NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

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NCGS OFFICERS

COUNSELORS

MEETING ANNOUNCEMENT

DATE: **Wednesday, October 26, 2005**

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

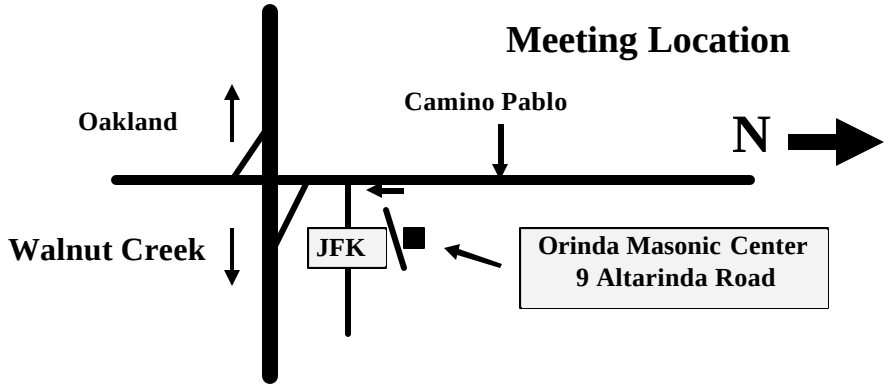
TIME: **6:30 p.m. Social; 7:00 p.m. talk (no dinner) Cost: $5 per regular member; $1 per student member**

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

SPEAKER: ***Todd Crampton,* Geomatrix Consultants, Inc.**

Engineering Geology of the Proposed 4th Bore of the Caldecott Tunnel

Geomatrix Consultants, Inc. recently completed geologic and geotechnical field studies to support preliminary design of the proposed 4th bore of the Caldecott Tunnel in the Oakland-Berkeley Hills. The geology of the tunnel area is complex and, in general, characterized by northwest-trending, steeply-dipping and locally overturned marine (Sobrante and Claremont Formations) and non-marine (Orinda Formation) sedimentary rocks of middle to late Miocene age. A comprehensive geologic/geotechnical field exploration program for the proposed 4th bore was carried out between December 2004 and July 2005 and included: field mapping, 18 exploratory test pits, nine exploratory borings, including four vertical borings ranging from 50 to 150 feet deep and five sub-horizontal/angled borings ranging from 400 to 920 feet long, in situ borehole testing (pressuremeter, Goodman jack, and packer permeability tests), and downhole geophysical logging (optical and acoustic imaging and P- and S-wave measurements). These investigations revealed a wide range of geologic conditions along the alignment, including variably fractured and locally crushed bedrock, variably oriented bedding, irregular and highly contorted bedding, intra-formational and inter-formational faults, diabase and probable sandstone dikes, pockets of "trapped" or confined groundwater, and locally bituminous conditions. Preliminary geologic interpretations of information obtained from the field studies suggest that many of the geologic units along the 4th bore alignment are juxtaposed by previously unrecognized, northwest-trending faults. These faults generally coincide with zones of intensely fractured and crushed rock and, in some cases, with changes in geologic structure. One fault, which marks the boundary between the Claremont and Orinda Formations, also may be a groundwater barrier. The rock mass structure of the geologic units along the alignment ranges from very



blocky to crushed and locally seamy. Representative intact rock strengths range from about 400 psi to 7500 psi. Evaluation of the complex geologic structure and geomechanical properties along the alignment by the Tunnel Design Team results in five ground classes, or support categories, which form the basis of the preliminary tunnel excavation and initial support design schemes.

Biography Todd Crampton is a Senior Geologist with Geomatrix Consultants, Inc., located in Oakland, California. He received his B.S. and M.S. degrees in Earth Science from U.C. Santa Cruz in 1992 and 1994, respectively. Todd is a Professional Geologist and a Certified Engineering Geologist in California with over 11 years of experience conducting and managing engineering geologic and geologic hazard studies for pipelines, water system facilities, tunnels, dams, and other critical and non-critical facilities.

We'll Also Have a Poster Presentation This Month! (See Abstract Inside)

Northern California Geological Society
c/o Mark Detterman
3197 Cromwell Place
Hayward, CA 94542-1209

Don't Forget to Renew!

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 2005-2006 Calendar

Saturday October 22, 2005
Teacher's Workshop, Black Diamond Mines Regional Preserve, Co-sponsored in association with the East Bay Regional Park District ***Let your children's teacher know about this event (Flyer on our website). It'll make a great field trip for their (or your) kids.***

Wednesday October 26, 2005
Todd Crampton, Geomatrix
Engineering Geology of the Proposed Fourth Bore of the Caldecott Tunnel

Poster Presentation: Sunshine Mansfield, Humboldt State University **2004 NCGS Undergraduate Scholarship Award Winner**
Geology of Punta Gorda, California
7:00 pm at Orinda Masonic Center

Tuesday, November 15, 2005
Rebecca Latimer, Chevron Energy Technology Company **Distinguished Lecturer, AAPG**
Uses, Abuses, and Examples of Seismic-Derived Acoustic Impedance Data: What Does the Interpreter Need to Know?
1:00 pm at Chevron in San Ramon; Building: Bishop Ranch 1; Room 1240; Non-Chevron folk should contact Beverly Reynolds (phone (925) 842-2710 or beverlyreynolds@chevron.com) to request a visitor badge by Noon Monday November 11, 2005 (and pick them up in the Lobby in Building A).

Wednesday November 16, 2005
Watch the Early Date!!
Dr. Eldridge Moores, University of California, Davis
Future of Geological Education
7:00 pm at Orinda Masonic Center

As Usual - No December Meeting

Wednesday January 25, 2006
Sarah Andrews, Author, Em Hansen Forensic Geology Novels
The Mind of the Geologist
7:00 pm at Orinda Masonic Center

Wednesday February 22, 2006
Dr. Richard Buffler, University of Texas at Austin
Geologic Setting of the Abdur Archaeological Site on the Red Sea Coast of Eritrea, Africa
7:00 pm at Orinda Masonic Center

Wednesday March 29, 2006
Dr. Mary Lou Zoback, U.S. Geological Survey, Menlo Park
The 1906 Earthquake – Lessons Learned, Lessons Forgotten, and Looking Forward
7:00 pm at Orinda Masonic Center

Wednesday, April 26, 2006
Kathleen Burnham, Consultant
San Gregorio and Northern San Andreas Faults, Point Lobos to Point Reyes, CA
(This is a lead-in to the May 2006 field trip: ***Point Lobos to Point Reyes: Evidence of ~180 km Offset of the San Gregorio & Northern San Andreas Faults***)
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
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, CA/Fault and bedrock mapping from Sonoma into northernmost Contra Costa counties, CA (Title TBA)
7:00 pm at Orinda Masonic Center

October Meeting Poster Presentation
Sunshine Mansfield

Geology of Punta Gorda, California

ABSTRACT

My study focuses on the Cooskie Shear zone, the contact between King Peak subterrane and Coastal terrane, exposed along the beach south of Punta Gorda. The purpose of this research was to determine if the contact is depositional and later faulted or a fault contact, as proposed by McLaughlin (1994). The field site is located in the Mendocino triple junction region on the "Lost Coast", a place known for isolation and rugged terrain. Active landslides dominate the landscape and winter storm waves erode the coastline. The King Peak subterrane is weaker and less resistant to erosion and overlies more massive and cemented Coastal terrane.

The King Peak subterrane may be subdivided into two structural domains in the mapping area. The region of the terrane at the contact is described as mélange. The mélange is characterized by disruption and fragmentation of turbidite beds in a scaly matrix composed of foliated argillite. Intrafolial folds are incoherent, warped, and a dependent of incompetent matrix. The mélange matrix is weak and easily erodes; mélange underlies bedding and forms slump features on the hill sides. The contact between the Coastal terrane and King Peak subterrane is obscured by landsliding over the Coastal terrane. A fault separates folded and fractured turbidites from the mélange. Fold shapes are asymmetric, slightly kinked and overturned with tight inner limb angles. Fold vergence is NNE and folds plunge gently ESE. Some folds have been refolded and appear disharmonic.

One of the structural challenges of interpreting the origin of Fransician Complex melange is determining if pervasive extensional deformation occurred during early formation of the subduction complex or happened during a later tectonic event. Evidence suggests there has been pervasive layer parallel extension within the terranes. Mechanisms for layer parallel extension can occur within the accretionary prism toe by gravitional spreading and burial of sediments in an unconfined environment. The contact may be uncomformable with a later component of simple shear obscuring original structural relations.

Upcoming NCGS Field Trips

October 29, 2005	***Panoche Hills Paleocene Cold Seeps*,** **Mel Erskine,** Consultant

See Attached Field Trip Flyer

November 12, 2005	***Coastal Cliffs and Landslides*** **Dr. Monty Hampton**, Emeritus, U.S. Geological Survey
September 2006	***Field Geological Mapping Using Modern Technology*** **Dr. George Brimhall,** U.C. Berkeley
October 2006	***TBA*** **Dr. Rolfe Erickson,** Emeritus, Sonoma State University

Please contact Tridib Guha at: tridibguha@sbcglobal.net **for questions you may have.**)

1906 Earthquake Centennial

The ***Northern California Geological Society*** will be participating in the centennial observance of the San Francisco 1906 Earthquake. We are currently finalizing our contributions to the observance and the events will be posted to the website of the ***1906 Earthquake Centennial Alliance*** (as well as the NCGS website!). The full set of events range from professional meetings, an SSA professional conference, multiple museum exhibits, as well as commissioned music to be played by the Contra Costa Wind Symphony, (and much more). Please visit the website if you have not done so to see what is planned by the alliance:
http://www.06centennial.org/

NCGS Centennial Events

March 2006	**Field Trip** - ***A Walk Along The Old Bay Margin in Downtown San Francisco - Tracing The Events of The 1906 Earthquake and Fire,*** **Dr. Ray Sullivan,** Emeritus, San Francisco State University
March 29, 2006	**Monthly Meeting** - ***The 1906 Earthquake – Lessons Learned, Lessons Forgotten, and Looking Forward***, **Dr. Mary Lou Zoback**, U.S. Geological Survey, Menlo Park
April 2006	**Family Field Trip** - ***Tracing the Hayward Fault – A Potential Disaster Area,*** **Dr. Joyce Blueford and Others,** Fremont Math Science Nucleus and California Geological Survey, respectively
April 26, 2006,	**Monthly Meeting** - ***San Gregorio and Northern San Andreas Faults, Point Lobos to Point Reyes, CA*** **Kathleen Burnham,** Consultant
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**, Consultant

NCGS Scholarship Awards Year 2005 – 2006

The Northern California Geological Society is pleased to announce the availability of three scholarship awards for the 2005-2006 academic year:

Undergraduate Scholarship Award of $500
For candidates working toward completion of a senior thesis or honors research program; Funding is provided for projects implemented during the 2006 calendar year *Application deadline is November 11, 2005 for a December 2, 2005 award date*

Graduate Scholarship Award (MS Degree) of $750
Graduate Scholarship Award (PhD Degree) of $1,000
For candidates working toward the MS or PhD degrees; Funding is provided for projects implemented during the 2006 calendar year. *Application deadline is January 31, 2006 for a February 28, 2006 award date*

Individual scholarship announcements with instructions can be requested from and proposals submitted to:

Phillip Garbutt
Chair, NCGS Scholarship Committee
6372 Boone Drive
Castro Valley, CA 94552-5077
Voice: (510) 885-3440 or (510) 581-9098 (evening)
Fax: (510) 885-2526
E-mail: phillip.garbutt@csueastbay.edu

Funding priority will be directed to research programs focused on topics in mapping, structural, stratigraphic, economic, engineering or environmental geology, geophysics, stratigraphic paleontology, or paleoecology, implemented within the State of California or immediately adjacent western states. Funds are intended to support field and laboratory components of research programs. Candidates will be evaluated based on submission of a cover letter requesting the award, a brief (no more than 2 page) summary of the proposed research topic, and a faculty signature confirming departmental approval of the application. Winners will be invited to speak or otherwise present their research at a regular evening NCGS meeting in Orinda, California.

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY and AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

K-12 EARTH SCIENCE TEACHER OF THE YEAR AWARD

$750 Northern California Geological Society
$500 Pacific Section AAPG
$5,000 National AAPG

Call for Nominations for the Year 2006 NCGS Competition

The Northern California Geological Society (NCGS) is pleased to announce that it will accept applications from candidates in the Northern California region for the Year 2006 competition for the Earth Science Teacher of the Year Award. The $750 NCGS award is intended to recognize pre-college earth science programs already in place, and to encourage their organization in districts where they have not been fully developed. Nominations of qualified K-12 teacher candidates are solicited from teachers, school administrators, teacher outreach programs, and other interested parties.

The NCGS awardee's application will be submitted to a regional competition sponsored by the American Association of Petroleum Geologists (AAPG) Pacific Section. The Pacific Section winner will receive a $500 award at the Pacific Section regional meeting in Anchorage, Alaska in May, 2006, plus up to $250 toward meeting expenses. The regional winner's project will be submitted to AAPG headquarters for the national contest. The national winner will receive an expense-paid trip to Long Beach in 2007 to attend the national meeting and receive the award.

At the national level, the AAPG Foundation presents an annual $5,000 award to a K-12 teacher for *Excellence in the Teaching of Natural Resources in the Earth Sciences.* The award recognizes balanced incorporation of natural resource extraction and environmental sustainability concepts in pre-college Earth science curricula. It includes $2,500 to the teacher's school for the winning teacher's use, and $2,500 for the teacher's personal use. The award will be given at the April 2007 AAPG Annual Meeting in Long Beach, California.

The deadline for application submittal by candidates for the $750 NCGS award is Friday, February 17, 2006.

Interested candidates or nominators can request Application Information and an Entrant Application Form, or submit an application, by contacting:

John Stockwell, Chair, K-12 Geoscience Education Committee
Northern California Geological Society
1807 San Lorenzo Avenue
Berkeley, California 94707-1840
Tel: (510) 526-1646
e-mail: kugeln@msn.com

K-12 GEOSCIENCE TEACHING AWARD

$500 Northern California Geological Society

Call for Applications for the Year 2005 - 2006 NCGS Competition

The Northern California Geological Society (NCGS) invites applications from candidates in the Northern California region for the Year 2005-2006 competition for the K-12 Geoscience Teaching Award. Applications may be submitted by any teacher regardless of experience.

Applications reflecting teaching of units addressed to any of the earth or environmental sciences, including but not limited to mineralogy, petrology, economic geology, geomorphology, paleontology, hydrology, and planetary geology are invited from physical science, earth science, and geology teachers.

The deadline for application submittal by candidates for the $500 NCGS award is Monday, January 16, 2006.

The winner will receive a $500 award at a Northern California Geological Society meeting in Orinda in late January, 2006.

Interested candidates can request Application Information and an Entrant Application Form or submit an application by contacting:

John Stockwell, Chair, K-12 Geoscience Education Committee
Northern California Geological Society
1807 San Lorenzo Avenue
Berkeley, California 94707-1840
Tel: (510) 526-1646
e-mail: kugeln@msn.com

USGS Map Sales forges new partnership with California Geological Survey

On October 1, 2005 the U.S. Geological Survey entered a partnership with the California Department of Conservation to transition over-the-counter retail sales in Menlo Park, California. The USGS will no longer

conduct over-the-counter retail sales of maps and publications in Menlo Park. Instead, the Department of Conservations' California Geological Survey (CGS) will assume responsibility for the integrated enhanced delivery of over-the-counter retail sales of maps and publications with no decrease in services to customers. Eight CGS geologists and retail sales staff members will be co-located on the USGS campus at 345 Middlefield Road, with two USGS employees to create a seamless "one-stop-shop" for delivery of natural science information products and services. The current inventory of USGS maps and publications will remain the same and be transferred to the state, while the California Geological Survey will add their own publications and products for sale. Product costs and the location in the USGS Building 3 will remain the same. Earlier concerns about the possibility of closing the Menlo Park map sales office are not only resolved, but the new sales office will be better than ever with a dedicated staff and a wider range of products available. This state-federal partnership will benefit all parties involved, as well as the public, and additionally opens the possibility for future endeavors between the U.S. Geological Survey and the California Geological Survey.

Tor Nilsen

We just received this note from Rick Blake on the passing of Tor Nilsen:

I regret to inform you that I just got a call from Tor Nilsen's wife Paula who told me that Tor passed away after a long struggle with cancer. Tor died on Sunday, Oct. 9, 2005 at the Nilsen home in San Carlos in his wife's arms. Funeral services will be held at the Church of the Epiphany in San Carlos this Saturday, October 15 at 2 PM. A reception will immediately follow at the Nilsen home. Tor was a very well respected California geologist who made huge contributions to our understanding of California geology and the geology the western United States. He was also a gentleman and a great family man. He will be deeply missed.
Sincerely,
Rick Blake
President
Sacramento Petroleum Association

Bud Reid

We also just received word on the passing of Bud Reid. Bud Reid passed away peacefully in his sleep on Sunday, October 2. He turned 79 years old on September 28. Bud was a stalwart in the California petroleum geology community, and served as a Foundation Trustee, AAPG President in 1995-96 and AAPG Vice President in 1980-81. He received the AAPG Honorary Membership Award and the Michel T. Halbouty Memorial Human Needs Award.

Upper Tertiary East Bay Volcanism Exposed at Sibley Regional Preserve

Reported by Dan Day

In the rugged hills between Orinda and Berkeley are exposed a complex suite of lithologies spanning marine to terrestrial environments, deepwater to fluvial sediments, and a thick sequence of basalt flows. The latter were the focus of the May 21, 2005, NCGS Field Trip ably led by **Dr. Stephen C. Edwards** and **Dr. Mel C. Erskine**, Consultant and long-time NCGS officer/advisor. Mel provided technical support, but Dr. Edwards was the trip spokesman. He described geological features at each stop and provided historical insight into the interpretive evolution of the local structure and lithology based on his experiences as a U.C. Berkeley student.

U.C. Berkeley Professor Emeritus **Garniss Curtis**, one of the early proponents of the potassium-argon radioactive dating technique, spent decades unraveling the geology of the East Bay Hills, and in particular, the volcanics exposed in the Sibley Regional Preserve. According to Stephen, the results of prodigious student mapping were not shared in the technical literature so that future mappers would not be able to purloin crucial information from published reports.

The Berkeley Hills has been of interest to local geologists, particularly the UC. Berkeley school, since the turn of the century. Andrew Lawson and his students mapped the Siesta Valley syncline just north of Highway 24, but no further south. Their interests lay with the sediments and volcanics in the hills adjacent to the university. In the 1940's and 1950's, Dr. Curtis began extensive mapping to the south. He interpreted Round Top, the highest peak in the Berkeley Hills, as a volcanic vent. As a young university student, Dr. Edwards was one of scores who mapped the area to fulfill their field training requirements. He continued to map and refine the local stratigraphy as a UCB graduate student, and is still doing so today.

Structurally, the Sibley Regional Preserve volcanics are part of the Siesta Valley syncline, a large trough-shaped structure overturned slightly on its western limb. The basalt flows interbedded with marine to terrestrial sediments form the highest ridges. Outcrops in the

Preserve showcase a variety of volcanic features, including lava flows, intrusive dikes and sills, breccias, volcaniclastic sediments, and sedimentary alteration features associated with eruptive events. The flows have been extensively dated at about 10 million years using the Ar^{39}/Ar^{40} technique, considered more accurate than the potassium-argon (K-Ar) method used by Garniss Curtis and his colleagues decades ago. The argon-39/argon-40 dates form a tighter cluster than the K-Ar dates, and indicate active eruptions occurred over a few hundred thousand years. Comprising the Miocene Moraga Formation, the basalts, volcaniclastics, and volcanic sediments are thought to be part of a much larger and compositionally more diverse volcanic field that has been dismembered by right lateral strike-slip along the greater San Andreas Fault system. Garniss Curtis believes the Sibley/Berkeley volcanics to be a northward displaced piece of the Hollister Quien Sabe volcanic field located 80 miles south on the east side of the Hayward-Calaveras Fault system. The Indian Rocks rhyolite outcrops in Berkeley (Northbrae Rhyolite), the andesites and dacites of Mt. Burdell north of Novato (Marin County), and the Tolay Volcanics in subsurface Sonoma County are also considered part of the Quien Sabe Volcanics. The Sibley Volcanics consist of basalts and basaltic andesites, with a considerable range in textural characteristics and structural style. The landscape is dominated by the vent at Round Top Mountain. Quarrying and deep erosional dissection of the near-vertical dipping strata have exposed the subterranean volcanic architecture here like nowhere else in California.

After sharing these historical and geological facts with the sizable group assembled at the Sibley Regional Preserve's Visitors' Center, Steve led the eager crowd south and east to a vantage point nearby. Here he pointed out distant ridges formed by dike complexes that fed the now eroded overlying volcanics. Round Top loomed to the east, dominating the skyline. Continuing uphill, the group stopped briefly at an East Bay Municipal Utilities District construction site exposing a vent in the hillside. The cut exposed dikes of aphanitic (fine-grained) plagioclase-augite (pyroxene) basalt crosscutting breccias and tuff-breccias containing chunks of the underlying Orinda Formation. The breccias were extruded from the vent and are overlain by a thicker layer of the basalt with may represent lava pooled above the vent opening. The north side of the construction site provided a breath-taking view of the ridges and valleys of the surrounding East Bay Hills.

As the trail wound around the northern flanks of Round Top, Stephen pointed out a distant break in slope representing the contact between the Moraga volcanics and the less resistant Orinda Formation. At this point, the group was standing on an ancient lava pool. A botanist by training, Stephen noted that various lithologies in the area can be identified by the vegetation they support. This is a characteristic long used by geologists when field mapping. These differences become particularly evident in the rainy season, when plant life is lusher. Native Americans used the basalt for bedrock mortars to grind acorns into flour. Although Stephen has mastered the art of arrowhead flaking, and done so with basalt from the Sibley Preserve, only sparse artifacts have been found to suggest the local Indians had shaped the volcanics into arrowheads.

Trekking farther along the trail, Stephen stopped at an outcrop exposing the contact with the Orinda formation. Water seeping from the outcrop showed the excellent water retaining properties of the heavily fractured volcanics, which are superb aquifers.

An abandoned Kaiser Sand and Gravel quarry on the northeast flank of Round Top exposed another vent. From this vantagepoint, Stephen described the brecciated vent-filling volcanic debris and slightly overturned attitude of the volcaniclastics. The vent was several hundred feet long and occupied a topographic high that was where the pit now lies. Eruption here occurred between 9.6 to 10.0 million years ago. A layer of well-bedded tuff is also revealed here, containing freshwater mollusk remains that indicate water pooled in the vent during dormant periods. Flows at this site are intensely vesicular, which suggests the lava flowed over ponded water or a water-saturated substrate. The brilliant red basal "baked zone" is observed elsewhere in the Berkeley Hills volcanics and is thought to be an oxidation feature linked to steam generation as the flow advanced across the Miocene landscape.

The group crossed over the Moraga-Orinda contact as they entered an area normally closed to the public. A ravine on the trail has been interpreted as block downdropped by faulting. Garniss Curtis thinks the nearly horizontal, rotated beds in this location, which were more vertically inclined before regional folding, are evident of viscous "plowing" action by the advancing flow fronts. Stephen mentioned that Miocene camel fossils have been found at this site.

A series of punctuated stops in the restricted area provided examples of tuffs, possibly water-lain, overlying basalt, a exposure of opaline amygdaloidal (almond-shaped mineralized vesicles) volcanics, an autobrecciated (fragmented during emplacement) flow, flows with basal baked zones, and an agglutinated lapilli tuff representing cinders deposited close to a vent opening.

The final stop was in the northernmost end of the park overlooking Highway 24 far below. Stephen produced a poster illustrating Garniss Curtis's Round Top Mountain block diagram. This geological map showed relationships between the Sibley volcanics and other igneous outliers in the Berkeley Hills to the north. Of particular interest was U.C. Berkeley geology professor George Brimhall's Berkeley Hills Rhyodacite Tuff exposed a mere 4 miles to the north. Also shown were the Hayward and Wildcat Faults. Stephen discussed their probable effects on the regional structure and juxtaposed lithologies. One theory proposes that the Rhyodacite Tuff may be a dismembered part of the Sibley volcanic field transported to its present location by 4 miles of offset along the Wildcat Fault. Regardless of their interpretation, correlating the various volcanic lithologies and fault-sliver outliers in the East Bay/Berkeley Hills provide a fascinating research topic for Bay Area geologists.

Upon concluding his presentation, Stephen and most of those in attendance reconvened at a site in Berkeley's Tilden Park for a delicious salmon and chicken barbecue provided for the NCGS by **Tridib** and **Mita Guha**. **Ron Crane** deserves thanks for helping set up the picnic tables and lighting the barbecue pit. Guest **Dennis Jones** and members **Mark Sorenson** and **Dan Day** manned the barbecue under Tridib's watchful eye. **John Stockwell** provided some vegetarian dishes. Clean up was assisted by **Chris Higgins** and his wife **Jane**, **Kathleen Burnham**, and **Mark** and **Karel Detterman**. Field Trip Coordinator **Tridib Guha** merits recognition for scheduling the field trip, planning and executing the barbecue, and making the necessary arrangements with Tilden Park. **Mel Erskine** provided Stephen Edwards with technical support.

The NCGS would be remiss not to show its sincerest appreciation to **Dr. Stephen Edwards**, Director of the Tilden Regional Botanical Garden, for sharing his knowledge of the Sibley Volcanic Preserve with its members. Stephen gave an outstanding presentation, laced with his subtle humor, on one of the most spectacular volcanic sites in the Bay Area. It also goes without saying that Stephen has been largely responsible for chronicling the geological history of the Preserve, for providing displays to share this information with the public, and for continuing his own field research to better understand the local geology. To this we are deeply indebted to him.

The Geology and Reservoir Structure of the Tengiz Oil Field, Kazakhstan

Reported by Dan Day

Several NCGS talks have been presented at NCGS meetings over the years discussing various aspects of the Tengiz supergiant oil field off the northeast shores of the Caspian Sea. At the May 25, 2005 meeting **Dr. Paul M. (Mitch) Harris** of Chevron gave a talk that summarized the geology and reservoir characteristics of this important play. His lecture ***Geologic Framework and Reservoir Distribution, Tengiz Oil Field, Kazakhstan*** addressed the platform's origin and reservoir characteristics from a carbonate petrologist's point of view. It was a concise, well-delivered summary of previous lectures that had already introduced NCGS members to important petroleum resources in this region.

Mitch Harris is Chevron's resident carbonate reservoir expert. His academic and professional career has focused on carbonate petrology applied to hydrocarbon reservoir characterization. He has spent decades carefully examining carbonate microstructures and using them to assess petroleum reservoir feasibility, distribution, and productivity. Much of his time has been dedicated to understanding the structure of the Tengiz Oil Field.

The Tengiz Oil Field has an estimated 6 to 9 billion barrels (bbl) of recoverable oil. The estimated total oil reserves (oil in place) are between 15 and 25 bbl. This field, a partnership between Chevron and other major producers, is Chevron's largest oil asset. It is located off the northeastern shore of the Caspian Sea, the world's largest inland body of water, occupying a large depression in the heart of Central Asia. The countries bordering this inland sea include Kazakhstan to the north and east, Iran to the south, Russia on the northwest, and several Islamic former Soviet Union republics on its western and southeastern shores. This region was the world's largest petroleum producer in the early 1900's, prior to the Middle Eastern oil discoveries. The western Caspian oil fields fed refineries in Volgograd during World War II and were prized by Nazi Germany. Russian exploration geologists discovered the massive Tengiz deposit in 1979, but did not have the technology to efficiently recover oil from its great depths. In 1993 several oil companies including Chevron formed the TengizChevroil joint partnership, of which Chevron has a 49% interest. Production began in the late 1990's using former Soviet wells and others drilled by the consortium.

The Tengiz field occupies a large 1.2 km. high late Paleozoic carbonate platform with a basal area of 160 km^2. The latter is over 50% larger than the base of Mt. Diablo. Production obstacles include the great reservoir depth (>5 km.), high temperatures and pressures in the production zones, and high (~18%) H_2S (hydrogen sulfide) content. The sulfur is extracted from the oil but poses a serious environmental threat, and generates an enormous quantity of sulfur that needs to be removed or consumed. There are currently over 100 wells in the Tengiz, over 50 drilled by the joint venture, that have a combined production rate of 400,000 barrels a day. Peak production is expected to reach a maximum of 700,000 barrels a day.

The Tengiz carbonate platform is a late Paleozoic feature similar to the contemporary Bahamas. Other platforms occur in the area, the smaller Korolev platform to the east and the significantly larger Kashagan complex in the north Caspian shallows to the west. Tengiz is an isolated platform surrounded by deep water. It grew upward with very steep sides, similar to the modern day Bahamas Turks and Caicos reef complex.

Numerous seismic profiles have criss-crossed the platform. They tell an interesting story. In the Late Devonian the platform began growing upward but was interrupted by a brief retreat, followed by rapid upward growth in the Mississippian. The Pennsylvanian saw platform progradation, which was stifled in the early Permian as sea level rose and drowned the platform. An extensive evaporite sequence sealed the platform. The petroleum source rocks were Devonian deepwater pelagic sediments (organic-rich shales) surrounding the platform. The 3-D seismic mapping used to unravel the platform's complex stratigraphy was supplemented by gamma ray logs, porosity maps, and retrieved cores.

A seismic dissection of the platform reveals parallel reflecting layers on the top, plunging off the sides to steeply inclined upper slopes, shallower-gradient middle slopes, and a gently dipping lower to distal facies. The upper platform and slope units can be divided into several distinct facies. Relatively horizontal platform deposits consist of grainstones, coarse particles with up to 30% interstitial porosity, and packstones, also containing coarse interstitial porosity but filled with carbonate mud. The upper platform slopes consist of intensely fractured compacted algal bioherms. The mid-level slopes are composed of tumbled reef debris and carbonate-cemented breccia. And the basal/distal facies are calcareous muds and hydrocarbon-rich pelagic sediments. However, a comprehensive working model of the complex requires comparison with a well-exposed terrestrial analog. This was adequately provided by examining outcrops of the Asturias carbonate complex, part of a thrust belt in northern Spain. Such a model helped to interpret seismic, well core, and geophysical data from a platform reef hidden over 4 km. beneath the surface. Comparison of the Spanish carbonate rocks with the Tengiz cores, particularly the jumbled progradational slope facies, helped stratigraphers develop a robust platform genesis model. In Spain, one can literally walk across clinoform outcrops and see the same details observed in the Tengiz cores. Areas with poor seismic signatures can be inferred using the Asturias model.

A robust platform evolutionary model necessitates combining seismic, well log (gamma ray/porosity) data, biostratigraphy, and outcrop analog information into a coherent package. The reservoir shows an abrupt interruption of upward growth and a transition to edge progradation at the Mississippian-Pennsylvanian boundary. Similarly, reservoir character changes across the broad platform top to the slightly raised microbial rim facies, and downward along the platform slopes. Unraveling reservoir behavior requires looking at the Pennsylvanian platform progradation that followed the Mississippian vertical growth and backstepping events. Platform growth began with an early phase of aggradation, an intermediate backstepping stage with a flat repetitious topography, and late stage progradation. The top of the platform has a 0.5 km-thick border zone that records the sequential backstepping, aggradation, and platform edge progradation. Seismic surveys and drill core data, coupled with the Asturias terrestrial reef model, helped clarify stratigraphic relationships.

Detailed platform surface characterization permits sedimentologists to develop a paleoenvironmental model for the complex. Precise imaging and numerous cores provided good topographic control. The platform top has several high areas that are grainstone terrains, indicating shallow, agitated water with significant wave action. Packstones dominate slightly deeper water surrounding these topographic highs. Porosity-permeability plots for grainstones and packstones show a one-to-one correlation between the logarithms of porosity versus rock permeability. The more porous grainstones therefore are ideal hydrocarbon reservoirs, whereas the packstones are not. Mapping grainstones and packstones therefore maps reservoir quality, and porosity maps show the distribution of these two carbonate facies. Since water depth controls the distribution of the grainstone and packstone facies, transgressive events terminate reservoir rock (grainstone) formation, and regressive sequences return to the porous reservoir facies.

Creating a model for the platform backstepping stage to the rim progradation required a close examination of the terrestrial Arturias reef outcrops. Carbonate sedimentologists followed the platform sequence in the field from a "reefy" upper rim facies onto an upper slope, a middle slope, and eventually into distal off-platform pelagic muds. The reefy rim consists of carbonate-cemented coralline debris. The upper slope is predominantly boundstone; highly fractured cemented coral debris. Much of the original open porosity has been filled with carbonate cement. There is localized solution enlargement of a compaction-generated fracture system. The mid-slope or flank areas exhibit what are interpreted as fracture conduits created by fluid circulation. These are open, vuggy (crystal lined), complexly interconnected cavities that have a major influence on fluid transport through the platform complex. Since these conduits control hydrocarbon mobility, engineering production models are understandably complex.

Pore cementation at the Mississippian-Pennsylvanian boundary forms an impermeable barrier that prohibits pressure communication between zones above and below this point. This compels fluids to seek other channels for pressure release. The upper platform flanks have low porosity and high fracture permeability, with evidence indicating the fractures are related to compaction. The mid-slope was less intensely fractured, but fractures are still pronounced. Both fracture systems were accessed and enlarged by circulating low temperature solutions driven by geothermal gradients established within the platform massif. Enlarged fracture systems provide good fluid communication between the platform and flanks, which is advantageous to oil production. Open fracture and interstitial porosity distribution can be used for fluid flow modeling.

The Tengiz complex is unique because it is a very well-defined platform reef with vastly different upper platform versus flank facies permeability, yet fortuitously good fracture-controlled fluid connectivity. It is vertically, laterally, and tangentially variable, and its reservoir characteristics, particularly fluid permeability, are largely controlled by the porous grainstone distribution and peripheral compaction fracture systems. Considering its age, the Tengiz complex is relatively unaltered and essentially undeformed. It is well preserved, has excellent secondary fracture enlargement for locally good fluid mobility, and well-distributed regions of porous reservoir rock (grainstones). The pore and fracture enlargement occurred during active platform growth from connate fluids circulated by geothermal gradients established within the carbonate platform. The porous reservoir rocks were charged with hydrocarbons from Devonian source rocks after an evaporite seal was deposited above the complex during the Permian retrogression that ended major reef-building activity. Subsequent reservoir charging events occurred in Permo-Mesozoic times. In the mid to late Permian, the evaporite seal was breeched and the remaining hydrocarbons were converted to bitumens. The rapid late Mississippian upward reef growth contributed to compaction-induced fracturing. Solution enlargement of these fracture systems occurred during the Bashkirian (early Permian) times. The steep-sided reef with 70 to 80 degree slopes had its rim constantly swept clean by prevailing currents and wave action. Carbonate debris tumbled over the edge and down the reef flanks. As various portions of the platform uplifted, debris was shed off the topographic highs into lower areas. In the latest Permian, shallow shelf clastic sediments preceded the evaporite sequence (an anhydrite basal evaporite seal overlain by 600 to 1000 meters of halite).

Dr. Harris elaborated on the nature of fracture-enlarging fluids and the role they played in hydrocarbon production. The circulating fluids that enlarged the existing compactional fracture systems along the platform rim were slightly acidic. Localized barite ($BaSO_4$) and sphalerite (ZnS) fracture deposits imply sub-hydrothermal solution activity driven by thermal gradients within the carbonate platform. Known as Cohalt convection cells, these circulation patterns open tight fractures and dolomitized (converted $CaCO_3$ to $CaMg(CO_3)_2$ – dolomite) the reef carbonate. The abundant H_2S in the oil at Tengiz is thought to be the by-product of first stage petroleum cracking. The spurt of late Mississippian upward growth and edge backstepping created the excellently producing, narrow marginal slope facies. The upward growth surge was stimulated by a long-term second order transgression. When sea level stabilized, upper Mississippian reef edge progradation began.

The Tengiz platform has undergone about 80 meters of compaction. It has been exposed to two cycles of the "Icehouse Glaciation" effect, a high amplitude sea level change, once in the Devonian-Mississippian and again in the Pennsylvanian. Its best current day analog is the Bahamas platform, specifically the Turks and Caicos Islands, which like the Tengiz and Korolev massifs, stand alone in a deepwater basin.

The NCGS is indebted to Dr. Mitch Harris for his excellent presentation on the Tengiz carbonate platform. The society thanks him for sharing a wealth of information about the basic reservoir structure, carbonate stratigraphy, and evolution of this strategic Caspian oil field. His talk summarized several previous lectures on this subject, which the NCGS was quite fortunate to have hosted.

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

NCGS FIELD TRIP
PANOCHE HILLS PALEOCENE COLD SEEPS

Saturday October 29, 2005

Leader: Mel Erskine, Geological Consultant

This field trip focuses 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 $\delta^{13}C$-depleted carbonates and the remains of chemosynthetic invertebrates are the primary evidence for Paleocene seepage in this region. However, 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.

In my own interpretation 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.

I note also that the KT boundary has been mapped within the Moreno Formation in this area. It is marked by shocked quartz but no radioactive layer.

THIS FIELD TRIP WILL BE LIMITED TO 30 PEOPLE. CARPOOL/VANPOOL IS A MUST

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

Time & Departure: Saturday October 29, 2005, 8:00 am (sharp), gathering place at the Chevron Parking Lot, San Ramon.

Cost: $25/person for both members & non-members

**********REGISTRATION FORM (Panoche Hills 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)
People who are willing to drive their car or SUV please indicate such.