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Community Stress Model (CSM)  
Community Geodetic Model (CGM)  
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Community Velocity Model (CVM)  
Community Rheology Model (CRM)
Core Institutions and Board of Directors (BoD)

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Science Working Groups & Planning Committee (PC)

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CEO Planning Committee (CEO PC)

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Center Management and Staff

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Advisory Council (AC)

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Welcome to the 2019 SCEC Annual Meeting!

This year marks the third year in the fifth phase of the Center (SCEC5: 2017-2022) and some leadership transitions. Once again, the SCEC community converges in Palm Springs, CA to share recent accomplishments and chart the future at the 29th SCEC Annual Meeting. This year 551 people have pre-registered for the meeting, including 144 first-time attendees and 271 early career participants.

The SCEC Science Planning Committee created a program that includes many timely aspects of earthquake science addressed by SCEC. We will review the advances of SCEC and strategize on the goals set forth in the SCEC5 proposal. A few months ago, the Ridgecrest earthquake sequence terminated in July an almost 20-year long, large earthquakes “drought” in SoCal, and highlighted again the highly complex nature of earthquakes. The Ridgecrest earthquake sequence will be discussed extensively in the meeting with over 65 posters, workshops on Saturday and Sunday, and in a plenary session on Monday.

A total of seven workshops will be held on Saturday and Sunday. Steve Day will kick off the regular meeting at 6 pm Sunday evening, as our Distinguished Speaker, with a talk on “Beyond elasticity in ground motion simulations”. 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. As usual, we have dedicated ample time for poster sessions, technical demonstrations, education and outreach activities, and some social gatherings. This year's session theme titles are borrowed from Bob Dylan songs.

Those of you who have attended past SCEC meetings know that much of the action happens in the poster sessions. All posters (320 in total) 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, particularly now that it has grown so large.

We welcome those who are new to the SCEC Collaboration, and look forward to connecting with our SCEC friends in Palm Springs!

Yehuda Ben-Zion, Director

Gregory C. Beroza, Co-Director

Go to meeting website: www.scec.org/meetings/2019/am
@SCEC #scecmee
Saturday, September 7

09:00 - 17:00 Workshop: Operational Earthquake Forecasting during the Ridgecrest Sequence and CSEP2 Progress, Maximilian Werner, Warner Marzocchi, David Rhoades, Thomas Jordan, and Andy Michael (https://www.scec.org/workshops/2019/csep), Plaza Ballroom D

09:00 - 17:00 Workshop: SCEC Community Geodetic Model, Michael Floyd, Gareth Funning, David Sandwell, Susan Owen, and David Bektaert (https://www.scec.org/workshops/2019/cgm), Plaza Ballroom B

09:00 - 17:00 Workshop: SCEC Community Velocity Model Technical Activity Group, Cliff Thurber (https://www.scec.org/workshops/2019/cvm), Plaza Ballroom C

Sunday, September 8

07:00 - 17:00 SSEC Annual Meeting Registration & Check-In, Hilton Lobby

08:00 - 12:00 Workshop: Research Mentor Training, Gabriela Noriega (https://www.scec.org/workshops/2019/mentors), Palm Canyon Room

08:30 - 12:30 Workshop: Evaluation of Seismic Hazard Models with Fragile Geologic Features, Mark Stirling and Mike Oskin (https://www.scec.org/workshops/2019/fgf), Horizon Ballroom

13:00 - 17:00 Workshop: Empower Yourself for Public Speaking Opportunities, Jason Ballmann and Mark Benthen (https://www.scec.org/workshops/2019/communications), Palm Canyon Room

15:00 - 16:30 Workshop: NSF-USGS Coordination on July 4-5, 2019 Earthquake Sequence, Kate Scharer and Luciana Astiz (https://www.scec.org/workshops/2019/nehp), Horizon Ballroom

15:00 - 17:00 Poster Set-Up, Plaza Ballroom

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

18:00 - 19:00 Distinguished Speaker Presentation, Horizon Ballroom

Steven Day’s academic degrees are from USC (BS 1971) and UC San Diego (PhD 1977). From 1977-1987 he was a Senior Research Scientist and Program Manager at S-Cubed, Inc, in San Diego, where much of his research employed nonlinear computational mechanics to investigate the coupling of underground explosions and earthquakes into the seismic wavefield. He was Professor of Seismology at San Diego State University from 1988 to 2015, with principal research interests in computational seismology, earthquake physics, and strong ground motion simulation. He has also worked and published in the areas of explosion and treaty-verification seismology, numerical methods, and crustal structure of US/Mexico border region. His most recent research focuses on the dynamics of rupture in the presence of fault geometrical complexities coupled to dynamically weakened friction laws, and the implications for seismic excitation. He has also been a consultant on earthquake- and forensic-seismology matters to a number of governmental bodies and private companies.

Beyond elasticity in ground motion simulations, Steve Day

Traditionally, numerical simulation of strong motion has been based upon a conceptualization of ground motion as a product of separate source, path, and site factors. This approximation is often a very useful fiction for earthquakes of modest magnitude, and even advanced applications such as CyberShake invoke it to good effect. Over the past 15 years, however, computational resources have grown sufficiently to enable SCEC scientists (and others) to simulate large (>M7) southern California earthquakes at high resolution (i.e., sufficient to resolve sedimentary basin structure at sub-km scale). As a result, it has become clear that this decoupled source/path/site viewpoint is untenable for large events in complex geological environments such as southern California. Instead, simulations strongly suggest that structural complexity, rupture dynamics, propagation path and local site response can couple strongly, both linearly and nonlinearly. A consequence is that nonlinear rock deformation may significantly impact ground motions in ways that differ fundamentally from the traditional engineering understanding of nonlinearity as a shallow site response. On a practical level, this emerging understanding has a number of implications: (i) Nonlinearity may modify ground motion amplitudes at much longer period than previously supposed. (ii) Forward directivity in large events is significantly modified by path complexity as well as by both near-source and along-path nonlinearity, and these effects require a fully coupled treatment. (iii) Nonlinearity in numerical models moderates anomalous extremes of ground motion predictions and can improve the robustness of our predictive capability. (iv) Simulation methodologies for which a linear source/path/site decomposition is fundamentally baked in, such as CyberShake, may need to reassess their treatment of large events. CyberShake, in particular, is limited to elastodynamic simulations due to its site-oriented Green’s tensor computational approach. A possible path
forward would be to perform fully nonlinear simulations for those events that are flagged as having anomalously large residuals in CyberShake disaggregations.

19:00 - 21:00  Welcome Dinner, Hilton Poolside
19:00 - 21:00  Leadership Meeting: SCEC Advisory Council, Palm Canyon Room
21:00 - 22:30  Poster Session, Plaza Ballroom

Monday, September 9

07:00 - 17:00  SCEC Annual Meeting Registration & Check-In, Hilton Lobby
07:00 - 08:30  Breakfast, Hilton Poolside
07:00 - 08:30  SCEC Transitions Program Breakfast, Tapestry Room

SCEC’s Office of Experiential Learning and Career Advancement (ELCA) is hosting its 3rd annual Transitions Program Breakfast Club meeting. Join fellow student and early-career peers and learn from senior SCEC scientists from a range of fields and sectors. The senior scientists will provide a short introduction and then answer questions about career pathways and opportunities over breakfast. The goal of these meetups is to provide a platform for early career attendees to connect with mentors for the purpose of discussing pathways in earthquake science careers. These networking opportunities are intended for anyone starting, pursuing, building, or transitioning into an earthquake science career. (www.scec.org/workshops/2019/transitions)

08:30 - 10:10  Plenary Session 1: “Changing of the Guard” The State of SCEC, Horizon Ballroom
               Moderators: John Shaw, Judi Chester
08:30  Welcome and State of the Center (Yehuda Ben-Zion)
08:50  Remarks from the National Science Foundation (Maggie Benoit)
09:00  Remarks from the U.S. Geological Survey (Mike Blanpied)
09:10  Remarks from the Pacific Gas & Electric Company (Albert Kottke)
09:15  Remarks from the Federal Emergency Management Agency (Bill Blanton)
09:20  SCEC Communication, Education, & Outreach Highlights (Mark Bentien)
09:35  SCEC Science Accomplishments (Greg Beroza and Christine Goulet)

10:10 - 10:30  Break
10:30 - 12:00  Plenary Session 2: “A Hard Rain’s A-Gonna Fall” How Should We Prepare for and Respond to Large Earthquakes in Southern California? Horizon Ballroom
               Moderators: Mike Oskin, Kate Scharer
10:30  What the “L”? Unraveling (and Responding to) the 2019 Ridgecrest, California, Earthquake Sequence, Susan E. Hough and The Ridgecrest Response Team

The 2019 Ridgecrest, California, earthquake sequence included a M6.4 event on 4 July and a M7.1 ~34 hours later. The two earthquakes occurred over a holiday weekend and had surface ruptures mostly within a high-security Navy base, which posed challenges for scientific response. I give a brief overview of the USGS/SCEC/Caltech response to the sequence, including fieldwork undertaken to map surface rupture within the base. Challenges notwithstanding, the response was facilitated by response exercises undertaken by the USGS Pasadena in spring, 2018, including exercising newly developed protocols to develop talking points. While several factors complicated the response to the Ridgecrest sequence, one key factor made the response much easier than it might have been: the limited toll taken by the earthquakes on life and property. The earthquakes did cause damage in the town of Trona, and possibly claimed one life in Nevada; damage was ,however, in the nearby town of Ridgecrest (pop. 28,000), and overall losses were far lower than would have occurred from comparable earthquakes in a more densely populated part of California. I also discuss briefly the factors that may have controlled near-field ground motions. The M6.4 and M7.1 earthquakes were recorded by 12 instruments within 40 km of the ruptures. These data can be supplemented by macroseismic data, including conventional intensities and displaced rocks, to characterize near-field ground motions from the M6.4 and M7.1. Near-field shaking intensities from both events were generally below MMI 9, with three concentrations of locally high (MMI 9-10+) values along the M7.1 mainshock rupture. Relative to near-field ground motions at hard-rock sites, instrumental ground motions at alluvial near-field sites were depleted in energy at frequencies higher than 2-3 Hz. Within 20 km, shaking intensities from the M7.1 were also higher than intensities from the M6.4 by only about 0.5 intensity units, rather than 1.3 units as predicted by the regional Intensity Prediction Equation. We discuss the factors that can account for these observations, including source effects and site effects. Both the macroseismic and instrumental observations suggest that
sediments in the Indian Wells Valley experienced a pervasively non-linear response, which could help explain why shaking intensities and damage in the closest population center, Ridgecrest, were relatively modest given its proximity to the earthquake.

Scott J. Brandenberg and GEER Reconnaissance Team, Scott J. Brandenberg and the GEER Reconnaissance Team

The Ridgecrest Earthquake sequence included a foreshock event on July 4 2019 (M6.4) and a M7.1 mainshock event on July 5 2019. These events occurred in the Eastern California Shear Zone, near Indian Wells Valley, south of China Lake and west of Searles Valley. The Geotechnical Extreme Events Reconnaissance (GEER) Association formed a team led by Jonathan Stewart who partnered with several organizations to collect perishable data and document the important impacts of these events, including the US Geological Survey, the California Geological Survey, the US Navy, the Southern California Earthquake Center, and local utilities. Critical geotechnical features of this event are extensive left-lateral (M6.4 event) and right-lateral (M7.1 event) surface ruptures over fault segments of variable complexity and width as well as across extensional and compressive step-over zones. We also document lifeline performance at fault crossings (gas, water, electrical), mainshock slip and afterslip, liquefaction and lateral spreading features, and liquefaction effects on structures. These effects are documented using field (ground) mapping and aerial imagery that will support subsequent development of high-resolution digital elevation models. Over 1200 ground motions were recorded from the foreshock and mainshock alone, with many additional aftershock records. The data demonstrate significant impacts of site response and rupture directivity on ground motion attributes.

Several insights from a decade of earthquake reconnaissance and response in New Zealand, Brendon A. Bradley

The 22 years from 1987 – 2009 was a forgotten period in the public eye for earthquake events in New Zealand. Contrastingly, the 2010-2011 Canterbury earthquakes and 2016 Kāikoura earthquake caused acute and chronic impacts on the economic and social fabric of New Zealand. In total, 10 individual earthquake events in the past decade caused appreciable damage, requiring regional or national states of emergency to be declared.

Coordinated national scientific reconnaissance and response, with strong international collaboration, has been an essential element through these events and this presentation attempts to convey several insights from first-hand experience throughout such endeavors, which revolve around three themes:

(i) Logistical challenges - avoiding over-exposure of stakeholders and affected parties, coordination mechanisms for low-impact events do not extrapolate easily to high-impact events, and the challenges of unforeseen data access restrictions;

(ii) Public and professional engagement opportunity – complacency, engagement across disciplinary boundaries, and the tension of scientific uncertainty vs. timely science-informed decision making;

(iii) Technological transformations in reconnaissance – near-real time impact assessment, remote sensing and machine learning, the irreplaceable value of first-hand observation for scientific understanding and intrinsic motivation.

12:00 - 13:30
Lunch, Terrace Restaurant, Tapestry Room, and Poolside

13:30 - 15:00
Plenary Session 3: "Like a Rolling Stone" What is A Fault (Zone)? Horizon Ballroom
Moderators: Nadia Lapusta, Cliff Thurber

What is a Fault Zone - inferences from stress state, Greg Hirth

When I was invited to help convene a panel discussion on the question “What is a fault zone?” my immediate reaction was to think of a Scholz/Sibson style synoptic model of a strike slip fault that extends from to surface to beneath the brittle-ductile transition. Through my own work on topics related to the brittle-ductile transition, I am convinced that rocks from many deforming regions support stresses in the range of 100 MPa (based on observations of microstructures in rocks exhumed from the brittle-ductile transition, extrapolation of lab data, measurements of stresses in boreholes, and larger scale geodynamic constraints). At this same time, I acknowledge the wide range of observations that don’t mesh well with a the decades-old view of a fault zone rheology based on "Byerlee friction" in the seismogenic zone and a transition to dislocation creep at higher temperature (e.g., heat flow anomalies, triggered LFEs at the base of the crust, subduction zone seismicity, the lack of a clear depth dependence to estimated earthquake stress drops). As part of the discussion, we will urge us all to consider how understanding fault zone structures at different scales and tectonic environments (from the surface through the lithosphere), and the mechanical processes that form them, can be used to constrain these problems and potentially resolve apparent discrepancies.
What is a FZ? Spatial and temporal variations in crustal fault zone structure and associated properties, Thomas M. Mitchell

Crustal fault zones (FZ) have been studied by field geologists, seismologists and experimentalists for decades. In a FZ, fault slip is hosted in a narrow fault core, surrounded by a fracture damage zone of variable size up to 100s of metres in width. This damage is accrued by a combination of quasistatic and coesismic processes. With increasing displacement and fault maturity, FZs increase both size and complexity, due to overprinting of incremental damage. Fracture damage in FZs imparts a fundamental control on earthquakes. Firstly, FZs rocks are generally more permeable than intact rocks, and hence play a key role in the migration of crustal fluids. Damaged rocks have reduced elastic moduli, cohesion and yield strength resulting in reduced elastic wave velocity, causing attenuation and potentially non-linear wave propagation effects during ruptures. The amount and spatial variation of these reductions can directly modify rupture dynamics, leading to the generation of slip pulses that can accelerate the transition to supershear rupture. Significant reductions of velocity within a FZ results in the structures trapping seismic waves that can continuously perturb stresses on the fault during earthquakes. Finally, the dynamic generation of damage as the rupture propagates can itself influence the dynamics of rupture propagation; by increasing energy dissipation, modulating the rupture velocity and modifying the size of the earthquake, changing the efficiency of weakening mechanisms such as thermal pressurisation of pore fluids, and even generating additional seismic waves. All of these effects imply that a feedback exists between the damage imparted immediately after rupture propagation, at the early stages of fault slip, and the effects of that damage on subsequent ruptures dynamics. To complicate matters, with increased pressure and temperature at depth, the structure, mechanical, and hydraulic characteristics of a FZ are subject to constant change (e.g. healing and/or sealing) during the seismic cycle as the fault evolves. Additionally, the structure and physical properties of damage depends not only on fault maturity, but also on the scale of observation.

I will discuss the state-of-the-art of our understanding of FZ structure, with aim to lead discussion on the feedbacks of FZ structure on earthquake dynamics and what length scales, physical and hydrological properties are relevant when modelling ruptures, and what are the key gaps in our knowledge.

What is a fault zone? A perspective from beneath the brittle-ductile transition, Elena Miranda

The term “fault zone” evokes an image of a localized, brittle feature that we associate with seismicity or creep in tectonically active regions. However, when we broaden our perspective to characterize the fault zones that comprise plate boundaries, we must also consider the shear zones that extend down-dip from brittle faults, beneath the brittle-ductile transition. The vicinity of the brittle-ductile transition is an important region where down-dip propagation of rupture can induce brittle deformation in rocks otherwise deforming by crystal plastic deformation. Conversely, the high stresses (~100-150 MPa) inferred from ductile rocks at the base of the brittle-ductile transition may also promote the critical loading of weak faults above the brittle-ductile transition. The degree to which temporal and spatial variations in brittle and ductile deformation can promote vertical linkage between fault zones and shear zones is therefore important for characterizing lithospheric-scale discontinuities like plate boundaries. In this panel discussion, I offer a summary of key features of shear zones both in the vicinity of the brittle-ductile transition and in the lower crust, and I emphasize the use of field observations and microstructural analysis of naturally deformed rocks in investigating shear zones. I also highlight a number of research questions that motivate future interdisciplinary work: 1) what are the unique structures in the rock record that are produced by the full range of fault slip behavior, 2) how do we quantify the rheology of rocks that undergo non-steady-state co-seismic deformation at the BDT, and 3) are the structures resulting from steady-state and transient deformation distinct from each other, and how can we discern them in naturally deformed rocks?

Fault behavior at and near Earth’s surface, Johanna (Josie) Nevitt

The question of “What is a fault zone?” in Earth’s shallow crust (~1 km depth) remains open-ended. In addition to expanding our knowledge of fundamental fault processes, answering this question has practical ramifications for hazard models, including the development of Probabilistic Fault Displacement Hazard Analyses in a physics-based framework, and the integration of slip rates into the Uniform California Earthquake Rupture Forecast and the USGS National Seismic Hazard Map.

The knowledge gap surrounding shallow fault processes stems largely from a historic lack of spatially-coherent geodetic data close to active faults, combined with an incomplete mechanical description of the weakly- to un- consolidated materials typically found near Earth’s surface. Recent and ongoing advances in geodetic imaging techniques are allowing us to accurately quantify near-fault deformation with unprecedented spatial resolution, often revealing a zone of distributed shearing (i.e., “off-fault deformation”) that is more complex than originally assumed. By combining near-field geodetic data with geological observations, fault zone drilling, shallow geophysical imaging, laboratory analysis, and mechanical modeling, we are now well-positioned to tackle a number of research questions regarding fault zone structure and behavior in the shallow crust, including:
(1) How do earthquake ruptures reach Earth's surface? This includes the question of how fault behavior changes as the principal slip surface breaks down to echelon, mixed-mode (i.e., Riedel-type) fractures, along with the enigma of rupture deceleration and arrest in the very shallow crust (<50 m depth).

(2) Is the vertical distribution of fault slip uniform from the shallow crust up to Earth's surface, or is there a systematic reduction of shallow fault slip?

(3) What is the relationship between compliant damage zones surrounding shallow faults and the distribution of shear deformation at Earth's surface?

(4) What micro- and meso-scale mechanisms contribute to fault zone deformation and what is the appropriate rheological description?

Answering these questions will require multi-disciplinary collaboration across the earthquake science community and will constitute a big step forward in our understanding of fundamental fault processes and the associated hazards.

15:00 - 17:00  
**Poster Session**

15:00  
"Every Grain of Sand" Lightning Talks (series of presentations from SCEC Community), Horizon Ballroom

15:30  
**Poster Viewing, Plaza Ballroom**

15:00 - 18:00  
**Leadership Meeting: SCEC CEO Planning Committee**, Palm Canyon Room

19:00 - 21:00  
SCEC Honors Banquet, Grand Ballroom at Hotel Zoso

21:00 - 22:30  
**Poster Session, Plaza Ballroom**

**Tuesday, September 10**

07:00 - 08:30  
Breakfast, Hilton Poolside

08:30 - 10:00  
**Plenary Session 4: “All Along the Watchtower” What are the New Advances in Step-Out Monitoring Technology?** Horizon Ballroom  
Moderators: Jamie Steidl, Elizabeth Cochran

08:30  
**Crossing the shoreline with DAS: Photonic seismology in Monterey Bay using the MARS cable,**  
Nate Lindsey, T. Craig Dawe, and Jonathan Ajo-Franklin

Emerging fiber-optic sensing technology coupled to existing subsea telecommunications cables can provide access to unprecedented seafloor observations of both ocean and solid earth phenomena. During March 2018, we conducted a Distributed Acoustic Sensing (DAS) measurement campaign along a buried fiber-optic cable typically used for data transfer to and from a scientific cabled observatory offshore Monterey Bay, called the Monterey Accelerated Research System (MARS) node. During a 4-day period of MARS node maintenance the MARS cable was repurposed as an evenly-spaced ~10,000-component, 20-kilometer-long DAS array. Full wavefield observation of a M3.4 earthquake that occurred 45-km inland near Gilroy, CA illuminated multiple recently-mapped and previously unmapped submarine fault zones, which were observed to slow the propagating wavefront and act as point scatterers reradiating body-wave energy as Scholte waves. In the shallow water of the MARS cable (h<100m), dominant noise (f~0.1-0.3 Hz) was found to match the predicted seafloor pressure field induced by shoaling ocean surface waves, otherwise known as the primary ocean microseism. DAS amplitudes track sea state dynamics during a storm cycle in the Northern Pacific, correlating with features of local bay buoy and onshore broadband seismometer data streams. We also observed secondary microseisims (f~0.5-2 Hz). Decomposing the incoming and outgoing wavefield components of the primary microseism noise we validated the Longuet-Higgins-Hasselmann theory that bi-directional ocean wind-waves setup by the coast reflection undergo nonlinear wave mixing to cause the secondary microseisims, even when the outgoing energy is only 1% of the incoming energy. We observe additional noise patterns at higher and lower frequencies that are consistent with previous point sensor observations of post-low-tide tidal bores (f~1-5 Hz), storm-induced sediment transport (f~0.8-10 Hz), infragravity waves (f~0.01-0.05 Hz), and breaking internal waves (f~0.001 Hz). The number of geophysical interactions observed over this brief four-day dark fiber recording evidences the introduction of an important new technique for seafloor science.

09:00  
**Recent observations and new frontiers in seafloor geodesy,** Noel Bartlow

In recent years, a number of multi-instrument seafloor geodesy deployments have been successfully carried out in Japan, New Zealand, Cascadia, Alaska, and elsewhere using both GNSS-Acoustic (GNSS-A) and Absolute Pressure Gauge (APG) instruments. GNSS-A instruments measure horizontal displacements to within 1-2 cm, while APGs are used to measure vertical displacements within similar precision, albeit with
long-term drift. In Japan, GNSS-A instruments recorded critical near-trench displacements following the 2011 Tohoku-oki earthquake (Sato et al., 2011), and more recently GNSS-A has been used to constrain the shallow locking in the Nankai subduction zone (Yokota et al., 2016). In New Zealand, the Hikurangi Ocean Bottom Investigation of Tremor and Slow Slip (HOBITSS) array of APG instruments recorded a slow slip event (SSE) in 2014. The APG recordings imply that slip appears to propagate to within ~2 km of the seafloor, although it isn’t possible to say whether or not it went to the trench (Wallace et al., 2016). Additionally, the APG data tighten the overall range of plausible slip potency in the 2014 SSE (Yohler et al., 2019). In Cascadia and Alaska, recent deployments of GNSS-A instruments will be used to constrain shallow locking. Early data from the Cascadia GNSS-A instruments are consistent with strong near-trench locking (Chadwell et al., AGU fall meeting 2018). Multiple experiments are currently underway in New Zealand to acquire a variety of seafloor and subsurface geodetic data, targeted at investigating slow slip and locking on the Hikurangi subduction zone. New advances in GNSS-A and APG technology, including the use of wave gliders, have brought costs down enabling wider use of these instruments. Multiple techniques have been developed to create self-calibrating APG instruments which reduce long-term drift significantly (Sasagawa et al., 2013; Sasagawa et al., 2018; Wilcock et al., AGU fall meeting 2018). Additional types of seafloor geodetic instruments are also in development, including optical fiber strainmeters (Zumberge et al., 2018). This talk will give an overview of these recent deployments, the recent technological advances in seafloor geodetic instrumentation, future directions, and community engagement aimed at expanding the number of researchers with access to these instruments.

09:30 Group Discussion

10:00 - 10:30 Break

10:30 - 12:00

**Plenary Session 5: “Chimes of Freedom” What Mechanisms Contribute to Earthquake Initiation, Triggering, and Forecasting?** Horizon Ballroom

Moderators: Morgan Page, Max Werner

**10:30 Spatiotemporal Evolution Pattern of Seismicity across California-Nevada and Its Implication for Future Large Earthquakes**, Yuehua Zeng

Rock mechanics studies and dynamic earthquake simulations show patterns of seismicity evolving with time through (1) accumulation phase, (2) localization phase, and (3) rupture phase. We observe a similar pattern of changes in seismicity during the past century across California and Nevada. To quantify these changes, we correlate GPS strain rates with seismicity. We find small and large earthquakes display different modes of behavior with time. While large earthquakes (M>6.5) were located within regions of highest strain rates, mostly along the San Andreas and other major California faults, small earthquakes (M<4) showed strong spatiotemporal variation. For example, from 1933 to the late 1980s, earthquakes (M>4) were more diffused and broadly distributed in both high and low strain rate regions (accumulation phase), particularly across the northern Walker Lane and further into a broad central and western Nevada region because of the stress shadows from the 1906 San Francisco earthquake. There were also significant increases in seismic activity along the central California creeping section to reduce the slip deficit from the 1906 and 1857 earthquakes that ruptured the northern and southern San Andreas segments of the section, respectively. From the late 1980s to present, seismicity has become more concentrated within the current high strain rate areas along the major fault strands (localization phase). During the same time period, the rate of large events (M>6.5) also increased significantly in the high strain rate areas, including the recent M7.1 Ridgecrest earthquake occurred in the East California Shear Zone. The strong correlation between current strain rate and the later period of seismicity suggests that the strain rate has evolved with time. We conclude that as the stress field has evolved out of the stress shadow of the last major earthquake, and seismicity and strain refocused on the major fault systems, California may have entered into a localization phase of its earthquake cycle which suggests increased seismic activity for large earthquakes.

11:00

**Foreshocks and aftershocks on geometrically complex faults**, Camilla Cattania, Sebastian Hainzl, and Paul Segall

Faults are geometrically heterogeneous across a wide range of scales: faults systems present multiple orientations, and single faults are fractal surfaces. I will present numerical studies highlighting the role of geometrical complexity in two types of seismic sequences: aftershocks on a regional fault network, and foreshocks during nucleation on a single fault.

In spite of the popularity of the Coulomb stress hypothesis for aftershock triggering, its predictive power has been questioned. Coulomb-based forecasts have performed poorly compared to statistical ones, largely due to the occurrence of aftershocks in areas of negative stress changes (stress shadows). We consider models coupling static stress changes and the Dieterich (1994) seismicity-rate theory. We show that variability in receiver fault orientation plays a first order role in the spatio-temporal distribution of aftershocks, and virtually suppresses stress shadows in the early part of the sequence. Accounting for variable receiver fault orientation systematically improves model performance, as confirmed by formal testing carried out by the
Collaboratory for the Study of Earthquake Predictability (CSEP). These results provide encouraging evidence for the predictive power of Coulomb-based models.

On the other hand, the physical mechanism driving foreshocks remains controversial, with two contrasting views: 1. foreshocks are driven by the aseismic nucleation process; 2. foreshocks occur as a cascade, with each event triggered by the previous ones, eventually triggering the mainshock. We consider seismic cycles on rate-state faults with fractal roughness, modeled with a 2-D pseudo-dynamic code. Roughness leads to a rich slip behavior, with widespread creep and microseismicity intensifying prior to the mainshock. These processes are well explained by spatial variations in normal stress due to roughness. Most microseismicity occurs during nucleation; in this phase, creep acceleration leads to seismicity rates increasing as 1/t, where t is the time to the mainshock, in agreement with the simulated catalog and with reported foreshocks. The relative location of the foreshocks is consistent with static stress triggering, and so is the presence of earthquake clusters deviating from the 1/t prediction. However, accelerating creep releases most of the moment, indicating that foreshocks aren't directly triggering the mainshock, but rather responding to a predominantly aseismic nucleation process.

11:30
Group Discussion

12:00 - 13:30
Lunch, Terrace Restaurant, Tapestry Room, and Poolside

13:30 - 15:00
Plenary Session 6: “I Shall Be Released” How Do We Merge Multi-Scale and Resolution to Better Characterize Earthquake Behavior? Horizon Ballroom
Moderators: Roland Bürgmann, Bridget Smith-Kanter

13:30
Multi-scale and multi-physics modeling of puzzling earthquake dynamics, Alice-Agnes Gabriel

Physics-based earthquake scenarios using modern numerical methods and hardware specific computational optimizations can shed light on the dynamics, and severity, of earthquake behavior. This is specifically useful in tectonic settings which are currently underrepresented in operational seismic or tsunami hazard assessment, as well as for bridging scales from subduction zones to geo-reservoirs. Additionally, exploiting expected exascale computing infrastructure will allow to go beyond scenario-driven approaches.

I will present recent examples of physics-driven interpretations that can be integrated synergistically with established data-driven efforts. A preferred model of the 2016 Mw 7.8 Kaikoura, New Zealand earthquake yields a rupture cascade across apparently weak crustal faults by combining observational constraints with mechanical viability. Bayesian dynamic source inversion of the 2016 Central Italy sequence allows subsequent analysis of the posterior samples to infer stable features of the results and their uncertainties.

Modeling how faults slip requires, in general, numerical methods which are capable of spanning a large range of spatial and temporal scales. In addition, pronounced geometric and rheological complexity needs to be accounted for. However, initializing such models with self-consistent fault and surface geometry, fault stress and rheology, fluid pressures and subsurface lithology is challenging. This can be overcome in coupled frameworks such as developed in the ASCETE project connecting subduction dynamics over millions of years, seismic cycling and earthquake dynamics down to fractions of a second, as well as tsunami propagation and inundation.

14:00

The stresses that load faults to rupture and trigger earthquakes have their origin in the global dynamics of our planet. Mantle convection and plate motion results in a far-field loading at regional scale, locally modified by topography, magmatic intrusion, static and dynamic stress transfer, groundwater, passing seismic waves, and probably a myriad of other phenomena. Understanding how these stress sources influence each fault requires a good knowledge of the rheology of the rocks both inside and between fault zones. We focus here on understanding how geological complexity and heterogeneity influences rock rheology, particularly in the ductile regime.

The wealth of datasets available over Southern California, many of which collected under the auspices of SCEC, makes it possible to develop a first-order view of various tectonic domains and the generic rock types present at depth. Mixing relations that utilize estimates of mineral assemblages in each rock type and experimentally calibrated flow laws provide rough estimates of rheology, strength, and effective viscosity and how it varies with depth and throughout the region. These estimates may be used in regional-scale numerical models to evaluate stress transfer, for example, but they must first be tested and evaluated against independent observations. For example, we discuss how integrated strength or equivalently depth-averaged viscosity varies throughout Southern California. Comparison with semi-independently derived estimates of these quantities based on geodynamic analysis shows a general qualitative agreement, but with important differences. For example, rheological estimates generally imply a stronger lithosphere than geodynamics estimates and a greater spatial variability in effectivity viscosity. This implies that strength reduction is a common phenomenon throughout the region. In the downdip continuation of seismogenic faults, the origin of
strength reduction may be grain size reduction and fabric development. In the blocks that separate the faults, it is more likely that stress level is insufficient to reach the maximum strength envelope assumed in this study. In that case, rheology cannot be estimated independently from stress. Our work highlights the importance of including geological complexity when considering lithospheric strength and also the limitation of traditional strength envelope approach.

14:30 Discussion

15:00 - 17:00 Poster Session
15:00 “Every Grain of Sand” Lightning Talks (series of presentations from S Cec Community), Horizon Ballroom
15:30 Poster Viewing, Plaza Ballroom

19:00 - 21:00 Group Dinner, Poolside
21:00 - 22:30 Poster Session, Plaza Ballroom

**Wednesday, September 12**

07:00 - 08:30 Breakfast, Hilton Poolside
07:00 - 08:30 Leadership Meeting: S Cec Planning Committee, Palm Canyon Room
07:00 - 08:30 Leadership Meeting: S Cec Board of Directors, Tapestry Room

08:30 - 10:00 Plenary Session 7: “Señor” What are the Boundaries of the S Cec Natural Laboratory? Horizon Ballroom
Moderators: Ramon Arrowsmith, Andrea Donnellan

08:30 Mysteries of the Deep: Faulting in the offshore California Continental Borderlands, Jillian M. Maloney

Despite recent seismic activity and decades of geophysical mapping, there is still much to learn about the offshore faults of the California Continental Borderlands. Namely, fault geometry, slip rates, and paleoseismic records are poorly constrained. Although lower slip rates (1-2 mm/yr) are estimated for most offshore faults, their potential hazard to southern California, where much of the population lives in coastal regions, should not be overlooked. In addition to direct hazard from seismic shaking, coastal areas can be prone to liquefaction, and offshore faulting has the potential to generate tsunami from either dip slip movement or triggering of submarine landslides. Given the complex nature of faulting in the region, one of the major unresolved questions is: how continuous is slip across multiple strands? For example, recent mapping and modeling have shown that the major coastal fault in the region, the Newport-Inglewood - Rose Canyon fault zone, has the potential to produce a M7.3 earthquake if it ruptures along the entire offshore length from San Diego to Los Angeles. Other onshore paleoseismic data suggests a cascading series of earthquakes from south to north along the fault system. However, there exist no paleoseismic data for the offshore fault segments to test these hypotheses. There are many difficulties associated with offshore fault studies, including a lack of outcrop and trenching scale studies and a limited seismic network. Even with these difficulties, an investment in research on California Continental Borderlands fault systems could greatly improve hazard assessments for the region, especially by constraining fault geometry and connectivity. Furthermore, although the majority of the motion between the Pacific and North American plates is accommodated on faults to the east, a better understanding of offshore faults would provide a more complete picture of the mechanics, geometry, and evolution of the plate boundary. This talk will highlight the significance of the Borderlands for fault hazard assessment in southern California.

09:00 Active faulting south of the border; the other half of the big bend domain of the Pacific-North American plate margin, John M. Fletcher, Alejandro Gonzalez-Ortega, Thomas K. Rockwell, Peter O. Gold, and Michael E. Oskin

The central portion of the Pacific-North American plate margin known as the Big Bend domain (BBD) contains kinematically and geometrically diverse arrays of faults that accommodate the transfer of shearing from the Gulf of California to more widely distributed belts in the north including the coastal region of California, Walker Lane and Great Basin. It turns out that an international border divides this interesting domain and artificially separates faults of the S Cec natural laboratory from their close family members in northern Baja California. In this talk we will present an overview of on-going multidisciplinary studies in the BBD. The great diversity of faulting in the BBD allows researchers to evaluate the factors that affect regional stress and directions of fault slip including (1) relative slip of lithospheric plates, (2) topographic gradients and (3) the regional partitioning of transpressional and transtensional slip components. Geologic studies demonstrate that the BBD is a geodynamically active region where pronounced decelerations of slip on well established faults like the southern San Andreas are compensated by the Plio-Pleistocene birth of new faults.
(e.g., San Jacinto, Elsinore, San Miguel Vallecitos, Agua Blanca faults) as well as the dramatic acceleration of slip on others (e.g., Laguna Salada, Cañada David and San Pedro Martir faults). These changes in the patterns of long-term slip rate imply important changes in boundary conditions, applied stress and lithospheric rheology throughout the BBD. Within the BBD, plate-margin shearing changes from transtension in the south to dominantly transpression in the north. Both shear regimes require three-dimensional strain, which can only be accommodated by networks of intersecting faults with diverse orientations and slip directions. Recent multifault earthquakes like the 2010 Mw7.2 Mayor Cucapah event demonstrate that the stability of interlocking fault networks and the limit of differential stress in the seismogenic crust are controlled by cross-cutting, misoriented, keystone faults that regulate slip on adjacent optimally oriented faults. All recent events including the 2019 Mw 7.1 Ridgecrest earthquake demonstrate that some of the most dangerous faults form blind structures with very subtle geomorphic expression, and thus multidisciplinary studies on both sides of the international border require close coordination to discover such faults and refine existing fault models.

09:30 Group Discussion

10:00 - 10:30 Break

10:30 - 12:00 Plenary Session 8: "The Times They are A-Changin" SCEC Looking Forward, Horizon Ballroom
Moderators: Yehuda Ben-Zion, Christine Goulet
10:30 Report from the Advisory Council (Meghan Miller)
11:00 2019 Science Plan and Request for Proposals (Greg Beroza and Judi Chester)
11:50 Director’s Closing Remarks (Yehuda Ben-Zion)
12:00 2018 SCEC Annual Meeting Adjourns
Ground Motions / Earthquake Engineering Implementation Interface (EEII)

001 Source and Site Spectral Inversion for k0 Computation in the Bay Area, Elias King, Alexis Klimasewski, Valerie Sahakian, and Annamearie Baltay

002 Empirical Self-similar Double-corner Frequency Spectrum as a Model for the Earthquake Source, Ralph Archuleta, and Chen Ji

003 Shallow crustal heterogeneity in Southern California estimated from earthquake coda waves, Nori Nakata, Hongjian Fang, Malcolm White, and Arben Pitarka

004 Modeling shallow crustal nonlinearity in physics-based earthquake simulations: Beyond perfect plasticity, Einaz Esmaeilzadeh Seylabi, Doria Restrepo, Domniki Asimaki, and Ricardo Taborda

005 An Iwan-type Plasticity Model for 3D Simulations of San Andreas Scenario Earthquakes, Daniel Roten, Kim Olsen, Steven Day, and Yifeng Cui

006 Developing a 3-D crustal velocity model for central Oklahoma, Shuo Zhang, and Hejun Zhu

007 Modeling of Empirical Transfer Functions including 3D Velocity Structure, Zhifeng Hu, Daniel Roten, Kim Olsen, and Steven Day

008 Near-Source Strong Ground Motion Characteristics of the 2018 MW 6.4 Hualien Earthquake in Taiwan, Zengping Wen

009 Simulation of elastic waves in the presence of topography using a curvilinear staggered grid finite difference method, Ossian O'Reilly, Alexander Breuer, Yifeng Cui, Christine Goulet, Kim Olsen, Daniel Roten, Guillaume Thomas-Colignon, and Te-Yang Yeh

010 A Site Response Module Toolbox for the Broadband Platform: Implementation and Verification, Jian Shi, and Domniki Asimaki

011 Shallow and deep nonlinear attenuation of S waves beneath PS10 during the 2002 Denali mainshock, Norman Sleep, and Tianze Liu

012 Analyzing Shallow Basin Effects in Los Angeles Basin using 3D Simulations and Dense Array Analysis, Voon Hui Lai, Robert Graves, Zhongwen Zhan, Chunquan Yu, and Donald Helmerger

013 The SCEC Broadband Platform: Open-Source Software for Strong Ground Motion Simulation and Validation, Fabio Silva, Philip Maechling, and Christine Goulet

014 Inclusion of Frequency-Dependent Spatial Correlation into the SDSU Broadband Ground-Motion Generation Method, Nan Wang, Rumi Takedatsu, Kim Olsen, and Steven Day

015 Hayward Fault Earthquake Ground Motion Simulations on GPU-Accelerated Platforms with SW4-RAJA, Arthur Rodgers, Ramesh Pankajaksh, Bjorn Sjogren, Anders Petersson, and Arben Pitarka

016 A Machine Learning Approach to Developing Ground Motion Models from Simulated Ground Motions, Kyle Withers, Morgan Moschetti, and Eric Thompson

017 Ground motion simulation validation with explicit uncertainty incorporation for small magnitude earthquakes in the Canterbury region, Sarah Neill, Robin Lee, and Brendon Bradley

018 Strong Ground Motions Simulations for Dunedin, Anna Kowal

019 Cybershake NZ v19.5: New Zealand simulation-based probabilistic seismic hazard analysis, Brendon Bradley, Jonney Huang, Jason Motha, Karim Tarbali, Robin Lee, Sung Bae, V Polak, M Zhu, C Schill, J Patterson, and D Lagrava

020 Hybrid Broadband Ground Motion Simulation Validation of New Zealand Earthquakes with an Updated 3D Velocity Model and Modified Simulation Methodology, Robin Lee, Brendon Bradley, Peter Stafford, Robert Graves, and Adrian Rodriguez-Marek

021 Comparing artificial neural networks with traditional ground-motion models for small magnitude earthquakes in Southern California, Alexis Klimasewski, Valerie Sahakian, and Amanda Thomas

022 An empirical- and simulation-based ground-motion model for Southern California, Morgan Moschetti, Eric Thompson, Nicolas Lucco, Thomas Jordan, Peter Powers, Allison Shumway, Mark Petersen, Robert Graves, Scott Callaghan, Christine Goulet, Kevin Milner, Philip Maechling, Feng Wang, and John Rekoske

023 Fully Nonergodic Ground Motion Models in Central California Using NGA-West2 and SCEC CyberShake Datasets, Xiaofeng Meng, Christine Goulet, Kevin Milner, and Scott Callaghan

024 Region-Specific Fourier-Based Site Amplification Modeling, Jeff Bayless, Andreas Skarlatoudis, and Jonathan Stewart

288 Effects of off-fault inelasticity on near-fault directivity pulses, Yongfei Wang, and Steven Day
Earthquake Forecasting and Predictability (EFP)

025 The Predictable Chaos of Slow Earthquakes, Jean-Philippe Avouac, Adriano Gualandi, Sylvain Michel, and Davide Faranda

026 MC-QSim – Introducing a new multi-cycle earthquake rupture simulator, Olaf Zielke, and Paul Martin Mail

027 Improving Earthquake Rupture Forecasts (Using California as a Guide), Edward Field

028 Explaining the paleo-event hiatus in California, Morgan Page, Edward Field, Kevin Milner, and Nicholas van der Elst

029 The USGS Automatic Aftershock Forecasting System, Michael Barall, Andrew Michael, and Jeanne Hardebeck

030 An Update on the Collaboratory for the Study of Earthquake Predictability (CSEP), Maximilian Werner, William Savran, Philip Maechling, Thomas Jordan, Danijel Schorlemmer, David Rhoades, Warner Marzocchi, and John Yu

031 CSEP2 from China Perspective, Yongxian Zhang, Zhongliang Wu, Xiaodong Zhang, Huazhong Yu, Shengfeng Zhang, Xiaotao Zhang, Chen Yu, and Chaozhong Hu

032 Probabilistic forecasting of induced seismicity in the Groningen gas field, Jonathan Smith, Meyer Hadrien, Jean-Philippe Avouac, Robert White, and Stephen Bourne

033 Forecasts of Induced Seismicity and its Hazard from a Hydromechanical Earthquake Nucleation Model, Justin Rubinstein, Jack Norbeck, and Andrew Barbour

034 Unified hydromechanical and nucleation models for induced seismicity in Western Oklahoma and South-Central Kansas, Guang Zhai, Manoochehr Shirzaei, and Michael Manga

035 Revisiting the Earthquake Interevent Time Distribution and the Poisson Model with the QTG Catalog for Southern California, Erin Hightower, and Jean-Philippe Avouac

036 A regionalized seismicity model for subduction zones based on geodetic strain rates, geomechanical parameters and earthquake-catalog data, José Bayona Viveros, Sebastian von Specht, Anne Strader, Sebastian Hainzl, Fabrice Cotton, and Danijel Schorlemmer

037 Assessing declustering methods in Hawaii for probabilistic seismic hazard assessment, Andrea Llenos, Andrew Michael, Morgan Moschetti, Charles Mueller, Mark Petersen, and Allison Shumway

038 Natural time analysis of quasi-periodic caldera collapse events during the 2018 Kilauea volcano eruptive sequence, Rebecca Fildes, Donald Turcotte, and John Rundle

039 Tsunami Squares: Validation by Comparison to the Regional Ocean Modeling System Tsunami Simulator and Earthquake Driven Inundation Mapping, David Grzan, John Rundle, John Wilson, and Tony Song

040 The seasonal variation of the geomagnetic solar daily variation field in China, Yingyan Wu

Seismology

041 Imaging and monitoring temporal changes of shallow seismic velocities at the Gamer Valley near Anza, California, following the M7.2 2010 El Mayor-Cucapah earthquake, Lei Qin, Yehuda Ben-Zion, Luis Bonilla, and Jamison Steidi

042 Time-dependent earthquake tomography in Southern California, Jing Hu, Hongrui Qiu, Pieter-Ewald Share, Jiawei Qian, Haijiang Zhang, and Yehuda Ben-Zion

043 Improving the resolution of co-seismic velocity change monitoring at active fault zones using the ambient seismic field, Jared Bryan, Kurama Okubo, Congcong Yuan, and Marine Denolle

044 Search for seismic velocity changes associated with CO2 injections at the carbon capture and storage site in Decatur, Illinois, Taka'aki Taira, J. Ole Kaven, Justin Rubinstein, and Elizabeth Cochran

045 On The Measurement Of Seismic Travel-Time Changes In The Time-Frequency Domain With Wavelet Cross-Spectral Analysis, Shujuan Mao, Aurelien Mordret, Michel Campillo, Hongjian Fang, and Rob van der Hilst

046 Updating the Caltech Millikan Shaker for time-lapse seismic imaging in Southern California, Yuling Zhang, Ethan Williams, Valere Lambert, and Zhongwen Zhan
047 Near-Surface Structure Constrained Using Body-Wave Polarization, Sunyoung Park, Victor Tsai, and Miaki Ishii

048 Damage Zone Resonance: Observation and Analytical Fitting of Fault Zone Trapped Wave Normal Modes Using Large-N Near-fault Seismic Arrays, Hongru Qiu, Amir Allam, Fan-Chi Lin, and Yehuda Ben-Zion

049 Towards identifying its seismic observables in models of coseismic off-fault damage, Kurama Okubo, Harsha Bhat, Esteban Rougier, and Marine Denolle

050 Train traffic as a powerful noise source for monitoring active faults with seismic interferometry, Florent Brenguier, Pierre Boué, Yehuda Ben-Zion, Frank Vernon, Christopher Johnson, Aurelien Mordret, O Coutant, Pieter-Ewald Share, E Beaucé, Daniel Hollis, and T Leccocq

051 Shallow velocity structure of Los Angeles Basin from ambient noise tomography with dense seismic arrays, Zhe Jia, and Robert Clayton

052 Mapping Near-Surface Rigidity Structure using Co-located Pressure and Seismic Stations from the EarthScope Transportable Array, Jiong Wang, and Toshiro Tanimoto

053 Seismic Imaging of Southern California with Scattered Waves, Jorge Castellanos, Robert Clayton, and Voon Hui Lai

054 S wave velocity model from ambient-noise surface-wave tomography in the San Gabriel and San Bernardino Basins, Yida Li, Robert Clayton, and Zhe Jia

055 Evaluating seismic velocity models in the Salton Trough, Southern California using spectral-element wave simulation of validation events, Rasheed Ajala, Patricia Persaud, Alan Juarez, and Gbyega Ayeni

056 Ambient Noise Love Wave Attenuation Inversion using the LASSIE Array through Los Angeles Basin, Xin Liu, and Gregory Beroza

057 Estimation of shear wave velocity structure using joint inversion of surface-wave phase and group velocities derived from ambient noise recordings, Takumi Hayashida, Toshiaki Yokoi, and Mukunda Bhattarai

058 Ambient noise tomography of the Saudi Arabian Shield, Francesco Civillini, Walter Mooney, and Hani Zahr\u00e1n

059 Intra-slab stress field and waveform modeling to determine velocity structure of the Indoburman Range, Patcharaporn Maneerat, Doug Dreger, and Roland B\u00f6rnmann

060 Rupture Models and Implication of Rupture Dynamics in Simulated Ground Motion for the 2016 M7 Kumamoto, Japan Earthquake, Arben Pitarka, Robert Graves, Arthur Rodgers, Koijuu Ikura, Ken Miyakoshi, and Hiroshi Kawase

061 On the Variability of Earthquake Ground Motion from the Savage Brush Flats High Density Array in Southern California, Debi Kilb, Christopher Johnson, Annemarie Ballay, and Frank Vernon

062 Site Response Across the San Gabriel, Chino and San Bernardino Sedimentary Basins from Application of the Spectral Ratio Method to Ambient Noise Recorded by Seismic Node Transects, Anisha Tyagi, Samuel Gurlay, Margaret Grenier, Rachel Kreuziger, and Jascha Polet

063 Broadband Ground-Motion Simulation for the Korean Peninsula, Jaejoon Lee, Yonghyun Chung, Kangryul Lee, and Changsoo Shin

064 Detecting offshore earthquakes with backprojection and matched-filter method, Tian Feng, Lingxun Meng, and Hui Huang

065 Classifying emergent and impulsive signals in continuous seismic waveforms, Christopher Johnson, Yehuda Ben-Zion, Haoan Meng, and Frank Vernon

066 Earthquake Detection in Dvelopcorde Films: An Image-based Detection Neural Network for Analog Seismograms, Kaiwen Wang, Weiqiang Zhu, William Ellsworth, and Gregory Beroza

067 Investigation of the Yorba Linda Trend using earthquake relocation based on waveform cross-correlation, Kyle Macy, and Jascha Polet

068 Pre-earthquake Response: Closing critical data gaps and preparing for large earthquakes, Yehuda Ben-Zion, Mark Benthien, Jason Ballmann, and Christine Goulet

069 Identification of Overlapping Earthquakes using a moveout-based matching pursuit method, Clara Daniels, Zhigang Peng, James McClennan, and Lijun Zhu

070 Using the Matrix Profile to detect seismic events – from the lab experiment scale to local and global scales, Nader Shakibay Senobari, Zachary Zimmerman, Gareth Funning, Peter Shearer, Philip Brisk, and Eamonn Keogh

071 Evaluation of Deep, Widespread Seismicity with Long Beach Dense Array, Lei Yang, Xin Liu, Weiqiang Zhu, and Gregory Beroza

072 Seismicity in Channning Sichuan, China, Li Sun

073 Tremor or train? An attempt to discern tremor and noise using a deep convolutional neural network, Lindsay Chuang, Zhigang Peng, Lijun Zhu, and James McClennan

074 Thermally Induced Deformation and Seismicity, Kyungjae Im, and Jean-Philippe Avouac

075 A mechanism for induced earthquakes at large distances and depths from injection wells, Thomas Goebel, Kyung Chang, and Emily Brodsky

076 Spatial and temporal evolution of seismicity, seismic velocity, and pore pressure in the Guy-Greenbrier, Arkansas, earthquake sequence, Zhuo Yang, and Marine Denolle

077 The Guy-Greenbrier seismic sequence revisited with deep learning, Yongsoo Park, Mostafa Moussavi, Weiqiang Zhu, William Ellsworth, and Gregory Beroza

078 A Percolation Model for Induced Seismicity: An Avalanche Burst Model for Induced b-Value Seismicity, Ronaldo Ortez, and John Rundle

079 Earthquake and Tectonic Tremor Dynamically Triggered by the 2019 Mw8.2 Mexico Earthquake, Hector Gonzalez-Huizar, Kevin Chao, and Vladimir Kostoglodov

080 Spatial decorrelation of tidal triggering and remote triggering at the Coso geothermal field, Wei Wang, Peter Shearer, and Xiaoqun Xu
081 Teleseismic dynamic triggering of microearthquakes in the Anza area, California: the role of dynamic strain and pore pressure, Wenyuan Fan, Andrew Barbour, and Elizabeth Cochran

082 A Systematic Investigation into Dynamic and Delayed Earthquake Triggering in a Seismically Hazardous Himalayan Fault Segment, Manuel Mendoza, Bo Li, Abhijit Ghosh, and Shyam Rai

083 Directivity Modes of Earthquake Populations with Unsupervised Learning, Zachary Ross, Daniel Trugman, Kamyar Azizzadenesheli, and Anima Anandkumar

084 A focal mechanism catalog for Southern California derived with deep learning algorithms, Yifang Cheng, Zachary Ross, Egill Hauksson, and Yehuda Ben-Zion

085 Comparing seismological interpretations of different source types produced in a rate-and-state fault model, Natalie Schaal, Nadia Lapusta, and Yen-Yu Lin

086 Characterizing earthquake source complexity in the trifurcation area of the San Jacinto fault zone, Qimin Wu, Xiaowei Chen, and Rachel Abercrombie

087 How to Measure Variations in High-Frequency Radiation for Small to Moderate Earthquakes, Peter Shearer, Rachel Abercrombie, and Wei Wang

088 Resolving the spatiotemporal variability of small earthquake source parameters at Parkfield and their relationship with 2004M6 Parkfield earthquake, Jiwen Zhang, Xiaowei Chen, and Rachel Abercrombie

089 Quantifying preparation process of large earthquakes: Damage localization and coalescent dynamics, Ilya Zaliapin, and Yehuda Ben-Zion

090 Numerical accuracy of staircase fluid-solid and free-surface boundary conditions for staggered-grid finite-differences, Te-Yang Yeh, and Kim Olsen

091 Analysis and removal of sediment signal in receiver functions, Vera Schulte-Pelkum, Justin Ball, Thorsten Becker, Robert Porritt, and Whitney Behr

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SCEC Institutions

The Southern California Earthquake Center (SCEC) is an institutionally based organization that recognizes both core institutions, which make a major, sustained commitment to SCEC objectives, and a larger number of participating institutions, which are self-nominated through the involvement of individual scientists or groups in SCEC activities and confirmed by the Board of Directors. Membership continues to evolve because SCEC is an open consortium, available to any individual or institution seeking to collaborate on earthquake science in Southern California.

Core Institutions and Representatives

Core institutions are designated academic and government research organizations with major research programs in earthquake science. Each core is expected to contribute a significant level of effort (both in personnel and activities) to SCEC programs, including Communication, Education and Outreach Program. Core institutions are obligated to contribute 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.

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<td>USC, Lead</td>
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<td>Bruce Shaw</td>
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<td>Christos Kyriakopoulos</td>
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Domestic Participating Institutions

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. Participating institutions do not necessarily receive direct support from the Center. Each participating institution (through appropriate official) appoints a qualified Institutional Representative to facilitate communication with the Center. The interests of the participating institutions are represented on the Board of Directors by two Directors At-Large.

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International Participating Institutions

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How to Apply as a Participating Institution

Email application to Mark Benthien (benthien@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.
SATURDAY, September 7
09:00-17:00  Workshop: OEF and CSEP2 Progress (Plaza D)
09:00-17:00  Workshop: Community Geodetic Model (Plaza B)
09:00-17:00  Workshop: Community Velocity Model (Plaza C)

SUNDAY, September 8
07:00-17:00  Registration and Check-In (Lobby)
08:00-12:00  Workshop: Research Mentor Training (Palm Canyon)
08:30-12:00  Workshop: Fragile Geologic Features (Horizon)
13:00-17:00  Workshop: Empower Yourself for Public Speaking Opportunities (Palm Canyon)
15:00-16:30  Workshop: NSF-USGS Coordination on July 4-5 Earthquake Sequence (Horizon)
15:00-17:00  Poster Set-Up (Plaza)
17:00-18:00  Annual Meeting Welcome Social (Lobby, Plaza)
18:00-19:00  Distinguished Speaker Presentation (Horizon)
19:00-21:00  Welcome Dinner (Poolside)
19:00-22:30  Poster Viewing (Plaza)

MONDAY, September 9
07:00-17:00  Registration and Check-In (Lobby)
07:00-08:30  Breakfast (Poolside)
07:00-08:30  SCEC Transitions Program Student Breakfast (Tapestry)
08:30-10:10  Session 1: State of SCEC (Horizon)
10:30-12:00  Session 2: Earthquake Response in So CA (Horizon)
12:00-13:30  Lunch (Restaurant, Tapestry, Poolside)
13:30-15:00  Session 3: What is a Fault Zone? (Horizon)
14:00-22:00  SCECmeetUP Space Available (Tapestry)

MONDAY, September 9 (continued)
15:00-15:30  Poster Lightning Talks (Horizon)
15:30-17:00  Poster Viewing (Plaza)
15:00-18:00  Leadership Meeting: SCEC CEO Planning Committee (Palm Canyon)
19:00-21:00  SCEC Honors Banquet (Hotel Zoso Ballroom)
21:00-22:30  Poster Viewing (Plaza)

TUESDAY, September 10
07:00-08:30  Breakfast (Poolside)
08:30-10:00  Session 4: Step-Out Monitoring Tech (Horizon)
10:30-12:00  Session 5: EQ Initiation, Triggering, Forecasting (Horizon)
12:00-13:30  Lunch (Restaurant, Tapestry, Poolside)
13:30-15:00  Session 6: Merging Multi-Scale and Resolution (Horizon)
14:00-22:00  SCECmeetUP Space Available (Tapestry)
15:00-15:30  Poster Lightning Talks (Horizon)
15:30-17:00  Poster Session (Plaza)
19:00-21:00  Group Dinner (Poolside)
21:00-22:30  Poster Viewing (Plaza)

WEDNESDAY, September 12
07:00-08:30  Breakfast (Poolside)
07:00-08:30  SCEC PC Breakfast Meeting (Palm Canyon)
07:00-08:30  SCEC Board Breakfast Meeting (Tapestry)
08:30-10:00  Session 7: SCEC Natural Lab Boundaries (Horizon)
10:30-12:00  Session 8: SCEC Looking Forward (Horizon)
12:00  Adjourn 2019 SCEC Annual Meeting