PITTSBURGH GEOLOGICAL SOCIETY

May 15, 2019

Poster Session 6:00 PM

Dinner 7:00 PM

Student Talks 8:00 PM

Dinner costs
$30.00 per person
$10.00 student member

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

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

NEW LOCATION
Cefalo's Banquet & Event Center, Carnegie PA

Role of Biogeochemistry in Unconventional Resource Development

Dr. Shikha Sharma

Associate Professor and Director, IsoBioGeM Laboratory
Department of Geology & Geography
West Virginia University

Deadline for Reservations: Wednesday, May 8.

Speaker Abstract

The rapid development of unconventional resources during the last couple of decades has had a tremendous impact on US energy production and the global oil economy. Unlike conventional hydrocarbon systems, the unconventional systems serve both as the source and reservoir of hydrocarbons and therefore are directly drilled into for hydrocarbon production. Studies based on a large number of wells drilled in different basins have revealed that the unconventional reservoirs are geologically complex, heterogeneous, and every play is unique in several ways. These spatiotemporal variations result in large variations in the amount and type of hydrocarbon produced, even within a single basin.

Although most wells in unconventional exploration area might be productive, not all may be necessarily economical due to high costs involved in drilling. To identify the sweet spots for drilling, various physicochemical and mechanical attributes of the reservoirs need to be taken into account. The talk will focus on how different biogeochemical tools can be used to identify sweet spots for drilling and further increase the efficiency of oil and gas production from these unconventional reservoirs.

Speaker Biography

Dr. Shikha Sharma is an Associate Professor of Geology and the Director of IsoBioGeM Laboratory at West Virginia University. Her coal and shale gas research program has been funded by several million-dollar research grants from federal agencies like US-DOE, NETL, NSF, EPA, and USGS. She has authored/co-authored more than 50 publications in high impact international peer review journals.

Dr. Sharma's current research projects focus on understanding biogeochemical controls on shale gas production, kerogen chemistry and water-rock-interactions in shale reservoirs after injection of hydraulic fracturing fluids.

PRESIDENT'S STATEMENT

I just finished reading (or should I say just finished listening to) *The Glass Universe: How the Ladies of the Harvard Observatory Took the Measures of the Stars* by Dana Sobel. This book offers a unique perspective into the lives of the women "computers" and their relationships with the male directors of the Harvard Observatory.

I realized while I listened to the narrator read the words on the pages that I knew nothing about the types of telescopes used or early techniques for capturing images of the night sky. One of these was a 60-inch reflector that had a huge curved mirror to collect the stellar light or incoming photons that slowly exposed the emulsion on a photographic glass plate. The Harvard Observatory began employing women as calculators, or "human computers," to interpret the telescopic observations made by their husbands, brothers or fathers each night while efficiently reading the nightly glass plates that captured images from the sophisticated telescopes at the time. Due to their endless dedication, careful observations and their commitment to the study of the night sky, progress was made in astronomy during the late 19th and early 20th centuries.

The women that studied the "glass universe" made new discoveries, devised a stellar classification system for the stars based on their spectral characteristics, helped to determine the composition of stars and developed techniques for measuring astronomical distances. Some of these women included Williamina Fleming, Annie Jump Cannon, and Dr. Cecilia Helena Payne-Gaposchkin. Williamina Fleming identified ten novae and more than three hundred variable stars and published a 15-letter spectra classification system in 1890. Annie Jump Cannon, revised Flemings system and designed a stellar classification system still in use today ranking stars as O, B, A, F, G, K or M, with "O" being the hottest stars and "M" the coolest (our Sun is a "G" star). Dr. Cecilia Helena Payne-Gaposchkin found that the stars are uniform in composition, and proved that the vast majority of the universe is hydrogen and helium. She became the first woman professor of astronomy at Harvard in 1956 and Harvard's first female department chair.

I was left with an impression that - despite the commonly-held belief that women had little to contribute to human knowledge - the hard work, commitment and careful observations and calculations made by this group of remarkable women changed our understanding of the stars and our place in the universe. They changed the old views that women could not continue in a scientific capacity after marriage and starting a family. They built a foundation that has allowed others to continue exploring our universe, to build powerful telescopes that venture into deep space, and rovers to analyze the surface of planets.

This summer, take time to look toward the stars and marvel in the beauty and the mysteries that they hold. In the words of Maria Mitchell, "Do not look at the stars as bright spots only. Try to take in the vastness of the universe." Now onto my next book, *Timefulness: How Thinking Like A Geologist Can Help Save the World* by Wisconsin geologist Marcia Bjornerud.

In closing, I would like to thank all the corporate sponsors that have helped PGS complete another successful year with great speakers and engaging topics. I would also like to thank the membership for consistently showing up to the meetings. We appreciate the interaction and good conversations. To the student members that are graduating, congratulations! Do not forget about PGS, keep active and come back to enjoy the comradery and keep us updated on your successes.

Have a wonderful summer and look forward to an exciting new speaker season in September.

Tamra

PGS AWARDS STUDENT RESEARCH IN EARTH SCIENCE AT THE COVESTRO PITTSBURGH REGIONAL SCIENCE AND ENGINEERING FAIR

On March 29, 2019, Carnegie Science Center held the annual Covestro Pittsburgh Regional Science and Engineering Fair at Heinz Field. PGS members **Wendell Barner** and **Judy Neelan** participated in judging of geoscience-related project. PGS sponsors two awards for the science fair, one for the Senior Division (High School) and one for the Intermediate Division (Middle School).

This year's recipient for the Senior Division is **Elena Hochheiser** – Pittsburgh Allderdice High School. Her science teacher/sponsor is Janet Walkeck. Ms. Hochheiser's project was titled "Constructing a Holocene history of Celestine Lake through an analysis of organic isotope composition within its sediment". Ms. Hochheiser analyzed lake sediment core samples from Celestine Lake (Jasper National Park, Alberta, Canada) to facilitate a paleo-reconstruction of autochthonous and allochthonous plant distribution in the lake and surrounding regional ecosystem and identify response to glacial movement through the application of bulk geochemical proxies.

The Intermediate Division recipient is **William Goetzman** – Hampton Middle School. His science teacher/sponsor is Gwen Cohen. Mr. Goetzman's project was titled "Water Quality in Pine Creek". Mr. Goetzman analyzed water samples from the headwaters of Pine Creek to the confluence of the Allegheny River. Monthly samples were collected throughout the year to demonstrate water quality effects from relatively undeveloped areas, to more developed areas, and below treatment facilities, to document and hypothesize that water quality will degrade from the headwaters to the confluence of Pine Creek and the Allegheny River.

THE 17th ANNUAL STUDENT NIGHT IS IN THE BOOKS!

Our April joint meeting with ASCE and AEG saw a huge turnout of professionals and students to view six very polished poster presentations and three professional-level talks given by local students. The picture below shows all the presenters, with the winners holding their awards. Congratulations to everyone!

LOCAL GEOLOGICAL EVENTS

SOCIETY OF PETROLEUM ENGINEERS

May 14, 2019 (lunch meeting)

"Innovative Approaches- Machine Learning, Frac Hits & Unconventional EOR" by Hayley Stephenson and Ali Shahkarami, BHGE Energy Innovation Center.

Cefalo's Banquet Center, Carnegie PA

GEOPHYSICAL SOCIETY OF PITTSBURGH

June 5, 2019

"1st Annual Appalachian Basin Geophysical Symposium" (see details on page 7)

NOAH's Event Center, Canonsburg, PA

PENNSYLVANIA COUNCIL OF PROFESSIONAL GEOLOGISTS

June 14, 2019

"Field Trip: The Last Ice Age in Western Pennsylvania: A Changing Climate as Seen in the Glacial Landscapes"

Doubletree by Hilton, Cranberry, PA

September 12, 2019

"Introduction to Inorganic and Organic Groundwater Geochemistry" by Bill Deutsch

Doubletree by Hilton, Cranberry, PA

The Pittsburgh Geological Society welcomes the following new member:

Luke J. Sherer
Field Technician
ACA Engineering, Inc.

We also welcome a new student member from Slippery Rock University:

Emilee M. Lucas

And two new student members from Indiana University of Pennsylvania:

Mitchell A. Moore
Sara E. Trio

THE PITTSBURGH GEOLOGICAL SOCIETY ENDOWMENT FUND

Established May 8th, 2014 through the

COMMUNITY FOUNDATION
Serving the Heart of Western Pennsylvania

THE PGS FALL FIELD TRIP WILL TAKE US BACK IN TIME TO VISIT MEADOWCROFT ROCK SHELTER

Join PGS on September 7, 2019 to visit Meadowcroft Rock Shelter, the oldest known habitation of humans in North America. We will travel as a group to Washington County and take an exclusive Insider Tour led by Dr. James Adovasio, discoverer and lead archeologist.

MEADOWCROFT

Insider Tour of Meadowcroft Rockshelter

Because Meadowcroft does not take group reservations, each PGS member who wishes to travel with us will need to purchase their own tour tickets from the Meadowcroft website by early June (the tours sell out quickly). The cost is $15 for Heinz History Center members and $30 for the public. **Please be sure to select the September 7 date when you purchase your ticket(s).**

https://www.heinzhistorycenter.org/events/insider-tour-meadowcroft-rockshelter-september-2019

IMPORTANT NOTE: You need to be able to walk up 65+ steps to reach the main rock shelter (see photo at left). There is no handicap accessibility for the site itself.

Once you've signed up with Meadowcroft, please email trip leader **Mary Ann Gross** (mgross@rangeresources.com) to hold your spot on the PGS Field Trip for transportation and other activities. Additional costs for these aspects of the field trip will be determined later. If you have any questions, you can also call Mary Ann at 724-873-3221.

UPCOMING EVENTS OF INTEREST TO MEMBERS OF PGS

THE ORIGIN OF WESTERN PENNSYLVANIA PLACE NAMES

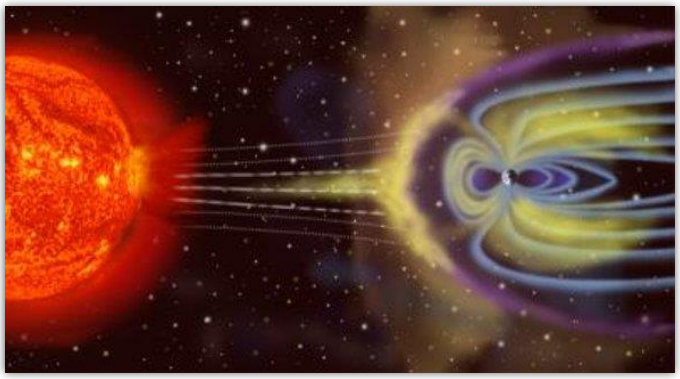
Photo of the Sample School, a historic schoolhouse in Cranberry Township on the front lawn of the Cranberry Municipal Center.

In 1796, two brothers named Mathew and William Graham arrived in what is now Cranberry Township, in Butler County, and acquired 200 acres of “Depreciation Land” used to pay Revolutionary War soldiers *in lieu* of cash. Over the following decades, the Graham family and Samuel Duncan, another early settler, opened a tavern, a distillery, a sawmill, and a grist mill. That area became Cranberry Township, whose name derives from the wild cranberries that were abundant along the banks of Brush Creek until the 1880s.

The township was chartered in 1804 to encompass 81 mi^2, but in 1854, its boundaries were redrawn, reducing it to only 25 mi^2. Prior to the completion of the Pennsylvania Turnpike's western section in 1951, Cranberry Township was primarily an agricultural community. The 1966 opening of I-79 led to its accelerated development. The 1989 opening of I-279 further accelerated the township's growth, shortening the drive time to downtown Pittsburgh to less than half an hour. The Cranberry Township Historical Society, formed in 1984, was created to collect and preserve relics of the community's early local history, such as the Sample Schoolhouse, a one-room school from the mid-1800s. Brush Creek, where the cranberries used to be plentiful, lends its name to the Brush Creek limestone, the lowest of six marine limestones in the Pennsylvanian-age Glenshaw Formation (Conemaugh Group).

DID YOU KNOW . . . ?

Earth’s magnetosphere, which extends outward about 10 times the diameter of the planet, vibrates like a drum when jets of solar plasma crash into it. The hypothesis describing this phenomenon was developed in the 1970s, but it took until recently to observe it because the tools weren’t available. In 2007, NASA launched five satellites to study the magnetosphere. The mission, called “Time History of Events and Macroscale Interactions during Substorms” (THEMIS), used all five THEMIS probes early on when



Jets of charged solar particles hit Earth’s magnetosphere, and some of the ripples traveling toward the poles are reflected back, setting up interference that allows standing waves to form.

they were almost in a perfectly straight line. Which was ideal for determining what happens when plasma hits the magnetosphere.

When a jet of plasma, traveling very fast, impacts on the magnetopoles, the boundary of the magnetosphere, ripples form in all directions. Some ripples travel toward the north and south poles and get reflected back, forming interference of the original and reflected waves. This allows standing waves to form very much like on the surface of a drum, giving it a very well-defined frequency. The THEMIS team converted the signals collected by the probes into audio that can be heard.

Based on the “drum-vibration” hypothesis, the oscillations should have a big effect, for example, causing motion within the radiation belts. Perturbations on the ground in the magnetic field tell us that the ionosphere is moving as well in the same way as the magnetosphere boundary. It's as though one side of the magnetosphere is ringing as a result. Such events occur on a colossal scale. The THEMIS team has proposed that future studies look into ground-based sensing methods that can reveal more about the magnetosphere’s behavior. Perhaps there’s an important upside in better understanding our planetary shield.

https://www.scientificamerican.com/podcast/episode/solar-jets-cause-standing-waves-in-earths-magnetic-field/

Shortly after a miles-wide asteroid slammed into Earth 66 ma, a hailstorm of tiny glass beads rained down on a flooding estuary in what's now North Dakota. As seismic waves from the impact thrashed the water, plants and animals became jumbled up and buried in shifting sediments, preserving them for millions of years. Now, research says the site represents an exceedingly rare snapshot of the moment that marked the demise of the dinosaurs. Although handfuls of fossils have been found previously at other localities that captured this moment in the geologic record, the North Dakota site potentially represents an entire ecosystem affected by the catastrophe. It is a sort of geologic equivalent of high-speed film of the very first moments after the impact.

A beautifully preserved fish from the Hell Creek Formation at the Tanis locality.

The site was nicknamed Tanis, referring to a “lost” ancient Egyptian city. It is an exposure of the Hell Creek Formation, a well-known series of rock layers that record the hundreds of thousands of years leading up to the K-Pg (Cretaceous-Paleogene –formerly called Cretaceous-Tertiary) extinction event. The site is being excavated by a team of paleontologists led by a Ph.D. candidate named Robert DePalma from the University of Kansas. Along with plenty of fossils, the team recovered bits of shocked quartz and tektites scattered throughout many layers of sediment, even in amber. After being washed onto land, a mass of fish became entombed simultaneously, many of them exquisitely preserved with their gills congested with impact debris. The sedimentary rocks suggest that a sudden rush of water occurred in a river valley or estuary, and the team has estimated the deluge must have occurred within the first hour after impact. The team

thinks that the floods were seiche waves caused by magnitude 10 to 11 earthquakes triggered by the impact.

Some paleontologists not associated with the team wondered whether the site might be too good to be true. Tanis abounds with fossils, including teeth, bones, and hatchling remains of almost every dinosaur group known from the Hell Creek Formation. There supposedly also occur foot-long feathers, possibly from dinosaurs, pterosaur remains, and an unhatched egg of some kind with a preserved embryo inside. Paleontologists still have a lot of questions because DePalma has not been entirely forthcoming with all of the essential information. DePalma, on the other hand, says that the current study is a geological introduction to Tanis, not a full description, and that the team is working on follow-up descriptions.

https://www.nationalgeographic.com/science/2019/03/fossils-found-from-day-dinosaurs-died-chicxulub-tanis-cretaceous-extinction/

The type of rocks you live near could greatly affect how much your area could be damaged by massive solar flares in future. Geology could decide what survives and what fries in the event of a serious solar storm, so researchers are busy mapping the rocks underfoot to see who is at risk of a techno-inferno when the big one strikes.

Jeffrey Love, a USGS geophysicist has been constructing a picture of the arrangement of the rocks making up the North American continent that would buzz with electromagnetic activity in the event of extreme geomagnetic activity spilling from the Sun. Although knowing where sites of potentially electromagnetically active geology occur is a good idea, it is also important to calibrate that activity with actual solar storms. Love and his team looked at which parts of the North American continent could be expected to be hotspots of destruction by comparing records of solar storms with variations in geomagnetic fields measured by several observatories and quantifying regions of geoelectrical activity over time. Differences between regions were striking –rocks in some areas made electrical activity up to 100 times worse than others. This is important to know because, as time passes, the risk of a devastating geomagnetic storm rises along with our dependency on technology.

A large event would start as a magnetic hole opening in the Sun's corona, channeling a wind of charged particles in our general direction. Earth's magnetosphere normally does a good job shielding us from the showers of plasma thrown out by the Sun, and even managing to handle the occasional vigorous downpours that strike from time to time. But the magnetosphere has its limits. US naval documents describe the detonation of dozens of mines off the Vietnam coast in 1972 that has been attributed to solar activity sparking off the mines' magnetic sensors.

A giant solar storm could wipe out communication and electricity systems on Earth. Such a storm is overdue.

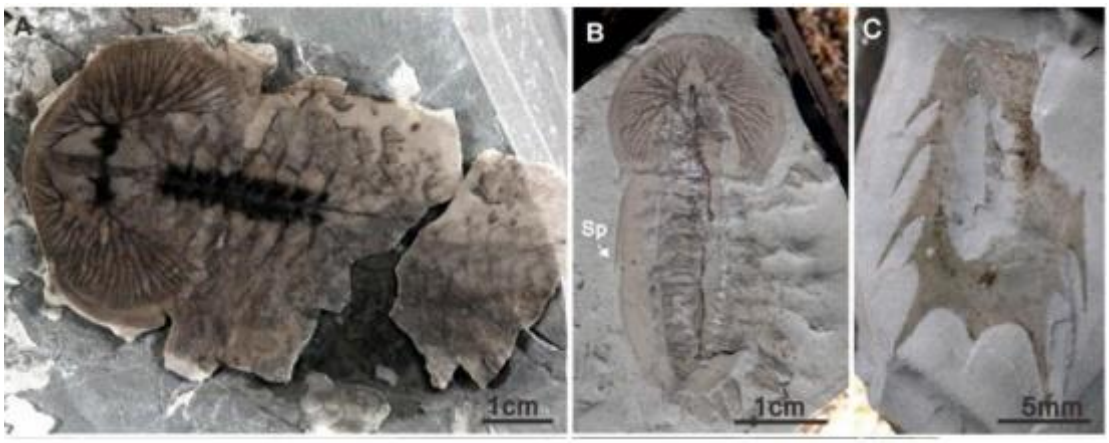
Going back farther in time, in 1859, while technology was still in its infancy, a powerful solar ejection overwhelmed telegraph wires, shocking operators and sparking fires during what is famously known as the Carrington Event.

Now, our world is covered by a web of wires that transport power and telecommunications signals into every corner of the globe. That network is especially vulnerable to potentially powerful solar storms. Indeed, the Earth's crust can carry induced voltages in places where the crust is made of the right kinds of materials, like water-logged slabs of porous sedimentary rock. So the interface between an ocean and a sandy shoreline poses risks of currents diverting and building, putting nearby power grids at greater risk.

Under the right conditions, granitic rocks could help short circuit power-grids running across their surface. Depending on a region's geology, sections of technological infrastructure could be supercharged with current during periods of intense solar activity, or relatively protected from harm. The electrically-resistant Appalachians could easily blow out any grid crossing the mountain range. Armed with the details of a good geoelectrical survey, authorities will be better prepared to plan for powerful solar storms that are bound to hit.

https://www.sciencealert.com/damage-from-a-solar-storm-can-be-higher-if-you-live-near-particular-types-of-rocks/amp

There's been another spectacular discovery in south China that is shedding more light on the bizarre creatures that lived on earth over 500 ma. Since 2007, when the site was discovered, paleontologists have excavated around 30,000 fossils, known as the Qingjiang biota, that date back to the Cambrian period 518 million years ago from a shale bed next to *Danshui river* in Hubei province in southern *China*. The newly discovered Lagerstätte, could rival the Burgess Shale in scope and importance. The researchers have analyzed over 4,300 specimens so far, identifying 101 multicellular species and eight algae, about 53% of them totally new to science.



Just some of the soft-bodied creatures from the Qingjiang biota.

As with the Burgess Shale, the Qingjiang fauna is so well preserved that it includes detailed impressions even of soft-bodied creatures. What makes this find so spectacular is that it fills gaps. Jellyfish, box jellies, anemones, branched algae, and sponges proliferate, where they are scant or missing from other deposits, and they are much better preserved than the Burgess and other deposits, which were damaged by metamorphic processes and weathering that affected other well-known Cambrian Lagerstätte. The preservation level is so exceptional that even jellyfish tentacles and comb jellies can be made out in detail. There's still a lot of work to be done to analyze and catalogue the remaining fossils,

and more fieldwork could yet turn up even more. One thing seems certain, however – this is going to mean great things for our understanding of animal evolution.

https://www.sciencealert.com/an-incredibly-rare-cambrian-fossil-discovery-is-filling-in-our-evolutionary-gaps/amp

The "Younger Dryas impact" hypothesis (also known as "Clovis comet" hypothesis) suggests that the enormous debris field of a disintegrating asteroid or comet struck North America, South America, Europe, and western Asia approximately 12,800 years ago. Based on the hypothesis, this event triggered extensive biomass burning, a brief impact winter, and climate change, and contributed to extinctions of late Pleistocene megafauna. The hypothesis has been controversial since it was proposed, and continues to be contested by those who prefer to attribute the end-Pleistocene reversal in warming entirely to terrestrial causes.

But now, a research team presents geological and paleontological evidence of the cosmic impact from far south of the equator. They identified the Younger Dryas boundary (YDB) layer at high latitudes in the Southern Hemisphere near 41°S, close to the tip of South America. This is especially interesting because the majority of evidence found so far had been from the Northern Hemisphere. A group of Chilean scientists studying sediment layers at Pilauco Bajo, a well-known Quaternary paleontological and archaeological site, have recognized changes associated with the YDB impact event, including a 12.8 ka 'black mat' layer that coincided with the disappearance of South American Pleistocene megafauna, an abrupt shift in regional vegetation, and a disappearance of human artifacts.

The Pilauco sediments included microscopic spherules, including chromium-rich ones, interpreted as having been formed by melting due to the extremely high temperatures associated with impact. This sediment layer also showed peak concentrations of platinum, gold, and native iron particles rarely found in nature. Chromium-rich spherules are not found in the Northern Hemisphere YDB impact sediments – only in South America, because volcanic rocks in the southern Andes can be rich in chromium, providing a local source for the element. The YDB impact objects, therefore, must have hit South America as well.

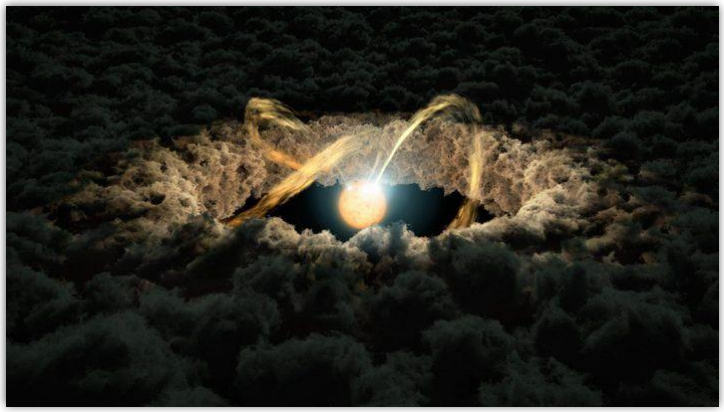
Artist's depiction of an asteroid plunging toward Earth.

Other evidence include a large biomass burning event that coincides with the timing of major YDB-related burning events in North America and western Europe. But where climatic conditions in the northern hemisphere became colder and wetter at the beginning of the Younger Dryas, the plant assemblages in the southern hemisphere indicate that there was an abrupt shift from wet and cold

conditions to warm, dry conditions. The rapidity with which the climate shifted is better attributed to impact-related shifts in atmospheric systems, rather than to oceanic processes, which tend to act more slowly. The impact and its associated major environmental effects are believed to have contributed to the extinction of local South American Pleistocene megafauna, as well as to the termination of the human culture similar to the Clovis culture in the North America. The Pilauco site is 3,728 miles from the closest well-documented site in South America, and its correlation with the many Northern Hemispheric sites greatly expands the extent of the YD impact event.

http://www.sci-news.com/paleontology/evidence-chile-younger-dryas-extraterrestrial-impact-hypothesis-07012.html

Astrochemistry is the subdiscipline of astronomy that links star formation to planet formation, including understanding how the Earth formed from interstellar gas and dust. It is also important in determining how the birth environment of our planet compares with the extrasolar planets now being observed around other stars on an almost daily basis.



Artist's rendering of a star surrounded by a protoplanetary disk. Material from the disk flows along the star's magnetic field lines and is deposited onto the star's surface, lighting it up brightly.

The American Astronomical Society (AAS) recently awarded the 2019 Heineman Prize for Astrophysics to Edwin Bergin, professor and chair of astronomy at the University of Michigan, in large part for his work on how primordial gas and dust turned into stars and habitable planets. Bergin's work addressed several aspects, including asking whether the ingredients for life on Earth came from our own solar system or from interstellar space. He suggests it came from our own system. His primary focus has been on tracking elemental pools of carbon and nitrogen and trying to determine where the Earth got its carbon during formation. Did it head towards the planetary core during the molten phase or stay on the surface?

Earth is primarily a silicate planet with only small amounts of carbon – below 0.1% of its mass – which might actually have been our saving grace. Bergin suggested things might be different if there had been an order of magnitude more carbon in the Earth's surface. The system of plate tectonics that recycle carbon, via CO_2, back into the surface, might not be as efficient as it is, which could tilt our world towards a runaway greenhouse with surface temperatures well in excess of the boiling point of water.

As much as half of Earth's water is likely older than the solar system itself, with an estimate of 30% to 50% originating from the molecular cloud from which our solar system originated, making this original water about 1 ma older than the solar system itself. At least half of Earth's water probably originated locally. It is crucial both for life and for enabling plate tectonics to occur, ensuring Earth can recycle carbon in its atmosphere. The prevailing concept is that Earth formed without water and received most of it over time from beyond the early so-called snowline, the region beyond the asteroid belt in which water transitions from vapor to ice.

Earth is also nitrogen-poor, having received only 1 nitrogen atom in 100,000, according to Bergin. Earth received its nitrogen from meteorites that were rich in organic carbon. Geochemical processes that released nitrogen in its molecular form destroyed the organics, leading to a nitrogen-dominated atmosphere. Ultimately, the formation of life on Earth involved hydrogen, carbon, nitrogen, oxygen, phosphorus, and sulfur (HCNOPS), with oxygen coming from water, not rocks. These elements, which are the hardest to incorporate into rocks, dominate the gas chemistry of interstellar space. The compounds formed from these elements do so via reactions in the gaseous state as well as within ice-coatings on silicate minerals. In contrast, the silicates formed millions to billions of years ago following supernova explosions or within the haloes of dying stars and floated through space basically as non-reactive solids.

So it should come as no surprise that the chemistry of life on Earth is based on these same reactive elements. Elements that are not as reactive are not likely to be crucial to life because life centers on the ability to react and generate chemical complexity. Nitrogen, as a key component of life on Earth, most likely would be similarly key to life elsewhere because the chemistry of life is based on the same elements, which probably is not a coincidence.

Venus had comparable initial conditions to Earth but is too close to the Sun, which led its water to boil into the atmosphere. The atmospheric water then was destroyed by incoming solar radiation. Since our oceans play a crucial role in the carbon cycle, the loss of the early oceans on Venus would have broken whatever emerging carbon cycle might have occurred on that planet. In addition, carbon in Venus' mantle would have been released slowly into the atmosphere with no chance for it recycling back into the mantle, leading to Venus being uninhabitable. There is a possibility that some extraterrestrial worlds occur inside their solar system's habitable zones, but have much more carbon than Earth. Such planets might not have been able to recycle the carbon. In that case, they would end up with a CO_2-dominated runaway greenhouse atmospheres and, like Venus, be essentially uninhabitable.

https://www.forbes.com/sites/brucedorminey/2019/01/31/earths-lack-of-carbon-may-have-saved-it-from-venus-like-fate-says-prize-winning-astrochemist/amp/

Modeling what happened after a massive asteroid struck the Yucatan has painted a hellscape capable of causing a mass extinction: choking dust, immense tsunamis, and enough debris leaving and reentering the atmosphere to set off global fires. But questions remain whether the impact alone drove the dinosaurs to extinction or if it merely finished the job started by a massive volcanic outburst happening in India. The Deccan Traps, the Late Cretaceous volcanic layers in India, cover an area roughly 193,000 square miles, and the eruptions that created them involved over 240,000 cubic miles of rock. Such immense eruptions have been linked to mass extinctions because they pumped lots of toxic chemicals into the atmosphere and caused rapid cooling and warming events.

Many scientists have argued that the Deccan Traps volcanism were already killing the dinosaurs, or had stressed ecosystems to the point where a bolide impact was merely the final straw. Not everyone accepts this idea, of course. Some have even suggested that the asteroid collision was the driving force behind changes in the Deccan Traps eruptions. Figuring out what actually occurred requires better knowledge of the when the eruptions happened and when the impact and the extinctions occurred.

Two recent studies claim to have figured out the answers. Unfortunately, the two studies disagreed on major issues. Both relied on radiometric dating, but the studies use different types, each with their own limitations. One looked at the decay of uranium trapped in zircons that formed during volcanic activity. This method is very precise, but since zircons form at high temperatures, they generally were underground before the eruptions rather than during them, meaning they don't provide a precise date of the eruption. The researchers in this study looked at large amounts of zircons and linked their dates to their specific locations in the eruptions that built the Deccan Traps. They then used statistical analysis to define outliers and took them into account to build a model of the most probable ages of different eruptions. Their study suggested that the Deccan traps were built in pulses, with a large eruption occurring about 100,000 years before the asteroid impact. An even larger one took place almost immediately after.

The Deccan Traps of India, enormous layers of volcanic deposits. Were they the result of many big eruptions or a few massive

The second team used argon dating. In this method, the gas only starts being trapped once a rock solidifies, so it essentially starts timing during the eruption itself. Unfortunately, argon can sometimes escape from the rock slowly over time. This team found that their analysis overlapped with that of the zircon team but there are some significant differences in the details. For example, their research found that the Deccan Trap eruptions overlapped with the mass extinction, occurring both before and after the event, but they found no evidence for pulses. They found, instead, that the Deccan Traps eruptions were nearly continuous, with about 75% of the material emplaced AFTER the mass extinction. Their dates are also consistent with a major shift in the properties of the erupted rock occurring at the same time as the impact, supporting the idea that the impact's seismic effects reached across the entire planet.

Eruptions like this release massive quantities of S and CO_2, which have opposing effects. Sulfur forms aerosols that tend to reflect a large amount of sunlight, causing short term atmospheric cooling. Carbon dioxide produces more long-term warming through the greenhouse effect. Some scientists think this climate seesaw contributed to some mass extinctions. The second study included an analysis correlating the eruptions with climate change, but found the two don't line up well. The researchers concluded that either something else was going on with the climate, or the release of gases doesn't always correspond with the volume of lava erupted.

So that result raises questions about how much the Deccan eruptions would have contributed to ecological disruptions. The results of the two studies have not led to a clearer picture of what happened and when. They do confirm that significant eruptions were happening before the mass extinction,

but the biggest of them seemed to be happening after, and the eruptions' effect on distant ecosystems is unclear. They also don't confirm whether the eruptions occurred as a small series of large outbursts or a relatively continuous series of smaller events. So, if you want to know how the dinosaurs REALLY went extinct, remember: there is still a lot of room for future science to work on the problem.

https://arstechnica.com/science/2019/02/new-dates-show-massive-volcanic-eruptions-overlapped-with-dinosaurs-death/?amp=1

Earth's oceans are much warmer than previously thought according to a new study. They are also heating up faster than had been believed, driven by climate change. The new study showed that the world's oceans have gotten much warmer since the 1960s with 2018 the warmest year on record for oceans.

So, what happens when the oceans get warmer? Rising sea levels, of course, because when water heats up, it takes up more space. Warming alone could make sea levels rise as much as 12 inches by the end of the twenty-first century, enough to displace millions of people who live on low-lying land. In addition, warming oceans are causing polar ice sheets to melt faster, which will make sea levels rise even more, by up to a 3 feet by 2100, forcing hundreds of millions of people to leave their homes. Within the next 30 years, more than 300 thousand homes in the US could be flooded every other week.

As if warmer oceans and melting ice caps aren't enough, tropical storms could become more intense and last longer. For example, Hurricane Harvey brought more than 5 feet of rain over four days in 2017, and for coastal areas already struggling with rising seas, such storms could bring even more flooding. Warming temperatures also mean changing rainfall patterns water vapor in the atmosphere becomes redistributed. Higher temperatures lead to more evaporation, so parts of the earth will get wetter while other parts get drier.

Of course, humans won't be the only ones affected. Coral reefs, for example, are especially sensitive to warmer seas. Between 2016 and 2017, as many as half the corals in the Great Barrier Reef of Australia died as a result of two ocean heat waves, and experts say warmer oceans mean these sorts of die-offs will become much more common. Flooding causes increased nutrient flow from land to the sea, leading to plankton blooms and anoxia, making life very difficult for fish and shellfish. Although many fish species migrate to cooler areas, the waters in some parts of the world are getting too warm for any fish making food shortages look more and more likely.

The coastal town of Scituate, Massachusetts being engulfed by a "bomb cyclone" that hit the east coast on March 2, 2018.

https://amp.cnn.com/cnn/2019/01/12/health/warm-ocean-effects-intl/index.html

According to a new study, about 40% of the world's insect species are in decline, primarily because insects are losing their habitats to farming, urbanization, pesticides, fertilizer use, and climate change. As a result, the repercussions of this loss could be catastrophic. The loss of insect populations is also a sign that the we are in the middle of a sixth mass extinction. While it's easier to be alarmed about wolves, sea turtles, and the white rhinoceros going extinct than it is to feel bad about losing bugs, the loss of insects is a dire threat, capable of triggering a catastrophic collapse of Earth's ecosystems.

A beekeeper inspecting one of his hives.

The new study looked at 73 historical reports on insect declines around the world and found the total mass of all insects on the planets is decreasing by 2.5% per year – insects are going extinct eight times faster than mammals, birds, and reptiles. If the trend continues, in 10 years we'll have 25% fewer insects; in 50 years only half will be left, and the Earth may not have any insects at all by 2119. That's a HUGE problem. Insects are food sources for countless bird, fish, and mammal species. Bees and butterflies are critical in pollenating fruits, vegetables, and nuts.

The researchers, in focusing their analysis on insects in European and North American countries, estimated that 41% of insect species are in decline, 31% are threatened (according to criteria set by the International Union for Conservation of Nature), and 10% are going extinct locally. The study suggested that bee species in the UK, Denmark, and North America have taken major hits. Bumblebees, honeybees, and wild bee species are all declining. In the US, the number of honeybee colonies declined from 6 million in 1947 to 2.5 million 60 years later. Moths and butterflies are also disappearing across Europe and the US – in the first nine years of the 21st century alone, the UK lost 58% of butterfly species on farmed land. Dragonflies, mayflies, and beetles appear to be dying off as well.

A 2017 analysis of all animal species planet-wide indicated that the Earth is undergoing a process of "biological annihilation." It estimated that as much as 50% of the total number of individual animals on Earth are already gone. In the past, mass extinctions have been caused by asteroid collisions, the emergence of ice ages, or other devastating climatic conditions. This sixth mass extinction, however, is driven by human activities such as deforestation, mining, and global warming. Since insects comprise about 2/3 of all terrestrial species on Earth, this trend confirms that extinction event is profoundly impacting life forms on our planet.

https://amp.businessinsider.com/insects-dying-off-sign-of-6th-mass-extinction-2019

PGS WEBSITE OF THE MONTH

https://massextinction.princeton.edu/deccan-volcanism/01-deccan-volcanism-adventure-science

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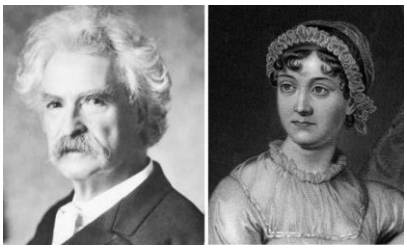
Fun Fact Having Nothing to Do with Geology

Humorist (and curmudgeon) Mark Twain did not like Jane Austen. He once wrote in a letter, "Every time I read Pride and Prejudice I want to dig her up and hit her over the skull with her own shin-bone."



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