NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

MEETING ANNOUNCEMENT

DATE: **Wednesday, October 31, 2018**

LOCATION: **Orinda Masonic Center, 9 Altarinda Rd., Orinda (see map on back page)**

TIME: **6:30 – 7:00 p.m.: Social; 7:00 p.m.: Presentation**

SPEAKER: ***Dr. Cristina M. Robins***

Senior Museum Scientist,
UC Museum of Paleontology

TOPIC: ***"Calaveras: The Most Significant Fossil Find in the Bay Area in Decades"***

The construction of the new Calaveras Dam has revealed a suite of fossils from previously unexplored strata, including a new species of baleen whale, and well over 2,000 shark teeth. This is the most significant fossil find in the Bay Area in decades. The talk will focus on the finds from Calaveras (additional ones are being identified daily), salvage paleontology, and how sites like this fit into the larger picture of Earth's history.

Biography

Cristina Robins studied geology as an undergraduate at Carleton College, Northfield, MN, and completed master's and doctorate work in Applied Geology at Kent State University, receiving her Ph.D. in 2013.

Dr. Robins has served in various teaching and museum curatorial jobs. A major highlight was her role as a project manager and post-doctoral associate with the Panama Canal Project – Partners in International Research and Education (PCP PIRE) through the Florida Museum of Natural History, where she oversaw a $4.5 million NSF grant to excavate as many fossils as they could in advance of construction in the area of the planned expansion of the Panama Canal.

In the 2016-2017 academic year, Dr. Robins served as a lecturer at San Jose State University, and since July 2017 she has been Senior Museum Scientist at the University of California Museum of Paleontology, Berkeley, CA, overseeing the Calaveras Fossil Project.

NCGS 2017 – 2018 Calendar

November 28, 2018 **7:00 pm**

Dr. Stephen Self, University of California – Berkeley

Anticipating future Volcanic Explosivity Index (VEI) 7 eruptions and their chilling impacts

California Board for Professional Engineers, Land Surveyors, and Geologists California Specific Exam Occupational Analysis Survey

The California Board for Professional Engineers, Land Surveyors, and Geologists (BPELSG) is undertaking a comprehensive research project of the professional geology profession referred to as an Occupational Analysis. You are invited to participate in an online survey that will validate the tasks and knowledge that are important to the work performed by geology professionals as it applies to the definition of geology and the authority to practice in California.

In accordance with §7841 (d) of the Geologist and Geophysicist Act, the California-Specific Exam is one of three exams required to obtain the California Professional Geologist practice authority license. The California Specific Exam is a SUPPLEMENT to the National Association of State Boards of Geology (ASBOG) Fundamentals of Geology (FG) and Practice of Geology (PG) exams. The California-Specific Exam is intended to address the areas of geologic practice that are specific to the State of California, and therefore not addressed by the ASBOG exams. The California-Specific Exam IS NOT intended to duplicate general geologic practice tasks common to all geologists nationwide that are covered by the national ASBOG FG and PG license exams.

The results of the study will be used to update the California-Specific Exam and will also provide BPELSG with valuable information regarding the work performed by geology professionals. The Occupational Analysis is completed every five to seven years and is the source for determining the content of the licensing exams. This analysis is an essential step in keeping the California Specific Exam current and practice-related.

BPELSG requests your assistance in completing an online survey that takes approximately 45 minutes to complete and can be saved and completed in multiple sessions. They invite you to participate in the online survey using this link: https://www.prometricsurvey.com/se/123C457B2D2B599601.

NCGS Field Trips

We will probably hold several 2019 trips on Mount Diablo, to focus on and coordinate with our 75th anniversary GSA volume on its geology.

- Devil's Slide (November 3; repeat of Nov 2017 trip; see 10/15 email from Crystal to sign up)
- Up to four different field trips to Mount Diablo and vicinity (2019; in planning stages)

We are always looking for new field trip opportunities. If you go on or hear about an interesting field trip, please let Will Schweller (willschweller@yahoo.com) know about it so that we can evaluate it for a future NCGS trip.

We plan a **silent auction** for the November meeting, as a fund-raiser for the publication costs for the 75th anniversary volume on the geology of Mount Diablo. This will probably involve a wider selection of items, so think about what you might want to part with! More information to follow in the November newsletter.

WE HAVE A FACEBOOK GROUP! FIND US ON FACEBOOK @NCGEOLSOC AND TWITTER @NORCALGEOSOC

Check out our updated NCGS Website at http://ncgeolsoc.org/**.** We have posted many older field trip guidebooks for free download, and we describe the process for purchasing newer guidebooks. The website includes a list of upcoming meetings, information on our scholarship program, a list of useful web links, and list of NCGS officers.

UC Berkeley Earth & Planetary Science Weekly Seminar Series

Interesting seminars are presented at 141 McCone Hall (usually) on Thursdays at 4 pm for most of the academic year, from late August through early May.
For an updated list of seminars, go to http://eps.berkeley.edu/events/seminars.

Bay Area Geophysical Society

This society meets approximately monthly in Pleasant Hill, but no upcoming meetings are currently listed on

the website. For details see: http://bayareageophysicalsociety.org/index.php/events/list/.

NCGS members are invited our next **Board of Directors meeting,** on **January 12** at the APTIM office at 4005 Port Chicago Highway. Board meetings are generally held at 8:30 am on a Saturday in January, May, and September, and are open to all NCGS members. Please contact Greg Bartow if you would like to attend, at gregbartow@yahoo,com.

NCGS Outreach Events

It's fall again, and the outreach committee has planned for NCGS representation at these upcoming events:

October 21: **Math-Science Nucleus Earthquake Fair** in Fremont

October 27: **Science Discovery Day** at Cal. State East Bay in Concord.

November 3: **Science Discovery Day** at A.T.&T. Park in S.F.

Contact Mark Petrofsky if you are interested in participating in any of these events:
mpetrof@hotmail.com

Bay Area Science

(http://www.bayareascience.org)

This website provides a free weekly emailed newsletter of an extensive listing of local science-based activities (evening lectures, classes, field trips, hikes, etc. – usually several per week).

Hayward Fault - 150th Anniversary of Great Quake (1868)

The 150th Anniversary of the Great Hayward Fault Earthquake in 1868 will be on Oct 21, 2018. Numerous events and tours are planned (also see "Outreach" above): https://msnucleus.org/haywardfault/150_hayward.html. If you have any questions please contact Joyce at blueford@msnucleus.org<mailto:blueford@msnucleus.org> or call (510) 790-6284.

Association of Environmental & Engineering Geologists, San Francisco Bay Area Chapter

Meeting locations rotate between San Francisco, the East Bay, and the South Bay. Please check the website for current details. For information on monthly meetings as well as this year's international congress, go to: http://www.aegweb.org/group/SF.

USGS Evening Public Lecture Series

The USGS evening public lecture series events are free and are intended for a general public audience that may not be familiar with the science being discussed. Monthly lectures are usually scheduled for the last Thursday of the month throughout the year, or often the previous Thursday to accommodate speakers. The lecture on Thursday October 25th will be ***Post-Fire Debris-Flow Early Warning: The case for forecast-based warning systems,*** by Dennis M. Staley and Jason W. Kean, USGS Landslide Hazards Program, and Mark Jackson, National Weather Service - Los Angeles. For more information on the lectures, and for a map of the location, go to: https://online.wr.usgs.gov/calendar/.

Fat from 558 million years ago reveals earliest known animal

ScienceDaily, September 20, 2018

This is a Dickinsonia fossil.

Credit: The Australian National University (ANU)

Scientists from The Australian National University (ANU) and overseas have discovered molecules of fat in an ancient fossil to reveal the earliest confirmed animal in the geological record that lived on Earth 558 million years ago.

The strange creature called Dickinsonia, which grew up to 1.4 metres in length and was oval shaped with rib-like segments running along its body, was part of the Ediacara Biota that lived on Earth 20 million years prior to the 'Cambrian explosion' of modern animal life.

ANU PhD scholar Ilya Bobrovskiy discovered a Dickinsonia fossil so well preserved in a remote area near the White Sea in the northwest of Russia that the tissue still contained molecules of cholesterol, a type of fat that is the hallmark of animal life.

Lead senior researcher Associate Professor Jochen Brocks said the 'Cambrian explosion' was when

complex animals and other macroscopic organisms -- such as molluscs, worms, arthropods and sponges -- began to dominate the fossil record.

"The fossil fat molecules that we've found prove that animals were large and abundant 558 million years ago, millions of years earlier than previously thought," said Associate Professor Jochen Brocks from the ANU Research School of Earth Sciences.

"Scientists have been fighting for more than 75 years over what Dickinsonia and other bizarre fossils of the Edicaran Biota were: giant single-celled amoeba, lichen, failed experiments of evolution or the earliest animals on Earth. The fossil fat now confirms Dickinsonia as the oldest known animal fossil, solving a decades-old mystery that has been the Holy Grail of palaeontology."

Mr Bobrovskiy said the team developed a new approach to study Dickinsonia fossils, which hold the key between the old world dominated by bacteria and the world of large animals that emerged 540 million years ago during the 'Cambrian explosion'.

"The problem that we had to overcome was finding Dickinsonia fossils that retained some organic matter," said Mr Bobrovskiy from the ANU Research School of Earth Sciences.

"Most rocks containing these fossils such as those from the Ediacara Hills in Australia have endured a lot of heat, a lot of pressure, and then they were weathered after that -- these are the rocks that palaeontologists studied for many decades, which explained why they were stuck on the question of Dickinsonia's true identity."

Palaeontologists normally study the structure of fossils, but Mr Bobrovskiy extracted and analysed molecules from inside the Dickinsonia fossil found in ancient rocks in Russia to make the breakthrough discovery.

"I took a helicopter to reach this very remote part of the world -- home to bears and mosquitoes -- where I could find Dickinsonia fossils with organic matter still intact," Mr Bobrovskiy said.

"These fossils were located in the middle of cliffs of the White Sea that are 60 to 100 metres high. I had to hang over the edge of a cliff on ropes and dig out huge blocks of sandstone, throw them down, wash the sandstone and repeat this process until I found the fossils I was after."

Associate Professor Brocks said being able to study molecules from these ancient organisms was a gamechanger. "When Ilya showed me the results, I just couldn't believe it," he said. "But I also immediately saw the significance."

ANU led the research in collaboration with scientists from the Russian Academy of Science and the Max Planck Institute for Biogeochemistry and the University of Bremen in Germany.

Journal Reference: Ilya Bobrovskiy, Janet M. Hope, Andrey Ivantsov, Benjamin J. Nettersheim, Christian Hallmann, Jochen J. Brocks. **Ancient steroids establish the Ediacaran fossil Dickinsonia as one of the earliest animals.** *Science*, 2018; 361 (6408): 1246 DOI: 10.1126/science.aat7228.

Sound waves reveal enormous diamond cache deep in Earth's interior

Study finds one to two percent of Earth's oldest mantle rocks are made from diamond

ScienceDaily, July 16, 2018

There may be more than a quadrillion tons of diamond hidden in the Earth's interior, according to a new study from MIT and other universities. But the new results are unlikely to set off a diamond rush. The scientists estimate the precious minerals are buried more than 100 miles below the surface, far deeper than any drilling expedition has ever reached.

The ultradeep cache may be scattered within cratonic roots -- the oldest and most immovable sections of rock that lie beneath the center of most continental tectonic plates. Shaped like inverted mountains, cratons can stretch as deep as 200 miles through the Earth's crust and into its mantle; geologists refer to their deepest sections as "roots."

In the new study, scientists estimate that cratonic roots may contain 1 to 2 percent diamond. Considering the total volume of cratonic roots in the Earth, the team figures that about a quadrillion (1016) tons of diamond are scattered within these ancient rocks, 90 to 150 miles below the surface.

"This shows that diamond is not perhaps this exotic mineral, but on the [geological] scale of things, it's relatively common," says Ulrich Faul, a research scientist in MIT's Department of Earth, Atmospheric, and Planetary Sciences. "We can't get at them, but still, there is much more diamond there than we have ever thought before."

Faul's co-authors include scientists from the University of California at Santa Barbara, the Institut de Physique du Globe de Paris, the University of California at Berkeley, Ecole Polytechnique, the Carnegie Institution of Washington, Harvard University, the University of Science and Technology of China, the

University of Bayreuth, the University of Melbourne, and University College London.

A sound glitch

Faul and his colleagues came to their conclusion after puzzling over an anomaly in seismic data. For the past few decades, agencies such as the United States Geological Survey have kept global records of seismic activity -- essentially, sound waves traveling through the Earth that are triggered by earthquakes, tsunamis, explosions, and other ground-shaking sources. Seismic receivers around the world pick up sound waves from such sources, at various speeds and intensities, which seismologists can use to determine where, for example, an earthquake originated.

Scientists can also use this seismic data to construct an image of what the Earth's interior might look like. Sound waves move at various speeds through the Earth, depending on the temperature, density, and composition of the rocks through which they travel. Scientists have used this relationship between seismic velocity and rock composition to estimate the types of rocks that make up the Earth's crust and parts of the upper mantle, also known as the lithosphere.

However, in using seismic data to map the Earth's interior, scientists have been unable to explain a curious anomaly: Sound waves tend to speed up significantly when passing through the roots of ancient cratons. Cratons are known to be colder and less dense than the surrounding mantle, which would in turn yield slightly faster sound waves, but not quite as fast as what has been measured.

"The velocities that are measured are faster than what we think we can reproduce with reasonable assumptions about what is there," Faul says. "Then we have to say, 'There is a problem.' That's how this project started."

Diamonds in the deep

The team aimed to identify the composition of cratonic roots that might explain the spikes in seismic speeds. To do this, seismologists on the team first used seismic data from the USGS and other sources to generate a three-dimensional model of the velocities of seismic waves traveling through the Earth's major cratons.

Next, Faul and others, who in the past have measured sound speeds through many different types of minerals in the laboratory, used this knowledge to assemble virtual rocks, made from various combinations of minerals. Then the team calculated how fast sound waves would travel through each virtual rock, and found only one type of rock that produced the same velocities as what the seismologists measured: one that contains 1 to 2 percent diamond, in addition to peridotite (the predominant rock type of the Earth's upper mantle) and minor amounts of eclogite (representing subducted oceanic crust). This scenario represents at least 1,000 times more diamond than people had previously expected.

"Diamond in many ways is special," Faul says. "One of its special properties is, the sound velocity in diamond is more than twice as fast as in the dominant mineral in upper mantle rocks, olivine."

The researchers found that a rock composition of 1 to 2 percent diamond would be just enough to produce the higher sound velocities that the seismologists measured. This small fraction of diamond would also not change the overall density of a craton, which is naturally less dense than the surrounding mantle.

"They are like pieces of wood, floating on water," Faul says. "Cratons are a tiny bit less dense than their surroundings, so they don't get subducted back into the Earth but stay floating on the surface. This is how they preserve the oldest rocks. So we found that you just need 1 to 2 percent diamond for cratons to be stable and not sink."

In a way, Faul says cratonic roots made partly of diamond makes sense. Diamonds are forged in the high-pressure, high-temperature environment of the deep Earth and only make it close to the surface through volcanic eruptions that occur every few tens of millions of years. These eruptions carve out geologic "pipes" made of a type of rock called kimberlite (named after the town of Kimberley, South Africa, where the first diamonds in this type of rock were found). Diamond, along with magma from deep in the Earth, can spew out through kimberlite pipes, onto the surface of the Earth.

For the most part, kimberlite pipes have been found at the edges of cratonic roots, such as in certain parts of Canada, Siberia, Australia, and South Africa. It would make sense, then, that cratonic roots should contain some diamond in their makeup.

"It's circumstantial evidence, but we've pieced it all together," Faul says. "We went through all the different possibilities, from every angle, and this is the only one that's left as a reasonable explanation." This research was supported, in part, by the National Science Foundation.

Journal Reference: Joshua M. Garber, Satish Maurya, Jean-Alexis Hernandez, Megan S. Duncan, Li Zeng, Hongluo L. Zhang, Ulrich Faul, Catherine McCammon, Jean-Paul Montagner, Louis Moresi, Barbara A. Romanowicz, Roberta L. Rudnick, Lars Stixrude. **Multidisciplinary Constraints on the**

Abundance of Diamond and Eclogite in the Cratonic Lithosphere. *Geochemistry, Geophysics, Geosystems*, 2018; DOI: 10.1029/2018GC007534.

Major fossil study sheds new light on emergence of early animal life 540 million years ago

ScienceDaily, May 21, 2018

All the major groups of animals appear in the fossil record for the first time around 540-500 million years ago -- an event known as the Cambrian Explosion -- but new research from the University of Oxford in collaboration with the University of Lausanne suggests that for most animals this 'explosion' was in fact a more gradual process.

The Cambrian Explosion produced the largest and most diverse grouping of animals the Earth has ever seen: the euarthropods. Euarthropoda contains the insects, crustaceans, spiders, trilobites, and a huge diversity of other animal forms alive and extinct. They comprise over 80 percent of all animal species on the planet and are key components of all of Earth's ecosystems, making them the most important group since the dawn of animals over 500 million years ago.

A team based at Oxford University Museum of Natural History and the University of Lausanne carried out the most comprehensive analysis ever made of early fossil euarthropods from every different possible type of fossil preservation. In an article published today in the Proceedings of the National Academy of Sciences they show that, taken together, the total fossil record shows a gradual radiation of euarthropods during the early Cambrian, 540-500 million years ago.

The new analysis presents a challenge to the two major competing hypotheses about early animal evolution. The first of these suggests a slow, gradual evolution of euarthropods starting 650-600 million years ago, which had been consistent with earlier molecular dating estimates of their origin. The other hypothesis claims the nearly instantaneous appearance of euarthropods 540 million years ago because of highly elevated rates of evolution.

The new research suggests a middle-ground between these two hypotheses, with the origin of euarthropods no earlier than 550 million years ago, corresponding with more recent molecular dating estimates, and with the subsequent diversification taking place over the next 40 million years.

"Each of the major types of fossil evidence has its limitation and they are incomplete in different ways, but when taken together they are mutually illuminating and allow a coherent picture to emerge of the origin and radiation of the euarthropods during the lower to middle Cambrian," explains Professor Allison Daley, who carried out the work at Oxford University Museum of Natural History and at the University of Lausanne. "This indicates that the Cambrian Explosion, rather than being a sudden event, unfolded gradually over the ~40 million years of the lower to middle Cambrian."

The timing of the origin of Euarthropoda is very important as it affects how we view and interpret the evolution of the group. By working out which groups developed first we can trace the evolution of physical characteristics, such as limbs.

It has been argued that the absence of euarthropods from the Precambrian Period, earlier than around 540 million years ago, is the result of a lack of fossil preservation. But the new comprehensive fossil study suggests that this isn't the case.

"The idea that arthropods are missing from the Precambrian fossil record because of biases in how fossils are preserved can now be rejected," says Dr Greg Edgecombe FRS from the Natural History Museum, London, who was not involved in the study. "The authors make a very compelling case that the late Precambrian and Cambrian are in fact very similar in terms of how fossils preserve. There is really just one plausible explanation -- arthropods hadn't yet evolved."

Harriet Drage, a PhD student at Oxford University Department of Zoology and one of the paper's co-authors, says: "When it comes to understanding the early history of life the best source of evidence that we have is the fossil record, which is compelling and very complete around the early to middle Cambrian. It speaks volumes about the origin of euarthropods during an interval of time when fossil preservation was the best it has ever been."

Journal Reference: Allison C. Daley, Jonathan B. Antcliffe, Harriet B. Drage, Stephen Pates. Early fossil record of Euarthropoda and the Cambrian explosion. *Proceedings of the National Academy of Sciences*, 2018: 201719962. DOI: 10.1073/pnas.1719962115.

Did key building blocks for life come from deep space?

ScienceDaily, September 28, 2018

All living beings need cells and energy to replicate. Without these fundamental building blocks, living organisms on Earth would not be able to reproduce and would simply not exist.

Little was known about a key element in the building blocks, phosphates, until now. University of Hawaii at Manoa researchers, in collaboration with colleagues in France and Taiwan, provide compelling new evidence that this component for life was found to be generated in outer space and delivered to Earth in its first one billion years by meteorites or comets. The phosphorus compounds were then incorporated in biomolecules found in cells in living beings on Earth.

The breakthrough research is outlined in "An Interstellar Synthesis of Phosphorus Oxoacids," authored by UH Manoa graduate student Andrew Turner, now assistant professor at the University of Pikeville, and UH Manoa chemistry Professor Ralf Kaiser in the September issue of Nature Communications.

According to the study, phosphates and diphosphoric acid are two major elements that are essential for these building blocks in molecular biology. They are the main constituents of chromosomes, the carriers of genetic information in which DNA is found. Together with phospholipids in cell membranes and adenosine triphosphate, which function as energy carriers in cells, they form self-replicating material present in all living organisms.

In an ultra-high vacuum chamber cooled down to 5 K (-450°F) in the W.M. Keck Research Laboratory in Astrochemistry at UH Manoa, the Hawaii team replicated interstellar icy grains coated with carbon dioxide and water, which are ubiquitous in cold molecular clouds, and phosphine. When exposed to ionizing radiation in the form of high-energy electrons to simulate the cosmic rays in space, multiple phosphorus oxoacids like phosphoric acid and diphosphoric acid were synthesized via non-equilibrium reactions.

"On Earth, phosphine is lethal to living beings," said Turner, lead author. "But in the interstellar medium, an exotic phosphine chemistry can promote rare chemical reaction pathways to initiate the formation of biorelevant molecules such as oxoacids of phosphorus, which eventually might spark the molecular evolution of life as we know it."

Kaiser added, "The phosphorus oxoacids detected in our experiments by combination of sophisticated analytics involving lasers, coupled to mass spectrometers along with gas chromatographs, might have also been formed within the ices of comets such as 67P/Churyumov-Gerasimenko, which contains a phosphorus source believed to derive from phosphine." Kaiser says these techniques can also be used to detect trace amounts of explosives and drugs.

"Since comets contain at least partially the remnants of the material of the protoplanetary disk that formed our solar system, these compounds might be traced back to the interstellar medium wherever sufficient phosphine in interstellar ices is available," said Cornelia Meinert of the University of Nice (France).

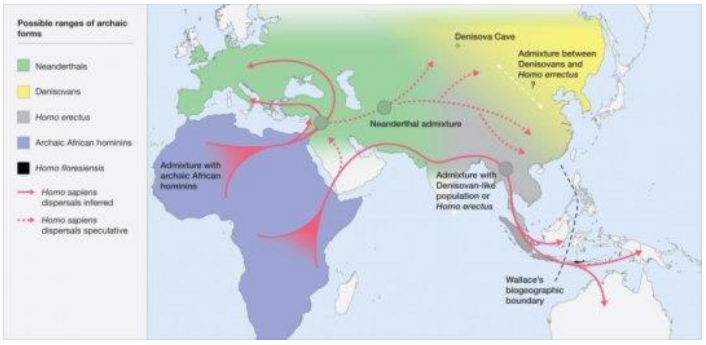
Upon delivery to Earth by meteorites or comets, these phosphorus oxoacids might have been available for Earth's prebiotic phosphorus chemistry. Hence an understanding of the facile synthesis of these oxoacids is essential to untangle the origin of water-soluble prebiotic phosphorus compounds and how they might have been incorporated into organisms not only on Earth, but potentially in our universe as well.

Turner and Kaiser worked with Meinert and Agnes Chang of National Dong Hwa University (Taiwan) on this project.

Journal Reference: Andrew M. Turner, Alexandre Bergantini, Matthew J. Abplanalp, Cheng Zhu, Sándor Góbi, Bing-Jian Sun, Kang-Heng Chao, Agnes H. H. Chang, Cornelia Meinert, Ralf I. Kaiser. **An interstellar synthesis of phosphorus oxoacids**. *Nature Communications*, 2018; 9 (1) DOI: 10.1038/s41467-018-06415-7.

Homo sapiens developed a new ecological niche that separated it from other hominins

ScienceDaily, July 30, 2018



Map of the potential distribution of archaic hominins, including H. erectus, H. floresiensis, H. neanderthalenesis, Denisovans and archaic African hominins, in the Old World at the time of the evolution and dispersal of H. sapiens between approximately 300 and 60 thousand years ago.

Credit: Roberts and Stewart. 2018. Defining the 'generalist specialist' niche for Pleistocene Homo sapiens. Nature Human Behaviour. 10.1038/s41562-018-0394-4.

Critical review of growing archaeological and palaeoenvironmental datasets relating to the Middle and Late Pleistocene (300-12 thousand years ago) hominin dispersals within and beyond Africa, published today in Nature Human Behaviour, demonstrates unique environmental settings and adaptations for Homo sapiens relative to previous and coexisting hominins such as Homo neanderthalensis and Homo erectus. Our species' ability to occupy diverse and 'extreme' settings around the world stands in stark contrast to the ecological adaptations of other hominin taxa, and may explain how our species became the last surviving hominin on the planet.

The paper, by scientists from the Max Planck Institute for the Science of Human History and the University of Michigan suggests investigations into what it means to be human should shift from attempts to uncover the earliest material traces of 'art', 'language', or technological 'complexity' towards understanding what makes our species ecologically unique. In contrast to our ancestors and contemporary relatives, our species not only colonized a diversity of challenging environments, including deserts, tropical rainforests, high altitude settings, and the palaeoarctic, but also specialized in its adaptation to some of these extremes.

Ancestral ecologies -- the ecology of Early and Middle Pleistocene Homo

Although all hominins that make up the genus Homo are often termed 'human' in academic and public circles, this evolutionary group, which emerged in Africa around 3 million years ago, is highly diverse. Some members of the genus Homo (namely Homo erectus) had made it to Spain, Georgia, China, and Indonesia by 1 million years ago. Yet, existing information from fossil animals, ancient plants, and chemical methods all suggest that these groups followed and exploited environmental mosaics of forest and grassland. It has been argued that Homo erectus and the 'Hobbit', or Homo floresiensis, used humid, resource-scarce tropical rainforest habitats in Southeast Asia from 1 million years ago to 100,000 and 50,000 years ago, respectively. However, the authors found no reliable evidence for this.

It has also been argued that our closest hominin relatives, Homo Neanderthalensis - or the Neanderthals -- were specialized to the occupation of high latitude Eurasia between 250,000 and 40,000 years ago. The base for this includes a face shape potentially adapted to cold temperatures and a hunting focus on large animals such as woolly mammoths. Nevertheless, a review of the evidence led the authors to again conclude that Neanderthals primarily exploited a diversity of forest and grassland habitats, and hunted a diversity of animals, from temperate northern Eurasia to the Mediterranean.

Deserts, rainforests, mountains, and the arctic

In contrast to these other members of the genus Homo, our species -- Homo sapiens - had expanded to higher-elevation niches than its hominin predecessors and contemporaries by 80-50,000 years ago, and by at least 45,000 years ago was rapidly colonizing a range of palaeoarctic settings and tropical rainforest conditions across Asia, Melanesia, and the Americas. Furthermore, the authors argue that the continued accumulation of better-dated, higher resolution environmental datasets associated with our species' crossing the deserts of northern Africa, the Arabian Peninsula, and northwest India, as well as the high elevations of Tibet and the Andes, will further help to determine the degree to which our species demonstrated novel colonizing capacities in entering these regions.

Finding the origins of this ecological 'plasticity', or the ability to occupy a number of very different environments, currently remains difficult in Africa, particularly back towards the evolutionary origins of Homo sapiens 300-200,000 years ago. However, the authors argue that there are tantalizing hints for novel environmental contexts of human habitation and associated technological shifts across Africa just after this timeframe. They hypothesize that the drivers of these changes will become more apparent with future work, especially that which tightly integrates archaeological evidence with highly resolved local palaeoecological data. For example, lead author of the paper, Dr. Patrick Roberts, suggests, "although a focus on finding new fossils or genetic characterization of our species and its ancestors has helped rough out the broad timing and location of hominin specifications, such efforts are largely silent on the various environmental contexts of biocultural selection."

The 'generalist specialist' -- a very sapiens niche

One of the main new claims of the authors is that the evidence for human occupation of a huge diversity of environmental settings across the majority of the Earth's continents by the Late Pleistocene hints at a new ecological niche, that of the 'generalist specialist'. As Roberts states "A traditional ecological dichotomy exists between 'generalists', who can make use of a variety of different resources and inhabit a variety of environmental conditions, and 'specialists', who have a limited diet and narrow environmental tolerance. However, Homo sapiens furnish evidence for 'specialist' populations, such as mountain rainforest foragers or palaeoarctic mammoth hunters, existing

within what is traditionally defined as a 'generalist' species."

This ecological ability may have been aided by extensive cooperation between non-kin individuals among Pleistocene Homo sapiens, argues Dr. Brian Stewart, co-author of the study. "Non-kin food sharing, long-distance exchange, and ritual relationships would have allowed populations to 'reflexively' adapt to local climatic and environmental fluctuations, and outcompete and replace other hominin species." In essence, accumulating, drawing from, and passing down a large pool of cumulative cultural knowledge, in material or idea form, may have been crucial in the creation and maintenance of the generalist-specialist niche by our species in the Pleistocene.

Implications for our pursuit of ancient humanity

The authors are clear that this proposition remains hypothetical and could be disproven by evidence for the use of 'extreme' environments by other members of the genus Homo. However, testing the 'generalist specialist' niche in our species encourages research in more extreme environments that have previously been neglected as unpromising for palaeoanthropological and archaeological work, including the Gobi Desert and Amazon rainforest. The expansion of such research is particularly important in Africa, the evolutionary cradle of Homo sapiens, where more detailed archaeological and environmental records dating back to 300-200,000 years ago are becoming increasingly crucial if we are to track the ecological abilities of the earliest humans.

It is also clear that growing evidence for hominin interbreeding and a complex anatomical and behavioural origin of our species in Africa highlights that archaeologists and palaeoanthropologists should focus on looking at the environmental associations of fossils. "While we often get excited by the discovery of new fossils or genomes, perhaps we need to think about the behavioural implications of these discoveries in more detail, and pay more attention to what these new finds tell us about new the passing of ecological thresholds" says Stewart. Work focusing on how the genetics of different hominins may have led to ecological and physical benefits such as high-altitude capacities or UV tolerance remain highly fruitful ways forward in this regard.

"As with other definitions of human origins, problems of preservation also make it difficult to pinpoint the origins of humans as an ecological pioneer. However, an ecological perspective on the origins and nature of our species potentially illuminates the unique path of Homo sapiens as it rapidly came to dominate the Earth's diverse continents and environments," concludes Roberts. The testing of this hypothesis should open up new avenues for research and, if correct, new perspectives as to whether the 'generalist specialist' will continue to be an adaptive success in the face of growing issues of sustainability and environmental conflict.

Journal Reference: Patrick Roberts, Brian A. Stewart. **Defining the 'generalist specialist' niche for Pleistocene Homo sapiens**. *Nature Human Behaviour*, 2018; DOI: 10.1038/s41562-018-0394-4.

Archeological plant remains point to southwest Amazonia as crop domestication center

Ancient people in the region began cultivating plants and altering forests earlier than previously thought

ScienceDaily, July 26, 2018

The authors believe that the Teotonio waterfall is what attracted people to this location for over 9000 years, as it was an extremely rich fishing location and an obligatory stopping point for people travelling by boat on this stretch of the Madeira river. It was the location of a fishing village (the village of Teotonio) until 2011, when residents were forced to move inland ahead of dam construction. The dam submersed the village and the waterfall. *Credit: Eduardo Neves, 2011*

The remains of domesticated crop plants at an archaeological site in southwest Amazonia supports the idea that this was an important region in the early history of crop cultivation, according to a study published July 25, 2018 in the open-access journal PLOS ONE by Jennifer Watling from the Museum of Archaeology and Ethnology at the University of São Paulo, Brazil and colleagues.

Genetic analysis of plant species has long pointed to the lowlands of southwest Amazonia as a key region in the early history of plant domestication in the Americas, but systematic archaeological evidence to support this has been rare. The new evidence comes from recently-exposed layers of the Teotonio archaeological site, which has been described by researchers as a "microcosm of human occupation of the Upper Madeira [River]" because it preserves a nearly continuous record of human cultures going back approximately 9,000 years.

In this study, Watling and colleagues analyzed the remains of seeds, phytoliths, and other plant materials in the most ancient soils of the site as well as on artefacts used for processing food. They found some of the earliest evidence of cultivated manioc, a crop which geneticists say was domesticated here over 8,000 years ago, as well as squash, beans, and perhaps calathea, and important tree crops such as palms and Brazil nut. They also saw evidence of disturbed forest and a soil type called "Anthropogenic Dark Earths" which both result from human alteration of local environments.

These findings suggest that the people of this region transitioned from early hunter-gatherer lifestyles to cultivating crops before 6,000 years ago, much earlier than previously thought. Along with plant domestication also came the familiar human habit of landscape modification, suggesting that human impact on Amazonian forests in this region goes back many thousands of years. Altogether, these results point to the Upper Madeira as a key locality to explore the earliest days of crop domestication in the New World.

Watling notes: "This discovery at the Teotonio waterfall in Southest Amazonia is some of the oldest evidence for plant cultivation in lowland South America, confirming genetic evidence."

Journal Reference: Jennifer Watling, Myrtle P. Shock, Guilherme Z. Mongeló, Fernando O. Almeida, Thiago Kater, Paulo E. De Oliveira, Eduardo G. Neves. **Direct archaeological evidence for Southwestern Amazonia as an early plant domestication and food production centre**. *PLOS ONE*, 2018; 13 (7): e0199868 DOI: 10.1371/journal.pone.0199868.

The origins of the High Plains landscape at base of Rocky Mountains

ScienceDaily, September 26, 2018

Starting at the eastern foot of the Rocky Mountains in the midwest United States, the dramatic landscape of the High Plains stretches across several US states. Dropping just a few hundred meters over a length of more than 500 kilometres, these plains have only a very gentle gradient and the nearly flat surfaces exhibit unique ecosystems, making them a geological and ecological anomaly.

In the High Plains there are hundreds of thousands of small ephemeral lakes known as playas, that are filled with rainwater only during wet seasons, drying out completely during dry periods. The lakes provide an important breeding, resting and wintering habitat for millions of birds and also supply recharge to the groundwater reservoir known as the Ogallala aquifer. At 450,000 square kilometres, it is the largest aquifer in North America. Without these groundwater resources, agriculture in this dry region would be nearly impossible.

By no means a geological bore

Geologists have given little attention to the High Plains in recent times. "For alpine geologists used to working in high mountains, the region is too flat and considered uninteresting," says Sean Willett, a professor of geology at ETH Zurich, with a chuckle. It was by chance that he and his two colleagues from the University of Nevada developed an interest in the region when they noticed "peculiar patterns of streams" crossing the High Plains. They have now published their reconstruction of the region's unusual geological history in "Nature."

The High Plains were formed 20 million years ago. Earth scientists have recently discovered a zone of unusually hot material in the Earth's mantle that creates a wave of uplift that is slowly shifting from west to east under the continental plate. This wave first uplifted the Colorado Plateau, then the Rockies and finally the plains themselves. This resulted in a steeper gradient of the mountains towards the plains, accelerating erosion. For 15 million years, a massive flow of sediment poured out of the mountains, down the river valleys and into the plains.

Sediment transported by the rivers was deposited to form huge alluvial fans at the foot of the mountains. Gravel and coarse sand completely filled river valleys and all older topography, effectively repaving the landscape to form the gentle slopes of the modern high plains.

Lakes with limestone sealant

Because alluvial fans only have a very low gradient, rivers flowing down its surface lack erosive power. The surface of these plains sealed with sand, mud and clay, thus making it possible for rain water to remain in sinks to form lakes. Chemical processes eventually led to a calcification of the lakebeds and soils, forming

limestone layers up to 10 meters thick. Finally, as it aged, cracks formed in the limestone, allowing water to seep through and feed a groundwater reservoir of vast area and volume, hosted in the gravels shed from the mountains.

The flow of sediment finally stopped around three to five million years ago. Since then, the High Plains' surfaces have changed very little (with the exception of human impact). "They are a preserved ancient landscape," says Willett.

Rivers flowing from the Rocky Mountains did, however, seek out new paths and carved deeper into the subsurface along the edges of the prehistoric alluvial fans. This inexorable process is still underway: the rivers continue to erode the alluvial fans, which is evident in the formation of escarpments and badlands with dendritic patterns of streams and rivers cutting into the plateaus of the High Plains. "What we are seeing today is a landscape in transition," the ETH professor points out. "It will take five or ten million years until the High Plains have completely eroded."

An unstoppable disintegration of the alluvial fans

Willet does not see any immediate threat to the groundwater supply. However, people should be aware that the forces breaking down the High Plains are responsible for where groundwater is found today and where agriculture is possible.

There is nowhere else in the world quite like the High Plains. There are, of course, gigantic alluvial plains in South America as well, and in the part of the Himalayas located in India. "But the High Plains have been inactive for nearly five million years, whereas the other large alluvial fans are still in the process of formation," says the researcher.

Journal Reference: Sean D. Willett, Scott W. McCoy, Helen W. Beeson. **Transience of the North American High Plains landscape and its impact on surface water.** *Nature*, 2018; 561 (7724): 528 DOI: 10.1038/s41586-018-0532-1.

Lead pollution in Greenland ice shows rise and fall of ancient European civilizations

Ice-core study finds evidence of plagues, wars and imperial expansion

ScienceDaily, May 14, 2018

To learn about the rise and fall of ancient European civilizations, researchers sometimes find clues in unlikely places: deep inside of the Greenland ice sheet, for example.

Thousands of years ago, during the height of the ancient Greek and Roman empires, lead emissions from sources such as the mining and smelting of lead-silver ores in Europe drifted with the winds over the ocean to Greenland -- a distance of more than 2800 miles (4600 km) -- and settled onto the ice. Year after year, as fallen snow added layers to the ice sheet, lead emissions were captured along with dust and other airborne particles, and became part of the ice-core record that scientists use today to learn about conditions of the past.

In a new study published in PNAS, a team of scientists, archaeologists and economists from the Desert Research Institute (DRI), the University of Oxford, NILU -- Norwegian Institute for Air Research and the University of Copenhagen used ice samples from the North Greenland Ice Core Project (NGRIP) to measure, date and analyze European lead emissions that were captured in Greenland ice between 1100 BC and AD 800. Their results provide new insight for historians about how European civilizations and their economies fared over time.

"Our record of sub-annually resolved, accurately dated measurements in the ice core starts in 1100 BC during the late Iron Age and extends through antiquity and late antiquity to the early Middle Ages in Europe -- a period that included the rise and fall of the Greek and Roman civilizations," said the study's lead author Joe McConnell, Ph.D., Research Professor of Hydrology at DRI. "We found that lead pollution in Greenland very closely tracked known plagues, wars, social unrest and imperial expansions during European antiquity."

A previous study from the mid-1990s examined lead levels in Greenland ice using only 18 measurements between 1100 BC and AD 800; the new study provides a much more complete record that included more than 21,000 precise lead and other chemical measurements to develop an accurately dated, continuous record for the same 1900-year period.

To determine the magnitude of European emissions from the lead pollution levels measured in the Greenland ice, the team used state-of-the-art atmospheric transport model simulations.

"We believe this is the first time such detailed modeling has been used to interpret an ice-core record of human-made pollution and identify the most likely source region of the pollution," said coauthor Andreas Stohl, Ph.D., Senior Scientist at NILU.

Most of the lead emissions from this time period are believed to have been linked to the production of silver, which was a key component of currency.

"Because most of the emissions during these periods resulted from mining and smelting of lead-silver ores, lead emissions can be seen as a proxy or indicator of overall economic activity," McConnell explained.

Using their detailed ice-core chronology, the research team looked for linkages between lead emissions and significant historical events.

Their results show that lead pollution emissions began to rise as early as 900 BC, as Phoenicians expanded their trading routes into the western Mediterranean. Lead emissions accelerated during a period of increased mining activity by the Carthaginians and Romans primarily in the Iberian Peninsula, and reached a maximum under the Roman Empire.

The team's extensive measurements provide a different picture of ancient economic activity than previous research had provided. Some historians, for example, had argued that the sparse Greenland lead record provided evidence of better economic performance during the Roman Republic than during the Roman Empire.

According to the findings of this study, the highest sustained levels of lead pollution emissions coincided with the height of the Roman Empire during the 1st and 2nd centuries AD, a period of economic prosperity known as the Pax Romana. The record also shows that lead emissions were very low during the last 80 years of the Roman Republic, a period known as the Crisis of the Roman Republic.

"The nearly four-fold higher lead emissions during the first two centuries of the Roman Empire compared to the last decades of the Roman Republic indicate substantial economic growth under Imperial rule," said coauthor Andrew Wilson, Professor of the Archaeology of the Roman Empire at Oxford.

The team also found that lead emissions rose and fell along with wars and political instability, particularly during the Roman Republic, and took sharp dives when two major plagues struck the Roman Empire in the 2nd and 3rd centuries. The first, called the Antonine Plague, was probably smallpox. The second, called the Plague of Cyprian, struck during a period of political instability called the third-century crisis.

"The great Antonine Plague struck the Roman Empire in AD 165 and lasted at least 15 years. The high lead emissions of the Pax Romana ended exactly at that time and didn't recover until the early Middle Ages more than 500 years later," Wilson explained.

The research team for this study included ice-core specialists, atmospheric scientists, archaeologists, and economic historians -- an unusual combination of expertise.

"Working with such a diverse team was a unique experience in my career as a scientist," McConnell said. "I think that our results show that there can be great value in collaborating across disciplines."

Journal Reference: Joseph R. McConnell, Andrew I. Wilson, Andreas Stohl, Monica M. Arienzo, Nathan J. Chellman, Sabine Eckhardt, Elisabeth M. Thompson, A. Mark Pollard, Jørgen Peder Steffensen. **Lead pollution recorded in Greenland ice indicates European emissions tracked plagues, wars, and imperial expansion during antiquity**. *Proceedings of the National Academy of Sciences*, 2018; 201721818 DOI: 10.1073/pnas.1721818115.

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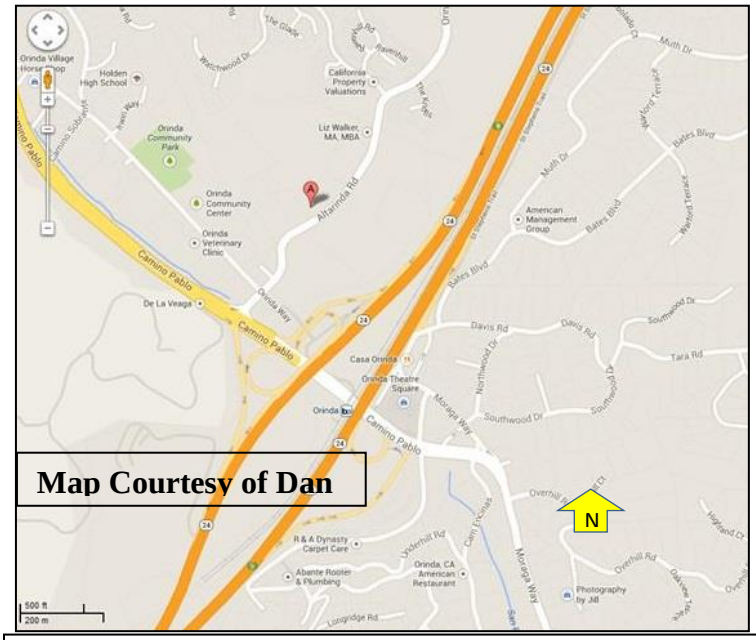

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