in the geologic record that could be consistent with plate tectonics starting much, much later. They suggest, for example, that the onset of plate tectonics probably initiated the climatic and oceanographic changes on Earth that led to “Snowball Earth”. After examining the literature for all the mechanisms that have been postulated for the onset of “Snowball Earth”, the team even argued that plate tectonics is the only singular event that can explain 22 hypotheses formulated by other scientists as triggers of “Snowball Earth”. The start of plate tectonics could have been responsible for each of the other explanations.

The onset of plate tectonics should have disturbed the oceans and the atmosphere by redistributing continents, increasing explosive arc volcanism and stimulating mantle plumes. The team speculated that strong climatic and oceanographic effects observed in the Neoproterozoic rock record is a powerful supporting argument that this is indeed the time of the transition from single lid to plate tectonics. The researchers suggested imagining a time when Earth didn’t have plate tectonics. After it evolved to have plate tectonics, there would have been a major shift in the Earth’s operating system that would have had a huge effect on climate.

http://www.sci-news.com/geology/snowball-earth-plate-tectonics-05985.html

Yet another international team of geologists, this one from Poland and the UK, has found evidence that the Late Devonian mass extinction event around 370 ma, one of five major extinction events in Earth’s history, was caused by massive volcanic eruptions. It killed up to 80% of species, and wiped out an abundant Devonian coral reef ecosystem. The Frasnian-Famennian event, so called because it occurred at the boundary between the Late Devonian Frasnian and Fammenian stages, was the final and most devastating pulse in a multi-step crisis. For years geologist have argued over its exact cause. Was it climate change, plate tectonics, volcanism, a bolide impact? What, exactly, did the killing?

The most likely culprit, according to the new research, is a major episode of volcanism, based on a widespread pulse of mercury that shows up in geochemical analyses of Late Devonian rocks. The researchers analyzed rocks from Morocco, Germany, and Siberia dating from the same short geologic interval of 372 ma, just prior to the Frasnian-Famennian boundary. The rocks, spread across two continents, varied from black and gray shales to limestones, and ranged from a few inches to a several feet thick. What was interesting was that they all shared a sharp mercury peak, hundreds of times higher than background.



Frasnian-Famennian stages with conodont biozones, the two-step Kellwasser crisis (a major global event), and volcanic eruptions on the left, with sites studied for mercury abundances shown on the map at right.

In other well-known mass extinctions, elevated mercury has been closely linked to extensive volcanism. According to the team, mercury is now considered to act as a signature for Earth-based catastrophes, the sort of signature that iridium gave to extraterrestrial-based extinctions. Mercury as a geochemical fingerprint of volcanism appears decisive in the new stage of mass extinction studies. Until this most recent discovery, the Late Devonian extinction was the one major exception to the rule. So, as a result, all five of the big mass extinction events, including the end-Cretaceous extinction, coincide with major volcanism.

http://www.sci-news.com/geology/volcanic-eruptions-late-devonian-mass-extinction-05967.html

Beaches, barrier bars like Cape Hatteras, and oceanic islands aren't the only things in danger of disappearing as sea level rises. The oceans also are eating away at coastal cliffs in places like California. And it might get even worse as Californians continue to develop and build at the edge of the Pacific Ocean. The USGS recently released a study that projects Southern California cliffs receding more than 130 feet by end of this century if the sea keeps rising.

That's a big number, and the consequences of such erosion could end up being very severe on major roads along the coast. Last year a landslide south of Big Sur buried Highway 1, which was rebuilt on top of the debris. Blocks of houses, parks, public facilities, and other features in coastal cities such as Malibu could be lost to the sea if the projections hold true. Evacuating and returning to clifftops hammered by the oceans has become standard in towns like Pacifica. Local disputes have intensified over how many more seawalls to build to fend off rising waters. And who will pay to maintain them? Some have suggested just leaving the coast entirely so that Mother Nature can have her way.

The USGS study, which examined cliffs from San Diego to Point Conception, used a sophisticated model that synthesizes existing data and conclusions to measure the impact of sea level rise on the defining features of California's coast. The results established a more concrete timeframe of cliff retreat for communities in southern California.

Cliffs like this one near Malibu could erode back 62 to 135 feet this century, depending on sea level rise.

Oceanfront property owners often react to the possibility of erosion by building seawalls. Approximately one-fifth of Southern California's coastline already has been armored with them, and that proportion probably will grow. Seawalls, however, prevent the cliffs from eroding and providing sand to beaches. They enable more development in already vulnerable locations and also fix the cliff in place. As the sea level rises, the beach in front cannot migrate inland, so it gets submerged. To make matters worse, a USGS study in 2017 projected that as much as two-thirds of Southern California's beaches could disappear by the end of the century because of rising seas and human interruptions to sediment flow.

http://www.latimes.com/local/lanow/la-me-cliff-erosion-sea-level-rise-20180627-story.html#nt=outfit

https://www.amnh.org/exhibitions/dinosaurs-ancient-fossils-new-discoveries/extinction

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Fun Fact Having Nothing to Do with Geology

September is the only month having the same number of letters in its name (in English) as the number of the month in the year.

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