DOCKETED	
Docket Number:	19-ERDD-01
Project Title:	Research Idea Exchange
TN #:	225822
Document Title:	USGS Overview of ShakeCast
Description:	USGS presentation during Sep 17 scoping workshop
Filer:	Yahui Yang
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	11/6/2018 10:45:24 AM
Docketed Date:	11/6/2018

OVERVIEW OF THE USGS SHAKECAST SYSTEM

CALIFORNIA ENERGY COMMISSION

***David Wald**, Kuo-Wan Lin, Daniel Slosky, Kishor Jaiswal & Nico Luco, **U.S. Geological Survey**, NATIONAL EARTHQUAKE INFORMATION CENTER*

Presented to the California Energy Commission, September 17, 2018

USGS science for a changing world CISN

USGS Earthquake "Event" Web Pages

Earthquake Hazards Program

↩ Latest Earthquakes

Overview

Interactive Map

Regional Information

Impact

Felt Report - Tell Us!

Did You Feel It?

ShakeMap

PAGER

Technical

Origin

Moment Tensor

Focal Mechanism

Finite Fault

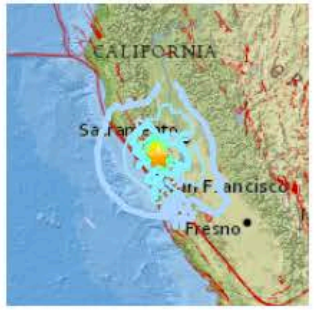
Waveforms

Download Event KML

M 6.0 – South Napa

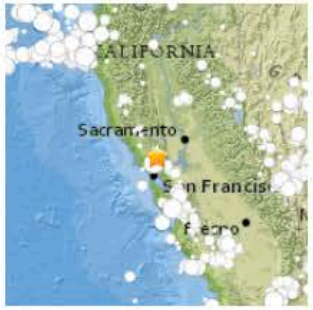
2014-08-24 10:20:44 UTC | 38.215°N 122.312°W | 11.1 km depth

Interactive Map



Contributed by NC[4]

Regional Information



Contributed by NC[4]

Felt Report - Tell Us!

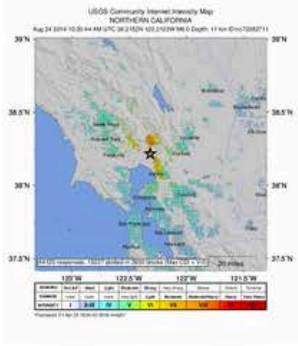
0 4 1 3 6 5

Responses

Contribute to citizen science. Please tell us about your experience.

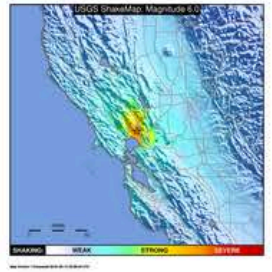
Citizen Scientist Contributions

Did You Feel It? VIII



Contributed by US[5]

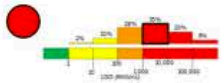
ShakeMap VIII



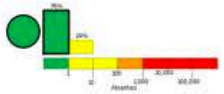
Contributed by ATLAS[2]

PAGER RED

Estimated Economic Losses



Estimated Fatalities



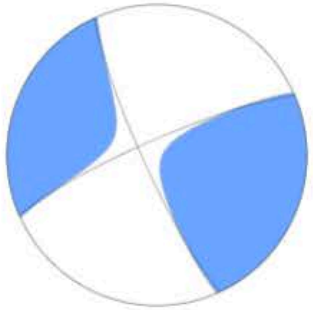
Contributed by US[5]

Origin

Review Status
REVIEWED
Magnitude
6.0 mw
Depth
11.1 km
Time
2014-08-24
10:20:44.070 (UTC)

Contributed by NC[4]

Moment Tensor



Contributed by NC[4]

Finite Fault

Cross-section of slip distribution

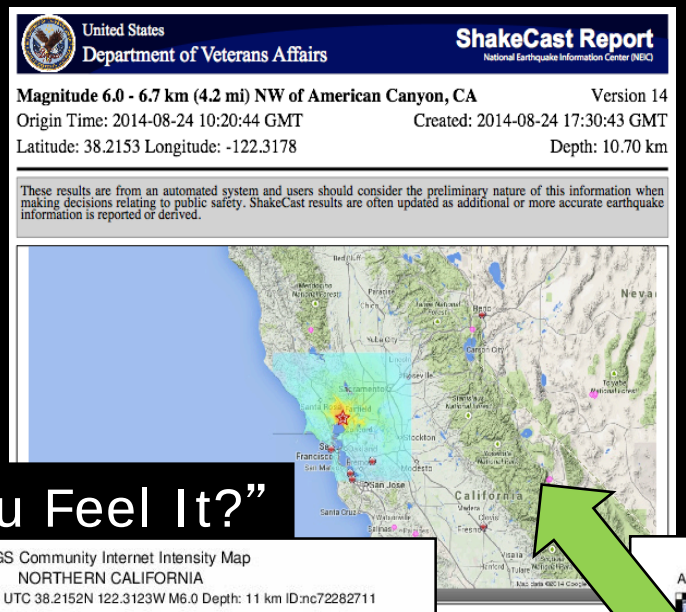
Contributed by US[5]

Tsunami

To view any current tsunami advisories for this and other events, please visit http://www.tsunami.gov.

NOAA

ShakeCast


United States Department of Veterans Affairs

ShakeCast Report
National Earthquake Information Center (NEIC)

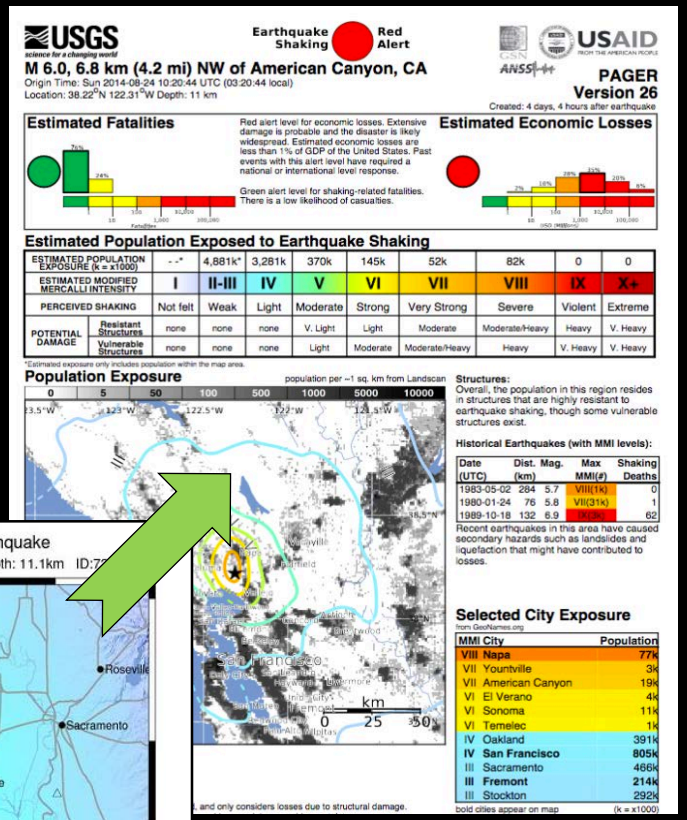
Magnitude 6.0 - 6.7 km (4.2 mi) NW of American Canyon, CA Version 14

Origin Time: 2014-08-24 10:20:44 GMT Created: 2014-08-24 17:30:43 GMT

Latitude: 38.2153 Longitude: -122.3178 Depth: 10.70 km

These results are from an automated system and users should consider the preliminary nature of this information when making decisions relating to public safety. ShakeCast results are often updated as additional or more accurate earthquake information is reported or derived.

PAGER (Prompt Assessment of Global Earthquakes for Response)


USGS science for a changing world

Earthquake Shaking — Red Alert

USAID FROM THE AMERICAN PEOPLE

CISN ANSS

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

*Estimated exposure only includes population within the map area.

Population Exposure

population per ~1 sq. km from Landscan

0 5 50 100 500 1000 5000 10000

Structures:
Overall, the population in this region resides in structures that are highly resistant to earthquake shaking, though some vulnerable structures exist.

Historical Earthquakes (with MMI levels):

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

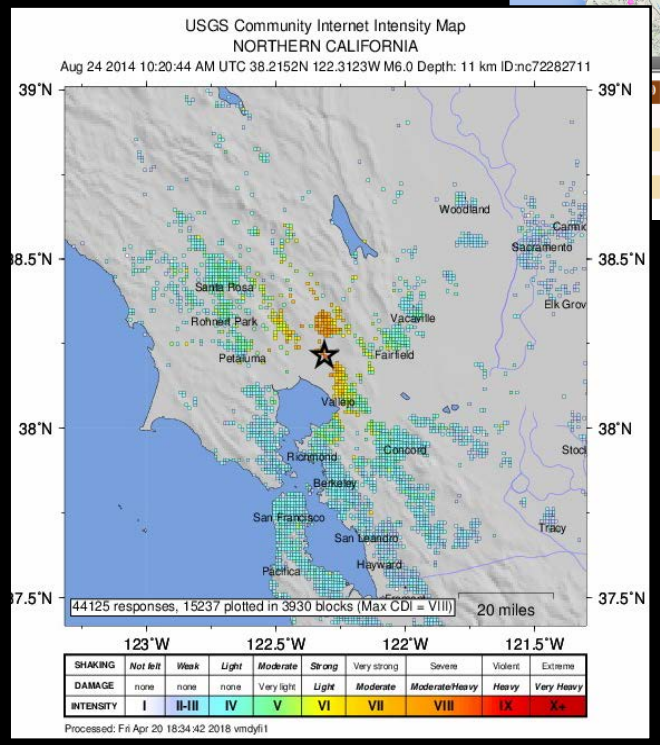
from GeoNames.org

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

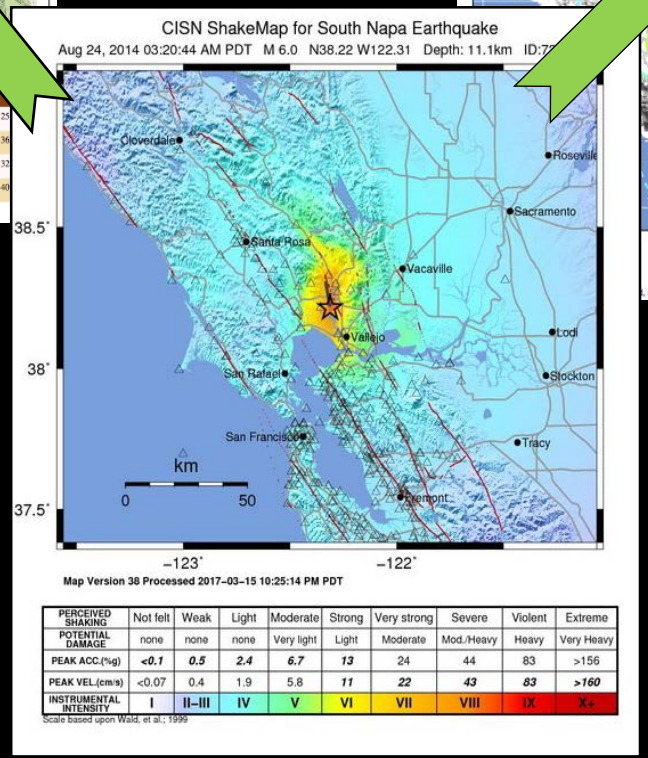
, and only considers losses due to structural damage.

bold cities appear on map (k = x1000)

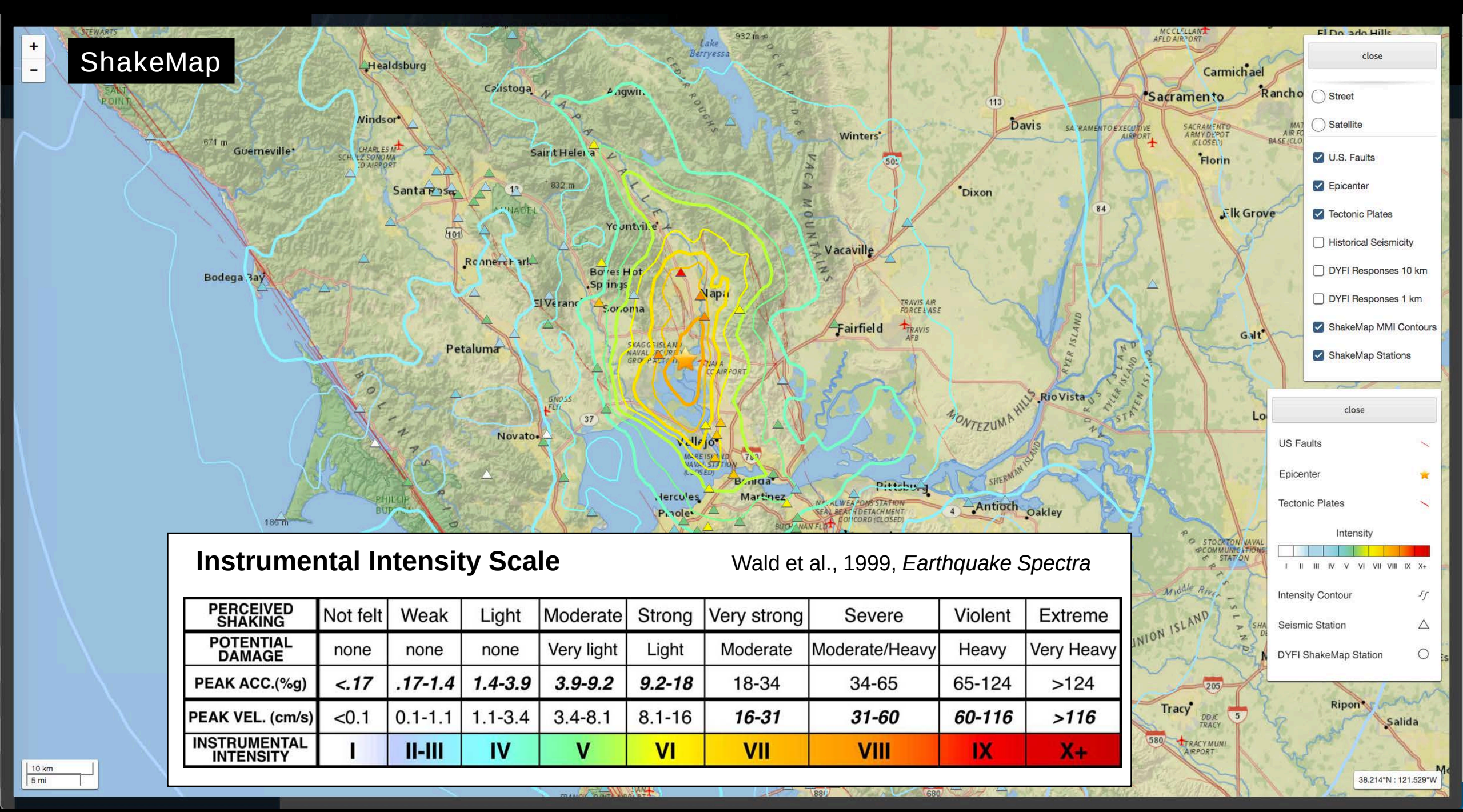
"Did You Feel It?"



ShakeMap



USGS



Instrumental Intensity Scale

Wald et al., 1999, *Earthquake Spectra*

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL. (cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

USGS science for a changing world

11th National Conference on Earthquake Engineering
11NCEE LA2018
June 25–29, 2018

Overview: What is ShakeCast?

- **Open-source USGS software**; user installs (or USGS hosts).
- ***Automatically* retrieves ShakeMap & compares shaking levels with unique facility fragilities**.
- **Generates & delivers report of inspection priorities** (hierarchical lists of facilities likely impacted).
- **Sends notifications & reports to specified personnel/responders**.
- Raises post-earthquake situational awareness in first min. to hrs. following an earthquake.
- Meant to Initiate users' response protocols.
- **Used for planning & training (with scenarios).**

USGS science for a changing world | Caltrans

ShakeCast Report

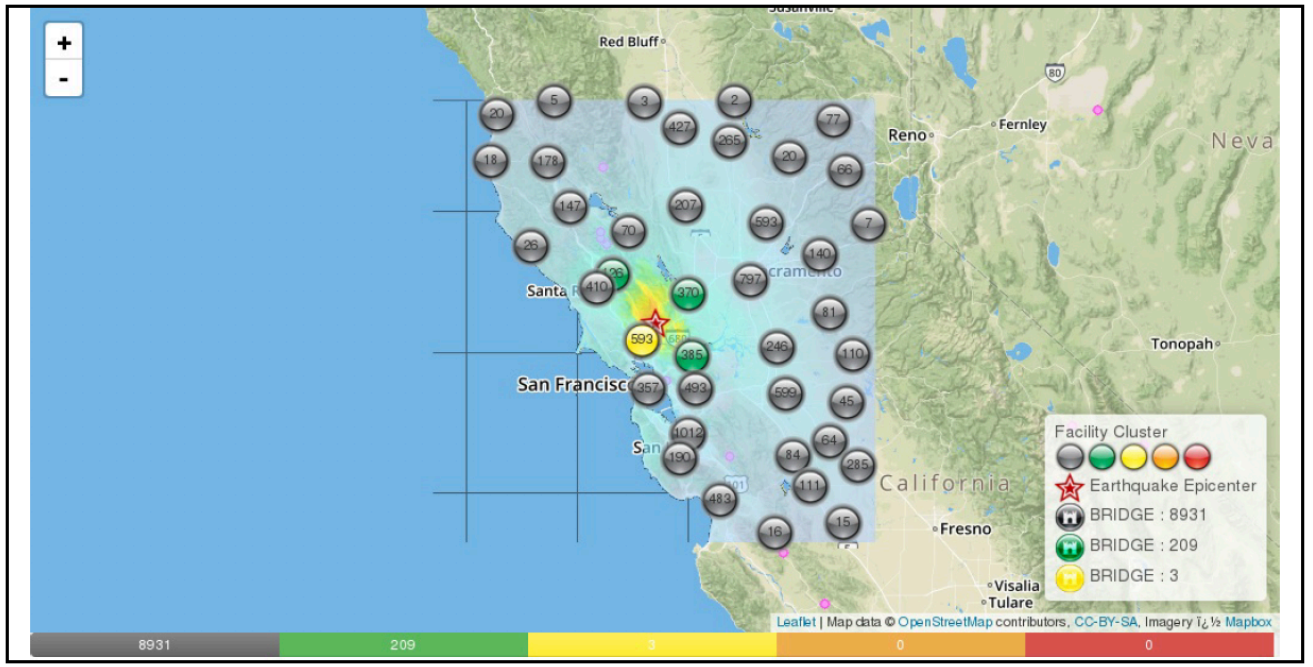
National Earthquake Information Center (NEIC)

Magnitude 6.02 - NORTHERN CALIFORNIA Version 1

Origin Time: 2014-08-24 10:20:44 GMT Created: 2018-06-15 20:39:34 GMT

Latitude: 38.21517 Longitude: -122.31233 Depth: 11.12 km

These results are from an automated system and users should consider the preliminary nature of this information when making decisions relating to public safety. ShakeCast results are often updated as additional or more accurate earthquake information is reported or derived.



Type	ID	Name	Ep. Distance (km)	Inspection Priority	PGA (%g)	PGV (cm/s)	PSA 1s (%g)	MMI	Vs30 (m/s)
BRIDGE	06_21_0098	21_0098 - STANLEY CREEK	4.3	Moderate	40.62	39.65	39.14	VIII	269.477
BRIDGE	06_21_0087	21_0087 - STATE ROUTE 29	8.1	Moderate	39.75	40.02	41.09	VIII	323.411
BRIDGE	06_21C0006	21C0006 - SODA SPRINGS CREEK	15.97	Moderate	22.29	33.05	31.06	VII	331.11
BRIDGE	06_21C0081	21C0081 - CARNEROS CREEK	2.14	Low	41.86	45.24	44.84	VIII	293.382
BRIDGE	06_21C0047	21C0047 - FAGAN CREEK	3.48	Low	33.04	28.63	27.89	VII	298.697
BRIDGE	06_21C0078	21C0078 - HUICHICHA CREEK	3.76	Low	41.78	41.55	40.81	VIII	307.819
BRIDGE	06_21_0049	21_0049 - NVRR NAPA RIVER STANLY	4.06	Low	34.59	38.13	37.43	VIII	219.46

ShakeCast: Sample Critical Users

Agencies

U.S.NRC

U.S. Fish & Wildlife Service

The Montana Department of Natural Resources & Conservation

US Army Corps

State of California Department of Conservation

Division of Oil, Gas, and Geothermal Resources

United States Department of Veterans Affairs

IAEA.org International Atomic Energy Agency

Transportation

Caltrans

WSDOT

LA Metro

UDOT Keeping Utah Moving

Nevada DOT

IDAHO Transportation Department

Oregon Department of Transportation

Oklahoma Department of Transportation

Business

Walmart

Travelers

Target

amazon Global Security prepare. secure. protect.

aem

1916 | 2016 Boeing

Lifelines/Utilities

Alameda County Water District — Serving the cities of Fremont, Newark, and Union City, California

County of Los Angeles Public Works — Public Service That Works

Southern California Edison — An Edison International Company

Santa Clara Valley Water District

San Francisco Water Power Sewer — Services of the San Francisco Public Utilities Commission

The Metropolitan Water District of Southern California

East Bay Municipal Utility District

Los Angeles Department of Water & Power

Sempra Energy

Department of Water Resources

PSE Puget Sound Energy

Critical Facilities

FERC Federal Energy Regulatory Commission

Raytheon

Department of Energy Hanford

OSHPD

Sandia National Laboratories

NASA Jet Propulsion Laboratory California Institute of Technology

Education

USC University of Southern California

Los Angeles Unified School District — Board of Education

Emergency Management

Utah Emergency Management

Engineering

MRP Engineering

Degenkolb

USRC U.S. Resiliency Council — Rating Building Performance in Natural Disasters

Infra • Terra

Port of Long Beach — The Green Port

Regional Integrated Multi-Hazard Early Warning System RIMES

California Department of TRANSPORTATION

ShakeCast Report

National Earthquake In

Magnitude 6.7 - Northridge

Origin Time: 1994-01-17 12:30:55 GMT

Created: 2014-02-21 1

Latitude: 34

These results
making decisi
information is

Type	ID
BRIDGE_ST	53 279
BRIDGE_ST	53 279
BRIDGE_ST	53 279
BRIDGE_ST	53 279
BRIDGE_ST	53 221
BRIDGE_ST	53 220
BRIDGE_ST	53 220
BRIDGE_ST	53 220

USGS science for a changing world

Dam & Public Safety ShakeCast Report

SOUTHERN CALIFORNIA EDISON

An EDISON INTERNATIONAL Company

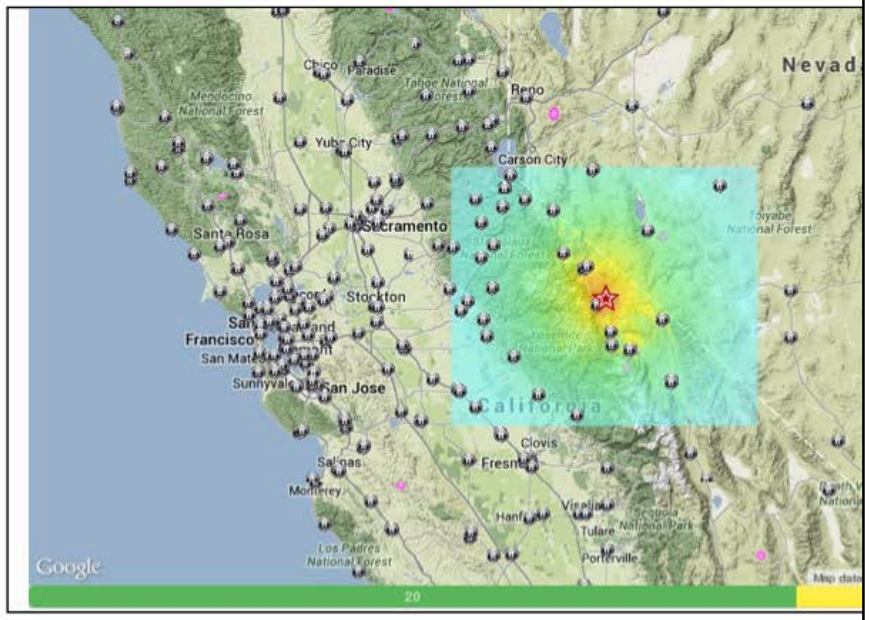
Magnitude 6.8 - Mono Lake

Origin Time: 2012-10-10 12:00:00 GMT

Created: 2

Latitude: 38.0320 Longitude: -119.0640

These results are from an automated system and users should consider the preliminar
making decisions relating to public safety. ShakeCast results are often updated as addit
information is reported or derived.



Name	Ep. Distance (km)	Review / Inspection Priority	PGA (%g)	PGV (cm/s)	PSA
Lundy Lake Dam	13.7	Moderate	32.84	33.24	65.73
Vermillion Valley Dam	73.79	Low	6.24	4.33	13.15
Tioga Lake Dam	20.08	Low	18.23	10.6	38.55
Saddlebag Dam	19.71	Low	18.79	11.02	39.88
Rhinedollar Dam	18.27	Low	19.37	11.46	41.29

United States Department of Veterans Affairs

ShakeCast Report

National Earthquake Information Center (NEIC)

Magnitude 5.1 - 2.4 km (1.5 mi) WNW of Brea, CA

Version 3

4:09:41 GMT

Created: 2014-03-29 04:33:23 GMT

e: -117.9222

Depth: 1.94 km

ed system and users should consider the preliminary nature of this information when

IAEA International Atomic Energy Agency

Nuclear ShakeCast

International Seismic Safety Centre (ISSC)

M 6.3 - KYUSHU, JAPAN

Version 1

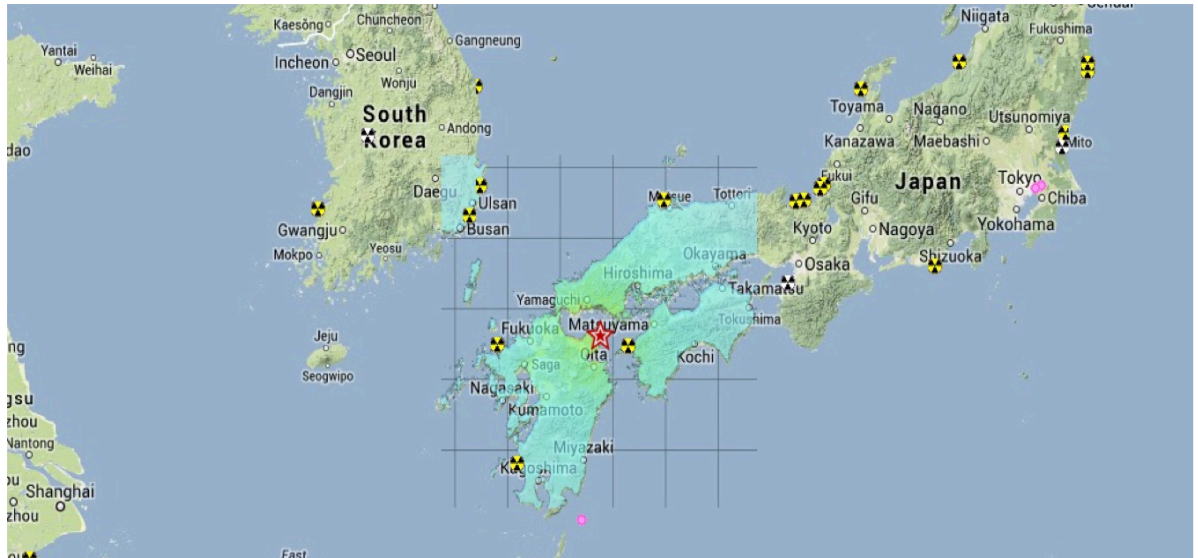
Origin Time: 2014-03-13 17:06:51 GMT

Created: 2014-03-13 17:28:23 GMT

Latitude: 33.6827 Longitude: 131.7366

Depth: 82.92 km

These results are from an automated system and users should consider the preliminary nature of this information when making decisions relating to public safety. ShakeCast results are often updated as addtional or more accurate earthquake information is reported or derived.



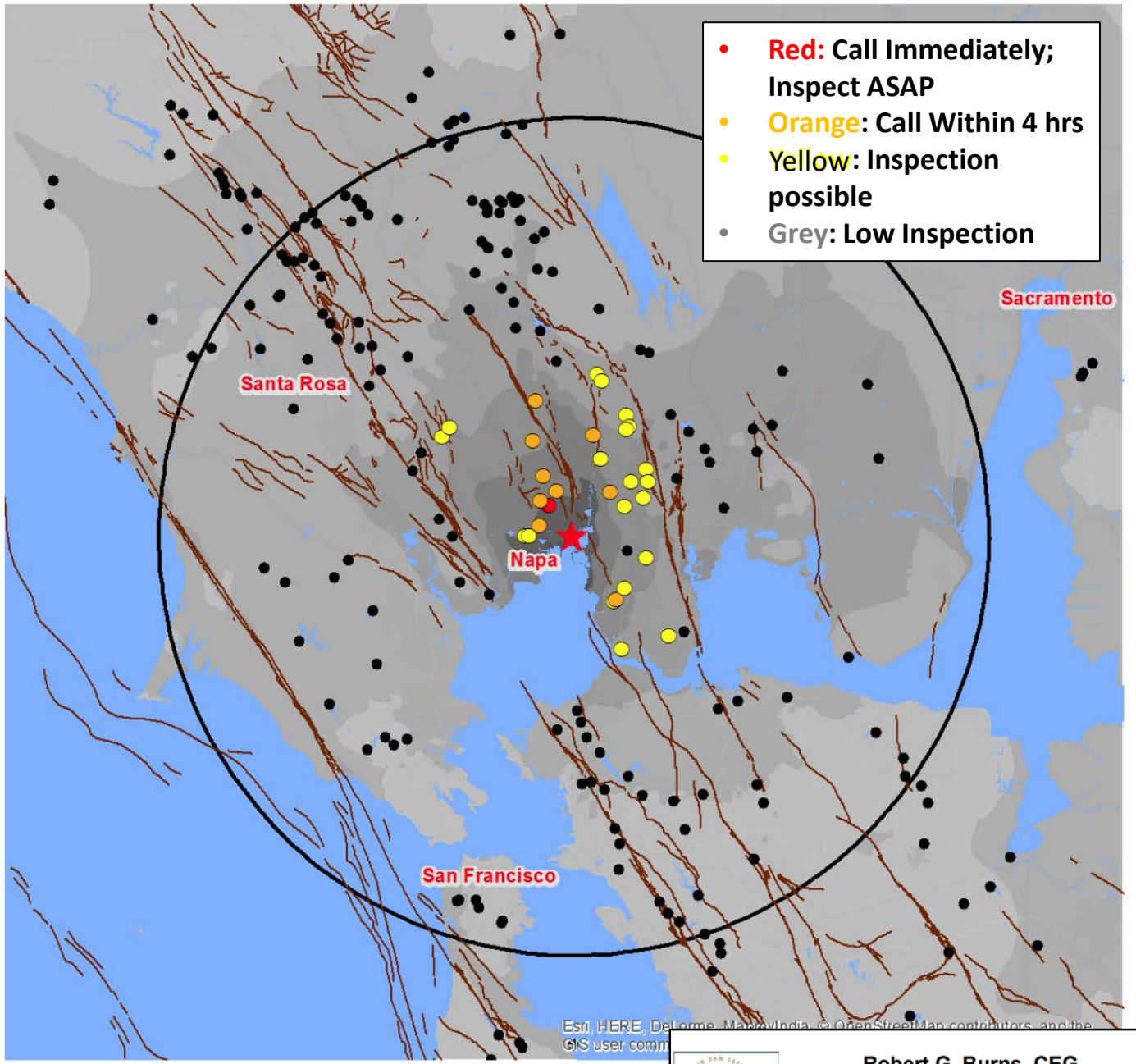
M6.0 Napa Earthquake
August 28, 2014

Search Radius

161 Dams

ShakeCast

31 Dams



Robert G. Burns, CEG
California Division of Safety of Dams

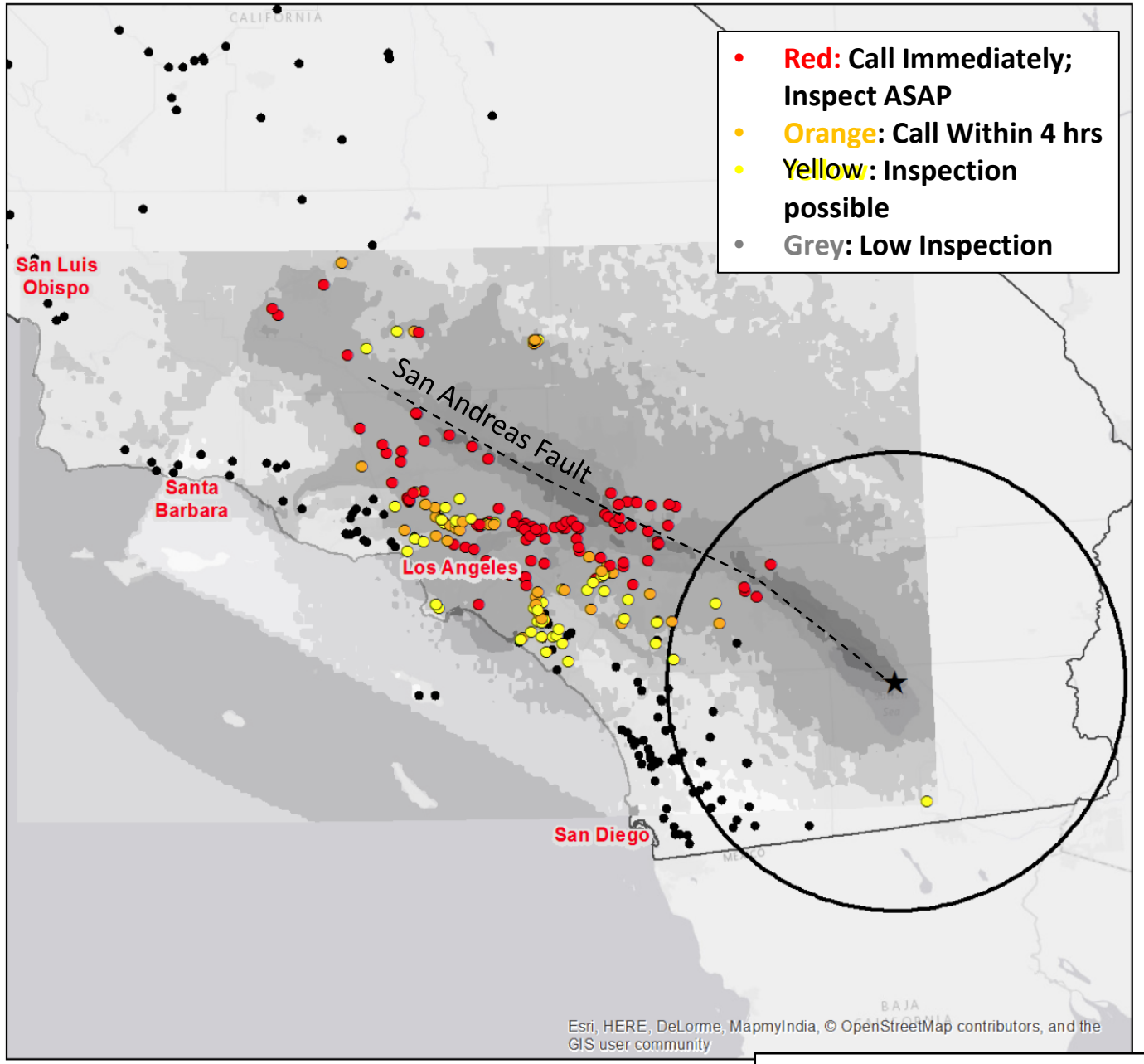
USGS
M7.8 ShakeOut
Scenario (2008)

Search Radius

26 Dams

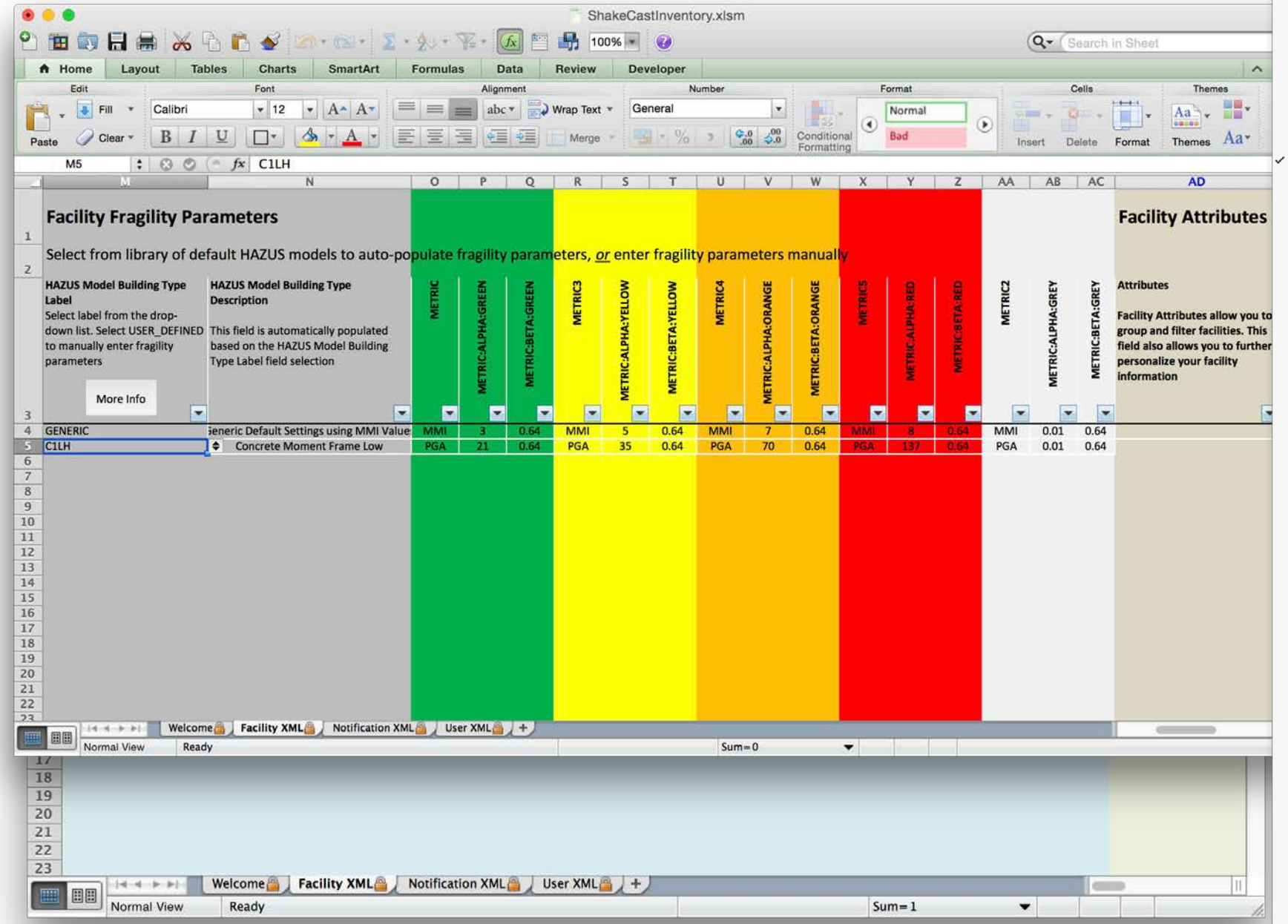
ShakeCast

190 Dams



Robert G. Burns, CEG
California Division of Safety of Dams

SHAKECAST WORKBOOK: FOR FACILITIES, FRAGILITIES, NOTIFICATIONS



W1H
W2H
S1LH
S1MH
S1HH
S2LH
S2MH
S2HH
S3H
S4LH
S4MH
S4HH
✓ C1LH
C1MH
C1HH
C2LH
C2MH
C2HH
PC1H
PC2LH
PC2MH
PC2HH
RM1LH
RM1MH
RM2LH
RM2MH
RM2HH
MHH
W1M
W2M
S1LM
S1MM
S1HM
S2LM
S2MM
S2HM
S3M
S4LM
S4MM
S4HM
C1LM
C1MM
C1HM
C2LM
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PC1M
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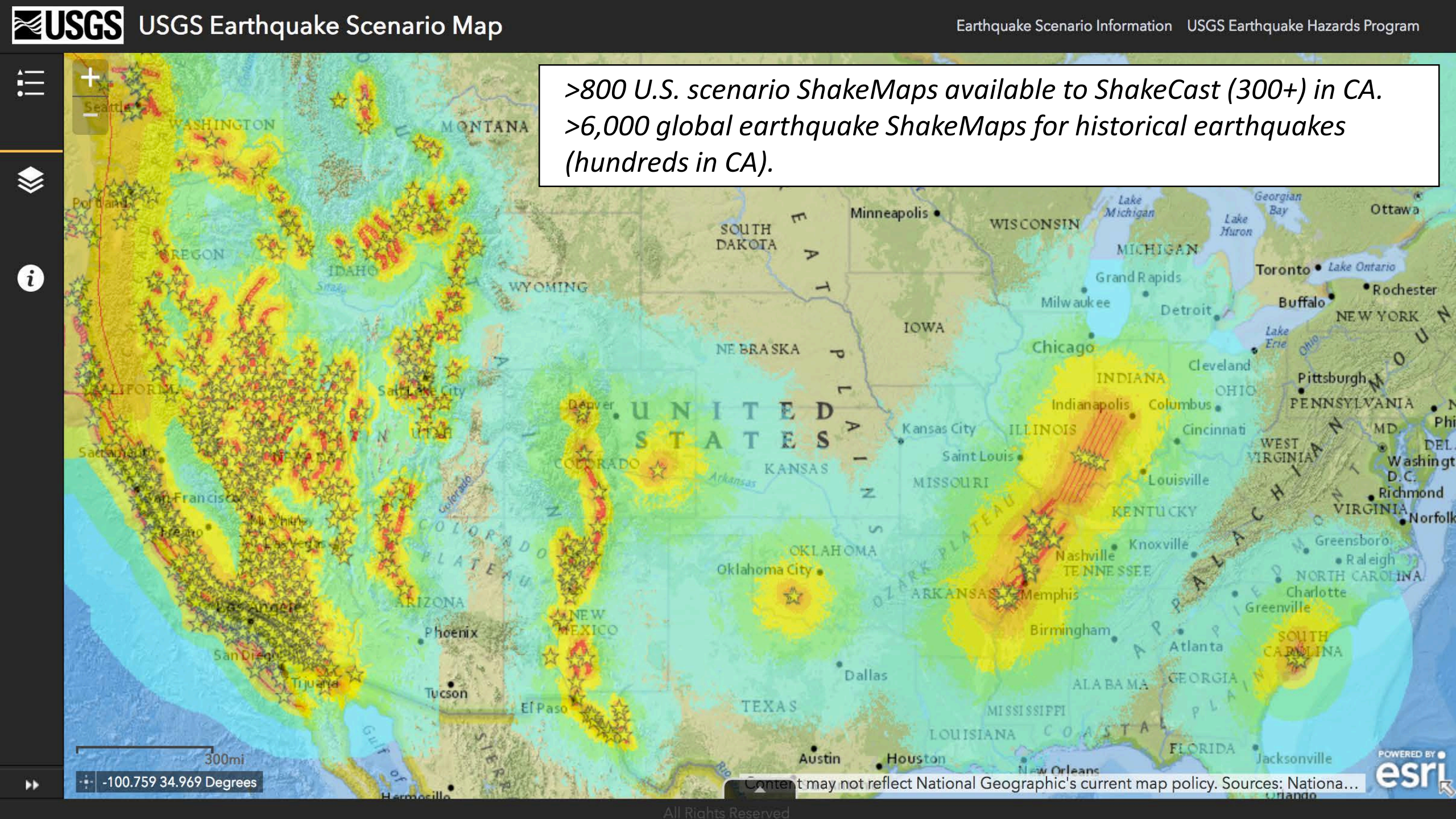
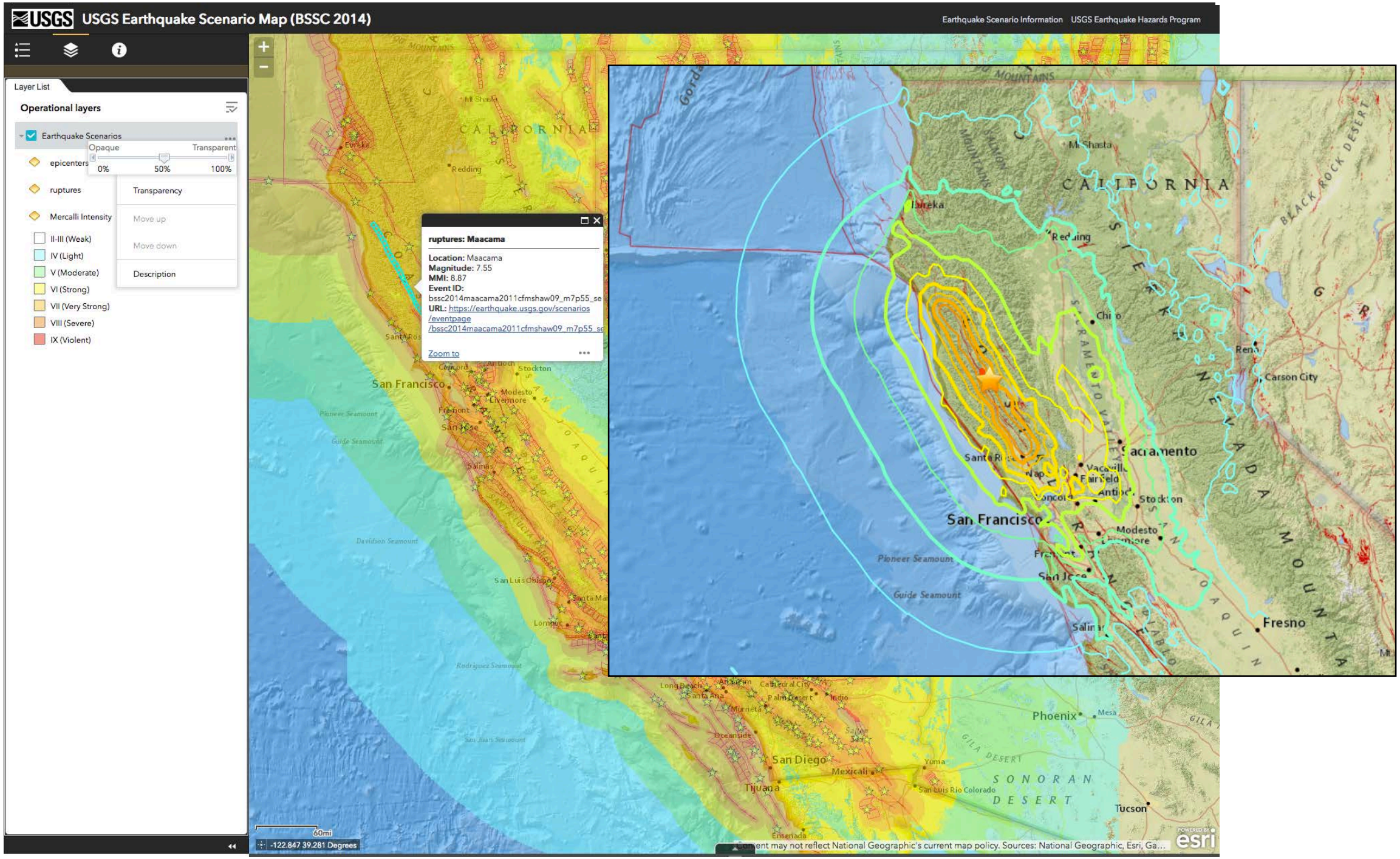
PC2MM
PC2HM
RM1LM
RM1MM
RM2LM
RM2MM
RM2HM
MHM


USGS Earthquake Scenario Map
Earthquake Scenario Information
USGS Earthquake Hazards Program
>800 U.S. scenario ShakeMaps available to ShakeCast (300+) in CA.
>6,000 global earthquake ShakeMaps for historical earthquakes (hundreds in CA).
Seattle
WASHINGTON
MONTANA
Portland
OREGON
IDAHO
WYOMING
SOUTH DAKOTA
Minneapolis
WISCONSIN
MICHIGAN
Lake Michigan
Lake Huron
Georgian Bay
Ottawa
Toronto
Lake Ontario
Grand Rapids
Milwaukee
Detroit
Buffalo
Rochester
NEW YORK
IOWA
NEBRASKA
Chicago
Cleveland
Lake Erie
Pittsburgh
PENNSYLVANIA
INDIANA
OHIO
Indianapolis
Columbus
Cincinnati
Kansas City
ILLINOIS
Saint Louis
WEST VIRGINIA
MD.
Washington D.C.
Richmond
VIRGINIA
Norfolk
Louisville
KENTUCKY
MISSOURI
KANSAS
Knoxville
Nashville
TENNESSEE
Greensboro
Raleigh
NORTH CAROLINA
Charlotte
Greenville
SOUTH CAROLINA
Atlanta
GEORGIA
Birmingham
ALABAMA
MISSISSIPPI
LOUISIANA
FLORIDA
Jacksonville
New Orleans
Houston
Austin
Dallas
TEXAS
Oklahoma City
OKLAHOMA
ARKANSAS
Memphis
Denver
COLORADO
Salt Lake City
UTAH
NEVADA
CALIFORNIA
Sacramento
San Francisco
Fresno
Los Angeles
San Diego
Tijuana
Phoenix
ARIZONA
NEW MEXICO
Tucson
El Paso
Hermosillo
Gulf of California
Colorado Plateau
Ozark Plateau
Great Plains
Appalachian Mountains
Coastal Plain
300mi
-100.759 34.969 Degrees
Content may not reflect National Geographic's current map policy. Sources: Nationa…
POWERED BY esri
All Rights Reserved


USGS Earthquake Scenario Map (BSSC 2014)
Earthquake Scenario Information
USGS Earthquake Hazards Program
Layer List
Operational layers
Earthquake Scenarios
Opaque
Transparent
0%
50%
100%
epicenters
ruptures
Mercalli Intensity
II-III (Weak)
IV (Light)
V (Moderate)
VI (Strong)
VII (Very Strong)
VIII (Severe)
IX (Violent)
Transparency
Move up
Move down
Description
ruptures: Maacama
Location: Maacama
Magnitude: 7.55
MMI: 8.87
Event ID:
bssc2014maacama2011cfmshaw09_m7p55_se
URL: https://earthquake.usgs.gov/scenarios/eventpage/bssc2014maacama2011cfmshaw09_m7p55_se
Zoom to
San Francisco
Sacramento
Fresno
Phoenix
San Diego
Tucson
Carson City
Reno
Stockton
Modesto
Pioneer Seamount
Guide Seamount
Davidson Seamount
Rodriguez Seamount
CALIFORNIA
SIERRA NEVADA MOUNTAINS
SONORAN DESERT
GILA DESERT
BLACK ROCK DESERT
60mi
-122.847 39.281 Degrees
esri

↩ Latest Earthquakes

Overview

Interactive Map

Regional Information

Impact

Felt Report - Tell Us!

Did You Feel It?

ShakeMap

Ground Failure

Technical

Origin

Focal Mechanism

Waveforms

Aftershock Forecast

Download Event KML

View Nearby Seismicity

Earthquakes

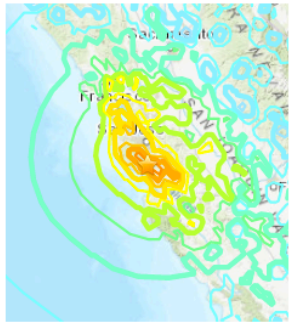
Hazards

BETA - Provide Feedback

M 6.9 – Loma Prieta, California Earthquake

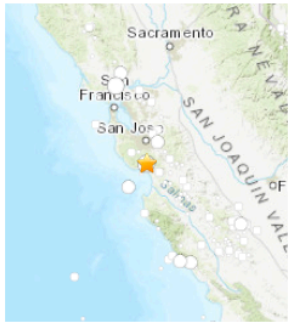
1989-10-18 00:04:15 (UTC) | 37.036°N 121.880°W | 17.2 km depth

Interactive Map



Contributed by NC [5]

Regional Information



Contributed by NC [5]

Felt Report - Tell Us!

0 0 0 0 2 3

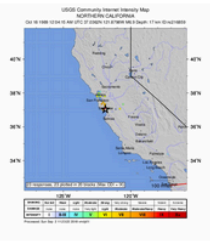
Responses

Contribute to citizen science. Please tell us about your experience.

Citizen Scientist Contributions

Did You Feel It?

IX

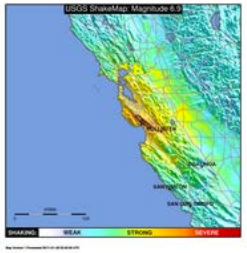


Community Internet Intensity Map

Contributed by US [6]

ShakeMap

IX



Contributed by ATLAS[1]

Ground Failure

Landslides

Significant area affected

Significant population exposed

Liquefaction

Significant area affected

Extensive population exposed

Contributed by US [6]

Origin

Review Status

REVIEWED

Magnitude

6.9 mh

Depth

17.2 km

Time

1989-10-18 00:04:15 UTC

Contributed by NC [5]

Focal Mechanism

Fault Plane Solution

Contributed by NC [5]

Aftershock Forecast

Be ready for more earthquakes.

Our model of the expected numbers and odds of future earthquakes.

Contributed by US [6]

View Nearby Seismicity

Time Range

± Three Weeks

Search Radius

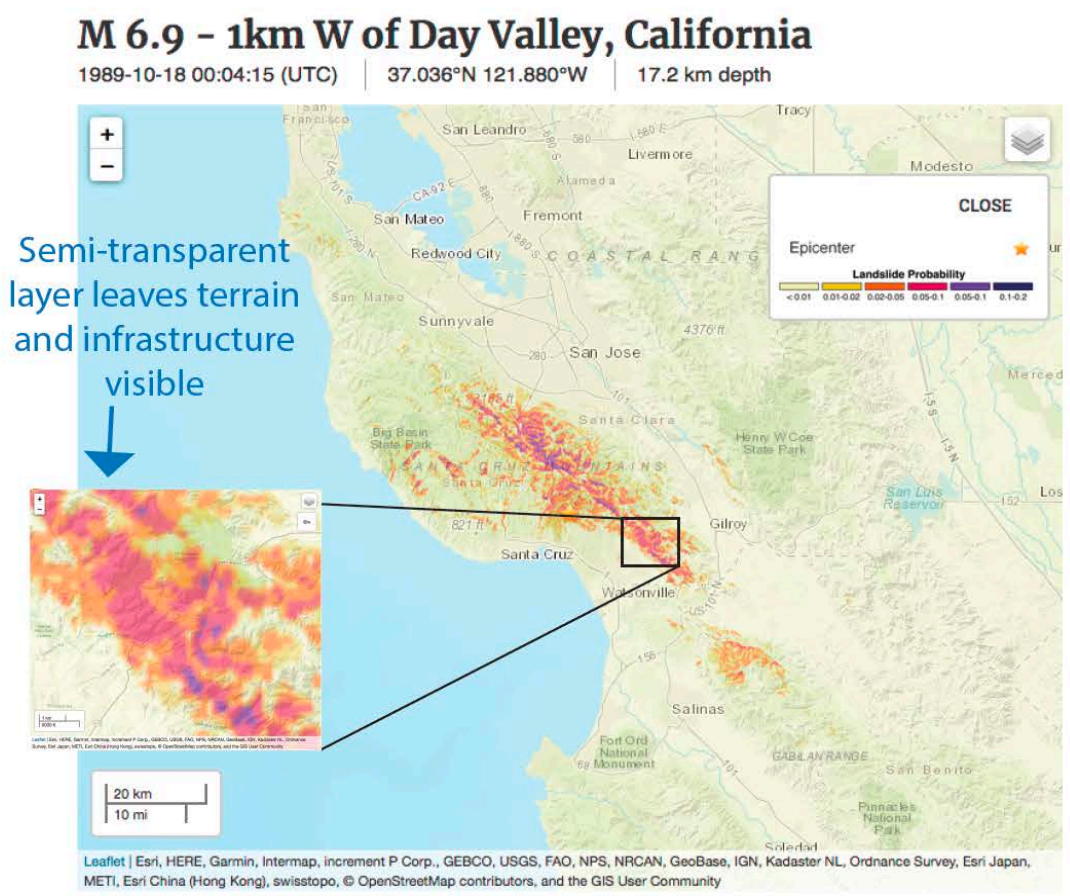
250.0 km

Magnitude Range

≥ 3.0

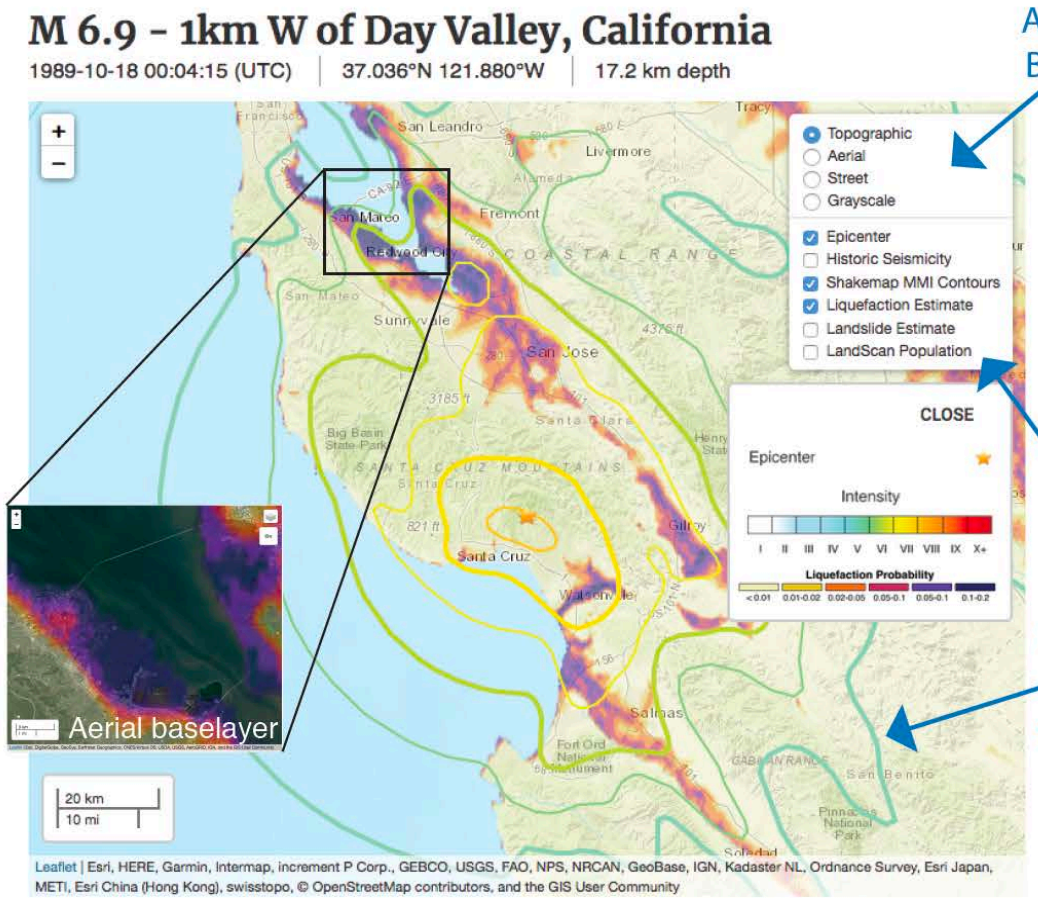
ANSS Comcat

Landslide Map



Semi-transparent layer leaves terrain and infrastructure visible

Liquefaction Map



Alternative Baselayers

Can add other earth-quake layers, like shaking contours and population

Landslide Probability

< 0.01	0.01-0.02	0.02-0.05	0.05-0.1	0.05-0.1	0.1-0.2

Liquefaction Probability

< 0.01	0.01-0.02	0.02-0.05	0.05-0.1	0.05-0.1	0.1-0.2

- Probability type is areal coverage
- Logarithmic bins to better visualize range of typical values
- Saturates at probability of 0.2, which equates to severe ground failure. Neither model ever reaches values much higher than 0.2.
- Same colorbar bins for both models

Kate Allstadt & Eric Thompson, USGS

Natural Gas Seismic Risk & Response R&D Gap Analysis

- **Need basic & refined fragility curves/tables for NG infrastructure:**
  - Storage facilities, pipelines & buildings, etc.
  - Tied to ShakeMap intensity measures (IMs, like PGV), or require new IMs.
- **Add strong motion stations at key facilities**
  - Add to USGS ShakeMap or locally inject.
  - Incorporate MEM sensors (PG&E, others)?
- **Ground Failure analyses:**
  - Landslide/liquefaction probabilities → volumes & displacements
  - Better geotechnical layers needed; mechanistic modeling needed for local scale
  - Landslide/liquefaction product integration; consolidated alerting
- **V4 development (pyCast)**
  - Pipeline-specific requirements: pipeline segments/geometries; consolidated alerting
  - Standardized response protocols