NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

NCGS Newsletter Editor:
Mark Detterman
mdetterman@blymyer.com
Secretary:
Dan Day: danday94@pacbell.net
NCGS Voice Mail: **925-424-3669**

Website: www.ncgeolsoc.org

MEETING ANNOUNCEMENT

DATE: **Wednesday, January 28, 2004**

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

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

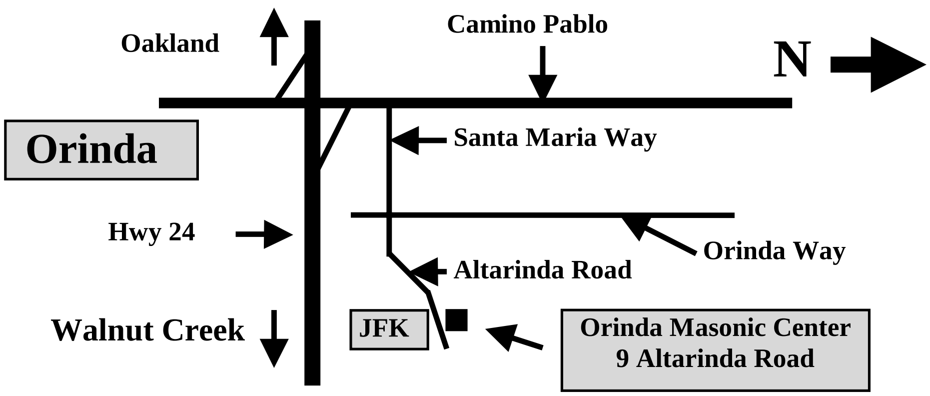
Speaker: Dr. Ronald Olowin, Professor of Astronomy and Physics, Saint Mary's College, Orinda

The Earth: Having a Sense of Place in the Cosmos

Tonight's talk will be largely based on images taken from the Hubble telescope. Although the exact emphasis was not known at the time of editing, it is expected that Dr. Olowin will use some of the very spectacular images taken by the Hubble Space Telescope to provide us with a sense of the earth's place in the universe. This may include accompanying star charts, astronomy-influenced art, and illustrated texts to trace the role that the stars and constellation mythology have played in shaping and guiding civilizations throughout history. Dr. Ronald Olowin is an active member of the astronomy community. Some of his principal interests are located at the intersection of astronomy, ethnoastronomy, archoastronomy, (the latter two collectively known as cultural astronomy) as well as the intersection of the arts and science (the *belles arts et letters*). He currently teaches at Saint Mary's College in Orinda, but he also instructs at such diverse institutions as The Center for Theology and Natural Sciences and presents at "The Inspiration of Astronomical Phenomena" conferences. Dr. Olowin has recently been co-curator for an exhibit at the Hearst Art Gallery at Saint Mary's College using images from the Hubble telescope. He is the former director of the Kirkpatrick Planetarium located in Oklahoma City.

Tonight's topic is likely to appeal to a wide audience, including many of your family members. Please consider bringing them.

Meeting Location



Check out our Recently Updated Website!!

It continues to be under reconstruction, and it's worth investigating!

www.ncgeolsoc.org

Northern California Geological Society
C/o Mark Detterman
3197 Cromwell Place

Hayward, CA 94542-1209

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

NCGS 2003-2004 Calendar

Wednesday January 28, 2004
Dr. Ronald Olowin, Professor of Astronomy and Physics, Saint Mary's College, Orinda
The Earth: Having a Sense of Place in the Cosmos (based on images taken from the Hubble telescope)
7:00 PM at Orinda Masonic Center

Wednesday February 25, 2004
Dr. Nahum Schneidermann, ChevronTexaco Overseas Petroleum
Global Gas
7:00 PM at Orinda Masonic Center

Wednesday March 31, 2004
Dr. Judd Case, Dean of Science, Saint Mary's College, Orinda (Tentative)
TBA – Likely on his recently completed expedition to Antarctica in search of Cretaceous fossils
7:00 PM at Orinda Masonic Center

Attention Members – Guidebook Search

As many of you are aware Sandy Figuers is compiling a list of NCGS field trip guidebooks. He is also attempting to locate copies of each of these guidebooks. He recently forwarded a list of the guidebooks that remain missing. Several from that list have been found, but others have remained elusive. NCGS and Sandy are in the process of determining how best to make as many of these historic guidebooks available to the geologic community. Should you have any of the following guidebooks in your collection Sandy Figures would appreciate hearing from you directly at Figuers@aol.com or 925-606-8595.

Kopf, R. and Lawler, D.; 2000; Chalk Bluff Preserve; NCGS; October 28, 2000; (no copy known)
Erskine, M. and Howell, D.; 1999; Vallecitos syncline and Coalinga fossil hunt; NCGS; October 2-3, 1999; (no copy known)
Roberts, B. and Michelson, R.; 1994; Remediation of soil and groundwater; NCGS; March 19, 1994; (no copy known)
Chevron, V. and Fischer, P.; 1986; Submarine Canyons Meganos Canyon and sand, north flank, Mt. Diablo; NCGS; April 18, 1986; (no copy known)
Nilsen, T.; 1985; Turbidites along the coast south of San Francisco; UCGS; April 4, 1985; (no copy known; Nilsen does not have a copy of this)
Unknown; 1981; Marin County; NCGS - AAPG joint field trip; (no copy known)
Unknown; 1977; A look at the Franciscan rocks of the Napa Valley; NCGS; June 11, 1977; (no copy known)
Kilkenny, J.; 1973; Geysers, Sonoma County; NCGS; September 29, 1973; (no copy known) NOTE - the author may be Koenig and this guidebook may be similar to the 1968 geysers guidebook.
Bowen, O.; 1973; Mother Load Country; NCGS; April 28-29, 1973; (no copy known)

Upcoming Meetings of Interest - Association of Engineering Geologists

Tuesday February 10, 2004
Chris Willis, California Geological Survey
Landslides in Big Sur
Spenger's, Berkeley

Tuesday March 9, 2004
Student Night with Dr. John Williams (Three Student Presentations)
Sinbad's, San Francisco

Tuesday April 13, 2004
Donald Wells, Geomatrix Consultants
Location of the Hayward Fault at UC Berkeley's Memorial Stadium
Location TBA

Contact Chris Hundemer at 408-866-5436 for more information ($30/member; $35/non-member)

Upcoming Field Trips of Interest - Association of Engineering Geologists

March or April 2004

Seismic Hazard of the Range Front Thrust Faults, Northeastern Santa Cruz Mountains / Southwestern Santa Clara Valley

Preliminary field trip co-leaders:

Bob McLaughlin, John Wakabayashi, Christopher Hitchcock, Ted Sayre, Reid Fisher, Steve Connelly, Ron Rubin, Glenn Borchardt, Drew Kennedy (*details to be forthcoming*)

AAPL Distinguished Lecture Discusses the Structural Interpretation of Complex Salt Basins

Reported by Dan Day

Dr. Bruce Trudgill of the Colorado School of Mines presented his AAPG Distinguished Lecture ***Unraveling the Complexities of Salt Basins Through the Integration of 3-D Seismic Analysis, Field Studies, and Structural Restoration"*** on October 14th. His lecture focused on integrating field studies and structural restorations with 3-D seismic imaging to help understand the tectonic evolution of salt basins and associated hydrocarbon reservoirs.

Bruce began his lecture with an introduction to salt basins and salt tectonics. Salt basins occur around the globe—on continents, along continental margins of most continents, and even in the Arctic region. Salt formations crop out in the Colorado plateau, and are an integral part of the stratigraphy and sedimentary architecture around the oil-bearing margin of the Gulf of Mexico. Salt (NaCl) is weaker than other sedimentary rocks under tension and compression. Oddly, its density (2.2 g/cc) is essentially constant, even under compaction. And a small amount of water dissolved in the salt can reduce its strength to zero! At depths of 500 to 1000 meters, the density of salt is less than that of clastic sediments, setting the stage for pressure differentials that drive salt tectonic processes. Unlike brittle clastic sediments in basins, salt behaves like a viscous fluid, and so can be deformed into discordant bodies, squeeze into and lubricate fault gaps between adjacent tectonic blocks, flow under low temperature and pressure conditions, and drag with it adjacent sediments. These unique phenomena can be self-driven by buoyancy effects owing to the lower density of the salt strata. This can convert initially horizontal salt layers into complex sheets, pillows, septa, and detached tear-shaped diapirs, often mobilized with the surrounding sediments by regional tectonic forces.

To illustrate these concepts, Bruce played a short animated movie based on scale model studies by Guglielmo, Vendeville, and Jackson at the University of Texas, Austin. Their modeling shows the progressive evolution of a symmetric salt diapir system beginning with graben formation during tensile crustal thinning. The extension initiates a period of reactive diapirism as salt rises upward in response to thinning of the overburden. The salt intrusion creates numerous faults in the overburden. This stage is followed active diapirism as buoyancy forces take over and drive the diapir upward, dragging adjacent sediments upward along near vertical contacts, and flexing the overburden into an anticlinal structure. The final stage is one of passive diapirism, as the salt dome pierces the sedimentary cover. A "turtle structure" forms at the crest of the dome as sediments are gradually deposited on its surface. Salt dissolution can lead to post-passive partial collapse of the dome and additional structural complexities. The various stages of salt diapir development can yield hydrocarbon traps, usually sealed off by the complex faulting patterns that develop. The passive diapir stage could initiate reservoir breaching in the anticlinal zone overlying the dome, allowing any accumulated hydrocarbons to escape. Thus, understanding the evolution and form of complex salt structures can aid in locating hydrocarbon plays where the proper source and reservoir rocks are present.

An important tool in the analysis of salt dome structures is seismic imaging. Today, 3-D imaging has become a fine tuned tool for evaluating geologic structures. In the Gulf of Mexico, for instance, the salt layers have formed very complex tongue-like shapes that intrude the stratigraphic column from Louisiana to Mexico. Often these thin diapirs migrate basinward under tectonic forces, forming very bizarre structures not unlike the wispy, elongated funnel of a tornado. 3-D imaging technology can be used to take vertical slices through the salt-intruded sections, and help reconstruct dismembered basins. Software programs are available that take the 3-D seismic data and restore the overlying and underlying sections to the horizontal. The process of unraveling these complex features also permits one to select the structures likely to bear hydrocarbons. These techniques have been used to locate petroleum plays in the Gulf of Mexico shelf.

Bruce demonstrated several computer-generated reconstructions of complex salt structures in the offshore Louisiana coast. The software uses 2 and 3-D seismic imaging data to reconstruct complex diapirs, tongue structures, septa, and detachments. These reconstructed images can be rotated and examined from various perspectives to determine likely locations of hydrocarbon reservoirs. Restoring these features to original horizontality can also aid exploration geologists in locating points of sediment buildup that might act as reservoirs.

Fortunately, many of these seismically imaged offshore submarine features can also be seen on land. Exceptional exposures of salt diapir activity can be seen in the Atlas Mountains of Morocco, in Iran's Zagros Mountains, and in Utah's Paradox Basin (part of the Umcompagre Uplift in southern Utah and Colorado). This region has excellent field exposures and a NW-SE structural trend cut by the Colorado River. Some of the best features occur near Moab, Utah. Here the salt-bearing Upper Pennsylvanian Paradox Formation not only reaches the surface, but forms a major topographic low (Moab Valley) where it has dissolved away over the ages. Elsewhere the salt strata form deeply buried anticlines and complexly faulted diapirs.

The Paradox Basin is a classic example of how salt strata can control regional stratigraphy and structure. Subtle field relationships in one outcrop indicate that sediments were deposited on the flanks of a dome, while it was exposed on the ocean floor. Local complexities suggest that the salt intrusion may have been dissolved or tectonically withdrawn from an area, allowing the sediments that it supported to drape over nearby units. Combining detailed seismic data, computer reconstruction of complex tectonic structures, and field observations of mobilized salt basins have greatly advanced our understanding of these phenomena. This information is a useful exploration tool in offshore oil fields where salt formations have added complexity to the existing structure.

The NCGS gratefully acknowledges Dr. Bruce Trudgill for presenting his lecture to its members and to his colleagues at ChevronTexaco's San Ramon Park facility. His talk clearly illustrated the contribution of computer reconstruction to deciphering complex structural features using state-of-the-art 3-D seismic data. As these field evolve, so will our understanding of subsurface structural features, and how they interact with hydrocarbon systems.

The NCGS would also like to thank ChevronTexaco for grants to cover the expenses of the AAPG Distinguished Lecture series. NCGS selects the speakers and their itinerary, and ChevronTexaco provides its lecture facilities for the presentations. Their continued corporate support of this program is deeply appreciated.

The Hidden Wonders of Monterey Bay

Reported by Dan Day

On October 29th, NCGS members were treated to a special look at the marine world in the greater Monterey Bay area. **Dr. Stephen Eittreim**, Emeritus, USGS, Menlo Park, presented ***Revealing The Hidden World Beneath Monterey Bay***. Dr. Eittreim received his Ph.D. degree from Lamont-Doherty Geological Observatory, Columbia University, and has since then been part of the USGS's Pacific Marine Branch based in Menlo Park. His specialties include marine seismic reflection analysis, acoustic seafloor mapping, seismic stratigraphy, ocean bottom photography, seafloor crustal and tectonic studies, and sediment transport. All of these disciplines play a significant role in interpreting the submarine marvels of Monterey Canyon and its environs.

Over the last several decades, the U.S. government has been methodically establishing national marine sanctuaries to protect our delicate marine ecosystems. Now over a dozen marine sanctuaries are scattered along America's coastlines. The largest is the Monterey Bay National Marine Sanctuary, which includes the largest submarine canyon complex on the Pacific coast of the Western Hemisphere. The sanctuary extends up the California coast to the mouth of San Francisco Bay, and 3 km. offshore to the 300 meter shelf break. Dr. Eittreim and his research team's studies in the sanctuary have yielded numerous publications in the National Marine Journal.

The jewel in this necklace is, of course, the extraordinary Monterey submarine canyon. The canyon was the original drainage route of the vast Central Valley via the Salinas River valley until it was cut off by uplift of the Diablo Range 200,000 years ago. Much Dr. Eittreim's research involved creating a geologic map of Monterey Bay and its submarine canyon. This was accomplished by sampling outcrops with piston and gravity cores. The outcrops were also surveyed using sidescan sonar images and mapped at a resolution of 1 meter per pixel.

Stephen paused to explain the various remote imaging techniques used to characterize the seafloor. Multibeam bathymetry utilizes sound transducers on the ship hull to emit acoustic signals that reflect off the bottom. This technique provides a topographic map of the ocean floor. Sidescan sonar tows a submarine barge equipped with acoustic transducers about 20 feet above the bottom. The acquired backscattered signals provide details of bottom topographic features. And the seismic hydrophone method yields a 50 meter deep tomogram of bottom sedimentary features. Armed with these tools, the researchers made numerous traverses north and south of the canyon axis, recording bottom details, sampling outcrops, and characterizing the sediments, structures, biologic communities, faults, and even the location of offshore pipelines. These techniques complement each other. The seismic hydrophone, for instance, gives shallow cross sections of the sidescan bathymetric surveys and detailed information to a depth of several meters.

The project also evaluated sediment transport along the coastal margin. The researchers examined surface muds and categorized them by composition and particle size. Oddly, although the California surface current flows southward along the coast, the bottom current, which does most of the sediment transport, moves in the opposite direction. A long tongue of sediment trickles along the shelf bottom toward San Francisco Bay, fed by clay-rich sediments from the Salinas River, and by sandier detritus from the Santa Cruz Mountains to the north.

An interesting bedrock feature was noticed at the mouth of the San Lorenzo River off Santa Cruz. Here the bedrock is covered with a 30 meter-thick veneer of muddy sediments. Seismic imaging revealed a sharp step in the bedrock slope offshore, then a continuation of the more gentle bedrock surface seaward. The research team cored the muds and determined a sedimentation rate of slightly over 2mm per year. This dated the underlying bedrock unconformity at about 14,000 years. Dr. Eittreim and his colleagues agreed that the sudden dip in the bedrock surface represents the old shelf break and a lower sea level stand 14,000 years ago.

Detailed outcrop sampling revealed exposures of the Sur Series crystalline rocks on the shelf bottom and other intriguing sedimentary features. Off the northeastern tip of the Monterey peninsula, bathymetric imaging picked up regions of large sand ripples oriented parallel to the shoreline. These features are localized in shallow depressions and are large-scale sand wave created by strong bottom currents.

West of Point Lobos, sonar captured the San Gregorio fault trace trending to the NNW. Dr. Eittreim's images showed relief features reminiscent of the San Andreas fault along the Carrizo Plain. Stephen noted that biological communities with abundant clam populations had established themselves along recent breaks in the San Gregorio fault. Biologic colonization is apparently driven by sulfur and organic-rich fluids percolating up the fault plane to provide nutrients for these organisms.

The key feature in the marine sanctuary is the monstrous Monterey submarine canyon. This is the largest canyon on the Pacific coast of North and South America. The sinuous canyon floor frequently becomes choked with detritus or blocked by underwater landslides. These are periodically breached by 100 to 150 mph turbidity currents that race down the slope scouring the channel surfaces before depositing their load at the canyon mouth. The canyon is as large as the Grand Canyon and contains some very recent landslide features. A current meter has been placed at the canyon mouth to monitor current flow rates there.

Dr. Gary Greene of the Moss Landing Marine Laboratory (MLML) has hypothesized that the canyon's origin is fault controlled. The canyon originated when a large land-locked lake (Lake Corcoran) occupied the Central Valley and emptied through the Coast Range via the Salinas River valley. This exit was cut off as the Coast Range grew, and a new drainage was established in the Sacramento-San Joaquin delta. Much of the canyon was incised during low sea level stands. Many of the canyon's meanders are thought to be fault controlled. There has also been some channel piracy caused by shifting sediment sources. The earliest sediments in the canyon fan deposits are thought to be Miocene age, based on sediment sampling to about 200 meters and extrapolating sedimentation rates to a total depth of 700 meters. Seafloor magnetic anomalies place an upper age limit on the fan deposits.

Another interesting offshore feature located about 3 hours south of Monterey by steamer is the Sur Pinnacles. This rugged bottom bedrock topographic feature took 4 years to characterize by a group effort involving the USGS, MLML, U.C. Santa Cruz, the Monterey Bay Aquarium Research Institute (MBARI), and a private organization called the Sanctuary People. It is one of 5 candidates for Marine Protected Area status lying offshore between Santa Cruz and this location. The purpose is to provide protective haven for marine biota that would otherwise be at risk from commercial fishing operations.

The NCGS sincerely thanks Dr. Stephen Eittreim for taking time from his busy schedule to discuss the work he and his colleagues at various Monterey Bay marine institutes have been doing in this Sanctuary. Their work is greatly enhancing our knowledge of marine processes off the California coast and is revealing unique seafloor phenomena that would otherwise go unnoticed.

Engineering Geology's Contribution to Safe Living in the Bay Area

Reported by Dan Day

The NCGS rounded out its 2003 monthly speaker agenda with a dynamic lecture on November 19th from **Dr. John W. Williams**, Chair of the Geology Department at San Jose State University. His talk entitled ***Engineering Geology Contributes to Safe Living in the Geologically Dynamic San Francisco Bay Area*** highlighted the challenges we all face living in a tectonically active region, and what society must do to live in harmony with its surroundings.

Dr. Williams opened with a whirl-wind tour of the greater Bay Area, noting its tectonic setting on the boundary between the Pacific and North American plates. All of us are familiar with the right-lateral motion of these two plates, grinding past one another at a relative rate of about 4 centimeters per year. Aerial views showed major features like the Crystal Springs reservoir nestled on top of the San Andreas fault and the homes in Daly City also located atop this active plate boundary. We have all felt the tremors created by the stresses between the two plates, which are not restricted only to the main right lateral faults splaying off the San Andreas. Dr. Williams then posed the question: What is engineering geology doing to help mankind survive these risks? In response, he noted four key geological issues that state residents and geoscientists need to address: earthquake hazards, landsliding, flooding, and the availability of mineral resources.

The single major geological hazard in California is, of course, earthquakes. John displayed a map of regional earthquake activity in northern California that he had downloaded a few days earlier. The seismic hot spots, denoted by colored epicenter dots, were clearly evident. Most of the major strike slip faults exhibited detectable activity. Man has been fascinated with seismicity for millennia. And similarly, the application of engineering concepts to solve geological problems was recognized in ancient times. In the Fourth Century B.C., Alexander the Great employed an engineering geologist to help him on his military maneuvers.

And a few hundred years later the Chinese had devised one of the first seismographs—a metal statue with four balls positioned at quadrants that would roll into the open mouths of waiting dragons when tremors struck.

As the term suggests, engineering geology is the application of geology to engineering problems. Today the engineering geologist works closely with civil engineers, providing a geological basis for large construction projects. In a geologically complex and dynamic state like California, their contributions are invaluable. Unfortunately, engineering geology is not utilized a frequently as it should be. Dr. Williams believes that the West Coast states need more engineering geologists to play an active role in major construction projects.

In 1971 the California Division of Mines and Geology (now the California Geological Survey) predicted state losses for the next thirty years from geological processes at $55 billion (1970 dollar value). These figures were tragically born out by the ensuing 1971 San Fernando earthquake, the 1989 Loma Prieta earthquake, the 1995 Northridge earthquake, and major landslide activity associated with El Nino-driven rains in the mid-1990's. To protect their 6.7 million inhabitants from similar disasters, the nine Bay Area counties need a team effort consisting of engineering geologists, public officials, legislators, media representatives, educators, and an informed public. The engineering geologist must contribute technically sound and well-communicated data to answer the questions of what, when, and where potential geologic hazards could occur.

Earthquake awareness was rudely awakened by the 1971 San Fernando Valley temblor, the first major event in California since the 1933 Santa Barbara quake. The public mind bore images of collapsed freeway overpasses and toppled hospital wings. Man's vulnerability was painfully exposed. Retrospectively, each major California quake has provided vital engineering geological information and revealed weaknesses in public disaster preparedness. The 1906 San Francisco quake damaged buildings in what is now the financial district, disrupted transportation, and ignited fires. The direct damage caused by the quake was about $80 million, but the ensuing fire caused $400 million in losses. The crippled transportation system and broken water and gas mains sealed the City's fate. When the city rebuilt, appropriate corrective actions were taken. Much of the remediative and mitigative action taken was based on Professor Andrew Lawson's report to the State Earthquake Investigation Commission, which identified areas of intense damage and triggered disaster response plans in the hardest hit communities. Similarly, the San Fernando quake triggered redesign of medical facilities, and the Loma Prieta quake accelerated retrofitting of highway and bridge structures. Even relatively minor damage can shut down major commuter thoroughfares and paralyze traffic flow around the Bay Area proper. The San Fernando event spawned the Alquist-Priolo Act, which limits the proximity of habitable structures to known fault traces. And the USGS Working Group on Earthquake Probabilities was an offshoot of the Loma Prieta temblor. This landmark research project was created to carefully assess major active faults in the Bay Area and assign short-term probabilities for specific magnitude earthquakes on critical fault traces. The study included trenching key locations along the San Andreas, Hayward, and Calaveras fault to determine the frequency and timing of significant ground-rupturing events. The initial assessment came out in 2000 and gave a 70% probability of a magnitude 6.7 or greater quake occurring in the Bay Area within the next 30 years. By 2003, the chances of such an event had been reduced to 62%. The top 10 active faults with significant earthquake potential were the Rodgers Creek fault, the northern Calaveras fault, the Hayward fault, and members of the Mount Diablo fault system. Recent advances in computer technology have made it possible to model ground-shaking activity associated with earthquakes, and to compile ground liquefaction maps for the Bay Area. Carl Wentworth and his colleagues at the USGS are instrumental establishing this database. This database feeds into the CGS Seismic Hazard Mapping Program.

Although the major earthquakes of the last century clearly illustrated the susceptibility of un-reinforced masonry to collapse, the Bay Area is still woefully behind in retrofitting habitable residences that have not been brought up to code. For instance, in Palo Alto only 18% of the needy structures have been retrofitted, and in Berkeley, only 50% have been brought up to code. The offenders are often older residences constructed in the housing boom after World War II. Unfortunately, the cost of remodeling deters many owners, who risk serious injury and severe structural damage if a major quake strikes their community. Predictive studies and mitigation efforts are constantly improving, and the state government has been quick to implement legislation to protect citizens from these catastrophes. However, education and public willingness to comply with recommended home retrofitting procedures is ultimately the responsibility of the individual.

A less obvious concern to Bay Area engineering geologists is the diminishing availability of industrial minerals. These are commonplace mineral resources used in building construction and for the maintenance of California's vast transportation infrastructure. They are raw materials used in concrete, roof materials, roadbeds, and foundations. The principle raw materials are clay, sand, and gravel. These vital resources are threatened by encroaching subdivisions and by environmental regulations restricting the proximity of quarrying operations to residential complexes. A recent industrial mineral evaluation by the California Geological Survey showed that currently permitted resources fulfill only 25% of the demand. In 1975 the state enacted the Surface Mining and Reclamation Act (SMARA) to identify potential industrial resources and regulate how the sites are reclaimed after use. The trick is to permit areas somewhat removed from major population centers and work them before sprawling residential developments force closure. The current situation needs to strike a balance between protecting the environment and supplying the needs of a growing population. This is a legislative issue that eventually needs to be addressed.

January 1982 saw an enormous amount of rainfall that triggered thousands of debris flows throughout the Bay Area. Seaside homes toppled off cliffs and landslides blocked major highways. The scene was repeated during the heavy El Nino rains of 1997-98, causing $150 million in damage. Highway 50 to Lake Tahoe is especially vulnerable to landsliding. Several major slide areas are being drained and carefully monitored to avoid further sliding. The 1982 storms gave scientists the minimum threshold rainfall needed to trigger debris flows and landslides. This allows emergency response units to warn the public when short-term rainfall approaches critical levels. Debris flows and landslides damage homes, block roads, and adversely affect transportation and commerce. In the end, the taxpayer pays the bill! Over the past decade, Earl Brabb and his coworkers at the USGS have compiled data on landslides and debris flows throughout the Bay Area. This information has been used to draft a Bay Area Landslide Susceptibility Map. Color coding is used to define various sensitivity levels based on topography, bedrock/soil composition, and annual rainfall. Remediative strategies can be tested at chronic landslide sites like the Devil's Slide south of Pacifica, and at the massive Mission San Jose landslide in Fremont. Zoning maps can help city planners and developers select sites that are low risk even in years of unusually high rainfall. The dollar savings justify the added effort.

Flooding was recognized as a serious threat to Californians after the March 10, 1928, St. Francis Dam disaster took 400 lives in Los Angeles. The public was more fortunate when the lower Van Norman earthen dam partially failed in the 1971 San Fernando Valley earthquake. At this time the state began to assess earth-filled hydraulic dams for liquefaction susceptibility. About 100 dams statewide were examined and 60 were modified. In addition, the state determined the downstream flood zone if the dams were to fail. Massive flooding in the late 1990's associated with heavy rains and snowfall resulted in levee failures along the San Joaquin and Sacramento Rivers from Yuba City-Marysville to Modesto. Runoff from rapid snow melt filled existing reservoirs to their capacities and water agencies had to discharge enormous quantities of water. The situation revealed the weakened state of earthen levees along the San Joaquin and Sacramento Rivers, which were breeched in several locations. Damage registered several hundred million dollars and left hundreds of families temporarily homeless. Agencies are working on these issues to come up with protective measures that will avoid this situation in the future. Unfortunately, many new housing developments in the Central Valley have been built up to the levee walls and are at potential risk if they are breeched by flood waters.

In light of these ever-present natural threats to the public, what has been done to mitigate or prepare the public for future events? There are considerable planning opportunities not only in California but elsewhere in the Pacific Northwest. Disasters have fostered new legislation like the Uniform Building Code, the Alquist-Priolo Act, the Seismic Safety Act, the Seismic Hazards Mapping Program, and Landslide Susceptibility Mapping. Hospitals have improved their structural design, their emergency evacuation response plans, and their post-earthquake functionality. The California Geological Survey and the USGS have played active roles in seismic hazard evaluation and landslide susceptibility assessment. The engineering geologist and geotechnical engineer will play an active role in preparing technical reports and publications for the appropriate agencies. Presently there is a need for qualified personnel to review these technical papers before releasing them to the public. The next step is to arouse public awareness and educate the populace in the geological processes at work, and how to effectively deal with them. Once the engineering geologist has issued a report, it must be understood and assimilated by lawmakers, incorporated into community plans and regulations, and accepted by the public. The research and educational process involves input from government agencies (USGS and California Geological Survey), city and county geologists, public planning organizations like ABAG (Association of Bay Area Governments), professional geological societies, colleges and universities, and private geotechnical consultants. Currently the USGS and CGS are underfunded and understaffed, university geoscience program attendance is on the decline, and earth science curricula are sorely neglected in our primary school system. It is up to the public, with input from universities, government agencies, and professional geological societies, to raise awareness and inform their fellow citizens on these topics. As philosopher Will Durant (1885-1981) quipped: "Civilization exists by geological consent, subject to change without notice." Our survival in this geologically active region depends on being aware of these natural processes and devising plans to coexist safely with them.

The NCGS offers many thanks to Dr. John Williams for his excellent presentation to its members. He clearly illustrated the geological risks facing California's residents and the need to educate the public on geological topics germane to their everyday lives. The common goal of this multidisciplinary effort is to prepare society for the geological hazards we all must live with.

MIOCENE VOLCANIC ROCKS AT BURDELL MOUNTAIN AND IMPLICATIONS FOR SLIP ALONG THE EAST BAY FAULT SYSTEM

Reported by Tom Wright

On a crisp, clear morning in late November, the coffee and baked stuff were especially welcome as two dozen NCGS members gathered at the Larkspur Ferry Terminal to examine yet another piece of the jigsaw puzzle that is Coast Range geology. Venturing into the farm lanes and suburban streets of northern Marin County, we were ably led by Rick Ford, whose Masters work at San Francisco State has clarified the relationships along the little-known northwest-trending Burdell Mountain Fault Zone (BMFZ). His very useful 14-page guidebook is well worth having.

This was the third NCGS field trip of 2003 into the North Bay region, examining work in progress by a joint project of the USGS (Bob McLaughlin and others) and the California Geological Survey (Dave Wagner), plus graduate students and faculty from SF State and San Jose State. Previous trips had visited the Clear Lake Volcanic Field, youngest and northeastern most of the North Bay Neogene volcanics, and the central belt of Sonoma and Donnell Ranch volcanics, ranging in age from 10.6 to 1.96 Ma. Today we would consider how the oldest and most westerly of the North Bay Neogene volcanics, the Burdell Mountain Volcanics, relate to these younger Neogene volcanics in the North Bay, and to the total San Andreas fault system.

At our first stop, on the Marin-Sonoma county line about 2 miles west of Highway 101, we looked first at a roadcut in Franciscan rocks (serpentine and altered sandstone) northeast of the BMFZ. A few hundred feet to the west, across the road and a thick gouge zone, we then examined a low roadcut of Novato Conglomerate southwest of the main strand of the BMFZ. In the afternoon, at Stop 4, we would visit the type locality of the Novato Conglomerate, where Lower Cretaceous mollusks (Buchia) have been found in an underlying shale bed. Clasts in the Novato Conglomerate contain Buchia and a rhyolite porphyry dated (by K/Ar) at 138+/-4 Ma, indicating that the Novato Conglomerate is no older than Lower Cretaceous (Valanginian).

The Novato Conglomerate at Stop 4 is on the northeast side of the BMFZ. Rick provided a clast count of the conglomerate here, and at Stop 1 across the fault and nearly 7 miles to the northwest. The clast counts and other features of the conglomerates at these two localities are remarkably similar, lending strong support to an estimated 10 km of right slip on the BMFZ.

Stop 2 took us into the pastures of a hospitable rancher where we saw the BMFZ expressed as uphill-facing scarps, sidehill benches, and offset streams, features that suggest late Holocene movement on the fault. In this area the BMFZ consists of several strands in a zone some 500 m wide. The total mapped length of the BMFZ is about 14 km; to the southeast it disappears beneath the wetlands adjoining San Pablo Bay and to the northwest it has not yet been traced within the sparse Franciscan outcrops of southwestern Sonoma County.

For Stop 3 we drove south on Highway 101 and into Olompali State Historic Park, parked, and walked beyond the old adobe ruins that are all that is left of a 26-room mansion that burned in 1969. Crossing pastures and stone walls, we came to a 3-m high fault scarp along the BMFZ and continued on to where a waterfall cascaded down an 8-ft scarp of Miocene andesite typical of the Burdell Mountain Volcanics (BMV). Landslides blanket nearly the entire east side of Burdell Mountain (plus most of its south end and half of its western side) and it seems unlikely that this outcrop was in place. A visit to the “intact” porphyritic andesite that caps Burdell Mountain was precluded by steep trails and lack to time.

En route back to the parking lot and lunch, I took a detour suggested by Rick Ford, and up a side creek found outcrops (possibly in place) of a Tertiary marine sandstone that underlies the BMV on the north end of the mountain, outside of the landslide areas. The stratigraphic sequence here – Franciscan Complex, Novato Conglomerate, marine sandstone (about 60 m thick), and BMV – matches very closely the sequence east of Hollister, where similar Franciscan rocks are overlain by Cretaceous Panoche conglomerates, sandstone and shale, by the early Miocene Lone Tree Formation (about 35 m thick and lithologically very similar to the sandstone at Burdell Mountain), and by the Quien Sabe Volcanics, also mostly a porphyritic andesite. The correlation between the two Miocene volcanic units had been in doubt because their K/Ar dates did not appear to match. But the newest Ar/Ar dates of 11.2 to 10.6 Ma from the BMV fit within the range of 11.7 to 7.4 Ma that constrains the age of the Quien Sabe Volcanics. There now seems to be scant reason to question the correlation between the Burdell Mountain and Quien Sabe sequences, nor the 175 km of implied right-slip across the fault system (including BMFZ, Hayward and Calaveras) that separates the two areas.

After lunch we visited the Novato Conglomerate at Stop 4 (see above) and then drove west through the northern edge of Novato to visit a knob of flow-banded rhyolite on a southwestern ridge of Burdell Mountain. This rock, with an Ar/Ar age of 11.1 Ma, is lithologically similar to the Northbrae Rhyolite of the Berkeley Hills, dated at 11.5 Ma and on the east side of the Hayward fault some 40 km to the southeast. The Burdell Mountain and Quien Sabe sequences, however, have no match in the Berkeley Hills.

There is still work to be done in this North Bay mapping project and we can look forward to significant new results at the Spring 2005 Joint Meeting of Pacific Section AAPG and GSA’s Cordilleran Section, in a symposium being organized by Bob McLaughlin and Dave Wagner.

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

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 2003 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 2003 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.

NCGS has joined with the American Association of Petroleum Geologists (AAPG) Foundation in presenting a $5,000 national award, to be given 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 2004 AAPG Annual Meeting in Dallas, Texas.

The deadline for application submittal by candidates for the $750 NCGS award is Friday, February 14, 2003.

The NCGS awardee's application will be submitted to a regional competition sponsored by the AAPG Pacific Section. The Pacific Section winner will receive a $500 award at the Pacific Section regional meeting in Long Beach, California, in May 2003, plus up to $250 toward meeting expenses and enrollment in the AAPG short course for earth science teachers, *Rocks in Your Head.* 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 Dallas in 2004 to attend the national meeting and receive the award.

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) 526-5346
e-mail: jpstock@ix.netcom.com