2026 SCEC Fault Creep Workshop

Leverage decades of Bay Area fault-creep observations to unlock new insights into earthquake behavior and join the community effort to modernize and expand long-term creep monitoring

https://www.scec.org/events/2026-fault-creep-workshop/

Date: March 3-6, 2026

Location: San Jose State University, San Jose, CA

Workshop Organizers: Elizabeth Madden (SJSU), Christie Rowe (UNR)

SCEC Award: 26025

View Workshop Report

Participants

The workshop brought together 58 scientists from universities, federal and state agencies, national laboratories, and industry representing a broad range of expertise in fault creep observations, geodesy, remote sensing, laboratory rock mechanics, earthquake physics, seismic hazard, and numerical modeling.

- Half were early-career scientists
- 10 students (9 graduate students & 1 undergrad) participated in all aspects of the workshop, including lightning talks and contributions to the white paper.

Motivation

Understanding **creep** is fundamental to our understanding of fault loading & unloading, stress transfer, seismic cycling, earthquake rupture dynamics, seismic hazard, constitutive behavior….

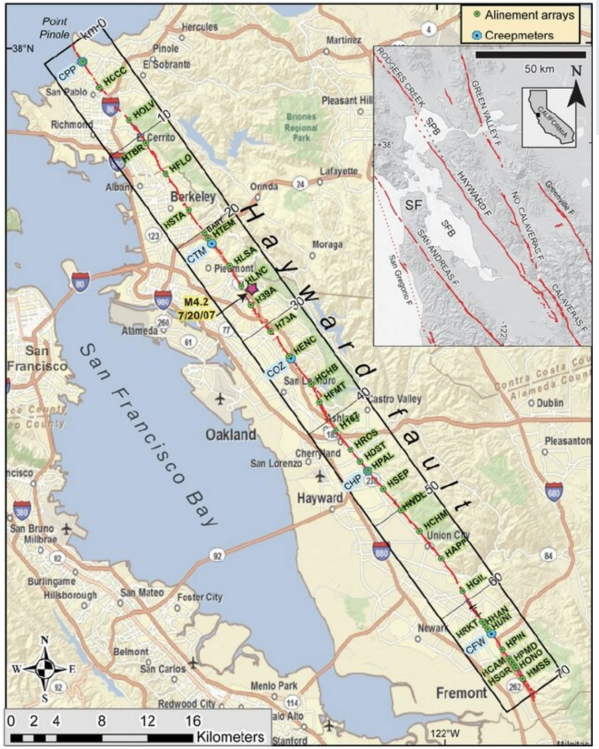
Fault creep measurements have been collected since the 1970s from nearly 90 alignment arrays across the San Francisco Bay Area.

How can we sustainably continue this data collection?

What is the role of alignment arrays relative to alternative methods for observing creep?

e.g. creepmeters, strainmeters, GNSS, InSAR, lidar, structure-from-motion photogrammetry, coda wave interferometry, optical imagery, microseismicity & repeating earthquakes, etc

March 3-6, 2026 at San José State University



RESEARCH ARTICLE | FEBRUARY 01, 2012

Long-Term Creep Rates on the Hayward Fault: Evidence for Controls on the Size and Frequency of Large Earthquakes

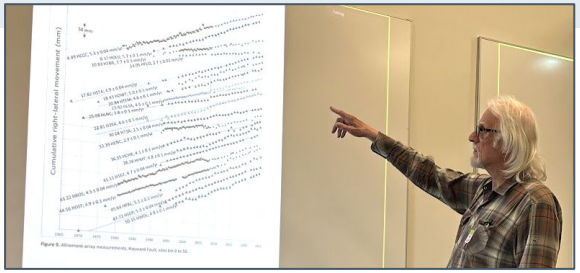
James J. Lienkaemper; Forrest S. McFarland; Robert W. Simpson; Roger G. Bilham; David A. Ponce; John J. Boatwright; S. John Caskey

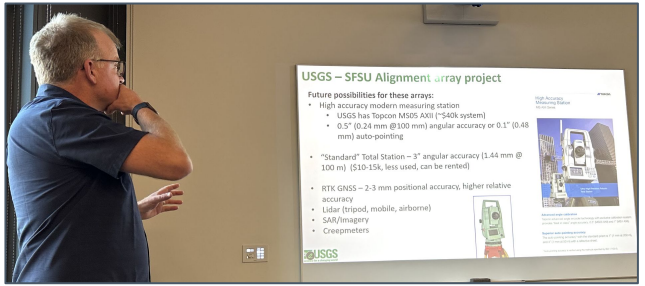
+ Author and Article Information

Bulletin of the Seismological Society of America (2012) 102 (1): 31–41.
https://doi.org/10.1785/0120110033 | Article history

Session 1 – what do we know and how?

Session 1: Creep and creep measurements Clarify what we know about fault creep in the San Francisco Bay Area. Identify what we still need to understand to advance fundamental science and improve seismic hazard assessment.	
• Introduction	Christie Rowe / Ahmed Elbanna
• Decades of Alignment Array Monitoring SFSU Creep Project	F. McFarland
• Geologists measuring creep in the Bay area - brief history and future possibilities (PDF)	Stephen DeLong
• An overview of the USGS Creepmeters along the San Andreas, Calaveras, and Hayward faults	Todd Ericksen
• Recent innovations in the measurement of fault creep (PDF)	Roger Bilham
• What surface data obscure: Measuring fault creep below the water table	Josie Nevitt
• Implementing Creep Measurements in US National Seismic Hazard Models	Kaj Johnson
Breakout 1 • What have we learned from existing fault creep observations? • What are the highest-priority research opportunities enabled by continued fault creep monitoring? • What additional observations or datasets are needed to better understand and mitigate seismic hazard? • Which aspects of the current datasets and monitoring methods are most valuable and should be maintained? • What important observations or capabilities are missing from the current datasets and monitoring methods? • Which datasets, measurements, or monitoring approaches are no longer effective or should be modernized?	





Session 2 – Measuring creep in the field

Session 2: Measuring Creep in the Field Ensure that all participants understand current fault creep monitoring technologies and discuss their advantages, limitations, and future applications. Explore emerging and potential new approaches for measuring fault creep.	USGS science for a changing world Chad Trexler, Jessie Vermeer, Cassie Hanagan, Rezagene Milani
Meet for all day field trip	
Visit one or two alignment array sites and take measurements	Stephen DeLong
Visit Gallegos Winery in Fremont, location of creepmeter CFW and a subsurface in-place inclinometer system across the Hayward fault. → multi-instrumental observatories - a way of the future?	Josie Nevitt / Roger Bilham / Todd Ericksen
Workshop Dinner (San José)	

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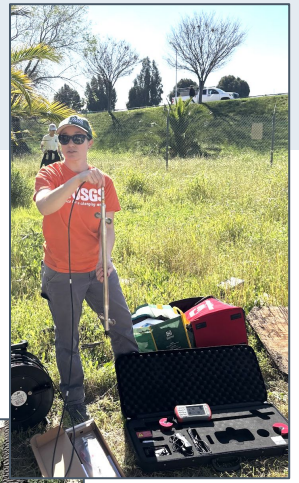

Days 3 & 4 – Creep monitoring methods & the future

Session 3: Deep dive on comparison of alignment arrays and other monitoring methods
Evaluate the strengths and limitations of current fault creep datasets and monitoring methods, with particular emphasis on alignment arrays. Compare alternative and complementary approaches—including microseismicity, remote sensing, creepmeters, structure-from-motion photogrammetry, and lidar—and assess their relative spatial and temporal resolution, data quality, and long-term monitoring potential.

Session 4: Planning for the future of creep monitoring
Develop a community strategy for maintaining the alignment array network, including criteria for prioritizing measurement sites and identifying sites for retirement or replacement. Consider the spatial and temporal sampling needed to address future research priorities, and evaluate opportunities to integrate or transition to complementary monitoring methods. Develop recommendations for post-earthquake creep monitoring and operational approaches for observing and forecasting afterslip.

13 presentations
16 lightning talks
2 breakout sessions












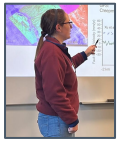

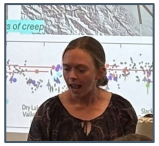


Session 5: Workplan writing

- Summarize state-of-the-art methods for monitoring creep
- Demonstrate importance of commitment to maintenance and expansion of fault creep monitoring & document direct utility of fault creep studies to address seismic hazard
- Define potential insights from new approaches, analytical advances, and integration of laboratory measurements of deformation behavior into mechanical and dynamic models
- Highlight potential for creep datasets to train machine learning models




Group B, Poster #096, Earthquake Geology

CREEP: Creep Rate, Episodicity, and Earthquake Potential - Technical Activity Group

Christie D. Rowe, Elizabeth H. Madden, & Michael Floyd

Contact: Christie D. Rowe (*rowec@unr.edu*)
Betsy Madden (*elizabeth.madden@sjsu.edu*)

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Fault Creep White Paper
March 3-6 2026

Contributors (add your name):
1. Introduction and Motivation
2. Historic to present day creep monitoring
2.1 Alignment Array History (Steve) + trilateration and triangulation
2.2 Creepmeters (Roger, Josie, Curtis)
2.3 Global Navigation Satellite Systems (Jess, Mike, Cate, Evan)
2.3.1 Satellite Positioning
2.3.2 Measuring Crustal Deformation with GNSS
2.3.3 GNSS Observations for Measuring Northern California Fault Creep
2.3.4 Complementary Measurements
2.3.5 Benefits and Limitations
2.3.1 Survey GNSS
2.3.4 Real-time
2.4 Lidar (Steve, Chelsea, Cassie)
2.5. Optical Imagery (Solène, Cassie, Chelsea, Steve)
2.6 InSAR (Gareth – with Eric, Junle and Katherine)
2.6.1 Satellite-based InSAR Evolution & Important Advances for Studying Fault Creep
2.6.2 Current Strengths & Challenges
2.6.3 References
2.7 Microseismicity locations and repeating earthquakes (Taka'aki and Travis, Norma, Jaesok)
2.8 Geology, geomorphology and Quaternary dating (Veronica Jessie Hannah, Belle, Kim, Steve)
3. Insights from observations of creeping faults (JOSIE, Solène, Veronica, Hiroki, Ruth, Travis, Roland, Roger)
3.x Creep data revealing asperities – combine with repeaters (Travis w/ review from Roland)
***Case Study of Hayward Fault? High seismic hazard & risk, longest dataset (winery), almost covers seismic cycle, this study integrates datasets, also good paleoseismic . Urbanized = good offset anthropogenic markers, but adds complexity to some of the remote sensing interpretation. Example of benefits / challenges of the different methods on a very high hazard and risk fault.*
Summary of presentation from Roland on Thurs. March 5, 2026
4. Current uses of fault creep data in the Bay Area and Beyond (Christie, Chris (PG&E), Danielle (CGS))
4.1 Direct displacement hazard - buried infrastructure, buildings
4.2 California Alquist-Priolo Zones - definition
4.3 Inputs to future NSHM (Kaj, Fred, Jess)
4.4 Methods validation – "we study creep so we are ready to study earthquakes" - Post Seismic Response
5. Future opportunities to learn from creep data (Ahmed, Hiroki, Junle, Veronica, Steve, Betsy)
5.1 Constraining Fault Zone Rheology beyond Friction (Hiroki)
5.3 Data sets for training Machine Learning Models (Betsy, Solène)
Unanswered questions! (I'm trying to make sure these questions are covered in the above subsections of section 5 - Hiroki)
5.4 Emerging methods
6. Forward looking suggestions