NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

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More Field Trip Photos Added!
Future Abstracts Available!

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MEETING ANNOUNCEMENT

DATE: **Wednesday, June 30, 2004**

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: **David A. Bero, P.G., R.G.**

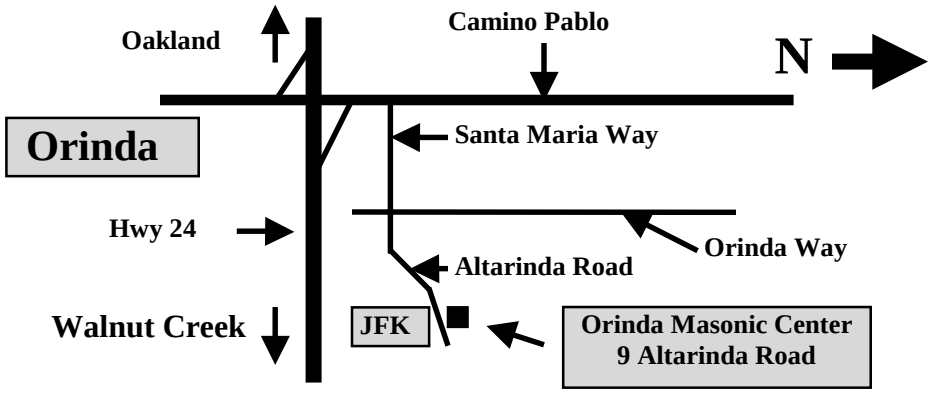
Geology of the Tiburon Peninsula, Marin County, California

Preliminary results of on-going detailed geologic mapping on the NW-SE trending Tiburon Peninsula, southern Marin County, has revealed a complex but locally coherent terrain composed of variably deformed and metamorphosed rocks of the Franciscan Complex. The structurally lowest terrain in the area consists principally of interbedded sandstone and shale, graywacke, lesser conglomerate, chert, and minor basalt (greenstone). This terrain is overlain by ultramafic (um) rocks composed mainly of altered peridotite (harzburgite) and serpentine which were originally emplaced along a low-angle fault. Uplift and extensive erosion has exposed large portions of the footwall sedimentary and volcanic terrain leaving two erosional remnants, or klippen, of the hanging wall um rocks: a roughly circular sheet capping Ring Mountain located in the NW portion of the peninsula, and an elongate, complexly folded and faulted sheet capping the central and SE portions of the peninsula.

The fault zone at the base of the overlying um rocks can be seen in various exposures throughout the peninsula and is recognized by the occurrence of pervasively sheared serpentinite and/or talc schist. It is also recognized by the presence of high-grade metamorphic blocks of varying size composed of blueschist, eclogite, and/or amphibolite that have weathered out of the soft, fault-sheared matrix and remain as dense, isolated blocks along the fault contact. These features are especially well exposed at Ring Mountain where the faulted base of the um sheet has been extensively exposed by erosion.

Footwall rocks exhibit alteration characteristics that increase as the fault is approached. Typically, red-bedded chert becomes intensely folded, bleached, brecciated, and re-silicified; relatively unaltered graywacke and/or interbedded sandstone and shale become increasingly foliated and commonly contain thin, tightly folded, quartz-filled cross fractures as the fault is approached. Clastic rocks adjacent to the fault contact commonly exhibit a well-developed schistose texture defined in hand specimen by the occurrence of thin bands of chlorite smeared around more resistant lens-shaped quartz grains. Preliminary thin section analyses of these shear zone schists indicate that they contain euhedral tablets of lawsonite within a cataclastic, clay-altered matrix. The

Meeting Location



textural features observed within the footwall rocks are interpreted as having been produced during emplacement of the overlying um sheet. The presence of euhedral lawsonite observed within the clay-altered matrix of the footwall schists indicate that these rocks were also subjected to localized high P/T conditions either during emplacement or post-emplacement of the overlying um sheet.

David Bero is a registered geologist in California and Wyoming. He received a Bachelor's degree in geology from Humboldt State University and a Master's degree in geology from CSU Fresno. He also studied economic geology and tectonics as a graduate student at the University of Arizona. He worked as an exploration geologist for various U.S. mining companies from 1980 – 1990, working throughout the Great Basin, the Klamath Mountains, the Sierra Nevada, and in Central America. From 1990 to the present he has worked as a consulting geologist for various engineering firms within the Bay Area and Sonoma County. For the past 14 years he has been mapping the geology of various areas within the Franciscan Complex. These studies include portions of the Sonoma County coastline near the town of Jenner and, more recently, the Tiburon Peninsula. He presented a preliminary geologic map of the Tiburon Peninsula at the recent GSA meeting held in Seattle, WA, in November 2003. This mapping effort has led to additional on-going studies of Tiburon Peninsula geology as well as other areas within southern Marin County.

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

NCGS 2003-2004 Calendar

Wednesday June 30, 2004
David A. Bero, P.G., R.G.
Geology of the Tiburon Peninsula, Marin County, CA
7:00 PM at Orinda Masonic Center

Upcoming NCGS Field Trips

July 10, 2004	***Geology and Groundwater Resources of the Merced Formation in the Westside Basin of the Coastal San Mateo and San Francisco Counties*** Ed Clifton, Ralph Hunter (Retired USGS), and Gregg Bartow (Public Utilities Commission)
Fall 2004	***Devil's Slide*** Carl Wentworth, U.S.G.S. and others
Fall 2004	***East San Jose Landslide - Tectonically Driven?*** Sands Figuers, Norfleet Consultants

Upcoming Meetings of Interest – Bay Area Geophysical Society

June 17, 2004 BAGS Luncheon:
Michael E. Pasyanos, Lawrence Livermore National Laboratory, Crust and Upper Mantle Structure Derived from Surface Wave Tomography

- **Location**: ChevronTexaco 6001 Bollinger Canyon Rd., San Ramon, CA 94583
- **Lunch**: 11:30 a.m., Cafeteria (Building A)
- **Talk**: 12:30 p.m., Rm. D1038
- **Map**: ChevronTexaco Park

Non-ChevronTexaco employees RSVP by email to WilliamAbriel@chevrontexaco.com or phone Bill Abriel at 925-842-3423 by 4:00 p.m. Tuesday, June 15th to request a visitors' pass.

No charge for this program. Lunch may be purchased in the ChevronTexaco cafeteria.

If you are coming for lunch, enter through the main gate, pick up your visitor pass from the receptionist in Building A, and meet us in the cafeteria (also in Building A). Look for us at a long table with a white tablecloth on the lower level, to your right after you exit the cashier. After lunch we will walk to the room where the talk will be held.

An abstract and biography is at:
http://sepwww.stanford.edu/bags/Talks

www.ncgeolsoc.org

Please check our website for abstracts and biographies for up coming (and previous) talks under the "Meetings" page. We've also recently posted photos and field trip reviews for all field trips (except the most recent). This includes the: June 2002 Sierra Buttes and Sixteen-to-One Mine, January 2003 San Francisco Bay Model, February 2003 Northbrae Rhyolite, April 2003 Pacheco Pass - Franciscan Metasedimentary Section, May 2003 Diablo-Antiform – Diablo Range Intersection, June 2003 Geology of the Right Stepover Region – Rogers Creek and Maacama Faults, August 2003 Clear Lake Volcanics, and the September 2003 Geology of the Pt. Reyes Area. See where we've been and what you may have missed! These pages are still a good way to see and learn a bit more about local geology. You'll find these under the "Pictures From Events" page. Please also let us know what you like or dislike about the website, and what you might find helpful for future use.

Employment Opportunity

Diablo Valley College in Pleasant Hill, California, is currently seeking qualified individuals for **part-time teaching opportunities in the geology department**, day program, for the fall term, beginning August, 2004. Minimum qualifications include a Master's Degree in geology, geophysics, earth science, meteorology, oceanography or paleontology, OR a Bachelor's Degree in geology AND a Master's in geography, physics or geochemistry, OR the equivalent. A Master's Degree in geology is preferred. Interested individuals should contact Jean Hetherington, 925-685-1230 x2462 or jhetheri@dvc.edu. Information about the college can be found at www.dvc.edu

Mt. Diablo South Flank
NCGS May 2004 Field Trip

Reported by ***Richard Cardwell***

Looming above the East Bay, Mt. Diablo is the outstanding physiographic feature of the region. Because of its great height and geographic isolation it forms the basis for the geographic reference system (townships, ranges and sections) used in surveying much of California and Nevada.

It is one of the four major peaks that dominate the landscape of the Bay Area and, at 3849 feet, is third in height behind Mt. Hamilton in the Diablo Range and Mt. St. Helena in the Mayacmas Mountains. It is reported that the area viewed from the summit is unsurpassed anywhere on earth except for the view from Mt. Kilimanjaro. From the top it is possible to see across much of California from the Sierra Nevada to the Golden Gate (and some say as far west as the Farallon Islands).

The origin of the Mt. Diablo structure has been argued for quite some time. Various explanations have included diapiric origins, piercement structures, and volcanic processes. Since his retirement from Chevron, Ron Crane has undertaken a project to map and understand the geology of this feature and the surrounding region. In 1995 he proposed that Mt. Diablo consists of thrusted rocks folded into the structure of a broad antiform. The antiform originated as a west-verging backthrust that was formed by an eastward driving wedge of sediments in front of the Salinian block. Major compression and uplift of the Mt. Diablo antiform began about 4 to 5 million years ago and is continuing today.

Mt. Diablo has been the focus of several NCGS field trips. On Saturday, May 1, NCGS members and friends joined Ron on a field trip to investigate the geology of the south flank of the Mt. Diablo structural domain. Ron led a similar field trip to the north flank in May, 2002.

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. The highlights of the trip are discussed below.

Stop 1 was on Peters Ranch Road in Danville west of Highway 680. Here we were in the East Bay Hills domain looking east toward the Mt. Diablo domain. We could see across San Ramon Valley to a series of three low ridges culminating in the Mt. Diablo massif. Each of these ridges was uplifted along a west-verging thrust fault.

In Ron's view the Calaveras fault is interpreted as a thrust fault on which the East Bay Hills are being thrust to the east. This interpretation contrasts with the more conventional view in which the Calaveras fault is primarily a strike-slip fault like the Hayward and San Andreas faults.

The San Ramon Valley is being compressed (shortened) between the southwest moving Mt. Diablo domain and the east moving East Bay Hills domain. Sediments in the San Ramon Valley have subsided over 18,000 feet.

Stop 2 was on Paraiso Drive at the bridge across San Ramon Creek in Danville on the east side of Highway 680. Here we were in the leading or southernmost edge of the Mt. Diablo domain. Beneath the bridge over San Ramon Creek we could see nearly vertical dips in the streambed. This deformation and the presence of a small bump in the topography suggest that we were standing on small thrust anticline that forms the leading edge of the Mt. Diablo domain.

Stop 3 was at the Finley Road entrance to Morgan Territory Regional Park east of Blackhawk. Here we were on the southeast flank of the Mt. Diablo domain. We walked down section on the northern flank of an up turned syncline. We started in the Upper Miocene section and walked through the Diablo formation, the Neroly sandstones, and the massive Briones sandstones. We continued to the Middle Eocene Domengine sandstone outcrops. We then crossed the Riggs Canyon Thrust Fault that thrusts Upper Cretaceous over Tertiary and Cretaceous rocks. North of the fault we were on an overturned anticline in the Campanian section.

For Stops 4 and 5 we drove up South Gate Road to the south entrance of Mt. Diablo State Park and had lunch at Rock City. Here we were again in the up turned northern flank of the San Ramon Valley syncline in the Domengine formation. These Middle Eocene sands of the Domengine formation were deposited down slope of the shelf edge in deep water.

The Wind Caves at Rock City are in the Domengine formation. The caves are not formed by wind, but in fact are formed by water percolating through the sand and dissolving the cement holding the sand grains together. We also observed iron stained bands in the sandstone known as Liesegang structures. These formed as a source of iron hydroxide diffused through the sandstone creating a beautiful banded appearance in the rock.

Stop 6 was at Curry Point on South Gate Road. The parking area is in a shaley Early Eocene section resting unconformably on Upper Cretaceous Campanian rocks. Here we viewed the south flank of Mt. Diablo. Much of the south side of Mt. Diablo is composed of greenstone and chert sequences of the Franciscan complex. At the base of this section is the Diablo Thrust that placed the Franciscan complex on Albian shales.

The Diablo Thrust separates the Tertiary and Campanian sediments in the syncline from the thrusted rocks of Early Cretaceous and Jurassic that are involved in the core of the antiform. In Albian time a section of oceanic crust and its overlying sediments was imbricated in the accretionary prism east of the oceanic trench. In Ron's interpretation a portion of this oceanic crust slid into a subsea trough and rested on Albian shales deposited in the forearc basin. The Mt. Diablo massif consists of a preserved section of oceanic crust including gabbro/diabase, serpentinite, basalt flows and pillows, and chert.

In driving from Stop 6 to Stop 7 we crossed the Diablo Thrust. Stop 7 was just up the road near The Pines Camp in the Franciscan complex. Here we had an overview of the entire southern flank of the uplift, and back across the San Ramon syncline toward Stop 1 where we began the day. The ridges are formed by two dominant sand sequences. They are the Eocene Domengine sand and the Miocene Briones sand.

At Stop 8 further up Summit Road we paused to observe some folded and faulted chert beds in the Franciscan. The chert overlies greenstone in other areas not visited on this trip. We continued up Summit Road crossing the axis of the Mount Diablo antiform near Laurel Dell camp.

Stop 9 was in the parking lot at the summit of Mt. Diablo. The Summit Visitors Center is built from fossil-rich Briones sandstone, but unfortunately is closed now. After taking in the view we proceeded to do a half mile hike around the summit on the Fire Interpretive Trail. Here we could see many of the rocks characteristic of the Franciscan including greenstones, red chert, pillow basalts, graywacke, and argillite.

The NCGS sincerely thanks Ron Crane for leading this excellent field trip and providing the field guide describing the trip in detail. We thank Tridib Guha for organizing the trip, handling trip registration, and arranging transportation. We thank Phil Reed and Don Lewis for their continued hard work getting coffee, donuts, lunches, and refreshments. And, of course, we thank all the drivers for the use of their cars.

Remote Sensing and GIS Revolutionize Map Making

*Reported by **Dan Day***

The May 26th NCGS meeting explored the applications of remote sensing and global imaging systems (GIS) to map making. Our speaker, James Ellis, of Ellis GeoSpatial, Walnut Creek, illustrated the tremendous contributions of cutting edge imaging technology to geoscience applications in "Mapping with Remote Sensing and GIS." Jim has spent twenty years in remote sensing and related technologies, first for Gulf Oil, then for Chevron, applying his skills to international environmental and exploration problems. In 1997 he helped establish The Map Factory. ChevronTexaco was a major customer. Two years ago he founded Ellis GeoSpatial to provide remote sensing and GIS solutions to private industry and government clients. He is considered a leading expert in remote sensing and GIS applications to the geosciences. And his presentation thrilled the audience with the versatility and the quantity of information that can be stored on a computerized map using today's digital technology.

Jim's talk covered the new high-resolution satellite images available on the internet, thermal imaging, hyperspectral imaging, digital elevation models (DEM), and combining images to construct a GIS. High-resolution satellite images capture visible and near infrared (longer wavelengths) spectra reflected off the earth's surface using IKONOS and Quickbird technology. The satellite sensor separates red-green-blue (RGB) and near-infrared spectra with an 8-foot square pixel resolution. Software algorithms can merge this acquired data into 2-foot pixel resolution. These images can be classified to show vegetation, soil types, and man-made surface features. Jim illustrated the functionality of these images, "layered" according to their red, green, blue, and near-infrared spectra, using a satellite image of the former Tosco refinery near Martinez, California. Clients may want to monitor vegetation distribution to find areas where plants are not growing. These sites may signal toxin release points where equipment repair and remediation are needed. Specific sites can be imaged over time to see if corrective measures have successfully restored plant life. The images can also be electronically traced upon to mark roads and buildings for infrastructure assessment. This information is particularly useful to government agencies.

Thermal imaging is another practical imaging tool. The thermal sensor in the imaging device detects heat emitted by surface materials. As an example, Jim

displayed a thermal camera that he used to take aerial images of Lake Merritt in Oakland. The colorized thermal image was superimposed on an aerial picture of the lake; the colors contoured ambient temperature ranges. Lake Merritt was sharply zoned into thermal regimes. Upon closer examination, these areas reflected the thermal effects of a floating divider across the lake, a fountain, and the point entry of storm water drainage into the lake. The environmental applications of this technology, particularly for monitoring industrial sites, are appealing.

Hyperspectral imaging is a revolutionary concept used to evaluate the spectral information of individual pixels. It can be used to categorize acquired wavelength data into as many as 224 layered spectral blocks in the near-infrared and infrared ranges. Discreet wavelength ranges can be used to characterized vegetation, soil, or wetland features, for example. Once the spectral characteristics of the target material are known, a specific spectra can be stripped out of the database pixel-by-pixel to depict its distribution throughout the image. This is an extremely powerful technique with applications to onshore oil and mineral exploration, surface resource evaluation, military surveillance, and government compliance monitoring. There is an enormous amount of data that can be gathered using this procedure. And standard spectral libraries for various materials, such as specific clay minerals or even floral species can be downloaded and used to identify these components in an image. Botanists can now monitor the spatial distribution of a particular plant type over time, and the exploration geologist can focus on surface mineral species that are associated with an ore body or with hydrothermal activity. Government monitoring agencies can assess the performance of landfill caps, industrial site environmental emission compliance, or infrastructure violations in the public and corporate sectors. Corporate clients can use this technique to track infrastructure deterioration and plan remediation work.

When combined with geologic maps and digital elevation models (DEM's), hyperspectral analysis can yield solutions to specific resource exploration problems. These combined techniques were used to pinpoint tar seeps in the Santa Barbara area that had been mapped by legendary field geologist Tom Dibblee. An on-site spectral image was made of individual tar seeps to determine their infrared spectra, and the GPS location was accurately recorded. A DEM image was constructed from aerial photographs to provide 3-D topographic relief, and Dibblee's geologic map was incorporated into the database as an additional digitized layer. The hyperspectral analysis matched Dibblee's geology very closely, and verified that this procedure could be used as both a hydrocarbon exploration tool and to monitor environmental spills or leaks.

A quick trip to the Gobi Desert in Mongolia, an essentially vegetation-free terrain, showed how hyperspectra of specific clay mineral species could be acquired and subsequently modified per the client's needs to compensate for interference from other mineral spectra. The ability of remote sensing techniques to rapidly canvass vast areas and pinpoint prospective exploration sites was clearly illustrated by these examples.

Jim closed with a sequence of DEM's constructed from aerial photos taken of the East Bay Hills. The aerial photographs were superimposed on the elevation model and digitally offset to produce a topographic image that can be viewed with 3-D glasses. The audience was given these glasses and examined images of Lafayette projected on the screen. By superimposing land parcel boundaries on the image, Jim was able to show how this technique could be used as a land use screening tool. Parcels could be categorized according to slope steepness, and construction zoned accordingly. Some images displayed golf courses and other cultural features. A 3-dimensional image of the Mount Diablo region with Ron Crane's geology layered into the GIS was displayed. It was noted that layers could be rendered transparent to superimpose the mapped geology on the aerial photograph. And the tour would not be complete without mentioning Martian imagery. Jim explained how spectral imagining could be applied to the barren Martian terrain, and used to determine the presence of various minerals. Its similarity to the Mongolian landscape was quite striking. Spectral analysis of Martian concretions showed that hematite was a surface constituent.

Those in attendance would no doubt agree that Jim Ellis' presentation clearly showed how remote imaging and GIS have revolutionized the geosciences. Their environmental and resource exploration applications are invaluable, and are carving out niches in compliance monitoring and infrastructure evaluation. With today's powerful computers, the enormous amounts of imaged data can be easily manipulated and merged with cultural features to provide databases useful to government, industrial, and public sectors.

The NCGS sincerely thanks Jim Ellis for his excellent presentation of remote imaging applications to the geosciences. For those interested, Jim teaches courses in Remote Sensing and Physical Geology at Diablo Valley College in Pleasant Hill. His company website is http://www.ellis-geospatial.com.

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

NCGS FIELD TRIP

Geology and Groundwater Resources of the Merced Formation in the Westside Basin of the Coastal San Mateo and San Francisco Counties

Saturday July 10, 2004

Field Trip Leaders:
Ed Clifton, (Retired) United States Geological Survey
Ralph Hunter, (Retired) United States Geological Survey
Greg Bartow, San Francisco Public Utility Commission

The Merced Formation, in its sea cliff exposures between Lake Merced and Mussel Rock, displays a nearly continuous section of more than 1700 m of late Pliocene and Pleistocene strata. The section offers a unique opportunity to explore the late Neogene and quaternary history of coastal California in the San Francisco Bay Area. Focus will be on depositional facies that range from shelf depth to eolian dune and their implications relative to sea level history and tectonism in this area over the past 2+ million years. Discussions will include the applicability of sequence stratigraphic concepts in a rapidly subsiding basin. One stop along the way will be devoted to a discussion of Lake Merced and the Westside Groundwater Basin.

Exposure of the Merced Formation differs from year to year. Past trips have encountered a variety of fossil remains, including that of a mammoth or mastodon, fossil foot prints of diverse Pleistocene mammals, sedimentary structures produced by ancient earthquakes, and an ash fall that, today, would devastate the Bay Area. Part of the walk will be along the base of a giant landslide that is activated by contemporary earthquakes and El Niño winters.

THIS FIELD TRIP WILL BE LIMITED TO 50 PEOPLE. CARPOOL/VANPOOL IS A MUST

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

Time: **Saturday July 10, 2004, 7:30 am**

Departure: Gathering place will be announced in the next issue and notified to the registrants by e-mail. Gather (?) at 7:30 am for distribution of guidebook, coffee and doughnuts, and leave by 8:00 a.m.

Cost: $30 for members;$40 for non-members and $20 for students. Cost includes refreshments, lunch, and field guides.

**********REGISTRATION FORM (Merced Formation Field Trip)**********

Name:_____ E-mail:_____

Address:_____

Phone (day):_____Phone (evening)_____ Please indicate check amount:

Lunch (Sandwich) Regular_____ Vegetarian _____ (Please check one)
Please mail form and check made out to **NCGS** to: **Tridib Guha, 5016 Gloucester Lane, Martinez, CA 94553**
Questions: e-mail: aars@earthlink.net: Phone: (925) 370-0685 (evening - PREFERRED) (925) 363-1999 (day – emergency)

People who are willing to drive their car or SUV please indicate (NCGS will pay for the fuel cost)