NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

APRIL MEETING ANNOUNCEMENT

DATE: **Wednesday, April 25, 2001**

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

TIME: **6:30 p.m. Social; 7:00 p.m. talk (no dinner)**
Cost is $5.00 per person

RESERVATIONS: Leave your name and phone number at 925-294-7530 or by e-mail at dday@nrmc.com before the meeting.

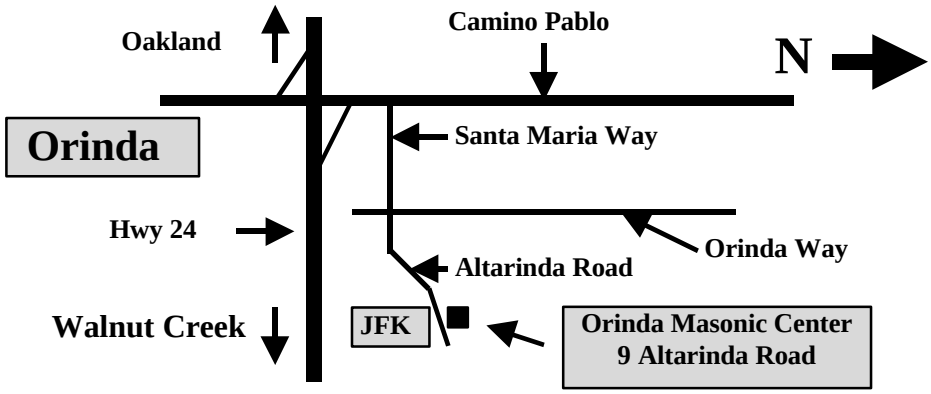
SPEAKER: Dr. John A. Karachewski, Weiss Associates, Lawrence Livermore National Laboratory

Geology of Southern New Mexico and the Desert Soil - Geomorphology Project

This presentation focuses on the Quaternary geology, terraces, and paleosols observed during a week-long field conference organized to honor the 45 years of pioneering research conducted by Leland Giles, John Rowley, and other colleagues at New Mexico State University. The first section introduces the geology, tectonics, chronostratigraphy, sedimentary environments, hydrogeology, and landforms of the southern Rio Grande Rift near Las Cruces. Several case histories are also presented to illustrate the influence of basin tectonics on the geometry of fluvial and alluvial-fan deposits. The second section discusses processes and parameters, which influence soil development in the southwestern US. These include: parent materials, age, topography, climate, vegetation, and the influence of man. The role of eolian processes, illuviation of clay minerals, and stages of carbonate development in soil horizons will also be reviewed. The third section illustrates the relationship between Quaternary terraces and paleosols between the Rio Grande River and the Organ Mountains as well as in the Jordana del Meurto, a closed sub basin with internal drainage. The final section presents recent work on the identification of paleosols in fine-grained alluvial fan deposits beneath Lawrence Livermore National Laboratory and their importance in characterization of hydrostratigraphic units.

John A. Karachewski has conducted geology and environmental projects throughout the western US for government agencies and industrial clients. He specializes in reconstructing hydrostratigraphic sequences and sedimentary environments, which results in detailed characterization and enhanced operation of remediation systems. His

(Continued on back page of the newsletter)



photography (www.geoscapesphotography.com) has also been extensively published by many national geological organizations. He has served in numerous positions with the Geological Society of America, Northern California Geological Society, and California Council of Geoscience Organizations. He received his doctorate from the Colorado School of Mines and his master's degree from Western Washington University.

Notice To All Members

The NCGS is working to develop an Earth Science teachers kit as a part of its K-12 outreach program. As we work to achieve this goal, we need volunteers to help out with this program. If you are interested in contributing to this project, please contact NCGS counselor, K-12 Programs, **Aase Schoen** (her name is pronounced Oh-see Shane) by e-mail at aase@silcon.com or by phone at 925-935-2600. Aase teaches Earth Science in the Acalanes Unified Joint High School District, Walnut Creek.

Northern California Geological Society
c/o Judy Hayes
453 Scotts Mill Rd.
Danville, CA. 94526-4234

Delegates wanted for June AAPG meeting in Denver

The NCGS has four delegates to the AAPG House of Delegates, the legislative body of the AAPG. Our delegates are Mel Erskine, Don Lewis, Bob Lindblom, and Frank Picha. One and probably two of these will not be able to attend this year's meeting on the morning of June 3, the opening day of the Annual Meeting in Denver. If you are attending the convention and would like to represent us as an alternate delegate, please let **Don Lewis** know. He can be reached at (925) 284-5480 or donlew@worldnet.att.net

NCGS 2001-2002 Calendar

Wednesday, January 31, 2001
Keith Knudsen, California Division of Mines and Geology (CDMG)
New Quaternary Geologic and Liquefaction Susceptibility Mapping of the Nine-County San Francisco Bay Region and CDMG's Seismic Hazard Mapping Program
Orinda Masonic Center

Wednesday, February 21, 2001 / AAPG Distinguished Lectures (see front page and flyer in this newsletter issue)
John Warme, Colorado School of Mines, Golden, CO.
Active Margin Sequences and Submarine Canyon Facies Models
Chevron Overseas Petroleum, Inc., 6001 Bollinger Canyon Road, San Ramon, CA. at 12:15 in Room B-1039B
AND
Anatomy of an Anomaly: The Catastrophic Devonian Alamo Impact Breccia, Nevada
Lafayette Veterans Memorial Building, 3941 Mt. Diablo Blvd., Lafayette, CA. / 6:30 pm social; 7:00 pm talk; cost $5
Joint Meeting with BAGS

Saturday, March 3, 2001
Caldecott Tunnel Field Trip (Please check flyer in newsletter)
9:30 am at Caldecott Tunnel Bldg. off Tunnel Rd., Berkeley. Leader:***Grant Wilcox,*** Branch Chief, CalTrans Geologists, Oakland, CA.
A trip including a movie on the tunnel construction, a trek through tunnel air ducts, and a synopsis of the tunnel engineering geology

Thursday, March 22, 2001 / AAPG Distinguished Lecture
Andrew Pulham, University of Colorado, Boulder, CO.
Reservoir Performance and Reservoir Quality in a Sequence Stratigraphic Framework: Case Studies from Siliciclastic Reservoirs in the Americas and Europe
Chevron Park, San Ramon, CA. at 12:00 noon in Building A, Room A-1036

Wednesday, April 25, 2001 PLEASE NOTE SPEAKER CHANGE!!
John Karachewski, Weiss Associates, Lawrence Livermore National Laboratory
Geology of Southern New Mexico and the Desert Soil - Geomorphology Project
Orinda Masonic Center

Wednesday, May 30, 2001
Dave Mustart, San Francisco State University
Tentative title: **Hydrothermal Pipes in Six Granitic Plutons in California: Evidence for Evolution and Migration of a Magmatic Volatile Phase**
Orinda Masonic Center

Wednesday, June 27, 2001
Bruce Jaffe, USGS Menlo Park
Tentative Title: **Mercury Contaminated Hydraulic Mining Debris in North San Francisco Bay: A Legacy of the Gold Rush**
Orinda Masonic Center

Wednesday, September 26, 2001
Richard Sedlock, San Jose State University
Tentative title: **Blueschists and Ophiolites in Baja: Coast Range Geology, But With Outcrops**
Orinda Masonic Center

Wednesday, October 24, 2001
David Lawler, Far West Geoscience Foundation, Berkeley (Tentative)
Title: **Hydraulic Gold Mining's Historical Legacy - Mercury Contamination Issues: Sierra Nevada and Klamath Mountain Regions, California**
Orinda Masonic Center

Wednesday November 28, 2001
David Des Marais, NASA Ames Reseach, Menlo Park
Title: **The Biogeochemical Carbon Cycle and the Coevolution of Early Earth and Biosphere**
Orinda Masonic Center

Wednesday January 30, 2002
Roger Ashley, USGS Menlo Park
Title: **Lode Gold Deposits of the Sierra Nevada and Their Environmental Impacts**
Orinda Masonic Center

March 22nd AAPG Distinguished Lecture Links Fine Scale Sequence Stratigraphy to Petroleum Reservoir Performance

This year's AAPG Haas-Pratt Distinguished Lecture was presented by **Dr. Andrew Pulham** of the Department of Geological Sciences at the University of Colorado, Boulder. His talk ***"Reservoir Performance and Reservoir Quality in a Sequence Stratigraphic Framework: Case Studies from Siliciclastic Reservoirs in the Americas and Europe"*** summarized work done in collaboration with ichnologist **Dr. George Pemberton** of the University of Alberta, Calgary, under a grant provided by Chevron Corporation. Their objective was to define key physical properties of petroleum reservoir rocks that influence oil and gas production characteristics. Perhaps the single most important factor in a reservoir's performance is its permeability, Understanding the relationship between a reservoir's porosity and permeability, and what controls the permeability allows developers to plan reservoir management and intervention strategies throughout the production cycle. To illustrate his conclusions, Dr. Pulham drew from two field examples taken from the offshore North Sea in Europe and from the western United States.

The North Sea reservoir is part of a Jurassic synrift transgressive sequence in which 30 feet of core was examined petrographically to assess rock permeability. The core was traken from the Bruce Field in the Kimmeridgian Jurassic on the North Sea's East Shetland Platform, a synrift sequence lying midway between northeastern Scotland and southern Norway. The field measures roughly 200 km. by 100 km. and lies on a series of synrift en-echelon normal faults deflected around the older Bressay Granite intrusion. Sediments were shed off the rift edges from south to north as part of the Brent delta complex. The sampled core section of reservoir rock captures a transgressive sequence moving north to south across the granite pluton. The structure is complex and complicated by a series of reactivated Precambrian basement faults that instigated post-depositional half graben block faulting. The core transcends four sandstone layers separated by mudstones that represent flooding surfaces. A petrographic study was conducted to determine which stratigraphic break was most significant to reservoir productivity. Physical properties indicated the second sandstone layer had essentially the same porosity but much higher permeability than the others. The permeability increase was attributed to its being a cleaner sand with less lithic fragments to weather into clays that block the pore channels. The next question was what caused this compositional change?

To answer this question, Drs. Pulham and Pemberton combined careful sedimentological analysis with biostratigraphy, paleonology (pollen), and ichnofacies (trace fossil) identification to develop an accurate paleoenvironmental reconstruction of this sequence. The basal layer lies on an unconformity and is a cross-bedded fluviatile braided stream sandstone complex displaying pollen and spore evidence of some marine influence near its top. The uppermost sands also show burrowing bioturbation (Conichnus trace fossil) indicating localized marine depositional centers. A westward-thickening mudstone representing a transgressive delta channel sequence overlies the sands. Upward in the column, dinocyst fossils indicate brackish water conditions. A second layer of fluvial sands caps this unit and is followed by a second transgressive pulse encroaching from north to south. Biostratigraphic and ichnofacies evidence indicate a tidal delta sequence accompanied by tidal shoal and coquina deposits. Finally a third transgressive pulse produces an erosional surface that cuts through the underlying strata. The biostratigraphy shows low faunal diversity and little bioturbation. At this point the half graben rift blocks are drowned by the transgressing marine waters and their footwall topographic highs protrude as elongated offshore islands. The uppermost sediments in the reservoir column represent the final transgressive shelf facies. Dr. Pulham paused and projected a series of color slides showing paleoenvironmental reconstructions of the transgressive events by colleague **Tom Saunders**. These artistic renditions are based on the core's sedimentological, biostatigraphic, and trace fossil data. His findings indicate that the most permeable, and hence the highest production rate, occurs in the cleanest siliciclastic sands formed in the high-energy tidal zone.

Dr. Pulham's second illustration was from the middle Cretaceous (Turonian) Ferron Sandstone in Muddy Creek Canyon, Utah. This unit represents the northeastward prograding Last Chance Delta, part of a Cretaceous synrift system. Five 200 foot-long cores evenly spaced along a 5000 foot transect in the direction of progradation were examined to match high permeability zones with their depositional environment. The canyon floor is occupied by shelf sediments overlain by prograding delta deposits including a delta front, a delta top, and inlet sediments. The cores reveal active normal growth faults on the delta complex that have hanging wall sands juxtaposed against footwall muds. Biostratigraphic and trace fossil evidence reveal a dlta sediment lobe snaking back and forth across the canyon outcrops. Between the lobes are wave-dominated sediments; tidal units with signature herringbone cross-bedding cut across the delta sediments. A modern day analogy would be Cat Island off the Mississippi Delta, which makes the end of a prograding delta complex.

The Last Chance Delta sedimentary stratigraphy also includes high-energy tidal sands, distributory channels, lagoonal complexes, and is capped by a coal swamp deposit to complete the regressive cycle. The most permeable sediments for a given grain size are the tidal sands, which comprise 25% of the reservoir but generate over 50% of its oil.

With these examples from transgressive and regressive sedimentary sequences, Dr. Pulham emphasized the need to define the high resolution stratigraphic architecture and create detailed paleoenvironmmental reconstructions of a reservoir to guide production and management strategies. His closing statements echoed these concepts: 1) original depositional fabrics typically remain intact in siliciclastic reservoirs in spite of post-depositional processes; 2) stratigraphic events dominate reservoir performance at single well and field-wide scales, and are likely to be texturally related; and 3) simple petrographic textural analysis combined with sedimentological, biostratigraphic, and ichnofacies analysis can help target high production units. High-energy tidal incision units have the greatest potential as high permeability producers with up to 5 times the production rates of other units. By using integrated approaches embracing microstructural characterization, biostratigraphy, ichnology, and sedimentology rapid models of reservoir stratigraphy and production strategies can be made.

Many thanks go to Dr. Andrew Pulham of the University of Colorado for providing an excellent insight into the application of high resolution sequence stratigraphy, petrographic examination, ichnofacies analysis, and quantitative biostratigraphy to petroleum reservoir characterization. The NCGS wishes to acknowledge the generous financial support of the AAPG Distinguished Lecture series by Chevron Overseas Petroleum, Inc. COPI also provided lecture facilities at its Chevron Park, San Ramon, complex for Dr. Pulham's presentation.

Over Seventy Attend Caldecott Tunnel Tours

Caltrans District 4 superintendents **Ray Mailhot** and **Mike Hart** led over seventy NCGS members, friends, and family on a tour of the historical Caldecott Tunnel Saturday, March 3, 2001. This major Bay Area traffic thoroughfare has a colorful history that highlights the obstacles, tragedies, and engineering achievements that are an intimate part of its lore.

The Superintendent Building at the west portal is an unassuming structure. But inside its walls feature historical newspaper clippings and other memorabilia that chronicle its major historical events. One spectacular tragedy imprinted on many visitors' minds is the infamous April 7, 1982, fiery crash that closed the tunnel's third bore for several days. The accident occurred in the early morning hours and involved an inebriated motorist whose disabled car stopped a gasoline tanker near the west tunnel exit. The truck was side-swiped by a bus that swerved to miss colliding with it. The ensuing fireball ignited by the collision killed seven people and melted the side panels off a beer truck trapped behind the vehicles. The fleeing tanker driver miraculously escaped unscathed. This was by far the most spectacular crash in the tunnel's 64-year history. But the ever-present threat of an accident in this heavily-traveled commuter tunnel has honed the skills of Caltrans emergency response teams.

The tours reviewed tunnel keepsakes exhibited throughout the Superintendent Building that span the six decades of its operation: signs, computer terminals, telephones, and ubiquitous press clippings. But how did it all begin? Back in the 1880's a trip from Lafayette to Oakland took over 2 hours by stagecoach to tranverse the steep ridges of the Berkeley Hills. Some encounters between horse-drawn vehicles on the steep summit roads were fatal. Talk of a tunnel joining Oakland and Berkeley on the Alameda County side with Orinda and Walnut Creek on the Contra Costa County side had been bantered around since the 1860's. Projects had been initiated and abandoned by the Oakland and Contra Costa Tunnel Company in the late 1870's, then revived by leading citizens in the 1890's. In 1903 the 1100 foot long single-lane Kennedy Tunnel was opened, circumventing the treacherous final 320 feet of the steep Summit Road route over the Hills. In 1926, a special joint highway commission was formed to tackle the construction of the Berkeley Low Level Tunnel to join Berkeley and Orinda. The project was finally begun in December 1934, and the two-bore Broadway Tunnel, later renamed the Caldecott Tunnel in honor of highway district president Thomas F. Caldecott, was opened in November, 1937.

The Caldecott Tunnel No. 1 and 2 bores are heavily reinforced concrete-lined arched structures 3610 feet long and 34 feet high. The roadways are on the bottom level and accommodate two 11 foot-wide traffic lanes. Vertical roadway clearance is 14 feet 10 inches. The upper portion of the arches houses two ventilation chambers, one for fresh air intake and the other for tunnel exhaust. The tunnels are 15 feet apart at the portals and average 150 feet apart throughout their lengths. The tunnel construction posed significant engineering problems. Geologically, the rocks represent an Upper Cretaceous forearc basin formed by a convergent plate collision. Beginning at the west portal, the tunnel bores pass through Lower Miocene deep water cherty sediments and similar sediments of the Middle to Upper Miocene Claremont Formation (Monterey Group) which are overlain by fluvial to lacustrine terrestrial sediments of the Pliocene Orinda

Formation. The latter marks the transition of tectonic activity along the plate boundary from subduction to the San Andreas strike-slip regime. The upper Orinda sediments interfinger with the ~10 million year old basal volcanics of the Berkeley Volcanics. The west end of the bore passes through high fractured and crushed chert and shale less than 400 feet from the entrance that collapsed on August 28, 1935, filling 125 feet of the tunnel with debris, killing 3 workers, and affecting the ground surface 100 feet above. This catastrophe halted tunnel construction for several months and prompted a detailed geologic survey of the tunnel by the Six Companies of California, a consortium of six skilled construction firms that had been awarded the tunnel contract. Completed portions of the tunnels and a preliminary drift passing completely through the mountain were examined by the late Ben M. Page of Stanford University, then a student under Professor C. F. Tolman. Dr. Page's published report on the ***Geology of the Broadway Tunnel, Berkeley Hills, California*** appears in Economic Geology, Volume 45, No. 2, March 1950, pages 142-166. It is an exceptionally well-written and detailed account of the tunnel's geology and its construction, with vivid descriptions of the unforeseen rock conditions underground that delayed its completion and increased its final cost. Copies of this article can be obtained from the NCGS by e-mailing Dan Day at **dday@nrmc.com** or phoning 925-294-7530.

After a second collapse on February 22, 1936, which fortunately injured no one, the tunnel construction continued until two years had elapsed. At that time the tunnel was about 70% complete, and the contractors were fined in accordance with the original contract for failing to complete the project on schedule. The contract had originally been awarded on a unit-cost basis for about $3.7 million. The Six Companies sued the highway district for $3.26 million and lost. The bores were finished by other companies using the same construction techniques, and were opened to the public on November 13, 1937. The final cost of the project was $4.2 million. A third tunnel bore was commissioned and completed after 3½ years in 1964 for a cost of $24 million. A fourth bore was planned but abandoned during Ronald Reagan's tenure as California Governor.

Construction of the original two-bore tunnel was described by superintendent **Mike Hart** who narrated a 20 minute silent film of the construction that had been edited from footage found in storage at the tunnel site. It shows the various engineering techniques used in the tunnel construction, and also gives an excellent account of living conditions in the Berkeley Hills at that time. Caltrans engineering geologist **Grant Wilcox** followed Mike with a superb description of the tunnel geology and engineering hazards, supplemented by a comprehensive discussion of the local geology by Caltrans geologist and Cal State Hayward geology graduate **Chris Risden**. Both provided an excellent description of rock lithology and engineering obstacles that had to be dealt with by the construction companies. Chris also display rock samples to illustrate the various units present in the tunnel vicinity.

The groups were then taken on tunnel tours after the historical and engineering geological accounts by Mike, Grant, and Chris were concluded. It should be noted that the tunnel system is ably manned by a staff of 22 persons filling three shifts per day, and include a console operator, a tunnel supervisor, and three operations people on each shift. Keep in mind that these personnel orchestrate the safe passage of 170,000 vehicles through the tunnels every 24 hour work day. The latter does not include the added headaches caused by major Bay Area entertainment and sporting events that affect the normal daily or weekend traffic routines. These situations must be dealt with separately. The tours first entered the west portal. There they were shown a mock-up of the tunnel lighting system. With the advent of newer sodium vapor lights, the lamps have been changed to improve illumination and save energy. Lighting is on full brightness during daylight hours and is dimmed at night when motorists are using their headlights. The next stop was the ventilation room. Here four 50 horsepower belt-driven squirrel-cage fans feed fresh air into the intake tunnels that enters the room through large louvered vents in the east wall. The fans are capable of forcing air into the intake tunnels at 50 mph. The air enters the distribution chamber above the roadway and is forced downward through vents where the floor meets the walls. The pressurized air enters the roadway below through slotted vents a few feet above the roadbed. The exhaust fumes are driven upward and out of the tunnel through another set of slots in the tunnel ceiling into the return exhaust duct. The Alameda County and Contra Costa County halves of the tunnel have separate ventilating systems.

The groups left the ventilation system and were taken behind the portal building, where Ray and Mike showed visitors the small canyon leading up the hillside to the east. The Oakland Hills fire of October 1991, made its way down to the west portal building and destroyed the welding room on the south side. Aside from this minor damage, the structure was undisturbed by the flames. After a short stop to look at the special equipment used to clean the tunnel walls, the groups were taken to the main control room in the third bore portal. The third bore was opened in 1964 and cost $24 million to construct. It gave Caltrans flexibility in handling large traffic volumes by allowing the second bore to be used as either and east or west bound lane depending on their needs. Its portal houses a control room with 8 video screens for monitoring not only Caldecott Tunnel traffic,

but conditions elsewhere East Bay that have a direct effect on its vehicle load. Ultimately Caltrans will install 13 monitors. The tunnels are fitted with carbon monoxide sensors and a fiber optic system for tracking traffic flow and triggering the ventilation system when toxic gases build up. Ray and Mike noted that even if the ventilation system failed, it would take about 4 hours for the CO concentration to reach a dangerous level from vehicles stalled in the tubes. The groups were shown a diesel generator that can supply 480 volts at 60 Hertz in the event of a power outage and a live demonstration of the pneumatically operated pop-up plastic dividers used to change lane direction in the second bore. The bright yellow plastic cylinders are remotely controlled by two-person drive through teams who also operate several changeable overhead message signs. The final stop on the tour was the two propeller-driven 100 horsepower intake fans capable of moving 250,000 cubic feet of air per minute at a top speed of 50 mph. A fourth tunnel bore is again under consideration, and its cost estimates range from $135 to $353 million depending on various design features. The design costs alone will run $26 million - more than the entire cost of the third bore!

The NCGS is truly indebted to **Ray Mailhot** and **Mike Hart** of the Caltrans Tunnel staff for leading the introduction to and the foot tours of the Caldecott Tunnel west portal. Our sincerest thanks also go to Caltrans Oakland Office Chief Geologist **Grant Wilcox** assisted by Caltrans Engineering Geologist **Chris Risden**. Both did an outstanding job of describing the local geology and the underground geological conditions encountered by the original tunnel contractors. These individuals deserve our appreciation for taking time from their busy schedules to show members how the tunnel was constructed and is being operated today.

NCGS member **Jean Moran** of Stetson Engineers and her husband **Bill Martin** deserve credit for arranging the two tours with Caltrans and for handling the usual registration duties quite admirably. Special thanks go to NCGS Counselor **Phil Reed** who provided the coffee, juice, and pasteries for the morning session, and the ice and beverages for the afternoon tour. The tours impressed upon everyone the teamwork and coordination that goes into the efficient operation of the Bay Area's crowded highway system.

CCGO Fundraiser Draws 120 to Hear the Geological History of San Francisco Bay

For its April 4th annual fundraising event, the California Council of Geoscience Organizations (CCGO) hosted a talk by retired USGS Quaternary and environmental geologist **Dr. Kenneth Lajoie**. Dr. Lajoie drew an audience of 120 at Jack London Square's Spaghetti Factory restaurant to hear him discuss ***"The Origin of San Francisco Bay."***

Dr. Lajoie has spent his professional career studying the environmental geology of California. This research includes coastal erosion, earthquake hazards, earthquake ground ruptures, the Mono Lake area, the Los Angeles basin terrace deposits, and radiometric and amino acid dating of recent marine fossils. His work on San Francisco Bay geological history stems from his graduate student days at U.C. Berkeley. In his opening statements, Dr. Lajoie noted that San Francisco Bay, like its counterpart Monterey Bay to the south, exists because it occupies a low spot in the California Coast Ranges. His talk was two-part: the first discussed the basin formation and the second focused on its saline and fresh water sources. The Bay is part of the San Andreas-Hayward-Calaveras strike-slip fault system which accounts for ~17mm of a total 35mm annual right lateral slip rate between the Pacific and North American plates. Because of a slight eastward bend in the San Andreas fault south of the Bay Area, this interplate displacement also involves ~1 mm/year compression. The Bay lies in a N34ºW-trending graben bounded by the San Andreas and Hayward faults. This down-dropped block is filled with 2000 feet of sediment derived in part from alluvial sediments provided by the Niles fan sourced from the Livermore Valley. Key drainages emptying into the South Bay are Alameda Creek, Coyote Creek, and Guadelupe Creek from the south. Alameda Creek is a key sediment source that forces the Bay away from the Hayward fault.

The current San Francisco Bay, according to Lajoie, began its development 22,000 years ago during the last glacial maximum. At that time sea level was 100 meters lower than today and the Bay Area coastline was about 6 miles beyond the Farallon Islands. This low sea level stand was dated by uranium series isotope and carbon-14 dating techniques of coral reef terraces in Barbados, Tahiti, and New Guinea. Ocean core studies indicate the last sea level rise occurred in four increments, and that the current shoreline was established about 2000 to 3000 years ago. About 15,000 years ago during this low level stand, sand dunes were formed by NW to SE-trending winds on the shores of the Sacramento-San Joaquin River at Antioch, at Oakland (Merritt sands), and on the San Francisco peninsula. Clues to the timing of Bay filling are offered by wood fragments unearthed at a Mountain View garbage disposal site. Also exposed were bison, camel, ground sloth, and mastodon fossil debris characteristic of the southern California La Brea fauna dated at 22,500 years B.P. Farther west and topographically higher researchers have found 10,000 year old snail shells and human burial sites dating from 4400 years ago at Palo Alto's San Francisquito Creek.

Other sources of ecological information that reflect the drowning of San Francisco Bay are Indian shell mounds. These midden sites are composed predominantly of oyster shells collected at the water's edge and brought back to the settlement for food. The shell mounds often extend 5 to 6 meters below sea level and chronicle the ecological evolution of the Bay. Ironically, the base of the mounds date back only to ~5000 years ago. Why are these sites relatively young? The answer is that the villages, and hence the midden sites, followed the Bay's incrementally rising shoreline. Much older midden sites, said Dr. Lajoie, would be found farther west in shelf areas now under the Pacific Ocean.

The long-term history of San Francisco Bay is predicated on glacial cycles of eustatic sea level change. The short-term (last 600,000 years) cycles follow the Milankovitch hypothesis which attributes the glacial climatic events on the earth's top-like precession on its rotational axis. Geochemists studying global temperature and sea level change by stable oxygen isotope analysis of deep sea cores and uranium series radiometric dating of coral reef terraces have established a time line for eustatic variations in sea level. In the last 250,000 years Dr. Lajoie concludes that the Bay has formed three times: at ~210,000 B.P., at ~120,000 B.P., and at ~4000 B.P. Besides sea level fluctuations, the Bay's existence also relied on tectonic conditions to establish the topographic low in the Coast Ranges where it now resides.

Water sources have played a significant role in the Bay's evolution. Dr. Lajoie shifted to fresh water sources feeding the Bay after discussing the processes that influenced sea level encroachment onto the land. His story begins nearly 800,000 years ago when a large freshwater body known as Corcoran Lake occupied much of the Central Valley. About 750,000 B.P. the Bishop Tuff was erupted from the Long Valley Caldera and was laid down as the fine Corcoran clay aquitard unit in the lacustrine sediments. A subsequent eruption from Mt. Lassen dated at 435,000 B.P. formed another widespread ash deposit know as the Rockland Ash. It is exp[osed in sea cliffs at Fort Funston in San Francisco. Up to ~560,000 years ago the central valley and Corcoran Lake drained through Pacheco Pass in the southern Coast Ranges into the Salinas Valley near Paso Robles, and flowed northward along the Salinas River into Monterey Bay. At this time tectonic uplift blocked the southern exit of Corcoran Lake and raised its level enough to breech the low Coast Ranges west of what is now the Sacramento-San Joaquin Delta. Waters rushing from this large freshwater lake carved out the Carquinez Strait. This single event dramatically changed the Central Valley's drainage pattern, as indicated by reworked Rockland Ash found in Bay and Sacramento delta sediments. The 15,000 year-old dunes in the Antioch and Oakland areas attest to the enormous amount of sediment discharged into the Bay by the Sacramento-San Joaquin River complex during post-glacial cycles when the melt waters created enormous braided stream systems flowing out of the Sierras.

Perhaps the most drastic changes to the San Francisco Bay ecosystem, however, has occurred during modern times. Civilized man has had a huge impact on the Sacramento-San Joaquin Delta, Suisun Bay, San Pablo Bay, and on the shallow southern end of San Francisco Bay proper. The first major disruptions were caused by Russian fur traders, who forced Aleut Indians from Alaska to help them slaughter thousands of sea otters in the Spanish-occupied Bay for their valuable pelts. From 1850 on man's effects on the estuary have been unparalleled. Levees built on delta islands have destroyed the peet layers and resulted in up toi 10 feet of land subsidence. Groundwater pumping has similarly caused up to 13 feet of subsidence and promoted salt water incursion in parts of the Santa Clara Valley. Commercial salt ponds have replaced salt water marshes and landfill used for residential and commercial property has subsided or suffered enhanced shaking during seismic events. Naval air stations have captured marshland and subsequently polluted groundwater with hazardous petrochemicals. And water pumped out of the Delta for irrigation and to water southern California has slowed natural erosion, destroyed freshwater marshes, and permitted salt water to enter the groundwater system. In the not too distant future, the greater San Francisco Bay Area, which has grown tremendously during the post World war II era, will be essentially continuous with the Sacramento-Stockton-Tracy metropolitan areas. And as the glacial climate cycle repeats itself, independent of any man-made greenhouse effects, the bay will once again recede in about 1000 years and the coastline will regress back beyond the Farallons.

The CCGO and its component geoscience organizations express their kind regards to **Dr. Kenneth Lajoie** for his outstanding account of San Francisco Bay's surprisingly short but nonetheless fascinating geological history. Special thanks go to CCGO past Secretary and NCGS past-President **John Karachewski**, who arranged for Dr. Lajoie appearance at the fundraiser and handled the registration duties. CCGO past-President **Betsy Mathieson** took time to introduce the audience to the CCGO website, which includes an employment listing and a calendar of Bay Area geoscience events. Readers are urged to visit the website at http://www.ccgo.org.

NEWS FROM THE DENVER EARTH SCIENCE PROJECT

This is an announcement for earth science professionals of all fields - education, government and industry. EARTHLINE - the newsletter of the Denver Earth Science Project is now available online. We will no longer be publishing a printed edition of Earthline, in order to save on costs. Go to our web page at: www.mines.edu/Outreach/Cont_Ed/desp.shtml and click on the "Earthline" button.

At the DESP page you will also find information about summer classes, science links, update information, etc.

SUMMER 2001 WORKSHOP PREVIEW

1) **Energy: A Closer Look At Oil & Gas** - Midland, Texas - June 26-28. This course is being sponsored by the West Texas Geology Foundation.

2) **Energy: A Closer Look At Oil & Gas** - Aurora, Colorado - July 9-11. This course is being sponsored in part by a grant from the USX Foundation and Marathon Oil Company.

3) **Energy: A Closer Look At Oil & Gas** - Houston, Texas Dates are not yet set, but probably will be during the first two weeks of June. This course is sponsored by the Society of Petroleum Engineers - Gulf Coast Section, the Houston Geological Society, and others.

4) **Oil & Gas Exploration** - Soldotna, Alaska - June 11-15. This course is sponsored by Unocal, Alaska.

5) **Oil & Gas Exploration** - Golden, Colorado - Dates for this course are not set yet. Sponsors are being sought.

6) **Oil & Gas Exploration** - Grand Junction, Colorado - Dates for this course are not set yet. Sponsors are being sought.

7) **Do You Know Your 3 R's? Radiation, Radioactivity, and Radon** - Golden, Colorado - June 18-20. This class is being sponsored by a grant from the Colorado Department of Public Health and Environment.

8) **Do You Know Your 3 R's? Radiation, Radioactivity, and Radon - Online Version** - Course work begins June 18 and ends July 28. There will be three online classes offered during the summer, centered in three locations around the state. Each class will involve six weeks of online work and include three Saturday morning classes to work with the materials in the module. Teachers will come together in either Durango, Montrose, or Grand Junction (whichever location is most convenient for you) for the Saturday morning classes. These online classes are being sponsored by a grant from the Colorado Department of Public Health and Environment.

9) **Ground Water Studies** - Golden, Colorado - June 21-22.

The Denver Earth Science Project will consider bringing a workshop to any location where sponsorship is available. Please contact us for details. Please pass this announcement on to other interested teachers. Anyone may be added to our e-mailing list. Send us your address.

Governor Davis appoints NCGS member to State Mining and Geology Board

Governor Gray Davis has just named several members and the chair to the California State Mining and Geology Board. Among the new members is California Council of Geosciences Organizations (CCGO) founder Robert E. Tepel. The State Mining and Geology Board is composed of nine members appointed by the Governor and confirmed by the senate, for four-year terms. The Board operates within the Department of Conservation and is granted certain autonomous responsibilities and obligations under several statutes. The Board serves as a regulatory, policy and appeals body representing the State's interests in geology, geologic and seismologic hazards, conservation of mineral resources, and reclamation of lands following surface mining activities. For more information about the Board, visit its web site at http://www.consrv.ca.gov/smgb/. Mr. Tepel has had a long and productive career at the Santa Clara Valley Water District in San Jose, California. He recently retired from the agency. He is a past president of the Association of Engineering Geologists (AEG) and recently was the chief organizer for the very successful Fall 2000 AEG-GRA Annual Meeting in San Jose, California. He has written many articles and even a book on professional licensure, one of his areas of interest. He has also been involved with the Association of State Boards of Geology (ASBOG). Under Mr. Tepel's leadership, CCGO was founded and grew. He helped with the mission, vision, incorporation, and strategic plan that have led CCGO to its current status as California's largest association of geoscientists. Mr. Tepel initially led the charge during the State legislature's sunset review of the Board of Registration for Geologists and Geophysicists about 5 years ago, and CCGO participated actively in the Board's sunset review last year. Mr. Tepel has remained supportive of CCGO over the years and we are proud of his appointment to the State Mining and Geology Board. For more information about the California Council of Geoscience Organizations, visit its web site at http://www.ccgo.org or contact CCGO President Jim Jacobs at AugerPro@jps.net or (510) 232-2728.

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

NCGS May 19-20, 2001 Field Trip

"The Golden B.E.A.R. Tour 2001"*

(Blueschists, Eclogites, Amphibolites, Refreshments)

Led by Neotectonics Expert, Consultant, and Beer Aficionado **Dr. John Wakabayashi**

This trip two-day trip will feature the most beautiful metamorphic rocks in California, the blueschists, eclogites, and amphibolites of the Franciscan Complex. These rocks have a fascinating history and have helped make the Franciscan one of the world's best known rock units. The rocks viewed on this trip are so gorgeous that they can be appreciated by the geologist and non-geologist alike. For those that believe that no Franciscan geology puzzle is complete without a pint to help solve it, we offer stops at some of the world's most acclaimed small breweries. These brewpubs are chosen for their fine (and reasonably priced) food as well as their award-winning brews, so these establishments can be appreciated by those who wish to pass on the brew as well. We will camp overnight at **Spring Lake Campground, Santa Rosa. Please bring your own sleeping bag and bedding/tent. Those who wish to stay at a motel in the area must make their own arrangements. <u>This trip will use a bus so that no one will have to drive</u>. <u>Space is limited and available on a first come-first serve basis! SIGN-UP TODAY!</u>**

Date: **Saturday-Sunday, May 19-20, 2001**

Departure: **7:30 a.m. <u>SHARP</u> from the Chevron, Concord, parking lot. (see directions below)**

OR

<u>A second meeting place will be arranged for attendees living in the north San Francisco Bay Area.</u>

Directions: Exit I-680 in Concord at Willow Pass Road. Go east one block to the stoplight at Diamond Blvd. Turn left onto Diamond Blvd. and drive north past the entrance to the Willows Shopping Center. Turn left into the Chevron parking lot and park in the lot assigned to the NCGS.

Cost: $60. Price includes bus transportation, breakfast pastries, camping fee, Saturday night barbecue, and guidebook.

<u>PLEASE NOTE:</u> Attendees are responsible for their own lunch and beverage costs both days!!

********** REGISTRATION FORM **********

Name _____ _____

Address (Street/City/Zip)_____ _____

Phone (day) _____ **Phone (evening)** _____ _____

E-mail or Fax No. _____

Will you meet the group at an alternate site in the north San Francisco Bay Area? _____

Please write a check to the NCGS and mail it with the completed registration form to

:

Tridib Guha, 5016 Gloucester Lane, Martinez, CA. 94553-4373

If you have any questions or need additional information, call Tridib at **(925) 363-1999** or by e-mail at **aars@ccnet.com.**

The Golden B.E.A.R. Tour 2001 Itinerary

SATURDAY

Stop 1: Ring Mountain, Tiburon Peninsula. This stop visits the dazzling crown jewel of Bay Area geology to view beautiful blueschists, eclogites and amphibolites. The metamorphism of these rocks gives us clues to processes that occur when subduction begins. The rocks are so captivating here it is not an exaggeration to say that it would be possible to spend the entire day here. But, we have other nice places to go…

Stop 2: Marin Brewing Company, Larkspur. Marin's Mt. Tam Pale Ale and IPA are benchmark beers, award-winning beers, and the pub food selection here is among the best of Bay Area brewpubs.

Stop 3: Blueschist facies metagreywacke, Novato. A brief look at the type of rock that constitutes the vast majority of blueschist facies rocks in the Franciscan. It's not blue, nor schist, but it was metamorphosed some 30 km beneath the Earth's surface.

Stop 4: Bear Republic Brewing Company, Healdsburg. This brewery has won a Great American Beer Festival gold medal with its Racer 5 IPA, and some hop-lovers (including me) think their Extra Pale Ale is even hoppier (especially if it's the cask conditioned version). The food is noteworthy, especially the incomparable herb-garlic fries, that feature melted parmesan over fries with tons of garlic, rosemary and parsley--all this and they're not greasy or overly salty, either. Best garlic fries on the planet, bar none!

Stop 5: Skaggs Springs schist near Lake Sonoma. This is a classic blueschist unit that makes up a belt that crops out over a distance of 70 km. In spite of its impressive appearance this unit has not received as much attention as some of the less impressive intact blueschists in the northern Coast Ranges. The visit to this schist includes viewing some fascinating field relations that include the occurrence of amphibolite, eclogite, and garnet amphibolite blocks in shear zones that cut the Skaggs Springs schist.

Camp Site: Spring Lake Campground, Santa Rosa.

SUNDAY

Stop 1: Jenner. This is a well known eclogite locality at the mouth of the Russian River. Most field trips visit a well-beaten block above Highway 1. Much more interesting is the pile of blocks on the north bank of the river at its mouth. In terms of beautiful blueschist, eclogite, and amphibolite blocks per unit area, this place takes the cake. No words can describe just how dazzling this pile of glittering blocks is. This is the only spot in the Franciscan where the rocks may be even prettier than at Ring Mountain.

Stop 2: Blueschist facies metabasalt, Occidental, California. These rocks look almost like ordinary basalt, until you see the those stringers of blue in them.

Stop 3 (lunch): Powerhouse Brewing Company, Sebastopol. I have heard good things about this place and will scout it out to confirm.

Stop 4: Moylan's, Novato. Moylan's produces some fine ales, particularly some of their specialty beers, such as their Imperial Stout and barleywine.

Stop 5 (optional). Moeser Lane, El Cerrito. This stop is a few hundred meters south of one of my favorite geology stops (the Schmidt Avenue quarry). This stop features one of the East Bay's amphibolite and blueschist stops. Alternatively, depending on interest, the Schmidt Avenue stop, with its superb structural relationships (exposed fault of blueschist facies greywacke over lower grade rocks) can be substituted.