NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

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Special Recognition Awards Announcement

Dan Day and Ron Crane

It had been a long time since the Northern California Geological Society has recognized a member of the Society for their long term and outstanding contributions to the Society. That issue came up in a number of the responses to the most recent questionnaire that we compiled. Because the June 25th meeting was the last meeting before our annual summer break and there were several transitions planned for the summer, we believed that it would be an appropriate time. Consequently, time was taken at the June meeting to recognize both Dan Day and Ron Crane for their services on behalf of the Society.

As you are likely aware **Dan Day** has been active and contributing to this Society for a long period of time:

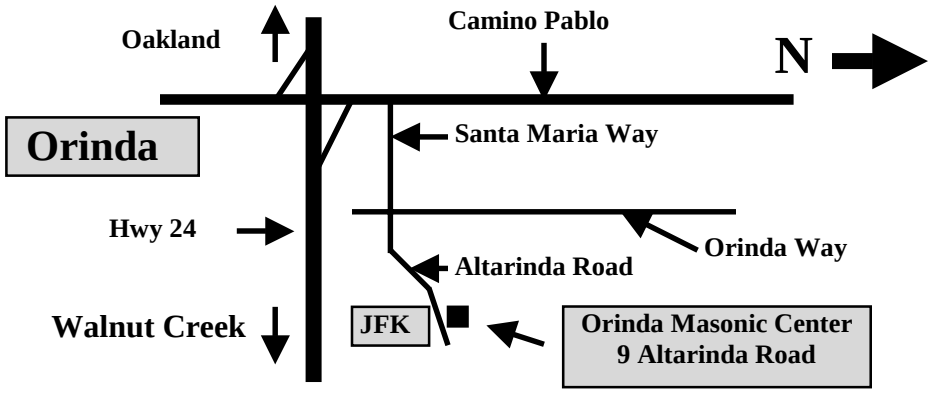
- $ Dan has been the secretary or newsletter editor for nearly 10 years, since 1994.
- $ In many comments from the last, and also the most recent questionnaire, one of the main reasons many members remain as members, especially after they leave the area, is the quality of the newsletter and the write-ups,
- $ Dan has generally written the detailed 1 to 2 page reviews each month for each speaker since that time, and he has provided many (most?) of the detailed field trip write-ups,
- $ Dan was vice president in 1997 to 1998 year, and president in 1998 to 1999 year,
- $ Dan purchases our munchy supply for each meeting, and stores the excess between the meetings,
- $ Dan supplies and handles our projection capabilities each month, and provides general housekeeping before and after each of the meetings,

Because Dan is leaving his position as newsletter editor we thought this would be an appropriate time to acknowledge his outstanding contributions and his long dedication to the Society.

Back in May after **Ron Crane**'s most recent field trip, Jean Moran found herself thanking Ron with yet another NCGS mug (reported to be the sixth). We briefly toyed with the idea of a complimentary

Meeting Location

(No meeting this month)



NCGS mug rack, but decided that an alternative was more appropriate. As you are also likely aware **Ron Crane** has also been very active and contributing to this Society for an extended period of time:

$ Principally Ron has lead or co-lead 12 field trips over a period of 15 yrs from 1988 to 2003.
$ Ron was also the field trip coordinator, as well as the vice president in 1987 - 1988,
$ Ron has presented an evening talk with Craig Lyon in 1995,
$ Ron was president in 2000 - 2001,
$ Ron has been listed and utilized as a counselor for our speaker program for a more than 5 yrs, and
$ Although he is not listed as such, Jean Moran has found Ron to be a wealth of ideas for future field trips,

As a consequence of each of their sustained contributions, the NCGS purchased special awards plaques made of slate that allowed the NCGS to carve in stone our recognition and thanks to each.

Please help us congratulate both on jobs well done!!

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.

Upcoming Field Trips…

August 2, 2003	***Clear Lake Volcanic Field***	**Rolfe Erickson**, Sonoma State
September 27, 2003	***Geology of the Point Reyes Area***	**Tom MacKinnon,** Consultant **John (Rusty) Gilbert**, ChevronTexaco
November 2003	***Mt. Burdell*** *(with a hike to the top!)*	**Rick Ford**, SFSU Graduate Thesis
Summer 2004 (TBA)	***Northern California Gold Belt, Quincy*** *(BLM has put all travel on hold)*	**Gregg Wilkerson**, BLM

National Earth Science Day, Black Diamond Mines Regional Preserve Educator's Day

Saturday, October 25, 2003

To help celebrate National Earth Science week, the East Bay Regional Park District and the Northern California Geological Society are hosting on Saturday October 25, 2003 a very special field trip for Bay Area teachers at Black Diamond Mines Regional Preserve, Antioch. The setting for the field trip is the coal mines and historic cemetery located in the foothills of Mount Diablo. The area played an important part in the early history of San Francisco Bay Area as it provided much of the coal needed for the emerging industries. A total of over 4 million tons of coal were mined between 1860 and 1904. The Mount Diablo Coalfield became the major population center in Contra Costa County during the 19th century and five mining towns were established in the coalfield. The coal mines finally closed about the time of the 1906 earthquake and the towns were abandoned leaving behind the many miles of underground coal workings and Rose Hill Cemetery. These unique facilities are maintained by the East Bay Regional Park District and are an ideal location for school field trips.

The field trip will be led by professional geologists from the Northern California Geological Society and naturalists from the Park District. The size of the group is limited to 30 teachers. The morning will be spent underground exploring the mines workings. Hard hats and flash lights will be provided. After the mine tour, a barbecue lunch will be served in the Picnic ground that will be followed by a leisurely walk through the old town site of Somersville and Rose Hill Cemetery. At the cemetery, the families of the mining communities are buried and we will learn about their way of life using records and the inscriptions preserved on the headstones.

A fee of about $25 will be charged to cover the costs of an extensive set of handouts and other resources that will be provided to the teachers on the geology, mining and history of the Mount Diablo Coalfield. 1 unit of academic credit is also available for this class on application through the EBRP Academy and California State University, Hayward.

For further information please contact Ray Sullivan at 415-338-7730 or sullivan@sfsu.edu

Please help us get the word out and send word of this announcement this to your favorite teacher!

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

Geology of the Clear Lake Volcanic Field, California

Saturday August 2, 2003

Trip Leader:

Dr. Rolfe Erickson, Sonoma State University

The active Clear Lake volcanic field lies ~80 miles NE of Oakland. The field is young, with units ranging from ~2.5 Ma to perhaps 10 Ka. The field has not developed a caldera nor large pyroclastic flows but may do so in the future. A spectrum of geochemical / petrological rock types are present, from basalt to rhyolite, with flows of all compositions and felsic tuff present in a large number of separate eruptive units. The field is small as are most of the units in it, and many of its major features can be examined in a day, making it an excellent area for petrologic instruction. A large magma body has been detected geophysically under the west central part of the field, but only subvolcanic phenomena such as the original fumaroles at the Geysers are active today. The largest effect of the magma at present is to drive the steam production in the Geysers steam field that lies just west of the volcanics.

The USGS has recently (1995) published a beautiful large format 3-sheet 1:24000 map and sections of the field. A number of recent studies there have been on such topics as isotope geochemistry, evidence for magma mixing, and the lower crustal metamorphic xenoliths found in some units. Research is active in the area.

The exact itinerary of the trip is still evolving, but we will at least examine the base of the volcanic section where the first eruptive products can be seen accumulating on the Mesozoic basement; representatives of the major rock types, including a flow which originated by magma mixing and a complex obsidian flow; base-surge deposits associated with small maars (explosion craters); the Sulphur Bank mine/EPA superfund site; a cinder cone where lower crustal xenoliths can be found; collapse deposits; and Mt. Konocti itself. We will discuss the source(s) and evolution of the magma(s) in and of themselves and as they relate to California tectonic history.

Rolfe Erickson earned his BA in Geology at Michigan Technological University in 1959, his MS in Geology in 1962 and his PhD in Geochemistry in 1970 from the University of Arizona. He has worked his entire professional career at Sonoma State University where he began in 1966. He teaches mineralogy, optical mineralogy, crystallography, igneous and metamorphic petrology, computer applications, and two field geology courses. His research interests are presently in the petrology of individual exotic blocks in the Franciscan depositional melanges around Cazadero, in peraluminous plutons in the Death Valley area, and in possible tektites found in Dry Creek valley west of Healdsburg.

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

Time: Saturday, August 2, 2003; leave Ferry Terminal @ 8:00 am (7:30 am coffee, pastries); return about 5:30 pm

Departure: We will meet at the northern side of the Larkspur Ferry Terminal (no charge for parking), closest parking area to Sir Francis Drake Blvd.; and carpool from there; We will also make a stop at the Rohnert Park 'park & ride' to pick up additional people who live further north.

Cost: $35**; $15 for adolescents (11 to 17). Cost includes transportation, refreshments, lunch, and field guide.**

********** **REGISTRATION FORM --- <u>PLEASE RSVP by Monday, July 28, 2003</u>** **********

Name _____ **E-mail or Fax No.** _____

Address (Street/City/Zip)_____

Phone (day) _____ **Phone (evening)** _____ Indicate if you are a nonmember (cost is $40) _____

Regular Lunch _____ Vegetarian Lunch _____ **(Please check one)** Indicate if you plan to meet us at Rohnert Park _____

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

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

Geology of the Point Reyes Area, California

Saturday, September 27, 2003

Trip Leader:
Tom MacKinnon, Consultant

Co-Leader:
John R. (Rusty) Gilbert, ChevronTexaco

In the Point Reyes area, movement along the San Andreas Fault has juxtaposed two disparate geologic assemblages. On the Pacific side, granitic basement and overlying mainly Mio-Pliocene sedimentary cover are present and form the Point Reyes Peninsula. In contrast, the eastern side is composed of variably metamorphosed, mainly Cretaceous, sandstone, shale, volcanics and chert of the Central Belt of the Franciscan Complex.

Our first two stops will be in the Franciscan where we will examine an outcrop of pillow lavas and an outcrop of the most common Franciscan rock types, graywacke (sandstone) and shale; both outcrops are considered to be blocks within melange, a characteristic of the "Central Belt". We'll try to spark a lively discussion on the origin of the Franciscan. Our next stop will be at the Point Reyes visitor center where we will see the San Andreas Fault. We will walk along the fault trace and discuss fault history, current research and predicted future movement. After lunch we will proceed onto the Point Reyes Peninsula to Kehoe Beach to view the granitic basement and overlying transgressive marine sequence including the siliceous shales of the Monterey Formation. Discussion topics will include the origin of Salinia and origin of the Monterey Formation; we will also summarize the petroleum exploration history in the Point Reyes area with reference to similar rocks in the Point Arena area. Our next stop will be at Drakes Beach where we will see extensive exposures of diatomaceous mudstone of the upper Miocene/Pliocene Purisima Formation. Our final stop (optional) will be to the Point Reyes lighthouse to see Paleocene turbidites, mainly conglomerate, that are inferred to have once been contiguous with the famous turbidite outcrops at Point Lobos near Carmel.

Tom MacKinnon received a BA and MA in Geology at the University of California, Santa Barbara in 1971 and 1975 respectively, and a Ph.D. from the University of Otago, New Zealand in 1981. He worked for ChevronTexaco for 21 years, including several years working on the geology of the Monterey Formation in California and seven years running the Chevron Corporation stratigraphic field schools. He "retired" from Chevron Texaco in 2002, taught a Geologic Hazards class at San Francisco State University in the Fall of 2002, and continues to work for ChevronTexaco on a part-time basis as a consultant.

John R. (Rusty) Gilbert received a BS in Geology from Rutgers in NJ in 1977 and an MS in Geology from the University of Massachusetts at Amherst in 1980. He has worked for Gulf Oil & ChevronTexaco since 1980 in a number of different domestic & international assignments, including preparing for various offshore California lease sales during the 1980's. He currently serves as Team Leader for the Stratigraphy & GeoStatistics Team with EPTC (ChevronTexaco's Exploration & Production Technology Co) based in San Ramon, CA.

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

Time: **Saturday, September 27, 2003; leave Ferry Terminal @ 8:00 am** (7:30 am coffee, pastries); return about 6:00 pm

Departure: We will meet at Larkspur Ferry Terminal (no charge for parking), closest parking area to Sir Francis Drake Blvd.; and carpool from there;

Cost: $40; **$15 for adolescents (11 to 17).** **Cost includes transportation, refreshments, lunch, and field guide.**

********** **REGISTRATION FORM --- PLEASE RSVP by September 23** **********

Name _____ **E-mail or Fax No.** _____

Address (Street/City/Zip) _____

Phone (day) _____ **Phone (evening)** _____ Indicate if you are a nonmember (cost is $45) _____

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

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

NCGS Field Trip to the Intersection of the Mt. Diablo Antiform and the Diablo Range

Reported by Richard Cardwell

Mt. Diablo, the Altamont Hills and the Diablo Range are some of the outstanding physiographic features of the Bay Area. Understanding how these features were formed has been the focus of several NCGS field trips. On Saturday, May 10, NCGS members and friends joined Ron Crane on a field trip to investigate the area where all these major features come together.

Since his retirement from Chevron, Ron has undertaken a major project to map and understand the geology of central California. The main products of his investigations are a series of geologic quadrangle maps and structural cross sections throughout the region. He has led numerous field trips in the area and has published seven field trip guidebooks through the NCGS.

Our day began at 7:30 a.m. at the Danville Park and Drive lot where Ron gave us an overview of the day's activities. He has subdivided central California geology into five domains each with consistent internal structure and stratigraphy. Ron's efforts have focused on understanding the structural relationships within and between domains. The domains are Mt. Diablo, East Bay Hills, Calaveras, Idria, and Diablo Range. The focus of this field trip is on the intersection of the Mt. Diablo domain with the Diablo Range domain.

The Mt. Diablo domain surrounds the 3849 foot peak of the same name, and is distinct from the Diablo Range domain. The Mt. Diablo domain consists of thrusted and folded rocks in the structure of an antiform. The Altamont Hills (with their wind turbines and the well-known Altamont Pass) are the southeastern extension of the Mt. Diablo antiform. This domain continues to the southeast with a saddle separating the Mt. Diablo antiform from the Black Buttes anticline.

The Diablo Range domain lies to the southwest of the Mt. Diablo domain, and it extends southeast to the Idria domain. In April we examined some of the geology of the southern Diablo Range domain on the field trip to Pacheco Pass led by Dr. Gary Ernst. The Diablo Range domain also consists of thrusted and folded rocks in the form of an anticline.

The main stratigraphic difference between these two domains is in the Cretaceous section. In the Mt. Diablo domain the bulk of the exposed sediments are Late Cretaceous while in the Diablo Range domain, the bulk of the sediments exposed are Early Cretaceous.

The main structural difference is that the Mt. Diablo domain is thrusted to the southwest while the Diablo Range domain is thrusted to the northeast. The San Ramon Valley is being compressed (shortened) by the southwest moving Mt. Diablo domain and the east moving East Bay Hills domain. Uplift and erosion of both the Mt. Diablo antiform and the Diablo Range is continuing today.

The highlights of the trip are discussed below.

Stop 1 is on Old Altamont Pass Road east of Livermore. Here we are in the Mt. Diablo domain. We are near the west flank of the Mt. Diablo antiform where it is plunging to the southeast. The faults bounding the western portion of this domain include a complex zone of thrust faults called the Greenville fault zone. The relationships here are clearly seen on cross section A-7. The antiform is asymmetric, overturned to the west. Here we see the structure in the upper Miocene Cierbo sandstone, a shoreline sand lying directly on the Campanian section.

Stop 2 is near the crest of the Mt. Diablo antiform. Here outcrops of flat lying Campanian sands and shales are exposed along the old transcontinental railway route. The geometry can be seen on section A-8. These sands are deep sea fan deposits sourced from the Sierra Nevadas. The outcrops contain many large and small concretions.

Stop 3 is on Grant Line Road on the east flank of the Mt. Diablo antiform (section A-12). Here we see the upper Miocene Neroly formation. It is a river (fluvial) deposit containing sands and pebbles with a striking blue coloration. The blue color is due to a montmorillonite-like clay mineral derived from a volcanic ash coating the sand grains.

Stops 4 and 5 are along Corral Hollow Road. We are still in the Mt. Diablo domain, but we have crossed a saddle in the structure separating the Mt. Diablo antiform from the Black Buttes anticline. The Campanian is thrust east over the Pleistocene along the Black Buttes fault (sections A-20 and A-21). This uplift is more recent than the Mt. Diablo uplift and must have occurred during the Pleistocene to Recent. Further along the road at Stop 6 we see the shallow dips in the Neroly formation at Castle Rock.

After lunch at Carnegie Motorcycle Park we turn onto Tesla Road for a series of stops. Here we are in a complex intersection zone between the Carnegie fault and the Corral Hollow fault. These are major bounding faults marking where the Diablo Range is thrust northward toward the Mt. Diablo domain creating a tightly squeezed trough between them.

At Stop 7 the Cierbo formation is steeply folded with near vertical beds (section A-17), and at Stop 8 we observe the Neroly from a distance showing nearly 80^{o} dips (section A-16).

We continue up the road for Stops 9 and 10 to examine outcrops of the Tesla formation (sections A-15 and A-14). Tesla is an Eocene formation equivalent to the Domengine section further to the north, and is composed of sands, coals, dark shales and clays. The Tesla has a high organic content and is the most likely source rock for the oil in the Livermore Oil Field. Oil seeps were first noted in the nineteenth century, and the field was drilled in the early part of the twentieth century.

Thin, soft brown coal beds in the Tesla were once mined in a commercial operation. The coal beds have a distinct yellow coating of sulfur on their surfaces. NCGS members collected gypsum rosettes (hydrous calcium sulfate) from the Tesla formation surrounding the coal beds.

Stops 11 and 12 are on Greenville road for a view of the Las Positas fault uplift (sections A-11 and A-10). Gravels transported from the Diablo Range were uplifted into an antiform during Holocene time.

The NCGS sincerely thanks Ron Crane for leading this excellent field trip. His field guide describes the trip in detail and includes many colored geologic maps and cross sections of the area. We thank Jean Moran for organizing the trip, handling trip registration, and arranging transportation. We thank Tridib Guha and Dan Day for lunch arrangements.

Geology of the Right Stepover Region Between the Rodgers Creek, Healdsburg and Maacama Faults

Reported by Tom Wright

Thirty-one members of NCGS enjoyed a wonderful field-trip in the mountains of Sonoma County over the weekend of June 6-8. Our tour was led by Bob McLaughlin and Andrei Sarna-Wojcicki of the USGS and Dave Wagner of the California Geological Survey (CGS). They provided a progress report (including a fine guidebook) on recent studies of the long-neglected North Bay region, where active dextral faults juxtapose hard-to-differentiate sequences of poorly-exposed late Cenozoic volcanic rocks. Our base was Pepperwood Ranch north of Santa Rosa, formerly a Bechtel family property and now a preserve owned by the California Academy of Sciences. Evenings were centered in the main room of Bechtel House, with preliminary geological maps available for discussion. The advance guard on Friday night fed on pizza and on Saturday night the entire group feasted on Tridib Guha's splendid barbecue of salmon, chicken, roast corn, and beans. The only downsides to the weekend were: the thick, wet fog that enveloped our mountainside lair late each evening and at Saturday's Stop 1, reduced our "360-degree regional overview" to a few hundred feet; and the rambunctious nanny-goat at Stop 3, the best accessible exposure of the southern Maacama fault but located in a goat pen where the goats browse on poison oak and then nuzzle any trespassers (this goat ate part of John Karachewski's guidebook while John was trying to photograph the fault!).

Ongoing geological studies in the North Bay area, aimed at a better understanding of its earthquake history and seismic hazards, are being funded through elements of the National Geological Mapping Act of 1992. Those elements include: FedMap, that is funding USGS mapping north of Santa Rosa; StateMap, providing 50/50 Federal matching of State funds for work in the southern Sonoma Mountains; and Edmap, supporting several exceptional graduate students in thesis mapping under CGS and USGS guidance. All the mapping is at the 1:24,000 scale. The USGS is providing argon/argon dating and the wonderful tephrochronology of Andrei Sarna-W, who has fingerprinted at least 12 tuffs and flows within the 8.17 (8.65?) to 1.96 Ma span of the Sonoma Volcanics. Results to date from this joint project suggest a very fruitful synergy within this group.

Saturday's trip ranged north and west of Santa Rosa and was led by McLaughlin and Sarna. Of particular interest was the Maacama fault and the ash beds and fluvial gravels that constrain geological mapping in this area. Six of the nine stops are accessible to the public and the guidebook includes a road-log, map and stop descriptions. Lunch was at the Petrified Forest, a vintage tourist stop, where redwoods and other conifers lie entombed in a 3.35 Ma ash bed. At stops 1, 3, and 5 we saw the Maacama fault in detail and in the geomorphic features of an active dextral fault zone up to 1 km wide. To the south in the Santa Rosa area, the right-step from the Maacama fault to the Rodgers Creek fault is reflected in the local, north-trending Rincon Valley graben, but elsewhere the new mapping shows a more complex structural pattern. The N-NW-trending Maacama fault zone is superimposed on a series of W-NW-trending, NE-dipping thrust and reverse faults that have shaped the valleys and ridges within and NE of the stepover area. These W-NW-trending faults are thought to be relicts of the Cascadian convergence regime, though some are seismically active (as is the Maacama fault). Offsets of obsidian-pebble lithofacies in Plio-Pleistocene gravels from their very localized sources east of the Maacama fault give a minimum displacement of 13 km on the fault; offset of a 2.85 Ma ash flow tuff section (visited at stops 5 and 7) suggests a displacement of about 24 km. Our last stop on Saturday was on the subdued scarp of a down-to-the-east fault that cuts the Santa Rosa plain. This broad plain has been built of fluvial sediments derived from the mountains to the east. Beneath it, as shown by Bouguer gravity, are the Windsor and Cotati basins, 2.5 to 3 km deep.

After breakfast on Sunday we caravanned an hour south from Pepperwood, through Petaluma and along Highway 116 into the southern Sonoma Mountains. As the entire day's trip would be on private ranch lands, there is no road log or map in the guidebook. Dave Wagner has provided a summary of the geology and tectonics of the area and was leader for the day, introducing at various stops the three graduate students who have worked within the EdMap program. On the east flank of the mountains along the Bennett Valley fault, Jim Allen (MS, San Jose State) presented a long-needed comprehensive study of the Petaluma Formation (8.4 to 4 Ma) and its western, marine equivalent, the Wilson Grove Formation. Argon/argon dating and tephrochronology by the USGS provides the essential framework for Allen's study and, in a significant breakthrough, includes a dating (9.3 - 9 Ma) of the volcanic rocks beneath the Petaluma Formation in the Petaluma oilfield. The lower Petaluma, 90 to 183 m thick, is shallow-marine to lacustrine mudstone that likely sourced the oil in that small field. Allen has differentiated the middle and upper Petaluma, fluvial to shallow-marine deposits derived from the east and totaling at least 1037 m in thickness, on the basis of clasts in the conglomerate beds. Both units contain Franciscan clasts but the upper

Petaluma conglomerates are dominated by clasts of Monterey chert and a unique white sandstone with glauconite and quartz veins. This distinction is carried westward into a belt of interbedded Petaluma and Wilson Grove formations that represents an oscillating Mio-Pliocene shoreline. The Monterey clasts are readily related to the 13 Ma Claremont chert but Allen had to search the East Bay Hills to find the source of the white sandstone in the Briones Formation east of San Jose. This match suggests a right-slip of about 67 km across the Hayward fault – and its northern equivalents – since about 5 – 6 Ma. Regarding the northern extension of the Hayward fault, Jim Allen has dropped a bombshell by finding unequivocal outcrops of upper Petaluma east of the Rodgers Creek fault within and on the east flank of the Sonoma Mountains. This appears to require a hitherto-unrecognized extension of the Hayward fault that veers northerly beneath San Pablo Bay and beneath the alluvial floor of the Sonoma Valley, complicating the right step from the Hayward to the Rodgers Creek fault.

After Allen's presentation we followed ranch roads onto the crest of the Sonoma Mountains and encountered the Rodgers Creek fault at Lee Lake, certainly the loveliest sag pond this geologist has yet seen. Carrie Randolph-Loar led us south along the fault zone to the site of her Gravelly Lake trench, a key element of her recent MS thesis at San Francisco State. The trench site was chosen after detailed air-photo mapping and a ground-penetrating-radar transect that proved to show quite clearly the two fault traces and several key horizons later revealed by trenching. The paleoseismic investigation at this site documented six events over the past 6,800+ years, with three events in the past 3,700 years. Earlier trenching some 8 km to the north (visited by a 1992 NCGS field trip) had found three events over the past 925 – 1,000 years, with a recurrence interval of 230 years. Several explanations were advanced for this discrepancy and further trenching is planned. We paused near the trench site for lunch and a brief presentation by Eric Ford, (SF State graduate student) on his mapping of the Burdell Mountain Volcanics (13.6 – 11.1 Ma) and Burdell Mountain fault zone, about six miles to the southwest. (Rick will lead a NCGS field trip there in November.) We were joined during lunch by the ranch owners, a pleasant and accommodating couple who accompanied us to the next several stops. These took us south into the trough between the Rodgers Creek and Tolay faults, where we saw an outcrop of Donnell Ranch Volcanics, 10.64 to 9.28 (8.52?) Ma, and discussed the complex faulting in this vicinity that includes east-vergent thrusting of Donnell Ranch Volcanics over Petaluma Formation. Recent major excavations at the Sears Point Raceway provided ephemeral exposures of a zone over 2,000 feet wide of intensely sheared Petaluma Formation and Franciscan rocks where the Tolay fault has been mapped. The Sears Point "anticline", a knob of Franciscan west of the Tolay fault, is now seen as a diapiric uplift, intermittently raised in late Miocene and subsequently. West of this uplifted knob, beneath the Petaluma River marshes and the Petaluma Valley, an inactive fault located chiefly by gravity data and called the Petaluma Valley fault, is believed to be the ancestral northern extension of the Hayward fault. Our final stop, just north of Highway 121, was a rhyolite outcrop just east of the Rodgers Creek fault, at about 8 Ma the oldest known part of the Sonoma Volcanics.

For those of us who are fascinated spectators as the interpretation of San Andreas tectonics unfolds, and may participate to the extent of occasionally throwing a loose ball back into the field of play, it is most heartening to see this team of skilled veterans and talented "rookies" working together in the North Bay region. We were left with a sense of great progress, yet much more work still to be done in unraveling a complex picture of late Cenozoic volcanism and evolving fault patterns in a young San Andreas transform zone. Just east of this zone in the Hollister area, the Quien Sabe Volcanics (11.6 – 7.4 Ma) are thought to correlate with the Burdell Mountain Volcanics (13.6 – 11.1 Ma), suggesting 175 km of displacement. Each successive fault block to the east contains a younger sequence of volcanic rocks: the Donnell Ranch Volcanics , 10.64 to 9.28 (8.52?) Ma east of the Petaluma Valley fault; the Sonoma Volcanics , 8.17 (8.65?) to 1.96 Ma within and east of the Rodgers Creek fault zone; and east of the Maacama fault, the Clear Lake Volcanics (2.2 – 0.007 Ma), the subject of a NCGS field trip on August 2. We have the concept of a volcanic hotspot (now the Geysers geothermal area) at the plate margin migrating northwestward in the wake of the Mendocino triple junction, perhaps a slab window behind the subducted Gorda slab. As portions of the resulting volcanic field become attached to the Pacific plate they are sliced off and carried northwest in a series of fault slices. In each slice the volcanic rocks are oldest at their southern end. The four volcanic units now overlap geographically, having been carried along almost as far as the "hotspot" has traveled over the past 12 My. The localized contraction north of San Pablo Bay, including the diapiric Sears Point uplift, may be involved in the deflection of dextral faulting from the Hayward fault north to Allen's postulated Sonoma Valley fault. This is just one of the complications yet to be resolved in the North Bay region. Bob McLaughlin and Dave Wagner have started to talk about a symposium on North Bay geology and tectonics at the 2005 Pacific Section/Cordilleran meeting in San Jose. I, for one, am looking forward to that!

Historical Data from the 1906 Earthquake Offers a New View of the Northern San Andreas Fault

Reported by Dan Day

Paleoseismologist **Carol Prentice** of the U.S. Geological Survey, Menlo Park, gave her audience a fascinating glimpse of the northern San Andreas fault at the June 25th NCGS Meeting. Her talk entitled ***At the Intersection of History and Geology: How Historical Research into the 1906 Earthquake Provides a Better Understanding of the San Andreas Fault*** gave an account of paleoseismic work she and other USGS scientists have done on the San Andreas using 1906 Earthquake historical records to guide their research.

Carol's first slides contrasted identical views taken in San Francisco on May 27, 1900, versus one from late April, 1906 following the April 18th earthquake. The devastation was remarkable. The principle report detailing the cultural and geological effects of the earthquake was edited by U.C. Berkeley professor Andrew Lawson, who headed the State Earthquake Investigation Commission. The latter was largely funded by money from the Carnegie Foundation. Carol and her colleagues used this report and archival records at the Bancroft and Stanford libraries to begin their research of motion along the San Andreas during the 1906 event. These resources yielded newspaper articles and photographs that could be used to corroborate the inferred fault offsets quoted in the literature. They also provided locations that could be checked to confirm these observations.

The literature search was not solely confined to the 1906 earthquake. Vital information was also provided by 1940's aerial photographs showing geomorphic features along the 435 kilometer-long 1906 rupture trace that have since been modified or destroyed by human activity. The reconnaissance work allowed scientists to select several locations for more detailed study. Carol's lecture covered four of these sites: Loma Prieta in the Santa Cruz Mountains, the San Francisco peninsula near San Bruno, Fort Ross on the coast north of the Marin Peninsula, and Shelter Cove near Point Arena where the San Andreas fault sets out to sea. All four locations exhibited ground rupture during the 1906 temblor, and had historical documentation that played a crucial role in the studies.

The October 17, 1989, Loma Prieta earthquake registered a magnitude 6.9, claimed 63 lives, and caused $10 billion in damage. The epicenter was located in the Santa Cruz Mountains at a depth of 18 km., and rupturing came no closer than 6 km. from the surface. There were numerous extensional ruptures in the Summit and Skyline Ridge areas, but no evidence of left-lateral slip. The paleoseismic team felt that a comparison with the 1906 quake, which also showed surface rupturing in this area, would be useful in resolving the tectonic model for this segment of the fault.

Using a 1975 map compiled by Sarna-Wojcicki et.al., Carol and USGS lead paleoseismologist David Schwartz confirmed a through-going trace of the San Andreas fault existed between Lexington and Elsman reservoirs in the vicinity of the Loma Prieta ruptures. Next they consulted the Lawson Report circa 1906, and referred to a survey of the area conducted by G.A. Waring. Waring was a Stanford graduate student working on the Lawson survey who recorded several tensional ruptures in this area off the main fault trace. His conclusions were limited by the lack of a paradigm for interpreting strike-slip fault motion. At this time, strike-slip motion was not recognized by most geologists. Waring was, however, a meticulous worker who documented his observations with detailed notes and many pictures. Several photos showed left-lateral offset that was subsequently reactivated in 1989. Key evidence for fault offset, however, was provided by Wright's Tunnel, a Southern Pacific Railroad tunnel that pierces the San Andreas fault near Loma Prieta. Waring's contribution to the Lawson Report includes evidence of tunnel offset contributed by a Southern Pacific Railroad engineer named Matthews. The 2 kilometer-long tunnel was offset 40 to 60 inches right-laterally about 120 meters from its east entrance. This offset range is based on three independent calculations and was thought to involve some shear deformation along the length of the tunnel. Southern Pacific alleged there were no original blueprints of the tunnel, and none have been found. Carol and her colleagues were forced to calculate offsets based on single fault plane versus distributed deformation models (incorporating a shear zone displacement to account for the measured offset). They calculated offsets using three methods and concluded that the post-1906 diagram of the tunnel displacement erroneously neglected to recognize that the west portal had been offset from the

eastern one. The USGS researchers surmised that the repair teams began work at both portals simultaneously, and eventually noticed that they would not meet if they assumed the portals had not been offset with respect to each another. Corrective action required that they follow a diagonal path to properly align the displaced portals. New estimates place the 1906 Wright Tunnel offset at about 1.8 meters (~6 feet). These observations confirm there was right-lateral displacement along the San Andreas in this area. The extensional faulting off the main fault trace would appear to be a near surface phenomenon independent of the major strike-slip activity.

Further north on the San Francisco peninsula the paleoseismic team had to deal with post-1906 urban development. Here important geomorphic features have been eradicated by modern construction activities. Fortunately, 1906 fault rupture photographs were recovered and supplemented by aerial photos from a pre-development 1946 survey to help researchers accurately locate the fault trace. This information was compiled into a GIS database which can retrieve photos of filled-in sag ponds, superimpose Alves-Priolo Act zones along the fault trace, and add fault traces from prior field surveys for comparison. This information is an invaluable tool for civic planning purposes.

Carol's next stop was Fort Ross on the Pacific coast north of San Francisco. Here the paleoseismic group wanted to determine slip rates along the San Andreas based on accurate C^{14} dates. Mill Gulch is a V-shaped stream gully that has been offset right-laterally 80 to 100 meters by the fault. The offset portion now forms an abandoned stream with a hanging valley that attests to post-offset coastal uplift. Here Highway 101 is also cut by the San Andreas. The challenge was to identify and date the youngest sediments in the abandoned stream as a time marker of initial stream offset. However, the exact location of the fault had to be determined to accurately measure the offset and calculate a slip rate. For this project, the group consulted a 1908 plane table map made by Francois Matthes, a geologist best known for his interpretations of Yosemite Valley geology. Matthes' 5-foot contour map provided the detail needed to dig a trench and precisely locate the fault. Organic matter from the uppermost layer of the abandoned stream channel gave a date of ~5000 years B.P., and a slip rate of 18±3 mm/yr. This is nearly identical to San Francisco peninsula slip rates.

An example from Shelter Cove, where the San Andreas heads seaward, completed Carol's presentation. Here Matthes had surveyed the earthquake damage in 1906 and noted strong shaking from Point Arena to Shelter Cove. The actual existence of the fault in Shelter Cove has been heatedly debated. Matthes' hand drawn map of the area was used to pinpoint geomorphic features that could be used to identify right-lateral slip, and presumably the San Andreas fault trace. Close examination of beach outcrops revealed a local shear zone that showed right lateral shear even in oriented thin sections. Shutter ridges, associated with strike-slip movement, are present in the area, and trenched features resembling shear zones also exhibited slip offset. Telegraph Creek shows about 180 meters of slip offset, which occurred over a 13,000-year time interval, based on age dating of basal stream deposits. This translates to a 14mm/yr slip rate on a fault that showed surface rupture in 1906, and is comparable to the San Andreas slip rates. Carol and her colleagues feel that these factors are strong evidence that the San Andreas fault passes through Shelter Cove. North of this point experts are unsure if the fault comes landward again.

Paleoseismic research has helped define the nature of the 1906 San Andreas fault rupture, determine its location where hidden by subsequent urban development, helped accurately calculate its recent slip rate at Fort Ross, and has resolved the question of its presence at Shelter Cove. The GIS system devised for the Peninsula segment of the fault has application to city and disaster planning, but has serious political and real estate implications. This spin-off of the project will require careful discussion with city managers before it is released to the public. Another interesting side issue of this presentation is the identification of strike-slip as a viable fault mechanism. The 1906 earthquake definitely forced geologists to recognize the San Andreas as a strike-slip fault. Strike-slip fault motion was gaining acceptance in New Zealand and Japan in the 1890's. However, even as late as the 1950's renowned geologists like Tom Dibblee were still trying to convince the geological community that strike-slip was the dominant motion on the San Andreas fault.

The NCGS wishes to show its appreciation to Carol Prentice for an excellent presentation on the application of historical data to resolve key issues about the northern segment of the San Andreas fault. Her talk clearly emphasized the usefulness of archived reports and photographs to present seismic research in areas where cultural development has marred or destroyed valuable geomorphological features. Paleoseismology has also proven to be an important tool for characterizing the nature of motion along the San Andreas fault system.

24th Biennial Groundwater Conference and 12th Annual GRA Meeting

October 28-29, 2003
DoubleTree Hotel, Ontario, CA

THE ROLE OF GROUNDWATER IN INTEGRATED WATER MANAGEMENT

Keynote Speaker -- Dr. Chip Groat, Director of the USGS

CALL FOR POSTERS

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Conference and Theme: For 48 years, the Biennial Groundwater Conference has provided policy-makers, practitioners, researchers, and educators the opportunity to learn about the current policies, regulations, and technical challenges affecting the use and management of groundwater in California. The theme of the 24th Biennial Groundwater Conference is "The Role of Groundwater in Integrated Water Management" and will emphasize the interconnected nature of water resources at basin-wide, regional, and global scales. Presentations will explore the role of groundwater in formulating water policies, planning and managing water resources, and optimizing beneficial uses.

Keynote: The Plenary session will begin with a keynote speech by **Dr. Chip Groat**, Director of the US Geological Survey. His speech will focus on recent publications and programs of the USGS that have emphasized the integrated nature of water resources, challenges of groundwater sustainability, the importance of long-term groundwater monitoring for water resources management, the importance of assessing water availability and use, and national goals for collecting and disseminating the necessary information for integrated water resources planning and management.

Venue: The two-day Conference features a Plenary session, concurrent policy and technical sessions, and a final general assembly.

The Session Topics Are:

* Regulatory and legislative actions affecting groundwater
* Developing a sound groundwater management plan
* Integrated water management
* Wastewater management
* Public outreach and public involvement strategies
* Desalination technologies
* Tools for quantifying groundwater resources
* Emerging contaminants
* Contaminant fate and transport
* Calculating a groundwater budget
* Transboundary and international issues

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Registered participants are invited to present posters summarizing results of their professional work that are relevant to groundwater issues in California. Participants interested in giving a poster presentation are invited to prepare and submit an abstract. ***The deadline for submitting an abstract is August 8, 2003.***

* Poster Presentation Information Sheet - **http://www.grac.org/PosterGuidelines.pdf**
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Visit the University of California Water Resources Center web site, **http://www.waterresources.ucr.edu**, for more details as they develop. For more information, contact **Pamela Dick** at the U.C. Center for Water Resources, **(909) 787-4327**. ***Information updates will also be posted on the GRA web site at*** **http://www.grac.org/conference.html**