NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

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JANUARY MEETING ANNOUNCEMENT

DATE: **Wednesday, January 29, 2003**

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

TIME: **6:30 p.m. Social; 7:00 p.m. talk (no dinner)**
Cost is $5.00 per person

RESERVATIONS: Leave your name and phone number at 925-424-3669 or at *danday94@pacbell.net* before the meeting.

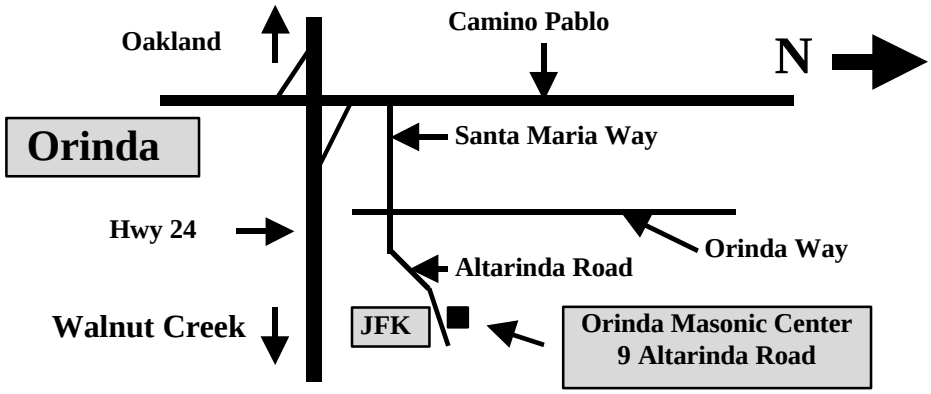
SPEAKER: **Dr. Kent Lightfoot, U.C. Berkeley**

Archaeology of the San Francisco Bay Region

This lecture will present an overview of the archaeology of the Bay Area with special focus on the impressive shell mounds which once dotted the bayshore. Produced by prehistoric hunter-gatherer peoples beginning about 5000-4000 years, these large mounds rose 3-9 meters in height and contained diverse artifacts, features, faunal remains, and hundreds of human burials.

The lecture will consider current interpretations about the use of these mounds by native peoples, and how these mounds may have played significant roles in the economic activities, social organization, and ceremonial practices of Bay Area tribal groups. The potential implications that the creation of this mounded landscape had on the ecology of San Francisco Bay will also be discussed.

Dr. Kent Lightfoot is Professor, Department of Archaeology, University of California, Berkeley, and Curator of North American Archeology at the Phoebe Hearst Museum of Anthropology, U.C. Berkeley. He received his B.A. in Anthropology from Stanford University in 1975, and his M.A. and Ph.D. degrees in Anthropology from Arizona State University in 1977 and 1981, respectively. From 1976 to 1981 he directed archaeological research along the Mogollon Rim and the Colorado Plateau, and directed surveys and excavations on eastern Long Island, New York, from 1982 to 1987. From 1988 to the present, Dr. Lightfoot has been Director of U.C. Berkeley Field Schools at Fort Elisabeth, Kauai, Hawaii and Three Saints Bay, Kodiak Island, Alaska, and continuously Director of the U.C. Berkeley Field School Program at Fort Ross State Historic Park in California. He has also been Director and Acting Director of the Archaeological Research Facility at U.C. Berkeley (1988-1992 and 1998-1999). Dr. Lightfoot's professional publications focus on culture change and ethnicity of the Fort Ross multicultural community, particularly regarding changes to the native American cultures there. Peripheral to this



are his on-going cultural archaeological studies of middle and late Holocene sites in the greater San Francisco Bay Area. One of Dr. Lightfoot's key interests is the archaeological implication of contact between cultures, with emphasis on European-native American encounters along the Pacific Rim from California to Alaska.

Would You Like To Be An AAPG Delegate?

One or two positions to be delegates from NCGS to the AAPG House of Delegates will become open July 1. The position is for three years. To consider being a delegate, you must be an AAPG member and feel that you may be able to attend the Sunday morning House meetings immediately preceding some or all of the annual AAPG meetings in 2004, 2005, and 2006.

We also have need for alternate delegates to substitute for any of our four delegates who cannot attend a given House meeting.

If you are interested, please contact **Don Lewis** at **donlewis@attbi.com** .

Northern California Geological Society
c/o Dan Day
9 Bramblewood Court
Danville, CA. 94506-1130

Would you like to receive the NCGS newsletter by e-mail? If you are not already doing so, and would like to, please contact **Dan Day** at danday94@pacbell.net to sign up for this service.

NCGS 2002-2003 Calendar

Wednesday, January 29, 2003
Dr. Kent Lightfoot, University of California Berkeley
Archeology of the San Francisco Bay Region
7 pm at Orinda Masonic Center

Wednesday, February 26, 2003
Calvin Stevens, San Jose State University
Stratigraphy of Eastern Sierra Nevada Roof Pendants and Their Relation to the White-Inyo Range
7 pm at Orinda Masonic Center

Wednesday, March 26, 2003
Dr. Constanze Weyhenmeyer, Lawrence Livermore National Laboratory
Reconstructing Paleoclimates using Groundwater Isotopes, Ice Cores, and Stalagmites
7 pm at Orinda Masonic Center

March 31-April 11, 2003 **AAPG Distinguished Lecture (tentative; exact date to be announced)**
Cindy Yielding, British Petroleum
The History of a New Play: Thunder Horse Discovery, Deepwater Gulf of Mexico
Location and time to be announced

Wednesday, April 30, 2003
Dr. Morgan Sullivan, California State University, Chico
Sequence Stratigraphy of the Ridge Basin, California
7 pm at Orinda Masonic Center

Wednesday, May 28, 2003
Dr. Ian Carmichael, University of California Berkeley
Topic to be announced
7 pm at Orinda Masonic Center

Wednesday, June 25, 2003
Carol Prentice, USGS, Menlo Park, CA.
***San Andreas Fault* (Exact title to be announced)**
7 pm at Orinda Masonic Center

Upcoming Field Trips…

Rogers Creek/Maacama Fault Zones	Bob McLaughlin, USGS	Spring 2003 (TBA)
January 11, 2003	Trip to see the Bay Model, Sausalito	See details in newsletter
February 22, 2003	Field Trip to Northbrae Rhyolite, Berkeley	See details in newsletter

Bay Area Geophysical Society

- Stanford Professor **Mark Zoback**, will discuss launching a major earthquake drilling project along the San Andreas fault.

  Set for **January 23, 2002**. Meeting location, time, and other specifics will be announced on the BAGS website. Please see: **http://news-service.stanford.edu/news/july10/pilothole-a.html** for details of Mark's talk.

- University of Houston Professor **Art Weglein**, will talk about multiples and imaging. Exact subject and title TBA. Set for Tuesday **March 11, 2003**.

Please check the BAGS website **http://sepwww.stanford.edu/bags/** *regularly for meeting notices and updates.*

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

San Francisco Bay-Delta Tidal Hydraulic Model

Saturday, January 11, 2003 at 1:30 p.m.

Trip Leader:
Robert Stevenson, Geologist, U.S. Army Corps of Engineers

Robert Stevenson is a geologist who has worked in national parks throughout the West, including Alaska. He currently is work for the Army Corps of Engineers in the educational programs of the Bay Model. He will take us on a tour of the Bay-Delta Tidal Hydraulic Model and demonstrate the impacts anticipated within the Bay if there was an oil spill. The Corps of Engineers first constructed the Model in 1956-57, later expanding it to include the delta in 1966-69, and more recently adapted a computerized monitoring system. The Model is a scientific engineering tool that reproduces water levels, flow patterns and salinity distributions in the Bay and Delta. Experiments are run with the model to study impacts from deepening or realignment of navigation channels, effects from potential oil spills, airport expansion, etc.

The Model, representing 343 square miles of bay, river, ocean and upland, is contained in a two-acre warehouse located where some of the WWII Liberty Ships were built. The physically scaled limits of the 320 feet (N-S) by 400 feet (E-W) Model encompass the Pacific Ocean extending 17 miles beyond the Golden Gate, San Francisco Bay, San Pablo Bay, Suisun Bay, and all of the Sacramento-San Joaquin Delta to Verona, 17 miles north of Sacramento on the north, and to Vernalis, 32 miles south of Stockton on the San Joaquin River on the south. Ship channels, rivers, creeks, sloughs, canals in the Delta, fills, major wharves, piers, slips, dikes bridges and breakwaters have been reproduced (and sometimes reorientation to fit in the building). The Model was calibrated to compensate for the hydraulic effects of the physical scale and orientation. The Model was constructed using 286 12 ft by 12 ft concrete slabs, individually supported on adjustable screws at each corner. It is able to simulate freshwater flows down Delta rivers to the Bay, where the water mixes with saltwater from ocean tides before emptying into the Pacific.

*(Partially excerpted from **"San Francisco Bay-Delta Tidal Hydraulic Mode, User's Manual" and "San Francisco Bay-Delta Model Map and Self-Guided Tour"** by the US Army Corps of Engineers.)*
You can see more of their work at ***http://www.spn.usace.army.mil/bmvc/bmvcinfo.htm***

Logistics: **Saturday, January 11, 2003** Meet at **1:15 pm** in front of the main entrance to the Bay Model. Though the address is 2100 Bridgeway; Sausalito, the building containing the model and visitor center is not on Bridgeway, but between Marinship Way and the waterfront. The visitor's entrance is located at the front of the building on the waterfront. There is plenty of parking.
Tour with oil spill demo starts at 1:30pm. Plan on 2-1/2 hours for tour and demo, with extra time to look at other displays (Liberty Ship construction, visitor center, etc.) on your own.

Map: Maps that show the location of the Bay Model from the ABAG and the ACoE are attached.

Cost: $7 for adults **(18 and over, includes donation);** free for adolescents and children **(under 18).**

********** REGISTRATION FORM --- PLEASE RSVP by Tuesday, January 7, 2003 **********

Name _____ _____

Address (Street/City/Zip)_____**Phone (day)**

_____

Phone (evening) _____ **E-mail or Fax No.** _____

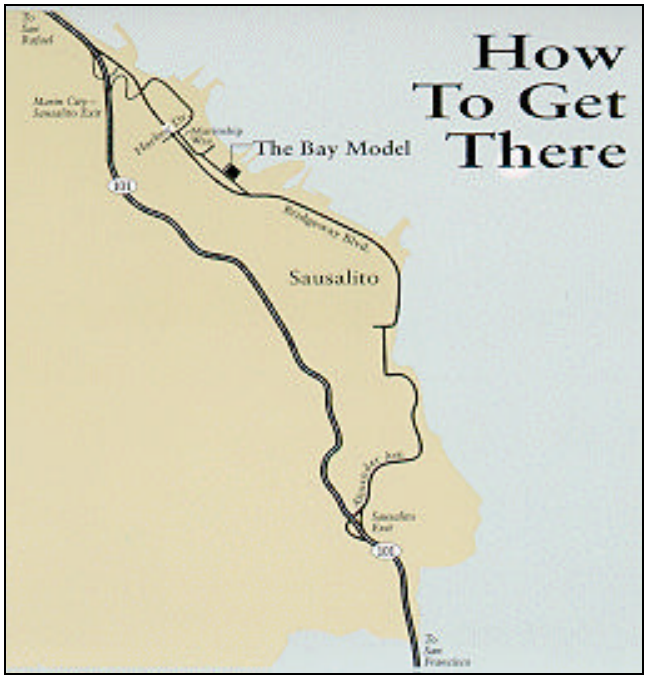
Indicate if you are a nonmember: _____

Please mail form and a check made out to NCGS by **January 7, 2003** to: **Jean Moran, P.O. Box 1861, Sausalito, CA 94966**
If you have any questions or need information, e-mail Jean at **jeanm@stetsonengineers.com** or call **415-331-6806** (evening)

If you are driving, follow Highway 101 to the **Sausalito - Marin City** exit. Follow the signs to Sausalito until you are driving towards downtown Sausalito on Bridgeway. Look for small brown and white **Bay Model** direction signs. Turn left on Harbor, then almost immediately turn right on Marinship Way and follow the signs to the Bay Model.

The building containing the model and visitor center is not on Bridgeway, but between Marinship Way and the waterfront. The visitor's entrance is located at the front of the building on the waterfront.

San Francisco Bay Model Visitor Center
2100 Bridgeway
Sausalito, CA 94965-1764
(415) 332-3870 (recorded message), (415) 332-3871 (office)



If you need additional directions to the Bay Model, please call the main office at 415-332-3871

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

Northbrae Rhyolite
Berkeley Hills

Saturday, February 22, 2003

Trip Leader:
Lin Murphy

In 1914, Andrew Lawson described the Northbrae as a Pliocene volcanic flow. Since then, the Northbrae has been repeatedly reinterpreted and is currently mapped as that part of the Jurassic Coast Range Ophiolite known as the Leona Rhyolite. Though now mapped as one unit, the widespread Leona and the aerially restricted Northbrae are distinguished from each other by their petrology, geochemistry, and morphology. Recent dating indicates that the Northbrae is a Late Miocene flow.

The geochemistry of the Leona Rhyolite shows a flat REE signature, similar to the keratophyres of the Coast Range Ophiolite. The Northbrae exhibits light REE enrichment and a negative Eu anomaly. In discrimination diagrams, the Northbrae plots as an within plate granite, whereas the Leona plots as a volcanic arc. The Northbrae formed as a glass flow or dome: it exhibits flowbanding, autobrecciated clasts, relict spherulites, and a microcrystalline matrix. The Leona contains no flowbanding or autobrecciation. Northbrae (and the related Cragmont Rock) exhibits silicification textures; Leona does not. In outcrop, Northbrae surfaces are frequently rounded, with some extremely polished areas. Leona outcrops, in contrast, are jagged, rough, and fractured. This research suggests that the Leona and the Northbrae Rhyolites have different petrogeneses and that they are distinct rock units.

In 2000, Murphy presented a hypothesis that explained Northbrae's distinct lithology as an exotic block within the Franciscan Complex or the Coast Range Ophiolite. In Spring 2002, zircons collected from the Northbrae gave a Late Miocene age (11.5 Ma) for its formation. This date precludes the Mesozoic exotic-block hypothesis. The Northbrae is thus a newly recognized unit of the Late Cenozoic volcanics that erupted in the wake of the northward-migrating Mendocino Triple Junction. Northbrae's rounded morphology, polished surfaces, and silicification may be explained by travel within the San Andreas fault system. The Northbrae may thus offer a new constraint on displacement within the Hayward-Calaveras fault system.

Logistics: **Saturday, February 22, 2003** Meet at **10 am** at Indian Rock Park off Marin Circle in north Berkeley. From there we will walk about the neighborhood looking at outcrops and visit Hinkle Park and Grest Stone Face Park. We will then carpool up to Cragmont Park off Euclid, south of Marin St. There is a shelter there for lunch. We will also go to Remillard Park to look at an entirely different rock, but an interesting one--a silica carbonate.

Map: Will be provided in next announcement

Cost: $15 for members, $20 nonmembers.

If you have any questions or need information, e-mail Jean at **jeanm@stetsonengineers.com** or call **415-331-6806** (evening)

Please Note:

This is a preliminary announcement meant to allow those interested to set aside February 22, 2003, for this field trip. Because the Bay Model trip is set for January 11, 2003, we would like to wait until the February newsletter comes out to provide a registration form and lunch selections. Please contact Jean Moran, NCGS Field Trip Coordinator <u>only</u> if you need more information about the trip content and logistics. She does not want to tackle the registration for the Northbrae Trip until after the Bay Model field trip is over.

Thank you!

In Fond Memory

Three long time NCGS members passed away in 2002. The following memorials for Roger Alexander, Andy Bengtson, and Gladys Louke were kindly prepared by Don Lewis (Roger and Andy) and Monzell Louke:

The geological community lost a notable member on June 8, 2002, when **Roger Gordon Alexander, Jr.**, died after a series of increasing health problems. His upbeat attitude and concern for others never flagged through his final months, as was attested by a large group of family and friends at a memorial gathering three weeks later.

Roger was born on October 11, 1922, in New York City. The son of a West Point professor and dean, Roger grew up at the Military Academy and attended Deerfield Academy in Massachusetts, where he picked up the lifelong nickname "Botts" after a Saturday Evening Post character. He went on to Princeton University where he was a class officer and earned an AB degree in Geology in 1943. He then served his country as an officer in the 44th Infantry Division, earning Silver and Bronze Stars in Europe before leaving the service as a captain.

After the war, Roger returned to Princeton, gaining a B.S. in Geological Engineering in 1947, an M.S. in Geology in 1948, and a Ph.D. in 1951 after teaching geology for two years at Williams College. His dissertation was on the Geology of the Whitehall Area, Montana.

Although an easterner by birth and training, and retaining his gracious New England manners throughout his life, Roger had loved the West ever since a western trip when he was 16. He therefore looked west for employment and in 1951 joined the Standard Oil Company of California in Los Angeles. It didn't take him long there to meet and marry Mia Suverkrop Ramsaur, another Standard geologist. Although Mia gave up her geological career to move around the world with Roger and raise three children, her background made it easy to understand the moves and what Roger was about at work. An exhibited artist, she has chronicled their life with superb paintings.

Within a few months of starting in Los Angeles, Roger was transferred to Salt Lake City, an occurrence that hastened Mia's decision to cast her lot with Roger. In the ensuing years, Standard moved Roger to Bakersfield, Los Angeles again, Ventura, San Francisco, and Houston. In 1969, Roger began his international career when he accepted a job in Perth as Chief Geologist for West Australia Petroleum Pty (Wapet), seconded from Standard. From there, the Alexanders moved to Dhahran, where Roger was for two years Chief Geologist for Aramco, again seconded from Standard of California. In 1974, Roger returned to San Francisco, where, after a three year period as a Geological Planning Consultant, he continued his distinguished career as a Chief Geologist, this time for Chevron Overseas Petroleum Inc. Roger retained this position until his retirement in 1985.

Well-liked wherever he went, Roger was active in the geological profession at all his stops. He was president of the Intermountain Association of Petroleum Geologists in 1954, vice-president of the Coast Geological Society in Ventura in 1962, an officer in 1964 and president in 1977 of the Northern California Geological Society in San Francisco, president of the West Australia branch of the Australia Petroleum Exploration Association in 1971, and president of the Arabian section of the American Institute of Mining and Metallurgical Engineers, which served as the only professional society in Dhahran at the time.

Roger joined AAPG in 1951, reaching his golden anniversary with both Mia and AAPG in 2001. At various times, Roger was an associate editor of the Bulletin, a delegate to the House of Delegates from Northern California, on the annual meeting committees for two San Francisco conventions, an officer of the Pacific section, and presenter of papers at annual meetings and the first Pratt Conference.

Following his retirement, Roger for many years taught a popular globe-spanning petroleum geology course at the University of California in Berkeley. He assisted at some of UCB's summer field camps and was universally appreciated by the students. His background, encouraging manner, and enthusiasm drew great respect from both faculty and students.

Roger's love of young people and of teaching them not only benefited generations of Chevron and UCB geologists but also was manifested in his many years of active support of the YMCA in Berkeley. He served on many committees and the board and was presented their Legacy Award in 1999.

In addition to his ever-strong interest in geology, in teaching and in young people, Roger was a life-long birder who thoroughly enjoyed the outdoors. His greatest love, however, was Mia and their family. He leaves son Lewis and daughters Virginia and Nelle, their spouses, and seven grandchildren with myriad happy memories. They miss him and so do his geological friends. The memory of his optimism, enthusiasm, intellectual curiosity, and concern for people will be the lasting legacy of this remarkable man.

Carl Anders "Andy" Bengtson died peacefully in Walnut Creek, California, on August 16 at the age of 86. Andy was a long-time NCGS member. Born in Chicago in 1916, Andy earned a BS from Augustana College and an MS from the University of Iowa in 1940.

In 1942, while pursuing doctoral studies at the University of Chicago, Andy enlisted in the Air Force and received a Certificate in Meteorology from the University of Chicago. He then served as a Weather Officer in England throughout the war, rising to the rank of Captain. In 1946 Andy moved to California, taking a geologist job with Standard Oil Company of California (Chevron). In 1948 Andy married Edla Johnson and the couple raised two fine boys, Bruce and John, and are the proud grandparents of three granddaughters.

While with Chevron in the early 1960s in Bakersfield, Andy invented the Statistical Curvature Analysis Technique (SCAT). This methodology revolutionized dipmeter and structural interpretation within Chevron and, after Chevron allowed publication of the technique in 1980, became an industry standard. Andy authored or co-authored a dozen papers related to SCAT and gave a number of papers at geological and geophysical conventions. He retired from Chevron in 1982 after a 36 year career as a structural geologist, subsurface geologist, and seismic interpreter in California and Alaska. Andy then had a successful second career consulting in dipmeter interpretation and in the commercialization of SCAT, which is still in use around the world.

Andy Bengtson was a kind, generous, and intelligent man, devoted to his wife and family. His friends, many of whom are NCGS members, will miss his quiet and thoughtful presence and gentle good humor.

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Gladys Peyser I.ouke was born on November 1, 1922, in San Francisco, California. She passed away on August 4, 2002, in Martinez, California, after a relatively short illness with cancer.

As a young child, Gladys was fascinated with rocks and fossils, and she was an avid hiker in the Sierras with her father from an early age. She attended grammar through high school in San Francisco. She attended U.C. Berkeley (at a time when it was uncommon for young ladies to study geology), where her mentor, Dr. Nicholas Taliaferro, encouraged her to take geology and other earth science courses, and she graduated with honors in paleontology in 1943.

From 1943 to 1954, she was employed as a geologist and stratigrapher with oil companies in Louisiana and California, including Texaco Inc. and Standard Oil of California. From 1954 to 1972, she worked as a geologist or geological consultant for a number of organizations in California, including the U.S. Geological Survey, California Division of Mines and Geology, and Richfield Oil Corporation. In 1972, Gladys and her husband, Monzell, started their own professional geology and geophysical company, where they worked together until their retirement in 1995.

Gladys was a member of the Pacific Section AAPG's Committee for the Study of Lateral Faulting in California, which published a series of San Andreas fault cross-sections in the mid- I 960s; she produced the first of the twelve-section series (Louke, 1964). Her other publications include geologic maps of the Emerald Mountain (Louke, 1966) and Tehachapi quadrangles (Dibblee and Louke, 1970). She was a registered professional geologist in California (No. 638) and a member of AAPG, AAAS, GSA, SEPM, and Sigma Xi.

Gladys Louke was an academic and professional pioneer for female geoscientists in California and was among the first women to be registered as a professional geologist. She joined the Pacific Section AAPG in 1945 and was among those with the longest period of sustained membership. She was also an officer in the NCGS when the organization met in San Francisco.

She is survived by her husband, two children, and four grandchildren. Gladys was a true professional and will be sorely missed by her family and friends.

Volcanoes, Oceans, The Origin of Life… and Project Neptune

In a unique departure from conventional protocol, **Dr. John R. Delaney** of the University of Washington's School of Oceanography gave an outstanding lecture on the origin of life, and an enticing glimpse at a ground-breaking research project on the Juan de Fuca Plate. ***"Volcanoes, Oceans, and Life in the Solar System…and a Bit About Neptune"*** probed critical events associated with the genesis of life as we know it in a thoughtful, engaging lecture style embellished with remarkable computer-generated graphical effects.

Life, like a garden, requires suitable preparation for its seeds to grow. Our Solar System, and countless others like it, are potential incubators that evolved from matter discharged from exploding stars. These are the sites of nucleosynthesis. Experts date the origin of the Solar System at 4.6 billion years ago, followed by an accretionary period for planets like the earth, that lasted about 800 million years. Painstaking geochemical studies of meteorites and tiny inclusions in them have refined certain aspects of our Solar System's formative years. The groundwork was laid by NASA's lunar expeditions of the 1970's and subsequently fine-tuned by the microelectronics technological boom of the last two decades. The accretionary process allowed the earth to segregate into a metallic core, a mantle, and the outer crust, accompanied by profuse outgassing. Accretionary consolidation of matter liberated heat by mineral crystallization. But this energy source was eventually replaced by radioactive decay-generated heat, which currently maintains the terrestrial thermal gradient. Atmospheric evolution continued through Archaean times, and as the oxygen level increased, deposition of banded iron formations began about 2.5 billion years ago. Oxygen buildup in the atmosphere also drove the explosive proliferation of eucaryotic (multicellular) organisms that appeared in the fossil record 500 to 600 million years ago.

Dr. Delaney noted that the key requirements for life as we know it are an atmosphere, continuous volcanic activity (plate tectonics driven), and water. All three developed throughout the earth's evolution. The accretion of a metallic core early in its history allowed our planet to outgas its lighter volatile compounds and form a silicate-rich outer crust. As the earth cooled, water vapor condensed into oceans and the gravitational field created by the core kept vital gases from escaping into space. Radioactive heating resulted in a stable internal thermal regime that promotes additional mantle outgassing and drives the plate tectonic system. And a favorable distance from the sun helps maintain surface temperature ranges suitable for her unique life forms. It is indeed a delicate symbiosis, with all the necessary factors coming together for life to evolve.

Man's insatiable appetite for exploring the unknown reaches of the Solar System has offered additional insight into the workings of our planetary neighbors. A prime example is the large satellites of Jupiter. Io is the innermost of the four. It shows little surface cratering, but Voyager spacecraft images revealed intense sulfurous volcanic activity caused by gravitational torquing of its core by Jupiter. Many of its surface features resemble those related to active terrestrial volcanism. A little further out is Europa, a desolate ice-covered wilderness. Its surface is a complex array of icebergs and ice plates 3 to 10 km thick floating on a layer of water underlain by rock and a metallic core. The outermost moon, Callisto, has no core or atmosphere. Heavy surface cratering attests to its volcanic inactivity. The contrast between these Jovian moons begs a similar comparison between earth and her lifeless, cratered companion, the moon. A brief sojourn to the Martian surface drew attention to the incredible similarity between the Red Planet's geomorphic features and volcanic topography / aqueous drainage systems here on earth. One can only imagine that analogies exist elsewhere in space.

This technical interlude offered a perfect segue to Dr. Delaney's next topic: a philosophical discussion of how society optimizes its rate of scientific discovery. Major scientific milestones occur every few decades. Galileo's observation in 1610 that planets revolve around the sun turned the world upside-down. No other significant discoveries were made for decades as the Roman Catholic Church wrestled with his heresy. In modern times, breakthroughs like the laser beam are often accidental, but still follow a decades-based discovery interval. Paramount to promoting frequent scientific discovery is nurturing an environment conducive to academic endeavors. One such program is **The Neptune Project**.

The Neptune Project is headquartered at the University of Washington. It is a partnership of academic, research institute, and nonprofit organizations from the U.S. and Canada with the purpose of establishing a network of fiber-optic linked underwater observatories in the northeastern Pacific Ocean. The base stations will be linked to land-based research laboratories and classrooms. Specifically targeted is the Juan de Fuca Plate off Oregon, Washington, and Victoria Island. Dr. Delaney chairs the executive team for the project, which includes representatives from Woods Hole Oceanographic Institute, Monterey Bay Aquarium Research Institute, the University of Victoria, the Jet Propulsion Laboratory in Pasadena, and the Institute for Pacific Ocean Science and Technology. Dr. Delaney's expertise is in the study of oceanographic systems. He provided examples of the ocean's influence on the carbon dioxide cycle, how it moderates climate, and how its current patterns control the mixing of CO_2 rich water near the surface with CO_2 poor water at depth. These interests blossomed with the creation of the Neptune Project, and are supplemented by those of the other partners. The Juan de Fuca Plate

encompasses a spreading ridge bounding the Pacific Plate to the west, and is being subducted beneath the North American Plate to the east. Its small size and access to both plate spreading and subduction processes over relatively short distances make it an ideal choice for this kind of project. The project has been actively involved with mapping the ocean floor, characterizing spreading center volcanism, and monitoring plate seismic activity. The broader scale scheme will involve fiber optic cable linkage of remote experimental sites capable of real-time, high speed monitoring of water temperature, water chemistry, seismicity, and other key parameters. Underwater research stations accessible by submarine transporters are also planned. Ultimately, the Project will include science and engineering firms, corporate members, educational facilities, and government interests.

The program currently has several ROV's (remote oceanographic vessels) and AUV's (autonomous underwater vehicles) for exploring the seafloor. Their exploits include detailed mapping of the Juan de Fuca spreading ridge crest and precise sampling of "hot smokers," iron and zinc sulfide-rich columns rising off the ridge floor and channeling 350ºC hydrothermal solutions into 2ºC bottom water. The vents support an amazingly diverse community of microorganisms and more complex tubeworm, clam, and crab colonies. The microorganisms are of biological interest because they include primitive single-celled Archaea and Extremophiles (high temperature microbes). The deep sea hydrothermal vent communities were discovered in the late 1970's. The microbiological communities are a more recent find that benefited from ROV/AUV technology that allowed scientists to retrieve portions of the smokers intact. The pharmaceutical research potential of these microbes alone is staggering, since many of these organisms have never been characterized. Researchers are planning to core drill the smokers in situ and insert incubators to colonize the microbes and allow easy sampling. Ore genesis is another intriguing aspect of this study, since many terrestrial sulfide ore deposits are now thought to have been formed in such environments. All these activities lend themselves to computer analysis and integration into a large-scale model of the Juan de Fuca Plate.

Dr. John Delaney of Project Neptune and the University of Washington deserves our deepest thanks for a splendid talk on the origin of life, ocean floor volcanism, and current hydrothermal activity along the earth's ocean spreading ridges. Interwoven with this story is a novel new concept of oceanographic research that uses current technology to establish a fiber optic cable linked seafloor station network to study biological, oceanographic, and tectonic processes on the Juan de Fuca Plate. If Dr. Delaney's visionary plans can be funded, the Neptune Project will undoubtedly revolutionize submarine exploration and significantly broaden our knowledge of plate tectonic processes and life forms flourishing at spreading ridges. His Distinguished Lecture also broke group by using a computer projection system to display actual submarine video footage of smokers from the Juan de Fuca Ridge and clever animated graphics clips to illustrate several of his points. For those interested in more information about the Neptune Project, please go to the website **http://www.neptune.washington.edu**.

Forensic Seismology and the Comprehensive Test Ban Treaty

The guest speaker at the November 20th NCGS meeting was **Dr. John "Jay" Zucca** of Lawrence Livermore National Laboratory. Jay has spent most of his career at LLNL working with top researchers to implement a seismology program to verify global compliance with the Comprehensive Test Ban Treaty. ***"Forensic Seismology Supports the Comprehensive Test Ban Treaty"*** gave NCGS listeners the details of this formidable challenge and how scientists are surmounting the hurdles that must be overcome to accomplish their goal.

The role that Jay and hid colleagues played in this project was to engineer hardware and software for government agencies to monitor nuclear testing worldwide and enforce compliance to the treaty. Research facilities involved with this study include LLNL, Sandia National Laboratories, and the Pacific Northwest Laboratory. The end users are a consortium of government agencies and commercial interests represented by the Department of Defense (DOD), the U.S. Air Force, the Department of Energy (funding agency), the USGS, members of the private sector, and international entities. On a national scale, the policy requirements will involve Presidential direction, oversight by a national technical means committee, and operation through the National Data Center. Each segment of this directive will necessitate detailed documentation at both the policy-making and data acquisition levels.

Technically, underground nuclear blasts are confined explosions that produce waveforms dominated by compressive (pressure) or P-waves. Earthquakes, the other source type that would be equivalent in magnitude to a nuclear detonation, produce waveforms involving P-waves and S-waves or shear waves. The latter travel through the earth's crust more slowly than P-waves and produce a dual waveform signature that differs from that made by an underground explosion. In either case, differences in arrival time at seismic stations can be used to triangulate the source. The traditional global teleseismic networks were used to locate large (>magnitude 4) seismic events. The seismic networks were spaced at distances >2000 km apart, the solution models assumed a very simple earth structural model, and the seismograms were simple. For Comprehensive Test Ban Treaty (CTBT) compliance, researchers were forced

to work on a regional scale at distances of less than 2000 km and Richter magnitudes of less than 4. Now regional geologic complexities must be considered in the seismic models and the seismograms become more complex. The major challenge facing seismologists is correcting arrival time models to account for the regional geologic features, which can alter wave velocities by a factor of 2 or 3. Accurate source location now demands more a precise crustal velocity model and a means of distinguishing earthquake seismicity from explosive events.

Accurate seismic location demands that an immense amount of geological data be incorporated into the regional seismic velocity model. This information is often available on the internet, or it can be supplied by other scientists in the international seismic community, from oil company data, or from academic researchers working in the area. Oftentimes local seismologists can provide vital modeling information in exchange for seismic data pertinent to their research (data swapping). The second stage of the process involves discriminating unwanted events like low magnitude earthquakes and mining explosions from nuclear detonations. This essentially involves waveform pattern recognition achieved through sophisticated software techniques. The latter can break down and identify waveform characteristics so the statistical overlap between earthquakes and explosion-generated populations is acceptable. A rigorous statistical method for correcting geophysical data to accurately pinpoint source locations is kriging. Kriging is also used in other geoscience applications, such as groundwater hydrogeology, to fit trend surfaces or to contour scattered data points. Another statistical technique employed by regional seismologists is biasing. In this case, the subsurface geology is poorly known, but the model can be statistically corrected using algorithms to fit the empirical results (ground truth).

Both empirical corrections and modeling corrections can give results close to actual observations, and can be successfully used to model the geophysical behavior of a region. Waveform discrimination to filter unwanted data can be used to reduce the error of either missing an event or erroneously reporting one to a probability of less than 10%. The true test of these models is validation using actual recorded seismic events. An area used for performance verification is the Caucasus Mountains between southern Russia and Turkey. Nestled in these mountains are the former Soviet republics of Georgia, Armenia, and Azerbaijan. This region has added importance because of close proximity to Iraq and Iran. This is therefore a key compliance zone that has fortuitously been well studied because of its active seismicity and its petroleum resources. The objective was to locate a seismic source to an accuracy of 15 km. Aftershocks of the 1991 earthquake in Racha, Georgia, were modeled, and the event epicenters were very accurately determined.

This success does not mean that all regions can be adequately characterized. However, supplemental information in remote or hostile regions can be acquired using satellite technologies like InSAR (interferometric satellite radar). Satellite imaging can map out very small changes in elevation to an accuracy of less than 1 centimeter. Jay illustrated this technology with images of the Solvay Mine in Wyoming, which produced a magnitude 5 seismic event when a collapse occurred on February 3, 1995. The seismic activity can thus be correlated with a surface phenomenon and identified as a man-made event. This is important, because mine collapses are indistinguishable from an explosive event. InSAR has also been used to track land subsidence associated with underground testing at the Nevada Test Site.

Another possible nuclear test method would be underwater detonations. To detect these events, the consortium has developed hydro-acoustic monitoring devices and tested them off remote Ascencion Island in the South Pacific. Researchers imploded glass fishing floats to simulate explosions. This program is in its infancy, and represents just another challenge that must be met to develop a long term CTBT compliance monitoring network.

Lawrence Livermore National Laboratory has played a major role in the CTBT surveillance effort. LLNL is the program's technical leader in event location, geophysical modeling, and statistical characterization. The Lab has put considerable effort into helping the end users understand this complex technology and implement it successfully. Its key contributions are to accurately identifying and locating nuclear detonation events. The political implications of false identifications are serious, as would be missing actual detonations. Right now the program needs more work on characterizing shallow and very deep earthquakes, and filtering out mine explosions from the data sets. Recognition response times of the current detection system is very fast; in a matter of 1 to 2 hours an event can be monitored, located, and identified. The seriousness of the CTBT issue is underscored by the $300 million the U.S. annually funds to ensure Russian nuclear weapons security, and the $40 million earmarked for helping former Russian weapons scientists find work in non-military disciplines.

The NCGS gives its sincerest thanks to Dr. Jay Zucca for enlightening its members on the forensic applications of seismologic technology to weapons containment and global nuclear test monitoring programs. The Lawrence Livermore National Laboratory is on the cutting edge of this research effort. Its discoveries will possibly revolutionize some aspects of regional seismic analysis. And its political implementation will help ensure a safer world. We wish Jay and his colleagues good luck with their research.

Earth and Space Science Education Setback

By: Susan Garcia. R.G., C.HG.*

The California State Board of Education issued a step backward to the Earth and Space Science community when they adopted the "Science Framework for California Public Schools, Kindergarten Through Grade Twelve," on February 6, 2002. The Science Framework "is the blueprint for reform of science curriculum, instruction, professional preparation and development, and instructional materials in this state. It outlines the implementation of the *Science Content Standards for California Public Schools* (adopted by the State Board of Education in 1998) and connects the learning of science with the fundamental skills of reading, writing, and mathematics. The Science Content Standards are a concise description of what to teach at specific grade levels, and this [the] framework extends those guidelines by providing the scientific background and classroom context."[1]

The Science Framework states that all high school students "take, at a minimum, two years of laboratory science providing fundamental knowledge in at least two of the following content strands: biology/life sciences, chemistry, and physics. **Laboratory courses in earth sciences are acceptable if they have as prerequisites (or provide basic knowledge in) biology, chemistry, or physics** [bold my emphasis]."[2] The Framework further states in a footnote that these laboratory requirements are consistent with "laboratory science subject requirement for admission to the University of California and, beginning in fall 2003, to the California State University."[3] This action relegates earth science to a second-class lab; thereby, making it more unlikely that a high school student will take an Earth Science course because he/she cannot readily use it for college entrance nor for college credit as an advanced placement course. Please note that GRA, along with many other professional organizations, sent a letter to the State Board of Education urging them to revise the wording that relegated Earth and Space Science laboratory courses to second-class status. The document was approved without modifications to the language.

Enrollment in Earth and Space Science Courses Drop

Actions, such as this, may be responsible for the drop in enrollment of high school students in Earth Science classes across the nation. According to the American Geological Institute's (AGI's) 2001 National Report on the Status of Earth Science Education, out "of the roughly13 million high school students in our nation, only 7% (860,000) will take a high school Earth and Space Science course. Contrast this with roughly 88% of students who take biology. Only two states (North Carolina and

[1] Science Framework for California Public Schools, Kindergarten Through Grade Twelve. Adopted by the State Board of Education on February 6, 2002, Subject to technical editing, p. 1.

[2] Ibid, p. 9.

[3] Ibid, p. 9, footnote 6.

Kentucky) require Earth and Space Science for graduation, and 17 states do not even consider Earth and Space Science as a standard lab science course."[4]

In addition to the decline in enrollment in high school Earth and Space Science classes, we are also seeing the decline at the college level. Fewer students are majoring in geology, which makes it a struggle for Geology Departments to preserve their funding while other departments are bursting at the seams with rising college student populations. AGI data reported in Geotimes[5], indicates that over 7000 Geology degrees were issued in the U.S. in 1983; by 1991 and 2001, this level had dropped to below 3000 and just above 2000, respectively. Masters of Science and Doctorate degrees in geology during this timeframe remained roughly between 1000 and 2000 for the MS and well below 1000 for the Ph.D.[6] The reduced interest in higher education in Earth Sciences impact the number of teachers who are being trained to instruct Earth and Space Science in high school. For example, if we compare the number of high school teachers for the sciences in 2000, we find that there were 51,048 Biology teachers, 25,931 Chemistry teachers, 15,853 Physic teachers and 14,057 Earth Science teachers.[7]

What is the Impact?

These reduced numbers of geology students and Earth and Space Science educators does not bode well to the groundwater profession and the well being of our State, or for that matter the nation. Is the next generation of groundwater professionals being trained? Can California afford not to have its residents trained in Earth and Space Science at a time when the population is soaring, our water resources are being tapped to their limits and natural geologic hazards abound? The State requires educated decision makers to address future water resource and geologic hazard issues.

What is GRA Doing?

What is GRA doing to help curtail this reduced interest in Earth and Space Science? I am aware of at least two actions by GRA in the last year and a half to help promote education in Earth and Space Sciences. One action was to support the "Revolution" resolution, which promotes Earth and Space Science education across the U.S. The other action was participation on the state-based alliance, which specifically promotes Earth and Space Science education in California.

Revolution

GRA's Board of Directors voted during their April 2002 Board meeting to support the following resolution developed by the National Conference on the Revolution in Earth and Space Science Education (Revolution) held in June 2001. This National Science

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[4] Barstow, Daniel, Editor, Blueprint for Change: Report from the National Conference on the Revolution in Earth and Space Science Education. 2001, June 21-24, Snowmass, Colorado. http://www.EarthScienceEdRevolution.org.

[5] Ridky, Robert, "Why We Need a Corps of Earth Science Educators," In Geotimes, 2002, September, pp. 16-19. http://www.geotimes.org

[6] Ibid, p. 19.

[7] Ibid, p. 19.

Foundation (NSF) funded conference was held to develop a "vision and 'blueprint' for K-12 Earth and Space Science education reform for the next decade."[8]

"As our nation deliberates on education policy and funding, we, as leading science educators and scientists, call for legislators, decision makers and stakeholders to implement all measures that support science education in general and earth and space science in particular.

Fueled by new technologies over the last 40 years, advances in Earth and space science are revolutionizing our understanding of Earth's systems and processes. This growing understanding is increasingly needed to inform political and economic decisions of local, national and global impact.

For this reason, a science-literate citizenry is vital to the nation's well being and security and will insure our nation's continued leadership in science and technology in the 21st century. To empower the public to make sound and reasoned choices, earth and space science must be taught throughout the United States in K-12 classrooms and be accessible to all students." - National Conference on the Revolution in Earth and Space Science Education, Snowmass, CO, June 2001[9]

Key recommendations from the Revolution are to:

- Establish state-based alliances to promote Earth and space science.
- Promote student learning experiences that have a stronger emphasis on inquiry-based learning, use of visualization technologies and understanding Earth as a system.
- Promote the approval at the high school level of Earth and Space Science as a lab science, with depth and rigor akin to biology, chemistry and physics.
- Create national and state professional development academies in Earth and Space Science.
- Enhance access to high-quality Earth and Space Science education for students and professional development for teachers.
- Develop a strong research program in Earth and Space Science education.

These recommendations are worthy of the support of GRA. The concept of Earth as a system is one that is most appropriate for our multidisciplinary profession. The Revolution indicates that "Understanding Earth as an integrated system of components and processes has become the dominant paradigm in Earth and Space Science research - and should become the central unifying principle in Earth and Space Science education as well. Students should not experience Earth and Space Science as a series of topics, but rather as a whole system – the interconnected geosphere, hydrosphere, atmosphere and biosphere."[10]

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[8] Barstow, Editor., 2001, p. 7

[9] Barstow, Editor, 2001, Blueprint for Change: Report from the National Conference on the Revolution in Earth and Space Science Education. Cover.

[10] Ibid, p. 13.

Funding was sought from the NSF for phase II of the Revolution, which was to create state-alliances and implement a portion of the recommendations. Due to reduced funding, the NSF denied the phase II Revolution funding in early October 2002. The Revolution is currently pursuing other sources of funding.

California Alliance for Earth and Space Science Education Formed

The California Science Teachers Association (CSTA) formed the California Alliance for Earth and Space Science Education (CAESSE) in December 2001. CSTA agreed to support CAESSE, even if NSF funding for phase II was not obtained. As a participant of the June 2001 Revolution, science teacher and GRA Board Member, I was asked to join the Steering Committee for CAESSE. On August 20, 2002, the Steering Committee met to develop its goals and to focus its energies on promoting Earth system science education within the State.

CAESSE is currently acquiring templates of Earth and Space Science laboratory courses that have been accepted by the University of California System as rigorous enough to serve as a laboratory for college entry. These templates will be promoted to other schools so that their Earth and Space Science laboratories can also be accepted.

In addition, CAESSE is examining the potential for tying Earth and Space Science content standards to specific job skills so that high school students have marketable skills that may be used toward Earth science careers. Also, by tying content standards to job skills, we may be able to access funding from the Department of Labor to help improve Earth and Space Science education by training new and existing teachers. CAESSE is expected to meet within the next quarter to further develop their mission.

What Happens Now?

GRA is in the wait and see mode. We need to determine what CAESSE will be doing in California, and how we can support their efforts. Individuals with suggestions on how CAESSE can proceed may contact me via e-mail at **ssgarcia55@cs.com** or Northern California Geological Society Past President **Don Lewis**, also on the CAESSE advisory board, at **donlewis@attbi.com**. Readers are also encouraged to visit the GRA website at **http://www.grac.org**.

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