NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

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NOVEMBER MEETING ANNOUNCEMENT

DATE: **Wednesday, November 20, 2002 (note date!)**

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. John "Jay" Zucca***, Lawrence Livermore National Laboratory

Forensic Seismology Supports the Comprehensive Test Ban Treaty

Although ratification and entry-into-force of the Comprehensive Test-Ban Treaty may not occur any time soon, nuclear test explosion moratoria remain in effect. Lawrence Livermore National Laboratory has been participating in a program to provide the U.S. Government with the tools necessary to monitor these moratoria in the primary areas of interest worldwide for the absence of nuclear test explosions. The thrust of our effort is to provide regional-wave propagation corrections to seismic event location and identification algorithms to account for regional variations in geologic structure. In association with our programmatic partners, Los Alamos and Sandia National Laboratories, we have developed two techniques to handle these variations: non-stationary Bayesian Kriging and MDAC (magnitude, distance, amplitude corrections). The kriging technique allows for smoothly varying predictions of seismic-phase travel-time and amplitude corrections along with rigorous propagation of statistical errors so that event solution uncertainties can be predicted accurately. MDAC is a systematic seismic-phase amplitude correction process that allows accurate seismic discrimination—the determination if an event is an explosion or earthquake. Krieged correction and MDAC surfaces are being implemented in the event processing pipeline at the US National Data Center for nuclear test monitoring which is located at the Patrick AFB in Florida.

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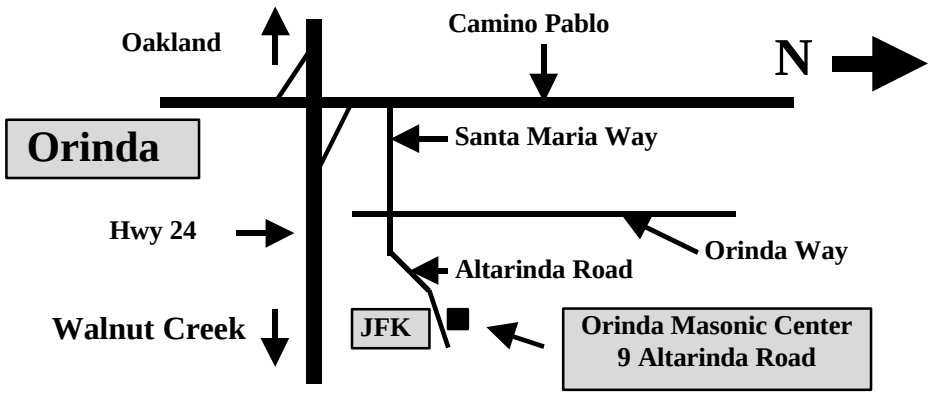
John J. (Jay) Zucca
Deputy Program Leader
Proliferation Prevention and Arms Control Program

B.S. 1976 (U.C. Santa Barbara) Geology and Mathematics
M.S. 1977 and Ph.D. 1981 (Stanford) Geophysics

Continued on back page of newsletter



Jay Zucca is a seismologist at the Lawrence Livermore National Laboratory in Livermore, California. After completing post-doctoral positions at the U.S. Geological Survey in Menlo Park and the University of Karlsruhe in Germany he went to Livermore in 1984. While at Livermore he has worked primarily on nuclear test monitoring issues concentrating on seismic instrumentation development, on-site inspection, and regional seismology. He was a member of the U.S. Delegation to the Nuclear Testing Talks (Threshold Test Ban Treaty), a member of the U.S. Delegation to the Conference on Disarmament for the Comprehensive Test Ban Treaty, and a member of the U.S. Delegation to the Preparatory Commission for the CTBT. He has also been involved with the Geothermal Program developing seismic imaging methods for geothermal resource exploration. In his current assignment he has overall responsibility for the nuclear explosion monitoring efforts and the Russian Transition Initiatives which create non-weapons jobs for former Russian weapons scientists.

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

NCGS 2002-2003 Calendar

Wednesday, November 20, 2002 **(please note: this meeting is one week earlier than normal)**
Dr. John "Jay" Zucca, *Lawrence Livermore National Laboratory*
Forensic Seismology Supports the Comprehensive Test Ban Treaty
7 pm at Orinda Masonic Center

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

Wednesday, February 26, 2003
Calvin Stevens, San Jose State University
Geology of the Mount Morrison Roof Pendant, Eastern Sierra Nevada
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.
Topic to be announced
7 pm at Orinda Masonic Center

Upcoming Field Trips…

Rogers Creek/Maacama Fault Zones	Bob McLaughlin, USGS	Spring 2003
January 11, 2003	Trip to see the Bay Area estuarine model	Details in next newsletter

Bay Area Geophysical Society

- **Jessica Murray** of Stanford University will talk about earthquake prediction.
  Set for **November 21, 2002**. ChevronTexaco, Room TBA, 6001 Bollinger Canyon Road, San Ramon
  Details of Jessica's presentation are covered in a news release posted at the Stanford University website: **http://news-service.stanford.edu/news/september25/shaky-925-a.html**

- 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 later.
  see: **http://news-service.stanford.edu/news/july10/pilothole-a.html**

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

Post-Eruptive History and Bathymetry of Crater Lake Highlights September Meeting

As Crater Lake celebrates its 100th year as a National Park, the NCGS was fortunate enough to have a nationally recognized volcanologist discuss its caldera development and filling after the explosive eruption of Mount Mazama 7700 years ago. **Dr. Charles R. Bacon** of the USGS, Menlo Park, spoke to NCGS members September 25th on ***"Volcanism in Nature's Bathtubs: The Caldera Lakes at Aniakchak and crater Lake. "***

Dr. Bacon, a member of the USGS Volcano Hazards Team, has spent much of his research time studying the evolution of Crater Lake and contrasting its development to that of other recent andesitic volcanoes in the Circum-Pacific arc. This talk specifically focused on the post-caldera Holocene history of Aniakchak volcano on the Alaskan Peninsula (Aleutian volcanic chain) as a guide for evaluating the post- caldera processes at Crater Lake. And why Aniakchak crater? Because this volcano lies about 400 miles southwest of Anchorage along major commercial air routes that could be affected by volcanic ash ejected into the atmosphere during an eruption.

Aniakchak erupted catastrophically about 3500 years ago and has exhibited much post-caldera activity. It is considered active, and consists of a 10 km-wide by 0.5 to 1.0 km deep caldera that was formed during this major eruptive event. Since then, at least a dozen vents in the caldera have erupted, spewing out tephra (ash) and lava. Aniakchak last erupted in 1931, a violent event, and although there are no current signs of impending volcanic activity, it will erupt again in the future. Soon after the 3500 year old eruption, a lake formed in the caldera depression. One side of the caldera wall failed suddenly, and the lake drained rapidly down the Aniakchak River to the ocean nearby. Various geomorphic features associated with the drainage event, including conspicuous floodplain sediments deposited by the raging torrent and large 20 meter-sized boulders scattered along its path, attest to the sheer force and quantity of water released when the lake drained. The exposed caldera floor had been intruded by shallow dacite domes and phreatic (sputtering) eruptive events occurred periodically as magma invaded groundwater-enriched layers. This well-preserved Alaskan eruptive event was used as a template by Dr. Bacon and his colleagues to interpret bathymetric features discovered on the bottom of Crater Lake, Oregon.

By comparison, the Crater Lake caldera measures 10 km. by 8 km. The 7700 year B.P. (before present) eruption scattered ash over eight states and three Canadian provinces, covering 5000 square miles with ejecta 6 inches deep! This massive series of eruptions were 42 times greater than 1980's Mount St. Helens event. The eruption demolished 12,000 foot-high Mount Mazama, a volcano that had erupted intermittently for 500,000 years. The 3000-foot deep crater left after Mazama exploded was initially too hot to hold water but eventually filled over an estimated 700 year interval with snow melt and rain-water to a constant level controlled by evaporation and seepage. Annual fluctuations in lake level are no more than 3 feet. At a depth of 1932 feet, Crater Lake is the deepest lake in the United States and the seventh deepest in the world (Lake Baikal, which fills a 400 mile long continental rift valley in southern Siberia is the deepest at slightly over 1 mile).

Fascination with Crater Lake led t o three bathymetric surveys of the lake bottom since its discovery by gold prospectors in 1853. The first survey was conducted in 1886 by William Steel during a joint USGS-U.S. Army expedition under Major Clarence Dutton. The survey was conducted using a Millers lead-line sounding machine, and the resulting map showed soundings only, and no contours. This effort was instrumental in getting Crater Lake established as a national park. The second survey was conducted in 1959 by the U.S. Coast and Geodetic Survey. It mapped the bathymetry of Crater Lake with an acoustic echo sounder using radar navigation. The contoured results are a fairly detailed map of the large-scale submarine lake features. By 1999, scientific interest in various aspects of the lake necessitated a better quality bathymetric map. High resolution multibeam mapping of the lake commenced in July, 2000, by the USGS Pacific Seafloor Mapping Project, at the request of the National Park Service. The survey boat had excellent GPS location capabilities and took 16 million soundings in 5 days. The details of this survey provide lucid evidence of volcanologic and geomorphic post-eruptive history of this landmark.

Dr. Bacon discussed in detail key features revealed by the year 2000 bathymetric survey. Wizard Island is the most prominent feature in the crater, and along with the submerged Merriam cone, reflects renewed volcanism and intrusion, some subaqueous activity, after the caldera collapsed. There are several wave-cut benches around Wizard Island and the lake perimeter that mark former climate-influenced water levels. Lava deltas emptied off the flanks of Wizard Island, and massive landslides slid off the caldera walls; the most obvious is the 300-meter wide block that avalanched into Chaski Bay. Details of former lake levels can be seen in the high resolution bathymetry. Today there are also some high heat flow regions on the lake bottom that feed brine pools and support algal mat communities. Eruption rates determined for post-caldera activity agree with rates estimated for recent island arc volcanism in the Pacific Arc, West Indies, and Indonesia. The Crater Lake caldera story has been repeated several times in the Cascade Range from Mount Lassen in northern California to southern British Columbia. A buried caldera lies hidden near Mount Baker in Oregon. Another interesting facet of Cascade Range dynamics is the paucity of subaerial volcanism compared with shallow level plutonic intrusive activity. These observations are linked to offshore subduction processes and complex plate tectonic interactions along the Pacific Northwest.

The NCGS offers its sincerest thanks to Dr. Charles Bacon for sharing his experiences exploring the Crater Lake caldera floor. His talk provided a unique perspective on one of America's most beautiful and cherished national landmarks. More information on Crater Lake and these bathymetric surveys can be found at **http://walrus.wr.usgs.gov/pacmaps/cl-index.html** and **http://www.aqd.nps.gov/grd/parks/crla/**

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Black Diamond Mines Teacher's Day Celebrates National Earth Science Week

The annual Black Diamond Mines Teacher's Day event was held on Saturday, October 12, 2002. As in past years, the NCGS and the East Bay Regional Parks District teamed up to provide the attending K-12 teachers an exciting glimpse at the geology and history of northern California's only major source of coal in the late Nineteenth Century. Teacher's Day has been held the last several years to celebrate National Earth Science Week. It provides a unique exposure to the complex geology associated with Mount Diablo, a tutorial on a moderately large scale mining operation, and a poignant look at the rich history of a major Contra Costa County population center that all but disappeared at the turn of the century.

The day began early in the morning in the underground Hazel Atlas room, a large chamber off the drifts constructed by Marvin Greathouse, who opened a mining operation at Black Diamond Mines in the 1920's to exploit the pure silica sand in the Eocene Domengine Formation as a raw material source for glass manufacturing and foundry casting molds. NCGS President Mark Detterman welcomed the teachers and gave a brief introduction to the NCGS, followed by Past President Don Lewis' discussion of the annual Teacher of the Year Award sponsored by AAPG, and our affiliation with this international petroleum geological society. Naturalist Bob Kanagaki of EBRPD followed with a discussion of the Park District's affiliation with Black Diamond Mines, noting its focus on characterizing park wild life and, largely through the singular efforts of staff member Traci Parent, its on-going attempt to unravel the detailed history of the five mining towns that were once nestled in these hills.

After these introductions, Dr. Ray Sullivan of San Francisco State University commenced his now classic discussion of the evolution of the Domengine formation, precursed by a brief discussion of the global plate tectonic scenario as the southern Pangean subcontinent Gondwanaland began to fragment in the late Mesozoic. This segued into a discussion of Bay Area geology and in particular the lower Tertiary section exposed on the northwest flank of Mount Diablo that has been conveniently bisected by Markley canyon. The sediments here trend NW-SE and dip steeply to the NE. The canyon exposes a 6000-foot section of rock beginning with the 45 million year-old Domengine Formation through the Nortonville Shale to the volcanic sand-rich Kirker Formation at 23 million years of age. The Domengine is correlated with the Ione Formation exposed in the western foothills of the Sierra Nevada Range. Both units were or are being mined for their clean silica sand and pure kaolin clay. Similarities between the two indicate a common origin. Ray displayed a map showing the reconstructed continental margin in northern California at 50 m.y. ago, and noted that the Pacific shoreline was at the Sierran foothills and that Concord, California, lay at the edge of the continental shelf. Nearly four decades of research at Black Diamond Mines have provided ray with evidence indicating that the Domengine (and Ione far to the east) was formed in an estuarine environment rather than along a coastal beach. An excellent analogy to this is the current Bay of Fundy between the Canadian maritime provinces of Nova Scotia and New Brunswick. Ray proceeded to contrast the structures exposed in the Domengine strata with similar features in the Bay of Fundy sediments. He also gave an excellent tutorial on the mechanics of estuarine sedimentation and the various features that occur in the subtidal, intratidal, and supratidal zones as a function of daily tidal fluctuations.

Next Ray discussed the coal seams located near the base of the Domengine and their historical significance. The discovery of coal in this area immediately after the 49er Gold Rush fueled a migration of coal miners to the area and the establishment of five mining communities: Somersville, Nortonville, Stewartville, West Hartley, and Judsonville. Ray, being of Welsh origin, has a particular interest in this area, which was inhabited largely by Welsh miners. His slides tell the story of how the Welsh constructed their coal mines and transported the coal to the surface. Some also speak of mining tragedies and the tough lives of the miners. Once mining died out at the turn of the century, the area reverted back to ranching and the mining towns were abandoned.

Following this geological and mining introduction, the group set off with EBRPD mining experts to explore the well-engineered tunnels left by the sand mining operations. The tunnel walls provided textbook examples of sedimentary features that Ray uses to illustrate his paleoenvironmental reconstruction of the estuarine Domengine sand units. After the mine tour, the hungry participants and their leaders convened in the picnic area for lunch—a delicious chicken and salmon barbecue prepared by NCGS Past President Tridib Guha, assisted by Treasurer

Phil Reed and Newsletter editor Dan Day. We have repeatedly mentioned the popularity of this repast with all who have attended past Teacher's Day functions. Suffice it to say that most people would agree that Tridib's legendary barbecue prowess grows with each event! Hardly a morsel was left after the meal.

The well-fed teachers then took to the road with Park historian Traci Parent, who led them to Rose Hill Cemetery. This historical burial ground contains much information about the coal mining communities. And Traci has also done an admirable job searching through newspaper archives to help determine some of the historical events and personal relationships—some tragic—that are alluded to in the grave markers. Her deep interest in the history of the mining communities has enriched our knowledge of the early days of Contra Costa County and this part of the Bay Area.

Many thanks to all who helped out with this year's Teacher's Day at Black Diamond Mines. The NCGS gratefully acknowledges Ray Sullivan, Mark Detterman, Don Lewis, Tridib Guha, Phil Reed, and Dan Day. And the event would not have been possible without the coordination and help from Bob Kanagaki, Traci Parent, and the supporting staff of Black Diamond Mines Regional Park. Their contribution to the park natural habitat, mining operations, and the regional history completes the picture of this unique Preserve.

NCGS Regional Hayward Fault Field Trip and Tyson's Lagoon/Tule Pond Trench Site

By Richard Cardwell

What do we know about the history of earthquakes on the Hayward fault? What does the fault look like as it runs through urban areas in Fremont and Hayward? And finally, when is the Hayward fault going to rupture in the next large earthquake? These are the questions that NCGS members and friends were attempting to answer on their fall field trip on Sunday, October 13.

The answers to the first two questions were provided by field trip leaders Dr. Russ Graymer of the USGS's Western Earth Surface Process Team and Dr. Jim Lienkaemper of the USGS's Earthquake Group. Our day began on a warm autumn morning at the Fremont BART Station parking lot. After being fortified by coffee and donuts supplied by Phil Reed, we walked across Walnut Avenue to examine our first stop -- the Tyson's Lagoon/Tule Pond Trench site. A deflection of the curb along Walnut Avenue was our first indication of where the fault was located.

Russ and Jim began by giving us an overview of earthquake activity and faulting along the Hayward fault. The only large earthquake known to occur on the Hayward fault during historical time was on October 27, 1868. (Is it just coincidence that so many significant Bay Area earthquakes seem to occur in October?) The magnitude of this event was estimated to be about M 6.9. There was between 45 to 60 kilometers of surface rupture from Oakland to Fremont, and the amount of right-lateral offset was about 1.9 meters. Until 1906, this event was known as the Great San Francisco Earthquake. Seismologists thought that another earthquake may have occurred along the fault in 1838, but recent work indicates that this event probably occurred along the southern Calaveras fault or the San Andreas fault. Since 1868 the Hayward fault has not generated a large earthquake.

One of the best techniques to determine the history of earthquakes along a fault before historical times is via trenching. Jim explained that a trench is dug across a fault, and the occurrences of large earthquakes are recognized by mapping where the fault has disturbed successive soil layers (as seen in the trench wall). Each disturbed layer is assumed to be caused by an individual earthquake. A trench is typically about a meter wide and up to 20 meters long. The depth of a trench will determine how far back in time one can investigate, but it is often determined by more practical matters such as the depth of the ground water table.

Jim described how an individual earthquake along the fault causes strike-slip motion as well as some vertical movement. It is this vertical component of faulting that is recorded in the disturbed soil layers. Individual events show fault-scarp colluvial deposits and liquifaction features. His trenches at Tule Pond show that there is typically 0.2-0.4 meters of uplift associated with each major earthquake.

We were joined by Gordon Seitz, a colleague of Jim's from Lawrence Livermore Lab. He explained how the time of each event can be determined by radiocarbon dating organic matter (charcoal, plant fibers, shells, humic matter, soil fungus) and also by using pollen data from disturbed soil layers. Carbon 14 ages are converted to calendar ages by calibration with tree rings.

Tule Pond is an ideal site for trenching because it is a sag pond formed by an offset step in the Hayward fault. A right step in a right-lateral, strike-slip fault will form a pull-apart graben where abundant and hopefully continuous layers of sediment can accumulate. Tule Pond accumulated sediments throughout much of the Holocene, and the stratigraphic record preserved in it provides an excellent environment for investigating earthquake recurrence. Jim and a team from the USGS have been actively investigating this site for many years. His previous work in 2000 (for trench number 00A) found four dateable events occurring in about 1470, 1630, 1730 and ending with the historical event in 1868. Statistical analysis yields a recurrence rate of about 130 ± 40 years. Interestingly, it has now been 134 years since the last large earthquake in 1868.

In order to extend the record farther back in time Jim and his team recently excavated several more trenches in the area that are much deeper than previous trenches. We were fortunate to have the opportunity to examine two trenches that were dug in September and are still open. Typically trenches are only open for about a month before being filled. Trenches 02A and 02E were open for examination by hard hat-wearing NCGS members. Trench 02A is one of the deepest trenches and contains evidence for 10-12 events going back 2000 years. The radiocarbon dating work has just begun, but the later events can be correlated to events in nearby trenches. Over an interval of 2000 years 10-12 events would suggest a longer recurrence rate than the most recent record, but some events may have been lost by unconformities.

Around noon we moved to Stop 2 where we had lunch at the Mission San Jose in Fremont. The original adobe church was built from 1805-1809, destroyed by the earthquake in 1868, and then finally restored in 1985. Here Russ gave us an overview of his mapping work along the Hayward fault. He noted that the surface trace of the fault is difficult to map along its entire extent, especially at its southern end where it joins the Calaveras fault.

The section of the Hayward fault in Hayward and Fremont is part of a broad zone. This fault zone has accumulated about 100 kilometers of right-lateral offset in the past 12 million years, yielding a geologically-determined slip rate of about 9 millimeters per year. Recent geodetic measurements show that the fault in the Fremont to Hayward section is creeping at the surface at an average rate of about 4.6 millimeters per year. Presumably, the slip rate difference is made up by movement during large earthquakes.

The rest of the day we examined several sites along the fault. At Stop 3 (south of Fremont) we examined a site where the Irvington gravels are offset by the Hayward fault. These gravels are 1.5 - 0.5 million years old and contain clasts of sandstone, metamorphic rocks (graywacke, blueschist), volcanic rocks, and red chert. From here we moved east to Stop 4 along the northern Calaveras fault (also called the Sonol fault) to examine the Livermore gravels. The Livermore gravels have the same age, lithology, and heavy minerals as the Irvington gravels. There is no evidence for significant offset along the Sonol fault.

Russ has proposed that the Irvington and Livermore gravels were probably once a single alluvial unit. Over the last 1 million years the gravels were separated by uplift of the range between the Sonol and Calaveras faults. The range consists of the northwest-trending Pleasanton, Sonol, and Walpert ridges. The range is cut by Niles Canyon -- a sinuous, deeply incised, east-west oriented canyon formed by Alameda Creek. Alameda Creek predates the uplift of the range, and the drainage was superposed on the range as it was uplifted. The uplift is best explained by oblique motion along the faults resulting in compression between the Hayward and Calaveras faults. Leveling surveys are consistent with this proposal, and they show that the creeping section of the Hayward fault has about 1 mm per year vertical uplift on its eastern side.

Stop 5 was in downtown Hayward where we examined the evidence for fault creep in an urban setting. The creep has cracked the walls in the old Hayward City Hall so badly that the building was abandoned. Other effects include offset curbs on B Street and warped building walls. We did not have time for Stop 6 at the Marcella Street trench site in Hayward. Here the Hayward fault occupies three different strands in a zone less than a kilometer wide.

The NCGS sincerely thanks Russ Graymer and Jim Lienkaemper for the excellent field trip. They prepared a superb field guide that includes many colored geologic maps, topographic maps, air photos, and trench logs. Further information is available at their USGS web site. Jean Moran did her usual excellent job in organizing the trip, handling trip registration, arranging transportation and food. Finally, our thanks to all of the drivers for use of their cars and vans.

NCGS

WE WANT YOUR INPUT AGAIN!

We want to keep our understanding of what YOU want up to date. So even if you responded to our questionnaire several years ago, please respond to this one! Everyone returning this questionnaire will be eligible for a drawing to give away two copies of your choice of local guidebooks**. So let us hear from you!**

1. **Which NCGS activities do you like best ?** (Please prioritize your preferences, starting with (1) as the best:

( ) Field Trips
( ) Evening speakers
( ) AAPG Distinguished Lecturers
( ) Noon speakers in Oakland or elsewhere (it's been awhile!)
( ) Family picnics
( ) Family night speakers on popular topics
( ) Newsletter

2. **I'm in favor of supporting**:
( ) Scholarships
( ) Earth Science Teacher of the Year award
( ) Teachers Day program during Earth Science Week

3. **What other activities would you like to see included or supported?**

4. **Why do you come to the evening meetings** (or why would you if you did)? (Please prioritize)

( ) See your friends
( ) Increase your network
( ) Beer, sodas and munchies
( ) Browse and buy guidebooks
( ) Treat spouse/friend to a big night out
( ) Oh, yes, the technical talk. They keep me up to date and are really interesting.
( ) Other

5. **Why *don't* you come to evening meetings ?** (Check those applicable)
( ) There is no dinner
( ) Too busy to give myself a treat; schedule conflicts
( ) Too far to drive
( ) The talk doesn't sound interesting
( ) I just fall asleep anyway
( ) I really don't like geology
( ) Other (Please tell us)

6. **What type of technical talk do you like ?** (Please prioritize)

   ( ) Bay Area geology and seismology
   ( ) California geology and seismology
   ( ) Interesting geology around the world
   ( ) Hydrogeology and remediation
   ( ) Geotechnical
   ( ) Petroleum geology
   ( ) Dinosaurs and the like
   ( ) Other (meteorology, astronomy, travel, ……) Please list any great ideas.

7. We moved to the Orinda location several years back now; however, the Bay Area is spread out. Is there is a better location?

   A. Do you think the location should move around? ( ) Yes ( ) No ( ) Depends
   B. What would be the best location for YOU?
   C. If not Orinda, can you suggest a specific meeting place?

8. **Would you like a membership directory ?** ( ) Yes ( ) No
   Even if it costs you a little bit ? ( ) Yes ( ) No

9. Would you prefer an e-mail version of the Newsletter? ( ) Yes ( ) No
   Receiving the newsletter by email saves the NCGS over $1/issue that can be applied to a scholarship or to a field trip to keep costs down. So, please give us your e-mail address:

10. **In which activity committees would you like to participate ?**
    ( ) Program
    ( ) Field trip
    ( ) Scholarship
    ( ) K-12 Education

11. **Here's a blank space** for your ideas, your input, your comments, your accolades, your gripes (Let us know!):

Name (so I can get a free guidebook if I'm living right):_____

Please send this form right away to:

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