NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

MEETING ANNOUNCEMENT

DATE: **June 26, 2013**

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. Lester McKee and Sarah Pearce, San Francisco Estuary Institute, Richmond, California**

Science support for improved management of sediment in Bay Area watersheds, creeks, and San Francisco Bay

San Francisco Bay watershed, with an area of 162,000 km² (about 40% of the area of the State of California) is home to around 13.5 million people. San Francisco Bay, the "urbanized estuary" and its watershed supports five major ports ($20 billion worth of cargo annually), five oil refineries, water supply for tens of millions of people, and irrigation water supply for millions of acres of farmland. The watershed of the nine counties directly around the Bay supports a population of 7.2 million, a thriving agricultural community of winegrowers, rangeland beef farming, and all the parks and open spaces area that we know and celebrate. The Bay itself is home to a range of wildlife and fisheries resources of importance. Annually, approximately three million cubic meters of sediment is removed to maintain navigation channels and harbors. Geology, slope, and climatic factors in addition to human factors play a strong role in the erosion and transport of sediment from our watersheds and drainage systems and thus sediment mass load that ultimately enters the Bay. Our research focuses on answering sediment related management questions associated with anadromous fish, flood control, pollutants carried on fine sediment, and regional scale sediment supply to San Francisco Bay. We have used a variety of project specific standard geomorphological field techniques, Geographic Information Systems (GIS), aerial photograph interpretation, and sediment transport equations to provide managers with vital information that can be directly applied to create a desired outcome. In some cases, this information has led to successful restoration of creeks and wetlands, and in other cases it has supported specific language in government policy and regulation documents. In this presentation, we will provide an overview of some of the more interesting examples of our work over the past 15 years on geological and land use controls on erosional characteristics of our Bay Area watersheds and sediment supply to San Francisco Bay.

…Continued on the Back…

NCGS 2012 – 2013 Calendar

June 26, 2013
Dr. Lester McKee and Sarah Pearce, San Francisco Estuary Institute
Science support for improved management of sediment in Bay Area watersheds, creeks, and San Francisco Bay

September 25, 2013
TBA

October 30, 2013
Dr. David A. Osleger, UC Davis
Paleo-precipitation records from Lake Tahoe cores

November 20, 2013
James J. Rytuba, Victoria E. Langenheim, and Daniel N. Goldstein, USGS, Menlo Park
Effects of the Paso Robles Geothermal System on water quality and availability in the Paso Robles Groundwater Basin, California

Upcoming NCGS Events

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

June 22, 2013 **(FULL!)**	***Geology of the Golden Gate Headlands;*** **Dr. William Elder, Golden Gate National Recreation Area**
August 16, 17, 18, 2013 **Friday – Sunday**	***Lassen Volcanic National Park – a wonderland of volcanoes and thermal features*** **Dr. Patrick Muffler, U.S. Geological Survey, Geologist Emeritus**

Peninsula Geologic Society

Upcoming meetings

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

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

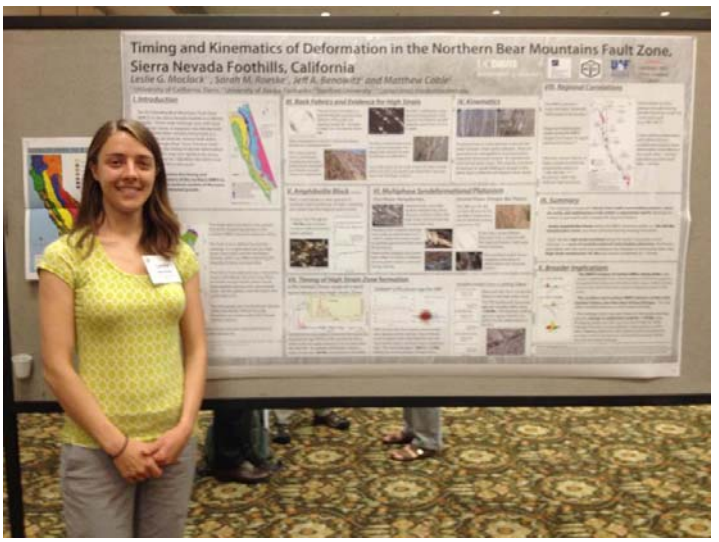
Upcoming Events

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/.

Garniss Curtis Memorial Update

The March newsletter contained an article about the passing of **Garniss Curtis**. Doris Sloan has provided us with a correction on the date of the memorial and a web link with further details. A celebration of Garniss Curtis' life will be held on Sept. 29, 2013, from 2 pm to 5 pm at the UC Berkeley Faculty Club. Details can be found at http://www.garnisscurtis.net.

NCGS Scholarship Awardee Leslie Maclock at the Fresno GSA Meeting



NCGS Masters Thesis Scholarship Awardee Leslie Moclock was sighted by **NCGS President Tom Barry** at the recent Geological Society of America Cordilleran Meeting in Fresno. Tom reports that the NCGS logo was used in the poster presentation. Tom also studied the Bear Mountain Fault Zone, so had a good talk with her to catch up on some recent developments. Her abstract follows.

TIMING AND KINEMATICS OF DEFORMATION IN THE NORTHERN BEAR MOUNTAINS FAULT

ZONE, SIERRA NEVADA FOOTHILLS, CALIFORNIA

MOCLOCK, Leslie G.1, ROESKE, Sarah M.1, BENOWITZ, Jeff A.2, and COBLE, Matthew A.3,

(1) Geology Department, University of California, Davis, One Shields Avenue, Davis, CA 95616, lmoclock@ucdavis.edu, (2) Geology and Geophysics, University of Alaska Fairbanks, P.O. Box 755780, Fairbanks, AK 99775, (3) Department of Geological and Environmental Sciences, Stanford University, 450 Serra Mall, Building 320, Stanford, CA 94305

The N-S trending Bear Mountains Fault Zone (BMFZ) in the Sierra Nevada foothills is a 300 km long by ~10 km wide melange zone with local high strain zones. It separates two lithotectonic belts and has been variably interpreted as a suture zone, an intra-arc reverse fault, and a transverse "mega-shear" zone. Previous work also suggests the timing of ductile deformation along the BMFZ may vary significantly along strike, from prior to ~160 Ma in the north to as young as ~123 Ma in the south.

This study examines the timing and deformation history of the northern BMFZ near Auburn, where excellent exposure occurs along the American River. This area is dominated by a zone of foliated greenschist-facies serpentine matrix melange up to 11 km wide. Blocks include gabbro, pillow basalt and breccia, massive metabasite, chert, and limestone, with lesser volcaniclastic rocks and clastic sediment. One higher-grade block consists of strongly foliated hornblende amphibolite. Metadiorite plutons that intrude the melange have been strongly deformed into wide zones of uniform greenschist that previous workers mapped as metavolcanic rocks.

Anastamosing foliation dips steeply east and contains a weak to moderately-developed downdip lineation. Rootless isoclinal folding at the cm-scale is ubiquitous. A 4 km-wide high strain zone has deformed the BMFZ up to its border with an intact, less-deformed volcanic and plutonic sequence previously dated to ~162 Ma. Kinematic indicators from the high strain zone show that flattening strain is dominant. Both reverse and normal motion are also indicated, likely due to large-scale folding. Of note, no conclusive evidence of transverse motion is present.

New isotopic ages bracket the timing of ductile deformation in this area to the Early and Middle Jurassic. Hornblende from the amphibolite block has a 40Ar/39Ar age of 195.9±2.4 Ma, and a weakly-deformed pluton intruding the high strain zone has a SHRIMP U/Pb zircon age of 160.9±1.3 Ma. Dikes and sills with 40Ar/39Ar muscovite and biotite ages of ~124 Ma are undeformed. Based on these results and structural interpretations, we infer that the northern BMFZ is a middle Jurassic or older feature that incorporates syndeformational plutonism and high strain, rather than an upper Jurassic-lower Cretaceous feature as seen in the south.

Report on Hike to Drake's Estero

*By **John Christian**, member of NCGS, the Contra Costa Hills club, and lifetime member of the Dallas Paleontological Society*

Here is a write up of a trip in May to Drake's Estero on Point Reyes with, and for, the Contra Costa Hills Club, a hiking club, (http://www.contracostahills.org/) that describes a hike gone horribly right…geological wonders everywhere!

On a related note, on **Sunday October 20th**, hiking club member and NCGS member, **Bill Motzer**, will be leading a hike to the New Almaden Mines near San Jose where he will discuss the history and geology of the mines. Details on the hike sponsored by the Contra Costa Hills Club will be in the September NCGS newsletter and on the CCHC website. We welcome all capable hikers.

Let me digress and ask two rhetorical questions. While I'm asking, please pull out a map of Pt. Reyes and Drake's Estero to see what I'm talking about. Should it not be called Drake's Estuary since Sir Francis Drake was English and not Spanish? By the same logic, I guess the neighboring estuary should be called l'estuaire de Limantour after a French trader who wrecked his boat nearby. Also, is it not a geographical version of "Spanglish" to have a Home BAY within Drake's ESTERO? Only in California!

Photo 1

On the way to the trailhead I stopped to take several photos of the artistic wind pruned trees just southwest of Nicasio Reservoir where the winds funnel through a narrowed canyon (photo 1). Note that the trees at the bottom of the canyon (where the wind speeds are lower) and the trees high on the ridge (that are further away from the wind tunnel in the narrowest part of the canyon) have rounded tops while most of the rest have been sculpted by the wind. See the wind pruned trees from Google Earth's satellite photo (photo 2). Note in the lower left, the linear features in the trees that indicate that the predominant wind flow is from the southwest. In the center and lower center of the photo some of the winds curve more to due east creating a fan shaped area of pruned trees.

Photo 2

Because the tide had receded in Drake's Estero, we found many interesting rocks at Sunset Beach, our final destination. Here's a photo of the exposed tidal flats in Home Bay which is part of Drake's Estero (photo 3).

Photo 3

Photo 4

At Sunset Beach, the 3 to 10 million years old late Miocene to early Pliocene Purisima Formation forms cliffs of mudstone, siltstone, sandstone and occasional layers of conglomerate. There are more fossil bones here than anywhere else I've seen outside of a museum. Many whale, sea lion and walrus fossils are found throughout the formation, but are most common in the more cemented layers and rounded concretions. The chemistry of the bones caused calcium carbonate (limestone) to cement the sediments around them to form these concretions. Sometimes whole skulls can be found in these concretions. Notice several rounded concretions in the cliffs at Sunset beach in this photo (photo 4).

Photo 5

Here's a large bone about 7 inches across, probably whale, based on its size (photo 5). Notice that the dark brown bone material is spongy just like the bone in a T bone steak. Over time the spongy bone fills with sediments and precipitated minerals such as quartz and calcium carbonate that make the fossil bone much heavier than a new bone. You can see the remains of several vertebrae arranged horizontally (photo 6). Note the raised vertical columns of hardened silt and sand that filled the spaces between the vertebrae. Here is a photo of only the 2nd shark tooth, (a cow shark), that I have seen in the Bay area (photo 7).

Photo 6

Photo 7

Photo 8

Photo 8 shows the pores of the bone being filled with chalcedony.

Photos 9 and 10

Photo 11

Other interesting rocks occur. Tafoni fenestra occurs in many of the sandstone boulders (photos 9 & 10) that sometime have fossilized bones such as the one that Mark Petrofsky is looking at (photo 11). Note the windows in the walls of the tafoni in the upper half of photo 9. The very sculpturesque tafoni are caused by water and crystallizing salt crystals that selectively break up and erode areas of the rock." Salty water soaks further into areas of the sandstone that have greater porosity and less resistant cementation. When the salt crystallizes in the rock, the sand grains are pushed out and eroded away leaving small caves or tafoni in the rock.

Thanks to Anne, the hike leader, for taking us on this trip at low tide. I was on this trail long ago but did not make it to the beach because the tide was too high and the tidal flats were too muddy. I'll have to come back at low tide again and explore more of this coastline and find more fossil treasures. If anyone at NCGS is interested in visiting this incredible site let me know! --John

Pipe dreams: Developer tapping into Antioch hills on quest for oil

By Paul Burgarino, Contra Costa Times

ANTIOCH -- This struggling city once envisioned a seemingly endless row of homes dotting its southeast hills that would fuel its continued growth and prosperity. But with the housing boom gone bust, a new vision for the landscape has emerged: oil rigs.

Antioch, which long ago abandoned its petroleum roots as its population boomed, is once again looking for a little Texas Tea to pump up its finances.

Sunset Exploration drilled an exploratory well deep into the ground the past two weeks hoping to find pockets of oil hundreds of feet below the surface. While it's still too early to tell whether significant oil reserves will be found, optimism is growing that Antioch could soon become one of the few Bay Area cities pulling petroleum out of the ground.

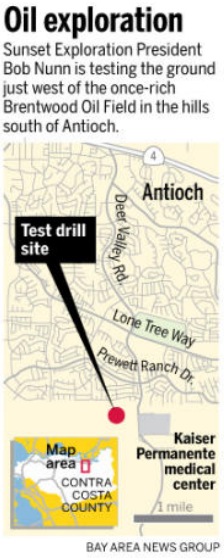
The property that Sunset is leasing from Shea Homes and Dividend Homes is about a half-mile west of Kaiser

Permanente's medical center and is on the fringe of what was known as the Brentwood Oil Field. Once drilled by Shell Oil Co. and Occidental Petroleum Corp., the site boomed in the 1960s and produced 9.8 million barrels of oil, the most of any field in Northern California.

"The easiest place to find acorns is under an oak tree, so we're hoping that the easiest place to find oil is where it's been found before," Sunset President Bob Nunn said. "(The area) used to be pretty prolific."

While oil drilling is common in Southern California and the San Joaquin Valley, it is almost unheard of in the Bay Area.

"From a historic perspective, it's fairly rare," said Tim Kustic, the state's supervisor of the Oil, Gas and Geothermal Resources, a division of the Department of Conservation.



With the exception of some wells in outlying parts of the Bay Area -- including Brentwood and far east Contra Costa County, Rio Vista, the hills east of Livermore and along the coast near Half Moon Bay -- the region is relatively untapped. The likely reason is the area's geology and subsurface foundation, Kustic said.

Further, Kustic said, petroleum excavation tends to occur in Southern California, whereas Northern California wells primarily produce natural gas.

"(Northern California) has never been a major oil-producing province," Kustic said.

The first crack at finding black gold didn't hit pay dirt. But Nunn says there are "some encouraging signs" that oil could be there.

After digging a 4,000-foot-deep hole at a 30-degree angle (to keep machinery far away from a nearby subdivision), the sand below the layers of shale was thicker than anticipated. It had some "minor hydrocarbon shows," or traces of oil, Nunn said. We think we found something worth pursuing," he said.

The next step, Nunn said, is to further study the geology of the area based on information gathered from the dig and come back in a couple months to drill another bore nearby. When Antioch annexed part of the field in 1994, the wells were defunct. The city banned mineral extraction in anticipation of residential and commercial growth.

City leaders repealed the ban in 2005 when development plans stalled.

"It's an interesting opportunity," Councilman Gary Agopian said. "Here's an example of where the community has been challenging us to find ways to improve economic development, and maybe this could help generate a little revenue for the city. There might not be anything there, but then again, hopefully, there might."

"It's not going to be a budget maker," adds City Manager Jim Jakel, "but it could bring in some money, no doubt about it."

Antioch's zoning administrator granted a temporary permit in March for Sunset to drill on 157 acres west of where oil companies once tapped the ground, renewing a 2008 city approval.

Arne Simonsen, Antioch's city clerk and a city councilman from 2000 to 2008, says he supported the drilling as a way to reduce foreign dependence on oil and natural gas.

Simonsen said the hills between Antioch and Brentwood, now covered with homes, were full of oil derricks when he moved to Antioch in the 1970s.

"They may as well take advantage of the open space to extract minerals while they can, before the housing boom comes back eventually," Simonsen said.

Sunset did not move right away on the previous approval because other projects in Southern California took priority, Nunn said.

Sunset is hoping to take advantage of an increase in California crude oil prices, which now top $100 a barrel, especially given that it costs the same to drill for less-lucrative natural gas. That spike has led many companies in the state to invest in more wells, particularly at or near sites that have paid off in the past.

Nunn says the western area of the field has yet to be tapped, which he hopes means there's still oil far below the surface.

"It's an exciting play," he said.

If oil is found, it would be stored in a tank on-site, with the liquid inside drained and taken off-site by trucks once a day. The gas would be funneled through existing underground lines that run under Deer Valley Road.

Before starting to dig, a public meeting was held to vet concerns, particularly those from residents who live about 1,500 feet away in homes on Mammoth Way. In the past, residents there have expressed concern about noise and soil contamination. Only one person attended the meeting.

A recent visit to the site found that the 100-foot-high rig and other heavy machinery were relatively loud on the site but cannot be heard from Mammoth or Deer Valley.

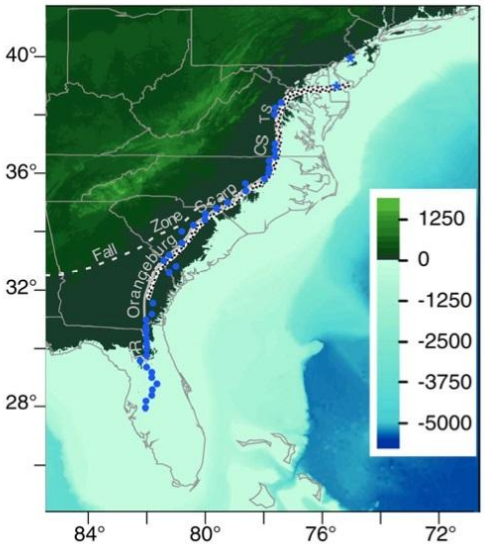
"We're trying to be good neighbors," Nunn said.

Earth's Mantle Affects Long-Term Sea-Level Rise Estimates

From Virginia to Florida, there is a prehistoric shoreline that, in some parts, rests more than 280 feet above modern sea level. The shoreline was carved by waves more than 3 million years ago -- possible evidence of a once higher sea level, triggered by ice-sheet melting. But new findings by a team of researchers, including Robert Moucha, assistant professor of Earth Sciences in The College of Arts and Sciences, reveal that the shoreline has been uplifted by more than 210 feet, meaning less ice melted than expected.

Equally compelling is the fact that the shoreline is not flat, as it should be, but is distorted, reflecting the pushing motion of Earth's mantle.

This is big news, says Moucha, for scientists who use the coastline to predict future sea-level rise. It's also a cautionary tale for those who rely almost exclusively on cycles of glacial advance and retreat to study sea-level changes.



The East Coast shoreline, also known as the Orangeburg Scarp, as it may have appeared 3 million years ago. (Credit: Image courtesy of Syracuse University)

"Three million years ago, the average global temperature was two to three degrees Celsius higher, while the amount of carbon dioxide in the atmosphere was comparable to that of today," says Moucha, who contributed to a paper on the subject in the May 15 issue of Science Express. "If we can estimate the height of the sea from 3 million years ago, we can then relate it to the amount of ice sheets that melted. This period also serves as a window into what we may expect in the future."

Moucha and his colleagues -- led by David Rowley, professor of geophysical sciences at the University of Chicago -- have been using computer modeling to pinpoint exactly what melted during this interglacial period, some 3 million years ago. So far, evidenced is stacked in favor of Greenland, West Antarctica and the sprawling East Antarctica ice sheet, but the new shoreline uplift implies that East Antarctica may have melted some or not at all. "It's less than previous estimates had implied," says Rowley, the article's lead author.

Moucha's findings show that the jagged shoreline may have been caused by the interplay between Earth's surface and its mantle -- a process known as dynamic topography. Advanced modeling suggests that the shoreline, referred to as the Orangeburg Scarp, may have shifted as much as 196 feet. Modeling also accounts for other effects, such as the buildup of offshore sediments and glacial retreats.

"Dynamic topography is a very important contributor to Earth's surface evolution," says Rowley. "With this work, we can demonstrate that even small-scale features, long considered outside the realm of mantle influence, are reflective of mantle contributions."

Building a case

Moucha's involvement with the project grew out of a series of papers he published as a postdoctoral fellow at the Canadian Institute for Advance Research in Montreal. In one paper from 2008, he drew on elements of the North American East Coast and African West Coast to build a case against the existence of stable continental platforms.

"The North American East Coast has always been thought of as a passive margin," says Moucha, referring to large areas usually bereft of tectonic activity. "[With Rowley], we've challenged the traditional view of passive margins by showing that through observations and numerical simulations, they are subject to long-term deformation, in response to mantle flow."

Central to Moucha's argument is the fact that viscous mantle flows everywhere, all the time. As a result, it's nearly impossible to find what he calls "stable reference points" on Earth's surface to accurately measure global sea-level rise. "If one incorrectly assumed that a particular margin is a stable reference frame when, in actuality, it has subsided, his or her assumption would lead to a sea-level rise and, ultimately, to an increase in ice-sheet melt," says Moucha, who joined SU's faculty in 2011.

Another consideration is the size of the ice sheet. Between periods of glacial activity (such as the one from 3 million years ago and the one we are in now), ice sheets are generally smaller. Jerry Mitrovica, professor of geophysics at Harvard University who also contributed to the paper, says the same mantle processes that drive plate tectonics also deform elevations of ancient shorelines. "You can't ignore this, or your estimate of the size of the ancient ice sheets will be wrong," he says.

Rise and fall

Moucha puts it this way: "Because ice sheets have mass and mass results in gravitational attraction, the sea level

actually falls near the melting ice sheet and rises when it's further away. This variability has enabled us to unravel which ice sheet contributed to sea-level rise and how much of [the sheet] melted."

The SU geophysicist credits much of the group's success to state-of-the-art seismic tomography, a geological imaging technique led by Nathan Simmons at California's Lawrence Livermore National Laboratory. "Nathan, who co-authored the paper, provided me with seismic tomography data, from which I used high-performance computing to model mantle flow," says Moucha. "A few million years may have taken us a day to render, but a billion years may have taken several weeks or more."

Moucha and his colleagues hope to apply their East Coast model to the Appalachian Mountains, which are also considered a type of passive geology. Although they have been tectonically quiet for more than 200 million years, the Appalachians are beginning to show signs of wear and tear: rugged peaks, steep slopes, landslides, and waterfalls -- possible evidence of erosion, triggered by dynamic topography.

"Scientists, such as Rob, who produce increasingly accurate models of dynamic topography for the past, are going to be at the front line of this important research area," says Mitrovica.

Adds Rowley: "Rob Moucha has demonstrated that dynamic topography is a very important contributor to Earth's surface evolution. … His study of mantle contributions is appealing on a large number of fronts that I, among others of our collaboration, hope to pursue."

Story Source: The above story is reprinted from materials provided by Syracuse University. The original article was written by Rob Enslin.

Journal Reference: D. B. Rowley, A. M. Forte, R. Moucha, J. X. Mitrovica, N. A. Simmons, S. P. Grand. **Dynamic Topography Change of the Eastern United States Since 3 Million Years Ago**. *Science*, 2013; DOI: 10.1126/science.1229180

Megavolcanoes Tied to Pre-Dinosaur Mass Extinction: Apparent Sudden Climate Shift Could Have Analog Today

Scientists examining evidence across the world from New Jersey to North Africa say they have linked the abrupt disappearance of half of earth's species 200 million years ago to a precisely dated set of gigantic volcanic eruptions. The eruptions may have caused climate changes so sudden that many creatures were unable to adapt -- possibly on a pace similar to that of human-influenced climate warming today. The extinction opened the way for dinosaurs to evolve and dominate the planet for the next 135 million years, before they, too, were wiped out in a later planetary cataclysm.

Along sea cliffs in southern England, geologist Paul Olsen of Columbia University's Lamont-Doherty Earth Observatory samples rocks from near the 201,564,000-year Triassic extinction boundary. (Credit: Kevin Krajick/Earth Institute)

In recent years, many scientists have suggested that the so-called End-Triassic Extinction and at least four other known past die-offs were caused at least in part by mega-volcanism and resulting climate change. However, they were unable to tie deposits left by eruptions to biological crashes closely in time. This study provides the tightest link yet, with a newly precise date for the ETE--201,564,000 years ago, exactly the same time as a massive outpouring of lava. "This may not quench all the questions about the exact mechanism of the extinction itself. However, the coincidence in time with the volcanism is pretty much ironclad," said coauthor Paul Olsen, a geologist at Columbia University's Lamont-Doherty Earth Observatory who has been investigating the boundary since the 1970s.

The new study unites several pre-existing lines of evidence by aligning them with new techniques for dating rocks. Lead author Terrence Blackburn (then at Massachusetts Institute of Technology; now at the Carnegie Institution) used the decay of uranium isotopes to pull exact dates from basalt, a rock left by eruptions. The basalts analyzed in the study all came from the Central Atlantic Magmatic Province (CAMP), a series of huge eruptions known to have started around 200 million years ago, when nearly all land was massed into one huge continent. The eruptions spewed some 2.5 million cubic miles of lava in four sudden spurts over a 600,000-year span, and initiated a rift that evolved into the Atlantic Ocean; remnants of CAMP lavas are found now in North and South America, and North Africa. The scientists analyzed samples from what are now Nova Scotia, Morocco and the New York City suburbs. (Olsen hammered one from a road cut in the Hudson River Palisades, about 1,900 feet from the New Jersey side of the George Washington Bridge.)

Previous studies have suggested a link between the CAMP eruptions and the extinction, but other researchers' dating of the basalts had a margin of error of 1 to 3 million years. The new margin of error is only a few thousand years -- in geology, an eye blink. Blackburn and his colleagues showed that the eruption in Morocco was the earliest, with ones in Nova Scotia and New Jersey coming about 3,000

and 13,000 years later, respectively. Sediments below that time contain pollen, spores and other fossils characteristic of the Triassic era; in those above, the fossils disappear. Among the creatures that vanished were eel-like fish called conodonts, early crocodilians, tree lizards and many broad-leaved plants. The dating is further strengthened by a layer of sediment just preceding the extinction containing mineral grains providing evidence of one of earth's many periodic reversals of magnetic polarity. This particular reversal, labeled E23r, is consistently located just below the boundary, making it a convenient marker, said coauthor Dennis Kent, a paleomagnetism expert who is also at Lamont-Doherty. With the same layers found everywhere the researchers have looked so far, the eruptions "had to be a hell of an event," said Kent.

The third piece of chronological evidence is the sedimentary layers themselves. Sedimentary rocks cannot be dated directly -- one reason why the timing of the extinction has been hard to nail. Olsen and some others have long contended that Earth's precession -- a cyclic change in the orientation of the axis toward the sun and resulting temperature changes -- consistently created layers reflecting the alternate filling and drying of large lake basins on a fairly steady 20,000-year schedule. This idea is well accepted for more recent time, but many scientists have had doubts about whether it could be applied much farther back. By correlating the precisely dated basalts with surrounding sedimentary layers, the new study shows that precession operated pretty much the same way then, allowing dates with a give or take of 20,000 years to be assigned to most sediments holding fossils, said Olsen.

Olsen has painstakingly cataloged the layers around the time of the End Triassic, and the initial phase of the extinction occurs in just one layer -- meaning the event took 20,000 years at most. But, he said, "it could have taken much less. This is the level of resolution we have now, but it's the 'less' part that is the more important, and that's what we are working on now."

Many scientists assume that giant eruptions would have sent sulfurous particles into the air that darkened the skies, creating a multi-year winter that would have frozen out many creatures. A previous study by Kent and Rutgers University geochemist Morgan Schaller has also shown that each pulse of volcanism doubled the air's concentration of carbon dioxide -- a major component of volcanic gases. Following the cold pulses, the warming effects of this greenhouse gas would have lasted for millennia, wiping out creatures that could not take too much heat. (It was already quite hot to begin with at that time; even pre-eruption CO_2 levels were higher than those of today.) Fossils show that heat-sensitive plants especially suffered; there is also evidence that the increased CO_2 caused chemical reactions that made the oceans more acidic, causing populations of shell-building creatures to collapse. As if this were not enough, there is also some evidence that a large meteorite hit Earth at the time of the extinction--but that factor seems far less certain. A much stronger case has been made for the extinction of the dinosaurs by a meteorite some 65 million years ago -- an event that opened the way for the evolution and dominance of mammals, including human beings. Volcanism may have been involved in that extinction as well, with the meteorite delivering the final blow.)

The End Triassic was the fourth known global die-off; the extinction of the dinosaurs was the fifth. Today, some scientists have proposed that we are on the cusp of a sixth, humanmade, extinction. Explosive human population growth, industrial activity and exploitation of natural resources are rapidly pushing many species off the map. Burning of fossil fuels in particular has had an effect, raising the air's CO_2 level more than 40 percent in just 200 years -- a pace possibly as fast, or faster, than that of the End Triassic. Resulting temperatures increases now appear to be altering ecosystems; and CO_2 entering seawater is causing what could be the fastest ongoing acidification of the oceans for at least the last 300 million years, according to a 2012 study. "In some ways, the End Triassic Extinction is analogous to today," said Blackburn. "It may have operated on a similar time scale. Much insight on the possible future impact of doubling atmospheric CO_2 on global temperatures, ocean acidity and life on earth may be gained by studying the geologic record."

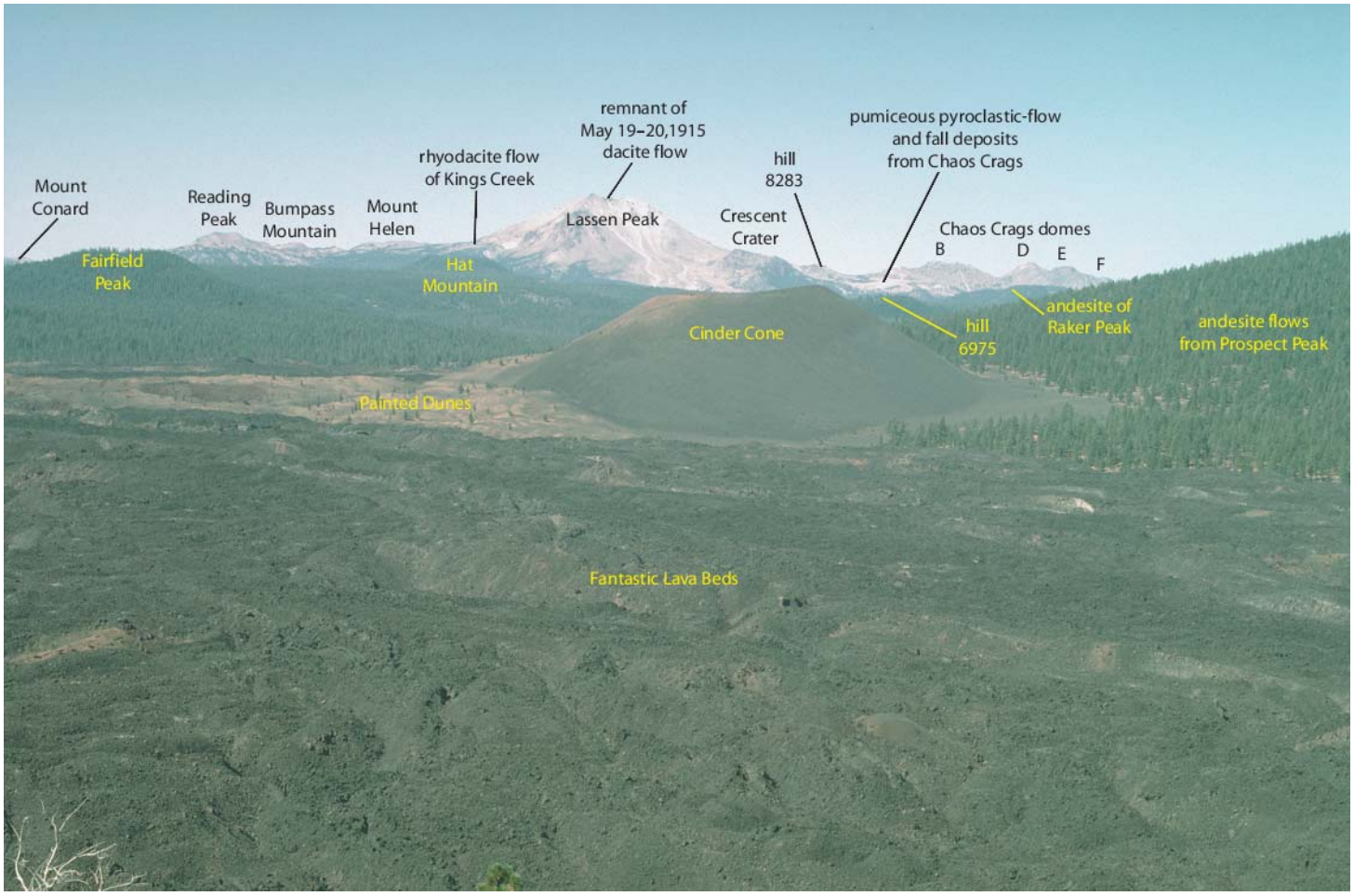
Paul Renne, a researcher at the Berkeley Geochronology Center in California, who studies the End Triassic but was not involved in the *Science* paper, said the study was "part of a growing pattern in which we see that the major ecosystem crises were triggered" by volcanism. He said the new data "make the case stronger than it was. … The pendulum continues to swing in favor of that idea." Of the actual mechanism that killed creatures, he said climate change was the most popular suspect. But, he added, "We still don't have any way yet of knowing exactly how much CO_2 was put into the atmosphere at that time, and what it did. If we did, we would then be able to say to people, 'Look folks, this is what we're facing now, and here's what we have to do about it. But we don't know that yet."

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

Journal Reference: Terrence J. Blackburn, Paul E. Olsen, Samuel A. Bowring, Noah M. McLean, Dennis V. Kent, John Puffer, Greg McHone, E. Troy Rasbury, and Mohammed Et-Touhami. **Zircon U-Pb Geochronology Links the End-Triassic Extinction with the Central Atlantic Magmatic Province**. *Science*, 21 March 2013 DOI: 10.1126/science.1234204

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

"LASSEN VOLCANIC NATIONAL PARK – A WONDERLAND OF VOLCANOES AND THERMAL FEATURES"



NCGS FIELD TRIP – Friday, Saturday, Sunday August 16, 17 & 18, 2013

Field Trip Leader:
Dr. Patrick Muffler
Geologist Emeritus, U.S. Geological Survey, Menlo Park, CA

Field Trip Director:
Tridib Guha
NCGS FIELD TRIP
Friday, Saturday, Sunday August 16, 17 & 18, 2013

"Lassen Volcanic National Park – A Wonderland of Volcanoes and Thermal Features"

Leader: Dr. Patrick Muffler, U.S. Geological Survey, Geologist Emeritus

The field trip will summarize 37 years of USGS volcanic and hydrothermal investigations in and around Lassen Volcanic National Park, primarily by Mike Clynne and Patrick Muffler. The area will be visited is presented on 1:50,000 Geologic Map of Lassen Volcanic National Park and Vicinity (USGS Scientific Investigations Map 2899, published in 2010).

***The following is a description of the features observed on the cover page entitled* "Mt. Lassen from Sunrise Peak."**

Cinder Cone and Lassen Peak
View looking west-southwest from west flank of Sunrise Peak, just east of Butte Lake (Prospect Peak quadrangle). Skyline above the timberline is the Lassen domefield. Reading Peak (unit dr, 212±5 ka), Bumpass Mountain (unit db, 232±8 ka), Mount Helen (unit dh, 249±12 ka), Crescent Crater (unit dc, 236±1 ka) and hill 8283 (unit d82, 261±5 ka) are part of the Bumpass sequence. The rhyodacite flow of Kings Creek (unit rk, 35±1 ka), the composite dacite dome of Lassen Peak (unit dl, 27±1 ka) and the rhyodacite domes and pumiceous pyroclastic-flow and fall deposits of Chaos Crags (1,103±13 yr B.P.) are part of the Eagle Peak sequence. Fairfield Peak (unit mfp, 82±14 ka), Hat Mountain (unit ah, ~45 ka) and Cinder Cone (1666 C.E.) are vents for basaltic andesite and andesite flows of the younger Twin Lakes sequence. Visible flows from Cinder Cone include Painted Dunes (units mp1and mp2) and Fantastic Lava Beds (units mf1and mf2). Hill 6975 is the vent for the andesite and basaltic andesite of Cluster Lakes (unit acl, 250–300 ka), part of the older Twin Lakes sequence. The andesite of Raker Peak (unit ap, 270±18 ka) is also part of the older Twin Lakes sequence. Prospect Peak (unit ap, 247±56 ka) is a regional calc-alkaline andesite and basaltic andesite volcano. Mount Conard (unit amc, 590–470 ka) forms the southeast rim of the eroded amphitheater of Brokeoff Volcano. Specific camera location 0.33 mi at 272° from Sunrise Peak. **Photograph taken by Patrick Muffler**.

We will circulate attendees list for carpooling to the meeting place.

THIS FIELD TRIP WILL BE LIMITED TO 42 PEOPLE.

********** Field Trip Logistics in preparation **********

Time & Meeting Place: August 16, 2013, 6:00 pm southwest corner Sun Valley Mall Parking lot, Concord. We will depart on a chartered bus (or vans) to Red Bluff. We will spend the night in a motel at Red Bluff. Next day, after the field trip, we will spend the night at Chester in a motel. Sunday we return to Concord.

Cost: in preparation (larger participation reduced cost)

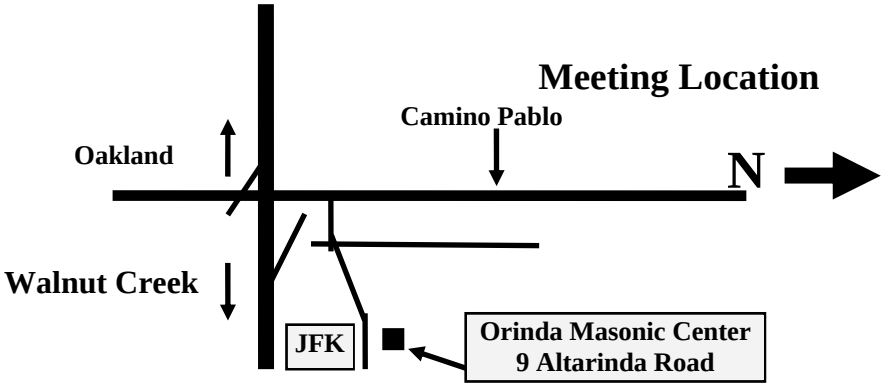
**********REGISTRATION FORM (Lassen Volcanic Field Trip) **********

Name:_____ E-mail:_____

Carpool origin:_____ Phone: ____ _____ Phone (alternate):_____

Lunch: Regular:_____ Vegetarian: _____ (Please check one)

Please e-mail registration to: **Tridib Guha** tridibguha@yahoo.com



Biographies: **Dr. Lester James McKee** received a B.Sc, with Honors, in Geloogy from the Univesity of Canterbury in New Zealand, and a Ph.D. in Resource Management from Southern Cross Univesity in Austrailia focusing on hydrology and nutrient biogeochemistry in wet-dry subtropical climatic regimes. Since 2000 he has been a Senior Scientist with the Clean Water Program at the San Francisco Estuary Institute (SFBI). He is the Lead Scientist with the Sources Pathways and Loading Workgroup (SPLWG), and the Regional Monitoring Program for Water Quality (RMP). He has 19 years of experience working on design and implementation of studies to provide knowledge about whole system mass balance in systems impacted by agricultural, urban, and industrial pollution; flow of water, and transport of sediments and pollutants into receiving water bodies; pollutant identification, prioritization, and source tracking in urban and agricultural landscapes; and performance analysis of best management practices (BMPs) and low impact design (LID). He provides mentorship and supervision to a group of five energetic multidisciplinary scientists mainly in the areas of geomorphology and hydrogeochemistry. He is the recipient of $7M+ in competitive grants and funding awards from local, state, and federal US sources. In addition, he collaborates on a further $4M+ of grants and funding awarded to the Institute.

Sarah A Pearce received a B.S. in Geosciences from Trinity University, San Antonio, TX, and an an MS in Geomorphology from Lehigh University, Bethlehem, PA, focusing on hydraulic geometry of ephemeral channels that cross thrust faults, North Flank of the San Bernardino Mountains, California. She has been a Geomorphologist with the San Francisco Estuary Institute since 2001. She has conducted many field-based studies on watersheds around the Bay focusing on sediment budgets, sediment source assessment, watershed assessments, and creek condition in support of beneficial uses. She is lead practitioner and trainer at SFEI for the California Rapid Assessment Method (CRAM) for wetlands, a statewide method for rapidly determining the condition of wetlands.

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Would you like to receive the NCGS newsletter by e-mail? If you are not already doing so, and would like to, please contact **Rob Nelson** at **rlngeology@sbcglobal.net** to sign up for this free service.