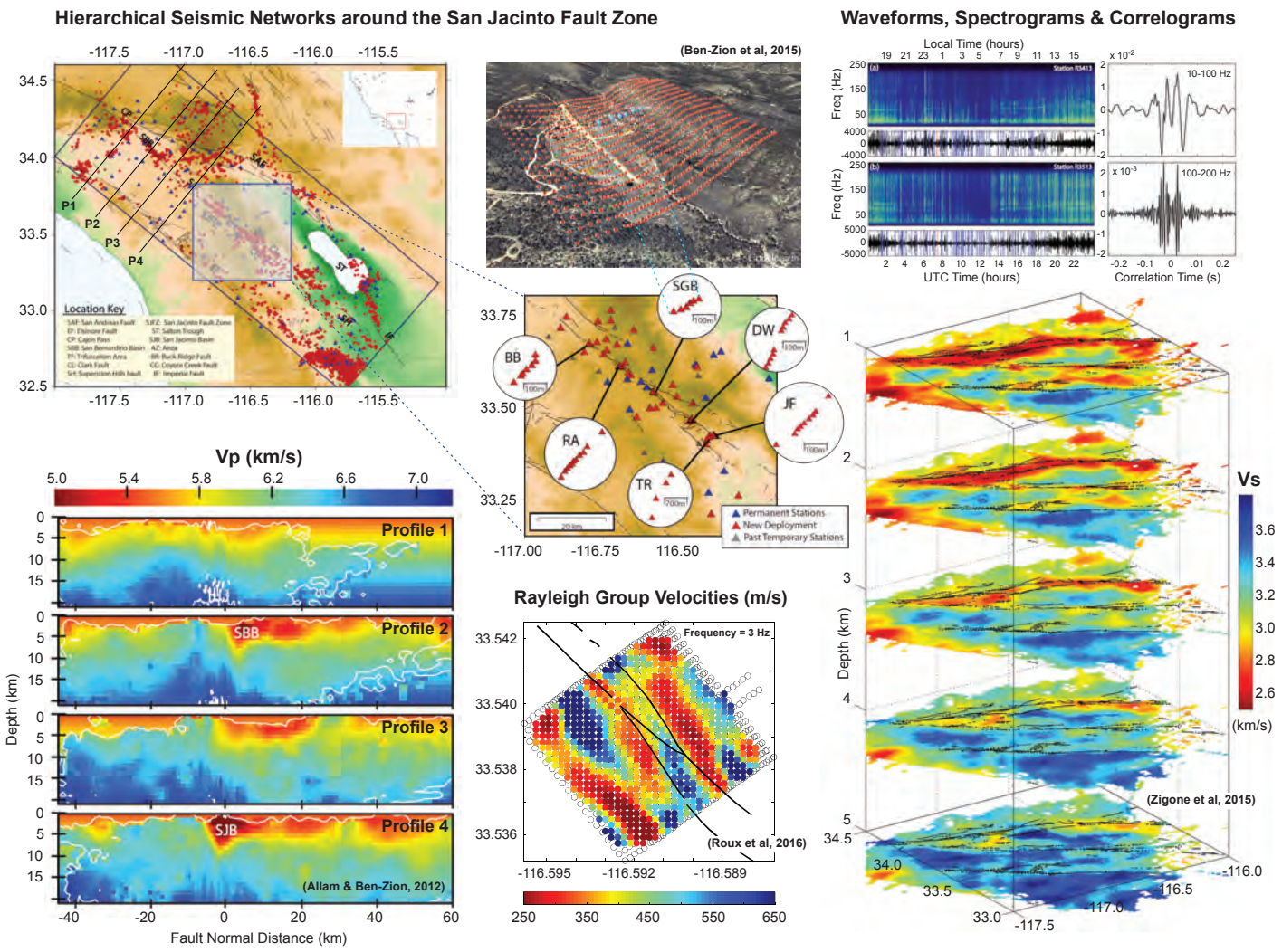
Southern California Earthquake Center

ANNUAL MEETING 2016



SCEC
AN NSF+USGS CENTER

MEETING PROGRAM

September 10-14, 2016

Core Institutions and Board of Directors (BoD)

The Board of Directors (BoD) is the primary decision-making body of SCEC; it meets three times annually to approve the annual science plan, management plan, and budget, and deal with major business items. The Center Director acts as Chair of the Board. The liaison members from the U.S. Geological Survey are non-voting members.

USC **Tom Jordan**, Chair	Harvard **Jim Rice**	Texas A&M **Patrick Fulton**	UC Santa Barbara **Ralph Archuleta**	USGS Menlo Park **R. Harris, S. Hickman**
Caltech **Nadia Lapusta**, VC	MIT **Tom Herring**	UC Los Angeles **Peter Bird**	UC Santa Cruz **Emily Brodsky**	USGS Pasadena **Rob Graves**
CGS **Chris Wills**	SDSU **Tom Rockwell**	UC Riverside **David Oglesby**	UNR **Glenn Biasi**	At-Large Member **Roland Bürgmann**
Columbia **Bruce Shaw**	Stanford **Paul Segall**	UC San Diego **Yuri Fialko**	USGS Golden **Jill McCarthy**	At-Large Member **Michele Cooke**

Science Working Groups & Planning Committee (PC)

The leaders of the Disciplinary Committees and Interdisciplinary Focus Groups serve on the Planning Committee (PC) for three-year terms. The PC develops the annual Science Collaboration Plan, coordinates activities relevant to SCEC science priorities, and is responsible for generating annual reports for the Center. Leaders of SCEC Special Projects (i.e., projects with funding outside the core science program) also serve on the Planning Committee. They ensure the activities of the Special Projects are built into the annual science plans.

SCEC4

PC Chair
Greg Beroza*

PC Vice-Chair
Judi Chester*

* PC Members

Disciplinary Committee

Seismology	Tectonic Geodesy	EQ Geology	Computational Sci
Egill Hauksson*	**Dave Sandwell***	**Mike Oskin***	**Yifeng Cui***
Elizabeth Cochran	**Gareth Funning**	**Whitney Behr**	**Eric Dunham**

Interdisciplinary Focus Groups

USR	SoSAFE	EFP	EEII
John Shaw*	**Kate Scharer***	**Jeanne Hardebeck***	**Jack Baker***
Brad Aagaard	**Ramon Arrowsmith**	**Ilya Zaliapin**	**Jacobo Bielak**
FARM	SDOT	GMP	
Greg Hirth*	**Kaj Johnson***	**Kim Olsen***	
Pablo Ampuero	**Liz Hearn**	**Domniki Asimaki**	

Special Projects

CME	CSEP	WGCEP
Phil Maechling*	**Max Werner***	**Ned Field***
	Danijel Schorlemmer	

TAGs

GMSV
Nico Luco
Sanaz Rezaeian

Technical Activity Groups (TAGs *continued*)

Code Verification	SIV	EQ Simulators	Transient Detection
Ruth Harris	**Pablo Ampuero**	**Terry Tullis**	**Rowena Lohman**

SCEC5

PC Chair
Greg Beroza*

PC Vice-Chair
Judi Chester*

* PC Members

Disciplinary Committee

Seismology	Tectonic Geodesy	EQ Geology	Computational Sci
Yehuda Ben-Zion*	**Dave Sandwell***	**Mike Oskin***	**Eric Dunham***
Jamie Steidl	**Gareth Funning**	**Whitney Behr**	**Ricardo Taborda**

Interdisciplinary Focus Groups / Working Groups

FARM	SDOT	EFP	Ground Motions
Nadia Lapusta*	**Kaj Johnson***	**Max Werner***	**Domniki Asimaki***
Nick Beeler	**Bridget Smith-Konter**	**Ned Field**	**Annemarie Baltay**
EEII	SAFS	CXM	Special Projects
Jack Baker*	**Kate Scharer***	**Liz Hearn***	**Christine Goulet***
Jon Stewart	**Michele Cooke**	**Brad Aagaard**	**Phil Maechling***

CEO Planning Committee (CEO PC)

The Communication, Education, and Outreach Planning Committee (CEO PC) comprises of stakeholders representing CEO program focus areas (public education and preparedness; K-14 education initiative; experiential learning and career advancement; and the implementation interface). The CEO PC provides guidance for CEO programs, reviews reports and evaluations, and identifies synergies with other parts of SCEC and external organizations.

* Board liaison
** PC liaison
*** AC liaison

Tim Sellnow***, Chair U Central Florida	**Kate Long***** CalOES	**Danielle Sumy** IRIS
Jacobo Bielak** CMU	**Salley McGill** CSUSB	**Chris Wills*** CGS

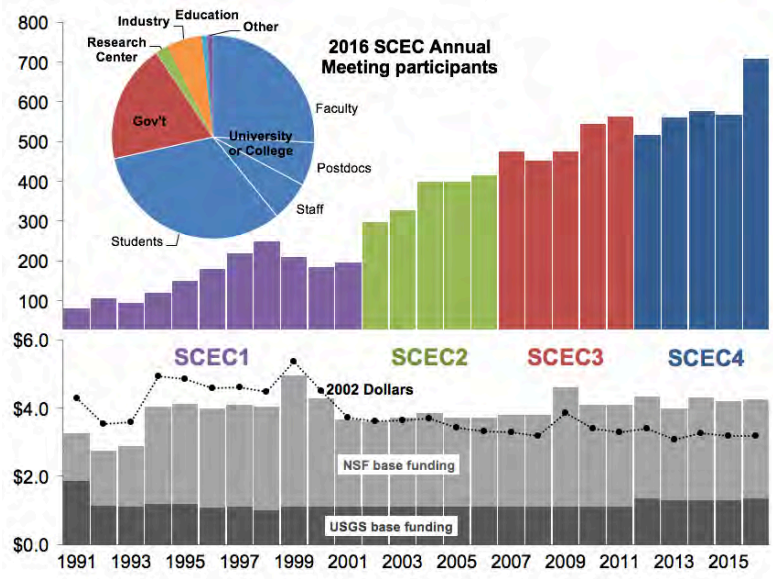
Advisory Council (AC)

The external Advisory Council (AC) provides guidance in all aspects of Center activities, including basic and applied earthquake research and related technical disciplines, formal and informal education, and public outreach. Members of the AC are elected by the Board for three-year terms and may be re-elected. The Council meets annually to review Center programs and plans, and prepares a report for the Center.

Gail Atkinson, Chair Western U	**Donna Eberhart-Phillips** UC Davis	**M. Meghan Miller** UNAVCO	**John Vidale** U Washington
Norm Abrahamson PG&E	**Kate Long** CalOES	**Farzad Naeim** John A Martin	**Andrew Whittaker** MCEER/Buffalo
Roger Bilham U Colorado	**Warner Marzocchi** INGV Rome	**Tim Sellnow** U Central Florida	

Welcome to the 2016 SCEC Annual Meeting!

The 2016 annual meeting marks the nucleation phase of the SCEC5 collaboration. At this meeting, we will review recent research accomplishments for SCEC4 and lay the groundwork for achieving the ambitious science goals set forth in the SCEC5 proposal.



Upper bar chart shows registrants at SCEC Annual Meetings 1991-2016. Pie chart shows the demographic profile for 2016 pre-registrants (707 total). The lower bar chart is the history of SCEC base funding in as-spent millions of dollars; the connected dots are the base-funding totals in 2002 dollars.

The figure above makes clear that interest and involvement in SCEC, as gauged by attendance at this meeting, are nearly off the charts. The SCEC Science Planning Committee has configured a program that will keep you engaged during your stay in the desert. Six workshops will be held on Saturday and Sunday, and at 6pm Sunday evening, Rick Sibson from the University of Otago will kick off the meeting as our Distinguished Speaker with a talk on "Earthquakes on Compressional Inversion Structures - Problems in Mechanics and in Hazard Assessment."

The agenda for the rest of the meeting features keynote speakers giving plenary talks on thought-provoking subjects that feed directly into discussions of major science themes. We also have dedicated time for poster sessions, technical demonstrations, education and outreach activities, and of course, some lively social gatherings.

Those of you who have attended past SCEC meetings realize that much of the action happens in the poster sessions. As in the past few years, posters will stay up for the entire meeting to allow more face-to-face interactions on the juicy details of SCEC research. SCEC leadership has a continuing interest in hearing your feedback on ways to improve the meeting, particualrly now that it has grown so large.

So welcome, or welcome back, to the SCEC annual meeting in sunny, temperate Palm Springs! We hope you find this meeting as informative, and as inspiring, as we do.

Thomas H. Jordan, Director

Gregory C. Beroza, Co-Director

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Go to meeting website:
www.scec.org/meetings/2016/am

@SCEC #scecmeet

Cover Image

Hierarchical seismic networks, data and imaging results for plate-boundary region around San Jacinto fault zone (SJFZ).

Top left: Regional seismic stations (blue triangles) and earthquake epicenters (red circles). **Top middle:** Zoomed in views showing dense linear arrays (instrument spacing 25-50m) across SJFZ at different locations and a dense rectangular array (instrument spacing 10-30m) with 1108 sensors at site SGB. **Top right:** Waveforms and spectrograms recorded at two stations 10m apart next to stacked correlograms of waveforms recorded by the stations in 4 weeks. **Bottom left:** P wave velocities from double-difference local earthquake tomography projected on vertical cross-sections crossing the San Jacinto, Elsinore and San Andreas faults (Allam & Ben-Zion, 2012). **Bottom middle:** Rayleigh wave group velocities from cross correlations of recorded ambient noise at the dense rectangular array (Roux et al., 2016). **Bottom right:** S wave velocities from noise-based tomography along horizontal cross sections at different depths (Zigone et al., 2016). Courtesy of Yehuda Ben-Zion (USC). Cover composite image by Tran Huynh (USC).

Saturday, September 10

08:00 - 09:00	Workshop Check-In at Plaza Ballroom Foyer of Hilton Palm Springs
09:00 - 17:00	**SCEC SoSAFE Workshop: Recent Successes and Future Challenges**
	Conveners: Kate Scharer (USGS) and Ramon Arrowsmith (ASU) Location: Palm Canyon Room
09:00	Introductions
	Earthquake Recurrence and Slip Over Short and Long Term: How Does It All Add Up?
	Creep and other earthquake cycle challenges from recent observations
09:15	The Dry Lake Valley site: Observations of structures formed by modern and prehistoric creep on the central San Andreas fault (Nate Toke)
09:30	South Napa 2013 trenches: creep, afterslip, missed events! (Tim Dawson)
09:45	Creep on the Imperial Fault and new faults in the Salton Trough (Eric Lindsey)
10:00	Near field and off fault deformation revealed using optical image correlation (Chris Milliner)
10:15	Break
	Adding up slip: Segment boundaries and slip rate variations
10:30	Slip rates and distributed deformation in and around San Gorgonio Pass (Michele Cooke)
10:45	Earthquake displacements and timing of events at Quincy and Mystic Lake, SJF (Nate Onderdonk)
11:00	Investigating the age and origin of small offsets at Van Matre Ranch along the San Andreas Fault in the Carrizo Plain, California (Barrett Salisbury)
11:15	Discussion
	- What does slip rate variability mean for fault and crustal rheologies?
	- Why aren't paleoseismic/geologic data used as constraints on this?
	- Proposal and project ideas
12:00	Lunch
	Integrating Earthquake and Paleoclimate/Paleoenvironmental Chronologies on the SoSAFE System
13:00	A lake-based event chronology for the Southern San Andreas and San Jacinto Faults (Tom Rockwell)
13:15	Sediment accumulation curves discriminate between proximal event records on the southern San Andreas Fault (Kate Scharer)
13:30	Holocene droughts, fires, floods and pluvials in southwestern California (Matt Kirby)
14:00	On the PAGES2k project, paleoclimate cyberinfrastructure and integrating paleoclimatology and paleoseismology Nick McKay
14:30	Discussion
	- Where does SoSAFE go to advance this research?
15:00	Break

Saturday, September 10

Outside Looking In: Broad Applications of Behavior of High Slip Rate Faults

15:15 So many earthquakes, so little time: An examination of SAF-system earthquake recurrence (Glenn Biasi)

15:30 RSQSim for paleoseismologists; what's under the hood and SoCal results (Jacqui Gilchrist)

16:00 Data integration and visualization tools for bringing paleoseismic data and simulator results together (Kevin Milner)

16:15 Discussion and Wrap Up

- Earthquake geology data and metadata needs
- Paleoseismology in the Collaboratory for Interseismic Simulation and Modeling (CISM)
- Simulator opportunities
- Adieu to SoSAFE!

16:45 Adjourn

09:00 - 17:00 SCEC Ventura Special Fault Study Area Workshop

Conveners: Scott Marshall (AppState), James Dolan (USC), Thomas Rockwell (SDSU), and John Shaw (Harvard)
Location: Plaza Ballroom AB

09:00 Opening Remarks and Introduction to the Ventura fault system (James Dolan, Tom Rockwell, John Shaw)

Crustal Structure, Near Surface Geophysics, Seismology

09:15 Subsurface Structure of the Western Transverse Ranges and Potential for Large Earthquakes (Yuval Levy)

09:30 3D Fault Geometry and Slip History of the North Channel-Pitas Point-Red Mountain Fault System (Craig Nicholson)

09:45 Constraints on the Geometry of the Ventura-Pitas Point Fault System at Depth & Implications for Hazards (John Shaw)

10:00 Moderated Discussion

10:30 Break

Geology, Paleoseismology, Tectonic Geomorphology

10:45 Evidence for Large (~M8.0) Multi-Segment Ruptures in the Ventura Pitas Point Fault System (Tom Rockwell)

11:00 Urban Paleoseismology of the Ventura Fault and Evidence for Large Coseismic Uplift Events (James Dolan)

11:15 Geomorphic Evidence for Recent Deformation along the Southern San Cayetano Fault (Dylan Rood)

11:30 Stress Drop Variations and Seismicity Characteristics in San Gorgonio and Ventura (Thomas Goebel)

11:45 Moderated Discussion

12:15 Lunch

Geodesy and Fault Modeling

13:00 Regional Geodetic Fault Slip Rates and Interseismic Deformation (Scott Marshall)

13:15 Uplift Across the Western Transverse Ranges from Integrated Analysis of GPS, InSAR, Leveling and Tide Gauge Data (Bill Hammond)

13:30 Kinematic Models of Fault Slip Rates in the Western Transverse Ranges (Kaj Johnson)

13:45 Moderated Discussion

14:15 Break

Saturday, September 10

Dynamic Rupture and Tsunamis

14:30 Searching for Tsunami Deposits in the Santa Barbara Channel (Alex Simms)

14:45 Dynamic Rupture and Tsunami Models Offshore Ventura (Kenny Ryan)

15:00 Tsunamis from Earthquakes on the Ventura-Pitas Point Fault System (Hong Kie Thio)

15:15 Moderated Discussion

15:45 Break

What's Next? Future Research Directions

16:00 Overview of Final Report to SCEC

16:15 Final Discussion: Plans for Future Work and/or Special Publication

16:45 Final Remarks (Scott Marshall)

17:00 Adjourn

09:00 - 17:00 SCEC on the Processes that Control the Strength of Faults and Dynamics of Earthquakes

Conveners: David Goldsby (U Penn), Whitney Behr (UT Austin), Eric Dunham (Stanford) and Greg Hirth (Brown)
Location: Plaza Ballroom CD

09:00 Workshop Overview and Introductions (David Goldsby/Whitney Behr)

Mechanisms of coseismic weakening

09:10 Controls on frictional strength and stability in gouge-filled faults in the seismogenic zone (Chris Spiers)

09:35 The role superplasticity may play during seismic slip (Nicola De Paola)

10:00 How coseismic weakening can be incorporated into earthquake models and linked with seismic data (Rob Viesca)

10:25 Group Discussion

10:55 Break

Spatial Variations in fault resistance

11:10 Field measurements of fault roughness (Emily Brodsky)

11:35 How roughness influences the dynamics of an earthquake in numerical models (Eric Dunham)

12:00 Lunch

13:00 How changes in coseismic weakening within the seismogenic zone limit the depth penetration of large earthquakes (Nadia Lapusta)

13:25 Earthquake source scaling (Marine Denolle)

13:50 Group Discussion

14:20 Break

Evolution of the slip zone during an earthquake

14:35 Recent progress identifying field evidence for seismic slip (Heather Savage)

15:00 How dynamic stresses influence the properties of fault damage fault zones (Ashley Griffith)

15:25 How chemical alteration of slip surfaces can be linked to coseismic weakening mechanisms such as flash heating (Jim Evans)

15:50 Group Discussion

Where we are and whither we are tending

16:20 Summary discussion / Wrap up

17:20 Adjourn

Sunday, September 11

07:00 - 17:00 **SCEC Annual Meeting Registration & Check-In** at Hilton Lobby

07:00 - 08:00 **Breakfast** at Hilton Poolside

08:00 - 12:00 **SCEC Collaboratory for Interseismic Simulation and Modeling (CISM) Workshop**
Convener: Thomas Jordan (USC)
Location: Horizon Ballroom

07:30	Continental Breakfast & Check-In
08:00	Introduction to CISM (Tom Jordan)
08:20	Multiscale forecasting using UCERF3 (Ned Field)
09:00	Earthquake forecasting using the RSQSim earthquake simulator (Jim Dieterich)
09:40	Contributions of the UseIT summer research program to CISM (Kevin Milner)
10:00	Generating long RSQSim catalogs for CISM analysis (Jacqui Gilchrist)
10:00	Discussion: Use of simulators in CISM forecasting research (All)
10:15	Break
10:30	Testing forecasting models in CSEP (Max Werner)
11:00	Is there an earthquake drought in California? (Dave Jackson)
11:30	CyberShake as a CISM ground motion prediction platform (Scott Callaghan)
11:45	Discussion: CISM plans for 2017 (All)
12:00	Adjourn and Lunch (Hilton Restaurant and Tapestry Room)

13:00 - 17:00 **International Workshop on Ground Motion Simulation Validation**
Conveners: Sanaz Rezaeian (USGS), Nicolas Luco (USGS), Brendon Bradley (QuakeCoRE), Iunio Iervolino (U Naples), and Leonardo Ramirez-Guzman (UNAM)
Location: Horizon Ballroom

13:00	Introductions (Sanaz Rezaeian)
13:05	The SCEC perspective on validations in SCEC5 (Christine Goulet)
	Overview of GMSV Efforts in New Zealand, Italy, Mexico, and at SCEC
13:15	QuakeCoRE GMSV research coordination and current priorities (Brendon Bradley)
13:25	Italian experience with 3D physics-based numerical simulations of earthquake ground motion (Marco Stupazzini)
13:40	Synthetic ground motion system for structural design and evaluation in Mexico City (Leonardo Ramirez-Guzman)
13:55	Organization and structure of the GMSV TAG in SCEC4 (Nico Luco)
14:05	Discussion: How should modelers and engineers participate in and contribute to the SCEC5 ground motion simulation validation efforts?
	Simulated Earthquake Ground Motions and Database Development
14:30	Development of a QuakeCoRE database for access to ground motion simulation outputs at specific locations (Sung Bae)
14:40	Datasets of recorded and simulated near-source earthquake ground motions: the experience gained in Italy (Marco Stupazzini)
14:50	Current SCEC simulations (Phil Maechling)
15:00	Discussion: What are the requirements of a database interface for users to access simulated ground motions and validation parameters?

Sunday, September 11

15:25	Break
	Validation Efforts and Engagement with Engineering Users
15:40	QuakeCoRE guidance on the utilization of ground motion simulations in engineering practice (Brendon Bradley / Jack Baker)
15:50	Engineering applications of 3D physics-based numerical simulations: two case studies from the Reluis project, Italy (Marco Stupazzini)
16:00	Demonstration of the efficacy of the BBP validation gauntlets for building response analysis applications (Nico Luco / Greg Deierlein)
16:15	Discussion: How should we engage engineering users in SCEC5?
16:45	Summary and Wrap Up (Sanaz Rezaeian)
17:00	Adjourn

13:00 - 17:00 **Workshop on Science Communication: Navigating and Maximizing a Digital, Social World**

Conveners: Wendy Bohon (IRIS), Beth Bartel (UNAVCO, and Jason Ballmann (SCEC)
Location: Palm Canyon Room

SCEC Communication, Education, and Outreach is pleased to announce an afternoon of social media discussions and media training at the SCEC Annual Meeting on Sunday, September 11th, between 1 PM and 5 PM, featuring award-winning earthquake journalist for the LA Times, Ron Lin, and communications experts and scientists from IRIS, UNAVCO, and SCEC.

Join with us in a casual, interactive environment where you will leave knowing best practices for social media networking, how to best prepare for and talk to the media, and where it's all going next. You might start a Twitter account while there, discover ways to follow your colleagues online, or meet a journalist or two who can bring your research to the right audience. There is no need to RSVP for these sessions. Refreshments will be served.

(1) Improving Your Online Presence: Social Media, Web Profiles, Emails, Blogs: Dr. Wendy Bohon (IRIS), Beth Bartel (UNAVCO), and Jason Ballmann (SCEC) will lead a panel, Q&A, and mini-trainings on how to outfit your digital prominence, with the goals of networking with other scientists and experts, best practices on sharing information publicly, and how to engage certain mediums like social media, blogs, emails, and websites.

(2) Talking to the Media, with Award-Winning LA Times reporter Ron Lin Learn about the story-writing process, what journalists look for and need to make a compelling article, prime examples of successful earthquake science articles, and how you can look for ways to make those broader impacts with your science!

13:00	Introduction
13:30	Key Online Mediums You Need to Know About
14:00	Who to Follow and Why (Following Spree!)
14:30	Sharing Information Publicly, Promoting Your Research
15:30	Talking to the Media, with Award-Winning LA Times reporter Ron Lin

Sunday, September 11

15:00 - 20:00 **Poster Set-Up** in Plaza Ballroom

17:00 - 18:00 **Welcome Social** in Hilton Lobby and Plaza Ballroom

18:00 - 19:00 **Distinguished Speaker Presentation** in Horizon Ballroom
Earthquakes on Compressional Inversion Structures - Problems in Mechanics and in Hazard Assessment (Richard H. Sibson)

19:00 - 20:30 **Welcome Dinner** at Hilton Poolside

19:00 - 21:00 **SCEC Advisory Council Meeting** in Palm Canyon Room

21:00 - 22:30 **Poster Session 1** in Plaza Ballroom

Monday, September 12

07:00 - 08:00 **SCEC Annual Meeting Registration & Check-In** at Hilton Lobby

10:00 - 15:00 **SCEC Annual Meeting Registration & Check-In** at Hilton Lobby

07:00 - 08:00 Breakfast at Hilton Poolside

08:00 - 10:00 **Session 1: The State of SCEC** in Horizon Ballroom

- 08:00 Welcome and State of the Center (Tom Jordan)
- 08:30 Agency Reports
  - National Science Foundation (Greg Anderson/Carol Frost)
  - U.S. Geological Survey (Bill Leith)
- 09:00 Communication, Education, & Outreach (Mark Benthien)
- 09:20 SCEC Science Accomplishments (Greg Beroza)

10:00 - 10:30 Break

10:30 - 12:30 **Session 2: Modeling Fault Systems – Supercycles**
Moderators: Mike Oskin, Kate Scharer

- 10:30 Open Intervals, Clusters and Supercycles: 1100 years of Moment Release in the Southern San Andreas Fault System: Are we Ready for the Century of Earthquakes? (Tom Rockwell)
- 11:00 The bridge from earthquake geology to earthquake seismology (Dave Jackson)
- 12:00 Discussion

12:30 - 14:00 Lunch at Hilton Restaurant, Tapestry Room, and Poolside

14:00 - 16:00 **Session 3: Modeling Fault Systems – Community Models** in Horizon Ballroom
Moderators: Brad Aagaard, Michele Cooke

- 14:00 How Sensitive are Inferred Stresses and Stressing Rates to Rheology? Clues from Southern California Deformation Models (Liz Hearn)
- 14:30 How stressed are we really? Harnessing community models to characterize the crustal stress field in Southern California, Karen Luttrell
- 15:00 Discussion

16:00 – 17:30 **Poster Session 2** in Plaza Ballroom

19:00 - 21:00 **SCEC Honors Banquet** at Woodstock Ballroom, Hard Rock Hotel

21:00 - 22:30 **Poster Session 3** in Plaza Ballroom

Tuesday, September 13

07:00 - 08:00 Breakfast at Hilton Poolside

08:00 - 10:00 **Session 4: Understanding Earthquake Processes** in Horizon Ballroom; Moderators: Nick Beeler, Nadia Lapusta

- 08:00 Constraints on the Source Parameters of Low-Frequency Earthquakes in Parkfield and Cascadia (Amanda Thomas)
- 08:30 Kumamoto earthquake: a complex earthquake sequence with large strike-slip ruptures (Koji Okumura)
- 09:00 Discussion

10:00 - 10:30 Break

10:30 - 12:30 **Session 5: New Observations** in Horizon Ballroom; Moderators: Yehuda Ben-Zion, Gareth Funning

- 10:30 The Ups and Downs of Southern California: Mountain Building, Sea Level Rise, and Earthquake Potential from Geodetic Imaging of Vertical Crustal Motion (Bill Hammond)
- 11:00 Offshore Pacific-North America lithospheric structure and Tohoku tsunami observations from a southern California ocean bottom seismometer experiment (Monica Kohler)
- 11:30 Discussion

12:30 - 14:00 Lunch at Hilton Restaurant, Tapestry Room, and Poolside

14:00 - 16:00 **Session 6: Characterizing Seismic Hazard - Operational Earthquake Forecasting** in Horizon Ballroom
Moderators: Ned Field, Max Werner

- 14:00 Induced earthquake magnitudes are as larger as (statistically) expected (Nick van der Elst)
- 14:30 Blurring the boundary between earthquake forecasting and seismic hazard (Matt Gerstenberger)
- 15:00 Discussion

16:00 - 17:30 **Poster Session 4** in Plaza Ballroom

19:00 - 21:00 Dinner at Hilton Poolside

19:00 - 21:00 **SCEC Advisory Council Meeting** in Boardroom

21:00 - 22:30 **Poster Session 5** in Plaza Ballroom

22:30 - 23:00 Poster Removal from Plaza Ballroom

Wednesday, September 14

07:00 - 08:00 Breakfast at Poolside

08:00 - 08:30 Report from the Advisory Council (John Vidale)

08:30 - 10:30 **Session 7: Reducing Seismic Risk** in Horizon Ballroom
Moderators: Jack Baker, Christine Goulet

- 08:30 Utilization of earthquake ground motions for nonlinear analysis and design of tall buildings (Greg Deierlein)
- 09:00 Progress Report of the SCEC Utilization of Ground Motion Simulations (UGMS) Committee (C.B. Crouse)
- 09:30 Discussion

10:30 - 12:00 **The Future of SCEC** in Horizon Ballroom

- 10:30 This Next Year: 2017 SCEC Science Collaboration (Greg Beroza)
- 11:30 Towards SCEC5 Priorities (Tom Jordan)
- 12:00 Adjourn

12:30 - 14:30 **SCEC Planning Committee Lunch Meeting** in Palm Canyon Room

12:30 - 14:30 **SCEC Board of Directors Lunch Meeting** in Tapestry Room

Distinguished Speaker Presentation — Sunday

Earthquakes on Compressional Inversion Structures - Problems in Mechanics and in Hazard Assessment, *Richard H. Sibson (University of Otago)*

Sunday, September 11, 2016 (18:00)

The dip-distribution of near-pure reverse-slip ruptures includes a dominant 'Andersonian' cluster (dips of 30±5°) flanked by groups of low-angle thrusts (dips of 10±5°), and moderate-steep reverse faults (dips of 50±5°). These last are attributable in part to 'compressional inversion' – reactivation during crustal contraction of normal faults inherited from earlier crustal extension – identified by a distinctive structural-stratigraphic signature and shown by seismic profiling to be widespread. It is easier, in terms of required stress levels, to impose brittle deformation on the crust during extension; compressional inversion is thus an inevitable consequence of the Wilson Cycle of oceanic opening and closure. Examples of seismically active inversion provinces include NE Honshu, Japan, and the NW South Island, NZ, with damaging inland earthquakes < M7.5.

Reactivation mechanics does much to explain the observed dip distribution for reverse-slip ruptures, suggesting first, that low-displacement faults are characterized by 'Byerlee' friction (μs ~ 0.6), and second, that high fluid overpressures are needed for continued reactivation of moderate-steep reverse slip faults. Support for the latter comes from the existence of hydrothermal vein systems formed by 'fault-valve' action around reverse faults exhumed from seismogenic depths, and from geophysical anomalies (bright-spot reflectors, anomalously high Vp/Vs, high electrical conductivity) in the mid-crust of areas undergoing inversion. Compressional inversion earthquakes are predominantly 'fluid-driven' (H2O, CO2?) because failure on such structures is likely induced by accumulating fluid overpressure rather than by increasing differential stress.

Evaluating hazard from inversion structures is problematic because their surface expression is often structurally complex with misleading dip-separations, and may be obscured near the margins of sedimentary basins. Complexity also arises from competition between inversion structures and younger, more optimally oriented thrusts. Inversion structures are likely widespread throughout North America within the west coast plate boundary zone (e.g. Ventura and Los Angeles Basins within the Transverse Ranges), within mid-continental rift zones, and along the Atlantic seaboard where inherited Mesozoic rift structures are occasionally reactivated in reverse-slip earthquakes (e.g. 1982 Miramachi, New Brunswick; 1983 Goodnow, NY).

Richard (Rick) Sibson graduated BScHons (1st Class) in Geology from the University of Auckland in 1968 before gaining an MSc and PhD (1977) from Imperial College, London, researching the structure of the Outer Hebrides Thrust zone. He taught structural geology at Imperial College (1973-1981) and at UC Santa Barbara (1982-1990), before returning to New Zealand as Professor of Geology in the University of Otago (1990-2009). His research focuses on the structure of crustal fault zones and the mechanics of shallow crustal earthquakes with coupled interests in crustal fluid flow and structural controls affecting the development of fault-hosted mineralisation. He has been a contributing author to over 95 research papers and has presented short courses to the mineral industry and academia in Australia, Canada, the United States, South Africa, Chile, Japan, Taiwan, and Italy.

He was elected to fellowship of the Geological Society of America (1991); the Royal Society of New Zealand (1993); the American Geophysical Union (1999); the Royal Society of London (2003); the American Association for the Advancement of Science (2005); and the Society of Economic Geologists (2010). Recent awards include the Wollaston Medal from the Geological Society of London (2010), a Career Contribution Award from GSA Structural Geology and Tectonics Division (2011), and appointment as the 2012 AGU Francis Birch lecturer, presenting "Inside a Crustal Earthquake: the Rock Evidence".

Plenary Talk Presentations — Monday

Open Intervals, Clusters and Supercycles: 1100 years of Moment Release in the Southern San Andreas Fault System: Are we Ready for the Century of Earthquakes?

Thomas K. Rockwell (SDSU)

Monday, September 12, 2016 (10:30)

Compilation of paleoseismic data from several dozen trench sites in the southern San Andreas fault system, along with geomorphic observations of displacement in recent earthquakes, allows for sequencing of the past 1100 years of large earthquakes for the southern 160 km of the main plate boundary. At least four generalizations are clear: 1) M7 and larger earthquakes account for most of the moment release in the southern San Andreas fault system over the past 1100 years; 2) large earthquakes on individual faults are quasi-periodic but display a relatively high coefficient of variation in recurrence time, similar to most long California paleoseismic records, and which may be a reflection of Coulomb stress interactions; 3) moment release has temporally varied during the past 1100 years but within potentially predictable bounds; and 4) the southern San Andreas fault system is currently moment deficit when compared to the previous millennium of moment release. Comparison of the timing of earthquakes with the timing of past high-stands of Lake Cahuilla supports the idea that lake fillings influenced and may have modulated the timing of southernmost San Andreas fault earthquakes. If so, then the long (300 year) open interval on the southern San Andreas fault may be in part explained by the absence of a complete lake filling episode in the past 300 years. Together, the record suggests that the southern San Andreas fault is late in the cycle but not necessarily “overdue”, and that a systems level approach may be more accurate in long-term earthquake forecasting than estimates made from individual faults. If the past is the key to the future, then the next century is likely to see far more large earthquake activity on the southern San Andreas fault system than was observed in the past one to two centuries.

The bridge from earthquake geology to earthquake seismology, *David D. Jackson (UCLA)*

Monday, September 12, 2016 (11:00)

Recurrence intervals of large earthquakes exceed the instrumental earthquake record, so we rely on paleo-seismic and surface deformation evidence to infer long-term earthquake rates and recurrence statistics. Paleo-seismic studies generally imply quasi-periodic recurrence and greater rates for large earthquakes than those deduced from instrumental data coupled with Gutenberg-Richter magnitude relations.

Under SCEC leadership a team of paleo-seismic experts compiled the most reliable data available for use in the third Uniform California Earthquake Rupture Forecast (UCERF3). They reported dates of observed displacements at 32 sites on 13 named faults in California. Corrected for multiple-site ruptures, the total reported paleo-event rate at those sites exceeds about 4 per century, yet none has occurred since 1916. Such a long hiatus is extremely unlikely for a Poisson process and even less probable for an ensemble of quasi-period processes.

Hypotheses for the hiatus of paleo-events include (1) extreme luck, (2) unexplained regional fault interaction, or (3) mistaken identification of non-seismic displacements as evidence of large earthquakes, or counting multiple branches of single ruptures as separate ruptures. The first can be rejected with 99% confidence. There is no evidence for the second in the pre-1916 paleo-seismic history or in any theoretical models yet reported. Temporal clustering of large quakes (“supercycles”?) could in principle explain the hiatus, but individual site records and rate-state frictional models suggest quasi-periodic recurrence instead. The third hypothesis could explain the observed quiescence because mistaken identity would be prevented by instrumental seismic data during the last century. In any case the paleo-event hiatus poses a serious challenge to earthquake forecast models. It also begs the larger question of how 2-dimensional fault-based observations and models can be reconciled with 3-D instrumental earthquake observations.

Plenary Talk Presentations — Monday

How Sensitive are Inferred Stresses and Stressing Rates to Rheology? Clues from Southern California Deformation Models, *Elizabeth Hearn (Capstone Geophysics)*

Monday, September 12, 2016 (14:00)

Variations in fault zone strength and lower lithosphere viscoelastic rheology have been shown to influence deformation patterns in fault systems over a range of time scales (e.g. Bird and Kong, 1994; Fay and Humphreys, 2005). Because of our mandate to characterize stresses in the southern California lithosphere, SCEC has proposed a resource (the Community Rheology Model) that will facilitate representing Southern California's rheology in deformation models. I will present some recent modeling results demonstrating how assumed fault zone and rock rheologies influence estimates of stresses, stressing rates and fault slip rates.

My kinematic and dynamic finite-element models incorporate the UCERF3 block model-bounding fault geometry (Field et al., 2014), with refinements suggested by geologists involved in the UCERF3 effort. The kinematic models are fit to either the SCEC CMM4 velocity field or a strain energy minimization criterion by varying fault slip rates, within the UCERF3 ranges. The (preliminary) dynamic models are tuned to fit geological fault slip rates and SHmax orientations by varying fault zone and rock rheologies. Deformation is driven from the sides in both sets of models.

The kinematic models suggest that 22-35% of the strain accumulation across Southern California is not associated with interseismic locking of the modeled faults, consistent with other studies (e.g. Bird, 2009, Johnson, 2013; Zheng and Shen, 2016). This is true whether or not the GPS velocity field is corrected for possible seismic cycle perturbations due to large SAF earthquakes. Plasticity exerts a profound influence on slip rates, deformation patterns and stresses obtained from dynamic deformation models. Variation in fault zone strength (quantified as shear traction) also affects stress magnitudes and orientations, but not surface velocities or slip rates in models with just the San Andreas Fault zone represented. Simulations are underway to assess how variations in fault zone strength and lithosphere rheology affect deformation in dynamic models incorporating the full fault network.

How stressed are we really? Harnessing community models to characterize the crustal stress field in Southern California, *Karen M. Luttrell (LSU)*

Monday, September 12, 2016 (14:30)

The in situ crustal stress field fundamentally governs, and is affected by, the active tectonic processes of plate boundary regions, yet questions remain about the characteristics of this field and the implications for active faults in the upper crust. We investigate the nature of this stress field in southern California by combining observations from the SCEC Community Stress Model, including stress orientation, stress from topography, and stress accumulation rate on major locked faults. First, we estimate the magnitude of the non-lithostatic in situ stress field in southern California by balancing in situ orientation indicated by earthquake focal mechanisms against the stress imposed by topography, which tends to resist the motion of strike-slip faults. Our results indicate that most regions require in situ differential stress of at least 20 MPa at seismogenic depth. In the areas of most rugged topography along the San Andreas Fault System, differential stress at seismogenic depth must exceed 62 MPa consistent with differential stress estimates from complimentary methods. Second, we assess the origin of the heterogeneity observed in the stress field by combining stress accumulation on major locked fault segments with stress from topography and a simple 2-D tectonic driving stress. Our results suggest that in situ stress heterogeneity at the regional scale is more influenced by deep driving processes acting on a laterally heterogeneous crust than by perturbations to the stress field associated with major locked faults in the upper crust. Finally, we discuss some potential avenues for moving toward a 4D representation of the crustal stress field in southern California.

Plenary Talk Presentations — Tuesday

Constraints on the Source Parameters of Low-Frequency Earthquakes in Parkfield and Cascadia

Amanda Thomas (U Oregon), Gregory C. Beroza (Stanford), David R. Shelly (USGS), Michael Bostock (UBC), Allan M. Rubin (Princeton), Genevieve Savard (UBC), & Lindsey Chuang (UBC)

Tuesday, September 13, 2016 (08:00)

Low-frequency earthquakes (LFEs) are small repeating earthquakes that occur in conjunction with deep slow slip. Like typical earthquakes LFEs are thought to represent shear slip on crustal faults but when compared to earthquakes of the same magnitude LFEs have lower corner frequencies, implying longer durations, and are depleted in high-frequency content relative to earthquakes of similar magnitude. Along the San Andreas Fault, and in the Cascadia subduction zone, LFEs occur in rapid succession, forming tectonic tremor. Here we present results from LFE source studies in both Parkfield and Cascadia. In Parkfield, we use an empirical Green's function approach to investigate which physical properties of the LFE source cause high-frequency depletion. We find that the M~1 LFEs have typical durations of ~0.2 s. Using the annual slip rate of the deep SAF and the average number of LFEs per year we estimate average LFE slip rates of ~0.24 mm/s. When combined with the LFE magnitude this number implies a stress drop of ~104 Pa, two to three orders of magnitude lower than ordinary earthquakes, and a rupture velocity of 0.35 km/s. Typical earthquakes are thought to have rupture velocities of ~80-90% the shear wave speed. In Cascadia, we correct LFE waveforms for path effects and use the resulting source time functions to calculate LFE duration and magnitude. We use these estimates to show that, like Parkfield, LFEs in Cascadia also have low stress drops, rupture and slip velocities. We also find that LFE duration displays a weaker dependence upon moment than expected for self-similarity, suggesting that LFE asperities are limited in dimension and that moment variation is dominated by slip. This behavior implies that LFEs exhibit a scaling distinct from both large-scale slow earthquakes and regular seismicity. Together the slow rupture velocity, low stress drops, and slow slip velocity explain why LFEs are depleted in high frequency content relative to ordinary earthquakes and suggest that LFE asperities represent areas capable of relatively higher slip speed in deep fault zones. Additionally, changes in rheology may not be required to explain both LFEs and slow slip; the same process that governs the slip speed during slow earthquakes may also limit the rupture velocity of LFEs.

Kumamoto earthquake: a complex earthquake sequence with large strike-slip ruptures

Koji Okumura

Tuesday, September 13, 2016 (08:30)

The Mw 7.3 mainshock of the Kumamoto earthquake on April 16 ruptured the Futagawa fault zone mostly as it was forecasted. However, the sequence of earthquakes, ruptures, and localized severe shaking were beyond the forecast demonstrating the complex nature.

The earthquake sequence began with a Mw 6.2 at 21:26 JST on April 14. This one ruptured deeper part of the Takano and Shirahata faults (TSF) in SW of the Futagawa fault. Strong shaking (JMA scale 7 out of 7) damaged many houses in a small area of Mashiki town-center to kill 9 people. Following another Mw 6.0 on the April 14 source area, the Mw 7.3 occurred at 01:25 JST on April 16. The mainshock induced several Mw 5.3 to Mw 5.9 earthquakes outside its source area, at 75 km NW, 45 km NW, and 40 km SW away from the epicenter. Those induced earthquakes and aftershocks occurred in a zone about 120 km long across Kyushu Island while the Mw 7.3 rupture was only 30 km long.

The 30 km long Mw 7.3 rupture mostly followed the previously mapped Futagawa fault zone with dextral offset up to 2 m. However, the surface offset of the TSF was only 0.3 m. Also, the TSF ruptured twice both on April 14 and on April 16. Assuming the two shocks ruptured the same fault plane, the small offset on April 16 could be due to the strain release on April 14, or to the rather short elapsed time of 1200 to 1500 years. The northeasternmost 5 km section, which also caused severe damages, cutting into the Aso caldera was not mapped before. Rapid erosion in this high-relief area probably erased or buried past surface ruptures. A 3.7 km long branch fault with ~1 m offset appeared from a restraining bend of the Futagawa fault to the Mashiki town-center with conjugate sinistral offset. These faults ruptured active alluvial plain.

The severest damages were concentrated in a small area of the Mashiki town-center where JMA intensity 7 was recorded twice during Mw 6.2 and Mw 7.0. The possible causes of the severe damages are the source process, site amplification, surface faulting, slope failure and lateral spreading, and so on. It is necessary to integrate analyses and models by different disciplines. From geologic points of view, the presumable complexity of shallow subsurface structures at the boundary between Holocene graben fill in south and upland-forming Pleistocene volcanics and gravels in north is a likely cause of the localized amplification. Further investigation is necessary to solve this significant hazard.

Plenary Talk Presentations — Tuesday

The Ups and Downs of Southern California: Mountain Building, Sea Level Rise, and Earthquake Potential from Geodetic Imaging of Vertical Crustal Motion

William C. Hammond (UNR), Geoffrey Blewitt (UNR), Corné W. Kreemer (UNR), Reed J. Burgette (NMSU), Kaj M. Johnson (Indiana, Charles M. Meertens (UNAVCO), & Frances Boler (UNAVCO)

Tuesday, September 13, 2016 (10:30)

Contemporary tectonic uplift in California and Nevada is an active part of ongoing plate boundary processes driving earthquakes. However, it has so far been difficult to confidently resolve and interpret uplift patterns. The challenges are twofold. First is the geodetic problem of isolating the signal of crustal-scale vertical motion given a large number of noisy time series from multiple networks irregularly distributed in space and time. Second is the problem of partitioning the signals into patterns of long-term tectonic deformation, earthquake cycle, flexural/isostatic adjustment, local basin response from groundwater hydrology, crustal loading, and/or mantle flow.

The spread of precise GPS networks and new developments in processing GPS data are leading to a clearer and more complete picture of vertical motions, improving knowledge of the rates of mountain growth, associated fault slip, and seismic hazard. To address the explosion in the quantity of new measurements, the 'Plug and Play' initiative is easing access to these data for everyone, enhancing their utility and impact. Plug and Play removes barriers at the beginning and end of the GPS processing chain, providing a free GPS data processing service and back-end products with free and open access. Currently the system has global scope, providing products for ~15,000 stations. To derive uplift maps from the data we apply our new robust estimation method "GPS Imaging" that combines non-parametric robust trend estimation with median-based despeckling and spatial filtering to suppress noise.

The resulting images show that the Sierra Nevada is the most rapid and extensive uplift feature in the western United States, rising up to 2 mm/yr, with uplift strongly modulated by climatic and anthropogenic forcing from groundwater pumping. The images reveal a discontinuity in the uplift field across Owens' Valley, suggesting that Sierra Nevada uplift is associated with crustal extension in the southern Walker Lane. Across the Western Transverse Ranges (WTR) of southern California we have taken the analysis further by combining four geodetic techniques: GPS, InSAR, levelling and tide gauges to constrain the vertical rate field. These results reveal 1-2 mm/yr of uplift across the WTR and San Gabriel Mountains block, focused west of the San Andreas fault, consistent with upward interseismic extrusion of these blocks as they experience contraction against the San Andreas Fault.

Offshore Pacific-North America lithospheric structure and Tohoku tsunami observations from a southern California ocean bottom seismometer experiment

Monica D. Kohler (Caltech)

Tuesday, September 13, 2016 (11:00)

The motivation for the offshore ALBACORE seismic experiment was to identify the physical properties and deformation styles of the western half of the Pacific-North America plate boundary in southern California. An array of 34 ocean bottom seismometers (OBSs) was deployed in 2010-2011, extending from the eastern California Borderland into Pacific oceanic plate 300 km west of the Patton Escarpment. The ALBACORE OBSs, together with 65 stations of the onshore Southern California Seismic Network, were used to measure ambient noise correlation functions and Rayleigh-wave dispersion curves which were inverted for 3D shear-wave velocities. The resulting shear-wave velocity model illustrates plate boundary deformation including both thickening and thinning of the crustal and mantle lithosphere within the California Borderland and at the westernmost edge of the North American continent. The velocity model defines the transition from continental lithosphere to oceanic tectonic environment, and indicates the persistence of uppermost mantle volcanic processes associated with East Pacific Rise spreading adjacent to the Patton Escarpment. One of the most prominent of these seismic structures is a low-velocity anomaly underlying San Juan Seamount, suggesting ponding of magma at the base of the crust, resulting in thickening and ongoing adjustment of the lithosphere due to the localized loading. Complementary to this, mapping of two active transpressional fault zones in the California Borderland - the Santa Cruz-Catalina Ridge fault and the Ferrelo fault - was carried out to characterize their geometries using over 4500 line-km of new multibeam bathymetry data recorded during the OBS deployment cruise, combined with existing data. The geometry of the fault systems shows evidence of multiple segments that could experience through-going rupture over distances exceeding 100 km. Transpression on west- and northwest-trending structures persists as far as 270 km south of the Transverse Ranges, extension persists in the southern Borderland, and these faults show potential for dip-slip rupture.

Plenary Talk Presentations — Tuesday

The 2011 Tohoku tsunami was serendipitously recorded by the ALBACORE seafloor co-located pressure gauges, demonstrating how dense array data can illustrate and validate predictions of linear tsunami wave propagation characteristics. Phase and group travel times were measured for the first arrival in the pressure gauge tsunami waveforms filtered in narrow period bands between 200 and 3000 s. For each period, phase velocities were estimated across the pressure gauge array based on the phase travel-time gradient using eikonal tomography. Clear correlation is observed between the phase velocity and long-wavelength bathymetry variations. In the deep open ocean, phase velocity dispersion is observed for both short and long periods. The pressure gauge tsunami records across the entire array show multiple, large-amplitude, coherent phases arriving one hour to more than 36 hours after the initial tsunami phase. Beamforming and back-projection analysis of the tsunami waveforms reveals locations of the bathymetric features in the Pacific Ocean that contributed to the scattered, secondary tsunami arrivals in southern California.

Induced earthquake magnitudes are as large as (statistically) expected

Nicholas J. van der Elst (USGS), Morgan T. Page (USGS), Debbie A. Weiser (USGS), Thomas H. Goebel (UCSC), & Seyed M. Hosseini (USC)

Tuesday, September 13, 2016 (14:00)

Injection-induced seismicity is a major contributor to seismic hazard in the central US. The question now is whether induced seismicity is amenable to statistical forecasting on any useful timescale. One of the major uncertainties affecting such a forecast is how large induced earthquakes can be. Are their maximum magnitudes determined by injection parameters, or by tectonics? Deterministic limits on induced earthquake magnitudes have been proposed based on the size of the reservoir or the volume of fluid injected. However, if induced earthquakes occur on tectonic faults oriented favorably with respect to the tectonic stress field, then they may be limited only by the regional tectonics and connectivity of the fault network. In this study, we show that the largest magnitudes observed at fluid injection sites are consistent with the sampling statistics of the Gutenberg-Richter distribution for tectonic earthquakes, assuming no upper magnitude bound. The data pass three specific tests: 1) the largest observed earthquake at each site scales with the log of the total number of induced earthquakes, 2) the order of occurrence of the largest event is random within the induced sequence, and 3) the injected volume controls the total number of earthquakes, rather than the total seismic moment. All three tests point to an injection control on earthquake nucleation, but a tectonic control on earthquake magnitude. The largest observed earthquakes are exactly as large as expected from the sampling statistics. The results imply 1) induced earthquake numbers can be estimated from previous activity and anticipated injection volumes, and 2) induced earthquake magnitudes should be treated with the same maximum magnitude bound that is used to treat seismic hazard from tectonic earthquakes.

Blurring the boundary between earthquake forecasting and seismic hazard

Craig A. Davis

Tuesday, September 13, 2016 (14:30)

Earthquake forecasting and seismic hazard have been traditionally considered as independent and separate fields of study. We are currently working on a range of topics that are beginning to blur the bounds between the two fields. With the Canterbury earthquakes it became apparent that traditional methods of seismic hazard modelling would not fully represent the expected hazard in the coming 50 years and we developed a hybrid long-term and time-dependent hazard model that melded the two fields. A distinction of this model is that it combined a range of models that produced forecasts from one-year to 50-years. A major contribution to the estimated uncertainty in the hazard came from the expected occurrence rate for the region in 20 to 50 years time. We are now developing models to allow improved estimates of this rate and to better capture the epistemic uncertainty in the short to long-term processes. By using the hybrid model idea, we combine, in an alternative to logic-trees, models based on differing data sets or hypotheses to produce a forecast of earthquake occurrence. By combining information from such things as seismicity, geodetic strain, geological data and slow slip events, we can provide forecasts that are typically more informative than any single model. Additionally, we are trying to better characterize the uncertainty inherent in all of the models; through an improved understanding of this uncertainty, we can develop better statistical tests of the models, and ideally provide more useful information to decision makers who are using the outputs of such models both in the form of short-term earthquake forecasts and long-term hazard forecasts. Finally, through our experiences in Christchurch and more recent earthquakes in New Zealand, we have gained valuable experience in how to communicate earthquake forecast information and, also, perhaps, a unique perspective on where future earthquake forecasting and hazard research might be the most beneficial to end-users of such information.

Plenary Talk Presentation — Wednesday

Utilization of earthquake ground motions for nonlinear analysis and design of tall buildings, *Gregory Deierlein (Stanford), Nenad Bijelic (Stanford), & Ting Lin (Marquette) Domniki Asimaki*

Wednesday, September 14, 2016 (08:30)

One of the promising applications of simulated ground motions is in the design of tall buildings and other unique structures, where nonlinear dynamic analyses are used to evaluate their seismic performance. In contrast to current practice, which requires amplitude scaling of recorded ground motions to represent extreme earthquake hazards, earthquake simulations can enable more direct assessment without ground motion scaling or reliance on empirical ground motion prediction equations. Moreover, comprehensive simulations, such as SCEC's Cybershake study, hold the potential to more realistically capture the influence of geologic basins and other geologic features on ground motion intensities, frequency content, and durations. This presentation will briefly review recent research on the use of nonlinear structural analysis in design, with particular focus on characterizing earthquake ground motions and their effects on structures. The important influence of response spectral shape and ground motion duration will be illustrated in a case study of a twenty-story building. Efforts to compare and contrast the response of structures to simulated and record motions will be presented as a step towards evaluating and validating earthquake simulations for use in engineering practice

Progress Report of the SCEC Utilization of Ground Motion Simulations (UGMS) Committee, *C.B. Crouse (AECOM), & Thomas H. Jordan (USC)*

Wednesday, September 14, 2016 (09:00)

The goal of the UGMS committee, since its inception in the spring of 2013, has been to develop digital long-period response spectral acceleration maps for the Los Angeles region, for inclusion in the NEHRP and ASCE 7 Seismic Provisions and in the Los Angeles City Building Code. The maps are based on 3-D numerical ground-motion simulations, generated using CyberShake, and ground motions computed using the four NGA West2 empirical ground-motion prediction equations that incorporate a basin amplification term. The UGMS developed a method to combine the response spectra from both approaches to generate risk-targeted Maximum Considered Earthquake (MCER) response spectra for the region. These response spectra cover the period band from 0 to 10 sec and will be proposed as an amendment to the ASCE -16 standard adopted by the City of Los Angeles. The MCER response spectrum at a given site would be obtained from a USGS-like web look-up tool. Users would input the site coordinates and site class (or Vs30), and the output would be a "site-specific" MCER response spectrum and associated SDS and SD1 values of the Design Response Spectrum. The user would have the option of obtaining more information, such as hazard curves, risk coefficients, and source and magnitude-distance deaggregation data. The look-up tool is currently being developed by SCEC with a scheduled release of a trial version toward the end of 2016 or early 2017.

The work of the UGMS committee has been coordinated with (1) the SCEC Ground Motion Simulation Validation Technical Activity Group (GMSV-TAG), (2) other SCEC projects, such as CyberShake and UCERF, and (3) the USGS national seismic hazard mapping project.

Poster Session Schedule

View full abstracts at www.scec.org/meetings/2016/am

Sunday, September 11, 2016

21:00 – 22:30 Poster Session 1

Monday, September 12, 2016

16:00 – 17:30 Poster Session 2

21:00 – 22:30 Poster Session 3

Tuesday, September 13, 2016

16:00 – 17:30 Poster Session 4

21:00 – 22:30 Poster Session 5

Ground Motion Prediction (GMP)

Posters 001-002, 265-280

001 **Next Generation SDSU BBP Module Validation,** *Kim B Olsen, and Rumi Takedatsu*

002 **The SCEC Broadband Platform: Open-Source Software for Strong Ground Motion Simulation and Validation,** *Fabio Silva, Christine A Goulet, Philip J Maechling, Scott Callaghan, and Thomas H Jordan*

265 **Towards Implementation of Multi-Segment Ruptures in the Broadband Platform: Composite Source Model,** *John G Anderson*

266 **From VS30 to near-surface velocity profiles: Integrating soft sediments in SCEC's UCVM,** *Domniki Asimaki, Jian Shi, and Ricardo Taborda*

267 **High-Frequency Nonlinear Simulations of Southern San Andreas Earthquake Scenarios,** *Daniel Roten, Kim B Olsen, Steven M Day, and Yifeng Cui*

268 **Using Simulated Ground Motions to Constrain Near-Source Ground Motion Prediction Equations in Areas Experiencing Induced Seismicity,** *Samuel A Bydlon, and Eric M Dunham*

269 **Analysis of Q-factor's parameters of Los Angeles through Simulation and Artificial Intelligence,** *Naeem Khoshnevis, and Ricardo Taborda*

270 **A Flexible and Memory-Efficient Displacement-Based Approach to Modeling Attenuation in Wave Propagation,** *Md Monsurul Huda, Ricardo Taborda, and Naeem Khoshnevis*

271 **Ground motions from induced earthquakes in Oklahoma and Kansas: implications for seismic hazard,** *Morgan P Moschetti, Steven Rennolet, Eric M Thompson, William Yeck, Dan McNamara, Robert Herrmann, Peter M Powers, and Susan Hoover*

272 **Verification and Validation of High-Frequency (fmax = 5 Hz) Ground Motion Simulations of the 2014 M 5.1 La Habra, California, earthquake,** *Ricardo Taborda, Kim B Olsen, Robert W Graves, Fabio Silva, Naeem Khoshnevis, William H Savran, Daniel Roten, Zheqiang Shi, Christine A Goulet, Jacobo Bielak, Philip J Maechling, Yifeng Cui, and Thomas H Jordan*

273 **Ground motion amplification in the Kanto Basin from future Itoigawa-Shizuoka earthquakes near Tokyo using virtual earthquakes,** *Marine A Denolle, Pierre Boué, Naoshi Hirata, Shigeki Nakagawa, and Gregory C Beroza*

274 **Green's functions retrieved by Multi-Component C3 for Ground Motion Prediction,** *Yixiao Sheng, Gregory C Beroza, and Marine A Denolle*

275 **On nonstationarity corrections and durations in ground motion applications of random vibration theory,** *Chris Van Houtte, Tam Larkin, and Caroline Holden*

276 **NGA 2 GMPE's Under Predict Long-Period Near-Source Motions from Large Earthquakes,** *Thomas H Heaton, and Becky Roh*

277 **Assessment of Predictive Values of Site Response based on GMPE approaches using a Large-N array,** *Nori Nakata*

278 **Ground Strains in Southern California from Earthquakes on the San Jacinto Fault,** *Andrew J Barbour, and Annemarie S Baltay*

279 **Frictional rheology for nonlinear attenuation: Implications for paleoseismology and strong S-waves,** *Norman H Sleep*

280 **Higher Earthquake Intensity Attenuation Rates in the Urbanized Southern Puget Lowland Than Elsewhere Along the Cascadia Forearc,** *Thomas M Brocher*

Unified Structural Representation (USR)

Posters 003-007

003 **CFM Version 5.1: New and revised 3D fault representations and an improved database,** *Andreas Plesch, Craig Nicholson, Christopher C Sorlien, John H Shaw, and Egill Hauksson*

005 **Structure of the San Andreas Fault Zone in the Salton Trough Region of Southern California: A Comparison with San Andreas Fault Structure in the Loma Prieta Area of Central California,** *Gary S Fuis, Rufus D Catchings, Daniel S Scheirer, Mark R Goldman, and Edward Zhang*

006 **Anomalous Uplift at Pitas Point: Implications from Onshore & Offshore 3D Fault & Fold Geometry and Observed Fault Slip,** *Craig Nicholson, Christopher C Sorlien, and Tom E Hopps*

007 **Displacement direction and 3D geometry for the south-directed North Channel – Pitas Point fault system and north-directed ramps, decollements, and other faults beneath Santa Barbara Channel.,** *Christopher C Sorlien, Craig Nicholson, Richard J Behl, and Marc J Kamerling*

Stress and Deformation Over Time (SDOT) — Posters 008-024

008 **Reconstruction Modeling of Topography and Lithosphere Dynamics using Western U.S. Strain History within the Pacific-North America Plate Boundary Zone,** *Alireza Bahadori, Bill E Holt, Lucy Flesch, Lijun Liu, Troy Rasbury, Gavin Piccione, and Rubin Smith*

009 **A new way to estimate shear tractions on active faults in southern California,** *Peter Bird*

010 **4D stress evolution models of the San Andreas Fault System using improved geodetic and paleoseismic constraints,** *Bridget R Smith-Konter, Karen M Luttrell, Xiaopeng Tong, and David T Sandwell*

011 **Temperature exerts the strongest control on the 3D rheology of the southern California lithosphere,** *Wayne R Thatcher, David S Chapman, and Colin Williams*

012 **Seasonal water storage modulating seismicity on California faults,** *Christopher W Johnson, Yuning Fu, and Roland Bürgmann*

013 **Towards Detailed Characterization of Spatio-temporal Variations in Stress Parameters along the San Jacinto Fault Zone,** *Niloufar Abolfathian, Patricia Martínez-Garzón, and Yehuda Ben-Zion*

014 **Can tectonic loading be observed as interseismic stress rotation?** *Jeanne L Hardebeck*

015 **Role of fault geometry on the spatial distribution of the slip budget,** *Phillip G Resor, Michele L Cooke, Scott T Marshall, and Elizabeth H Madden*

016 **Quantifying Late Quaternary deformation in the Santa Maria Basin: A OSL, GPS and soil chronosequence based model for determining strath terrace deformation in the Zaca Creek drainage, Santa Barbara County,** *Andrew C Farris, and Nate W Onderdonk*

017 **Progress towards deriving the three-dimensional coseismic deformation field along the White Wolf fault during the Mw ~7.3 1952 Kern County earthquake,** *Alexandra E Hatem, James F Dolan, and Chris W Milliner*

018 **Learning viscoelasticity with neural networks,** *Phoebe DeVries, Thomas B Thompson, and Brendan J Meade*

019 **Using Well Water Level To Measure Volumetric Strain Considering The Dissipation Effect,** *Yuqing Xie, Yonghong Zhao, and Lingsen Meng*

020 **Coulomb stress evolution over the past 200 years and seismic hazard along the Xianshuihe fault zone of Sichuan, China,** *Zhigang Shao, Jing Xu, Hongsheng Ma, and Langping Zhang*

021 **Calculating regional stresses for northern Canterbury: the effect of the 2010 Darfield earthquake,** *Susan Ellis, Charles A Williams, John Ristau, Martin Reyners, Donna Eberhart-Phillips, and Laura M Wallace*

022 **Evidence for strong lateral seismic velocity variation in the lower crust – upper mantle beneath the California margin,** *Voon Hui Lai, Robert W Graves, Shengji Wei, and Donald V Helmberger*

023 **Fault-parallel shear fabric in the ductile crust of Southern California imaged using receiver functions,** *Vera Schulte-Pelkum, and Karl Mueller*

024 **Discriminating Between Induced vs Tectonic Seismicity in Intraplate Regions: the Contribution of the Long-Term History of Fault Behavior,** *Maria Beatrice Magnani, Michael L Blanpied, Heather DeShon, and Matthew Hornbach*

Fault and Rupture Mechanics (FARM) — Posters 025-078

025 **Biomarkers as a tool to measure coseismic temperature rise,** *Genevieve L Coffey, Heather M Savage, Pratigya J Polissar, Brett M Carpenter, and Cristiano Collettini*

026 **Biomarker thermal maturity at seismic timescales in high-velocity rotary shear experiments,** *Hannah S Rabinowitz, Heather M Savage, Elena Spagnuolo, and Giulio Di Toro*

027 **Slip and Seismic Radiation Along Bi-material Faults: An Experimental Analysis,** *Brett M Carpenter, Ximeng Zu, Xiaowei Chen, and Ze'ev Reches*

028 **Laboratory investigation of friction along rock joints and identification of peaks in shear stiffness prior to the joint's shear failure,** *Ahmadreza Hedayat, and John Hinton*

029 **Earthquake source complexity? Near-fault velocity spectra from laboratory failures and their relation to natural ground motion,** *N. M Beeler, Brian D Kilgore, and David A Lockner*

030 **Progress Report on Addition of a High-Speed Drive to High-Pressure, Rotary-Shear Apparatus,** *Terry E Tullis*

031 **Multi-Scale Flash Heating and Frictional Weakening at Seismic Slip-Rates in Rock,** *Frederick M Chester, Omid Saber, and J. L. Alvarado*

032 **Dynamic Weakening of Sliding Friction and the Influence of Gouge Development,** *Monica R Barbery, Frederick M Chester, Judith S Chester, and Omid Saber*

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Core institutions are designated academic and government research organizations with major research programs in earthquake science. Each core institution is expected to contribute a significant level of effort (both in personnel and activities) to SCEC programs, as wells as a yearly minimum of $35K of institutional resources (spent in-house on SCEC activities) as matching funds to Center activities. Each core institution appoints an ***Institutional Director*** to the Board of Directors.

SCEC membership is open to participating institutions upon application. Eligible institutions may include any organization (including profit, non-profit, domestic, or foreign) involved in a Center-related research, education, or outreach activity. As of August 2014, the following institutions have applied for and approved by the SCEC Board of Directors as participating institutions for SCEC4.

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Apply as a Participating Institution

E-mail application to John McRaney [mcraney@usc.edu]. The application should come from an appropriate official (e.g. department chair or division head) and include a list of interested faculty and a short statement on earthquake science research at your institution. Applications must be approved by a majority vote of the SCEC Board of Directors.

HILTON PALM SPRING RESORT

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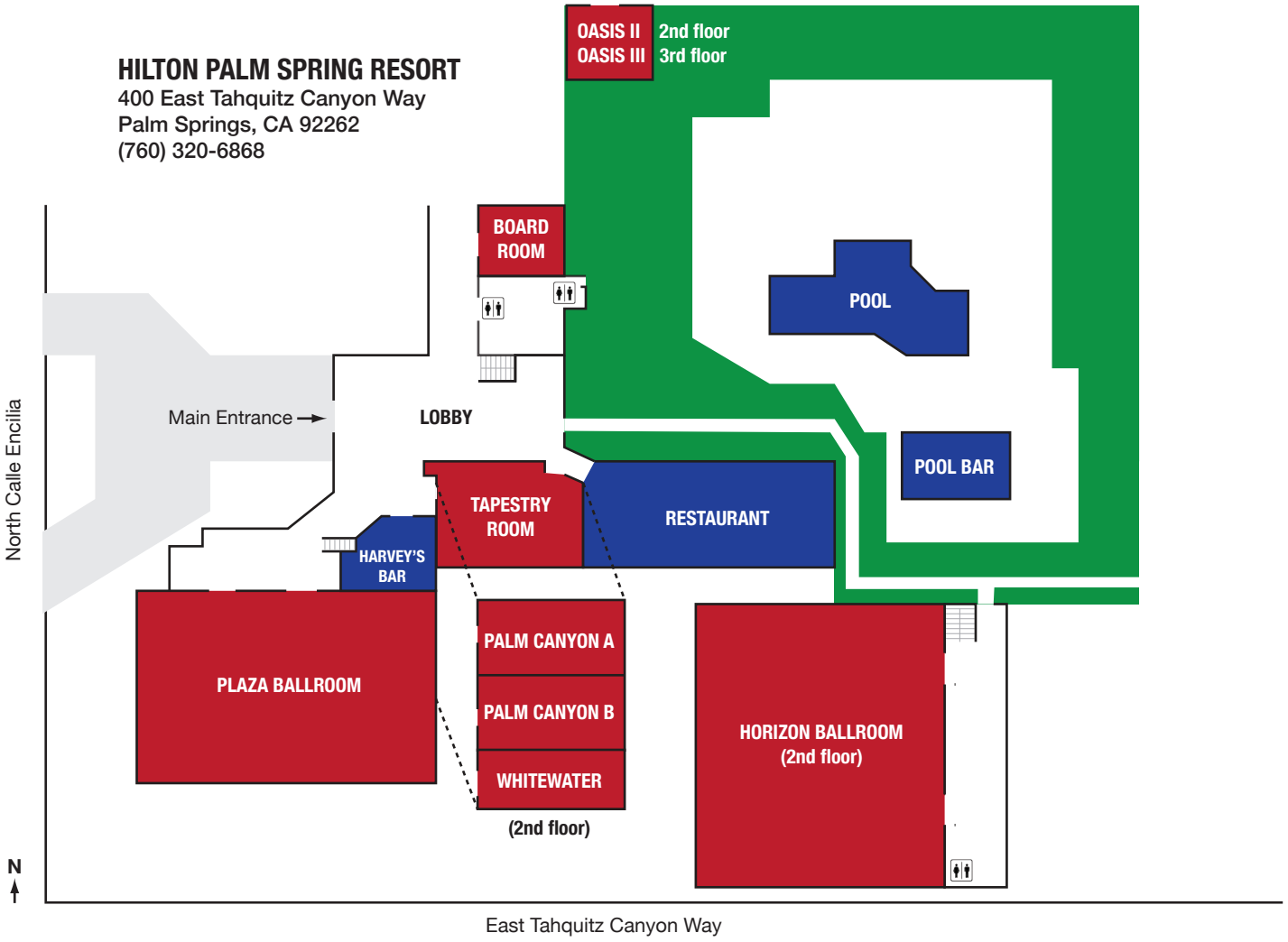

SATURDAY, September 10

09:00-17:00 Workshop: SoSAFE (Palm Canyon)
09:00-17:00 Workshop: Ventura SFSA (Plaza AB)
09:00-17:00 Workshop: Fault Mechanics (Plaza CD)

SUNDAY, September 11

07:00-17:00 Registration and Check-In (Lobby)
08:00-12:00 Workshop: CISM (Horizon)
13:00-17:00 Workshop: GMSV (Horizon)
13:00-17:00 Workshop: CEO (Palm Canyon)
15:00-20:00 Poster Set-Up (Plaza)
17:00-18:00 Annual Meeting Welcome Social (Lobby, Harvey's, Plaza)
18:00-19:00 Distinguished Speaker Presentation (Horizon)
19:00-20:30 Welcome Dinner (Poolside)
19:00-21:00 SCEC Advisory Council Dinner Meeting (Palm Canyon)
21:00-22:30 Poster Session (Plaza)

MONDAY, September 12

07:00-08:00 Registration and Check-In (Lobby)
10:00-15:00 Registration and Check-In (Lobby)
07:00-08:00 Breakfast (Poolside)
08:00-10:00 Session: The State of SCEC (Horizon)
10:30-12:30 Session: Modeling Fault Systems-Supercycles (Horizon)
12:30-14:00 Lunch (Restaurant, Tapestry, Poolside)
14:00-16:00 Session: Modeling Fault Systems-Community Models (Horizon)

MONDAY, September 12 (continued)

16:00-17:30 Poster Session (Plaza)
19:00-21:00 SCEC Honors Banquet (Hard Rock Hotel Ballroom)
21:00-22:30 Poster Session (Plaza)

TUESDAY, September 13

07:00-08:00 Breakfast (Poolside)
08:00-10:00 Session: Understanding Eartquake Processes (Horizon)
10:30-12:30 Session: New Observations (Horizon)
12:30-14:00 Lunch (Restaurant, Tapestry, Poolside)
14:00-16:00 Session: Characterizing Seismic Hazard-Operational Earthquake Forecasting (Horizon)
16:00-17:30 Poster Session (Plaza)
19:00-21:00 Dinner (Poolside)
21:00-22:30 Poster Session (Plaza)
22:30-23:00 Poster Removal (Plaza)

WEDNESDAY, September 14

07:00-08:00 Breakfast (Poolside)
08:00-08:30 SCEC Advisory Council Report (Horizon)
08:30-10:30 Session: Reducing Seismic Risk (Horizon)
10:30-12:00 Session: The Future of SCEC (Horizon)
12:00 Adjourn 2016 SCEC Annual Meeting

12:30-14:30 SCEC PC Lunch Meeting (Palm Canyon)
SCEC Board Lunch Meeting (Tapestry)