NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

MEETING ANNOUNCEMENT

DATE: **November 19, 2014**

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: **Christopher Lewis, Consultant**

Tales from the Oil and Gas Fields and Thereabouts

Some 20 years ago the author decided to write a series of stories about events and people he encountered during his career with the oil industry as a petroleum geologist. This comprised a total of 61 stories plus two from pre-oil days. After that he did not do anything with them until his daughter persuaded him that he should publish them on Amazon Kindle. He thought other geologists might be interested in his experiences and mentioned this to two ex-presidents of the AAPG. They both liked the idea and told him to contact Hans Kraus who looks after "Historical Highlights" in the AAPG Explorer. Hans was keen on publishing his history as long as there was no mention of the Kindle book --- except in the author's accompanying biography.

The talk will cover many of the tales in the book starting with the unusual account of how the author, a liberal arts graduate became an oil geologist. The next section will cover the discoveries he was associated with, including four major ones: Sarir in Libya, and Prudhoe Bay, Kuparuk River and Endicott in Alaska. All these have interesting tales associated with them. He will then consider the eight field seasons he experienced in Alaska including his cruise up the Inland Passage as assistant to the first mate, his very narrow escape in a helicopter crash, and his struggles trying to work out Brooks Range tectonics, among other things.

If time permits, the author would be delighted to elaborate on several other of the more interesting stories.

Biography: Christopher Lewis graduated with honors in French, German and Geography at Cambridge University in 1955. He spent a year as a trainee insurance broker at Lloyds of London and then decided to become a geologist. He graduated with honors in Mineralogy and Petrology at the University of London in 1960. He intended to teach or do research at a university, but was persuaded by British Petroleum to devote his energies to "soft rocks".

…Continued on Back…

NCGS 2012 – 2013 Calendar

November 19, 2014; 7:00 pm
Christopher Lewis
Tales of the Oil and Gas Fields and Thereabouts

January 28, 2015; 7:00 pm
Dr. Lisa White, UCMP
Understanding Global Change From Deep Time To The Anthropocene

February 25, 2015; 7:00 pm
Dr. Bradley Erskine, Kleinfelder, PG, CEG, CHG, Principal Geologist
Building a Dam out of Naturally Occurring Asbestos: Challenges and Solutions at the Calaveras Dam Replacement Project, Sunol, CA

March 25, 2015; 7:00 pm
Dr. Jake Lowenstern, USGS
The Yellowstone Volcano: Past, Present and Future - Monitoring the sleeping giant beneath Yellowstone National Park

April 29, 2015; 7:00 pm
Dr. Robert B. Miller, Professor and Chair of Geology, San Jose State University
Interpretations of Magmatic Fabrics and Structures: Insights from the Sierra Nevada and North Cascades

May 27, 2015; DINNER MEETING; 6:00 pm
B. Lynn Ingram, UC Berkeley
The West without Water

NCGS Field Trips

Saturday April 25, 2015 ***An undefined Petroleum system along the Santa Cruz County coast, California***
Dr. Allegra Hasford Scheirer and Dr. Leslie B. Magoon, Stanford University, Stanford

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.

Bay Area Science

This website provides a free weekly emailed newsletter consisting of an extensive listing of local science based activities (evening lectures, classes, field trips, hikes, and etc). Go to: http://www.bayareascience.org/

Association of Engineering Geologists San Francisco Section

Upcoming Events

Meeting locations rotate between San Francisco, the East Bay, and the South Bay. Please check the website for current details. To download meeting details and registration form go to: http://www.aegsf.org/.

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

2014-2015 RICHARD CHAMBERS MEMORIAL SCHOLARSHIPS

The Northern California Geological Society is pleased to announce the availability of their **Richard Chambers Memorial Scholarships** to help support graduate–level student research in geology during the 2014-2015 academic year. More than one scholarship may be awarded at each academic level.

A $1,000 Scholarship will be awarded to students working towards the Masters Degree. A $2,000 Scholarship will be awarded to students working towards the Ph.D. Degree.

These scholarships will be awarded competitively, based upon our review of submitted summaries of proposed research. Funds are intended to support field and laboratory components of research programs. The research should be scheduled for completion during the 2014-2015 calendar years. Winners' may/will be invited to speak or otherwise present their research at a regular NCGS evening meeting in Orinda, California.

Funding priority for these scholarships will be directed to research focused on topics in general geology, geologic mapping, structural, economic, engineering and/or environmental geology, geophysics, stratigraphy, paleontology and/or paleoecology implemented in northern California and/or states immediately adjacent to northern California.

Application Procedure

Candidates may apply by forwarding a signed cover letter on University Department letterhead requesting the award, accompanied by a brief (no more than 2 pages) summary of their proposed research topic. This letter must include candidates contact information (both departmental and home mailing and email addresses, & telephone numbers).

The bottom of the candidate letter must bear this note (filled out):

Degree Program: _____,

Approved by: _____,
(print): _____,

Title: _____,

Telephone: _____,

e-mail address: _____,

and date: _____.

with the signature and printed name, title, telephone & e-mail of the department chair person or thesis advisor. Please indicate which scholarship (Masters or Ph.D.) you are applying for. No other application form is required.

Please submit your letter and proposal by U.S. Mail postmarked **no later than DECEMBER 14, 2014** to:

Phillip Garbutt, Chair
Voice: (510) 581-9098
NCGS Scholarship Committee
e-mail: plgarbutt@comcast.net
6372 Boone Drive
NCGS website: http://www.ncgeolsoc.org
Castro Valley, CA 94552-5077
Issued: September 5, 2014
Scholarship Awards will be made on or about January 31, 2015

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY and AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

K-12 EARTH SCIENCE TEACHER OF THE YEAR AWARD

$750 Northern California Geological Society
$500 Pacific Section AAPG
$6,000 National AAPG
Call for Nominations for the Year 2014-15 NCGS Competition

The Northern California Geological Society (NCGS) is pleased to announce that it will accept applications from candidates in the Northern California region for the Year 2014-15 competition for the Earth Science Teacher of the Year Award. The $750 NCGS award is intended to recognize pre-college earth science programs already in place, and to encourage their organization in districts where they have not been fully developed. Nominations of qualified K-12 teacher candidates are solicited from teachers, school administrators, teacher outreach programs, and other interested parties.

The NCGS awardees' application will be submitted to a regional competition sponsored by the American Association of Petroleum Geologists (AAPG) Pacific Section. The Pacific Section winner will receive a $500 award at the Pacific Section regional meeting in Ventura / Oxnard, CA, May 2015, plus up to $250 toward meeting expenses. The regional winner's project will be submitted to AAPG headquarters for the national contest. The national winner will receive an expense-paid trip to attend the national AAPG meeting in Alberta, Canada, June 2016, to receive the national award. The remaining regional winners will receive $500 as honorable mentions.

At the national level, the AAPG Foundation presents an annual $6,000 award to a K – 12 teacher for *Excellence in the Teaching of Natural Resources in the Earth Science.* The award recognizes balanced incorporation of natural resource extraction and environmental sustainability concepts in pre-college Earth science curricula. It includes $3,000 to the teacher's school for the winning teacher's use, and $3,000 for the teacher's personal use.

The deadline for application submittal by candidates for the $750 NCGS award is Tuesday, January 16, 2015.

Interested candidates or nominators can request Application Information and an Entrant Application Form, or submit an application, by contacting:

Phil Reed
Chair, K – 12 Geosciences Education Committee
Northern California Geological Society
488 Chaucer Circle, San Ramon, CA
925.829.0628
philecreed@comcast.net

Recent Releases
California Geological Survey

- **July 30, 2014 - CGS Special Report 234: Assessment of Post-Fire Runoff Hazards for Pre-Fire Hazard Mitigation Planning - Southern California.** Click here for release statement. Click here to download the pdf.

- **June 30, 2014 - CGS Special Report 233: Scenario Earthquake Hazards for the Long Valley Caldera-Mono Lake Area, East-Central California**. The Report is now available for download. Click here to download the pdf.

- **April 29, 2014 - California's Non-Fuel Mineral Production for 2012** The Report is now available for download. Click here to download the pdf.

- **February 6, 2014 - 2014 CGS Calendar, Geological Gems of California State Parks** Click here to download the pdf Click here to order for $1.00

- **January 31, 2014 - Radon Potential of the Palos Verdes Area, California** Click here for release statement Click here to download the report and map

- **December 10, 2013 - Update of Mineral Land Classification: Aggregate Materials in the North San Francisco Bay Production-Consumption Region, Sonoma, Napa, Marin, and Southwestern Solano Counties, California**
  Click here for release statement. Click here to download the Report and Maps.

- **April 17, 2013 - California's Non-Fuel Mineral Production for 2011**
  The report is now available for download. Click here to download.

- **April 10, 2013 - New Landslide Inventory Maps**
  Landslide Inventory Map of the Burbank and Hollywood 7.5-minute Quadrangle is now available.
  Click here for the Release Statement. Click here to download the maps.

- **March 1, 2013 - Map Sheet 52 (UPDATED 2012)**
  Aggregate Sustainability in California
  Click here for the Release Statement. Click here to download the Report and Map.

- **January 22, 2013 - Special Report 217 (REVISED)**
  Geologic Compilation of Quaternary Surficial Deposits in Southern California.
  Click here for the Release Statement. Click here to download the Report.

- **CGS releases State Geologic Map and State Fault Activity Map.**
  Printed copies are now available for purchase.
  Geologic Map Release Statement.
  Fault Activity Map Release Statement.

  Click here for more recent releases!

Goldilocks and the Three Zones

(Part 2)

By NCGS Member ***Dr. Bill Motzer***

This article originally appeared in The Vortex from the California Section of the American Chemical Society (CALACS). Go to www.calvaryslz.org/calacs/ where you can download pdfs of the original articles and/or peruse past issues of The Vortex.

In Part 1 of Goldilocks Zones (*Vortex*, September 2012), I described the habitable zone (HZ) concept as the distance from a star that a terrestrial-like planet could maintain liquid water on its surface and consequently form and contain terrestrial-like life. Much of the HZ concept is a function of the right type of chemistry at the right time and even if a planet is within a HZ, there are additional criteria for life to form, evolve, and endure. These are explained in more detail below.

(1) A stable metal-rich star. Based on nucleocosmochronology, the Sun formed about 4.57 billion years ago (Ga) from collapse of a giant molecular cloud composed mostly of hydrogen and helium (H and He). The Sun is a G2 main sequence star consisting of 74.9% H and 23.8% He; heavier elements (i.e., *metals* in astronomy) with less than 2% of its mass as oxygen (O =~1%), carbon (C=0.3%), neon (Ne=0.2%), and iron (Fe=0.2%). It is approximately halfway through its main-sequence stage of core nuclear fusion of H to He, occurring at a rate of more than 4 x 10^6 metric tons per second converted into energy as neutrinos and radiation. If a star's metallicity is too low, Earth-*like* planets composed mostly of O, Mg, Si, and Fe may not form. These elements are produced primarily by massive stellar supernovas enriching the originally pure H and He interstellar gas with their processed ejecta including elements above Fe on the periodic table. An Earth-*mass* planet may form from H, He, and water at lower metallicity, but it might be far less habitable (see below).

(2) A metal-rich rocky planet. Terrestrial planets all have similar structures: a central metallic, mostly iron-rich core generally surrounded by a silicate mantle and a stable outer crust. A metallic (Fe-Ni) core is important because it generates a planet's magnetic field by a dynamo effect (see below). Terrestrial planets also possess more carbon-rich secondary atmospheres either generated through internal volcanism or by cometary and perhaps even asteroid impacts, as opposed to the gas giants that have primary atmospheres of mostly H and He captured directly from the original solar nebula. Several types of terrestrial planets have been postulated:

Silicate planets: the standard type (e.g. Venus, Earth, and Mars) as seen in our Solar System, composed primarily of a silicon-based rocky mantle with a metallic (iron) core.

Iron-rich planets consisting almost entirely of iron having greater density and a smaller radius than terrestrial planets of comparable mass. Mercury has a metallic core about 60 to 70% of its planetary mass. Iron-rich planets may form in high-temperature regions close to a star, particularly if the protoplanetary disk was also iron rich.

Carbon planets with metallic cores surrounded by carbon-based minerals. They may be considered a type

of terrestrial planet if metals dominate over carbon. The Solar System's carbonaceous asteroids may represent "failed" carbon planets.

Coreless planets consisting entirely of silicates with no metallic core. The Solar System contains no coreless planets, but chondrite asteroids and meteorites are common in it. Coreless planets are believed to form farther from the star where volatile oxidizing material is more common.

Super-Earths are planets with masses between Earth and Neptune. They may be gas planets or terrestrial, depending on their mass and other parameters. The latter represent the upper-end of the terrestrial-planet mass range.

(3) A strong constant magnetic field protecting the planet's surface from solar charged particles (aka *solar wind*), by deflecting most charged particles that would strip away either its atmosphere over geologic time or the ozone layer protecting a planet from harmful ultraviolet (UV) radiation. CO_2 loss calculations of Mar's atmosphere by solar wind scavenging is consistent with a near-total loss of its atmosphere since Mar's magnetic field turned off, perhaps as early as 4.0 Ga. Paleomagnetic studies of Australian volcanic rocks suggest the presence of Earth's magnetic field since at least 3.45 Ga.

(4) A stable almost circular orbit. The current changing Earth-Sun distance results in an increase of about only 6.9% in solar energy reaching Earth at perihelion relative to aphelion. A stable orbit keeps a planet within its HZ throughout its orbital year allowing for a stable climate. Highly elliptical orbits may result in a planet being periodically outside of its HZ resulting in wide climate variations. Additionally, highly elliptical orbits of gas giants may also result in inward migration affecting a habitable planet's orbital stability.

(5) A planetary rotation with a stable axis is extremely important to its habitability because its rotation period affects day to night temperature variations, obliquity stability (see below), and perhaps magnetic field generation. A very slow rotation results in greater day to night temperature differences because the prolonged absence of light may inhibit any photosynthetic life. Where synchronous rotation occurs, water may freeze-out on the dark hemisphere (see below) resulting in continuous freeze-out. Fortunately, Earth's current 23.4^{o} axial tilt relative to its orbital plane has been stable over geologic time, although cycles of precession or "wobbles" occur. This stability is attributed to Earth's moon. Mars and perhaps Venus lack such stability due to the lack of a large moon**.** Mars' obliquity is probably chaotic, varying from 0° to 60° over several millions of years, depending on planet perturbations.

(6) A dense (but not too dense or thin) atmosphere. Most of the Solar System's terrestrial planet's atmospheres are carbon-rich. Venus has a dense CO_2 atmosphere and Mars has a tenuous CO_2 atmosphere. Much of Earth's original CO_2 atmosphere is now in the form of carbonates precipitated from dissolved CO_2 in Earth's oceans largely as a result of shell-producing organisms (see December 2007 Vortex: *Where Has All the Carbon Dioxide Gone*?). If a planet has an oxygen-rich atmosphere and possesses a magnetosphere, it should also form an ozone layer that filters out tissue damaging UV.

(7) A world ocean. Earth's global ocean is the largest confirmed surface ocean of all observable planets. Approximately 71% of the Earth's surface ($\sim 3.6 \times 10^8$ km^2) is covered by saline water. Because it is the principal component of Earth's hydrosphere, the ocean is integral to all known life, forming an important part of the carbon cycle, and influencing climate and weather patterns. Its total volume is approximately 1.3×10^9 km^3 with an average depth of 3,790 m. It is habitat to 230,000 known species; perhaps 2 million marine species may exist. Life most likely originated in the ocean by a process of abiogenesis. Mars and Venus are believed to once have had large oceans but Mars lost its atmosphere and oceans and a runaway greenhouse effect probably boiled away Venus' original global ocean.

(8) Continental platforms and plate tectonics. On Earth, continents consist of "lighter" crustal granitic rocks "floating" on a layer of denser basaltic rocks. It's believed that this is from the denser basalt becoming saturated with water with subsequent melting during subduction into the less dense granite (see June 2012 Vortex: *Crusty Chemistry*). Therefore, continental formation requires abundant water, perhaps a world ocean. Stable continental platforms are important for the evolution of more complex life forms such as plants and animals.

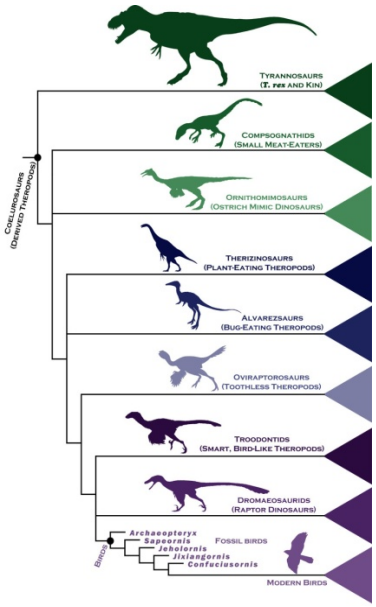
[In remembrance of Neil Armstrong (1930-2012), Apollo Astronaut and first human to walk on the Moon.]

Dinosaur family tree gives fresh insight into rapid rise of birds

The most comprehensive family tree of meat-eating dinosaurs ever created is enabling scientists to discover key details of how birds evolved from them.

The study, published in the journal *Current Biology*, shows that the familiar anatomical features of birds -- such as feathers, wings and wishbones -- all first evolved piecemeal in their dinosaur ancestors over tens of millions of years.

However, once a fully functioning bird body shape was complete, an evolutionary explosion began, causing a rapid increase in the rate at which birds evolved. This led eventually to the thousands of avian species that we know today.



Researchers examined the evolutionary links between ancient birds and their closest dinosaur relatives, by analyzing the anatomical make-up of more than 850 body features in 150 extinct species, and used statistical techniques to analyze their findings and assemble a detailed family tree.

Credit: Steve Brusatte

A team of researchers, led by the University of Edinburgh (UK) and including Swarthmore College Associate Professor of Statistics Steve C. Wang, examined the evolutionary links between ancient birds and their closest dinosaur relatives. They did this by analyzing the anatomical make-up of more than 850 body features in 150 extinct species and used statistical techniques to analyze their findings and assemble a detailed family tree.

Based on their findings from fossil records, researchers say the emergence of birds some 150 million years ago was a gradual process, as some dinosaurs became more bird-like over time. This makes it very difficult to draw a dividing line on the family tree between dinosaurs and birds.

Findings from the study support a controversial theory proposed in the 1940s that the emergence of new body shapes in groups of species could result in a surge in their evolution.

"The evolution of birds from their dinosaur ancestors was a landmark in the history of life," says Wang. "This process was so gradual that if you traveled back in time to the Jurassic, you'd find that the earliest birds looked indistinguishable from many other dinosaurs."

Wang invented a novel statistical method that was able to take advantage of new kinds of data from the fossil record, which reached the conclusion that early birds had a high rate of evolution. He adds that "birds as we know them evolved over millions of years, accumulating small shifts in shape and function of the skeleton. But once all these pieces were in place to form the archetypal bird skeleton, birds then evolved rapidly, eventually leading to the great diversity of species we know today."

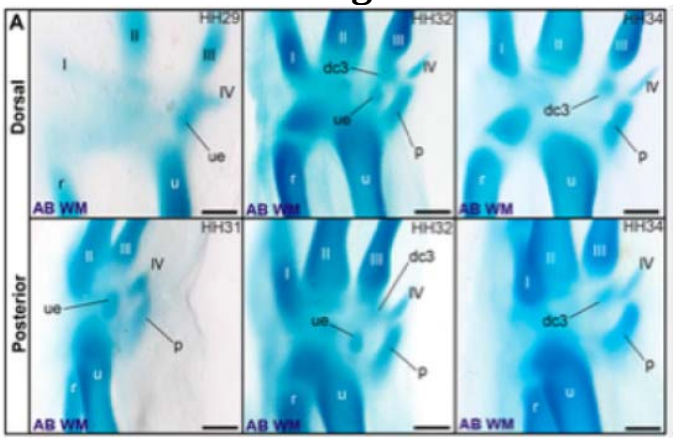
"There was no moment in time when a dinosaur became a bird, and there is no single missing link between them, " says Steve Brusatte of the University of Edinburgh's School of GeoSciences, who led the study. "What we think of as the classic bird skeleton was pieced together gradually over tens of millions of years. Once it came together fully, it unlocked great evolutionary potential that allowed birds to evolve at a super-charged rate."

The work was supported by the European Commission, National Science Foundation, the University of Edinburgh, Swarthmore College's Research Fund, Swarthmore College's James Michener Faculty Fellowship, Columbia University, and the American Museum of Natural History.

Story Source: The above story is based on materials provided by Swarthmore College.

Journal Reference: Stephen L. Brusatte, Graeme T. Lloyd, Steve C. Wang, Mark A. Norell. **Gradual Assembly of Avian Body Plan Culminated in Rapid Rates of Evolution across the Dinosaur-Bird Transition**. *Current Biology*, 2014; DOI: 10.1016/j.cub.2014.08.034

How dinosaur arms turned into bird wings



(A) Whole-mount alcian blue staining confirms the ulnare is the first carpal formed in avian embryos, distal to the ulna. Thereafter, a distal carpal 3 (referred to as "element x" in previous embryological descriptions) is formed distal to the ulnare, coexisting with it. Finally, the ulnare disappears, whereas dc3 persists. Credit: J. Botelho et al.; DOI: 10.1371/journal.pbio.1001957

Although we now appreciate that birds evolved from a branch of the dinosaur family tree, a crucial adaptation for flight has continued to puzzle evolutionary biologists. During the millions of years that elapsed, wrists went from straight to bent and hyperflexible, allowing birds to fold their wings neatly against their bodies when not flying.

How this happened has been the subject of much debate, with substantial disagreement between developmental biologists, who study how the wings of modern birds develop in the growing embryo, and palaeontologists

who study the bones of dinosaurs and early birds. A resolution to this impasse is now provided by an exciting new study publishing on September 30 in *PLOS Biology*.

Underlying this striking evolutionary transformation change is a halving in the number of wrist bones, but developmental biologists and palaeontologists have different names for most of them, and seldom agree on the correspondence between specific dinosaur bones and those of their bird descendants. Indeed, each field has radically different data sources, methods, and research objectives, talking little to each other.

The critical advance made in the new study involved combining these two strands of research. Using an interdisciplinary approach, the lab run by Alexander Vargas at the University of Chile has re-examined fossils stored at several museum collections, while at the same time collecting new developmental data from seven different species of modern birds. Joao Botelho, a Brazilian student in Vargas' lab, developed a revolutionary new technique that allows him to study specific proteins in 3D embryonic skeletons. By combining these data from both fossils and embryos, the research team has made a major step forward in clarifying how the bird wrist evolved.

From early dinosaur ancestors with as many as nine wrist bones, birds have only kept four during the course of evolution, but which of the original bones are they? The identity of each of these bones was debated. For instance, the late Yale professor John Ostrom famously pointed out in the 1970's that the wrists of both birds and bird-like dinosaurs possess a very similar, half-moon shaped bone called the semilunate, and that this bone resulted from the merging of two bones present in dinosaurs. This formed part of Ostrom's then-controversial argument that birds descended from dinosaurs. However, the failure of developmental biologists to confirm this raised doubts that it was the same bone, and even that birds came from dinosaurs.

Now, the new data obtained by the Vargas lab has revealed the first developmental evidence that the bird semilunate was formed by the fusion of the two dinosaur bones. They go on to show that another bone -- the pisiform -- was lost in bird-like dinosaurs, but then re-acquired in the early evolution of birds, probably as an adaptation for flight, where it allows transmission of force on the downstroke while restricting flexibility on the upstroke. Combined, the fossil and developmental data provide a compelling scenario for a rare case of evolutionary reversal.

The study by the Vargas lab also settled the identity of the other two bones of the bird wrist, which were commonly misidentified in both fields. This emphasizes the downsides of not integrating all data sources, and reveals a situation perhaps akin to that of astronomy and experimental physics in the pursuit of cosmology: Together, palaeontology and development can come much closer to telling the whole story of evolution -- this integrative approach resolves previous disparities that have challenged the support for the dinosaur-bird link and reveals previously undetected processes, including loss of bones, fusion of bones, and re-evolution of a transiently lost bone.

Story Source: The above story is based on materials provided by PLOS.

Journal Reference: João Francisco Botelho, Luis Ossa-Fuentes, Sergio Soto-Acuña, Daniel Smith-Paredes, Daniel Nuñez-León, Miguel Salinas-Saavedra, Macarena Ruiz-Flores, Alexander O. Vargas. **New Developmental Evidence Clarifies the Evolution of Wrist Bones in the Dinosaur–Bird Transition**. *PLoS Biology*, 2014; 12 (9): e1001957 DOI: 10.1371/journal.pbio.1001957

Scientists propose existence and interaction of parallel worlds: Many Interacting Worlds theory challenges foundations of quantum science

Griffith University academics are challenging the foundations of quantum science with a radical new theory based on the existence of, and interactions between, parallel universes.

In a paper published in the journal *Physical Review X*, Professor Howard Wiseman and Dr Michael Hall from Griffith's Centre for Quantum Dynamics, and Dr Dirk-Andre Deckert from the University of California, take interacting parallel worlds out of the realm of science fiction and into that of hard science.

The team proposes that parallel universes really exist, and that they interact. That is, rather than evolving independently, nearby worlds influence one another by a subtle force of repulsion. They show that such an interaction could explain everything that is bizarre about quantum mechanics.

Quantum theory is needed to explain how the universe works at the microscopic scale, and is believed to apply to all matter. But it is notoriously difficult to fathom, exhibiting weird phenomena which seem to violate the laws of cause and effect.

As the eminent American theoretical physicist Richard Feynman once noted: "I think I can safely say that nobody understands quantum mechanics."

However, the "Many-Interacting Worlds" approach developed at Griffith University provides a new and daring perspective on this baffling field.

"The idea of parallel universes in quantum mechanics has been around since 1957," says Professor Wiseman.

"In the well-known "Many-Worlds Interpretation," each universe branches into a bunch of new universes every time a quantum measurement is made. All possibilities are therefore realised -- in some universes the dinosaur-

killing asteroid missed Earth. In others, Australia was colonised by the Portuguese.

"But critics question the reality of these other universes, since they do not influence our universe at all. On this score, our "Many Interacting Worlds" approach is completely different, as its name implies."

Professor Wiseman and his colleagues propose that:

- The universe we experience is just one of a gigantic number of worlds. Some are almost identical to ours while most are very different;
- All of these worlds are equally real, exist continuously through time, and possess precisely defined properties;
- All quantum phenomena arise from a universal force of repulsion between 'nearby' (i.e. similar) worlds which tends to make them more dissimilar.

Dr Hall says the "Many-Interacting Worlds" theory may even create the extraordinary possibility of testing for the existence of other worlds.

"The beauty of our approach is that if there is just one world our theory reduces to Newtonian mechanics, while if there is a gigantic number of worlds it reproduces quantum mechanics," he says.

"In between it predicts something new that is neither Newton's theory nor quantum theory.

"We also believe that, in providing a new mental picture of quantum effects, it will be useful in planning experiments to test and exploit quantum phenomena."

The ability to approximate quantum evolution using a finite number of worlds could have significant ramifications in molecular dynamics, which is important for understanding chemical reactions and the action of drugs.

Professor Bill Poirier, Distinguished Professor of Chemistry at Texas Tech University, has observed: "These are great ideas, not only conceptually, but also with regard to the new numerical breakthroughs they are almost certain to engender."

Story Source: The above story is based on materials provided by Griffith University.

Journal Reference: Michael J. W. Hall, Dirk-André Deckert, Howard M. Wiseman. **Quantum Phenomena Modeled by Interactions between Many Classical Worlds**. *Physical Review X*, 2014; 4 (4) DOI: 10.1103/PhysRevX.4.041013

Sunlight, not microbes, key to carbon dioxide in Arctic

The vast reservoir of carbon stored in Arctic permafrost is gradually being converted to carbon dioxide (CO_2) after entering the freshwater system in a process thought to be controlled largely by microbial activity.

Terrestrial organic matter is shown spilling into a lake. Credit: Image courtesy of Oregon State University

However, a new study -- funded by the National Science Foundation and published this week in the journal *Science* -- concludes that sunlight and not bacteria is the key to triggering the production of CO_2 from material released by Arctic soils.

The finding is particularly important, scientists say, because climate change could affect when and how permafrost is thawed, which begins the process of converting the organic carbon into CO_2.

"Arctic permafrost contains about half of all the organic carbon trapped in soil on the entire Earth -- and equals an amount twice of that in the atmosphere," said Byron Crump, an Oregon State University microbial ecologist and co-author on the *Science* study. "This represents a major change in thinking about how the carbon cycle works in the Arctic."

Converting soil carbon to carbon dioxide is a two-step process, notes Rose Cory, an assistant professor of earth and environmental sciences at the University of Michigan, and lead author on the study. First, the permafrost soil has to thaw and then bacteria must turn the carbon into greenhouse gases -- carbon dioxide or methane. While much of this conversion process takes place in the soil, a large amount of carbon is washed out of the soils and into rivers and lakes, she said.

"It turns out, that in Arctic rivers and lakes, sunlight is faster than bacteria at turning organic carbon into CO_2," Cory said. "This new understanding is really critical because if we want to get the right answer about how the warming Arctic may feedback to influence the rest of the world, we have to understand the controls on carbon cycling.

"In other words, if we only consider what the bacteria are doing, we'll get the wrong answer about how much CO_2 may eventually be released from Arctic soils," Cory added.

The research team measured the speed at which both bacteria and sunlight converted dissolved organic carbon into carbon dioxide in all types of rivers and lakes in the Alaskan Arctic, from glacial-fed rivers draining the Brooks Range to tannin-stained lakes on the coastal

plain. Measuring these processes is important, the scientists noted, because bacteria types and activities are variable and the amount of sunlight that reaches the carbon sources can differ by body of water.

In virtually all of the freshwater systems they measured, however, sunlight was always faster than bacteria at converting the organic carbon into CO_2.

"This is because most of the fresh water in the Arctic is shallow, meaning sunlight can reach the bottom of any river -- and most lakes -- so that no dissolved organic carbon is kept in the dark," said Crump, an associate professor in Oregon State's College of Earth, Ocean, and Atmospheric Sciences. "Also, there is little shading of rivers and lakes in the Arctic because there are no trees."

Another factor limiting the microbial contribution is that bacteria grow more slowly in these cold, nutrient-rich waters.

"Light, therefore, can have a tremendous effect on organic matter," University of Michigan's Cory pointed out.

The source of all of this organic carbon is primarily tundra plants -- and it has been building up for hundreds of thousands of years, but doesn't completely break down immediately because of the Arctic's cold temperatures. Once the plant material gets deep enough into the soil, the degradation stops and it becomes preserved, much like peat.

"The level of thawing only gets to be a foot deep or so, even in the summer," Crump said. "Right now, the thaw begins not long before the summer solstice. If the seasons begin to shift with climate change -- and the thaw begins earlier, exposing the organic carbon from permafrost to more sunlight -- it could potentially trigger the release of more CO_2."

The science community has not yet been able to accurately calculate how much organic carbon from the permafrost is being converted into CO_2, and thus it will be difficult to monitor potential changes because of climate change, they acknowledge.

"We have to assume that as more material thaws and enters Arctic lakes and rivers, more will be converted to CO_2," Crump said. "The challenge is how to quantify that."

Some of the data for the study was made available through the National Science Foundation's Arctic Long-Term Ecological Research project, which has operated in the Arctic for nearly 30 years.

Story Source: The above story is based on materials provided by Oregon State University.

Journal Reference: R. M. Cory, C. P. Ward, B. C. Crump, G. W. Kling. **Sunlight controls water column processing of carbon in arctic fresh waters**. *Science*, 2014; 345 (6199): 925 DOI: 10.1126/science.1253119

Last decade's slowdown in global warming enhanced by an unusual climate anomaly

HadCRUT4 Temperature Anomaly 1850-2013 (°C) (blue and red bars). Secular trend (red line), multidecadal variability (green line) and reconstructed signal from the statistical analysis (black line). Hiatus periods are indicated with grey bars in the x-axis. *Credit: © EU, 2014*

A hiatus in global warming ongoing since 2001 is due to a combination of a natural cooling phase, known as multidecadal variability (MDV) and a downturn of the secular warming trend. The exact causes of the latter, unique in the entire observational record going back to 1850, are still to be identified, according to an article by the European Commission's Joint Research Centre (JRC).

The earth hasn't warmed at the same pace during the 20th century. The noticeable temperature increases during some periods interspersed with fairly stable or decreasing levels during others have been explained as a combination of secular global warming (likely humanmade) and natural climate variability. We are currently, in the early 21st century, experiencing a hiatus period, during which surface temperatures have not risen at the same rate as higher atmospheric radiative forcing.

JRC scientists analysed surface temperature data records -- which began in 1850 -- to separate natural variations from secular (i.e., long-term) trends. They identified three hiatus periods (1878-1907, 1945-1969 and 2001 to date), during which global warming slowed down. These hiatus periods coincide with natural cooling phases -- the multidecadal variability (MDV), most likely caused by natural oceanic oscillations. The scientists therefore conclude that the MDV is the main cause of these hiatus periods during which global warming decelerated.

However, they found that the current hiatus period is, for the first time, particularly strongly influenced by changes in the secular trend, which shows a strong acceleration from 1992-2001 and a deceleration from 2002 to 2013.Such rapid and strong fluctuations in the secular warming rate are unprecedented.

This unique fluctuation in the recent secular warming rate could have several causes, such as recent changes in the tropical Pacific Ocean, the accelerated melting of Arctic ice, changes in the deep ocean heat storage or the increasing content of aerosols in the stratosphere. The authors recommend further scientific investigation of the causes and consequences of this change, in order to address whether the global climate sensitivity has recently changed. Such research is crucial to understanding current climate conditions and creating plausible scenarios of future climate evolution.

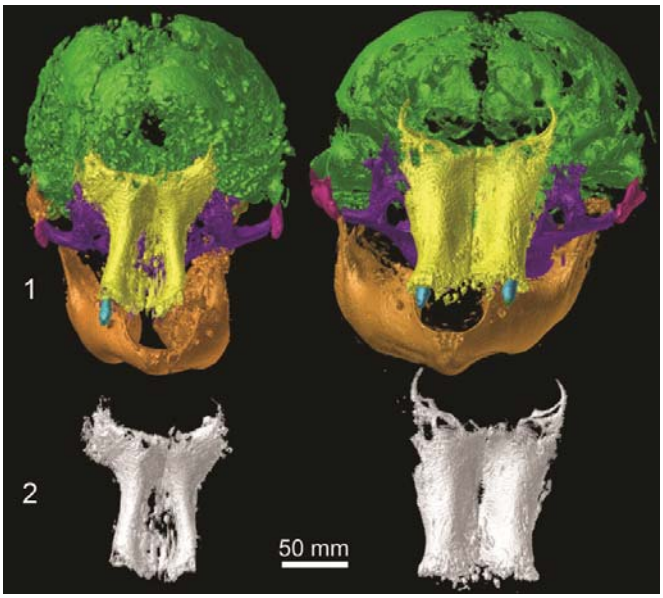
Story Source: The above story is based on materials provided by European Commission, Joint Research Centre (JRC).

Journal Reference: Diego Macias, Adolf Stips, Elisa Garcia-Gorriz. **Application of the Singular Spectrum Analysis Technique to Study the Recent Hiatus on the Global Surface Temperature Record**. *PLoS ONE*, 2014; 9 (9): e107222 DOI: 10.1371/journal.pone.0107222

Short lives, violent deaths: Two CT-scanned Siberian mammoth calves yield trove of insights

CT scans of two newborn woolly mammoths recovered from the Siberian Arctic are revealing previously inaccessible details about the early development of prehistoric pachyderms. In addition, the X-ray images show that both creatures died from suffocation after inhaling mud.

Lyuba and Khroma, who died at ages 1 and 2 months, respectively, are the most complete and best-preserved baby mammoth specimens ever found. Lyuba's full-body CT scan, which used an industrial scanner at a Ford testing facility in Michigan, was the first of its kind for any mammoth.



CT images showing a side-by-side comparison of skulls from Lyuba (left) and Khroma, with bones of the front of the skull shown below.

Credit: University of Michigan Museum of Paleontology

"This is the first time anyone's been able to do a comparative study of the skeletal development of two baby mammoths of known age," said University of Michigan paleontologist Daniel Fisher.

"This allowed us to document the changes that occur as the mammoth body develops," Fisher said. "And since they are both essentially complete skeletons, they can be thought of as Rosetta Stones that will help us interpret all the isolated baby mammoth bones that show up at other localities."

Fisher, director of the U-M Museum of Paleontology, is lead author of a paper published online July 8 in a special issue of the Journal of Paleontology. The paper provides a detailed discussion of the findings from the Lyuba and Khroma CT scans and includes about 30 previously unpublished CT images.

The paper's 10 authors are from the United States, Russia and France. They include three recent U-M graduates and a collections manager at the U-M paleontology museum.

Siberian permafrost yields mammoth surprises

Lyuba and Khroma lived more than 40,000 years ago and belonged to mammoth populations separated by roughly 3,000 miles. Lyuba was found by reindeer herders in May 2007 on the banks of the Yuribei River on the Yamal Peninsula, in northwest Siberia. She was found frozen and partially dehydrated but otherwise appeared to be intact, except for the loss of most of her hair and all of her nails.

Khroma was found in October 2008 near the Khroma River in northernmost Yakutia, in northeast Siberia. She was frozen in permafrost in an upright position. Ravens and possibly arctic foxes scavenged exposed portions of her carcass, including parts of the trunk and skull and the fat hump that likely covered the back of her neck. Otherwise, the body was recovered in good condition.

Because of the remarkable preservation of Lyuba and Khroma, stringent conditions were placed on their study. Some dissection and limited sampling were allowed, but both specimens were left mostly intact. CT scans offered a non-destructive means of visualizing and analyzing much of their anatomy without compromising exhibit potential or options for future analysis.

CT scans of Lyuba were done in Tokyo in 2009 and in Wisconsin in 2010, using medical scanners. But because of Lyuba's size (about 110 pounds and slightly smaller than a baby elephant), the researchers could not acquire 3-D data from her entire body. They finally succeeded in October 2010 at Ford Motor Co.'s Nondestructive Evaluation Laboratory in Livonia, Mich., using a scanner designed for finding flaws in vehicle transmissions.

Khroma's CT scans were done at two French hospitals. Micro-CT scans of teeth from both mammoth calves were conducted at the University of Michigan School of Dentistry. From the dental studies, Fisher and colleagues determined that Lyuba died 30 to 35 days after birth and estimated that Khroma's age at death was between 52 and 57 days.

Dating technique more than 30 years in the making

The researchers used a technique developed by Fisher over the past 30-plus years that involves counting daily growth layers inside the teeth, a bit like counting the annual growth rings on a tree to determine its age. The dental studies also indicate that both mammoths were born in the spring.

Scans of Khroma's skull showed she had a brain slightly smaller than that of a newborn elephant, which hints at the possibility of a shorter gestation period for mammoths.

Lyuba's skull is conspicuously narrower than Khroma's, and her upper jawbones are more slender, while Khroma's shoulder blades and foot bones are more developed. These differences may simply reflect the one-month age

difference between the calves, or they could relate to the different populations from which the two calves derived.

The researchers refer to both calves as mummies due to the high level of soft-tissue preservation. In addition to fully articulated skeletons, the carcasses held preserved muscle, fat, connective tissue, organs and skin. Khroma even had clotted blood inside intact blood vessels and undigested milk in the stomach.

"These two exquisitely preserved baby mammoths are like two snapshots in time. We can use them to understand how factors like location and age influenced the way mammoths grew into the huge adults that captivate us today," said co-author Zachary T. Calamari of the American Museum of Natural History, who began investigating mammoths as a U-M undergraduate working with Fisher.

Short lives, violent deaths

In addition to providing unprecedented insights into mammoth development, the CT scans of Lyuba and Khroma show that both youngsters died after inhaling mud, then suffocating, according to the authors of the Journal of Paleontology paper. This death scenario was suggested for Lyuba shortly after she was first examined. The Khroma CT scans demonstrate that she suffered a similar fate.

In Lyuba, the scans revealed a solid mass of fine-grained sediment blocking the air passages in the middle of the trunk. Sediment was also seen in Lyuba's throat and bronchial passages. If Lyuba had died by drowning rather than suffocation -- as some have suggested -- then traces of sediment should also have been detected in parts of the lungs beyond the bronchial passages, but that was not the case.

Slightly coarser sediment was found in Khroma's trunk, mouth and throat. Her lungs weren't available for study because they were scavenged before the carcass was recovered. Since both animals appear to have been healthy at the time of death, a "traumatic demise" involving the inhalation of mud and suffocation appears to be the most likely cause of death in both cases, according to the authors.

The researchers suspect that Lyuba died in a lake because sediments found in her respiratory tract include fine-grained vivianite, a deep blue iron- and phosphate-bearing mineral that commonly forms in cold, oxygen-poor settings such as lake bottoms.

It's possible that Lyuba crashed through the ice while crossing a lake during the spring melt. If she was struggling to breathe while submerged in a frigid lake, the mammalian "diving reflex" may have kicked in during her final moments, Fisher said. The reflex is triggered by cold water contacting the face, and it initiates physiological changes that enable animals to stay underwater for extended periods of time.

Those changes include a shifting of blood from the extremities to the body's core, including the brain and heart. The blood shift would help explain small vivianite nodules found on Lyuba's facial tissues during a necropsy. The CT scans revealed vivianite nodules, up to several millimeters in length, on the surface of the skull and inside it.

Blood provided iron source for vivianite nodules?

Blood coursing into Lyuba's brain, due to the mammalian diving reflex, may have provided the iron source for the vivianite nodules, according to the authors. Lactic acid-producing bacteria ate away at her bones after death, possibly liberating the phosphate ions used to make vivianite, Fisher said.

A possible death scenario for Khroma places the calf and her mother on a riverbank in the spring. Khroma had been nursing less than an hour before her death, as evidenced by undigested milk found in her stomach during a necropsy by a team of scientists that included Fisher.

"It looked like you'd just popped the top on a container of yogurt," Fisher recalled. "It was that white. It was that smooth. Just fresh, creamy milk from mama mammoth."

Perhaps the riverbank collapsed and the two mammoths, mother and daughter, plunged into the river. A fall would account for the fractured spinal column revealed by Khroma's CT scan, as well as the mud she inhaled.

The CT scan paper is part of a special Journal of Paleontology issue on three-dimensional visualization and analysis of fossils. In addition to Fisher and Calamari, the paper's authors are Ethan A. Shirley, Christopher D. Whalen and Adam Rountrey of the U-M Museum of Paleontology; Alexei N. Tikhonov of the Russian Academy of Sciences; Bernard Buigues of the International Mammoth Committee in France; Frederic Lacombat of the Musee de Paleontologie de Chilhac in France; and Semyon Grigoriev and Piotr A. Lazarev of the North-Eastern Federal University in Russia.

Fisher is the Claude W. Hibbard Collegiate Professor of Paleontology, a professor in the Department of Earth and Environmental Sciences, and a professor in the Department of Ecology and Evolutionary Biology. Calamari, Shirley and Whalen are recent U-M graduates and spent a month in Siberia with Fisher in 2012, searching for mammoth remains. Rountrey is the collections manager for vertebrates at the U-M Museum of Paleontology.

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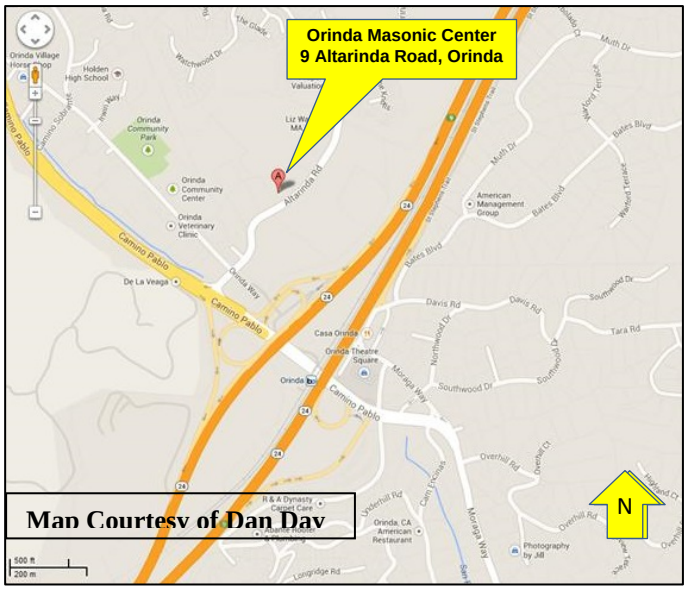
Story Source: The above story is based on materials provided by University of Michigan and ScienceDaily.

Journal Reference: Daniel C. Fisher, Ethan A. Shirley, Christopher D. Whalen, Zachary T. Calamari, Adam N. Rountrey, Alexei N. Tikhonov, Bernard Buigues, Frédéric Lacombat, Semyon Grigoriev, Piotr A. Lazarev. **X-ray computed tomography of two mammoth calf mummies**. *Journal of Paleontology*, 2014; 88 (4): 664 DOI: 10.1666/13-092



Biography, continued: He spent almost over 30 years working full time in the petroleum industry, almost entirely with BP and its associates. He was lucky enough to be closely involved with several oil discoveries, four of which were major ones: Sarir in Libya in 1961, and Prudhoe Bay, Kuparuk and Endicott in Alaska. He spent eight seasons field mapping in Alaska, chiefly on the Alaska Peninsula and the Brooks Range. He also spent two years in London overseeing BP's exploration activities in the "Americas", which, in fact stretched from West Greenland to the Falkland Islands. Most of the activity was in Canada, the US, Colombia and Peru.

He took early retirement from BP/Sohio in 1987. Besides being a consultant for Alaska exploration he helped set up in Houston, Energy Exploration Management Company, which was funded by Noranda Mines through John Masters at Canadian Hunter with the ambitious aim of finding giants in the onshore US. The company lasted just three years.

Since then he has chiefly provided a service of Basin and Play Evaluation in the US using the Nehring Data Base of Significant Oil and Gas Fields and Reservoirs. He has been a close friend of Richard Nehring for many years and like him, takes a keen interest in US oil and gas reserve estimates.

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