NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

A Word of Thanks to Our Officers

Last year was a difficult year for America, emotionally and economically. Many of us encountered longer work hours and increased job responsibilities. The NCGS officers were not exempt from these burdens. At this time it is fitting that we recognize and thank our officers for volunteering their time under these hardships so that all NCGS members could enjoy another year of excellent monthly talks and exciting field trips. Their hard work and devotion made last year's events possible.

President **Randy Kirby** has devoted many years to the NCGS and its programs, particularly K-12 and the AAPG Teacher of the Year Award. In addition to these duties, he has kept NCGS on course throughout the last year, while continuing to establish contacts with Bay Area earth science teachers through Dr. Ellen Metzger's Bay Area Earth Science Institute (BAESI) at San Jose State University. Randy has been deeply involved with K-12 programs and has headed the Teacher of the Year Award program for many years. He has established an extensive system of contacts as an effort to sponsor the earth sciences in our primary school system.

Incoming President **Mark Detterman** has also served the NCGS well. Mark continued his services as Program Chair through the first of the year. He has passed on his program duties to Past President **John Karachewski**, who orchestrated the winter/spring 2002 monthly speaker agenda. Mark devoted time to both the monthly speaker programming and the AAPG Distinguished Lecture Series, which is a formidable task. The NCGS has been an annual sponsor of the Distinguished Lecture Series, and has received generous financial assistance from **ChevronTexaco** to defray the costs of this function. Mark has served NCGS well as the contact who arranges the speaker schedules and chaperones the lecturers as our guests. The AAPG Distinguished Lecture Series is one of the premier events hosted by the NCGS, and Mark's efforts to ensure that all went well are sincerely appreciated. We likewise wish him our best as 2002-2003 NCGS President!

Phil Reed deserves accolades for his excellent job as Treasurer. His responsibilities include handling the annual membership dues and new members, keeping our books balanced, and paying bills for all monthly meetings, field trips, and other activities. Phil was outstanding in this capacity. He also found time to help with field trips and Teachers' Day at Black Diamond Mines Regional Preserve.

Jean Moran finishes her first year as Field Trip Coordinator with several notable accomplishments. Prior to this year, she and husband **Bill Martin** organized an enormously successful Caldecott Tunnel Tour in March, 2001. She followed with the Point Lobos-Moss Landing Marine Laboratories field trip hosted by Dr. H. Gary Greene of MLML in January; a look at the detailed sequence stratigraphy of the Domengine Formation at Black Diamond Mines led by Morgan and Ray Sullivan in April; a review of complex structural relationships at Mount Diablo with Ron Crane and Craig Lyon in May; and a two-day trip to the 16-to-1 Gold Mine in Alleghany and the Northern Sierra Nevada Range led by Ray Wittcopp of the 16-to-1 Mine, and Dr. Elwood Brooks and Phil Garbutt of Cal State Hayward

University. This post is particularly time consuming. The Coordinator must handle all trip logistics, food, and registration in addition to soliciting trip leaders. Jean will continue her excellent service as Field Trip Coordinator in 2002-2003, so be prepared for more enjoyable field excursions. It should also be noted that dependable Past President **Tridib Guha** helped Jean with transportation and food issues on all the trips that he attended. His expertise as a former Field Trip Coordinator for the NCGS and the Houston Geological Society has been invaluable!

Additional thanks go to the NCGS Counselors **Ron Crane, Barbara Fletcher, Don Lewis, Ray Sullivan,** and **Tridib Guha**. These individuals provide guidance for the organization and help to plan our annual activities. Many also support these events behind the scene. Their hard work is graciously acknowledged.

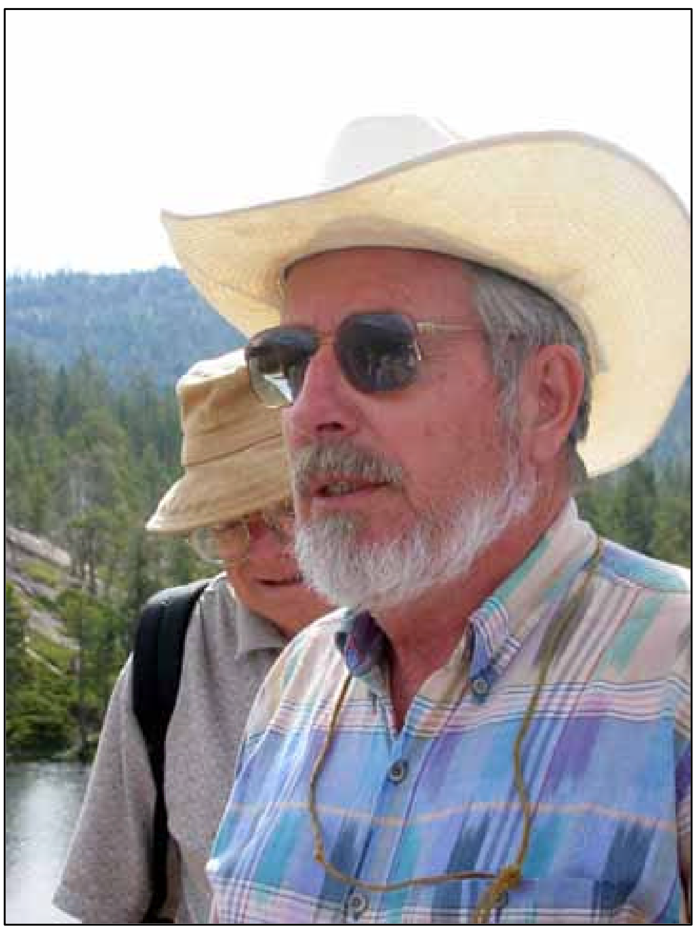
Two members deserve special recognition at this time for their service to NCGS. The first is Past President **Mel Erskine** who handles NCGS Publications, which includes all field trip guidebooks and publications sponsored by NCGS. Mel volunteered for this position, and has been meticulously cataloging this literature for several years. As a long time NCGS member involved with the Pacific Section AAPG, Mel knows AAPG protocol and has many connections in the California geological community, in both professional and academic circles. His contacts have provided the NCGS with excellent speakers and field trip leaders, and his experience in professional geological organizations has been extremely beneficial in planning our yearly calendar.

It would be a major oversight not to acknowledge **Dr. Ray Sullivan** of San Francisco State University for his continuing service to the NCGS. Ray spearheads the annual Teacher's Day at Black Diamond Mines Regional Preserve, a joint effort with the East Bay Regional Parks District to celebrate Earth Science Week each October. Ray always does an outstanding job explaining the local geology to the participants. This function is an important part of our K-12 outreach to earth science teachers in the Bay Area. And Ray is key to making it a successful venture each year. Of course, the barbecue lunch provided by **Tridib Guha** and his wife, **Mita**, is rumored to be another reason this particular event is so popular! Ray and his son, Morgan, an Exxon-Mobile geologist, led a detailed field trip at Black Diamond Mines that showcased their sequence-stratigraphic model of the Domengine Formation. Their work resulted in an estuarine model for the Domengine-Ione sandstone complex, a ubiquitous Eocene unit exposed in the western Sierra Nevada foothills and locally in the greater Mount Diablo region.

Before closing, the officers of NCGS would like to invite other members to volunteer their skills, as time permits, to the organization in whatever capacity appeals to them. We really need help in the Scholarship and K-12 program support, as well as a small staff to manage the monthly newsletter. All of us are finding that our spare time is becoming scarce, but with the help of other members, we can still maintain the quality of the events and programs hosted by the NCGS. Please consider donating a little time to our organization. You will find it rewarding, and the professional contacts that you make a valuable career networking tool.

Photos from the **"Geology of the Eastern Belt of the Northern Sierra Nevada and 16:1 Gold Mine Tour", June 28-30, 2002** ***courtesy of Mike Diggles,*** **USGS, Menlo Park**

NCGS members on an outcrop of Devonian-Mississippian volcani-clastics at Upper Salmon Lake in the Lakes Basin, Sierra County. Saturday, June 29, 2002. This phase of the trip was led by **Dr. Elwood Brooks** and **Phil Garbutt,** California State University, Hayward.



Saturday's trip leader, **Dr. Elwood Brooks** of California State University, Hayward.

Ray Wittcopp, geologist at the 16-to-1 Mine, discusses mine geology and operation in the mine lunch room underground on Sunday, June 30.

Phil Garbutt of the Cal State Hayward Geology Department admires "The Whopper," an enormous gold nugget found at the 16-to-1 Mine, Alleghany, California.

The NCGS sincerely thanks Michael F. Diggles, geologist with the Western Publications Group, USGS Menlo Park, for making his pictures available to us. More pictures from the June 28-30th 16-to-1 Field Trip can be found on his website **http://www.diggles.com/sixteen/**. For more pictures from the trip, e-mail Mike at **mdiggles@usgs.gov**.

NCGS Field Trip on the Geology of the Eastern Belt of the Northern Sierra Nevada and the Sixteen-to-One Gold Mine

by Richard Cardwell

The June 29-30 field trip took two dozen NCGS members and friends to explore the geology of the Eastern Belt of the northern Sierra Nevada. The focus of the trip was to examine the anatomy of a Paleozoic island arc and to visit a working gold mine. Most of the group met on Friday evening at the San Francisco State University Sierra Nevada Field Camp near Bassetts along Highway 49. The Camp offered "luxury camping" including large platform tents with mattresses, hot water showers, flush toilets and a dining hall with staff to prepare meals.

The first day of the trip on Saturday was led by Dr. Elwood Brooks, Professor Emeritus, and Phil Garbutt of CSU Hayward. Professor Brooks has worked in the area since 1969 and his guidebook for the trip, **Geology of the Eastern Belt of the Northern Sierra Nevada**, is an excellent introduction to the area.

The day began at 8:00 with a short drive north to Upper Salmon Lake. Our hike around Salmon Lake was mercifully free of mosquitoes for this time of year due to a slight breeze. At the first outcrop Dr. Brooks began with an overview of the geologic setting. The Eastern Belt of the northern Sierra Nevada lies east of the Feather River Peridotite Belt (Melones fault zone). The belt consists of an early Paleozoic accretionary prism complex and a series of three overlying late Paleozoic and Jurassic volcanic-arc sequences.

The accretionary prism is represented by the Shoo Fly Complex and is composed of quartz sandstone and mudstone derived from the North American craton. The rocks that we would be examining were the foundations of a Late Devonian-Early Mississippian island arc complex. The other two island arc complexes are of Permian age and Jurassic age. Uplift and tilting resulted in the exposure of the Shoo Fly complex in the west followed by the Devonian/Mississippian arc, Permian arc, and Jurassic arc lying progressively further to the east. The entire package tilts to the east at moderate dips of about 20 degrees. The island arcs were probably formed adjacent to the paleo-craton of North America along a west-dipping subduction zone.

The Late Devonian-Early Mississippian island arc complex is represented by three formations of volcanic assemblages. The Sierra Buttes Formation is the oldest (Late Devonian) followed by the Elwell Formation (Late Devonian) and then the Taylor Formation (Late Devonian-Early Mississippian). These are overlain by chert of the Mississippian-Pennsylvanian age Peale Formation. The entire package is known as the Taylorsville sequence. For most of the day, we progressed from the Taylor Formation down section to the Sierra Buttes Formation.

All of the formations appear to be deposited under subaqueous, marine conditions at a depth of approximately one kilometer of water. There is very little indication of subaerial deposition. The Late Devonian-Early Mississippian age of the Taylorsville sequence is established by conodonts and goniatites. The entire sequence was metamorphosed several times. In this area we were mostly in lower-greenschist facies rocks, although some rocks containing prehnite-actinolite facies also occur.

Our first stop on our hike was Stop 7 in the Guidebook. Here we examined clastic volcanic (andesitic to basaltic) rocks of the Taylor Formation. Individual units consist of a debris-flow deposit overlain by ash flow turbidites. The debris-flow deposit consists of broken pillow basalts in an ash and lapilli matrix. The pillows are basalt and basaltic andesite with glassy rinds and vesicles. An example is shown as Figure 12 in the Guidebook. The overlying ash flow turbidites form upward-fining units that are typically less than one foot thick.

Our second stop (Guidebook Stop 8) was nearby and showed discrete, unbroken pillows embedded in a tuffaceous matrix (Figure 14). The ash contains pumice clasts that have now been replaced by quartz. At our third stop (Guidebook Stop 10) we examined Bouma sequences in the ash flow turbidites. Trace fossils lie along the bedding plane of the uppermost units.

Our fourth stop was along Horse Lake in a forested saddle underlain by the chert and volcanic (andesitic) rocks of the Elwell Formation. The Elwell is dominated by a brittle radiolarian chert and phosphatic units.

Our fifth stop (located between Guidebook Stops 10 and 11) was in one of the upper units of the volcanic (dacitic to andesitic) rocks of the Sierra Buttes Formation. The rocks appear as a distinctive reddish-colored unit, and they represent a subaqueous, pyroclastic flow containing pumice and breccia. The unit is cut by near-vertical andesite and basalt dikes and sills. The dacite-like breccia is highly silicic. It has been proposed that the silicic magma formed by melting of both the asthenosphere and the overlying continental crustal material within the Shoo Fly Complex. This is supported by Nd isotopes. The silicic enrichment of the Sierra Buttes Formation at the base of this mid-Paleozoic volcanic arc sequence indicates that it is petrologically an inverted system. The two younger volcanic arc systems do not show this inversion.

After lunch our sixth stop (Guidebook Stop 12) was an andesite sill in the Elwell Formation that is fractured into columnar joints (Figure 18). Above it is a debris-flow deposit incorporating chert with phosphatic nodules, volcanogenic sandstones, Sierra Buttes dacite clasts, and Elwell sill rocks. This deposit is the basal member of the Taylor Formation.

Our final stop (Guidebook Stop 13) allowed us to see and collect world-class exposures of peperite in the Elwell Formation. Peperite forms when andesite magma intrudes into unlithified chert and phosphatic units, and then it is quenched rapidly at the low-temperature, near-seafloor conditions. The andesite and phosphate nodules fracture and the soupy chert is injected into the fractures. Dispersed peperite is formed when steam explosions are violent enough to mix all the components in a more homogeneous-looking rock. We then continued around Upper Salmon Lake and back to our cars for a return to the Sierra Nevada Field Camp for the evening.

The second day began with an 8:00 start, and after some wandering along back-country roads, we managed to find the Sixteen-to-One Mine located in Allegheny just south of Downieville. The mine tour was led by Consulting Geologist Raymond Wittkopp and assisted by miner Larry Cates. The mine is the last deep, active hard-rock gold mine operating in California. Ray provided everyone with four publications discussing gold in California and the 16-to-1 Mine.

Ray began with an overview of the area, and then he described the historical and current mining practices. The 16-to-1 Mine was discovered in 1896 by miners working the nearly placer deposits. It was named for the ratio of sixteen ounces of silver to one ounce of gold proposed for U.S. coinage by William Jennings Bryan in his presidential campaign speeches. To date the mine has produced over one million ounces of gold and was one of the most productive and profitable gold mines in California. The mine was closed during World War Two and reopened in 1945. In the last decade the miners have had success using metal detectors to locate pockets of ore three to four feet behind the existing mine walls.

No current reserves are booked for the mine. Any new ore pockets that are discovered are mined immediately and removed. Typical pockets are 1000 to 1500 ounces. All of the extracted ore is sold for specimens and jewelry at prices ranging from 4 to 8 times spot gold prices.

After the overview we donned our boots and hard-hats and grabbed our flashlights. At the mine entrance we counted off and shuffled in single file to begin a four hour tour of the mine. With only our flashlights for illumination it took about five minutes to become used to the darkness. The cool temperatures inside the mine were a welcome relief from the hot sun outside. We entered through a tunnel that took us into the 800 foot level of the mine. All depths in the mine are measured along the dip of the vein. This 800 foot level is where the miners are currently working. From there we descended along the vein to the “Ballroom” just below the 1000 foot level. The water table in the mine is at 800 feet and below this level water must be pumped from the mine. The mine is currently being pumped to the 2400 foot level. Total depth in the mine is 3000 feet.

The gold ore is located in a quartz vein system that follows the trace of a thrust fault. The fault is part of the Melones fault system that lies west of the Shoo Fly Complex that we discussed on the first day. The fault strikes north-south and dips east at about 30 degrees. The fault and veins cut through the wall rock of the Carboniferous Calaveras Group. The Tightner Member of the Calaveras Group is present throughout most of the mine and is a metamorphic unit of predominantly amphibolite and chlorite schist, quartzite, slate and serpentine. Just below 1700 feet the vein is offset by a more recent high-angle, reverse fault that drops the vein down to the east.

The quartz vein varies from two feet to fifty feet with an average of about six feet. The vein filled voids along the fault plane. As the wall rock moved along an undulating fault plane, voids were formed that were later filled with a hydrothermal fluid that transported the quartz and gold.

Geochemical (isotope) analysis indicates that the origin of the veins originated at a depth of about six km. The age of mineralization is approximately 108-127 million years. Hydrothermal fluids, rich in carbon dioxide, moving along the fault zone caused alteration of both schist and serpentinite by sulfidization and carbonatization. There is evidence that both the silica and the gold may have been leached from the walls themselves. Carbonate rich solutions appear to be the key for the formation of the gold deposits. It may be that the Mesozoic intrusions in the area are the engines that drive carbonate-rich fluids to leach gold out of the country rock. These same fluids are responsible for altering serpentine to the distinctive blue-green rock called mariposite. Where the fluids encounter a void along the fault plane, there is a drop in pressure that may precipitate quartz and gold from the solution.

All gold is found within quartz veins. There are five general indicators of which veins typically contain gold. 1. Gold is typically found within 100 feet of where the fault cuts through a serpentine body in the wall rock. 2. Gold is found where mariposite is located in the upper part of the vein near the hanging wall, or where mariposite is found as blocks (horsts) within the quartz veins. 3. Gold is located near where the fault pinches and rolls. 4. Gold is found in areas where there is an abundance of fault gouge. 5. Gold is found where quartz has a greasy looking appearance and has numerous fluid inclusions.

After a group photo in front of mine everyone went to the mine office to have a look at the ore specimens recovered from the mine. A number of members purchased hand specimens of quartz laced with small veins of gold.

The NCGS sincerely thanks Dr. Brooks and Phil Garbutt for the excellent field trip through the Taylorsville sequence, and Ray Wittkopp and Larry Cates for the exciting trip through the mine. Jean Moran did her usual superb job in arranging food, transportation, camping facilities, and handling trip registration. Our thanks also to all of the drivers for driving the cars and vans. Finally we thank the staff of San Francisco State University Sierra Nevada Field Camp for the use of their facility and their hospitality.

The NCGS thanks Past President Richard Cardwell *for taking time to write this article and share his experiences on this field trip with other NCGS members.*

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Current Status of Indian Rock (Northbrae Rhyolite) Research, June 2, 2002

Lin Murphy, NCGS 2000 Scholarship Awardee

All mapping of the Berkeley Hills (Robinson, 1956; Knox, 1973; Dibblee, 1980) has grouped the Northbrae and Leona Rhyolites as parts of one flow. Since the 1990's the Northbrae Rhyolite (NR) has been lumped together with the Leona Rhyolite (LR) and classified as a quartz keratophyre within the Coast Range Ophiolite (CRO). Without the benefit of an assignment of radiometric age, I determined that the NR and LR had separate petrogeneses, based on petrographic and geochemical differences. (See Abstract for GSA meeting, 2001 and NCGS article, June 2001).

The alternatives to explain the Northbrae Rhyolite (NR) include:

1. an exotic block in the CRO; or
2. a volcanic rock formed in the wake of the migrating Mendocino Triple Junction (MTJ), similar in petrogenesis to the Tolay, Pinnacles, and Berkeley Hills volcanics.

The Northbrae Rhyolite is very different in appearance from the other MTJ volcanics. The volcanic rocks from Pinnacles, Burdell Mountain, and Berkeley do not display the rounded polished surfaces, cementation, induration, and silicification that are present in the NR. NR is not spatially related to the Berkeley volcanics; rather it is imbedded in the rocks of the CRO and Franciscan formation to the west. I have not had a chance to examine the Tolay and Quien Sabe, but hope to do so on my June trip to Berkeley from Boulder, CO, where I now live.

One possible explanation for the differences between NR and LR is that NR was formed at an anomalous ridge or in an environment similar to that of the Izu-Bonin arc /trench system in the west Pacific. The NR was then brought to the CA coast and accreted in a manner similar to that modeled by Shervais (2001) for St. John's Mountain. Further support for the exotic-block-transport model are the rounded and polished surfaces of NR, which are very similar to those found on a Franciscan ecologite on the Sonoma coast.

At last year's Cordilleran GSA meeting Bob Fleck of USGS offered to date the NR. The recently acquired age of the NR (10.5 to 11.5my) strongly suggests that it has affinities with the MTJ volcanics. The recently determined age of the NR is too young for alternative #1, above. The MTJ volcanics are used by many people to support models of offset along the

San Andreas family of faults. As neotectonics is not my primary interest, I leave the accumulated data of my research to those who can use it in their fault movement reconstructions.

The NR remains interesting on its own as an example of a glass flow or dome and of the alteration of volcanic rocks. As for Cragmont Rock, the recent date is consistent with my suggestion that it is the brecciated carapace of the lava flow or dome. According to Dibblee's 1980 map of the Richmond quadrangle, all outcrops of the NR and Cragmont are within the Hayward Fault Zone.

The recently acquired date for the NR seems to determine its genesis. It would be great to be able also to date the silicified volcanics at Cragmont and Hinkle Parks, near Indian Rock Park in Berkeley. I plan to continue looking for another piece of the NR across some Central California fault. Please email me if you know of a flow-banded rhyolite with autobrecciated clasts like NR or a brecciated silicic rock like that found in Cragmont Park. I would also like to discuss alteration mechanisms with anyone who has experience in this area. In particular, I'd like to make an educated guess whether Pinnacles rock might look like Cragmont if it were intensely silicified. Photographs of NR and Cragmont are on my website. **http://eqdoc.home.netcom.com/lin.html**

In the Works…

The following field trips are being pursued, but have not been finalized! Watch future newsletters for details.

Rogers Creek/Maacama Fault Zones	Bob McLaughlin, USGS	Rescheduled for Spring 2003
Hayward Fault Trench Field Trip	Jim Lienkaemper, USGS	Early October, 2002 (Date TBA)

Conferences…

GROUNDWATER RESOURCES ASSOCIATION OF CA 11th ANNUAL MEETING & CONFERENCE

"Sustaining Groundwater Resources: The Critical Vision"

September 18-19, 2002
Sutton Place Hotel in Newport Beach, CA

The goal of GRA's 11th Annual Meeting and Conference is to present local and regional (and a few global) groundwater management strategies and programs that are currently being implemented or refined to ensure reliable (sustainable) groundwater supplies.

There are significant challenges now and in the future to address the expanding stresses on our water resources that are occurring through extraction, transfer, consumption, recharge interception, and supply diversion. These stresses dictate the need for multi-faceted groundwater management programs that: 1) define clear management objectives, 2) define the managed resource (i.e., the total water balance and flow system for the physical conceptual model of the groundwater basin), 3) employ comprehensive monitoring programs to gather the data necessary to manage groundwater resources, and 4) plan for and implement water resources management actions such as surface and subsurface recharge, in-lieu use, and conjunctive management to ensure water supplies are replenished and the balance of the hydrologic system is maintained. This Conference intends to broaden attendees' awareness of the critical vision for accomplishing sustainability through presentations provided in General and Concurrent Sessions identified below.

VIEW THE FULL PROGRAM AGENDA **- http://www.grac.org/amagenda.html**

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NGWA SOUTHWEST FOCUS CONFERENCE: Water Supply and Emerging Contaminants

February 20-21, 2003, Hyatt Regency Phoenix
Co-Sponsors include the Groundwater Resources Association of California

FOCUS on the Southwest with applicability to National Issues NGWA (the National Ground Water Association) will focus on the issues critical to ground water in the Southwest in this special conference. The conference will cover a broad range of topics from water supply issues to irrigation in the region famous for the scarcity of water. The emerging contaminant portion of the conference will focus on 3 specific compounds: n-nitrosodimethylamine (NDMA), 1-4,dioxane, and perchlorates.

ANNOUNCEMENT & CALL FOR PAPERS **- http://www.grac.org/NGWA.pdf**

For more information about NGWA **- http://www.ngwa.org**