

# NORTHERN CALIFORNIA GEOLOGICAL SOCIETY



## *NCGS Newsletter & Website Editor:*

Mark Detterman

[mdetterman@blymyer.com](mailto:mdetterman@blymyer.com)

## *Secretary:*

Dan Day: [danday94@pacbell.net](mailto:danday94@pacbell.net)

NCGS Voice Mail: 925-424-3669

Website: [www.ncgeolsoc.org](http://www.ncgeolsoc.org)

## NCGS OFFICERS

### *President:*

Bill Perkins,

[weperkins@comcast.net](mailto:weperkins@comcast.net)

### *President-Elect:*

Barb Matz,

[barbara.matz@shawgrp.com](mailto:barbara.matz@shawgrp.com)

### *Field Trip Coordinator:*

Rob Nelson,

[rlngeology@sbcglobal.net](mailto:rlngeology@sbcglobal.net)

### *Treasurer:*

Phil Reed, [philecreed@msn.com](mailto:philecreed@msn.com)

### *Program Chair:*

Mark Sorensen,

[msorensen@itsi.com](mailto:msorensen@itsi.com)

### *Scholarship:*

Phil Garbutt,

[plgarbutt@comcast.net](mailto:plgarbutt@comcast.net)

### *K-12 Programs:*

John Stockwell,

[kugel@peoplepc.com](mailto:kugel@peoplepc.com)

### *Membership:*

Barb Matz,

[barbara.matz@shawgrp.com](mailto:barbara.matz@shawgrp.com) or

John Christian,

[jmc62@sbcglobal.net](mailto:jmc62@sbcglobal.net)

## COUNSELORS

Mel Erskine,

[mcerskine@comcast.net](mailto:mcerskine@comcast.net)

Tridib Guha,

[Tridibguha@sbcglobal.net](mailto:Tridibguha@sbcglobal.net)

Don Lewis, [donlewis@comcast.net](mailto:donlewis@comcast.net)

Ray Sullivan,

[sullivan@lucasvalley.net](mailto:sullivan@lucasvalley.net)

## MEETING ANNOUNCEMENT

**DATE:** Wednesday, April 25, 2007

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

**TIME:** 6:30 p.m. Social; 7:00 p.m. talk (no dinner) Cost:  
\$5 per regular member; \$1 per student member

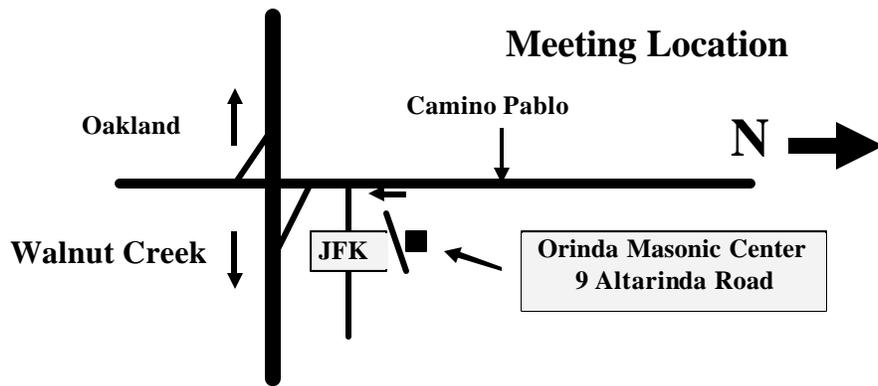
**RESERVATIONS:** Leave your name and phone number at  
925-424-3669 or at [danday94@pacbell.net](mailto:danday94@pacbell.net)  
before the meeting.

**SPEAKER:** *Dr. Isabel P. Montañez, U.C. Davis*

### *CO<sub>2</sub> - Forced Climate and Vegetation Instability During Late Paleozoic Deglaciation*

This talk will focus on evidence for substantially changing atmospheric CO<sub>2</sub> levels and surface temperatures during a 40-million year period ~305 to 265 million years ago, which encompasses the deterioration of the most widespread and long-lived icehouse of the last half billion years. This time period is our only vegetated Earth analogue of how the global climate system responds to natural global warming, and the consequent biotic impacts. Our results document strong linkages between atmospheric pCO<sub>2</sub>, climate and ice volume during the final stages of this ancient Ice Age (referred to as the Late Paleozoic Ice Age) that are consistent with greenhouse-gas-forcing of climate and epic deglaciation. Notably, these changes in atmospheric CO<sub>2</sub> contents are associated with substantial climate instability and climate-driven evolutionary-scale changes in tropical flora.

**Biography:** *Dr. Isabel P. Montañez* is a Full Professor in the Department of Geology, University of California, Davis, where she carries out research in reconstructing ancient climate regimes and their associated carbon-water cycle feedbacks and ecosystem impacts using an integration of field, geochemical, geochronologic and paleoecologic studies. She has served on numerous scientific, professional society, and editorial boards including the review panel of the NSF Geology and Paleontology Program; Co-Editor of *Sedimentology*; the Editorial Boards of *Geology* and *GeoBiology*, Associate Editor for *GeoSpheres*; AAPG's Committee on Global



Climate Change, the Steering Committee of the NSF-directed initiative in ‘deep-time’ paleoclimatology, *GeoSystems*; and Research Councilor for the Society for Sedimentary Geology (SEPM). She and her research group have published regularly on topics related to paleoceanography and paleoclimatology including studies of marine and terrestrial depositional systems as well as diagenetic signatures of basinwide fluid-flow and regional dolomitization. She is the recipient of the Society for Sedimentary Geology’s (SEPM) *James Lee Wilson Medal* for Excellence in Sedimentary Geology by a Young Scientist, the AAPG *Cam Sproule Award* for best publication in the AAPG Bulletin or other affiliated publications, and SEPM’s award for *Outstanding Paper in the Journal of Sedimentary Research* (1992).

Northern California Geological Society  
c/o Mark Detterman  
3197 Cromwell Place  
Hayward, CA 94542-1209

**Would you like to receive the NCGS newsletter by e-mail?** If you are not already doing so, and would like to, please contact **Dan Day** at [danday94@pacbell.net](mailto:danday94@pacbell.net) to sign up for this service.

# NCGS 2006 Calendar

Wednesday April 25, 2007

Isabel Montanez, UC Davis

*Evidence for Rapid Climatic Variation in the Geologic Past*

7:00 pm at Orinda Masonic Center

Wednesday May 30, 2007 **DINNER MEETING!!**

**Book signing opportunity --- See Announcement**

**Reservations are required by May 25, 2007**

**We will not be able to accommodate "Walk-Ins"**

Dr. James Moore, US Geological Survey

*The adventures of Clarence King (First USGS*

*Director) and his survey of the 40th*

6:00 pm at Orinda Masonic Center

Wednesday June 27, 2007

Jeffery P Schaffer, Napa Valley College

*Constraints on Sierra Nevada Uplift and Glaciation*

7:00 pm at Orinda Masonic Center

Wednesday September 26, 2007

TBA

7:00 pm at Orinda Masonic Center

---

## Upcoming NCGS Field Trips

April 21, 2007

*Field Trip to the World's  
Smallest Mountain Range:  
The Sutter Buttes*

Dr. Brian Hausback  
Martin Steinpress, Organizer

May 12, 2007

*Devils Slide, Thomas  
Whitman, CalTrans*

Spring / Summer  
2007 (Pending)

*Modern Geophysical  
Techniques for Site  
Characterization,  
Dr. Mitchell Craig, Cal State  
University East Bay*

July 7 & 8, 2007

*Crustal Deformation of the  
Eastern Sierra Frontal Fault,  
Dylan Rood, LLNL and UC  
Santa Barbara*

Do you have a place you've wanted to visit for the geology? Let us know. We're definitely interested in ideas. For those suggestions, or for questions regarding, field trips, please contact Rob Nelson at:

[rlngeology@sbcglobal.net](mailto:rlngeology@sbcglobal.net)

---

## Peninsula Geologic Society

### Upcoming meetings

For an updated list of meetings, abstracts, and field trips go to <http://www.diggles.com/pgs/>. The PGS has also posted guidebooks for downloading, as well as photographs from recent field trips at this web address. Recent field trips include: *The 1906 Earthquake and the San Andreas Fault on the San Francisco Peninsula* (2006), *Granites in the Franciscan* (Fall 2005), *San Andreas Fault - Carrizo Plain* (Spring 2005), *Panoche and Tumey Hills* (2004), *White-Inyo Range* (2002), *Napa Wine County* (December 2001), *Mount Shasta and the Klamath Mountains* (May 2001), *Big Sur (Salina / Nacimiento Amalgamated Terrane, Big Sur coast Central California*, 2000), and the *Northern Sierra Nevada (Geologic Transect of the Northern Sierra Nevada Along the North Fork of the Yuba River*, 1982). Posted upcoming meetings include the following topics and dates:

- May 8, 2007, Jacob B. Lowenstern, USGS, Scientist In-Charge, Yellowstone Volcano Observatory - *What's cooking at Yellowstone*. Dinner in 320-109. Lecture in 320-105
- June 5, 2007, Elizabeth Miller, VP address, *on the Wrangell connection*. Also, Elections. Dinner in Hartley. Lecture in 320-105

---

## Association of Engineering Geologists San Francisco Section

### Upcoming meetings

Meeting locations have been rotating between San Francisco, the East Bay, and the South Bay. For further meeting details go to: <http://www.aegsf.org/>.

- May 8, 2007, Prem Attanayake, Chief Hydrogeologist, Bechtel Corp, Identifying Environmental Impacts due to Underground Excavations
  - November 13, 2007, Bruce Hilton and Tim Bech, Kleinfelder, Ferguson Rockslide on Highway 140 near Yosemite.
-

## **Paleoseismology in Seismic Hazard Assessment: Distinguishing Active Faults from Neotectonic Features That Look Like Them (with a Field Trip to Ridgetop Spreading Zones)**

Dr. James McCalpin, President,  
GEO-HAZ Consulting; Crestone, Colorado

AEG-approved 2-Day Short Course with Field Trip (Day 1: Classroom Lecture at UC Riverside; Day 2: Field Trip in San Gabriel Mountains). Friday-Saturday, **April 27-28, 2007** 16 hours (8 hours per day) CEU Credits: UCR-Extension and AEG accreditation. Cost is \$3250 (Members), \$400 (non-Members). Sponsored by AEG and AEG Inland Empire Chapter, Southern California Section, Association of Environmental and Engineering Geologists.

Final details can be obtained from the following PDF:  
(<http://www.aegweb.org/files/public/SeisPaleoseismology.pdf>).

---

### **Scripps/UCSD Geophysicist Among International Team Finding Evidence of First Plate Tectonics 3.8 Billion Years Ago** Science Magazine, March 22, 2007

Observations indicate that plate tectonics began before any currently known structural geological record on Earth.

Identification of the oldest preserved pieces of Earth's crust in southern Greenland has provided evidence of active plate tectonics as early as 3.8 billion years ago, according to a report by an international team of geoscientists in the March 23 edition of *Science* magazine.

The finding pushes back the date of continent-forming processes previously determined as 2.5 billion years ago to a much earlier era considerably closer to Earth's formation some 4.5 billion years ago. Geochemical analysis of rocks has previously suggested an earlier date for plate tectonics, but this is the first study to find physical evidence of tectonics among Earth's oldest known rock structures, according to Hubert Staudigel of Scripps Institution of Oceanography at UC San Diego.

"The fact that this rock structure is so well preserved is particularly lucky," Staudigel said. "The materials were formed as seafloor along a

spreading center and accreted to a continental plate and just stuck there, surviving almost unscathed for as long as 3.8 billion years."



**Geophysicist Hubert Staudigel in his lab with a seafloor pillow lava.**

Coauthors of the report are Harald Furnes of University of Bergen, Norway; Maarten de Wit of University of Cape Town, South Africa; Minik Rosing of the University of Copenhagen, Denmark; and Karlis Muehlenbachs of the University of Alberta, Canada.

The study focuses on an area near the southwestern coast of Greenland where there is a rare outcrop of ancient rock, called the Isua Supracrustal Belt, which have been dated at 3.8 billion years old. The Isua rocks are ophiolites, which have a green hue from the chlorite minerals within them and are found in all major mountain belts, usually located in areas associated with volcanism and plate tectonics. The Isua deposits were first described in the 1960s. They also have been found to contain fossilized evidence of the earliest bacterial life on Earth, also about 3.8 billion years old, in studies conducted in 1999 by Minik Rosing.

The new study reveals the geological structure at Isua contains both seafloor pillow lavas and dikes, or sheets, of basalt that intruded into the pillow lavas after they formed. These features and the chemistry of the ophiolites indicate that the area was formed as the result of seafloor spreading, according to lead author Furnes. Even though the

rocks have physically changed over time, it is still possible to see their original characteristics because of the preservation of fine-grained crystals that show they were cooled by contact with surrounding colder rocks, Furnes said.

"To what extent one is able to see an original structure in a highly deformed rock depends basically on the experience of the observer," Furnes said. "In our case we knew what we were looking for, and all of us who did the field work have reasonably good experience with identifying pillow lavas and associated dikes."



**Well preserved pillow lavas are an indication of ancient plate tectonics at Isua Supracrustal Belt in southwestern Greenland.**

The finding of ophiolites in the oldest known rock structures leads the scientists to believe that such rocks have formed throughout Earth's nearly 4.5 billion year history, according to de Wit.

"Our work shows that some form of seafloor spreading and oceanic crust formation occurs as far back in history as geological records go," de Wit said.

Rosing said, "Our paper describes large-scale structural relationships that show the ancient oceanic crust was comparable to the modern crust in its structure and composition and that a section of ancient oceanic crust could be preserved by uplifting onto stable crust, similar to how more modern ophiolite complexes have formed."

The paper also sheds light on the ongoing debate about the oxygen isotope composition of seawater through geological time periods. The reactions of seafloor and seawater largely control the ocean's oxygen isotope makeup, but scientists have been polarized between those that maintain the oxygen isotope content has remained relatively constant and

those that argue for variation. According to Muehlenbachs, this work shows that the early ocean had the same or slightly heavier oxygen isotope composition as that of the modern ocean.

"We can conclude from the oxygen isotope analyses of the pillows and dikes that the earliest ocean had already chemically reacted with the seafloor," Muehlenbachs said. "This has great implications to the historical chemical composition of the oceans and may have played a role in the evolution of life."



**The striations in a rock outcropping shows the layers of sheeted dikes created by ancient seafloor spreading at the Isua Supracrustal Belt in southwestern Greenland.**

The geological processes of the early Earth were largely responsible for the distribution of elements throughout the land, air and oceans, having fundamental consequences for the development of life, according to Staudigel. He said the science team was sampling the Isua Supracrustal Belt looking for chemical or isotopic traces of life in the pillow lavas when they realized the area supplied geological structures proving plate tectonics from the earliest history of Earth.

The Norwegian Research Council, the Nordic Center for Earth Evolution, GeoForschungsZentrum Potsdam, Agouron Institute and the National Sciences and Engineering Research Council of Canada provided funding for the research.

Reference: "A Vestige of Earth's Oldest Ophiolite," Science, 23 March 2007; Scripps Institution of Oceanography: <http://scripps.ucsd.edu>

---

# NORTHERN CALIFORNIA GEOLOGICAL SOCIETY



## NCGS FIELD TRIP TO THE DEVIL'S SLIDE

Saturday May 12, 2007

Leader: Grant Wilcox, CEG

Senior Engineering Geologist, CalTrans

Devil's Slide is a large, active landslide in steep, ocean fronting slopes, approximately 15 miles south of San Francisco. This slide has impeded efforts to provide transportation to the coastal communities for over 100 years. The slide is within the Salinian Block of northwesterly migrating basement terrain. It occurs within Jurassic to Lower Cretaceous quartz diorites, in complex fault contact with Paleocene marine sandstones, shales and conglomerates. Most of the section was overturned, intensely deformed by folding and faulting and obscured by landslide deposits. Landslide conditions are further exacerbated by groundwater conditions.

Highway 1 crosses the Devil's Slide area and has been a constant source of debate within Caltrans on how to correct this costly roadway section. The repair strategy for the roadway section consisted of improving the bearing capacity of the area immediately below the failed portion of roadway by installing long rock bolts, which were covered with a 4" thick reinforced shotcrete layer. In addition, four rows of 150' deep tiebacks were then placed within the center of the sliding blocks to hold the roadway in place. Finally, a 150-foot micro-pile wall was constructed from the north end of the tie-back wall to prevent the head scarp from migrating up slope.

As a long-term solution to the problems at Devil's Slide, Caltrans is in the process of constructing two highway tunnels approximately 4400 feet long to bypass the Devil's Slide area. For the upcoming field trip we will be looking at the existing unstable coastal bluff, the different repair strategies utilized over time, and finally the tunnel project.

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

**THIS FIELD TRIP WILL BE LIMITED TO 30 PEOPLE.**

**Time & Departure:** May 12, 2007, 9:00 am (sharp), at the Safeway Parking lot in Pacifica.

**Cost:** \$30/person

\*\*\*\*\*REGISTRATION FORM (Devil's Slide Field Trip)\*\*\*\*\*

Name: \_\_\_\_\_ E-mail: \_\_\_\_\_

Address: \_\_\_\_\_ Phone (day): \_\_\_\_\_ Phone (evening): \_\_\_\_\_

Lunch: Regular: \_\_\_\_\_ Vegetarian: \_\_\_\_\_ (Please check one) Check Amount: \_\_\_\_\_

Please mail a check made out to NCGS to: **Rob Nelson**  
**269 College View Drive,**  
**Rohnert Park, CA 94928**

**Carpooling is suggested for this fieldtrip. Parking onsite is very limited. Please let us know if you can provide a van and NCGS can reimburse your gasoline expenses.**

Questions: e-mail: [rlngeology@sbcglobal.net](mailto:rlngeology@sbcglobal.net) Phone: (707) 795-8090 (evening)  
(707) 548-3268 (day)

# NORTHERN CALIFORNIA GEOLOGICAL SOCIETY



## NCGS DINNER MEETING

### *The adventures of Clarence King (First USGS Director) and his survey of the 40th parallel*

Wednesday May 30, 2007

Speaker: **Dr. James G. Moore**, U.S. Geological Survey, Menlo Park (Retired)

6:00 pm at Orinda Masonic Center

(Reservations are required by May 25, 2007)

We are sorry but we will not be able to accommodate "Walk-Ins"

The Northern California Geological Society is pleased to announce that once again we will be stepping out of our normal meeting routine. Come join the NCGS at this *special dinner and evening* with **Dr. James G. Moore**. Step back in time with us and come listen to Dr. Moore speak about the adventurous time of geologic exploration by Clarence King and the survey of the 40<sup>th</sup> parallel. Jim reports that he will have a supply of books on hand for purchase (And since he wrote the book, we think he might even consider autographing them!).

For this special event, planned for our normal monthly meeting date, but **starting one-half hour early**, we will be in typical NCGS style, with a delicious entrée of **Teriyaki sesame chicken**, with garden and Caesar salads, rolls & butter, and cheese ravioli with a Fettuccini Alfredo sauce. For vegetarian dinners **Vegetarian Lasagna** will be served in place of the Teriyaki Chicken. Desert will include cookies, brownies, fruit bars/carrot cake. Early reports are that we may again be blessed with wines from **Rosenblum Cellars** of Alameda. Please note that a vegetarian option is only available if notified ahead (see attached form).

**Abstract: *The adventures of Clarence King (First USGS Director) and his survey of the 40th parallel***

*"King of the 40th Parallel—Discovery in the American West"*, was published in 2006 and chronicles the adventures of Clarence King, the founding director of the USGS. The book recounts the life and achievements of Clarence King, widely recognized as one of the most gifted Americans of his era. King's genius, singular accomplishments, and near-death adventures unfold in a narrative centered on his personal relationship with his lifelong friend, James Gardner. The book covers the adventurous aspects of conducting geological fieldwork in the West, much of it documented by letters written by King and Gardner. The book is copiously illustrated with 150 historical maps, etchings, and historic photographs showing localities and people important to the story. (For more details see: [http://www.sup.org/book.cgi?book\\_id=5222%205223](http://www.sup.org/book.cgi?book_id=5222%205223))

Clarence King was fascinated with volcanoes. Through the close association with two of his Yale professors, James Dana and George Brush, he was captivated by stories of Mount Shasta, and this motivated him and his friend James Gardner to cross the continent by wagon train. He climbed Mount Lassen twice in 1863 and seven

**Dr. James G. Moore**

**May 30, 2007**

years later climbed Mount Shasta. He found there the first active glaciers discovered in the nation. Because of this discovery he sent geologists Samuel Emmons to the unclimbed Mount Rainier and Arnold Hague to Mount Hood. They also discovered moving glaciers. In 1872 King studied the active lava lake in the fire pit Halemaumau at Kilauea volcano.

At the age of 25 he commanded the Geological Exploration of the 40th Parallel, a survey program that mapped a 100-mile-wide strip across the Great Basin and Rocky Mountains on the planned railroad route. King's leadership and the series of landmark maps and monographs that he prepared and edited set the standard for excellence in earth science practice and publishing. When the existing four federal surveys were combined in 1879 to create the U.S. Geological Survey, King was the clear choice for Director of the new agency.

**Biography:** **Dr. James G. Moore**, now retired from the U. S. Geological survey, received his BS in geology from Stanford University, MS from the University of Washington, and Ph.D. from Johns Hopkins University.

He has conducted geologic studies for several decades in the central Sierra Nevada with the U. S. Geological Survey, and this familiarity with the area motivated him to write a book published by Stanford University Press titled, "*Exploring the Highest Sierra*" (see: <http://www.geotimes.org/feb01/geomedia.html#review2>). The book weaves together the history of exploration and mapping of the range with the development of pioneering geologic concepts, such as the glacial origin of the giant Sierra canyons, and the magmatic origin of the granitic rock that dominates the range. Another recently published book: "*King of the 40th Parallel—Discovery in the American West*" recounts the adventures of Clarence King who became the first director of the U.S. Geological Survey.

Jim served as Scientist-in-Charge of the Hawaiian Volcano Observatory and has gone on to investigate about 20 on-going volcanic eruptions world-wide. He has participated in about 25 oceanographic cruises and in 50 dives in research submarines mostly to investigate volcanic rocks on the submerged flanks of young volcanoes.

\*\*\*\*\* **Dinner Logistics** \*\*\*\*\*

Meeting Details: Social Hour: 6:00 – 7:00 pm; Dinner: 7:00 – 8:00 pm Presentation: 8:00 – open

**Time :** May 30, 2006, 6:00 pm, Orinda Masonic Center 9 Altarinda Road, Orinda, CA.

**Cost:** \$ 20/person

\*\*\*\*\***REGISTRATION FORM (Dr. James Moore Dinner)** \*\*\*\*\*

Name: \_\_\_\_\_ E-mail: \_\_\_\_\_

Address: \_\_\_\_\_ Phone (day): \_\_\_\_\_ Phone (evening): \_\_\_\_\_

Dinner: Regular: \_\_\_\_\_ Vegetarian: \_\_\_\_\_ (Please check one); Check Amount: \_\_\_\_\_

Please mail a check made out to **NCGS** to: **Tridib Guha**  
**5016 Gloucester Lane,**  
**Martinez, CA 94553**

Questions: e-mail: [tridibguha@sbcglobal.net](mailto:tridibguha@sbcglobal.net) Phone: (925) 370-0685 (evening - PREFERRED)  
(925) 363-1999 (day)

# NORTHERN CALIFORNIA GEOLOGICAL SOCIETY



## NCGS FIELD TRIP

TO

## THE SIERRA NEVADA FRONTAL FAULT ZONE

Saturday / Sunday July 7 & 8, 2007

**Leader: Dylan Rood; LLNL and UC Santa Barbara**

Up to 25% of the plate boundary deformation in the western US is currently localized within a ~100-150 km wide dextral shear zone referred to as the Eastern California Shear Zone (ECSZ) and Walker Lane Belt (WLB). Active deformation near the western edge of the Great Basin is demonstrated by Quaternary fault patterns, seismicity, and geodetic data. The Sierra Nevada Frontal Fault Zone (SNFFZ) is located on the westernmost margin of the Great Basin, at the tectonic boundary between the relatively undeformed Sierra Nevada block and WLB. In the central-eastern Sierra Nevada, the SNFFZ consists of a series of left-stepping fault-bounded basins produced by normal or oblique-slip faulting. Little is known about either the long-term history of slip on many of these faults or the variation in slip rates through time. The major focus of this field trip will be to examine and discuss the location, geometry, kinematics, and rates of deformation across the transition from the Sierra Nevada to the Walker Lane belt (WLB) in the region of the eastern Sierra Nevada from Sonora Pass to Mono Basin.

On this field trip, we will discuss the deformation history of the SNFFZ during Tertiary through Quaternary time. The field trip area is unusual, if not unique, in the Sierra Nevada and western Great Basin, because it offers distinctive strain markers spanning the past 10 My. Well-preserved and regionally extensive Late Tertiary, Pleistocene, and Late Quaternary markers provide accurate estimates of cumulative slip across faults (both vertical and horizontal). We will visit several localities where we constructed fault slip rates by combining geologic and/or geomorphic mapping, GPS surveying, and various geochronologic methods (including  $^{40}\text{Ar}/^{39}\text{Ar}$  and cosmogenic  $^{10}\text{Be}$  exposure dating).

Specifically, we will observe:

- (1) Evidence for Miocene (~10 Ma) faulting along the SNFFZ within the Ancestral Cascades Arc by looking at an angular unconformity exposed within the unique Tertiary volcanic stratigraphy of the Sonora Pass region.
- (2) A long record of Quaternary normal faulting preserved in a suite of glacial deposits in the Sonora Junction area. With differential displacements along the same fault system ranging in age from 10 Ma to 10 ka, we can compare Tertiary and Quaternary fault slip rates.
- (3) Tertiary and Quaternary deformation in the Bridgeport Basin, where both normal and oblique-dextral faulting is expressed in offset Tertiary volcanic and Quaternary glacial/alluvial markers.
- (4) Geothermal evidence for active faulting in the Bridgeport Basin by visiting the beautiful hot springs of this part of the eastern Sierra.

**Meeting Time and Place: 9:00 A.M. on July 7 at Buckeye Campground**

**Directions to Buckeye Campground:** Follow Highway 395 south from Bridgeport, turn left and travel approximately seven miles on Twin Lakes Road. Turn right on Buckeye Road at Doc and Al's Resort and travel about 3 miles. Turn left at fork and travel another mile to campground.

**Camping/Motel:** We will be camping at Buckeye campground on Friday and Saturday nights. Otherwise, motels are available in the Bridgeport area.

**Because of differences in arrival times, you will be responsible for Friday night's dinner. Breakfast and lunch on Saturday and Sunday will be provided. There will be a NCGS sponsored dinner on Saturday Night. Get your BBQ aprons on, or be prepared otherwise to help out!**

**Cost: \$115                      Limit: 30 People**

**\*\*\*\*\*REGISTRATION FORM (Sierra Nevada Frontal Fault Zone Field Trip) \*\*\*\*\***

Name: \_\_\_\_\_ E-mail: \_\_\_\_\_

Address: \_\_\_\_\_ Phone (day): \_\_\_\_\_ Phone (evening): \_\_\_\_\_

Lunch: Regular: \_\_\_\_\_ Vegetarian: \_\_\_\_\_ (Please check one) Check Amount: \_\_\_\_\_

Please mail a check made out to NCGS to: **Rob Nelson  
269 College View Drive,  
Rohnert Park, CA 94928**

**Carpooling is suggested for this fieldtrip.**

Questions: e-mail: [rlngeology@sbcglobal.net](mailto:rlngeology@sbcglobal.net) Phone: (707) 795-8090 (evening)  
(707) 548-3268 (day)