

# NORTHERN CALIFORNIA GEOLOGICAL SOCIETY



Website: [www.ncgeolsoc.org](http://www.ncgeolsoc.org)

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## MEETING ANNOUNCEMENT

**DATE:** February 29, 2012

**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:** John Karachewski, PhD, PG, CHG  
Department of Toxic Substances  
Control, Berkeley

### *An Introduction to Geographic Information Systems (GIS) - "Free Software and Data for Recreational, Educational, and Geologic Investigations"*

Traditionally, Geographic Information System (GIS) studies have been undertaken by sophisticated users, who integrated hardware, software, and data for capturing, managing, analyzing, and displaying geographically referenced information. Rapid and accelerating technological developments in hardware, such as computers, smart phones, and Global Positioning System (GPS) receivers, along with popular software such as Google Earth have made geographic data widely available to the general public. In addition, local, state, and federal government agencies are routinely and increasingly posting geographic data and online mapping services to their websites.

This presentation provides a brief introduction to gis concepts, but focuses on free software (Google Earth, ArcGIS Explorer, and ArcGIS Online) as well as environmental and geologic data for the San Francisco Bay area and California. Because most users are already familiar with Google Earth, only a brief discussion of select features, such as video tutorials, path/elevation profiles, and historical imagery will be provided. Although less known, more time will be devoted to ArcGIS Explorer due to its significantly greater functionality, especially with respect to different basemaps and rich data content. This presentation will also highlight examples of data available from the Association of Bay Area Governments (ABAG), California Geological Survey (CGS), and US Geological Survey (USGS), with an emphasis on natural hazards.

This presentation will also provide several case histories illustrating integration of GPS and GIS data for recreational and educational projects. I routinely use a recreational GPS unit to record my hiking or biking tracks and then use this data to both geotag my photographs and then view my...

... Continued on page 3...

# NCGS 2010 – 2011 Calendar

February 29, 2012

Dr. John Karachewski, DTSC

*An Introduction to Geographic Information Systems (GIS) - “Free Software and Data for Recreational, Educational, and Geologic Investigations”*

7:00 pm at Orinda Masonic Lodge

March 28, 2012

Dr. Gerhard Neuhuber, GallZeidler Consultants, LLC; *Caldecott Tunnel Construction 4<sup>th</sup> Bore / NATM Tunnel in San Francisco SH 24 California; After Three Tunnel Constructions and Investigation Programs – Are There No Surprises Anymore?*

7:00 pm at Orinda Masonic Lodge

April 25, 2012

Dr. Ray Sullivan, *Ocean Floor to Shelf; The Lower Tertiary Sequences in the Sacramento Basin*

7:00 pm at Orinda Masonic Lodge

May 30, 2012

Dr. Goeff Marcy, UC Berkeley;  
*The Hunt for Another Earth*

6:00 pm at Orinda Masonic Lodge

**(Dinner Meeting!)**

**(Early Time!)**

June 27, 2012

Dr. Donald L Gautier, US Geological Survey  
*Volumes, Uncertainty and Costs of Undiscovered Arctic Petroleum*

7:00 pm at Orinda Masonic Lodge

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## Upcoming NCGS Events

April 2012

(Date Tentative)

*Caldecott Fourth Bore Project  
CalTrans and Dr. Gerhard  
Neuhuber*

June 2, 2012

*Ocean Floor to the Shelf; The  
Lower Tertiary Sequences on  
the Flanks of the Mt. Diablo  
Dr. Ray Sullivan*

July 2012

(Date Tentative)

*Ancient Basalts of the  
“Youthful” North Fork  
Feather River Canyon  
Jeff Schaffer*

Do you have a place you've wanted to visit for the geology? Let us know. We're definitely interested in ideas. For those suggestions, or for questions regarding, field trips, please contact Tridib Guha at: [TridibGuha@yahoo.com](mailto:TridibGuha@yahoo.com)

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## Peninsula Geologic Society

### Upcoming meetings

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.

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## Bay Area Science

(<http://www.bayareascience.org/>)

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).

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## 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/>.

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## 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 evening of each month during most of the year but are occasionally presented on the preceding Thursday evening to accommodate the speakers. For more information on the lectures, including a map of the lecture location (Building 3, 2nd floor; Conference Room A) go to: <http://online.wr.usgs.gov/calendar/>

- *Mapping a Flood...Before it Happens --the new USGS FloodPath early warning system*, Marijke van Heeswijk
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## The 2011-2012 NCGS Richard Chambers Memorial Scholarship Awards

The Northern California Geological Society is pleased to announce the awarding of its **Richard Chambers Memorial Scholarships** for 2011-2012. These scholarships are named for former member Richard Chambers who provided a bequest to the NCGS.

Two \$1,000 Richard Chambers Memorial Scholarships were awarded to students pursuing their Masters degree and one for \$2,000 was awarded to a student seeking a Doctorate degree. These awards were announced at the NCGS January meeting.

Receiving Richard Chambers Memorial Scholarships at the **Masters level** were **Leslie Moclock**, a student at the University of California, Davis, with a research proposal titled *Kinematic analysis of the northern Bear Mountains Fault Zone, Sierra Nevada Foothills*. Her advisor is Dr. Sarah Roeske. The other Masters level scholarship went to **Michelle Gevedon**, a student at California State University, Fullerton. Her proposed research is titled *Multi-isotopic analysis of magmatic zircon from mafic rocks across the Sierra Nevada: Addressing tectonic models with geochemistry*. Her advisor is Dr. Diane Clemens-Knott.

Receiving the Richard Chambers Memorial Scholarship at the **PhD level** is **Scott Bennett**, a student at the University of California, Davis. His research is titled *Testing the role of Rift Obliquity in Rupturing Continental Lithosphere: Dating Rift-related Transtensional Structures in the Northern Gulf of California*. His advisor is Dr. Michael Oskin.

The Northern California Geological Society received sixteen outstanding applications for the 2011-2012 Richard Chambers Memorial Scholarships.

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## NCGS K-12 News

### 2012 NCGS Geoscience Teaching Award

We are pleased to award **Chung Sinn Khong**, Yerba Buena High School, San Jose, the 2012 NCGS Geoscience Teaching Award. His Earth & Environmental Science class with the Paleontology and Climate Units covers many aspects of geoscience. The program also contains materials on observation and critical thinking. He includes a broad spectrum of materials and references as well as exercises that will help students apply basic principles and discuss specific topics in geological and environmental sciences.

Please welcome Chung and his wife at our May Dinner Meeting. Read about him on our website ([http://www.ncgeolsoc.org/K-12 Geoscience Teaching Awards.htm](http://www.ncgeolsoc.org/K-12_Geoscience_Teaching_Awards.htm)).

### Call for K-12 Geoscience Mentors

**NCGS members** - are you interested in mentoring K-12 Science Teachers? What about talking to classroom groups? **Contact Paul Henshaw**, NCGS K-12 Programs Chair ([Drphenshaw@comcast.net](mailto:Drphenshaw@comcast.net)). We will put you on our K-12 Resource List to help us answer the call from Bay Area Schools and Museums for assistance

in: mentoring teachers; speaking at schools/museums; providing information for classroom teaching units; and participating in local geoscience education events. Let us know your interests.

We will contact you as calls for assistance come to us so that you can choose when to participate.

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## Dr. John Karachewski's

### Presentation Abstract (continued)

*An Introduction to Geographic Information Systems (GIS) - "Free Software and Data for Recreational, Educational, and Geologic Investigations"*

...photographs and then view my route draped on USGS geologic maps in Google Earth. This approach has allowed me to gain new insights into the diversity and complexity of Bay area geology. I will also illustrate how multiple data sets for the Hayward Fault on the Cal campus were integrated to develop a new ArcGIS Explorer laboratory exercise for a class at Diablo Valley College. Lastly, I will provide examples of how GIS analysis leads to improved understanding and recommendations for evaluating environmental investigations at hazardous waste sites.

In summary, the following list of websites provides a brief and partial compilation of environmental and geologic resources awaiting your discovery!

### SOFTWARE

Google Earth: <http://www.google.com/earth/index.html>  
Learn (video tutorials)  
<http://www.google.com/earth/learn/>

ArcGIS Explorer  
<http://www.esri.com/software/arcgis/explorer/index.html>  
Demos (video tutorials)  
<http://www.esri.com/software/arcgis/explorer/demos.html>  
Georeference Add-On  
<http://blogs.esri.com/Info/blogs/arcgisexplorerblog/archive/2010/12/17/georeferencing-add-in-for-explorer-desktop.aspx>

ArcGIS Online (create, store, and manage maps, apps, and data, and share resources in the cloud)  
<http://www.esri.com/software/arcgis/arcgisonline/features/personal-use.html>

### GIS DATA AND ONLINE MAP VIEWERS

Association of Bay Area Governments (ABAG) Map Portal <http://gis.abag.ca.gov/>

California Natural Resources Agency / Map Server (library of gis layers): <http://atlas.resources.ca.gov/>

Cal-Atlas (geospatial clearinghouse)  
<http://atlas.ca.gov/>

California Emergency Management Agency | Hazard Mitigation Portal – MyHazards  
Learn About Natural Hazards In Your Neighborhood  
<http://myhazards.calema.ca.gov/>

California EPA – Department of Toxic Substances Control (DTSC) Envirostor  
<http://www.envirostor.dtsc.ca.gov/public/>

California EPA – State Water Resources Control Board – Geotracker; <http://geotracker.waterboards.ca.gov/>

California Geological Survey (online interactive 1:250,000 geologic and faults maps)  
[http://www.consrv.ca.gov/cgs/information/geologic\\_mapping/Pages/index.aspx](http://www.consrv.ca.gov/cgs/information/geologic_mapping/Pages/index.aspx)

California Geological Survey -  
Alquist-Priolo Earthquake Fault Zone Maps  
[http://www.quake.ca.gov/gmaps/ap/ap\\_maps.htm](http://www.quake.ca.gov/gmaps/ap/ap_maps.htm)

California Geological Survey -  
Tsunami Inundation Maps (Access Interactive Tsunami Maps using Google Maps)  
[http://www.quake.ca.gov/gmaps/tsunami/tsunami\\_maps.htm](http://www.quake.ca.gov/gmaps/tsunami/tsunami_maps.htm)

National Atlas (click on “Map Layers” to view data for download – including Geology Chapter)  
<http://www.nationalatlas.gov/>

Northern California Earthquake Data Center (NCEDC)  
<http://www.ncedc.org/>

San Francisco Estuary Institute – EcoAtlas  
<http://www.sfei.org/ecoatlas>

Southern California Earthquake Data Center (SCEDC)  
<http://www.data.scec.org/>

USGS - The National Map: Historical Topographic Map Collection; <http://nationalmap.gov/historical/>

USGS – Earth Explorer (satellite images, aerial photographs, and cartographic products)  
<http://earthexplorer.usgs.gov/>

USGS - Knowles, Noah. 2010. Potential Inundation Due to Rising Sea Levels in the San Francisco Bay Region. *San Francisco Estuary and Watershed Science*, **8**:1. Available at  
[http://escholarship.org/uc/search?entity=jmie\\_sfews;volume=8;issue=1](http://escholarship.org/uc/search?entity=jmie_sfews;volume=8;issue=1).

Data from website:

<http://cascade.wr.usgs.gov/data/Task2b-SFBay/data.shtm>

USGS - San Francisco Bay Region Geology and Geologic Hazards  
**(Google Earth geologic maps for ALL Bay area counties)**  
<http://geomaps.wr.usgs.gov/sfgeo/geologic/downloads.html>

USGS - San Francisco Bay Region Geology (older website with detailed maps and gis data: pdfs for printing and professional ArcGIS license required for extracting and viewing digital files)  
<http://geomaps.wr.usgs.gov/sfbay/index.html>

USGS - Quaternary Fault and Fold Database of the United States (Google Earth files or GIS Shapefiles)  
<http://earthquake.usgs.gov/hazards/qfaults/>

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## CGS Landslide Inventory Maps

The California Geological Survey (CGS) has developed the Landslide Inventory Map Series to provide additional information to geotechnical professionals, local government personnel, as well as property owners and developers who use [Seismic Hazard Zone Maps](#). Earthquake-induced landslide zones of required investigation include inventories of known landslides, but previously these inventories were only available as small-scale plates in seismic hazard zone reports.

Landslide inventory maps show locations and characteristics of landslides that have moved in the past but generally do not indicate the mechanism(s) that triggered them. The geologic, terrain and climatic conditions that led to past slope failures often provide clues to the locations and conditions of future slope failures. Therefore, inventory maps provide useful information about the potential for future landsliding. In addition, recognizing the type and recency of landsliding can also facilitate the scope and design of site-specific geotechnical investigations and guide slope remediation strategies.

Inventory maps are prepared primarily by geomorphic analysis of aerial photographs and secondarily by field reconnaissance, interpretation of topographic map contours and review of previous mapping. Landslides shown on the Landslide Inventory Map Series were compiled at a scale of 1:24,000 on the U.S. Geological Survey topographic map and several key characteristics are shown through cartographic symbology. Each map in this series contains an explanation of the map symbology as well as a brief description of the geology and landslide occurrences in the map area.

These landslide inventory maps are the first of many to be released in the San Francisco Bay and Southern

California regions. This series is a new addition to the list of publications that CGS currently distributes. If you would like to purchase a printed Landslide Inventory Map you may do so by contacting [CGS Publications](#).

Recent additions to this inventory include the:

- Calaveras Reservoir, Milpitas, Niles, San Jose East and San Jose West 7.5-Minute Quadrangles, Alameda and Santa Clara Counties, (June 2011)
- Lick Observatory 7.5-Minute Quadrangle (December 2011), and the
- Murrieta 7.5 Minute Quadrangle (December 2011)

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## Ubehebe volcano in Death Valley could erupt again

David Perlman, Chronicle Science Editor  
Thursday, January 26, 2012

Once upon a time inside Death Valley, an ancient volcano exploded in a deadly mixture of steam and rock that sent a towering mushroom cloud aloft and left a crater a half-mile wide and nearly 800 feet deep.

That same volcano, named Ubehebe, could explode again at any time, say scientists who have used new techniques to determine just when that first huge blast sent the region shuddering.



Geologists exploring the crater in the past had found a trove of Indian artifacts amid the volcanic rubble. By dating those relics they estimated that the volcano blew its top about 6,000 years ago - which would have meant there would be no more underground water left to fuel the hot volcanic rocks for another explosion.

But now a team of scientists from Columbia University, exploring the crater floor, has gathered small chunks of sandstone and quartzite - sedimentary debris from that ancient explosion. By dating particles of the element beryllium inside those rocks, they determined that the explosion had dug the volcanic crater no more than 1,200 years ago, and probably only about 800 years ago.

Ubehebe's explosion was caused when an upwelling plume of hot volcanic magma from deep underground met a pocket of underground water. Instantly the mixture exploded in a blast of superheated steam, shattering rock and releasing deadly gases. It's called a phreatomagmatic explosion.

The various forms of atomic beryllium inside the rock samples gathered by scientists from Columbia's Lamont-Doherty Earth Observatory are known as isotopes. They have different weights, and when cosmic rays strike them, those weights change at a known rate. So, by counting the changes, the scientists could determine the varying dates when Ubehebe exploded.

The scientists now believe that there's enough underground water in the aquifer beneath Death Valley - and enough hot magma for another big explosion to occur in the near future.

"There is no basis for thinking that Ubehebe is done," said Columbia's Nicholas Christie-Blick, a geologist at the Earth Observatory.

California's many volcanoes are under constant surveillance by scientist at the U.S. Geological Survey in Menlo Park, and Margaret T. Mangan is the scientist in charge of the Long Valley Observatory, based in Menlo Park.

Mangan said the Columbia research, reported in the current issue of the journal *Geophysical Research Letters*, has pinned down previous research into the status of the Death Valley volcano more precisely than before.

"The proverbial nail in the coffin," she said, "is for Ubehebe being a young, potentially active volcano."

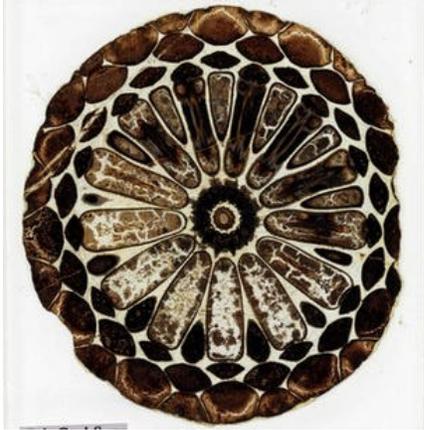
That name Ubehebe is a Paiute word and was first applied to the 5,678-foot Ubehebe Peak, which is 24 miles southwest of the crater. How the name Ubehebe became associated with the crater is unknown, but to the Timbisha Shoshone Indians, the crater has been known as "Tem-pin-tta- Wo'sah," meaning Coyote's Basket.

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## Lost Charles Darwin fossils rediscovered in cabinet

A "treasure trove" of fossils - including some collected by Charles Darwin - has been re-discovered in an old cabinet. The fossils, lost for some 165 years, were found by chance in the vaults of the British Geological Survey HQ near Keyworth, UK. They have now been photographed and are available to the public through a new online museum exhibit released today. The find was made by the palaeontologist Dr Howard Falcon-Lang.

Dr Falcon-Lang, who is based in the department of earth sciences at Royal Holloway, University of London, spotted some drawers in a cabinet marked "unregistered fossil plants". "Inside the drawer were hundreds of beautiful glass slides made by polishing fossil plants into thin translucent sheets," Dr Falcon-Lang explained. "This process allows them to be studied under the microscope. Almost the first slide I picked up was labelled 'C. Darwin Esq'." The item turned out to be a piece of fossil wood collected by Darwin during his famous Voyage of the Beagle in 1834. This was the expedition on which he first started to develop his theory of evolution.



*The fossil plants are polished into thin, translucent sheets*

In the course of his visit to Chiloe Island, Chile, Darwin encountered "many fragments of black lignite and silicified and pyritous wood, often embedded close together". He had these shipped back to England where they were cut and ground into thin sections. Joseph Hooker, a botanist and a close friend of Darwin, was responsible for assembling the "lost" collection while he briefly worked for the British Geological Survey in 1846.

The fossils became "lost" because Hooker failed to number them in the formal specimen register before setting out on an expedition to the Himalayas. The collection was moved several times and gradually became forgotten. Dr John Ludden, executive director of the Geological Survey said: "This is quite a remarkable discovery. It really makes one wonder what else might be hiding in our collections."

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## **Winged Dinosaur Archaeopteryx Dressed for Flight**

Since its discovery 150 years ago, scientists have puzzled over whether the winged dinosaur Archaeopteryx represents the missing link in birds' evolution to powered flight. Much of the debate has focused on the iconic creature's wings and the mystery of whether -- and how well -- it could fly.



*Berlin specimen of Archaeopteryx: Paleontologists have long thought that Archaeopteryx fossils, including this one discovered in Germany, placed the dinosaur at the base of the bird evolutionary tree. (Credit: Museum für Naturkunde Berlin)*

Some secrets have been revealed by an international team of researchers led by Brown University. Through a novel analytic approach, the researchers have determined that a well-preserved feather on the raven-sized dinosaur's wing was black. The color and parts of cells that would have supplied pigment are evidence the wing feathers were rigid and durable, traits that would have helped Archaeopteryx to fly.

The team also learned from its examination that Archaeopteryx's feather structure is identical to that of living birds, a discovery that shows modern wing feathers had evolved as early as 150 million years ago in the Jurassic period. The study, which appears in *Nature Communications*, was funded by the National Geographic Society and the U.S. Air Force Office of Scientific Research.

"If Archaeopteryx was flapping or gliding, the presence of melanosomes [pigment-producing parts of a cell] would have given the feathers additional structural support," said Ryan Carney, an evolutionary biologist at Brown and the paper's lead author. "This would have been advantageous during this early evolutionary stage of dinosaur flight."

The Archaeopteryx feather was discovered in a limestone deposit in Germany in 1861, a few years after the publication of Charles Darwin's *On the Origin of Species*. Paleontologists have long been excited about the fossil and other Archaeopteryx specimens, thinking they place the dinosaur at the base of the bird evolutionary tree. The traits that make Archaeopteryx an evolutionary intermediate between dinosaurs and birds, scientists say, are the combination of reptilian features (teeth, clawed fingers, and a bony tail) and avian features (feathered wings and a wishbone).

The lack of knowledge of Archaeopteryx's feather structure and color bedeviled scientists. Carney, with researchers from Yale University, the University of Akron, and the Carl Zeiss laboratory in Germany, analyzed the feather and discovered that it is a covert, so named because these feathers cover the primary and secondary wing feathers birds use in flight. After two unsuccessful attempts to image the melanosomes, the group tried a more powerful type of scanning electron microscope at Zeiss, where the group located patches of hundreds of the structures still encased in the fossilized feather.

"The third time was the charm, and we finally found the keys to unlocking the feather's original color, hidden in the rock for the past 150 million years," said Carney, a graduate student in the Department of Ecology and Evolutionary Biology, studying with Stephen Gatesy.

Melanosomes had long been known to be present in other fossil feathers, but had been misidentified as bacteria. In 2006, coauthor Jakob Vinther, then a graduate student at Yale, discovered melanin preserved in the ink sac of a fossilized squid. "This made me think that melanin could be fossilized in many other fossils such as feathers," said Vinther, now a postdoctoral researcher at the University of Texas-Austin. "I realized that I had opened a whole new chapter of what we can do to understand the nature of extinct feathered dinosaurs and birds."

The team measured the length and width of the sausage-shaped melanosomes, roughly 1 micron long and 250 nanometers wide. To determine the melanosomes' color, Akron researchers Matthew Shawkey and Liliana D'Alba statistically compared Archaeopteryx's melanosomes with those found in 87 species of living birds, representing four classes: black, gray, brown, and a type found in penguins. "What we found was that the feather was predicted to be black with 95 percent certainty," Carney said.

Next, the team sought to better define the melanosomes' structure. For that, they examined the fossilized barbules -- tiny, rib-like appendages that overlap and interlock like zippers to give a feather rigidity and strength. The barbules and the alignment of melanosomes within them, Carney said, are identical to those found in modern birds.

What the pigment was used for is less clear. The black color of the Archaeopteryx wing feather may have served to regulate body temperature, act as camouflage or be employed for display. But it could have been for flight, too.

"We can't say it's proof that Archaeopteryx was a flier. But what we can say is that in modern bird feathers, these melanosomes provide additional strength and

resistance to abrasion from flight, which is why wing feathers and their tips are the most likely areas to be pigmented," Carney said. "With Archaeopteryx, as with birds today, the melanosomes we found would have provided similar structural advantages, regardless of whether the pigmentation initially evolved for another purpose."

Contributing authors include Vinther, Shawkey, D'Alba, and Jörg Ackermann from Carl Zeiss.

**Story Source:** The above story is reprinted from materials provided by Brown University.

**Journal Reference:** Ryan M. Carney, Jakob Vinther, Matthew D. Shawkey, Liliana D'Alba, Jörg Ackermann. *New evidence on the colour and nature of the isolated Archaeopteryx feather.* *Nature Communications*, 2012; 3: 637 DOI: [10.1038/ncomms1642](https://doi.org/10.1038/ncomms1642)

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## Ancient Dinosaur Nursery: Oldest Nesting Site Yet Found

An excavation at a site in South Africa has unearthed the 190-million-year-old dinosaur nesting site of the prosauropod dinosaur *Massospondylus*-revealing significant clues about the evolution of complex reproductive behaviour in early dinosaurs. The newly unearthed dinosaur nesting ground predates previously known nesting sites by 100 million years, according to study authors.

A new study led by University of Toronto Mississauga paleontologist Robert Reisz, with co-author, Professor David Evans of ecology and evolutionary biology and the Royal Ontario Museum, along with a group of international researchers, describes clutches of eggs, many with embryos, as well as tiny dinosaur footprints, providing the oldest known evidence that the hatchlings remained at the nesting site long enough to at least double in size.



UTM professor Robert Reisz and his team unearthed this skull of adult and complete embryo of the Early Jurassic (190-million-year-old) dinosaur *Massospondylus* in the South African nesting site. (Credit: Photo courtesy of Robert Reisz)

At least 10 nests have been discovered at several levels at this site, each with up to 34 round eggs in tightly clustered clutches. The distribution of the nests in the sediments indicate that these early dinosaurs returned repeatedly to this site, a behaviour known as nesting fidelity, and likely assembled in groups to lay their eggs, (colonial nesting), the oldest known evidence of such behaviour in the fossil record. The large size of the mother, at six metres in length, the small size of the eggs, about six to seven centimetres in diameter, and the highly organized nature of the nest suggest that the mother may have arranged them carefully after she laid them.

"The eggs, embryos, and nests come from the rocks of a nearly vertical road cut only 25 metres long," said Reisz, a professor of biology at U of T Mississauga. "Even so, we found ten nests, suggesting that there are a lot more in the cliff, still covered by tons of rock. We predict that many more nests will be eroded out in time as natural weathering processes continue."

The fossils were found in sedimentary rocks from the Early Jurassic Period in the Golden Gate Highlands National Park in South Africa. This site has previously yielded the oldest known embryos belonging to *Massospondylus*, a relative of the giant, long-necked sauropods of the Jurassic and Cretaceous periods.

"Even though the fossil record of dinosaurs is extensive, we actually have very little fossil information about their reproductive biology, particularly for early dinosaurs," said Evans (pictured left, bottom, with Reisz, above), associate curator of vertebrate palaeontology at the Royal Ontario Museum. "This amazing series of 190 million year old nests gives us the first detailed look at dinosaur reproduction early in their evolutionary history, and documents the antiquity of nesting strategies that are only known much later in the dinosaur record."

The study, co-authored by Drs. Hans-Dieter Sues (Smithsonian Institute, U.S.), Eric Roberts (James Cook University, Australia), and Adam Yates (University of the Witwatersrand, South Africa), is published in the *Proceedings of the National Academy of Sciences*.

An exhibition currently on display at the Royal Ontario Museum until May 2012, *Dinosaurs Eggs and Babies: Remarkable Fossils from South Africa*, features the oldest fossilized dinosaur eggs with embryos ever found, as well as other impressive discoveries

**Story Source:** The above story is reprinted from materials provided by University of Toronto. The original article was written by Nicolle Wahl.

**Journal Reference:** Robert R. Reisz, David C. Evans, Eric M. Roberts, Hans-Dieter Sues, Adam M. Yates. **Oldest known dinosaurian nesting site and reproductive biology of the Early Jurassic**

*sauropodomorph Massospondylus*. *Proceedings of the National Academy of Sciences*, 2012; DOI: [10.1073/pnas.1109385109](https://doi.org/10.1073/pnas.1109385109)

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## Ancient Domesticated Dog Skull Found in Siberian Cave: 33,000 Years Old

A 33,000-year-old dog skull unearthed in a Siberian mountain cave presents some of the oldest known evidence of dog domestication and, together with an equally ancient find in a cave in Belgium, indicates that modern dogs may be descended from multiple ancestors.

If you think a Chihuahua doesn't have much in common with a Rottweiler, you might be on to something.

An ancient dog skull, preserved in a cave in the Altai Mountains of Siberia for 33,000 years, presents some of the oldest known evidence of dog domestication and, together with equally ancient dog remains from a cave in Belgium, indicates that domestication of dogs may have occurred repeatedly in different geographic locations rather than with a single domestication event.



*The 33,000-year-old skull of a domesticated dog was extraordinarily well preserved in the Razboinichya cave in the Altai Mountains of Siberia. (Credit: Image courtesy of Greg Hodgins)*

In other words, man's best friends may have originated from more than one ancient ancestor, contrary to what some DNA evidence previously has indicated.

"Both the Belgian find and the Siberian find are domesticated species based on morphological characteristics," said Greg Hodgins, a researcher at the University of Arizona's Accelerator Mass Spectrometry Laboratory and co-author of the study that reports the find.

"Essentially, wolves have long thin snouts and their teeth are not crowded, and domestication results in this shortening of the snout and widening of the jaws and crowding of the teeth."

The Altai Mountain skull is extraordinarily well preserved, said Hodgins, enabling scientists to make multiple measurements of the skull, teeth and mandibles that might not be possible on less well-preserved remains. "The argument that it is domesticated is pretty solid," said Hodgins. "What's interesting is that it doesn't appear to be an ancestor of modern dogs."

The UA's Accelerator Mass Spectrometry Laboratory used radiocarbon dating to determine the age of the Siberian skull.

Radioactive carbon, or carbon-14, is one of three carbon isotopes. Along with naturally occurring carbon dioxide, carbon-14 reaches the surface of Earth by atmospheric circulation, where plants absorb it into their tissues through photosynthesis.

Animals and humans take in carbon-14 by ingesting plants or other animals that have eaten plants. "Carbon-14 makes it into all organic molecules," said Hodgins. "It's in all living things."

"We believe that carbon-14 production is essentially constant over time," said Hodgins. "So the amount of carbon-14 present in living organisms in the past was similar to the levels in living organisms today. When an animal or plant dies, the amount of carbon-14 in its remains drops at a predictable rate, called the radioactive half-life. The half-life of radiocarbon is 5,730 years."

"People from all over the world send our laboratory samples of organic material that they have dug out of the ground and we measure how much carbon-14 is left in them. Based on that measurement, and knowing the radiocarbon half-life, we calculate how much time must have passed since the samples had the same amount of carbon-14 as plants and animals living today."

The researchers use a machine called an accelerator mass spectrometer to measure the amount of radioactive carbon remaining in a sample. The machine works in a manner analogous to what happens when a beam of white light passes through a prism: White light separates into the colors of the rainbow.

The accelerator mass spectrometer generates a beam of carbon from the sample and passes it through a powerful magnet, which functions like a prism. "What emerges from it are three beams, one each of the three carbon isotopes," said Hodgins. "The lightest carbon beam, carbon-12, bends the most, and then carbon-13 bends slightly less and carbon-14 bends slightly less than that."

The relative intensities of the three beams represent the sample's carbon mass spectrum. Researchers compare the mass spectrum of an unknown sample to the mass spectra of known-age controls and from this comparison, calculate the sample's radiocarbon age.

At 33,000 years old, the Siberian skull predates a period known as the Last Glacial Maximum, or LGM, which occurred between about 26,000 and 19,000 years ago when the ice sheets of Earth's last ice age reached their greatest extent and severely disrupted the living patterns of humans and animals alive during that time. Neither the Belgian nor the Siberian domesticated lineages appear to have survived the LGM.

However, the two skulls indicate that the domestication of dogs by humans occurred repeatedly throughout early human history at different geographical locations, which could mean that modern dogs have multiple ancestors rather than a single common ancestor.

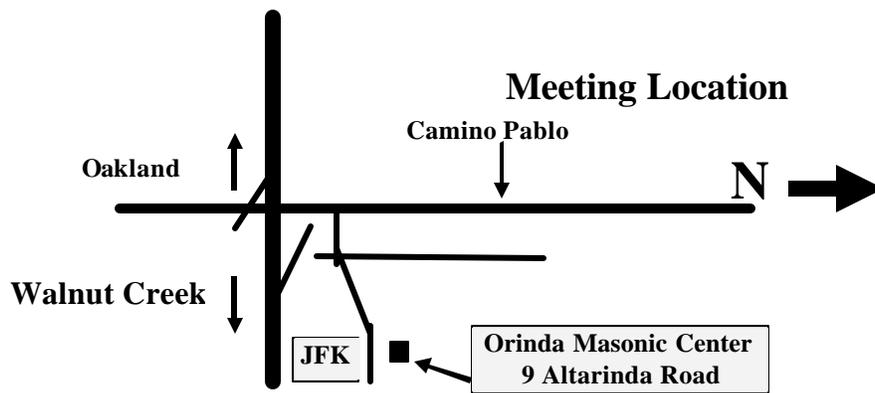
"In terms of human history, before the last glacial maximum people were living with wolves or canid species in widely separated geographical areas of Euro-Asia, and had been living with them long enough that they were actually changing evolutionarily," said Hodgins. "And then climate change happened, human habitation patterns changed and those relationships with those particular lineages of animals apparently didn't survive."

"The interesting thing is that typically we think of domestication as being cows, sheep and goats, things that produce food through meat or secondary agricultural products such as milk, cheese and wool and things like that," said Hodgins.

"Those are different relationships than humans may have with dogs. The dogs are not necessarily providing products or meat. They are probably providing protection, companionship and perhaps helping on the hunt. And it's really interesting that this appears to have happened first out of all human relationships with animals."

**Story Source:** The above story is reprinted from materials provided by University of Arizona. The original article was written by Shelley Littin, NASA Space Grant intern, University Communications.

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**Biography:** Dr. John Karachewski provides geologic and GIS support for the Cleanup Program at the California-EPA in the Department of Toxic Substances Control (DTSC) in Berkeley. John has conducted geology and environmental projects throughout the western United States from Colorado to Alaska to Midway Island and throughout California. He received his Master's degree from Western Washington University and his doctorate from the Colorado School of Mines. John has volunteered for nearly every officer position at NCGS and is currently serving as program chairman for the third time. John is also currently president of the San Francisco Bay Area Branch for the Groundwater Resources Association of California. This spring, he is also co-teaching a maps and cartography class with Jim Ellis at Diablo Valley College. He is also leading five geology hikes this year for the Point Reyes National Seashore Association.

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