NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

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MEETING ANNOUNCEMENT

DATE: **Wednesday, January 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**

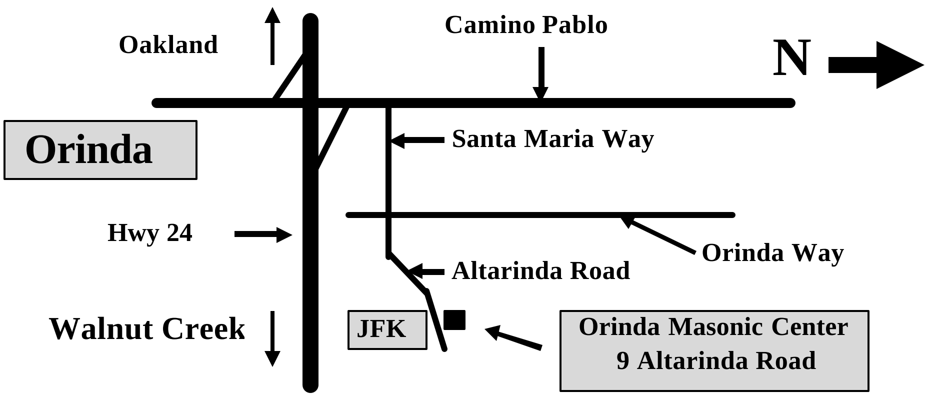
RESERVATIONS: **Leave your name and phone number at 925-424-3669 or at *danday94@pacbell.net* before the meeting.**

SPEAKER: Cheryl Smith, **President**
Peninsula Geological Society

Geochemical Investigation of Distribution Habitat of Arabis macdonaldiana in the Six River National Forest, Del Norte County, California

This study is an assessment of anomalous growth patterns of *Arabis mackonaldiana* by the examination of possible geochemical effects on these growth patterns. High concentrations of specific elements or a combination of elements, in addition to low concentrations of nutrients needed for growth, are possible explanations. Soils developed from serpentinized mafic and ultramafic rocks may be reactively enriched in various toxic metals, including nickel, magnesium, barium, and chromium, and lacking in important nutrients, such as calcium. Nickel in serpentinized soil is toxic to most plant life. However, nickel accumulation by biota is essential for evolutionary adaptation. Extraordinary facilitation of serpentine taxa is called *hyperaccumulation*, (Robertson 1985). This enables taxa to alter the toxicity of nickel, thus enabling toleration.

Meeting Location



Biography

Cheryl Smith is currently President of the Peninsula Geological Society. For those of you who are not aware, the PGS meets the second Tuesday of most months, and like the NCGS observes a summer recess. She is currently employed at Northrop Grumman Systems Corporation in San Jose. She obtained her BS in geology from Humboldt State University in 2000. Since then she has worked at the U.S. Geological Survey, the Alameda County Water Agency in Fremont, and at several firms involved in environmental cleanup and remediation.

To lean more about programs and field trips hosted by the Peninsula Geological Society go to:
http://www.diggles.com/pgs/

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 September 29, 2004
Greg Croft, Consulting Geologist
Regional Trends in World Oil Production
7:00 PM at Orinda Masonic Center

Wednesday October 27, 2004
Dr. Roland Burgmann, Univ. of California, Berkeley
Slipping and Sliding on the Hayward Fault
7:00 pm at Orinda Masonic Center

Wednesday November 17, 2004
Dr. Wayne Narr, ChevronTexaco Energy Technology Company, San Ramon
Understanding and Predicting Fractures at Tengiz – A Giant, Naturally Fractured Reservoir in the Caspian Basin of Kazakhstan
7:00 pm at Orinda Masonic Center

As Usual - No December Meeting

Wednesday January 26, 2005
Dr. Cheryl Smith, U. S. Geological Survey
Geochemical Investigation of the Distribution of* Arabis macdonaldiana *in the Josephine Ophiolite, Six Rivers National Forest, Del Norte County, California
7:00 pm at Orinda Masonic Center

Wednesday February 23, 2005
Dr. Robert Tilling, U.S. Geological Survey
Confronting Volcanic Hazards
7:00 pm at Orinda Masonic Center

Wednesday March 30, 2005
Dr. Barbara Bekins, U. S. Geological Survey
Hydrogeology and the Weak nature of Plate Boundary Faults
7:00 pm at Orinda Masonic Center

Wednesday April 27, 2005
Dr. Michael Manga, University of California, Berkeley
An Explosive Theory About Volcanoes
7:00 pm at Orinda Masonic Center

Wednesday May 25, 2005
TBA
7:00 pm at Orinda Masonic Center

Wednesday June 29, 2005
TBA
7:00 pm at Orinda Masonic Center

Upcoming NCGS Field Trips

Spring (March) 2005	***Colorful Geology of the Fremont Area*** **Joyce Blueford and Paul Belasky**
Spring (May) 2005	***Robert Sibley Volcanic Regional Preserve in Berkeley Hills*** **Stephen Edwards,** Director, Tilden Regional Botanic Garden

Announcement to All NCGS Members

The Pacific Section AAPG Executive Committee (ExCom) will be meeting at ChevronTexaco on afternoon of Wednesday January 26, 2005. This is the same day as our first meeting in 2005. If you are interested in the inner workings of this Pacific Section AAPG Committee, be advised that all interested members are invited to attend. The meeting is 1 to 4 pm, but you will need to let Bob Kieckhefer (**BobKieckhefer@chevrontexaco.com**) know by noon on Tuesday January 25, 2005 if you wish to attend so he can arrange badges. Conference room D/2094 in Building D is tentatively reserved for the meeting. Vehicles are no longer permitted in the traffic circle in front of Building A Reception, so visitors should park in one of the parking lots and walk to the Reception lobby to get their badges. **Some of the PSAAPG ExCom will be attending our meeting that evening.**

Looking for Convention Volunteers!!

If you would like to help out at the Pacific Section AAGP / Cordilleran Section GSA Convention (April 29 to May 1, 2005) we are seeking volunteers for several positions. Our most pressing needs are a Catering Chair and an experienced Power Point Projector Technician. In addition we need a Judging Chair, no experience necessary because it is primarily a manager position.

Upcoming Meetings of Interest – Bay Area Geophysical Society

Wednesday January 26th, 2005
Dr. Gary Acton, University of California, Davis

Paleomagnetic and rock magnetic signature of oceanic crust: Results from recent deep drilling in the Pacific Ocean

Talk: 12:00 p.m., Science North 347
Location: California State University, Hayward, 25800 Carlos Bee Blvd., Hayward, CA 94542
Lunch: 1:00 p.m. (We will have lunch after the talk at a nearby restaurant, no RSVP required.)
Directions: CSU Hayward Campus
Map: CSU Hayward Campus

Abstracts, biographies, directions, and maps can be found at:
http://sepwww.stanford.edu/bags/calendar

Program Chair Bill Perkins reports that the slides used by **Greg Croft** (September 2004 presentation) have been posted by Greg at: www.38n.net/NCGS_Talk.htm for your further edification and use. Please take advantage of this benefit if you have a further interest.

Tracking East Bay Tectonics with Satellite-Based Imaging Systems

U.C. Berkeley geophysicist **Dr. Roland Burgmann** described state-of-the-art GPS technology being used to model deformation along the East Bay fault system at the October 27, 2004 NCGS meeting. The project is a collaborative effort between the USGS, NEHRP, NSF, and NASA, with technical support from the U.C. Berkeley Seismological Laboratory. The study was motivated by the need to predict earthquake hazards in the East Bay, particularly since the Hayward fault has been given a high probability of generating a magnitude 6.5-plus earthquake in the next 30 years. Roland's interest is focused on aseismic creep along the northern segment of the Hayward fault, which last suffered a major temblor in 1868, a magnitude 7.0 jolt. Fault trenching and carbon 14 dating at various locations along the fault indicate these major events repeat on 150 to 180 year intervals. Creep on East Bay faults and its affiliation with tectonic events intrigues Dr. Burgmann and was the cornerstone of his presentation.

The East Bay fault system is renowned for its splendid creep features—offset street curbs, twisted buildings, and even a sheared college stadium (Go Bears!!)! Most of this aseismic distortion occurs north of Fremont, at an average creep rate of about 5mm per year. Half of the Hayward fault movement is aseismic. But Roland is curious about what happens at depth. Are the faults locked at depth? Can we predict when these locked segments will rupture? What ground shaking will occur when the segments suddenly move? From a mechanical view, a locked fault exhibits no strain and therefore, no creep. "Creeping" faults are under elastic strain and therefore move aseismically. The Hayward fault has locked segments intermingled with creeping zones. At depth, locked zones begin to creep again.

So how is aseismic creep studied? By measuring the offset of cultural features, by deploying GPS and InSAR (side angle radar) systems along the fault to track its movement, and by acquiring and analyzing microseismic events to predict larger temblors. The GPS geodetic system tracks movement along the northern Hayward fault via carefully positioned borehole GPS receivers that monitor signals from an array of 30 satellites in orbit. This complex system is capable of determining ground positions to a resolution of ±1 to 2 millimeters, and is calibrated using U.S. Coastal and Geodetic Survey benchmarks. GPS horizontal distance determinations are very accurate, but vertical distances are not as well defined. Using these technologies, U.C. Berkeley has established a sophisticated network of stations to monitor a variety of seismic parameters throughout northern and central California.

The Berkeley Seismological Laboratory (BSL) has established a suite of geophysical networks designed to monitor seismic activity and crustal movement in northern and central California. The Berkeley Digital Seismic Network is an array of 20 broadband, high dynamic range stations equipped with a seismometer, a strong motion accelerometer, a digital data logger, and often with temperature and pressure sensors. The stations are scattered across northern and central California, and at Hull Mountain, Oregon. The Bay Area is heavily monitored. Northern California is tapped at the Modoc Plateau, Yreka, Mt. Lassen, Humboldt, and Oroville Dam. The central Coast Range is surveyed at Hollister, Pacheco Peak, and Parkfield. Data acquired by these stations is transmitted continuously to Berkeley using digital telemetry. Three-day battery backup and dial-up telephone access is provided to each site.

The Hayward Fault Network is another geophysical monitoring system situated along the Hayward Fault. It is an array of borehole instruments operated by U.C. Berkeley along the northern part of the fault, and by the USGS, Menlo Park, along the southern segment. The boreholes have an accelerometer and a geophone with a 24-bit data logger. Further south in Parkfield, the BSL has created the High Resolution Seismic Network in conjunction with the Parkfield Prediction Experiment. It was originally intended for controlled source monitoring, but was upgraded for earthquake monitoring. Boreholes are equipped with geophones, 24-bit data loggers, and continuous telemetry to a data acquisition center in Parkfield, which detects events and forwards waveform data to BSL for archiving.

U.C. Berkeley tracks Pacific-North American tectonic plate deformation via the Integrated Instrumentation Program for Broadband Observations of Plate Boundary Deformation, or Mini-PBO. The program is a multi-institutional effort to install an instrumentation system to study plate boundary deformation, emphasizing earthquake analysis. There are three components: 1) eight sites with borehole tensor strainmeters and seismometers, pressure and tilt sensors, and geodetic GPS receivers in the San Francisco Bay Area; 2) nine continuous GPS sites installed in the Parkfield area; and 3) support of a 5 meter X-band SAR (side angle radar) downlink facility in San Diego to accept and archive data. Parkfield is a segment of the San Andreas Fault system actively generating seismic data crucial to the interpretation of plate boundary deformation. Data acquired from these areas will allow geophysicists to model plate interactions along the western margin of North America.

But terrestrial exploits are not the BSL's only interest. A collaborative effort with the Monterey Bay Aquarium Research Institute (MBARI) has created two important projects: the Monterey Bay Ocean Bottom International Seismic Experiment (MOISE), and the Monterey Ocean Bottom Broadband (MOBB) project. Both are an effort to design, construct, and operate a seafloor observatory. The MOISE experiment was performed in the summer of 1997, and all the deployed equipment was successfully recovered. The MOBB project began in April, 2002, and is planned for permanent residence on the seafloor. These projects will supply data from the ocean bottom to monitor tectonic activity in a seismically active submarine site.

Crustal deformation in the greater Bay Area is currently being monitored by the Bay Area Regional Deformation Network (BARD). This system of over 60 continuously operating GSP stations in northern and central California is focused on deformation in the Parkfield area, the Long Valley caldera south of Mono Lake, and the San Francisco Bay Area. The goal is to catalogue crustal deformation along the Pacific-North American plate, and to act as a tool for earthquake hazard reduction and stimulate rapid earthquake emergency response in the greater San Francisco Bay Area.

Another important contribution to Bay Area seismological research is the Northern California Earthquake Data Center (NCEDC), co-operated by the U.C. Berkeley Seismological Laboratory and the USGS. This is a long term project to archive and distribute geodetic and seismological data for Northern and Central California, as information is acquired by the networks listed above. The program is partially funded by the USGS arm of the National Earthquake Hazards Reduction Program (NEHRP). Certain data is available to the public via the NCEDC website, providing one has the necessary software tools.

All of the above are part of the Berkeley Seismological Laboratory's multi-faceted surveillance of Northern and Central California's tectonic activity. Closer to home, the seimological group has placed geopositioners on Berkeley Memorial Stadium to monitor creep along the Hayward fault, which transects this structure. Currently, the creep rate measured there is 4 to 5 mm per year. Interestingly, displacements on the order of 100's of meters, 10's of kilometers, and 1000's of kilometers can all be measured with the same precision by these global satellite networks. Conclusions drawn from data acquired by the geophysical monitoring systems listed above agree well with calculations derived from classical field methods. There is about 20 mm/yr right lateral offset between the California Central Valley and the west side of the Hayward fault, and an offset rate of 38 mm/yr between the Central Valley and the Pacific plate. Seismological research indicates the upper 10 to 15 km of the San Andreas Fault is locked in places. Elsewhere, the fault and adjacent strike-slip systems experience aseismic creep. The creep leads to deformation adjacent to the fault traces, which can be modeled as elastic strain. The strain fields can be mathematically converted to provide slip rates for surface creep and locked zones at depth. The calculated slip rates for the aseismically creeping segments of the Hayward fault are about 5 mm/yr to a depth of 4 to 6 km. Locked zones are scattered below this depth. Noting the overall dextral displacement along the Hayward fault determined by geodetic measurements, Roland and his colleagues have concluded that there is a slip deficit building up along the entire fault trace that translates in a single release scenario, to one magnitude 6.8 earthquake per century. Optimal slip rates on other Bay Area faults range from 2 to 17 mm/yr. Roland mentioned that there are about 100 GPS stations located around the Hayward fault, and that deformation gradients diminishing away from the fault can be seen. And what causes some fault segments to creep? The answer is not clear, but Roland noted that in areas prone to creep the rock lithologies across the fault plane are different.

An important tool for determining ground deformation is radar interferometry. The InSAR satellite emits radar waves 23 degrees off vertical that are reflected back to a receiver on the spacecraft. Over time, images of the same area show a phase shift in the radar signal that can be used to calculate the differential ground motion. This technique has a high spatial resolution, but is more accurate for measuring horizontal displacement than vertical motion. One of the problems facing this technique is atmospheric delay of the radar signals, which must be averaged out. The radar images collected during an 8 year survey (1992-2000) have been used to detect the elastic rebound of recharged aquifers in the Santa Clara Valley (6 cm uplift), creep along the Hayward fault, and elastic strain accumulated on the San Andreas fault. Roland pointed these features out on several color-coded Bay Area images. Some of these interpretations, he noted, require assumptions such as elastic behavior of the crust and constant slip rates, but the results in general agree with independent techniques.

An emerging new radar technology is Permanent Scatterer InSAR. Here stable features such as utility poles can be used to identify fault motion and vertical displacement. An eight-year study was used to detect up to 8 cm subsidence in some imaged areas, an estimated 0.4 ± 0.2 mm/yr uplift rate of the East Bay Hills, and deep-seated landslide movement in Berkeley east of the Hayward fault. Images can be correlated with breakage of EBMUD pipes and utility lines. The study will eventually cover the entire greater San Francisco Bay Area.

Roland elaborated on the application of side angle radar imaging technology to landslide movement. Landslides can move up to 4 cm/yr and the rates can accelerate 3 to 4 fold during the rainy season. Slip rates can be correlated with rainfall and periods of unusually high precipitation, such as the 1997-1998 El Niño years. Imaging studies were conducted in the East Bay Hills and will be used to delineate areas prone to landsliding or recurring movement along existing slides. The images will also help to identify the extent of large slides in heavily vegetated areas or where cultural features are sparse. The ultimate application will be hazard control and land use planning. Another useful application is to couple tide gage records to radar uplift/subsidence data.

The NCGS expresses its sincerest thanks to Roland Burgmann of U.C. Berkeley for an excellent, well-illustrated presentation on GPS and satellite-based radar imaging applications to seismology and tectonics in Northern California. His talk emphasized the incredible jump in technology brought about by the satellite communications and electronic advances of the last 30 years. Who would have imagined these by-products of the space program would ultimately find valuable applications in the earth sciences?

The Characterization and Development of Naturally Fractured Petroleum Reservoirs Presented at the NCGS November Meeting

The November 17, 2004, NCGS meeting featured the talk ***Naturally Fractured Reservoirs: Risks, Misconceptions, and Innovations***, given by **Dr. Wayne Narr**, Consulting Structural Geologist with ChevronTexaco Exploration and Product Technology Company in San Ramon. Wayne, a former Gulf Oil and Chevron Overseas Petroleum employee, has spent his professional career as a structural geologist, initially in exploration, then as a researcher at Chevron's La Havre research center, and currently as a member of the corporation's Reservoir Engineering team. His academic career included stints at Pennsylvania State University and Princeton University, both known for strong structural geological curricula. Wayne's goal was to discuss the emerging role of naturally fractured reservoirs (NFR's) in today's evolving global petroleum market, and to present the results of studies at the Tengiz supergiant oil field in the former Soviet republic of Kazakhstan, off the northeast shore of the Caspian Sea. Modeling of the Tengiz play was based on a careful study of fracture development and distribution along the margins of the Permian Capitan Reef complex in the Guadelupe Mountains, New Mexico.

As conventional oil field quality diminishes, naturally fractured reservoirs (NFR's) have gained importance as a primary or enhanced recovery hydrocarbon source. The major drawback to these reservoir types is their heterogeneity, which mandates that the fracture system geometry be well known. Wayne focused on two types of limestone reservoirs to make his point. One is the conventional type, and the other a naturally fractured reservoir. The former generally has relatively high production rates, whereas the NFR has quite variable productivity. As a rule of thumb, NFR's will have 80% of their production from 20% of the wells. The fractures are usually quite small, and only a small percentage contribute to reservoir productivity. Statistical methods are often used to calculate fracture intersection probability, to improve exploration success, and to refine the estimated ultimate hydrocarbon recovery.

Wayne presented a schematic conceptual model of how fractures are distributed in a solid rock mass. He noted that a 3-dimensional understanding of the fracture system is crucial to exploiting a naturally fractured reservoir's hydrocarbon resources. Depending on the structural setting, the rock will have a uniformly spaced joint system consisting of numerous tight fractures, which are in general not good producers. What one is looking for are regularly occurring fracture swarms and fracture intersections, which greatly improve the fluid flow and production rate. To adequately characterize a reservoir's fracture system requires a considerable amount of core sampling. But subsurface fracture systematics can also be modeled by examining exposures of identical lithologies in equivalent structural settings. For example, sandstone fracturing can be observed in relay ramp structures in the Windgate Formation at the Arches National Park in Utah. Careful study of fracture mechanics here can be used to develop drilling strategies in subsurface reservoirs with similar structural regimes. Wayne pointed out the through-going jointing pattern in the Windgate sandstone that would lead to good hydrocarbon production properties. The joints in this unit occur in clusters.

Classic fracture theory has been applied to geological structures for decades. A common example is fracture systems associated with anticlines and synclines. Anticlines, for instance, exhibit a variety of fracture patterns and orientations depending on the location. The local stress regime can therefore concentrate fracture swarms in areas of high tensional stress. However, recently renewed studies on the origin of joints in rocks suggests that the association of pervasive fracture systems with various aspects of fold structures is at least in part an idealization. In other words, rocks do not always behave according to popular theory. And when flexed, they do not always fracture. Currently, structural geologists are looking at bed curvature on tectonic structures to predict the locations of maximum joint concentration. But cores that pierced a strongly folded asymmetric anticline in the East Painter reservoir, Wyoming, yielded an excellent sampling dataset—and showed no correlation between bedding curvature and fracture density.

Field studies and theoretical considerations are used to solve complex reservoir problems, such as production from the Tengiz oil field off the northeast coast of tbe Caspian Sea in Kazakhstan. The Tengiz supergiant reservoir is located in the Pre-Caspian basin, a low-lying region in Central Asia at the intersection of colliding tectonic plates. Compressional forces have thrust the nearby Caucasus mountain range upward to elevations of 18,000 feet like a sharp knife's edge separating southern Russia from the Turkish republics to the south. It towers over the steppes below, and the huge Caspian basin to the east and northeast, part of which lies almost 100 feet below sea level. The Tengiz play is located on the margins of a large Paleozoic carbonate platform about 14 km. across. Put in perspective, this massif is almost twice the diameter of Mt. Diablo at its base. Hydrocarbon production from this platform has captured the interest of many major petroleum companies, including ChevronTexaco.

The Tengiz reservoir is in Devonian to Pennsylvanian age carbonate platform rocks. The upper surface has a raised lip and a slightly depressed, compacted top area. The platform grew upward and then as it matured, the edges began to prograde rapidly. Later, it incurred rapid lateral growth. It is these flank regions that have the best productivity. The typical petroleum product averages 14% H_2S (hydrogen sulfide) and is under a 0.85 lithostatic load overpressure. Lost drilling mud circulation and flow capacities (performance versus matrix permeability) on the flanks strongly suggest fracture systems control reservoir petroleum mobility. Cores that penetrate the fractured zones indicate the fractures are oriented both perpendicular and parallel to the carbonate platform rim. However, there is considerable variability in fracture concentration over short distances. The fractures do not appear to be tectonic in origin, but rather syndeposional features that have been locally enlarged by circulating pore fluid dissolution.

To better understand the Tengiz fracture systematics, Wayne decided to explore a subaerial analogy, the Permian Capitan Reef in New Mexico. Wayne and his colleagues examined several well-exposed outcrops and noted an important feature—Neptunian dikes. These are fracture fillings several inches wide, multiply sutured with biologically generated carbonate that forms diffuse contacts with the surrounding country rock. The sutured fractures at Capitan Reef are oriented parallel to the reef slope margin. They were formed by collapse and compaction of the carbonate debris. The carbonate dikes average 120 meters long by 30 cm. wide. The fracture density as a function of length was calculated and compared with orientation, location, and fracture density data from the Tengiz oil field. The only difference at Tengiz is the absence of biological fracture fillings.

The challenges to be met at Tengiz are to determine which fractures sets are effective oil producers, how to model the fracture system in a reservoir setting, and to develop a good fluid flow model for the producing fracture sets. Fortunately, from resistivity logs the team acquired good fracture images. However, the productivity versus fracture pattern is not obvious from the resistivity images. The information provided by resistivity surveys can be used to calculate fracture density and construct 3-D models of fracture systems. Geostatistical analysis of the data and application of conceptual models alone cannot establish accurate predictive tools for the exploration geologists. The teams eventually applied neural network analysis using facies, porosity, rock formation, seismic anomalies, resistivity data, and shape factors to construct fracture density models that agreed with well productivity.

The next step was to incorporate this dataset into fluid flow simulations. This involved complex mathematical modeling using tensor methods (a 3-D grid that has a variety of physical parameters associated with each point). The classic dual porosity fluid flow model, a geologically abstract method, was not an effective predictive tool, but a single medium K-tensor method gave more reliable estimates of fluid flow behavior. The reservoir was partitioned into cells and various fracture parameters were associated with each cell to form a 3-D data grid. A computer program used this data matrix to calculate cell-by-cell the maximum and minimum permeability directions to establish reservoir flow patterns. The K-tensor modeling technique is becoming an important reservoir characterization tool now that it is necessary to recognize NFR's as primary reservoir types. NFR's are forcing the petroleum industry to accept higher risk tolerances and to develop new reservoir engineering processes.

Wayne summarized Tengiz NRF research by noting that the petroleum-producing fractures in the relatively undeformed Tengiz carbonate platform massif are formed early in the platform evolution as syndepositional features created by compaction and gravity collapse of reef debris on its flanks. The producing fracture systems strike parallel to the platform margins and are in greatest abundance along the outermost platform rim and slope. An excellent outcrop analogy is the Permian Capitan Reef in eastern New Mexico's Guadelupe Mountains. He mentioned that fracture porosity on a volumetric basis is difficult to estimate because it is scale dependent, but estimated the maximum at Tengiz to be about 0.1% and the average to be 0.01%. A conceptual analogy of an NFR network would be roadway systems leading to major freeway arteries from a city or housing development. The smaller disseminated fracture systems feed larger conduits, which become passageways for hydrocarbon extraction. Once the fracture system has been drained and collapses, production stops because the matrix rock is not very permeable. Right now productivity and reserve estimates based on naturally fractured reservoir models are not particularly accurate. Research is now heavily focused on improving these estimates, and on developing better analytical tools for locating and exploiting NFR petroleum reserves.

Many thanks to Wayne Narr of ChevronTexaco, San Ramon, for rescuing our November speaker program with a fascinating update on naturally fractured petroleum reservoir research. His willingness to fill in on short notice is deeply appreciated. Wayne, a structural geologist with considerable experience in rock fracture mechanics, can be reached at **wnarr@chevrontexaco.com**.

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 2005 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 2005 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 2006 AAPG Annual Meeting in Houston, Texas.

The deadline for application submittal by candidates for the $750 NCGS award is Tuesday, February 15, 2005.

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 San Jose, California, in late April 2005, 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 Houston in 2006 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 visiting our website (http://www.ncgeolsoc.org/) or 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
kugeln@msn.com

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

2004-2005 COLLEGIATE SCHOLARSHIPS PROGRAM

The Northern California Geological Society is pleased to announce the availability of two scholarship awards for the 2004-2005 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 2005 calendar year
Application deadline is November 19, 2004 for a December 17, 2004 award date

Graduate Scholarship Award of $1000
For candidates working toward the MS or Ph.D degree
Funding is provided for projects implemented during the 2004 calendar year
Application deadline is January 31, 2005 for a March 31, 2005 award date

Interested candidates can obtain applications from our website (http://www.ncgeolsoc.org/), or from **Randy Kirby,** and they should be submitted to:

Randy E. Kirby
Chair, NCGS Scholarship Committee
67 Brookwood Road, Unit 20
Orinda, CA 94563
Voice: (925) 288-2344
Fax: (925) 827-2029
e-mail: rkirby.geosci@usa.net

Funding priority will directed to research programs focusing on topics in structural, stratigraphic, economic, engineering or environmental geology, geophysics, mapping, stratigraphic paleontology, or paleoecology, implemented within the State of California or immediately adjacent western states. 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.

Issue date: September 24, 2004