NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

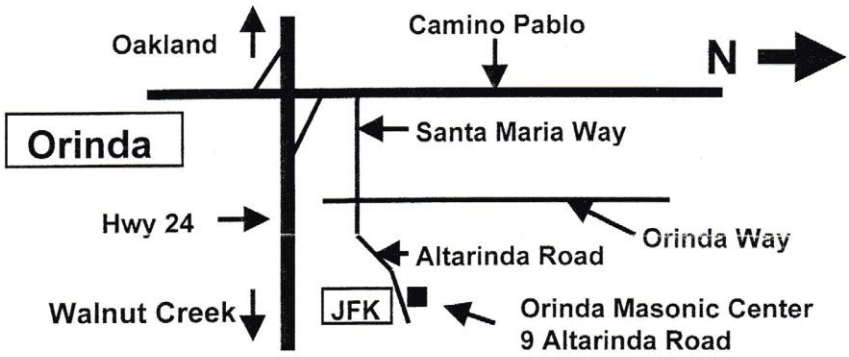
OCTOBER MEETING ANNOUNCEMENT

DATE: Wednesday, October 13, 1999

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

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

RESERVATIONS: Leave your name on the recorder at 925-294-7530 anytime before the meeting.



SPEAKER: Dr. Benjamin D. Santer
Program for Climate Model Diagnosis and Intercomparison
Lawrence Livermore National Lab

Climate Change: Natural or Human-Induced?

In 1995, the Intergovernmental Panel on Climate Change (IPCC) concluded that the balance of scientific evidence "suggests a discernible human influence on global climate". This lecture will discuss key aspects of the scientific evidence that led to the IPCC's historic conclusion. It will focus on three topics. The first deals several general issues: what factors influence climate, how climate has changed over the past century, and climate might change over the next century. The second addresses so-called "fingerprint" studies, in which scientists compare observed patterns of climate change, such as temperature fields at the Earth's surface, with predictions made by computer models of the climate system. Such research is useful in gaining an improved understanding of the causes of climate change. The third topic covers recent attempts to resolve the disagreement between thermometer measurements of atmospheric

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NCGS Fall 1999 Calendar

Oct. 13	Dr. Ben Santer, LLNL *1998 McArthur Grant* Winner	***Global Climate Change: Natural or Human-Induced?***
Oct. 16	Andrei Sarna-Wojcicki	***Volcanics of the Bay Area Region Field Trip*** (see flyer)
Nov. 10	Richard Blake	***Evidence of an Ancient Asteroid Impact Scar in the Sacramento Valley Area, California***

IMMEDIATE JOB OPENING: SENIOR/ASSOCIATE ENGINEERING GEOLOGIST

Geotechnical/environmental/materials engineering firm established in 1968 has an immediate opening for a SENIOR OR ASSOCIATE ENGINEERING GEOLOGIST for our offices in SAN JOSE AND MONTEREY, CALIFORNIA. Requires M.S. and California R.G. and C.E.G. Minimum 8 years experience including management of multiple simultaneous projects and supervision of engineering geologic staff. Superior verbal and written communication, client relations, and teamwork skills needed. Small-company atmosphere with billion-dollar-corporation backing. Fast-paced work environment in rapidly growing area. Excellent salary and benefits. Please send your resume and cover letter to: **D&M CONSULTING ENGINEERS, INC.** (formerly Terratech), A URS Corporation Company, 1365 Vander Way, San Jose, CA 95112 (Fax 408/297-7716; E-mail: **DMCE.SanJose@mindspring.com**) or 12 Thomas Owens Way, Monterey, CA 93940 (Fax 831/372-7481; E-mail: **DMCE.Monterey@mindspring.com**). EOE

The 1999 AAPG Grants-in-Aid Fund Recipients

The Northern California Geological Society is pleased to announce the 1999 recipients of the **AAPG Foundation Grants-in-Aid**. Abstracts submitted from recipients of this award world-wide will be published in the November 1999 issue of the AAPG BULLETIN. This year the AAPG Grants-in-Aid Committee received 273 applications, each of which was carefully reviewed by three committee members and competitively ranked against all other applications. Funding provided by the AAPG Foundation Grants-in-Aid Fund totaled $155,500 and was awarded to 127 successful grant applicants. Grants from the Grants-in-Aid Program are awarded in varying amounts up to a maximum of $2,000. The purpose of the Grants-in-Aid program is to foster research in the geosciences by providing support to graduate and post-graduate students in the earth sciences whose research has application to the search for and development of petroleum, energy-minerals resources, and related environmental geology issues.

AAPG Foundation Grants-in-Aid application forms for the 2000 program were made available in September to download from the Foundation web site at **www.aapg,org/fdn.html** or by contacting **Rebecca Griffin, AAPG Foundation, P.O. Box 979, Tulsa, OK 74101-0979 USA.**

The following students from the region administered by the NCGS were awarded grants under this program:

Cynthia Marie Martinez, Department of Geology & Environmental Sciences, Stanford University
Named Grant Winner: Moore
Thesis Title: ***The Record of Tertiary Sedimentation in the Basin and Range and Implications for the Evolution of Extensional Detachment Faults***

William Gordon Shipp, Geology Department, University of California, Davis
Named Grant Winner: Kilkenny
Thesis Title: ***Determining Acid Rock Drainage Flux Using Geochemical Tracers at Sulfur Bank Mercury Mine, Clear Lake, California***

Nathaniel Stephens, Geology Department, University of California, Davis
Thesis Title: ***Stratigraphy and Stromatolites in a Late Devonian Reef Tract, Canning Basin, Western Australia***

Kirsten Ann Tambo, Geology Department, University of California, Davis
Thesis Title: ***Stable Carbon Isotope Stratigraphy at the Olenellid-Corynexochid Trilobite Extinction Boundary in the Lower to Middle Cambrian***

The NCGS and its members wish to congratulate these students for distinguishing themselves as 1999 AAPG Grants-in-Aid scholars. We wish all of them good luck as they pursue their thesis research.

The rafts engaged in a few water fights before banking along Norton Ravine to examine intercalated (interfingered) metatuff and metasedimentary rocks of the American River terrane. The complex is predominantly an olistostromal unit whose high-energy depositional environment and mixed sedimentary/volcanic lithologies suggest deposition in a deep-sea trench. As the group embarked from this stop, the landmark "Lollipop Tree" loomed on a hilltop far above the river and signaled that the Gorge section with its class 3 rapids was close at hand. Downstream from Norton ravine the river crosses the East Bear Mountains Fault that separates the Placerville Belt terranes from the Shingle Springs Complex. The Gorge cuts through high grade amphibolite to granulite facies rocks derived from a mafic (ophiolitic?) protolith that locally exhibits partial melting and textures associated with high grade migmatite rocks. The metamorphism has been dated at ~190 m.y. (Early Jurassic), but the age of the protolith is unknown.

The Unsuspecting rafters were soon swept into a succession of churning rapids beginning with Fowlers Rock, Upper Haystacks, Satan's Cesspool, Deadman's Drop, and Lower Haystacks. In the brief calms between rapids, the rafts literally clung to outcrops as the passengers examined the high grade metamorphic features and partial melting textures displayed by the water-polished rocks before plunging into the next series of rapids. Bouncing Rock, Double Dip, Hospital Bar, Recovery Room, and Surprise rapids completed the gorge section with some standing wave troughs so deep the rafts momentarily disappeared before being launched through the wavecrest on the downstream side. Chris Lewis was repeatedly tossed into the center of his raft, and scrambled back to his post only to be curtly tossed back again by the next wave. All the rafts emerged unscathed and weary but thrilled by the 20 minutes of whitewater excitement in the Gorge. When the rafts entered the mouth of Folsom Lake, a motorboat towed them to under Salmon Falls bridge to the Skunk Canyon dock, where the passengers were bussed back to Camp Lotus. Russ challenged the rafters to reflect on the complicated geological history revealed by the outcrops they had seen. Tectonic processes had brought oceanic crust, seamounts, island arc terranes, and high grade metamorphics to the continental margin, accreted them, intruded them with granitic plutons, juxtaposed them along reverse faults, exhumed them, and eroded the exposed terranes into the river canyons they had just enjoyed.

It goes without saying that **Russ Graymer** led an outstanding trip that combined the excitement of whitewater rafting with a look at the geology of the Placerville Belt that can best be obtained along the banks of the South Fork of the American River. Russ's excellent discussion of the rocks, the tectonics, and the stratigraphy of this complex region, as well as his own obvious enthusiasm for the geology and the whitewater rafting made this a particularly enjoyable field trip. **Bill Howell**, NCGS Field Trip Coordinator, deserves accolades for selecting All Outdoor Whitewater Rafting as the host company and for handling all aspects of the registration, logistics, and transportation. Thanks go to Bill for pursuing Russ Graymer's offer to lead a whitewater geological excursion down the South Fork, and for penciling it into this year's field trip agenda. The NCGS sincerely thanks **All Outdoors Whitewater Rafting** for providing the equipment, experienced guides, and delicious lunch that combined with Russ's geological expertise to make this another memorable field trip.

Viva Del Puerto!!

Brushy Peak! Ohlone Wilderness! Del Puerto Canyon! The third part of a field trip triple-header exploring the geological evolution of the East Bay Hills-northern Diablo Range continued on August 21st when **Ron Crane** and **Sandy Figuers** took attendees on a traverse across the Diablo Range from Mt. Hamilton to Del Puerto Canyon south-west of Tracy. The geoscientists who assembled that morning were eager to learn more about the on-going orogeny that is currently sculpting California's Coast Range.

Ron re-capped the five-stage history of the Coast range geological development, beginning with the formation of a deepwater basin in Early cretaceous times (100 to 130 m.y. ago). An Albian compressive event formed the Highland thrust belt to the west and was the source of olistostromal material that began shedding itself eastward into the adjacent basin about 100 m.y. ago. This was followed by a mid-Miocene (~15 m.y.) and early Pliocene compression that forced the Calaveras basin to close and thrust the Diablo Range, subaerially exposed during the early Tertiary, as a wedge into the basin sedimentary sequence. A backthrust between the ophiolitic plate and the Sierran basement to the east raised the Cretaceous section, cut through the olistostrome units, and continued NE to merge with the Williams and Verona thrust south of the Livermore Valley, uplifting all the area to the NE. In Pleistocene times, uplift was concentrated on the NE side of the Diablo Range. Quaternary to present orogenic activity has created thrusting at the NW end of the Williams thrust, on the Las Positas Fault in the Livermore Valley, and on the Verona Fault. The Mt. Diablo domain is moving SW as the East Bay Hills move eastward.

The drive from San Ramon to the first stop at Alum Rock Park in San Jose was accompanied by descriptions of local geology as the caravan left Bollinger Canyon and headed south on I-680. Ron and sandy explained features associated with the San Ramon-Livermore Valley, now overridden from the south by the Diablo range, from the east by the Altamont Hills, and from the west by the East Bay Hills thrust.

At Alum Rock Park the group examined an outcrop of Cretaceous gravels containing well-rounded, poorly sorted cobbles of volcanic rocks from a source area to the west. Ron and Sandy recapped the trip route across the northern Diablo

capped by Upper Triassic limestones. These dramatic layered basalts, not unlike the Columbia River basalts, give excellent paleomagnetic data to help scientists retrace their origin. Paleomagnetics indicate the basalts came from equatorial regions between 15° north and south latitude. The long distance transport of the Wrangellia Terrane illustrated the scale of transport by plate tectonic processes. In addition, the paleomagnetic data and paleontological data from overlying limestone units are in agreement.

Throughout the Cordillera the dominant tectonic event is associated with a collisional process. These events can be tied to a time line by careful analysis of radiolarian fauna in cherts transported with the oceanic crust. The radiolaria and occasional macrofauna provide a time framework that plays a key role in unraveling these collisional events and the origin of the individual terranes. The emplacement of the Wrangellia Terrane was solved by careful paleomagnetic analysis of the flood basalts. Dr. Jones feels that a rebirth in paleomagnetic studies as a tool for terrane analysis would be a tremendous benefit in reconstructing continental accretionary events. It has unfortunately fallen out of acceptance with many geologists, but can provide valuable information if properly applied to terrane analysis.

A second example emphasizing the importance of paleontology to terrane reconstruction is Alaska's Chulitna ophiolite. The ophiolite was dated as Upper Devonian age by an ammonite fauna similar to others identified in Nevada and Idaho. This warm water fauna suggested significant transport from its point of origin before being accreted to the Alaskan landmass. Similarly, the North American Cache Creek Terrane contains Permian Tethyan fusilinids of equatorial origin that are also found in Japan. Hence, their widespread occurrence around the Pacific basin is testimony to the large-scale distributive capabilities of plate tectonic spreading processes.

Dr. Jones then focused his attention on northern California, where about 20 accretionary terranes have been identified. In the northwestern part of the state, high pressure-low temperature metamorphic terranes predominate. To the east, lower grade assemblages are exposed. The simplified version of post-Franciscan northern California geology has subduction occurring offshore and a forearc basin represented by the Great Valley sediments lying to the east between the subduction complex and an arc complex driven by the subduction mechanism manifested as the Sierra Nevada batholith. Dr. Jones stated emphatically that this model is grossly oversimplified if not wrong. A workable accretionary model for northern California is considerably more complex. Regarding the Coast Range, he favors a brittle-ductile transition zone detachment of the upper crust working in conjunction with the San Andreas Fault system high angle strike-slip faulting to explain the various compressive structural features we observe there. Several fault splays off the San Andreas proper dissect the East Bay Hills. They have been shown to take up a considerable amount of the strike-slip motion between the Pacific and North American plates. A careful examination of the Gualala Terrane north of Point Reyes (see NCGS October, 1998 newsletter) provides key evidence to determine how active the main San Andreas fault trace has been in Neogene time. The Upper Cretaceous sedimentary rocks of the Gualala block rest on the Coast Range ophiolitic (Franciscan-type) basement, and to the west of this sliver the section lies on Salinian (granitic) basement. The Upper Cretaceous section includes the Anchor Bay Formation, a conglomerate containing mafic cobbles, mostly gabbros and pyroxenites. A warm water rudist (clam) fauna is associated with the conglomerate that is found in Mexico, but only west of the San Andreas Fault in these latitudes. A matching lithology with disarticulated rudist fragments has been discovered on Skyline Drive on the San Francisco peninsula. Attempts at reconstructing the fault movements that had to occur to displace these two sites severely restricts movement on the intervening segment of the San Andreas Fault.

To illustrate this model, Dr. Jones digressed to reconstruct Neogene motion on the San Andreas Fault in the greater Bay Area. A total of ~300 km. of motion on the San Andreas can be measured by equating the Pinnacles Volcanics with the Neenach Volcanics. About 165 km. of offset occurs in the Permanente Terrane, and 150 to 160 km. of displacement occurs between the Point Reyes and Monterey along the Hosgri-San Gregorio Fault system. About 160 km. of offset occurs between the 9.5 to 10 m.y old Tolay Volcanics and the 8 to 10.5 m.y. old Quien Sabe Volcanics. The latter accounts for about half of the total motion on the San Andreas Fault that can be reasonably hypothesized in northern California. Taking these various offsets into account, it leaves only 24 to 30 km. of displacement for the main trace of the San Andreas Fault in the Bay Area. This relative inactivity on the main trace can be explained by assigning the pre-Pleistocene motion to the Pilarcitos Fault on the San Francisco peninsula and declaring it the active segment of the fault during that time interval. A missing piece to the complex puzzle of transporting the warm water rudist fauna so far north suggests that some post-Eocene / pre-Neogene strike-slip translation must have occurred along a proto-San Andreas system that linked the Gualala Terrane with more southerly latitudes. Whatever the exact mechanism might be, Dr. Jones emphasized that it must require an oblique subduction mechanism. Dr. Jones' closing statements reiterated the mounting body of evidence in the geological record that shows the San Andreas is a highly segmented fault system with a unique history along each strand, and with similar complex histories on each of the fault splays that makes up the San Andreas strike-slip system in northern California.

The NCGS expresses its sincerest gratitude to Dr. David L. Jones for making the long journey from his Placerville home to give this fascinating account of accretionary terrane studies in the North American Cordillera. His Alaskan slides were spectacular, and his account of San Andreas displacement mechanisms underscores the tectonic complexity of the greater San Francisco Bay Area.

temperature change at the Earth's surface and estimates of tropospheric temperature change derived from satellites.

Ben Santer was born in Washington D.C. in 1955. In 1966, his father took a position with an American company in Germany, and transplanted the entire Santer family to Dortmund. Ben attended a British Army school, where he was the only student who could not play soccer, rugby, or cricket. After completing his British University entrance examinations, Ben attended the University of East Anglia in Norwich, England, where he obtained his B.Sc. in Environmental Sciences (with First Class Honors) in 1976. While at East Anglia Ben was introduced to mountaineering and rock-climbing, twin hobbies which he still pursues actively (although somewhat less actively than in his student days).

In 1983, Ben decided pursue his interest in climate modeling and enrolled in a Ph.D. program at the Climatic Research Unit of the University of East Anglia. His thesis supervisor was Prof.essor Tom Wigley, and the subject of his research was the use of Monte Carlo methods in the validation of climate models. He obtained his Ph.D. in climatology in 1987, and immediately thereafter took up a post-doctoral position at the Max-Planck Institute for Meteorology in Hamburg, Germany. It was the director of the Max-Planck Institute, Professor Klaus Hasselmann, who first suggested that Ben should direct his attention towards the problem of identifying a human-induced "signal" in observed records of climate-change.

After spending five years in Hamburg, Ben joined Professor Larry Gates' group at the Program for Climate Model Diagnosis and Intercomparison (PCMDI) at Lawrence Livermore National Laboratory. Ben's research at PCMDI focusses on model validation and climate-change detection and attribution. In 1994, Ben was asked to act as Convening Lead Author of Chapter 8 ("Detection of Climate Change and Attribution of Causes") of the 1995 Report by the Intergovernmental Panel on Climate Change. Ben's involvement with the IPCC Report was an experience best described as "character-building".

When not searching for "fingerprints" of human activities on climate, Ben is usually exploring California with his four-year-old son Nicholas.

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