NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

MEETING ANNOUNCEMENT

DATE: **March 26, 2014**

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. Thomas C. MacKinnon, Consultant,**
20 Tara Road, Orinda CA 94563

Geology of the Monterey Formation of California With Comments on Recent Oilfield Developments

Diatomaceous rocks and their diagenetic equivalents, chert, porcelanite and siliceous mudstone are abundant in Miocene deposits of the Pacific region. Of these, the Monterey Formation is the best known and most extensive. Its origin is tied to a fortuitous combination of tectonic, climatic and oceanographic events. In Oligocene-Early Miocene times, a change from subduction to a transform margin resulted in extension of the borderland and formation of new marine basins isolated from terrigenous input. In Miocene times, global cooling and changes in ocean circulation resulted in increased upwelling and productivity, and rapid accumulation of relatively undiluted biogenic sediment. Near the end of the Miocene, plate motion shifted from transtension to transpression, resulting in mountain building and a sudden influx of terrigenous material; this signaled the end of Monterey-style deposition in most areas of California.

Rapid burial and basin-margin uplift continued through the Pliocene to the present, creating an ideal setting for oil field formation. As burial proceeded, soft diatomaceous rocks were converted to brittle chert, porcelanite, and siliceous mudstone. With further burial, organic-rich Monterey rocks generated hydrocarbons. Rocks overlying or adjacent to the Monterey included porous sandstones that made ideal reservoirs. Oil migration was aided by fractures in brittle Monterey rock types. Approximately 29 Billion barrels of oil have been produced in California, with roughly 90% probably sourced from the Monterey. Most of this oil has been produced from clastic rocks, leaving enormous amounts of oil still trapped in the matrix of low permeability Monterey rock types.

In 2011 a report by INTEK, funded by the federal government, claimed that the Monterey Formation contained 15 billion barrels of recoverable oil, making it the largest resource base in the US. Using the INTEK numbers at face value, economists at USC predicted that California could experience an enormous economic boom. Both reports have been criticized as being wildly optimistic and not factually based, but not before they created a firestorm of public controversy resulting in new regulations on fracking.

The main problem with the INTEK report was incorrectly assuming the Monterey would behave like the new tight oil and gas plays (i.e. Bakken, Marcellus) elsewhere in the U.S.; but the Monterey has little in common with these plays.

… Continued on the back…

NCGS 2012 – 2013 Calendar

April 30, 2014
Stephen D. Reynolds, California Geological Survey, ***Reclamation of the abandoned Spenceville Copper Mine***

May 28, 2014
DINNER MEETING; TBA

June 25, 2014
Jason Utas, PhD Candidate at UCLA; Meteorites

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/.

How Rare is Rare? (Part 1)

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.

Introduction: This is not an article about how rare or well done you should grill your favorite steak. Instead this month's column is about the rare earth elements (REE) also known as the lanthanide series (note: in 1995, the International Union of Pure and Applied Chemistry recommended that *lanthanide* be replaced with the term *lanthanoid*). REE have been much in the news lately, because they are now considered as critical and strategic metals required in today's microelectronic and green industries (see August 30, 2010 *C&EN News*, v. 88, n. 5, pp. 9-12). In the 18th and 19th centuries, REE were considered rare because they occurred in rather rare minerals. Additionally, REE were difficult to separate from their component oxides because of their chemical similarity and reactivities. Therefore, separation processes required to efficiently produce REE metals were not developed until the 20th century.

Like many chemists, I first became acquainted with the REE in high school chemistry, when we studied the Periodic Table: REE were somewhat dismissed as not too important elements, and the same was true in undergraduate chemistry (although the REE are the largest chemically coherent group in the periodic table). My real introduction to the REE was in graduate school when I worked with the U.S. Geological Survey in the Idaho batholith (IB), a large grey granite intrusion very similar to California's Sierra Nevada batholith. The IB also contains much younger white to pink granite intrusions with unique REE signatures that are significantly different from the IB granites. This significance is so striking that one can geochemically map the younger pink granites based solely on their REE signatures.

Physicochemistry: REE commonly include the 15 lanthanides (atomic number, Z = 57 through 71, respectively): lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), promethium (Pm), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb), and lutetium (Lu). Also included, because of their chemical similarity, are scandium (Sc; Z = 21) and yttrium (Y; Z = 39). Pm (Z = 61) has no stable isotopes. It was considered to be an "artificial" element because it is largely a uranium fission reactor by-product. Of 36 identified Pm radioisotopes, the most stable is ^{145}Pm with a half-life of 17.7 years and it occurs naturally from the spontaneous fission of ^{238}U and alpha decay of ^{151}Eu. Trace amounts have been found in pitchblende, but the quantities are so small that total calculated Pm equilibrium mass in the Earth's crust is only 560 g, largely from natural uranium decay with about 12 g occurring from alpha decay of ^{151}Eu.

In the Periodic Table, the REE are in Group 3 and Period 6; however, Sc is in Period 3 and Y is in Period 5 with both classified as transition metals. Traditionally, the REE have been divided into two groups: "light" rare earth elements (LREEs which are La through Eu (Z = 57 to 63) and "heavy" rare earth elements (HREE), Gd through Lu (Z = 64 to 71). Although Y is the least dense REE, it is commonly grouped with the HREE because it is physically and chemically similar to them.

The REEs are also considered to be lithophile elements (i.e., enriched in the Earth's crust). They naturally occur together because they have similar ionic radii (r) decreasing from LREE to HREE (r = 0.101 nm for Ce to r = 0.093 nm for Lu) and all are trivalent with the sometime exception of Ce^{4+} and Eu^{2+}, which can form in some geochemical environments. Therefore, an increase in atomic number does not accompany a valence change,

resulting in different REE substitutions into various mineral crystal lattices with multiple REE contained within a single mineral. Such substitutions account for REE's wide dispersion in the Earth's crust and REE deposits that are generally segregated into those enriched in either LREE or HREE (including Y).

Crustal Abundance: Ce is the most abundant of the REE, with average crustal concentrations ranging from 20 to 70 mg/kg; it is actually slightly more abundant than copper (50 to 68 mg/kg) or lead (10 to 14 mg/kg). (Note: average concentration ranges are given because various authors have published slightly different average concentrations.) Except for Pm, all of the REE have more abundant crustal average ranges than gold (0.004 to 0.0031 mg/kg), silver (0.07 to 0.08 mg/kg), and mercury (0.05 to 0.085 mg/kg). Published REE average ranges in mg/kg are: La (18 to 39), Pr (3.5 to 9), Nd (12 to 41.5), Sm (4.5 to 8), Eu (0.14 to 2), Gd (4 to 6.4), Tb (0.65 to 2.5), Dy (3 to 7.5), Ho (0.7 to 1.7), Er (2.1 to 6.5), Tm (0.2 to 1), Yt (2.7 to 8), Lu (0.35 to 1.7), Y (24 to 70), and Sc (5 to 22).

Although it can now readily be seen that average REE crustal concentrations exceed those of many mined commercial industrial metals, REE are rarely concentrated into mineable ore deposits because they are often associated with rather rare igneous rock types such as alkaline and carbonatite intrusives, residual deposits formed from deep weathering of these rocks, pegmatites, iron-oxide copper-gold deposits, marine phosphates, and placer deposits.

Conclusions: REE are not as rare as their name implies. However, they may soon become rare because their current demand in commercial products may soon exceed supply. In Part 2, I'll discuss in more detail the unique geochemistry that forms the primary REE deposits, their locations and some of their uses in modern commercial products.

Liquid Water on Mars?

In case you are interested, the following link appears to show photographs / video of water on Mars through a period of recent time.

http://content.time.com/time/video/player/0,32068,1095910237001_0,00.html?iid=tabvidrecirc

Volcanoes, including Mt. Hood, can go from dormant to active in a few months

A new study suggests that the magma sitting 4-5 kilometers beneath the surface of Oregon's Mount Hood has been stored in near-solid conditions for thousands of years, but that the time it takes to liquefy and potentially erupt is surprisingly short -- perhaps as little as a couple of months.

The key, scientists say, is to elevate the temperature of the rock to more than 750 degrees Celsius, which can happen when hot magma from deep within the Earth's crust rises to the surface. It is the mixing of the two types of magma that triggered Mount Hood's last two eruptions -- about 220 and 1,500 years ago, said Adam Kent, an Oregon State University geologist and co-author of the study.

Mount Hood, in the Oregon Cascades, doesn't have a highly explosive history. Credit: Photo courtesy Alison M Koleszar

Results of the research, which was funded by the National Science Foundation, were published this week in the journal *Nature*.

"If the temperature of the rock is too cold, the magma is like peanut butter in a refrigerator," Kent said. "It just isn't very mobile. For Mount Hood, the threshold seems to be about 750 degrees (C) -- if it warms up just 50 to 75 degrees above that, it greatly increases the viscosity of the magma and makes it easier to mobilize."

Thus the scientists are interested in the temperature at which magma resides in the crust, they say, since it is likely to have important influence over the timing and types of eruptions that could occur. The hotter magma from down deep warms the cooler magma stored at 4-5 kilometers, making it possible for both magmas to mix and to be transported to the surface to eventually produce an eruption.

The good news, Kent said, is that Mount Hood's eruptions are not particularly violent. Instead of exploding, the magma tends to ooze out the top of the peak. A previous study by Kent and OSU postdoctoral researcher Alison Koleszar found that the mixing of the two magma sources -- which have different compositions -- is both a trigger to an eruption and a constraining factor on how violent it can be.

"What happens when they mix is what happens when you squeeze a tube of toothpaste in the middle," said Kent, a professor in OSU's College of Earth, Ocean, and Atmospheric Sciences. "A big glob kind of plops out the

top, but in the case of Mount Hood -- it doesn't blow the mountain to pieces."

The collaborative study between Oregon State and the University of California, Davis is important because little was known about the physical conditions of magma storage and what it takes to mobilize the magma. Kent and UC-Davis colleague Kari Cooper, also a co-author on the *Nature* article, set out to find if they could determine how long Mount Hood's magma chamber has been there, and in what condition.

When Mount Hood's magma first rose up through the crust into its present-day chamber, it cooled and formed crystals. The researchers were able to document the age of the crystals by the rate of decay of naturally occurring radioactive elements. However, the growth of the crystals is also dictated by temperature -- if the rock is too cold, they don't grow as fast.

Thus the combination of the crystals' age and apparent growth rate provides a geologic fingerprint for determining the approximate threshold for making the near-solid rock viscous enough to cause an eruption. The diffusion rate of the element strontium, which is also sensitive to temperature, helped validate the findings.

"What we found was that the magma has been stored beneath Mount Hood for at least 20,000 years -- and probably more like 100,000 years," Kent said. "And during the time it's been there, it's been in cold storage -- like the peanut butter in the fridge -- a minimum of 88 percent of the time, and likely more than 99 percent of the time."

In other words -- even though hot magma from below can quickly mobilize the magma chamber at 4-5 kilometers below the surface, most of the time magma is held under conditions that make it difficult for it to erupt.

"What is encouraging from another standpoint is that modern technology should be able to detect when magma is beginning to liquefy, or mobilize," Kent said, "and that may give us warning of a potential eruption. Monitoring gases, utilizing seismic waves and studying ground deformation through GPS are a few of the techniques that could tell us that things are warming."

The researchers hope to apply these techniques to other, larger volcanoes to see if they can determine their potential for shifting from cold storage to potential eruption, a development that might bring scientists a step closer to being able to forecast volcanic activity.

Story Source: The above story is based on materials provided by Oregon State University and ScienceDaily. February 16, 2014.

Volcanoes contribute to recent global warming 'hiatus'

LLNL scientist Benjamin Santer and his climbing group ascend Mt. St. Helens via the "Dogshead Route" in April 1980, about a month before its major eruption. The group was the last to reach the summit of Mt. St. Helens before its major eruption that May. New research by Santer and his colleagues shows that volcanic eruptions contribute to a recent warming "hiatus." Credit: Image courtesy of DOE/Lawrence Livermore National Laboratory

Volcanic eruptions in the early part of the 21st century have cooled the planet, according to a study led by Lawrence Livermore National Laboratory. This cooling partly offset the warming produced by greenhouse gases.

Despite continuing increases in atmospheric levels of greenhouse gases, and in the total heat content of the ocean, global-mean temperatures at the surface of the planet and in the troposphere (the lowest portion of Earth's atmosphere) have shown relatively little warming since 1998. This so-called 'slow-down' or 'hiatus' has received considerable scientific, political and popular attention. The volcanic contribution to the 'slow-down' is the subject of a new paper appearing in the Feb. 23 edition of the journal *Nature Geoscience.*

Volcanic eruptions inject sulfur dioxide gas into the atmosphere. If the eruptions are large enough to add sulfur dioxide to the stratosphere (the atmospheric layer above the troposphere), the gas forms tiny droplets of sulfuric acid, also known as "volcanic aerosols." These droplets reflect some portion of the incoming sunlight back into space, cooling Earth's surface and the lower atmosphere.

"In the last decade, the amount of volcanic aerosol in the stratosphere has increased, so more sunlight is being reflected back into space," said Lawrence Livermore climate scientist Benjamin Santer, who serves as lead author of the study. "This has created a natural cooling of the planet and has partly offset the increase in surface and atmospheric temperatures due to human influence."

From 2000-2012, emissions of greenhouse gases into the atmosphere have increased -- as they have done since the Industrial Revolution. This human-induced change typically causes the troposphere to warm and the stratosphere to cool. In contrast, large volcanic eruptions cool the troposphere and warm the stratosphere. The

researchers report that early 21st century volcanic eruptions have contributed to this recent "warming hiatus," and that most climate models have not accurately accounted for this effect.

"The recent slow-down in observed surface and tropospheric warming is a fascinating detective story," Santer said. "There is not a single culprit, as some scientists have claimed. Multiple factors are implicated. One is the temporary cooling effect of internal climate noise. Other factors are the external cooling influences of 21st century volcanic activity, an unusually low and long minimum in the last solar cycle, and an uptick in Chinese emissions of sulfur dioxide.

"The real scientific challenge is to obtain hard quantitative estimates of the contributions of each of these factors to the slow-down."

The researchers performed two different statistical tests to determine whether recent volcanic eruptions have cooling effects that can be distinguished from the intrinsic variability of the climate. The team found evidence for significant correlations between volcanic aerosol observations and satellite-based estimates of lower tropospheric temperatures as well as the sunlight reflected back to space by the aerosol particles.

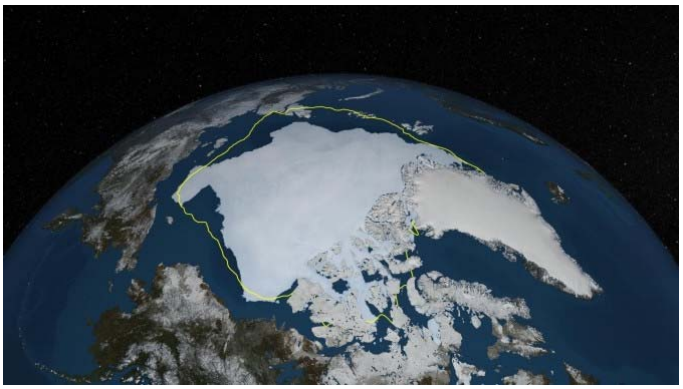
"This is the most comprehensive observational evaluation of the role of volcanic activity on climate in the early part of the 21st century," said co-author Susan Solomon, the Ellen Swallow Richards professor of atmospheric chemistry and climate science at MIT. "We assess the contributions of volcanoes on temperatures in the troposphere -- the lowest layer of the atmosphere -- and find they've certainly played some role in keeping Earth cooler."

The research is funded by the Department of Energy's Office of Biological and Environmental Science in the Office of Science. The research involved a large, interdisciplinary team of researchers with expertise in climate modeling, satellite data, stratospheric dynamics and volcanic effects on climate, model evaluation and computer science.

Story Source: The above story is based on materials provided by DOE/Lawrence Livermore National Laboratory and ScienceDaily, February 24, 2014.

Journal Reference: Benjamin D. Santer, Céline Bonfils, Jeffrey F. Painter, Mark D. Zelinka, Carl Mears, Susan Solomon, Gavin A. Schmidt, John C. Fyfe, Jason N. S. Cole, Larissa Nazarenko, Karl E. Taylor, Frank J. Wentz. **Volcanic contribution to decadal changes in tropospheric temperature**. *Nature Geoscience*, 2014; DOI: 10.1038/ngeo2098

NASA satellites see Arctic surface darkening faster



This image shows a visualization of Arctic sea ice cover on Sept. 12, 2013, with a yellow line showing the 30-year average minimum extent. A new study shows that the magnitude of surface darkening in the Arctic (due to the retreat of sea ice) is twice as large as that found in previous studies. Credit: NASA Goddard's Scientific Visualization Studio/Cindy Starr

The retreat of sea ice in the Arctic Ocean is diminishing Earth's albedo, or reflectivity, by an amount considerably larger than previously estimated, according to a new study that uses data from instruments that fly aboard several NASA satellites.

The study, conducted by researchers at Scripps Institution of Oceanography, at the University of California, San Diego, uses data from the Clouds and Earth's Radiant Energy System, or CERES, instrument. There are CERES instruments aboard NASA's Tropical Rainfall Measurement Mission, or TRMM, satellite, Terra, Aqua and NASA-NOAA's Suomi National Polar-orbiting Partnership (Suomi NPP) satellites. The first CERES instrument was launched in December of 1997 aboard TRMM.

As the sea ice melts, its white reflective surface is replaced by a relatively dark ocean surface. This diminishes the amount of sunlight being reflected back to space, causing Earth to absorb an increasing amount of solar energy.

The Arctic has warmed by 3.6 F (2 C) since the 1970s. The summer minimum Arctic sea ice extent has decreased by 40 percent during the same time period. These factors have decreased the region's albedo, or the fraction of incoming light that Earth reflects back into space -- a change that the CERES instruments are able to measure.

Scripps graduate student Kristina Pistone and climate scientists Ian Eisenman and Veerabhadran Ramanathan used satellite measurements to calculate Arctic albedo changes associated with the changing sea ice cover. Albedo is measured as a percentage. A perfectly black surface has an albedo of zero percent and a perfectly white surface has an albedo of 100 percent. The albedo of fresh snow is typically between 80 and 90 percent whereas the albedo of the ocean surface is less than 20

percent. Clouds and other factors, like aerosols and black carbon, also influence the albedo of Earth.

The researchers calculated that the overall albedo of the Arctic region fell from 52 percent to 48 percent between 1979 and 2011. The magnitude of surface darkening is twice as large as that found in previous studies. They also compared their results to model simulations to assess the capability of computer models to portray and forecast albedo changes.

Previous studies have used a combination of computer models and observations in their calculations to estimate how much extra energy has been absorbed by the oceans. In contrast, the Scripps team opted to directly correlate albedo measurements made by NASA's CERES instrument data with observations of sea ice extent made by the Special Sensor Microwave Imager (SSM/I) radiometers aboard Defense Meteorological Satellite Program satellites. This approach avoided the possibility of systematic issues in computer models.

"It's fairly intuitive to expect that replacing white, reflective sea ice with a dark ocean surface would increase the amount of solar heating," said Pistone. "We used actual satellite measurements of both albedo and sea ice in the region to verify this and to quantify how much extra heat the region has absorbed due to the ice loss. It was quite encouraging to see how well the two datasets -- which come from two independent satellite instruments -- agreed with each other."

The National Science Foundation-funded study appears in the journal *Proceedings of the National Academy of Sciences* 45 years after atmospheric scientists Mikhail Budyko and William Sellers hypothesized that the Arctic would amplify global warming as sea ice melted.

"Scientists have talked about Arctic melting and albedo decrease for nearly 50 years," said Ramanathan, a distinguished professor of climate and atmospheric sciences at Scripps who has previously conducted similar research on the global dimming effects of aerosols. "This is the first time this darkening effect has been documented on the scale of the entire Arctic."

Eisenman, an assistant professor of climate dynamics, said that the results of the study show that the heating resulting from albedo changes caused by Arctic sea ice retreat is "quite large." Averaged over the entire globe, it's one-fourth as large as the heating caused by increasing atmospheric CO_2 concentrations during the same period.

The NASA dataset used in this study consists of a merging of CERES data and measurements from the *Moderate Resolution Imaging Spectroradiometer* (MODIS) instrument, which flies on two of the same satellites as CERES -- namely the Terra and Aqua satellites. MODIS is able to distinguish between clouds and sea ice, which have similar brightness. This capability helps improve the accuracy of the CERES albedo readings, said Norman Loeb, CERES principal investigator.

"By exploiting the unique capabilities of simultaneous CERES and MODIS measurements, the NASA satellite data enable studies on how albedo is changing with unprecedented detail and accuracy," said Loeb.

For more information about NASA's CERES instrument, visit: http://ceres.larc.nasa.gov/

Story Source: The above story is based on materials provided by NASA and ScienceDaily, February 19, 2014

Journal Reference: K. Pistone, I. Eisenman, V. Ramanathan. **Observational determination of albedo decrease caused by vanishing Arctic sea ice**. *Proceedings of the National Academy of Sciences*, 2014; DOI: 10.1073/pnas.1318201111

Pinwheel 'living' crystals and the origin of life

Simply making nanoparticles spin coaxes them to arrange themselves into what University of Michigan researchers call 'living rotating crystals' that could serve as a nanopump. They may also, incidentally, shed light on the origin of life itself.

The researchers refer to the crystals as 'living' because they, in a sense, take on a life of their own from very simple rules.

Sharon Glotzer, the Stuart W. Churchill Collegiate Professor of Chemical Engineering, and her team found that when they spun individual nanoparticles in a simulation -- some clockwise and some counterclockwise -- the particles self-assembled into an intricate architecture.

The team discovered the behavior while investigating methods to make particles self-assemble -- one of the major challenges in nanotechnology -- without complicated procedures. When the pieces are a thousand times smaller than a grain of sand, normal techniques for building structures are no longer effective.

For this reason, researchers like Glotzer are exploring ways to make order develop naturally from disorder, much like what may have occurred at the very beginnings of life.

"If we can understand that, not only can we begin to imagine new ways to make materials and devices, but also we may begin to understand how the first living structures emerged from a soup of chemicals," said Glotzer, who is also a professor of materials science and engineering, macromolecular science and engineering, physics, and applied physics.

"One way biology approaches the challenge of assembly is by constantly feeding building blocks with energy. So, that's what we did with nanoparticles."

Recently, researchers in the field have found that if particles are given energy for some basic motion, such as moving in one direction, they can begin to influence one another, forming groups. Glotzer's team looked at what would happen if the particles all were made to rotate.

"They organize themselves," said Daphne Klotsa, a research fellow in Glotzer's lab. "They developed collective dynamics that we couldn't have foreseen."

The team's computer simulation can be imagined as two sets of pinwheels on an air hockey table. The air pushing up from the table drives some of the pinwheels clockwise, and others counterclockwise. When the pinwheels are tightly packed enough that their blades catch on one another, the team found that they begin to divide themselves into clockwise and counter-clockwise spinners -- a self-organizing behavior known among researchers as phase separation.

"The important finding here is that we get phase separation without real attraction," Klotsa said.

She calls the self-sorting counterintuitive because no direct forces push the same -- spin pinwheels together or push opposite-spinners apart.

The separation occurs because of the way the pinwheel blades collide. While a pair of pinwheels may be spinning in the same direction, where their blades might meet, they're actually moving in opposite directions. This means that the blades will push into one another and stick together, causing the pair of pinwheels to rotate as one, at least briefly.

In contrast, the blades of opposite spinners are moving in the same direction where they meet, so they don't stick together. Since same-spinning pinwheels spend more time linked up, they gradually accumulate into groups.

When the pinwheels divide into clockwise and counterclockwise tribes, the boundary between the groups becomes a thoroughfare for particles in the mix that aren't spinning. The blades at the boundary push these nonspinning particles along the border, making them less likely to dive back into the denser collections of pinwheels. The team said this phenomenon could potentially be harnessed as a sort of nanopump to transport objects in a device.

While the computer simulations were in two dimensions, as though on a flat surface, the team anticipates that rotating particles could also grow into 'living,' three-dimensional crystals. The particles would be free to turn their spin axes in any direction, so they could eventually form a 3D liquid crystal with aligned axes.

The results appeared online in this week's issue of *Physical Review Letters* and will be presented at a March 6 meeting of the American Physical Society. This work was funded by the U.S. Department of Energy.

Story Source: The above story is based on materials provided by University of Michigan and ScienceDaily, February 24, 2014.

Journal Reference: Nguyen H. P. Nguyen, Daphne Klotsa, Michael Engel, Sharon C. Glotzer. **Emergent Collective Phenomena in a Mixture of Hard Shapes through Active Rotation**. *Physical Review Letters*, 2014; 112 (7) DOI: 10.1103/PhysRevLett.112.075701

New insights into origin of birds focuses on key characteristics that preceded flight: Body size, forelimb length

The key characteristics of birds which allow them to fly -- their wings and their small size -- arose much earlier than previously thought, according to new research from the Universities of Bristol and Sheffield into the Paraves, the first birds and their closest dinosaurian relatives which lived 160 to 120 million years ago.

Mark Puttick and colleagues investigated the rates of evolution of the two key characteristics that preceded flight: body size and forelimb length. In order to fly, hulking meat-eating dinosaurs had to shrink in size and grow much longer arms to support their feathered wings.

"We were really surprised to discover that the key size shifts happened at the same time, at the origin of Paraves," said Mr. Puttick of Bristol's School of Earth Sciences. "This was at least 20 million years before the first bird, the famous *Archaeopteryx*, and it shows that flight in birds arose through several evolutionary steps."

Being small and light is important for a flyer, and it now seems a whole group of dozens of little dinosaurs were lightweight and had wings of one sort or another. Most were gliders or parachutists, spreading their feathered wings, but not flapping them.

Ruby Throated Hummingbird in flight. Being small and light is important for a flyer, and it now seems a whole group of dozens of little dinosaurs were lightweight and had wings of one sort or another. Most were gliders or parachutists, spreading their feathered wings, but not flapping them; Credit: © gregg williams / Fotolia

"Out of all these flappers and gliders, only the birds seem to have been capable of powered flight," said co-author Mike Benton, Professor of Vertebrate Paleontology at Bristol.

"But you wouldn't have picked out *Archaeopteryx* as the founder of a remarkable new group."

The study applied new numerical methods that calculate the rate of evolution of different characteristics across a whole evolutionary tree, and identify where bursts of fast evolution occurred.

"Up to now you could only have guessed roughly where the major evolutionary transitions occurred," said Dr Gavin Thomas of the University of Sheffield, "but the new methods pinpoint the size changes. The small size of birds and their long wings originated long before birds themselves did."

Birds owe their success to their flight, wings and feathers. Until the 1990s, when the first feathered dinosaurs were found in China, birds were thought to have originated rapidly, marking a major transition from dinosaurs. Now, we know that *Archaeopteryx* was only one of a large number of small, flying dinosaurs.

"The origin of birds used to be seen as a rapid transition," said Mark Puttick, "but now we know that the key characteristics we associate with them arose much earlier."

Story Source: The above story is based on materials provided by University of Bristol and ScienceDaily, February 23, 2014.

Journal Reference: Mark N. Puttick, Gavin H. Thomas, Michael J. Benton. **HIGH RATES OF EVOLUTION PRECEDED THE ORIGIN OF BIRDS**. *Evolution*, 2014; DOI: 10.1111/evo.12363

How Earth might have looked: How a failed Saharan Atlantic Ocean rift zone sculped Africa's margin

Break-up of the supercontinent Gondwana about 130 Million years ago could have lead to a completely different shape of the African and South American continent with an ocean south of today's Sahara desert, as geoscientists from the University of Sydney and the GFZ German Research Centre for Geosciences have shown through the use of sophisticated plate tectonic and three-dimensional numerical modeling.

The study highlights the importance of rift orientation relative to extension direction as key factor deciding whether an ocean basin opens or an aborted rift basin forms in the continental interior.

For hundreds of millions of years, the southern continents of South America, Africa, Antarctica, Australia, and India were united in the supercontinent Gondwana. While the causes for Gondwana's fragmentation are still debated, it is clear that the supercontinent first split along the East African coast in a western and eastern part before separation of South America from Africa took place. Today's continental margins along the South Atlantic ocean and the subsurface graben structure of the West African Rift system in the African continent, extending from Nigeria northwards to Libya, provide key insights on the processes that shaped present-day Africa and South America.

A hypothetical model of the circum-Atlantic region at present-day, if Africa had split into two parts along the West African Rift system. Here, the north-west part of present day Africa would have moved with the South American continent, forming a "Saharan Atlantic ocean". Credit: Sascha Brune/Christian Heine

Christian Heine (University of Sydney) and Sascha Brune (GFZ) investigated why the South Atlantic part of this giant rift system evolved into an ocean basin, whereas its northern part along the West African Rift became stuck.

"Extension along the so-called South Atlantic and West African rift systems was about to split the African-South American part of Gondwana North-South into nearly equal halves, generating a South Atlantic and a Saharan Atlantic Ocean," geoscientist Sascha Brune explains. "In a dramatic plate tectonic twist, however, a competing rift along the present-day Equatorial Atlantic margins, won over the West African rift, causing it to become extinct, avoiding the break-up of the African continent and the formation of a Saharan Atlantic ocean."

The complex numerical models provide a strikingly simple explanation: the larger the angle between rift trend and extensional direction, the more force is required to maintain a rift system. The West African rift featured a nearly orthogonal orientation with respect to westward extension which required distinctly more force than its ultimately successful Equatorial Atlantic opponent.

Story Source: The above story is based on materials provided by Helmholtz Centre Potsdam - GFZ German Research Centre for Geosciences and ScienceDaily, February 28, 2014.

Journal Reference: C. Heine, S. Brune. **Oblique rifting of the Equatorial Atlantic: Why there is no Saharan Atlantic Ocean**. *Geology*, 2014; 42 (3): 211 DOI: 10.1130/G35082.1

How Could Dinosaurs Weigh Up to 80 Tons? New Research On Sauropod Gigantism

Sauropods, the largest land animals in Earth's history, are still mightily puzzling the scientists. These plant-eating dinosaurs with their long necks and small heads could reach a height of 10 meters or more and dominated all other land vertebrates in terms of size. They could weigh up to 80 tons, more than any other known land vertebrate. One question that has been intensely debated is how these giants of the animal kingdom regulated their own body temperature.

According to the calculations of the Mainz-based ecologist, the body temperature of these animals did not increase with body weight. Her estimates indicate that sauropods may have had an average body temperature of some 28 degrees Celsius. The upper limit for the body temperature that can be tolerated by vertebrate species living today is 45 degrees Celsius. The body temperatures that Griebeler postulates for the sauropods are thus well below those of today's endothermic vertebrates but consistent with those of ectothermic monitor lizards. Her calculations of sauropod body temperature take into account the relationship between the maximum rate of growth and the basal metabolic rate of an animal, whereby the latter is largely determined by body temperature.

Griebeler's work is part of a collection that brings together the results of recent research into sauropod gigantism. The gigantism of these vertebrates, unique in the history of Earth, raises many questions, such as why no other land creatures have ever achieved this size and what their bauplan, physiology, and life cycle would have been like. The collection put together by the leading open access journal *PLOS ONE* consists of 14 contributions from the fields of ecology, morphology, animal nutrition, and paleontology that all address the fundamental question of how the sauropods managed to become so extraordinarily massive.

Egg containing a titanosaur embryo, on display as part of a special exhibition at the Senckenberg Natural History Museum, Frankfurt am Main. This fossilized egg was discovered in Neuquén province, Argentina, and has an approximate diameter of 15 centimeters. (Credit: copyright Eva Maria Griebeler)

"We are pleased that this new research is freely accessible not only to other scientists, but also to sauropod fans," said PD Dr. Eva Maria Griebeler. She and Dr. Jan Werner are members of the research group "Biology of the Sauropod Dinosaurs: The Evolution of Gigantism (FOR 533)," funded by the German Research Foundation (DFG). The collection was initiated as a result of a related international conference on this subject. Both scientists from the Ecology division at the Institute of Zoology at Mainz University have been working for more than six years within this research group. They have written three of the 14 contributions in the collection.

In one article, Jan Werner and his colleague Koen Stein of the University of Bonn describe a new method of determining the density of bone tissue and juxtapose sauropod data and results extrapolated for comparable endothermic mammals. Although the bone structure and the density of certain tissues of sauropods were similar to those of today's mammals, the results do not conclusively demonstrate that sauropods were also endothermic animals. Other functional aspects, such as similar weight-bearing stresses, could have resulted in the development of convergent forms of bone tissue.

Another article looks at the reproductive biology of sauropods. Here Werner and Griebeler discuss the hypothesis that a high rate of reproduction contributed to the gigantism of the large dinosaurs. They discovered that the reproductive pattern of most dinosaurs was similar to that of modern reptiles and birds. The reproductive pattern of theropods, i.e., ancestors of the modern birds, turned out to be comparable with that of birds, prosauropods, and sauropods rather than reptiles. However, contrary to the assumptions of previous studies, the calculations of the Mainz scientists did not corroborate the hypothesis that the large dinosaurs would have laid a particularly large number of eggs. In terms of total eggs produced annually, this number could not have exceeded 200 to 400 eggs for a sauropod weighing 75 tons. Today's large sea turtles are known to lay clutches in this range.

Story Source: The above story is based on materials provided by Universität Mainz and ScienceDaily January 14, 2014.

Journal References: Eva Maria Griebeler. **Body Temperatures in Dinosaurs: What Can Growth Curves Tell Us?** *PLoS ONE*, 2013; 8 (10): e74317 DOI: 10.1371/journal.pone.0074317

Koen W. H. Stein, Jan Werner. **Preliminary Analysis of Osteocyte Lacunar Density in Long Bones of Tetrapods: All Measures Are Bigger in Sauropod Dinosaurs**. *PLoS ONE*, 2013; 8 (10): e77109 DOI: 10.1371/journal.pone.0077109

Jan Werner, Eva Maria Griebeler. **New Insights into Non-Avian Dinosaur Reproduction and Their Evolutionary and Ecological Implications: Linking Fossil Evidence to Allometries of Extant Close Relatives**. *PLoS ONE*, 2013; 8 (8): e72862 DOI: 10.1371/journal.pone.0072862

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

NCGS FIELD TRIP
Saturday May 3, 2014

"ANCIENT SUBMARINE LANDSLIDES IN A SUBMARINE CANYON FILL – THE CARMELO FORMATION AT POINT LOBOS"

Leader: Dr. Edward Clifton, US Geological Survey, Geologist Emeritus

The Carmelo Formation at Point Lobos State Reserve is a superbly exposed example of conglomerate and sandstone deposited in an early Paleogene submarine canyon. This field trip focuses on an aspect of the canyon that has been largely fill that has been largely overlooked: the influence of large submarine landslides. Too large to be readily seen in outcrop, mass failures in the Carmelo explain many of its anomalous structural and sedimentologic features. The field trip will focus on the evidence for these features and their impact on the canyon fill. We will examine evidence for large-scale exhumation of the canyon that was possibly caused by a massive slide of the canyon fill. We will explore the baffling contact with the underlying granodiorite in the southern part of the Reserve and the possibility that it resulted from a massive slide. We will see how a large slide disrupted a thick succession of canyon fill and the possible impact on strata far removed from the slide. We will consider the possibility that none of the strata exposed on the South Shore of the Reserve in place.

Please carpool share the ride and cost. We will circulate attendees list for carpooling to the meeting place. No. geologic hammer

THIS FIELD TRIP WILL BE LIMITED TO 30 PEOPLE.

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

Time & Meeting Place: May 3, 2014, 8:45 am at the Reserve entrances
Cost: $30/person includes guidebook, contribution to the Reserve;morning coffee, muffins, lunch, refreshments. No more plastic water bottle, bring your own water bottle

**********REGISTRATION FORM (Pt. Lobos Field Trip) **********

Name:_____ E-mail:_____

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

Check no./amount _____ Please indicate if you want to drive a car and the # of people ride share

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

Please mail registration with a check payable to NCGS:

Tridib Guha
5016 Gloucester Lane
Martinez, CA 94553

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

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

NCGS DINNER MEETING Wednesday May 28, 2014

6:00 PM at Orinda Masonic Center

"WHY DON'T VERTEBRATES CARE ABOUT MASS EXTINCTIONS?"

Speaker: Dr. Kevin Padian, Professor and Curator, Department of Integrative Biology and Museum of Paleontology, University of California, Berkeley

(Reservations are required by May 23, 2013, Limit 100 persons)
We are sorry but we will not be able to accommodate "walk-ins"

This is NCGS 's 70 th anniversary. Stepping out of our normal routine, the **Northern California Geological Society** is pleased to announce this *special dinner and evening* with **Dr. Kevin Padian**. For this unique event, planned for our normal monthly meeting date, but starting one-half hour early, we are planning in typical NCGS style, a **Back Forty Texas BBQ dinner consisting of Pork Ribs and BBQ Chicken, Tossed Green Salad, BBQ Beans, Fresh Corn Cobettes. For vegetarian dinners a deluxe veggie burger will be served in place of BBQ. Desert will include assorted cookies and brownies. We may be again serving wines from California specials (90 pts +).** Please also note that a vegetarian option is available if notified ahead (please see the registration form below).

Abstract:

We know that there have been five major mass extinctions in the history of life. The problem is, no one told the vertebrates. We don't have any serious evidence that terrestrial vertebrates have experienced heightened extinction rates during episodes when marine invertebrates have dropped in diversity. There is absolutely no convincing evidence for synchronicity between marine and terrestrial realms in these troubled times. But wait, it gets worse: we have no standard definition of mass extinction. So how do we know when a mass extinction has occurred? Worse than that, we don't differentiate between increases in extinction rate and drops in origination rates when it comes to changes in net diversity. So it's like not making a difference in going broke between losing your job and spending all your wages at the track. Is it any wonder we're so confused?

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

Meeting Details: Social Hour: 6:00 – 7:00 pm; Dinner: 7:00 – 8:00 pm **Presentation**: 8:00 – open
Time: May 28, 2014, 6:00 pm, Orinda Masonic Center 9 Altarinda Road, Orinda, CA. **Cost**: **$25/person**

**********REGISTRATION FORM (Dr. Kevin Padian's Dinner) **********

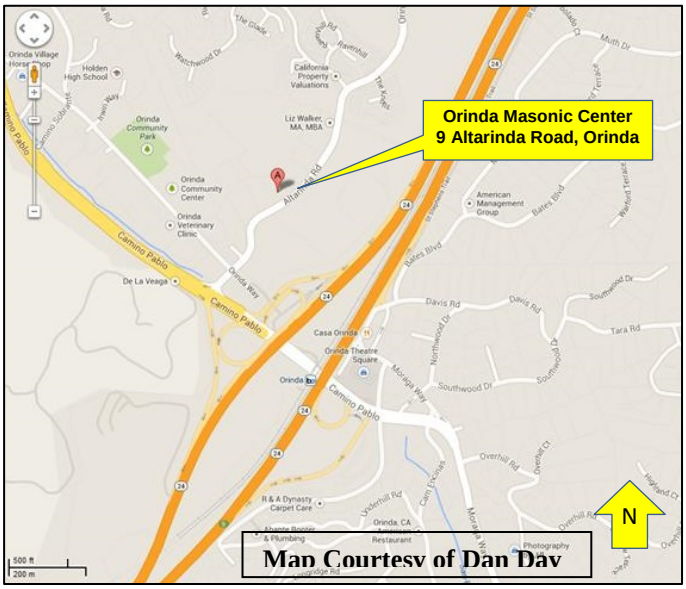
Name:_____ E-mail:_____

Phone (day):_____ Phone (cell) _____

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

Please mail a check made out to **NCGS** to: **Tridib Guha**
5016 Gloucester Lane
Martinez, CA 94553

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



Continued - Geology of the Monterey Formation of California with Comments on Recent Oilfield Developments

While it is clear that tremendous amounts of oil do remain within Monterey "shales" and diatomite, no easy way has been found to extract it. For decades operators have been using every available technique for enhancing production. This includes water flooding, steam flooding (lateral and huff-and-puff), CO2 flooding, and acidization, utilizing both vertical and horizontal injector and producing wells, some of which are fracked. There is no Monterey "Revolution", however, operators will continue to seek better ways to extract the tremendous volume of oil remaining for many years to come.

Dr. Tom Mackinnon received BA and MA degrees in Geology from the University of California at Santa Barbara in 1970 and 1975 respectively, and a Ph.D. in geology from the University of Otago, New Zealand in 1981. In New Zealand he worked on the regional geology of the Torlesse subduction complex (cf. Franciscan). From 1981 to 2008 he worked for Chevron in California, including eight years as coordinator of Chevron Stratigraphic Schools and many years working sporadically on the Monterey Formation. Tom is currently working on structural and metamorphic problems in the Eastern belt of the Franciscan Complex in Grindstone Creek, west of Willows, CA.

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

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