PITTSBURGH GEOLOGICAL SOCIETY

Annual Joint Meeting with the Pittsburgh Chapters of AEG and ASCE Geo-Institute

Drones: Providing New Perspectives For Geologic Research And Investigations

Martin F. Helmke PhD PG

West Chester University of Pennsylvania and PCPG President-Elect

January 16, 2019

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 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

NEW DEADLINE for reservations: Wednesday, January 9.

Speaker Abstract

Unoccupied Aerial Systems (UAS, or drones) have rapidly become popular and powerful research tools for geologists. In addition to providing an aerial view of a project site, drone imagery and 3-dimensional photogrammetry can be used to document site environmental conditions, evaluate structural geology, conduct fracture trace analysis, monitor sinkholes and subsidence, evaluate coal mine fires, record mass movement, delineate wetlands, and document paleontological specimens among other applications.

Drones equipped with scientific instruments such as telephoto lenses, thermal cameras, multispectral imagers, geophysical devices, and chemical sensors are capable of recording precise scientific measurements in locations inaccessible by traditional methods. The objective of this presentation is to review geologic case studies across the US that have benefitted from drone technology and help geologists become more familiar with drone capabilities, legal limitations, best practices, and business models before taking to the sky.

Speaker Biography

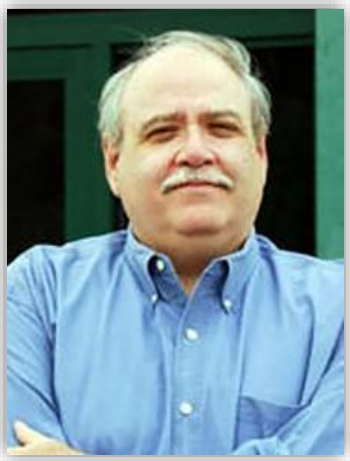
Dr. Martin Helmke is Full Professor of Hydrogeology in the Department of Earth and Space Sciences at West Chester University of Pennsylvania, President Elect of the Pennsylvania Council of Professional Geologists, and President of Helmke Hydrogeologic, LLC. Dr. Helmke holds a PhD in Geology and Water Resources from Iowa State University and has 21 years experience applying fixed-wing and multi-rotor UAVs for geologic research. He is an FAA-licensed drone pilot dedicated to promoting the use of drones for geologic and environmental investigations.

New Meeting Location

Beginning in January 2019, the Pittsburgh Geological Society will be moving its monthly meetings to **Cefalo's Banquet and Event Center** in Carnegie PA. This change means that dinner reservations must now be made by **Wednesday of the week prior to the meeting**.

Directions: Take Parkway West to Exit 65 for Carnegie. If exiting from westbound lanes, use the left exit ramp to Lydia Street. Cefalo's Banquet Center will be facing you when Lydia Street ends at Washington Avenue. Overflow parking is across the street from the site.

Upcoming PGS Meeting



This Issue is Dedicated in Memory of PGS Honorary Member, Past President, and Tireless Volunteer

Frank Benacquista

(1958 – 2018)

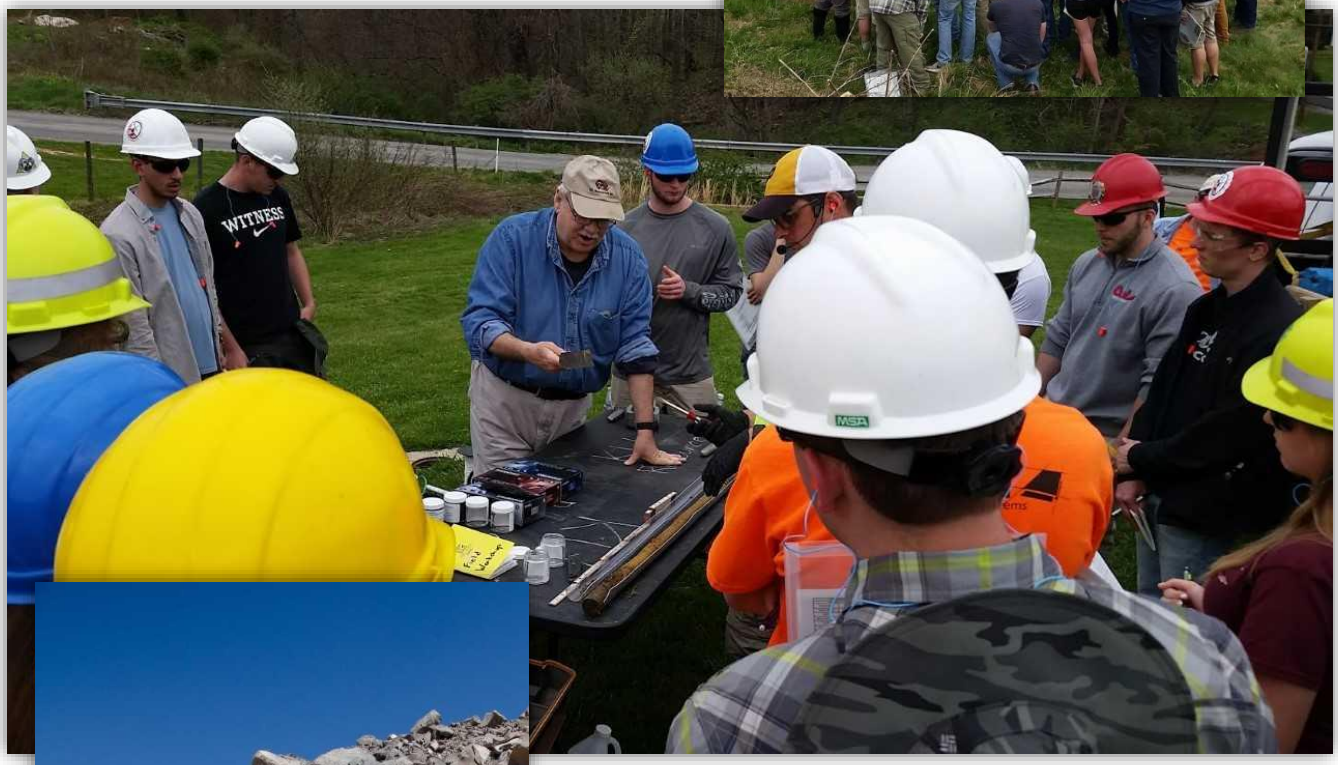
The Pittsburgh Geological Society lost one of its staunchest supporters when Honorary Member Frank Benacquista passed away unexpectedly at the age of 60 on December 3, 2018. Most society members knew Frank as the constant presence at the back of Foster's dining room, dispensing our pre-meeting drinks and snacks with good cheer, and handing out the post-meeting PDH certificates with a smile and a friendly greeting.

Frank was a Pittsburgh native, graduating from Mount Lebanon High School in 1976. He earned his BS degree in engineering geology from the University of Pittsburgh in 1981 while also working as a geologist technician for the US Bureau of Mines and for Doran & Associates. After graduating, Frank spent a year working for Appalachian Geophysical Surveys. He returned to Pitt for master's degree studies from 1982 to 1986, then took a position as a geotechnical and material science geologist for a local engineering firm, Ackenheil & Associates. In 1989, Frank was hired by Earth Sciences Consultants in Export PA where he worked for 15 years, eventually becoming a project manager in charge of environmental investigations.

In 2004, Frank joined KU Resources, Inc. where he continued to work as a project manager in charge of EPA Phase 1 and Phase 2 site investigations, geotechnical investigations, and asbestos and lead-based paint surveys. He was promoted to Chief Geologist at KU Resources in 2016, a professional distinction that was mentioned in the Pittsburgh Business Times. His work involved maintaining technical standards for the firm's geological investigations and ensuring the accuracy of reports.

Frank joined the Pittsburgh Geological Society in 1994 and served in many capacities over the years, including as President in 2005-2006.

He was instrumental in developing, organizing, and helping to run the PGS Student Drilling Workshops. He never tired of giving students the kinds of hands-on training that he knew would help them in their own careers. Frank would patiently explain all parts of the drilling and site investigation process to students at the workshops, showing them how to use field equipment correctly to take rock and water samples.



Frank Benacquista exemplified the kind of professionalism and dedication to the science of geology that the Pittsburgh Geological Society was founded to promote. He contributed generously of his time and energy to ensure the success of many society initiatives, from field trips to scholarships to student outreach. He enjoyed the company of his fellow geologists, but he was always happiest when he knew he was making a contribution to the science he loved and spent his life involved in.

Frank will be deeply missed by the members of the Pittsburgh Geological Society and by the entire geological community of western Pennsylvania.

PRESIDENT'S STATEMENT

Happy New Year!

As another year begins, PGS will have many changes, beginning with the new meeting venue. Starting this month the meetings will be held at Cefalo's Banquet & Event Center. This will mean a new menu, a cash bar, and limited snacks.

We will also start the New Year with a newly-adopted code of conduct (look for it on the PGS website soon) and the initiation in fall 2019 of a PGS academic scholarship. The academic scholarship will be named after Frank Benacquista to honor his long service and outstanding dedication to PGS.

This month's newsletter also honors Frank and his commitment to the student members, the geology profession and to PGS. Frank was an honorary member of PGS and the winner of the 2009 Walt Skinner Award. He spent many hours making sure that the snack plates were filled and that drinks were supplied at each meeting. I remember meeting Frank at my first PGS meeting in the fall of 2002. He greeted me with a smile and a handshake, and proceeded to introduce me to others around him. After that first initial introduction, I felt comfortable as a new member walking into the meetings knowing that a friendly face was there to greet me.

As years passed, Frank and I would chat about the interesting projects he was working on and how I could incorporate geologic issues into the classroom. His knowledge of the industrial history of Pittsburgh was remarkable and I loved listening to his stories. Most of the time I had no idea where the sites were that he was talking about, but it didn't really matter and I always walked away knowing just a little bit more about the geology of Pittsburgh.

Frank's commitment to educating others on the geology of Pittsburgh extended well beyond the monthly meetings. He committed much of his time to planning and organizing the student drilling workshop, providing the field resources and teaching the students about geology and field techniques. We will continue offering the student drilling workshop using the same organizational scheme he worked so hard to master. He had dedicated his time to PGS and for this we are truly grateful. His presence at the workshop and at each meeting will be sorely missed. Please feel free to share stories or any photograph of Frank in the coming newsletters.

I would also like to take a moment to thank the following corporate sponsors that have committed to fund PGS this year. We are grateful for your generosity and support. These include: ACA Engineering, Inc., American Geosciences, Inc., American Geotechnical and Environmental Services, Inc., Ammonite Resources, AWK Engineering, Barner Consulting, LLC, Battelle, Billman Geologic Consultants, Inc., Enviro-Equipment Inc., Falcede Energy Consulting, LLC, Geo Environmental Drilling Company, LLC, Groundwater and Environmental Services, Inc., HDR Engineering, Inc., Howard Concrete Pumping Co., Huntley and Huntley, Inc., Key Environmental, Inc., Moody and Associates, Inc., Pennsylvania Drilling Co., Range Resources, Appalachia, LLC, and THG Geophysics. To our corporate sponsors, please take a moment to review the information on our website and let us know if we need to change or update any information.

In closing, I would like to wish everyone a happy and healthy New Year. May this year be filled with success, happiness, prosperity, and good health.

See you at the meeting!

Tamra

LOCAL GEOLOGICAL EVENTS

SOCIETY OF PETROLEUM ENGINEERS

January 8, 2019 (lunch meeting)
"Drilling Extended Laterals in the Marcellus Shale" by Josh Doak, Director of Drilling, Range Resources.

Cefalo's Banquet & Event Center, Carnegie PA

GEOPHYSICAL SOCIETY OF PITTSBURGH

January 9, 2019 (lunch meeting)
"Depth Imaging in the Appalachian Basin, Challenges and Approaches for Utica and Marcellus PSDM : a Roundtable Discussion"

Cefalo's Banquet & Event Center, Carnegie PA

AMERICAN CHEMICAL SOCIETY-ENERGY TECHNOLOGY GROUP

Thursday, January 17, 2019

"Shale Gas Extraction & Public Health" by Heather Harr of the League of Women Voters of Pennsylvania

Lombardozzi's Restaurant, Pittsburgh PA

The Pittsburgh Geological Society welcomes the following new society members:

Emily R. Stahl, Student,
University of Pittsburgh

Rachel A. Miller
Geotechnical Designer
Navarro & Wright Consulting Engineers

THE PITTSBURGH GEOLOGICAL SOCIETY ENDOWMENT FUND

Established May 8th, 2014 through the

COMMUNITY FOUNDATION
Serving the Heart of Western Pennsylvania

Contributions can be made through bequests, memorials, and gifts to the ***Pittsburgh Geological Society / Endowment Fund*** or directly to the Community Foundation Serving the Heart of Western Pennsylvania at 220 South Jefferson Street, Suite B, Kittanning, PA 16201. For more information please contact Ray Follador, PGS Finance Committee Chair at (724) 744-0399.

PGS Member Spotlight: Jacob Podrasky, 2018-2019 Student Board Delegate

Geological Education
California University of Pennsylvania, Geology Major, expected graduation: May 2019

How long have you been a member of PGS?
3.5 years (since my freshman year at CalU)

Any interesting internships or projects?
Interned with Department of Conservation and Natural Resources in both the PA Geological Survey and Bureau of State Parks

What is your favorite subject/area of study?
Geomorphology, Sedimentology & Stratigraphy

What are your plans following graduation?
Go to work? Grad School? Not really sure. Until the time comes I plan to do what I can do to best prepare myself for any opportunity that life may put in my way.

What would you do if money wasn't an issue?
Probably travel to as many places as I possibly could to see as many cool rocks as I possibly could. Or buy a concerning amount of dogs. Or both!

What is your favorite PA geology site?
Balanced Rock at Trough Creek State Park

What is the most geologically exciting place you have visited so far?
Great Sand Dunes National Park and Preserve in southern Colorado

What is your favorite or least favorite "Bad" geology movie or book and why?
The Monolith Monsters. The graphics and special effects were ahead of its time. The acting was top notch. The geologic accuracy was absolutely textbook. The film is a true cinematic masterpiece. Definitely a must see.

What is your favorite rock, mineral, or fossil? Labradorite

What is one of your favorite quotes (geology related or not)? "The Data is in the Strata"

If you could meet any geologist, living or dead, who would you meet?
Dr. Kyle Fredrick, so my life has already peaked.

UPCOMING EVENTS OF INTEREST TO STUDENT MEMBERS OF PGS

This announcement is provided as a courtesy to the Pennsylvania Council of Professional Geologists, who generously underwrite the PGS – AEG - ASCE Student Night. For more information about PCPG 2019 poster session and competition, please check their link at:

https://pcpg.wildapricot.org/2019PosterSessionCompetition

PGPG 2019 Student Poster Session and Competition

Deadline for abstracts: January 25, 2019. See below.

The Pennsylvania Council of Professional Geologists (PCPG) is announcing our 2019 Undergraduate Student Research Poster Session and Competition.

Students pursuing undergraduate degrees in the geosciences at colleges and universities located within Pennsylvania, and contiguous states, are eligible. The poster session will be held during PCPG's Annual Meeting on March 6, 2019, at the Holiday Inn Harrisburg Hershey in Grantville, PA. PCPG hosts this event as part of the organization's efforts to more fully engage with geoscience students studying at universities and colleges. Presenting a poster at the event is a tremendous opportunity to directly interact with individuals and companies that provide geoscience services throughout Pennsylvania. Our members include consultants, oil and gas geoscientists, university professors, and others.

The posters must be illustrative of research performed and presented by the entrant with oversight by their advisor. The poster topic shall generally fall within the disciplines of the geosciences (geology, geochemistry, geophysics, etc.). PCPG anticipates entrants will submit abstracts covering a wide range of topics.

Enter the competition by submitting an abstract via Email to PCPG by January 25, 2019. Ten students will be selected from the abstracts to present posters at PCPG's Annual Meeting. Each successful entrant shall be awarded a $500 check from PCPG the day of the Annual Meeting, which is in recognition of being selected for the Session and can be used for lodging, travel and reproduction services. In addition, a $1,000 prize for "Best Poster" will be awarded at the end of the Annual Meeting.

Guidelines for entering PCPG's 2019 Undergraduate Research Poster Session and Competition are, as follow:

- Correctly following these guidelines is a criteria for being selected to present your poster at PCPG's Annual Meeting.
- Abstracts must be 300 words or less.
- Abstracts must be signed and dated by the student ***and their advisor.***
- Abstracts must be submitted via Email to PCPG by midnight January 25, 2019. Your last name must appear in subject line, followed by the phrase *Poster Submission* so it appears as (for example), Smith Poster Submission.
- Ten students will be selected to present their posters at PCPG's Annual Meeting on March 6, 2019 to be held at the Holiday Inn Harrisburg Hershey, 604 Station Road, Grantville, PA 17028.
- Posters should be on heavy stock paper or foam board, in landscape orientation, 4 feet by 8 feet in size. Mounting frames will be provided for presenting posters at the venue.
- Students will have their posters set up and ready for presentation by 10:00 AM the day of the competition. Presentation will continue throughout the day and end at 3:00 PM.
- The posters will be judged by a panel of six Professional Geologists (PGs) who are members of PCPG.

THE ORIGIN OF WESTERN PENNSYLVANIA PLACE NAMES

The citizens of California, PA, which occurs on an entrenched meander of the Monongahela River in Washington County, debated about what to call their town when it was founded in 1849. Some suggested Columbia and others Sagamore. They eventually named it for the territory of California because it was founded in the same year as the great California Gold Rush, with the hope that it would bring them growth and prosperity. The town was incorporated as a borough in 1853, and 100 years later, the borough merged with and consumed the adjacent East Pike Run Township.

Aerial view of California Borough on an entrenched meander of the Monongahela between Washington (left bank) and Fayette (right bank) counties. The location of California University of Pennsylvania is shown on the map by the blue teardrop.

California PA is home to California University of Pennsylvania (CalU), founded originally as an academy for kindergarten through college-level education. It became a normal school in 1865 and, as a result of many changes over the years, it became California State Teachers College in 1928, California State College in 1959, and CalU in 1983. California has the distinction of being: the home of the Vesta #4 Coal Mine, ranked as the largest bituminous coal mine in the world when it opened in 1893; home to the former Vigilant Mine, which produced the world's largest single lump of coal; and the birthplace of Viola Liuzzo, the civil rights activist murdered by the Ku Klux Klan in Selma, Alabama, during "Bloody Sunday" on March 7, 1965.

DID YOU KNOW . . . ?

There is roiling mass of carbon dioxide and slurry-like soil called a mud pot migrating across California at something like 20 feet/year. Scientists so far haven't been able to determine why it is moving or if it can be stopped.

It appeared in the Salton Trough, an area of California being stretched by tectonic forces between the San Andreas Fault and the East Pacific Rise. This is where the Colorado River dumps much of its sediment load, including geologically historical sediment in deeper layers that get heated up and compacted. This has been creating metamorphic rock and expelling CO2, which has been escaping to surface through pre-existing fractures and creating mud pots within the

Mud Pots near Calipatria, California.

overlying sediment and mud volcanoes at the surface.

Although mud pots and volcanoes are common, they normally are stationary. When they begin to move, however, geologists sit up and take notice, like when this mud pot began to move sometime between 2015 and 2016. It is currently moving toward Union Pacific Railroad near Niland. A well drilled to depressurize the source of the gas had no effect, and steel plates driven 80 feet into the ground to stop it were circumvented; the mud pot simply ducked under them and continued its linear path of destruction. Mud pots and mud volcanoes generally don't emit much water, but this one is producing about 40,000 gallons of water a day, leading some investigator to call it a spring.

So, why is it moving? No one knows. It isn't accelerating and contrary to some reports, there is no link between seismic changes in the area, nor to volcanic activity, and the mud pot's movements. The water smells like rotten eggs, a sure sign that hydrogen sulfide is being emitted, possibly due to bacterial activity. The basin is kept filled by agricultural runoff water, and fertilizers can cause algae populations in the lake to soar. When the algae die, bacteria feast upon them, excreting plenty of hydrogen sulfide.

The mud spring is close to the Wister Fault, a southeastern extension of the San Andreas. However, it appears to be tracing a path that's at right angles to the region's major faults. It may be following another fault crossing through the area, but it's unclear why the mud pot hasn't turned into a fissure-like opening, so that the escaping gas could take advantage of one long crack in the ground.

Neither the USGS nor the California Geological Survey is actively studying the phenomenon, so the muddy mystery probably will persist for some time. This could be a problem because the mud pot's path threatens to undercut existing railroad tracks, so Union Pacific is using a track detour as a contingency plan.

https://www.nationalgeographic.com/science/2018/11/bubbling-pool-mud-moving-california-dont-know-why-geology/

The Earth is an incredibly dynamic planet. Water and ice weather and erode rock, then build more through sedimentation. The mantle churns and spews lava through volcanos. The continental plates push together, then tear apart and move on. But geological and meteorological processes act so slowly that it's easy to think our planet will always look the way it does now. Plates typically move just a few centimeters per year. We don't think about tectonics creating new plates, new continents.

Yet the East African Rift, an active rift valley in southwestern Kenya, is visibly breaking apart the landscape, severing a major highway, and giving us the chance to see a continent split apart. In about 10 million years the east African plate of Somali will be isolated by ocean, and in 50 million years Africa's bulk will have pushed into Europe. Current predictions see all of the continents squashed together again in a mere 250 million years. This cycle of break-ups and reformations also affects how the sun and moon influence the oceans.

The East African Rift Valley runs 3,700 miles from northern Jordan Rift Valley in Asia to Mozambique in South Eastern Africa. It is located at a tectonic plate boundary that started to separate about 35 million years ago.

Monthly tides like those we're used to seeing can only occur when there are sizeable basins of water. There are computer models that suggest tides might have been a lot weaker at times over the 250 million years, and it has only been for the past two million years (since the beginning of the Pleistocene) that "supertides" have been able to wash over the globe. So, as the continents continue to shift, the current ocean basins might change shape enough over the next hundred million years or so to interfere with tidal activities again.

Similarly, but in a far smaller time frame, movements in the distribution of our planet's water can affect how continents move. For example, Australia is shaking back and forth on a scale of millimeters as it move north. Although such a small wobble seems trivial, it could make a huge difference by disrupting GPS estimates by a significant amount. Thus, in a world where we're increasingly reliant on mapping technology, such a tiny change to the face of Earth could be a serious issue for us.

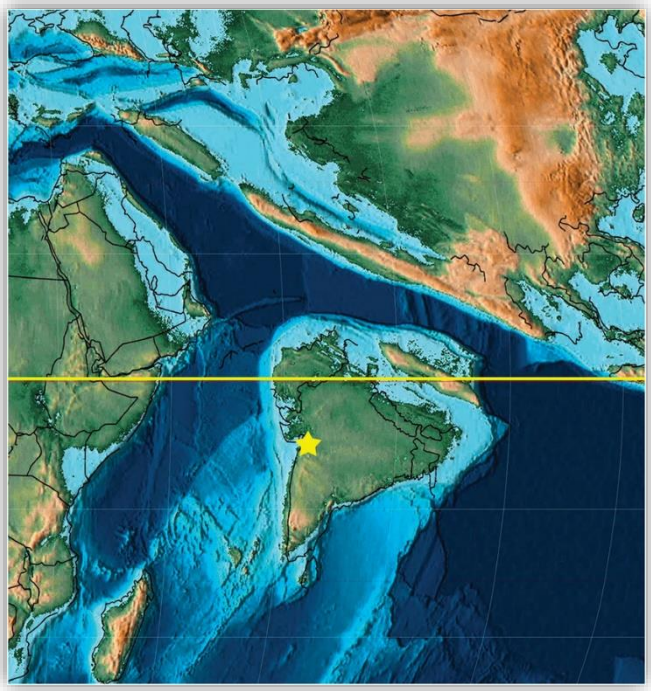
And, we're only just beginning to comprehend how rising sea levels can affect the crust, bending it out of shape on a far larger scale. Scars left by grinding ice during the last great ice age are clear across much of the globe, and as glaciers continue to melt we'll no doubt be left with a similarly marked landscape. Moraine accumulating at the edges of glaciers can weaken ice shelves, which could cause additional sea level rise as Antarctica's ice cap slowly degrades. It has been little more than a century since we started to fully appreciate how dynamic Earth is. And we still have a lot to discover, especially if we are to survive as a species.

https://www.sciencealert.com/recent-geological-discoveries-changing-face-of-planet-earth/amp

Some countries, such as the United States, the United Kingdom, and Australia, have worked hard and succeeded at preserving their valuable geological sites. Geological conservation, however, struggles to make its case in every country in the world, particularly in developing countries where losses of important sites probably occur almost every day.

In India, for example, laws to protect important geological and paleontological sites are rarely enforced and so weak as to be nearly nonexistent. One such site, Vastan in a corner of western India, is home to open-pit lignite mines. Three years ago, an immense excavation at Vastan that was three miles wide and 328 feet deep and streaked with fossils was closed.
As the population of South Asia grows and as more rural areas and hinterlands are converted into urban spaces, areas of great scientific interest are being essentially abandoned. Still, many geologists and paleontologists travel to Vastan every year to sift through thin layers of sediment with ice picks and brushes trying to piece together fragments of some of the most archaic mammalian forms ever to walk the Earth in order to unravel the evolution of modern mammals.

The lignite, and the fossils, date to the early Eocene, about 54.5 ma. At that time, Earth was 53.6°F hotter than it is today, gripped in the most intense global warming event the planet has known. India was a tropical island that had recently broken free of Madagascar and was headed toward an epic collision with Laurasia that would compress the ancient Tethys Sea and thrust up the Himalayan Mountains.



The location of the Vastan Mine is shown by the yellow star on this paleogeographic map.

Vastan was a swamp on the edge of the island, next to a tropical rainforest teeming with rabbits, bats, snakes, lizards, frogs, birds, ancient relatives of horses and tapirs, and an extinct order of mammals called tillodonts that resembled saber-tooth bears. Many of these creatures are archaic forms, the oldest of their kinds found in Asia. They provide a tantalizing set of clues to a long-standing evolutionary puzzle – where did the world's modern mammals come from, how did they evolve, how did they spread, how and when did they arrive on India, how did they get off, and how much did they evolve there?

The Vastan area is uniquely positioned to answer these questions. Paleontologists had long been hunting for the lineages of modern mammals, such as cattle and camels, horses and tapirs. Finds at Vastan suggest the lineages stretch back to India from where the mammals may have immigrated. Some roots of life might well be traced back to Vastan.

For example, one group of paleontologists identified a small-hoofed creature as the descendant of the original ancestor of modern horses and tapirs. The creature's anatomy, they found, combined the traits of two wildly disparate groups. Its fused jaw resembled that of the first horses and rhinos, but its teeth and limb anatomy placed it further back in time, helping the paleontologists fill a missing gap in the record of archaic hoofed animals. The creature's presence in Vastan just before India made contact with Eurasia suggests that the ancestors of horses and rhinos quite likely originated in India.

Paleontologists sift through sediment at the Vastan coal mine in India, which has yielded a fossil trove that help explain mammal evolution.

Paleontologists from around the world agree the findings from the Vastan mines are abundant, surprising, and important. Understanding how one of the world's largest and most populous countries can neglect its rare and important fossil record requires the combined perspectives of scientists, archaeologists, and government officials. Together they answer the question: Was there ever any chance of keeping the excavators at bay?

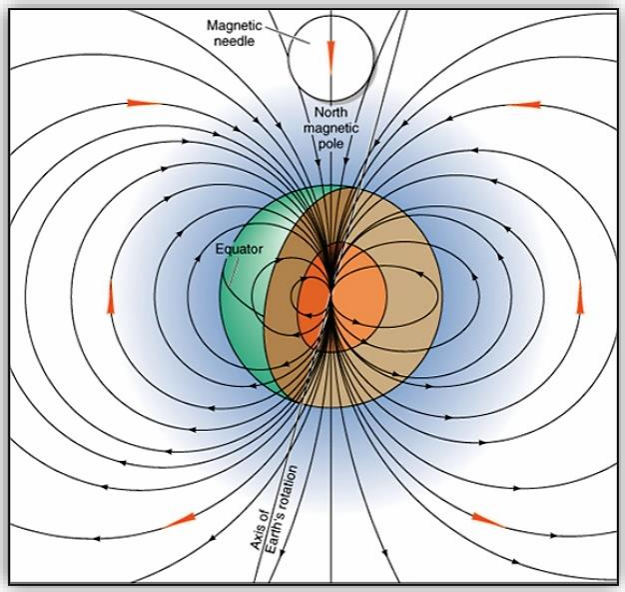
But, there are many factors that have combined to making the unimaginable inevitable in India. Everything remotely mineral belongs to the Ministry of Mines, which caters to extractive interests, and monuments and protected sites can only be "declared," not maintained. Many are in very bad shape because there are no laws to be able to prosecute or take action against builders or offenders, so all that can be done is put up a sign saying "This is a unique feature of importance." Such bureaucratic "niceties" are cast aside when they come up against anything in the "national interest." (Sound familiar?) India's lack of concern for fossils can also be seen in its ineffective crackdown on thieves and smugglers who ransack excavated to sell, trade, and even worship fossils. The end result is that India lags far behind other countries in paleontological and geological preservation, and there's no indication that this will change anytime soon.

http://nautil.us/issue/66/clockwork/paving-over-the-fossil-record-rp

A new study suggests that Earth at one time could have had a different kind of magnetic field, one generated by magma on the surface rather than by rotation of the core. According to the research, long before Earth had a skin of tectonic plates, its molten insides flowed on its outside and its core had not yet hardened. Despite this, a magnetic field had already started to form. An analysis of the electrochemistry of moving magma has found sufficiently sized oceans of liquid rock can generate their own magnetic fields.

Scientists from the University of California Berkeley simulated the surface conditions of young "super-Earths," large rocky planets with subsurface pressures and temperatures guaranteed to keep them in a molten state. They found the make-up of the molten surface could give rise to a large enough electrical conductivity to form a planetary dynamo, and all it would take was a flow of magma just 1 millimeter per second to manage it. These were the first detailed calculations for higher temperature and pressure conditions, resulting in conductivities appearing to be a bit higher so that the fluid motions needed to make this all work are less extreme.

Earth has a powerful dynamo in the form of a rotating core of liquid iron and nickel swirling within a “shell” of lighter minerals and charged particles. Our magnetic field is necessary to protect our atmosphere from being blown away by stellar winds. We need that atmosphere to keep the surface temperature constant, and it shields the biosphere from lethal doses of radiation, thus allowing for life-sustaining chemical reactions. Magnetic fields also deflect high-energy particles from bombarding the planet. It is, therefore, a safe bet that no magnetic field equals no life.



Earth’s magnetic field is currently generated by currents in its outer core.

If the new study is correct, it is likely that more exoplanets than we thought might have a magnetic field protecting their surfaces from radiation, thereby having the potential of hosting life. Knowing which planets outside of the Solar System can generate magnetic fields should help us sort out which are likely to be sterile versus which might be worth studying for biology.

In addition, by categorizing the different ways planets create magnetic fields, we can determine the best way to study the geology of a planet without actually setting a vehicle on its surface. For example, Jupiter’s magnetic field arises from the convection of liquid metallic hydrogen, whereas Uranus and Neptune are assumed to have a magnetic field generated in the ice layers.

How a surface dynamo might interact with core processes is still unknown, considering we know so little about our planet's interior. Interactions between a liquid core magnetic field and a magma ocean are not easy to predict, but could result in a significant dipolar component. Ideally, to form a protective bubble, a magnetic field should have a neat dipole shape, as opposed to a mess of loops.

Most of the really large rocky planets tend to be pulled close to their stars where solar eruptions and constant heat would destroy the chance of atmosphere existing. A sufficient dipole magnetic field would give some of them a chance of retaining an atmosphere while shielding the surface from extreme solar activity. Unfortunately, such close proximity to a star also increases the chances such a world would be tidally locked, making its day and year more or less the same length. The researchers’ analysis suggests a dipole field would require a relatively rapid rotation, thus ruling out slower-spinning worlds. The number of known exoplanets, including a number of Earth-like worlds, has been growing and is now in the thousands, so we're going to need better methods of studying them. Searching for hints of magnetic fields could help us prioritize our search for life among the stars.

https://www.sciencealert.com/these-molten-worlds-suggest-earth-once-had-a-different-kind-of-magnetic-field/amp

On November 11, 2018, just before 9:30 am, seismic waves rolled around the world, creating a sort of rumbling. The waves began about 15 miles offshore of Mayotte, a French island lying between Africa and Madagascar, then rumbled across Africa, setting off sensors in Zambia, Kenya, and Ethiopia. They crossed the oceans, affecting seismographs in Chile, New Zealand, Canada, and Hawaii. And they didn't just zip by – they rang for more than 20 minutes. Despite that, no human felt them, and only one person noticed the signals on the USGS’s real-time seismogram displays. An earthquake enthusiast saw the signals and posted images of them to Twitter that rippled around the world as researchers attempted to figure out the source of the waves. Was it a meteor strike? A submarine volcano eruption? Even those who specialize in unusual earthquakes had no idea what caused it.

Many of the features of the waves were strange. For example, they had a surprisingly monotone, low-frequency “ring.” During a normal earthquake, the P-waves and S-waves have relatively high frequencies that generate a sort of “ping” rather than rumbling. Surface waves are more similar to the strange waves that rolled out of Mayotte. However, there were no earthquakes involved, and while most earthquakes send out waves of different frequencies, Mayotte's signal was monochromatic, that is, clean and dominated by one type of wave that took a steady 17 seconds to repeat.

Based on the research that has been done so far, the tremors seem to be related to a seismic swarm that has gripped Mayotte since last May. Hundreds of earthquakes have rattled the small nation during that time, most radiating from just east of the strange seismic event. Most of those were minor tremblors, with a magnitude 5.8 being the largest recorded in the island's history. Yet the frequency of these shakes has declined in recent months and no traditional quakes rumbled there when the mystery waves began on November 11.

Uninhabited island with coral reef, near Grande Terre island, Mayotte

The French Geological Survey has been monitoring the recent quakes closely, and it suggests that a new center of volcanic activity may be developing off the coast. Mayotte is a volcanic isle, but the volcano has been quiet for over 4,000 years. The Survey’s analysis suggests that the new activity may point to magmatic movement miles offshore under thousands of feet of water, in an area that hasn't been studied in detail. GPS data show the island has moved more than 2.4 inches east and 1.2 inches south, leading researchers to estimate that a magma body measuring about a 1/3 cubic mile is rising through the oceanic crust near Mayotte. One researcher filtered out the low-frequency signals and found what appear to have been P- and S-waves of tiny tremors associated with magma moving and fracturing rock as it makes its way through the crust. But even those signals were a little strange, seeming to be a little too perfect to be considered natural.

Other researchers think the November 11 incident actually began with an earthquake of sorts that came and went largely unnoticed because it was a slow earthquake. Such slow quakes, which are quieter than normal quakes because they result from a gradual release of stress over hours or even days, are typically associated with volcanic activity. However, although a submarine eruption could have produced the low rumblings, there has not yet been any evidence shown for one.

Most educated guesses tie the event to resonance in a magma chamber that was triggered by a subsurface shift or a chamber collapse. It is also possible that the signal's odd uniformity could be partly due to the local geology, which might be filtering the sounds and letting the single 17-second wave period escape. Mayotte sits in a region crisscrossed by faults, including fracture zones from the final breakup of Gondwana. In addition, the underlying crust is somewhat transitional, shifting between continental and oceanic crusts. Because of the difficulties involved, the exact cause of the signal might not be known for some time to come.

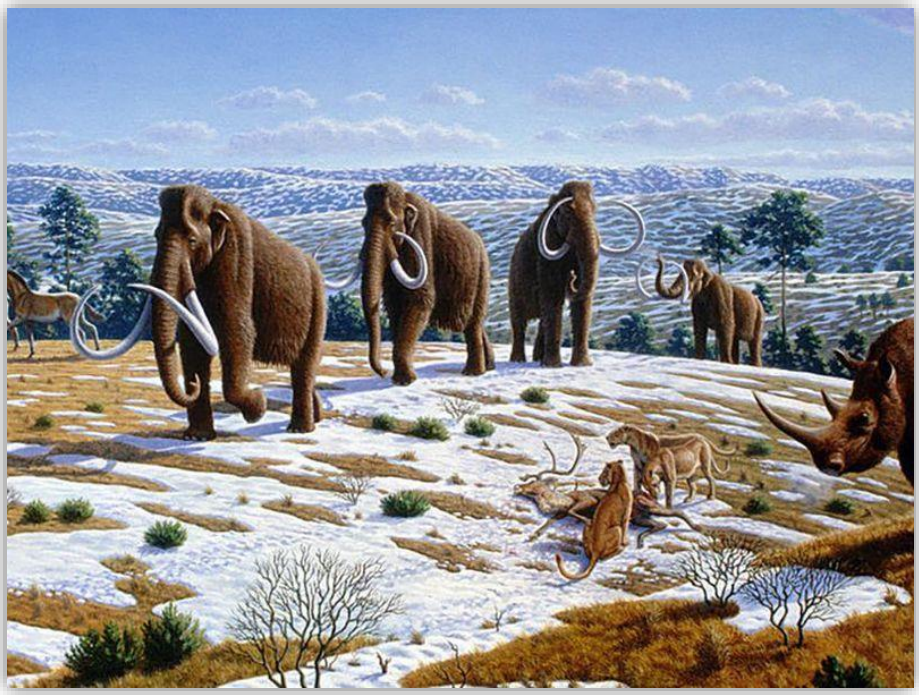
https://www.nationalgeographic.com/science/2018/11/strange-earthquake-waves-rippled-around-world-earth-geology/

During the Early Pleistocene, about 1.8 ma, Earth was full of large animals (megafauna) such as: lions, dire wolves, and giant sloths in North America; camel-like creatures and 4,500-lb bears in South America; rhinoceroses and cave hyenas in Eurasia; and giant wombats and 7-ft flightless birds in Australia. In addition, elephant relatives like woolly mammoths and mastodons occurred on many of those continents, as well as on many islands. Then, during the Pleistocene, they all went extinct.

Today, most of what constitutes megafauna exists only in Africa, and there's not that many of those left. Archaeologists and environmentalists came to a damning conclusion – humans were to blame. The "overkill hypothesis," as it is known, states that the arrival of modern humans in each new part of the world brought with it the extinction of all the megafauna, whether through hunting or outcompeting them for resources. If we didn't exist, all those animals would still be around.

But, can humans really be to blame for all of the extinctions? Some scientists say no, citing new data for the lack of modern humans at the time the extinctions took place. Researchers recently found human artifacts in the Madjedbebe rock shelter in northern Australian that indicate humans arrived on the continent around 65 ka, 10,000 year earlier than previously thought. Australian megafauna didn't start going extinct until sometime between 60 ka and 40 ka, however, showing that people were on the landscape well before megafauna started suffering population stress and showing signs of extinction. Similarly, a recent study suggests humans arrived in North America 100,000 years earlier than previously thought. If humans were to blame for the Pleistocene extinctions, the extinctions should have started with the arrival of human, not thousands or tens of thousands of years later.If humans DIDN'T kill the megafauna, it might suggest our relationship is more one of being just another species on the landscape, rather than a total domination and inflicting environmental violence.

Of course, not everyone agrees with the archaeologists. Some geologists suggest that the recent data actually confirm the "overkill hypothesis." An earlier argument against a human role in the Australian megafaunal extinction was that humans first appeared there around 50 ka. Since the megafauna were extinct almost immediately afterward, humans couldn't have been involved because they wouldn't have had enough time to build a population size sufficient to have any kind of impact. The new data helps solve this discrepancy, the geologists say. An earlier arrival date gives humans time to increase in population size and to spread across the landscape, eating whatever they came across and transforming the environment.

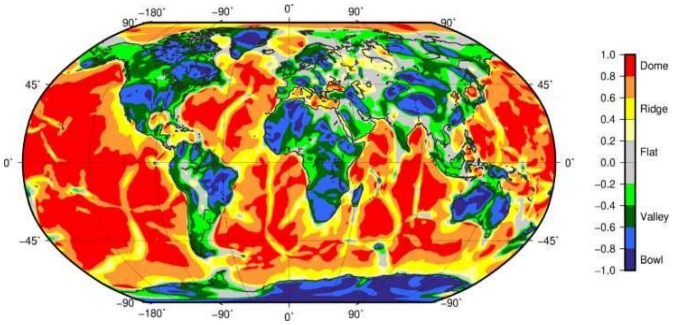


Megafauna like woolly mammoths and saber-tooth cats, all of whom have been extinct for thousands of years, filled the world during the Pleistocene. Were humans responsible for their extinction?

Since humans preying on some of the large animals must be undeniable, it must also be undeniable that something happened to the ecosystem structure and function at about the same time. As evidence of human predation, one researcher from Colorado has spent years studying the burnt remains of eggs laid by giant flightless birds in Australia that went extinct approximately 47,000 years ago. He has argued that the burn patterns on eggshells found in more than 200 hearth sites across Australia were very different from patterns created by natural wildfires. Although he can't make a firm statement, he thinks the smart money is that the megafauna would still be around if humans hadn't arrived.

https://www.smithsonianmag.com/science-nature/what-happened-worlds-most-enormous-animals-180964255/

A team of German and British scientists recently unveiled key geological features of the Earth's lithosphere, including the crust and the upper mantle. Their research is considered to be a step forward in the quest to image the structure and setting of different continents, including Antarctica, the least understood piece of the whole plate tectonic puzzle, using satellite gravity data. These data provided a new tool to link the remote ice-covered continent with the rest of the Earth, thereby improving our understanding of Antarctica's deep structure. This is particularly important, because the properties of its lithosphere can also influence the overlying ice sheets.



Global shape index derived from GOCE satellite gravity data. Dome-ridge features characterize Earth's oceans while valley to bowl features prevail over continents. Several deep blue areas on the map reveal different cratons -some of the oldest cores of the continents, e.g. in Canada, Greenland, Africa and Antarctica.

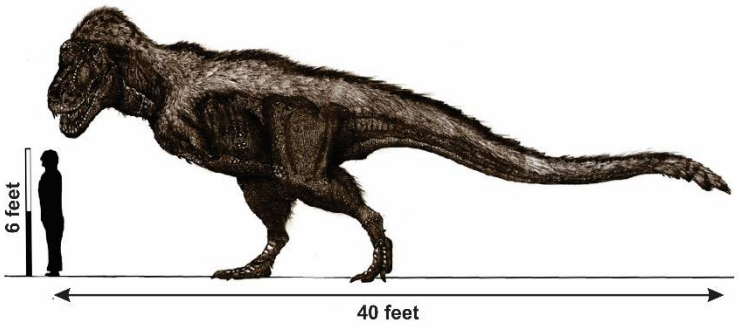
The team used data from the European Space Agency's (ESA), Gravity field and steady-state Ocean Circulation Explorer (GOCE) mission to collect their data. GOCE measures differences in horizontal and vertical gradients of the gravity field, which can be complex to interpret. The researchers combined these to produce simpler "curvature images" that reveal large-scale tectonic features of the Earth more clearly. The new gradient images improve our knowledge of Earth's deep structure. It can be combined with seismological data to produce more consistent images of the crust and upper mantle in 3-D, which is crucial to understanding how plate tectonics and deep mantle dynamics interact. Such satellite gravity research is revolutionizing our ability to study the lithosphere of the entire Earth.

East Antarctica, for example, shows a more complex mosaic of ancient lithosphere provinces. While GOCE shows fundamental similarities, it also shows unexpected differences between East Antarctica's lithosphere and that of other continents to which it was joined until the Late Jurassic 160 ma. The new study presents a view of the Earth's continental crust and upper mantle not previously achievable using global seismic models alone. The researchers noted that, despite their similar seismic characteristics, there are contrasts in the gravity signatures for the cratons, indicating differences in their deep structure and composition. Inasmuch as the cratons form the oldest cores of the lithosphere, they hold key records of Earth's early history.

https://phys.org/news/2018-11-views-earth-tectonics.amp

Some people would just DIE to have their own dinosaur skeleton. What could possibly make someone want to risk life and limb for a fossil? That's something a young Florida man named Eric Prokopi might be asking himself now. His life-long obsession with dinosaur fossils, and his escalating hunger for profit, lured him into a world of smugglers, collectors, and the black-market.

He started young, collecting shark teeth at age five on a beach in the Florida Panhandle. After he learned to dive at age 10, he began jumping into Florida rivers and bringing up fossil bones of Pleistocene megafauna and learning how to reconstruct their skeletons. Then he began selling his fossils because his parents didn't want them filling the house. So he sold fossil teeth and bones,



T. rex's Asian cousin, Tarbosaurus bataar, shown as a feathered theropod, with an average human for scale.

and entire skeletons, at trade shows and online. This led him to want to find bigger creatures for bigger profits. As with many fossil hunters, he was significantly in debt and looking for a significant payout by the time *Tarbosaurus bataar* came into the picture. *T. bataar,* an Asian cousin of *Tyrannosaurus rex,* is very similar in appearance to its North American counterpart. It also was a large apex predator with the same kinds of stubby little two-fingered arms, but it had more teeth. So far, it is known only from the Gobi Desert of Mongolia.

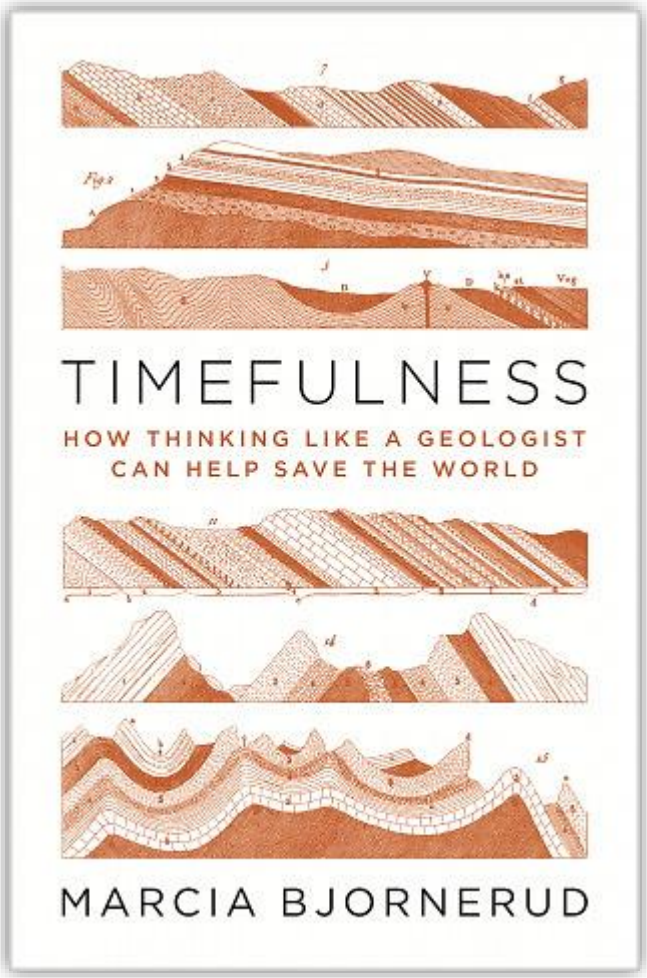
Prokopi acquired a skeleton of *T. bataar* from the Gobi, brought it to market in New York City in May 2012, and auctioned it off for a little over $1 million. Now, a typical buyer is someone who probably wants to put something on a shelf where his/her friends can admire it. There is another class of buyer who has the space and money to buy larger items. The man who paid $1 million for *T. bataar,* a New York City lawyer and developer, was looking to put the skeleton in his building overlooking the Hudson River; the ground floor of this structure is a cavernous space similar to a natural history museum. He wanted to have people entering the building greeted by the enormous skeleton.

However – it is illegal to import "stolen" materials, and Mongolia is one country where you are not allowed to pick up, keep, or own a fossil. The government considers all fossils as national natural resources, so the black market in fossil trade has grown to work around the law. Black marketeers smuggled *T. bataar* out of Mongolia. Since the Mongolian government has called for the return of all dinosaur fossils poached from the country, the US government got involved in the auction sale. There ensued two court cases. The first was a civil action, the federal government's attempt to claim the skeleton on behalf of the President of Mongolia. Prokopi could have surrendered the skeleton and probably merely paid a fine. He thought he was entitled to it, however, and decided to fight for it.

The second court case involved criminal federal charges of smuggling and black market profiteering and Prokopi lost. After a stint in prison he struggled to get back on his feet. He now lives in Savannah, Georgia, on a decommissioned WWII navy tugboat, which he repurposed as a house. He is now thinking of getting into a new line of work – the *boatel* business!

https://nypost.com/2018/09/05/inside-the-fossil-smuggling-operation-that-stretched-from-mongolia-to-nyc/

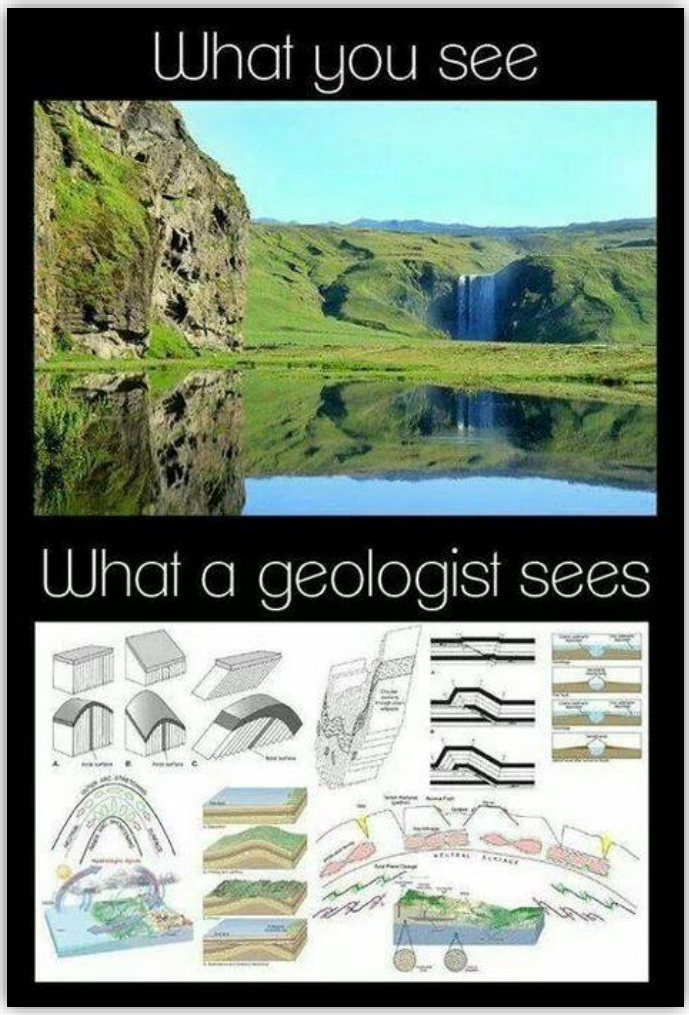
Marcia Bjornerud says geology has a PR problem. In her recent book, *Timefulness: How Thinking Like a Geologist Can Help Save the World*, she shows how human society as a whole appears to be incapable of thinking on a decadal time scale, let alone anything like geologic time scales. This is unfortunate because we really need to think long-term about many aspects of Earth systems, like climate and the environment. Unfortunately, our political leaders can only think in terms of political cycles (2-, 4-, and 6-years) and our business leaders are only interested in quarterly earnings. If people only understood the history of the Earth, they would perceive the world very differently.



The cover of a book about geologic time that everyone including non-geologists should read.

But even a lot of educated people don't accept the geologic past. To them, it's obscure, or they don't have much background in it, it goes against their religious teachings, or it just doesn't seem real. As geologists, we find this frustrating to say the least. Geology has vast explanatory powers – there's something exhilarating about being able to stare at the landscape and see how it evolved over time.

While most people think geology is only concerned with dusty mineral collections or exploring for oil and gas, in reality geology can be about big existential questions as much as it is about discovering resources. For example, we can look at the landscape as a work in progress that has been erased (eroded, deformed, etc.) many times over, yet still retains the ghosts of its former self if only we spend the time looking for them.



The average person doesn't notice, but as geologists, we learn how to read the vestiges of earlier landscapes and reconstruct past cycles of their development in the rocks and landscape.

Geologists tend to realize how ephemeral any particular iteration of the Earth's surface really is. We are on a continuum - processes that have been going on for 4.6 billion years are going to continue probably for another 4 or 5 billion. The general public might think, "Who cares? The geologic past doesn't affect me!" Surprise! Many of the problems we face today result from slow, inexorable Earth processes that have been occurring for millions or billions of years, but are now interacting with humans with undesirable consequences.

The climate system, for example, is very complicated. Things have been changing on a decadal scale, and so far we have not been able to deduce from the geological record whether previous changes have happened that quickly or if they took century, millennia, or even millions of years. Then there are still fundamental questions about earthquake recurrence. We have not yet learned how to predict earthquakes in real time, and most geophysicists have reached the conclusion that we probably never will get to that point. Therefore, the best thing to do is prepare to make people safer by building better infrastructure and resilient homes.

Those are pretty fundamental humanitarian questions. People should pause and think about time in ways they normally don't consider it. Everything in the natural world is the product of evolution over long periods of time. We should all know the big picture story of Earth's development. We should all develop a sense of the rates of natural processes, and how they compare to the rates at which humans are changing the planet. Without that understanding, we have been blithely wandering into the natural systems and disrupting them. We are causing species to go extinct faster than they can evolve.

We are all facing these common challenges; unfortunately, it seems there are no grown-ups in the room right now planning ahead. We need to develop a good sense of temporal proportion. So far, we're not doing a very good job of it.

https://www.theverge.com/platform/amp/2018/10/23/18015908/marcia-bjornerud-timefulness-geology-climate-change-environment

PGS WEBSITE OF THE MONTH

https://earthsky.org/space/mapping-the-threat-of-small-near-earth-asteroids

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Fun Fact Having Nothing to Do with Geology

The largest snowflake ever reported was 15 inches wide and 8 inches thick, discovered by a rancher in Montana in 1887.

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