

# NORTHERN CALIFORNIA GEOLOGICAL SOCIETY



## NCGS OFFICERS

**President:**  
John Karachewski, OHM  
510-227-1105 X407

**President-Elect:**  
Dan Day, National Refractories

**Vice-President:**  
Don Hill, Weiss Associates  
510-450-6000

**Secretary:**  
Clark Fenton, Woodward-Clyde  
510-874-1775

**Treasurer:**  
Ed Simonis, Fluor-Daniel GTI  
916-372-4700

**Program Chair:**  
Don Lewis  
510-284-5480

**Scholarship Chair:**  
Roger Greensfelder  
510-228-5071

## COUNSELORS

**Programs:**

William Bailey 510-842-0592

Dieter Letsch 510-842-0422

Frank Picha 510-842-3759

**Field Trips:**

Tim Ault 510-372-9100 X3160

Greg Bartow 510-286-0741

Bob Horwath 805-734-8800

**NCGS Voice Mail:**  
510-842-0592

**NCGS Newsletter:**  
510-294-7530

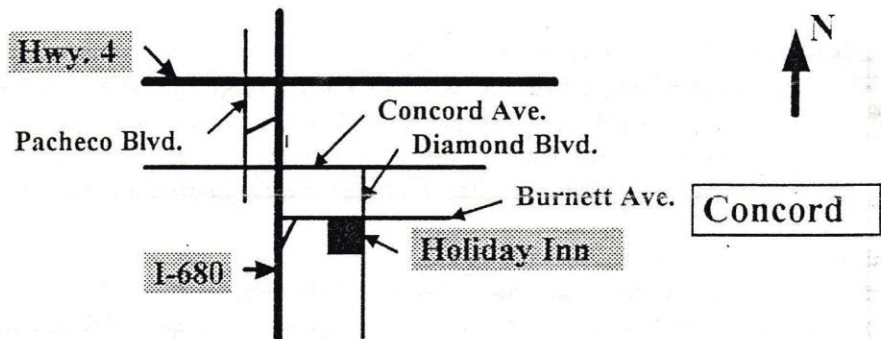
## SEPTEMBER MEETING ANNOUNCEMENT

**DATE:** Thursday, September 18, 1997

**LOCATION:** Holiday Inn, 1050 Burnett Ave., Concord, CA.

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

**RESERVATIONS:** Leave your name on the NCGS recorder at  
510-842-0592 anytime before the meeting.



**SPEAKER:** Richard G. Blake, Lawrence Livermore Laboratory

### *Sacramento Valley's Meganos Submarine Canyon: Geology and Hydrocarbon Accumulations in the Brentwood Area*

The Meganos Submarine Canyon is a subsurface erosional feature cut by subaerial or submarine downslope current action and filled with shale in Paleocene or early Eocene time. The canyon trends in a westerly direction through Contra Costa County in the southern Sacramento Valley and terminates in outcrop in Deer Valley on the northeast flank of Mt. Diablo. The base of the shale-filled canyon rests unconformably on a paleotopographic surface fashioned by erosion. The surface has an unusually complex shape near the town of Brentwood due to the presence of several major north-south trending faults which were active before and after the erosion and filling of the canyon. These faults partially controlled erosion and filling of tributary channels running southeasterly into the main canyon, resulting in a topographic surface considerably more complicated than is usual in Sacramento Valley submarine

(Continued on back page of newsletter)

## NCGS Fall 1997 Calendar

Thursday, September 18, 1997

Rick Blake, Lawrence Livermore National Laboratory

*Sacramento Valley's Meganos Submarine Canyon: Geology and Hydrocarbon Accumulations in the Brentwood Area*

Concord Holiday Inn, 6:30 pm social; 7:00 pm talk. Cost is \$5.00 per person

Saturday, September 27, 1997

**NCGS Hollister/Cienega/Pinnacles National Monument Field Trip**

Led by Dr. Vincent Matthews, Geology Department, Arizona State University

*please see field trip flier in this newsletter for more information*

Thursday, October 16, 1997

Sandy Figuers, Norfleet Consultants

*Subsurface Geology and Hydrogeology of the East Bay Plains*

Concord Holiday Inn, 6:30 pm social; 7:00 pm talk. Cost is \$5.00 per person

Saturday & Sunday, October 11-12, 1997

**NCGS Northern Sierra Nevada Uplift Geological Field Excursion**

Led by Dr. David Jones, Paleontologist/Geologist, USGS (retired)

David Lawler, Geologist/Paleontologist, FarWest Geoscience Foundation

*please see field trip flier in this newsletter for more information*

Thursday, November 20, 1997

Tim Rose, Lawrence Livermore National Laboratory

*Isotope Hydrogeology of Fracture Flow Systems in an Active Volcanic Region, Southern Cascade Range*

Concord Holiday Inn, 6:30 pm social; 7:00 pm talk. Cost is \$5.00 per person

**December NCGS Meeting speaker, topic, and location to be announced**

### *Mt. Diablo "Trek Through Time"*

**Attention all hikers!** The 3rd annual "Trek Through Time" on Mt. Diablo will be held on **Saturday, October 4, 1997**. The hike takes you from Rock City in Mt. Diablo State Park to the summit through 100 million years of geologic time, or you can go an easy halfway through 50 million years of time. Interpretive lecturers will be stationed at stops along the way to discuss the geology and other features of the mountain. *An application can be obtained at the September 18th NCGS meeting, or by calling Keith Patterson at (510) 927-7222.*

# ***NCGS Field Trip***

## ***Hollister/Cienega/Pinnacles National Monument***

**Saturday, September 27, 1997**

**Led by Dr. Vincent Matthews**

This trip will visit several classic localities along the San Andreas and Calaveras faults which clearly demonstrate offset features that are multiple orders of magnitude different in displacement and timing; from offsets measured in centimeters that occurred during the past few decades to an offset of several hundred kilometers that occurred over the past twenty million years.

The town of Hollister sits astride the Calaveras fault near its juncture with the San Andreas fault. Active creep is offsetting curbs, sidewalks, and buildings. A several-block walk through town illustrates different strain features including lateral slip, compression, and extension. The Almaden winery in the Cienega Valley straddles an active creep zone on the San Andreas fault which displaces a large building, concrete ditch, and vineyard rows.

The Pinnacles National Monument contains ten different volcanic rock units that are the northern match for rocks 320 kilometers to the south in Mojave Desert. The Pinnacles/Neenach correlation is widely recognized as the most convincing documentation of large-scale displacement on the San Andreas fault system. The Pinnacles strata are key evidence for interpretations of early Miocene paleogeography because they are interpreted to be subaqueous rather than subaerial volcanic deposits.

A hike of up to several miles and a 1,000 foot elevation gain may be planned at Pinnacles National Monument. *Afternoon temperatures in the park can still be quite hot at this time of year. Field trip participants should provide their own sun protection, daypack, and water bottles.*

**Trip Leader:** Vince Matthews mapped and studied the Pinnacles/Neenach rocks for his Ph.D. dissertation at the University of California, Santa Cruz. He taught at UCSC and the University of Northern Colorado prior to a career in the petroleum industry where he held executive positions with Amoco, Lear, Union Pacific, and Penn Virginia. He is currently a Visiting Professor in the Geology Department at Arizona State University.

**Time:** Saturday, September 27, 1997 from Concord at 7:30 am (sharp) Return Saturday evening about 8:00 pm

**Departure Points:** Concord - Chevron Parking Lot, 2101 Diamond Blvd; exit I-680 at Willow Pass Road. Go 1 block east, turn north (left) onto Diamond Blvd. For a possible South Bay location contact field trip coordinator.

**Cost:** \$45 for NCGS member; \$60 for non-member. This fee includes trip guidebook, bus transportation, breakfast pastries, lunch, and refreshments.

—Registration Form for Field Trip to Hollister/Cienega/Pinnacles National Monument—

Name \_\_\_\_\_

Address \_\_\_\_\_

Phone (days) \_\_\_\_\_ (evening) \_\_\_\_\_

e-mail/FAX \_\_\_\_\_

Vegetarian (circle if yes)

*Make checks payable to NCGS and mail with this registration form to:*

**John A. Karachewski, NCGS Field Trip, 2869 San Carlos Dr., Walnut Creek, CA, 94598-4155**

**PLEASE NOTE: Attendance is limited to 45 people and on a first come - first serve basis.**

**For questions contact John at (510) 227-1105 extension 407.**

## Kazakstan-Chevron Joint Oil Venture Reviewed at June NCGS Meeting

**Rick Caskey**, Chevron Overseas Petroleum's CIS Business Unit Field Coordinator, described the evolution of Chevron's Tengiz venture with the former Soviet Republic of Kazakstan at the June 19th NCGS meeting. The Tengiz oil deposit is located on the northeast edge of the land-locked Caspian Sea just north of Iran. It was discovered by the Soviets in 1979 during deep drilling operations, and is the largest oil find of the last 20 years. The deposit occupies a 4000 km<sup>2</sup> (~19km by 25 km) surface block that started production in 1992. There are an estimated 25 billion barrels of oil in place, with 6 to 8 billion barrels of recoverable oil. The reservoir is located at a depth of 4000 to 5000 meters, is under 12,000 psi pressure, and contains ~18% H<sub>2</sub>S (sour gas). The oil is a high quality 42° API type currently produced from 27 wells at 160,000 barrels per day.

The Tengiz field is situated in the north Caspian Basin in a lower Permian-Carboniferous carbonate sequence interpreted as an accretional mound similar to the modern Bahama Banks. The oil source rocks are underlying Devonian shales and the cap-rocks are mid-Permian salt formations. The reservoir is flat-topped with steeply dipping debris slopes and apparent normal faults on the sides. When Chevron became a partner with the Kazakstan government in April, 1993, Soviet well data had to be converted to a Western log format. Subsequent seismic traverses helped to clarify the subsurface geology and determine which of the 57 producing wells were most suitable for optimum production efficiency. An economical process to contain the hydrogen sulfide and convert it to sulfur was designed and implemented in the initial stages of Chevron's involvement. These projects were all part of Chevron's \$1 billion initial capital investment to improve safety, upgrade the transportation infrastructure, and modernize existing production equipment at the site.

The operating situation since 1993, according to Mr. Caskey, has improved dramatically. The operating expense has dropped from ~\$275 per metric ton of oil in 1993-94 to only ~\$25 per metric ton in the first quarter 1997. Production has risen from 50,000 barrels per day initially to 160,000 barrels per day in 1997, and is projected to reach ~750,000 barrels per day by 2000. The project began making money in 1995, and turned a profit for the Kazakstan government the following year. In the next three years Chevron estimates Tengiz-Chevroil will net \$1.5 billion for its stockholders.

One very fortunate aspect of Chevron's involvement with this former Soviet satellite nation was the very well-developed railroad infrastructure already in existence to facilitate oil transport out of this land-locked country. Existing Soviet pipelines transported 6 million barrels per day, half the amount being transported before the USSR collapsed. To increase this pipeline capacity, the Caspian Pipeline Consortium was established. The Russian, Kazakstan, and Oman governments hold 50% interest, and Chevron, LukArco, Mobil, Rosneft/Shell, and British Gas the other 50%. The first oil is scheduled to be pumped along these pipelines to ports on the Black Sea in 2000, beginning at 500,000 barrels per day and reaching an ultimate capacity of 1.5 million barrels per day. Today the Tengiz-Chevroil project is perceived as a stable and profitable venture that now includes Mobil Oil and Lukoil as minor partners. Funding is now available for additional geological work to better characterize and develop the full potential of this enormous oil reserve.

The NCGS thanks Rick Caskey and Chevron Overseas Petroleum, Inc. for presenting this informative update on a very exciting, and initially risky, oil venture to its members. Chevron has been very supportive of the NCGS this year, and has hosted several AAPG Distinguished Lectures at its San Ramon facility. We are indebted to COPI for their continued involvement with these and other NCGS functions.

### **Western States Seismic Policy Council XIX Annual Conference November 4-7, 1997 at the Ocean Pointe Resort, Victoria, B.C.**

#### Policy Sessions Topics:

Session #1: Building Codes and Seismic Zonation

Session #2: Hazard Loss Estimation and Scenario Development

Session #3: Earthquake and Hazard Insurance

**Reservations by phone: 415/974-6435; Fax: 415/974-1747; E-mail: [wsspc@wsspc.org](mailto:wsspc@wsspc.org)**

# NCGS Summer Field Trip Goes for the Gold!

A travel-weary but satisfied group of 51 field trip attendees pulled into Concord Sunday night, June 15th, following a two-day excursion into the Northern Sierra gold country. The trip was expertly led by **David Lawler** of the FarWest Geoscience Foundation, and **Greg Wilkerson** of the Bureau of Land Management, Bakersfield, and included an impressive group of Bay Area geologists who have done pioneering field studies of the Auriferous Gravels, and the Paleozoic stratigraphy of the Northern Sierras. This list included **Howard Oliver** and **Warren Yeend** of the USGS Menlo Park, co-authors of USGS Circular 566, "*Tertiary Gold-Bearing Channel Gravel in Northern Nevada County, California*" (1968); **Dr. Elwood Brooks**, California State University, Hayward; and **Dr. Scott Creely**, Professor Emeritus, San Jose State University and author of California Division of Mines and Geology Bulletin 184, "*Geology of the Oroville Quadrangle, California*" (1965).

The first stop was at the Idaho-Maryland Mine in Grass Valley, operated by the Emperor Gold Corporation, where Chief Geologist **Mark Paine** explained the history and geology of the underground workings. The mine property has 130 acres of surface rights and 2750 acres of mineral rights, of which ~10% have been explored. The mine has 71 miles of tunnels that have produced 2.4 million ounces of gold from 1863 to 1956, when fixed gold prices forced it to close. Existing gold resources are estimated to be ~3.0 million ounces of gold, primarily between the 2000 and 3280 foot levels, and likely continuing below. The mine is second only to the nearby Empire Mine in gold produced in California by underground mining. Located in the Grass Valley-Nevada City Mining District, the fourth largest gold-producing district in the U.S., the Idaho-Maryland lies in the Jurassic rifted submarine ophiolite/island arc metavolcanic-metasedimentary complex of the western Sierra Nevada Foothill Metamorphic Belt. It was intruded by diabase and gabbro of the Lake Combie Complex, then folded and deformed during the late Mesozoic Nevadan Orogeny and intruded by Cretaceous Grass Valley-Yuba River granodiorite plutons. The district is flanked by the late Paleozoic Calaveras Complex and the Clipper gap Formation, or by serpentine tectonic melange derived from the Lake Combie Complex, across the NW-trending Weimar and Wolf creek Faults, two major regional right-lateral wrench faults. The gold mineralization occurs along quartz veins that are structurally related to the Cretaceous granodiorite intrusions, and clearly post-date the plutonic emplacement. The veins are concentrated in pressure shadows within and adjacent to the plutons that formed in response to regional tectonic stresses acting on rocks with quite different fracturing characteristics. The Idaho-Maryland vein system differs from others in the district because of its higher grade, wider ribboned vein pattern, and extensive wall rock alteration. It is considered to be the center of gold mineralization in this 6 mile by 7 mile size gold district.

The second trip stop was the San Juan Ridge Mine in the Tertiary Auriferous Gravels in northern Nevada County. The mine, operated since 1992 by Siskon Gold Corporation, is located about 5 miles east of North San Juan and a few miles west of the Malakoff Diggins State Park. Siskon Project Geologist **Bob Pease** described the geology of the placer gravels to the group. The Tertiary Gravels are the remains of the ancestral Yuba River drainage system. The lower gravel member (blue gravel) lies unconformably on diorite and slate bedrock. It is a sandy gravel conglomerate, locally cemented with calcite and silica, that contains the main concentration of placer gold. This unit is ~80 feet thick and is unconformably overlain by ~100 feet of relatively non-indurated gravelly sand (middle gravel/red gravels). The upper gravels consist of an ~300 foot section of gravelly clayey sand unconformably overlying the middle (red) gravels. The gravels were hydraulic mined from 1850 to 1884, when legislation forced an end to hydraulic mining in the state. Open pit mining of the deposits was briefly considered in 1979-80, and more recently, underground mining of the gravels was deemed economic. The current mining scheme uses a conventional room and pillar technique, and accesses the lower gravels through an 1800 foot long declined tunnel 16 feet wide by 16 feet high. The mineable ore occurs in boulder gravel lenses ~30 feet wide and several hundred feet long arranged in a channel within 10 feet of the bedrock that measures 300 feet wide and 16 feet thick. The channel forms two 6000 to 6200 foot long ore bodies, the east and the west, that are separated by a 1000 foot barren zone. The gold occurs in the sub-1/4 inch pea gravel and sand, which is separated from the coarser cobbles and boulders underground, and pumped to the surface for jiggling and gravity/centrifugal concentration. The average ore grade is ~0.14 ounces of gold per cubic yard in the auriferous boulder lenses, with estimated reserves of 257,000 ounces of gold.

The final June 14th stop was the Sixteen To One Mine in the Alleghany District, another underground lode deposit. Mine engineer **Jason Burke** described the mine and the ore deposit, part of the Northern Mines region, characterized by higher grade, but more localized quartz vein deposits than those of the Mother Lode proper. This ore

*(Continued on next page)*

*(Gold Country Field trip continued from previous page)*

body was discovered in 1896 and has been operated almost continuously ever since. Approximately 1 million ounces of gold have been removed from milky quartz veins up to 6 feet thick that fill east-dipping faults associated with the Melones fault system in the Tightner and Kanaka Members of the Permo-Carboniferous Calaveras Formation. The Tightner is a chlorite-amphibolite schist comprising ~90% of the mine, and the Kanaka is conglomerate, chert, and slate. The vein emplacement is along reverse faults in the Calaveras, and involves considerable metasomatic alteration of the host rocks that occurred ~110 to 125 million years ago. The usual mining plan at the Sixteen To One has been to drift (tunnel) horizontally along an exposed quartz vein until a gold pocket is reached and then mine it by raising or stoping until the gold runs out. This hit-and miss process is now being supplemented by an advanced radar technology that allows the miners to "see" several feet into the vein or wall rock and detect the much denser gold pockets. This technology is still in the developmental stages, but should prove to be an invaluable exploration tool. The mine is currently being operated at the 2400 foot level to follow a major ore vein split into an anticipated gold-bearing pocket. Existing muck and passageways are being carefully examined to find gold discarded by old timers in favor of higher grade ore. A 100 ounce piece of gold discovered a few years ago was exhibited near the mine entrance, giving credence to the belief that there are still substantial gold reserves in the Sixteen To One deposit.

The twelve vehicle caravan reached the San Francisco State Field Camp in Bassetts at sunset, ate a hearty dinner prepared by the kitchen staff, and watched a slide presentation by **Dr. Elwood Brooks** of Cal State Hayward detailing the next day's first stop before turning in for the night. After breakfast, the trip commenced at Upper salmon Lake on the way to Graeagle, where Dr. Brooks led a short hike to see outcrops of the Upper Devonian Taylor and Elwell Formations. The group saw excellent exposures of andesite/basaltic andesite pumice lapilli tuffs, volcanoclastics, debris flows, pillows, tuffaceous turbidite sequences, and peperite (unlithified black phosphatic chert beds injected by andesitic sills). The caravan stopped briefly for lunch at pre-Upper Devonian (?) Shoofly Formation outcrops on the North Fork of the Feather River, then listened to **Angela Jayco** describe structural and stratigraphic relationships of Paleozoic arc-derived rocks exposed in the northernmost Sierra Nevada.

The final stop took the group down the Feather River canyon to Cherokee, outside Oroville, where one of the largest hydraulic mining complexes of the late 1800's was built. The mining and geologic history of the area was presented by **Dr. Scott Creely**, Professor Emeritus, San Jose State, who helped map this area in the mid 1950's. Steady mining of the Cherokee gravels dates back to 1854, with hydraulic mining commencing in 1858. In 1870 a complex system of pipes and canals was devised to transport water to the site from Concow Valley about six miles away. The water was transported across the gorge of the West Branch of the Feather River by a 30 inch diameter, 2.5 mile long iron pipe that provided a 900 foot drop from the source and provided tremendous water pressure at the mine. The key to its survival until 1915, however, was the purchase of acreage downstream to settle out suspended sediment, thus maintaining compliance with anti-debris legislation that closed other hydraulic mining operations in the Sierras in the 1880's. Post 1915 mining of the gravels has been exclusively underground, where the best pay occurs 10 to 30 feet above the bedrock contact. Attempts to work the mine as recently as 1990 failed because the 0.075 ounce per cubic yard ore grade could not support operations at today's gold prices. In addition to the ~51,000 ounces of gold taken from 1888 to 1996, the mine has also yielded 400 to 500 diamond gemstones, the largest weighing 6 carats. After a brief stop in nearby Dry Creek to examine an exposure of concretionary Chico Formation, the group headed back to the Bay Area.

This trip would not have been possible without the efforts of trip leaders **David Lawler** and **Gregg Wilkerson**. David also edited the trip guidebook with **Mel Erskine**, which is an excellent compilation literature on the economic geology, tectonics, structure, stratigraphy, and paleontology of the Northern Sierras. **Tim Ault**, Field Trip Coordinator, and **Tridib Guha**, Past-President, deserve credit for handling field trip registration, food, transportation, and for arranging the meals and lodgings at the SFSU Field Camp with **Ray Sullivan's** help. The cooking staff at the camp merits our thanks for handling such a large group of hungry geologists so well! Many thanks to all who provided vehicles and their driving skills to transport the attendees over this 500 mile trip. The NCGS also expresses its appreciation to representatives of the host mining operations, **Mark Paine** (Idaho-Maryland Mine), **Bob Pease** (San Juan Ridge Mine), and **Jason Burke** (Sixteen To One Mine); and to **Drs. Elwood Brooks** (Cal State Hayward) and **Scott Creely** (San Jose State) and **Angela Jayco**, **Howard Oliver**, and **Warren Yeend** of the U.S. Geological Survey for their contributions to the trip.

## Upcoming National Ground Water Association (NGWA) Events

### September 3-6

49th Annual NGWA Convention and Expo (6010), Las Vegas, NV

### September 22-23

Natural Attenuation for Remediation of Contaminated Sites (572), Columbus, OH

### September 22-25

Analysis and Design of Aquifer Tests - Including Slug Tests and Fracture Flow (191), Columbus, OH

### November 3-4

Fundamentals of Groundwater Chemistry (236), Boston, MA

### November 5-7

Applications of Groundwater Chemistry (486), Boston, MA

### November 12-14

Petroleum Hydrocarbons Conference/Expo (5040), Houston, TX

### December 8-10

Principles of Ground Water - Fate, Transport and Remediation (132), Salt Lake City, UT

### December 10-11

Low Cost Remediation Strategies (142), Salt Lake City, UT

For more information, call NGWA at (800) 551-7379 or (619) 898-7791; or visit NGWA's website at <http://www.h2o-ngwa.org>.

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### Waterloo DNAPL Course

On November 10-12, the University Consortium Solvents-in-Groundwater Research Program presents a short course titled, *"DNAPLs in Fractured Geologic Media: Behavior, Monitoring, and Remediation."* The course will be held at the Cathedral Hill Hotel in San Francisco, California. Topics include: properties of DNAPLs; DNAPL flow and mass distribution; conceptual models for DNAPLs source areas and plumes; mathematical model for DNAPLs; distribution of DNAPLs in fractured media; and technologies for monitoring and removal of DNAPLs in fractured media. The course fee is \$975. For registration information, contact Robin Jowett at Waterloo Educational Services, (510) 836-3102, or fax (519) 836-3381. For technical information, call (519) 888-45667, ext. 5935, fax (519) 836-3381, or e-mail [pbonin@cgrpc.watstar.uwaterloo.ca](mailto:pbonin@cgrpc.watstar.uwaterloo.ca).

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### UCSC Extension Course

Friday-Saturday, September 5-6, 1997 *Introduction To Soils Classification and Subsurface Mapping*

X427 Natural Sciences, EDP 971U28. By UCSC with Christopher Palmer, M.A.

Two meetings, 9 a.m.-5 p.m., Cost: \$225. At UCSC Extension, 3120 De la Cruz Blvd., Santa Clara, CA.

RSVP UCSC (800) 660-8639 or (408) 427-6600, fax (408) 427-6690, [www.ucsc.edu/unex](http://www.ucsc.edu/unex)

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### From BARNEY POPKIN'S E-mail List of Bay Area Environmental Events & Services

If you are interested in the S.F. Bay & Delta, you might want to check out the S.F. Estuary Institute at <http://www.abag.ca.gov/bayarea/sfep/index.html>. or call (510) 286-0738 to subscribe to The Estuary newsletter. Now in print: State of The Estuary Report, 1992-1997: Vital Statistics, New Science, Environmental Management by S.F. Estuary Project, to be available in late Sept. from (510) 286-0460; CALFED Ecosystem Restoration Program Plan Draft Executive Summary, Vol. I, II & III available separately from (916) 657-2666; Central Valley Project Implementation Act Draft Programmatic Environmental Impact Statement, by Bureau of Reclamation available in September, available from (916) 979-2837; Diazinon Toxicity Control Reports by Alameda County Public Works Agency, available from (510) 286-0962; Dredged Materials Management Guidance by EPA Ocean & Coastal Protection Division, available from (202) 260-1952; 1996 California Water Quality Assessment Report by State Water Quality Control Board, January 1997, available from (916) 657-2390; Applied River Morphology by David Rosgen, Wildland Hydrology Books, 1996, \$98, available from (970) 264-7121.

To get on Barney Popkin's E-mail List for San Francisco-Area Environmental Events (Every Friday or Saturday Night Since 1994), please e-mail Barney at [bpopkin@sirius.com](mailto:bpopkin@sirius.com), fax him at work at (415) 543-5480, or call him via voice mail at (415) 222-8351.

*(Continued from front page of newsletter)*  
canyons.

The complexity of shape of the shale-filled canyon and the canyon's updip truncation of numerous sand reservoirs, combined with the presence of common sealing faults, has resulted in the formation of several oil and gas fields. The fields include the Brentwood oil and gas field, and River Break, Dutch Slough, Knightsen, East Brentwood, and South Oakley gas fields. Cumulative production from these fields total 9.4 million barrels of oil and condensate, and 325 billion cubic feet of natural gas through 1996.

This talk will explore in detail the geology of these subsurface structures and their association with the Meganos Submarine Canyon.

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**Richard G. Blake** joined Lawrence Livermore National Laboratory in 1992 as an environmental scientist/hydrogeologist. He graduated with a B.S. (1977) and an M.S. (1983) in Geology from California State University, Los Angeles. He is a California Registered Geologist and is currently the Hydrogeology Team Leader in the Environmental Restoration Division at LLNL. Mr. Blake has also spent seventeen years working in the California oil and gas exploration industry, seven years as District Geologist for PG&E's subsidiary Natural Gas Corporation of California, five years as Fleet Oil Company's vice president and exploration manager, and an independent oil and gas consultant from 1992 to the present. His publications include papers about California oil and gas exploration, stratigraphy and sedimentation, engineering geology and geologic hazards, hydrogeology, and environmental restoration. Mr. Blake currently consults for several oil and gas companies in California and is personally involved in over 100 square miles of Sacramento Valley natural gas exploration projects involving 3-D seismic studies.

Northern California Geological Society  
c/o Dan Day  
9 Bramblewood Court  
Danville, CA. 94506-1130

