Statewide California Earthquake Center

Community Stress Drop Validation Workshop

January 20, 2026

Session II: New empirical dataset

11:00a - 12:30p Pacific

Tuesday January 20, 2026

Virtual

Rachel Abercrombie rea@bu.edu

Annemarie Baltay abaltay@usgs.gov

Session II: New Data Sets

Research and Data Sets beyond CA for possible NSF Focus

Keisuke Yoshida: HiNET *Source time functions from repeating earthquakes off Tohoku*

Northern California: For SCEC Focus

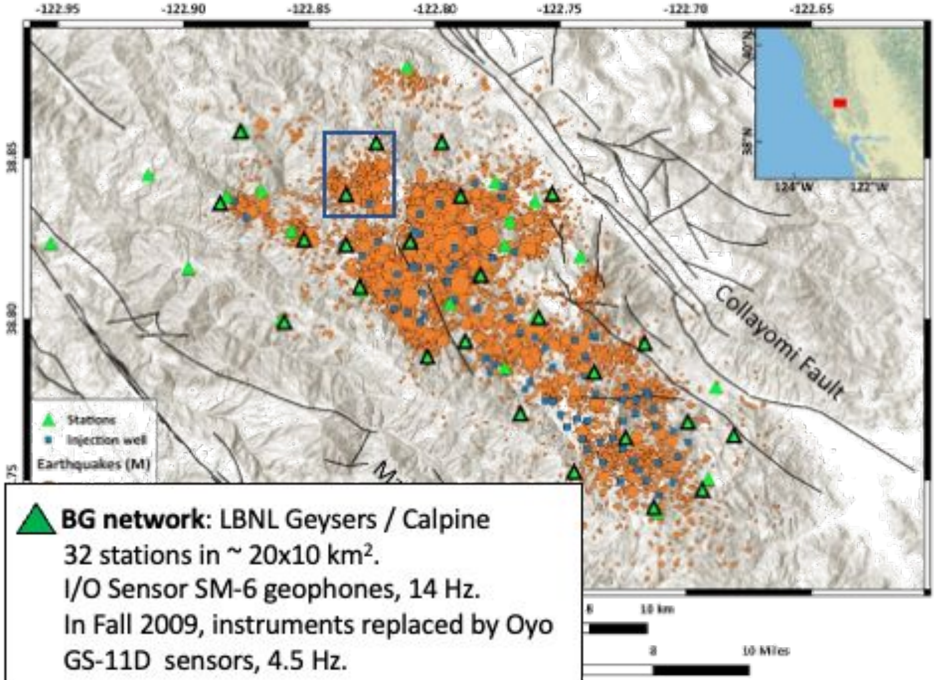
Geysers - Pati Martinez-Garzon
Source Physics Experiment - Colin Pennington
Lake Almanor - Rob Skoumal
Calaveras/SAF branch - Elizabeth Cochran
Parkfield - Peter Shearer
Nevada - Daniel Trugman
Bay Area - Hao Guo
San Ramon - Annemarie Baltay

Patricia Martínez-Garzón

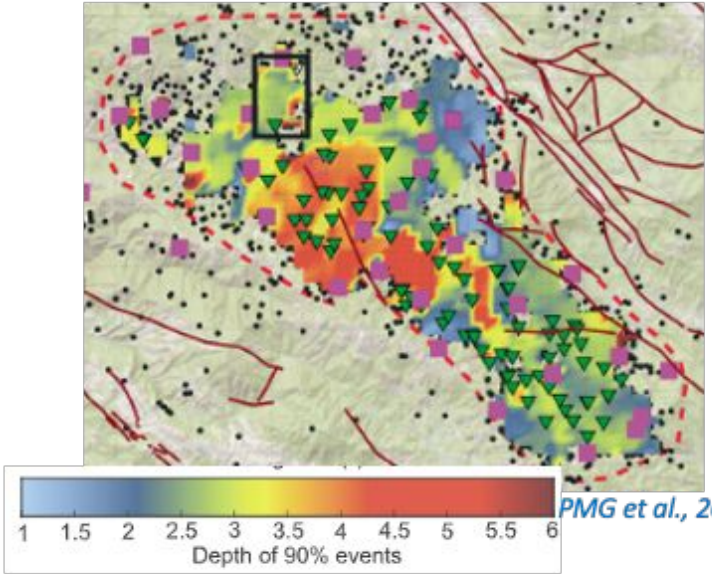
The Geysers geothermal field

> 60 years of sustained geothermal production

> 20,000 events annually, M [0.0 – 5-0], 23 M_W > 4 EQs since 2009



BG network: LBNL Geysers / Calpine
32 stations in ~ 20x10 km².
I/O Sensor SM-6 geophones, 14 Hz.
In Fall 2009, instruments replaced by Oyo GS-11D sensors, 4.5 Hz.



PMG et al., 2018 (JGR)

Event catalog and waveforms publicly available at:

Northern California Earthquake Data Center (NCEDC)

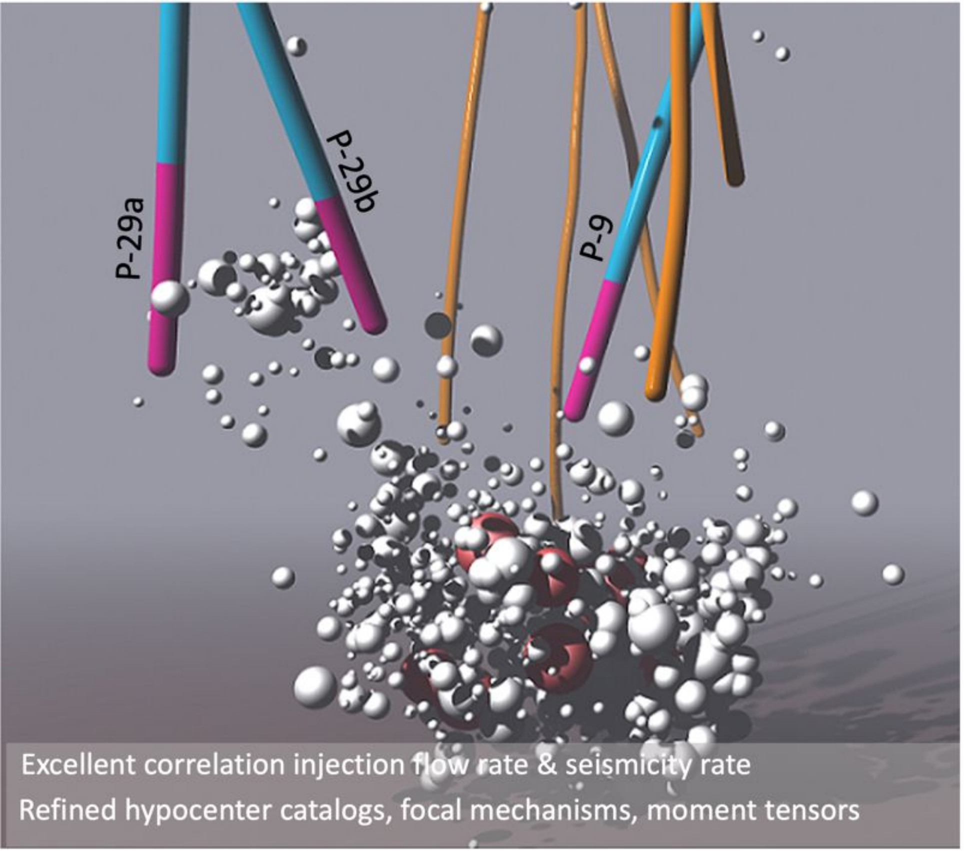
Enhanced Geothermal Systems (EGS) Earthquake Catalog Search

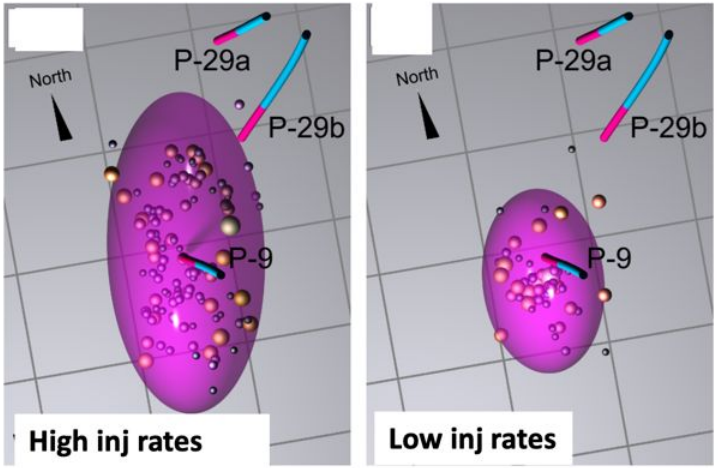
The Geysers: an example of excellent monitoring of a mature geothermal reservoir

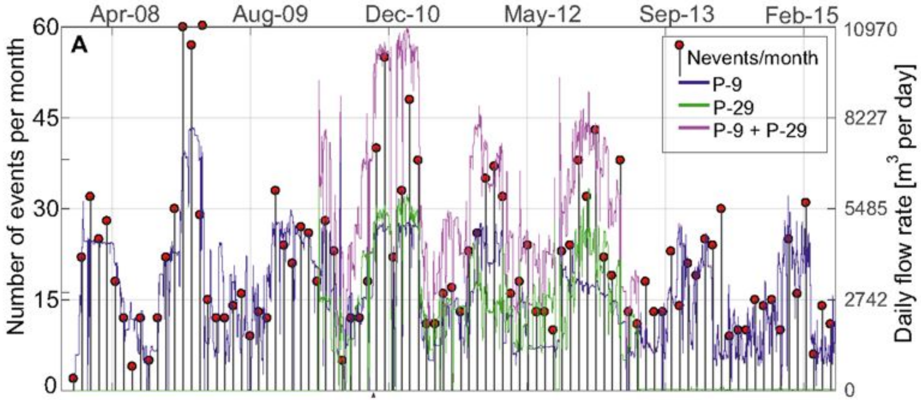
Patricia Martínez-Garzón

EPISODES PLATFORM

The Geysers NW Cluster [0.5x1km^2]





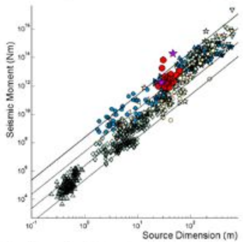


See Martínez-Garzón et al., (2020, The Leading Edge) for a review

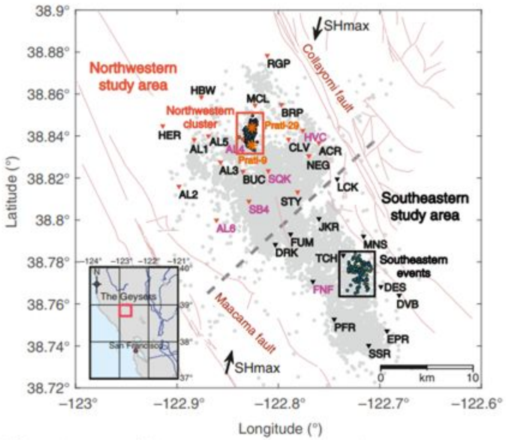
Data collected at : https://episodesplatform.eu/?lang=en#episode:THE_GEYSERS_Prati_9_and_Prati_29_cluster

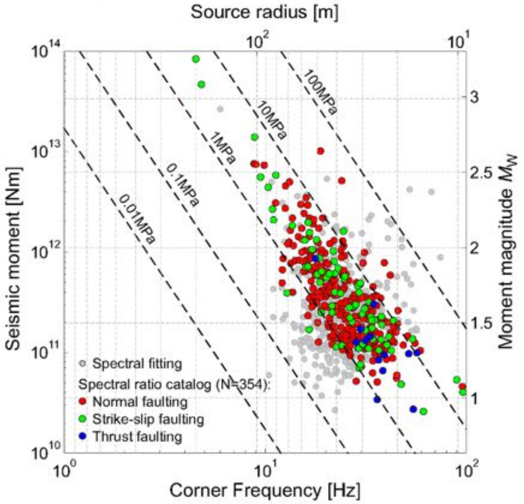
Patricia Martinez-Garzon

The Geysers geothermal field: A playground for source parameters

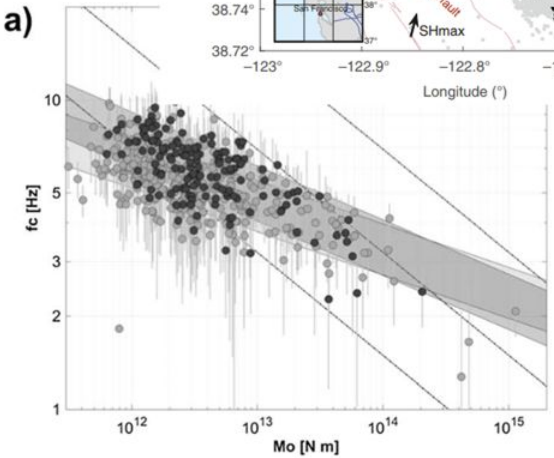


Empirical Greens Function
Viegas & Hutchings, 2010

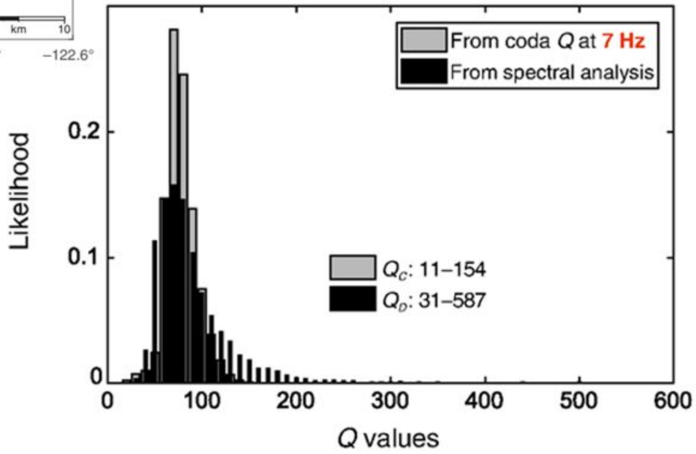




Spectral fitting + Spectral ratio
Kwiatek et al., JGR, 2015



GIT + Genetic algorithms
Picozzi et al., JGR, 2017



Quality factor coda analysis
Blanke et al., BSSA, 2019

The Geysers geothermal field: A playground for source parameters

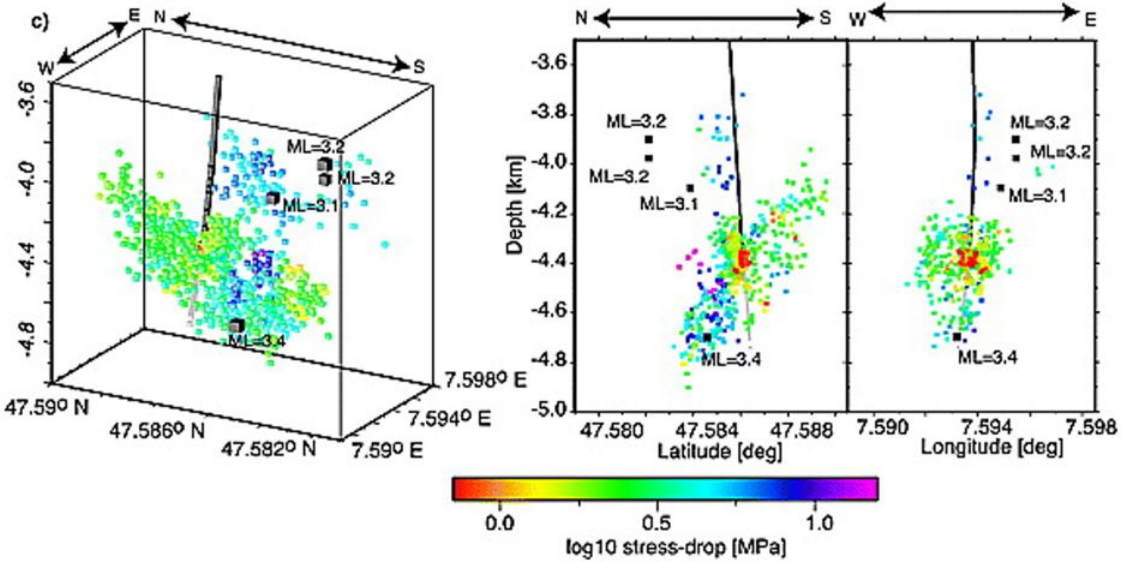
<u>What can we learn with The Geysers data?</u>

→ Physics of earthquakes in a highly fractured – fluid rich medium
stress drop, directivity, moment tensors

→ Strong spatial clustering, shallow hypocentral depth 2 - 4 km:
shorter paths might help targeting the source

→ Good candidate for benchmarking:
This data has been used for decades to validate different seismological techniques (4D tomography, moment tensor inversion, source parameters, shear wave splitting)

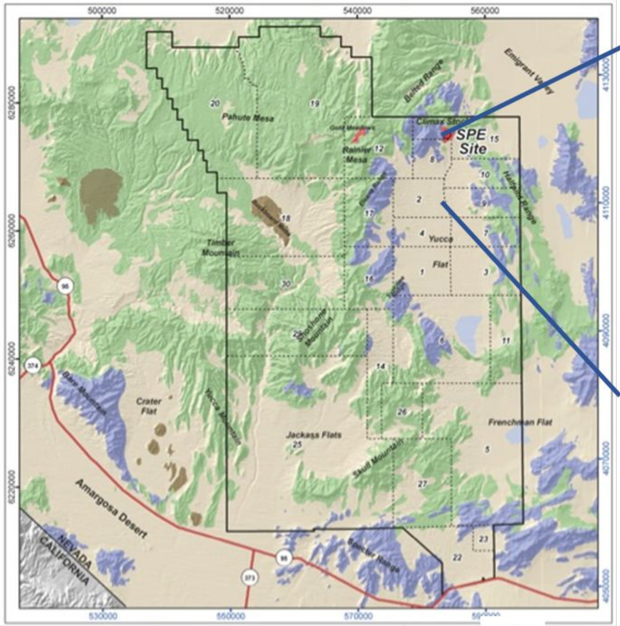
→ Extra scientific bonus: medium properties not stationary



Goertz-Allmann et al., GRL, 2011

Colin Pennington
LLNL-CFPRES-2014978

Source Physics Experiment: Background



SPE Phase I - FY10-FY16 and FY16 FSS

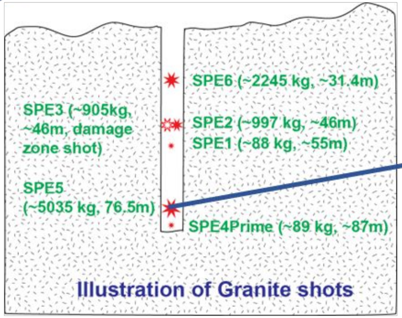


Illustration of Granite shots

- Granite media
- Near site of 3 nuclear tests in the 1960's

DAG (SPE Phase II) - FY17-FY19 & FY20 LSECE

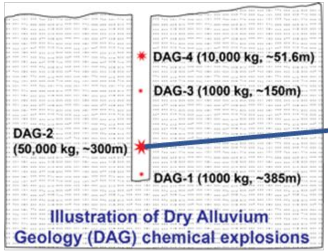


Illustration of Dry Alluvium Geology (DAG) chemical explosions

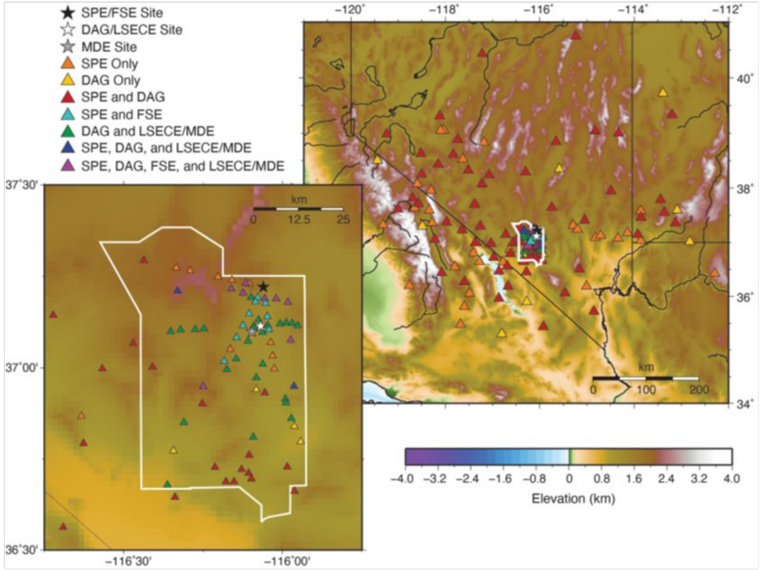
- Dry alluvium geology (DAG)
- 9 nuclear tests within 1 km
- 96", 1400' hole drilled in 1983

Last buried explosion: DAG-4 completed June 22, 2019; surface explosion LSECE Apollo on October 29, 2020

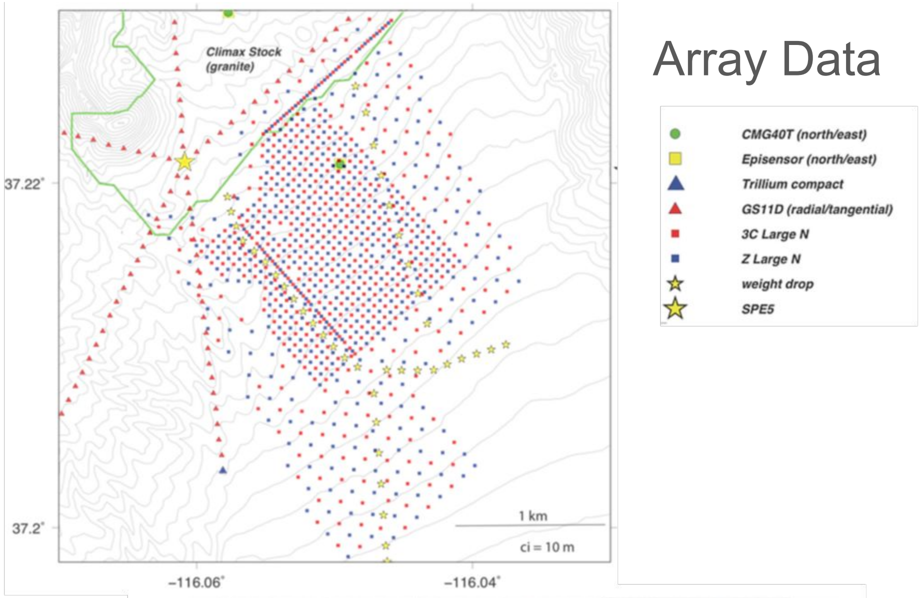
Colin Pennington

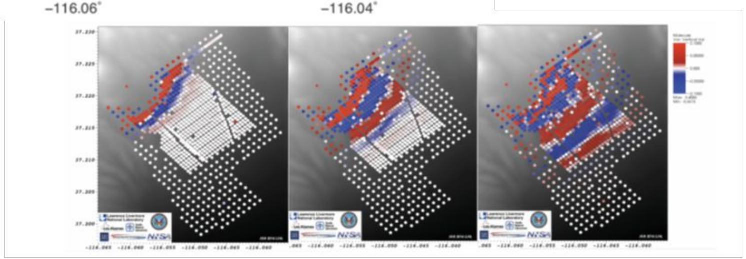
Source Physics Experiment: Data

Regional Data



Array Data



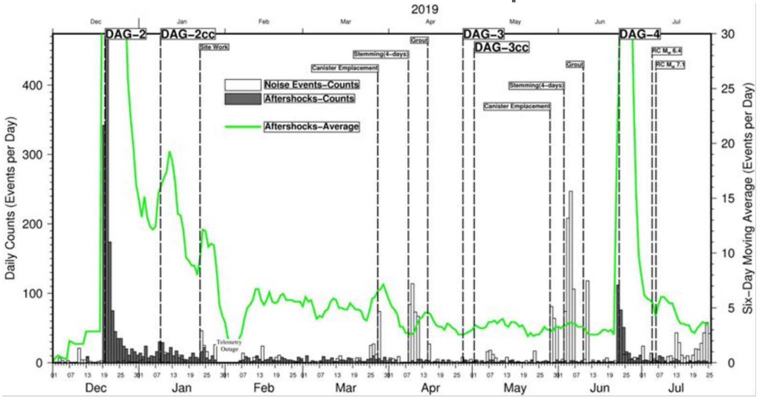


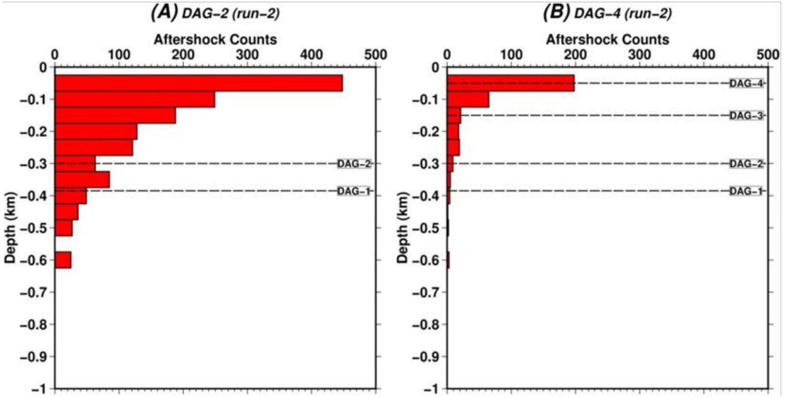
Data can be found here: https://ds.iris.edu/mda/search/?search=&q=SPE

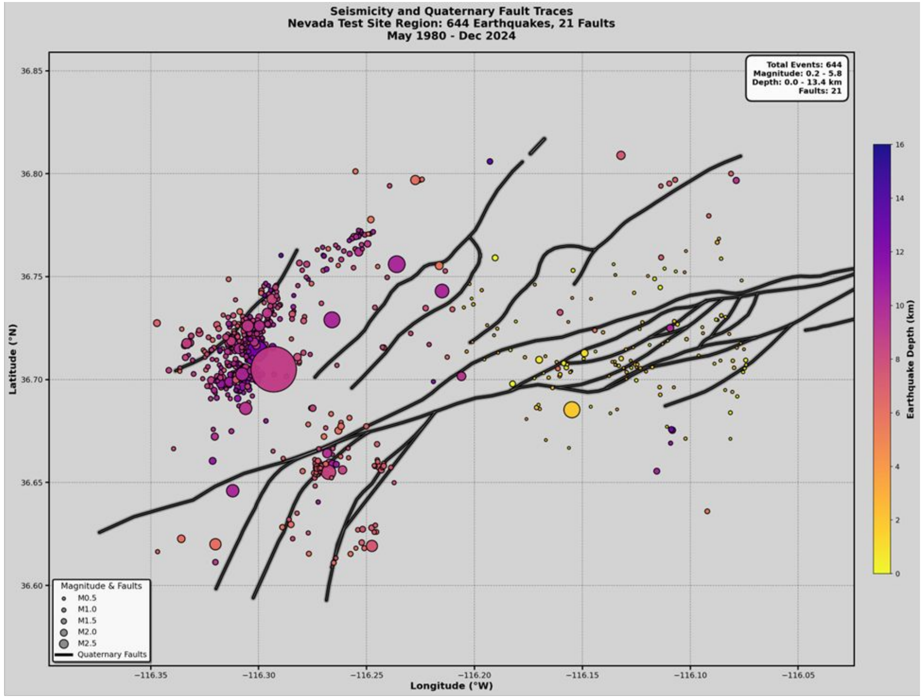
Colin Pennington

Source Physics Experiment: Earthquakes

Most events from SPE 1-2 are small aftershocks from the explosions





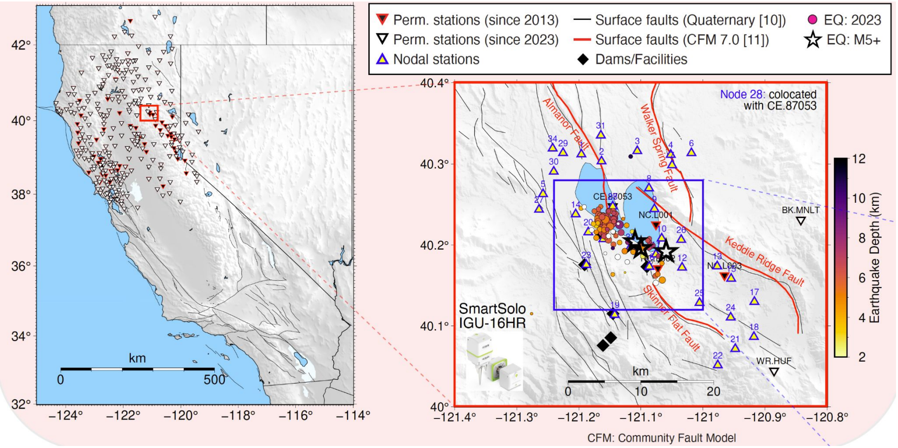


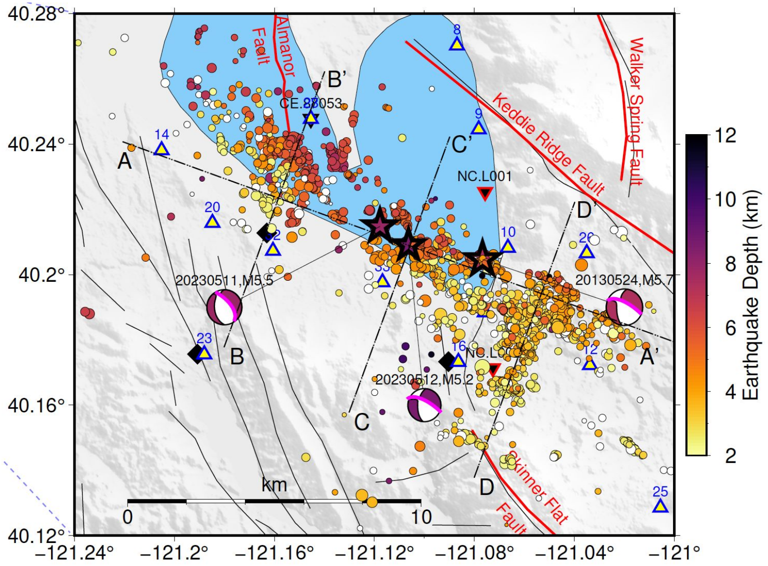
Natural earthquakes occur on the southern part of the test site. They are the focus of SPE 3

Name: Rob Skoumal

Lake Almanor

- 2023 May 11 Mw 5.5
  (Also 2013 May 24 Mw 5.7)
- Relatively sparse network coverage
  - 1 strong-motion < 10 km
  - 2 broadband < 25 km
- Nodal deployment
  - 34 nodal stations within 5-10 km of mainshock (May 13 - July 27)
- Relocated 2013-2025 catalog with velocity model, focal mechanisms, ground motions/site spectra (work led by Clara Yoon & Grace Parker)
- Interesting scientifically (dams, capable of M > 6)

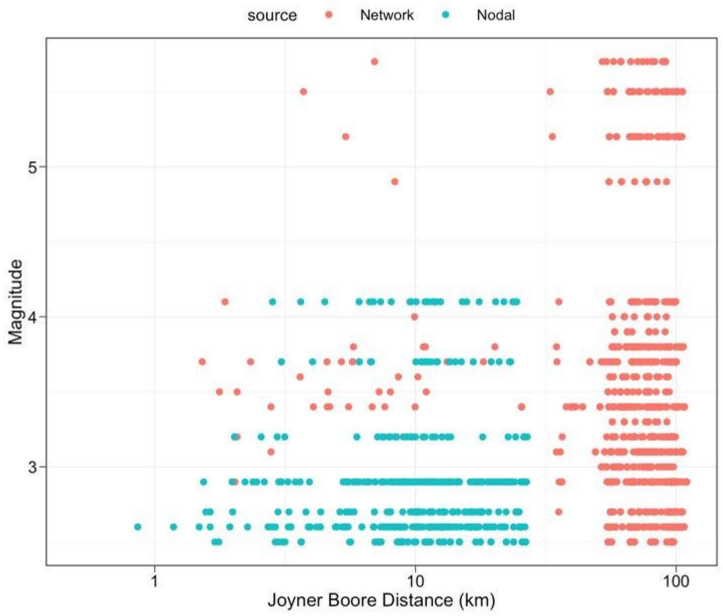


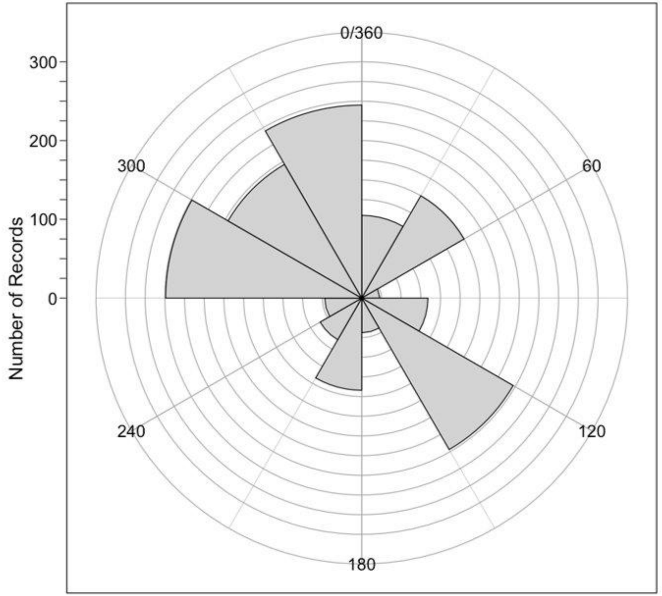


Name: Rob Skoumal

Lake Almanor (cont.)

- Overall:
  - 57 earthquakes (M2.5+)
  - 85 stations
  - 1729 records
- Nodes:
  - 22 earthquakes (M2.5+)
  - 34 stations
  - 425 records

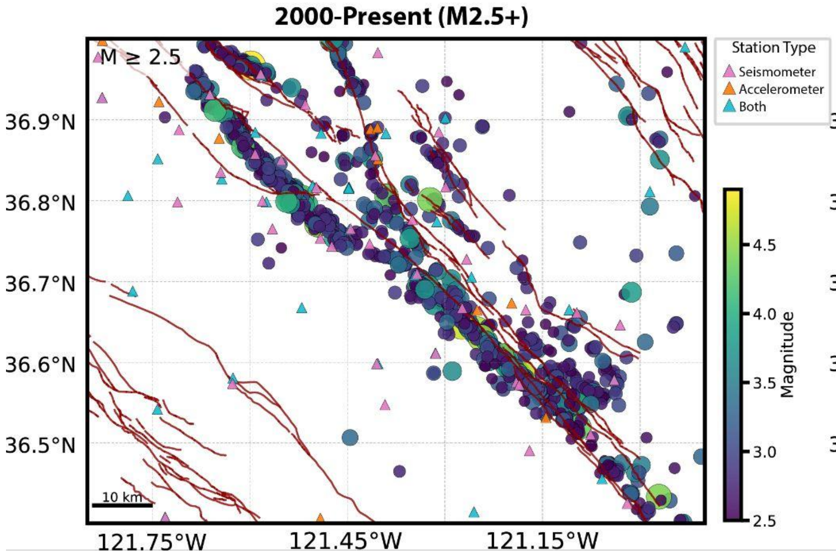


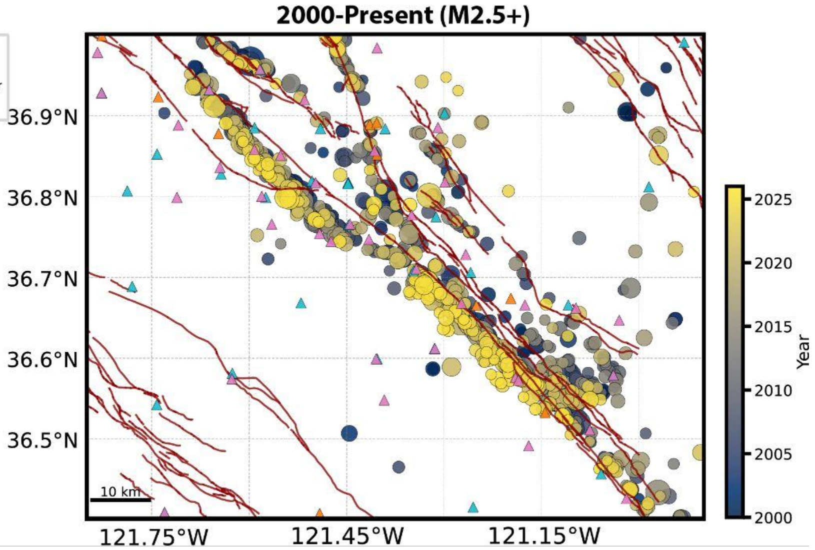


Name: Elizabeth Cochran

Calaveras/SAF Branch

- Variable slip behavior across the fault branches
- Faults and seismicity are relatively well-characterized by prior studies (e.g., Bakun et al., 1984; Taira et al., 2014; Waldhauser and Schaff, 2021, etc.)
- Important to SF Bay Area hazard
- Unusual site effects in Tres Pinos (southern end of area)



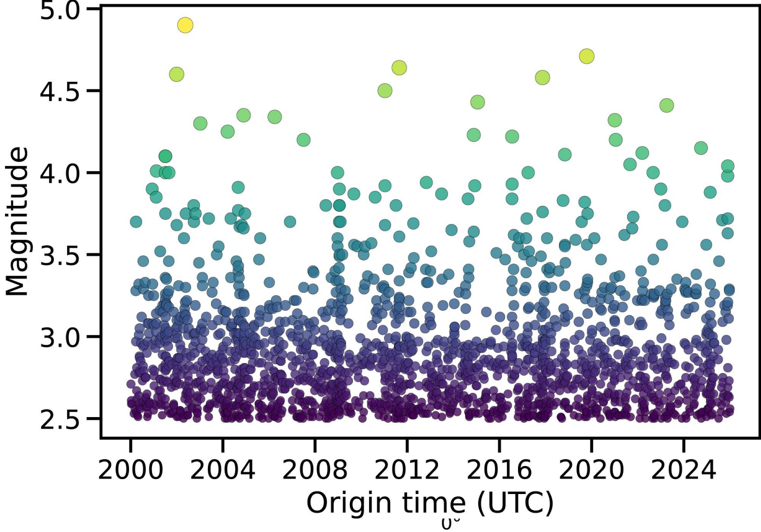


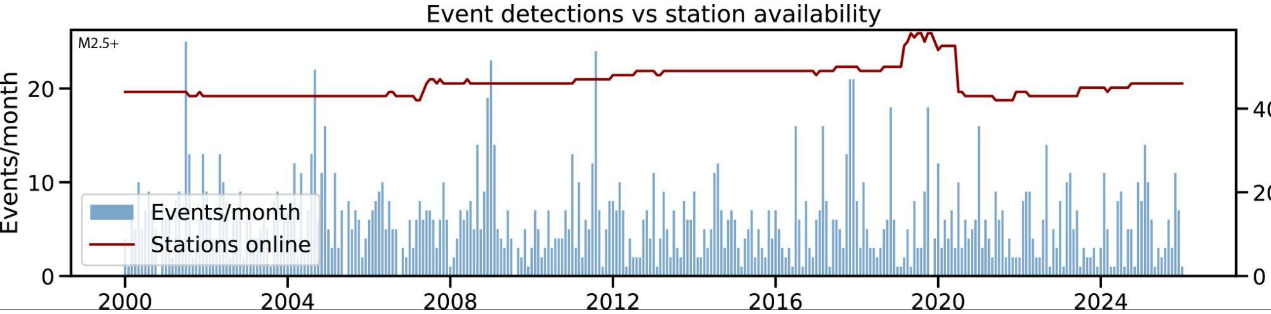
Only stations with at least 1 year of data are included

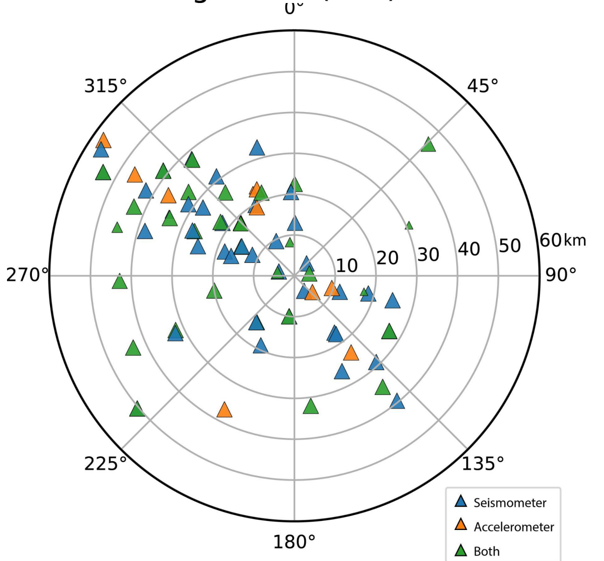
Name: Elizabeth Cochran

Calaveras/SAF Branch

- Earthquakes since 2000:
  - 6 M4.5+ since 2000 (4 M4.5+ since 2010)
  - 1869 M2.5+ since 2000 (1078 M2.5+ since 2010)
- Stations:
  - 81 stations in the study area running for at least 1 year: 33 accel+seis; 44 seis only (including 7 PB borehole stations); 9 accel only.







Only stations with at least 1 year of data are included

Peter Shearer

Why Parkfield?

Parkfield is uniquely suited to address two key science questions:

(1) What is causing spatial variations in average Δσ (HF radiation)?

(2) What is Δσ for small (M < 2) earthquakes (central to scaling issue)?

Ridgecrest aftershocks Δσ cross-section

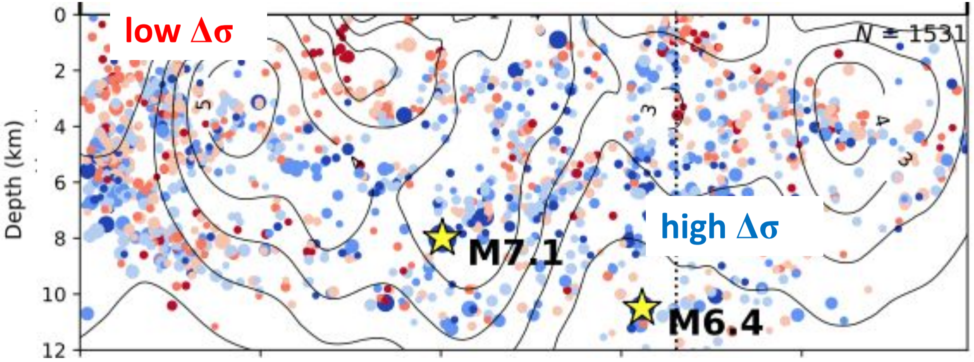


figure from Vandevert et al. (2025)

Ridgecrest summary plot

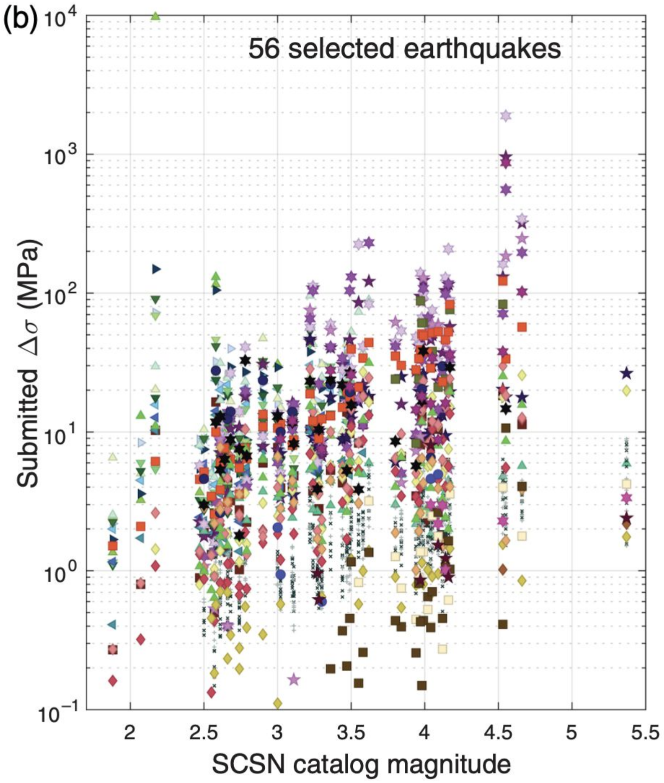


figure from Abercrombie et al. (2025)

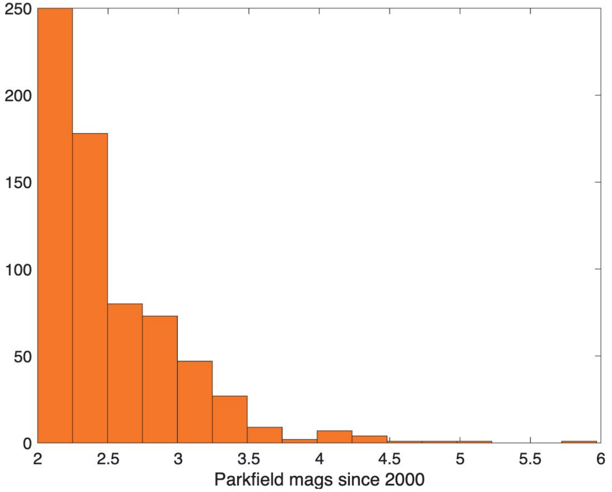
Peter Shearer

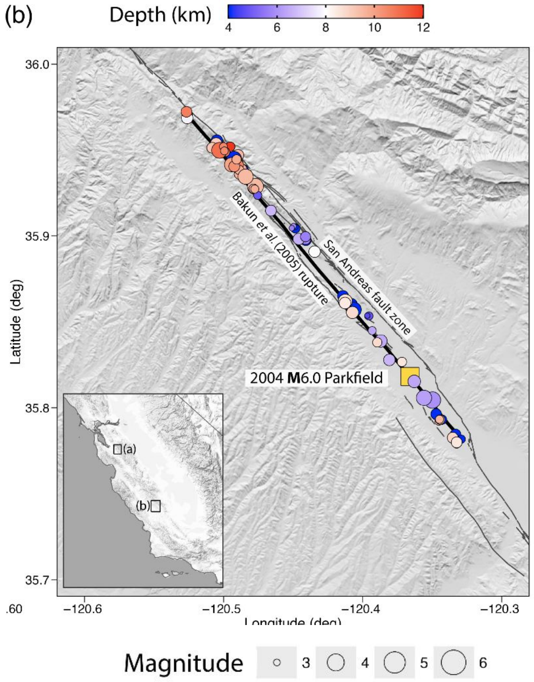
Parkfield: Most studied Fault?

Long Term Dense Deployments, SAFOD Hole

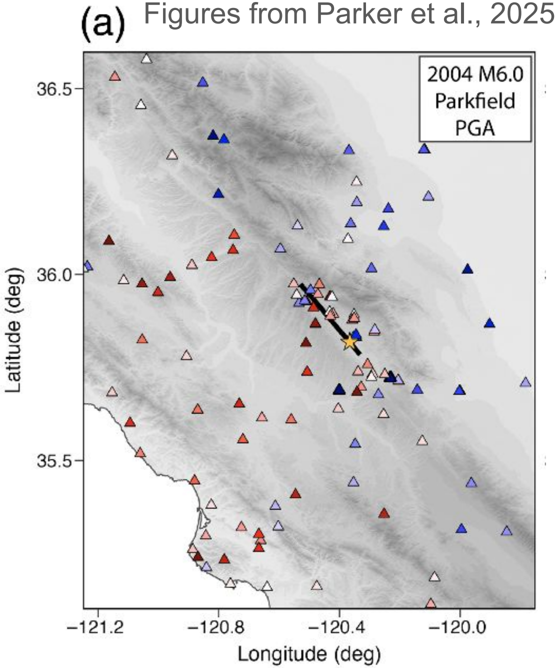
Transition from locked to Creeping, Temporal variation throughout Earthquake Cycle (M6)

Extensive supporting research: velocity structure, geology, geodesy etc.





Figures from Parker et al., 2025



Boreholes: HRSN 50-300m, "easy access" since 2001, fewer functioning stations in recent years. 250 s/s
SAFOD: Pilot hole: a few years multi-depth; main hole very short term single geophone deployments, >2000 Hz. DAS in progress.

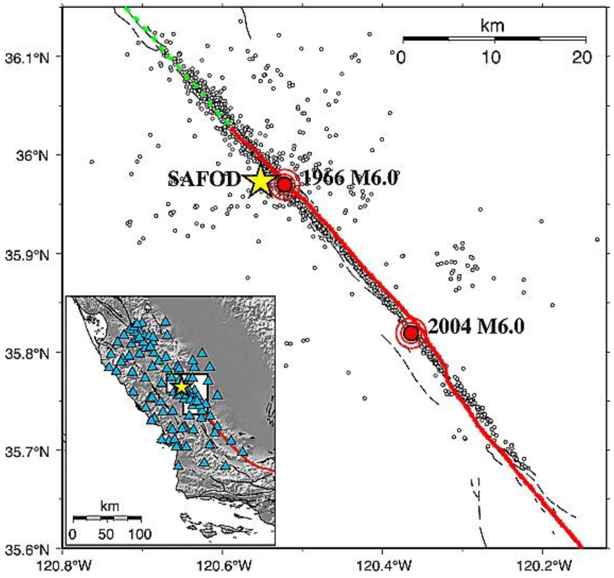
Peter Shearer

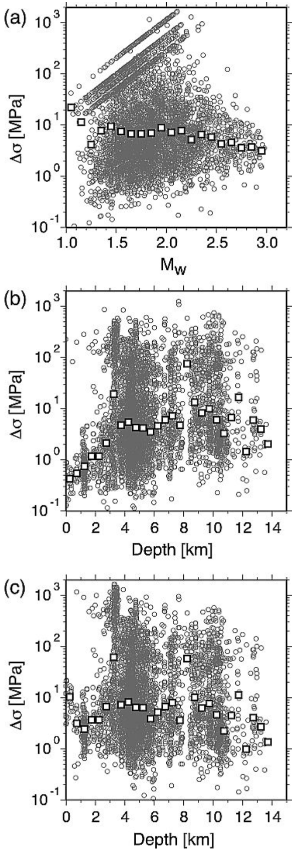
Parkfield - Previous Spectral Stress Drop Studies

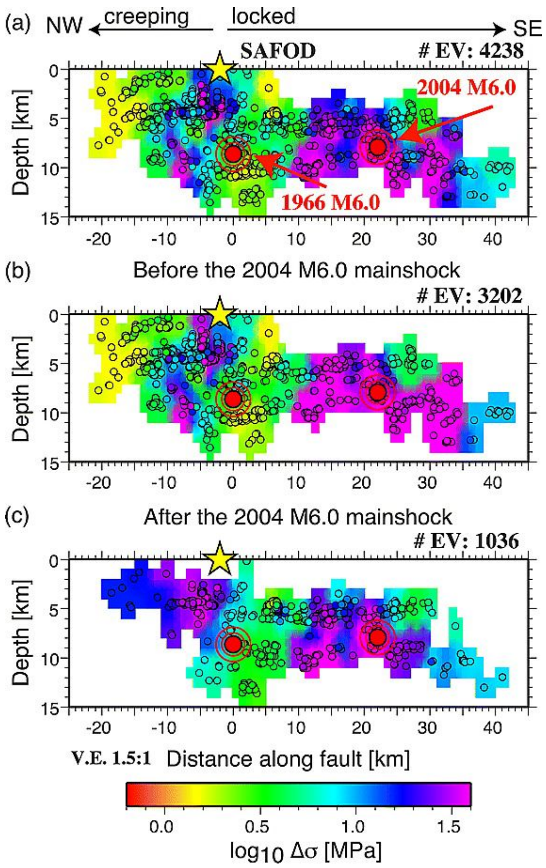
Allmann & Shearer JGR 2007

Surface Stations, 1984-2005, ~4200 eq, M1-3, f: 1-20Hz

Spectral Decomposition, Single ECS.







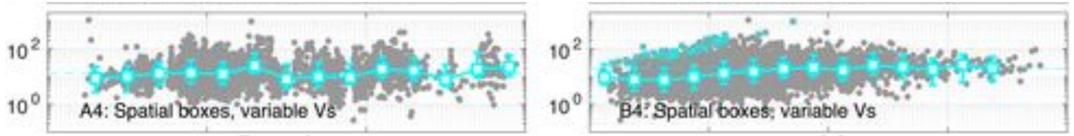
Peter Shearer

Parkfield - Previous Spectral Stress Drop Studies

Zhang, Chen, Abercrombie. JGR 2022

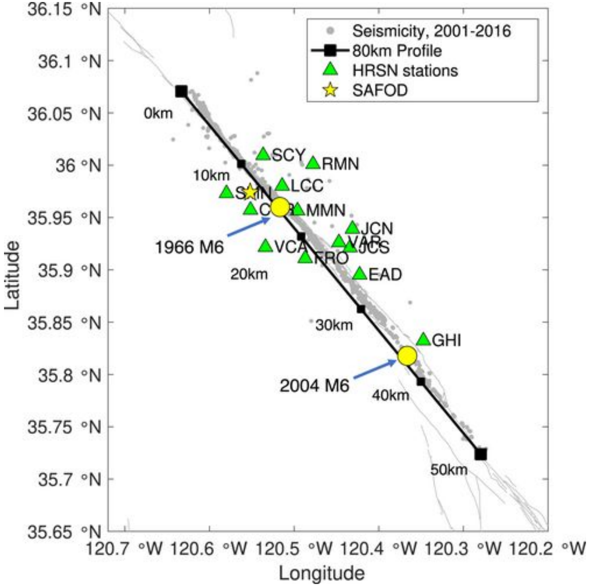
Borehole Stations, 2001-2016, ~5000 eq, M0-4 (1-3?), f: 2-60 Hz

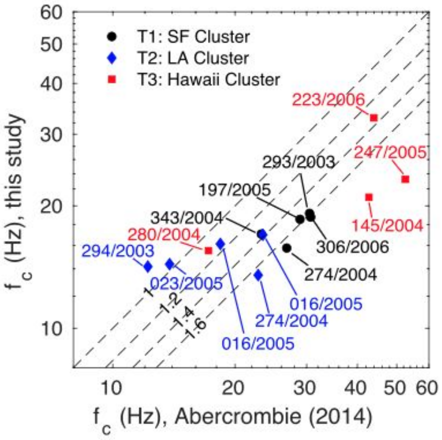
Spectral Decomposition, ECS vary spatially & depth



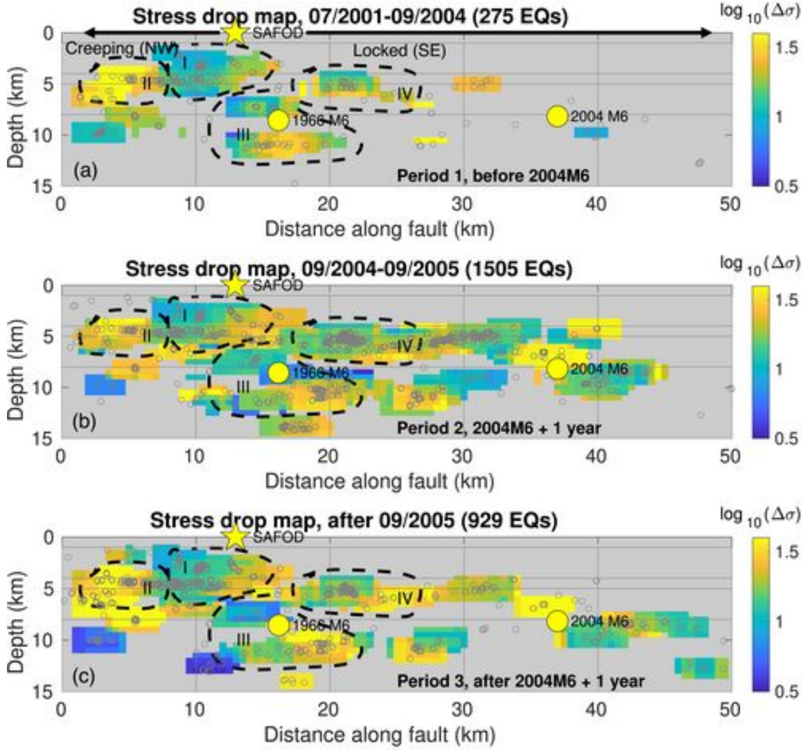
Depth
Ds

M





Repeating small EQ clusters targeted by SAFOD hole have high fc and inferred stress drops



Nine Mile Ranch (2016-2017)

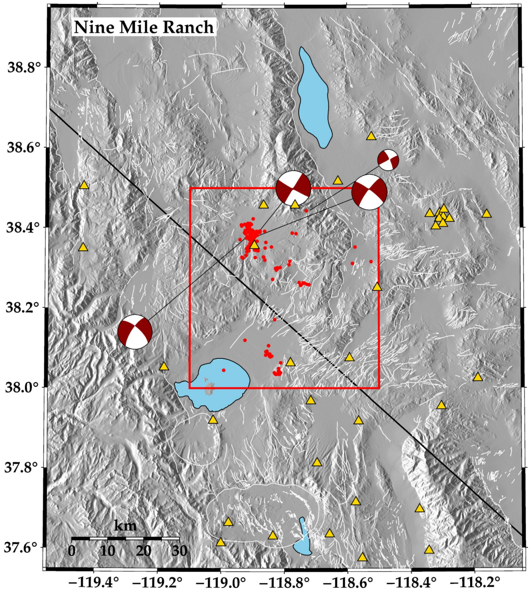
Daniel Trugman

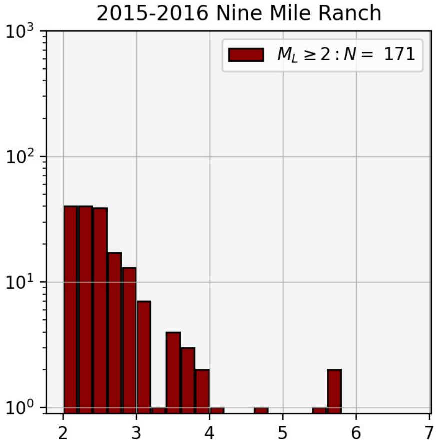
The 2016 Nine Mile Ranch Earthquakes: Hazard and Tectonic Implications of Orthogonal Conjugate Faulting in the Walker Lane

Rachel L. Hatch-Ibarra*[1,2], Rachel E. Abercrombie[1,3], Christine J. Ruhl[4], Kenneth D. Smith[1], William C. Hammond[5], and Ian K. Pierce[6]

ABSTRACT

The Nine Mile Ranch (NMR) sequence began with three M_w 5.4–5.6 earthquakes within one hour of each other in December 2016 in the remote area of Fletcher Valley, Nevada; only 4 min separated the first and second events. We analyze this complex earthquake sequence in the Walker Lane to determine the geometry and driving mechanism(s), and to improve understanding of deformation and seismic hazard in this region. Field reconnaissance found that these earthquakes caused significant damage to the Nine Mile ranch house but no surface rupture. We precisely relocate 6000+ earthquakes to reveal activated planar structures, unmapped at the surface, including two large, orthogonal, conjugate faults. Moment tensor solutions, focal mechanisms, and relocations show the two conjugate faults to be a vertical, northeast-trending left-lateral strike-slip fault, and a northwest-trending right-lateral strike-slip fault that dips ~60° to the northeast. The three main events lie at the intersection of both the faults, but the locations and orientations are most consistent with the first (M_w 5.6) and third (M_w 5.5) events rupturing the left-lateral northeast-trending fault plane; the second event (M_w 5.4) ruptured the right-lateral northwest-trending fault plane. Calculated static stress changes support this interpretation. Smaller events and structures show predominantly strike-slip and normal faulting. We calculate the local interseismic strain rate tensor and coseismic displacements using Global Positioning System data to determine whether nearby volcanic centers played a role in causing the fault geometry. Our results, combined with the spatiotemporal development of the sequence and the moment tensor solutions, indicate that regional scale tectonic forces are the dominant driving factors of this sequence. The NMR sequence adds to the documented variety of spatiotemporal patterns and driving mechanisms of earthquake sequences and swarms within the Walker Lane, providing further information and constraints on seismic hazard in this active region.



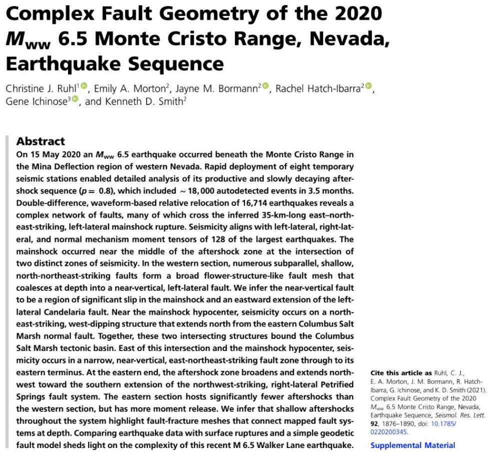


Pros:
- Compact cluster of events (3 M5s…)

Cons:
- Some azimuthal gaps in station coverage
- Not a huge sequence, few M4s

Prior Δσ studies: None

Monte Cristo (2020-2021)



Complex Fault Geometry of the 2020 M_{ww} 6.5 Monte Cristo Range, Nevada, Earthquake Sequence

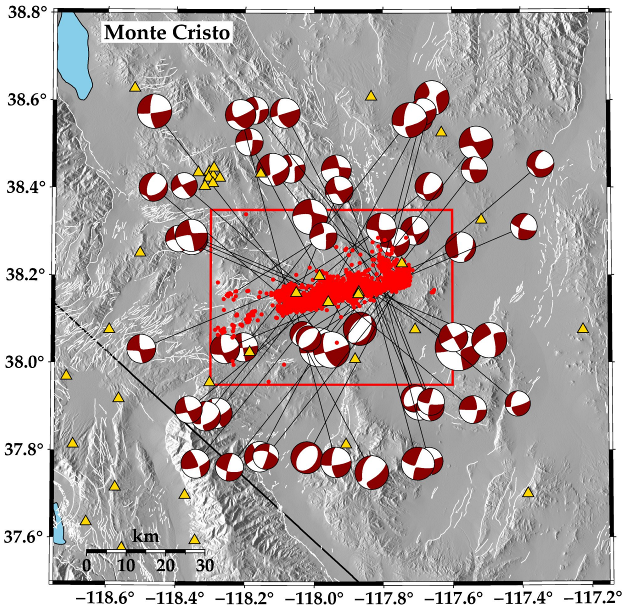
Christine J. Ruhl[1], Emily A. Morton[2], Jayne M. Bormann[2], Rachel Hatch-Ibarra[2], Gene Ichinose[3], and Kenneth D. Smith[2]

Abstract

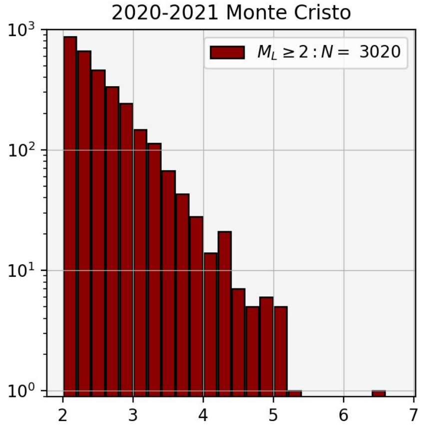
On 15 May 2020 an M_{ww} 6.5 earthquake occurred beneath the Monte Cristo Range in the Mina Deflection region of western Nevada. Rapid deployment of eight temporary seismic stations enabled detailed analysis of its productive and slowly decaying aftershock sequence ($p = 0.8$), which included ~18,000 autodetected events in 3.5 months. Double-difference, waveform-based relative relocation of 16,714 earthquakes reveals a complex network of faults, many of which cross the inferred 35-km-long east–northeast-striking, left-lateral mainshock rupture. Seismicity aligns with left-lateral, right-lateral, and normal mechanism moment tensors of 128 of the largest earthquakes. The mainshock occurred near the middle of the aftershock zone at the intersection of two distinct zones of seismicity. In the western section, numerous subparallel, shallow, north-northeast-striking faults form a broad flower-structure-like fault mesh that coalesces at depth into a near-vertical, left-lateral fault. We infer the near-vertical fault to be a region of significant slip in the mainshock and an eastward extension of the left-lateral Candelaria fault. Near the mainshock hypocenter, seismicity occurs on a northeast-striking, west-dipping structure that extends north from the eastern Columbus Salt Marsh normal fault. Together, these two intersecting structures bound the Columbus Salt Marsh tectonic basin. East of this intersection and the mainshock hypocenter, seismicity occurs in a narrow, near-vertical, east-northeast-striking fault zone through to its eastern terminus. At the eastern end, the aftershock zone broadens and extends northwest toward the southern extension of the northwest-striking, right-lateral Petrified Springs fault system. The eastern section hosts significantly fewer aftershocks than the western section, but has more moment release. We infer that shallow aftershocks throughout the system highlight fault-fracture meshes that connect mapped fault systems at depth. Comparing earthquake data with surface ruptures and a simple geodetic fault model sheds light on the complexity of this recent M 6.5 Walker Lane earthquake.

Cite this article as Ruhl, C. J., E. A. Morton, J. M. Bormann, R. Hatch-Ibarra, G. Ichinose, and K. D. Smith (2021). Complex Fault Geometry of the 2020 M_{ww} 6.5 Monte Cristo Range, Nevada, Earthquake Sequence, *Seismol. Res. Lett.* **92**, 1876–1890, doi: 10.1785/0220200345.

Supplemental Material



Daniel Trugman



Pros:

- Tons of earthquakes! One of the most active sequences in the Western US

Cons:

- Some azimuthal gaps in station coverage
- Many, many uncataloged events
- High activity → high noise levels

Prior Δσ studies: None

Antelope Valley (2021-2022)

Daniel Trugman

The Rocks That Did Not Fall: A Multidisciplinary Analysis of Near-Source Ground Motions From an Active Normal Fault

D. T. Trugman, J. Brune, K. D. Smith, J. N. Louie, G. M. Kent

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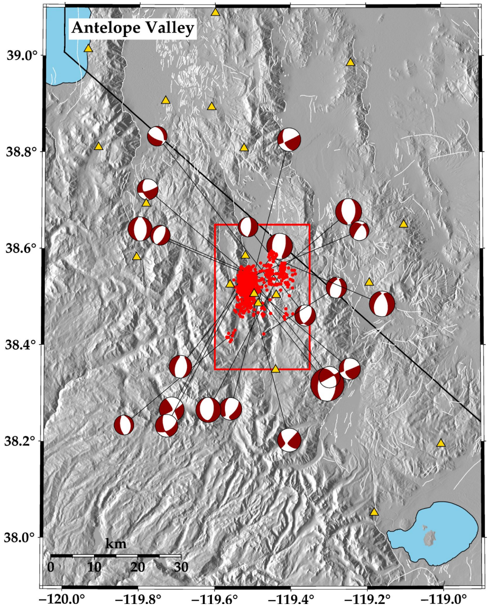
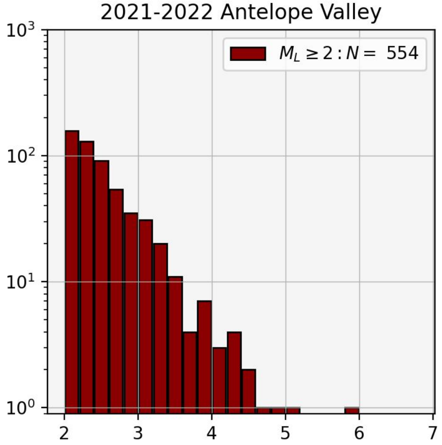
Abstract

On 8 July 2021 a M6.0 normal faulting earthquake rocked the community of Walker and the surrounding region near the California-Nevada border. In the 1990s, field surveys of nearby Meadowcliff Canyon identified numerous precarious rocks deemed likely to topple in the event of strong shaking. Despite their proximity (~6 km) to the 2021 earthquake, the precarious rocks still remain standing. In this work, we combine advanced source and ground motion characterization techniques to help unravel this mystery. High-precision hypocentral locations reveal a clear north/south-striking, east-dipping rupture plane along the southern extension of the Slinkard Valley fault. The mainshock nucleated near the base of the fault, triggering thousands of aftershocks. Bayesian source spectral analyses indicate that the mainshock had a moderately-high stress drop (~17 MPa), and that aftershocks with deeper hypocenters have higher stress drops. Peak Ground Acceleration (PGA) recordings at regional stations agree well with existing ground motion models, predicting PGA of ~0.3 g in Meadowcliff Canyon, a level sufficient to topple precarious rocks based on PGA-derived stability criteria. We demonstrate that despite these large ground accelerations, the pulse duration in Meadowcliff Canyon is too short to supply the impulse necessary to damage these features, observations which support the application of dynamic toppling models that account for the joint effects of pulse amplitude and duration when assessing rock fragility. This study provides a unique vantage point from which to interpret rarely-observed strong-motion recordings from close to an active normal fault, one of many that dominate hazard along the eastern Sierra.





Pros:
- Normal faulting events (for variety)
- Spatially compact but dense sequence

Cons:
- Some azimuthal gaps in station coverage

Prior Δσ studies: Trugman (2023)

Parker Butte (2024-2025)

Daniel Trugman

The M 5.7 Parker Butte Earthquake near Yerington, Nevada: Anatomy of a Dual-Plane Rupture in the Walker Lane from High-Precision Relocated Earthquakes, InSAR, GPS, and Strong-Motion Data

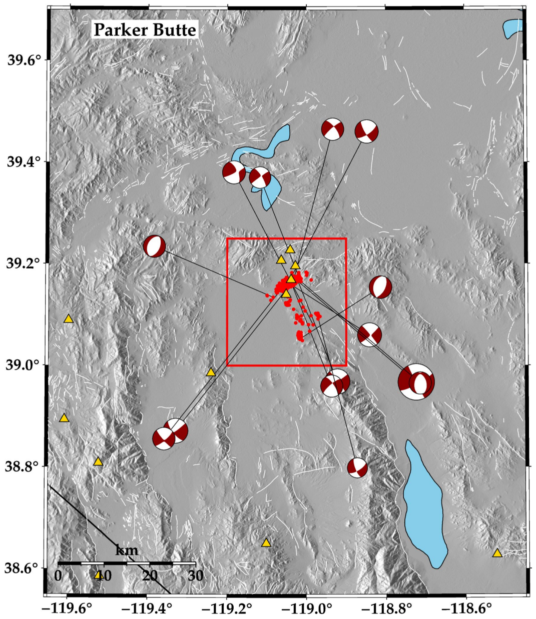
Kyren R. Bogolub*[1], Daniel T. Trugman[1], Yu Jiang[1], William C. Hammond[2], Kenneth D. Smith[1], Rich D. Koehler[2], and Christie D. Rowe[1]

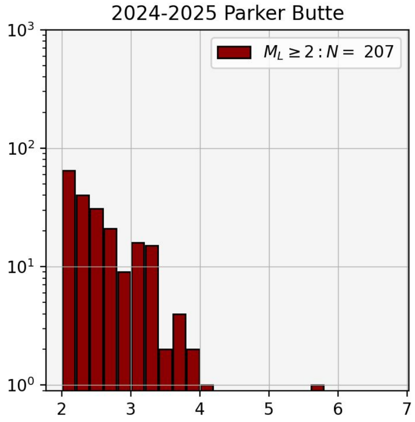
Abstract

On 9 December 2024, at 3:08 p.m. local time, the M_w 5.7 Parker Butte earthquake occurred about 24 km north-northeast of Yerington, Nevada. From 1 December 2024 to 10 May 2025, we cataloged 1301 earthquakes, including seven events $M_L > 3.5$. We use high-precision earthquake relocation, Interferometric Synthetic Aperture Radar (InSAR) data, Global Positioning System (GPS) data, and strong-motion data to explore the tectonic context and spatiotemporal evolution of this sequence. The high-precision relocations of the sequence reveal a main cluster of earthquakes that form a planar feature which can be fit with a plane striking N62°E and dipping 85° SE. Events that are not in the main cluster are primarily 5–10 km to the southeast and are more scattered, but some smaller linear clusters can be identified. We used InSAR and GPS data to model fault geometry and slip. From this analysis, we found that the ground deformation can be fit with a single fault 12 km long × 8 km wide with a strike of N61.5°E ± 1.0°, dipping 73° ± 1.5° southeast and slip up to ~50 cm, concentrated between depths of 2.5 and 7 km, consistent with an M_w 5.7 rupture. However, a better fit is found by adding a second fault plane. The second fault strikes N24.5°W and was detected as a displacement discontinuity in descending InSAR scenes, correlating to minor surface fracturing observed in the field, but had low aftershock activity. The GPS observations of interseismic deformation before the event show similar directions of principal strain accumulation and strain release in the mainshock moment tensor. Ground-motion measurements from the mainshock strong-motion data are generally in agreement with existing active crustal ground-motion models for the western United States. The sequence provided a valuable dataset for examining faulting rupture patterns in the Walker Lane Shear Zone.

Cite this article as Bogolub, K. R., D. T. Trugman, Y. Jiang, W. C. Hammond, K. D. Smith, R. D. Koehler, and C. D. Rowe (2025). The M 5.7 Parker Butte Earthquake near Yerington, Nevada: Anatomy of a Dual-Plane Rupture in the Walker Lane from High-Precision Relocated Earthquakes, InSAR, GPS, and Strong-Motion Data, *Seismol. Res. Lett.* **XX**, 1–13, doi: 10.1785/0220250203.

Supplemental Material





Pros:

- Recent, widely felt sequence near Reno
- Compact cluster of events

Cons:

- Some azimuthal gaps in station coverage
- Oddly deficient in high M3, M4 events

Prior $\Delta\sigma$ studies: None

Reno / Carson Area Sequences

Daniel Trugman

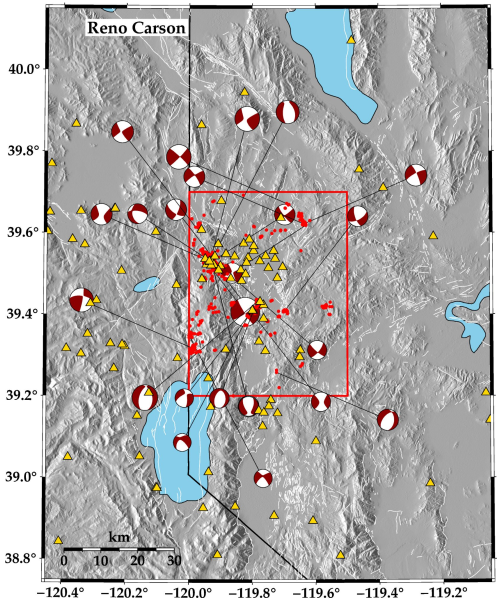
Spatially Consistent Small-Scale Stress Heterogeneity Revealed by the 2008 Mogul, Nevada, Earthquakes

Christine J. Ruhl*[1,2,3], Rachel E. Abercrombie[2,4], and Peter M. Shearer[5]

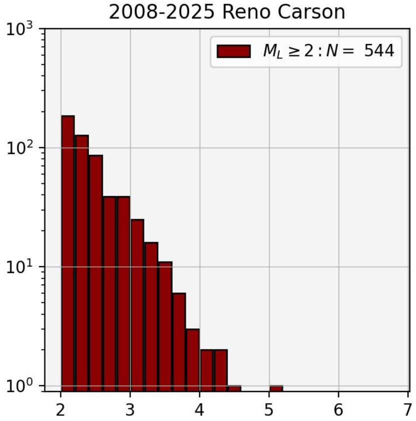
Abstract
We compute and analyze stress drops for 4175 earthquakes (M_L 0–5) in the 2008 Mogul, Nevada, swarm–mainshock sequence using a spectral decomposition approach that uses depth-dependent path corrections. We find that the highest stress-drop foreshocks occur within the fault zone of the M_w 4.9 mainshock, nucleating at the edges of seismicity voids and concentrating near complexities in the fault geometry, confirming and extending inferences from prior work based on empirical Green's functions for ~150 of the larger Mogul earthquakes. The region of the highest stress-drop foreshocks is not reruptured by aftershocks, whereas low-stress-drop areas are consistently low during both the foreshock and aftershock periods, implying that stress drop depends on inherent individual fault properties rather than timing within the sequence. These results have implications for swarm evolution and fault activation within complex 3D structures.

Cite this article as Ruhl, C. J., R. E. Abercrombie, and P. M. Shearer (2023). Spatially Consistent Small-Scale Stress Heterogeneity Revealed by the 2008 Mogul, Nevada, Earthquakes, *The Seismic Record.* **3**(3), 239–248, doi: 10.1785/0320230026.

Supplemental Material



Pros:
- Good station coverage (for Nevada!)
- Multiple sequences, spatially compact clusters
- Some good in-situ site measurements



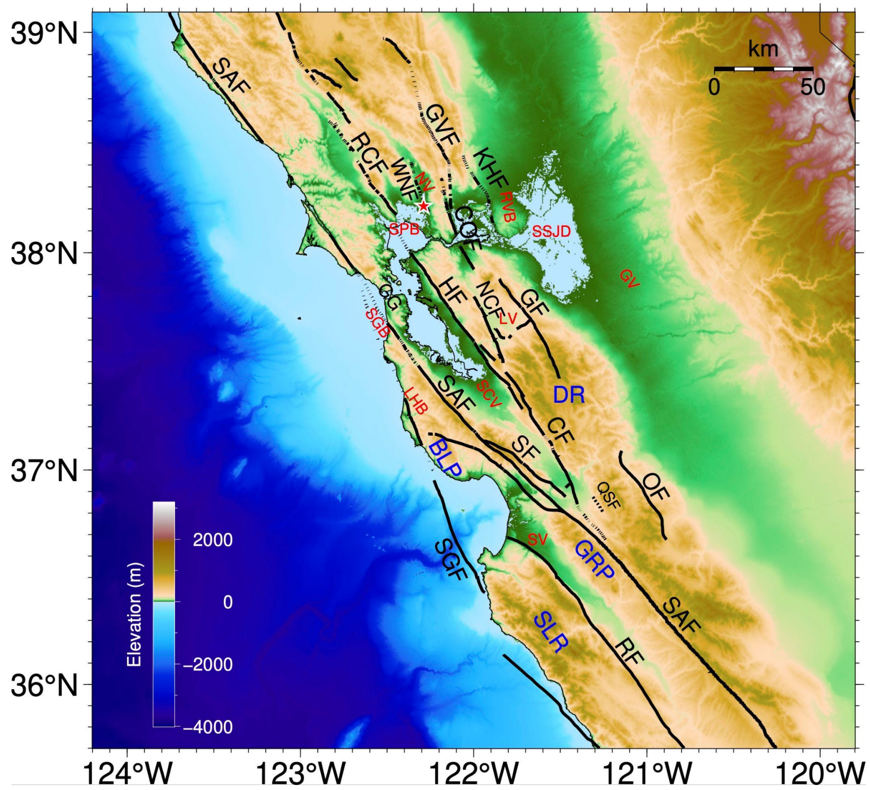
Cons:
- Few M4-M5 events outside of Mogul
- Longer time period means changes in instrumentation

Prior $\Delta\sigma$ studies: Ruhl (2017, 2023) - Mogul only

Hao Guo
(UW-Madison)

San Francisco Bay Region, northern California

Major fault systems in the Bay Area



Scientific Importance:

- High concern for seismic hazard analysis due to widely distributed, seismically active fault systems and dense population. Major fault systems within this area include the San Andreas, Hayward, and Calaveras faults, which are able to generate M6-7 earthquakes. Numerous other subparallel active faults strike thought this area.
- Faults with various locking state

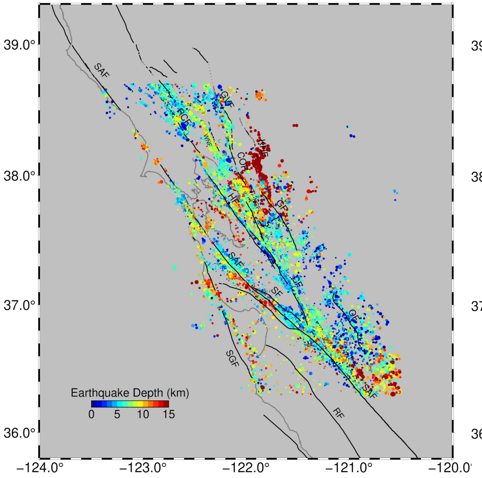
Pros:

- Active seismicity with a wide range of magnitude
- Good station coverage in space and time
- 3-D Vp and Vs models from body-surface wave joint tomography (Guo et al., 2025)
- 3-D Qp and Qs models from body-wave t* tomography (Eberhart-Phillips, 2016)

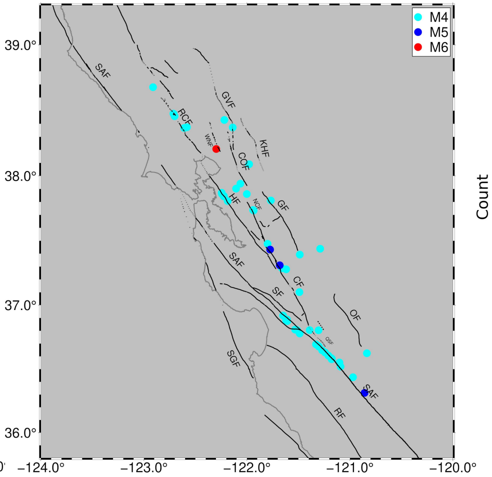
Hao Guo

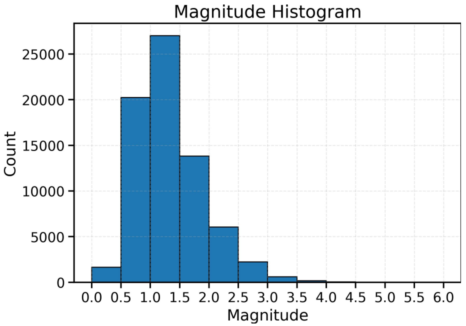
Earthquake Distribution

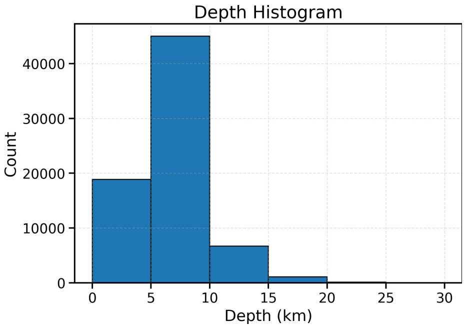
All events since 2003



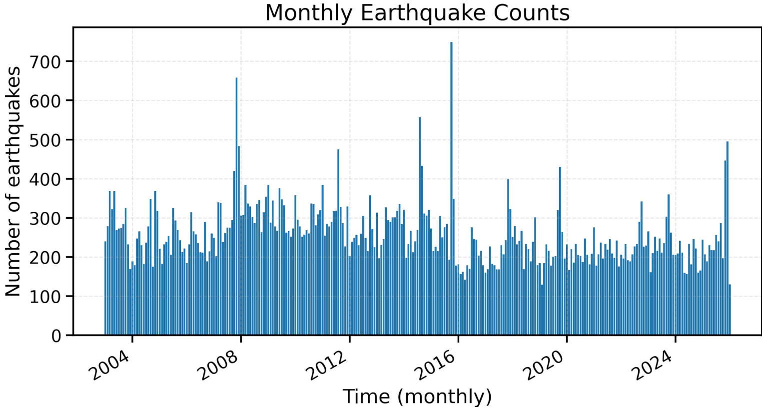
All M>4 events since 2003







- >70,000 events (magnitude 0–6) since 2003 in the NCEDC double-difference catalog, averaging ~3000 events per year
- ~22,000 M0; ~40,000 M1; 8,000 M2; 760 M3; 51 M4; 3 M>5; 1 M6 (2014 South Napa M6)
- Most events occurred within 0 to 20 km depth



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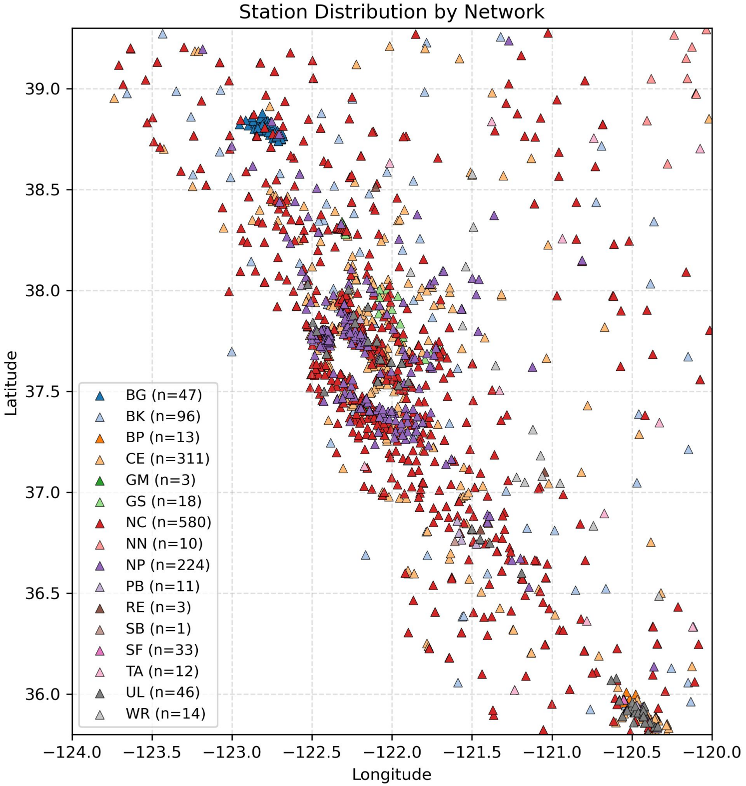
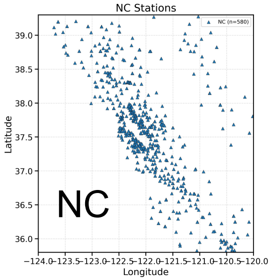
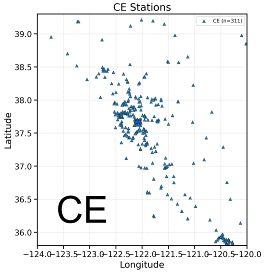
Station Distribution

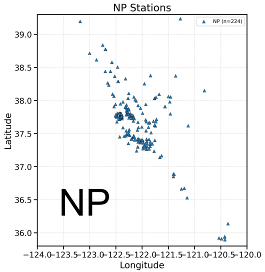
Stations archived in the Northern California Earthquake Data Center (NCEDC)

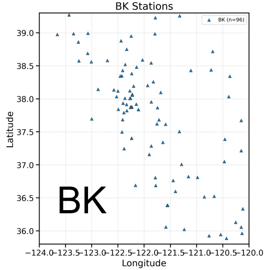


Permanent networks with most stations:









1. NC (Northern California Seismic Network, USGS): 580 stations including short-period, broadband, strong-motion, and borehole.

2. CE (California Geological Survey Network): 311 accelerograph stations for measuring strong motion

3. NP (National Strong Motion Program): 224 strong motion accelerograph stations

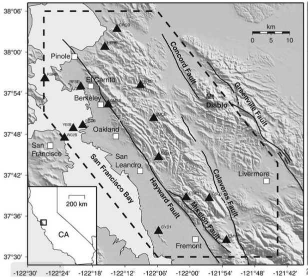
4. BK (Berkeley Digital Seismic Network and Berkeley Borehole Network): 96 broadband and/or borehole stations

Hao Guo

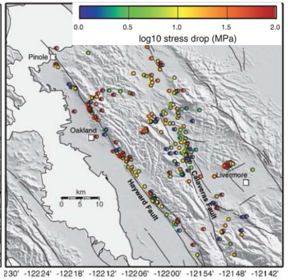
Previous and Ongoing Stress Drop Studies in the Bay Area

Hardebeck & Aron (2009)

Borehole stations

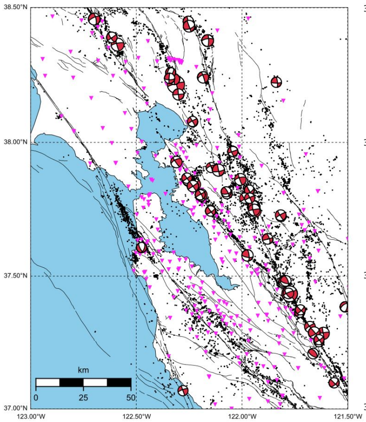


Stress drop results

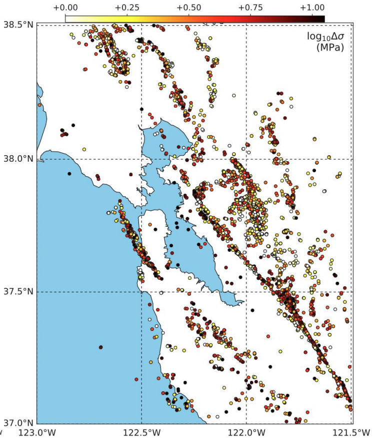


Trugman & Shearer (2018)

NC stations

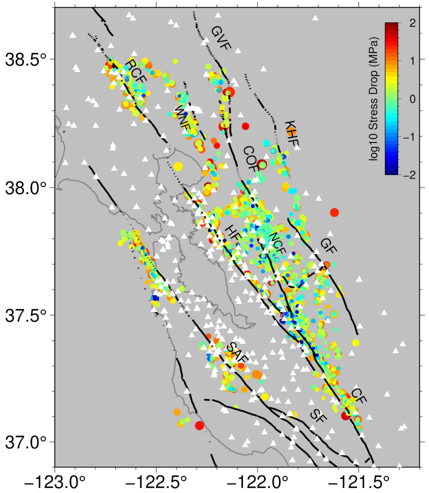


Stress drop results



Guo & Thurber, in prep.

NC stations & stress drop results



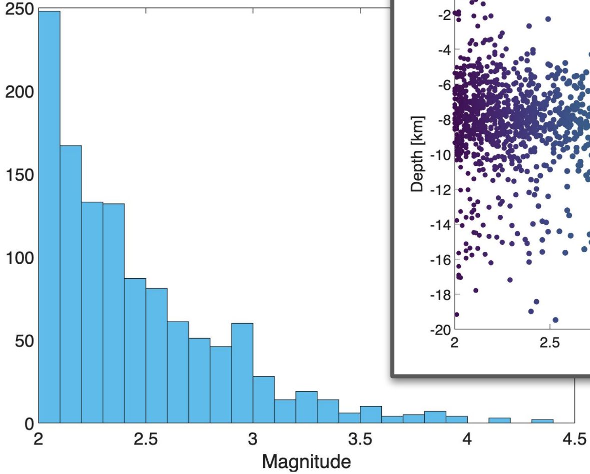
- Region: East Bay region
- Data: 2770 earthquakes (M1-4.2); P-wave spectra (f: 4-55 Hz); 15 borehole stations of the USGS/UC Berkeley, Hayward fault network
- Period: 1998-2007
- Method: Spectral decomposition

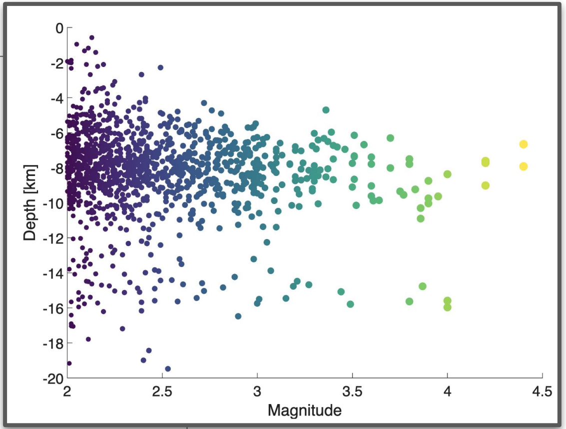
- Region: entire Bay region
- Data: 5297 events (M1.5-6); P-wave spectra (f: 2.5-25 Hz); NC stations
- Period: 2002-2016
- Method: Spectral decomposition

- Region: entire Bay region
- Data: ~8,000 events (M1.5-6, ~4,700 shown above); P-wave spectra (f: ~1-30 Hz); NC stations
- Period: 2003-2023
- Method: Joint spectral ratio inversion

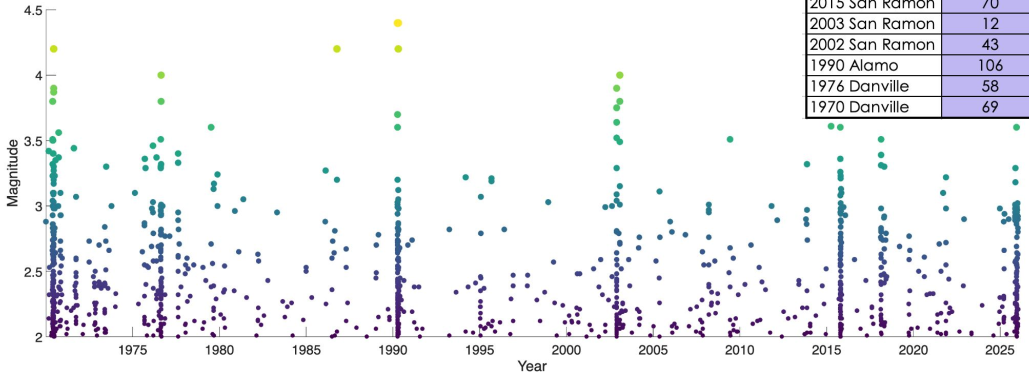
Name: Annemarie Baltay and Elizabeth Cochran and others

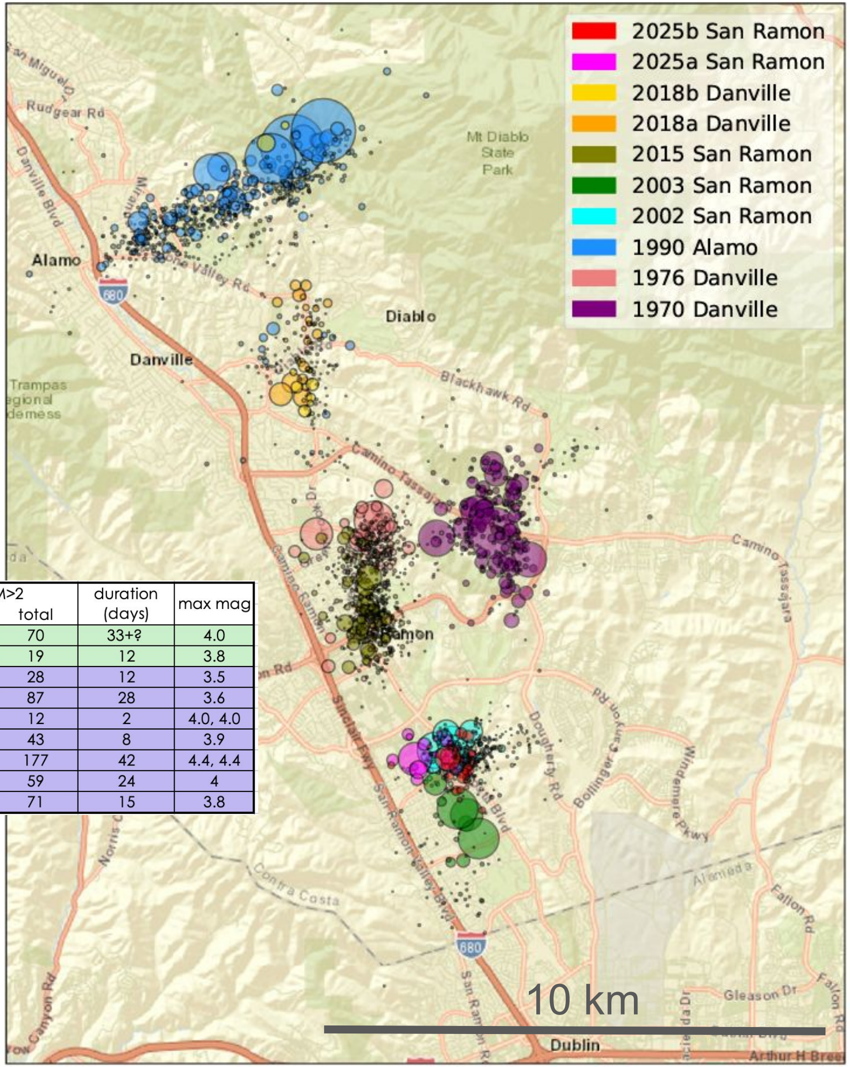
San Ramon Swarms





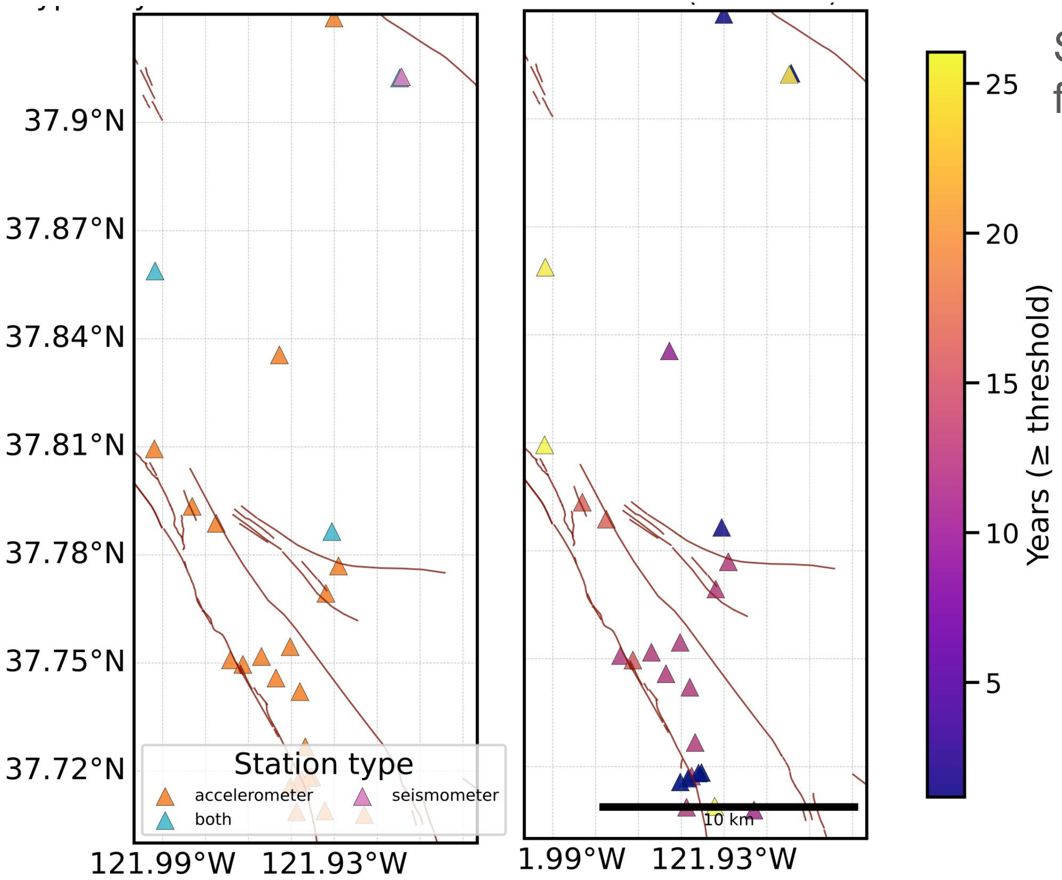
Name	#Eqs M>2 first 14 days	total	duration (days)	max mag
2025 December	52	70	33+?	4.0
2025 November	19	19	12	3.8
2018 Danville	28	28	12	3.5
2015 San Ramon	70	87	28	3.6
2003 San Ramon	12	12	2	4.0, 4.0
2002 San Ramon	43	43	8	3.9
1990 Alamo	106	177	42	4.4, 4.4
1976 Danville	58	59	24	4
1970 Danville	69	71	15	3.8



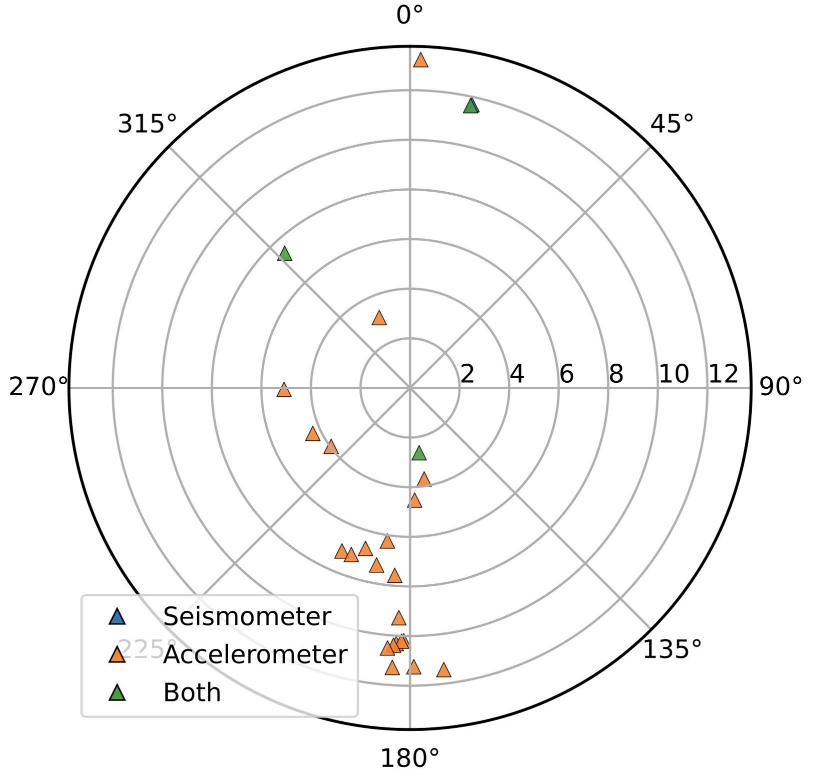


Name: Annemarie Baltay and Elizabeth Cochran and others

San Ramon Swarms - approximate station coverage



Stations since 2000 that have been running for at least a year



Summary

VOTE for your preferred dataset!
https://forms.gle/f857XgwPRtQwWQsJA

region	M range	# EQs	f range	Depth	# of Sensors	comments	Science implications
Geysers Small area	0-5	23 M>4 since 2009 Thousands of small	4.5 Hz phones	2-4km	32 in 20x10 km	Are any large events clipped? summer/winter attenuation varies?	Fluid-driven effects, several stress drop studies
SPE Small area	M<3	Short duration	High f	< 1km	Very dense close-in recording	Known sources, aftershocks of explosions	Very specific focused study.
Lake Almanor	M<5.7	57 > M2.5 with nodals	Nodals + a few BB, SM	crustal. ~2 - 10 km	Little for 10 years (2 in 25 km); dense for 2 months	34 station Nodal deployment	Hazard implications for dams
Calaveras larger area	M<5	Since 2000: 6 M4.5+; 1869 M2/5+	Similar to Ridgecrest	crustal.	81 in study area, Spacing ~10 km	Similar scale and recording to Ridgecrest?	Hazard in the bay area, spatial variations
Parkfield medium area (small within HRSN)	M1-6	5000+	Surface: 1-20, HRSN 1-60Hz.	crustal. ~2 - 12km	Dense surface, and shallow borehole. Very short term deep SAFOD	Very well studied. DAS, SAFOD borehole. Comparison with	What is causing spatial variations? What is stress drop for small EQs? Temporal changes following M6
Nevada Medium scale	M2+ catalogued	**Monte Cristo**- lots of EQs, 9 Mile, Antelope Valley, Parker Butte, **Reno-Carson area**	Similar to Ridgecrest		Sparse, big azimuthal gaps, short nodal deployment for Monte Cristo	Novel! Not well studied. Station coverage is sparse. May need relocations? No previous Best coverage probably Reno/Carson area	Could test limits of methods! Site measurements available for Reno/Carson
Bay Area (large area)	<6 (Napa)	~800>M3, 55>M4 since 2003	Similar to Ridgecrest, Hayward borehole 4-55 Hz	crustal	Lots, approx 10 km?	Velocity and attenuation models exist, good geology. Could focus on Hayward area? (borehole)	Seismic hazard to Bay Area.
San Ramon (small, within Bay area)	< 4.4	~250+ since 2000 M2+			Quite dense		Why ongoing clusters? Why move around?

Rank your top three datasets!