NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

MEETING ANNOUNCEMENT

DATE: **November 18, 2015**

LOCATION: **Orinda Masonic Center, 9 Altarinda Rd., Orinda**

TIME: **6:30 p.m. social; 7:00 p.m. talk (no dinner) Cost: $5 per regular member; $1 per student or K – 12 teachers**

SPEAKER: **Dr. Andrea L. Foster, U.S. Geological Survey, Menlo Park, California**

The Environmental Legacy of California's Gold Rush: Arsenic and Mercury Contamination from Historic Mining

California's mid-19th century gold (Au) rush produced incredible wealth and left a rich historical legacy. However, the contamination of water, sediment, and biota by arsenic and mercury is part of the environmental legacy associated with historic mining in California, and remains an important concern (and cost burden to taxpayers) today. Synchrotron-based X-ray spectroscopic techniques have been and continue to be important for understanding and mitigating the negative environmental impacts of these two elements, in California and around the world.

A major environmental legacy of the CA gold rush are the fish consumption advisories in place for most of the state's water bodies that received sediment from mercury (Hg) mining operations in the California Coast Range mountains and/or early Au mining operations in the Sierra Nevada (at which Hg was used to recover Au by amalgamation). The sediment contained elemental mercury [Hg(0)] as well as more soluble Hg minerals; all of these can be transformed to organic methylmercury under specific environmental conditions. Methylmercury is a potent neurotoxin that biomagnifies up the food chain, creating health risks for consumers of high-trophic level fish. Synchrotron-based methods have proved key to the identification of the forms of mercury at historic Hg mines and have also helped to elucidate the physiological mechanisms of Hg toxicity in lab studies.

A second environmental legacy of the CA gold rush is the contamination of large areas of mined land in the Sierra Foothills region by arsenic (As), which is a known carcinogen in its *dissolved*, inorganic forms. Unlike the case for Hg, which was purposefully introduced at the Au mines, As naturally occurs in close association with Au in the deposits that were mined extensively in the Sierra Foothills during the gold rush. Ingestion and/or inhalation of As-rich particles are important pathways of human exposure to the element in the vicinity of historic mine sites, but knowledge of the specific forms of particulate As present is required in

(continued on back page)

NCGS 2015 – 2016 Calendar

January 27, 2016 **7:00 pm**
Program to be announced

The spring program will be announced shortly. The customary dinner meeting is planned for the May meeting.

Yes, Already! *It's Renewal Time!* Our Year Runs From September to September. Please Use the Renewal Form Included as Page 11 of the Newsletter!

NCGS Field Trips

Field Trips in Preliminary Planning Stage:

- Geology of Devil's Slide
- Pt. Sal Ophiolite in Santa Barbara Co,
- Convergent Margin Tectonics across Central California Coast Ranges - Pacheco Pass
- Tuscan Formation volcanic mudflow deposits, Cascade foothills

Peninsula Geologic Society

For an updated list of meetings, abstracts, and field trips go to http://www.diggles.com/pgs/. The PGS has also posted guidebooks for downloading, as well as photographs from recent field trips at this web address. Please check the website for current details.

UC Berkeley Earth & Planetary Science Weekly Seminar Series

On Thursday, Nov. 12 at 4 pm at 141 McCone, Mark Zoback of Stanford will speak on the topic "**Implications of a Critically-Stressed Crust for Unconventional Natural Gas Development and the Risks of Induced Seismicity.**"

For an updated list of seminars go to http://eps.berkeley.edu/events/seminars.

Early Career Scientists Sought to Speak in K-12 classrooms

The following is an email from The National Center for Science Education received by the Kathleen Burnham; it may be of interest to some of our members. NCSE provides information and advice on keeping evolution and climate change in the science classroom.

Dear Kathleen,

The National Center for Science Education is piloting a new program this fall to get early career scientists into K-12 classrooms to talk about climate change and evolution!

We are looking for all types of early career scientists, from graduate students all the way up to folks in their first years of their academic positions. The time commitment for the program is low, just one in-class visit and regular monthly social media interactions throughout the semester, but the impact will be enormous. This is a great opportunity for scientists looking to share their work with a broader audience and inspire a new generation of scientists and science-loving citizens.

Interested? Intrigued? Know of a great fit for such a new and innovative program? Perfect! Sign up yourself, share with colleagues or departments who might be interested, and send some early career scientists our way!

To find out more about the program and sign up, visit our website or contact Minda Berbeco at berbeco@ncse.com.

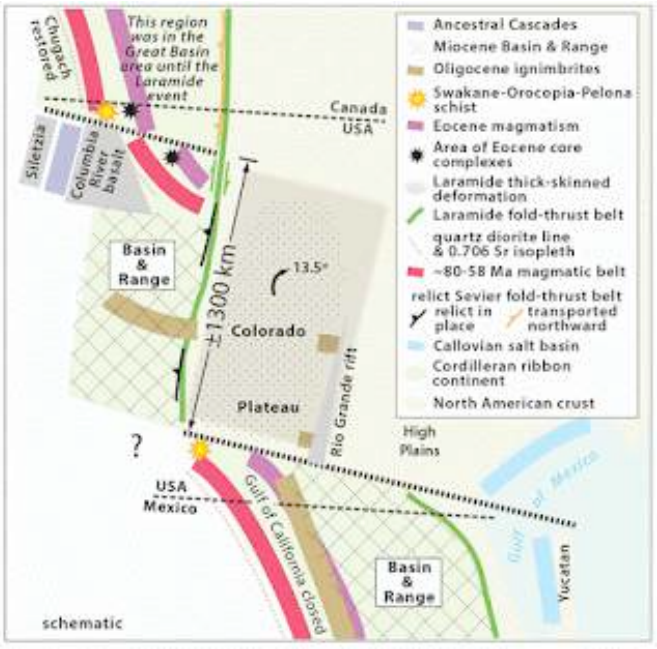
Sincerely,
Minda Berbeco
Programs and Policy Director
National Center for Science Education
420 40th Street Suite 2
Oakland, CA 94702
p. 510-601-7203 e. berbeco@ncse.com

2015-2016 Richard Chambers Memorial Scholarships

The NCGS will award Richard Chambers Memorial Scholarships to up to three students in early 2016. Up to three $ 1,000 scholarships will be awarded to students pursuing Masters Degrees and one $ 2,000 scholarship to a student pursuing a Doctorate Degree.

The 2015-2016 RCMS application deadline is December 18, 2015. Applicants should go to the NCGS website for the application process. Phil Garbutt will bring copies of the application procedures to the NCGS general meetings between now and December.

New report on Cordilleran tectonics likely to generate its own upheaval

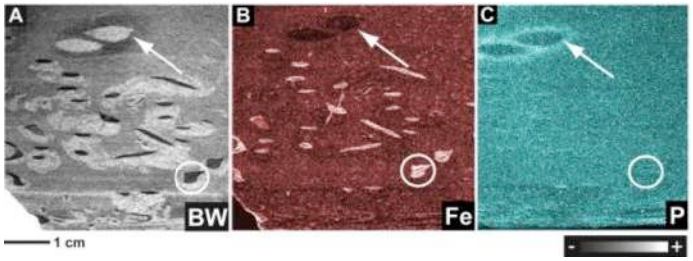


A new paper published recently is bound to generate heated debate. Tucson-based geologist Robert "Bob" Hildebrand's article "Dismemberment and northward migration of the Cordilleran orogeny: Baja-BC resolved came out in GSA Today on October 28 with a provocative conclusion. Bob proposes that the sinistral Texas Lineament and the sinistral Lewis & Clark transverse zone, located about 1300 kilometers to the north, can be restored to one through-going zone. [*Above, Figure 2 from the paper. The proposed fault is shown in green extending across the entire N-S extent of the US.*]

The proposed right-lateral fault divides the Basin & Range province from the Colorado Plateau across the extent of Arizona and Utah and well into Canada. Bob's previous alternative tectonic theories have drawn a lot of attention and animated discussion. This one is going to do the same.

Source: Blog of the State Geologist of Arizona: http://arizonageology.blogspot.com/2015/10/new-report-on-cordilleran-tectonics.html.

X-ray study reveals new details of how burrowing sea creatures shape geology



Using a rapid X-ray scanning technique developed for fossil studies at SLAC's Stanford Synchrotron Radiation Lightsource, researchers studied the detailed chemistry of fossilized burrows, likely produced by sea worms 80 million years ago. These images show a black and white photograph of a cross-section of a fossil sample (left), a false-color scan of the sample's iron content (middle, with iron concentrations shown in lighter shades), and a false-color scan of the phosphorous content (at right but not visible, with phosphorous concentrations shown in lighter shades). Credit: D. Harazim, et al., Geology

Research at the Department of Energy's SLAC National Accelerator Laboratory reveals new details about how tiny, burrowing sea organisms can influence the chemistry and structure of rocks where hydrocarbon deposits such as oil and gas are found.

An international team of scientists used X-rays to image the chemistry of rock samples containing well-preserved 80-million-year-old fossilized burrows, which may have been made by millimeter-sized bristly worms known as polychaetes. They found that the worms appeared to concentrate some chemical elements in their burrows while depleting others.

The study, published online Oct. 7 in the journal *Geology*, provides new insight into how ancient sea worms interact with the sediment on the ocean bottom and control the composition and geochemical signature of rocks formed by that sediment, which today serve as markers for ancient climate patterns and oil and gas reservoirs.

The pioneering X-ray scanning method that researchers used at SLAC opens up new ways to study Earth's distant environmental and geological past and supports research about the formation of hydrocarbon deposits.

While it's only in its early stages, the research shows a lot of promise, said Dario Harazim, a petroleum geologist who led the study while working as instructor at Memorial University of Newfoundland in Canada. "We might need to rethink the processes of how certain elements are incorporated into the rock record -- how they are preserved and how we use them to reconstruct the chemistry and other properties of the ancient ocean," Harazim said.

"To date, the ancient ocean temperatures, oxygen levels and other factors important in rock formation have been considered major drivers controlling the accumulation of trace elements in the rock," he said. "Here, we provide new insight into how burrowing organisms play a major

role in controlling the trace amounts of some elements in rocks formed from sediment."

While the sea worms like the ones that likely made these ancient burrows are still important in the modern environment, they are difficult to observe because they are embedded in the sticky mud of the sea floor. Removing worms and their surrounding mud to a more convenient location for study would disrupt their relationship with their natural environment and might not yield trustworthy results.

From Dino Birds to Burrowing Worms

Harazim partnered with a research group based at University of Manchester to study exceptionally preserved rock samples from Baja California in Mexico. The Manchester group had worked with SLAC distinguished staff scientist Uwe Bergmann to develop a fast X-ray scanning technique for studying fossils at SLAC's Stanford Synchrotron Radiation Lightsource (SSRL), a DOE Office of Science User Facility. The technique has been used to study chemical traces of feathers and tissues in a famous fossil link between birds and dinosaurs.

Unlike many conventional techniques, the unique fast-scanning technique at SSRL is non-destructive, so it preserved the features and localized chemistry of the worm burrows. It can also image large sample surfaces of up to tens of square centimeters.

"The large-scale imaging capabilities at SSRL permitted the precise mapping of very small chemical concentrations associated with these organisms' interaction with their environment," said Phillip Manning, a University of Manchester paleontologist who helped to pioneer the technique. "This latest collaboration between accelerator physics and paleontology has once again resurrected chemical ghosts that shed new light on key scientific questions."

The study shows how a unique and sophisticated feeding strategy allows the sea worms to separate sediment particles of different sizes, Harazim said: "They consume mineral particles, clay and bacteria that live on the mineral surfaces. As this mix passes through their chemically aggressive gut, this material is getting broken down and degraded."

The way the worms redistribute and digest these grains, and how they control the concentration of some elements, is still not well understood. Their feeding creates pockets of porous sediment that can potentially fill over time with concentrations of mineral cement, organic material and potentially even hydrocarbons.

The researchers, who verified the SSRL results with those obtained from other conventional methods, found that certain elements, including strontium and barium, are depleted from all areas of the rock. These elements were likely either being absorbed into the worms' bodies or released to the surrounding waters.

Applications in Ancient Climate, Ocean Chemistry Studies

Further research may lead to a better understanding of how analyzing the chemical signature of these burrowing organisms may relate to ancient climate patterns and changes in ocean chemistry, Harazim said. "This technique allows you to study how the activity of burrowing organisms can influence the chemistry and composition of the rock they are living in. It helps us to better understand the geological record and helps us to read Earth's geological past in a more sophisticated way," he said.

He said there are plans for follow-up research with different types of fossilized samples to see if there are commonalities in their chemical concentration and distribution.

"There is still a lot to learn about how these organisms impact the porosity and geochemical composition of rocks, and how loose sediment becomes rock," he said.

The work was supported by the American Association of Petroleum Geologists, the International Association of Sedimentologists, the Society for Sedimentary Geology, the Geological Society of America, the Natural Sciences and Engineering Research Council of Canada, and the Science and Technology Facilities Council.

Story Source: The above post is reprinted from materials provided by SLAC National Accelerator Laboratory.

Journal Reference: Dario Harazim, Duncan McIlroy, Nicholas P. Edwards, Roy A. Wogelius, Phillip L. Manning, Kristin M. Poduska, Graham D. Layne, Dimosthenis Sokaras, Roberto Alonso-Mori, Uwe Bergmann. **Bioturbating animals control the mobility of redox-sensitive trace elements in organic-rich mudstone**. *Geology*, 2015; G37025.1 DOI: 10.1130/G37025.1

Findings rock long-held assumptions about ancient mass extinction

New evidence gathered from the Karoo Basin in South Africa sheds light on a catastrophic extinction event that occurred more than 250 million years ago and wiped out more than 90% of life in Earth's oceans and about 70% of animal species on land.

In research published in Geology, a Univ. of Texas at Dallas geologist and his colleagues describe new findings that challenge the currently accepted model of the "Great Dying" and how it affected land animals. That event occurred at the end of the Permian geologic period. The new evidence derives from a key volcanic ash deposit that the team discovered in rock layers, or

strata, that were reported to chronicle the mass extinction. By dating the volcanic ash-bearing deposit, researchers concluded that two phases of this extinction—one on land, the other in the oceans—occurred at least 1 million years apart, as opposed to roughly at the same time, as the geoscience community has assumed for decades.

Based on previous dating of shelly fossils and ash beds in marine strata, the die-off among marine species has been well-determined and is generally agreed upon by scientists to have occurred about 251.9 million years ago.

However, the timing of the extinction on land has been more challenging to date definitively. This is due, in part, to a dearth of datable volcanic deposits below and above plant and animal fossils in rocks surrounding the boundary where the Permian period ends and the Triassic begins, said Dr. John Geissman, professor and head of the Dept. of Geosciences and one of the authors of the study.

"There has been some concern in the scientific community about whether the extinction among vertebrates on land was actually coincident with that in the marine realm in terms of their timing," Geissman said. "Nonetheless, many researchers have just tacitly assumed that the land event occurred roughly concurrently with the marine extinction." Geissman is part of an international research team led by Dr. Robert Gastaldo, lead author of the Geology study and the Whipple-Coddington Professor of Geology at Colby College in Maine. Gastaldo and his colleagues have spent more than a decade conducting intensive study of exposed rocks in the Karoo Basin in southern South Africa. These regions preserve fossils that chronicle what has long been interpreted as the disappearance of key reptile and amphibian species at the end of the Permian period and the reemergence of completely different species in the Triassic period. The rock layers straddle the space in between where scientists infer the global extinction occurred.

Geissman joined Gastaldo's Karoo Basin team about four years ago. As an expert in paleomagnetism, he uses magnetic polarity stratigraphy to help determine the age of ancient rock layers. The process involves examining variations in Earth's magnetic field polarity over time that are preserved in the layers. Two years ago, during a hike with a colleague through an arroyo in the Old Lootsberg Pass area in the Karoo Basin, Geissman noticed a feature in the rocks that looked familiar.

"Typically in this area, if there is a gulley, everything exposed will be preserved, which is ideal," Geissman said. "As we were walking up this arroyo I saw something that I knew I'd seen before in the Western U.S. where I teach a field geology class for UT Dallas students, but I hadn't seen it here before.

"I knew exactly what it was—it was a fossilized volcanic ash bed." The find was significant for two reasons. One, zircon crystals found in ash beds can be dated geologically by examining the decay rate of uranium isotopes contained in the zircon. And secondly, according to the researchers, this ash bed was the first datable evidence found in close proximity to the position in the layers of rock where the extinction of land species was thought to have taken place.

The petrified ash bed lies about 60 m below the inferred extinction event, which means it resulted from a volcanic eruption that occurred earlier than the extinction. In the world of geology, stratigraphic thickness equates to time—over the eons, layers of sediments are laid down at a rate of so many meters per thousand years, and in this region of the globe, the sedimentation rates translate those 60 m into, roughly, between 200,000 and 300,000 years, Geissman said.

The team dated the volcanic ash bed at about 253.5 million years old, so moving forward in time 200,000 years—or 60 m—would indicate the terrestrial phase of the extinction took place about 253.3 million years ago, according to the study. "This study places the terrestrial vertebrate turnover about 1.5 million years earlier than the accepted estimated age of the marine end Permian-extinction," Geissman said. "Even if we conservatively say they were a million years apart, that still challenges long-held assumptions about the largest extinction event in Earth's history."

Geissman's examination of the distribution of magnetic polarity in rock samples from the Karoo Basin backed up the team's conclusions. In January, Geissman will join his colleagues again for further research in the region.

"It's been a lot of fun working with a great group of stimulating colleagues willing to challenge things," Geissman said. "It was very gratifying to walk out along an arroyo, see something that I had seen in much younger rocks in the Western U.S., and just know that the dating should work, and indeed it did.

"Part of the satisfaction in this type of research is the serendipity in terms of finding things. It's all about tromping over as much real estate as you can."

Source: Univ. of Texas at Dallas

Robert A. Gastaldo, Sandra L. Kamo, Johann Neveling, John W. Geissman, Marion Bamford, and Cindy V. Looy, 2015. Is the vertebrate-defined Permian-Triassic boundary in the Karoo Basin, South Africa, the terrestrial expression of the end-Permian marine event? Geology, v. 43, p. 939-942.

Antarctic ice shelf is thinning from above and below

BAS radar sled on the Larson Ice Shelf.
Credit: Adam Clark, BAS

A decade-long scientific debate about what's causing the thinning of one of Antarctica's largest ice shelves is settled this week (Wednesday 13 May) with the publication of an international study in the journal *The Cryosphere.*

The Larsen C Ice Shelf -- whose neighbors Larsen A and B, collapsed in 1995 and 2002 -- is thinning from both its surface and beneath. For years scientists have been unable to determine whether it is warming air temperatures or warmer ocean currents that were causing the Antarctic Peninsula's floating ice shelves to lose volume and become more vulnerable to collapse. This new study takes an important step forward in assessing Antarctica's likely contribution to future sea-level rise.

The research team combined satellite data and eight radar surveys captured during a 15-year period from 1998-2012. They found that Larsen C Ice Shelf lost an average of 4 meters of ice, and had lowered by an average of one meter at the surface.

Lead author, Dr Paul Holland from British Antarctic Survey (BAS), says: "What's exciting about this study is we now know that two different processes are causing Larsen C to thin and become less stable. Air is being lost from the top layer of snow (called the firn), which is becoming more compacted -- probably because of increased melting by a warmer atmosphere. We know also that Larsen C is losing ice, probably from warmer ocean currents or changing ice flow.

"If this vast ice shelf -- which is over two and a half times the size of Wales and 10 times bigger than Larsen B -- was to collapse, it would allow the tributary glaciers behind it to flow faster into the sea. This would then contribute to sea-level rise."

The Antarctic Peninsula is one of the fastest warming regions on Earth, with a temperature rise of 2.5°C over the last 50 years.

The team, who continue to monitor the ice shelf closely, predict that a collapse could occur within a century, although maybe sooner and with little warning. A crack is forming in the ice which could cause it to retreat back further than previously observed. The ice shelf appears also to be detaching from a small island called Bawden Ice Rise at its northern edge.

Professor David Vaughan, glaciologist and Director of Science at BAS, says: "When Larsen A and B were lost, the glaciers behind them accelerated and they are now contributing a significant fraction of the sea-level rise from the whole of Antarctica. Larsen C is bigger and if it were to be lost in the next few decades then it would actually add to the projections of sea-level rise by 2100.

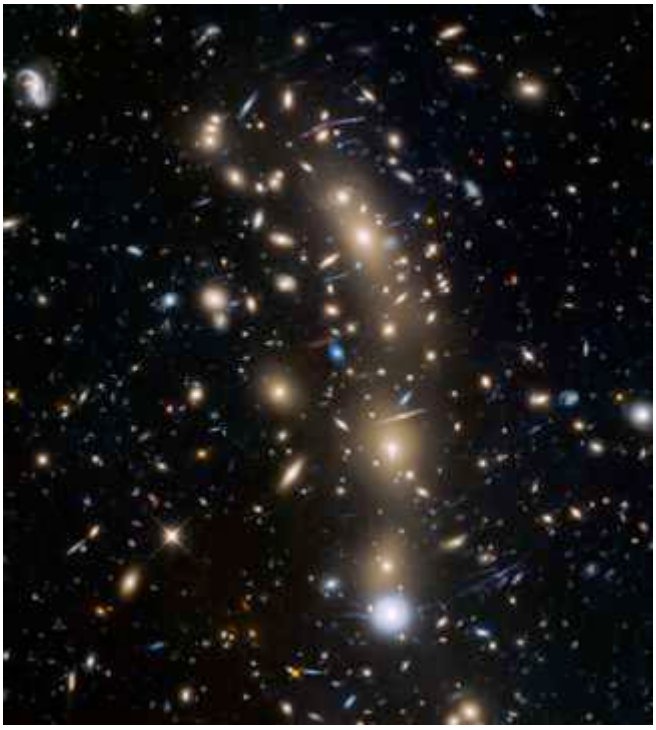
"We expect that sea-level rise around the world will be something in excess of 50 cm higher by 2100 than it is at present and that will cause problems for coastal and low-lying cities. Understanding and counting up these small contributions from Larsen C and all the glaciers around the world is very important if we are to project, with confidence, the rate of sea-level rise into the future."

The study was carried out by scientists from British Antarctic Survey, the United States Geological Survey, University of Colorado, University of Kansas and Scripps Institution of Oceanography. It was funded by the Natural Environment Research Council in the UK, National Science Foundation in the US and a range of international funding bodies around the world.

Story Source: The above post is reprinted from materials provided by British Antarctic Survey. *Note: Materials may be edited for content and length.*

Journal Reference: P. R. Holland, A. Brisbourne, H. F. J. Corr, D. McGrath, K. Purdon, J. Paden, H. A. Fricker, F. S. Paolo, A. H. Fleming. **Oceanic and atmospheric forcing of Larsen C Ice-Shelf thinning**. *The Cryosphere*, 2015; 9 (3): 1005 DOI: 10.5194/tc-9-1005-2015

Hubble spies Big Bang frontiers



Hubble Frontier Fields view of MACSJ0416.1–2403
Credit: NASA, ESA and the HST Frontier Fields team (STScI)

Observations by the NASA/ESA Hubble Space Telescope have taken advantage of gravitational lensing to reveal the largest sample of the faintest and earliest known galaxies in the Universe. Some of these galaxies formed just 600 million years after the Big Bang and are fainter than any other galaxy yet uncovered by Hubble. The team has determined, for the first time with some confidence, that these small galaxies were vital to creating the Universe that we see today.

An international team of astronomers, led by Hakim Atek of the Ecole Polytechnique Fédérale de Lausanne, Switzerland, has discovered over 250 tiny galaxies that existed only 600-900 million years after the Big Bang [1] -- one of the largest samples of dwarf galaxies yet to be discovered at these epochs. The light from these galaxies took over 12 billion years to reach the telescope, allowing the astronomers to look back in time when the universe was still very young.

Although impressive, the number of galaxies found at this early epoch is not the team's only remarkable breakthrough, as Johan Richard from the Observatoire de Lyon, France, points out, "The faintest galaxies detected in these Hubble observations are fainter than any other yet uncovered in the deepest Hubble observations."

By looking at the light coming from the galaxies the team discovered that the accumulated light emitted by these galaxies could have played a major role in one of the most mysterious periods of the Universe's early history -- the epoch of reionization. Reionization started when the thick fog of hydrogen gas that cloaked the early Universe began to clear. Ultraviolet light was now able to travel over larger distances without being blocked and the Universe became transparent to ultraviolet light [2].

By observing the ultraviolet light from the galaxies found in this study the astronomers were able to calculate whether these were in fact some of the galaxies involved in the process. The team determined, for the first time with some confidence, that the smallest and most abundant of the galaxies in the study could be the major actors in keeping the Universe transparent. By doing so, they have established that the epoch of reionization -- which ends at the point when the Universe is fully transparent -- came to a close about 700 million years after the Big Bang [3].

Lead author Atek explained, "If we took into account only the contributions from bright and massive galaxies, we found that these were insufficient to reionize the Universe. We also needed to add in the contribution of a more abundant population of faint dwarf galaxies."

To make these discoveries, the team utilized the deepest images of gravitational lensing made so far in three galaxy clusters, which were taken as part of the Hubble Frontier Fields program [4]. These clusters generate immense gravitational fields capable of magnifying the light from the faint galaxies that lie far behind the clusters themselves. This makes it possible to search for, and study, the first generation of galaxies in the Universe.

Jean-Paul Kneib, co-author of the study from the Ecole Polytechnique Fédérale de Lausanne, Switzerland, explains, "Clusters in the Frontier Fields act as powerful natural telescopes and unveil these faint dwarf galaxies that would otherwise be invisible."

Co-author of the study Mathilde Jauzac, from Durham University, UK, and the University of KwaZulu-Natal, South Africa, remarks on the significance of the discovery and Hubble's role in it, "Hubble remains unrivalled in its ability to observe the most distant galaxies. The sheer depth of the Hubble Frontier Field data guarantees a very precise understanding of the cluster magnification effect, allowing us to make discoveries like these."

These results highlight the impressive possibilities of the Frontier Fields program with more galaxies, at even earlier time, likely to be revealed when Hubble peers at three more of these galaxy clusters in the near future.

Notes:

[1] The calculated redshift for these objects is between z = 6 and z = 8.

[2] Neutral hydrogen gas absorbs all the high-energy ultraviolet light emitted by hot young stars very

efficiently. At the same time, the absorbed ultraviolet light ionizes the hydrogen. The very low density ionized hydrogen gas filling the universe became fully transparent. The hot stars carve out transparent bubbles in the gas and once all these bubbles merge to fill all of space, reionization is said to be complete and the Universe becomes transparent to ultraviolet light.

[3] This corresponds to a redshift of about z = 7.5.

[4] The Hubble Frontier Fields is a three-year, 840-orbit program which will yield the deepest views of the Universe to date, combining the power of Hubble with the gravitational amplification of light around six different galaxy clusters to explore more distant regions of space than could otherwise be seen.

Story Source: The above post is reprinted from materials provided by ESA/Hubble Information Centre.

Journal Reference: Hakim Atek, Johan Richard, Mathilde Jauzac, Jean-Paul Kneib, Priyamvada Natarajan, Marceaulimousin, Daniel Schaerer, Eric Jullo, Harald Ebeling, Eiichi Egami, and Benjamin Clement, 2015. **Are Ultra-Faint Galaxies At Z = 6 − 8 Responsible For Cosmic Reionization? Combined Constraints From The Hubble Frontier Fields Clusters And Parallels**. *Astrophysical Journal*, October 2.

Large, violent animal packs shaped the ecosystems of the Pleistocene epoch

Wide variety of data used to reconstruct an ancient era

Violent attacks by carnivores are illustrated.
Credit: Painting by Mauricio Anton

For years, evolutionary biologists have wondered how ecosystems during the Pleistocene epoch survived despite the presence of many species of huge, hungry herbivores, such as mammoths, mastodons and giant ground sloths. Observations on modern elephants suggest that large concentrations of those animals could have essentially destroyed the environment, but that wasn't the case.

Now life scientists from UCLA and other universities in the U.S. and England argue that the ecosystem was effectively saved by predatory animals that helped keep the population of large herbivores in check. Their findings, reported this week in the journal *Proceedings of the National Academy of Sciences*, show that intense, violent attacks by packs of some of the world's largest carnivores -- including lions much larger than those of today and sabertooth cats -- went a long way toward shaping ecosystems during the Pleistocene epoch.

The research could have implications for animal conservation efforts today. The paper notes that many of today's endangered species evolved during or before the Pleistocene epoch, and under very different conditions from today's. "Recreating these [Pleistocene] communities is not possible, but their record of success compels us to maintain the diversity we have and rebuild it where feasible," the researchers write.

Led by Blaire Van Valkenburgh, a UCLA evolutionary biologist, the researchers found that, because of their larger size, the ancient carnivores were very capable of killing young mammoths, mastodons and other species, which prevented those animals from destroying ecosystems in the Pleistocene, which ended about 11,700 years ago. The paper suggests that the extinction of the largest of the "hyper-carnivores" (such as lions, sabertooth cats and hyenas) during the late Pleistocene almost certainly was caused by the disappearance of their preferred prey, including young mega-herbivores (the mammoths, mastodons and giant ground sloths).

"Based on observations of living mega-herbivores, such as elephants, rhinos, giraffes and hippos, scientists have generally thought that these species were largely immune to predation, mainly because of their large size as adults and strong maternal protection of very young offspring," said Van Valkenburgh, who holds an appointment in the UCLA College's department of ecology and evolutionary biology.

"Data on modern lion kills of elephants indicates that larger prides are more successful and we argue that Pleistocene carnivore species probably formed larger prides and packs than are typically observed today -- making it easier for them to attack and kill fairly large juveniles and young adult mega-herbivores."

The scientists used several different techniques and data sources to estimate information about the Pleistocene animals. Among them:

- Examining fossils of their teeth and applying the ratio of tooth size to body mass of today's animals. (This led the researchers to estimate

that the extinct species were between 50 and 100 percent larger than today's tigers, African lions and spotted hyenas.)

- Synthesizing data on the relationship between the age and shoulder height of the extinct animals versus shoulder height and body mass of today's elephants.
- Analyzing data on 50,000 instances of kills in the wild to estimate the typical and maximum sizes of the prey of Pleistocene carnivores.

Many scientists had thought that the populations of mammoths, mastodons and giant ground sloths were limited through evolution by changes in reproductive timing in response to shortages in resources like food and water.

Today's large predators benefit their ecosystems in part by providing carcasses that feed an array of smaller species. The same was true during the Pleistocene, when keeping mega-herbivore populations in check meant that there was more vegetation for smaller mammals and birds. The predators might even have had indirect effects on river ecosystems, because the banks of the rivers were not being denuded by mega-herbivores and less likely to erode.

The study's co-authors are Matthew Hayward of Bangor University College of Natural Sciences in England, William Ripple of Oregon State University, Carlo Meloro of Liverpool John Moores University in England and V. Louise Roth of Duke University.

Story Source: The above post is reprinted from materials provided by University of California, Los Angeles. The original item was written by Stuart Wolpert. *Note: Materials may be edited for content and length.*

Journal Reference: Blaire Van Valkenburgh, Matthew W. Hayward, William J. Ripple, Carlo Meloro, and V. Louise Roth. **The impact of large terrestrial carnivores on Pleistocene ecosystems**. *PNAS*, October 26, 2015 DOI: 10.1073/pnas.1502554112

New Evidence Suggests Life On Earth Began Much Earlier Than We Thought

photo credit: panyajampatong/Shutterstock

The emergence of life on Earth is a hotly debated topic in the scientific realm. When precisely did the chemistry of the world give rise to biology? A new study, published in the journal Proceedings of the National Academy of Sciences, provides compelling evidence that life started 4.1 billion years ago, 300 million years earlier than previously thought.

The research team, led by the University of California, Los Angeles (UCLA), looked inside 79 zircon crystals in Western Australia, and found that just one of them contained an unexpected substance. Zircons are among the oldest material on Earth, forming as a mineral within certain magmas as they cool. As they are incredibly durable, with a strong resistance to corrosion or temperature changes, they act as time capsules, preserving the conditions around the moment of their crystallization.

This single 4.1-billion-year-old zircon contained graphite, a form of carbon – the element all life on Earth is based on. When this was chemically analyzed, the researchers discovered to their shock that it was enriched with carbon-12, a lighter version of carbon associated with life.

Until now, the scientific consensus was that life could only have started after the Late Heavy Bombardment (LHB), an ancient time when the Earth experienced a prolonged series of impacts. The Earth, violently volcanic and at the end of a planetoid shooting gallery, was thought to be far too hostile back then for the planet's chemistry to be able to transition into hereditary material, likely DNA, which at some point replicated enough to form life in a process known as abiogenesis.

Life on Earth was, until now, thought to have begun around 3.8 to 3.5 billion years ago. Although there are some possible earlier chemical signatures of it, the first fossilized evidence came from some heavily deformed, 3.7-billion-year-old rocks in Greenland, which also showed traces of the light carbon-12 element

within graphite. Ruling out that this carbon was not formed by geological processes, researchers thought that this was the first preserved evidence of life on Earth. Either way, by at least 3.5 to 3 billion years ago, there was ample fossil or chemical evidence that simple cells, some of which were using a primitive form of photosynthesis, were around.

This new finding, which the researchers have high confidence in, suggests that life started immediately after the LHB, and only 450 million years after Earth itself was forged in the fires of our young Solar System.

"Twenty years ago, this would have been heretical; [back then,] finding evidence of life 3.8 billion years ago was shocking," said Mark Harrison, co-author of the research and a professor of geochemistry at UCLA, in a statement. "Life on Earth may have started almost instantaneously. With the right ingredients, life seems to form very quickly."

Source quoted in article: Elizabeth A. Bella, Patrick Bohnke, T. Mark Harrison, and Wendy L. Mao, 2015. Potentially biogenic carbon preserved in a 4.1 billion-year-old zircon, in PNAS [Proceedings of the National Academy of Science] doi: 10.1073/pnas.1517557112.

With the exception of some viruses, the DNA of all life on Earth shares four bases – chemical building blocks that make up our DNA strands. This universal feature strongly suggests that the event that first synthesized DNA only happened once, or that any other synthesizing attempts were terminated. If life began 4.1 billion years ago, this means that DNA itself began to replicate even earlier, perhaps at the end of the LHB.

Everything living on planet Earth began with this rare synthesis event, traced back to right near the beginning of the world. Darwin would have loved this.

From the blog The Fossil Form at http://www.thefossilforum.com/http://www.thefossilforum.

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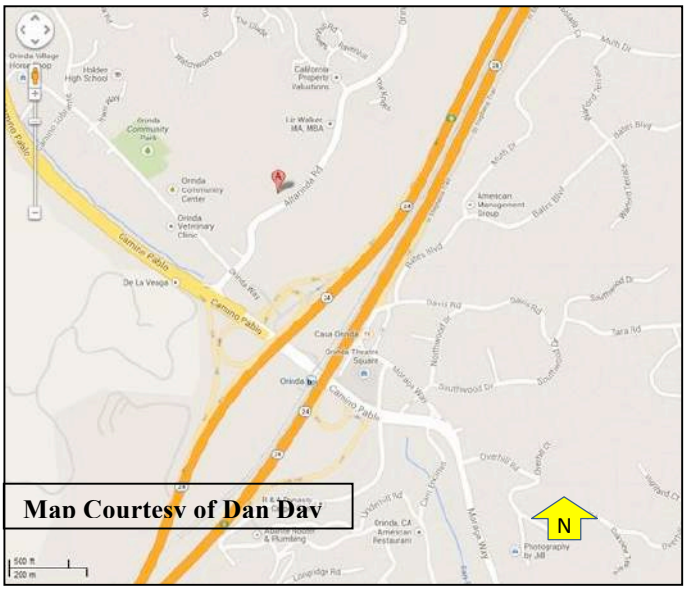

Abstract (cont'd from Page 1): order to model the As-specific health risk. Because this information is difficult to obtain, site-specific assessments of arsenic bioavailability (in animal models) can be required in order to redevelop historically-mined lands in this region. The high cost of these studies can often slow or halt the redevelopment of these lands, and the lack of such testing has resulted in several high-profile lawsuits and expensive cleanup operations in the past. Synchrotron-based methods have been used extensively to describe the forms of arsenic present at individual CA mines, and are currently being used to develop a more streamlined, economical approach to assessing the human health risks related to particulate arsenic at historic mine sites in the Sierra Foothills region.

Biography: Andrea L. Foster was born in Indiana and spent most of her childhood there (with brief stays in Connecticut and Kentucky). She obtained her B.S. (honors) in Geology from Indiana University (Bloomington) in 1992 and her PhD from Stanford University in 1999. The same year, Foster accepted an appointment with the USGS Mineral Resources Program in Menlo Park. Her work investigating the environmental chemistry of arsenic at California mine sites began with PhD research and continues to this day. However, she has also participated in mineral resource and/or environmental investigations of other elements including cadmium, chromium, copper, gallium, selenium, tellurium, and zinc; many of these studies were focused on sites in CA. Foster has primarily used synchrotron X-ray techniques in her research, but is actively developing in-house Raman spectroscopic methods to augment her synchrotron studies.

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