PITTSBURGH GEOLOGICAL SOCIETY

VIRTUAL MEETING

February 16, 2022

Virtual Meeting Times

Board Meeting	**6:00 PM**
Zoom Login	**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 the Pittsburgh Geological Society Galey Fund for Students when they request a certificate on the PGS website.

Online Meeting Guidelines

All attendees are encouraged to join the Zoom link for 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.

Chicxulub direct ejecta deposits (Cretaceous-Paleogene boundary) of Belize, Central America

David T King Jr.
Professor of Geology
Auburn University

Please RSVP by February 15 to receive the Zoom link.

Speaker Abstract

The Cretaceous-Paleogene (K-Pg) boundary unit in Belize is a stratigraphic unit that can be mapped at the surface and traced in well logs in the subsurface. This stratigraphic unit ranges in thickness from about 15 m to less than one meter. Thickness generally decreases in all directions away from the source crater, but there are anomalously thick zones in local fault-bounded grabens. At Albion Island in northern Belize, this informal stratigraphic unit has been named the Albion formation, but elsewhere there is no assigned name. The K-Pg boundary unit in Belize commonly lies atop the post-Barton Creek regional unconformity, and in places fills in low areas on that karstic surface. The typical sequence of lithologies within the K-Pg boundary unit is: a spherule-bearing fine clastic bed; boulder-bearing breccia beds; and a re-worked, pebbly ejecta unit. The basal fine clastic unit lies on eroded limestones of the Barton Creek formation at Albion Island, but lies atop a paleosol on Barton Creek at Armenia. Fine clastic matrix of this bed is a mixture of clay and clay-sized carbonate fragments. Spherules in the fine clastic unit range in size from a few mm to a few cm. The spherules typically have a lithic fragment at the nucleus and finely layered carbonate coatings surrounding the nucleus. The boulder-bearing breccia beds are impactoclastic deposits that contain a mixture of angular limestone blocks (including boulders up to 15 m in diameter) and finely pulverized carbonate matrix containing varying amounts of green glass shards (mainly altered to clay). The boulder-bearing breccia beds do not persist across all of northern Belize, and are apparently limited to areas within a few 10s of km of the Mexican border. The re-worked pebbly ejecta unit consists of matrix and grain-supported conglomeratic beds of rounded and in some places polished (pink to red) limestone pebbles and some grey to tan chert pebbles ranging in size from a few cm to a few dm. The striated polish on the surfaces of these limestone pebbles is quite distinctive and appears to have been formed by the abrasive activity of numerous fine particles. Some limestone pebbles exhibit apparent impact craters and pits. In rare instances, the small impacting particle remains in the impact pit. The chert is not so well polished, and commonly has a chalcedonic rim. The re-worked pebbly ejecta is interpreted to have fallen over wide areas in northern Belize and to have been subsequently washed into grabens or other low-lying areas, and there deposited with a fine clastic matrix. The upper surface of the K-Pg boundary unit in Belize is a disconformity in most places and the subsequent hiatus spans most of Paleogene.

Speaker Biography

David T. King, Jr. holds the rank of Professor of Geology at Auburn University and is an independent consulting geologist who is an LPG (licensed professional geologist) in the states of Alabama, Louisiana, and Texas. Dr. King has over 40 years of post-doctoral experience in the fields of sedimentology and stratigraphy. He has worked in the Jurassic hydrocarbon basins of southern Alabama and Mississippi and in Cretaceous basins in the U.S. Gulf Coast and in Belize and adjacent parts of México. In addition, he has a wide variety of academic and research interests in many aspects of geology and stratigraphy, including planetary and impact geology. He has studied Wetumpka, Flynn Creek, and Chesapeake Bay impact craters and the ejecta of Chicxulub in Alabama, Belize, and Italy. Dr. King has published over 100 scientific papers and over 250 scientific abstracts and has worked as a consultant to the publishing industry as an editor and writer. He has written extensively on geology and geological education for general audiences and regularly gives public lectures. Dr. King is the co-author of a widely used geology text, The Earth through Time, 11th ed. (2018). He regularly teaches introductory, advanced, and graduate courses in geology, and he has supervised over 40 graduate students in geology.

Please note that PGS is monitoring the COVID-19 situation closely and will continue to modify our mask policy based on the recommendation of national and local experts. The US Centers for Disease Control and Prevention (CDC) currently recommends the following:

- Those who are not vaccinated should wear a mask indoors in all public places.
- Those who have a condition or are taking medications that weaken their immune system should wear a mask indoors in all public places.
- If you are fully vaccinated, to maximize protection from the Delta and Omicron variants and to prevent possibly spreading it to others, you should wear a mask indoors in public places if in an area of substantial or high transmission. Allegheny County is classified as an area of high transmission.

To best align with the recommendations of the CDC, PGS strongly recommends that meeting attendees wear a mask and maintain social distancing to protect other meeting attendees and themselves. Masks may be removed when eating or drinking; however physical distancing is encouraged for those times. Please note that some members in attendance may qualify as immunocompromised, or may be caregivers for those who are, regardless of vaccination status.

UPCOMING PGS MONTHLY MEETINGS

Meeting Date	***Scheduled Speaker***	***Presentation Topic***
March 16, 2022	Jamie Farrell, Utah State University	Geology of Yellowstone
April 20, 2022	19th Annual Student Research Night	
May 11, 2022	TBA	Oil and Gas Industry Topic

The Pittsburgh Geological Society welcomes four new members:

River C. Howard
Student, Slippery Rock University

Daniel R. Kerschner
Geologist, KU Resources

Erica R. Perry
Recent Graduate, Slippery Rock University

Benjamin M. Suhrie
Recent Graduate, Ohio University

PRESIDENT'S STATEMENT

The January joint meeting was a great success thanks to the diligent work of the PGS, ASCE-GI, and AEG program coordinators, and despite the PGS president (me) nearly stealing the presenter's suit jacket by accident during social hour. Speaking of the January talk, Dr. Todd Halihan, professor of geology at Oklahoma State University, provided a fascinating lecture to our in-person attendees regarding his diverse experience in conducting electrical geophysical data as a means of studying hydrologic and contaminant issues. I had no idea that the electrical properties of microbial communities could affect resistivity surveys!

The January meeting also included a number of important announcements as we start 2022 strong. First of all, please note that the February meeting, featuring a talk by Dr. David King of Auburn University, will take place as a fully remote endeavor via Zoom. Registration will be free to PGS members and will include PDH availability. Non-members registering for the meeting will be asked to donate $10 to the PGS Galey Fund for Students if requesting a PDH. In addition, the February meeting will feature a prize drawing available to all PGS members and a separate prize drawing for all student members in attendance. You may register using the usual method via the PGS website, but please note the difference in payment.

As another pressing concern, Karen Rose Cercone is retiring from her current position as newsletter coordinator. PGS thanks her for her many years of service and is seeking her replacement as newsletter coordinator in addition to any PGS members willing to participate in a newsletter committee. Anyone interested should contact the board using the "Contact us" link of the website to express interest.

PGS is also working on a couple of field trip opportunities through collaboration with Jim Hamel. A spring landslide field trip has been tentatively scheduled for the weekend of either March 26 or April 2, 2022. Members who have reserved a spot for the previous cancelled landslide trip will be contacted soon regarding intent. In addition, a virtual landslide field trip (free for members) authored by Jim Hamel and constructed by Brett McClinton as lead of the virtual field trip task force has been finalized and is ready for distribution. Please use the "contact us" form on the website to request access. Note that a Google account or gmail account will be required to access the virtual landslide trip. As a final note to our student members, please be advised that applications for the Frank Benacquista scholarship will be accepted up to the deadline of May 3, 2022. See the "For students" section of the website for more information.

I'm looking forward to our February 16th meeting and hope that the increased accessibility will allow for more members to attend. Dr. King's main research interest involves the study of asteroid and comet impacts on Earth and will focus on the Chicxulub crater in the Yucatan Peninsula. I hope to see you all in Zoom soon!

Dan

LOCAL GEOLOGICAL EVENTS

GEOPHYSICAL SOCIETY OF PITTSBURGH (GSP)

February 8, 2022 **11:30 AM - 1:30 PM**

"Direct probabilistic inversion applications for reservoir characterization: case studies" by Dr. Raul Cova, Qeye

For more information: http://www.thegsp.org/

Cefalo's Banquet and Event Center, Carnegie, PA

OHIO GEOLOGICAL SOCIETY (OGS)

March 2, 2022 **10:00 AM - 4:00 PM**

"Playing the Knox Unconformity: Reconnaissance and High Grading Prospects in Knox County, Ohio by Integrating Geological, Petrophysical and 2D/3D Geophysical Interpretations" A one-day workshop led by Fred Poland and Hamid Ali Shahid, GVERSE – GeoGraphix

For more information: https://www.ohiogeosoc.org/events/geographix-workshop/

Hilton at Easton, 3900 Chagrin Dr, Columbus, OH

PENNSYLVANIA COUNCIL OF PROFESSIONAL GEOLOGISTS (PCPG)

February 16, 2022 **1:00 - 2:00 PM**

"Dust Suppression with Appalachian Basin Oil and Gas Produced Water: Efficacy and Water Quality" by Nathaniel Warner, PhD, Assistant Professor, Civil and Environmental Engineering Department, The Pennsylvania State University (Webinar: 60 minutes)

Details and registration: https://pcpg.org/event-4616235

March 29, 2022 **8:00 AM - 4:00 PM**

"Hydro-structural Methods in Bedrock Aquifer Characterization and Remedial Decision Making" (In-person Seminar, 405 minutes) by Thomas D. Gillespie P.G., Gilmore & Associates, Inc.

Details and registration: https://pcpg.org/event-4448953

Chester County Public Safety Training Campus, Coatesville, PA

April 19, 2022 **9:00 AM - 4:00 PM**

"Essentials of Borehole Geophysics with Field Demonstration" (In-person Workshop, 300 minutes) by Scott Wendling, P.G., Vice President, ARM Geophysics.

Details and registration: https://pcpg.org/event-4530196

3240 Schoolhouse Road, Middletown, PA

UPDATE ON THE PGS 2022 LANDSLIDE FIELD TRIP

PEOPLE WHO PAID FOR THE CANCELLED 2020 FIELD TRIP WILL BE RECEIVING AN EMAIL SOON TO DETERMINE IF THEY DESIRE TO GO ON THE MARCH 2022 FIELD TRIP. PLEASE BE AWARE THAT PARTS OF THE TRIP ARE OVER RUGGED TERRAIN AND REQUIRE CLIMBING POTENTIALLY SLIPPERY SLOPES. WATCH YOUR EMAIL FOR FURTHER DETAILS.

PGS VIRTUAL LANDSLIDE FIELD TRIP ANNOUNCEMENT

After months of work, PGS is ready to announce the soon-to-be released **Virtual Landslide Field Trip** and accompanying **Field Trip Guidebook**! Among others, this effort was fueled primarily by Dr. James Hamel, PGS Honorary Member and consulting geologist and engineer, and the Slippery Rock University team of Brett McClinton, Geography, Geology, and Environment Major, and Jeremiah Brown, Strategic Communications and Media. John Harper, PGS Honorary Member, edited the Guidebook.

This virtual experience examines the landslides along I-79 north of Pittsburgh between the Ohio River/Glenfield Borough area and the Mt. Nebo exit. Included are landslides on the nearby Western Pennsylvania Conservancy property along Toms Run Road and a discussion of the Kilbuck Township's infamous Walmart slide along PA Route 65.

Directions will be forthcoming on how to access the Virtual Field Trip and Guidebook. It is hoped the actual field trip will run in early spring 2022, possibly on March 26/27 or April 2/3. Keep an eye on the PGS web site and future newsletters to learn more.

PGS - AEG - ASCE STUDENT NIGHT IS APRIL 20

Students are invited to present college research projects at the **19th Annual PGS – AEG – ASCE Student Research Night on April 20, 2022**. If you have been conducting undergraduate or graduate research in any geological or geotechnical field, you can share your work in this virtual meeting with members of three regional professional scientific societies. All student presenters will receive official certificates of recognition. The three students chosen to give oral presentations will each receive awards of $100, while the three best poster presenters will each receive awards of $50.

The deadline for submitting abstracts for student research night will be March 16, 2022. Abstract submission forms and guidelines will be posted on the PGS website at: https://www.pittsburghgeologicalsociety.org/student-night.html.

PGS STUDENT FIELD WORKSHOP IS BACK!

Dates: April 8 & 9, 2022 (rain or shine)
Location: California University of Pennsylvania SAI Farm

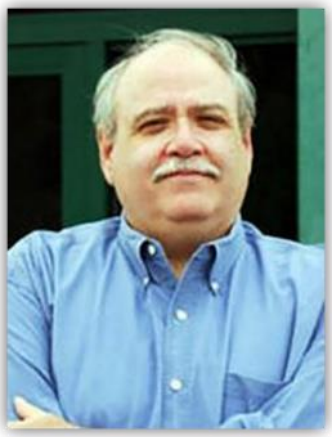
Friday Evening Program with Dinner

Networking and Preparing for a Geoscience Career – Advice from Working Professional Geologists. Held at the hotel where rooms will be reserved for those who want to stay near the field site/

Saturday Drilling and Sampling Field Workshop

You will experience soil sampling using a drill rig, basic sampling techniques, soil & rock descriptions, well installation basics, use of basic monitoring equipment and design of a drilling program. Light Breakfast and Lunch will be provided.

More information about how to reserve you spot will be provided in future newsletters. In the meantime, you can direct any questions to Kyle Fredrick at fredrick@calu.edu with "PGS Drilling Workshop" in the subject line.



The Frank Benacquista Undergraduate Scholarship

The PGS Frank Benacquista Undergraduate Scholarship is an award of $500 to an undergraduate-level earth science student. This scholarship, created in honor of a long-time PGS member and student advocate, is intended to assist a student with college education costs and to promote student participation in the Pittsburgh Geological Society. Any student who is majoring in the earth sciences, is at least a sophomore, and attending a four-year accredited college or university in the Pittsburgh region is eligible to apply. The applicant must be a student member of PGS or must have applied for student membership at the time the application for the Frank Benacquista scholarship is submitted.

Required Materials

The full application must include the following:

- One-page resume
- Cover letter introducing yourself and elaborating on key points of your resume with a focus on activities outside of the classroom such as research projects, academic club service, or community involvement
- One-page essay describing your background, decision to pursue earth science, career goals, and academic objectives beyond the bachelor's degree (if any)
- Copy of your transcript (unofficial) and documentation that you are a current student. The requisite standard to apply is a minimum of 12 semester credits of earth science courses. Successful applicants should have a strong academic record that can be achieved through course work, research or service
- Letter of recommendation from a professor or another professional in the earth science field that provides information on your performance and activities in the classroom, in the department, or at an affiliated or non-affiliated institution. The letter should address your work ethic and your character in how you work and assist others in the classroom or field.

Scholarship Application Process

The application may be sent in digital form (email with attachments) to the current PGS President at harris_d@calu.edu. Follow these instructions when sending as an email:

- In subject line of email message, please type "PGS Scholarship, Your Last Name"
- Include a professional message to the President stating that you are submitting your application for the PGS Frank Benacquista Undergraduate Scholarship
- Attach all documents required as Word or PDF documents. Please make sure that each document is titled with your last name. For example: Jones Resume.pdf, Jones Essay.pdf
- Your application packet may alternately be printed out and submitted by mail to: **Pittsburgh Geological Society, Attn: Scholarship Committee, P.O. Box 58172 Pittsburgh, PA 15209**

Application Deadline and Award Date

All applications must be received by **May 3, 2022**. The scholarship will be awarded at the first meeting of the Pittsburgh Geological Society in September, 2022.

Acceptable Fund Uses

Students may use the scholarship toward tuition fees, for field camp, to purchase equipment required for hands-on exploration as required by academic course work (e.g., rock hammers, hand lens), to attend geologic conferences, educational field trips, the PGS field trip, or the Field Conference of PA Geologists.

Basis of Awards

Awards will be based on the cover letter, recommendation letter, transcript, and the content and creativity of the essay as judged by the Scholarship Committee. The decision of the scholarship committee is final.

PGS NOW HAS ITS OWN ONLINE MERCHANDISE STORE!

PGS Secretary Diane Miller has arranged for our society to have an on-line store where we can purchase PGS-branded goods.

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

There are many styles of shirts, sweatshirt, polo shirts and hoodies available in your choice of size. You can also check out the hats, mugs, water bottles, bags, blankets, and car stickers, all with the PGS logo prominently displayed.

Best of all, the profits go to the Galey Fund, which helps offset the cost of meals for student members. So proudly wear, carry, or display your affiliation with the best geological society in western Pennsylvania and know that you are also helping to support student participation in our nine annual meetings.

THE ORIGIN OF WESTERN PENNSYLVANIA PLACE NAMES

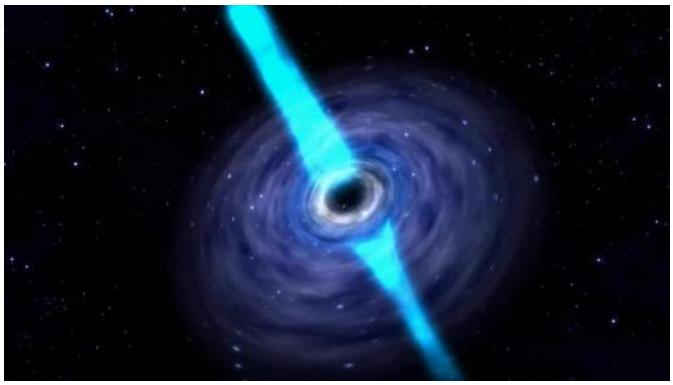
Dormont Borough, in the South Hills of Allegheny County, is situated on land once held by the Delaware and Shawnee tribes. In 1768, the territory was purchased from the Six Nations along with Fort Stanwix. After years of being claimed by Cumberland, Bedford, and Washington counties, it finally became part of St. Clair Township in Allegheny County in 1788. Dormont was incorporated as a borough on March 31, 1909, making it the first independent municipality in the South Hills.

The Borough of Dormont in the South Hills of Pittsburgh is famous for one of the largest municipal pools in Pennsylvania, the Dormont Pool.

The borough got its name from the French *d'or mont*, meaning "Mount of Gold." The name, suggested by Gilbert M. Brown, the first burgess of Dormont, refers to the beautiful hills on which the town was built, as well as the wonderful opportunities they offer. Construction of the Mt. Washington streetcar tunnel and the Liberty Tunnels brought rapid development and increased population, while the convenience of the borough's location and the many amenities offered its residents has kept it densely populated. Perhaps the most iconic amenity is its large swimming pool, one of the largest in Pennsylvania, but the borough also has two parks, basketball and tennis courts, a Little League field, a fine library, a children's playground, and seasonal activities for both children and adults.

DID YOU KNOW . . . ?

One of the many questions scientists are looking to answer about Earth, the Solar System, and the Universe is, "How are chemical elements produced, especially heavy elements like gold and uranium?" All heavy elements on Earth today were formed in astrophysical environments under extreme conditions, such as inside stars, stellar explosions, and during the collisions of neutron stars. Researchers have been trying to determine which of these events have the correct conditions suitable for forming the heaviest elements. The stunning 2017 observation of gravitational waves and electromagnetic radiation originating from a neutron star merger suggests that many heavy elements might be produced and released during these celestial collisions. It is a question of when and why the elements are ejected, and whether there might be other situations in which they can be produced, that still needs to be answered, however. Now, using elaborate computer simulations, a research team from



Neutron-rich material ejected from the accretion disk of a black hole enables the rapid neutron-capture process that is most likely responsible for the creation of heavy elements like gold and uranium. The light blue region is a particularly fast ejection of matter, which typically originates parallel to the disk's rotation axis.

Germany, Belgium, and Japan has shown that the creation of heavy elements is actually normal for certain black holes that have accretion disks of dense and hot matter several hundred miles in diameter. Systems like this are formed both after

the merger of two massive neutron stars and during the collapse and subsequent explosion of a rotating star, called a *collapsar*. To date, the internal compositions of such accretion disks has not been well understood, especially with respect to the conditions under which an excess of neutrons forms. A large number of neutrons facilitates the rapid neutron-capture process that is a basic requirement for the synthesis of heavy elements.

Neutrinos, which enable the conversion between protons and neutrons, play a key role in this process. During their study, the researchers investigated the conversion rates of neutrons and protons under many accretion disk configurations. As a result, they discovered that the disks will be very rich in neutrons as long as certain conditions are met, the most important of which is the total mass of the disk. The more massive the disk, the more often neutrons are formed from protons through capture of electrons under emission of neutrinos. The more neutrons formed the more often they are available for the synthesis of heavy elements by means of the r-process (the rapid neutron-capture process, a set of nuclear reactions responsible for the creation of approximately half of the atomic nuclei heavier than iron). If the mass of the disk is too high, however, the opposite reaction occurs and plays an increased role. Then the neutrons recapture more neutrinos before they can leave the disk. Those neutrons then convert back to protons, thereby hindering the r-process.

The researchers discovered that the optimal mass of an accretion disk necessary for prolific production of heavy elements was about 0.01 to 0.1 solar masses. This provides clear-cut evidence that neutron star mergers that create accretion disks with those masses could be the point of origin for a large portion of heavy elements. It is not clear at this time, however, whether or how often such accretion disks occur in collapsar systems. The researchers are also investigating the light signals generated by the ejected matter. These data will be used to infer the mass and composition of the ejected matter in future observations of colliding neutron stars.

Accurate knowledge of the masses and other properties of the newly formed elements is very important for correctly reading these light signals, however, but such data are currently insufficient. It will take a new generation of particle accelerators to be able to measure them with exceptional accuracy. Add to that the well-coordinated interactions of theoretical models, experiments, and astronomical observations, and researchers should be able to test neutron star mergers as the origin of the heavy elements.

https://scitechdaily.com/element-synthesis-in-the-universe-where-does-gold-come-from/

Scientists think they have discovered a geological "secret passage" beneath Panama that could explain why rocks from the mantle can be found more than 1,000 miles from where they originated. The speculated opening, which occurs about 62 miles below Earth's surface, has been postulated to allow mantle materials to flow from beneath the Galápagos Islands to beneath Panama. This newly discovered form of transport could also help explain why Panama has so few active volcanoes. On the west coast of Central America, the Cocos Plate is subducting beneath the North American, Caribbean, and Panama plates, creating a line of volcanoes called the Central American Volcanic Arc. Volcanism stops in western Panama, which sits on the Panama plate, creating a gap that has long been a mystery.

Researchers found a hole in the mantle in the Cocos Plate, which lies right off the coast of Panama, the country shown between the two white lines.

Now a team of researchers report that the culprit might be an opening in the Cocos Plate. Subduction of the Cocos Plate beneath North America causes large earthquakes, including

the 2017 magnitude-8.1 Chiapas quake that killed dozens of people. The researchers investigated the geochemistry of the region, collecting volcanic rock samples as well as gas and fluid samples from hot springs, looking at ratios of molecular isotopes. They were especially focused on He and Pb isotopes. The mantle is mostly made up of silicates, but the precise composition varies over even small distances. The researchers found some strange anomalies under Central America. They found that in western Panama, and behind the volcanic arc in Costa Rica, there were exotic geochemical signatures that closely resemble those in the Galápagos Islands.

Because there was no clear way to explain how mantle elements from the Galápagos could get all the way to Panama, the researchers used seismic imaging of the mantle and computer modeling to try to explain what might be happening. They found a hole deep beneath Panama, like a window through the Cocos Plate, that allows for an influx of this mantle component. This hole could be the result of a pre-existing natural fracture in the Cocos Plate, or it could be a place where the crust cracked during subduction. Regardless, it lets mantle materials flow through from one side of the plate to the other.

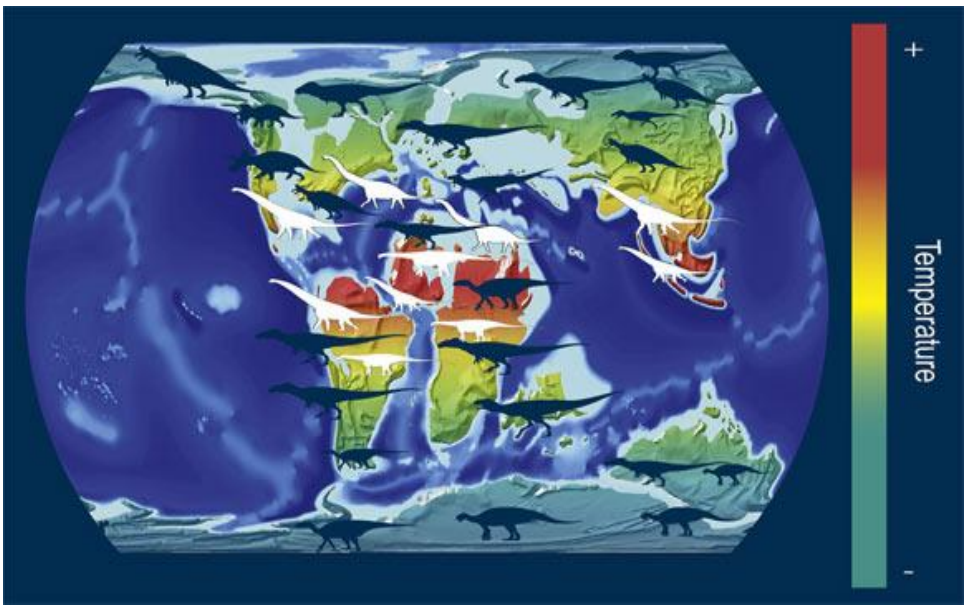
This discovery left open the question of what might be driving the flow. It might be that the materials are moving through the Panama Fracture Zone, a zone of cracking in the crust and upper mantle that connects the Galápagos to Panama, but it's difficult to see what would drive such long-distance transport through that zone, or even whether such transport is even possible. A more likely scenario is that the large-scale circulation of the mantle is the driving mechanism, circulating materials through the opening in the subducting slab.

The existence of the window also explains the lack of active volcanoes in Panama. Since water locked into the crust of subducting slabs lowers the melting point of rocks, leading to the formation of magma, it promotes the formation of volcanoes. The opening in the slab beneath Panama indicates that there is a gap in the water-rich crust in that spot. This, in turn, means it is harder to get magma flowing there. There are unexplained anomalies in the chemistry of the mantle all over the world, so the research team hopes to conduct a similar analysis in Chile and, ultimately, around the globe.

https://www.livescience.com/mantle-material-flow-panama-window

While it is well known that dinosaurs occupied terrestrial ecosystems across the planet during the Mesozoic, perhaps less well known is that the giant sauropods like *Diplodocus* and *Brachiosaurus* were restricted to lower latitudes. Only the ornithischians, like *Triceratops*, and theropods, like *Tyrannosaurus*, were capable of living in the polar regions of Earth as well as the temperate and tropical latitudes.

A new study that evaluated the role of climate in shaping these biogeographic patterns through the Jurassic and Cretaceous periods found that some parts of the planet always seemed to be too cold for sauropods, which probably avoided any temperatures approaching freezing. Other dinosaur types, in contrast, could thrive in Earth's polar regions, from central Antarctica to Alaska.



Generalized world map during the Mesozoic showing that sauropods (white) were more latitudinally restricted than theropods and ornithischians (black).

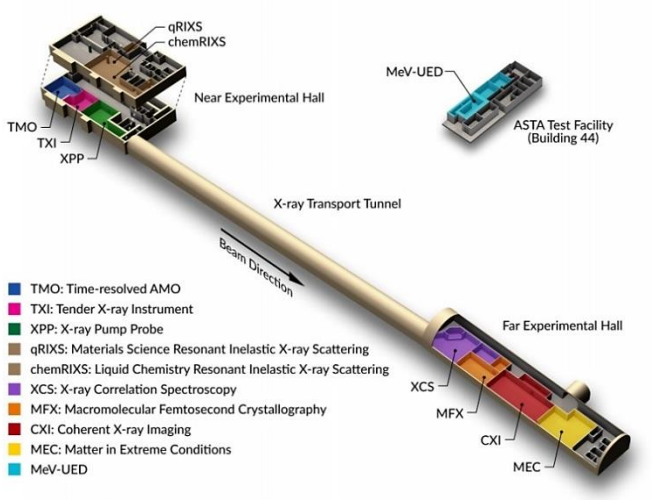
The study found the fossil record shows no occurrences of sauropods above 50º north latitude (most of Canada, northern Europe, and the British Isles) or below 65º south (Antarctica). In contrast, there are plenty of records of theropods and ornithischians living above 50º north starting around 145 ma ago. Due to a warmer climate, these areas were free of ice and had lush vegetation. This disparity suggests that sauropods had different thermal constraints than other dinosaurs. Since they were slightly closer to being cold-blooded, like modern-day reptiles, they must have relied more on their environment to heat their bodies. The researchers also suggest that their impressive size means that sauropod physiology may have been unique.

By combining data from the three basic dinosaur types with data about climate throughout the period of 201-66 ma ago, along with information on continental movement across the globe, they concluded that sauropods preferred open, semi-arid habitats, similar to today's savannahs, than other dinosaurs. It is possible that sauropods were either physiologically incapable of thriving in colder regions, or that they succeeded less well in these areas than other dinosaurs. A mix of features, including a larger surface area due to their long necks and tails, may have helped sauropods shed heat more easily than Recent mammals do. Plus, the sauropods possibly had much more efficient respiratory systems similar to those of birds.

Some theropods and ornithischians had feathers or downy fur that helped them retain body heat, but there is no evidence that any sauropods had of that kind of insulation. Strategies for keeping their eggs warm might also have differed among the dinosaurs. While Theropods probably warmed eggs by sitting on them, and ornithischians used heat generated by decaying plants, the sauropods could have buried their eggs, like Recent reptiles, relying on heat from the sun and the ground.

http://www.sci-news.com/paleontology/tropical-sauropod-dinosaurs-10380.html

At the Earth's core, under crushing pressures and scorching temperatures, the inner core consists of a solid ball of nickel and iron that super-rotates inside the fluid iron and nickel outer core. Now the conditions of the outer core have been recreated in a laboratory in such a way that scientists have been able to observe the structural deformation of iron. As a result, scientists can now understand not only our own planet, but also what happens when chunks of iron collide in space.



Schematic diagram of Stanford National Accelerator Laboratory's Linac Coherent Light Source X-ray free-electron laser used to detect structural changes in iron at pressures and temperatures such as occur in Earth's outer core.

The research team that accomplished this, from France and the US, didn't quite create inner core conditions. Under normal Earth conditions, the crystal structure of iron is a cubic lattice with atoms at the corner of each cube, and one at the center. When iron is compressed under extremely high pressures, this lattice changes shape, deforming into a hexagonal structure. This allows more atoms to be packed into the same volume of space. It had been very difficult to determine what happens at the enormous pressures and temperatures such as found at the Earth's core, however, until recently when laser technology advanced to the point where small samples can be subjected to extreme conditions in the lab, similar to the pressures and temperatures found in white dwarf stars.

The team deployed two lasers. The first was an optical laser that fired at a microscopic sample of iron to generate intense pressure and heat. While Earth's outer core has pressures that range between 135 and 330 Gigapascals (GPa) and temperatures between 4,000º and 5,000ºK, the laboratory sample was subjected to up to 187 GPa of pressure, and temperatures up to 4,070ºK. Then they had to measure the atomic structure of the iron during this process, a more challenging job. For that, the team used the second laser, Stanford National Accelerator Laboratory's Linac Coherent Light Source (LCLS) X-ray free-electron laser, that probed the sample as the optical laser fired. This enabled them to make a measurement in one billionth of a second, essentially freezing the atoms where they are in a nanosecond.

The resulting images, compiled into a sequence, revealed that iron responds to the additional stress induced by these conditions by twinning. For iron at outer core conditions, this means the atomic arrangement rotates by nearly 90 degrees, allowing the metal to withstand extreme conditions. Twinning allows the iron to become incredibly strong before it starts to flow plastically over much longer amounts of time. The information on how iron behaves under extreme conditions can be integrated into future models and simulations that will be important for how scientists understand things like space collisions.

There are mostly metallic asteroids that probably represent the exposed cores of planets disrupted during formation in the early solar system. When these objects collide with other objects, the structure of the iron therein may deform. Now, because of this new research, we have a better idea of how this happens. Scientists can decide whether to accept or reject some of the models that have been proposed for really fundamental deformation mechanisms and help encourage some of the predictive capability they have been lacking for modeling how materials respond at extreme conditions.

https://www.sciencealert.com/the-insane-pressures-and-temperature-of-earth-s-outer-core-have-been-recreated-in-a-lab

A swarm of more than 55 earthquakes recently shook the ocean floor off the coast of Oregon in early December 2021, but scientists say it had a low risk of threatening life or property on land. The U.S. Geological Survey said the quakes were mostly in the range of magnitude 4.0 to 5.5, with the largest measured at 5.8. The swarm occurred in the Blanco Fault Zone, an area that commonly is subjected to moderate-sized earthquakes. The fault zone's proximity to the Cascadia Subduction Zone (CSZ) has led to worries that earthquakes will add strain to faults in the subduction zone, which are capable of producing very large quakes along coastal Oregon and Washington. Seismologists, however, say that it is not a threat. The quake swarm was quite a distance from the CSZ.

Locations of the more than 55 earthquakes that occurred on the Blanco Fault Zone off the coast of Oregon in December 2021.

Currently, scientists' best understanding of how stress transfers through the crust and mantle suggests that such events don't noticeably change stress on the subduction zone. The Blanco Fault Zone is about 200 miles from the CSZ. Subduction of the Juan de Fuca plate beneath the North American plate at Cascadia has produced large, devastating earthquakes and dangerous tsunamis. The Blanco Fault Zone, however, is a transfer fault zone that occurs where the Juan de Fuca plate and the Pacific plate rub against each other, producing very little of the up-and-down motion that produces tsunamis.

The crust at the Blanco Fault Zone is also relatively young and warm, in comparison with the more brittle continental crust found at something like the San Andreas fault. Younger, warmer crust

breaks more easily in smaller seismic events, and the seismic waves don't travel as far as they do in older, colder crust. In addition, the Blanco Fault Zone is far enough offshore that even the seismic waves from its larger quakes don't reach land. And they occur quite often. In fact, during the last 20 years alone, 91 earthquakes of magnitude 5.0 or larger have occurred on the Blanco Fault Zone. These are all reasons why scientists aren't alarmed by the December earthquake swarm.

https://www.livescience.com/blanco-fault-zone-earthquake-swarm-oregon

Flowering plants such as grains, fruits, and vegetables include most of the plants that provide humans with food and drink. In addition, they are instrumental in many of our familiar landscapes such as wetlands, meadows, and forests. Now, an international team of researchers has identified the great impact flowering plants have had on the evolution of life on Earth.

Between 100 and 50 ma ago, flowering plants dramatically enhanced Earth's biodiversity and even rebuilt entire ecosystems. Flowering plants were already in existence for some time prior to 100 ma ago, but they only began to appear more commonly during the Cretaceous, in the last 70 ma of the Age of Dinosaurs. Dinosaurs, however, apparently didn't eat them. Instead, they continued eating ferns and conifers such as pines.

It was only after the dinosaurs went extinct that angiosperms really diversified. The Angiosperm Terrestrial Revolution, as paleontologists call it, marked a colossal change in ecosystems and biodiversity on land. More than a million species of Recent insects, including pollinators such as bees and wasps, leaf-eaters such as beetles, locusts and bugs, and those feeding on nectar such as butterflies, owe their livelihoods to angiosperms. These insects in turn are food for spiders, lizards, birds, and mammals. Once the dinosaur disappeared, the great tropical rainforests began to flourish, and angiosperms began to dominate life on land. Today, two-thirds of all plant and animal species live in rainforests.

A typical angiosperm-dominated rainforest might contain hundreds of species of flowering plants, as well as hundreds of species of other plants like ferns and mosses, and thousands of species of fungi, insects, spiders, amphibians, reptiles, birds and mammals. Conifer forests contain fewer species of other plants and animals, and they probably were never as species-rich. Angiosperms owe their great success to more

Reconstruction of *Archaefructus sinensis*, an early angiosperm plant.

than the demise of the dinosaurs, however. The angiosperm flower was a remarkable evolutionary innovation; their special colors and other adaptations make sure specific insects pollinate them successfully. Angiosperms also drive the evolution of the insects and other animals that pollinate them, and they build complex forest structures that provide homes to thousands of species. They also capture much more of the Sun's energy than conifers and their relatives, and pass the extra energy through the entire ecosystem.

https://phys.org/news/2021-11-impact-evolution-life-earth.html

WEBSITE OF THE MONTH

https://www.space.com/54-earth-history-composition-and-atmosphere.html

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Fun Fact Having Nothing to Do with Geology

Shellac, the goo used as a wood finish and food glaze on jelly-beans, comes from the secretions of a female lac bug, found on trees in India and Thailand.

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