NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

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MEETING ANNOUNCEMENT

DATE: **Wednesday, January 31, 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* before the meeting.**

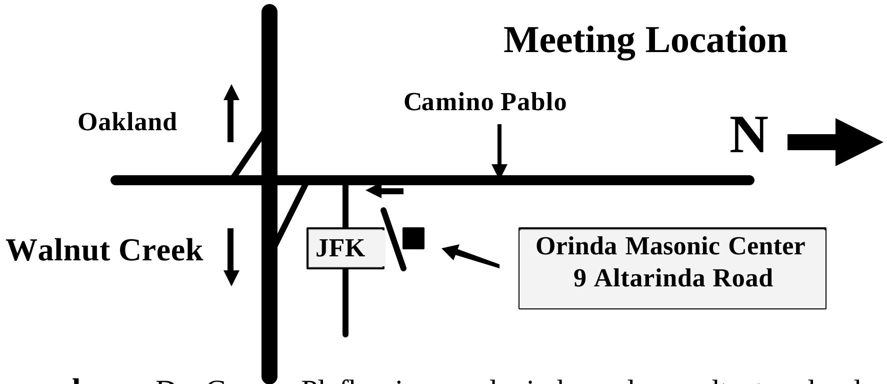
SPEAKERS: ***Dr. George Plafker,* U.S. Geological Survey, (Emeritus) and Plafker Geohazard Consultants**

New evidence for a secondary tectonic source for the cataclysmic tsunami of 12/26/2004 on NW Sumatra

The near field tsunami generated by the great M9.1 Sumatra-Andaman earthquake of 12/26/2004 devastated about 200 km of the NW Sumatra coast and caused 169,000 of the 232,000 tsunami deaths; far-field waves resulted in the remaining 63,000 deaths. On Sumatra, flow depths (7 to 32 m) and maximum run up heights (to 38 m) exceed by a factor of 2–3, tsunamis generated by historical megathrust quakes of comparable or larger magnitude such as Chile (1960) and Alaska (1964).

This paper addresses the question: "Why was the Sumatra tsunami so large and destructive compared to all previous tsunamis that accompanied great megathrust earthquakes?" To answer this question we collected, in May 2005, 110 eyewitness accounts along the NW Sumatra coast to determine tsunami arrival times and characteristics. We also re-surveyed some pre-quake echo sounder lines offshore from NW Sumatra, in October 2006, to ascertain whether there were any large depth changes that could have generated the local tsunami.

Based on these data, our working hypothesis is that large slip on one or more steeply dipping intraplate thrusts or backthrusts that splay off the Sunda megathrust caused the local tsunami that struck NW Sumatra, whereas slip on the gently-dipping Sunda megathrust was the probable source of the far-field tsunami. Our hypothesis is compatible with: 1. Data on arrival times and characteristics of the near field tsunami; and 2. A numerical tsunami source model consisting primarily of coseismic uplift along a splay fault about 80 km long, 60 degree dip, and ~20 m slip that is superimposed on minor uplift (<3 m) due to up-dip slip on the megathrust.



Biography: Dr. George Plafker is a geologic hazard consultant and volunteer scientist emeritus for the U. S. Geological Survey in Menlo Park. George received his B.S. from Brooklyn College, followed by an M.S. from UC Berkeley. He received his Ph.D. from Stanford University, in Geology and Geophysics. George has a wide range of experience, the foremost of which includes 37 years doing geologic mapping, engineering geology of dam sites, neotectonic studies, and onshore-offshore petroleum basin evaluation with the USGS, primarily in Alaska. These activities focused on the geologic effects of earthquakes, tsunamis, seismic hazards, and regional tectonics in Alaska, the western conterminous U.S., and nine foreign countries. His other experience includes 11 years of consulting on hazards from subaerial and submarine landslides in Alaska and on faulting, tectonic tsunamis, and earthquake-related ground shaking in California; 5½ years petroleum exploration in Guatemala and Bolivia with Chevron Oil Company; and 1½ years engineering geology of dam sites in California with U.S. Army Corps of Engineers.

George's primary professional interests include active faults, paleoseismology, regional tectonics, and earthquake hazards; coseismic deformation and tsunamis related to subduction zone and backarc thrust fault earthquakes; mechanisms of submarine slides and slide-generated waves and subaerial high-speed rock avalanches; and onshore & offshore regional geology, tectonics, and petroleum potential of the Gulf of Alaska margin. George is the author or co-author of 200+ published papers and geologic maps and 100+ abstracts on geology, tectonics, and the geologic aspects of earthquakes, primarily in Alaska. He was senior editor for, and a major contributor to, *The Geology of Alaska*, published in 1994 by the Geological Society of America (1,055 pages, 13 map plates).

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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 2006 Calendar

Wednesday January 31, 2007
Dr. George Plafker, USGS, Menlo Park.
New evidence for the source of the devastating Banda Aceh tsunami of 2004
7:00 pm at Orinda Masonic Center

Wednesday February 28, 2007
Dr. Paul Belasky, Ohlone College, Fremont
The real "geopoetry," and the "poets of the soil": Geological school of 20th century poetry in St. Petersburg, Russia, explores why we are geologists
7:00 pm at Orinda Masonic Center

March 5-23, 2007 AAPG Distinguished Lecture (Specific Date TBA)
Dr. Jean-Laurent Mallet, Ecole Nationale Superieure de Geologie, Nancy, France,
Integrated earth modeling: From seismic interpretation to flow simulation in reservoirs
Lunch Hour; Chevron, San Ramon

Wednesday March 28, 2007 (tentative)
Jacob Lowenstern, USGS, Menlo Park
Intrusion, deformation, and degassing at the Yellowstone caldera
7:00 pm at Orinda Masonic Center

Wednesday April 25, 2007
Jeff Unruh, UC Davis and William Lettis and Associates
Emplacement and uplift of Mount Diablo
7:00 pm at Orinda Masonic Center

Wednesday May 30, 2007
TBA
7:00 pm at Orinda Masonic Center

Wednesday June 27, 2007
TBA
7:00 pm at Orinda Masonic Center

Upcoming NCGS Field Trips

Spring 2007	***Extraordinary Fluid Pressure Release at Cantua Creek,*** **Dr. Mel Erskine**, Consultant
May 12, 2007 (Tentative)	***Modern Geophysical Techniques for Site Characterization,*** **Dr, Mitchell Craig,** Cal State East Bay
Spring – Summer 2007 (Tentative)	***Devils Slide*, Thomas Whitman,** Cal-Trans
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

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 / Nacimento 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:

- February 13, 2007, John Tinsley, USGS, *Cave Discovery and Cave Science, Sequoia National Park*. Dinner in 320-109. Lecture in 320-105

- March 13, 2007, Ross S. Stein, USGS Earthquake Hazards Team, *Earthquake Hazards of Tokyo -- A Global Problem*. Dinner in Hartley. Lecture in 320-105

- April 10, 2007, *TBA*. Dinner in 320-109. Lecture in 320-105

- 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

FRIENDS OF THE PLEISTOCENE PACIFIC CELL FIELD TRIP October 4 – 7, 2007

Quaternary Stratigraphy, Drainage-Basin Development, and Geomorphology of the Lake Manix Basin, Mojave Desert

Principal trip leaders:
Marith Reheis, Dave Miller, Joanna Redwine, Stephanie Dudash

Information will be distributed using the Pacific Cell yahoo group; if you want to receive information make sure you are registered by sending your email address to friends_of_the_pleistocene@yahoogroups.com. Send questions to mreheis@usgs.gov or dmiller@usgs.gov.

October 4 (Thursday)--Optional pre-day for the energetic and physically fit to see critical evidence for pre-late Pleistocene shorelines and discharge predating the cutting of Afton Canyon, requiring 4WD and >1-hour one-way hike in rough terrain to access the outcrops. Possible half-day afternoon hike to view fan and lake stratigraphy south of the Mojave River.

October 5 (Friday)--Afton subbasin: Overview and deposits along North Afton beach ridge and older fan-delta deposits; the "slackwater" deposits; evidence for large flood from upstream basin(s) and inception of first lake in Afton subbasin; stratigraphy and dating of late Pleistocene shoreline fluctuations.

October 6 (Saturday)--Manix subbasin: Buwalda Ridge, evidence for highstands exceeding 543 m and Manix fault; intersection of Manix Wash and Mojave River, including outcrop and core stratigraphy and dating; history of Mojave River, including inception of Manix basin and river evolution following demise of Lake Manix; faulting and uplift of lake deposits on SW flank of Harvard Hill.

October 7 (Sunday)--Coyote Lake subbasin: SE Coyote beach ridge deposits and record of fluctuating lakes during and after late Pleistocene Lake Manix; Coyote Wash barrier beaches and Mojave River channel deposits; history of post-Manix Coyote Lake.

Marith Reheis; U.S. Geological Survey, MS-980 Federal Center, Box 25046 Denver, CO 80225; phone: 303-236-1270; fax: 303-236-5349

California Geological Survey Releases a Revised Geologic Map of California

On October 31, 2006 the CGS announced that **Map Sheet 57**, a revised **Geologic Map of California**, had been released. The 20-inch by 23-inch color map depicts the generalized geology of California, and is for sale at $4.00 (flat or rolled). Go to: http://www.consrv.ca.gov/CGS/information/publications/index.htm to order (apparently not downloadable).

California Geological Survey Announces a New Map Series

Continuing the flurry of publications, the CGS also announced a new map series, the **Landslide Inventory Map Series**, on December 4, 2006.

The CGS developed the Landslide Inventory Map Series to provide additional information to geotechnical professionals, local government personnel, as well as property owners and developers who use Seismic Hazard Zone Maps. Earthquake-induced landslide zones of required investigation include inventories of known landslides, but previously these inventories were only available as small-scale plates in seismic hazard zone reports.

Landslide inventory maps show locations and characteristics of landslides that have moved in the past but generally do not indicate the mechanism(s) that triggered them. The geologic, terrain and climatic conditions that led to past slope failures often provide clues to the locations and conditions of future slope failures. Therefore, inventory maps provide useful information about the potential for future landsliding. In addition, recognizing the type and recency of landsliding can also facilitate the scope and design of site-specific geotechnical investigations and guide slope remediation strategies.

Inventory maps are prepared primarily by geomorphic analysis of aerial photographs and secondarily by field reconnaissance, interpretation of topographic map contours and review of previous mapping. Landslides shown on the Landslide Inventory Map Series were compiled at a scale of 1:24,000 on the U.S. Geological Survey topographic map and several key characteristics are shown through cartographic symbology. Each map in this series contains an explanation of the map symbology as well as a brief description of the geology and landslide occurrences in the map area.

These landslide inventory maps are the first of many to be released in the San Francisco Bay and Southern California regions. This series is a new addition to the list of publications that CGS currently distributes. If you would like to purchase a printed Landslide Inventory Map you may do so by contacting CGS Publications.

Go to: http://www.consrv.ca.gov/CGS/information/publications/LSIM_index.htm to download a copy of maps of interest to you.

California Geological Survey Releases a Special Reports 195 and 196

In a flurry of publication, the CGS also reported on November 7, 2006 that **Special Report 195** (Landslides in the Highway 299 Corridor between Blue Lake and Willow Creek, Humboldt County) and **Special Report 196** (Landslides in the Highway 1 Corridor between Bodega Bay and Fort Ross, Sonoma County) had been released.

As noted on the website, the CGS has developed “highway corridor landslide hazard maps” to meet the needs of engineers, geologists, planners, and maintenance staff of the California Department of Transportation (Caltrans). The project was initiated after the 1997 Mill Creek Slide closed a portion of U.S. Highway 50 for approximately one month. Maps prepared by CGS as part of the emergency response and recovery from the 1997 incident now serve as a planning and maintenance document for developing long-term mitigation strategies. Recognizing the value of this product, Caltrans contracted with CGS to develop a series of maps of selected California highway corridors within a variety of climatological and geological settings. The maps provide an inventory of landslide activity along the selected highway corridors. This “big picture” perspective will benefit planning of route improvements and lead to more effective landslide risk mitigation for California's highways. Go to: http://www.consrv.ca.gov/CGS/rghm/landslides/index.htm to download your copy.

Special Reports 184 (*Landslides in the Highway 101 Corridor between Wilson Creek and Crescent City, Del Norte County*), **185** (*Landslides in the Highway 1 Corridor: Geology and Slope Stability along the Big Sur Coast between Point Lobos and San Carpoforo Creek, Monterey and San Luis Obispo Counties*), **186** (*Landslides in the Highway 60 Corridor San Timoteo Badlands Riverside County*), **187** (*Landslides in the Highway 101 Corridor between Leggett and Piercy, Mendocino County*), and **188** (*Landslides in the Interstate 5 Corridor between Valencia and Gorman, Los Angeles County*) are also downloadable on this webpage, as are further details about the landslide mapping program.

NCGS Announces Award of $500 Undergraduate Scholarship

The NCGS is pleased to announce the award of the ***2007 Undergraduate Scholarship*** for $500 to **Ms. Sharon Bywater**. She is a student in the Geology Department at **Southern Oregon University**. Her advisor is Dr. Bill Elliot. Details on her thesis topic and intended use of these funds are as follows:

PETROGRAPHIC ANALYSIS OF SANDSTONE CONCRETIONS IN THE HORNBROOK FORMATION (UPPER CRETACEOUS) IN HILT, CALIFORNIA

The Hornbrook Formation (Upper Cretaceous) is exposed along the northeastern margin of the Klamath Mountains from southwestern Oregon to north-central California. The Hornbrook Formation lies nonconformably on Paleozoic and Mesozoic igneous and metamorphic rocks of the Klamath Mountains, and is overlain disconformably by the Eocene Payne Cliffs Formation. The Hornbrook Formation strikes N30^{o}W and dips 20^{o} to 30^{o} to the northeast on the eastern flank of the Klamath Mountains and is subdivided into five members: Klamath River

Conglomerate (oldest), Osburger Gulch Sandstone, Ditch Creek Siltstone, Rocky Gulch Sandstone, and Blue Gulch Mudstone (youngest). The sediments of the Hornbrook Formation are interpreted to have been deposited in a forearc basin similar to the Upper Cretaceous sediments of the Great Valley forearc in central California (Sliter et al., 1984; Nilsen, 1984, 1993). Surprisingly, a previous petrographic study conducted by Golia and Nilsen (1984) reported an absence of volcanic rock fragments in the Hornbrook sandstones, although the sedimentary rocks of the Hornbrook Formation are interpreted to have been deposited in a forearc basin. Instead, this study concluded that the sandstone compositions for the Hornbrook Formation are consistent with a continental block to recycled orogen provenance rather than showing an unroofing sequence of a continental volcanic arc typical of forearc basins (Golia and Nilsen, 1984).

The absence of volcanic rock fragments in sandstones of the Hornbrook Formation may be the result of (1) compaction and/or obliteration of volcanic rock fragments during diagenesis, e.g. formation of pseudomatrix, (2) alteration of volcanic detritus to clay minerals by circulating diagenetic fluids, or (3) absence of volcanic detritus during deposition of the Hornbrook Formation. Assuming the sandstones of the Hornbrook Formation originally contained volcanic rock fragments and were deposited in a forearc setting, I propose to conduct petrographic investigation of sandstone concretions from the various members of the Hornbrook Formation. My hypothesis is that because concretions are usually formed by early cementation, the likelihood that volcanic rock fragments would be preserved is significantly increased. The early cementation associated with concretions would most likely decrease the effects of compaction and/or alteration by diagenetic fluids. Sandstone concretions are present throughout the Hornbrook stratigraphic succession, ranging in size from 2 to 3 cm in diameter to over 2 meters in diameter. Thus, volcanic rock fragments, if they are recognizable, will most likely be preserved in the sandstone concretions of the Hornbrook Formation.

Approximately 4 to 5 samples of sandstone concretions will be collected in stratigraphic succession within each member of the Hornbrook Formation, providing a total of 20 to 25 samples. The sandstones will be slabbed and thin-sections prepared in the Rock Preparation Laboratory in the Geology Department at Southern Oregon University. Petrographic analyses will be conducted using standard point counting techniques (e.g., Ingersoll and Suczek, 1979) with 1000 counts per thin-section. The following categories of framework grains will be tabulated: monocrystalline quartz grains (Qm), polycrystalline quartz grains (Qp), total quartzose grains (Q=Qm+Qp), plagioclase feldspar grains (P), potassium feldspar grains (K), total feldspar grains (F=P+K), volcanic rock fragments (Lv), metavolcanic rock fragments (Lvm), sedimentary and metasedimentary lithics (Lsm), unstable lithic fragments (L=Lv+Lvm+Lsm), and total polycrystalline lithic fragments (Lt=L+Qp) as defined by Dickinson and Suczek (1979). From the point-count data collected from the sandstone concretions, Q-F-L, Q-P-K, and Qm-F-Lt ternary diagrams will be plotted and compared to the work conducted by Golia and Nilsen (1984). If the sandstone concretions do preserve unstable rock fragments, in particular volcanic lithics, then the provenance interpretation for sandstones of the Hornbrook Formation will differ from the work of Golia and Nilsen (1984). In addition, the presence of volcanic rock fragments in the sandstone concretions would verify my hypothesis and further support the interpretation that the Hornbrook Formation was deposited in a forearc basin with volcanic inputs.

The scholarship from the Northern California Geological Society would be used to pay for transportation from Ashland, Oregon to Hilt, California and surrounding localities in northern California to collect samples of the sandstone concretions from the Hornbrook Formation. Additionally, the awarded funds would also be used to purchase sample bags, glass slides, cover slips, saw blades, epoxy, and other supplies and materials necessary to prepare thin-sections of the collected rock samples. I will be using field equipment and the Rock Preparation Laboratory in the Geology Department at Southern Oregon University to conduct this research. In addition, any remaining funds would be used to support my travel to a conference (e.g. Geological Society of America) to present the results of this research.

References Cited

Dickinson, W. R., and Suczek, C. A., 1979, Plate tectonics and sandstone composition: American Association of Petroleum Geologists Bulletin, v. 63, p. 2164-2182.

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Applying Terrestrial Outcrop Models to Shallow Marine and Deltaic Hydrocarbon Exploration

Submitted by Dan Day

Correlations between field exposures and subsurface sedimentary features were discussed in **Dr. Janok Bhattacharya's** March 21, 2006 AAPG Distinguished Lecture ***Applying Deltaic and Shallow Marine Outcrop Analogs to the Subsurface***. The talk, hosted at Chevron's San Ramon Park facility, detailed the fundamental problems associated with hydrocarbon reservoir characterization, and the improvements made by cross-correlating subsurface data with facies-equivalent terrestrial outcrops. A former oil industry exploration geologist, Dr. Bhattacharya has continued his reservoir research as a member of the University of Texas, Houston, faculty.

Today, petroleum exploration is focused on deltaic environments, which have become major hydrocarbon resources. Dr. Bhattacharya's lecture addressed the general problems of successfully tapping these petroleum resources, drew comparisons between deltas and seismic-imaged subsurface sediments, described basic delta facies architecture, and correlated subsurface data to well-characterized outcrop analogs.

The relative complexity of subsurface reservoirs complicates determining flow unit continuity or locating flow barriers like shales and pore cements. These production obstacles can be associated with spatial elements that can occur on a regional scale, between wells, or at individual well sites. Outcrop analog databases provide:

- Regional to field-scale studies of both reservoir and non-reservoir units that represent shallow marine and deltaic environments.
- Detailed 3-dimensional facies architectures of small scale inter-well heterogeneities and sub-environments to help fine-tune reservoir models.
- Improved visualization of shoreline and deltaic processes to better conceptualize and modify facies models as seismic, well log, and well core interpretive tools.

Another important analytical tool is sequence stratigraphy. It consolidates facies models and provides a better understanding of overall reservoir architecture. The exploration geologist must be able to incorporate these concepts into a coherent and functional reservoir model.

The major hurdle to shoreline and deltaic reservoir modeling is successfully correlating subsurface data on a regional to field-wide scale. The various datasets involved are well log data, drill cores, and 3-D seismic imaging. The need to incorporate this subsurface information into a working reservoir model is a major challenge.

Functional reservoir solutions require an interpretative framework that integrates facies models and sequence stratigraphy. In successful projects, many datasets had to be analyzed from representative terrestrial outcrops, and high resolution seismic surveys of Quaternary delta and shoreline depositional systems. These needs drove theoretical and numerical model development programs. The basic physics of sedimentary depositional mechanisms in beach and delta environments have been well characterized. These principles were used as the basis for modeling calculations.

To help his audience understand the evolution of delta and nearshore sedimentary theory, Dr. Bhattacharya took a short historical interlude. Sedimentologists began modeling delta and shoreline facies in the early 1970's, producing the Galloway Triangle for characterizing delta behavior. The three corners in this diagram represented river, wave, and tidal domination of deltaic processes. The relative intensity of these inputs was thought to influence the form and sedimentary architecture of a given delta system. The 1980's and early 1990's saw the rise of sequence stratigraphy as a regional sedimentary interpretive tool. However, in the 1990's the shallow marine environment as a hydrocarbon reservoir resource was glossed over, as was the importance of biostratigraphy as an exploration tool. Ichnofacies biostratigraphy used as an exploration tool has been a critical element in several recent hydrocarbon reservoir models.

As classic petroleum reservoirs become scarce, shoreline and delta plays have been receiving more attention. The North Slope in Alaska, the MacKenzie delta in Canada, the Niger delta in Nigeria, the Angolan offshore, and Russian's Sakhalin Island off its Pacific coast are recent examples. Originally modeled as horizontally bedded sediments, delta fronts in cross section actually consist of gently dipping marine and nonmarine topset beds, foreset beds (clinoforms), and bottomset deep marine sediments. The shoreface sediments show optimum thickening, characteristic hummocky cross-stratification, and abundant shoreline reworking. There are often amalgamated hummocky cross beds with climbing wave ripples encasing some trace fossil burrows, and rare "background" mudstone horizons.

Using the Galloway Triangle for delta processes, several situations can be identified. River dominated systems exhibit mudstones at the bottom of upward coarsening sequences and are associated with prograding deltas. Wave dominated delta systems display aggrading ripple sets, lack bioturbation, contain wave-dominated bedforms, and include some minor turbidite activity. Shore facies are wave dominated and contain upward coarsening facies. Nondeltaic systems are quite horizontal and are located far from fluvial sediment sources. The shore face itself is a <u>surface</u> caused by the asymmetry of shoaling waves (making frictional contact with bottom sediments). There is an upper, middle, and lower shore face, each with its characteristic sedimentary features sculpted by the circular fluid motion of the wave fronts.

Dr. Bhattacharya noted that wave, tidal, and river dominated delta systems can all have periodic storm event overprints. In wave dominated situations, the sediment is gradually forced shoreward. During fair weather conditions, the normal wave base eradicates the hummocky cross stratification. Storm surges eventually flow offshore and eradicate the deepwater bedforms they created. So why should normal shore facies be considered as wave dominated? To answer this question, one must closely examine delta front facies successions.

Delta fronts and shore facies occur side-by-side, and are influenced by offshore current flow. They have different geometries and internal structures (architectures). A comparison of the two systems benefits immensely from examining outcrop analogs. The Southwest U.S. contains some excellent exposures in the Cretaceous Foreland Basins. Janok elaborated using New Mexico's Gallup Sandstone as an example. Parasequence Point near Ship Rock displays clean, non-bioturbated sandstone with Bouma sequences, delta turbidites, and hyper-pycnal (high density) flow features. Steeply dipping clinoforms indicate a strong fluvial influence. There are also sandstone cliffs covered with a diffuse shrub growth, and abundant bioturbation marked by Ophiomorpha shrimp burrows (ichnofacies). These observations are consistent with a high energy wave dominated coastal shoreface environment.

To illustrate a delta fan model, attention was shifted to the Danube (Romania) delta on the Black Sea, the Brazos delta, the Guardicena delta in Iberia, and the Damietta branch of the Nile River delta. The Danube River has a deflated (truncated) delta due to strong offshore currents. Hence, delta sediment deposition occurs down-current (down drift) from the delta mouth. Wave-dominated deltas with symmetrical shapes imply head-on (perpendicular to the shoreline) wave impingement. Oblique wave impact creates asymmetrical delta patterns that are strongly influenced by delta discharge rates. The Gallup Sandstone is interpreted as a wave-dominated lagoonal sequence. Where offshore currents and oblique wave action have modified the delta, sediments will be strung out parallel to the shoreline. This model has been applied to Utah's Book Cliffs succession.

The facies architecture of delta and shallow marine sediments is important to subsurface seismic reflection and well data interpretations. Foreset beds (clinoforms) are key features associated with advancing delta fronts. These have been observed in outcrop analogs. However, the 3-D architecture of fluvial-dominated deepshore facies requires additional information. The latter has benefited from ground-penetrating radar analysis of terrestrial outcrops. The Cretaceous Wall Creek member of the Fountain Formation, Wyoming, was carefully studied using field mapping and radar techniques. Its key features are upward thickening sediments and abundant ichnofacies burrows. Radar imaging was used to reconstruct subsurface (unexposed) 3-D clinoform bedding sequences. The Raptor Ridge site in Wyoming was characterized using ground penetrating radar (GPR), outcrop mapping, outcrop surveys, and core logs. Mudstones coarsen upwards into a massive concretion-bearing sandstone. Laminated bedsets may be river deposits accumulated during periods of high sediment influx. Abundant mud drapings suggest a tidal reworking environment. An extensive 3-D GPR survey of the calcite concretion distribution that was modeled using SGB SIM software suggests the nodules may be associated with fluid pathways that could influence petroleum reservoir production.

Seismic data can reveal bedding plane geometry in nearshore and deltaic sediments. This was done in the Cretaceous Wall Creek sediments, in the Quaternary Rhone River delta, and in the Mekong River delta, Vietnam. The Mekong data was acquired on the inland delta plain, on the ridge plain, and on the offshore delta. The delta sediments were C^{14} dated to determine progradation rates. Three sites yielded excellent cores for reconstructing the local stratigraphy. The results dispel previous assumptions of horizontal "layer-cake" stratigraphy versus clinoform models for proximal to distal delta sedimentary structure. The new interpretation of delta stratigraphy and the re-evaluation of shoreface sediments was driven by the failure of previous models to predict the production behavior of hydrocarbon reservoirs.

Sedimentary structural interpretation has thus evolved from the 1970's emphasis on lithostratigraphic correlation, through the development of sequence stratigraphy in the 1990's. The latter resulted in more complex reservoir models, but also permitted improved reservoir production and recovery. Stratigraphers were trained to compartmentalize lithologies. Zone stratigraphy divided deltaic facies into fluvial, fluvial plain, deltaic, prodeltaic, and shelf environments. Closer examination indicated that depositional environments are not mutually exclusive, but that they often overlap. Dr. Bhattacharya and his colleagues have developed new models for interpreting deltaic and shoreface systems that are more compatible with observed reservoir production behavior.

Careful examination of terrestrial outcrop analogs have provided vital information for re-interpreting some shoreface deposits as delta front sediments. Detailed 3-D facies architectures were assembled from high resolution seismic and ground penetrating radar surveys of these outcrops. Concept application to subsurface reservoirs has yielded successful hydrocarbon production and fluid flow models. Improved 3-D reservoir characterization has been achieved. A turning point was the realization that deltas are not symmetrical systems, and that sedimentary facies and structures are asymmetrically distributed up-drift and down-drift from the delta mouth where wave action is directed oblique to the shoreline. The latter drives sediments parallel to the shorefront and forces delta sediment loads down current.

The NCGS and its members deeply appreciate the opportunity to hear Dr. Janok Bhattacharya's thoughts on the subsurface application of terrestrial outcrop analogs, and new facies interpretations based on these exposures, to the development of delta and shallow marine petroleum reservoirs. His AAPG Distinguished Lecture appearance is funded by generous grants from Chevron and the Pacific Section AAPG. The NCGS also wishes to thank Chevron Corporation for graciously providing a lecture room at its San Ramon Park facility for Dr. Bhattacharya's presentation.

NCGS Notes the Passing of Two Members

Helen Grinstead, a longtime NCGS member, passed away on October 29th, her 57th wedding anniversary. A member of the Society's counselors committee for several terms, Helen was an enthusiastic presence on many field trips over the years.

A native of Washington, D.C. and a graduate of the University of Pennsylvania, she was a volunteer and natural history docent at Oakland Museum and Lindsay Wildlife Museum in Walnut Creek. Three years ago

Helen and her husband, Bob, moved to Davis, CA from their longtime Walnut Creek home. A woman who lived life to the fullest with passion and curiosity she will be missed by her husband, children, and grandchildren.
--- Thelma Dana

Robert E. Wallace
USGS Earthquake Expert

GEOLOGIST TRAVELED THE WORLD TO STUDY QUAKE RISKS, CAUSES

By Julie Sevrens Lyons
S.J. Mercury News

Not many people have a creek named after them -- or a ridge with their moniker, or more than 150 books, articles, geologic maps and reports on local and foreign lands to their name.

But Robert E. ``Bob'' Wallace was anything but average. His career with the U.S. Geological Survey in Menlo Park extended more than 50 years, leaving a legacy in the field of earthquake research.

He helped found the survey's earthquake research program in Menlo Park in 1964 after Alaska's Good Friday earthquake -- the second-largest ever recorded -- wrecked parts of Anchorage and set off a deadly tsunami. The program brought geologists, geophysicists, experimentalists and engineers together in a coherent team.

Mr. Wallace was chief scientist of the program from 1973 until his retirement in 1987 and then worked for the survey for free, as an emeritus professor, for 11 years.

But he also found time to paint watercolor landscapes, watch birds, travel with his wife and do cowboy-style rope tricks, which he learned as a child and performed on stage during college.

``It was one of the things he took pleasure in because it was so different,'' said his son, Alan Wallace, who followed in his father's footsteps to become a USGS scientist studying mineral deposits and water resources in Nevada.

He added, ``We spent all my summers growing up pretty much out in the field.''

Mr. Wallace died of kidney failure on Jan. 8 in Reno, Nev., at age 90.

An authority on tectonics, earthquake geology, mineral resources and engineering geology, he received numerous awards and accolades during his career, including a medal from the Seismological Society of America and the Career Contribution Award of the Geological Society of America.

Long interested in the geology of earthquakes, he increasingly focused on what he termed paleoseismology, the study of how ancient earthquakes can be used to predict others. He was widely recognized as one of the world's leading experts on earthquake hazards.

With his wife, Trudy, who died in 2005 after more than 60 years of marriage, Mr. Wallace lived in the wilds of 1940s Alaska and the deserts of southern Russia, and summered for many years in a spartan cabin in remote Nevada that was built about the 1860s.

Mr. Wallace's pioneering studies ``inspired an entire generation of Earth scientists to look critically at the Earth and learn to read its past and future from the stories told by the young deposits,'' former colleague William L. Ellsworth of the USGS said in an e-mail.

In the 1960s, he demonstrated that the section of the San Andreas fault in the Carrizo Plain National Monument had moved repeatedly. Wallace Creek is one of the named features in that park.

In 1989, Mr. Wallace commented in an awards ceremony that it was a fluke that he wound up involved in that line of research: He had originally signed up to head up the USGS's Snow, Ice and Permafrost program, but the colonel who offered him the job was killed while practicing parachute jumps. ``Except for fate,'' he said, ``I would today be an iceman, or perhaps a snowman.''

During World War II, the survey assigned him to search for uranium in Alaska. The mission was a bust, but the group did discover gold in the Nyac District of southwestern Alaska. The location of that discovery has since been named Wallace Ridge.

``He's really one of the survey's legends,'' said Tom Hanks, a senior geophysicist there. ``He was a really important scientist in an organization that has produced a number of important scientists.''

Robert E. Wallace

Born: July 16, 1916, in New York City
Died: Jan. 8, 2007, in Reno
Survived by: A sister, Harriet Wallace of Savoy, Ill., and his son, Alan Wallace of Reno
Services: None planned

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY and AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

K-12 EARTH SCIENCE TEACHER OF THE YEAR AWARD

$750 Northern California Geological Society
$500 Pacific Section AAPG
$5,000 National AAPG

Call for Nominations for the Year 2006 - 2007 NCGS Competition

The Northern California Geological Society (NCGS) is pleased to announce that it will accept applications from candidates in the Northern California region for the Year 2006 - 2007 competition for the Earth Science Teacher of the Year Award. The $750 NCGS award is intended to recognize pre-college earth science programs already in place, and to encourage their organization in districts where they have not been fully developed. Nominations of qualified K-12 teacher candidates are solicited from teachers, school administrators, teacher outreach programs, and other interested parties.

The NCGS awardee's application will be submitted to a regional competition sponsored by the American Association of Petroleum Geologists (AAPG) Pacific Section. The Pacific Section winner will receive a $500 award at the joint national and Pacific Section regional meeting in Long Beach, California in April 2007, plus up to $250 toward meeting expenses. The regional winner's project will be submitted to AAPG headquarters for the national contest. The national winner will receive an expense-paid trip to attend the joint national and Pacific Section AAPG meeting in Long Beach, California in April 2007 to receive the national award.

At the national level, the AAPG Foundation presents an annual $5,000 award to a K-12 teacher for *Excellence in the Teaching of Natural Resources in the Earth Science*. The award recognizes balanced incorporation of natural resource extraction and environmental sustainability concepts in pre-college Earth science curricula. It includes $2,500 to the teacher's school for the winning teacher's use, and $2,500 for the teacher's personal use.

The deadline for application submittal by candidates for the $750 NCGS award is Friday, February 2, 2007.

Interested candidates or nominators can request Application Information and an Entrant Application Form, or submit an application, by contacting:

John Stockwell, Chair, K-12 Geoscience Education Committee
Northern California Geological Society
1807 San Lorenzo Avenue
Berkeley, California 94707-1840
Tel: (510) 526-1646
e-mail: kugeln@peoplepc.com

NORTHERN CALIFORNIA GEOLOGICAL SOCIETY

2007 GRADUATE SCHOLARSHIP ANNOUNCEMENT – MS & PhD DEGREES

The Northern California Geological Society is pleased to announce the availability of a scholarship to help support graduate-level student research in geology during the year 2007.

- **$750 will be awarded to students working toward the MS degree**
- **$1,000 will be awarded to students working toward the PhD degree**

These scholarships will be awarded competitively, based upon our review of submitted summaries of proposed research. Funds are intended to support field and laboratory components of research programs. The research must be scheduled for completion during the 2007 calendar year. Winners will be invited to speak about or otherwise present their research at a regular evening NCGS meeting in Orinda, California.

Application Procedure

Candidates may apply by forwarding a signed cover letter on department letterhead requesting the award, accompanied by a brief (no more than 2 page) summary of the proposed research topic. The letter must include candidate contact information (both departmental and home mailing address, telephone, and e-mail).

The bottom of the candidate letter must bear the note:

"Degree Program _________, Approved by ____________, (Print) ____________, Title _____________,
Telephone _____________, E-mail ____________. Date ____________."

with the signature and printed name/title/telephone/e-mail of a department chairperson or thesis advisor, to show that the recipient has departmental approval to receive the award. An application form is not required.

Please submit the letter and proposal to:

Phillip Garbutt
Chair, NCGS Scholarship Committee
6372 Boone Drive
Castro Valley, CA 94552-5077
Voice: (510) 885-3440 or (510) 581-9098 (evening)
Fax: (510) 885-2526
e-mail: phillip.garbutt@csueastbay.edu or plgarbutt@comcast.net

no later than January 31, 2007. Awards will be made by February 28, 2007.

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