

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY



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MEETING ANNOUNCEMENT

DATE: Wednesday, April 26, 2006

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 member

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

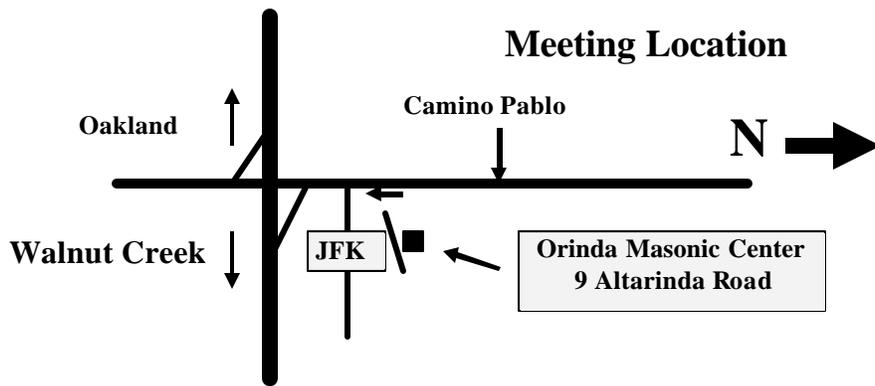
SPEAKER: Kathleen Burnham, Independent Researcher
*Point Lobos and Point Reyes:
Evidence of ~180 Km Offset on the
San Gregorio/Northern San Andreas Fault*

Virtually identical suites of distinctive felsic volcanic and granitic conglomerate clasts, together with other shared characteristics, indicate that the Paleocene or Eocene Point Reyes Conglomerate and the Carmelo Formation (at and near Point Lobos), were originally deposited in the same submarine canyon system. Essentially all of the abundant, and several of the rare, clast varieties at each location appear in the other location, matrix of the two conglomerates is indistinguishable, and the same species of a rare trace fossil occurs in both formations. Petrography, petrology, microprobe geochemistry, and SHRIMP zircon U/Pb dating suggest mutual parent rocks, depositional history, and diagenesis, indicating that the Point Reyes Conglomerate is a displaced segment of the Carmelo Formation.

Although the basement granodiorites of Point Reyes and of Point Lobos are similar enough to be zones of a single pluton; petrography, petrology, and microprobe geochemistry show the unusual Porphyritic Granodiorite of Monterey near Point Lobos is the best candidate for origin of certain boulders within the Point Reyes Conglomerate.

None of the fourteen other Cretaceous and Paleogene conglomerates considered in this study share the Point Reyes/Point Lobos suite of clasts.

This paleogeography has proved to be predictive. Since its first introduction in April 1998, other authors have reported five additional geological and geophysical correlations which are consistent with this model. Thus thirteen pairs of correlative features have now been documented which are juxtaposed across the San Gregorio/northern (north of Bolinas) San Andreas fault by a single post-middle Miocene dextral offset of 180 ± 5 km.



Biography: NCGS member Kathleen Burnham grew up in a former coal mining district of southern Iowa. Along with her siblings she spent many hours searching for crinoid and brachiopod fossils eroding from the Pennsylvanian limestone in our family's pasture. Her first course in geology was taken at the University of New Mexico, Albuquerque, but she got her real start in geology via Merritt College field courses led by the late George S. Hilton. These courses were so valuable and fun that she continued to attend Merritt College geology field courses while attending Sonoma State University. She earned a bachelor degree in geology from Sonoma State University, and a Masters in geological and environmental sciences at Stanford University. She now undertakes independent research in Cretaceous and Paleogene conglomerates of the California Coast Ranges for clues to fault offset and paleogeography. Kathleen will be leading a two-day NCGS field trip in late May that will look at field evidence for tonight's talk (see attached flyer). The field trip will be a reprise of the field trip she lead during the GSA / AAPG April 2005 Convention in San Jose. Her most recent publication will appear in the Pacific Section SEPM publication *Using Stratigraphy, Sedimentology, and Geochemistry to Unravel the Geologic History of the Southwestern Cordillera: A Volume in Honor of Patrick L. Abbott* due out this year.

Northern California Geological Society
 c/o Mark Detterman
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If a "2005" Appears after Your Name Please Contact Our Membership Secretary – Our Records Show You as Delinquent In Your Membership And *This Will Be Your Last Newsletter!*

NCGS 2006 Calendar

Wednesday, April 26, 2006

Kathleen Burnham, Independent Researcher
Point Lobos and Point Reyes:

**Evidence of ~180 Km Offset on the
San Gregorio/Northern San Andreas Fault**

(This is a lead-in to the May 2006 field trip; see attached flyer.)

7:00 PM at Orinda Masonic Center

Wednesday May 31, 2006

Dr. George Brimhall, UC Berkeley
**A History of Field Geology at UC Berkeley, and
Issues Facing Field Geology Training Programs
Today**

(This is a lead-in to field trip in September 2006:
**Field Geological Mapping Using Modern
Technology**)

7:00 PM at Orinda Masonic Center

Wednesday June 28, 2006

Dr. Robert Kayen, US Geological Survey
Title TBA

7:00 pm at Orinda Masonic Center

Wednesday September 27, 2006

Dr. Doris Sloan, University of California, Berkeley
Dr. John Karachewski, Weiss Associates
Slide Show Lead-in to Book Publication (**Geology of
the San Francisco Bay Region**, UC Press;
<http://www.ucpress.edu/books/pages/9237.html>)

Wednesday October 25, 2006

**Dr. Richard Stanley, Dr. Russell Graymer, Dr.
Carl M. Wentworth**, U.S. Geological Survey, Menlo
Park

**Subsurface geology, hydrology, basin evolution, and
climatic cyclicity of the Santa Clara Valley area**

7:00 pm at Orinda Masonic Center

1906 Earthquake Centennial

Seismological Society of America

100th Anniversary Earthquake

Conference

Managing Risk in Earthquake Country

April 18 – 22, 2006

Moscone Center, San Francisco

The anniversary of the 1906 Earthquake is a valuable opportunity for earth scientist, engineers, policy

makers, emergency responders and businesses to take stock of how well we are protecting our communities and mitigating the dangers associated with earthquakes. To attend the premier disaster mitigation conference in 2006 visit the conference website (www.1906eqconf.org).

For a full listing of centennial events visit the website of the **1906 Earthquake Centennial Alliance** (<http://www.06centennial.org>). Events will range from professional meetings, multiple museum exhibits, commissioned music to be played by the Contra Costa Wind Symphony, and much more. NCGS events (below) will be posted to the website shortly.

NCGS Centennial Events

(The field trips are now listed on the
1906 Centennial Website)

April 15, 2006 **Family Field Trip - Tracing the
Hayward Fault – A Potential
Disaster Area, Dr. Joyce
Blueford, and Dr. Mitchell
Craig**, CSU East Bay, Hayward
Fremont Math Science Nucleus
and California Geological
Survey, respectively

See NCGS Website for Field Trip Flyer

April 26, 2006, **Monthly Meeting - San
Gregorio and Northern San
Andreas Faults, Point Lobos to
Point Reyes, CA Kathleen
Burnham**, Independent
Researcher

May 20 – 21, 2006 **Field Trip - Point Lobos to Point
Reyes: Evidence of ~180 km
Offset of the San Gregorio &
Northern San Andreas Faults,
Kathleen Burnham**, Independent
Researcher

See Attached Field Trip Flyer

1906 Earthquake Centennial Events

Here is a small sample of what you can hear on the radio or watch on TV. FOR A MORE COMPLETE LISTING of TV Shows, Films, Music & Radio, take a LOOK AT

THE ONLINE CALENDAR OF EVENTS on the 1906 Earthquake Centennial Alliance website at <<<http://1906centennial.org>>>. Thank you CBS 5 for sharing your program schedule. Check your local listings.

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USGS featured in the following programs--

April 12, 7 PM, CBS 5 [[and on UPN Bay Area (KBHK-TV) on Sat., April 22 from 9-10 pm]], "SHOCK WAVES: 100 Years After the 1906 Earthquake." Produced by Steve Wessells, USGS video producer.

April 15 & 16, 6 PM, KRON-4, Bay Area Backroads "EARTHQUAKE ROAD TRIP" featuring Andy Snyder (Parkfield) and Russell Graymer, USGS.

April 16, 4 PM, ABC 7, 1906 - A CITY REMEMBERS, News Anchor Dan Ashley hosts an hour-long special on the 1906 earthquake that forever changed San Francisco. [[Multiple airing: April 18, 2006, 3 PM and April 18, 8 PM]].

April 18, 11 AM - 1 PM, NPR's "Talk of the Nation" will broadcast a program about the 1906 earthquake live from the Exploratorium's McBean Theater.

April 18, 6 PM, CBS 5, THE NEXT BIG ONE - Brian Hackney – On the anniversary of the 1906 quake, Brian Hackney takes a look at when and where the next big one will hit? Most likely it'll be the eight months pregnant Hayward fault.

April 18, 7-8 PM, CBS 5, TOWN HALL MEETING "The Great Quake: Science and Survival" at the Oakland Museum, CBS 5 Science Reporter Brian Hackney hosts.

April 18, NBC 11, ECHOES FROM THE PAST: THE 1906 EARTHQUAKE, One hour documentary. An early dawn disaster transforms a region. Individuals find their lives turned upside down.

April 21st, NPR's "Science Friday" program, hosted by Ira Flatow, will broadcast a program about the science of earthquakes live from the Exploratorium's McBean Theater.

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More radio and TV programs. FOR A MORE COMPLETE LISTING of TV Shows, Films, Music & Radio go to the 1906 Alliance website at <http://1906centennial.org/>.

April 16, 5 AM, KGO AM810 Radio, "A MOST DREADFUL EARTHQUAKE" author is guest of KGO's John Rothmann.

April 17, 9 PM, KQED Channel 9 (SF Bay Area PBS) "SEEKING 1906"

Apr. 10, 6 PM, CBS 5, QUAKE SAFE SCHOOLS - Sherry Hu – Thousands of kids could be in their classrooms when the big one hits. Over 1000 Bay Area schools are on the vulnerable list. Which bay area schools are the safest? We take a look at one school that's quake prepared.

April 11, 5 PM, CBS 5 (should air), QUAKE EXPO - Sugerman piece with Joann Hayes White should run several days before the Fire Dept. Expo.

April 11, 6 PM, CBS 5, CHINESE DISPLACEMENT - Linda Yee - the untold story of what happened to the Chinese after Chinatown was destroyed; a group of white leaders in SF tried to move the Chinese to Hunters Point, building some pagodas and turn it into a tourist attraction. But that was stopped after a group of local landlords, who overcharged the Chinese for rent in Chinatown, resisted and the Empress Dowager of China threatened to cut off trade.

April 12, 6 PM, CBS 5, OAKLAND MIGRATION - Bill Schechner - 70,000 San Franciscans made their way to Oakland after the quake. Some returned. Some stayed and made Oakland the city it is today. Are you ready? - Survival kits-Ken Bastida, we'll have an expert meet up with Ken at his house and do an inventory of ken's survival kit.

April 13, 6 PM, CBS 5, NEW QUAKE TECHNOLOGY-SUE KWON - the latest technology to make your home and office quake safe.

April 14, 6 PM, CBS 5, TRACES OF 1906-KEN BASTIDA - though it's been a hundred years, there are still visible reminders of the 06 quake. Ken takes a tour in areas around SF that still have scars and remnants of the earthquake.

April 14, For 11 PM, CBS 5, 06 CRIME WAVE-LINDA YEE - after the quake hit, many policemen left their posts, anarchy was rampant, soldiers looted. A lot of the bad actors were shipped to Oakland. Interview with former police officer who wrote a book on this subject.

April 17, 6 PM, CBS 5, 100-YEARS AGO TODAY - Mike Sugerman - Enrico Caruso sang in SF the night

before and then was jolted awake the morning after. He never returned to SF.

April 18, 5 PM, CBS 5, SOUTHBAY IMPACT- Len Ramirez – the quake was not just centered in San Francisco. Len takes a look at the damage caused in the South bay.

April 18, 6 PM, CBS 5, Mike Sugerman speaks with Carl Nolte about the day the 1906 earthquake struck San Francisco.

1906 Ground Motion Simulations

Members who attended Dr. Mary Lou Zoback's March 29th NCGS Dinner presentation, will have seen these clips with her comments during her presentation. Others may have seen them on TV news casts when they were released on March 28, 2006. However, if you have not seen them you definitely will find these interesting and thought provoking. The best clips to give a good feel for the extent of ground motion or seismic waves are the oblique shots rather than the overhead shot. You can understand why it's difficult to even stand in a large quake. Go to: <http://earthquake.usgs.gov/> Then click on the "1906 centennial" link near the bottom of the left hand column. On the next page click on the 4th item down and select from there. We provide the more "generic" website address for those who have not been to this website; there is a good deal of interesting information outside the 1906 centennial subsection.

1906 Centennial Volunteer Docent Opportunity!

Dr. Zoback put out the call for volunteers at the March 29th dinner meeting by announcing that the USGS and the 1906 Centennial Organization are looking for volunteer docents to help staff *The Hayward Fault Exposed! An Interpretive Viewing and Educational Exhibit* located at Central Park in the City of Fremont. This is a wide and 12- to 15-foot-deep trench that has been excavated across the Hayward Fault for public viewing. This is a rare public viewing of a fault trench excavation. You will (or can) be answering questions and leading groups of visitors, according to your desires, as well as opening and closing the exhibit in the AM and the PM, respectively. The exhibit will run from April 8 to May 28 on weekends between 10am to 3pm, and by appointment during the week days (especially for schools). For more detailed information go to:

<http://1906centennial.org/activities/trenchexhibit/> then you can sign up and select a time that suits your schedule at:

<http://1906centennial.org/activities/trenchexhibit/volunteers.php>. You may also contact Heidi Stenner at the USGS at (650) 329-4801 for further information.

Other Upcoming NCGS Field Trips

(See Also – NCGS Centennial Events)

April 22 & 23, 2006 ***Panoche Hill Paleocene and Cantua Creek Cretaceous Fossil Overpressure Zone Cold Seeps, Dr. Mel Erskine, Consultant, Dr. Hilde Schwartz, University of California, Santa Cruz***

(See Attached Flyer – Continued Rain Will Cancel – If you sign up you will be notified by email of a cancellation.)

September 2006 ***Field Geological Mapping Using Modern Technology Dr. George Brimhall, U.C. Berkeley***

For questions regarding these field trips, please contact Tridib Guha at: tridibguha@sbcglobal.net

Northern California Geological Society Student Award At The San Francisco Bay Area Science Fair

Reported by John Stockwell

The Northern California Geological Society is pleased to announce that it has awarded a prize of \$100 to 13-year old 8th grade student Kathleen Abadie of Montara in recognition of her entry in the 53rd annual *San Francisco Bay Area Science Fair* held at the end of March at the San Francisco County Fair Building (the old Hall of Flowers). Her entry entitled "**Ready, Set ... Flow**" studied permeability in sands of different grain size. She wrote that she has always loved geology. Kathleen attends Cunha Intermediate School in Half Moon Bay.

Entries at the fair represent the best of many individual school or district based science fairs. The fair, open to all Bay Area students in grades 7 to 12, "...is dedicated

to encouraging original scientific research on the part of young people from all walks of life..." There are six categories for judging: Environmental Sciences, Engineering and Computer Applications, Behavioral Sciences, Biological Sciences, Physical Sciences, and Mathematics and Computers. More can be learned about the SFBASF at their website: <http://home.pacbell.net/sfbasf/>

It is expected that the Society will continue to make this award annually.

No prize was awarded at the new Contra Costa Science and Engineering Fair, also held the end of March, at the Heald College Conference Center in Concord. There were no sufficiently geoscience based entries.

Participation in the Bay Area Fair was down markedly from last year, the new Contra Costa Fair having apparently siphoned off entries from eastern Contra Costa County.

Northern California Geological Society Geoscience Teaching Awards

Reported by John Stockwell

Three Bay Area teachers were recognized and presented award checks at the special March 29 dinner meeting. All were successful in NCGS' annual **Geoscience Teaching Award** competition. Pierre de St. Croix was awarded \$500. Cheryl Costello and Mary Jane Holmes each received \$250. NCGS is especially pleased to be making these awards to teachers with obviously high interest in geology. Normally only one award would have been made, but this year NCGS received three applications of unusually high quality. Cheryl and Mary Jane were very close runners-up to Mr. de St. Croix. There were other applicants, each of whom was provided with a teaching kit from Burminco, "Minerals and Rocks They Make."

Mr. de St. Croix lives in Dublin and teaches 6th grade earth science at Harvest Park Middle School in Pleasanton. During the 2005-2006 school year, Pierre is teaching a unit entitled "Earth's Resources (Earth's History and Fossils)." His curriculum exhibited a high degree of imagination and detail. Pierre received a BA in geology with a minor in education from UC Davis and a Masters in science education also from UC Davis. Pierre enjoys the piano and guitar and a wide variety of outdoor activities including fossil and rock collecting. He is engaged to be married in October. Pierre will use his award to help colleagues and himself purchase "the necessary lab supplies needed to further enhance hands-

on, project-based learning with regard to Earth's resources and the concepts that support the standards surrounding the preservation of them."

Mrs. Costello teaches geology at Monte Vista High School in Danville. The curriculum for her geology course at Monte Vista is well thought out, detailed, and comprehensive. Cheryl's education includes a B.S. in geology from University of the Pacific and an M.S. in geology from CSU, Hayward (now CSU, East Bay). Before becoming a teacher she was an environmental consultant. Cheryl lives in Pleasanton with her husband Mike and 2-year-old son Matthew. She enjoys the opportunity she now has to teach a subject she loves. Cheryl will use her award to purchase laboratory materials, videos, and visual enhancements for her classroom.

Mrs. Holmes is a member of NCGS. Her degrees are in history with teaching minors in science and music. She has been teaching for more than 30 years and is now a science specialist in the Fremont School District at Parkmont Elementary School. In that capacity Mary Jane offers a fourth grade earth sciences unit in which are included numerous hands-on labs. She was recently Chair of the District Elementary Science Committee and currently mentors newer science specialists. Mary Jane is widely traveled, plays the piano and guitar, and enjoys hands-on arts. Her favorite hobby, however, is geology. In pursuit of this hobby she attends numerous conferences and generally seeks out every opportunity to expand her geological knowledge. She is a member of the Castro Valley Mineral and Gem Society. Mary Jane is married to Tom Debley, has two adult sons, a daughter-in-law, and "the world's most delightful granddaughter." Mary Jane's home is in Oakland. She will use her award to purchase solidly geological teaching materials.

Engineering Challenges Facing the Caldecott Tunnel 4th Bore

Reported by Dan Day

As the East Bay population grows, freeways become more congested and daily commutes longer. Highway 24 from Walnut Creek to Oakland is a key artery connecting San Francisco Bay proper with the East Bay communities in the I-680 corridor. Relieving this mounting traffic headache has transportation experts considering a fourth bore for the Caldecott Tunnel linking Berkeley and Orinda through the East Bay Hills. An update on the challenges facing this controversial project was provided by Geomatrix Consultants Senior

Geologist **Todd Crampton** in his October 26, 2005 NCGS presentation *Engineering Geology of the Proposed 4th Bore of the Caldecott Tunnel*.

Todd, a Certified Engineering Geologist (CEG) and California Professional Geologist, has been with Geomatrix Consultants since 1994 managing geologic hazard studies and engineering projects for pipelines, water system facilities, tunnels, dams, and other structures. His experience with preliminary investigations for the Caldecott Tunnel fourth bore began with a comprehensive survey conducted between December 2004 and July 2005. The survey involved field mapping, 18 test pits, 9 exploratory borings (four 50 to 150 foot vertical holes and five 400 to 920 foot subhorizontal to angled bore holes), in situ bore hole testing (pressuremeter, Goodman jack, and Packer permeability tests), and down hole geophysical logging (optical/acoustic imaging, P and S wave measurements). These studies will feed into the design phase of the tunnel bore project to establish construction cost estimates. The principle contractor is Jacobs Associates Tunnel and Geotechnical Design, with other firms as subcontractors. Historically, the first and second bores were successfully completed, with considerable engineering effort, in the late 1930's. A third tunnel was completed north of these two in 1964. The fourth will be excavated north of it. A two lane roadway will require a 53 foot diameter bore, and a three-lane highway a 70 foot wide bore. The specifics are still being debated. Past experience, however, necessitates that there be 32-foot high retaining walls at each portal. Construction design will also require modification of current on and off ramps.

Anticipating future tunnel expansion, Caltrans purchased the right-of-way for a potential fourth bore years ago. Contractors have also learned from prior developers' mistakes. During construction of the first and second bores, the contractors were faced with serious rock instability problems at the west portal. Two cave-ins occurred and three lives were lost. Following these disasters, the late Ben Page, then a Stanford University graduate, began detailed mapping along the tunnel bore and identified many unusual structural features. Page's research uncovered numerous complexities associated with the dominant local structure – the Siesta Valley syncline. The tunnel penetrates the overturned southwest limb of the syncline. Shear forces that accompanied the tight folding, and weathering of pre-tectonic diabase dike intrusions weakened the units and posed formidable engineering challenges. Page eventually published his tunnel transect in *Economic Geology*, Vol. 45, No. 2 March, 1950, pp. 142-166, entitled *Geology of the Broadway Tunnel, Berkeley Hills, California*. It was a very well conducted, albeit

ironic, study by a Stanford University alumnus of an area heavily trekked by U.C. Berkeley students.

Original tunnel boring efforts were complicated by several geological factors. The presence of numerous rock units, sporadic fracture zones in the siliceous Claremont (Monterey equivalent) Formation, irregular rock distribution, localized hydrothermal alteration, and sandstone dikes. There is very little geological information on the third tunnel bore. U.C. Berkeley professor Garniss Curtis obtained third bore logging data only through subversive means. Any geotechnical data acquired during its excavation has been carefully guarded.

Todd's geotechnical work covered a broad range of lithology and rock behavior. The 3-inch diameter cores taken from 4-inch test borings were subjected to standard point load and crushing tests. The tests revealed significant ranges in geomechanical conditions along the tunnel alignment. These included wide variations in rock integrity, from massive to fractured and crushed zones within the same lithologic unit, intact to locally seamy conditions, sudden changes in bedding orientation, bedding contortion, intra- and inter-formational faulting, highly weathered basalt and sandstone dikes, pockets of trapped groundwater, and local bituminous zones. Investigations further confirmed the existence of previously unknown northwest-trending faults that juxtapose geological units. These faults occur in severely crushed or sheared zones and often involve sudden structural changes. Some also appear to be groundwater barriers. The preliminary geotechnical evaluation has been used to classify rock mechanical properties into five categories that will be used to guide the initial tunnel excavation and structural design.

Todd summarized the tunnel geology using Ben Page's original stratigraphic nomenclature. The current tunnel bores lie between the Hayward and Moraga faults, penetrating at a right angle through the slightly overturned northwest-striking west limb of the Siesta syncline under Grizzly Peak ridge. The tunnel trajectory is not crossed by recognized active faults. Its orientation to bedding planes helped mitigate excavation difficulties. The initial unit exposed in the original west portal excavation (not penetrated by the tunnel bores) is highly fractured, thinly bedded brown shale of the Miocene Sobrante Formation ("First Shale"). The next unit encountered is the gray to buff-colored, massive to obscurely bedded, medium-grained, carbonate-cemented "Portal Sandstone." It is a competent unit, but rapidly grades into shaley sandstone and sandy shale units where the tunnel bores commence. The shaley units are weak, exhibit chaotic bedding, and are often poorly defined and locally intermingled by shearing forces associated with

the synclinal deformation. These units continue 230 to 265 feet into the tunnels. The Sobrante units are overlain by the 10 to 45 foot-thick highly fractured, treacherous "Preliminary Chert" of the Miocene Claremont (Monterey) Formation. The "Second Sandstone" is a well-consolidated unit 315 to 360 feet thick, often highly fractured and cut by weakened dikes. It passes into the somewhat organic cherts, porcelanites, and shales of the Middle Miocene Claremont (Monterey) Formation proper that underlies the crest of Grizzly Peak ridge. It is a thinly bedded sequence of cherty strata interbedded with thin shales. The Claremont cherts and shales are highly contorted and strongly fractured. Many diabase dikes in the Claremont are actually bedding plane sills, intrusions thought to be linked with the younger Moraga volcanics exposed at Sibley Regional Volcanic Preserve. Most are highly altered and bleached by hydrothermal activity. Sediment deformation was largely syndepositional (soft sediment) rather than brittle. The Claremont proper constitutes over 1100 feet of the Caldecott bores. It is unconformably overlain by more than 1500 feet of probable lower to middle Pliocene nonmarine fluviatile mudstones, friable sandstones, and scattered conglomerates of the Orinda Formation. This unit constitutes the final one-third of the tunneled distance to the east portal.

Although local access roads provided some valuable outcrop data to field teams, the cores and test pits added much vital information. Bore holes were instrumented with piezometers and optical probes. Some of the holes intersected artesian groundwater. Angled drill holes pierced the faulted Claremont-Orinda formation boundary in a muddy gully above the east portal. Here the contact is encountered at the surface, where contorted bedded cherts suddenly transition into Pliocene mudstones and sandstones. No test pits were dug on the east portal but borings were taken. The west portal side was more extensively characterized.

Drilling began in December, 2004 during a period of heavy rainfall. The recovered cores were very crumbly and held together by clay seams. Bore N1 taken near the west portal attests to the overall weakened nature of the sediments. The drill hole advanced slowly, and required much casing over its 300-foot length. It eventually collapsed. Two vertical bores were made at the west portal. The deepest was 110 feet and was abandoned because of poorly consolidated rock. No optical or geophysical data was taken.

Several drill sites were established along Tunnel Road. Bore N2 dipped 48°W for 400 feet through the Preliminary Chert of the Claremont into the Shaley Sandstone units of the underlying Sobrante Formation. The boring encountered several bleached igneous dikes

bounded by baked sediment contacts. Some shale-rich zones were very clayey. Core N4 to the west was 920 feet long and inclined 12° to the horizontal. This borehole penetrated the Second Sandstone and at 527 feet reached the Claremont Chert-sandstone contact. The drill entered a highly deformed zone and at 600 feet, intersected an extremely deformed and heavily dike-intruded zone thought to be the Wildcat Fault trace.

Bore N5 on the east portal side was drilled on East Bay Regional Park District land. It penetrated intercalated Claremont cherts and shales, some dolomitic sands, and scattered diabase dikes. Just north of the east portal, boring N7 was taken in a notched hillside. It crosses 850 feet of interbedded gravels, mudstones, and conglomerate beds up to 30 feet thick. Mineralized fractures in the mudstones give a false impression of rock strength. The Caldecott east portal is anchored in 150 feet of well-cemented, vertical-dipping conglomerate.

Jacobs Associates contracted Geomatrix Consultants to complete a preliminary geotechnical characterization of the tunnel lithologies. The latter included a description of overall rock characteristics and basic mechanical properties, some reference to historical engineering behavior, and the predicted excavation behavior. The lithologies were ranked into five categories, 1 having the best characteristics and 5 the worst. Percentages of each type were calculated. These classifications will be used to guide the preliminary tunnel structural design and the excavation strategy. The worst support areas are the tunnel portals, and these will require cut and cover buttressing. The "running ground" or sections where closely-fractured, water-saturated rock is expected to flow like slurry are ranked category 5. It is expected that some engineering adjustments will have to be made as construction progresses. Some tunnel funding has been acquired by recent bond measures, but over the past few years estimated costs have continued to soar. The finer project details are still being negotiated. Construction is scheduled to begin in 2008, and completion expected by 2012. Ironically, the BART tunnel is located only a short distance north of the Caldecott, and already major structural and lithologic discontinuities are encountered. This attests to the geologic complexity found in the East Bay Hills, and throughout the California Coast Range.

The NCGS is sincerely grateful to **Todd Crampton** of Geomatrix Consultants, Inc. for discussing the engineering geology of the Caldecott Tunnel fourth bore with its members. If this project is undertaken, construction teams will face many of the same problems the original Six Companies did in the late 1930's, but at much higher costs and with stricter safety regulations.

An NCGS Field Trip Report - A Walk Along The Old Bay Margin in Downtown San Francisco - Tracing The Events of The 1906 Earthquake and Fire

Reported by Joe Morganti

Historian Will Durant is alleged to have said that, among other factors, great cities and civilizations exist “at the pleasure of geology,” and certainly no city bears this out more than San Francisco. With the April 18 centennial of the most devastating earthquake in American history fast approaching, about 30 NCGS members and guests recently had a chance to see a somewhat deeper perspective on that tragedy. On March 19, **Dr. Raymond Sullivan**, professor emeritus of San Francisco State University’s Department of Geosciences, led us on a memorable field trip “*Retracing the Events of the 1906 Earthquake and Fire along the Old Bay Margins in Downtown San Francisco.*” For those like myself, who are not geologists, it was a fascinating and sobering view of the impact of geology in action, especially the consequences of erecting buildings on areas manifestly ill-suited to accommodate them. Professor Sullivan neatly summarized the situation by stating that the first part of the city’s destruction was controlled by geology but, in the second phase, the forces of meteorology predominated: after the earthquake came the fire and the fire destroyed the city. Two other factors became clear in the course of the day. First was the role of structural engineering. Of the 52 steel reinforced buildings in the downtown area, for example, only six were so damaged that they could not be salvaged and rebuilt. The other deciding factor was the human one, where individual actions—or lack of them—made all the difference. As will be seen, one incident of carelessness resulted in wildly exacerbating the fire in its early stages and the death of San Francisco’s fire chief resulted in serious and irreversible mistakes in handling the fire.

The field trip consisted of three short walks through downtown San Francisco. The first covered the South of Market area where then, as now, buildings had been constructed on old Mission Bay marshland that had been filled with sand and debris and where the damage and loss of life was staggering. The second walk focused on the fire as it spread from the South of Market area up toward Market Street and beyond. Finally, the third walk followed Montgomery Street through the north of Market area, following the path of the fire as it progressed into the old Yerba Buena Cove, a rough semicircle beginning at about Jackson and Montgomery to the north, continuing down to First and Market and ending roughly at Stewart and Folsom. The following

notes draw heavily on the excellent field trip guide prepared by Dr. Sullivan.

Walk one: South of market and the subsidence area. The first walk consisted of three stops within an area roughly bounded by Fifth Street on the north, Seventh Street on the south, Harrison on the east and Natoma on the west. The area rests on old Mission Bay marshland filled largely with sand from nearby dunes. The water table is very high and the potential for liquefaction is very great. Not surprisingly, this area has been described as “Ground Zero” for the 1906 earthquake and the loss of life and property was among the highest in the city.

Stop one: Sixth and Howard Streets. In 1906 this area was densely populated with immigrants and transients living and working in multi-story wooden frame buildings. When the earthquake struck at 5:12 AM most residents awoke to find their residences collapsing, the city water and sewage lines disrupted and the gas mains broken, as well. Between the extensive damage and the fire that almost immediately broke out, the death toll mounted rapidly to an estimated 300 people.

Stop two: Intersection of Sixth and Folsom Streets. Walking along the side streets at this stop and the previous one, the role of subsidence in the area was apparent. Although no 1906 buildings remain, and many buildings show the results of renovation following the 1989 Loma Prieta earthquake, there are still buildings clearly out of alignment, such as a residence at 481 Tehama Street, tipping gently backward from the sidewalk. Dr. Sullivan mentioned that although the fire in this area resulted from the ground shaking, another—and critical—fire had altogether human causes. Not far away, at Hayes and Gough, a family had been cooking breakfast on a damaged stove which quickly started a small fire. Normally this would have been quickly put out but, lacking sufficient water, the “ham and eggs fire” quickly became a full-fledged conflagration, gaining strength from prevailing winds and headed straight toward the destruction on Market Street and South of Market. The combined blaze was soon virtually out of control, leading to the decision to begin dynamiting any structures in its path so as to reduce potential fuel. This strategy proved to have ambiguous consequences as the dynamite and, later--when the dynamite was exhausted--black powder, often served to spread the very fire it was supposed to starve. Fire Chief Dennis Sullivan had been fatally injured by the earthquake and he would very likely have handled the fire in a far less destructive fashion than those fighting the fire without his direction.

Stop three: Subsidence area. This area is bounded by Fifth Street on the east and Eighth Street on the west, Mission Street to the north and Bluxome Street to the

south. During this portion we observed some remarkable evidences of subsidence in structures along such small side streets as Shipley, Clara, Layton, Moss, Russ and Natoma, the most dramatic example being 623 Natoma. The first floor of this bay window home, typical of post-1906 construction in the area, has sunk completely below street level and its bay window is now only inches from the sidewalk. A former eight foot entry door is completely below sidewalk level and is just barely visible. Interestingly, real estate in this area, which had been relegated to the lower classes before 1906, now fetches an extremely high price.

Walk two: Market Street from Seventh to First Streets. This part of the tour was notable for the number of pre-1906 buildings that either survived the earthquake and fire relatively intact or else were able to be restored, even to maintaining their original facades. As mentioned, steel frame construction was a key issue here. An 1868 earthquake along the Hayward fault—plus numerous pre-1906 fires—had alerted city planners to require that high-rise or official buildings be constructed of masonry or stone with steel framing. Although many wooden structures throughout the city did survive the earthquake with minimal damage, the fire that followed bore out the wisdom of the planners. Some of the pre-1906 structures still standing along Market include the Sixth Circuit Court of Appeals (the old Post Office building), the Hibernia Bank building, the Flood Building and, especially, the Old Mint, just off Market at 88 Fifth Street. The current (April 2006) issue of *Smithsonian* magazine has an excellent article, “Grace under fire,” illustrating how the Mint was saved, along with \$300 million in gold and silver (more than \$6 billion in today’s dollars) which may have helped save the US economy from collapse.

Stop four: Lotta’s Fountain (at Market, Montgomery and Post Streets). This gift to San Francisco from the famous gold rush actress and singer, Lotta Crabtree, survived the earthquake and fire and became the most critical gathering place for survivors seeking information about family and friends separated during the disaster. Survivors of the 1906 earthquake still gather here every April 18 and over a dozen are planning on attending this year’s memorial.

Stop five: Old Shoreline marker at the Mechanics Monument (Donahue Statue) (Bush and Battery). This six block area along Market Street, from Bush and Battery to the Ferry Building, showed, once again, the dangers of erecting high-rise structures on Bay fill. Collapsed buildings, along with ruptured water and gas mains, soon gave rise to several fires which, assisted by prevailing winds, quickly joined with fires begun earlier in the day, and headed toward the Ferry Building and the area north of market Street.

Walk three: Montgomery Street to Jackson Square. After a delicious and filling lunch in Chinatown we proceeded to the final portion of the tour which covered what had been the Financial District in 1906. Since this area is underlain by Franciscan bedrock, this was one of the few areas that survived the earthquake relatively intact.

Stop six: Portsmouth Square (Kearney between Clay and Washington). This was the location of the first settlement, Yerba Buena, which, by 1906, had become the heart of Chinatown. Ironically, most of the buildings in the area survived the earthquake with minimal damage and the residents originally felt they were safe. By early afternoon, however, the fire was unstoppable and, driven by winds, devastated the area.

Stop seven: Jackson Square. Bounded by Montgomery on the south, Jackson on the west, Sansome on the south and Washington on the east, this block showed amazing resilience and good fortune to survive the earthquake and fire largely intact. It contains some of the oldest commercial buildings in the city, especially along the 700 block of Montgomery and the 400 block of Jackson (including the Whiskey warehouse, of vital importance to save!). Although threatened several times during the three days of fire, on the final day a shift in the wind made all the difference and the block was spared.

Altogether, the earthquake-created fire lasted three days and destroyed nearly 5 square miles of the city and over 28,000 homes. Over 250,000 people were homeless and the death toll was likely well over 3,000. In those three days the eleventh largest city in North America had been largely reduced to ruins and yet by Christmas eve, 1910 it had been so successfully rebuilt that a renowned opera singer could present a concert at Lotta’s Fountain to celebrate the rebirth of San Francisco. Those of us who had a chance to learn about the events of that era in a geological context found it an enormously valuable experience. Several of us mentioned that we had walked by many of the buildings mentioned on the tour without much thought as to their remarkable history. As a result of this tour, few of us will do that again.

Three final points. First, many people made this field trip possible and we are very grateful to all of them but especially to **Tridib Guha** and **Dr. Sullivan**. Second, an article by Joel Achenbach in the current (April 2006) issue of *National Geographic* (“The Next Big One”) not only provides a nice overview of the 1906 earthquake but provides a very useful earthquake primer, complete with an accompanying map, “Earthquake Risk: a Global View.” Finally, for a convenient and comprehensive summary of earthquake centennial events, go to <http://1906centennial.org/>.

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY



NCGS FIELD TRIP IN COMMEMORATION OF 1906 EARTHQUAKE CENTENNIAL

Pt. LOBOS TO Pt. REYES: EVIDENCE OF ~ 180 Km OFFSET OF THE SAN GREGORIO & NORTHERN SAN ANDREAS FAULT

Saturday - Sunday May 20-21, 2006

Leader: Kathleen Burnham

NCGS member Kathleen Burnham will lead a two-day field trip, as part of NCGS' contribution to the 1906 Earthquake Centennial. Roughly 50 million years ago, the granitic rocks and conglomeratic turbidites of Point Lobos and Point Reyes were parts of a single deep submarine canyon system. During the past 27 million years, they've been separated approximately 180 km by dextral slip of the San Gregorio and northern San Andreas faults. Similarity of these rocks has been noted as far back as 1899, but Kathleen's research establishes details which nail down the correlation. Her paleogeographic reconstruction has proved predictive: since its first introduction, other geologists have proposed four geologic and geophysical correlations which fit her model. Point Reyes and Point Lobos are stunningly beautiful, and may be the only pair of localities on earth in which evidence of a large lateral offset is preserved in public parks at both ends.

On day one, participants will examine granitic rocks, conglomerate, and trace fossils at Point Lobos State Park, near Monterey, and then drive ~180 km along the San Gregorio and northern San Andreas faults to Olema, north of San Francisco. On day two, we will examine correlative rocks at Point Reyes National Seashore, as well as a 16 ft. (5m) offset of the 1906 San Francisco earthquake. This will be an interactive, rather than lecture-style field trip. This trip will be substantially different from Clark and Brabb's 1996 field trip.

Participants are requested to refrain from the use of aftershave, hand lotion, hair tonic, cologne, or other fragranced personal products, as the field trip leader is disabled by chemical sensitivity.

THIS FIELD TRIP WILL BE LIMITED TO 27 PEOPLE.

***** Field Trip Logistics *****

Time & Departure: TBA **Cost:** \$125/person

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

Name: _____ E-mail: _____

Address: _____ Phone (day): _____ Phone (evening): _____

Lunch: 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@sbcglobal.net Phone: (925) 370-0685 (evening - PREFERRED) (925) 363-1999 (day – emergency)

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY



NCGS FIELD TRIP “PANOCHÉ HILLS PALEOCENE and CANTUA CREEK CRETACEOUS FOSSIL OVERPRESSURE ZONE COLD SEEPS”

Saturday and / or Sunday April 22 and 23, 2006

Leaders: Dr. Mel Erskine, Consultant

Dr. Hilde Schwartz, University of California, Santa Cruz

Important Notices: This is a “bring your own meal and make your own arrangements” field trip. Anyone interested may participate in either or both days. You are responsible for getting to the field areas. A list of participants will be circulated so that you can arrange carpools if interested. **Please note – continued rain will cancel both days – If you sign up you will be notified by email of cancellation, and / or re-scheduling, of the trip.**

The Saturday portion of this field trip is a reprisal of the field trip lead by Dr. Erskine in October 2005. It will benefit greatly from the added presence of Dr. Hilde Schwartz of UC Santa Cruz. She was responsible for mapping and presenting this fascinating area in a field trip and talk at the San Jose meeting of GSA/AAPG last year. Saturday, this field trip will focus on ancient cold seep features exposed along the western margin of the south central Diablo Range. The primary field area is located in the southern Panoche Hills, where extensive Paleocene seafloor fluid migration system is well exposed in the upper portion of the Cretaceous and Paleocene Moreno Formation. Fossiliferous $\delta^{13}\text{C}$ -depleted carbonates and the remains of chemosynthetic invertebrates are the primary evidence for Paleocene seepage in this region. A network of interconnected clastic intrusions linked to the paleoseep carbonates likely represents the plumbing for the fluid system and is thus considered to be an additional paleoseep component. Seep-related carbonates and clastic intrusions in the Moreno Formation are exposed for 20 kilometers along strike. From the base of the lowest clastic intrusions to the uppermost paleoseep carbonates the system is nearly 800 meters thick; the carbonates themselves are exposed over approximately 200 meters of section, representing prolonged, episodic expulsion of fluids. Dr. Erskine’s interpretation is that these seeps were driven primarily by dewatering of a thick shale sequence due to compaction loading, however regional unconformities in the early Paleocene of the Vallecitos syncline to the southwest suggests at least a probable tectonic component. This will be discussed on the outcrop. Dr. Erskine also notes that the KT boundary has been mapped within the Moreno Formation in this area. It is marked by altered glass spherules, but no radio active layer.

On Sunday, we will visit outcrops in upper Cantua Creek on the NE slopes of San Benito Mountain, east of New Idria. Dr. Erskine has interpreted a strongly disrupted, relatively thin, Cretaceous sandstone in the upper Cantua Creek drainage to be the result of very large fluid overpressures developed during the thrusting of the Idria antiform. In this interpretation, fluids escaping from the Panoche shales below, and the Moreno shales above the porous sandstone, saturated the sandstone. The resulting fluid overpressures were apparently great enough to allow the sandstone to break up and rotate between the sealing shales. The fluids injected the porous sandstone blocks and deposited iron and selenium, probably as sulfides. The present outcrops are strongly stained by iron oxides and gossans are common. Soil pH values as low as 3 and 4 have been measured. Selenium values in soil as high as 4000 ppm have also been measured.

The Cantua Creek area is on BLM land, but we must cross private land to get to it. We will be accompanied by Julie Anne Delgado, a botanist from the BLM office in Hollister, and others interested in the botanical anomaly developed on this unusual sandstone outcrop.

Some of the participants will be camping in Cantua Creek and some will be staying in Motels on nearby I-5. This is a “bring your own meals and make your own arrangements” field trip. Anyone interested may participate in either or both days. Meeting places and times will be announced in early March. The Panoche Hills portion will require 4 wheel drive vehicles, but we will consolidate vehicles at the entrance gate. The Cantua Creek site is on good gravel roads. To minimize disruption of the rancher; however, we will consolidate into as few vehicles as possible outside his gate.

Please go to the NCGS Website for a Registration Form! (www.ncgeolsoc.org)