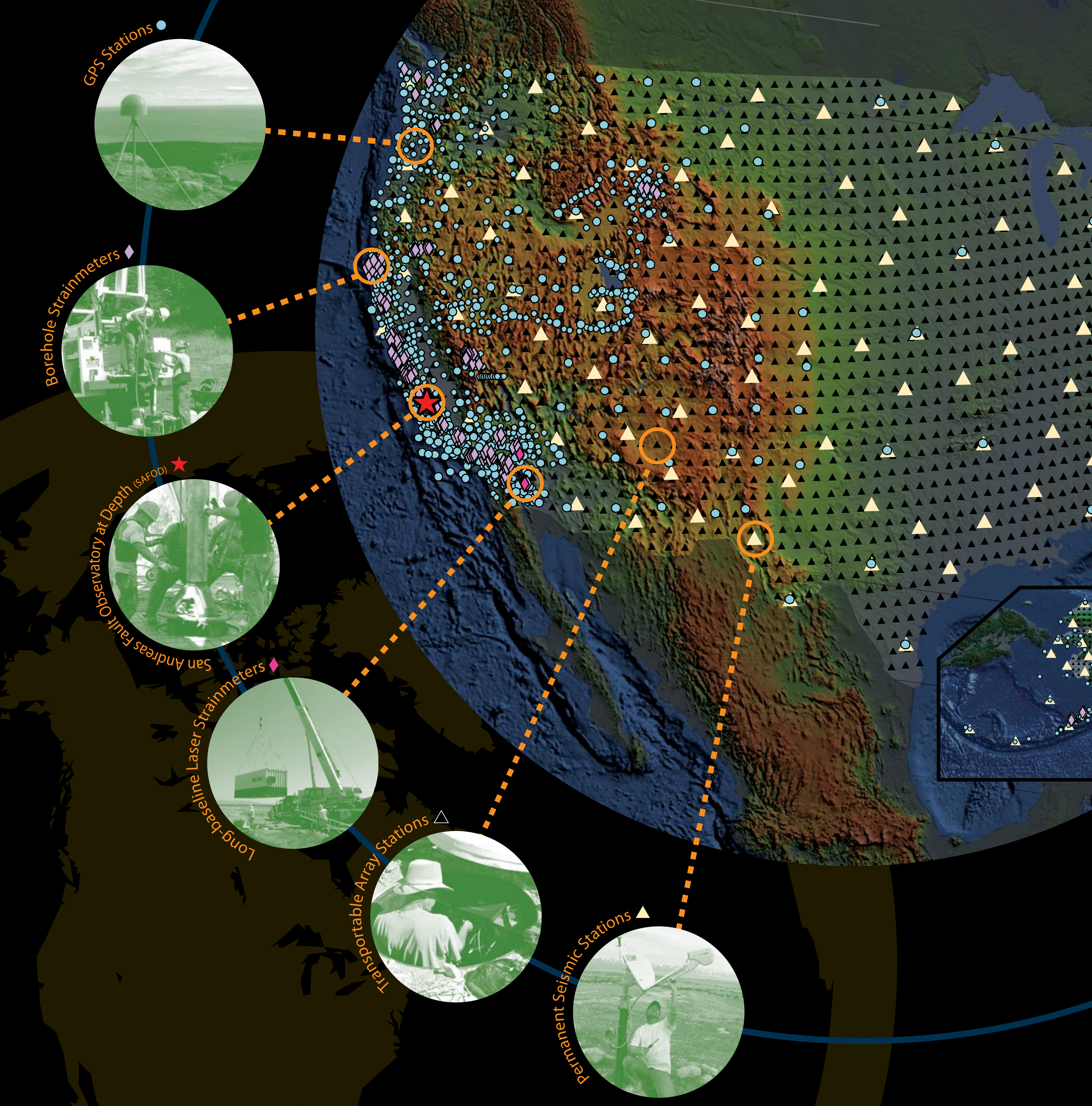


NATIONAL MEETING

March 27–30, 2007

Portola Plaza, Monterey, California

earthscope

Table of Contents

Meeting Goals:

- Present latest results from EarthScope science
- Emphasize integrated, multi-disciplinary science
- Enhance role of young scientists
- Look to the future

Organizing Committee:

Wayne Thatcher, U.S. Geological Survey
Roland Burgmann, University of California, Berkeley
Jonathan Price, University of Nevada, Reno

Program Committee:

Aaron Velasco, University of Texas at El Paso
Ben van der Pluijm, University of Michigan
Peter Shearer, University of California, San Diego
Emily Brodsky, University of California, Santa Cruz
George Hilley, Stanford University

earthscope

The EarthScope National Meeting is supported by NSF.
Additional funding is provided by NASA and USGS.

NSF

USGS

NASA

Tuesday, March 27

7:00am – 6:00pm	Registration	*ELEVATOR LOBBY*
8:00am – 1:30pm	Field Trip (pre-registration required) *David Schwartz · USGS*	*Meet in the Portola Plaza Lobby.*

8:00am – 9:30pm	**Self-Supported Workshops (registration required)**	
8:00am – 3:00pm	SNARF Working Group *Geoff Blewitt · Nevada Bureau of Mines and Geology*	*DRIFTWOOD*
8:00am – 3:00pm	Preparing for SAFOD Phase 3: Locating the Target Earthquakes and Overview of Core Handling and Analysis Plan *Steve Hickman, Bill Ellsworth · U.S. Geological Survey* *Mark Zoback, Charlie Weiland · Stanford University*	*COTTONWOOD*
8:00am – 3:00pm	MARGINS/GeoSwath Multidisciplinary Workshop: Integrated Collaborations in Cascadia and the Walker Lane/Salton Trough *Geoff Abers · Boston University* *Basil Tikoff · University of Wisconsin*	*REDWOOD*
8:00am – 3:00pm	CIG Training Session for Modeling of Long-Time Scale Geodynamics *Michael Gurnis · California Institute of Technology*	*KAUFMAN*
8:00am – 12:00pm	Introduction to Selected DMC Data Access Tools *Tim Ahern, Chad Trabant · IRIS*	*IRONWOOD I*
12:30pm – 4:00pm	What Data Products Does PBO Provide and How Do I Get Them? *Greg Anderson, Kathleen Hodgkinson · UNAVCO*	*IRONWOOD II*
3:00pm – 7:00pm	Using EarthScope Data in the Classroom *John Taber · IRIS* *Susan Eriksson · UNAVCO*	*REDWOOD I*
3:00pm – 6:00pm	Continental Intraplate Deformation & Seismicity: What We Know, What We Don't, and What We Need To *Seth Stein · Northwestern University*	*IRONWOOD*
7:30pm – 9:30pm	Xenoliths & EarthScope Workshop *Randy Keller · University of Oklahama*	*IRONWOOD*

3:00pm – 6:30pm	**Mini-Courses**	
3:00pm – 3:45pm	Geochemistry and Petrology of the Crust and Mantle Made Simple *Mihai Ducea · University of Arizona*	*BONSAI BALLROOM*
3:45pm – 4:30pm	Tomography/Seismic Imaging *Suzan van der Lee · Northwestern University*	*BONSAI BALLROOM*
4:30pm – 5:00pm	*Break*	
5:00pm – 5:45pm	How Anyone Can Access EarthScope Data *Greg Anderson (PBO) · UNAVCO* *Chad Trabant (USArray) · IRIS Consortium* *Charlie Weiland (SAFOD) · Stanford University*	*BONSAI BALLROOM*
5:45pm – 6:30pm	GPS/InSAR and EarthScope *Matt Pritchard · Cornell University*	*BONSAI BALLROOM*

2007 EarthScope National Meeting Schedule

Wednesday, March 28

6:00am – 6:00pm	Registration	*PORTOLA LOBBY*
7:00am – 7:45am	***Breakfast***	*DE ANZA BALLROOM*
8:00am – 10:00am	**Plenary Session:** Building and Destroying a Volcano in Real Time *Michael Lisowski · U.S. Geological Survey* *Stephanie Prejean · Alaska Volcano Observatory*	*STEINBECK FORUM*
10:00am – 10:30am	***Break***	*DE ANZA FOYER*
10:30am – 11:15am	New Opportunities for EarthScope Science: Perspectives from NSF, NASA & USGS *Kaye Shedlock · NSF* *John LaBrecque · NASA* *Linda Gundersen · U.S. Geological Survey*	*STEINBECK FORUM*
11:15am – 12:00pm	Poster Session: Open	*SERRA BALLROOM*
12:00pm – 1:00pm	***Lunch***	*DE ANZA BALLROOM*
1:00pm – 3:00pm	**Plenary Session:** What Have We Learned About Faults and Earthquakes? *Yuri Fialko · Scripps Institution of Oceanography* *John Solum · U.S. Geological Survey*	*STEINBECK FORUM*
3:00pm – 3:30pm	***Break***	*DE ANZA FOYER*
3:30pm – 5:30pm	**Plenary Session:** Non-Volcanic Tremor and Episodic Slip: Fundamental Processes or Curiosities? *David Shelly · Stanford University*	*STEINBECK FORUM*
5:30pm – 7:00pm	Poster Session: –Building and Destroying a Volcano in Real Time –What Have We Learned About Faults and Earthquakes? –Non-Volcanic Tremor and Episodic Slip: Fundamental Processes or Curiosities?	*SERRA BALLROOM*
7:30pm – 9:30pm	Reception with hors d'oeuvres and Speaker at the Monterey Bay Aquarium Extending Seismic Networks to the Deep Sea *Marcia McNutt · Monterey Bay Aquarium Research Institute*	*Meet in the Portola Plaza Lobby. Shuttle leaves starting at 7:00pm*

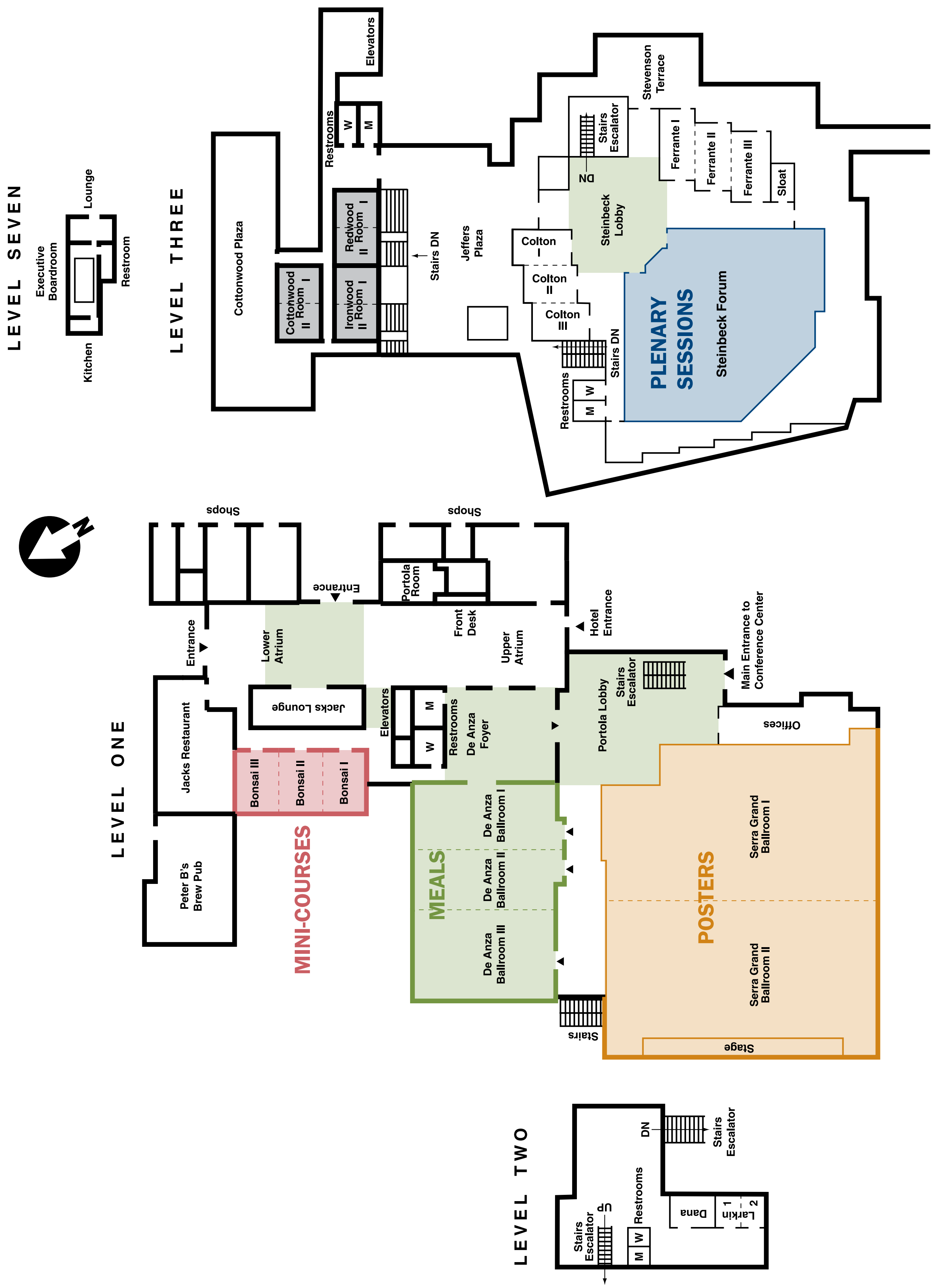
Thursday, March 29

6:00am – 6:00pm	Registration	*PORTOLA LOBBY*
7:00am – 7:45am	*Breakfast*	*DE ANZA BALLROOM*
8:00am – 10:00am	**Plenary Session:** Mantle Lithosphere: Crucial or Irrelevant to Continental Deformation? *Hersh Gilbert, Purdue University* *William Holt · State University of New York, Stony Brook*	*STEINBECK FORUM*
10:00am – 10:30am	*Break*	*DE ANZA FOYER*
10:30am – 12:30pm	**Plenary Session:** Bringing EarthScope Research into the Undergraduate Classroom *Barbara Tewksbury · Hamilton College*	*STEINBECK FORUM*
12:30pm – 1:30pm	*Lunch*	*DE ANZA BALLROOM*
1:30pm – 3:15pm	Poster Session: –Mantle Lithosphere: Crucial or Irrelevant to Continental Deformation? –The New Madrid Seismic Zone –Quality Control, Data Centers and New Tools –New Technology and Methods	*SERRA BALLROOM*
3:15pm – 3:45pm	*Break*	*DE ANZA FOYER*
4:00pm – 6:00pm	**Plenary Session:** What Drives the Western United States and How Does it Deform? *Lucy Flesch · Purdue University*	*STEINBECK FORUM*
6:00pm – 7:00pm	*Dinner on your own*	
7:00pm – 9:00pm	Poster Session: –What Drives the Western US & How Does it Deform? –Building a Continent in 4D –Infrastructure	*SERRA BALLROOM*

2007 EarthScope National Meeting Schedule

Friday, March 30

7:00am – 7:45am	*Breakfast*	*LOWER ATRIUM*
8:00am – 10:00am	**Plenary Session:** Building a Continent in 4D *Basil Tikoff · University of Wisconsin, Madison*	*STEINBECK FORUM*
10:00am – 10:30am	*Break*	*STEINBECK LOBBY*
10:30am – 12:30pm	**Closing Plenary Session:** Future Directions in EarthScope Science EarthScope and the Integration of Synoptic Data: "Understanding the Structure and Evolution of a Continent *Anne Meltzer · Lehigh University* Reconciling Deformation and Rheology Using EarthScope Data *Thomas Herring · Massachusetts Institute of Technology* Broad Band Seismology at the Blue End of the Spectrum: Opportunities and Challenges for EarthScope Science *William Ellsworth · U.S. Geological Survey*	*STEINBECK FORUM*


LEVEL SEVEN
Executive Boardroom
Lounge
Restroom
Kitchen
LEVEL THREE
Cottonwood Plaza
Cottonwood Room II I
Ironwood Room II I
Redwood Room II I
Restrooms
W
M
Elevators
Stairs DN
Jeffers Plaza
Colton I
Colton II
Colton III
Stairs DN
Restrooms
M W
Stairs Escalator
DN
Steinbeck Lobby
Stevenson Terrace
Ferrante I
Ferrante II
Ferrante III
Sloat
PLENARY SESSIONS
Steinbeck Forum
LEVEL ONE
Shops
Shops
Entrance
Portola Room
Front Desk
Lower Atrium
Upper Atrium
Entrance
Hotel Entrance
Jacks Lounge
Elevators
Restrooms
M
W
De Anza Foyer
Portola Lobby
Stairs Escalator
Main Entrance to Conference Center
Offices
Jacks Restaurant
Peter B's Brew Pub
Bonsai III
Bonsai II
Bonsai I
MINI-COURSES
MEALS
De Anza Ballroom I
De Anza Ballroom II
De Anza Ballroom III
POSTERS
Serra Grand Ballroom I
Serra Grand Ballroom II
Stairs
Stage
LEVEL TWO
DN
Stairs Escalator
Restrooms
M W
Up
Stairs Escalator
Dana
Larkin 1 2

I. Building and Destroying a Volcano in Real Time

Co-Chairs: Wayne Thatcher, U.S. Geological Survey; Aaron Velasco, University of Texas at El Paso

Monitoring crustal deformation and seismic activity and imaging subsurface structure of magmatic systems provides fundamental constraints on how volcanoes grow and evolve. EarthScope monitoring at Mt. St. Helens and Augustine is already supplying information on how these processes occur in near real time, providing a snapshot on how these volcanoes are built and destroyed.

8:00am Invited Plenary Talks

Under Construction: What We've Learned About Volcano Building from the Ongoing Eruption at Mount St. Helens · Michael Lisowski et al.

Tracking Magma Ascent in the 2006 Eruption of Augustine Volcano, Alaska: The Role of EarthScope · Stephanie Prejean et al.

9:00am Short Contributed Talks

Time-Dependent Finite Element Modeling of Effusive Silicic Eruptions · Kyle Anderson and Paul Segall

Accelerated Uplift of the Yellowstone Caldera, 2004-2006, From GPS and InSAR Observations · Wu-Lang Chang et al.

Eruption Dynamics at Mount St. Helens Imaged from Inversion of Broadband Seismic Wafeforms: Interaction of the Shallow Magmatic and Hydrothermal Systems · Gregory Waite et al.

9:30am Panel Discussion

Michael Lisowski, Stephanie Prejean, Paul Segall, David Hill

II. What Have We Learned About Faults and Earthquakes?

Co-Chairs: Emily Brodsky, University of California, Santa Cruz; Ben van der Pluijm, University of Michigan

A major goal of EarthScope is to figure out why earthquakes happen. What are the mechanics of starting, propagating and stopping a sudden slip event? The SAFOD project directly targets the earthquake source zone through a variety of geophysical and geological tools focused on the San Andreas fault. Other parts of EarthScope are designed to capture the longer term geodetic deformation associated with earthquakes or the shorter term shaking. This session will highlight the results with an emphasis on combining the insights from multiple tools.

1:00pm Invited Plenary Talks

Space Geodetic Imaging of Deformation Due to Active Faults Throughout the Earthquake Cycle · Yuri Fialko

What Have we Learned About Faults and Earthquakes? Using a View from SAFOD to Increase Understanding of Fault Behavior · John Solum

2:15pm Short Contributed Talks

Contributions of EarthScope to Earthquake Hazard Assessment in Northern California · Tom Brocher et al.

Early Insights into the Mechanical Behavior of Materials in the 3D SAFOD Volume · Brett Carpenter et al.

Similarity of Paleostress and in Situ Stress at SAFOD and Implications for a weak San Andreas Fault · Rafael Almeida et al.

Kinematic Modeling of the SAFOD Target Events · Douglas Dreger et al.

III. Non-Volcanic Tremor and Episodic Slip: Fundamental Processes or Curiosities?

Co-Chairs: Roland Burgmann, University of California, Berkeley; Emily Brodsky, University of California, Santa Cruz

EarthScope is focusing significant effort on the two regions where non-volcanic tremor and/or slow slip events have been recognized, including the deployment of borehole strainmeters, seismometers and GPS stations along the Cascadia subduction zone and in the Parkfield/Cholame region. This session will present fundamental issues about the nature and implications of observed transient deformation events and seismic tremor activity, which have been recognized along some subduction zones as well as strike-slip faults in Japan and California. Not all slow deformation events have known tremor activity associated with them and not all tremor events have been accompanied by resolvable deformation transients. What is needed to clarify what processes (slip, fluid flow, and/or others) are associated with the observed phenomena (tremor, transient surface deformation, long-period earthquakes, triggered seismicity)? What are the implications of these transient processes for earthquake occurrence and hazard estimates?

3:30pm **Invited Plenary Talk**

The Mechanics of Episodic Tremor and Slip · David Shelly et al.

4:20pm **Short Contributed Talks**

A 70+ Station GPS Recording of the January, 2007 Cascadia ETS · Tim Melbourne

Slow-Slip and Triggered Earthquakees on Kilauea Volcano with Implications for Slow-Slip and Tremor in Subduction Zones · Paul Segall et al.

Do Episodic Tremor and Slip (ETS) Events Affect Seismicity in the Northern Cascadia Subduction Zone? · Tom Pratt

Non-Volcanic Tremor Driven by Large Transient Shear Stresses · Justin Rubinstein et al.

Imaging Subduction, Episodic Tremor and Slip in the Pacific Northwest: Cascadia Arrays for EarthScope (CAFE) · Geoffrey Abers et al.

Tremor · Aaron Wech and Kenneth Creager

Effect of Parkfield Earthquake on Tremor Activity Below the San Andreas Fault Near Cholame, CA · Bob Nadeau

IV. Mantle Lithosphere: Crucial or Irrelevant to Continental Deformation?

Co-Chairs: Peter Shearer, University of California, San Diego; Aaron Velasco, University of Texas at El Paso

There is long-standing debate over the role of the mantle in the development of topographic features, plate movement, deformation zones, and continental formation. Questions include the role of a weak asthenosphere and ductile flow directions associated with the orogenies, the importance of delamination and upper-mantle buoyancy forces, and the degree of coupling among plates, microplates and the mantle flow field. Data currently being collected and analyzed by EarthScope will help to resolve these issues through detailed mapping of surface deformation, seismic observations of mantle structures, and geodynamic modeling of stress and mantle flow. This research includes direct geodetic observations of the surface strain field, seismic imaging of velocity anomalies, correlation of surface geologic features with seismic structures at depth, shear-wave splitting constraints on the mantle flow field, and modeling of plate boundary dynamics and driving forces for continental deformation. This session explores geodetic, seismic, and geological evidence for the role of mantle dynamics on continental formation and deformation.

8:00am **Invited Plenary Talks**

Lithosphere Coupling with Mantle Circulation in Western North America, Central Asia, and the Rest of the World · William Holt et al.

The Sierra Nevada: Evidence of the Importance of Mantle Lithosphere in Continental Deformation · Hersh Gilbert et al.

9:00am **Short Contributed Talks**

Lithosphere Temperature, Strength, and Deformation in Western North America and EarthScope · Roy Hyndman et al.

Colorado Rockies Experiment and Seismic Transects (CREST): Cenozoic Uplift, Magmatism, and Mantle to Surface Fluid Interconnections Associated with the Aspen Anomaly · Karl Karlstrom et al.

Mapping Upper-Mantle Anisotropy Beneath the Western US: Toward a Coupled Seismic and Geodynamic Analysis of Crust-Mantle Coupling · James Gaherty et al.

9:30am **Panel Discussion**

William Holt, Hersh Gilbert, Roy Hyndman, James Gaherty, Karl Karlstrom

V. Bringing EarthScope Research into the Ungergraduate Classroom

Co-Chairs: Michael Hamburger, Indiana University; Aaron Velasco, University of Texas at El Paso

The EarthScope initiative provides unprecedented opportunities to both the research and education communities. As participants in the EarthScope experiment, many of us bring our experience and expertise with state-of-the-art geophysical and geological data into the classes we teach. This session will allow participants to share their experiences—ranging from tried-and-true exercises to fresh, untested new ideas—on the use of EarthScope-related data and results into the undergraduate science classroom. We invite participants to contribute a poster focused on educational applications of EarthScope science, and to bring along a lab exercise, homework problem, or new idea for using EarthScope data in the classroom.

10:30am **Invited Plenary Talk**

From Data to Insight: Developing Effective Undergraduate Activities Using EarthScope Data · Barb Tewksbury

11:00am **Break Out/Discussion**

EarthScope Data in the Classroom · Michael Hamburger, Indiana University; Barb Tewksbury, Hamilton College

11:20am **Poster Summaries**

11:40am **Poster Session**

Bringing EarthScope Research into the Undergraduate Classroom

VI. What Drives the Western US & How Does it Deform?

Co-Chairs: George Hilley, Stanford University; Wayne Thatcher, U.S. Geological Survey

The kinematics of the Western US represents the balance between plate-boundary loading, normal and shear tractions acting along the base of the lithosphere, internal lithospheric buoyancy, local surface processes, and lithospheric rheology. USArray will provide constraints on the structure of the lithosphere that may reflect lateral and vertical rheological variations and constrain lithospheric buoyancy. Plate Boundary Observatory (PBO) will provide a clear picture of the deformation-rate field over geodetic (i.e., decadal) time scales. Over these geodetic time scales, the deformation-rate field records processes related to the long-term loading of the plate margins, interseismic earthquake cycle effects, and near-surface hydrologic processes. Geologic studies that constrain the kinematics of the Western US over thousands to millions of years lack the spatial resolution of geodetic instrumentation, but contain information about changes in plate boundary loading and rheology, while filtering out many of the shorter time-scale processes (e.g., hydrologic signals and earthquake-cycle effects) that may confound inferences of plate-boundary loading. Thus, the analysis of the deformation-rate field in the Western US over various time scales should provide important clues to the relative magnitude of the driving forces that produce the deformation, and how these forces have changed over time. In this session, we invite posters and short contributions that use geodetic and/or geologic data to quantify the kinematics of the Western US. In addition, geodynamic studies that seek to explain such observations in terms of the driving forces and rheology of the Western US are also encouraged. We especially seek contributions that link specific observations of the kinematics of the Western US over various time scales to its dynamics through geodynamic models.

4:00pm **Invited Plenary Talk**

Driving Forces of the Western North American Plate Boundary Zone · Lucy Flesch et al.

4:30pm **Short Contributed Talks**

Dislocation Models of Interseismic Deformation in the Western United States · Fred Pollitz et al.

The Walker Lane: How Complex is It? Geodetic and Geologic Strain in the Western Basin and Range Using Enhanced Block Modeling Algorithms · William Hammond et al.

Rotational Mantle Flow Beneath the Western US · George Zandt and Gene Humphreys

The Uplift of the Southern Sierra Nevada, the Isabella Seismic Anomaly and Death Valley Extension: A Single Geodynamic Process? · Laetitia Le Pourhiet and Michael Gurnis

VII. Building a Continent in 4D

Co-Chairs: Ben van der Pluijm, University of Michigan; Jonathan Price, University of Nevada, Reno

As a major geophysical experiment, EarthScope is providing heretofore unprecedented views of the structure of the North American continent today. The geodetic observations, and to some extent the seismic observations, will give us a short-term view of geological changes (signals in time frames from seconds to several years), but full four-dimensional analysis, back into deep time, will require the integration of EarthScope's geophysical observations with geochronology, structural geology, neotectonics, mineral physics, petrology, geochemistry, and detailed geologic mapping. This session will highlight some of the promising areas for this integration.

8:00am Invited Plenary Talk

Building a Continent: The Scientific Motivation Behind a Coast-to-Coast GeoSwath · Basil Tikoff

8:40am Short Contributed Talks

Processes of Terrarne Accretion and Modification: The Klamath Mountains of Cascadia · Kate Miller and Calvin Barnes

Regional Geophysical Analyses to Patch Together the Pieces of the GeoSwath · Randy Keller et al.

EarthScope in 'Fly-Over' Country . . . Exploring the Structure and Geological Evolution of the Crust and Lithosphere of the Continental Interior · Ernest Hauser

A Continent-Wide 1-Hz Map of Lg Code Q Variation Across Eurasia and its Relation to Lithospheric Evolution · Brian Mitchell et al.

9:20am Panel Discussion

2007 EarthScope National Meeting Participants

A

Lon Abbott	Red Rocks Community College
Geoffrey Abers	Boston University
Duncan Agnew	University of California, San Diego
Tim Ahern	IRIS
Sheyla Alayón	University of Puerto Rico at Mayaguez
Richard Allen	UC Berkeley
Rafael Almeida	Texas A & M University
Mark Alvarez	IRIS
Mohamed Aly	Idaho State University
Kent Anderson	IRIS
Greg Anderson	UNAVCO
Kyle Anderson	Stanford University
Victoria Andreatta	UNAVCO, Inc.
Elizabeth Anthony	University of Texas at El Paso
Edwin Apel	University of California, Berkeley
David Applegate	U.S. Geological Survey
Ramon Arrowsmith	Arizona State University
Richard Aster	New Mexico Tech
Luciana Astiz	University of California San Diego
Gary Axen	New Mexico Inst. of Mining and Technology

B

Hassan Babaie	Georgia State University
Chaitan Baru	University of California, San Diego
Andre Basset	UNAVCO inc
Bruce Beaudoin	IRIS PASSCAL
Susan Beck	University of Arizona
Heather Bedle	Northwestern University
Caroline Beghein	Arizona State University
Rick Bennett	University of Arizona
Mark Benthien	Southern California Earthquake Center
Susan Bilek	New Mexico Tech
Terrence Blackburn	Massachusetts Institute of Technology
Brian Blackman	UNAVCO
Michael Blanpied	U.S. Geological Survey
Thomas Bleier	QuakeFinder
Geoffrey Blewitt	University of Nevada, Reno
Karin Block	Lamont-Doherty Earth Observatory
Frederick Blume	UNAVCO
Yehuda Bock	Scripps Institution of Oceanography
Paul Bodin	University of Washington
Mark Brandon	Yale University
Richard Brazier	Penn State University DuBois Campus
Richard Briggs	Caltech
Tom Brocher	U.S. Geological Survey
Emily Brodsky	University of California, Santa Cruz
Daniel Brothers	University of California, San Diego
Justin Brown	Stanford University
Larry Brown	Cornell University
Kevin Brown	Scripps Institution of Oeanography
Scott Burdick	Massachusetts Institute of Technology
Roland Burgmann	University of California, Berkeley
Robert Busby	IRIS
Rhett Butler	IRIS
Katrina Byerly	University of South Carolina

C

Eric Calais	Purdue University
Warren Caldwell	Stanford University
Josh Calkins	University of Arizona
Keith Cardon	University of Texas at El Paso
Brett Carpenter	Pennsylvania State University
Rufus Catchings	U.S. Geological Survey
Wu-Lung Chang	University of Utah
J. Andres Chavarria	Paulsson Geophysical
Judith Chester	Texas A&M University
Frederick Chester	Texas A&M University
Elizabeth Cochran	University of California, Riverside
Brian Coyle	UNAVCO
Kenneth Creager	University of Washington
Christopher Crosby	Arizona State University

D

Jeffrey Dingler	University of California, San Diego
Tim Dittman	UNAVCO
Mai Linh Doan	University of California, Santa Cruz
Andrea Donnellan	Jet Propulsion Laboratory
Perle Dorr	IRIS
Briget Doyle	College of Charleston
Douglas Dreger	UC Berkeley
Mihai Ducea	University of Arizona
Ken Dueker	University of Wyoming

2007 EarthScope National Meeting Participants

Clark Dunson. . . . . QuakeFinder
Adam Dziewonski. . . . . . Harvard University

E

Kevin Eagar . . . . Arizona State University
Jennifer Eakins . . . . University of California, San Diego
Arias Eliana . . . . IRIS/PASSCAL
William Ellsworth . . . . . . U. S. Geological Survey
Susan Eriksson. . . . . . . UNAVCO
James Evans . . . . Utah State University

F

Jamie Farrell . . . . University of Utah
Noah Fay. . . . . University of Arizona
Karl Feaux . . . . UNAVCO
Keegan Fengler. . . . . . . UNAVCO/PBO
Yuri Fialko . . . . UCSD
Eric Fielding . . . . Caltech
Melvin Fillerup . . . . University of South Carolina
Delphine Fitzenz . . . . . . CNRS - Geophysics Institute Strasbourg
Lucy Flesch. . . . . Purdue University
David Forand . . . . Utah State University
Matthew Fouch. . . . . . . Arizona State University
David Fountain . . . . National Science Foundation
James Fowler. . . . . IRIS
Andrew Frassetto . . . . . . University of Arizona
Jeff Freymueler . . . . University of Alaska, Fairbanks
Gary Fuis. . . . . U.S. Geological Survey
Junichi Fukuda . . . . Indiana University
Patrick Fulton. . . . . Penn State University
Gareth Funning. . . . . . . University of California, Berkeley

G

James Gaherty . . . . Lamont-Doherty Earth Observatory
Abhijit Gangopadhyay. . . . University of Texas at Austin
Stephen Gao . . . . University of Missouri - Rolla
Miriam Garcia . . . . University of Texas at El Paso
Ed Garnero. . . . . Arizona State University
Hersh Gilbert . . . . Purdue University
Holly Given . . . . Joint Oceanographic Institutions
David Goldsby . . . . Brown University
Art Goldstein . . . . National Science Foundation
Noel Gourmelen . . . . . . University of Miami - RSMAS
Priscilla Grew. . . . . University of Nebraska-Lincoln
Aurelie Guilhem . . . . . . University of California, Berkeley
Linda Gundersen . . . . . . U.S. Geological Survey
Yonggui Guo . . . . Rice University
Cansun Guralp . . . . Guralp Systems, Ltd.
Michael Gurnis . . . . California Institute of Technology

H

Jafar Hadizadeh . . . . . . University of Louisville
Katrin Hafner. . . . . UNAVCO, Inc.
Bezalel Haimson . . . . . . University of Wisconsin
Michael Hamburger. . . . . Indiana University
William Hammond . . . . . Nevada Bureau of Mines and Geology
Samantha Hansen . . . . . University of California, Santa Cruz
Steven Hansen . . . . University of Wyoming
Roger Hansen . . . . University of Alaska Fairbanks
Steven Harder . . . . University of Texas at El Paso
Rebecca Harrington . . . . University of California, Los Angeles
Robert Harris. . . . . Oregon State University
Derrick Hasterok . . . . . . University of Utah
Michael Hasting . . . . . . UNAVCO Inc
Ernest Hauser . . . . Wright State University
Gavin Hayes . . . . Penn State University
John He . . . . GSC Pacific
Margaret Hellweg . . . . . . UC Berkeley
Don Helmberger . . . . . . Caltech
Daniel Hernandez . . . . . Stony Brook University
Thomas Herring . . . . . . Massachusetts Institute of Technology
Stephen Hickman . . . . . U.S. Geological Survey
Dave Hill . . . . U.S. Geological Survey
George Hilley . . . . Stanford University
kathleen Hodgkinson . . . . UNAVCO
John Hole . . . . Virginia Tech
Austin Holland . . . . University of Arizona
William Holt . . . . Stony Brook University
Nicolas Houlie . . . . UC California
Stephan Husen. . . . . . . ETH Zurich
Alexander Hutko . . . . . . UCSC
Roy Hyndman . . . . Pacific Geoscience Centre

I

Shane Ingate. . . . . IRIS

J

Mike Jackson . . . . UNAVCO
Efrat Jaeger . . . . San Diego Supercomputer Center, UCSD
Susanne Janecke . . . . . . Utah State University
John Jasbinsek . . . . Univerity of Wyoming
Alemayehu Jemberie . . . . North Carolina A&T State University
Fred Jenkins . . . . UNAVCO
Chen Ji . . . . University of California, Santa Barbara
Ingrid Johanson . . . . . . U.S. Geological Survey
Leonard Johnson . . . . . . National Science Foundation
Jenda Johnson . . . . IRIS-USArray
Wade Johnson . . . . UNAVCO

K

Alan Kafka . . . . Boston College
Johnson Kaj . . . . Indiana University
Linus Kamb . . . . IRIS
Karl Karlstrom . . . . University of New Mexico
Marianne Karplus . . . . . . Stanford University
Kelly Keighley Bradbury . . . Utah State University
Randy Keller . . . . University of Oklahoma
Louise Kellogg . . . . University of California, Davis
Burton Kennedy . . . . . . Lawrence Berkeley Natl Lab
Kathleen Keranen . . . . . Stanford University
Nancy King . . . . U. S. Geological Survey
David Kirschner. . . . . . . Saint Louis University
Hiroko Kitajima . . . . Texas A&M University
Simon Klemperer . . . . . . Stanford University
Christian D. Klose . . . . . . Columbia University
Matthew Knuth . . . . University of Wisconsin
Minoo Kosarian . . . . . . Penn State University
Corn Kreemer . . . . University of Nevada, Reno
Ralf Krug . . . . Pinnacle Technologies
Ban-Yuan Kuo . . . . Institute of Earth Sciences, Academia Sinica
Charles Kurnik . . . . UNAVCO

L

John LaBrecque . . . . . . NASA HQ
John Langbein . . . . U.S. Geological Survey
Charles Langston . . . . . . CERI, University of Memphis
Sandra Laursen . . . . . . University of Colorado
Thorne Lay . . . . University of California, Santa Cruz
Kerstin Lehnert . . . . Columbia University
William Leith . . . . U.S. Geological Survey
Arthur Lerner-Lam . . . . . Lamont-Doherty Earth Observatory
Alan Levander . . . . Rice University
Vadim Levin . . . . Rutgers university
Qingsong Li . . . . Lunar and Planetary Institute
Yong-Gang Li . . . . University of Southern California
Chuntao Liang . . . . University of Memphis
Leslie Linn . . . . IRIS
Michael Lisowski . . . . . . U.S. Geological Survey
Mian Liu . . . . University of Missouri, Columbia
Kelly Liu . . . . University of Missouri, Rolla
Simon Lloyd . . . . Northwestern Universtiy
David Lockner . . . . U.S. Geological Survey
Rowena Lohman . . . . . . Jet Propulsion Laboratory
Anthony Lowry . . . . Utah State University
Paul Lundgren . . . . California Institute of Technology
Amy Luther . . . . University of New Mexico

M

Maria Beatrice Magnani . . Center for Earthquake Research and Info.
Tilahun Mammo . . . . . . Addis Ababa University
Chris Marone . . . . Penn State
Nancy Martin . . . . Jackson Creek Middle School
Lauren Mattatall . . . . . . Arizona State University
Glen S. Mattioli . . . . University of Arkansas
Margaret-Ann Mayer . . . . Dine College
Patricia McCrory . . . . . . U.S. Geological Survey
Neil McGlashan . . . . . . Cornell University
Jason McKenna . . . . . . U.S. Army Engineer R&D
George McMechan . . . . . University of Texas At Dallas
Marcia McNutt . . . . Monterey Bay Aquarium Research Institute
John McRaney . . . . University of Southern California
Charles Meertens. . . . . . UNAVCO
Tim Melbourne . . . . CWU
Anne Meltzer . . . . Lehigh University
David Mencin . . . . UNAVCO
Kate Miller . . . . University of Texas at El Paso
Jean Miller . . . . IAGT
Brian Mitchell . . . . Saint Louis University
Walter Mooney . . . . U.S. Geological Survey

2007 EarthScope National Meeting Participants

Diane Moore	U. S. Geological Survey
Robin Morris	IRIS
Lynne Murdock	Department of the Interior, National Parks
Jessica Murray	U. S. Geological Survey
Mark Murray	New Mexico Tech

N

Robert Nadeau	University of California, Berkeley
Shaji Nair	Arizona State University
Mohammed Nassief	King Abdul Aziz University
Douglas Neuhauser	University of California, Berkeley
Maria Neves	Universidade do Algarve
Andrew Newman	Georgia Institute of Technology
Alex Nikulin	Rutgers university
Fenglin Niu	Rice University

O

David Okaya	University of Southern California
Shelley Olds	UNAVCO
Michael Oskin	University of North Carolina at Chapel Hill
Susan Owen	Jet Propulsion Laboratory

P

Josep M Pares	University of Michigan
Jeffrey Park	Yale University
Jerome Paros	Paroscientific, Inc.
Lina Patino	National Science Foundation
Benjamin Pauk	UNAVCO
Gary Pavlis	Indiana University
Chris Pearson	National Geodetic Survey
Zhigang Peng	Georgia Institute of Technology
David Phillips	UNAVCO
Fred Pieper	IAGT
Hans-Peter Plag	Unversity of Nevada, Reno
Fred Pollitz	U.S. Geological Survey
Christine Powell	University of Memphis
Thomas Pratt	U. S. Geological Survey
Stephanie Prejean	U.S. Geological Survey
Jonathan Price	University of Nevada, Reno
Matt Pritchard	Cornell University
Christine Puskas	University of Utah

R

Ivan Rabak	The University of Memphis
Horst Rademacher	Guralp Systems, Ltd.
Andrew Rathbun	Pennsylvania State University
Minghua Ren	University of Texas at El Paso
Carlos Rios	Oregon State University
Michael Ritzwoller	University of Colorado at Boulder
Steven Roecker	Rensselaer Polytechnic Institute
Barbara Romanowicz	University of California, Berkeley
Stephane Rondenay	Massachusetts Institute of Technology
Dylan Rood	Lawrence Livermore National Laboratory
Jeffrey Roth	Arizona State University
Justin Rubinstein	University of Washington
Eva-Maria Rumpfhuber	University of Texas at El Paso
Isabelle Ryder	University of California, Berkeley
Michael Rymer	U.S. Geological Survey

S

Etienne Samson	Pinnacle technologies
Victor Santillan	Central Washington University
Jeanne Sauber	NASA Goddard Space Flight Center
Jeffery Sayers	Ball State University
Daniel Scheirer	U.S. Geological Survey
Robert Schlottmann	University of California, Santa Cruz
Nicholas Schmerr	Arizona State University
Adam Schultz	National Science Foundation
Bill Schultz	IAGT
Susan Schwartz	University of California, Santa Cruz
David Schwartz	U.S. Geological Survey
Eugene Schweig	U.S. Geological Survey
Dogan Seber	University of California, San Diego
Paul Segall	Stanford
Steven Semken	Arizona State University
Ewa Shannon	East Chicago Central High School
Guangfu Shao	University of California, Santa Barbara
Serge Shapiro	Freie Universitaet Berlin
Gillian Sharer	IRIS
Peter Shearer	University of California, San Diego
Kaye Shedlock	National Science Foundation
David Shelly	Stanford University
Paul Silver	Carnegie Institution of Washington

Gerald Simila. . . . . CSU Northridge
David Simpson . . . . IRIS
Robert Smalley . . . . The University of Memphis
Kevin Smith . . . . University of Nevada, Reno
Robert Smith . . . . University of Utah
Catherine Snelson . . . . . University of Nevada, Las Vegas
Hollice A. Snyder . . . . . . U.S. Geological Survey
John Solum . . . . Sam Houston State University
Seok-Goo Song . . . . . . Stanford University
Teh-Ru Song . . . . Caltech
Christopher James Spiers . . Utrecht University
Glenn Spinelli . . . . New Mexico Tech
Josh Stachnik . . . . University of Wyoming
Seth Stein . . . . Northwestern University
Blaise Stephanus. . . . . . UNAVCO
Robert Stern . . . . University of Texas at Dallas
Daniel Stockli . . . . University of Kansas
Martin Stute . . . . Lamont-Doherty Earth Observatory
Daoyuan Sun. . . . . California Institute of Technology
Laura Swafford . . . . Northwestern University

T

John Taber . . . . IRIS
Taka'aki Taira . . . . University of Utah
Toshiro Tanimoto . . . . . . University of California, Santa Barbara
Mike Taylor . . . . University of Kansas
Sheryl Tembe. . . . . SUNY Stony Brook
Mary Templeton . . . . . . IRIS
Joya Tetreault . . . . University of New Mexico
Barbara Tewksbury . . . . . Hamilton College
Wayne Thatcher. . . . . . . U.S. Geological Survey
Clifford Thurber . . . . University of Wisconsin, Madison
Basil Tikoff . . . . University of Wisconsin
Harold Tobin . . . . University of Wisconsin, Madison
Thomas Torgersen . . . . . University of Connecticut
Chad Trabant . . . . IRIS
Anne Trehu . . . . Oregon State University

V

Nicholas van der Elst . . . . University of California, Santa Cruz
Suzan van der Lee . . . . . Northwestern University
Ben van der pluijm . . . . . University of Michigan
Peter van Keken . . . . . . University of Michigan
Jolante van Wijk . . . . . . Los Alamos National Laboratory
Aaron Velasco . . . . University of Texas at El Paso
Frank Vernon . . . . University of California, San Diego

W

Gregory Waite . . . . U.S. Geological Survey
Christian Walls . . . . UNAVCO
Zhenming Wang . . . . . . University of Kentucky
Baoshan Wang . . . . Institute of Geophysics, China
Linda Warren . . . . University of Arizona
Frank Webb . . . . JPL
Aaron Wech . . . . University of Washington
Dayanthie Weeraratne . . . Carnegie Institution of Washington
Meng Wei . . . . Scripps Institution of Oceanography
Charles Weiland . . . . . . Stanford University
John West . . . . Arizona State University
James Whitcomb . . . . . . National Science Foundation
Douglas Wiens . . . . Washington University
Raymond Willemann . . . . IRIS
Colin Williams . . . . U.S. Geological Survey
Todd Williams . . . . UNAVCO-PBO
Charles Williams . . . . . . Rensselaer Polytechnic Institute
Teng-Fong Wong . . . . . . Stony Brook University
Lindsay Wood . . . . IRIS
Rob Woolley . . . . IRIS

Y

Yingjie Yang . . . . University of Colorado
Tomoko Yano . . . . University of California, Santa Barbara
Huaiyu Yuan . . . . University of Wyoming
Sang-Ho Yun . . . . U.S. Geological Survey

Z

George Zandt. . . . . University of Arizona
Hua-wei Zhou . . . . University of Houston
Wen-lu Zhu. . . . . Woods Hole Oceanographic Institution
Mark Zoback . . . . Stanford University
Brian Zurek. . . . . Lehigh University

BUILDING AND DESTROYING A VOLCANO IN REAL TIME

1 **ACCELERATED UPLIFT OF THE YELLOWSTONE CALDERA, 2004-2006, FROM GPS AND INSAR OBSERVATIONS**
Wu-Lung Chang Chang, Chuck Wicks, Robert Smith, Jamie Farrell, and Christine Puskas

2 **TEMPORAL STRESS VARIATIONS OF THE YELLOWSTONE VOLCANIC SYSTEM: SEISMIC AND MAGMATIC CONTRIBUTIONS**
Jamie Farrell, Robert Smith, and Greg Waite

3 **A MECHANICAL MODEL OF THE LARGE-DEFORMATION 2005 SIERRA NEGRA VOLCANO ERUPTION DERIVED FROM INSAR MEASUREMENTS**
Sang-Ho Yun, Paul Segall, and Howard Zebker

4 **INTERFEROGRAM FORMATION IN THE PRESENCE OF LARGE DEFORMATION**
Sang-Ho Yun, Howard Zebker, Paul Segall, Andy Hooper, and Michael Poland

5 **TIME-DEPENDENT FINITE ELEMENT MODELING OF EFFUSIVE SILICIC ERUPTIONS**
Kyle Anderson and Paul Segall

6 **ERUPTION DYNAMICS AT MOUNT ST. HELENS IMAGED FROM INVERSION OF BROADBAND SEISMIC WAVEFORMS: INTERACTION OF THE SHALLOW MAGMATIC AND HYDROTHERMAL SYSTEMS**
G P Waite, B A Chouet, and P B Dawson

7 **THE EARTHSCOPE PLATE BOUNDARY OBSERVATORY RESPONSE TO THE 2006 AUGUSTINE ALASKAN VOLCANIC ERUPTION.**
Benjamin Pauk, Michael Jackson, Karl Feaux, Barrett Friesen, Max Enders, Austin Baldwin, Ally Marzulla, and Kelly Fournier

8 **RELATIONSHIPS BETWEEN VOLCANIC CINDER CONE ANGLE AND AGES: A POTENTIAL DIAGNOSTIC TOOL FOR ESTIMATING QUATERNARY ERUPTION AGES AND VOLCANIC HAZARDS**
Miriam E. Garcia, Elizabeth Y. Anthony, Jose M. Jr. Hurtado, and Joseph G. Miller

WHAT HAVE WE LEARNED ABOUT FAULTS AND EARTHQUAKES?

9 **WHAT HAVE WE LEARNED ABOUT FAULTS AND EARTHQUAKES? USING A VIEW FROM SAFOD TO INCREASE UNDERSTANDING OF FAULT BEHAVIOR**
John Solum

10 **CONTRIBUTIONS OF EARTHSCOPE TO EARTHQUAKE HAZARD ASSESSMENT IN NORTHERN CALIFORNIA**
Tom Brocher, Arthur Rodgers, Brad Aagaard, Bill Ellsworth, Steve Hickman, Diane Moore, Jessica Murray, and Carol Prentice

11 **PROBABILISTIC MODELING OF EARTHQUAKE OCCURRENCE: FIRST EXAMPLES OF DATA INTEGRATION WITHIN A BAYESIAN FRAMEWORK.**
Delphine Fitzenz, Chris Spiers, Andre Jalobeanu, and Stephen Hickman

12 **KINEMATIC MODELING OF THE SAFOD TARGET EVENTS**
Douglas Dreger, Robert Nadeau, and Angela Morrish

13 **A MICROSEISMIC VIEW OF THE IMMEDIATE SAFOD TARGET ZONE**
Robert M. Nadeau

14 **SUPERSTITION HILLS FAULT CREEP EVENT ON OCT.3 2006**
Meng Wei and David Sandwell

15 **INVESTIGATING FAULT CREEP PHENOMENA IN THE SAN FRANCISCO BAY AREA USING PS-INSAR AND GPS**
Gareth Funning, Alessandro Ferretti, Fabrizio Novali, and Roland Burgmann

16 **ICE MASS CHANGES AND EARTHQUAKE HAZARD IN SOUTHERN ALASKA**
Jeanne Sauber and Natasha Ruppert

17 **BAYESIAN GEODETIC INVERSION FOR FAULT SLIP DISTRIBUTION**
Junichi Fukuda and Kaj Johnson

Posters

18 **INSAR OBSERVATIONS OF CREEP ON THE CENTRAL SAN ANDREAS FAULT**
Isabelle Ryder and Roland Burgmann

19 **REGIONAL MOMENT TENSORS IN NORTHERN CALIFORNIA: ADDING DATA FROM USARRAY STATIONS**
Margaret Hellweg, Douglas Dreger, and Barbara Romanowicz

20 **ASSESSING SEISMIC SLIP FRACTIONS AT SUBDUCTION ZONES**
Laura Swafford and Seth Stein

21 **BACK-PROJECTION IMAGING THE RUPTURES OF THE NOVEMBER 15, 2006 AND JANUARY 13, 2007 KURIL EARTHQUAKES**
Alexander Hutko and Thorne Lay

22 **THE SAN ANDREAS FAULT IN SOUTHERN CALIFORNIA IS ALMOST NOWHERE VERTICAL—IMPLICATIONS FOR TECTONICS, SHAKING HAZARDS, AND GEODETIC MODELING**
Gary Fuis, Victoria Langenheim, Daniel Scheirer, and Monica Kohler

23 **STRUCTURAL ANALYSIS OF THE SAN ANDREAS FAULT ZONE IN THE SAFOD BOREHOLE**
Sarah Draper, Kelly Bradbury, and James Evans

24 **RESULTS OF ELEMENTAL, STABLE ISOTOPE, ORGANIC MATTER, AND FISSION-TRACK ANALYSES OF SAFOD DRILL-HOLE CUTTINGS AND CORE MATERIAL**
David Kirschner, John Solum, Judith Chester, Fred Chester, Stephen Hickman, Diane Moore, John Garver, and Jim Evans

25 **ANALYSES OF SIDEWALL CORES AND CUTTINGS FROM A DEEPER SECTION OF THE SAFOD BOREHOLE**
Kelly Bradbury, Corey Barton, John Solum, James Evans, and Sarah Draper

26 **PETROLOGIC AND TECTONIC ANALYSES OF EOCENE ROCKS WEST OF THE SAN ANDREAS FAULT, SAFOD**
Sarah Draper, David Kirschner, Jon Garver, James Evans, Kelly Bradbury, and Laird Thompson

27 **SPATIAL AND PROCESS ONTOLOGIES FOR BRITTLE SHEAR ZONES: SAFOD PROJECT**
Hassan Babaie and Jafar Hadizadeh

28 **ASSESMENT OF ACOUSTIC AND MAGNETIC PROPERTIES IN CORE SAMPLES FROM THE SAFOD MAIN HOLE: PRELIMINARY RESULTS**
Laurent Louis, Teng-fong Wong, Philippe Robion, and Christian David

29 **PALEOMAGNETIC REORIENTATION OF THE SAFOD BOREHOLE**
Josep Pares, Ben van der Pluijm, Anja Schleicher, and Stephen Hickman

30 **CONTINUOUS IN-SITU MEASUREMENT OF STRESS-INDUCED TRAVEL TIME VARIATION AT PARKFIELD**
Fenglin Niu, Paul Silver, Tom Daley, and Ernest Majer

31 **SPACE/TIME PROPERTY VARIATIONS ON THE PARKFIELD SAN ANDREAS FROM FAULT GUIDED WAVES**
Yong-Gang Li and Peter Malin

32 **DETECTING SEISMOGENIC STRESS EVOLUTION AND CONSTRAINING FAULT-ZONE RHEOLOGY IN SAN ANDREAS FAULT, FOLLOWING THE 2004 PARKFIELD EARTHQUAKE**
Taka`aki Taira, Paul Silver, Fenglin Niu, and Robert Nadeau

33 **SIMILARITY OF PALEOSTRESS AND IN SITU STRESS AT SAFOD AND IMPLICATIONS FOR A WEAK SAN ANDREAS FAULT**
Rafael Almeida, Judith Chester, and Frederick Chester

34 **SMALL-SCALE VARIATION IN SEISMIC ANISOTROPY ACROSS THE SAN ANDREAS FAULT NEAR PARKFIELD, CALIFORNIA**
Lauren R. Mattatall and Matthew J. Fouch

35 **ROCK DAMAGE AND HEAL ON THE SAN ANDREAS FAULT INVOLVED IN THE 2004 M6 PARKFIELD EARTHQUAKE**
Yong-Gang Li, Po Chen, Elizabeth S. Cochran, and John E. Vidale

36 **SEISMIC EVIDENCE FOR A WIDE DAMAGE ZONE AT THE CALICO FAULT, CALIFORNIA**
Elizabeth Cochran, Peter Shearer, Yuri Fialko, YongGang Li, and John Vidale

37 **SEISMIC IMAGING OF VELOCITY CONTRAST ALONG THE SAN ANDREAS FAULT SYSTEM WITH FAULT ZONE HEAD WAVES GENERATED BY REPEATING EARTHQUAKES**
Peng Zhao and Zhigang Peng

38 **SWELLING CLAYS AND SHALLOW FAULT BEHAVIOR: MICROSTRUCTURAL AND MICROCHEMICAL RESULTS FROM THE SAN ANDREAS FAULT OBSERVATORY AT DEPTH (SAFOD)**
Ben van der Pluijm, Anja Schleicher, Laurence Warr, Sara Tourscher

39 **VELOCITY WEAKENING IN PHYLLOSILICATE-BEARING FAULT GOUGES: IS THERE EVIDENCE FOR SIMILAR PROCESSES IN SAFOD SAMPLES?**
André Niemeijer and Chris Spiers

40 **FRICTIONAL PROPERTIES OF SERPENTINE AT HIGH SLIDING VELOCITY**
David Goldsby and Greg Hirth

41 **TALC IN SAFOD SERPENTINITE CUTTINGS AND ITS POSSIBLE SIGNIFICANCE FOR FAULT CREEP**
Diane Moore and Michael Rymer

42 **EARLY INSIGHTS INTO THE MECHANICAL BEHAVIOR OF MATERIALS INTHE 3D SAFOD VOLUME**
Brett Carpenter, Andrew Rathbun, Demian Saffer, and Chris Marone

43 **FRICTIONAL BEHAVIOR OF SAFOD FAULT-ROCKS AND PUNCHBOWL ULTRACATACLASITE SHEARED AT SEISMIC SLIP RATES**
Hiroko Kitajima, Toshihiko Shimamoto, Judith Chester, and Frederick Chester

44 **WHAT IS THE ROLE OF MINOR GOUGE ZONES IN THE DAMAGE ZONE OF THE SAF SYSTEM?**
Jafar Hadizadeh, Hassan Babaie, Karen Mair, and Giulio Di Toro

45 **GEOMETRICAL EFFECTS OF FAULT BENDS ON FAULT DEFORMATION AND STICK SLIP BEHAVIOR: INSIGHTS FROM DISTINCT ELEMENT SIMULATIONS**
Yonggui Guo and Julia Morgan

46 **HEAT FLOW MEASUREMENTS ACROSS THE SAN ANDREAS FAULT NEAR PARKFIELD, CALIFORNIA – PRELIMINARY RESULTS FROM SAFOD**
Colin Williams, Frederick Grubb, and S. Peter Galanis, Jr.

47 **THE EFFECT OF THERMAL REFRACTION ON HEAT FLOW SCATTER NEAR THE SAN ANDREAS FAULT, PARKFIELD, CA**
Patrick Fulton and Demian Saffer

48 **CHANGES IN TIDAL RESPONSE OF PORE PRESSURE DATA OF PBO BOREHOLES**
Mai Linh Doan and Emily Brodsky

49 **HELIUM ISOTOPE MEASUREMENTS ON MATRIX FLUIDS FROM THE SAFOD DRILLCORE**
Martin Stute, Gisela Winckler, Peter Schlosser, and Thomas Torgersen

NON-VOLCANIC TREMOR AND EPISODIC SLIP: FUNDAMENTAL PROCESSES OR CURIOSITIES

50 **IMAGING SUBDUCTION, EPISODIC TREMOR AND SLIP IN THE PACIFIC NORTHWEST: CASCADIA ARRAYS FOR EARTHSCOPE (CAFE)**
Geoffrey Abers, Zhu Zhang, Tim Melbourne, Stephane Rondenay, Bradley Hacker, Kenneth Creager, Steve Malone, and Aaron Wech

51 **TREMOR**
Aaron Wech and Kenneth Creager

52 **LOCATING CASCADIA DEEP TREMOR USING ENVELOPE CROSS CORRELATION**
Kenneth Creager, Geoffrey Abers, Zhu Zhang, Tim Melbourne, Stephane Rondenay, Bradley Hacker, Aaron Wech, and Stephen Malone

53 **NON-VOLCANIC TREMOR DRIVEN BY LARGE TRANSIENT SHEAR STRESSES**
Justin Rubinstein, John Vidale, Paul Bodin, Ken Creager, Steve Malone, and Joan Gomberg

54 **SLOW-SLIP AND TRIGGERED EARTHQUAKES ON KILAUEA VOLCANO, WITH IMPLICATIONS FOR SLOW-SLIP AND TREMOR IN SUBDUCTION ZONES**
Paul Segall, Shin-ichi Miyazaki, Allan Rubin, Emily Desmarais, and David Shelley

55 **REFINING THE CHARACTERIZATION OF A STRAIN RATE TRANSIENT ALONG THE SAN ANDREAS AND SAN JACINTO FAULTS FOLLOWING THE OCTOBER 1999 HECTOR MINE EARTHQUAKE.**
Daniel Hernandez, William E. Holt, Richard A. Bennett, and A. John Haines

MANTLE LITHOSPHERE: CRUCIAL OR IRRELEVANT TO CONTINENTAL DEFORMATION

56 **LITHOSPHERE TEMPERATURE, STRENGTH, AND DEFORMATION IN W. NORTH AMERICA & EARTHSCOPE**
Roy Hyndman, Claire Currie, and Stephane Mazzotti

57 **COMPOSITIONAL AND THERMAL CONTRIBUTIONS TO NORTH AMERICAN ELEVATION**
Derrick Hasterok and David Chapman

58 **PROGRESS ON A NEW REGIONAL MODEL OF THE UPPER MANTLE S-VELOCITY STRUCTURE BENEATH THE NORTH AMERICAN CONTINENT**
Heather Bedle and Suzan van der Lee

59 **S-WAVE VELOCITY STRUCTURE OF THE HIGH LAVA PLAINS, OREGON, FROM RAYLEIGH-WAVE DISPERSION INVERSION**
Linda Warren, David James, and Arthur Snoke

60 **AMBIENT NOISE TOMOGRAPHY IN THE WESTERN US USING EARTHSCOPE/USARRAY TRANSPORTABLE ARRAY DATA**
Michael Ritzwoller, Morgan Moschetti, Yingjie Yang, Fan-Chi Lin, Gregory Bensen, Anatoli Levshin, and Mikail Bramin

61 **HIGH-RESOLUTION 3-D SHEAR VELOCITY MODEL OF THE CRUST AND UPPER MANTLE BENEATH W. US: SURFACE WAVE TOMOGRAPHY COMBINING AMBIENT SEISMIC NOISE AND TELESEISMIC DATAA:**
Yingjie Yang, Donald Forsyth, Michael Ritzwoller, and Morgan Moschetti

62 **TRAVEL TIME TOMOGRAPHY WITH USARRAY DATA**
S. Burdick, C. Li, R.D. van der Hilst, V. Martynov, T. Cox, J. Eakins, L. Astiz, and F.L. Vernon

63 **PROBING CONTINENTAL LITHOSPHERE USING WAVEFORMS**
Teh-Ru Song and Don Helmberger

64 **P AND S WAVEFORM DISTORTIONS REVEAL A DEPLETED, DESTABILIZED CONTINENTAL LITHOSPHERE NEAR THE RIO GRANDE RIFT**
Teh-Ru Song and Don Helmberger

65 **OFFSET OF A BRIGHT, SHALLOW MOHO ACROSS THE COAST SHEAR ZONE IN THE COAST MOUNTAINS BATHOLITH, 52°-56° N**
Josh Calkins, George Zandt, and Ken Dueker

66 **UPPER MANTLE VELOCITY DISCONTINUITY STRUCTURE BENEATH THE PACIFIC NORTHWEST, UNITED STATES FROM PS CONVERTED PHASES**
Kevin Eagar and Matthew Fouch

67 **WAVEFIELD MIGRATION OF EARTHSCOPE USARRAY DATA APPLIED TO PRECURSORS OF SS TO IMAGE UPPER MANTLE DISCONTINUITY STRUCTURE**
Nicholas Schmerr, Christine Thomas, and Edward Garnero

68 **THE SIERRA NEVADA: EVIDENCE OF THE IMPORTANCE OF MANTLE LITHOSPHERE IN CONTINENTAL DEFORMATION**
Hersh Gilbert, George Zandt, Criag Jones, and Tom Owens

69 **SEISMIC ANISOTROPY OF THE LOWER CRUST IN THE CENTRAL SIERRA NEVADA**
Andy Frassetto, Hersh Gilbert, George Zandt, Owen Hurd, Craig Jones, Ian Bastow, and Tom Owens

70 **EARS AND THE BULK CRUSTAL PROPERTIES OF THE SIERRA NEVADA**
Katrina Byerly, Hersh Gilbert, George Zandt, Craig Jones, Thomas J. Owens, and Philip Crotwell

71 **COLORADO ROCKIES EXPERIMENT AND SEISMIC TRANSECTS (CREST): CENOZOIC UPLIFT, MAGMATISM, AND MANTLE TO SURFACE FLUID INTERCONNECTIONS ASSOCIATED WITH THE ASPEN ANOMALY**
Karl Karlstrom, Rick Aster, Jon MacCarthy, Matt Heizler, David Hilton, Laura Crossey, Cristina Takacs-Vesbach, and Ken Dueker

72 **SEISMIC ANISOTROPY, SUBDUCTION, MANTLE FLOW AND UPLIFT IN THE NORTHERN APENNINES, CENTRAL ITALY**
Jeffrey Park, Jaroslava Plomerova, Petr Jedlicka, Simone Salimbeni, Silvia Pondrelli, Lucia Margheriti, Francesco Pio Lucente, and Vadim Levin

73 **MAPPING UPPER-MANTLE ANISOTROPY BENEATH THE WESTERN US: TOWARD A COUPLED SEISMIC AND GEODYNAMIC ANALYSIS OF CRUST-MANTLE COUPLING**
James Gaherty, Li Zhao, Po Chen, Arthur Lerner-Lam, Joya Tétreault, and Mousumi Roy

74 **RADIAL AND AZIMUTHAL ANISOTROPY IN THE LITHOSPHERE AND ASTHENOSPHERE UNDER NORTH AMERICA FROM LONG PERIOD WAVEFORM INVERSION**
Barbara Romanowicz and Federica Marone

75 **TESTING THE FIVE SIMPLEST UPPER MANTLE ANISOTROPIC VELOCITY PARAMETERIZATIONS USING TELESEISMIC S AND SKS DATA FROM THE BILLINGS, MONTANA PASSCAL ARRAY**
Huaiyu Yuan, Ken Dueker, and Derek Schutt

76 **SHEAR-WAVE SPLITTING IN THE GREAT BASIN**
John D. West and Matthew J. Fouch

77 **UPPER MANTLE SEISMIC VELOCITY STRUCTURE IN THE GREAT BASIN**
Caroline Beghein, Matthew Fouch, and J. Arthur Snoke

BRINGING EARTHSCOPE RESEARCH INTO THE UNDERGRADUATE CLASSROOM

78 **GEOEARTHSCOPE AND RELATED TOPOGRAPHIC LIDAR DATASETS IN THE CLASSROOM: LESSONS ABOUT GEOMORPHOLOGY, DIGITAL ELEVATION MODELS, AND CYBERINFRASTRUCTURE**
Ramon Arrowsmith

79 **SITE RECONNAISSANCE AND OUTREACH ACTIVITIES FOR THE TRANSPORTABLE ARRAY**
Perle Dorr, Matt Mercurio, Robert Busby, and John Taber

80 **EARTHSCOPE ENGAGES AMERICAN INDIAN STAKEHOLDERS IN ARIZONA**
Steven Semken, Peterson Zah, Jaynie Parrish, Matthew Fouch, Edward Garnero, Rena Martin, and Donald Lippert

81 **AN INTERACTIVE MAP TOOL FOR EARTHSCOPE EDUCATION AND OUTREACH**
Michael Hamburger, Marianne Weingroff, Anne Hereford, William Holt, Lou Estey, Chuck Meertens, Susan Eriksson, and Stuart Wier

82 **AFRICAARRAY**
Andrew Nyblade, Gerhard Graham, Richard Brazier, and Paul Dirks

83 **SCEC COMMUNICATION, EDUCATION, AND OUTREACH PROGRAM**
Mark Benthien

84 **DATA FOR EDUCATORS: BRINGING GPS AND DATA-RICH ACTIVITIES INTO COLLEGE AND SECONDARY EARTH SCIENCE CLASSROOMS**
Shelley Olds, Andrew Newman, and Susan Eriksson

85 **THE BOSTON COLLEGE EDUCATIONAL SEISMOLOGY PROJECT: INVITING STUDENTS INTO THE WORLD OF SCIENCE RESEARCH**
Alan Kafka, Anastasia Macherides-Moulis, Leslie Campbell, Barbara Sheffels, Michael Barnett, John Ebel, Dina Smith, and Stephen Swift

86 **USING GPS DEFORMATION DATA IN UNDERGRADUATE CLASSES AND RESEARCH PROJECTS: STORIES FROM THE FRONT LINES**
Glen S. Mattioli

87 **USING SPACE GEODETIC DATA TO TEACH ABOUT TECTONICS, EARTHQUAKES, AND HAZARDS**
Seth Stein

88 **BRINGING RESEARCH AND DISCOVERY INTO EARTH SCIENCE CLASSROOMS WITH 3D VISUALIZATION OF GEOPHYSICAL DATA**
Ed Garnero and Marvin Simkin

89 **INTEGRATING EARTHSCOPE WITH REGIONAL GEOLOGY AND GEOLOGIC HAZARDS: LESSONS LEARNED FROM TEACHERS ON THE LEADING EDGE**
Robert Butler, Bonnie Magura, Charles Ault Jr., Roger Groom, Chris Hedeen, and Jenda Johnson

90 **USING IRIS INSTRUMENTS IN AN UNDERGRADUATE GEOPHYSICS COURSE**
Gary Pavlis

91 **IRIS UNDERGRADUATE INTERNSHIP PROGRAM AND ORIENTATION ENTERS ITS SECOND YEAR**
Michael Hubenthal and Rick Aster

92 **AN ONGOING PROJECT TO TRANSLATE EARTHSCOPE EDUCATION AND OUTREACH MATERIALS TO SPANISH**
Charley Faria, John DeLaughter, and Carlos Rios

93 **CONSCIENTIZATION AND MISCONCEPTIONS ROLES IN NATURAL HAZARD PREPAREDNESS: AN EARTHSCOPE PRIORITY GOAL.**
Carlos Rios, John DeLaughter, Shawn Rowe, and Charley Faria

WHAT DRIVES THE WESTERN US & HOW DOES IT DEFORM?

94 **ACCELERATED LOADING RATE ACCOMPANIES CLUSTERED EARTHQUAKE ACTIVITY IN THE EASTERN CALIFORNIA SHEAR ZONE**
Michael Oskin, Lesley Perg, Eitan Shelef, Michael Strane, Emily Gurney, and Brad Singer

95 **PRELIMINARY GEOMORPHIC AND STRUCTURAL OBSERVATIONS ALONG THE CENTRAL SEGMENT OF THE GARLOCK FAULT; WHY DOES THE GARLOCK DEFY SLIP RATE PREDICTIONS?**
Michael Taylor, J. Douglas Walker, Zachary Casey, Eugene Szymanski, Justin Fairchild, Bethia Hall, Jacqueline Grunau, William Scriven, and David Lobue

96 **STRAIN PARTITIONING AND FAULT INTERACTION IN THE SAN ANDREAS FAULT PLATE BOUNDARY ZONE: INSIGHTS FROM GEODYNAMIC MODELING**
Mian Liu, Qingsong Li, and Hui Wang

97 **A 3D EARTHQUAKE CYCLE MODEL FOR THE SAN FRANCISCO BAY AREA**
Kaj Johnson, Junichi Fukuda, and Paul Segall

98 **TECTONIC IMPLICATIONS OF HEAT FLOW DETERMINATIONS IN PBO STRAINMETER BOREHOLES**
Robert N. Harris, Colin F. Williams, Frederick V. Grubb, and David S. Chapman

99 **TESTING THE CONSTANCY OF TERTIARY AND QUATERNARY DEFORMATION RATES ACROSS THE SIERRA NEVADA FRONTAL FAULT ZONE USING CRN GEOCHRONOLOGY AND PALEOMAGNETIC DATA**
Dylan H. Rood, Robert C. Finkel, and Douglas W. Burbank

100 **INSAR AS A TOOL TO STUDY CONTINENTAL SCALE DEFORMATION**
Noel Gourmelen, Mariarosaria Manzo, Francesco Casu, Riccardo Lanari, and Falk Amelung

101 **CONTINUOUS GPS VELOCITIES IN THE INTERMOUNTAIN-WEST : NEW CONSTRAINTS ON THE MOTION OF THE COLORADO PLATEAU**
Corné Kreemer

102 **GEOTHERMS, FLUIDS AND LITHOSPHERIC STRUCTURE OF THE GREAT BASIN–COLORADO PLATEAU TRANSITION ZONE, 38.5N LATITUDE**
Derrick Hasterok, Phillip E. Wannamaker, William Doerner, and David S. Chapman

103 **A MULTIDISCIPLINARY INVESTIGATION OF RIO GRANDE RIFT DEFORMATION**
Anthony R. Lowry, Anne F. Sheehan, R. Steven Nerem, Monica Guerra, Mousumi Roy, and Amy Luther

104 **PRELIMINARY CONSTRAINTS ON VARIATIONS IN CRUSTAL COMPOSITION AND THICKNESS ACROSS THE BASIN AND RANGE-COLORADO PLATEAU TRANSITION ZONE IN WEST-CENTRAL ARIZONA USING RECEIVER FUNCTION ANALYSIS OF USARRAY DATA**
Lon Abbott and Matt Fouch

105 **QUATERNARY TECTONISM IN A COLLISION ZONE, NORTHWEST WASHINGTON**
Patricia McCrory, Steven Intelmann, Ray Weldon, Stephen Wolf, and William Danforth

106 **CONSTRAINING SERPENTINITE PRESENCE BENEATH THE CASCADES.**
Alex Nikulin, Vadim Levin, and Jeffrey Park

107 **CONVECTIVE INTERACTIONS IN THE MANTLE BENEATH THE PACIFIC NORTHWEST: THE FATE OF THE JUAN DE FUCA PLATE**
Richard Allen and Mei Xue

108 **ASTHENOSPHERIC DYNAMICS OF THE PACIFIC NORTHWESTERN UNITED STATES**
Matthew Fouch

109 **SEISMIC VELOCITY STRUCTURE OF THE PACIFIC NORTHWEST FROM SEISMIC TOMOGRAPHY AND FORWARD MODELING OF RELATIVE DELAY TIMES**
Jeffrey B. Roth, the HLP Seismic Working Group , and Matthew J. Fouch

110 **CONSTRAINING YELLOWSTONE MAGMATIC PROCESSES ALONG THE EASTERN SNAKE RIVER PLAIN VIA AMBIENT NOISE AND TELESEISMIC RAYLEIGH WAVE DISPERSION INVERSION**
Josh Stachnik, Ken Dueker, and Derek Schutt

111 **INTERFEROMETRIC SAR INVESTIGATION OF THE SLOW RATE OF SURFACE DEFORMATION IN THE EASTERN SNAKE RIVER PLAIN, IDAHO, USA**
Mohamed H. Aly, David W. Rodgers, Glenn D. Thackray, and Christopher D. Kemp

112 **DRIVING FORCES OF THE WESTERN NORTH AMERICAN PLATE BOUNDARY ZONE**
Lucy Flesch, William Holt, and John Haines

113 **DISLOCATION MODELS OF INTERSEISMIC DEFORMATION IN THE WESTERN UNITED STATES**
Fred Pollitz, Doug Wilson, Patricia McCrory, Jerry Svarc, and Jessica Murray

114 **THE WALKER LANE: HOW COMPLEX IS IT? GEODETIC AND GEOLOGIC STRAIN IN THE WESTERN BASIN AND RANGE USING ENHANCED BLOCK MODELING ALGORITHMS**
William Hammond, Corné Kreemer, and Geoff Blewitt

115 **KINEMATICS AND DYNAMICS OF WESTERN U.S. DEFORMATION**
Christine Puskas, Lucy Flesch, and Robert Smith

116 **INFLUENCES ON THE TOPOGRAPHIC CHARACTER OF THE WESTERN U.S.: SPECULATIONS ON THE ROLE OF INHERITED STRUCTURES, PLATE MOTION, AND UPPER MANTLE PROPERTIES**
David Coblentz, Jolante van Wijk, and Karl Karlstrom

117 **VARIABLE FAULT STRENGTH AND CRUSTAL BLOCK INTERACTIONS IN THE WESTERN UNITED STATES: INSIGHTS FROM DYNAMIC MODELING OF THE SIERRA NEVADA BLOCK**
Noah Fay and Gene Humphreys

118 **THE UPLIFT OF THE SOUTHERN SIERRA NEVADA, THE ISABELLA SEISMIC ANOMALY AND DEATH VALLEY EXTENSION: A SINGLE GEODYNAMIC PROCESS?**
Laetitia Le Pourhiet, Michael Gurnis, and Jason Saleeby

119 **ROTATIONAL MANTLE FLOW BENEATH THE WESTERN US**
George Zandt and Gene Humphreys

120 **HTDP 2.9: UPDATING HTDP FOR THE 28 SEPTEMBER 2004, M 6.0 PARKFIELD, CALIFORNIA EARTHQUAKE**
Christopher Pearson and Richard Snay

121 **COMBINATION OF GPS-OBSERVED VERTICAL MOTION WITH ABSOLUTE GRAVITY CHANGES CONSTRAIN THE TIE BETWEEN REFERENCE FRAME ORIGIN AND EARTH CENTER OF MASS**
Hans-Peter Plag, William C. Hammond, and Corne Kreemer

122 **CALREF, A STABLE REFERENCE FRAME FOR THE NORTHERN CALIFORNIA**
Nicolas Houlié and Barbara Romanowicz

BUILDING A CONTINENT IN 4D

123 **EARTHSCOPE MAGNETOTELLURICS - WHAT NEXT?**
Shane Ingate

124 **GEOEARTHSCOPE: AERIAL AND SATELLITE IMAGERY AND GEOCHRONOLOGY**
David Phillips, Mike Jackson, and Chuck Meertens

125 **THE GEON LIDAR WORKFLOW AS A DISTRIBUTION PATHWAY FOR FORTHCOMING GEOEARTHSCOPE LIDAR DATASETS**
Christopher Crosby, Han Kim, Efrat Frank, Viswanath Nandigm, Ashraf Memon, Chaitan Baru, Ramon Arrowsmith, and Newton Alex

126 **INSTANTANEOUS SLIP RATES FROM GEOLOGY AND GEODESY**
Rick Bennett

127 **EARTHCHEM'S DEEP LITHOSPHERE DATASET: WEB-BASED ACCESS TO MANTLE XENOLITH GEOCHEMISTRY AND PETROLOGY**
Karin Block, Kerstin Lehnert, and Mihai Ducea

128 **INTERPRETATION OF SEISMIC STRUCTURE FROM MANTLE XENOLITHS: CIMA VOLCANIC FIELD - WALKER LANE (CA), SAN CARLOS VOLCANIC FIELD - BASIN AND RANGE (AZ), POTRILLO VOLCANIC FIELD - RIO GRANDE RIFT (NM), AND KNIPPA QUARRY - BALCONES IGNEOUS PROVINCE (TX)**
Keith Cardon, Randy Keller, Robert Stern, Urmidola Raye, Elizabeth Anthony, and Minghua Ren

129 **GEO/THERMOCRHONOLOGY OF LOWER CRUSTAL XENOLITHS FROM MONTANA : IMPLICATIONS FOR THE STRUCTURE AND EVOLUTION OF NORTH AMERICAN LITHOSPHERE**
Terrence Blackburn, Samuel Bowring, Frank Dudas, and James Crowley

130 **GEOLOGICAL INTERPRETATION OF MULTI-DIMENSIONAL GEOPHYSICAL MONITORING DATA BASED ON SELF-ORGANIZING MAPS**
Christian Klose

131 **QUANTIFYING REGIONAL VELOCITY RATIO IN CALIFORNIA: USING SEISMIC DATA TO MAP SHALLOW STRUCTURE**
Gavin Hayes and Kevin Furlong

132 **PROCESSES OF TERRANE ACCRETION AND MODIFICATION: THE KLAMATH MOUNTAINS OF CASCADIA**
Kate Miller and Calvin Barnes

133 **INTEGRATING CONTROLLED-SOURCE AND PASSIVE SEISMIC DATASETS**
Eva-Maria Rumpfhuber, Randy Keller, and Aaron Velasco

134 **REGIONAL GEOPHYSICAL ANALYSES TO PATCH TOGETHER THE PIECES OF THE GEOSWATH**
Randy Keller, Benjamin Drenth, Mai Ha, Evan Hamilton, Maxwell Okure, Jessica Pardo, Roderick Perez, and Angelo Sipuikinene

135 **VELOCITY STRUCTURE OF THE LAS VEGAS VALLEY, NEVADA**
Catherine Snelson, Sandra Saldana, Shelley Zaragoza, and John Karr

136 **EARTHSCOPE IN 'FLY-OVER' COUNTRY . . . EXPLORING THE STRUCTURE AND GEOLOGICAL EVOLUTION OF THE CRUST AND LITHOSPHERE OF THE CONTINENTAL INTERIOR**
Ernest Hauser

137 **STRUCTURE AND EVOLUTION OF THE TAGUS ABYSSAL PLAINSTRUCTURE AND EVOLUTION OF THE TAGUS ABYSSAL PLAIN**
Maria C. Neves, Alexandra Afilhado, and Luís Matias

138 **LITHOSPHERIC STRUCTURE OF NORTH AFRICA AND WESTERN EURASIA**
Minoo Kosarian and Charles Ammon

139 **FOCUSSING EARTHSCOPE OUTSIDE THE US - A STUDY OF ANDEAN CRUSTAL THICKNESS**
Neil McGlashan and Larry Brown

140 **UBIQUITOUS LOW-VELOCITY LAYER ATOP THE 410-KM DISCONTINUITY IN THE NORTHERN ROCKY MOUNTAINS**
John Jasbinsek and Ken Dueker

141 **IMAGING THE LAYERED STRUCTURE OF THE EARTH'S CRUST AND MANTLE BENEATH WESTERN US USING CONVERTED WAVES FROM USARRAY AND OTHER BROADBAND DATA SETS**
Kelly Liu and Stephen Gao

142 **ACCRETION AND CRUSTAL IMBRICATION: EXAMPLES FROM WYOMING AND BRITISH COLUMBIA IRIS-PASSCAL TELESEISMIC EXPERIMENTS**
Steven Hansen, Jeannette Peck, and Ken Dueker

143 **HIGH RESOLUTION POTENTIAL OF THE EARTHSCOPE FLEXIBLE ARRAY: AN IMAGE OF CONTINENTAL DELAMINATION IN THE ROMANIAN EASTERN CARPATHIANS**
Melvin Fillerup, James Knapp, and Camelia Knapp

THE NEW MADRID SEISMIC ZONE

144 **NEW MADRID: A COLD, DYING FAULT?**
Seth Stein, Andrew Newman, Jason McKenna, and Carol Stein

145 **A FOCUSED DRILLING PROGRAM IN THE NEW MADRID SEISMIC ZONE**
Jason McKenna, Andrew Newman, Seth Stein, and Carol Stein

146 **THE CENTRAL UNITED STATES SEISMIC OBSERVATORY**
Zhenming Wang and Edward Woolery

147 **GPS CONTRIBUTION TO NEW MADRID SEISMIC ZONE HAZARD ESTIMATION**
Robert Smalley

148 **LOCAL STRESS CONCENTRATION DUE TO FAULT INTERSECTIONS: A POSSIBLE CAUSE OF INTRAPLATE SEISMICITY IN NEW MADRID AND MIDDLETON PLACE SUMMERVILLE SEISMIC ZONES**
Abhijit Gangopadhyay and Pradeep Talwani

149 **ANALYSIS OF THE REELFOOT MAGNETIC ANOMALY AND AGE OF THE REELFOOT THRUST FAULT**
Ivan Rabak, Charles Langston, and Christine Powell

150 **CLUSTERING AND SCATTERING OF INTRAPLATE EARTHQUAKES: PRELIMINARY RESULTS FROM GEODYNAMIC MODELING**
Qingsong Li and Mian Liu

151 **HIGH RESOLUTION GROUP VELOCITY MODEL FOR EASTERN NORTH AMERICA BASED ON AMBIENT NOISE TOMOGRAPHY**
Chuntao Liang and Charles Langston

Posters

QUALITY CONTROL, DATA CENTERS AND NEW TOOLS

152 SUPPORTING EARTHSCOPE FACILITY SITING WITH GIS
Matt Mercurio, Fred Pieper, Bill Schultz, and Jean Miller

153 THE EARTHSCOPE USARRAY ARRAY NETWORK FACILITY (ANF): METADATA, NETWORK AND DATA MONITORING, AND QUALITY ASSURANCE
Jennifer Eakins, Frank Vernon, Vladik Martynov, Luciana Astiz, Robert Newman, and Trilby Cox

154 ADVANCES IN WEB-BASED VISUALIZATION OF THE STATE-OF-HEALTH OF EARTHSCOPE'S TRANSPORTABLE ARRAY
Robert Newman, Kent Lindquist, Frank Vernon, Geoff Davis, Jennifer Eakins, and Luciana Astiz

155 USARRAY DATA AND QUALITY CONTROL AT THE IRIS DMC
Chad Trabant, Mary Templeton, Gillian Sharer, and Peggy Johnson

156 ASSESSMENT OF STATION PERFORMANCE: NOISE LEVELS AT BDSN, TA AND NC
Robert Uhrhammer, Margaret Hellweg, Barbara Romanowicz, and Peter Lombard

157 THE SPADE SEARCHABLE PRODUCT ARCHIVE
Linus Kamb, Rob Casey, and Tim Ahern

158 DIVERSE GEOPHYSICAL DATA FOR EARTHSCOPE-RELATED SCIENCE AT THE NORTHERN CALIFORNIA EARTHQUAKE DATA CENTER
Douglas Neuhauser, Mario Aranha, Stephane Zuzlewski, Robert Uhrhammer, Stan Silverman, Fred Klein, Lynn Dietz, and Babara Romanowicz

159 THE PLATE BOUNDARY OBSERVATORY BOREHOLE STRAINMETER PROGRAM: DATA ANALYSIS AND PRODUCTS
Kathleen Hodgkinson, Greg Anderson, Mike Hasting, Brent Henderson, Mike Jackson, Wade Johnson, Dave Mencin, and PBO-DMIT Group

160 TIDAL CALIBRATION OF PBO STRAINMETERS LOCATED IN THE PACIFIC NORTHWEST
John Langbein

161 NOISE IN GPS MEASUREMENTS FROM SOUTHERN CALIFORNIA AND SOUTHERN NEVADA
John Langbein

162 FUTURE DEVELOPMENTS IN THE GEON WORKFLOW-BASED TOOL FOR LIDAR PROCESSING AND ANALYSIS
Efrat Jaeger-Frank, Christopher J Crosby, J Ramon Arrowsmith, Viswanath Nandigam, Ashraf Memon, Ilkay Altintas, and Chaitan Baru

163 EARTH SCIENCE COMMUNITY IT RESOURCES THROUGH A UNIFIED DATA AND ANALYSIS PORTAL
Frank Webb, Kedar Sharon, Dong Danan, Newport Brian, Bock Yehuda, Jamason Paul, Chang Reuy-juin, and Fang Peng

164 SYNSEIS: A COMPUTATIONAL ENVIRONMENT FOR SYNTHETIC SEISMOGRAM SIMULATIONS
Dogan Seber, Cindy Santini, Choonhan Youn, and Tim Kaiser

NEW TECHNOLOGY AND METHODS

165 VERTICAL MOTION OBSERVED WITH GPS: WHAT CAN WE LEARN ABOUT REGIONAL GEOPHYSICAL SIGNALS, EARTH STRUCTURE, AND RHEOLOGY?
Hans-Peter Plag, Corne Kreemer, William C. Hammond, and Geoff Blewitt

166 PLATE BOUNDARY OBSERVATORY ANALYSIS USING THE AMBIZAP GPS PROCESSING ALGORITHM
Geoffrey Blewitt

167 SEISMIC ARRAY PROCESSING WITH HIGH RATE GPS DATA
James Davis and Robert Smalley

168 GPS AND PLATE TECTONICS: WHAT ARE WE MEASURING?
Edwin Apel and Roland Burgmann

169 WAVE GRADIOMETRY FOR EARTHSCOPE
Charles Langston

170 INTER-REGION VARIABILITY IN PERSISTENT SCATTERER BEHAVIOR
Rowena Lohman

171 MITIGATING SEISMIC NOISE CAUSED BY ATMOSPHERIC PRESSURE CHANGES WITH COLLOCATED, HIGH-RESOLUTION, BROADBAND BAROMETERS
Jerome Paros

172 SEISMIC IMAGING OF SOUTHERN CALIFORNIAN CRUST USING DEFORMABLE-LAYER TOMOGRAPHY AND PRESTACK DEPTH MIGRATION: INNOVATIVE APPLICATIONS FOR EARTHSCOPE/USARRAY PROJECTS
Hua-wei Zhou, Michael Thornton, Li Li, Chris Gantela, and Tom Bjorklund

173 DECONVOLUTION EXPERIMENTS WITH USARRAY DATA BRING DEEP EARTH STRUCTURE INTO GREATER FOCUS
Ed Garnero, Wolfgang Stefan, Rosemary Renaut, and Thorne Lay

174 ARRAY PROCESSING OF TELESEISMIC BODY WAVE PHASES RECORDED BY THE TRANSPORTABLE ARRAY
Gary Pavlis and Frank Vernon

175 MAPPING THE PV-PPV BOUNDARY BENEATH CENTRAL AMERICA
Daoyuan Sun and Don Helmberger

176 IMMERSIVE VIRTUAL REALITY FOR INTERACTION AND VISUALIZATION OF 3D GEOPHYSICAL DATA
Louise Kellogg, Magali Billen, Eric Cowgill, Bernd Hamann, Oliver Kreylos, Margarete Jadamec, and Gerald Bawden

177 AIR-GUN AS AN ONSHORE SEISMIC SOURCE?
Baoshan Wang, Huawei Zhou, Hongkui Ge, and Yong Chen

178 A MOORED GEODETIC SEAFLOOR MONITORING SYSTEM (GEOCE)
Kevin Brown, David Chadwell, Uwe Send, and Mike Tryon

INFRASTRUCTURE

179 SITE RECONNAISSANCE FOR THE EARTHSCOPE/USARRAY TRANSPORTABLE SEISMIC ARRAY: GEOGRAPHIC INFORMATION SCIENCES & COMMUNITY PARTICIPATION IN OREGON AND WASHINGTON STATES
Carlos Rios, Matt Mercurio, Maxwell Ruckdeschel, Robert Busby, Anne Trehu, Mark Meyers, Paul Anderson, Jan Baur, Mark Bernard, Brian Anderson, Monika Moore, Susan Potter, Barbara Zennaro, Shanon Helbock, Don Lippert

180 THE FLEXIBLE ARRAY COMPONENT OF USARRAY; INSTRUMENTS FOR FOCUSED STUDIES
Marcos Alvarez, Jim Fowler, Eliana Arias, and Noel Barstow

181 NASA CONTRIBUTION TO THE EARTHSCOPE PROJECT
Victoria Andreatta, Dave Stowers, Oivind Ruud, and Steve Fisher

182 THE PLATE BOUNDARY OBSERVATORY: DATA MANAGEMENT PROGRESS AND HIGHLIGHTS
Greg Anderson, PBO Data Management Team , Mike Jackson, and Chuck Meertens

183 PBO FACILITY CONSTRUCTION: GPS NETWORK STATUS
Karl Feaux, Mike Jackson, Dave Mencin, Ben Pauk, Katrin Hafner, Brian Coyle, Chris Walls, and Barrett Friesen

184 LAND USE PERMITTING OF THE PLATE BOUNDARY OBSERVATORY COMPONENT OF THE EARTHSCOPE PROJECT
Kyle Bohnenstiehl, Chelsea Jarvis, and Keegan Fengler

185 ALMOST THERE: STATUS OF THE SOUTHERN CALIFORNIA REGION OF THE PLATE BOUNDARY OBSERVATORY
Christian Walls, Edward Arnitz, Shawn Lawrence, Scott Bick, Ryan Bierma, Karl Feaux, and Mike Jackson

Posters

186 **GPS INSTALLATION PROGRESS IN THE NORTHERN CALIFORNIA REGION OF THE PLATE BOUNDARY OBSERVATORY**
Brian Coyle, Andre Basset, Todd Williams, Doerte Mann, Adam Woolace, and Karl Feaux

187 **UPDATE ON PLATE BOUNDARY OBSERVATORY GPS INSTALLATIONS IN THE PACFIC NORTHWEST**
Katrin Hafner, Ken Austin, Sarah Doelger, Keegan Fengler, and Karl Feaux

188 **PBO FACILITY CONSTRUCTION: BASIN AND RANGE AND ROCKY MOUNTAIN REGIONS STATUS**
Barrett Friesen, Fred Jenkins, David Kasmer, and Karl Feaux

189 **THE PBO BOREHOLE STRAINMETER/SEISMIC NETWORK**
Michael Hasting, David Mencin, Wade Johnson, and Tim Dittmann

190 **LONG-BASE STRAINMETERS IN THE PBO: EARLY RESULTS**
Frank Wyatt and Duncan Agnew

SAN ANDREAS AND CALAVERAS FAULTS FIELD TRIP

MARCH 27, 2007

Field trip leaders: David P. Schwartz, Ingrid A. Johanson, Heidi D. Stenner, Tom Fumal • US Geological Survey, Menlo Park

The San Francisco Bay region is an amazing natural laboratory for studying deformation associated with a major strike-slip plate boundary. Deformation across the Pacific-North American plate boundary in the greater San Francisco Bay region is accommodated primarily by slip on a series of right lateral strike-slip faults that includes the San Gregorio, San Andreas, Hayward, Rodgers Creek, Calaveras, Greenville, and Concord-Green Valley (Figure 1). The Bay Area has the highest density of active faults per km2 of any urban center in the United States, and the Working Group on California Earthquake Probabilities (WGCEP, 2003) has estimated a 62% likelihood of one or more $M \geq 6.7$ earthquakes on this fault system in the urban corridor between 2002 and 2031. The rate of slip across the plate boundary appears to be relatively constant at different time scales: GPS rates of 39.8 ± 1.2 mm/yr (Prescott et al., 2001) and 37.9 ± 0.6 mm/yr (d'Alessio et al., 2005); geologic slip rates on faults of 40 ± 5 mm/yr for hundreds to several thousands of years (WGCEP, 2003); and a long term (5 my) rate of 41 ± 1.0 mm/yr from global plate motion models (DeMets and Dixon, 1999). In contrast, regional convergence across the boundary is negligible. However, changes in strike along faults

ROAD LOG

Leave Portola Plaza hotel.

1.0 miles	Merger onto CA-1 North.
13.4 miles	Merge onto CA-156 E via Exit 414B toward Castroville/US-101/San Jose.
6.4 miles	Merge onto US-101 N/CA-156 E toward Hollister/San Francisco.
8.8 miles	Merge onto CA-156 E toward San Juan Bautista/Hollister.
2.2 miles	Turn left onto Monterey St and enter San Juan Bautista.
	The Mission San Juan, which you can see to the right, was founded on June 24, 1797 by Father Fermin de Lausen. It sits on the crest of a northeast-facing scarp of the San Andreas fault. The Mission is the 15th of the 21 California missions. Construction of the main church was started in 1803 and, despite damage from several earthquakes, it has been in continuous use since July 1, 1812. In addition, the Mission played key role in the conclusion of Alfred Hitchcock's 1958 film classic Vertigo that starred Jimmy Stewart and Kim Novack.
0.0 miles	Turn left on First Street.
0.6 miles	**STOP 1.** San Andreas Fault, Nyland Ranch
1.3 miles	Backtrack through San Juan Bautista and make right onto CA-156.
8.3 miles	Turn left onto CA-25/Bolsa Rd.
3.7 miles	Turn right onto Shore Road.
1.2 miles	Turn right onto Frazier Lake Road (hard packed dirt ranch road).
1.0 miles	**STOP 2.** Calaveras Fault, Costa Ranch paleoseismic site. From here we will walk a short distance to the Calaveras fault.
2.2 miles	Backtrack and make left onto CA-25/Bolsa Rd.
6.9 miles	Right onto 3rd St.
<0.1 miles	Right onto West St., which becomes Virginia St.
0.1 miles	Right on Locust St.
<0.1 miles	**STOP 3.** Calaveras Fault, Surface Creep in Hollister. Locust St. and Central Ave. From here walk southeast along the Calaveras fault to Dunne Park (approximately 500m). Buses will be waiting with lunch.
39.9 miles	Return to Monterey.

have produced zones of transpression with associated active thrust faulting (often blind) and uplift. The most recent and prominent example of this is the 1989 Loma Prieta earthquake. This event occurred on a blind reverse-oblique slip fault beneath the Santa Cruz Mountains, which is located within a restraining bend on the San Andreas fault. Another major blind thrust occurs beneath the region's second highest peak, Mt. Diablo (3849 ft/1173 m), located in a restraining step between the Greenville and Concord-Green Valley faults (Figure 1).

In addition to locked sections of faults that fail coseismically to produce large earthquakes, the Bay Area is also home to the largest concentration of creeping faults known worldwide. These include

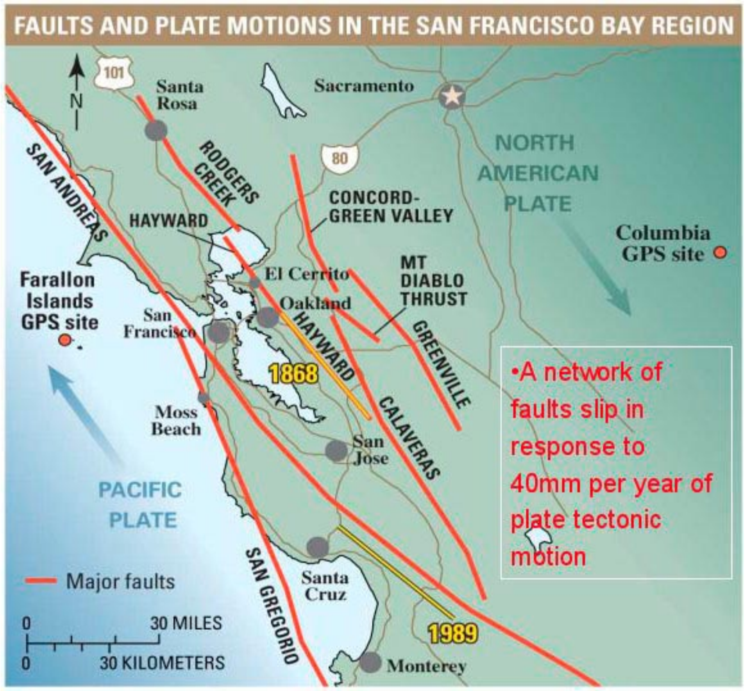


Figure 1. Major faults within the Pacific-North American plate boundary in the greater San Francisco Bay region. Locations of 1868 Hayward and 1989 Loma Prieta ruptures are shown in yellow; the entire length of the northern San Andreas fault (470 km) ruptured in 1906 (from WGCEP, 2003).

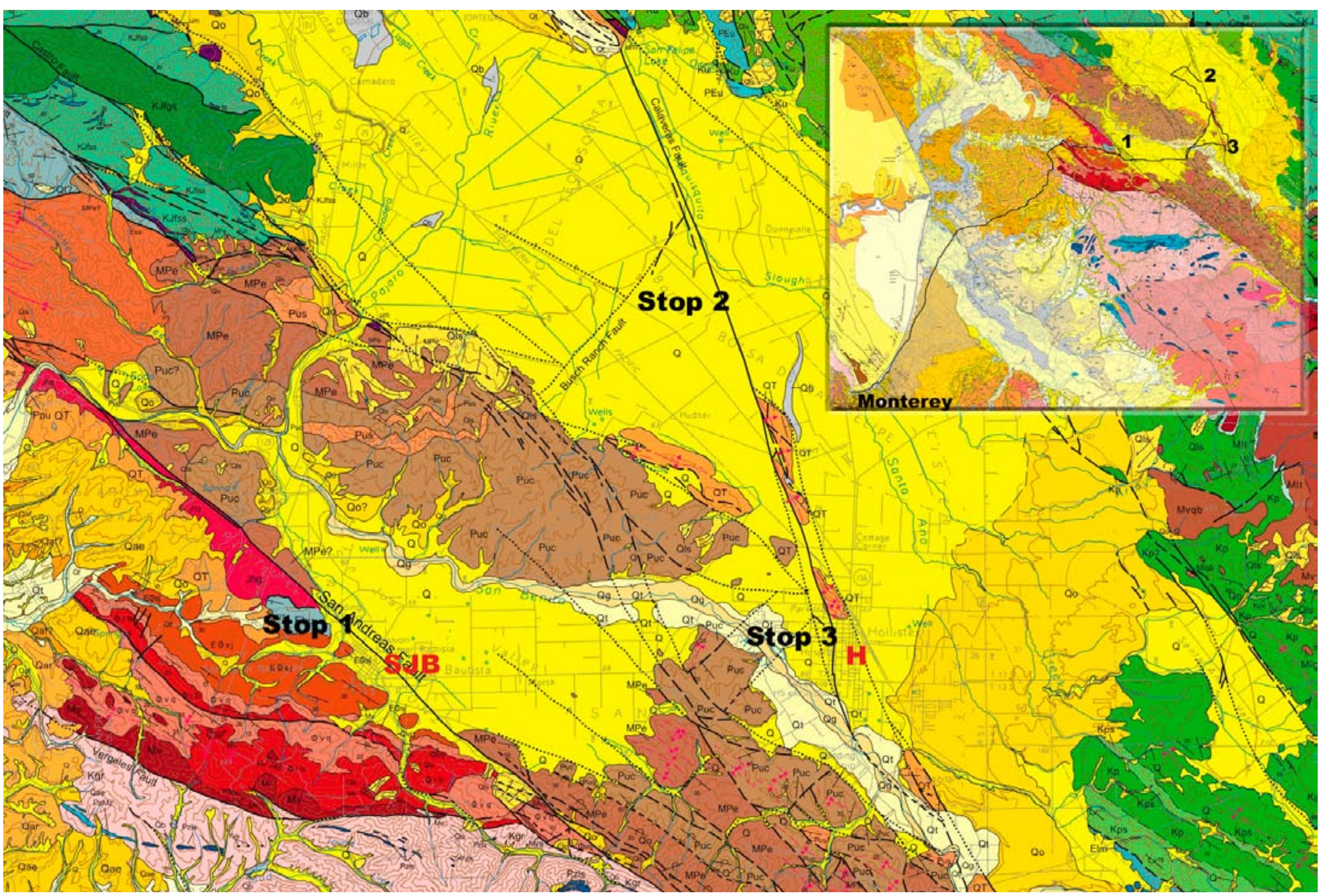


Figure 2. Geologic map of the San Andreas and Calaveras fault zones in the vicinity of San Juan Bautista and Hollister (Wagner et al., 2002). Field stops are shown: 1) San Andreas fault, Nyland ranch; 2) Calaveras fault, Costa ranch; 3) Calaveras fault, Hollister

the Hayward, central and southern segments of the Calaveras, the Concord-Green Valley, the Maacama, the Sargent, as well as the southernmost part of the 1906 San Andreas rupture. The ratio of creep rate to the longer-term geologic slip rate can vary from approximately 50 percent (Hayward fault) to essentially 100 percent (central and southern Calaveras fault). An important question is: to what degree and how does creep affect the occurrence of large earthquakes on faults?

The Earthscope field trip has three stops where we will look at the San Andreas and Calaveras faults (Figure 2). These are in the vicinity of San Juan Bautista and Hollister, where the two faults accommodate about 80 percent of Pacific-North American plate boundary slip. At the latitude of San Juan Bautista the San Andreas and Calaveras faults are 11 km apart. South of Hollister the two faults converge; the Calaveras is re-named the Paicines fault and with the separation distance between the two is on approximately 3 km at the surface. The crust between the two faults in the region of convergence is complexly deforming, with seismicity distributed on active structures at depth that are not clearly recognizable at the surface (Figure 3). Other notable fault intersections/splays in the Bay Area associated with significant partitioning of slip and changes in slip rate are the Calaveras/Hayward and San Andreas/San Gregorio (Figure 1). The field trip provides the opportunity to discuss how GPS, InSAR, creep measurements, historical seismicity, and paleoseismology are being used to improve our understanding of the behavior of these major active faults.

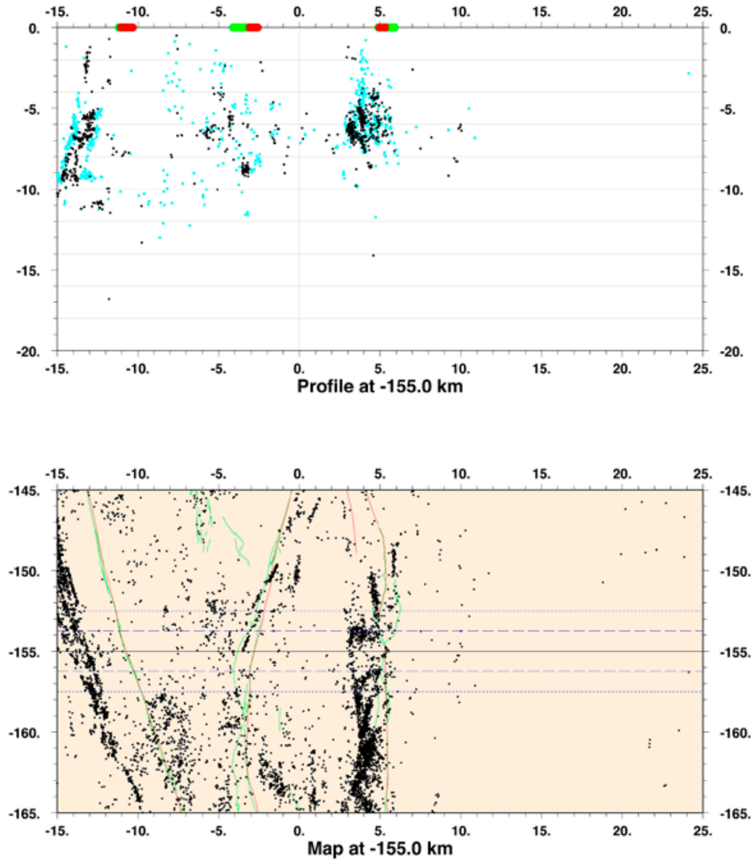


Figure 3. Seismicity map and cross section showing double-difference relocated earthquakes from 1984-2000 in the San Juan Bautista (SJB)-Hollister (H) area (from Simpson et al., 2004). The vertical cross-section at top is centered on –155 (on map). Earthquakes plotted in black fall within +/-1.25 km of the vertical section. Earthquakes plotted in blue fall within +/-2.5 km of the vertical section. Red/green lines on the maps and red/green dots at the top of profile plots are faults: SA is San Andreas, C is Calaveras, and QS is Quien Sabe.

STOP 1. San Andreas fault, Nyland Ranch *(Schwartz, Johanson, Fumal)*

~USE EXTREME CAUTION IN CROSSING THE ROAD!~

At this location the San Andreas fault is geomorphically expressed as a subtle, linear trough located on the west side of First Street/Old San Juan Highway. It crosses beneath an asphalt ranch road, which is cracked and right laterally offset by creep across the main trace, as are the fences on both sides. Note the narrow zone of deformation with most of the slip at the main fault trace and a small percentage of slip occurring as warping that extends only a few meters from the main trace. This narrow zone of deformation is typical of the surface expression of strike-slip ruptures, whether the offset is one meter or nine meters. Creep at this site is currently being monitored with a nail array by UC Santa Barbara.

In 1906 the fault produced surface rupture here, likely in the form of a mole-track; the amount of 1906 slip is not

Mr Nyland reports that he has had trouble with pipe breakage at the fault at various times in the past. When asked where the 1906 earthquake fault breakage was located, he pointed at the current zone of slippage and said "I was eleven years old and living here at the time of the 1906 earthquake and remember a mound of dirt along the fault right where the road is now cracking. The mound of dirt occurred within a broad trough that was about 1m deep and was later filled to level the ground. The mound also crossed the main road to the south. I helped my father dig away the mound formed in the earthquake so that people could use the main road into San Juan Bautista again".

known, although 3.5 m of offset occurred 15 km to the north (see below). Arthur Nyland, the original owner of the ranch, was interviewed by R. Nason (1971):

Nyland ranch is on the San Juan Bautista (SJB) segment of the San Andreas fault, which exhibits complex behavior with heterogeneous slip patterns in both time and space. This section of the fault forms the transition zone between the creeping section of the San Andreas to the south and the locked Santa Cruz Mountains segment to the north. It has been recently characterized by Johanson and Burgmann (2005) using a joint inversion of InSAR and GPS data (Figure 4 and Figure 5). The SJB segment experiences a variety of transient phenomena including shallow creep events and deeper slow earthquakes (Figure 6), and moderate sized (~M5) earthquakes. Creep events are shallow slip events (<500 m), perhaps occurring when sediments reach a yield point after loading from steady creep below (Wesson, 1988). At San Juan Bautista they are generally observable on only one instrument as they involve slip on a small fault area (Gladwin, 1994). Slow earthquakes include larger and deeper fault areas than creep events and are observable on more than one instrument. Four such events have occurred (in 1992, 1996, 1998, and 2004) since strain- and creep-meter monitoring began, ranging in equivalent magnitude from 4.9 to 5.1 and with a time-span of about one week (Linde et al., 1996, Gwyther, 2000, Bilham, 2004). The largest earthquake on this segment since a M5.5 event in 1961, was the 1998 Mw 5.1 San Juan Bautista earthquake (Uhrhammer et al., 1999). This event was immediately followed by a slow earthquake with comparable magnitude (Mw 5.0). Not only are slip rates on this segment highly time-dependent, but the secular component is heterogeneously distributed in space (Figure 5). Superimposed on a general decrease in creep rate from south to north are two low-slip/locked asperities (red dashed lines in figure 5). These low slip asperities exhibit a slip deficit that could produce an M6.3 – 6.7 earthquake once a century (Johanson and Burgmann, 2005).

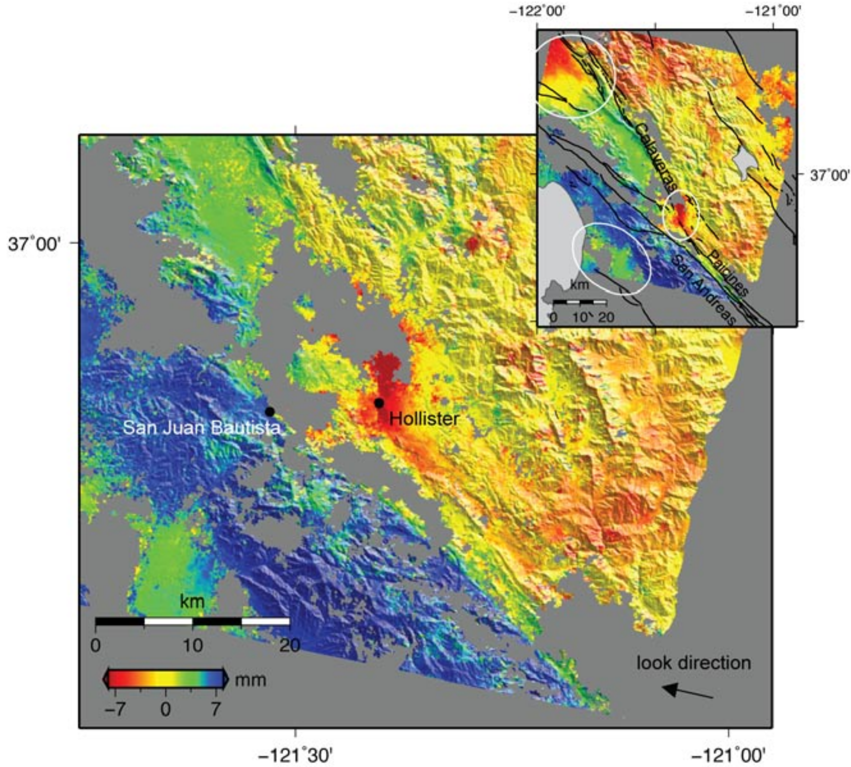


Figure 4: Stack of nine interferograms spanning the period 1995-2001 (Johanson and Burgmann, 2005). Main figure is a close-up of the Hollister/ San Juan Bautista area; inset figure is the complete satellite frame extending from the Santa Clara Valley in the northwest to the creeping section in the southeast. Colors indicate the change in distance between the ground and the satellite in the satellite's look direction (23° off vertical). The broad deformation pattern associated with strain accumulation on the San Andreas Fault (SAF) system is visible as the frame-wide progression from blue to yellow colors. Uplift due to groundwater recharge is apparent in the Santa Clara Valley, near Hollister, and near Watsonville (white circles). Surface creep along the SAF is indicated by the sharp contrast in color from blue to green at the surface trace.

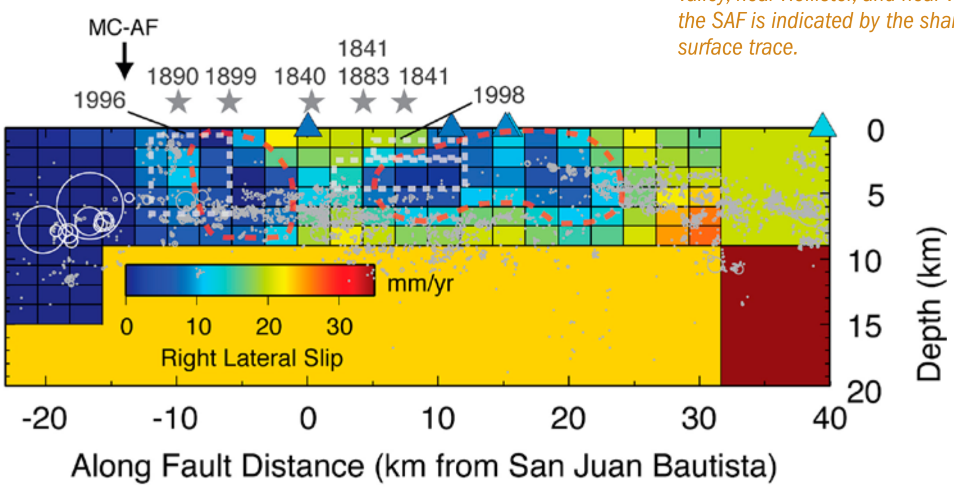


Figure 5: Results of inversion for interseismic creep on the San Juan Bautista segment from interferogram stack on Figure 4 and continuous and campaign GPS (modified from Johanson and Burgmann, 2005). The model resolves two locked/low-creep asperities (outlined in dashed red lines). Slow earthquakes in 1996 and 1998 appear to have been located near the edges of the strong asperities (Gwyther et al., 2000). Also plotted is double-difference relocated seismicity (grey circles) and the 1994 Chittenden earthquake sequence. Creep rates measured by creepmeters are shown for comparison and colored with the same scale as the slip model. Stars mark the approximate locations of historical earthquakes. MC-AF is the Mill Canyon-Arano Flat paleoseismic site.

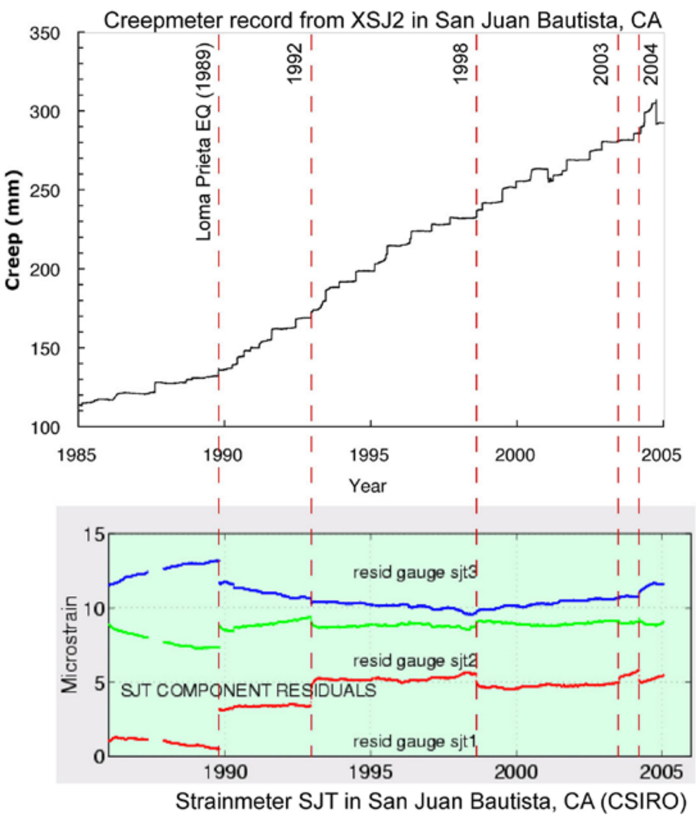


Figure 6: Relationship of creep events as observable from creepmeter records (top) to slow earthquakes as observable in strainmeter records (bottom, from http://www.gtsmtechnologies.com/index_files/nehrp.htm). Creep events, being shallow phenomena, affect only the near-fault creepmeter. However, slow earthquakes, which involve slip on a larger fault area, are discernable on strainmeters that are located off-fault.

The Mill Canyon-Arano Flat Paleoseismic Site

Fifteen kilometers to the north of STOP 1, USGS geologists under the guidance of Tom Fumal have developed two paleoseismic sites about 0.6 km apart on the San Andreas fault at Mill Canyon and Arano flat (Figure 5). These sites are on the Kelly-Thompson ranch, which has been in the same family since 1851 and has been preserved in a near pristine condition. The fault is geomorphically very well expressed along this reach. The combination of rapid deposition and abundant datable organic material has resulted in the first high-resolution chronology of large earthquakes on the Santa Cruz Mountains segment of the fault.

At Mill Canyon the most recent ground rupturing event, the 1906 San Francisco earthquake, is well-expressed as a series of in-filled fissures and small scarps. Evidence was found for three additional ground-rupturing earthquakes since about A.D. 1500 (Figure 7). Of particular interest at this site is the dating of the penultimate earthquake and its relation to the Bay Area earthquake of 1838. The 1838 event is generally considered to have occurred on the San Andreas fault. While this is a reasonable interpretation from the limited historical information there is uncertainty regarding its location and magnitude; and, at present, no direct geologic evidence of this event has been observed. Bakun (1999), based on estimated intensities from damage reports, calculated the magnitude as M6.8 ± 0.4 and suggested the Peninsula San Andreas as the most likely source. Several investigators (Tuttle and Sykes, 1992; Toppozada and Borchardt, 1998) have speculated that the 1838 earthquake ruptured both the Peninsula and Santa Cruz Mountains segments of the

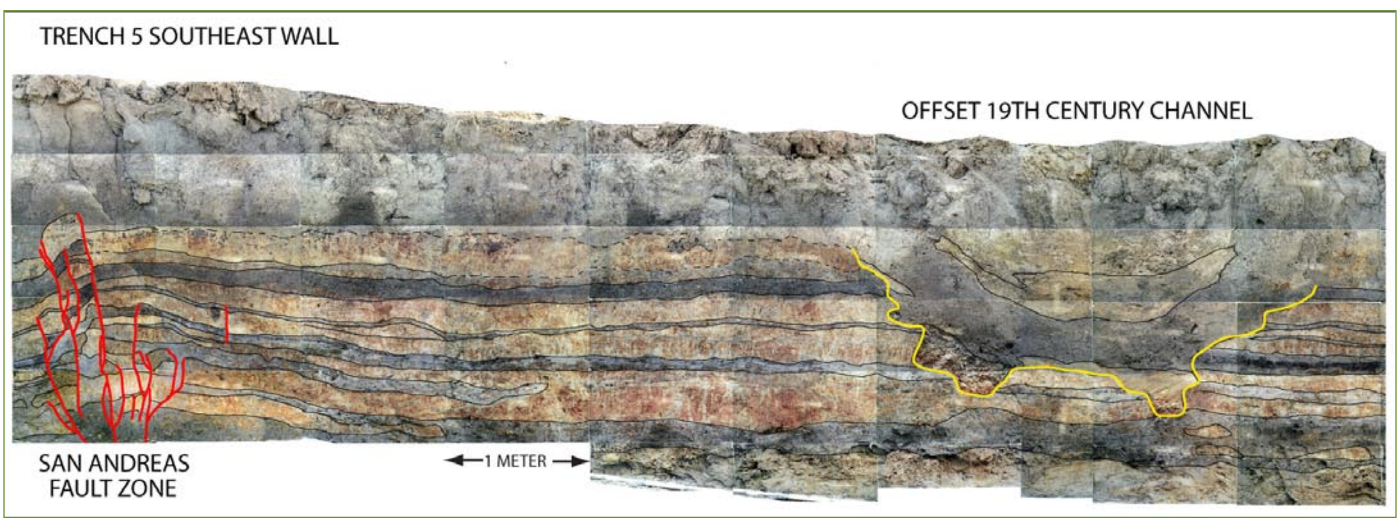


Figure 7. Photomosaic of the northwest wall of trench 6 at Mill Canyon (Fumal, in preparation). Faulting during the 1906 earthquake occurred along a single trace in this exposure producing a small scarp and accompanying small fissure. An earthquake about A.D. 1650-1730 occurred when the organic soil overlying gravelly unit 8 was at the ground surface, producing a small scarp and accompanying colluvial wedge consisting of fragment of unit 8 in an organic-rich matrix. This wedge is overlain by sand and gravel of unit 5, which was subsequently faulted about A.D. 1700-1770, producing a deep, gravel-filled fissure. Evidence for a fourth earthquake is not visible in this exposure but appears as a fissure filled with unit 8 gravel on the southeast wall of trench 6.

San Andreas fault, producing an earthquake of M 7.3-7.5 with 90-130 km of surface rupture. Radiocarbon ages of detrital charcoal at Mill Canyon suggest an age of the penultimate earthquake of A.D. 1700-1776, however. Additional support for this age comes from a 1.5-meter-deep fissure that formed during this earthquake. It was sampled for Erodium, a non-native pollen that first appeared in the San Francisco Bay area about 1770 and was ubiquitous in the region by 1800. Erodium pollen would have been present at this site in 1838 and should be found in the fill of any fissure formed during an earthquake of that vintage. The presence or absence of this pollen in critical deposits is presently playing an important role in dating Bay Area paleoearthquakes that occurred between the early 1700s and early-middle 1800s, a time period in which radiocarbon gives multiple ages. Along with observations 15 km further north at Grizzly Flat (Schwartz and others, 1998), the Mill Canyon results indicate that if the 1838 event was on the San Andreas, it did not extend into Santa Cruz mountains.

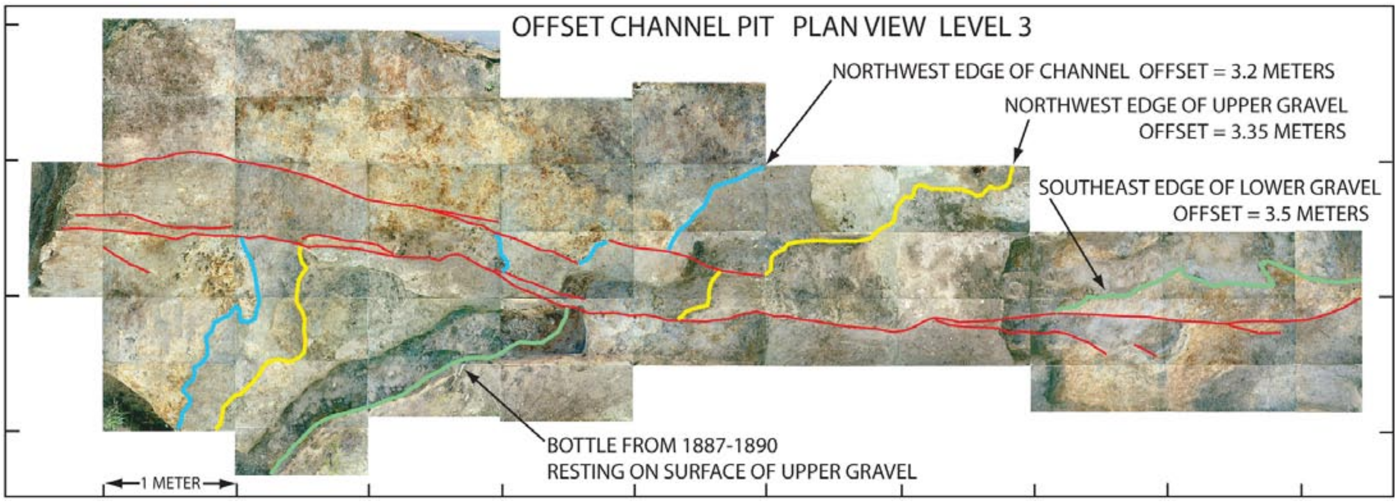


Figure 8. Photomosaic plan view of the floor of an excavation exposing a small channel offset across the San Andreas fault (Fumal, in preparation). The 1906 fault traces are in red. Three piercing points were measured: 1) the northwest margin of the channel cut into older fluvial sediments (blue), 2) the northwest edge of the upper layer of sand and gravel in the channel fill (yellow), and the southeast edge of a lower cobble gravel in the thalweg of the channel (green). Offsets range from 3.2 to 3.5 The upper sand and gravel layer contained abundant artifacts including bottles made only between 1887 and 1890.

At Arano Flat, faulting is expressed as a 1 to 2-m-wide zone that deforms alluvial fan deposits overlying well-bedded overbank deposits The trenches at this location contained evidence for at least nine surface-faulting earthquakes since about A.D. 1000. Evidence for ground-rupturing events includes in-filled fissures, folding with growth strata, and multiple upward terminations of fault traces. Earthquake ages were constrained using an OxCal chronological model incorporating AMS (accelerator mass spectrometer) radiocarbon ages of 113 samples of detrital charcoal from 19 layers and stratigraphic ordering. The mean recurrence interval is about 105 years, while individual intervals range from about 10-310 years. One of the key questions that affects the understanding of fault behavior, hazard analysis, ground motion estimates, and insurance rates is whether the short recurrence times observed here represent only large events on the Santa Cruz Mountains segment of the fault (including multiple segment ruptures such as 1906) or whether the site is also recording overlapping ruptures from the San Juan Bautista segment.

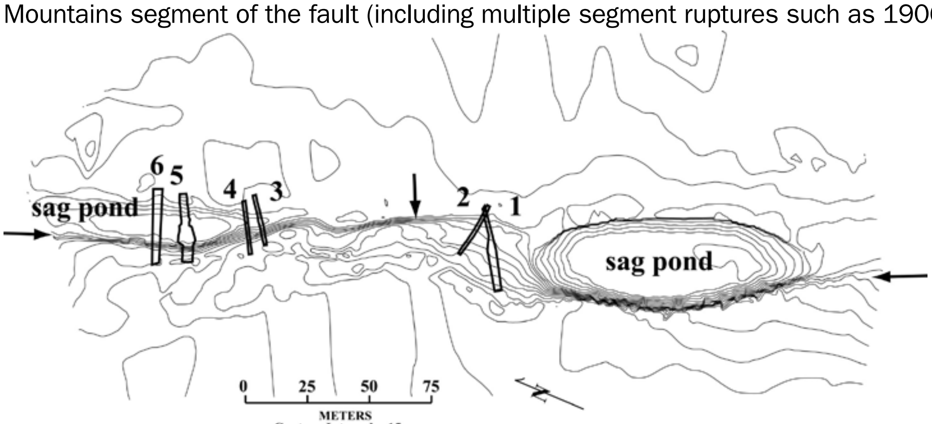


Figure 9. Topographic map of the Costa Ranch site. Trenches are numbered 1-6, arrows point at main fault where a down-to-the-east scarp is formed. Contour interval is 15 cm (Stenner, in preparation).

Arano Flat also provides one of the few observations of 1906 slip along the southern section of the 1906 rupture. A small tributary channel of Arano Creek flowed across the alluvial flat during the 19th century, crossed the fault, and re-joined the main stream. The upper part of the fill in this channel contains abundant artifacts, mostly fragments of glass and ceramics associated with a small house that was located about 700 m southeast of the trench site during the turn of the century. These artifacts include intact bottles made only from 1887-1890. Progressive excavation of this channel exposed it across the fault (Figure 8). The channel is offset 3.2- 3.5 m. Given that that there is no evidence either here or at Mill Canyon of the 1890 M 6.3 earthquake (Bakun, 1999), which produced surface rupture on the San Andreas fault southeast of Pajaro Gap, this entire amount of slip likely occurred during the 1906 earthquake. This slip value is high compared to the geodetic estimate of 2.3-3.1 m for slip at depth (Thatcher et al., 1997) or the geologic estimate of 1.7-1.8 m of surface slip at Wright's tunnel (Prentice and Ponti, 1997), about 33 km northwest of Arano Flat.

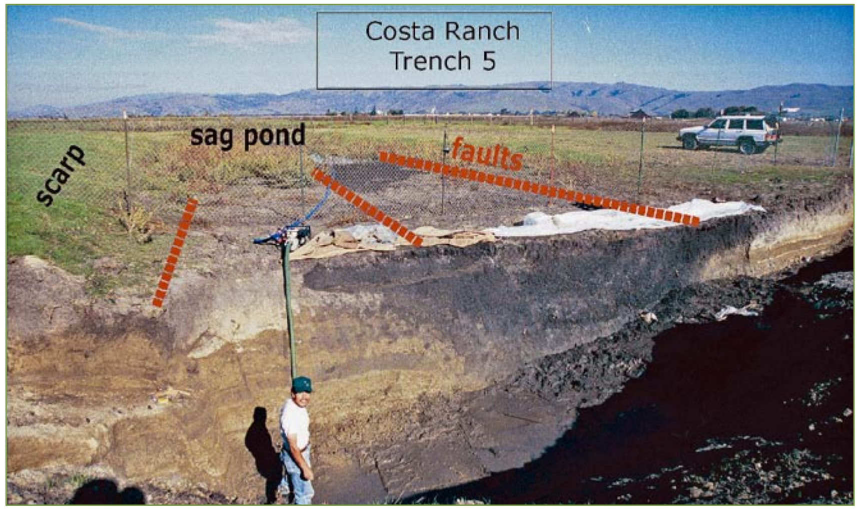


Figure 10. View to the north of Trench 5 across Calaveras fault sag pond at Costa Ranch. Red dashed lines are surface traces of faults exposed in the trench. Photo by H. Stenner.

STOP 2. Calaveras Fault, Costa Ranch Paleoseismic Site *(Stenner)*

The Calaveras fault splays from the San Andreas (or joins it, depending on your point of view) south of Hollister and extends 125 km north to Danville in the San Ramon Valley. It is one of the most active and complex faults in the Bay Area. The northern 40 km (referred to as the Northern Calaveras fault) has little to no creep, is essentially devoid of microearthquakes, and is considered capable of producing M 6.8-6.9 earthquakes (WGCEP, 2003). In contrast, the central/southern Calaveras fault is characterized by abundant microearthquake activity that likely reflects the high rate of creep. The average creep rate from 1968 to 1999 was 16.3 mm/yr (Galehouse and Lienkaemper, 2003); the average geologic slip rate is 14 ± 5 mm/yr for the past 4000 years (Kelson et al., 2001). Within the uncertainty of the geologic data, the long-term slip rate on the central Calaveras is consistent with the short-term slip rate derived from aseismic slip data and geodetic modeling. Historically, the central Calaveras fault has been the source of moderate magnitude earthquakes (1949 Gilroy, M 5.2; Coyote lake, M 5.9; 1984 Morgan Hill, M 6.2; 1988 Alum Rock, M 5.1). A similar sequence of comparably sized earthquakes occurred between 1897 and 1911. Based on the historical seismic record and the agreement between geodetic/creep rates and geologic slip rates, the WGCEP (2003) concluded that there is little or no strain accumulation that would result in a large earthquake along this section of the fault. However, evidence from trenches at San Ysidro Creek on the central Calaveras can be interpreted as support for ≥ 2m-displacement surface rupturing earthquakes, with three events in the past four thousand years (Kelson et al., 2001).

At the Costa Ranch site we will walk a 300m-long section of the Calaveras fault that exhibits classical strike-slip geomorphology characterized by fault scarps and sag ponds (Figure 9). A fundamental question is whether these surface features can be formed by creep alone, or also require coseismic surface rupture during large earthquakes. From 1971-79, a creepmeter at this location recorded 15 mm/yr of creep, and another creepmeter at Shore Road, less than

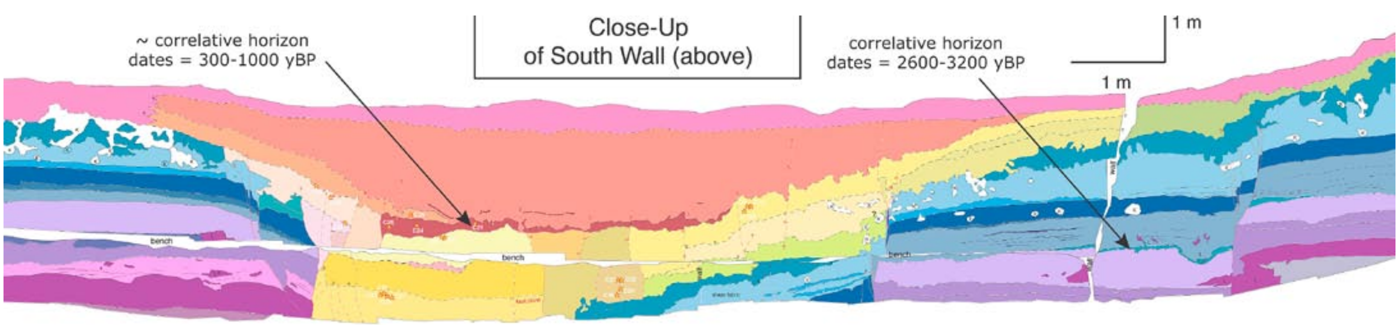


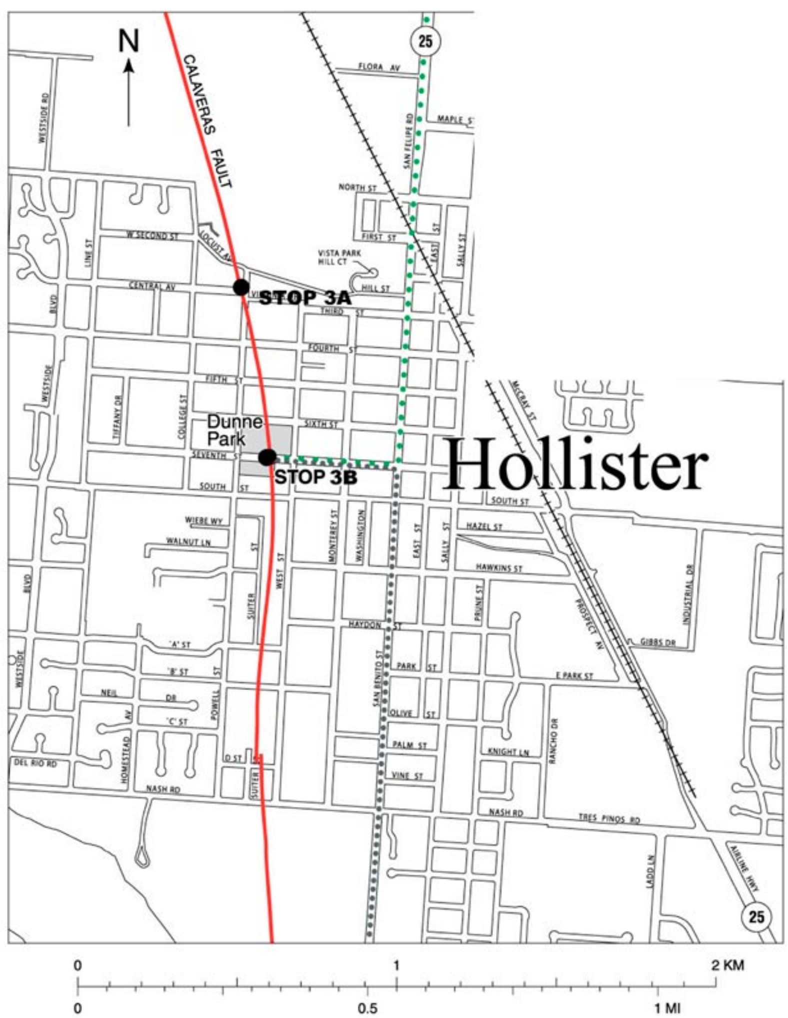
Figure 11. Log of south wall of Trench 6 at Costa Ranch on the Calaveras fault showing structure and stratigraphy of the northern sag pond. The sag is bounded on both eastern and western sides by obliquely slipping faults that allow the section between to subside. The main fault zone, which accommodates both normal and lateral slip, is located immediately east of the pond's middle. The position of this trace suggests that a majority of slip occurs through the extensional sag pond area on at least one major Reidel shear, possibly acting as a linking structure as the overall fault geometry bends to the right. Minor faulting occurs throughout the sag pond, about 6 meters wide, but the main shear zone is ~1 m across. The faults exposed in the trench either reach the surface or, as within the fairly massive sag pond clay, are difficult to trace upward (Stenner, in preparation).

2 km to the north, recorded 6.5-12 mm/yr, depending on the averaging technique (Schulz and others, 1979; Schulz and others, 1982). The fault trace makes a 25-30 m right step at the southern end of the site, and at the north end of the site it bends to the east, producing sag ponds in the resulting extensional zones at both locations (Figure 9). In total six trenches were excavated at the Costa Ranch (unfortunately none is presently open). Trenches 1 and 2 crossed the large step-over; Trenches 3-6 crossed the fault scarp and sag pond to the north (Figures 10 and 11).

Trenches 1 and 2 exposed 1 to 2.5 m of overbank sediments (silt, sand, and clay) on which a moderately to very heavily bioturbated organic horizon has developed. No evidence for distinct colluvial wedge packages or fissures (both of which are indicators of instantaneous surface rupture that would be associated with large earthquakes) , or consistent upward fault terminations were observed. Most of the faults were traced to the surface because of continuous creep, and some strands were obscured in the bioturbated soil horizon. Trenches 3 and 4 exposed stratigraphy similar to that in Trenches 1 and 2: fluvially deposited silt, sand, and clay overlain by an organic horizon.Three radiocarbon dates within the upper fluvial sediments yielded a range of 1800–2700 years BP. In Trenches 3 and 4 some faults extend to the surface as obviously creeping traces, and others are likely creeping but have not experienced sufficient creep to demarcate their location through the young, bioturbated upper soil horizon. All deformation observed in Trenches 3 and 4 can be explained solely by creep processes, but coseismic rupture is not completely excluded.

Trench 5 and Trench 6 were excavated across the northern sag pond (Figure 9). A photograph of the north wall of Trench 5 and a log of the south wall of Trench 6 are shown on Figures 10 and 11, respectively. Both trenches exposed the youngest stratigraphy at Costa Ranch, with more than a meter of accumulated sag pond sediment carbon-dated at younger than 1000 yrBP. Two dated shells suggest an even younger deposit of 300 yrBP (Trench 5). The sag pond strata, observed in both Trenches 5 and 6, are progressively warped down into the sag and thicken towards the center. The uppermost unit, likely historical, also thickens into the center of the sag, and is faulted (vertical component ~1 cm) by at least two creeping traces. The base of the sag pond was not exposed in either trench. The total vertical component of slip is therefore more than 2 meters. Using an estimated range in age for the oldest sag pond sediment of 1000-2000 yBP, a minimum vertical slip rate would be 1-2 mm/yr. There is no geologic basis for independently estimating the horizontal slip rate at this location.

In summary, no evidence for coseismic surface rupture of significant size has been found on the 11 trench walls exposing the southern Calaveras fault in late Holocene sediment at Costa Ranch. Fissures fills or consistent upward terminations were not observed in any of the trenches. Creep and micro-to-moderate magnitude seismicity may accommodate all of the fault slip, resulting in a low probability of future large earthquakes rupturing the central and southern parts of the fault. The lack of evidence cannot preclude the possibility, however, that the fault has ruptured in a large earthquake. With the high creep rate for this section of the fault evidence for large, coseismic surface rupture may have been overprinted and modified by creep. Large coseismic rupture may also have occurred at depth and did not reach the surface, or a rupture may have been severely attenuated toward the surface because of creep.



STOP 3. Calaveras Fault, Dunne Park Area, Hollister *(Stenner, Schwartz)*

In contrast to Stop 2, where we observed the long-term geologic effects of creep in unconsolidated deposits, we can see the effect of creep on manmade structures including roads, curbs, concrete retaining walls, and houses. Surface creep and its effects can be observed in urbanized areas along other Bay Area faults including the Hayward (especially in Fremont, Hayward, and Berkeley), Concord-Green Valley (in Concord), and Maacama (great creep in Willits). However, the Hollister creep features are the best developed because of the high creep rate of 12-14 mm/yr at this location (Lisowski et al., 1991). Hollister experienced significant damage from the 1906 and 1989 earthquakes, as well as minor damage from the 1979 Coyote Lake (M 5.6) and 1984 Morgan Hill (M6.2) earthquakes on the Calaveras fault. Along with Parkfield, Hollister bills itself as the "earthquake capital".

We'll walk from the intersection of Locust St. and Central Ave. (Figure 11, Stop 3A) six blocks southeast to Dunne Park (Stop 3B). The west-facing break in slope extending across the grassy section of the park is the scarp of the Calaveras fault. Weather permitting we'll eat lunch on the fault trace, and maybe experience a small event or two for dessert, before returning to Monterey.

References

Bakun,W. H., 1999, Seismic activity of the San Francisco Bay region: Bulletin of the Seismological Society of America, v.89, pp.764-784.

Bilham, R., N. Suszek, and S. Pinkney, 2004, California creepmeters, Seismological Research Letters, v.75, p. 481-492.

d 'Alessio, M.A., Johanson, I.A., Burgmann, R., Schmidt, D.A., and Murray, M.H., 2005, Slicing up the Bay Area: block kinematics and fault slip rates from GPS-derived surface velocities: Journal of Geophysical Research, v. 110, B60403, doi:10.1029/2004JB003496

DeMets, C., and Dixon, T.H., 1999, New kinematic models for Pacific-North America motion from 3 Ma to present; I, Evidence for steady motion and biases in the NUVEL-1A model: Geophysical Research Letters, v. 26, no. 13, p. 1921-1924.

Linde, A. T., M. T. Gladwin, M. J. S. Johnston, R. L. Gwyther, and R. G. Bilham, 1996, A slow earthquake sequence on the San Andreas fault: Nature, v. 383, p. 65-68.

Galehouse, J.S., and Lienkaemper, J.J., 2003, Inferences drawn from two decades of alinement array measurements of creep on faults in the San Francisco Bay region: Bulletin of the Seismological Society of America, v. 93, p. 2415-2433.

Gladwin, M. T., R. L. Gwyther, R. H. G. Hart, and K. S. Breckenridge, 1994, Measurements of the strain field associated with episodic creep events on the San Andreas fault at San Juan Bautista, California: Journal of Geophysical Research, v. 99, p. 4559-4565.

Gwyther, R. L., C. H. Thurber, M. T. Gladwin, and M. Mee , 2000, Seismic and aseismic observations of the 12th August 1998 San Juan Bautista, California M5.3 earthquake, paper presented at 3rd San Andreas Fault Conference, Stanford University, September 6, 2000.

Johanson, I. A., and R. Bürgmann, 2005, Creep and quakes on the northern transition zone of the San Andreas Fault from GPS and InSAR data: Geophysical Research Letters, v 32, 5.

Kelson, K.I., and others, 1998, Late Holocene slip rate and amounts of coseismic rupture along the central Calaveras fault, San Francisco Bay area, California: Final Technical Report submitted to the U.S. Geological Survey National Earthquake Hazard Reduction Program, Award Number 1434-HQ-97-GR-03151, 26 pp.

Kelson, K., 2001, Geologic characterization of the Calaveras fault as a potential seismic source, San Francisco Bay area, California: Calif. Geol. Surv. Bull., v. 210, p. 179-192.

Lisowski, M., Savage, J. C., and Prescott, W. H., 1991, The velocity field along the San Andreas fault in central and southern California: Journal of Geophysical Research, v.96, p. 8369-8389.

Nason, R.D., 1971. Investigations of fault creep slippage in northern and central California, Ph.D. Thesis, University of California, San Diego, 231p.

Prentice, C. S., Ponti, D. J.,1997, Coseismic deformation of the Wrights Tunnel during the 1906 San Francisco earthquake; a key to understanding 1906 fault slip and 1989 surface ruptures in the south Santa Cruz Mountains, California: Journal of Geophysical Research, v.102, p.635-648.

Prescott, W.H., Savage, J.C., Svarc, J.L., and Manaker, David, 2001, Deformation across the Pacific-North America plate boundary near San Francisco, California: Journal of

Geophysical Research, B, v. 106, no. 4, p. 6673-6682.

Schwartz, D.P., Pantosti, D., Okumura, K., Powers, T., and Hamilton, J., 1998, Paleoseismic investigations in the Santa Cruz Mountains: Implications for the recurrence of large magnitude earthquakes on the San Andreas Fault: Journal of Geophysical Research, v. 103, p. 17,985-18,001.

Schulz, S.S., and Burford, R.O., 1979, Catalog of creepmeter measurements in central California for 1976 and 1977: U.S. Geological Survey Open-File Report 79-1609, 375 p.

Schulz, S.S., Mavko, G.M., Burford, R.O., and Stuart, W.D., 1982, Long-term creep observations in central California: Journal of Geophysical Research, v.87, no. B8, p.6977-6982.

Simpson, R.W., Graymer, R.W., Jachens, R.C., Ponce, D.A., and Wentworth, C.M., 2005, Cross-sections and maps showing double0difference relocated earthquakes from 1984-2000 along the Hayward and Calaveras faults, California: U.S. Geological Survey Open-File Report 04-1083.

Thatcher,W. R; Marshall, G. A., and Lisowski, M., 1997, Resolution of fault slip along the 470-km-long rupture of the great 1906 San Francisco earthquake and its implications: Journal of Geophysical Research, v.102, p.5353-5367.

Tuttle, M. P. and Sykes, L. R., 1992, Re-evaluation of several large historic earthquakes in the vicinity of the Loma Prieta and Peninsular segments of the San Andreas fault, California: Bulletin of the Seismological Society of America, v.82, pp. 1802-1820.

Toppozada, T. R. and Borchardt, G., 1998, Re-evaluation of the 1836 "Hayward fault" and the 1838 San Andreas fault earthquakes: Bulletin of the Seismological Society of America, v. 88, pp. 140-159.

Uhrhammer, R., L. S. Gee, M. H. Murray, D. Dreger, and B. Romanowicz, 1999, The Mw 5.1 San Juan Bautista, California earthquake of 12 August 1998: Seismological Research. Letters, v.70, p. 10-18.

Wagner, D.L., Greene, H.G., Saucedo, G.J., Pridemore, C.L., Watkins, S.E., Little, J.D., and Bizzarro, J.J., 2002, Geologic map of the Monterey 30'x60' quadrangle and adjacent areas, California: A digital database: California Geological Survey CD, v. 2002-04. Regional Geologic Map Series

Wesson, R. L., 1988, Dynamics of fault creep: Journal of Geophysical Research v .93, p. 8929-8951.

Working Group on California Earthquake Probabilities, 200, Earthquake probabilities in the San Francisco Bay region: 2002-2031: U.S. Geological Survey Open-File Report 03-214.