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Overview of South Napa earthquake August 24, 2014

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September 5, 2014

U.S. Department of the Interior
U.S. Geological Survey

August 24, 2014, 3:20 AM local time

- Magnitude-6.0 earthquake struck just west of the town of Napa, hours before dawn.
- Largest earthquake in Bay Area since 1989.
- About 80,000 residents experienced severe shaking, another 200,000 felt strong to very strong shaking.
- Injured 200, cut power to 70,000, and caused extensive damage, especially to older or unreinforced masonry structures.

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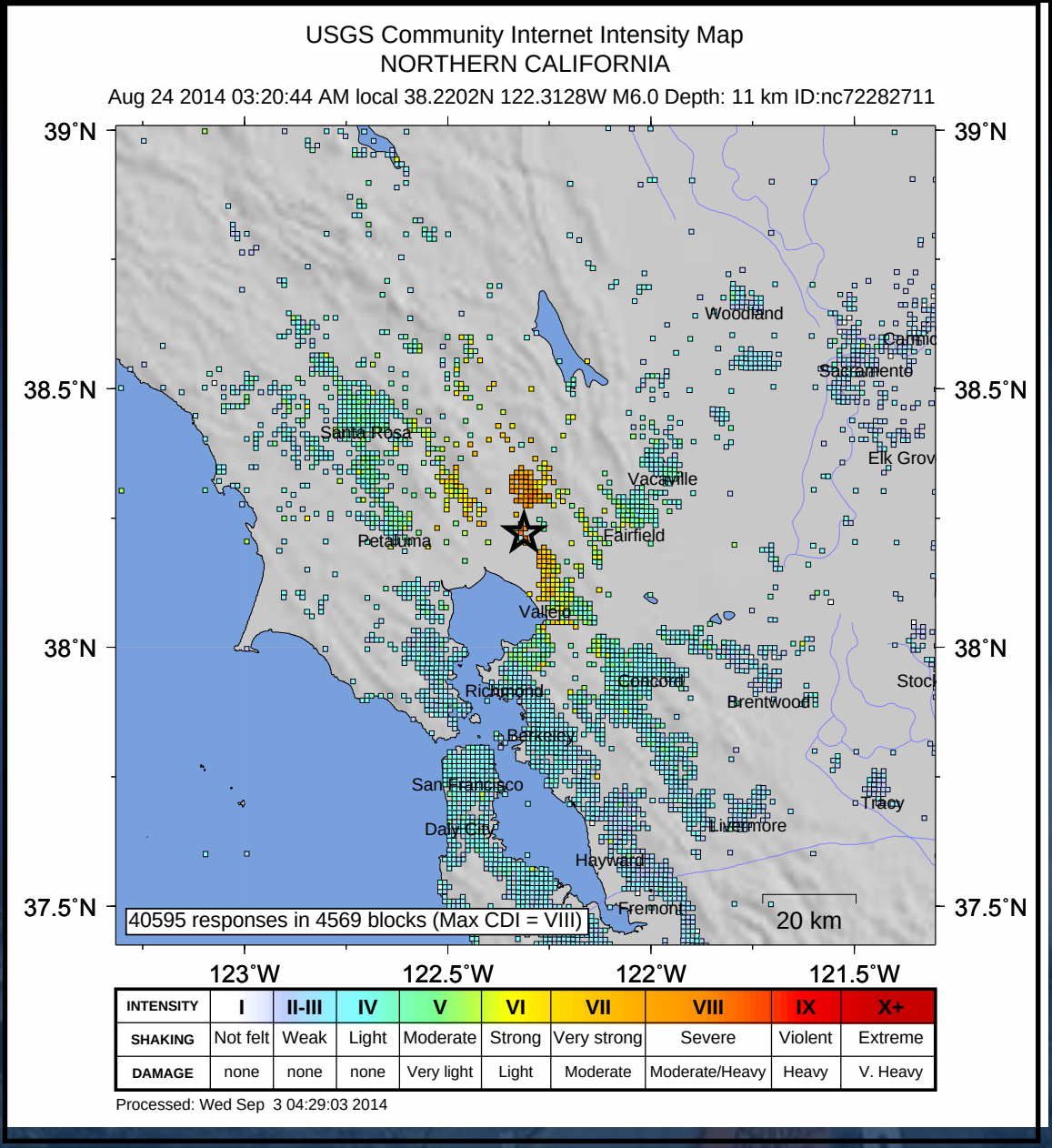
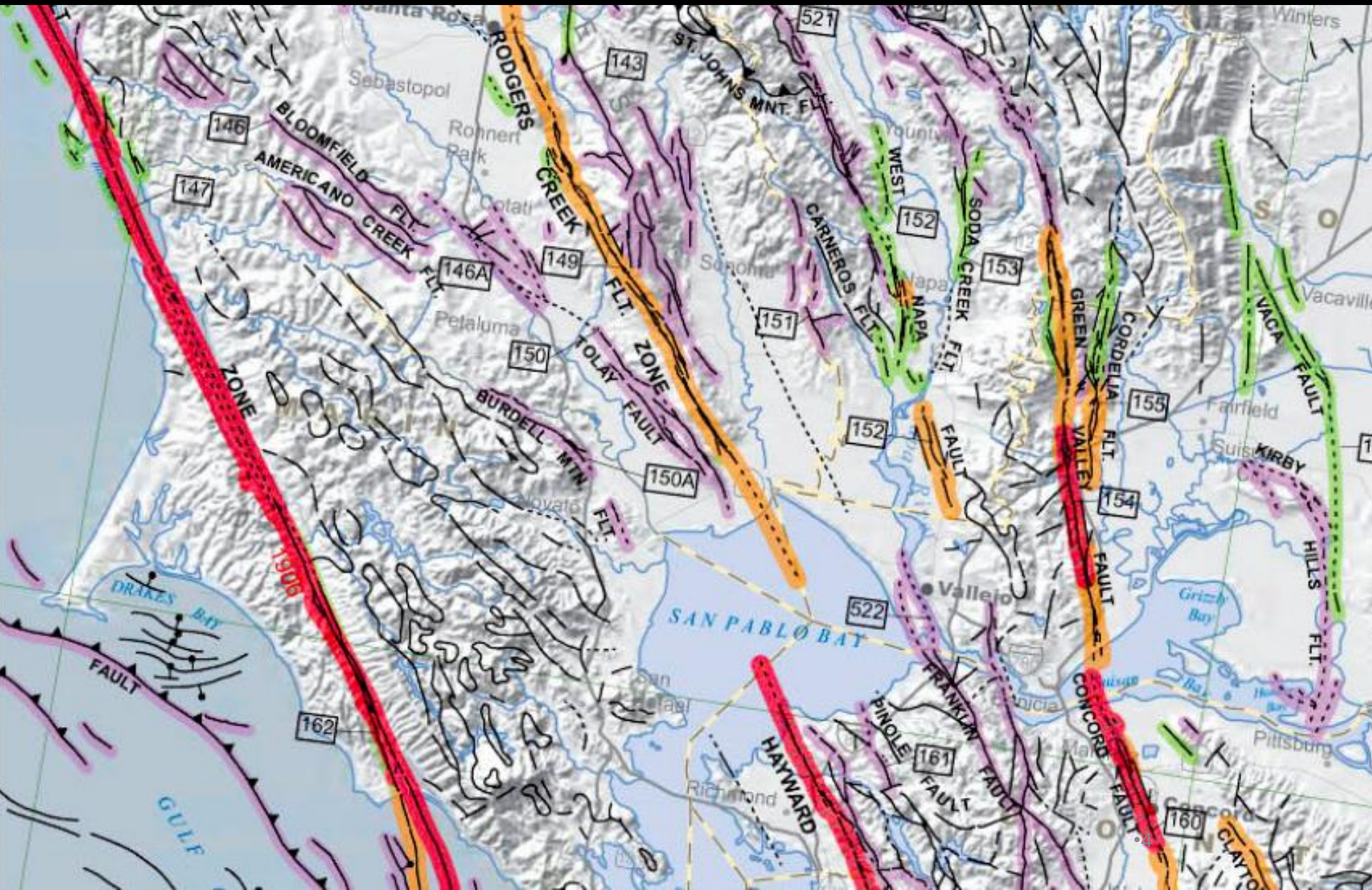


Quaternary faults in the SF Bay Area

Quaternary faults in the North Bay

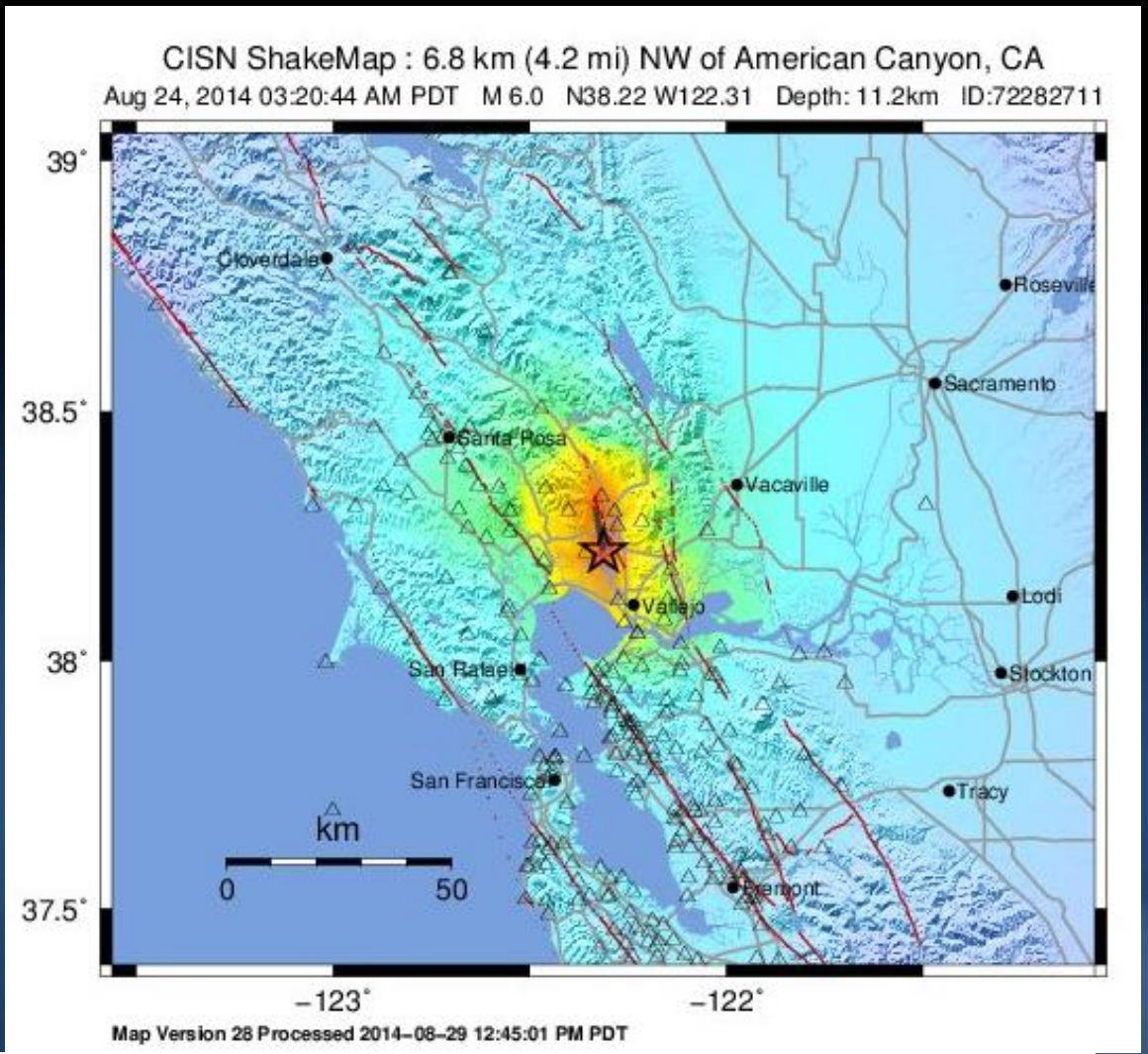


ShakeMap

Empirical estimate of ground shaking in the epicentral region.

Measured on the Modified Mercalli Intensity Scale, ranging from MMI-I (not felt, no damage) to MMI-X+ (extreme shaking, very heavy damage).

Adjusted in the hours after an event as more data become available, and to account for estimates of earthquake rupture surface.

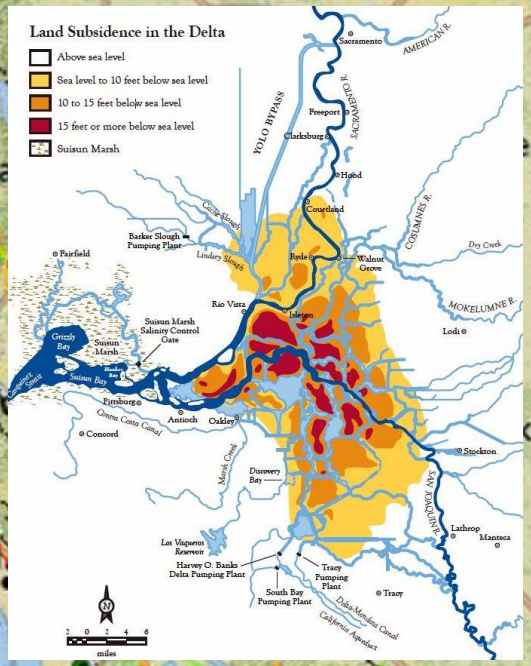


PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<0.1*	*0.5*	*2.4*	*6.7*	*13*	24	44	83	>156
PEAK VEL.(cm/s)	<0.07	0.4	1.9	5.8	*11*	*22*	*43*	*83*	*>160*
INSTRUMENTAL INTENSITY	I	II–III	IV	V	VI	VII	VIII	IX	X+

Scale based upon Wald, et al.; 1999

Dodged bullet: Sacramento-San Joaquin Delta

Subsidence: Red areas >15 feet below sea level



Prompt Assessment Global Earthquakes Response

- Correlates ShakeM population density database to estimat of potential disaster.
- New versions released when new information changes the forecasted impacts.
- Alert levels for estimated fatalities/economic losses.

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Earthquake Shaking — Red Alert

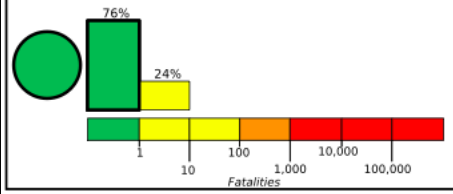
GSN ANSS USAID FROM THE AMERICAN PEOPLE

M 6.0, 6.8 km (4.2 mi) NW of American Canyon, CA

Origin Time: Sun 2014-08-24 10:20:44 UTC (03:20:44 local)
Location: 38.22°N 122.31°W Depth: 11 km

PAGER
Version 26
Created: 4 days, 4 hours after earthquake

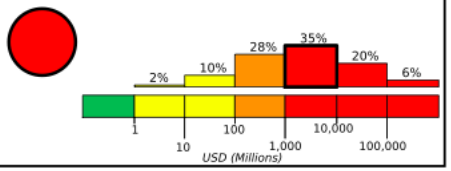
Estimated Fatalities



Red alert level for economic losses. Extensive damage is probable and the disaster is likely widespread. Estimated economic losses are less than 1% of GDP of the United States. Past events with this alert level have required a national or international level response.

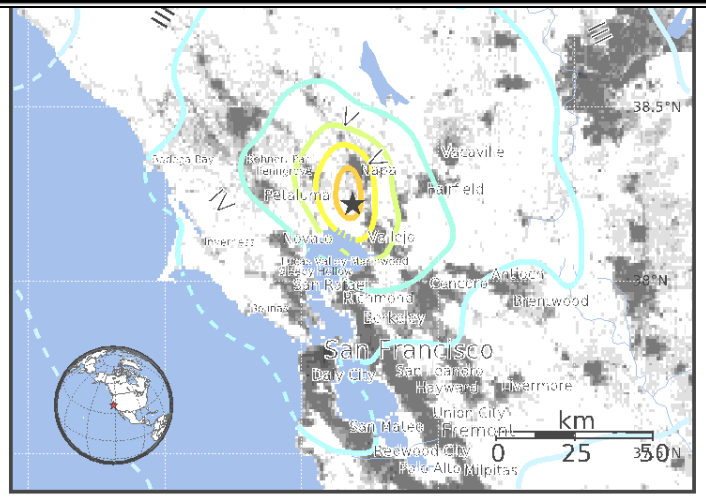
Green alert level for shaking-related fatalities. There is a low likelihood of casualties.

Estimated Economic Losses



Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)		- -*	4,881k*	3,281k	370k	145k	52k	82k	0	0
ESTIMATED MODIFIED MERCALLI INTENSITY		I	II-III	IV	V	VI	VII	VIII	IX	X+
PERCEIVED SHAKING		Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	Resistant Structures	none	none	none	V. Light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy
	Vulnerable Structures	none	none	none	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy	V. Heavy



Date (UTC)	Dist. (km)	Mag.	Max MMI(#)	Shaking Deaths
1983-05-02	284	5.7	VIII(1k)	0
1980-01-24	76	5.8	VII(31k)	1
1989-10-18	132	6.9	IX(3k)	62

Recent earthquakes in this area have caused secondary hazards such as landslides and liquefaction that might have contributed to losses.

Selected City Exposure

from GeoNames.org

MMI	City	Population
VIII	Napa	77k
VII	Yountville	3k
VII	American Canyon	19k
VI	El Verano	4k
VI	Sonoma	11k
VI	Temelec	1k
IV	Oakland	391k
IV	**San Francisco**	**805k**
III	Sacramento	466k
III	**Fremont**	**214k**
III	Stockton	292k

bold cities appear on map (k = x1000)

PAGER content is automatically generated, and only considers losses due to structural damage. Limitations of input data, shaking estimates, and loss models may add uncertainty.
http://earthquake.usgs.gov/pager

Event ID: nc72282711

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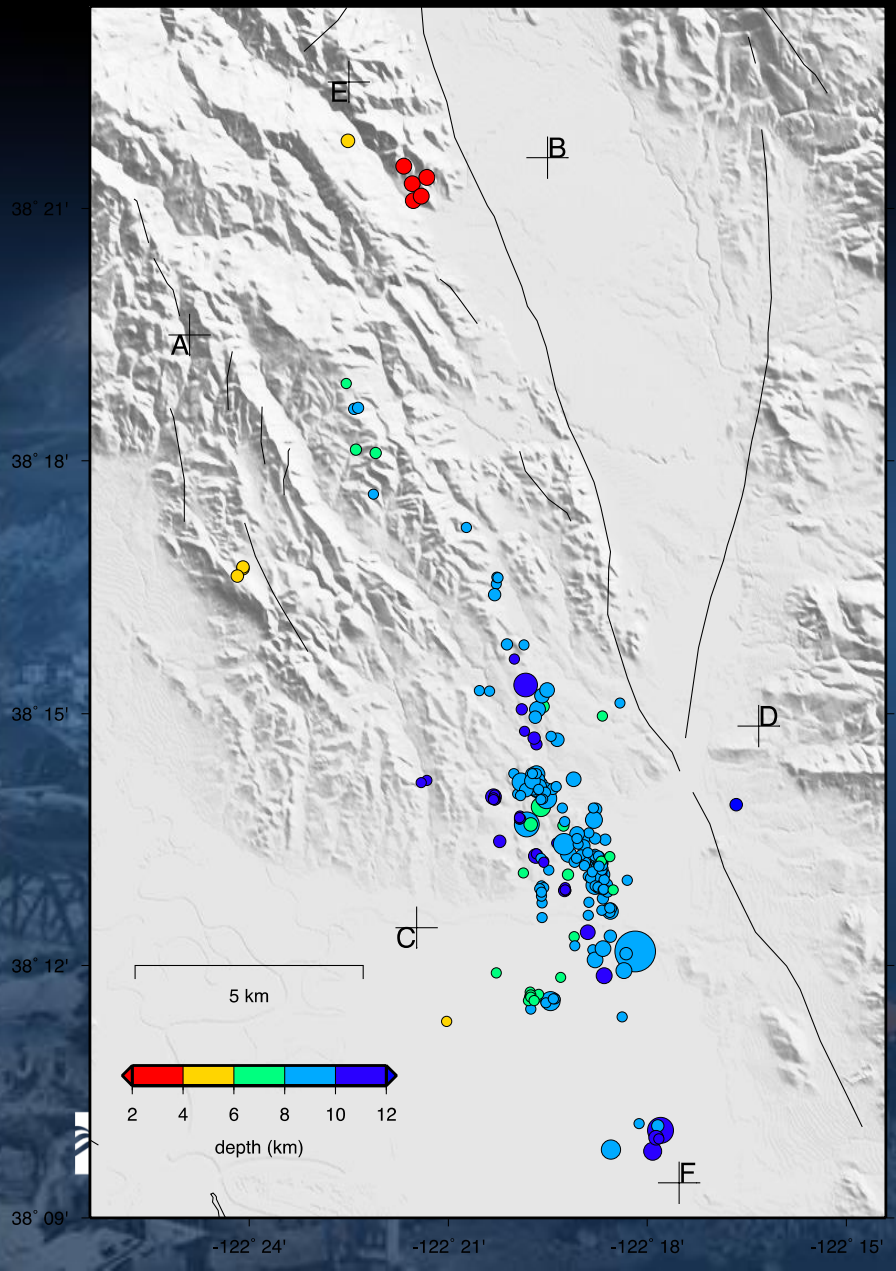
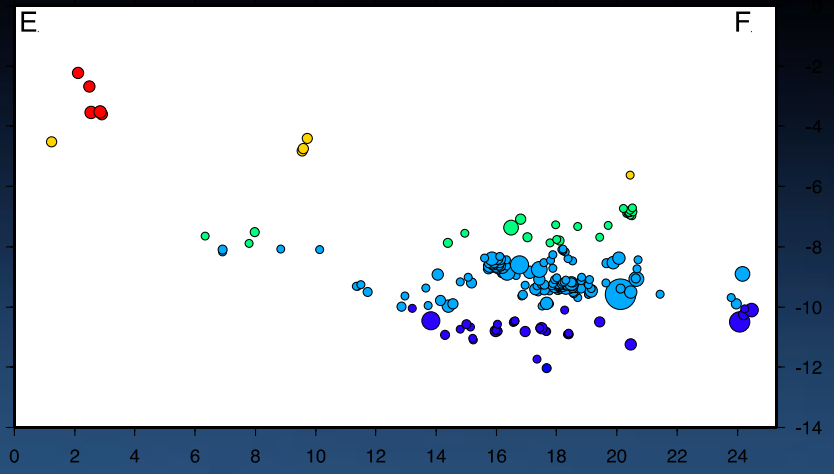
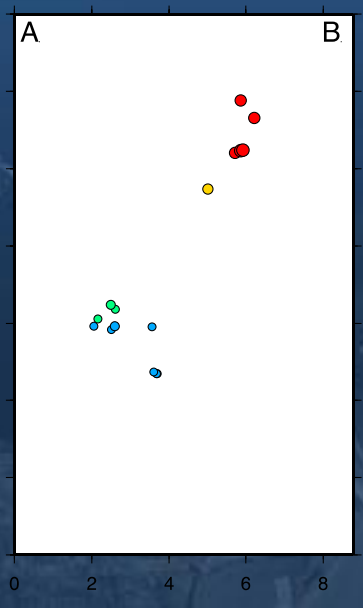
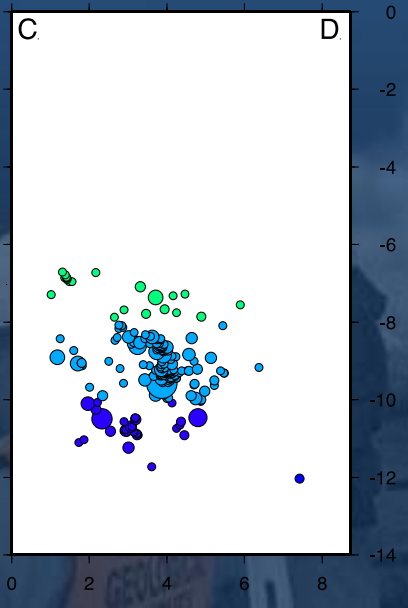
Aftershocks



First week of aftershocks







Static stress changes

Calculations imply increased hazard on West Napa and Green Valley faults.

Courtesy R. Stein and S. Toda (Tohoku U.)

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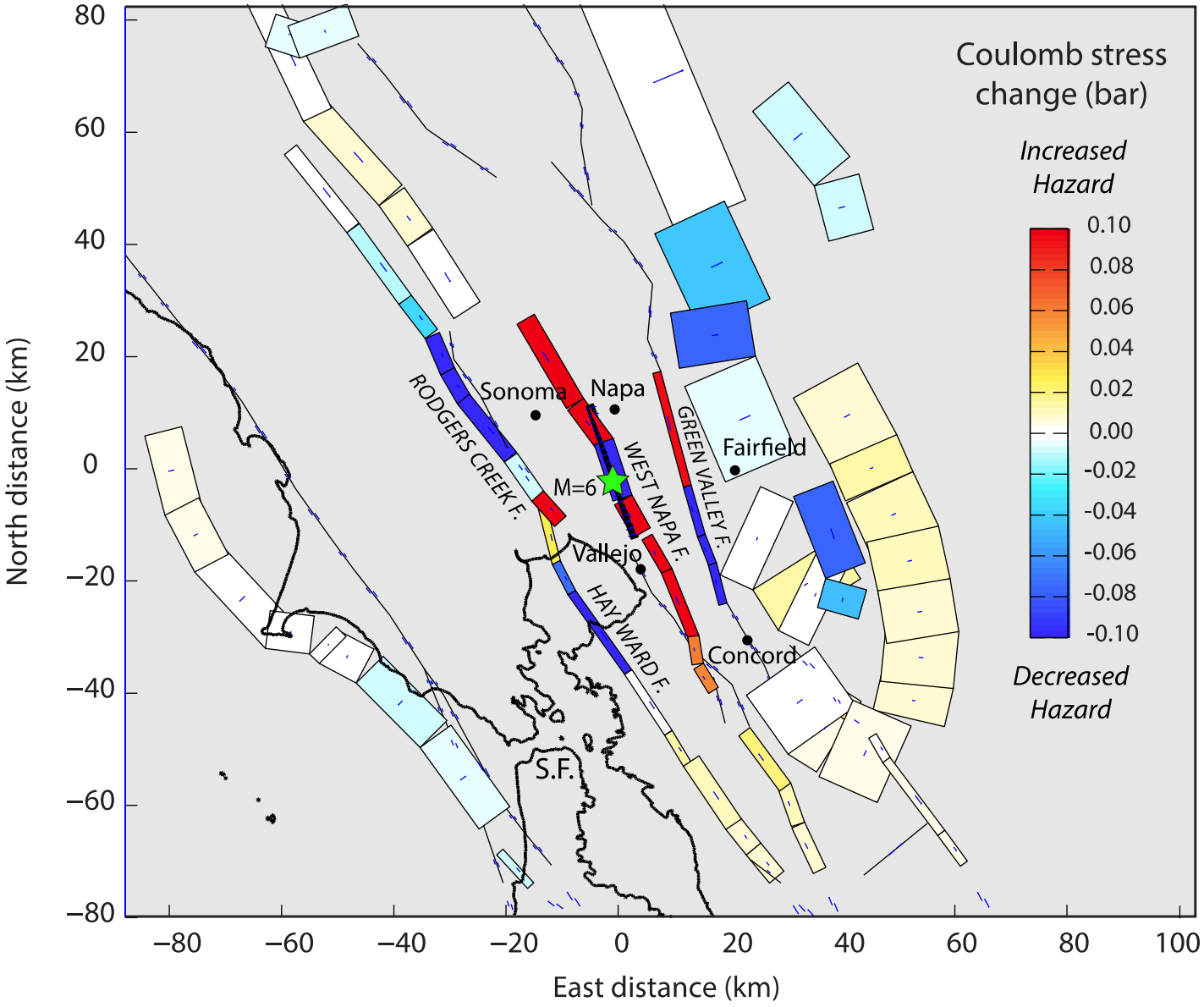
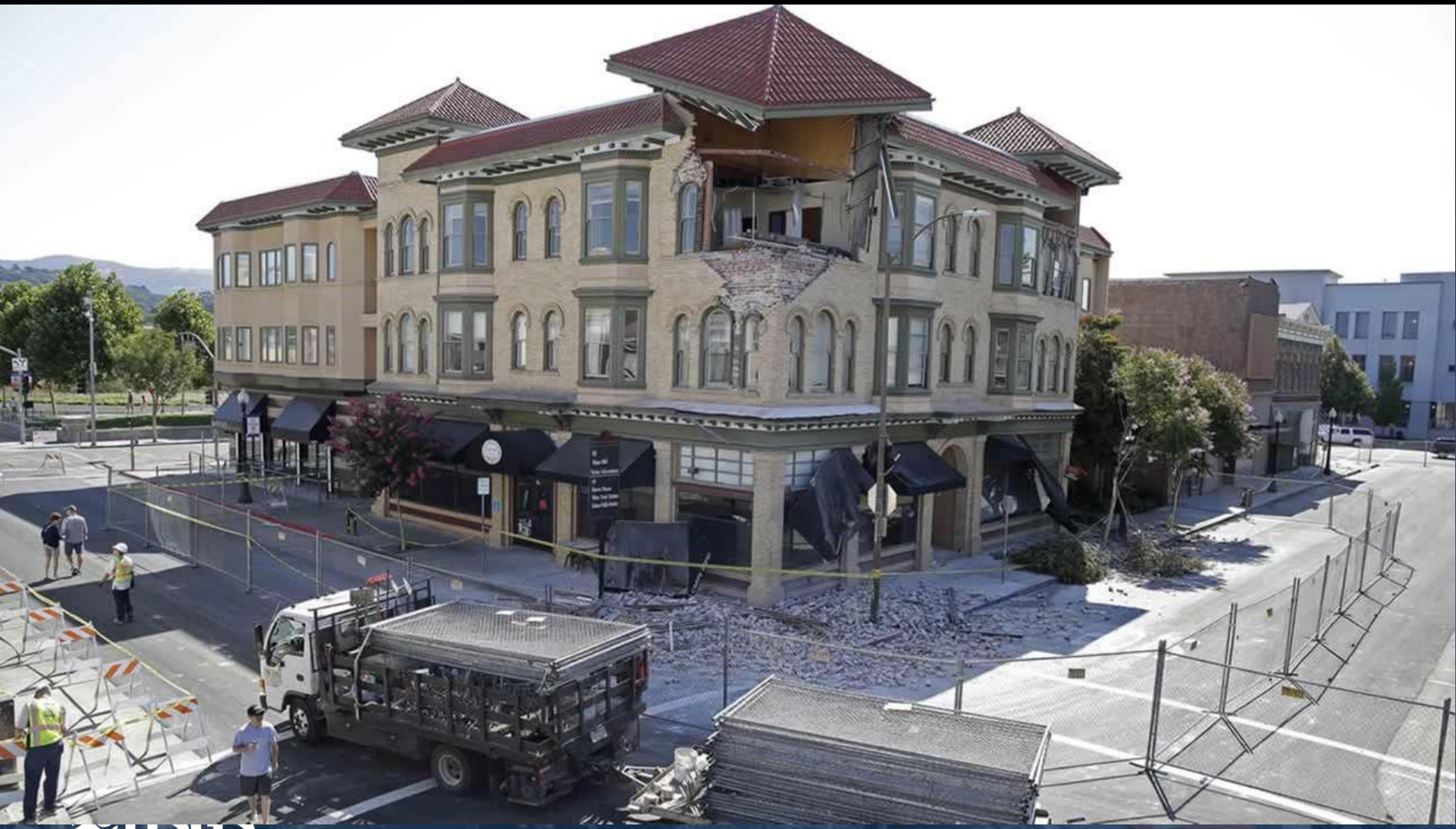
Coulomb stress imparted by the
24 August 2014 M=6.0 Amercian Canyon Earthquake
resolved on UCERF3 Bay area faults (as of 28 Aug 2014: 1:00 am PST)



Post-earthquake investigations: Surface rupture

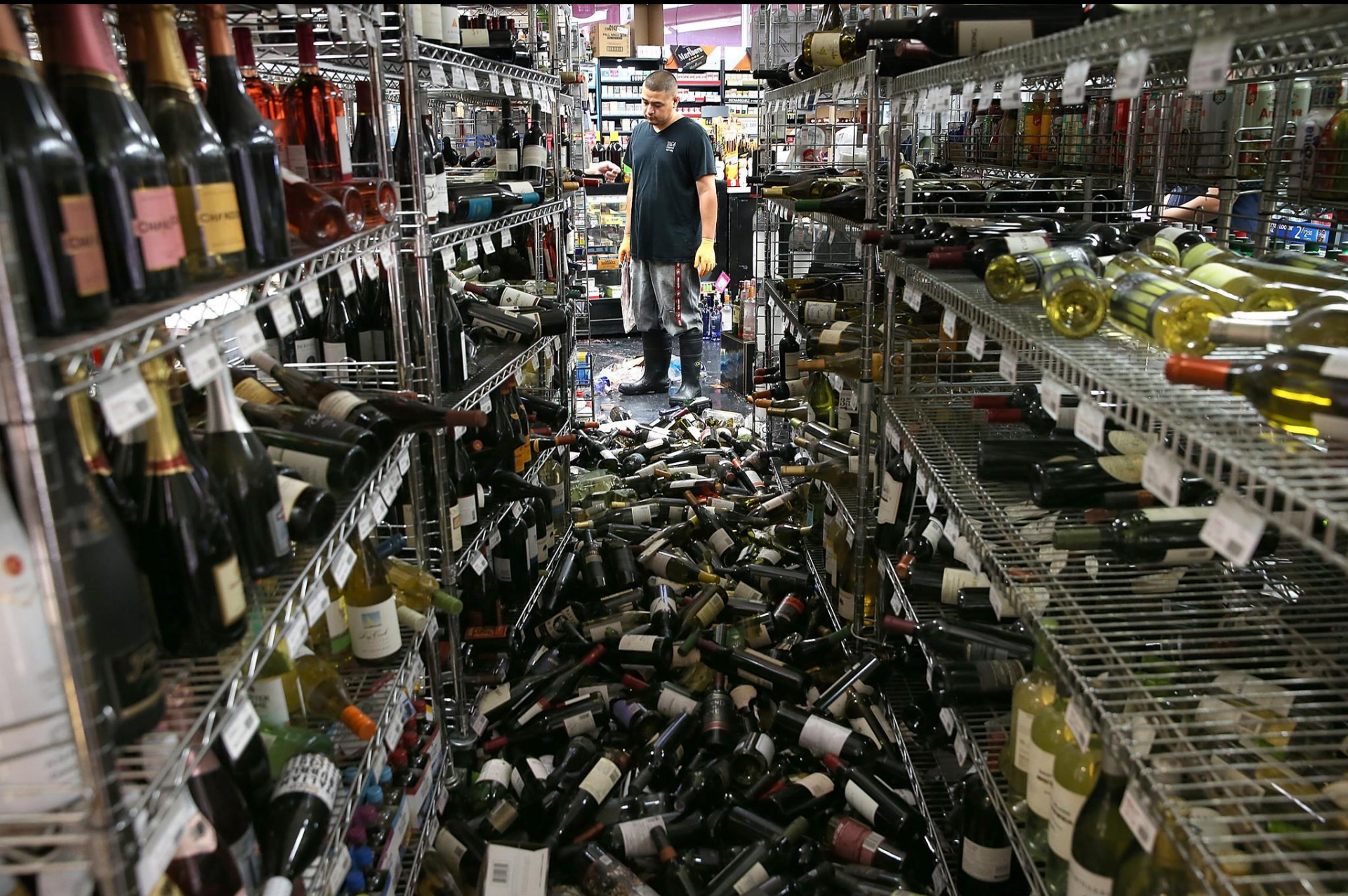
Other investigations of surface rupture

Post-earthquake investigations: Damage to structures and contents

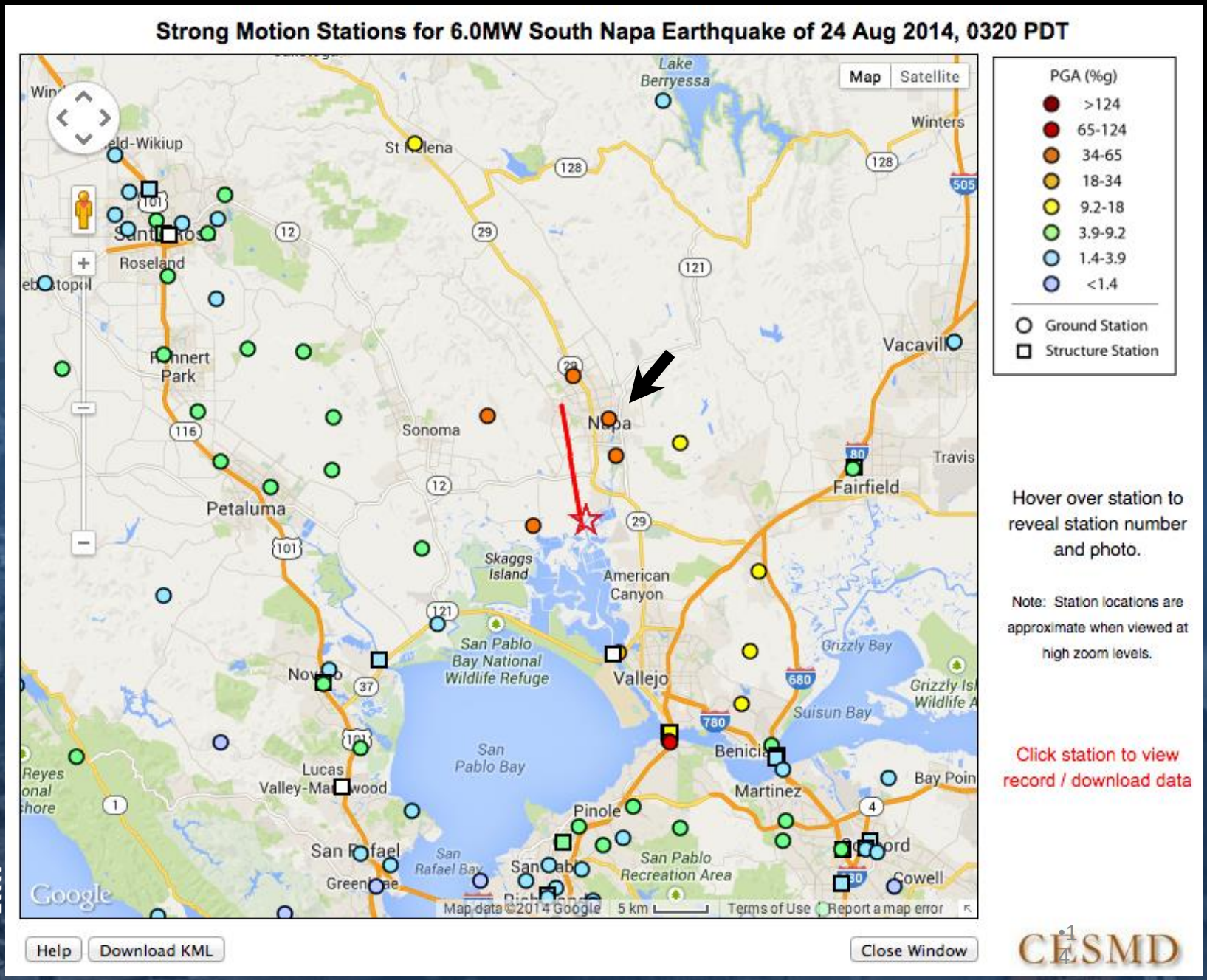


•ABC news

Damage to structures and contents



Strong motion seismic data



Earthquake Early Warning

- An EEW system uses first seconds of p-wave observations to rapidly estimate magnitude and epicenter, and to broadcast a warning ahead of strong shaking.
- Prototype early warning system is under test in California.
- System worked well during South Napa M6 earthquake:
  - Warning generated 5 seconds after origin time, with estimated magnitude of 5.8.
  - Up to 10 seconds warning for San Francisco, Oakland, Berkeley.
  - No warning possible within 20 km of epicenter.

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Remote sensing

- Geologists did aerial recon of surface ruptures.
- Commercial satellite imagery.
- LiDAR will be acquired, to identify subtle features and to identify paleoseismology study sites.
- InSAR being used to identify locations of rupture, and to model fault slip at depth.
  - Interferogram by ARIA using data from COSMO-SkyMed.
  - Interferogram by UK COMET using new Sentinal-1a.
  - Additional radar tasking requested via NGA and others (COSMO-SkyMed, TerraSAR-X, RADARSAT-2).
  - NASA UAVSAR flown by JPL at USGS request.

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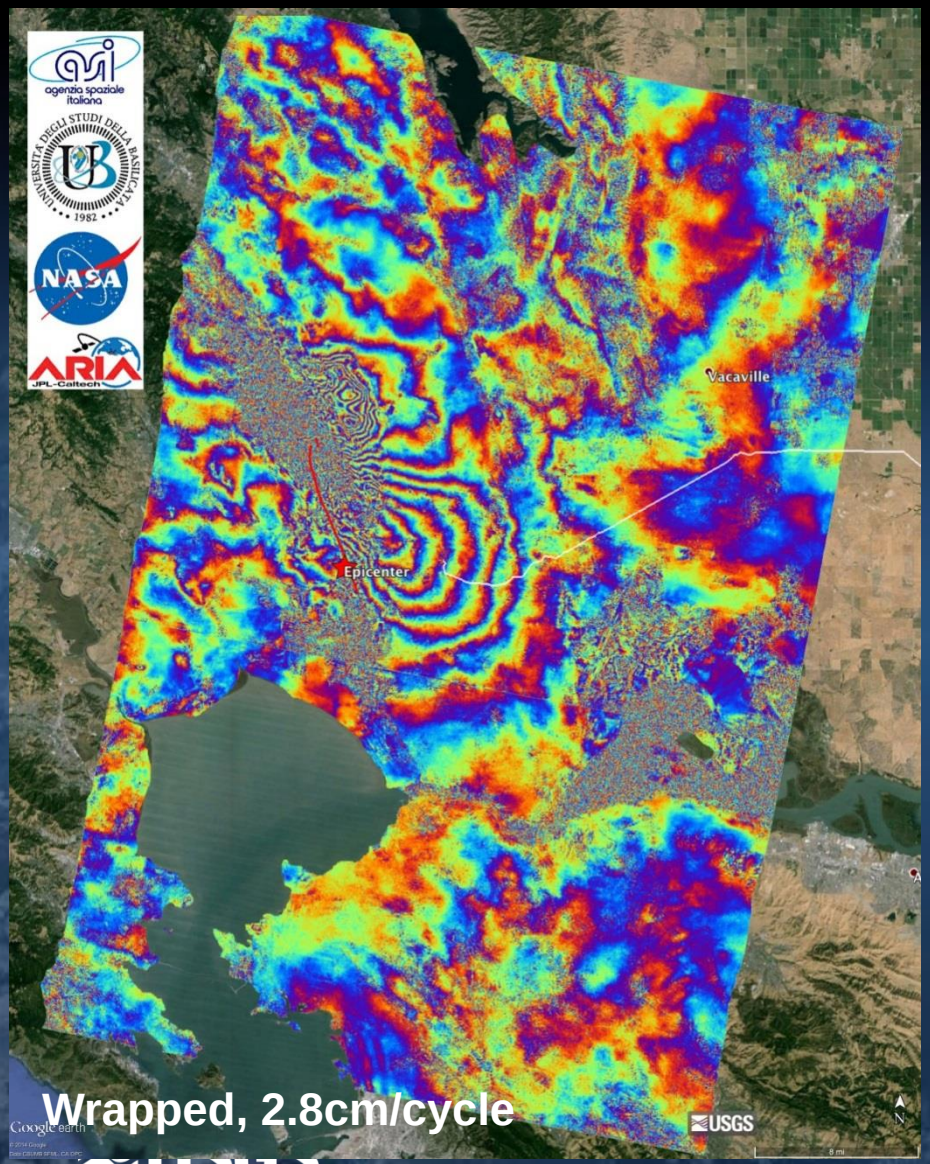
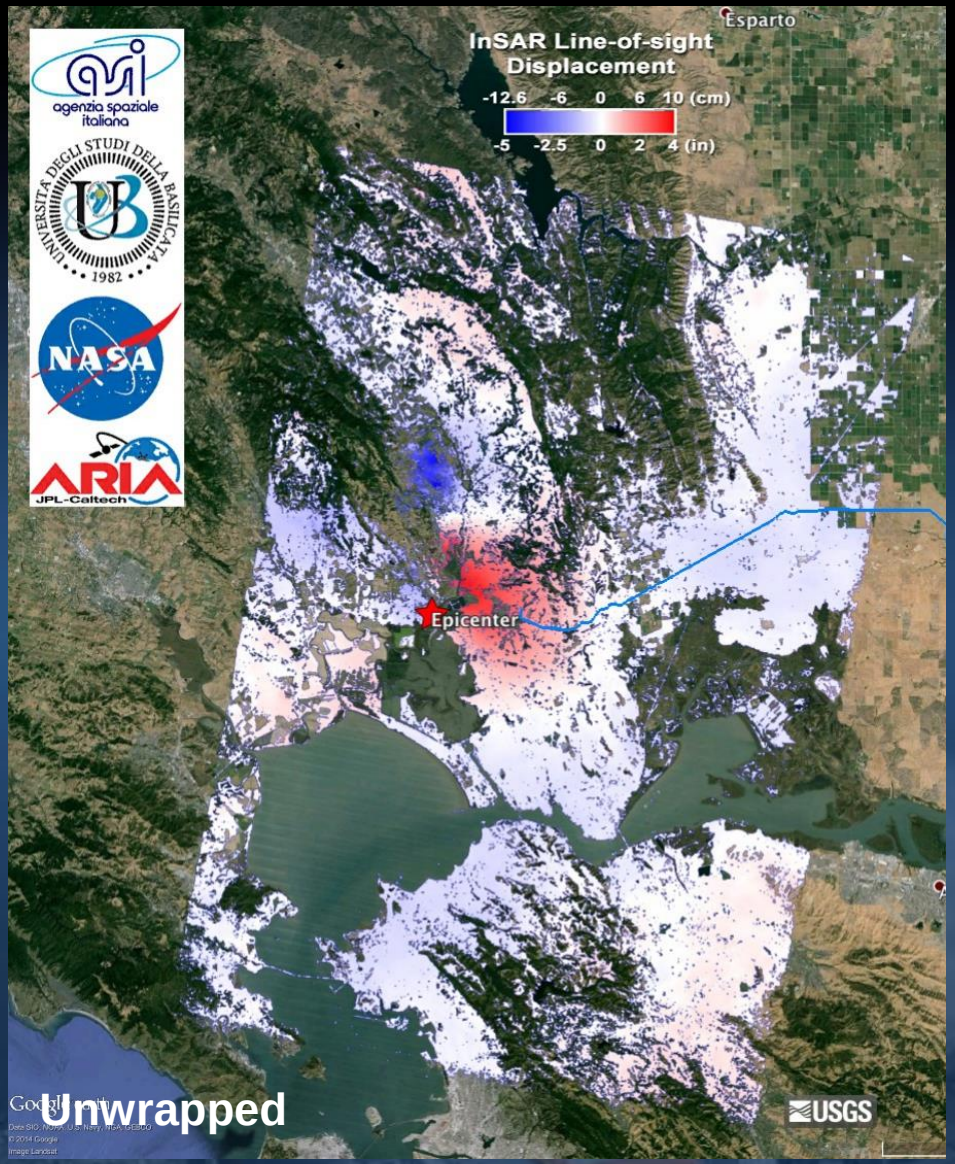
InSAR with COSMO-SkyMed data





Interferogram calculated by ARIA using data from COSMO-SkyMed

Any questions?

Get more information at

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