

---

# Welcome!



**E**arthquake  
**C**ountry  
**A**lliance

**ECA Bay Area**  
Winter 2024 Workshop

## **Ice-Breaker Discussion:**

What concerns you most about a large Bay Area earthquake?

---

1

---

## **ECA Bay Area Coordinating Committee Co-Chairs**

**Ray Bonilla**  
Elevance Health

**Dena Gunning**  
Central County Fire Department (San Mateo)

**Jeff Airth**  
San Francisco International Airport

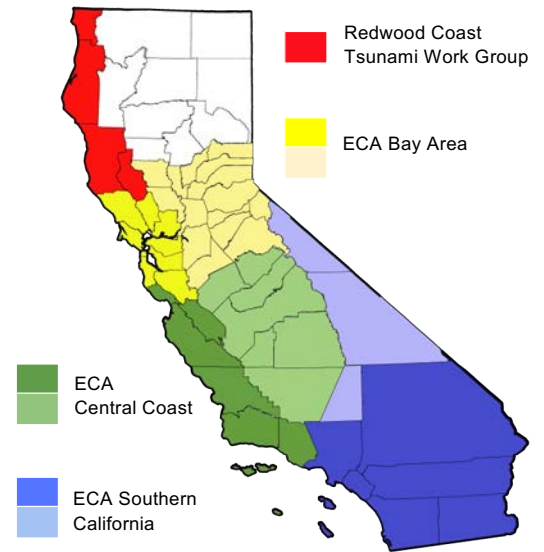
---

2

---

# Earthquake Country Alliance

- 4000+ *Public-Private-Grassroots* leaders
- Subject matter expert *Committees* develop resources and programs
- *Regional Alliances* organize meetings and outreach activities
- California's Office of Emergency Services provides FEMA NEHRP funding for ECA earthquake mitigation activities
- USC's Statewide California Earthquake Center (SCEC.org) administers ECA



Join: [EarthquakeCountry.org/join](https://EarthquakeCountry.org/join)



---

3

---

## ECA Bay Area Coordinating Committee

- Coordinating Committee Chairs: **Ray Bonilla**, Elevance Health  
**Dena Gunning**, Central County Fire Dept. (San Mateo County)
  - Communications Coordinator: **Susan Garcia**, USGS
  - Events Bureau Coordinators: **Chief David Cosgrave**, San Mateo County Dept. of Emgcy. Svs.  
**Kacey Treadway**, Santa Clara County Ofc. of Emgcy. Mgmt.
  - Media Bureau Coordinator: **Open Position**
  - Membership Coordinator: **Wendi Ellis**, US Department of Health and Human Services
  - Participation Bureau Coordinator: **Theresa Langdon**, Alameda County Office of Emergency Services
  - Regional Workshops Coordinator: **Jeff Airth**, SFO
- SCEC Liaison for ECA Bay Area: **Mark Benthien (ECA/SCEC)**  
[bayarea@earthquakecountry.org](mailto:bayarea@earthquakecountry.org)

*Each Coordinator welcomes additional members of their committee!*

[EarthquakeCountry.org/bayarea](https://EarthquakeCountry.org/bayarea)

---

4

---

# Today's Agenda

## Welcome & Self-Introductions

### Bay Area Disaster-Related Funding, Resources, and Trainings

Mark Benthien (*ECA Exec. Director*) & Dena Gunning (*Central County Fire Department*)

### Bay Area CERT Coalition

Sandra Firpo (*San Mateo Consolidated Fire Department*)

### Slow Slip and Earthquake Potential Along the Hayward Fault

Prof. Roland Bürgmann (*UC Berkeley Seismology Laboratory*)

### Quake Break

Savvas Marcou (*UC Berkeley Graduate Student*)

### Break

### Loma Prieta 35 Anniversary Planning

Share stories; brainstorm plans; ShakeOut day location

### Announcements by Participants & Open Discussion

Activities/events, new resources, recommended trainings, etc.

---

5

---

## Self Introductions

# Name

# Organization or Community

---

5

---

# Bay Area Disaster-Related Funding, Resources, and Trainings

***Dena Gunning***

*Central County Fire Department (San Mateo)*

***Mark Benthien***

*ECA Executive Director,  
Statewide California Earthquake Center*

---

7



## Upcoming Opportunities

### **Preparedness Events/Trainings – San Mateo County**

Chinese **CERT** offered by Central County Fire Department (April)  
San Mateo County Disaster Preparedness Fair (August)

### **Grants**

2023-24 Listos California Youth Development Grant (LY) Program

***RFP Due Date: 03/04/2024***

[caloes.ca.gov/grant-announcement/2023-24-listos-california-youth-development-grant-ly-program-rfp/](https://caloes.ca.gov/grant-announcement/2023-24-listos-california-youth-development-grant-ly-program-rfp/)

### **Emergency Management Training**

California Emergency Services Association (CESA) Professional Emergency  
Management Certification Program for California Emergency Managers

[cesa.net/cesa-emergency-management-certification](https://cesa.net/cesa-emergency-management-certification)

---

8

# ECA Statewide Activities

Develop Messaging and Resources:

- [EarthquakeCountry.org](http://EarthquakeCountry.org)
- [EarthquakeCountry.org/resources](http://EarthquakeCountry.org/resources)
- [Terremotos.org](http://Terremotos.org)



Support Tsunami Preparedness Week:

- [TsunamiZone.org/california](http://TsunamiZone.org/california)



March  
23-31,  
2024

Created and Coordinate  
The Great California ShakeOut:

- [ShakeOut.org/california](http://ShakeOut.org/california)



Oct. 17,  
2024

Webinars & other events

- [EarthquakeCountry.org/calendar](http://EarthquakeCountry.org/calendar)

# ECA Mini Awards

- Purpose:** provide materials for ECA member projects that improve earthquake resilience by promoting mitigation, awareness, and preparedness, and multiply impact of programs
- Purchases:** \$500 to \$1000 each
- Eligibility:** Proposals for earthquake **mitigation** and **education** activities
- Pre-defined packages:** Sets of materials will be available, however you can also customize them or propose other items



- 2024 Awards:** Applications open in March

## READY AMERICA THE DISASTER SUPPLY PROFESSIONALS

### Secure WORKPLACE \$500 Package

ITEM #	ITEM NAME	IMAGE	QUANTITY
4160-64	Furniture Strap		15
4740	File Cabinet Strap		15
5040	Bookcase Strap		15
4173	Home Electronics Safety Strap, Black		30
4338	A-Maze-ing Picture Hook, 4 Pack		10
4250	Kitchen & Cabinet Door Latch, 4 Pack		10
88111	QuakeHOLD! Museum Putty		10

Federal

---

# *ECA Bay Area Mini 2023 Recipients*

San Francisco Community College Police Department  
Thrive Alliance of Nonprofits for San Mateo County  
Highlands CERT  
Japantown Community Benefit District  
Los Altos Block Action Team 33  
Hearst-and-Short Neighborhood Group (Berkeley)

---

11

---

## Seven Steps To Earthquake Safety

**BEFORE**

1. Secure Your Space



2. Plan To Be Safe



3. Organize Supplies



4. Minimize Financial Hardship



5. Drop, Cover, and Hold On



6. Improve Safety



**AFTER**

7. Reconnect and Restore



[EarthquakeCountry.org/sevensteps](https://EarthquakeCountry.org/sevensteps)

[Terremotos.org/sietepasos](https://Terremotos.org/sietepasos)

---

12

# Updated Materials in 16 Languages

**If You Feel Shaking or Get an Alert:**

If Possible: **DROPI COVER! HOLD ON!**

Usin Con: اگر لرزش از آه ای یا احس کردید با هشداری دریافت کردید:

Usin Wotke: اگر لرزش از آه ای یا احس کردید با هشداری دریافت کردید:

Si Siente Un Temblor o Recibe Una Alerta:

Si Es Posible: **AGACHESE! COBRASE! SUJETESE!**

Si Usa Bastón:

Si Usa Andadera:

Si Usa Silla de Ruedas:

EarthquakeCountry.org/step5

**Kế Hoạch Hành Động**

**Bảy Bước Giữ An Toàn**

**Cov Niam Tswv Yim Pab Thaum Muaj Av Qeeg**

Thaum Kij Muaj Muaj Av Qeeg Co Co lo yag twi li Qho Xov Xwm. Th Thau Kij Twi Kheng Kom Cov Khom Food Thau Lo Lo Rong

ShakeOut

EarthquakeCountry.org/step5

**Pilong Hakbang sa Paghahanda sa Lindol**

ShakeOut

EarthquakeCountry.org/step5

**Recommended Earthquake Safety Actions**

ShakeOut

EarthquakeCountry.org/step5

## EarthquakeCountry.org/languages



**HayWired Scenario EXERCISE TOOLKIT**

**A guide for creating discussion-based exercises using the HayWired Earthquake Scenario**

USGS science for a changing world

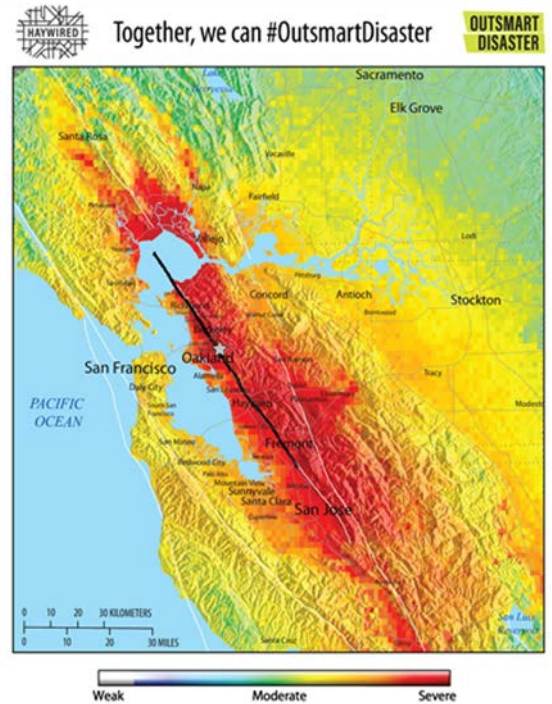
Earthquake Country Alliance

CALIFORNIA RESILIENCY ALLIANCE

---

# USGS HayWired Scenario

- Comprehensive assessment of what would happen due to a Magnitude 7 earthquake on Hayward fault
- Emphasizes impacts from modern society's lifeline interdependencies and reliance on the Internet
- Last similar earthquake was in 1868, when there were far fewer buildings, infrastructure, and people
- Learn more and download a toolkit for discussions based on the scenario at [EarthquakeCountry.org/HayWired](http://EarthquakeCountry.org/HayWired)



---

15

---

## HayWired Scenario Estimates

100,000+ buildings significantly damaged  
Widespread infrastructure damage  
450 large fires  
\$83+ billion damages  
22,000 people trapped in elevators  
18,000 injuries  
800 deaths

---

16

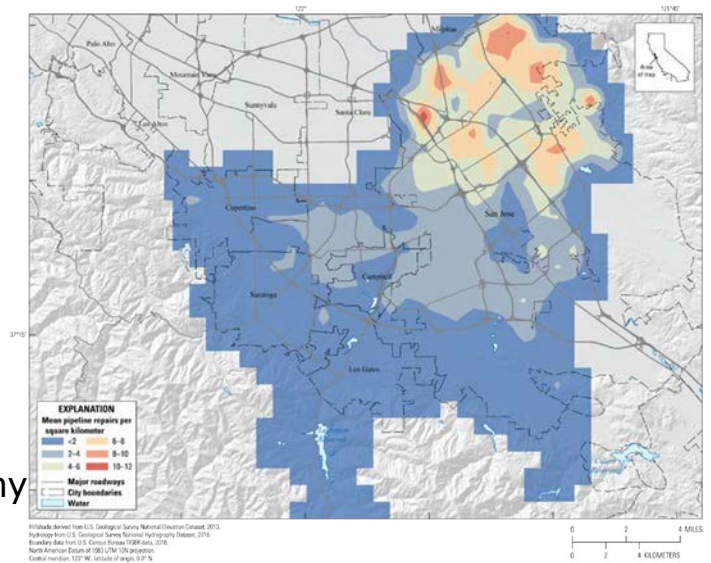


---

# The HayWired Scenario is Useful for Exercises

---

- Emphasizes the variety of physical, technological, and societal impacts associated with the multiple hazards and cascading impacts of such an event.
- Insights gained from exercising for an earthquake can help us to better meet other more frequent challenges.
- The Toolkit has been designed to help any organization plan, lead, and learn from discussion-based exercises.



Number of water pipeline repairs needed per square kilometer after the earthquake, in San Jose and nearby areas

17

---

# Toolkit Development Partners

---

As with the HayWired reports, partners from many organizations have helped to develop the Toolkit or provide feedback:

- United States Geological Survey (USGS)
- Federal Emergency Mgmt. Agency (FEMA)
- California Governor's Office of Emergency Services (CalOES)
- California Geological Survey
- Earthquake Country Alliance (ECA)
- Statewide California Earthquake Center (SCEC)
- California Resiliency Alliance (CRA)
- Association of Bay Area Governments
- Bay Area Council Economic Institute
- Joint Venture Silicon Valley
- Bay Area Center for Regional Disaster Resilience
- Pacific Earthquake Engineering Research Institute (PEERI)
- California Seismic Safety Commission

18

# Exercise Themes & Ideas

- The Toolkit identifies **30 Themes** addressed in the scenario, spanning **45 ideas** for discussion-based exercises, organized within each emergency management phase.
- Document symbols indicate **17 Facilitator Tools** based on the suggested ideas (**and soon 3 more!**)

	Planning and Preparedness	Response	Recovery	Mitigation
Access to Data & Information		29		39
Accounting for Employees		29		
Aftershocks & Fault Aftershocks			35	
Alternate Locations	23		36	
Building Content				39
Clean-up				39
Communications & Internet	23 & 24	29 & 30		
Customer Base			36	
Economic Impact			36	
Elevators		31		
Employee Commutes and Residences	24			
Employee Retention & Staffing Shortage		31	37	
Fires After the Earthquake				40
Fuel (Gasoline and Diesel)	24	31		
Generators	25			
Insurance			37	
Lifeline Infrastructure in Fault Zones				40
Mail   Package Delivery		32		
Mental Wellbeing			37	
Natural Gas	25	32		
Payroll	26			
Power (Electricity)	26	33	38	
ShakeAlert®	26			40
Shutting Off Utilities				41
Slow Return to Normal			38	
Structural & Non-Structural Building Damages				41
Supply Chain   Movement of Goods	27			41
Water	27	33 & 34		
Wastewater   Sewer	27	34		
Working Remotely	28			

19

# Facilitator Tools

- Each set of *Facilitator Tools* includes:
  - Discussion Guide*
    - Suggested exercise objectives
    - Recommended participants
    - Discussion questions to select from
    - Locations of relevant data in the Reports
  - Imagery Slideset*
    - Relevant maps, charts, and tables
- Facilitators can follow closely, or use as inspiration for their exercises



20

# Download and Learn More

- All materials are available at [EarthquakeCountry.org/haywired](https://EarthquakeCountry.org/haywired)

- **2024 Trainings and Outreach:**

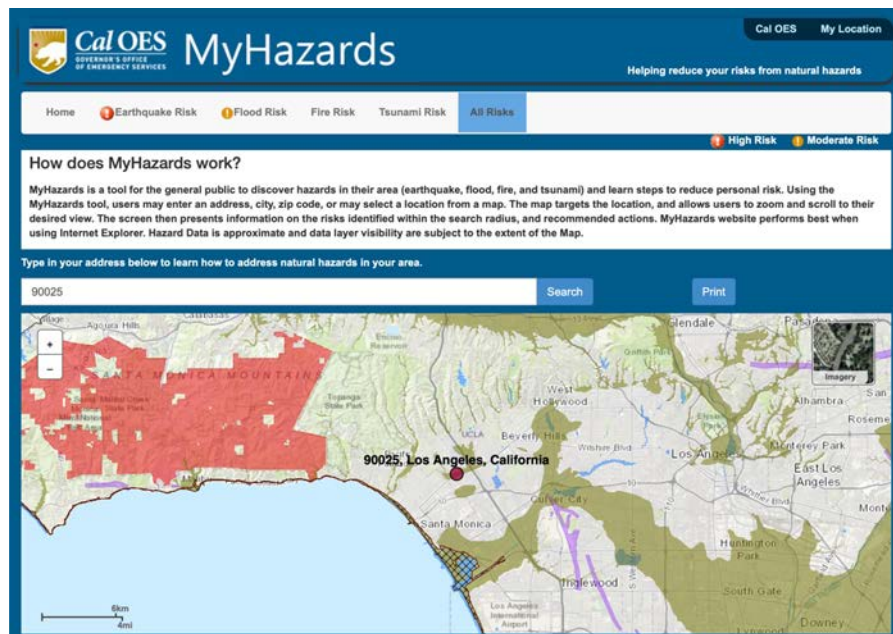
City of Newark – multiple trainings for small and large businesses (March 18-20)

We have support for several other workshops this Spring. Email [Benthien@usc.edu](mailto:Benthien@usc.edu) if you can host a workshop or know someone who may be interested.

Ideal audiences: Businesses, business associations, non-profits, government agencies, and others looking to improve planning and resilience.



# Know Your Hazards



[MyHazards.CalOES.ca.gov](https://MyHazards.CalOES.ca.gov)

## California Tsunami Maps and Data

- Updated tsunami hazard maps were updated using the best currently available scientific information.
- Maps assist the public and local governments in identifying their tsunami hazard for evacuation planning.
- Use the “find address” box to see if the areas you work, live, visit, or commute are in a Tsunami Hazard Area.

[tsunami.ca.gov/map](https://tsunami.ca.gov/map)

**County-Specific Page Links**

- Alameda [2021]
- Contra Costa [2021]
- Del Norte [2021]
- Humboldt [2021]
- Los Angeles [2021]
- Marin **UPDATED 2022**
- Mendocino [2021]
- Monterey [2021]
- Napa **UPDATED 2022**
- Orange [2021]
- San Diego **UPDATED 2022**
- San Francisco [2021]
- San Luis Obispo [2021]
- San Mateo [2021]
- Santa Barbara [2021]
- Santa Clara [2021]
- Santa Cruz **UPDATED 2022**
- Solano **UPDATED 2022**
- Sonoma **UPDATED 2022**
- Ventura **UPDATED 2022**

## California Tsunami Preparedness Week

- March 23-31, 2024
- Activities coordinated locally across the state
- Register your activities, similar to ShakeOut participation.
- Hold a “Tsunami Walk”
- Become a TsunamiReady Community
- Many ways to participate!

**WELCOME TO THE TSUNAMIZONE IN CALIFORNIA!**

You can register to participate in California's Tsunami Preparedness Week, March 27 - 31, in 2023. Learn [how to participate](#) by downloading and viewing [TsunamiZone](#) maps near you and even participating in a social media conversation about tsunamis - it's up to you. Remember, we're all in this together.

**Register your participation**

View [list of public events that have been submitted](#) (Note: this is not the same list as registered activities of individuals and organizations.)

**98,476** California participants and counting!

Click the map for details about each area.

Select an area to view resources for that location.

Over 190,000 participants registered

**CALIFORNIA RESOURCES**

- 1) CalOES MyHazards Tool**  
Learn more about the risks for tsunamis and other natural hazards (including earthquakes, floods, and fire) in your neighborhood, and how to reduce your risk at [MyHazards](#), a tool provided by the California [Department of Emergency Services](#).
- 2) CGS Tsunami Inundation Maps**  
California tsunami inundation maps show where areas on land can become quickly flooded from a tsunami's waves. [Tsunami hazard maps](#) are intended to be used to help people plan how they can get from dangerous areas to safe areas by showing where high, safe ground is located. These maps can be used by anyone to plan a safe evacuation route. You can [practice](#) walking out of the tsunami zone to be better prepared for a real tsunami. CGS has also developed an easy-to-use [California Tsunami Preparedness Guide](#) for the

[TsunamiZone.org/california](https://tsunami.org/california)

---

# Q&A

To be notified of future events and recordings, join ECA (free!):

[EarthquakeCountry.org/join](https://EarthquakeCountry.org/join)

Questions? [info@earthquakecountry.org](mailto:info@earthquakecountry.org)

---

25

---

## **Bay Area CERT Coalition**

***Sandra Firpo***

*San Mateo Consolidated Fire Department*

---

26



# BAY AREA CERT COALITION (BACC)

CHECK OUT: [WWW.BAYAREACERTCOALITION.ORG](http://WWW.BAYAREACERTCOALITION.ORG)

WELCOME TO BURLINGAME, CA

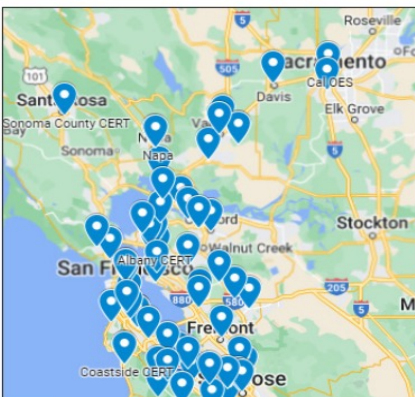


The Bay Area CERT Coalition or BACC is a regional gathering of CERT Program Managers and Coordinators from approximately 74 CERT Programs around the Bay Area.

BACC was founded in 2017 by enthusiastic CERT Program Managers who formed this wonderful organization which has become a resource and support for CERT organizers around the Bay. Each meeting features a guest speaker and an update on CERT throughout the state. Opportunities, needs, and training techniques are often discussed and shared.

BACC meets quarterly, and its current Co-Chairs are Danielle Bell of San Ramon Fire and Sandra Firpo of San Mateo Consolidated Fire.

The Bay Area CERT Coalition is delighted to welcome CERT members from all over the USA as you visit Northern California during the 2023 National CERT Conference!



To learn more, please visit [www.bayareacertcoalition.org](http://www.bayareacertcoalition.org)

A map of the CERT Programs in the Bay Area (and a bit beyond) - members of the Bay Area CERT Coalition (BACC)

## About BACC

A regional group of CERT Program Managers and Coordinators, supporting one another and helping build a culture of preparedness across the Bay Area!



A SPECIAL THANKS

TO OUR PARTNERS, SPONSORS,  
AND EXHIBITORS



**Cal OES**  
GOVERNOR'S OFFICE  
OF EMERGENCY SERVICES



**MERIT**  
**momentum.**  
refresh



# BACC & National CERT Conference 2023

BACC was instrumental in getting the bid to host the National CERT Conference in the Bay Area.

- 1000 attendees
- 42 States
- Workshops, Training, Displays, Vendors, Fun!

32

29

# NATIONAL CERT CONFERENCE 2023

HELD IN BURLINGAME  
NORTHERN CALIFORNIA



**Searchable Map and Info on BACC Website**

**OVER 70 CERT PROGRAMS AROUND THE BAY AREA ARE CONNECTED WITH BACC**

31

**Support**  
Provide support and resources for fellow Program Managers and Coordinators.

**Inform**  
Keep all Programs on track with reliable and current information.

**Empower**  
Empower our colleagues to provide the best CERT Programs possible!

**Be Part of the Solution**

BACC strives to help CERT Programs provide strong, accurate information and training throughout the Bay Area.

32



# Volunteer Leadership Team



Danielle Bell  
BACC Co-Chair

Emergency Coordinator and  
CERT Program  
Manager with the San  
Ramon Valley Fire  
Protection District



Sandra Firpo  
BACC Co-Chair

Emergency Services  
Specialist and CERT Program  
Manager for San Mateo  
Consolidated Fire  
Department



Kam McCowan  
Recording Secretary

Volunteer CERT Coordinator  
for Woodside Portola Valley  
Fire Protection District

Reach us all via email at: [Leadership@bayareacertcoalition.org](mailto:Leadership@bayareacertcoalition.org)



## Summary

[www.bayareacertcoalition.org](http://www.bayareacertcoalition.org)

[Leadership@bayareacertcoalition.org](mailto:Leadership@bayareacertcoalition.org)

- BACC meets Quarterly – currently on Zoom.
- Next meeting is May 8th.
- If you have a CERT Program Manager or Coordinator who should be on these meetings – please send contact info to:

[Leadership@bayareacertcoalition.org](mailto:Leadership@bayareacertcoalition.org)



**BAY AREA**  
**CERT**  
**COALITION**  
COMMUNITY EMERGENCY  
RESPONSE TEAM

**THANK YOU**

Sandra Firpo   
+1 (650) 522-7963   
Leadership@bayareacertcoalition.org   
www.bayareacertcoalition.org 

35

35

# Q&A

To be notified of future events and recordings, join ECA (free!):  
[EarthquakeCountry.org/join](https://EarthquakeCountry.org/join)

Questions? [info@earthquakecountry.org](mailto:info@earthquakecountry.org)

36

---

# Slow Slip and Earthquake Potential Along the Hayward Fault

**Prof. Roland Bürgmann**  
*UC Berkeley Seismology Laboratory*

---

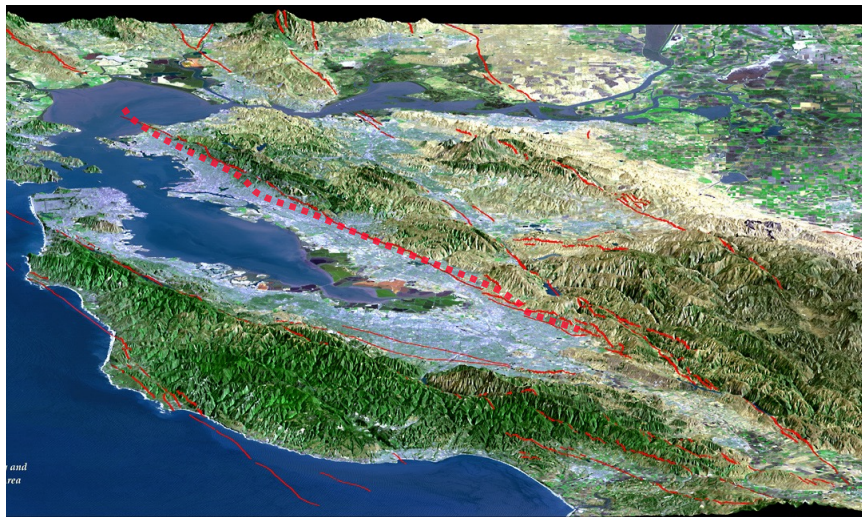
37

---

## Slow Slip and Earthquake Potential Along the Hayward fault

Roland Bürgmann

With Manoochehr Shirzaei, Taka'aki Taira, Kaj Johnson, Mostafa Khoshmanesh, Yifang Cheng, and more



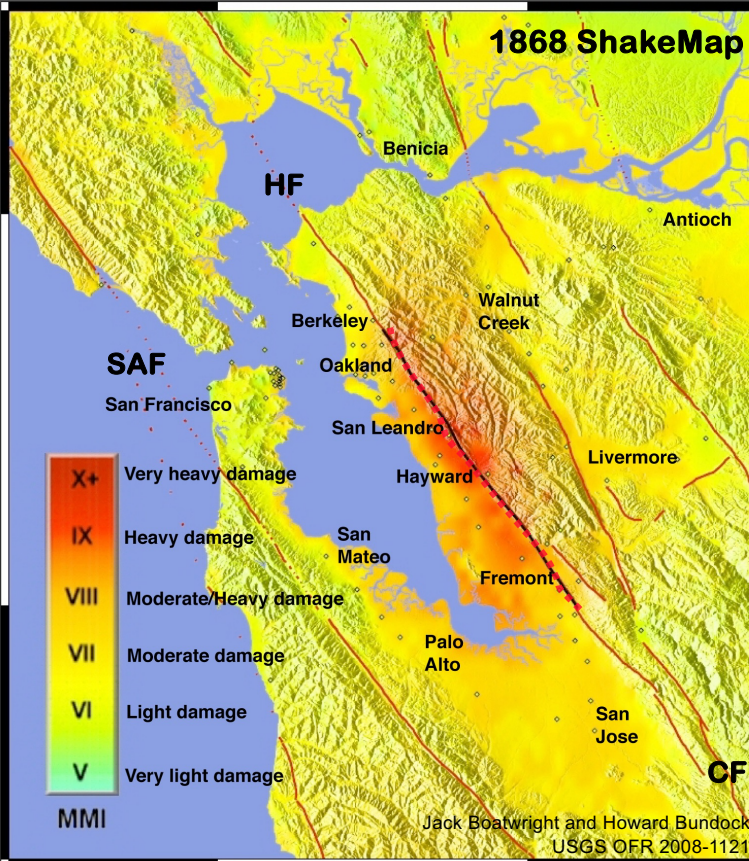
38

# October 21, 1868, $M \approx 7$ "Great San Francisco Earthquake"



The event was called the "Great San Francisco Earthquake" only until 1906....

39



## "The Great 1868 San Francisco Earthquake"

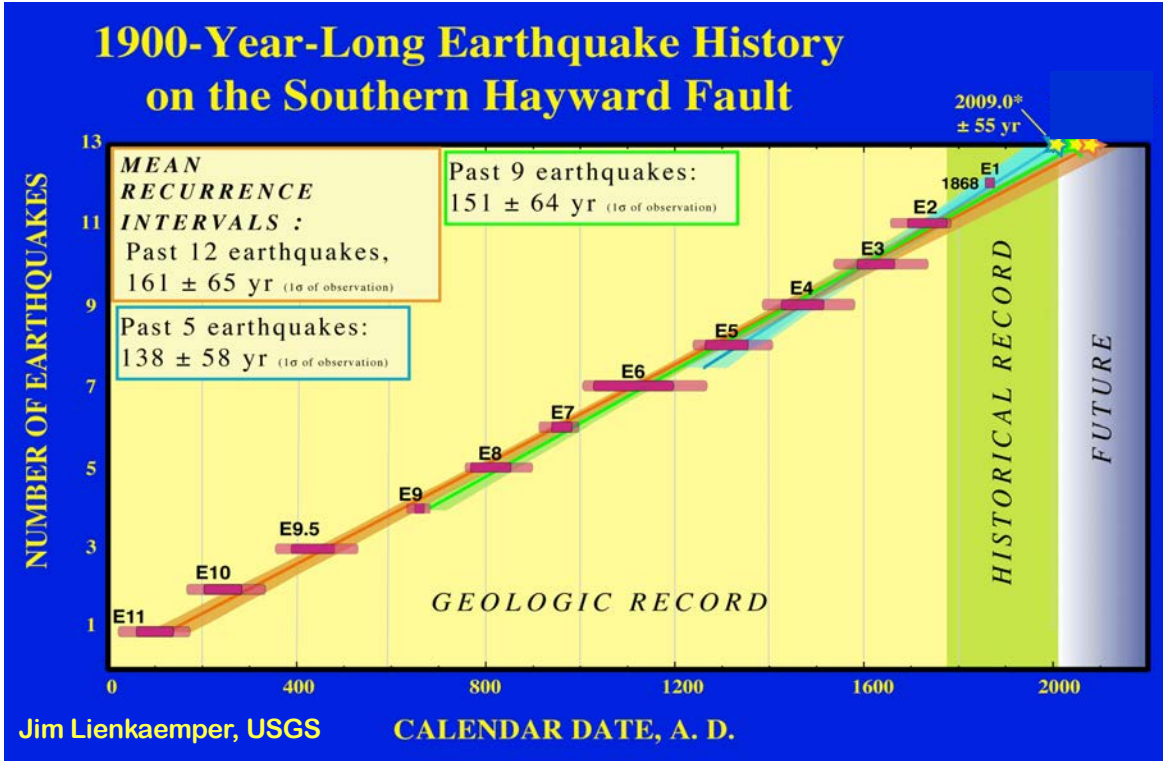
Magnitude 6.7 - 7,  
surface rupture from  
Fremont to Oakland

30 deaths (7th most  
deadly California  
earthquake)

Bay Area population was  
~260,000 (at ~8 million,  
it is now ~30 \* larger)

40

> 155 Years Later and ~150-year Recurrence



41

# HayWired

**The HayWired Earthquake Scenario— April 18, 2018**

## WE CAN OUTSMART DISASTER

**The HayWired Earthquake Scenario— WE CAN OUTSMART DISASTER**

The HayWired earthquake scenario, led by the U.S. Geological Survey (USGS), anticipates the impacts of a hypothetical magnitude-7.8 earthquake on the Hayward Fault. The fault is along the east side of California's San Francisco Bay and is among the most active and dangerous in the United States, because it runs through a densely urbanized and interconnected region. One way to learn about a large earthquake without experiencing it is to conduct a scientifically realistic scenario. The USGS and its partners in the HayWired Coalition and the HayWired Campaign are working to energize residents and businesses to engage in ongoing and new efforts to prepare the region for such a future earthquake.

This map of the San Francisco Bay region, California, shows simulated ground shaking caused by the hypothetical magnitude-7.8 earthquake on the Hayward Fault. Red shows the most severe ground shaking and where damage is the worst. The earthquake begins beneath the City of Oakland (star) and causes the Hayward Fault to rupture along about 52 miles of its length (thick black line). White lines are other major faults in the region.

<https://pubs.er.usgs.gov/publication/fs20183016>

Prepared in cooperation with the California Geological Survey

**The HayWired Earthquake Scenario—Earthquake Hazards**

Scientific Investigations Report 2017–5013–A–H

**The HayWired Earthquake Scenario—Engineering Implications**

Scientific Investigations Report 2017–5013–I–0

42

---

## Surface Creep All Along the Hayward Fault!

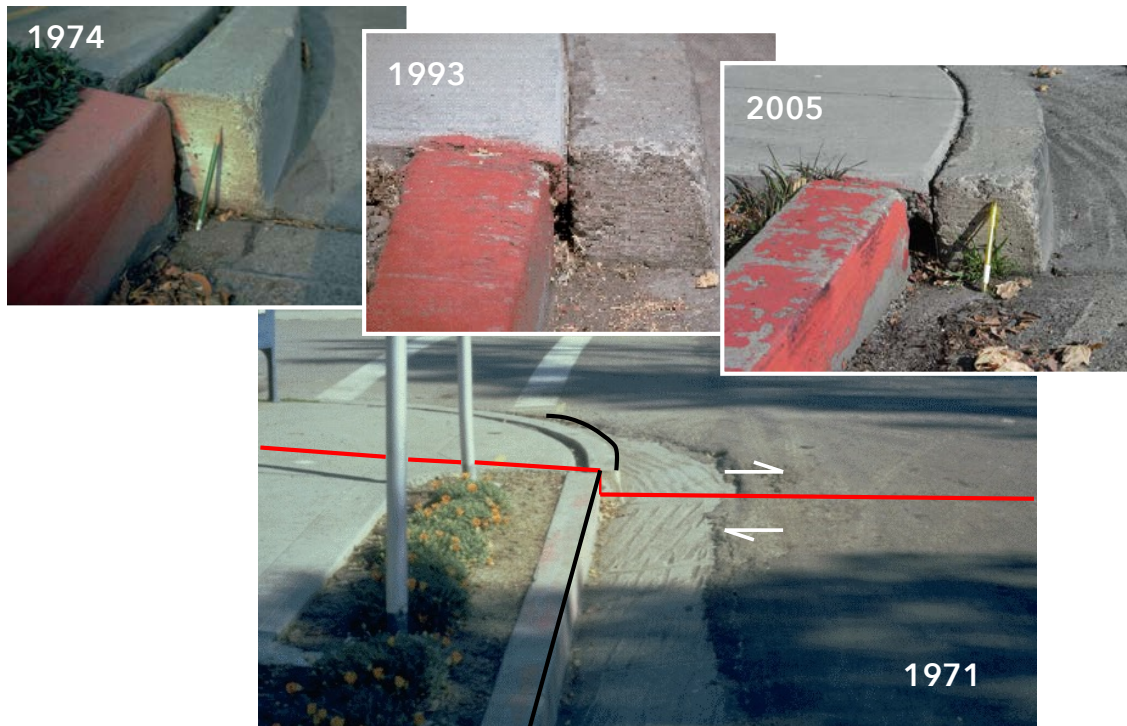


---

43

---

## Surface Creep at Rose Street in Hayward



<http://www.mcs.csuhayward.edu/~shirschf>

---

44

---

## Surface Creep at Rose Street in Hayward



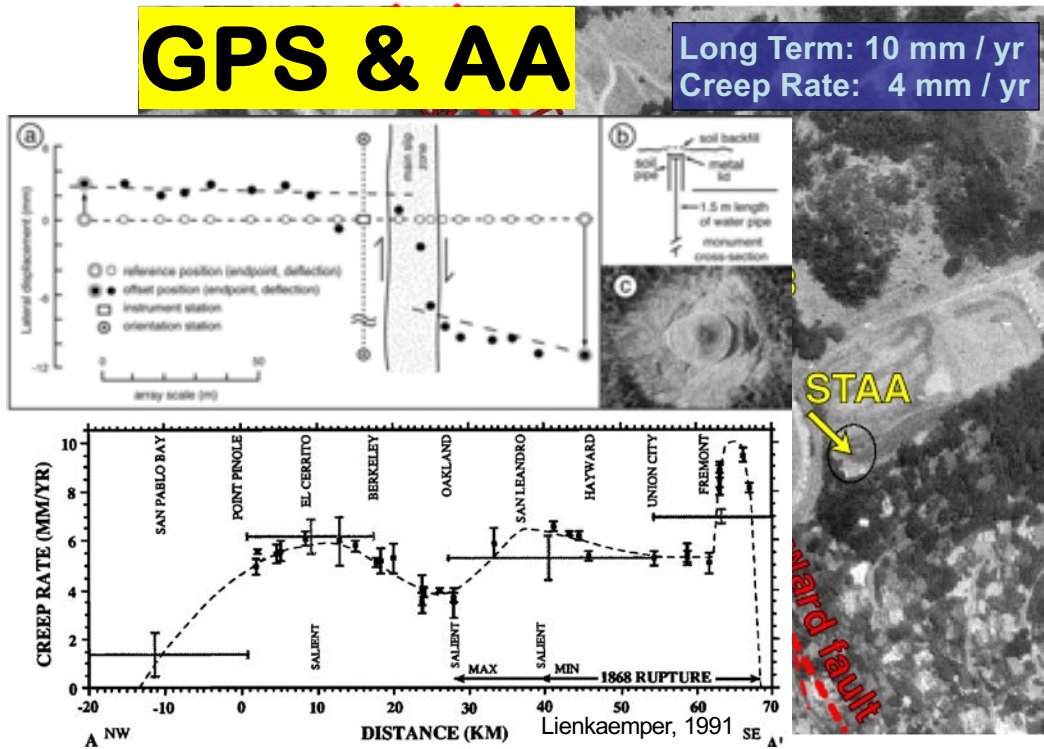
EPS020 student Dahlia Catherine Miner Kapelke

---

## Hayward Fault Creep at Cal Memorial Stadium

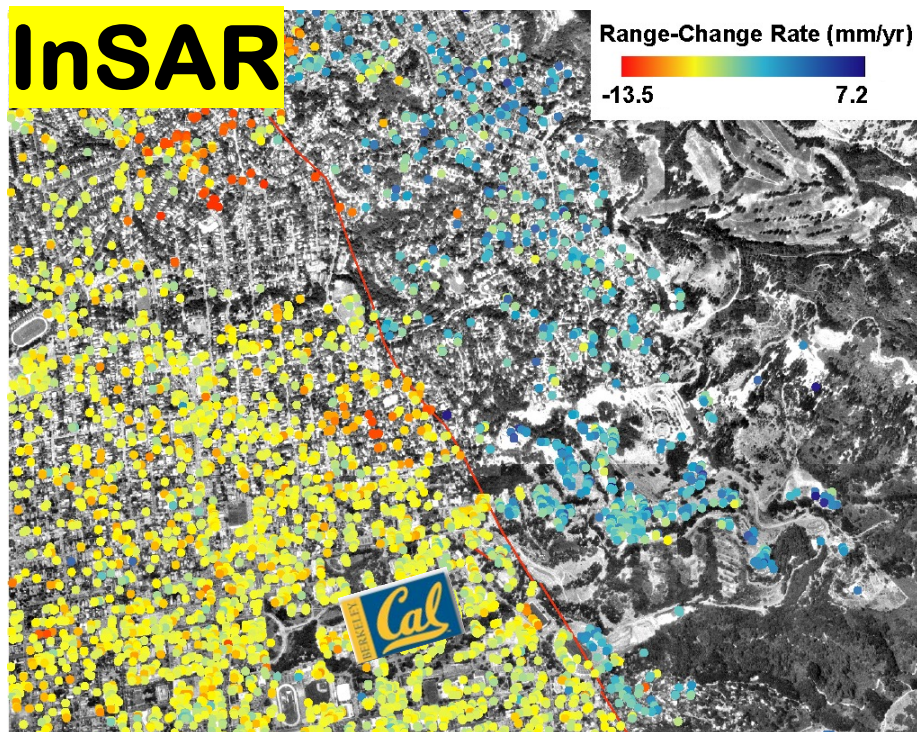


## Hayward Fault Creep at Cal Memorial Stadium



47

## Creep All Along the Hayward Fault From Space

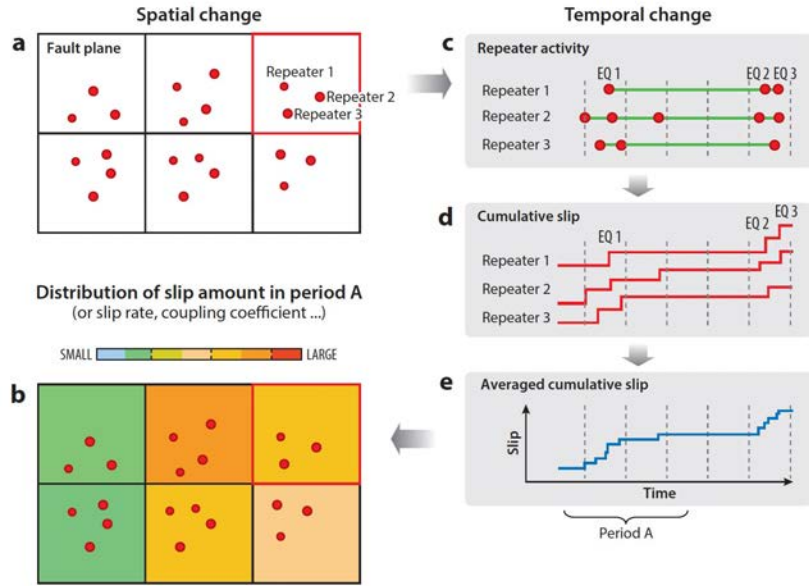


48



# Creep on The Hayward Fault From Repeaters

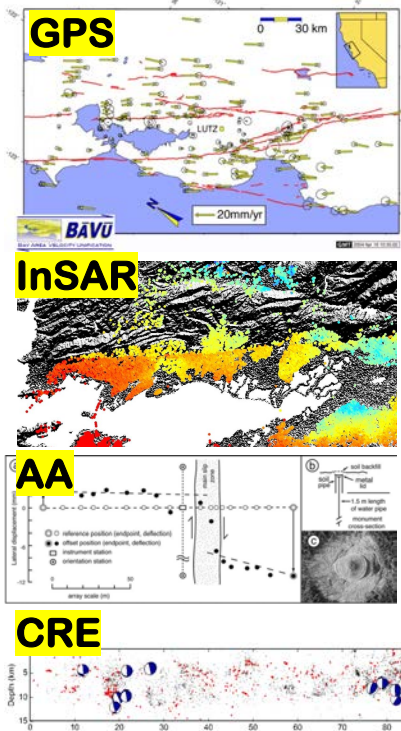
**CRE**



Uchida & Bürgmann, 2019 AREPS

49

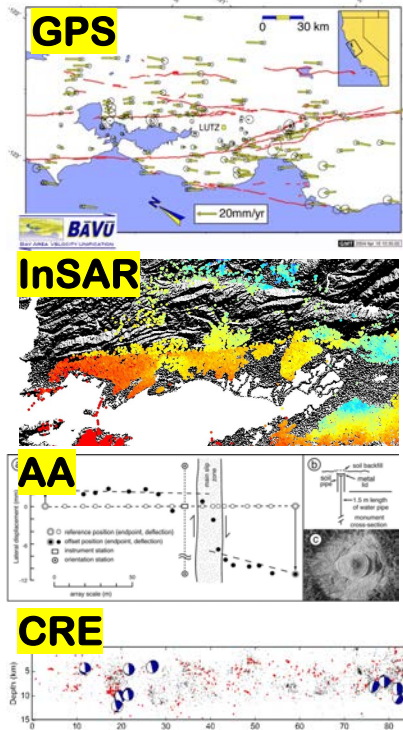
# Mapping Surface Deformation to Fault Creep at Depth



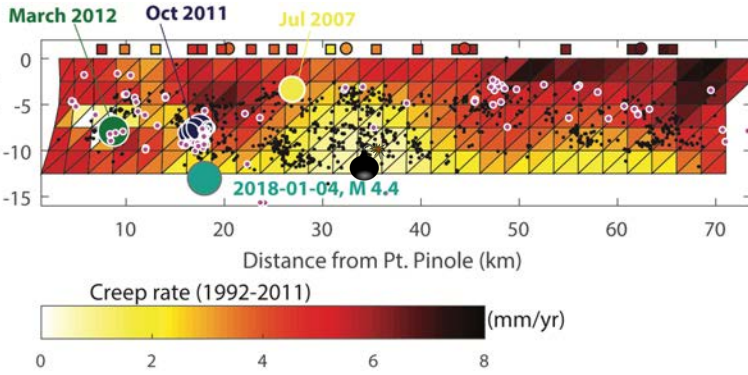
Input: Slip Constraints

50

# Mapping Surface Deformation to Fault Creep at Depth

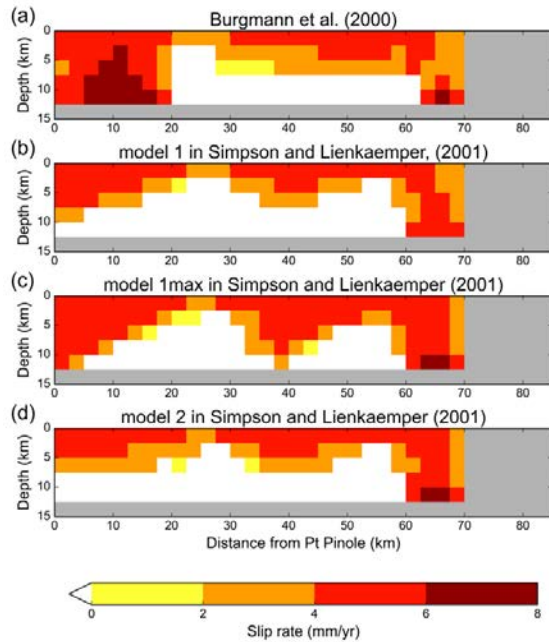


Input: Slip Constraints  
 Output: Interseismic Fault Creep/Coupling

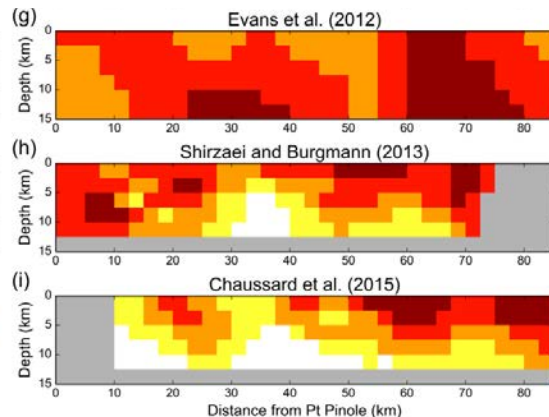


Shirzaei & Bürgmann, 2013

# Mapping Surface Deformation to Fault Creep at Depth



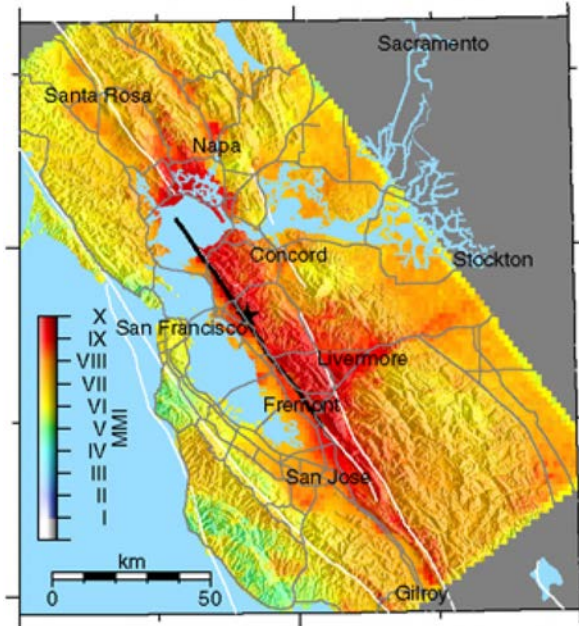
Slip deficit rises at ~M 6.8/100yr  
 Recurrence interval ~150 yr  
 → High earthquake hazard!  
 UCERF Forecast: 33 % of  $M \geq 6.7$  by 2043



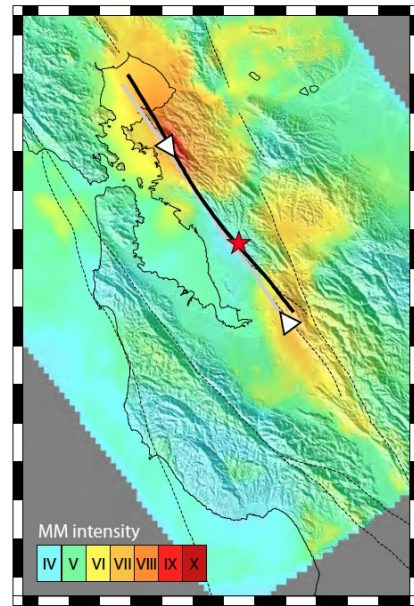
Yifang Cheng, unpublished compilation (2023)

# Fault Creep Affects Shaking Hazard

Creep Neglected, Mw 7.12



No rupture on creeping parts  $M_w$  6.82

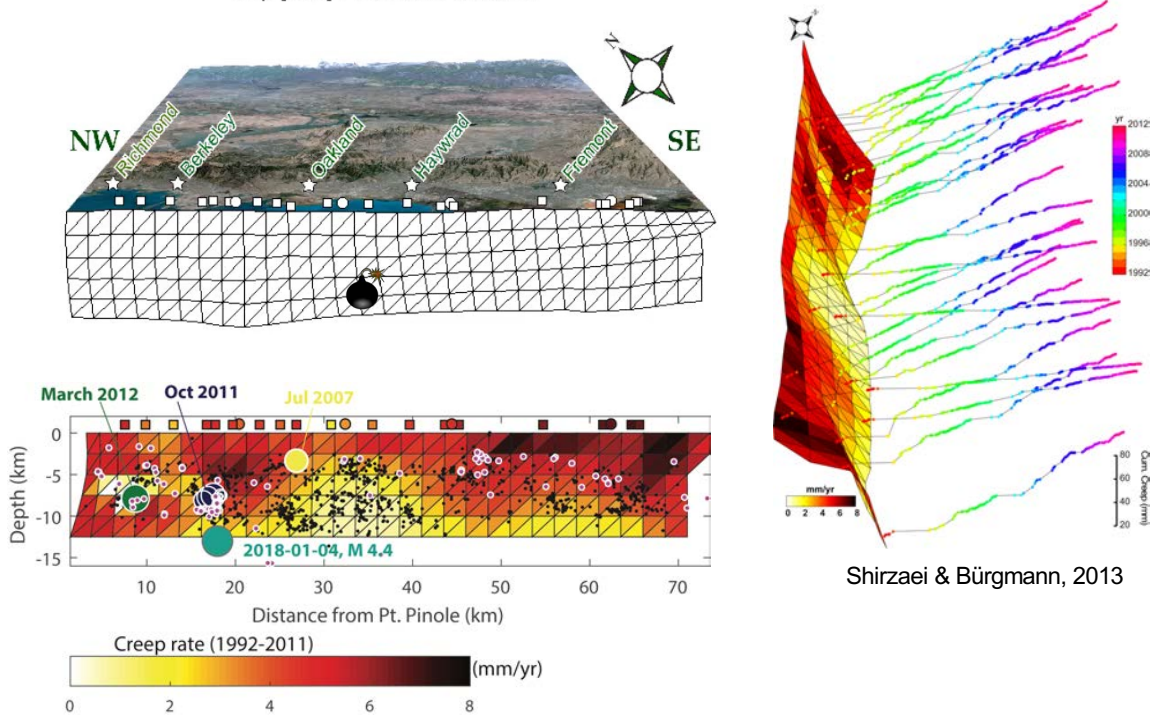


B. Aargard et al., 2010

53

# Will There be Warning Signs?

Slip [mm] : 1992/5/6-1992/5/6

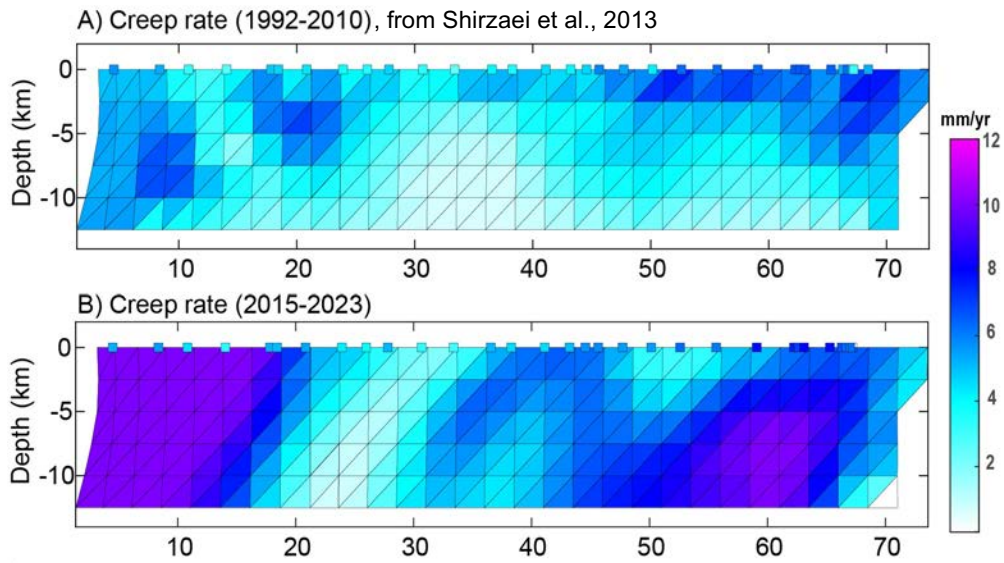


Shirzaei & Bürgmann, 2013

54

# InSAR Decadal Creep-rate Changes From InSAR

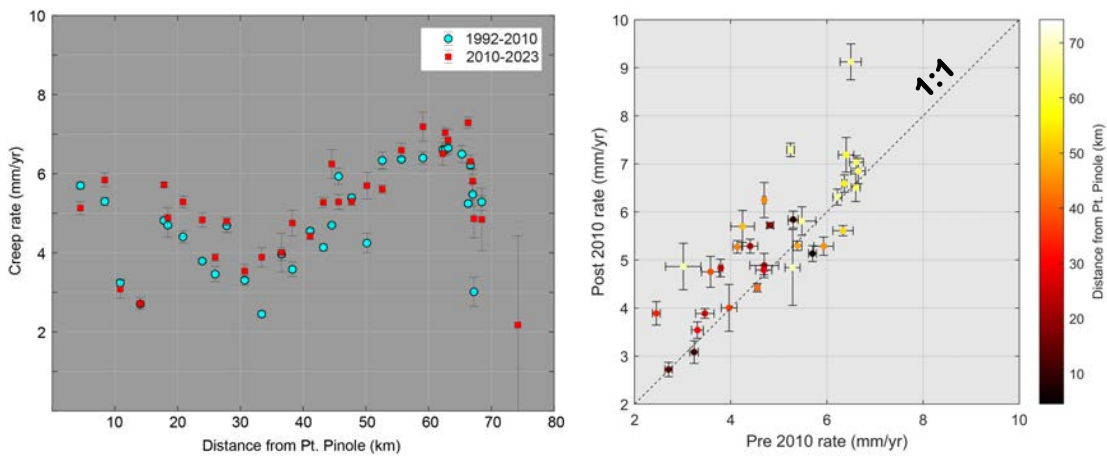
## 1992 – 2010 ERS & Envisat vs. 2015 – 2023 Sentinel-1



55

# AA Decadal Creep-rate Changes From Field Data

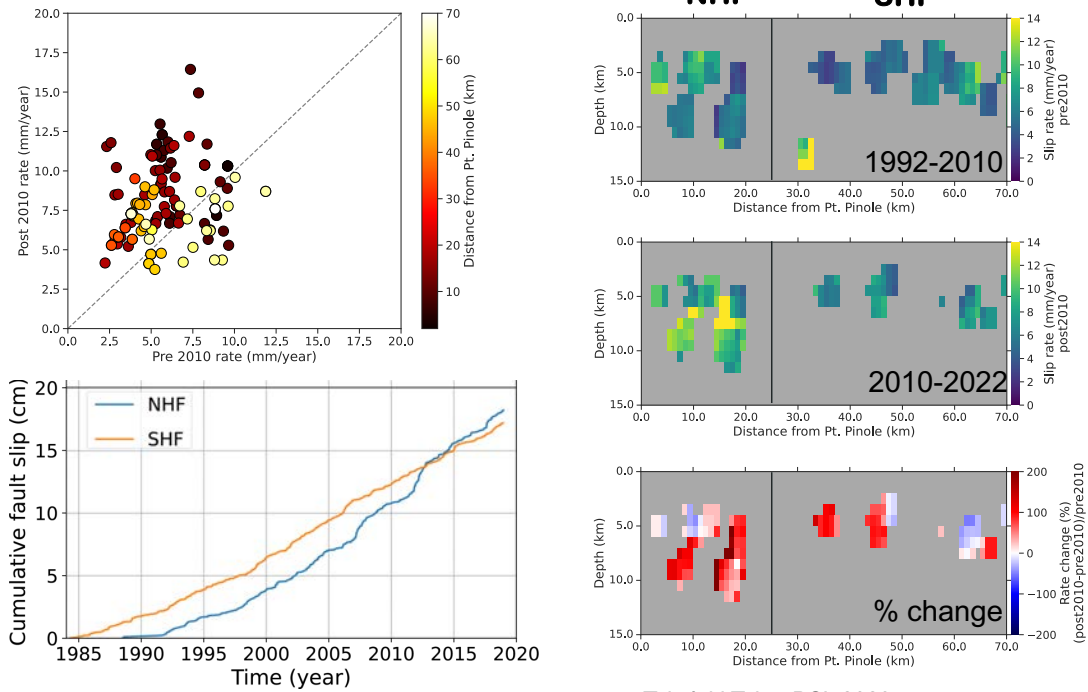
## 1992 – 2010 vs. 2010 – 2022 alignment array data



Alignment Array data from McFarland, Lienkaemper, Caskey, and Elliot, 2017  
U.S. Geological Survey data release (ver. 2.1, October 2022)

56

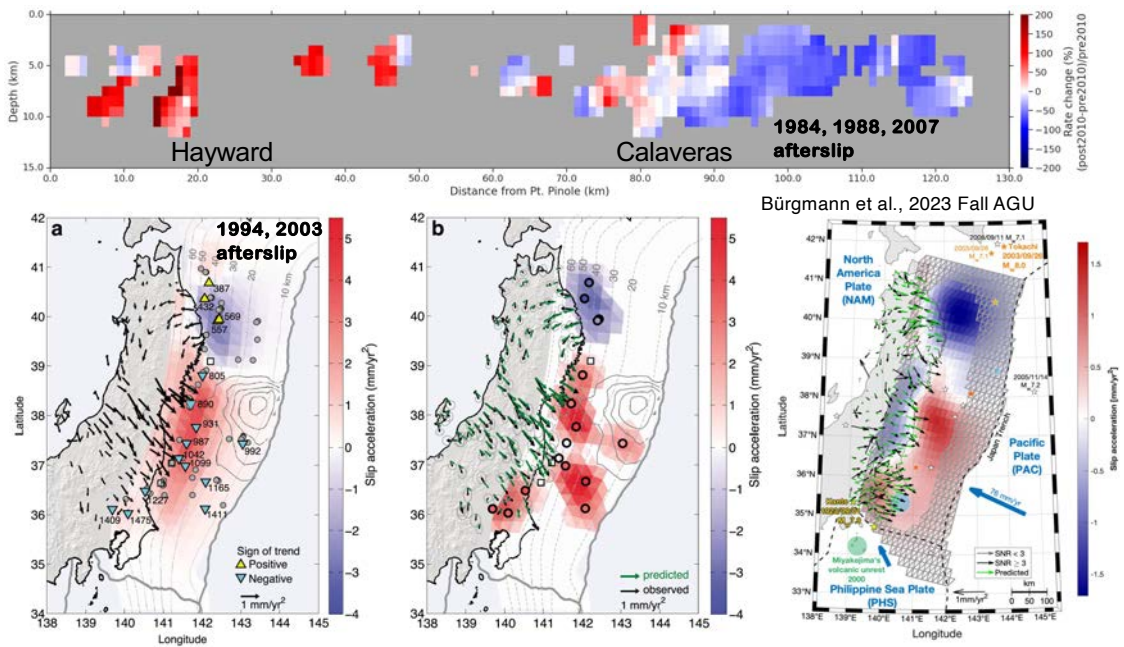
# CRE Decadal Creep-rate Changes From Repeaters



Taka'aki Taira, BSL 2023

57

## Decadal acceleration on Hayward Fault is reminiscent of 1996 -2011 acceleration of Japan Trench megathrust slip

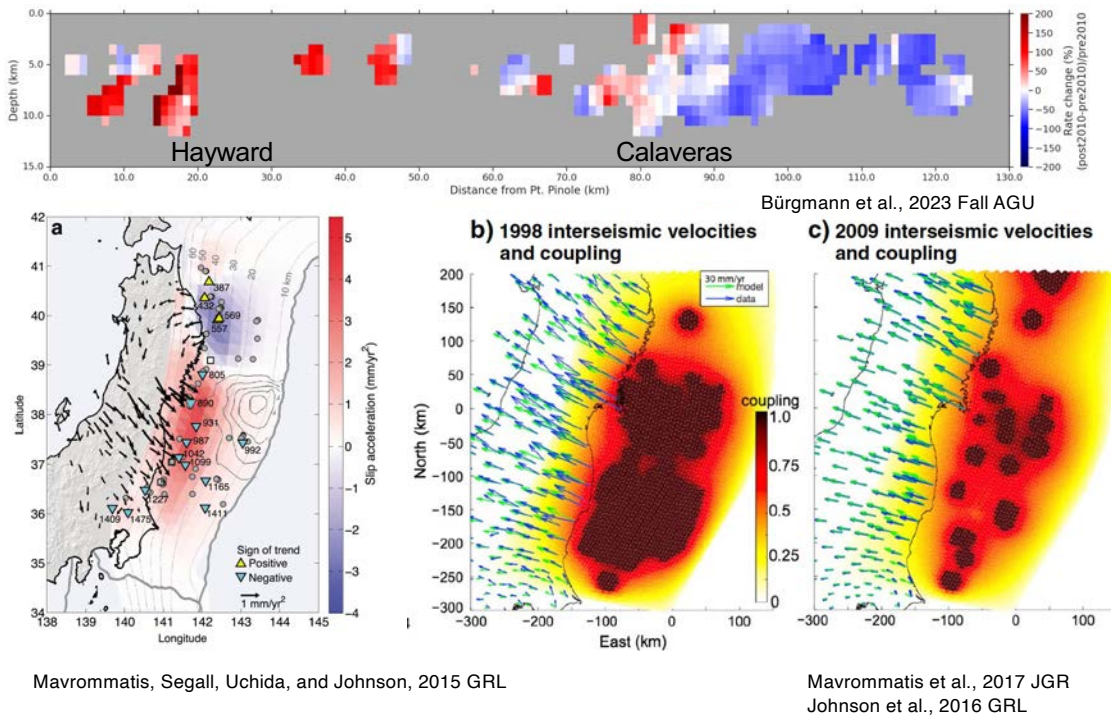


Mavrommatis, Segall, Uchida, and Johnson, 2015 GRL

Marill et al., 2021 JGR

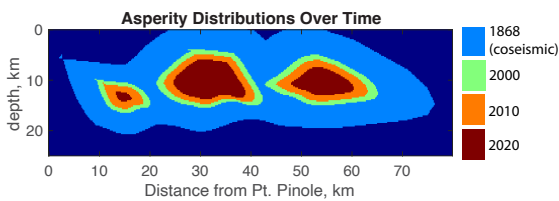
58

## Decadal acceleration due to interseismic asperity shrinking?



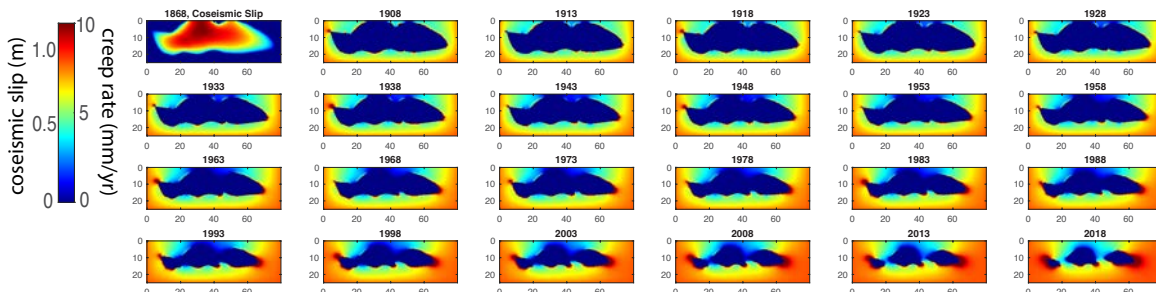
59

## Shrinking Asperity Model for Hayward Fault



- Coseismic slip imposed over initial asperity area with applied stress drop distribution
- Asperities shrink following fracture mechanics model of Cattania and Segall (2019)
- Creep rate is solved for over incremental “crack growth” boundary element calculations

### 1868 – 2018 snapshots of interseismic creep rate (mm/yr)

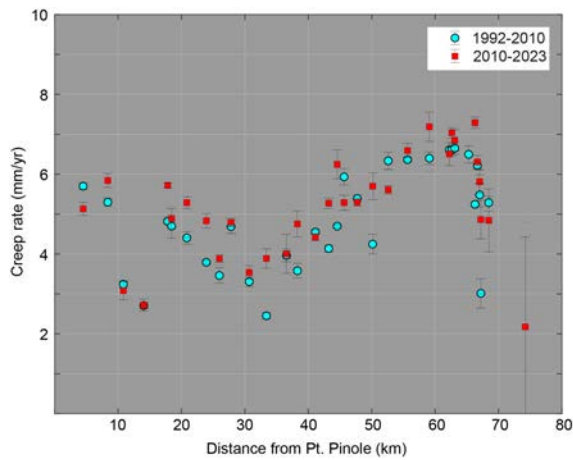


Kaj Johnson, 2023

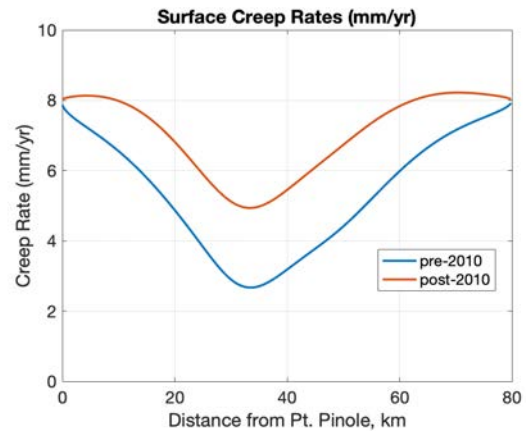
50

## Comparison of Surface Creep From AA Data and Model

### 1992-2010 vs. 2010-2022 surface creep rates from alignment array data



### Model surface creep rates

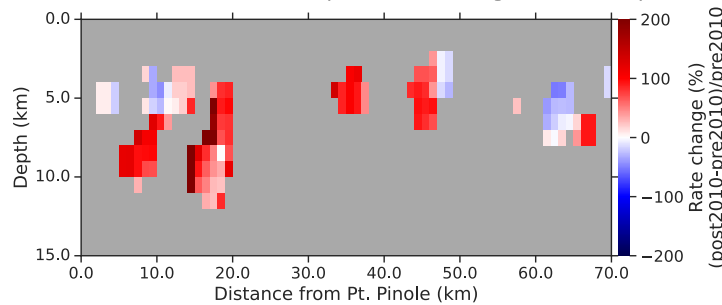


Alignment Array data from McFarland, Lienkaemper, Caskey, and Elliot, 2017  
U.S. Geological Survey data release (ver. 2.1, October 2022)

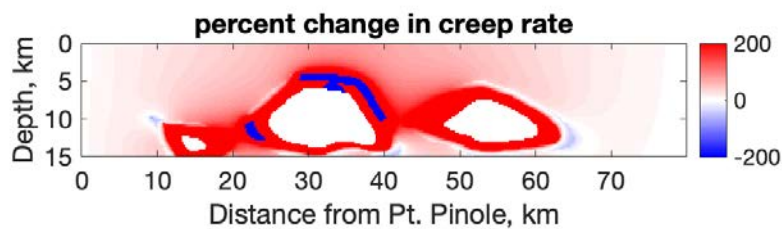
51

## Comparison of Creep Rate Changes from Repeating Earthquakes and Model

### Pre-2010 vs. Post-2010 creep rate change from repeating earthquakes



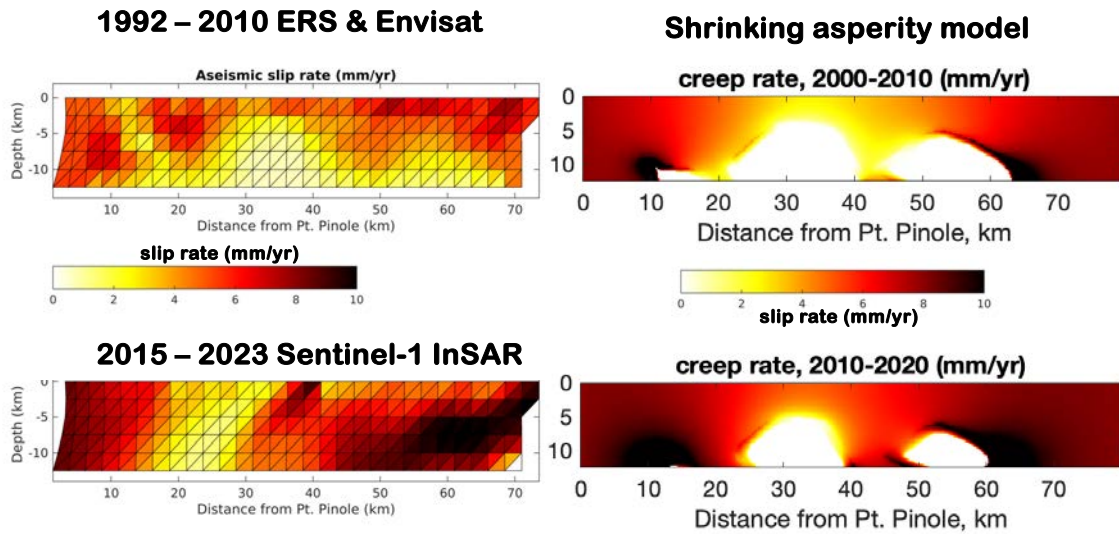
### 2000-2010 vs. 2010-2020 creep model rate change



52

---

## Comparison of Geodetic Inversions with Model Creep Rates



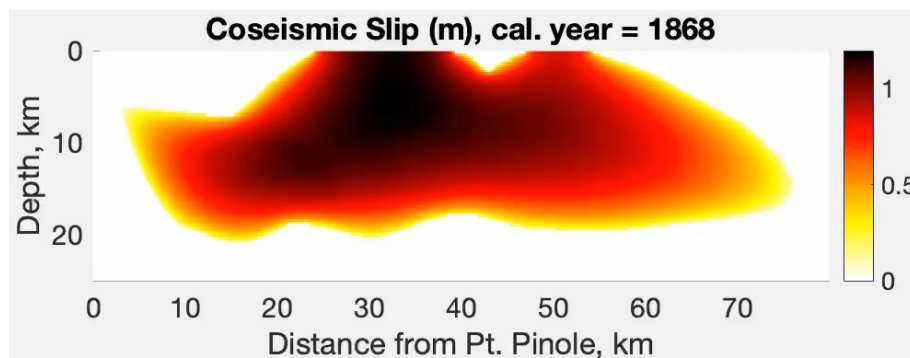
---

53

---

## Slow Slip and Earthquake Potential Along the Hayward fault

- Aseismic creep on Hayward fault reduces earthquake potential but does not substantially decrease the hazard
- We find decadal accelerations in fault creep rate on the Hayward fault from InSAR, surface creep and repeating earthquakes
- These decadal creep-rate changes may reflect continued interseismic shrinking of rupture asperities



---

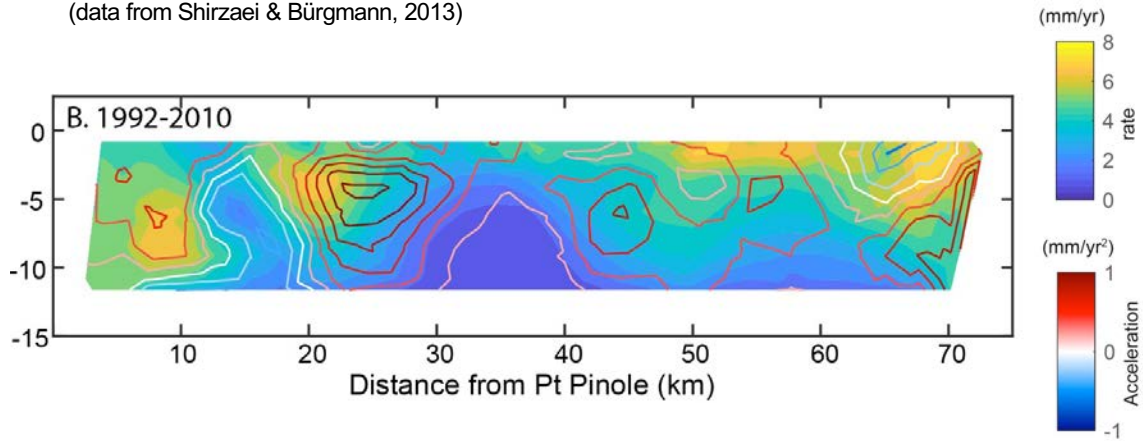
54



## Spatio-temporal variations of creep from InSAR

### ERS & Envisat InSAR Acceleration (1992 – 2010)

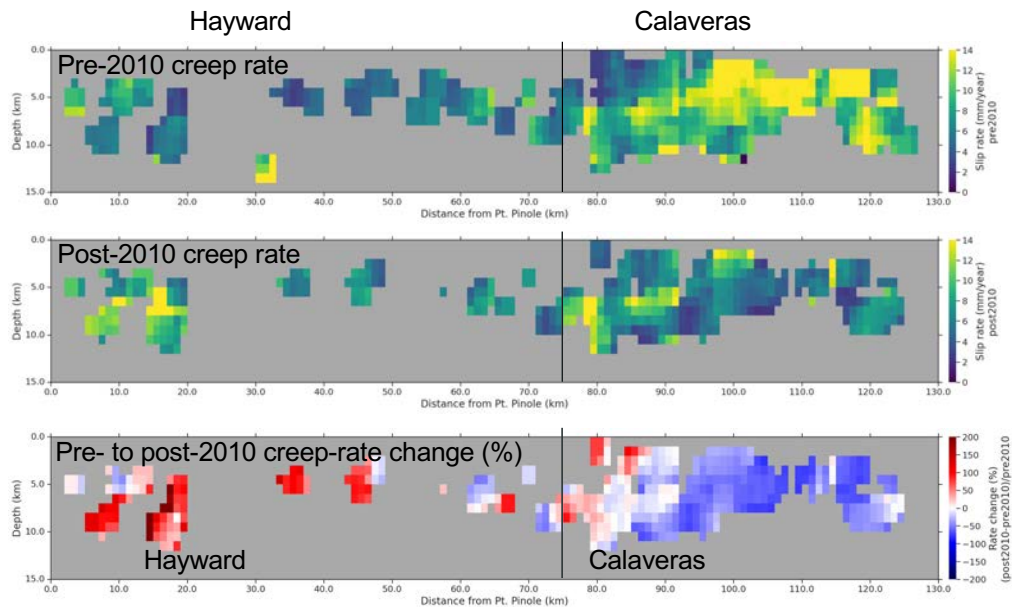
(data from Shirzaei & Bürgmann, 2013)



55

## Spatio-temporal variations of creep from CREs

### 1992 – 2010 vs. post-2010 creep rate from repeating earthquakes

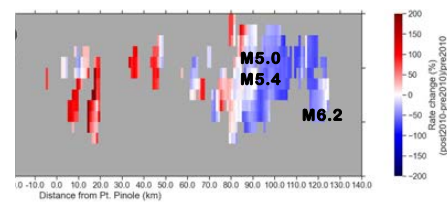
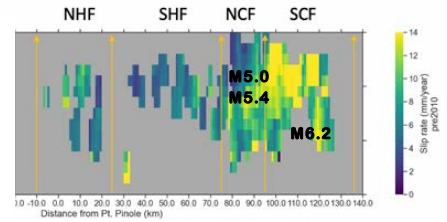
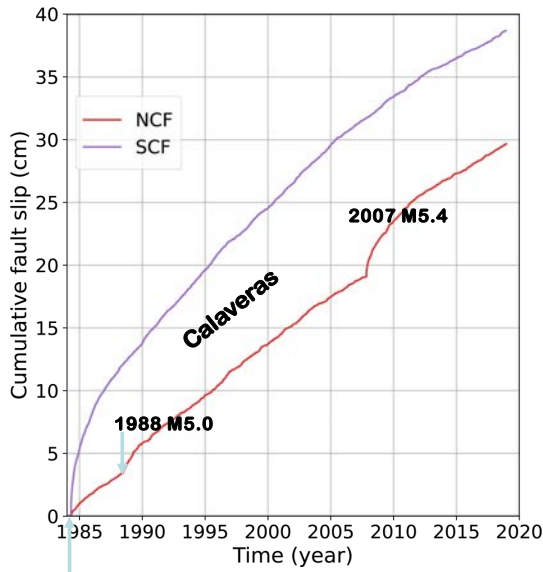


Shirzaei, Khoshmanesh, Taira and Bürgmann, in prep.

56

# Calaveras fault deceleration due to enduring afterslip

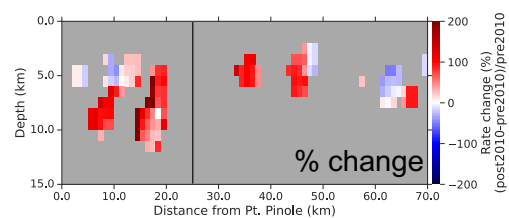
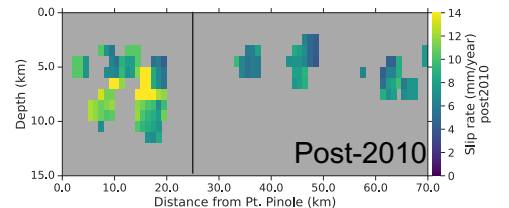
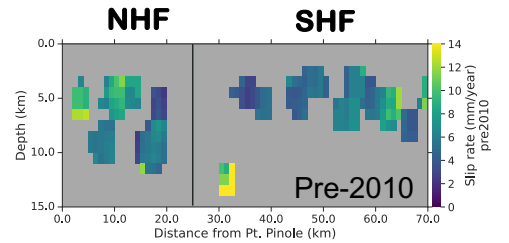
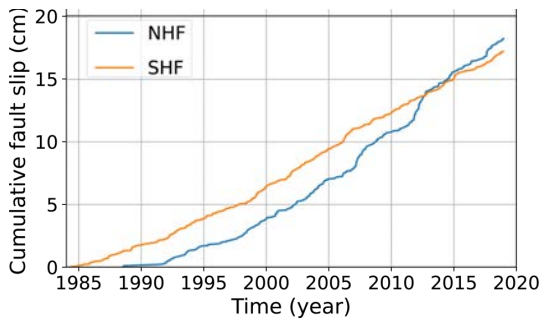
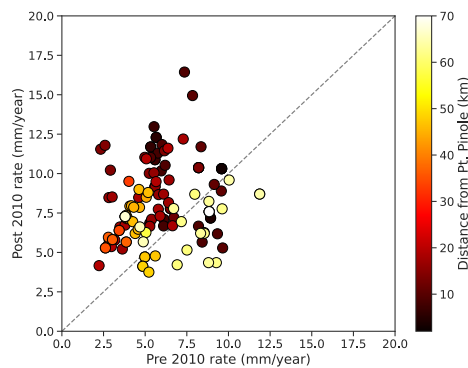
## 1992 – 2010 vs. post-2010 creep rate from repeating earthquakes



Shirzaei, Khoshmanesh, Taira and Bürgmann, in prep.

57

# Hayward fault acceleration due to ???

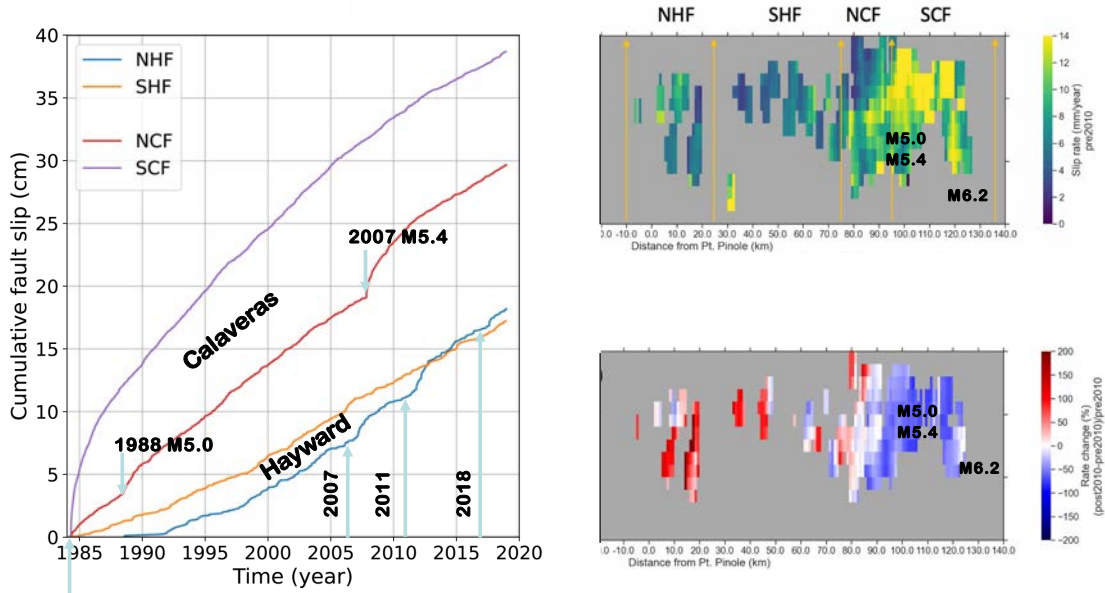


Taka'aki Taira, 2023 unpublished

58

# Spatio-temporal variations of creep and coupling on the Hayward fault at decadal time scales?

## Cumulative HF and CF slip from 1985 to 2020

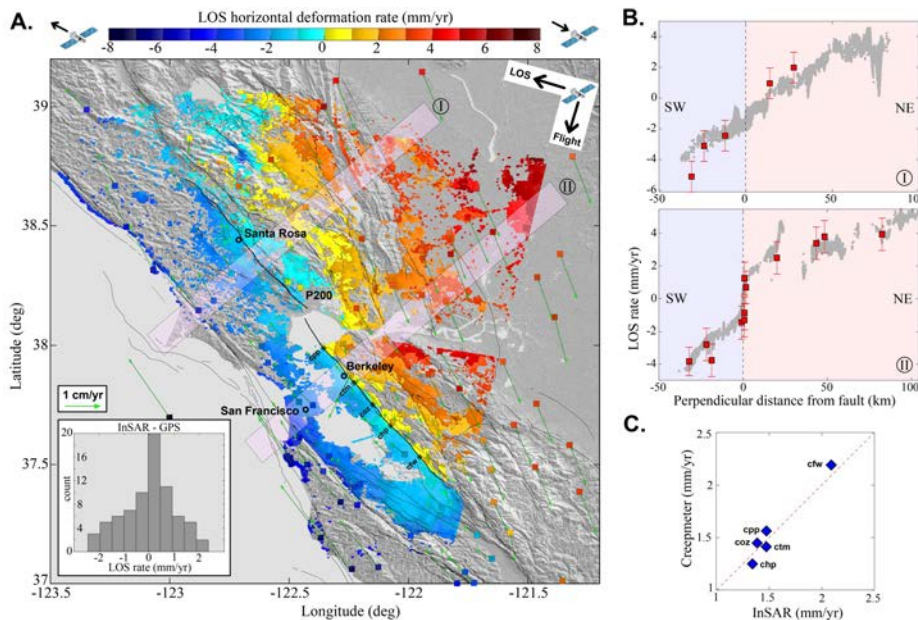


1984 M6.2  
Shirzaei, Khoshmanesh, Taira and Bürgmann, in prep.

59

# Spatio-temporal variations of creep and coupling on the Hayward fault at decadal time scales?

## 2015 – 2022 Sentinel-1 InSAR

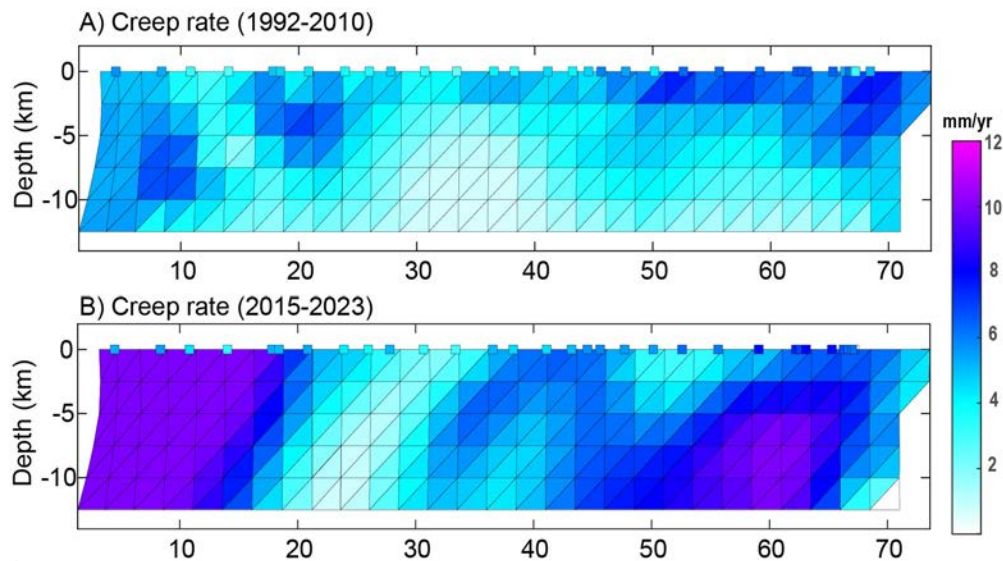


Shirzaei, Khoshmanesh, Taira and Bürgmann, in prep.

70

# Spatio-temporal variations of creep and coupling on the Hayward fault at decadal time scales?

## 1992 – 2010 ERS & Envisat vs. 2015 – 2022 Sentinel-1 InSAR

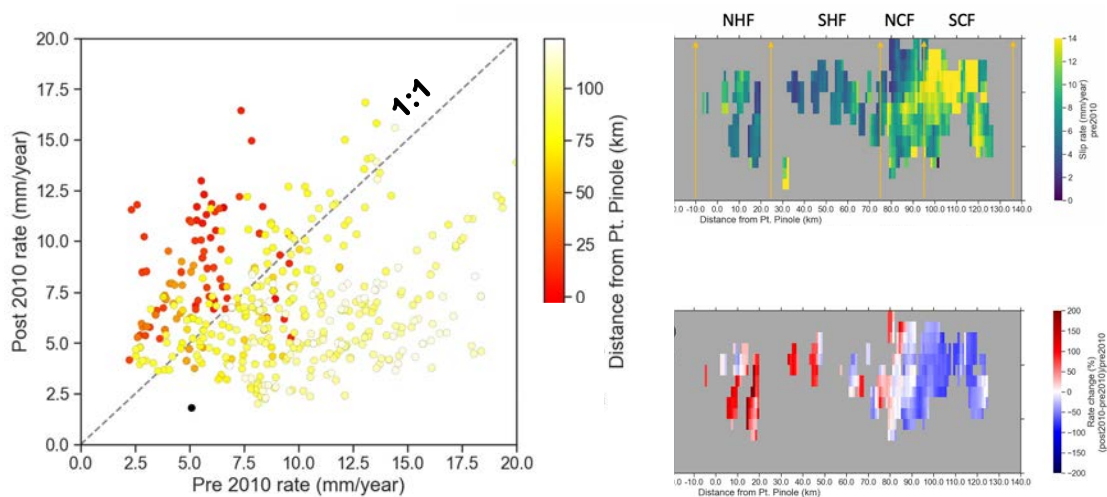


Shirzaei, Khoshmanesh, Taira and Bürgmann, in prep.

71

# Spatio-temporal variations of creep and coupling at decadal time scales?

## 1992 – 2010 vs. post-2010 creep rate from repeating earthquakes

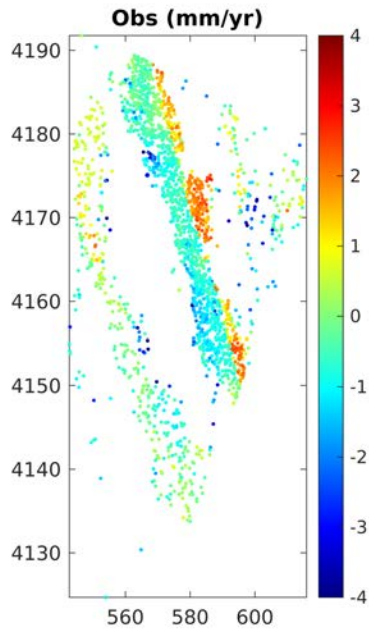


Shirzaei, Khoshmanesh, Taira and Bürgmann, in prep.

72

---

## Creep Inversion Procedure, Identical to Shirzaei & Bürgmann 2013



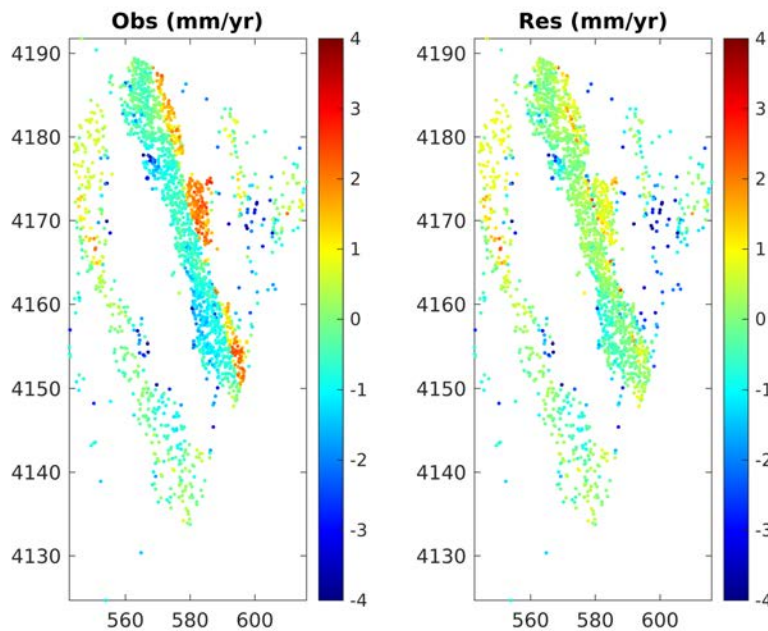
- Hayward fault mesh same as SB-2013.
- Descending S1 sampled at location of Envisat-ERS data.
- Regional trend of the displacement field due to steady plate-boundary deformation is simulated and subtracted using a model of 14 deep dislocations (Table A1; see also Table DR1 in Bürgmann et al., [2006])
- .....

---

73

---

## Creep Inversion Results

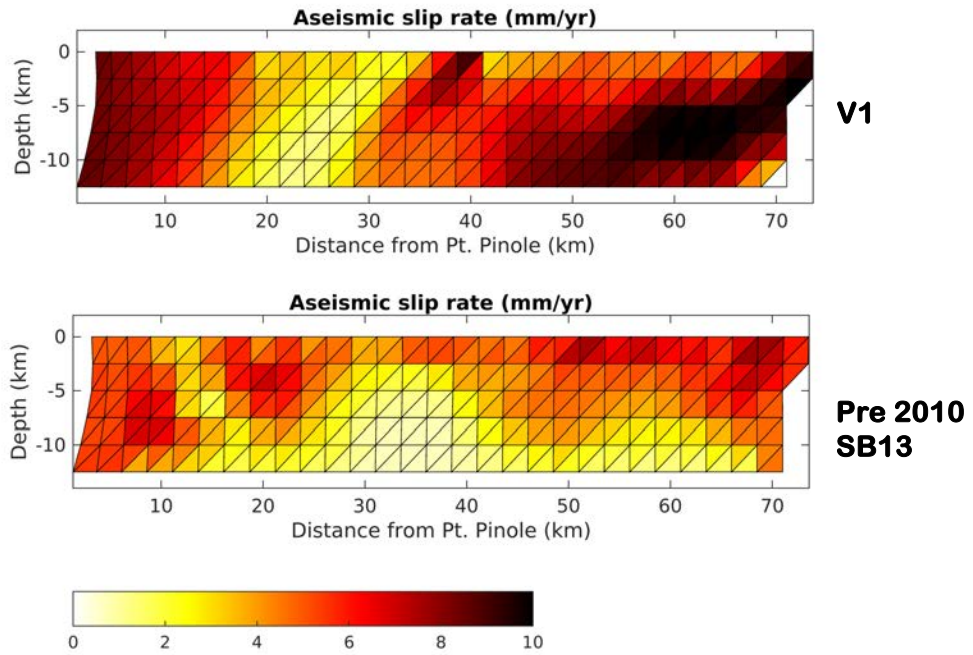


---

74

---

## Creep Inversion Results

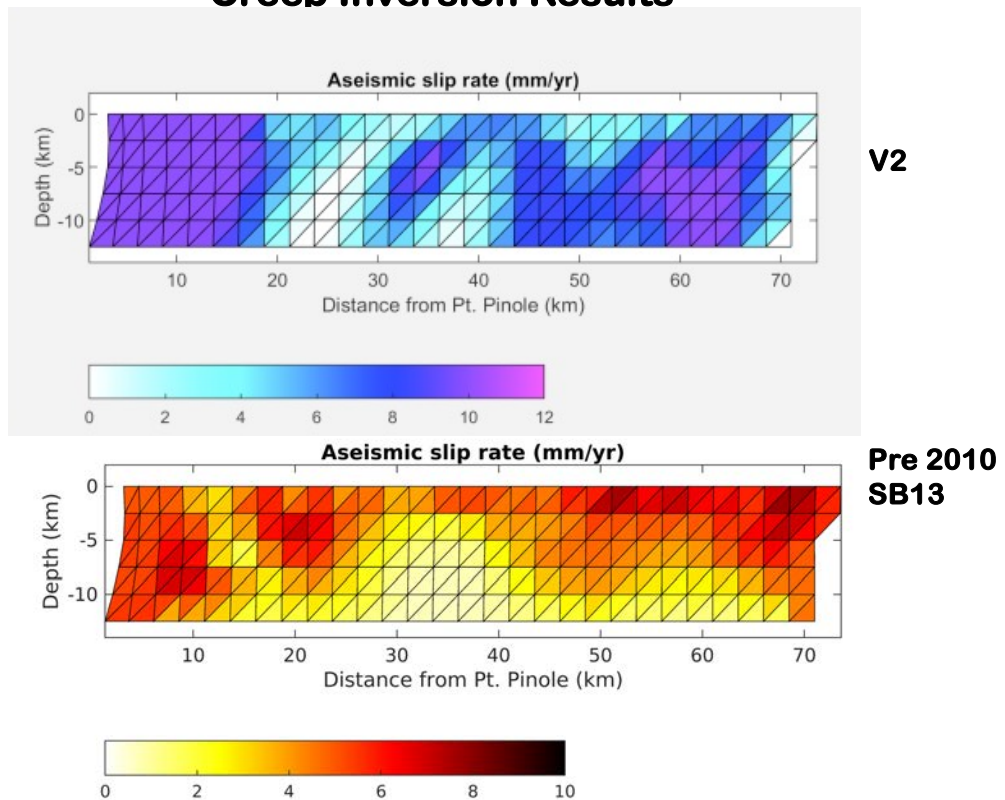


---

75

---

## Creep Inversion Results

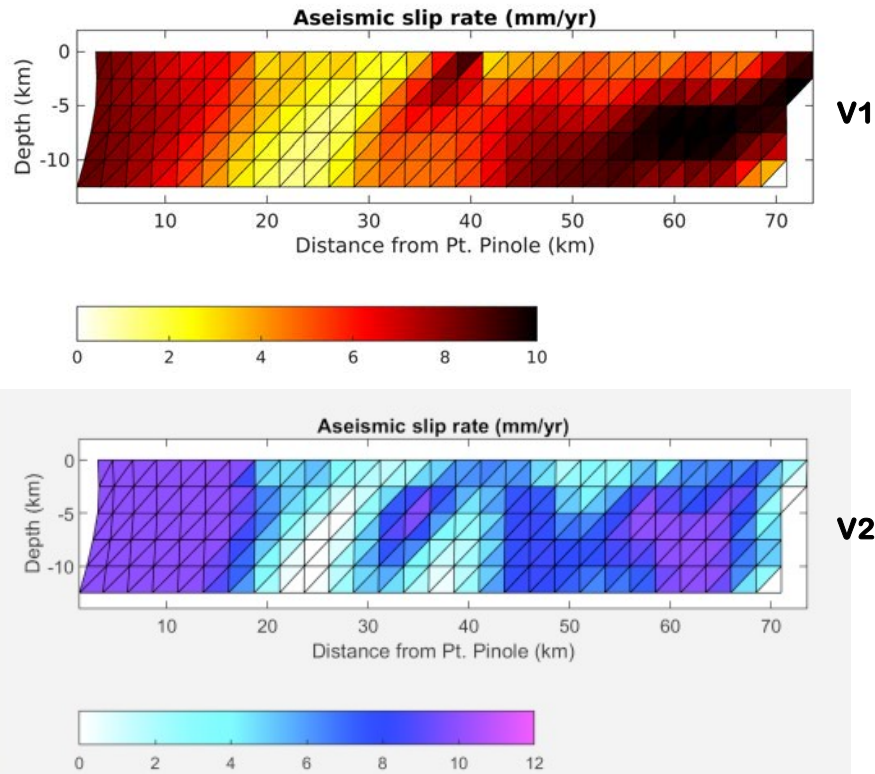


---

76

---

## Creep Inversion Results



77

---

# Q&A

To be notified of future events and recordings, join ECA (free!):  
[EarthquakeCountry.org/join](https://EarthquakeCountry.org/join)

Questions? [info@earthquakecountry.org](mailto:info@earthquakecountry.org)

---

78

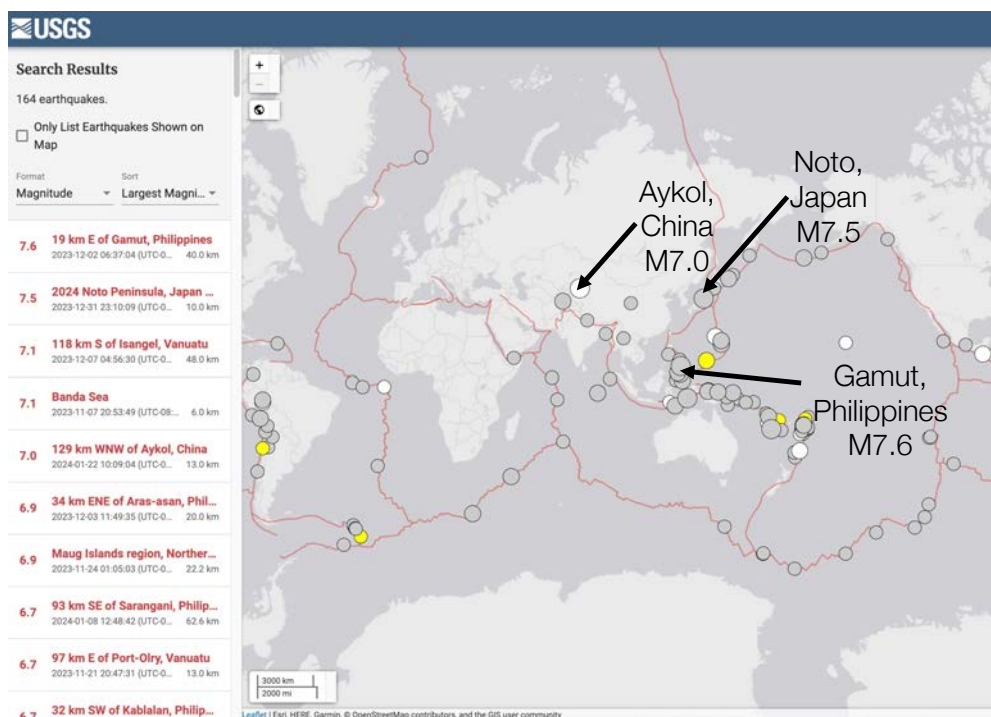
# ECA Bay Area Workshop Quake Break

Savvas Marcou  
PhD Student  
Berkeley Seismology Lab



79

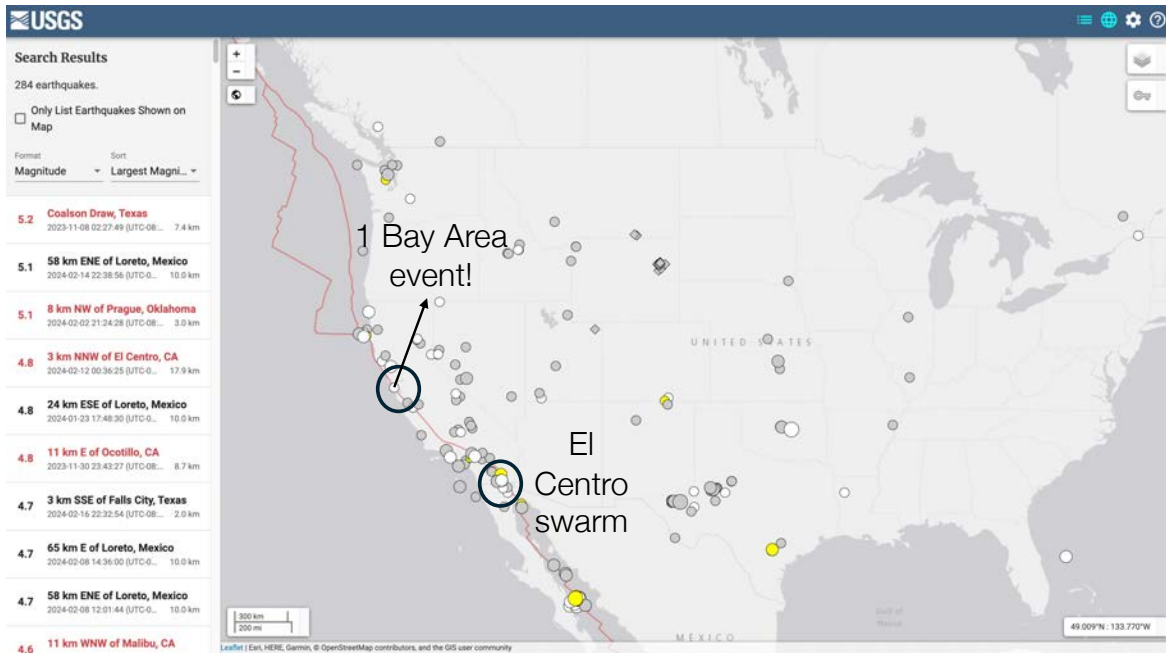
## World, $M > 5.5$ , since Nov 1, 2023



80

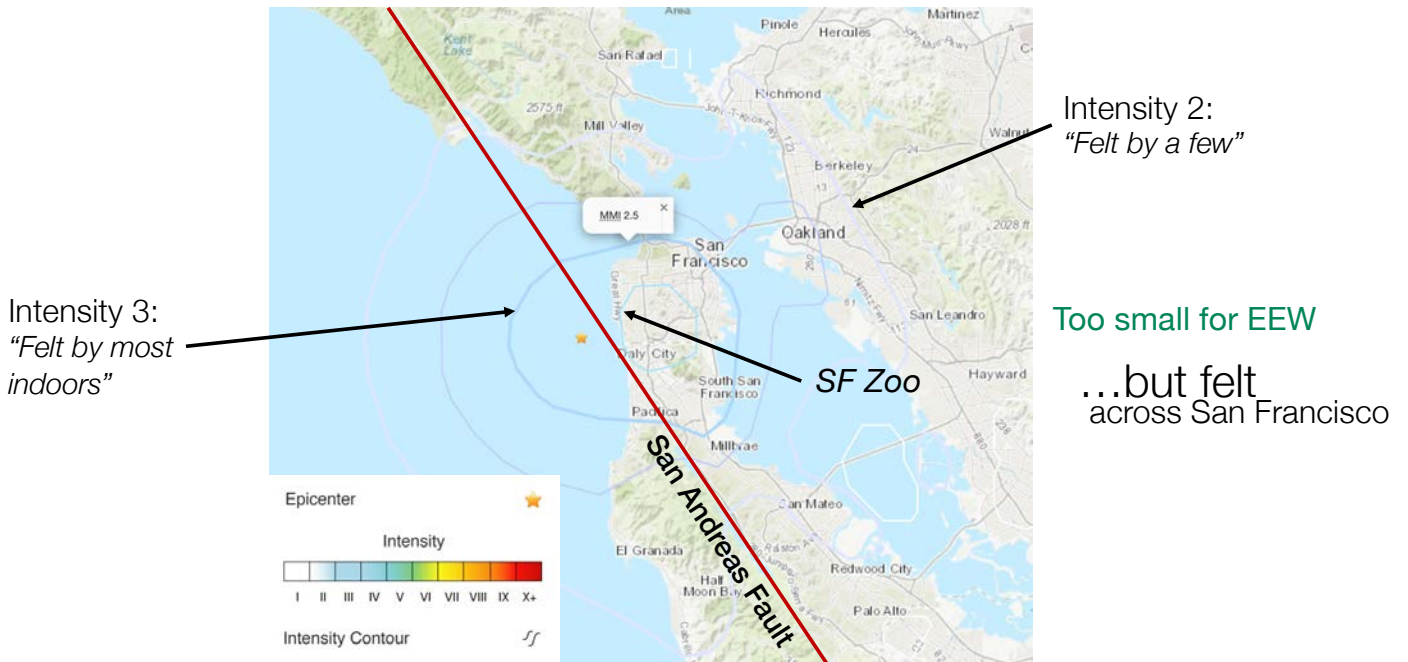


# US, M>3.0, since Nov 1, 2023



31

## M3.2 San Francisco Zoo earthquake February 2, 2024



earthquakes.usgs.gov

32



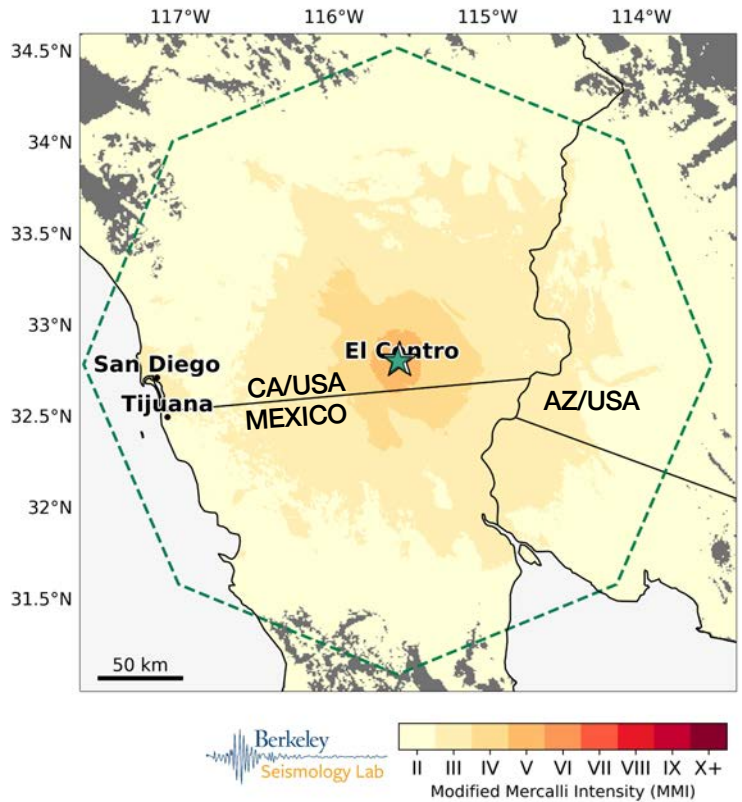
# M4.8 El Centro Monday 12 Feb 2023, 00:36 PST

## ShakeAlert:

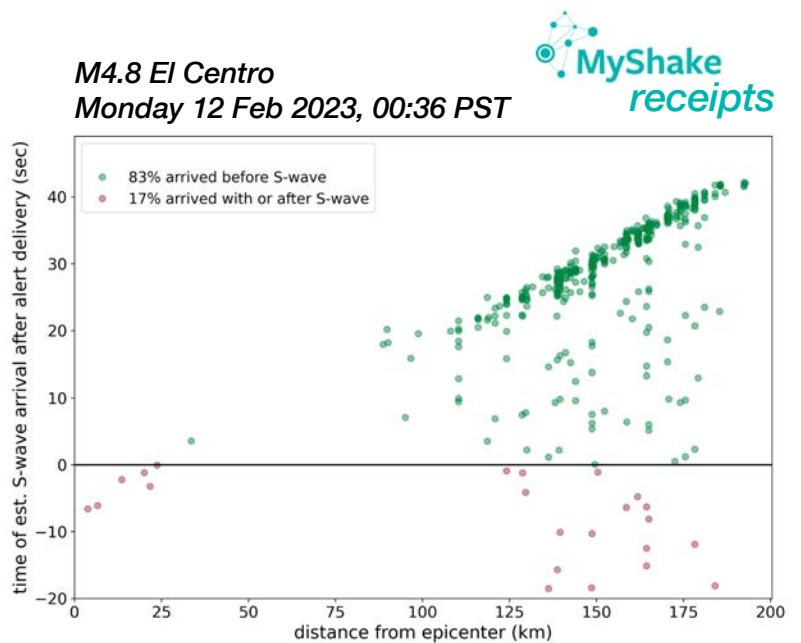
Initial: **M5.8**  
(5.0 sec from origin time)  
Final: **M5.2**  
(21.2 sec from initial update)

~80 k MyShake alerts sent

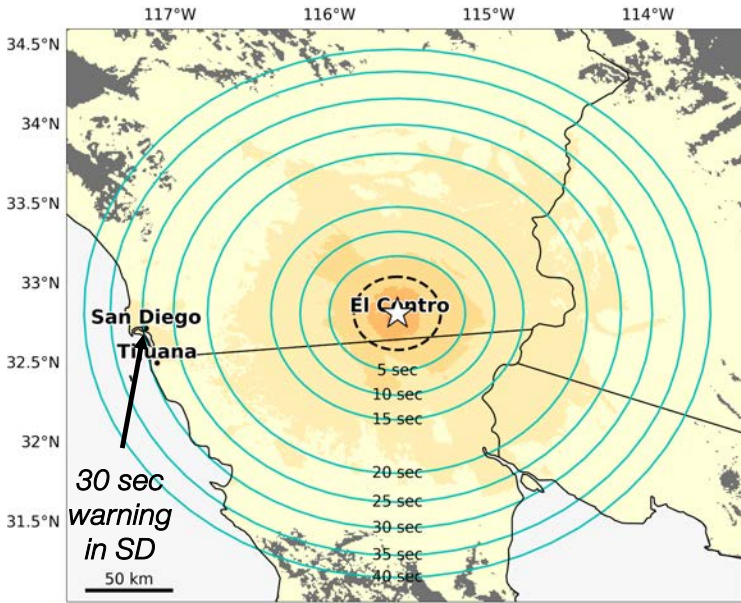
M4.81 El Centro Earthquake, February 12, 2024  
Max Contour Received from ShakeAlert and USGS ShakeMap



## From MyShake message receipts to warning times

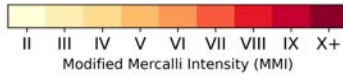


M4.81 El Centro Earthquake, February 12, 2024  
MyShake Warning Time Contours and USGS ShakeMap



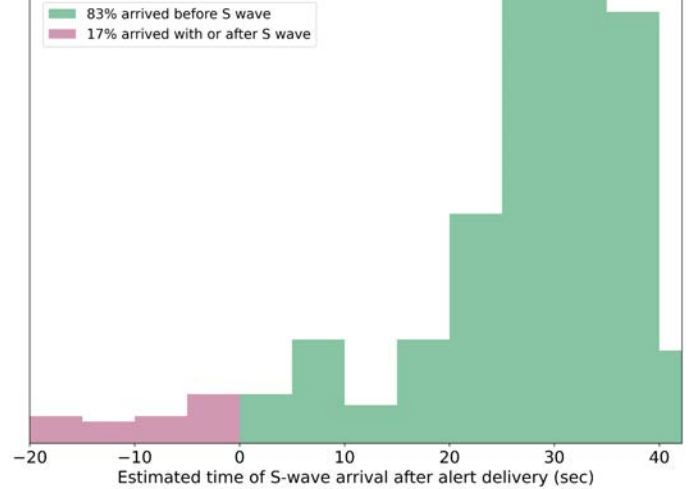
MyShake  
Warning times

Berkeley  
Seismology Lab



MyShake Warning times  
Be Quake Ready

M4.8 El Centro earthquake  
February 12, 2024



35

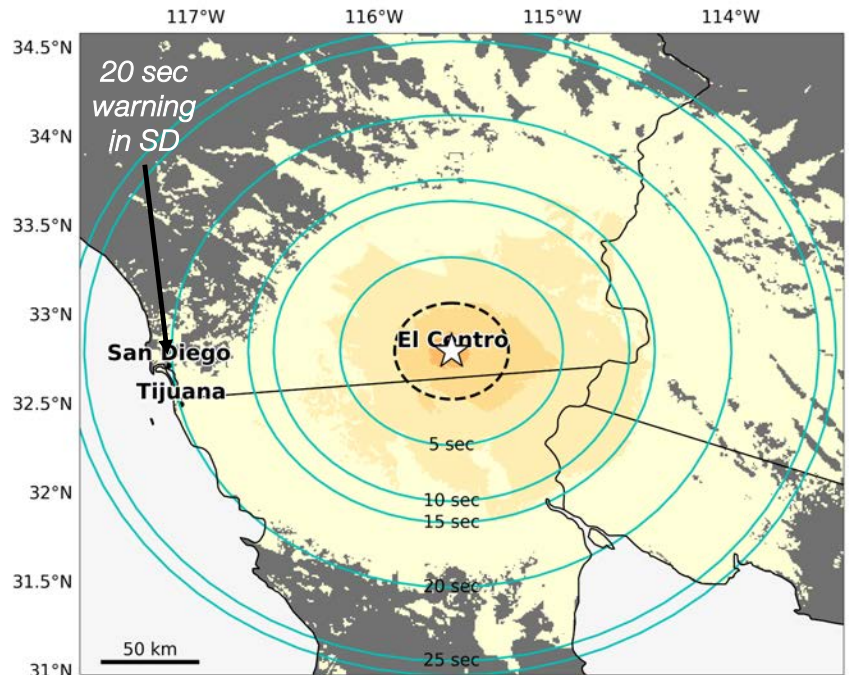
M4.6 El Centro  
Monday 12 Feb 2023,  
00:42 PST

ShakeAlert:

Initial M5.0  
(8 sec from origin time)  
Final M5.5  
(13 sec from initial update)

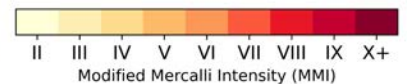
~90 k MyShake alerts sent

M4.56 El Centro Earthquake, February 12, 2024  
MyShake Warning Time Contours and USGS ShakeMap



MyShake  
Warning times

Berkeley  
Seismology Lab



36

---

# Q&A

To be notified of future events and recordings, join ECA (free!):  
[EarthquakeCountry.org/join](https://EarthquakeCountry.org/join)

Questions? [info@earthquakecountry.org](mailto:info@earthquakecountry.org)

---

37

---

## **Loma Prieta 35 Anniversary Planning including Quake Heroes Expos**

***Mark Benthien***  
*ECA Executive Director*  
*Statewide California Earthquake Center*

---

38

---

# Northridge 30th Anniversary Campaign

- SCEC/ECA is leading the development of a year-long educational campaign to commemorate the 30th anniversary of the Jan. 17, 1994, Northridge earthquake
- Purpose: increase awareness about earthquake hazards, encourage preparedness and mitigation, and inform about self-protective actions and response skills.
- Grant funding and sponsorships, including:
  - Cal OES
    - California Seismic Safety Commission
    - Earthquake Program via FEMA NEHRP Funding (2/3 CSUN Quake Heroes event)
    - California Earthquake Authority
  - Optimum Seismic
  - Other public/private partners.
- Cornerstone will be large “Quake Heroes Expo” events.



## Quake Heroes



- Stories of people who experienced the 1994 Northridge earthquake in Los Angeles, and how they helped others
- Key moments tied to the *Seven Steps to Earthquake Safety*
- Scientists and engineers share how they informed the public about what happened, and learned key lessons for reducing future losses (tuck-under parking buildings are featured)
- Encourages viewers to become trained (CERT, CPR, etc.) so they are prepared to help others
- A model for communicating risk and motivating whole community preparedness and mitigation
- Production sponsored by FEMA, NSF, USGS, Structural Engineers Association of Southern California, Simpson Strong-Tie, Hero in You Foundation, Safe-T-Proof, and others



**RETROSPECTIVE INTERVIEWS**



**ARCHIVAL NEWS FOOTAGE**



**CINEMATIC RE-ENACTMENTS**

THE REAL-  
LIFE HEROES OF OUR  
FILM



**MIKE**  
Photographer

A photographer who risks his life to rescue several trapped neighbors, one of whom he ends up marrying. He becomes an overnight celebrity, praised for his heroics, and meets the president.



**ANA**  
Nurse

An off-duty nurse who is trapped in an apartment with her daughter until a neighbor kicks down their door. She then leaves to help evacuate the patients of a badly damaged hospital.



**JOE**  
Reporter

The only reporter in LA to go live on-air within seconds of the shaking. His first time ever anchoring, Joe sets a TV ratings record, then goes into the field to report on major incidents.



**LARRY**  
Fire Battalion  
Chief

The Los Angeles County Fire Battalion Chief who acts as his department's eyes-in-the-sky from a helicopter: surveying damage, directing search teams and updating command center.



**BUFFY**  
Art  
Therapist

A young newlywed who has trouble finding clothes after the quake jolts her awake. She helps free several trapped neighbors, comforts the grieving, and is featured on *World News Tonight*.



**REY**  
Firefighter  
EMT

An EMT who crawls into a collapsed parking structure to care for a man who is pinned under concrete. The eight-hour rescue is broadcast on live TV and is complicated by aftershocks.



**JACKIE**  
Reverend

The director of outreach for one of the largest churches in LA. She leads a major long-term recovery effort for those affected by the quake within the Inglewood/South Central community.



**KEN**  
Geoscientist

A young scientist who experiments with GPS technology to map earthquakes. He is able to use this new science to model the fault rupture faster than seismic data, for the first time ever.

## Quake Heroes Expos

- Screenings for large groups
- May include panel discussion before the film with local leaders, scientists, engineers, etc.
- After viewing the film, attendees can immediately take actions at a *Seven Steps to Earthquake Safety* resource and information fair where they can:
  - register for CERT and other trainings
  - Receive free or low-cost disaster supplies and earthquake safety fasteners
  - learn about earthquake insurance and retrofitting
  - sign up for alerts
  - experience an earthquake simulator
- Learn more and schedule a discussion at [QuakeHeroes.org!](http://QuakeHeroes.org)



## Quake Heroes Events

- International Association of Emergency Managers (Region IX) Conference (Garden Grove, March)
- International Association of Emergency Managers conference (Long Beach, November)
- YMCA Westchester Quake Heroes Expo (Dec 1)
- Cal State Northridge (Feb 3)
- Coachella Valley (March 30)
- Oakland: Summer (two events)
- Santa Clara COAD: Spring or Summer)

**QUAKE HEROES**

★ WESTCHESTER FILM PREMIERE & EXPO ★

FRIDAY, DECEMBER 1  
6PM - 9PM

Westchester Family YMCA Annex  
8020 Alverstone Ave  
Los Angeles, CA 90045

Scan the QR Code to Register!

Watch an inspiring film based on true stories! Ride an earthquake simulator!  
Discounts on earthquake preparedness supplies! Sign up for safety trainings!

the Y | SC/E/C | Watch the Trailer | PS

93

## NR30: Key Components

**NORTHRIDGE 30**  
1994 → 2024

- **Quake Heroes Expos** (many events across SoCal and statewide, planned with diverse and vulnerable communities (seniors, low-income neighborhoods, in multiple languages) as well as for businesses, faith-based organizations, community centers, government agencies, etc. Each event will feature our motivational film and a preparedness fair with booths for each of the *Seven Steps to Earthquake Safety* (including sign-ups for free trainings and free or low-cost supplies). Interested? Visit [QuakeHeroes.org](https://www.quakeheroes.org).
- **Additional Quake Heroes Film Screenings** (smaller venues with essential resources for preparedness - LA County libraries, etc.
- **Structural Engineers Association planning Symposium at Caltech on January 17**
- **Northridge 30th Anniversary Commemoration on January 17, 2024** (Major public and media event, possibly at CSUN with surrounding communities)
- **“Seven Steps” Presentations** (to community groups, houses of worship, small business associations, etc., in multiple languages, covering earthquake preparedness, mitigation, and response).
- **Social Media Toolkit** (Development of a multi-lingual comprehensive social media toolkit for partner organizations to promote campaign messaging).
- **News Media Outreach and Coverage** (Press releases about Campaign activities and earthquake-related topics and to generate additional public awareness).
- **Presentations/Booths** at sector-based conferences and other venues
- **Evaluation of key activities**

94

---

# Loma Prieta Earthquake 35<sup>th</sup> Anniversary

October 17, 2024  
(2024 International ShakeOut Day!)

What is being planned?  
What could be planned - before?  
What could be planned - on Oct. 17?  
What could be planned - after? How long?

---

95

---

## Q&A

To be notified of future events and recordings, join ECA (free!):  
[EarthquakeCountry.org/join](https://EarthquakeCountry.org/join)

Questions? [info@earthquakecountry.org](mailto:info@earthquakecountry.org)

---

96



---

# Short Announcements from Attendees

---

97

---

## How to Collaborate within the ECA

1. Join the ECA (free!) [EarthquakeCountry.org/join](https://EarthquakeCountry.org/join)

2. Participate with an ECA Regional Alliance

Attend quarterly workshops (or host one!) [EarthquakeCountry.org/calendar](https://EarthquakeCountry.org/calendar)

Serve on your region's Coordinating Committee

Plan local events, recruit members, organize ShakeOut activities, etc.

Learn more: [EarthquakeCountry.org/alliance](https://EarthquakeCountry.org/alliance)

3. Serve on an ECA Sector-Based Committee

Public Sector

Healthcare

Business

Higher Education

Accessibility

PreK-12 Education

Non-Profit & Faith-Based

Learn more: [EarthquakeCountry.org/committees](https://EarthquakeCountry.org/committees)

---

98

---

# How to Collaborate within the ECA

## 4. Collaborate via an ECA Outreach Bureau

*News and Social Media Bureau*- coordinate local and statewide earthquake news & events

*Participation Bureau*- recruit and support your area's ShakeOut and Tsunami Week registrants

*Events Bureau*- train and arrange speakers and staffing for preparedness fairs, conference booths, etc.

Request a presenter or information table: [EarthquakeCountry.org/events](https://EarthquakeCountry.org/events)

Email [info@earthquakecountry.org](mailto:info@earthquakecountry.org) to learn more.

## 5. Use, share, and help promote our resources and activities (link from your site, etc.)

Seven Steps to Earthquake Safety- [EarthquakeCountry.org/sevensteps](https://EarthquakeCountry.org/sevensteps)

Guidance in Multiple Languages- [EarthquakeCountry.org/languages](https://EarthquakeCountry.org/languages)

Workshops, webinars, & other events- [EarthquakeCountry.org/calendar](https://EarthquakeCountry.org/calendar)

ECA Mini Awards- [EarthquakeCountry.org/miniawards](https://EarthquakeCountry.org/miniawards)

---

99

---

# What is something that you:

learned  
will do  
will use  
will tell others

---

---

# Open Discussion & Networking

---

101

---

## Connect with ECA Bay Area

- [EarthquakeCountry.org/bayarea](http://EarthquakeCountry.org/bayarea)
- [bayarea@earthquakecountry.org](mailto:bayarea@earthquakecountry.org)
- [Terremotos.org](http://Terremotos.org)
- [Twitter.com/eca](https://twitter.com/eca)
- [info@earthquakecountry.org](mailto:info@earthquakecountry.org)



---

102