NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

MEETING ANNOUNCEMENT

DATE: **February 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. Bradley Erskine, Principal Geologist, PG, CEG, CHG Kleinfelder, Inc.**

Building a Dam out of "Naturally Occurring Asbestos"; Challenges and Solutions at the Calaveras Dam Replacement Project

The San Francisco Public Utilities Commission is well into construction of the Calaveras Dam Replacement Project (CDRP), a new earthen dam in northern California designed to withstand a major earthquake on the nearby active Calaveras fault. The first phase of construction involved excavation and on-site disposal of 3 million tons of material including a highly complex assemblage of Franciscan subduction zone mélange containing fibrous minerals across the amphibole chemical spectrum. To date, 30 amphibole species and subspecies have been detected in air monitoring samples using the CARB AHERA counting rules. The second phase, in progress, is construction of the zoned dam using on-site materials. The upstream shell is constructed of blueschist rock composed primarily of fibrous glaucophane, a sodic amphibole similar to riebeckite, and winchite, one amphibole comprising the "Libby amphibole mix". This material is blasted from an on-site quarry, then loaded, hauled, and placed as engineered fill. The limited chemical range of amphibole in solid solution affords the opportunity to fingerprint site amphiboles, distinguish them from offsite amphiboles, and document their containment on site.

This project represents the largest construction project involving NOA in the country, and involves disturbance of one of the most complex geological and mineralogical units in the world. As such, applying regulations that were designed for building materials and routine construction sites, and controlling and monitoring airborne emissions on such a massive scale, is a major challenge.

After a review of the dam history, design, and some fault-related geotechnical challenges, this presentation will document how the NOA team, composed of geologists and industrial hygienists, is managing the NOA program, and in particular, how an innovative techniques are being applied to identify differentiate asbestiform amphiboles derived on site from those that are present off site. *…Continued on last page…*

NCGS 2014 – 2015 Calendar

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

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

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

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

NCGS Field Trips

March 21, 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

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

Additional Trips in Preliminary Planning Stage -

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

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!

At the January 2015 Board Meeting NCGS member **John Christian** was elected as Chair of the NCGS Outreach Committee, also formed at the January Board Meeting. Please welcome him! 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.

Help NCGS at the Mineral and Gem Society of Castro Valley Show March 6-8th

John Christian is seeking help to staff our tables at the Mineral and Gem Society of Castro Valley show March 6-8 (Friday through Sunday), located at the Newark Pavilion in Newark at 6430 Thornton Avenue. This is opportunity to discuss and teach the wonderful Northern California geology to the general public using a collection of local

rocks, geology maps, guidebooks, photos of field trips and your knowledge. This is the Bay Area's largest and best rock and gem show. Please help us at this very fun event. You don't have to be an expert; your enthusiasm is the most important quality. This event helps us to fulfill our purpose that allows us to be a non-profit organization: promotion of education in the earth sciences. This event helps NCGS in many ways. It helps NCGS find: new members; fieldtrip leaders: speakers; students for our scholarships and teachers for our awards.

This is not a commitment for the entire day! Plan to spend 2 to 4 hours on the day you can help out, more if you enjoy talking and educating others! John plans to arrange to bring photos of our field trips and dozens of local California rocks. He also plans on arranging to bring rocks and minerals to give away to the kids. If you have rocks and minerals that you want to donate to this cause please bring them to the NCGS meeting. Please coordinate with John and let him know if you plan to do so at jmc62@sbcglobal.net or (510) 540-1008. For information on the show see: http://www.mgscv.org/show.html.

John also reports that the NCGS will have a display case at the show that NCGS can use to promote our society. He is looking for a member to take the lead to design a display to fill that case. We thought that it would be interesting to use our rocks and minerals to educate the public about an important Bay Area geological subject. Suggested topics include: minerals and rocks associated with subduction; mercury mining in the Bay Area. All ideas are welcomed.

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!**

Goldilocks and the Three Zones

(Part 4); *By NCGS Member* ***Dr. Bill Motzer***

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

> 'This porridge is too hot!' she exclaimed. So, she tasted the porridge from the second bowl.
>
> 'This porridge is too cold,' she said. So, she tasted the last bowl of porridge.
>
> 'Ahhh, this porridge is just right,' she said happily and she ate it all up."
>
> From "Goldilocks and the Three Bears"

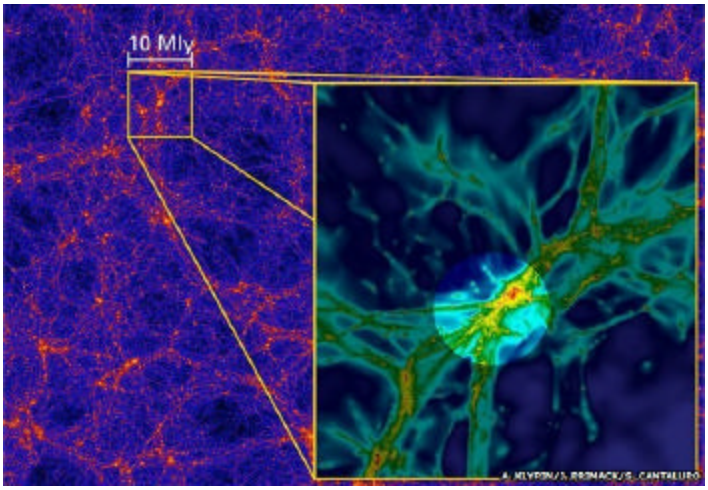
An announcement that a new *Cosmos* series would debut this March 9th on Fox and on March 10th on the National Geographic Channel prompted me to continue my series on the three types of Goldilocks Zones. The original *Cosmos* was hosted by astronomer Carl Sagan; the new series will be hosted by astrophysicist Neil deGrasse Tyson, frequently seen on the History Channel's *Universe* and PBS' *NOVA Science NOW*. In Part 1 (September 2012 Vortex), the stellar Goldilocks Zone, also known as the habitable zone (HZ-1), was defined as the distance from a star that a terrestrial-like planet could maintain liquid water on its surface and consequently contain terrestrial-like life. In Part 3 (February 2013 Vortex), we further defined the galactic habitable zone (GHZ) or HZ-2 as a galactic region with conditions best suited to development and survival of terrestrial-type life. In this article we'll discuss the possibility that our universe contains or is a habitable zone or HZ-3, which may actually be a function of space and time after the Big Bang (ABB).

Based on theoretical physics and astronomical observations, cosmologists now theorize that the BB occurred about 13.7 billion years (by) ago during which the forces of gravity, electromagnetism, and the strong and weak atomic forces were created. (Note: the BB was not an "explosion" but rather an expansion of space). According to theoretical physicists, at 10^{-43} seconds ABB, gravity separated from the other unified forces. The standard theoretical model then posits that at 10^{-35} seconds ABB, the strong forces separated from the combined electromagnetic and weak forces (aka the electroweak force) and a brief but intense expansion known as inflation occurred. At 10^{-32} seconds the universe's temperature was still an astonishing 10^{27} ^{o}C. Additionally, at ~10^{-23} seconds ABB, expansion was so rapid that it may have occurred at a rate exceeding the speed of light.

These forces were so fine-tuned that a change in one part of 10^{-18} could have altered the universe's expansion rate: if too weak, stars may not have formed; if too strong, recollapse might have occurred. However, the expansion seems to have been just right because by about 3 minutes ABB, temperatures dropped to 10^{13} ^{o}C and matter began forming as free protons, neutrons, electrons, and neutrinos. By ~370,000 to 380,000 years ABB, the expanding universe had cooled just enough (to ~10,000 ^{o}C) so that these particles combined, forming neutral (baryonic) matter – largely hydrogen with some helium and a trace of lithium. Although atoms comprised only 12% of the universe, these first atoms were the building blocks for formation of the first stars. Additionally, a slight irregularity in distribution of this early matter occurred, allowing formation of mega structures; the resulting gravitational forces caused the hydrogen clouds to condense and spin and at ~10 x 10^{6} ^{o}C fusion began and stars began shining, emitting photons (light). (The period between formation of the first atoms and first stars is known as the *cosmic dark ages*.) The first stars were believed to be quite massive – perhaps more than 100 to 300 times that of our Sun and, as observed by the Hubble Deep Field telescope, by about 600-800 million years ABB, these massive stars formed the first galaxies.

After only two million years of existence, these first massive stars exploded into supernovas producing the elements necessary for rocky planet and complex life

formation. But it may have taken several generations of star formation to produce more abundant metalliferous gaseous clouds and stars similar to our Sun and perhaps as much as 8 by ABB, for complex life to form. What is fascinating is that only 4% of the universe is composed of baryonic matter (see April 2013 Vortex, Science Café report), with dark energy composing ~73% of the Universe and dark matter at 23%. Both total 96%, and their actual properties remain a mystery, although recent observations may have detected dark matter (see figure below). Of the remaining observable matter, 3.6% is interstellar gas (mostly hydrogen with some helium and a few heavier elements) and only 0.4% is regular matter (stars, planets, and people). We therefore, may exist in the universe's golden age – where the formation of life is both possible and abundant. And where we go from here may be predictable and we'll discuss that in a future article.



An intense quasar, ~10 x 10^9 light years (LY) from Earth, illuminates part of a surrounding cosmic web, which is about 2 million LY across. The glowing gas appear to trace filaments of dark matter. Source: http://www.bbc.co.uk/news/science-environment-25809967

UC Berkeley taps its old mine shaft to study Hayward Fault

By Will Kane; *Sunday, March 16, 2014*
Photos: Michael Short, The Chronicle
Thank John Christian for spotting this article.

Mining 101 on the UC Berkeley campus a hundred years ago: the basics of dynamite, shoring a mine shaft, mine surveying and mine rescue.

And it wasn't just mining theory. The students, 18, 19 and 20 years old, actually blasted and dug a shaft, called the Lawson Adit, into the rocky hills on the northeastern corner of campus.

The shaft, which before a series of cave-ins ran nearly 900 feet into the earth just east of the Hearst Mining Building, still stretches some 200 dark, damp feet into the earth, but now sits mostly neglected behind an unassuming locked gate.

Earthquake researchers hope to install seismographs and high-frequency microphones that can detect the squeals of the nearby Hayward Fault later this year, but for now the adit is a mostly unknown bit of Berkeley - and Bay Area - history.

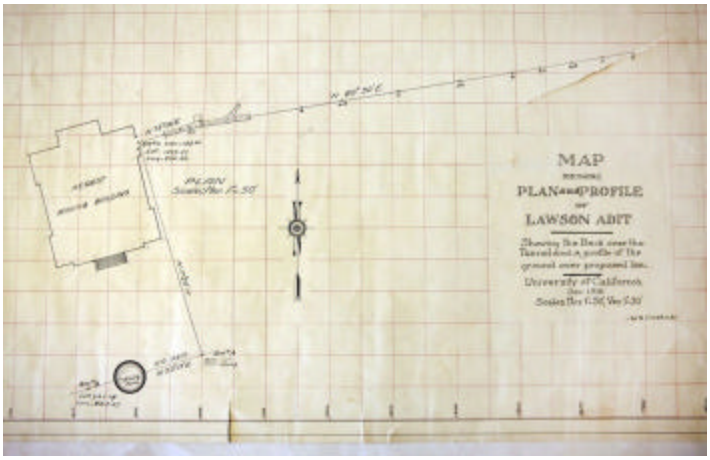


Photo: Michael Short, The Chronicle; Image 1 of 21
Researchers plan to install instruments in the old UC Berkeley mine shaft to detect tremors from the Hayward Fault.

Map of the Lawson Adit and Hearst Mining Building from 1916, from the archive of the Bancroft Library on the UC Berkeley campus in Berkeley, CA. Legend of the map reads: "Map showing Plan and Profile of Lawson Adit. Showing the Back over the Tunnel and a profile of the ground over proposed line. University of California Dec. 1916."

"It is an actual mine, the tunnel was dug by students with their professors watching," said Scott Shackleton, an assistant dean at the UC Berkeley College of Engineering, and the keeper of the adit. "They were paid, I think, a dollar an hour."

Students work day and night

The students would work round-the-clock shifts mucking, blasting and surveying. They were never searching for

product, but were instead learning the principles of mining, much like engineering students today build and test structural models in labs.

Tracks carried mining carts into the nearby Hearst Mining Building, where steam-powered crushers would break apart the rock and students could experiment with new pulley and conveyer systems.

Students wore heavy work outfits and gas masks, swung picks and hoisted boxes of blasting powder - a far cry from today's business students who wear flip-flops and shorts to class.

"They weren't mining, but they were just teaching the mining techniques," Shackleton said. "Kids would be sitting out there taking a break with dynamite and shovels."

Pondering today's students eating lunch on boxes of dynamite, Shackleton added: "Oh my God, you wouldn't have students doing that now. Can you imagine?"

The adit was started in 1916 and named after Andrew Lawson, the then-dean of the College of Mining at UC Berkeley. The Hercules Powder Company donated 1,000 pounds of dynamite and a San Francisco iron works donated the latest type of ore cart for students.

Over the next 12 years, students blasted enough rock away to extend the mine 200 feet into the hills.

The original redwood timbers installed nearly 100 years ago still support the first 75 feet or so of the mine, and the old iron tracks still run down the center of the tunnel.

"It is kind of like a Disneyland type of thing, the timbers are hanging down," Shackleton said. Somewhere, deep in the mine, is the old mining cart.

Eventually the mining school was absorbed by the College of Engineering and the mining operations stopped.

But in 1939, as the campus was considering building the Stern Hall dormitory in the hills above the Hearst Mining Building, engineers extended the mine shaft another 700 feet so they could map the exact location of the Hayward Fault.

"As they got closer to the Hayward Fault they had a lot of problems because the soil got really loosey-goosey," Shackleton said.

Cave-ins

Eventually large sections of the mine caved in, and the campus decided it was too risky to keep digging or clean out the debris. Today the shaft extends to less than half of what it was.

In the 1950s, engineers replaced a hundred feet of the redwood timbers with concrete that could support the weight of the new wing of Donner Lab above the shaft.

Now, Shackleton and the two other campus officials who have a key to the padlocked gate, visit the shaft about three times a year, just to make sure no animals or fraternity brothers have found their way into the passage.

Later this year, a team of researchers will head a few hundred feet into the mine to install instruments designed to detect faint tremors at the nearby Hayward Fault.

"There's a lot that we don't know about the details of what does it feel like when you are right close to the fault," said Peggy Hellweg, a Berkeley research geophysicist. "It is exciting, I am surprised that no one has put any seismology instrumentation into it before."

Additional photos can be found at: http://www.sfgate.com/science/article/UC-Berkeley-taps-its-old-mine-shaft-to-study-5321060.php#photo-6022413

New at the California Geological Survey

December 30, 2014 - CGS Map Sheet 62: Geology of Ring Mountain and Tiburon Peninsula, Marin County, California. See the following link for a release statement: http://www.consrv.ca.gov/cgs/information/publications/release_statements/Documents/MS_62_release_statement.pdf

November 7, 2014 - CGS Map Sheet 61: Geologic Map of Part of Eastern Placer County, Northern Sierra Nevada, California. See the following link for a release statement: http://www.consrv.ca.gov/cgs/information/publications/release_statements/Documents/MS_61_release_statement.pdf

December 23, 2014 - CGS Special Report 226: Radon Potential in San Mateo County, California. See the following link for a release statement: ftp://ftp.consrv.ca.gov/pub/dmg/pubs/sr/sr_226/SR226_RELEASE_statement.pdf

To download the pdf report: ftp://ftp.consrv.ca.gov/pub/dmg/pubs/sr/sr_226/SR226_San_Mateo_Radon_FINAL.pdf

For a map: ftp://ftp.consrv.ca.gov/pub/dmg/pubs/sr/sr_226/SR226_San Mateo_Radon_Final_map.pdf

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

http://www.consrv.ca.gov/cgs/rghm/loss/Documents/CGS_SR233_ofr2014_1045.pdf

Seafloor volcano pulses may alter climate: Strikingly regular patterns, from weeks to eons

Vast ranges of volcanoes hidden under the oceans are presumed by scientists to be the gentle giants of the planet, oozing lava at slow, steady rates along mid-ocean ridges. But a new study shows that they flare up on strikingly regular cycles, ranging from two weeks to 100,000 years -- and, that they erupt almost exclusively during the first six months of each year. The pulses -- apparently tied to short- and long-term changes in earth's orbit, and to sea levels -- may help trigger natural climate swings. Scientists have already speculated that volcanic cycles on land emitting large amounts of carbon dioxide might influence climate; but up to now there was no evidence from submarine volcanoes. The findings suggest that models of earth's

natural climate dynamics, and by extension human-influenced climate change, may have to be adjusted. The study appears this week in the journal *Geophysical Research Letters.*

"People have ignored seafloor volcanoes on the idea that their influence is small -- but that's because they are assumed to be in a steady state, which they're not," said the study's author, marine geophysicist Maya Tolstoy of Columbia University's Lamont-Doherty Earth Observatory. "They respond to both very large forces, and to very small ones, and that tells us that we need to look at them much more closely." A related study by a separate team this week in the journal *Science* bolsters Tolstoy's case by showing similar long-term patterns of submarine volcanism in an Antarctic region Tolstoy did not study.

Volcanically active mid-ocean ridges crisscross earth's seafloors like stitching on a baseball, stretching some 37,000 miles. They are the growing edges of giant tectonic plates; as lavas push out, they form new areas of seafloor, which comprise some 80 percent of the planet's crust. Conventional wisdom holds that they erupt at a fairly constant rate--but Tolstoy finds that the ridges are actually now in a languid phase. Even at that, they produce maybe eight times more lava annually than land volcanoes. Due to the chemistry of their magmas, the carbon dioxide they are thought to emit is currently about the same as, or perhaps a little less than, from land volcanoes -- about 88 million metric tons a year. But were the undersea chains to stir even a little bit more, their CO2 output would shoot up, says Tolstoy.

Magma from undersea eruptions congealed into forms known as pillow basalts on the Juan De Fuca Ridge, off the U.S. Pacific Northwest. A new study shows such eruptions wax and wane on regular schedules. Credit: Deborah Kelley/University of Washington

Some scientists think volcanoes may act in concert with Milankovitch cycles--repeating changes in the shape of earth's solar orbit, and the tilt and direction of its axis -- to produce suddenly seesawing hot and cold periods. The major one is a 100,000-year cycle in which the planet's orbit around the sun changes from more or less an annual circle into an ellipse that annually brings it closer or farther from the sun. Recent ice ages seem to build up through most of the cycle; but then things suddenly warm back up near the orbit's peak eccentricity. The causes are not clear.

Enter volcanoes. Researchers have suggested that as icecaps build on land, pressure on underlying volcanoes also builds, and eruptions are suppressed. But when warming somehow starts and the ice begins melting, pressure lets up, and eruptions surge. They belch CO2 that produces more warming, which melts more ice, which creates a self-feeding effect that tips the planet suddenly into a warm period. A 2009 paper from Harvard University says that land volcanoes worldwide indeed surged six to eight times over background levels during the most recent deglaciation, 12,000 to 7,000 years ago. The corollary would be that undersea volcanoes do the opposite: as earth cools, sea levels may drop 100 meters, because so much water gets locked into ice. This relieves pressure on submarine volcanoes, and they erupt more. At some point, could the increased CO2 from undersea eruptions start the warming that melts the ice covering volcanoes on land?

That has been a mystery, partly because undersea eruptions are almost impossible to observe. However, Tolstoy and other researchers recently have been able to closely monitor 10 submarine eruption sites using sensitive new seismic instruments. They have also produced new high-resolution maps showing outlines of past lava flows. Tolstoy analyzed some 25 years of seismic data from ridges in the Pacific, Atlantic and Arctic oceans, plus maps showing past activity in the south Pacific.

The long-term eruption data, spread over more than 700,000 years, showed that during the coldest times, when sea levels are low, undersea volcanism surges, producing visible bands of hills. When things warm up and sea levels rise to levels similar to the present, lava erupts more slowly, creating bands of lower topography. Tolstoy attributes this not only to the varying sea level, but to closely related changes in earth's orbit. When the orbit is more elliptical, Earth gets squeezed and unsqueezed by the sun's gravitational pull at a rapidly varying rate as it spins daily -- a process that she thinks tends to massage undersea magma upward, and help open the tectonic cracks that let it out. When the orbit is fairly (though not completely) circular, as it is now, the squeezing/unsqueezing effect is minimized, and there are fewer eruptions.

The idea that remote gravitational forces influence volcanism is mirrored by the short-term data, says Tolstoy. She says the seismic data suggest that today, undersea volcanoes pulse to life mainly during periods that come every two weeks. That is the schedule upon which combined gravity from the moon and sun cause ocean tides to reach their lowest points, thus subtly relieving pressure on volcanoes below. Seismic signals interpreted as eruptions followed fortnightly low tides at eight out of nine study sites. Furthermore, Tolstoy found that all known modern eruptions occur from January through June. January is the month when Earth is closest to the sun, July when it is farthest -- a period similar to the squeezing/unsqueezing effect Tolstoy sees in longer-term cycles. "If you look at the present-day eruptions, volcanoes respond even to much smaller forces than the ones that might drive climate," she said.

Daniel Fornari, a senior scientist at Woods Hole Oceanographic Institution not involved in the research, called the study "a very important contribution." He said it was unclear whether the contemporary seismic

measurements signal actual lava flows or just seafloor rumbles and cracking. But, he said, the study "clearly could have important implications for better quantifying and characterizing our assessment of climate variations over decadal to tens to hundreds of thousands of years cycles."

Edward Baker, a senior ocean scientist at the National Oceanic and Atmospheric Administration, said, "The most interesting takeaway from this paper is that it provides further evidence that the solid Earth, and the air and water all operate as a single system."

The research for this paper was funded in large part by the U.S. National Science Foundation.

Story Source: The above story is based on materials provided by The Earth Institute at Columbia University.

Iceland rises as its glaciers melt from climate change

Earth's crust under Iceland is rebounding as global warming melts the island's great ice caps, a University of Arizona-led team reports in an upcoming issue of *Geophysical Research Letters*.

The paper is the first to show the current fast uplift of the Icelandic crust is a result of accelerated melting of the island's glaciers and coincides with the onset of warming that began about 30 years ago, the scientists said.

Some sites in south-central Iceland are moving upward as much as 1.4 inches (35 mm) per year -- a speed that surprised the researchers.

"Our research makes the connection between recent accelerated uplift and the accelerated melting of the Icelandic ice caps," said first author Kathleen Compton, a UA geosciences doctoral candidate.

Geologists have long known that as glaciers melt and become lighter, Earth rebounds as the weight of the ice decreases.

Whether the current rebound geologists detect is related to past deglaciation or modern ice loss has been an open question until now, said co-author Richard Bennett, a UA associate professor of geosciences.

"Iceland is the first place we can say accelerated uplift means accelerated ice mass loss," Bennett said.

To figure out how fast the crust was moving upward, the team used a network of 62 global positioning satellite receivers fastened to rocks throughout Iceland. By tracking the position of the GPS receivers year after year, the scientists "watch" the rocks move and can calculate how far they have traveled -- a technique called geodesy.

The new work shows that, at least for Iceland, the land's current accelerating uplift is directly related to the thinning of glaciers and to global warming.

"What we're observing is a climatically induced change in Earth's surface," Bennett said.

He added there is geological evidence that during the past deglaciation roughly 12,000 years ago, volcanic activity in some regions of Iceland increased thirtyfold.

Others have estimated the Icelandic crust's rebound from warming-induced ice loss could increase the frequency of volcanic eruptions such as the 2010 eruption of Eyjafjallajökull, which had negative economic consequences worldwide.

The article "Climate driven vertical acceleration of Icelandic crust measured by CGPS geodesy" by Compton, Bennett and their co-author Sigrun Hreinsdóttir of GNS Science in Avalon, New Zealand, was accepted for publication Jan. 14, 2015, and is soon to be published online. The National Science Foundation and the Icelandic Center for Research funded the research.

Some of Iceland's GPS receivers have been in place since 1995. Bennett, Hreinsdóttir and colleagues had installed 20 GPS receivers in Iceland in 2006 and 2009, thus boosting the coverage of the nation's geodesy network. In central and southern Iceland, where five of the largest ice caps are located, the receivers are 18 miles (30 km) or less apart on average.

The team primarily used the geodesy network to track geological activity such as earthquakes and volcanic eruptions.

In 2013, Bennett noticed one of long-running stations in the center of the country was showing that site was rebounding at an accelerated rate. He wondered about it, so he and his colleagues checked the nearby stations to see if they had recorded the same changes.

"The striking answer was, yes, they all do," he said. "We wondered what in the world could be causing this?"

The team began systematically analyzing years of signals from the entire network and found the fastest uplift was the region between several large ice caps. The rate of uplift slowed the farther the receiver was from the ice cap region.

Other researchers had been measuring ice loss and observed a notable uptick in the rate of melting since 1995. Temperature records for Iceland, some of which go back to the 1800s, show temperatures increasing since 1980.

To determine whether the same rate of ice loss year after year could cause such an acceleration in uplift, Compton tested that idea using mathematical models. The answer was no: The glaciers had to be melting faster and faster every year to be causing more and more uplift.

Compton found the onset of rising temperatures and the loss of ice corresponded tightly with her estimates of when uplift began.

"I was surprised how well everything lined up," she said.

Bennett said, "There's no way to explain that accelerated uplift unless the glacier is disappearing at an accelerated rate."

Estimating ice loss is laborious and difficult, he said. "Our hope is we can use current GPS measurements of uplift to more easily quantify ice loss."

The team's next step is to analyze the uplift data to reveal the seasonal variation as the ice caps grow during the winter snow season and melt during the summer.

Story Source: The above story is based on materials provided by University of Arizona. The original article was written by Mari N. Jensen.

Journal Reference: Kathleen Compton, Richard A. Bennett, Sigrun Hreinsdóttir. **Climate driven vertical acceleration of Icelandic crust measured by CGPS geodesy**. *Geophysical Research Letters*, 2015; DOI: 10.1002/2014GL062446

Doubt cast on global firestorm generated by dino-killing asteroid

Pioneering new research has debunked the theory that the asteroid that is thought to have led to the extinction of dinosaurs also caused vast global firestorms that ravaged planet Earth.

A team of researchers from the University of Exeter, University of Edinburgh and Imperial College London recreated the immense energy released from an extra-terrestrial collision with Earth that occurred around the time that dinosaurs became extinct. They found that the intense but short-lived heat near the impact site could not have ignited live plants, challenging the idea that the impact led to global firestorms.

These firestorms have previously been considered a major contender in the puzzle to find out what caused the mass extinction of life on Earth 65 million years ago.

The researchers found that close to the impact site, a 200 km wide crater in Mexico, the heat pulse -- that would have lasted for less than a minute -- was too short to ignite live plant material. However they discovered that the effects of the impact would have been felt as far away as New Zealand where the heat would have been less intense but longer lasting -- heating the ground for about seven minutes -- long enough to ignite live plant matter.

The experiments were carried out in the laboratory and showed that dry plant matter could ignite, but live plants including green pine branches, typically do not.

Dr Claire Belcher from the Earth System Science group in Geography at the University of Exeter said: "By combining computer simulations of the impact with methods from engineering we have been able to recreate the enormous heat of the impact in the laboratory. This has shown us that the heat was more likely to severely affect ecosystems a long distance away, such that forests in New Zealand would have had more chance of suffering major wildfires than forests in North America that were close to the impact. This flips our understanding of the effects of the impact on its head and means that palaeontologists may need to look for new clues from fossils found a long way from the impact to better understand the mass extinction event."

Plants and animals are generally resistant to localised fire events -- animals can hide or hibernate and plants can re-colonise from other areas, implying that wildfires are unlikely to be directly capable of leading to the extinctions. If however some animal communities, particularly large animals, were unable to shelter from the heat, they may have suffered serious losses. It is unclear whether these would have been sufficient to lead to the extinction of species.

Dr Rory Hadden from the University of Edinburgh said: "This is a truly exciting piece of inter-disciplinary research. By working together engineers and geoscientists have tackled a complex, long-standing problem in a novel way. This has allowed a step forward in the debate surrounding the end Cretaceous impact and will help Geoscientists interpret the fossil record and evaluate potential future impacts. In addition, the methods we developed in the laboratory for this research have driven new developments in our current understanding of how materials behave in fires particularly at the wildland-urban-interface, meaning that we have been able to answer questions relating to both ancient mass extinctions at the same time as developing understanding of the impact of wildfires in urban areas today."

The results of the study are published in the *Journal of the Geological Society*.

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

Journal Reference: Claire M. Belcher, Rory M. Hadden, Guillermo Rein, Joanna V. Morgan, Natalia Artemieva, and Tamara Goldin. **An experimental assessment of the ignition of forest fuels by the thermal pulse generated by the Cretaceous–Palaeogene impact at Chicxulub**. *Journal of the Geological Society*, January 22, 2015 DOI: 10.1144/jgs2014-082

Evidence from warm past confirms recent IPCC estimates of climate sensitivity

New evidence showing the level of atmospheric CO_2 millions of years ago supports recent climate change predications from the Intergovernmental Panel on Climate Change (IPCC).

A multinational research team, led by scientists at the University of Southampton, has analysed new records showing the CO_2 content of the Earth's atmosphere between 2.3 to 3.3 million years ago, over the Pliocene.

During the Pliocene, the Earth was around 2ºC warmer than it is today and atmospheric CO_2 levels were around 350-400 parts per million (ppm), similar to the levels reached in recent years.

By studying the relationship between CO_2 levels and climate change during a warmer period in Earth's history, the scientists have been able to estimate how the climate will respond to increasing levels of carbon dioxide, a parameter known as 'climate sensitivity'.

The findings, which have been published in *Nature*, also show how climate sensitivity can vary over the long term.

"Today the Earth is still adjusting to the recent rapid rise of CO_2 caused by human activities, whereas the longer-term Pliocene records document the full response of CO_2-related warming," says Southampton's Dr Gavin Foster, co-author of the study.

"Our estimates of climate sensitivity lie well within the range of 1.5 to 4.5ºC increase per CO_2 doubling summarized in the latest IPCC report. This suggests that the research community has a sound understanding of what the climate will be like as we move toward a Pliocene-like warmer future caused by human greenhouse gas emissions."

Lead author of the study, Dr Miguel Martínez-Botí, also from Southampton said: "Our new records also reveal an important change at around 2.8 million years ago, when levels rapidly dropped to values of about 280 ppm, similar to those seen before the industrial revolution. This caused a dramatic global cooling that initiated the ice-age cycles that have dominated Earth's climate ever since."

The research team also assessed whether climate sensitivity was different in warmer times, like the Pliocene, than in colder times, like the glacial cycles of the last 800,000 years.

Professor Eelco Rohling of The Australian National University in Canberra says: "We find that climate change in response to CO_2 change in the warmer period was around half that of the colder period. We determine that this difference is driven by the growth and retreat of large continental ice sheets that are present in the cold ice-age climates; these ice sheets reflect a lot of sunlight and their growth consequently amplifies the impact of CO_2 changes."

Professor Richard Pancost from the University of Bristol Cabot Institute, added: "When we account for the influence of the ice sheets, we confirm that the Earth's climate changed with a similar sensitivity to overall forcing during both warmer and colder climates."

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

Journal Reference: M. A. Martínez-Botí, G. L. Foster, T. B. Chalk, E. J. Rohling, P. F. Sexton, D. J. Lunt, R. D. Pancost, M. P. S. Badger, D. N. Schmidt. **Plio-Pleistocene climate sensitivity evaluated using high-resolution CO_2 records**. *Nature*, 2015; 518 (7537): 49 DOI: 10.1038/nature14145

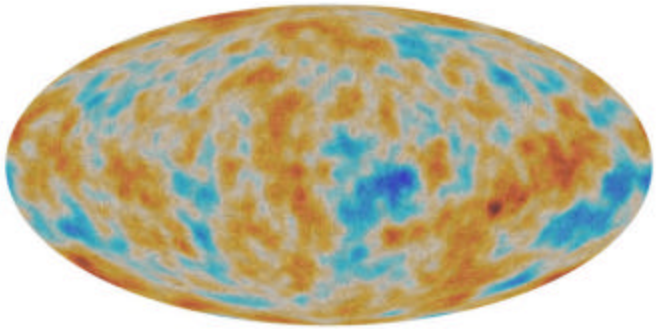
Cosmology: First stars were born much later than thought

New maps from ESA's Planck satellite uncover the 'polarised' light from the early Universe across the entire sky, revealing that the first stars formed much later than previously thought.

The history of our Universe is a 13.8 billion-year tale that scientists endeavour to read by studying the planets, asteroids, comets and other objects in our Solar System, and gathering light emitted by distant stars, galaxies and the matter spread between them.

A major source of information used to piece together this story is the Cosmic Microwave Background, or CMB, the fossil light resulting from a time when the Universe was hot and dense, only 380,000 years after the Big Bang.

Thanks to the expansion of the Universe, we see this light today covering the whole sky at microwave wavelengths.



Polarisation of the cosmic microwave background. Credit: Copyright ESA and the Planck Collaboration

Between 2009 and 2013, Planck surveyed the sky to study this ancient light in unprecedented detail. Tiny differences in the background's temperature trace regions of slightly different density in the early cosmos, representing the seeds of all future structure, the stars and galaxies of today.

Scientists from the Planck collaboration have published the results from the analysis of these data in a large number of scientific papers over the past two years, confirming the standard cosmological picture of our Universe with ever greater accuracy.

"But there is more: the CMB carries additional clues about our cosmic history that are encoded in its 'polarisation'," explains Jan Tauber, ESA's Planck project scientist.

"Planck has measured this signal for the first time at high resolution over the entire sky, producing the unique maps released today."

Light is polarised when it vibrates in a preferred direction, something that may arise as a result of photons -- the particles of light -- bouncing off other particles. This is exactly what happened when the CMB originated in the early Universe.

Initially, photons were trapped in a hot, dense soup of particles that, by the time the Universe was a few seconds old, consisted mainly of electrons, protons and neutrinos. Owing to the high density, electrons and photons collided with one another so frequently that light could not travel any significant distant before bumping into another electron, making the early Universe extremely 'foggy'.

Slowly but surely, as the cosmos expanded and cooled, photons and the other particles grew farther apart, and collisions became less frequent.

This had two consequences: electrons and protons could finally combine and form neutral atoms without them being torn apart again by an incoming photon, and photons had enough room to travel, being no longer trapped in the cosmic fog.

Once freed from the fog, the light was set on its cosmic journey that would take it all the way to the present day, where telescopes like Planck detect it as the CMB. But the light also retains a memory of its last encounter with the electrons, captured in its polarisation.

"The polarisation of the CMB also shows minuscule fluctuations from one place to another across the sky: like the temperature fluctuations, these reflect the state of the cosmos at the time when light and matter parted company,"

says François Bouchet of the Institut d'Astrophysique de Paris, France.

"This provides a powerful tool to estimate in a new and independent way parameters such as the age of the Universe, its rate of expansion and its essential composition of normal matter, dark matter and dark energy."

Planck's polarisation data confirm the details of the standard cosmological picture determined from its measurement of the CMB temperature fluctuations, but add an important new answer to a fundamental question: when were the first stars born?

"After the CMB was released, the Universe was still very different from the one we live in today, and it took a long time until the first stars were able to form," explains Marco Bersanelli of Università degli Studi di Milano, Italy.

"Planck's observations of the CMB polarisation now tell us that these 'Dark Ages' ended some 550 million years after the Big Bang -- more than 100 million years later than previously thought.

"While these 100 million years may seem negligible compared to the Universe's age of almost 14 billion years, they make a significant difference when it comes to the formation of the first stars."

The Dark Ages ended as the first stars began to shine. And as their light interacted with gas in the Universe, more and more of the atoms were turned back into their constituent particles: electrons and protons.

This key phase in the history of the cosmos is known as the 'epoch of reionisation'.

The newly liberated electrons were once again able to collide with the light from the CMB, albeit much less frequently now that the Universe had significantly expanded. Nevertheless, just as they had 380 000 years after the Big Bang, these encounters between electrons and photons left a tell-tale imprint on the polarisation of the CMB.

"From our measurements of the most distant galaxies and quasars, we know that the process of reionisation was complete by the time that the Universe was about 900 million years old," says George Efstathiou of the University of Cambridge, UK.

"But, at the moment, it is only with the CMB data that we can learn when this process began."

Planck's new results are critical, because previous studies of the CMB polarisation seemed to point towards an earlier dawn of the first stars, placing the beginning of reionisation about 450 million years after the Big Bang.

This posed a problem. Very deep images of the sky from the NASA-ESA Hubble Space Telescope have provided a census of the earliest known galaxies in the Universe, which started forming perhaps 300-400 million years after the Big Bang.

However, these would not have been powerful enough to succeed at ending the Dark Ages within 450 million years.

"In that case, we would have needed additional, more exotic sources of energy to explain the history of reionisation," says Professor Efstathiou.

The new evidence from Planck significantly reduces the problem, indicating that reionisation started later than previously believed, and that the earliest stars and galaxies alone might have been enough to drive it.

This later end of the Dark Ages also implies that it might be easier to detect the very first generation of galaxies with the next generation of observatories, including the James Webb Space Telescope.

But the first stars are definitely not the limit. With the new Planck data released today, scientists are also studying the polarisation of foreground emission from gas and dust in the Milky Way to analyse the structure of the Galactic magnetic field.

The data have also enabled new important insights into the early cosmos and its components, including the intriguing dark matter and the elusive neutrinos, as described in papers also released today.

The Planck data have delved into the even earlier history of the cosmos, all the way to inflation -- the brief era of accelerated expansion that the Universe underwent when it was a tiny fraction of a second old. As the ultimate probe of this epoch, astronomers are looking for a signature of gravitational waves triggered by inflation and later imprinted on the polarisation of the CMB.

No direct detection of this signal has yet been achieved, as reported last week. However, when combining the newest all-sky Planck data with those latest results, the limits on the amount of primordial gravitational waves are pushed even further down to achieve the best upper limits yet.

"These are only a few highlights from the scrutiny of Planck's observations of the CMB polarisation, which is revealing the sky and the Universe in a brand new way," says Jan Tauber.

"This is an incredibly rich data set and the harvest of discoveries has just begun."

Series of publications: http://www.cosmos.esa.int/web/planck/publications

Story Source: The above story is based on materials provided by **European Space Agency**.

Ancient skull shows modern humans colonized Eurasia 60-70,000 years ago

While it is widely accepted that the origins of modern humans date back some 200,000 years to Africa, there has been furious debate as to which model of early Homo sapiens migration most plausibly led to the population of the planet -- and the eventual extinction of Neanderthals. While fossil records prove that some anatomically modern human groups reached the Levantine corridor (the modern Middle East) as early as 100,000 years ago, genetic testing indicates that human populations inhabiting the globe today descended from a single group that migrated from Africa only 70,000 years ago -- an unexplained gap of 30,000 years. Little evidence has emerged to bridge the contradictory theories.

Until now. The discovery in the Manot Cave of Israel's Western Galilee of an almost complete skull dating back

55,000 years provides direct anatomical evidence that fills the historic time gap of modern human migration into Europe. It is also the first proof that anatomically modern humans existed at the same time as Neanderthals in the same geographical area.

The finding, by Prof. Israel Hershkovitz, the Tassia and Dr. Joseph Meychan Chair for the History and Philosophy of Medicine at the Department of Anatomy and Anthropology at TAU's Sackler Faculty of Medicine and Head of The Dan David Laboratory for the Search and Study of Modern Humans at the Steinhardt Museum of Natural History and National Research Center, was published in *Nature* this week.

This image shows a skull found in the Manot Cave, Israel. Credit: Clara Amit, Israel Antiquities Authority

A new light on our ancestors

"The morphology of the skull indicates that it is that of a modern human of African origin, bearing characteristics of early European Upper Palaeolithic populations. This suggests that the Levantine populations were ancestral to earlier European populations," said Prof. Hershkovitz. "This study also provides important clues regarding the likely inbreeding between anatomically modern humans and Neanderthals."

The Manot Cave, where the skull was unearthed, was discovered accidentally in 2008 when a bulldozer struck the cave roof, revealing a time capsule tens of thousands of years old. "This is a goldmine," said Prof. Hershkovitz. "Most other caves are 'disturbed caves,' but this is untouched, frozen in time -- truly an amazing find. Among other artefacts found there, the skull, which we dated to 55,000 years ago using uranium thorium methods, was astonishing. It provides insight into the beginnings of the dispersal of modern humans all over the world."

According to Prof. Hershkovitz, the skull disproves two major narratives: that all modern human populations are linked to migrations out of Africa 100,000 years ago, and that early European Upper Paleolithic populations interbred with local European Neanderthals. Instead the skull indicates that modern humans met and interbred with Neanderthals in Israel, only to later pass on their genes to the rest of the world. Considering Europe was in the last Ice Age period, its harsh climate rendered it generally inhospitable, so humans from the Levant moved first to Asia, and only later (45,000 ago) to Europe.

Sorting out the contradictions

"This was a wonderful scenario, but there was one problem," said Prof. Hershkovitz. "Geneticists discovered that present-day human populations were linked to a group of African modern humans who started migrating 70,000 years ago. Accordingly, all previous migrations of modern humans out of Africa were presumed to have reached a dead end, contributing nothing to present-day human life. But this was a prediction based on genetic studies only. No fossils to be found anywhere to back it up."

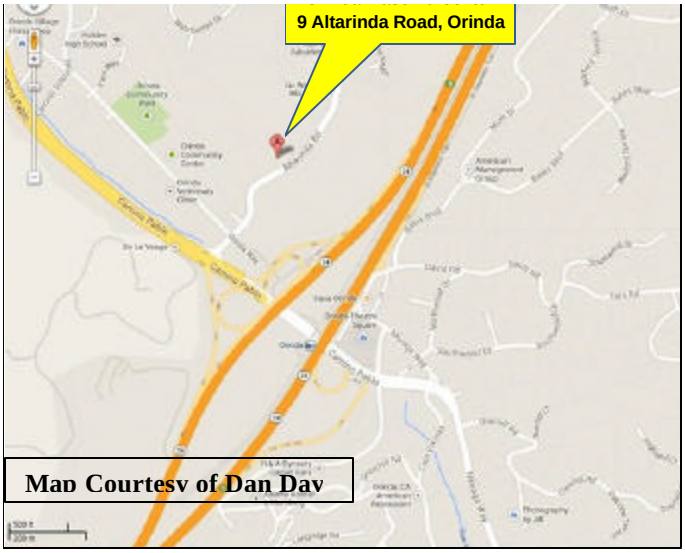
The first physical evidence that modern man left Africa 70,000 years ago, stopped in Israel, then moved afterward to Europe came in the form of the newly discovered Manot skull. "This skull dates back 55,000 years, a critical time period," said Prof. Hershkovitz. "If modern humans indeed moved from Africa 70,000 years ago to Israel, this skull means they settled in the Levant for a long period of time, before moving to Europe (45,000 years ago).

"When we analysed the morphology of Manot skull, we made two important discoveries. First, we found African affinities, confirming that the Manot population originated in Africa. Second, we noted many morphological peculiarities akin to early Upper Paleolitic populations in Europe, which suggest ancestral connections to earlier European populations. All of this confirms that people in Manot came from Africa, stayed in Israel for several thousand years, and later, when weather conditions improved, moved to Europe. The Manot people are indeed the ancestors of European populations."

A further critical finding was the apparent communication and interbreeding between the local Neanderthals and the Manot Homo sapiens in the Levant -- not in Europe, as some anthropologists previously hypothesized. "When the Manot people came to Israel, they encountered a flourishing population of Neanderthals, with whom they must have communicated, shared tools and interbred with," said Prof. Hershkovitz. "According to our analysis of the skull, which bears a complex mix of archaic and modern characteristics, this was probably the only place on earth where Neanderthals and anatomically modern humans lived side by side for a long period of time."

Story Source: The above story is based on materials provided by American Friends of Tel Aviv University.

Journal Reference: Israel Hershkovitz, Ofer Marder, Avner Ayalon, Miryam Bar-Matthews, Gal Yasur, Elisabetta Boaretto, Valentina Caracuta, Bridget Alex, Amos Frumkin, Mae Goder-Goldberger, Philipp Gunz, Ralph L. Holloway, Bruce Latimer, Ron Lavi, Alan Matthews, Viviane Slon, Daniella Bar-Yosef Mayer, Francesco Berna, Guy Bar-Oz, Reuven Yeshurun, Hila May, Mark G. Hans, Gerhard W. Weber, Omry Barzilai. **Levantine cranium from Manot Cave (Israel) foreshadows the first European modern humans**. *Nature*, 2015; DOI: 10.1038/nature14134



Biography: Dr. Bradley Erskine is a Principal Geologist with Kleinfelder with 27 years of experience in managing and supporting a broad spectrum of environmental engineering projects. He holds a bachelor degree in geology from University of California Los Angeles, a Masters degree from San Diego State University (Paleomagnetics), and doctorate degree from the University of California at Berkeley in geology with a specialty in metamorphic petrology and mineralogy, and has applied this expertise to the evolving field of Naturally Occurring Asbestos. He currently is managing a $20M asbestos monitoring and compliance program for the San Francisco Public Utilities Commission, where excavation of 7 million yards of NOA material and construction using NOA containing rock is required to build an earthen replacement dam in Northern California.

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