NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

MEETING ANNOUNCEMENT

DATE: **March 25, 2015**

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

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

SPEAKER: **Dr. Jake Lowenstern, U.S. Geological Survey**

The Yellowstone Volcano: Past, Present and Future - Monitoring the sleeping giant beneath Yellowstone National Park

The talk will focus on the past, present and future of the Yellowstone volcanic and geothermal system. Over the past two million years, Yellowstone has produced some of the largest single explosive volcanic eruptions known on Earth, as well as hundreds of lava flows, large earthquakes, and massive steam explosions. The region continues to exhibit continual volcanic unrest, such that scientists with the Yellowstone Volcano Observatory watch over a sophisticated monitoring network to detect new activity. The incursion of heat and mass from the Yellowstone hotspot on pre-existing Archean basement, and Mesozoic and Cenozoic sediments results in a remarkable coalescence of mantle, crustal, and atmosphere-derived fluids that interact in the geothermal system. Studies of Yellowstone renowned geothermal system therefore provide insight both into the mantle, but also into the billions of years of geologic history that preceded recent volcanism.

Dr. Jake Lowenstern is a native of Virginia, and a graduate of Dartmouth College (A.B.) and Stanford University (M.S. and Ph.D.). His career has focused on magmas and the hydrothermal systems that form above them. Since 1993, he has worked at the U.S. Geological Survey in Menlo Park, where he has led studies on topics ranging from gas geochemistry to igneous petrology to zircon geochronology to geothermal prospecting. Since 2002, he has served as scientist-in-charge of the Yellowstone Volcano Observatory.

NCGS 2014 – 2015 Calendar

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

June 24, 2015 **7:00 pm**
Dr. Will Schweller, NCGS President and Consultant
Injected Sands – Mother Nature's Giant Frac Job?

September 30, 2015 **7:00 pm**
TBD

October 28, 2015 **7:00 pm**
TBD

November 18, 2015 **(1 Week Early)** **7:00 pm**
TBD

NCGS Field Trips

April 18, 2015
Visit UC Museum of Paleontology - CalDay

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

June 27, 2015
Anatomy and provenance of a deep-water boulder conglomeratic submarine canyon in the Upper Cretaceous Panoche Formation (Cenomanian), Great Valley Group, San Luis Reservoir, central California-
Dr. Todd J. Greene, Department of Geological and Environmental Science, California State University, Chico

July 25, 2015
The Geysers - Geothermal Energy

Additional Trips in Preliminary Planning Stage -

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

Peninsula Geologic Society

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

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/.

Seeking Member Write-Ups

Have you recently gone to, or seen an interesting geologic feature, event, or…? Let us know! NCGS would like to diversify the content of the newsletter and we want to make sure you know that your articles are welcome. There may be some editing for length, content, or grammar, but we want to welcome your articles! Send them to Mark Detterman at mdetter1@gmail.com. Our members will thank you!

New NCGS Outreach Committee

NCGS member **John Christian** was recently elected as Chair of the NCGS Outreach Committee. Over the last several years John has been instrumental in obtaining a booth and staffing the booths on behalf of NCGS at many local shows including annual Gem and Mineral Society shows and at booths at the American Geophysical Union (AGU) public open day events. These events have brought in a number of new members and have raised the profile of the NCGS locally as a source of geologic information. If you have an interest in discussing geology, rocks, gems and minerals, and educating the general interested public in all matters geologic, please let John know and he will likely find an interesting event for your consideration! You can reach him at jmc62@sbcglobal.net.

NCGS Looking for Cal Day Volunteers

John reports that we have tables for NCGS outreach at UC Berkeley's Cal Day, Saturday, April 18th in the geology building, McCone Hall. Please sign up with John to help staff the table from 9AM to 3:45PM. Please let him know what 2 or 3 hour time period you can help.

If we have enough support, everyone should have enough time to see the free events that nearly every department has. His favorites include the tour of the

seismology lab, the tour of the fossils inside the Paleontology Museum and the botanical garden. There are also rumors that UC might open the Campanile for a tour of the 20 tons of LA Brea tar pit fossils. Please contact John soon.

Wanted - Newsletter Editor!

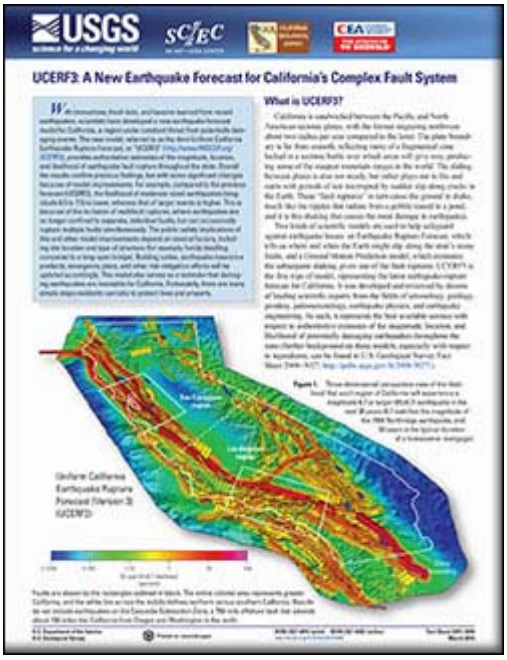
At the January 2015 Board Meeting NCGS newsletter editor **Mark Detterman** announced that he is seeking fresh eyes and new blood to pick up the editing of the NCGS newsletter beginning in September 2015. He plans to continue managing the NCGS website, unless better laid plans are put forward! **If you have wanted to contribute to the NCGS, please step up and let him know!**

Working Group on California Earthquake Probabilities

As you have no doubt heard, on March 10, 2015, the WGCEP issued its third California Earthquake Rupture Forecast or (UCERF3) and found that California faces a greater than 99 percent chance of being rocked by a strong earthquake in the next 30 years. For details see -

UCERF3: A New Earthquake Forecast for California's Complex Fault System

By Edward H. Field and members of the 2014 WGCEP



Abstract

With innovations, fresh data, and lessons learned from recent earthquakes, scientists have developed a new earthquake forecast model for California, a region under constant threat from potentially damaging events. The new model, referred to as the third Uniform California Earthquake Rupture Forecast, or "UCERF3" (http://www.WGCEP.org/UCERF3), provides authoritative estimates of the magnitude, location, and likelihood of earthquake fault rupture throughout the state. Overall the results confirm previous findings, but with some significant changes because of model improvements. For example, compared to the previous forecast (Uniform California Earthquake Rupture Forecast 2), the likelihood of moderate-sized earthquakes (magnitude 6.5 to 7.5) is lower, whereas that of larger events is higher. This is because of the inclusion of multifault ruptures, where earthquakes are no longer confined to separate, individual faults, but can occasionally rupture multiple faults simultaneously. The public-safety implications of this and other model improvements depend on several factors, including site location and type of structure (for example, family dwelling compared to a long-span bridge). Building codes, earthquake insurance products, emergency plans, and other risk-mitigation efforts will be updated accordingly. This model also serves as a reminder that damaging earthquakes are inevitable for California. Fortunately, there are many simple steps residents can take to protect lives and property.

Geology Professor Publishes Definitive Geologic Maps of Marin County

Philip Mooney, Sonoma News, February 27, 2015

After more than 20 years of research, Sonoma State University geology professor David Bero has published detailed maps of Ring Mountain and the Tiburon Peninsula. He presented these new maps as the featured speaker of the Sonoma State University Geology Club's lecture series on February 19.

Geologists around the world are known for their love of the outdoors, and Bero, who has been lecturing at Sonoma State for the past eight years, is no exception. He has spent nearly every weekend during the past 20 years hiking the trails and enjoying the sweeping vistas of his native Marin County. But unlike day hikers gazing at the panoramic ocean views, Bero's focus is on the rocks beneath him.

"I have lived and worked in the Bay Area for much of my career," says Bero. "Not all geologists are fortunate enough to have world-class geologic localities right out their front door. I have always been drawn to the beauty of Marin County and the rocks of the Franciscan Complex underlying the area. That combination has kept my interest and has remained my research focus for over two decades."

The rocks of the Franciscan Complex make up the remnants of an ancient subduction zone, where oceanic crustal rocks are pushed down to great depths beneath a continent. During this process, rocks are altered by increased heat and pressure, later moving back toward the surface along a series of complex faults.

"The unique thing about Ring Mountain is the concentration and variety of the high grade metamorphic blocks that occur there," says Bero. Metamorphic blocks

are rare, ancient rocks composed of unusual minerals. "The variety of temperature and pressure conditions recorded by these metamorphic blocks has made this area a key laboratory for a better understanding of the subduction process."

Bero is one of many geologists who have studied Ring Mountain over the years, but nothing has been published on the scale and resolution he has made. This is now the definitive geologic map of the region.

"I've spent many days out there during the past 20 years mapping sorting out the variety of rock types and multiple fault offsets representing about 160 million years of local earth history," says Bero. "I hope these geologic maps and accompanying report will be useful for those in the geologic community considering, or actively involved in, research in the area, as well as those teaching or leading field trips in one of the classic area of the Franciscan Complex."

Yellowstone: Geysers erupt periodically because they have loops in their plumbing

Manga and his colleagues studied eruptions at the Lone Star geyser in the wilds of Yellowstone National Park. Credit: Michael Manga

Geysers like Old Faithful in Yellowstone National Park erupt periodically because of loops or side-chambers in their underground plumbing, according to recent studies by volcanologists at the University of California, Berkeley.

The key to geysers, said Michael Manga, a UC Berkeley professor of earth and planetary science, is an underground bend or loop that traps steam and then bubbles it out slowly to heat the water column above until it is just short of boiling. Eventually, the steam bubbles trigger sudden boiling from the top of the column, releasing pressure on the water below and allowing it to boil as well. The column essentially boils from the top downward, spewing water and steam hundreds of feet into the air.

"Most geysers appear to have a bubble trap accumulating the steam injected from below, and the release of the steam from the trap gets the geyser ready to erupt," Manga said. "You can see the water column warming up and warming up until enough water reaches the boiling point that, once the top layer begins to boil, the boiling becomes self-perpetuating."

The new understanding of geyser mechanics comes from Manga's studies over the past few years of geysers in Chile and Yellowstone, as well as from an experimental geyser he and his students built in their lab. Made of glass with a bend or loop, it erupts periodically, though, surprisingly, not as regularly as a real geyser they studied in the Atacama desert of Chile, dubbed El Jefe. Over six days of observation, El Jefe erupted every 132 seconds, plus or minus two seconds.

"At many geysers it looks like there is some cavity that is stuck off on the side where steam is accumulating," Manga explained. "So we said, 'Let's put in a cavity and watch how the bubble trap generates eruptions.' It allows us to get both small eruptions and big eruptions in the lab."

Manga and his colleagues, including first author Carolina Munoz-Saez, a UC Berkeley graduate student from Chile, report their findings on the Chilean geysers in the February 2015 issue of the *Journal of Volcanology and Geothermal Research*. A description of the laboratory geyser appeared in the September 2014 issue of the same journal.

Balance of pressure and temperature

Fewer than 1,000 geysers exist around the world -- half of them in Yellowstone -- and all are located in active or formerly active volcanic areas. Water from the surface trickles downward and gets heated by hot magma, eventually, perhaps decades later, rising back to the surface in the form of hot springs, mud pots and geysers.

Why geysers erupt periodically, some with a regularity you can set a clock by, has piqued the interest of many scientists, but German chemist Robert Bunsen was the first to make pressure and temperature measurements inside a geyser -- the Great Geysir in Iceland, after which geysers are named -- in 1846. Based on these measurements, he proposed that eruptions start when water starts to boil at the surface, reducing pressure within the superheated water column and allowing boiling to propagate downward from the surface. Pressurized water boils at a higher temperature, so reducing the pressure on overheated water allows it to boil.

Since then, Manga said, a few researchers have stuck video cameras into geysers and seen features that suggest there are underwater chambers or loops that trap steam bubbles. Manga's measurements in Yellowstone and Chile link the temperature and pressure changes

down the water column with the underground plumbing to explain the periodic eruptions.

Geysers key to understanding volcanoes

Manga studies geysers to gain insight into volcanic eruptions, which bear many similarities to geysers but are much harder to study. Manga and his students feed temperature and pressure sensors as deep as 30 feet into geysers -- something impossible to do with a volcano -- and correlate these with above-ground measurements from seismic sensors and tiltmeters to deduce the sequence of underground events leading to an eruption. They have also been able to submerge video cameras as deep as six feet into geysers to view the submerged conduits and chambers below. He hopes to be able to extrapolate his findings to volcanoes, deducing the internal mechanics from exterior seismic and gravity measurements.

But geysers are fascinating in themselves, he said.

"One of our goals is to figure out why geysers exist -- why don't you just get a hot spring -- and what is it that controls how a geyser erupts, including weather and earthquakes," he said.

In this month's publication, Manga and his students report on El Jefe ("the chief"), a geyser located at an elevation of about 14,000 feet in the El Tatio geyser field in Chile, where water boils at 86 degrees Celsius (187 degrees Fahrenheit) instead of 100 (212 degrees F). In 2012, they recorded internal and external data during 3,600 eruptions over six days. They compared these to above-ground measurements at Lone Star and other geysers in Yellowstone. Invasive measurements are forbidden in the park.

They concluded that Bunsen was essentially correct -- boiling starts at the top of the superheated water column and propagates downward -- but also that it's the escaped bubbles from trapped steam in the rock conduits below the geyser that heat the water column to the boiling point. As the entire water column boils out of the ground, more than half the volume of stuff emerging is steam, though most of the mass is liquid water, they found. The plume seen from afar is mostly steam condensing into water droplets in the air, Manga said.

Preplay

In places like Yellowstone, the bubbles that slowly escape from the underground loop cause mini-eruptions called preplay leading up to the major eruption. Eruptions stop when the water column in the geyser cools below the boiling point, and the process repeats. All these underground processes seem to be affected only by the heat source deep below the geyser, because they could find no evidence that the surface temperature affected eruptions.

Manga plans to continue his Yellowstone and Chilean studies -- his next trip to Yellowstone is in the fall -- to gather more data to help explain the periods of geysers and better understand below-ground processes.

Co-authors with Manga and Munoz-Saez on the February paper are Shaul Hurwitz of the U.S. Geological Survey in Menlo Park, California; Maxwell Rudolph of Portland State University in Oregon; Atsuko Namiki of Hiroshima University in Japan; and professor emeritus Chi-Yuen Wang of UC Berkeley.

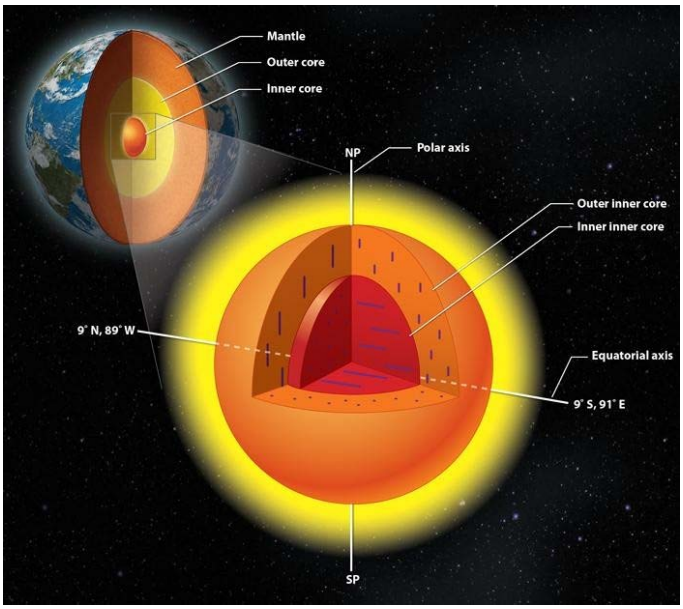
The September 2014 paper was co-authored by UC Berkeley undergraduates Esther Adelstein, Aaron Tran, Carolina Muñoz-Saez and researcher Alexander Shteinberg.

The work is supported by the National Science Foundation and the CONICYT program to support Berkeley-Chile collaborations, which is administered by UC Berkeley's Center for Latin American Studies.

Story Source: The above story is based on materials provided by University of California - Berkeley.

Journal Reference: Carolina Munoz-Saez, Michael Manga, Shaul Hurwitz, Maxwell L. Rudolph, Atsuko Namiki, Chi-Yuen Wang. **Dynamics within geyser conduits, and sensitivity to environmental perturbations: Insights from a periodic geyser in the El Tatio geyser field, Atacama Desert, Chile**. *Journal of Volcanology and Geothermal Research*, 2015; 292: 41 DOI: 10.1016/j.jvolgeores.2015.01.002

Earth's surprise inside: Geologists unlock mysteries of the planet's inner core



A research team from the University of Illinois and colleagues in China found earth's inner core has an inner core of its own, with crystals aligned in a different direction. *Credit: Lachina Publishing Services*

Seismic waves are helping scientists to plumb the world's deepest mystery: the planet's inner core.

Thanks to a novel application of earthquake-reading technology, a research team at the University of Illinois and colleagues at Nanjing University in China have found that the Earth's inner core has an inner core of its

own, which has surprising properties that could reveal information about our planet.

Led by Xiaodong Song, a professor of geology at the U. of I., and visiting postdoctoral researcher Tao Wang, the team published its work in the journal *Nature Geoscience* on Feb. 9.

"Even though the inner core is small -- smaller than the moon -- it has some really interesting features," said Song. "It may tell us about how our planet formed, its history, and other dynamic processes of the Earth. It shapes our understanding of what's going on deep inside the Earth."

Researchers use seismic waves from earthquakes to scan below the planet's surface, much like doctors use ultrasound to see inside patients. The team used a technology that gathers data not from the initial shock of an earthquake, but from the waves that resonate in the earthquake's aftermath. The earthquake is like a hammer striking a bell; much like a listener hears the clear tone that resonates after the bell strike, seismic sensors collect a coherent signal in the earthquake's coda.

"It turns out the coherent signal enhanced by the technology is clearer than the ring itself," said Song. "The basic idea of the method has been around for a while, and people have used it for other kinds of studies near the surface. But we are looking all the way through the center of the Earth."

Looking through the core revealed a surprise at the center of the planet -- though not of the type envisioned by novelist Jules Verne.

The inner core, once thought to be a solid ball of iron, has some complex structural properties. The team found a distinct inner-inner core, about half the diameter of the whole inner core. The iron crystals in the outer layer of the inner core are aligned directionally, north-south. However, in the inner-inner core, the iron crystals point roughly east-west.

Not only are the iron crystals in the inner-inner core aligned differently, they behave differently from their counterparts in the outer-inner core. This means that the inner-inner core could be made of a different type of crystal, or a different phase.

"The fact that we have two regions that are distinctly different may tell us something about how the inner core has been evolving," Song said. "For example, over the history of the Earth, the inner core might have had a very dramatic change in its deformation regime. It might hold the key to how the planet has evolved. We are right in the center -- literally, the center of the Earth."

Story Source: The above story is based on materials provided by University of Illinois at Urbana-Champaign.

Journal Reference: Xiaodong Song et al. **Equatorial anisotropy in the inner part of Earth's inner core from autocorrelation of earthquake coda**. *Nature Geoscience*, Feb 9, 2015

Arctic ice cap slides into the ocean

Satellite images have revealed that a remote Arctic ice cap has thinned by more than 50 metres since 2012 -- about one sixth of its original thickness -- and that it is now flowing 25 times faster.

A team led by scientists from the Centre for Polar Observation and Modelling (CPOM) at the University of Leeds combined observations from eight satellite missions, including Sentinel-1A and CryoSat, with results from regional climate models, to unravel the story of ice decline.

The findings show that over the last two decades, ice loss from the south-east region of Austfonna, located in the Svalbard archipelago, has increased significantly. In this time, ice flow has accelerated to speeds of several kilometres per year, and ice thinning has spread more than 50km inland -- to within 10km of the summit.

"These results provide a clear example of just how quickly ice caps can evolve, and highlight the challenges associated with making projections of their future contribution to sea level rise," said the study's lead author Dr Mal McMillan, a member of the CPOM team from the University of Leeds.

Heavily crevassed terminus of Kapp Mohn outlet glacier, Austfonna, in May 2013, after 25-fold increase in flow speed. Credit: Dunse et al., The Cryosphere Discussions

The study, published in *Geophysical Research Letters* and reported online today by the European Space Agency (ESA), is the first to make use of measurements from ESA's latest Earth observation satellite, Sentinel-1A.

Sentinel-1A, the first satellite developed for Europe's Copernicus programme, was launched in April last year, while CryoSat has been in orbit since 2010.

Dr McMillan said: "New satellites, such as the Sentinel-1A and CryoSat missions, are essential for enabling us to systematically monitor ice caps and ice sheets, and to better understand these remote polar environments."

Melting ice caps and glaciers are responsible for about a third of recent global sea level rise. Although scientists predict that they will continue to lose ice in the future, determining the exact amount is difficult, due both to a

lack of observations and the complex nature of their interaction with the surrounding climate.

"Glacier surges, similar to what we have observed, are a well-known phenomenon," said Professor Andrew Shepherd from the University of Leeds, the Director of CPOM.

"However, what we see here is unusual because it has developed over such a long period of time, and appears to have started when ice began to thin and accelerate at the coast."

There is evidence that the surrounding ocean temperature has increased in recent years, which may have been the original trigger for the ice cap thinning.

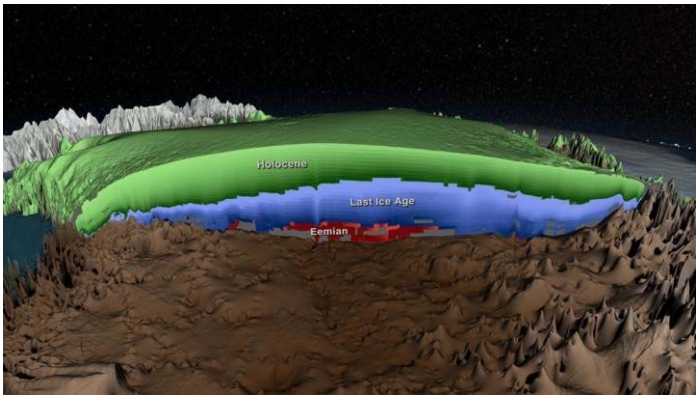
"Whether or not the warmer ocean water and ice cap behaviour are directly linked remains an unanswered question. Feeding the results into existing ice flow models may help us to shed light on the cause, and also improve predictions of global ice loss and sea level rise in the future," said Professor Shepherd.

Long-term observations by satellites are the key to monitoring such climate-related phenomena in the years and decades to come.

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

Journal Reference: Malcolm McMillan, Andrew Shepherd, Noel Gourmelen, Amaury Dehecq, Amber Leeson, Andrew Ridout, Thomas Flament, Anna Hogg, Lin Gilbert, Toby Benham, Michiel van den Broeke, Julian A. Dowdeswell, Xavier Fettweis, Brice Noël, Tazio Strozzi. **Rapid dynamic activation of a marine-based Arctic ice cap**. *Geophysical Research Letters*, 2014; DOI: 10.1002/2014GL062255

3-D view of Greenland Ice Sheet opens window on ice history



This is a cross-section of the age of the Greenland Ice Sheet. Layers determined to be from the Holocene period, formed during the past 11,700 years, are shown in green. Layers accumulated during the last ice age, from 11,700 to 115,000 years ago, are shown in blue. Layers from the Eemian period, more than 115,000 years old, are shown in red. Regions of unknown age are gray. Credit: NASA

Scientists using ice-penetrating radar data collected by NASA's Operation IceBridge and earlier airborne campaigns have built the first comprehensive map of layers deep inside the Greenland Ice Sheet, opening a window on past climate conditions and the ice sheet's potentially perilous future.

This new map allows scientists to determine the age of large swaths of the second largest mass of ice on Earth, an area containing enough water to raise ocean levels by about 20 feet.

"This new, huge data volume records how the ice sheet evolved and how it's flowing today," said Joe MacGregor, the study's lead author, a glaciologist at The University of Texas at Austin Institute for Geophysics (UTIG), a unit of the Jackson School of Geosciences.

Greenland's ice sheet has been losing mass during the past two decades, a phenomenon accelerated by warming temperatures. Scientists are studying ice from different climate periods in the past to better understand how the ice sheet might respond in the future.

Ice cores offer one way of studying the distant past. These cylinders of ice drilled from the ice sheet hold evidence of past snow accumulation and temperature and contain impurities such as dust and volcanic ash compacted over hundreds of thousands of years. These layers are visible in ice cores and can be detected with ice-penetrating radar.

Ice-penetrating radar works by sending radar signals into the ice and recording the strength and return time of reflected signals. From those signals, scientists can detect the ice surface, sub-ice bedrock and layers within the ice.

New techniques used in this study allowed scientists to efficiently pick out these layers in radar data. Prior studies had mapped internal layers, but not at the scale made possible by these newer, faster methods.

Another major factor in this study was the scope of Operation IceBridge's measurements across Greenland, which included flights that covered distances of tens of thousands of kilometers across the ice sheet.

"IceBridge surveyed previously unexplored parts of the Greenland Ice Sheet and did it using state-of-the-art CReSIS radars," said study co-author Mark Fahnestock, an IceBridge science team member and glaciologist from the Geophysical Institute at the University of Alaska Fairbanks (UAF-GI).

CReSIS is the Center for Remote Sensing of Ice Sheets, a National Science Foundation science and technology center headquartered at the University of Kansas in Lawrence, Kansas.

IceBridge's flight lines often intersect ice core sites where other scientists have analyzed the ice's chemical composition to map and date layers in the ice. These core data provide a reference for radar measurements and provide a way to calculate how much ice from a given climate period exists across the ice sheet, something known as an age volume. Scientists are

interested in knowing more about ice from the Eemian period, a time from 115,000 to 130,000 years ago that was about as warm as today. This new age volume provides the first data-driven estimate of where Eemian ice may remain.

Comparing this age volume to simple computer models helped the study's team better understand the ice sheet's history. Differences in the mapped and modeled age volumes point to past changes in ice flow or processes such as melting at the ice sheet's base. This information will be helpful for evaluating the more sophisticated ice sheet models that are crucial for projecting Greenland's future contribution to sea-level rise.

"Prior to this study, a good ice-sheet model was one that got its present thickness and surface speed right. Now, they'll also be able to work on getting its history right, which is important because ice sheets have very long memories," said MacGregor.

Story Source: The above story is based on materials provided by University of Texas at Austin.

Journal Reference: Joseph A. MacGregor, Mark A. Fahnestock, Ginny A. Catania, John D. Paden, S. Prasad Gogineni, S. Keith Young, Susan C. Rybarski, Alexandria N. Mabrey, Benjamin M. Wagman, Mathieu Morlighem. **Radiostratigraphy and age structure of the Greenland Ice Sheet**. *Journal of Geophysical Research: Earth Surface*, 2015; DOI: 10.1002/2014JF003215

Physicists offer a solution to the puzzle of the origin of matter in the universe

New research by UCLA physicists, published in the journal *Physical Review Letters*, offers a possible solution to the mystery of the origin of matter in the universe.

UCLA physicists offer a possible solution to the mystery of the origin of matter in the universe. Credit: NASA

Alexander Kusenko, a professor of physics and astronomy in the UCLA College, and colleagues propose that the matter-antimatter asymmetry could be related to the Higgs boson particle, which was the subject of prominent news coverage when it was discovered at Switzerland's Large Hadron Collider in 2012.

Specifically, the UCLA researchers write, the asymmetry may have been produced as a result of the motion of the Higgs field, which is associated with the Higgs boson, and which could have made the masses of particles and antiparticles in the universe temporarily unequal, allowing for a small excess of matter particles over antiparticles.

If a particle and an antiparticle meet, they disappear by emitting two photons or a pair of some other particles. In the "primordial soup" that existed after the Big Bang, there were almost equal amounts of particles of antiparticles, except for a tiny asymmetry: one particle per 10 billion. As the universe cooled, the particles and antiparticles annihilated each other in equal numbers, and only a tiny number of particles remained; this tiny amount is all the stars and planets, and gas in today's universe, said Kusenko, who is also a senior scientist with the Kavli Institute for the Physics and Mathematics of the Universe.

The research also is highlighted by *Physical Review Letters* in a commentary in the current issue.

The 2012 discovery of the Higgs boson particle was hailed as one of the great scientific accomplishments of recent decades. The Higgs boson was first postulated some 50 years ago as a crucial element of the modern theory of the forces of nature, and is, physicists say, what gives everything in the universe mass. Physicists at the LHC measured the particle's mass and found its value to be peculiar; it is consistent with the possibility that the Higgs field in the first moments of the Big Bang was much larger than its "equilibrium value" observed today.

The Higgs field "had to descend to the equilibrium, in a process of 'Higgs relaxation,'" said Kusenko, the lead author of the UCLA research.

Two of Kusenko's graduate students, Louis Yang of UCLA and Lauren Pearce of the University of Minnesota, Minneapolis, were co-authors of the study. The research was supported by the U.S. Department of Energy (DE-SC0009937), the World Premier International Research Center Initiative in Japan and the National Science Foundation (PHYS-1066293).

Story Source: The above story is based on materials provided by University of California - Los Angeles.

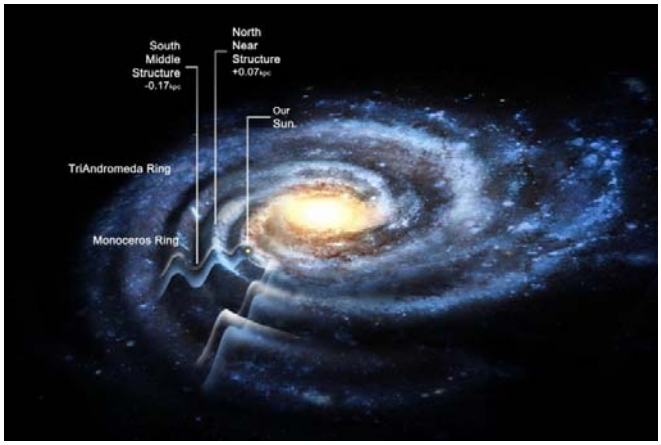
Journal Reference: Alexander Kusenko, Lauren Pearce, Louis Yang. **Postinflationary Higgs Relaxation and the Origin of Matter-Antimatter Asymmetry**. *Physical Review Letters*, 2015; 114 (6) DOI: 10.1103/PhysRevLett.114.061302

The corrugated galaxy: Milky Way may be much larger than previously estimated

The Milky Way galaxy is at least 50 percent larger than is commonly estimated, according to new findings that reveal that the galactic disk is contoured into several concentric ripples. The research, conducted by an international team led by Rensselaer Polytechnic Institute Professor Heidi Jo Newberg, revisits astronomical data from the Sloan Digital Sky Survey which, in 2002, established the presence of a bulging ring of stars beyond the known plane of the Milky Way.

"In essence, what we found is that the disk of the Milky Way isn't just a disk of stars in a flat plane -- it's

corrugated," said Heidi Newberg, professor of physics, applied physics, and astronomy in the Rensselaer School of Science. "As it radiates outward from the sun, we see at least four ripples in the disk of the Milky Way. While we can only look at part of the galaxy with this data, we assume that this pattern is going to be found throughout the disk."



The Milky Way galaxy is at least 50 percent larger than is commonly estimated, according to new findings that reveal that the galactic disk is contoured into several concentric ripples. Credit: Rensselaer Polytechnic Institute

Importantly, the findings show that the features previously identified as rings are actually part of the galactic disk, extending the known width of the Milky Way from 100,000 light years across to 150,000 light years, said Yan Xu, a scientist at the National Astronomical Observatories of China (which is part of the Chinese Academy of Science in Beijing), former visiting scientist at Rensselaer, and lead author of the paper.

"Going into the research, astronomers had observed that the number of Milky Way stars diminishes rapidly about 50,000 light years from the center of the galaxy, and then a ring of stars appears at about 60,000 light years from the center," said Xu. "What we see now is that this apparent ring is actually a ripple in the disk. And it may well be that there are more ripples further out which we have not yet seen."

The research, funded in part by the National Science Foundation and titled "Rings and Radial Waves in the Disk of the Milky Way," was published today in the *Astrophysical Journal*. Newberg, Xu, and their collaborators used data from the Sloan Digital Sky Survey (SDSS) to show an oscillating asymmetry in the main sequence star counts on either side of the galactic plane, starting from the sun and looking outward from the galactic center. In other words, when we look outward from the sun, the mid-plane of the disk is perturbed up, then down, then up, and then down again.

"Extending our knowledge of our galaxy's structure is fundamentally important," said Glen Langston, NSF program manager. "The NSF is proud to support their effort to map the shape of our galaxy beyond previously unknown limits."

The new research builds upon a 2002 finding in which Newberg established the existence of the "Monoceros Ring," an "over-density" of stars at the outer edges of the galaxy that bulges above the galactic plane. At the time, Newberg noticed evidence of another over-density of stars, between the Monoceros Ring and the sun, but was unable to investigate further. With more data available from the SDSS, researchers recently returned to the mystery.

"I wanted to figure out what that other over-density was," Newberg said. "These stars had previously been considered disk stars, but the stars don't match the density distribution you would expect for disk stars, so I thought 'well, maybe this could be another ring, or a highly disrupted dwarf galaxy."

When they revisited the data, they found four anomalies: one north of the galactic plane at 2 kilo-parsecs (kpc) from the sun, one south of the plane at 4-6 kpc, a third to the north at 8-10 kpc, and evidence of a fourth to the south 12-16 kpc from the sun. The Monoceros Ring is associated with the third ripple. The researchers further found that the oscillations appear to line up with the locations of the galaxy's spiral arms. Newberg said the findings support other recent research, including a theoretical finding that a dwarf galaxy or dark matter lump passing through the Milky Way would produce a similar rippling effect. In fact, the ripples might ultimately be used to measure the lumpiness of dark matter in our galaxy.

"It's very similar to what would happen if you throw a pebble into still water -- the waves will radiate out from the point of impact," said Newberg. "If a dwarf galaxy goes through the disk, it would gravitationally pull the disk up as it comes in, and pull the disk down as it goes through, and this will set up a wave pattern that propagates outward. If you view this in the context of other research that's emerged in the past two to three years, you start to see a picture is forming."

The research was funded by the NSF, as well as the Chinese National Science Foundation and the National Basic Research Program of China.

Newberg currently researches the structure and evolution of our own galaxy, using stars as tracers of the galactic halo and disks. These stars in turn are used to trace the density distribution of dark matter in the Milky Way. She has been a participant of the Sloan Digital Sky Survey and is currently head of participants in LAMOST U.S., a partnership allowing U.S. astronomers to take part in a survey of more than 7 million stars by the Large Sky Area Multi-Object Fiber Spectroscopic Telescope in China (LAMOST).

Story Source: The above story is based on materials provided by Rensselaer Polytechnic Institute (RPI).

Journal Reference: Yan Xu, Heidi Jo Newberg, Jeffrey L. Carlin, Chao Liu, Licai Deng, Jing Li, Ralph Schönrich, Brian Yanny. **RINGS AND RADIAL WAVES IN THE DISK OF THE MILKY WAY**. *The Astrophysical Journal*, 2015; 801 (2): 105 DOI: 10.1088/0004-637X/801/2/105

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

An undefined Petroleum system along the Santa Cruz County, California

NCGS FIELD TRIP - Saturday April 25, 2015

Field Trip Leaders:

Dr. Allegra Hasford Scheirer and Dr. Leslie B. Magoon

Department of Geological and Environmental Sciences , Stanford University, Stanford, California

Field Trip Director: Tridib Guha

Numerous asphalt-saturated sandstone deposits on and near the Santa Cruz County coast in central California confirm the presence of a previously undefined petroleum system. These asphalt occurrences lie about 25 to 50 km south-southeast of the La Honda Basin, where 5 small oil fields have produced nearly 2 million barrels of oil and 300 million cubic feet of gas. The close proximity of the Santa Cruz County coast to the petroleum system of the La Honda Basin indicates that similar elements are at work along the coast. The likely source rock for these asphalt deposits is California's "superstar" oil source rock, the Monterey Formation. It has been suggested that the Santa Cruz Mudstone overlying the Monterey Formation could also serve as a local petroleum source rock. However, the real importance of the Santa Cruz Mudstone is that it is the thickest of three overburden rocks that are required to thermally mature the underlying Monterey Formation. All this happens on the southern flank of the Ben Lomond Mountain, a persistent granitic and metamorphic high. The offset of the San Gregorio Fault plays a crucial role in determining the critical moment for this petroleum system.

To better understand the petroleum system in this area, we will investigate the migration pathways and reservoir rocks along the Santa Cruz county coast. At our first four stops, we will be standing on young marine terrace deposits but looking primarily at Santa Cruz Mudstone, and to a lesser extent, Santa Margarita Sandstone. There are no exposures of the Monterey Formation along the coast in our field trip area.

A major geologic feature of the Santa Cruz County Coast is the sand injectite. On this field trip we will see a large subaerially exposed injectite complex at Yellow Bank and Panther beaches. Here, fluidized sand from the Santa Margarita Sandstone is injected upward into fractured Santa Cruz Mudstone. The emplacement of these intrusions was facilitated because deposition and induration of the Santa Cruz Mudstone increase confining pressure within underlying siliciclastic unit; stresses triggered the injection of sand into the lower pressured fractures in the mudstone.

We will also observe carbonate concretions on the beach in the city of Santa Cruz that mark the locations of fossil seafloor cold seeps. These vent structures closely resemble modern-day examples found on the floor of Monterey Bay. Both modern and fossil vent features appear to be closely associated with fault systems. The occurrence of carbonate slabs in areas of active hydrocarbon seepage is common in seafloor settings.

Please carpool/vanpool and share the ride and cost. We will circulate an attendees list for carpooling to the meeting place. No. geologic hammers are allowed!

THIS FIELD TRIP WILL BE LIMITED TO 30 PEOPLE.

Field Trip Logistics in preparation

Time & Meeting Place: April 25, 2015, 9:00 am at the meeting place (will be notified)

Cost: $40/person, which includes a guidebook, morning coffee, muffins, lunch, and refreshments. No more plastic water bottles will be allowed on Field Trips! Please bring your own water bottle.

REGISTRATION FORM (Santa Cruz Field Trip)

Name:_____

E-mail:_____

Carpool origin Residence:_____

Phone: ____ _____ Phone (alternate):_____

Check no./amount _____

Please indicate if you want drive a car and the # of people on ride share

Lunch: Regular:_____ Vegetarian_____

(Please check one)

_____

Please mail registration with a check payable to NCGS:

Tridib Guha, 5016 Gloucester Lane, Martinez, CA 94553

Questions e-mail: tridibguha@yahoo.com Phone: 925-451-1999

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

NCGS DINNER MEETING Wednesday May 27, 2015

6:00 PM at Orinda Masonic Center

"THE WEST WITHOUT WATER"

Speaker: Dr. B. Lynn Ingram, Professor of Geology, University of California, Berkeley

(Reservations are required by May 22, 2015, Limit 100 persons)
We are sorry but we will not be able to accommodate "walk-ins"

Stepping out of our normal routine, the **Northern California Geological Society** is pleased to announce this *special dinner and evening* with **Dr. Ingram**. For this unique event, planned for our normal monthly meeting date, but starting one-half hour early, we are planning in typical NCGS style, a **Back Forty Texas BBQ dinner consisting of Pork Ribs and BBQ Chicken, Tossed Green Salad, BBQ Beans, Fresh Corn Cobettes. For vegetarian dinners a deluxe veggie burger will be served in place of BBQ. Desert will include assorted cookies and brownies. We may be again serving wines from California specials (90 pts +).** Please also note that a vegetarian option is available if notified ahead (please see the registration form below).

Abstract:

The West without Water documents the tumultuous climate of the American West over twenty millennia, with tales of past droughts and deluges and predictions about the impacts of future climate change on water resources. Looking at the regions current water crisis from the perspective of its climate history, the authors ask the central question of what is "normal" climate for the West, and whether the relatively benign climate of the past century will continue into the future.

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

Meeting Details: Social Hour: 6:00 – 7:00 pm; Dinner: 7:00 – 8:00 pm; **Presentation**: 8:00 – open

Time: May 27, 2015, 6:00 pm, Orinda Masonic Center 9 Altarinda Road, Orinda, CA.

Cost: **$25/person**

******************************REGISTRATION FORM (Dr. Ingram's Dinner)**************************

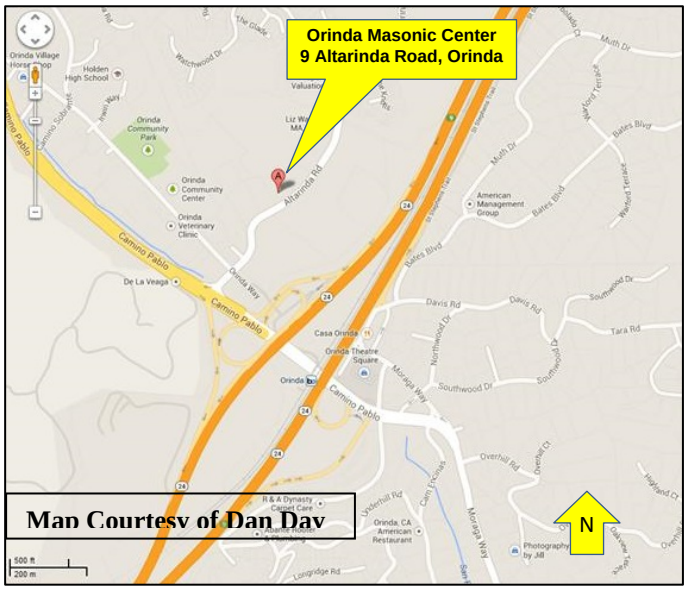
Name:_____

E-mail:_____

Phone (day):_____ Phone (cell) _____

Dinner: Regular: _____ Vegetarian: _____ (Please check one) Check Amount: _____

Please mail a check made out to **NCGS** to:
Tridib Guha, 5016 Gloucester Lane, Martinez, CA 94553
Questions: e-mail: tridibguha@yahoo.com
Phone: (925) 451-1999



Northern California Geological Society
c/o Mark Detterman
3197 Cromwell Place
Hayward, CA 94542-1209

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