NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

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APRIL 2003 MEETING ANNOUNCEMENT

DATE: **Wednesday, April 30, 2003**

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

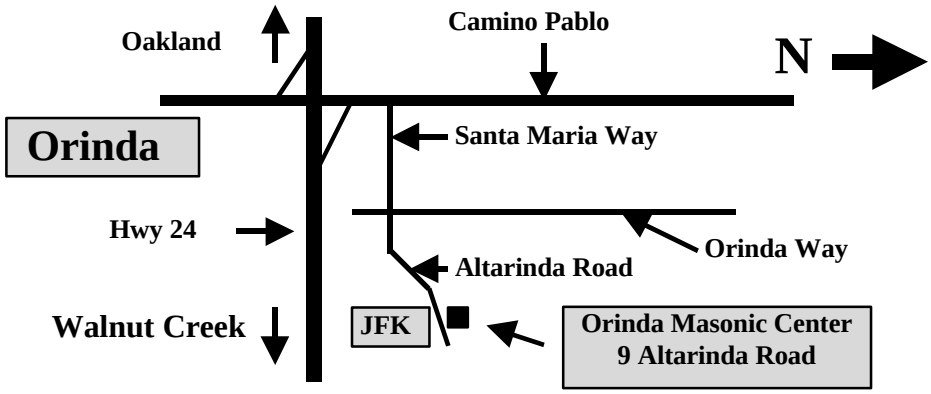
TIME: **6:30 p.m. Social; 7:00 p.m. talk (no dinner)**
Cost is $5.00 per person

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

Speaker: **Dr. John Waskabayashi**, consultant

The Tale of Two Uplifts: Tectonics and the Evolution of Sierra Nevada Topography

Stream incision, faulting, thermochronologic, and geobarometric data, suggest that Sierra Nevada topography is a consequence of two periods of uplift. Stream incision of up to 1 km has occurred since ~5 Ma. Maximum Eocene-Miocene incision was 150 m. Uplift of the Sierra Nevada, westward tilting, stream incision, and east-down normal and dextral faulting along the present eastern escarpment of the range began at about 5 Ma. Although the western Basin and Range-Sierran boundary has encroached westward since at least 15 Ma, this faulting had no impact on the incision streams crossing the Sierra until ~5 Ma. Based on reconstructions of Tertiary channels and marker horizons, late Cenozoic rock uplift of the Sierra Nevada is 1700-1900 m. The amount of late Cenozoic uplift appears to be consistent from the northernmost Sierras to the Kings River drainage even though peak elevations are much higher in the south. Low summit erosion rates suggest that the rock uplift approximates the surface uplift of crestal summits. The low summit erosion rates coupled with much higher canyon incision rates indicate the relief is increasing in the Sierra. Tertiary stream gradients were lower than modern ones, suggesting that the bottoms of the canyons have been uplifted in the late Cenozoic, and that the mean elevation of the Sierra Nevada has increased significantly. The elevation of pre-Cenozoic basement rocks above the base of Tertiary paleochannels ranges from <200 m in the northern part of the range to >1000 m in the south, and shows that significant relief predates late Cenozoic incision. Elevations at ~5 Ma (before late Cenozoic uplift) may have been less than 900 m in the northern Sierra and exceeded 2500 m in the southern Sierra. The greater paleorelief in the southern part of the range is the reason for the higher elevations there. Minimal Eocene-Miocene stream incision suggests that paleorelief and paleoelevations are relics of pre-Eocene uplift. Reduction of elevation and relief following pre-Eocene uplift may have coincided with eclogitic recrystallization of the mafic root of Sierran batholith. This eclogitic keel may have foundered in the late Cenozoic, triggering uplift. Late Cenozoic uplift accounts for most of the elevation of the northern Sierra Nevada, but less than half of the elevation of the southern Sierra.



John Wakabayashi is a Bay Area native and who has taken countless of trips to the Sierra Nevada since 1966. He received a bachelor's degree in Geology from U.C. Berkeley in 1980 and a Ph.D. in Geology from U.C. Davis in 1989 as a student of Eldridge Moores. His thesis work was on the tectonics and metamorphism of the Franciscan Complex in the San Francisco Bay area. He has worked as a geologic consultant since graduating from Davis, first as an employee of Earth Sciences Associates from 1989-1992, and from 1993 to the present as an independent consultant. His consulting work includes seismic hazard/neotectonics, general engineering geology, environmental, and contract petrographic work. He continues to be active conducting independent research. This started with studies related to subduction complex tectonics and the relationship between tectonics and regional metamorphism, but has now broadened to transform tectonics, neotectonics, and tectonic geomorphology. The Sierra Nevada work is one of several pieces of research that actually originated as consulting work. In this case it was consulting work conducted for PG&E. John has also taught tectonics as a temporary instructor at California State University, Hayward. A more complete summary of his research and consulting work can be found on his website at **http://www.tdl.com/~wako/**. Of course John's site is best known for its extensive wilderness trout fishing pages and the brewing and beer appreciation page!!!

Northern California Geological Society
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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 2002-2003 Calendar

Wednesday, April 30, 2003
Dr. John Waskabayashi, consultant
The Tale of Two Uplifts: Tectonics and the Evolution of Sierra Nevada Topography
7 pm at Orinda Masonic Center

Wednesday, May 28, 2003
Dr. Ian Carmichael, University of California Berkeley
Topic to be announced
7 pm at Orinda Masonic Center

Wednesday, June 25, 2003
Carol Prentice, USGS, Menlo Park, CA.
***San Andreas Fault* (Exact title to be announced)**
7 pm at Orinda Masonic Center

Upcoming Field Trips…

May 10, 2003	***Diablo Antiform-Diablo Range Intersection***	**Ron Crane**, Consultant
June 6-8, 2003	***Rodgers Creek-Maacama Step-over Area*** 2-day overnighter at Cal Academy Pepperwood Ranch west of Franz Valley	**Bob McLaughlin**, USGS, **Dave Wagner**, California Geological Survey and others
August 2, 2003	***Clear Lake Volcanic Field***	**Rolfe Erickson**, Sonoma State
TBA	***Northern California Gold Belt, Quincy***	**Gregg Wilkerson**, BLM
Summer 2003 TBA	***Devil's Slide / Pebble beach or Pigeon Point***	**Scott Morgan, Morgan & Jody Castle** of Earth Mechanics
October 11, 2003	***Point Reyes Area***	**Tom MacKinnon**

Bay Area Geophysical Society

April 29, 2003 BAGS Luncheon: Lawrence Berkeley National Laboratory Staff Scientist **G. M. Hoversten**, will present ***Magnetotelluric Investigations of the Kilauea Volcano, Hawaii***. A summary of Dr. Hoversten's talk can be found at **http://sepwww.stanford.edu/bags/Talks/2003_04_hoversten.html**.

Date: Tuesday, April 29, 2003
Social and Lunch: 11:30 a.m. in the ChevronTexaco cafeteria.
Talk: 12:30 p.m. in Room C-2187, ChevronTexaco Park, 6001 Bollinger Canyon Rd., San Ramon, CA.

No charge for this program.
Buy your own lunch in the ChevronTexaco cafeteria.

Note: Non-ChevronTexaco employees RSVP to Bob Kieckhefer at **wfki@chevrontexaco.com** or phone **Warren King** at **925-842-9964** by noon Monday, April 28th. ***This must be done to ensure that you get a visitor's pass***.

No talks are currently posted at the BAGS website.
Please check the BAGS website **http://sepwww.stanford.edu/bags/** *regularly for meeting notices and updates.*

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

NCGS Field Trip
Diablo Antiform-Diablo Range Intersection

Saturday, May 10, 2003

Field Trip Leader:

Ron Crane, Consultant

The field trip is designed to investigate the intersection between the Mt. Diablo antiform and the Diablo Range. We will start in Danville, and proceed southward to a stop where the down-plunge view of the Diablo Range can be clearly seen. The first stop will be at the Greenville fault zone. We will then proceed up Old Altamont Pass Road through the flanks and crest of the antiform. The group will continue on to Black Butte Anticline and to several stops along Corral Hollow Road to investigate the area where the gentle plunge of the antiform is in contact with vertical beds of the intersection area. Return to Danville.

********** Field Trip Logistics **********

THIS FIELD TRIP WILL BE LIMITED TO 30 PEOPLE

Time: **Saturday, May 10, 2003** I-680 / Sycamore Valley Road Park and Ride – **7:30 am**

Departure: We will gather at the Danville Park and Drive lot immediately east of the I-680 freeway on the Sycamore Valley Road exit, at the far end of the parking lot. ***Gather there at 7:30 a.m.*** for a brief discussion, distribution of field guides, coffee and doughnuts, and leave by 8 a.m. The trip should be over by 4 p.m. unless there are unexpected delays/discussions.

Cost: $35 for adults (18 and over); **$15 for adolescents** (11 to 17).
Cost includes transportation, refreshments, lunch, and field guides.

********* REGISTRATION FORM --- PLEASE RSVP by Monday, May 5, 2003 **********

Name _____ **E-mail or Fax No.** _____

Address (Street/City/Zip)_____

Phone (day) _____ **Phone (evening)** _____

Indicate if you are a nonmember (cost is $40) _____

Regular Lunch _____ Vegetarian Lunch _____ **(Please check one)**

Please mail form and a check made out to NCGS to: **Jean Moran, P.O. Box 1861, Sausalito, CA. 94966**
If you have any questions or need additional information, e-mail Jean at jeanm@stetsonengineers.com, or call 415-331-6806 (evening)

The Sedimentary Origin of the Ridge Basin, Southern California

NCGS members got an interesting glimpse at the genesis of a small terrestrial sedimentary basin at the March 26th NCGS meeting. The speaker was **Dr. Morgan Sullivan** of California State University, Chico, and he talked about ***"Fluvial-Deltaic Cyclicity, Ridge Basin, Southern California: Evidence for Kinematic Cyclostratigraphy."*** If the name seems familiar, it might be because Morgan is the son of NCGS Past President **Ray Sullivan**, a long time faculty member at San Francisco State University. Both Ray and son Morgan are proponents of sequence stratigraphy, a discipline used to interpret complex sedimentary strata, that is used as an exploration tool by the oil industry. It should be noted that in spite of the negative press the oil industry has received over the years for its environmental practices, it has made outstanding contributions to the fields of sedimentology, sedimentary petrology, structural geology, and stratigraphy. And many sedimentary terrains around the world would be much less well understood if it were not for the mapping and subsurface work done by oil companies. Much of the complex geology of the Los Angeles basin and the Ventura Channel was interpreted by petroleum geologists.

The Ridge basin was carefully studied by Exxon Oil in the early 1990's because it had very well exposed outcrops and its stratigraphic features, though mostly of terrestrial origin, had application to marine basin evolution. Morgan and NCGS colleague Kenn Ehman of Skyline Ridge, Inc., were employed by Exxon's Clastic Facies Research Group at this time and together studied the basin and its sediments to unravel its stratigraphic history. Kenn and some of his Exxon colleagues had previously collaborated with the dean of Ridge basin geologists, U.C. Santa Barbara professor John Crowell, who did most of the early work in this area.

The Ridge basin, a popular field site for U.C. Santa Barbara geology students, is an asymmetrical Neogene (Miocene-Pliocene) pull-apart basin located at a serpent-like bend in the San Gabriel-San Andreas faults systems in the Transverse Range north of Los Angeles. The field area lies across I-5 in the Grapevine. It is 30 to 40 km. long by 6 to 15 km. wide—narrow enough to see actual stratigraphic changes across the synclinal basin valley. Its major tectonic element is the San Gabriel fault, which bounds it on the southwest; the San Andreas fault forms its northwest boundary. In cross section, it is an asymmetrical trench filled with up to 14 km. of sediments which dip more steeply (up to 45) as one goes across the basin from the San Gabriel fault toward the northeast. The thicker southwestern limb of the syncline is filled by the Violin Breccia, a coarse conglomerate shed from the edge of the San Gabriel fault into the deepest part of the basin. The central part of the basin is floored by lacustrine sediments of the Peace Valley Formation. Interfingering with the lacustrine mudstones and Violin Breccia are the Ridge Route Formation sediments shed from the San Andreas fault side. An important piece of structural information was provided by an Exxon seismic line run oblique to the San Gabriel fault in an east-west direction. The subsurface data suggests that the San Gabriel fault becomes listric at depth (like a sliding board, steep dipping at the surface and approaching horizontal at depth), which is consistent with preliminary gravity survey models across the basin and with the homoclinal basin fill structure. Carbonaceous material in the sediments indicate that the maximum sediment burial depth was only 12,000 to 14,000 feet. Seismic imaging likewise reveals that the deepest part of the basin lies adjacent to the San Gabriel fault, and shallows toward the north-northeast. These observations are the basis for Morgan's subsequent stratigraphic interpretations.

Morgan noted that the first step in understanding the sedimentary framework of the Ridge basin was to establish its chronostratigraphy, or the time lines linking various geographical parts of the basin with each other. These time lines are the "skeleton" on which the stratigraphy can be hung. Careful stratigraphic examination of the basin sediments revealed a cyclic nature to the sediment packages on both sides of the basin. The Ridge Route Formation is largely a deltaic fluviatile system emptying into a lacustrine setting. It ranges from a proximal (near source) fluviatile sands, channelized stream mouth bars, through finer-grained delta front sediments to distal prodelta turbidite muds. These contrast with the much coarser-grained fluvial-dominated Violin

Breccia sediments shed off the San Gabriel fault side of the basin. It forms compact alluvial fans that were shed into the basin as proximal conglomerates and gravity flows, yielding downslope to channelized sediments, delta front deposits, and distal muds. These deposits are more areally restricted than the Ridge Route deltaic sediments.

As Morgan and Kenn studied the stacking patterns (vertical sequences of sedimentary succession) of the basin sediments, they noticed that both sources were cyclic in nature, but out of phase with each other. When the Violin Breccia dominated the basin fill, the Ridge Route was in regression, and when the latter prograded into the basin, the Violin Breccia had regressed. Further research indicated that the cyclic sedimentary deposits represented parasequences, or genetically related units bounded by flooding surfaces. Each parasequence represents a pulse of sedimentary activity thought to be related to tectonic activity along the San Gabriel fault. Strike-slip oblique motion along the fault caused the basin to rapidly deepen on the southwest side, increasing the accommodation space or basin volume, and promoting renewed sediment influx. The Violin Breccia was the dominant sediment source and its deposits eventually worked their way toward the San Andreas (Ridge Route) side as the basin filled. As tectonism subsided, the Ridge Route source dominated, and worked its way across a much shallower basin as the Violin Breccia deposits regressed.

Morgan and his colleagues identified five distinct phases of basin cyclic activity. Biostratigraphy (mammal fossils) and paleomagnetic data helped them determine that the exposed sediments were deposited between 5 and 8.5 million years ago, in parasequences cycles lasting on the order of 100,000 to 1 million years. Structural considerations indicate the offset along the San Gabriel fault over this time was about 31 miles. The nonmarine nature of the deposits points to tectonics rather than eustacy (sea level changes) as driving the cycles. The active nature of the San Gabriel fault at this time suggests it was the dominant strike-slip fault in this region until the current San Andreas system became active approximately 5 m.y. ago. However, this study implies there was an oblique component to its motion, expressed as the listric fault plane curvature with depth that was interpreted from the Exxon seismic data.

The NCGS sincerely thanks Morgan Sullivan of Cal State Chico for his excellent presentation of an unusually well-exposed terrestrial sedimentary basin. Its stratigraphic architecture has interpretive applications to marine basins and is a classic study in tectonically-controlled sedimentary basin evolution. Ironically, another NCGS member, Kenn Ehman, partnered with Morgan for this study and with other Exxon colleagues, they provided important reconnaissance information for his sequence stratigraphic analysis of the Ridge basin. But best of all, Morgan is now applying his skills to educating a new generation of geoscientists in the application of interpretive tools like sequence stratigraphy to sedimentary geology.

An excellent reference on the tectonic evolution of the Ridge basin is ***"A New Angle on the Tectonic Evolution of the Ridge Basin, A "Strike –Slip" Basin in Southern California";*** S.M. May, K.D. Ehman, G.G. Gray, and J.C. Crowell, GSA Bulletin, v. 105, pp. 1357-1372, 1993.

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AAPG Distinguished Lecture Recaps Searching For Deepwater Plays in the Gulf of Mexico

AAPG Distinguished Lecturer **Cindy Yeilding** of British Petroleum spoke about exciting new plays in the Gulf of Mexico on April 2nd at ChevronTexaco, San Ramon. Her presentation ***"The History of a New Play: Thunder Horse Discovery, Deepwater Gulf of Mexico"*** highlighted the steps leading to a major petroleum find off the coast of Louisiana. The intriguing aspect of this talk was its "rags to riches" flavor--a chronicle of how a "back to basics" attitude, perseverance, and strong management support can result in success.

The story begins in the late 1980's, when a major oil and gas play dubbed "MARS" was discovered in deep water ponded turbidites off the Louisiana coast. British Petroleum thought they knew the play, but followed up this successful endeavor with seven dry holes. In spite of this dismal performance, management supported its exploration team and gave them an opportunity to reflect on their mishaps, regroup, and devise a new strategy to

tap the region's petroleum resources. The oil and gas were there; they just needed to develop a better understanding of the systems they were dealing with. After carefully evaluating their approach to deepwater exploration, the exploration team decided the best philosophy was a fundamental approach using basic geological attributes of the basin to drive their exploration program, rather than seismic attributes only. They also focused on exploring from the source rocks upslope to locate potential reservoirs. Their program began with a regional geological review of the northern Gulf of Mexico from Texas to the Florida panhandle. This was done in 1991-92, and from this data the group selected promising subregions with deepwater sediments for further analysis. Various key attributes of candidate sites were carefully scrutinized and ranked according to risk. Eventually, BP chose Mississippi Canyon off the Mississippi delta as its primary target. The team felt that this area had the most desirable reservoir attributes (fetch areas and reservoir trap characteristics) and the highest probability of success in the northern Gulf. This decision was backed by carefully examined seismic and well log data selected with the help of chronostratigraphic diagrams that detailed the major regional deepwater depocenters.

In 1992-93 two BP exploration teams converged on the 5000 square-mile Mississippi Canyon subregion. This exploration stage was dubbed the "Elephant Hunt." Its purpose was to identify subsurface structures with potential petroleum reserves of more than 250 million barrels (downgraded from the original 500 million barrel target). These sites required large catchment areas (culminations), clean delivery systems, and desirable reservoir characteristics. The Boarshead Basin in the south central Mississippi Canyon off the Louisiana birdsfoot delta complex promised the best sites to test BP's new play concepts. Two turtle structures (4-way dip or domed features) in slat-domed sediments had been discovered there, with primary targets in Miocene strata. The target sediments are bounded by the shelf margin to the north, the Atwater Fold Belt to the south, and pinch out to the east. But before the two prospects could be drilled, BP had to complete 3-D seismic surveillance and depth imaging of the region, secure its acreage position (site leases) to include these prospects, and acquire deepwater rigs for drilling in 1500 to 7000 foot water depths. By 1997, all of the Mississippi Canyon had been covered by 3-D seismic, but the depth imaging, which defined the vertical extent of bounding salt bodies and helped position the test well, needed major breakthroughs to accomplish these goals. BP's acquisition of Amoco solved the drilling rig problem. Lease sales and partner trades gave BP a satisfactory acreage position. When drilling commenced, the team's efforts were rewarded with one successful play, Thunder Horse, which hit oil on June 1, 1999 and one dry hole.

Post-drilling assessment helped the teams put their work in perspective. The regional and subregional geological evaluations (1991-93) were very efficient, cost effective, and an integral part of the program. However, detailed prospect characterization and drilling were expensive and labor intensive. Deepwater drilling is difficult at best, and this particular project experienced setbacks that were eventually resolved when the Amoco rig was brought on site. Continued drilling in this area provides continuing insight into the subsurface complexity of the play, and ensures that the development team does not become overconfident! Cindy attributes the overall success of BP's revamped Gulf of Mexico exploration program to strong management support, a return to basic exploration concepts, less emphasis on seismic attributes, and a sound understanding of the regional and subregional deepwater geology. BP is confident the Gulf of Mexico will evolve into a world-class petroleum system, as suggested by its success in the Mississippi Canyon. However, exploiting these potential plays is not without significant risk, and pushes the limits of current deepwater exploration and production technology.

The NCGS extends its sincerest thanks to Cindy Yeilding for presenting her story of British Petroleum's deepwater Gulf of Mexico exploration program to a large audience at ChevronTexaco's San Ramon corporate headquarters. *The NCGS also acknowledges ChevronTexaco's continuing support of the AAPG Distinguished Lecture series with a generous grant to help cover lecture expenses, and by kindly hosting many of these lectures at its San Ramon facility.*