NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

Website: www.ncgeolsoc.org

NCGS OFFICERS

President:
Will Schweller
willschweller@yahoo.com

President-Elect:
Open

Past President:
Phil Reed, Retired
philecreed@yahoo.com

Field Trip Coordinator:
Stefano Mazzoni
mazzonigeoscience@gmail.com

Treasurer:
Barbara Matz, Shaw Group, Inc.
barbara.matz@cbifederalservices.com

Program Director:
John Karachewski, Department of Toxic Substances Control
cageo@sbcglobal.net

Scholarship Chair:
Phil Garbutt, Retired
plgarbutt@comcast.net

K-12 Program Chair:
Phil Reed, Retired
philecreed@yahoo.com

Membership Chair:
Tom Barry
tomasbarry@aol.com

NCGS Outreach Chair:
John Christian
jmc62@sbcglobal.net

NCGS Newsletter Editor:
Mark Sorensen, Gilbane
msorensen64@earthlink.net

NCGS Website Editor:
Mark Detterman, Alameda County Environmental Health
mdetter1@gmail.com

Recording Secretary:
Dan Day, VA Engineering, Inc.
danday94@pacbell.net

COUNSELORS

Don Lewis, Retired
donlewis@comcast.net

Ray Sullivan, Emeritus, San Francisco State University
rays.rock@gmail.com

MEETING ANNOUNCEMENT

DATE: **May 25, 2016**

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

TIME: **6:00 p.m. social; 6:45 p.m. dinner; 8:00 pm – 9:00 pm talk. Cost: $25 per person**

SPEAKER: **Dr. Charlie Paull, Senior Scientist at the Monterey Bay Aquarium Research Institute (MBARI)**

Topic: Monterey Canyon: Superhighway to the Deep-Sea

Dr. Charlie Paull will describe the on-going efforts to understand the geologic processes occurring within Monterey Submarine Canyon, offshore of central California. For perspective, Monterey Canyon is equivalent in size to the Grand Canyon. Submarine canyons in general are conduits in which sediment-laden flows (including the wide range of gravity flows from slumps to turbidity currents) swiftly transport massive amounts of sediment from the shallow ocean to the deep sea. While such flows are among the most important processes by which sediments are carried across the Earth's surface and are credited for forming the canyons, very few direct measurements have ever been made of what actually happens during the sediment flow events. The lack of empirical data on sediment flows is a consequence of the difficulty in accessing canyon floors, the inability to predict when flows will happen, and the reality that energetic flows put monitoring equipment at risk. To understand submarine canyons and to further deep-sea technology development, the Monterey Bay Aquarium Research Institute (MBARI) has taken on the challenge of monitoring sediment flows and making direct measurements within these events. To achieve this goal, state of the art robotic vehicles have been utilized and several novel new instruments have been developed. With these technologies, Charlie's group at MBARI and neighboring institutions, have demonstrated that sediment-laden flows occur on a sub-annual basis in Monterey Canyon and produced startling surprises as to what happens during these energetic submarine events. These efforts have changed the focus of marine geologic research on submarine flows from a forensic science to making real time measurements of the evolving system.

NCGS 2015 – 2016 Calendar

June 22, 2016 7:00 pm

Jerome V. De Graff, CSU Fresno, Richard H. Jahns Lecturer for 2016 by the Association of Environmental & Engineering Geologists and the Geological Society of America

Fire, Earth & Rain

NCGS Field Trips

Field trips in a preliminary planning stage:

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

Peninsula Geologic Society

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

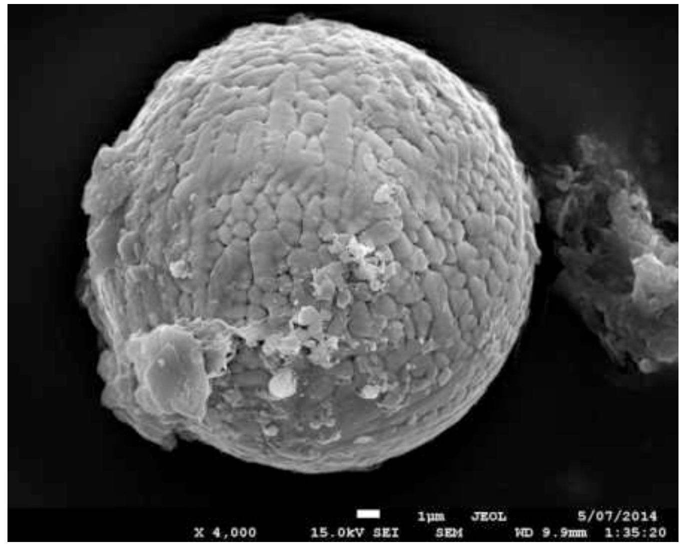
UC Berkeley Earth & Planetary Science Weekly Seminar Series

Interesting seminars are presented weekly at EPS throughout the academic year, generally from late August through early May. For an updated list of seminars, go to http://eps.berkeley.edu/events/seminars.

Reminder: *It's Past Renewal Time!* Our Year Runs From September to September. If you haven't already renewed, please use the Renewal Form in previous newsletter, or see the Treasurer at the meeting at registration time.

NCGS members are invited to attend any of our **NCGS Board meetings** held quarterly throughout the year (except for summer), generally in September, January, and May, at the CB&I (formerly Shaw E&I) offices at 4005 Port Chicago Hwy, Concord, CA 94520. The next board meeting is scheduled for 8:30 am to noon on Saturday, September 10, 2016.

Cosmic dust reveals Earth's ancient atmosphere



This is one of 60 micrometeorites extracted from 2.7 billion year old limestone, from the Pilbara region in Western Australia. These micrometeorites consist of iron oxide minerals that formed when dust particles of meteoritic iron metal were oxidized as they entered Earth's atmosphere, indicating that the ancient upper atmosphere was surprisingly oxygen-rich.

Credit: Andrew Tomkins

Using the oldest fossil micrometeorites -- space dust -- ever found, Monash University-led research has made a surprising discovery about the chemistry of Earth's atmosphere 2.7 billion years ago.

The findings of a new study published recently in the journal *Nature* -- led by Dr Andrew Tomkins and a team from the School of Earth, Atmosphere and Environment at Monash, along with scientists from the Australian Synchrotron and Imperial College, London -- challenge the accepted view that Earth's ancient atmosphere was oxygen-poor. The findings indicate instead that the ancient Earth's upper atmosphere contained about the same amount of oxygen as today, and that a methane haze layer separated this oxygen-rich upper layer from the oxygen-starved lower atmosphere.

Dr Tomkins explained how the team extracted micrometeorites from samples of ancient limestone collected in the Pilbara region in Western Australia and examined them at the Monash Centre for Electron Microscopy (MCEM) and the Australian Synchrotron.

"Using cutting-edge microscopes we found that most of the micrometeorites had once been particles of metallic iron -- common in meteorites -- that had been turned into iron oxide minerals in the upper atmosphere, indicating higher concentrations of oxygen than expected. This was an exciting result because it is the first time anyone has found a way to sample the chemistry of the ancient Earth's upper atmosphere," Dr Tomkins said.

Imperial College researcher Dr Matthew Genge -- an expert in modern cosmic dust -- performed calculations that showed oxygen concentrations in the upper atmosphere would need to be close to modern day levels to explain the observations.

"This was a surprise because it has been firmly established that the Earth's lower atmosphere was very poor in oxygen 2.7 billion years ago; how the upper atmosphere could contain so much oxygen before the appearance of photosynthetic organisms was a real puzzle," Dr Genge said.

Dr Tomkins explained that the new results suggest the Earth at this time may have had a layered atmosphere with little vertical mixing, and higher levels of oxygen in the upper atmosphere produced by the breakdown of CO 2 by ultraviolet light.

"A possible explanation for this layered atmosphere might have involved a methane haze layer at middle levels of the atmosphere. The methane in such a layer would absorb UV light, releasing heat and creating a warm zone in the atmosphere that would inhibit vertical mixing," Dr Tomkins said.

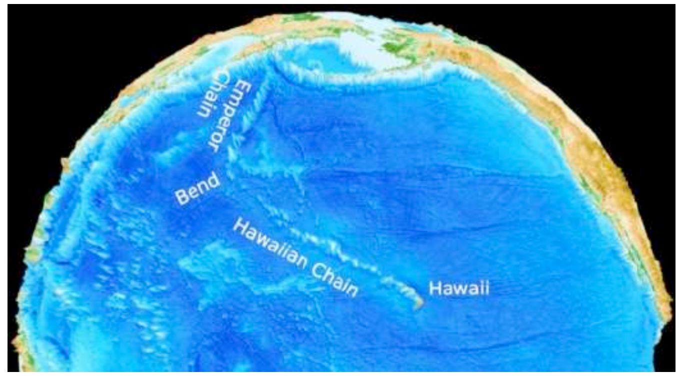
"It is incredible to think that by studying fossilized particles of space dust the width of a human hair, we can gain new insights into the chemical makeup of Earth's upper atmosphere, billions of years ago." Dr Tomkins said.

Dr Tomkins outlined next steps in the research. "The next stage of our research will be to extract micrometeorites from a series of rocks covering over a billion years of Earth's history in order to learn more about changes in atmospheric chemistry and structure across geological time. We will focus particularly on the great oxidation event, which happened 2.4 billion years ago when there was a sudden jump in oxygen concentration in the lower atmosphere."

Story Source: The above post is reprinted from materials provided by Monash University.

Journal Reference: Andrew G. Tomkins, Lara Bowlt, Matthew Genge, Siobhan A. Wilson, Helen E. A. Brand, Jeremy L. Wykes. **Ancient micrometeorites suggestive of an oxygen-rich Archaean upper atmosphere**. *Nature*, 2016; 533 (7602): 235 DOI: 10.1038/nature17678.

How the spectacular Hawaiian-Emperor seamount chain became so bendy



The Hawaii-Emperor seamount chain.

Credit: University of Sydney

The physical mechanism causing the unique, sharp bend in the Hawaiian-Emperor seamount chain has been uncovered in a collaboration between the University of Sydney and the California Institute of Technology (Caltech).

Led by a PhD candidate at the University of Sydney's School of Geosciences, researchers used the Southern Hemisphere's most highly integrated supercomputer to reveal flow patterns deep in the Earth's mantle -- just above the core -- over the past 100 million years. The flow patterns explain how the enigmatic bend in the Hawaiian-Emperor seamount chain arose.

True to the old adage -- as above, so below -- the Sydney-US collaboration found the shape of volcanic seamount chains (chains of mostly extinct volcanoes), including Hawaii, is intimately linked to motion near the Earth's core.

The findings of PhD candidate Rakib Hassan and fellow researchers including Professor Dietmar Müller from the University's EarthByte Group, are being published in *Nature*.

Mr Hassan explained: "Until now, scientists believed the spectacular 60° bend in the Hawaiian seamount chain -- not found in any other seamount chains -- was related to a change in plate motion combined with a change in flow direction in the shallow mantle, the layer of thick rock between the Earth's crust and its core.

"These findings suggest the shape of volcanic seamount chains record motion in the deepest mantle, near the Earth's core. The more coherent and rapid the motion deep in the mantle, the more acute its effects are on the shape of seamount chains above," he said.

Although solid, the mantle is in a state of continuous flow, observable only over geological timescales. Vertical columns of hot and buoyant rock rising through the mantle from near the core are known as mantle plumes. Volcanic seamount chains such as Hawaii were created from magma produced near the surface by mantle plumes. Moving tectonic plates sit above the mantle and carry newly formed seamounts away from the plume underneath -- the oldest seamounts in a chain are therefore furthest away from the plume.

"We had an intuition that, since the north Pacific experienced a prolonged phase where large, cold tectonic plates uninterruptedly sank into the mantle, the flow in the deepest mantle there would be very different compared to other regions of the Earth," Mr Hassan said.

One of the most contentious debates in geoscience has centered on whether piles of rock in the deep mantle -- to which plumes are anchored -- have remained stationary, unaffected by mantle flow over hundreds of millions of years.

The new research shows the shapes of these piles have changed through time and their shapes can be strongly dependent on rapid, coherent flow in the deep mantle.

Between 50-100 million years ago, the edge of the pile under the north Pacific was pushed rapidly southward, along with the base of Hawaii's volcanic plume, causing it to tilt. The plume became vertical again once the motion of its base stopped; this dramatic start-stop motion resulted in the seamount chain's sharp bend.

Using Australia's National Computational Infrastructure's supercomputer Raijin, the team created high-resolution three-dimensional simulations of mantle evolution over the past 200 million years to understand the coupling between convection in the deep Earth and volcanism.

Mr Hassan said the simulations were guided by surface observations -- similar to meteorologists applying past measurements to predict the weather. "These simulations required millions of central processing unit (CPU) hours on the supercomputer over the course of the project," he said.

Professor Müller concluded: "Our results help resolve a major enigma of why volcanic seamount chains on the same tectonic plate can have very different shapes. "It is now clear that we first need to understand the dynamics of the deepest 'Underworld', right above the core, to unravel the history of volcanism at Earth's surface," said Professor Müller.

Watch the animation here: https://youtu.be/Xy5kHjAHXec

Story Source: The above post is reprinted from materials provided by University of Sydney.

Journal Reference: Rakib Hassan, R. Dietmar Müller, Michael Gurnis, Simon E. Williams, Nicolas Flament. **A rapid burst in hotspot motion through the interaction of tectonics and deep mantle flow**. *Nature*, 2016; 533 (7602): 239 DOI: 10.1038/nature17422

New Ice Age knowledge

Pacific stores the greenhouse gas carbon dioxide at depths of thousands of meters

An international team of researchers headed by scientists from the Alfred Wegener Institute has gained new insights into the carbon dioxide exchange between ocean and atmosphere, thus making a significant contribution to solving one of the great scientific mysteries of the ice ages. In the past 800,000 years of climate history, the transitions from interglacials and ice ages were always accompanied by a significant reduction in the carbon dioxide content in the atmosphere. It then fell from 280 to 180 ppm (parts per million). Where this large amount of carbon dioxide went to and the processes through which the greenhouse gas reached the atmosphere again has been controversial until now. The scientists have now managed to locate a major carbon dioxide reservoir at a depth of 2000 to 4300 meters in the South Pacific and reconstruct the details of its gas emission history. Their new findings have been published open access in the scientific journal *Nature Communications*.

The southern Pacific Ocean is regarded as one of the largest ventilation windows of the world oceans. This is where the global conveyor belt of ocean currents transports the carbon-rich water from great depths to the surface of the sea for a short time. The gas concentration balance between water and air takes place where the two meet. This usually means that the carbon-rich water masses release the greenhouse gas carbon dioxide they had stored into the atmosphere, thus contributing to the greenhouse effect and the warming of the earth.

But what happened with this oceanic window during the last ice age and during the transition to the current warm period? When there was no ventilation, what happened to the carbon-rich water from the depths? With these key questions in mind, the international team of researchers consisting of geologists, geochemists and modelers analyzed sediment cores from the South West Pacific.

The reason why the samples were taken in this marine region was as follows: The atmospheric carbon dioxide curve known from ice cores shows that at the end of the last ice age large amounts of "old" carbon dioxide were released into the atmosphere. Its old age means that this carbon dioxide comes from a reservoir that had not been in contact with the atmosphere for a long period of time. From a climate historical perspective the most likely place where the carbon dioxide is hidden is therefore the oceanic deep water. Most of it is in the Pacific, and it contains around 60 times more carbon than the pre-industrial atmosphere.

The examined sediment samples come from water depths of 830 to 4300 meters; they go back 35,000 years and contained calcareous shells of single-celled foraminifera that live on the seafloor and are important for climate reconstructions. The calcareous shells were radiocarbon dated (14C) and thus provided information about the age of the above-mentioned water mass where the organisms lived, and about the period in which there was no exchange between this water mass and the atmosphere. "The older a water mass, the more carbon dioxide it stores, because bound carbon in the form of animal and plant remains constantly trickles down from the surface," says Dr Thomas Ronge, lead author of the study and geologist at the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI).

This allowed him and his colleagues to find out that the water of the Southern Ocean approx. 20,000 years ago was strongly stratified and the individual water masses hardly intermixed at all. "Our results were surprising and indicated that the deep South Pacific during this glacial period was not only augmented with old carbon dioxide from the decomposition of organic material, but also as a result of eruptions of submarine volcanoes," Thomas Ronge explains.

On the basis of these new climate data, the AWI researchers are now able to draw the following picture of the ice age ocean 20000 years ago. "We know from other studies that it is likely that during the transition from interglacial to ice age a large sea ice cover formed on the Antarctic Ocean, which closed the oceanic ventilation window. At the same time, the Southern Westerly Winds moved northwards, so that the buoyancy in the Southern Ocean was reduced and only a small amount of deep water reached the surface," Thomas Ronge explained.

In fact, deep ocean circulation slowed down to such an extent that the heavy, saline water mass below a depth of 2000 meters was not in contact with the surface for almost 3000 years. "During this time, so much bound carbon in the form of animal and algae remains trickled down from the more intermixed sea surface into the deep water layer that we were able to identify it as the major carbon reservoir that we have looked for so intensively," says Thomas Ronge. The data also showed that the already old age of the water masses was artificially increased from about 3000 to 8000 years as a result of the injected volcanic carbon.

At the end of the last ice age, when the Antarctic sea ice decreased again, the westerly winds returned to the south and the ocean circulation picked up speed again, the deep water enriched with carbon reached the surface of the sea. "The water then released large amounts of the stored carbon in the form of old carbon dioxide into the atmosphere and thus significantly accelerated the warming of the planet," says Thomas Ronge.

Today, carbon-rich deep water around the Antarctic is transported to the sea surface as well. Since the industrialization, however, carbon dioxide concentration in the atmosphere has increased to more than 400 ppm, which means that the Southern Ocean is not currently emitting carbon dioxide, and instead is absorbing the greenhouse gas, which in turn slightly dampens global warming. Previous model studies indicate, however, that this ratio may reverse in the coming centuries.

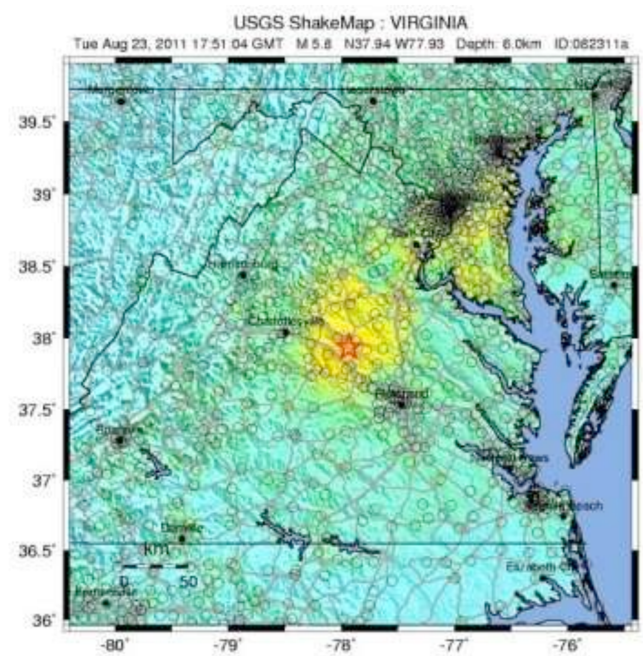
There is evidence to suggest that the current climate change causes westerly winds to increase, which increasingly transports carbon dioxide-rich deep water to the surface. "Examining the sensitivity of this system to different time scales and which processes are particularly important is currently a focal point of several research groups at the Alfred Wegener Institute and worldwide," says Prof Ralf Tiedemann, co-author of the study and head of the department of geosciences at the AWI.

Story Source: The above post is reprinted form materials provided by Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research.

Journal Reference: T. A. Ronge, R. Tiedemann, F. Lamy, P. Köhler, B. V. Alloway, R. De Pol-Holz, K. Pahnke, J. Southon, L. Wacker. **Radiocarbon constraints on the extent and evolution of the South Pacific glacial carbon pool**. *Nature Communications*, 2016; 7: 11487 DOI: 10.1038/ncomms11487.

Editor's Note: Also see "Carbon release from ocean helped end the Ice Age" in Science Daily at https://www.sciencedaily.com/releases/2015/02/150211132019.htm.

Likely cause for recent southeast US earthquakes: Underside of the North American Plate peeling off



Shaking from the magnitude 5.8 earthquake near Mineral, Virginia on August 23, 2011 was felt by more *people than any other earthquake in U.S. history, according to the U.S. Geological Survey. Credit: USGS*

The southeastern United States should, by all means, be relatively quiet in terms of seismic activity. It's located in the interior of the North American Plate, far away from plate boundaries where earthquakes usually occur. But the area has seen some notable seismic events -- most recently, the 2011 magnitude-5.8 earthquake near Mineral, Virginia that shook the nation's capital.

Now scientists report in a new study a likely explanation for this unusual activity: pieces of the mantle under this region have been periodically breaking off and sinking down into the Earth. This thins and weakens the remaining plate, making it more prone to slipping that causes earthquakes. The study authors conclude this process is ongoing and likely to produce more earthquakes in the future.

"Our idea supports the view that this seismicity will continue due to unbalanced stresses in the plate," said Berk Biryol, a seismologist at the University of North Carolina at Chapel Hill and lead author of the new study. "The [seismic] zones that are active will continue to be active for some time." The study was published today in the *Journal of Geophysical Research -- Solid Earth*, a journal of the American Geophysical Union.

Compared to earthquakes near plate boundaries, earthquakes in the middle of plates are not well understood and the hazards they pose are difficult to quantify. The new findings could help scientists better understand the dangers these earthquakes present.

Old plates and earthquakes

Tectonic plates are composed of Earth's crust and the uppermost portion of the mantle. Below is the asthenosphere: the warm, viscous conveyor belt of rock on which tectonic plates ride.

Earthquakes typically occur at the boundaries of tectonic plates, where one plate dips below another, thrusts another upward, or where plate edges scrape alongside each other. Earthquakes rarely occur in the middle of plates, but they can happen when ancient faults or rifts far below the surface reactivate. These areas are relatively weak compared to the surrounding plate, and can easily slip and cause an earthquake.

Today, the southeastern U.S. is more than 1,056 miles from the nearest edge of the North American Plate, which covers all of North America, Greenland and parts of the Atlantic and Arctic oceans. But the region was built over the past billion years by periods of accretion, when new material is added to a plate, and rifting, when plates split apart. Biryol and colleagues suspected ancient fault lines or pieces of old plates extending deep in the mantle following episodes of accretion and rifting could be responsible for earthquakes in the area.

"This region has not been active for a long time," Biryol said. "We were intrigued by what was going on and how we can link these activities to structures in deeper parts of the Earth."

A CAT scan of the Earth

To find out what was happening deep below the surface, the researchers created 3D images of the mantle portion of the North American Plate. Just as doctors image internal organs by tracing the paths of x-rays through human bodies, seismologists image the interior of the Earth by tracing the paths of seismic waves created by earthquakes as they move through the ground. These waves travel faster through colder, stiffer, denser rocks and slower through warmer, more elastic rocks. Rocks cool and harden as they age, so the faster seismic waves travel, the older the rocks.

The researchers used tremors caused by earthquakes more than 2,200 miles away to create a 3D map of the mantle underlying the U.S. east of the Mississippi River and south of the Ohio River. They found plate thickness in the southeast U.S. to be fairly uneven -- they saw thick areas of dense, older rock stretching downward and thin areas of less dense, younger rock.

"This was an interesting finding because everybody thought that this is a stable region, and we would expect regular plate thickness," Biryol said.

At first, they thought the thick, old rocks could be remnants of ancient tectonic plates. But the shapes and locations of the thick and thin regions suggested a different explanation: through past rifting and accretion, areas of the North American Plate have become more dense and were pulled downward into the mantle through gravity. At certain times, the densest parts broke off from the plate and sank into the warm asthenosphere below. The asthenosphere, being lighter and more buoyant, surged in to fill the void created by the missing pieces of mantle, eventually cooling to become the thin, young rock in the images.

The researchers concluded this process is likely what causes earthquakes in this otherwise stable region: when the pieces of the mantle break off, the plate above them becomes thinner and more prone to slip along ancient fault lines. Typically, the thicker the plate, the stronger it is, and the less likely to produce earthquakes.

According to Biryol, pieces of the mantle have most likely been breaking off from underneath the plate since at least 65 million years ago. Because the researchers found fragments of hard rocks at shallow depths, this process is still ongoing and likely to continue into the future, potentially leading to more earthquakes in the region, he said.

Story Source: The above post is reprinted from materials provided by University of North Carolina at

Chapel Hill. The original item was written by Lauren Lipuma.

Journal Reference: C. Berk Biryol, Lara S. Wagner, Karen M. Fischer, Robert B. Hawman. **Relationship Between Observed Upper Mantle Structures and Recent Tectonic Activity Across the Southeastern United States**. *Journal of Geophysical Research: Solid Earth*, 2016; DOI: 10.1002/2015JB012698.

Scientists track Greenland's ice melt

Researchers from MIT, Princeton University, and elsewhere have developed a new technique to monitor the seasonal changes in Greenland's ice sheet, using seismic vibrations generated by crashing ocean waves. The results, which will be published in the journal *Science Advances*, may help scientists pinpoint regions of the ice sheet that are most vulnerable to melting. The technique may also set better constraints on how the world's ice sheets contribute to global sea-level changes.

"One of the major contributors to sea level rise will be changes to the ice sheets," says Germán Prieto, the Cecil and Ida Green Career Development Assistant Professor in the Department of Earth, Atmospheric and Planetary Sciences (EAPS) at MIT. "With our technique, we can continuously monitor ice sheet volume changes associated with winter and summer. That's something that global models need to be able to take into account when calculating how much ice will contribute to sea level rise."

Prieto and his colleagues study the effects of "seismic noise," such as ocean waves, on Earth's crust. As ocean waves crash against the coastline, they continuously create tiny vibrations, or seismic waves.

"They happen 24 hours a day, seven days a week, and they generate a very small signal, which we generally don't feel," Prieto says. "But very precise seismic sensors can feel these waves everywhere in the world. Even in the middle of continents, you can see these ocean effects."

The seismic waves generated by ocean waves can propagate through Earth's crust, at speeds that depend in part on the crust's porosity: The more porous the rocks, the slower seismic waves travel. The scientists reasoned that any substantial overlying mass, such as an ice sheet, may act like a weight on a sponge, squeezing the pores closed or letting them reopen, depending on whether the ice above is shrinking or growing in size.

The team, led by Aurélien Mordret, a postdoc in EAPS, hypothesized that the speed of seismic waves through Earth's crust may therefore reflect the volume of ice lying above. "By looking at velocity changes, we can make predictions of the volume change of the ice sheet mass," Prieto says. "We can do this continuously over time, day by day, for a particular region where you have seismic data being recorded."

Short track

Scientists typically track changing ice sheets using laser altimetry, in which an airplane flies over a region and sends a laser pulse down and back to measure an ice sheet's topography. Researchers can also look to data gathered by NASA's GRACE (Gravity Recovery and Climate Experiment) mission -- twin satellites that orbit Earth, measuring its gravity field, from which scientists can infer an ice sheet's volume.

As Prieto points out, "you can only do laser altimetry several times a year, and GRACE satellites require about one month to cover Earth's surface."

In contrast, ocean waves and the seismic waves they produce generate signals that sensors can pick up continuously."This has very good time resolution, so it can look at melting over short time periods, like summer to winter, with really high precision that other techniques might not have," Prieto says.

Seismic shakeup

The researchers looked through seismic data collected from January 2012 to January 2014, from a small seismic sensor network situated on the western side of Greenland's ice sheet. The sensors record seismic vibrations generated by ocean waves along the coast, and they have been used to monitor glaciers and earthquakes. Prieto's team is the first to use seismic data to monitor the ice sheet itself.

Looking through the seismic data, the scientists were able to detect incredibly small changes in the velocity of seismic waves, of less than 1 percent. They tracked average velocities from January 2012 to 2014, and observed very large seismic velocity decreases in 2012, versus 2013. These measurements mirrored the observations of ice sheet volume made by the GRACE satellites, which recorded abnormally large melting in 2012 versus 2013. The comparison suggested that seismic data may indeed reflect changes in ice sheets.

Using data from the GRACE satellites, the team then developed a model to predict the volume of the ice sheet, given the velocity of the seismic waves within Earth's crust. The model's predictions matched the satellite data with 91 percent accuracy.

Toward that end, the team plans next to use available seismic networks to track the seasonal changes in the Antarctic ice sheet. "Our efforts right now are to use what's available," Prieto says. "Nobody has been looking at this particular area using seismic data to monitor ice sheet volume changes."

If the technique is proven reliable in Antarctica, Prieto hopes to stimulate a large-scale project involving many more seismic sensors distributed along the coasts of Greenland and Antarctica.

"If you have very good coverage, like an array with separations of about 70 kilometers, we could in principle make a map of the regions that have more melting than others, using this monitoring, and maybe better refine models of how ice sheets respond to climate change," Prieto says.

Story Source: The above post is reprinted form materials provided by Massachusetts Institute of Technology. The original item was written by Jennifer Chu.

Journal Reference: A. Mordret, T. D. Mikesell, C. Harig, B. P. Lipovsky, G. A. Prieto. **Monitoring southwest Greenlands ice sheet melt with ambient seismic noise**. *Science Advances*, 2016; 2 (5): e1501538 DOI: 10.1126/sciadv.1501538.

Water storage made prehistoric settlement expansion possible in Amazonia

Contemporary water storage. Location: Bom Futuro. Credit: Per Stenborg

The pre-Columbian settlements in Amazonia were not limited to the vicinities of rivers and lakes. One example of this can be found in the Santarém region in Brazilian Amazonia, where most archaeological sites are situated in an upland area and are the result of an expansion of settlements in the last few centuries before the arrival of Europeans. This is concluded by a research team consisting of archaeologists from the University of Gothenburg and Brazilian colleagues.

'Our results stand in contrast to the traditional understanding of pre-Columbian Amazonia. A common view has been that villages only existed along the rivers. However, our work shows that people eventually also populated inland areas,' says Per Stenborg, archaeologist and director of the Swedish part of the Swedish-Brazilian project Cultivated Wilderness: Socio-economic Development and Environmental Change in Pre-Columbian Amazonia.

The project started 10 years ago and involves archaeologists and soil scientists. Road constructions and exploitation in the region have rendered archaeological rescue work even more urgent.

The remains of more than 110 human settlements have been found, and most of them were built on the so-called Belterra Plateau, situated south of the present city of Santarém. Some of the sites have been investigated in more detail.

'We found both large natural and small human-made depressions that were used for water storage. The human-made depressions, or ponds, have been enclosed by berms consisting of a mix of compact clay soil and household waste, such as pottery sherds. We have also been able to date a lot of material, including pottery and charcoal from hearths.'

It has long been known that people have populated areas along the rivers for thousands of years. What Stenborg and his colleagues have been able to add to this knowledge is that something happened around the fourteenth century.

'The oldest inland settlements we have dated are from that time. There seems to have been some type of inland expansion in connection with the development of technologies for water management and agriculture.

Thus, the period A.D. 1300-1500 seems to have been characterized by major change in the prehistoric communities in this part of Amazonia, with significant population growth coupled with new types of water management and agriculture.

During the dry periods, the water supply is very limited in the inland rainforests, why water storage was necessary for permanent settlement. In addition, the soil tends to be relatively poor, yet fertile soil called terra preta, or Amazonian dark earth, has emerged near settlements. According to the archaeologists, this is another indication of the presence of a large community in the area.

'We've found signs of a previously unknown magnitude of community organization. The settlements seemed to have been part of a larger organization. One indication of this is that the pottery we've found is stylistically consistent regardless of whether it is from settlements along the river or in the inland,' says Stenborg.

The network of settlements in different environments not only gave people access to different types of natural resources, it also enabled them to farm the land for longer parts of the year. Since the river banks are flooded during the six-month rainy season, those areas are farmed during the dry season. In contrast, it was during the rainy periods that farming was possible in the inland areas.

Story Source: The above post is reprinted from materials provided by University of Gothenburg. The original item was written by Thomas Melin.

Reference: "Water storage made prehistoric settlement expansion possible in Amazonia." ScienceDaily. ScienceDaily, 28 April 2016. www.sciencedaily.com/releases/2016/04/160428103155.htm.

Ice Age Fossils in Fremont

During construction of a seismic project to retrofit two large water transmission pipelines in Fremont, crews made an unexpected discovery: more than 50 specimens of ice age fossils. Found in what seems to be two separate deposits, or geologic layers, one grouping dates back to between 11,000 to 240,000 years before present during the Rancholabrean North American Land Mammal Age and the other possibly belonging to the slightly older Irvingtonian North American Land Mammal Age – 240,000 to 1.8 million years ago. These fossils have found a new permanent home not far from where they were found – the Children's Natural History Museum of Fremont.

Construction

As part of its $4.8 billion Water System Improvement Program, the San Francisco Public Utilities Commission upgraded two large water transmission lines where they cross over three traces of the Hayward Fault near Highway 680 and Mission Boulevard in Fremont (Seismic Upgrade Project in Fremont). Construction on the retrofit of the pipes as they cross the fault began in fall of 2012, and used the latest in cutting edge seismic technology. A new 305-foot-long articulated concrete vault, which includes the pipeline with one-of-a-kind ball joints and a slip joint, was constructed under Mission Boulevard. The pipeline can absorb 6.5 feet of horizontal offset and 9 feet of compression during an earthquake on the Hayward Fault.

Crews Find Specimens

During excavation of the articulated concrete vault in August of 2013, construction crews found the humerus of a bison at a depth of approximately 25 to 30 feet. Crews would later find more than 50 specimens during construction. Upon discovery of significant paleontological artifacts, the project doubled their paleontological staff from one half-time to one full-time staff person in order to properly excavate and catalogue the discoveries.

See more photos from the construction site at the internet address provided below.

What Ice Age Fossils did they find?

Both groupings of fossils belong to the Pleistocene Epoch, which spans 2.6 million to 11,700 years ago. This was the time of the last ice age, when large glaciers covered portions of North America, Europe, and Asia.

Remains of at least 2 bison, horse, elk, camel, deer, brush rabbit, deer mice, and pocket gophers were found in the soil unit that can be dated to the Rancholabrean North American Land Mammal Age of 11,000 to 240,000 years before present. This area of Fremont could have looked like the Serengeti of today, with grasslands accented by brush and trees. These fossils were deposited in what appears to be a fast moving stream bed.

The layer that possibly dates to the Irvingtonian North American Land Mammal Age, which dates back 240,000 to 1.8 million years ago, show indications of a freshwater lake bed during this period. The fossil record includes the presence of freshwater snails, fish, mussels, and crayfish as well as reptiles and amphibians.

Rancholabrean

This portion of the East Bay hosted many animals that are familiar to us today: deer, rabbits, pocket gophers, and coyote, for example. Animals that later became extinct in North America also roamed this area, such as horses and camels. Camels actually originated in North America and migrated to Asia and beyond via the "Land Bridge" between North American and Asia. Modern horses in America today descend from horses brought by Europeans; they are not the ancestors of the North American horses. Bison at this time were about 20% larger than their modern relatives. Columbian Mammoths, huge ground sloths, sabertoothed tigers, and short faced bear also lived in this area during the Rancholabrean period. We know this because their remains have been found in other fossil deposits.

The name Rancholabrean stems from the La Brea Tar Pits in Southern California, where the first 'index' specimens from this time period were found. The La Brea Tar Pits continue to be the world's premier location for Pleistocene animal fossils.

Irvingtonian

The earlier Irvingtonian North American Land Mammal Age takes its name from the Irvington District in Fremont, and can be directly attributed to the activities of a group of self-named 'boy paleontologists' and their mentor Wes Gordon starting in the 1940s. For more than 10 years, Wes and his students excavated tens of thousands of Pleistocene fossil finds from a gravel quarry in Fremont. As with the Rancholabrean, the index species for the Irvingtonian Land Mammal Age were discovered here in the Bay Area by the work of Wes Gordon and his young paleontologists. Children's Natural History Museum in Fremont Although the majority of the fossils from the 'boy paleontologists' went to the University of California Berkeley, some of the collection went to the San Lorenzo school district, where Wes worked. In 2004, the Gordon family approached the Math Science Nucleus in Fremont to take on this collection, which not only included Irvingtonian fossils, but also books, and an extensive rock collection. Six truck loads later, the Math Science Nucleus was in possession of 30 display cases, 150 boxes of fossils, posters, a 400-pound mammoth skull, and one mounted moose head. The Math Science Nucleus began to plan to continue Wes Gordon's legacy of educating children about the earth and the natural history of their hometown. The museum has been growing ever since.

The museum, located at 4074 Eggers Drive, hosts dozens of student field trips each year, and is the only museum in the Bay Area to regularly display fossils from the Bay Area. The San Francisco Public Utilities Commission was approached by Dr. Joyce Blueford, Paleontologist, from the museum following the news of a fossil discovery from another SFPUC construction site, the Calaveras Dam Replacement Project.

Source: San Francisco PUC website: http://www.sfwater.org/index.aspx?page=989.

Why Does This Antarctic Waterfall Run Blood-Red?

Antarctica's McMurdo Dry Valley is one of the world's most extreme deserts, and also one of the strangest. Featuring a row of snow-free valleys and the longest river on the continent, the Onyx River, it's also home to a five-story-tall waterfall that runs bright red down the side of an enormous glacier.

Image: Hassan Basagic

To discover the reason behind the waterfall's eerie hue, we have to trace its history back 5 million years, when sea levels rose and flooded East Antarctica. At the same time, a salty lake formed. Over millions of years, ice settled on the salty lake and formed huge glaciers, which cut the lake off from the rest of Antarctica and kept it 400 meters underground. Over time, the subglacial lake became even saltier - three times saltier than seawater, in fact - which means it was impossible to freeze.

Cut off from its physical surroundings, the incredibly salty water that feeds Antarctic's Blood Falls has not once been exposed to sunlight in several million years and is completely devoid of oxygen. "It's also extremely rich in iron, which was churned into the water by glaciers scraping the bedrock below the lake," says Natasha Geiling at *Smithsonian Magazine*. "When water from the subglacial lake seeps through a fissure in the glacier, the salty water cascades down the Taylor Glacier into Lake Bonney below. When the iron-rich water comes into contact with the air, it rusts - depositing blood red stains on the ice as it falls."

Not only is the blood-red, super-salty water severely lacking in oxygen and any exposure to light, it also happens to be home to some extremely odd wildlife. When the lake was forming million of years ago, tiny microbes moved in, and found themselves trapped when the glaciers grew and set on top. The microbes have been thriving in the lake ever since, sourcing the energy they need by breaking down sulfates - naturally occurring substances that contain sulfur and oxygen.

"After that, something eerily magical happens with the by-products," says Geiling at *Smithsonian Magazine*, "the iron in the water interacts with them to restore the sulfates, basically recycling the sulfates for the microbes to break down into oxygen over and over again."

Source: *Smithsonian Magazine*

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

NCGS DINNER MEETING Wednesday May 25, 2016
Orinda Masonic Center, 9 Altarinda Road, Orinda, CA

Monterey Canyon: Superhighway to the Deep-Sea

Dr. Charlie Paull
Senior Scientist at the Monterey Bay Aquarium Research Institute (MBARI)

(Reservations are required by May 20, 2015, Limit 100 persons)
We are sorry but we will not be able to accommodate "walk-ins"

The **NCGS** is pleased to host this *special dinner meeting* with **Dr. Paull**. This annual event will be catered by *Back Forty Texas BBQ and consist of Pork Ribs and BBQ Chicken, Tossed Green Salad, BBQ Beans, and Fresh Corn Cobettes. A deluxe veggie burger is available upon request (see below). Desert will include assorted cookies and brownies. Wine will also be served.*

Dr. Charlie Paull will describe the on-going efforts to understand the geologic processes occurring within Monterey Submarine Canyon, offshore of central California. For perspective, Monterey Canyon is equivalent in size to the Grand Canyon. Submarine canyons in general are conduits in which sediment-laden flows (including the wide range of gravity flows from slumps to turbidity currents) swiftly transport massive amounts of sediment from the shallow ocean to the deep sea. While such flows are among the most important processes by which sediments are carried across the Earth's surface and are credited for forming the canyons, very few direct measurements have ever been made of what actually happens during the sediment flow events. The lack of empirical data on sediment flows is a consequence of the difficulty in accessing canyon floors, the inability to predict when flows will happen, and the reality that energetic flows put monitoring equipment at risk. To understand submarine canyons and to further deep-sea technology development, the Monterey Bay Aquarium Research Institute (MBARI) has taken on the challenge of monitoring sediment flows and making direct measurements within these events. To achieve this goal, state of the art robotic vehicles have been utilized and several novel new instruments have been developed. With these technologies, Charlie's group at MBARI and neighboring institutions, have demonstrated that sediment-laden flows occur on a sub-annual basis in Monterey Canyon and produced startling surprises as to what happens during these energetic submarine events. These efforts have changed the focus of marine geologic research on submarine flows from a forensic science to making real time measurements of the evolving system.

**************************************Dinner Logistics**************************************

Social Hour: 6:00 – 6:45 pm; **Dinner**: 6:45 – 8:00 pm; **Presentation**: 8:00 – 9:00 pm
Cost: **$25/person**

******************** ✂ *************Registration ***

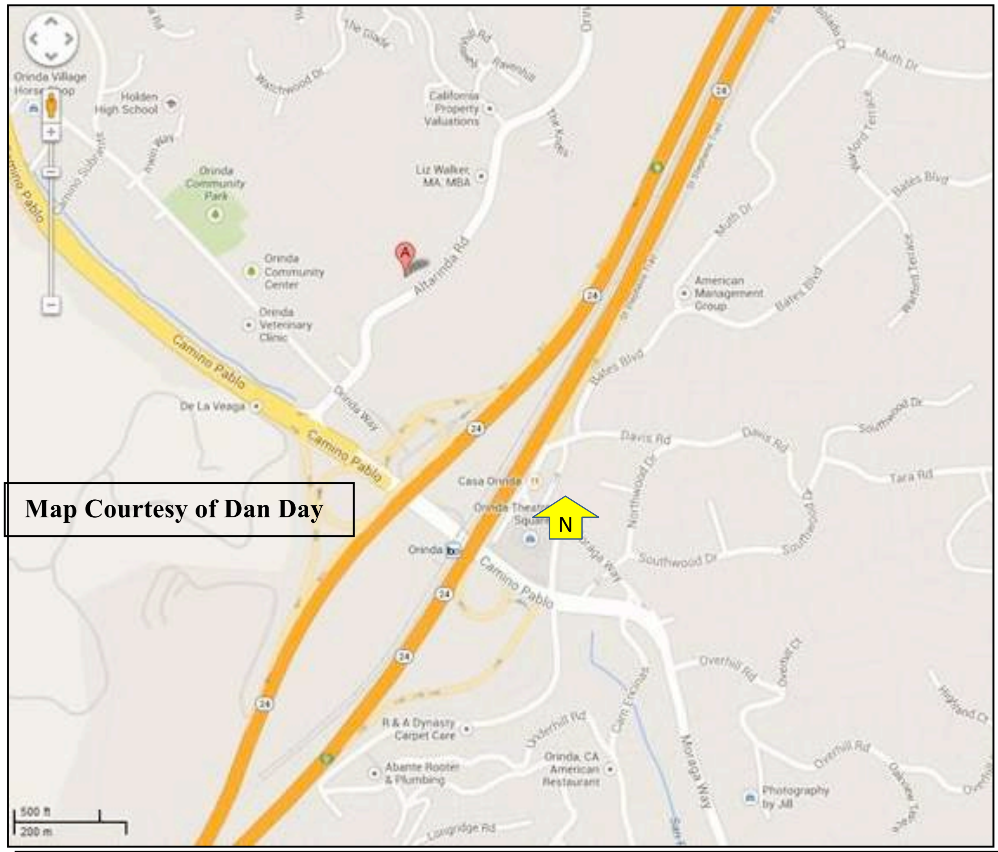
Name(s):____

E-mail:____

Phone (day):_________________________________Phone (cell)___________________________________

Check one per person: Regular Dinner: ____ Vegetarian: ___ # Attending_____________Check Amount: ___________

Please clip and mail this registration form with a check made out to **NCGS** to:
Barbara Matz, 803 Orion #2, Hercules CA 94547
Questions: e-mail barbara.matz@cbifederalservices.com; Phone: (415) 713-8482



Map Courtesy of Dan Day

Northern California Geological Society
c/o Mark Sorensen
734 14th Street, #2
San Francisco, CA 94114

Would you like to receive the NCGS newsletter by e-mail? If you are not already doing so, and would like to, please contact Tom Barry at **tomasbarry@aol.com** to sign up for this free service.