

# Hot Science Cool Talks

UT Environmental Science Institute

# 29

## ***Citizen Science: Man vs. Machine in Providing Rapid Earthquake Information***

**Dr. David Wald  
March 26, 2004**

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# **Citizen Science: *Man versus Machine* in Providing Rapid Earthquake Information**

***Dr. David Wald ([wald@usgs.gov](mailto:wald@usgs.gov))***

***United States Geological Survey, Golden, Colorado  
&  
Colorado School of Mines, Golden, Colorado***



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

# *Special Thanks to...*

## *The Seismological Society of America*



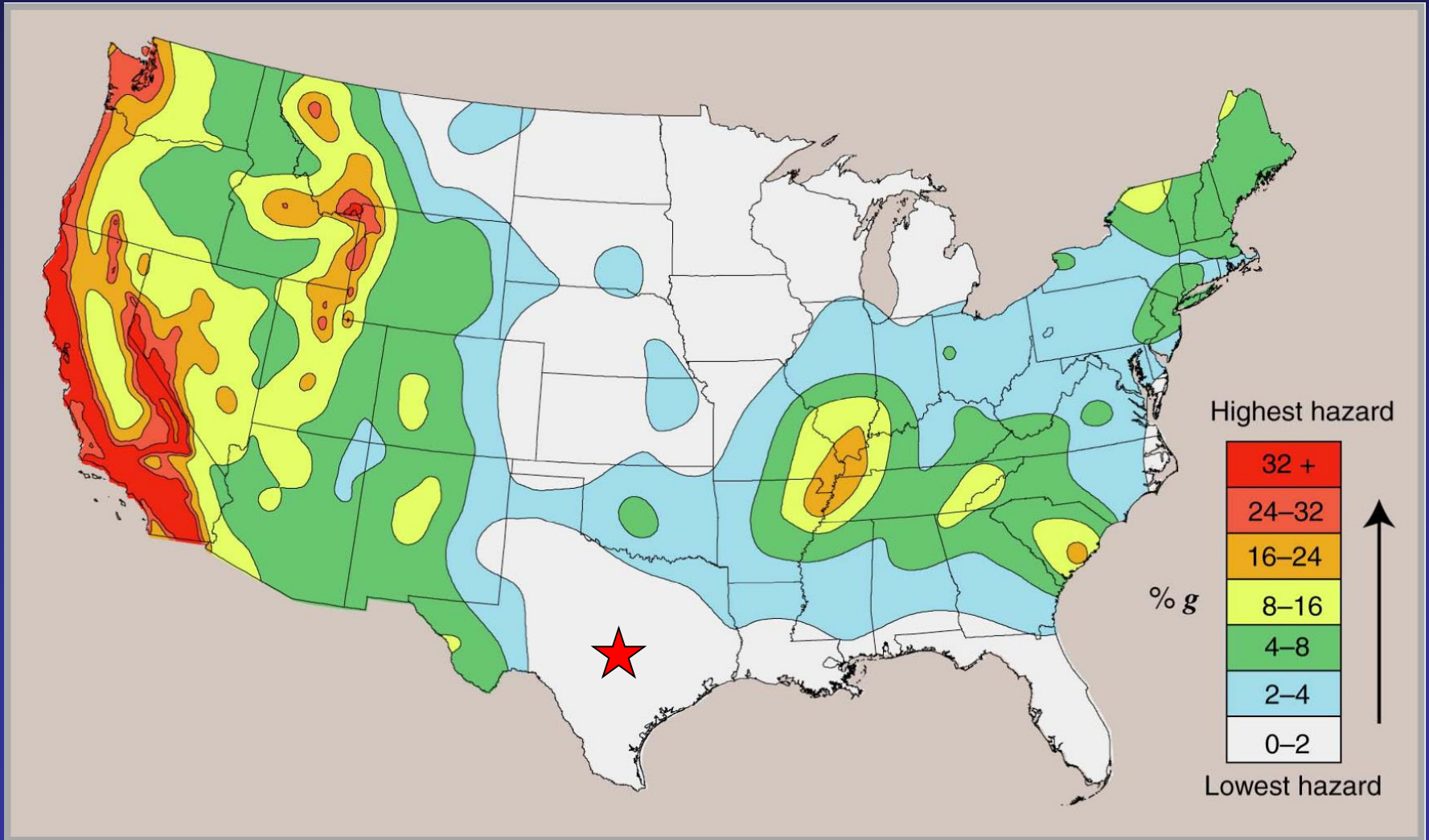
## *The Incorporated Research Institutions for Seismology*



# *Talk Outline...*

- **Brief Overview of Earthquake Hazards**
- **ShakeMap (“Machine”)**
- **“Did You Feel It?” (“Man”)**

# United States Geological Survey's National Hazard Map



# USGS National Earthquake Information Center

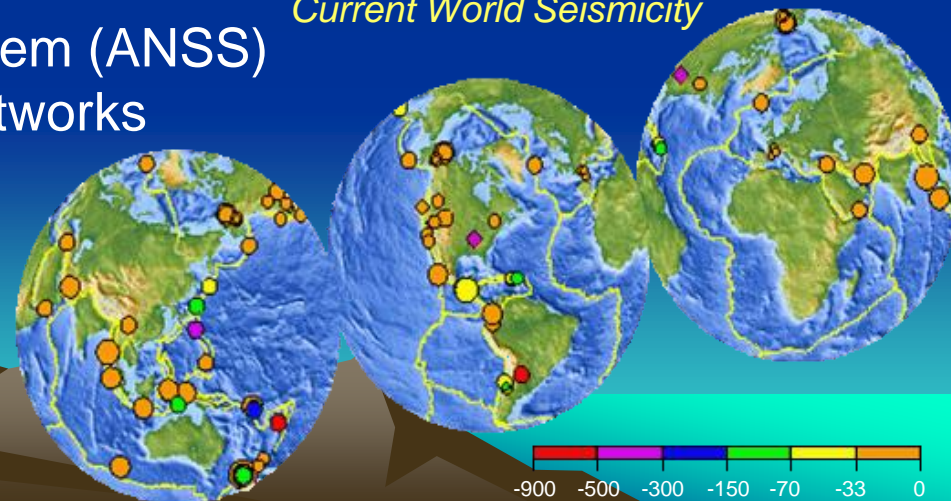
## Earthquake Monitoring

- The USGS is the federal agency responsible for comprehensive monitoring of earthquakes (nationally & globally)
- Rapid reporting of earthquake information for post-earthquake & emergency response
- Distribution of earthquake information for public awareness of hazards and mitigation
- Data collection and analysis for mitigation research and decision making (land-use and planning, earthquake engineering, retrofit, etc.)

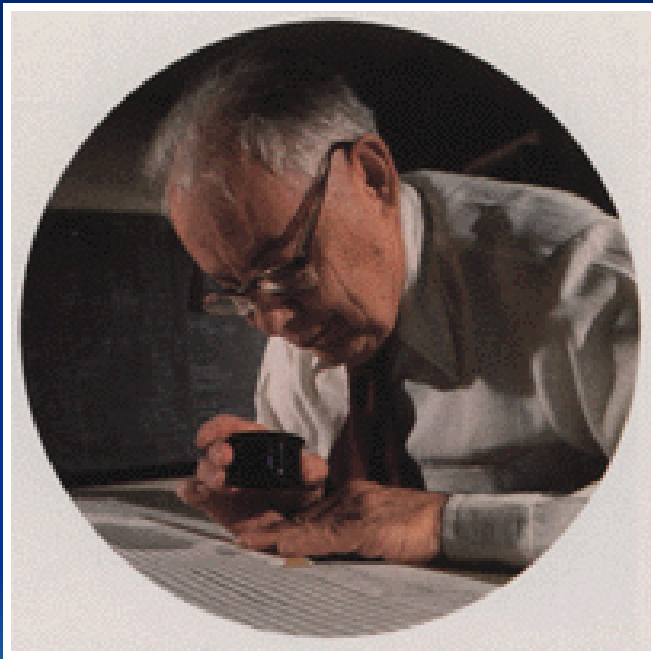
## Seismic Networks

- Advanced National Seismic System (ANSS)
- Regional and Urban Seismic Networks
- Global Seismograph Network

*Current World Seismicity*



# Magnitude *vs.* Intensity



# Magnitude

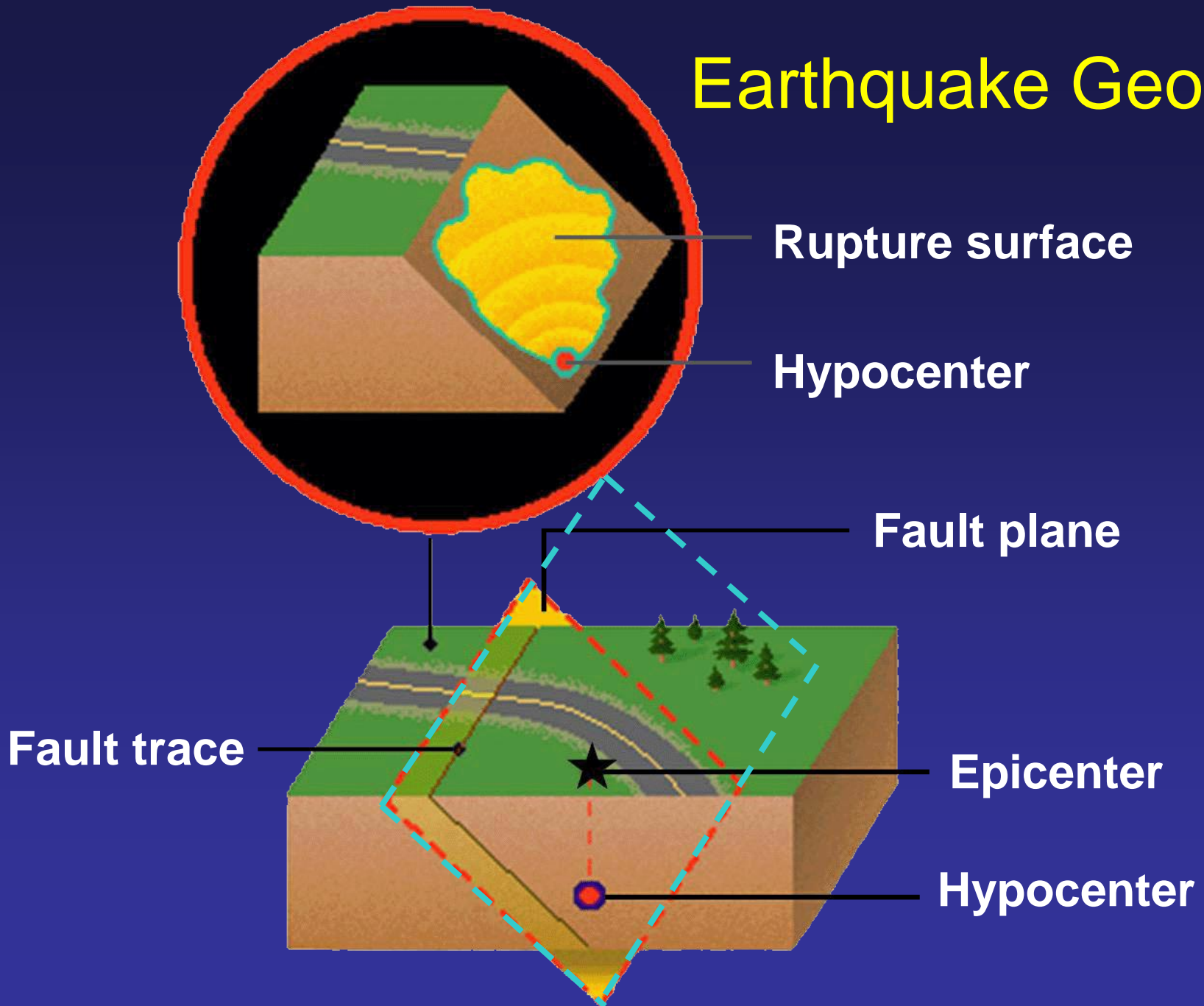
- Represents the **size** of the earthquake, but not necessarily the damage or shaking level
- Determined by area of the fault and how much it slipped
- **Decimal value** (e.g., 6.7). Only one value is used for a single earthquake
- Described by the “**Richter scale**”, though “energy” magnitude is now generally used

# Intensity

- Represents the **effects** of an earthquake: the **shaking** and **damage** at different locations
- Determined from observations of shaking and damage
- **Roman numerals** from I to X are used. The value varies depending on **location**
- The **Modified Mercalli Intensity Scale** is used in U.S.



# Earthquake Geology



# What Controls the Level of Shaking?

- Magnitude
  - Larger faults, stronger shaking, longer duration, and energy released over a larger area
- Distance from fault
  - Shaking decays with distance
- Site Effects
  - Very soft soils amplify the shaking
- Focusing
  - Local pockets of higher shaking (lens effect)
- Directivity (location of epicenter)
  - Strongest shaking in direction of rupture

1989, magnitude 6.9,  
Loma Prieta earthquake-  
damage occurred distant  
from the epicenter

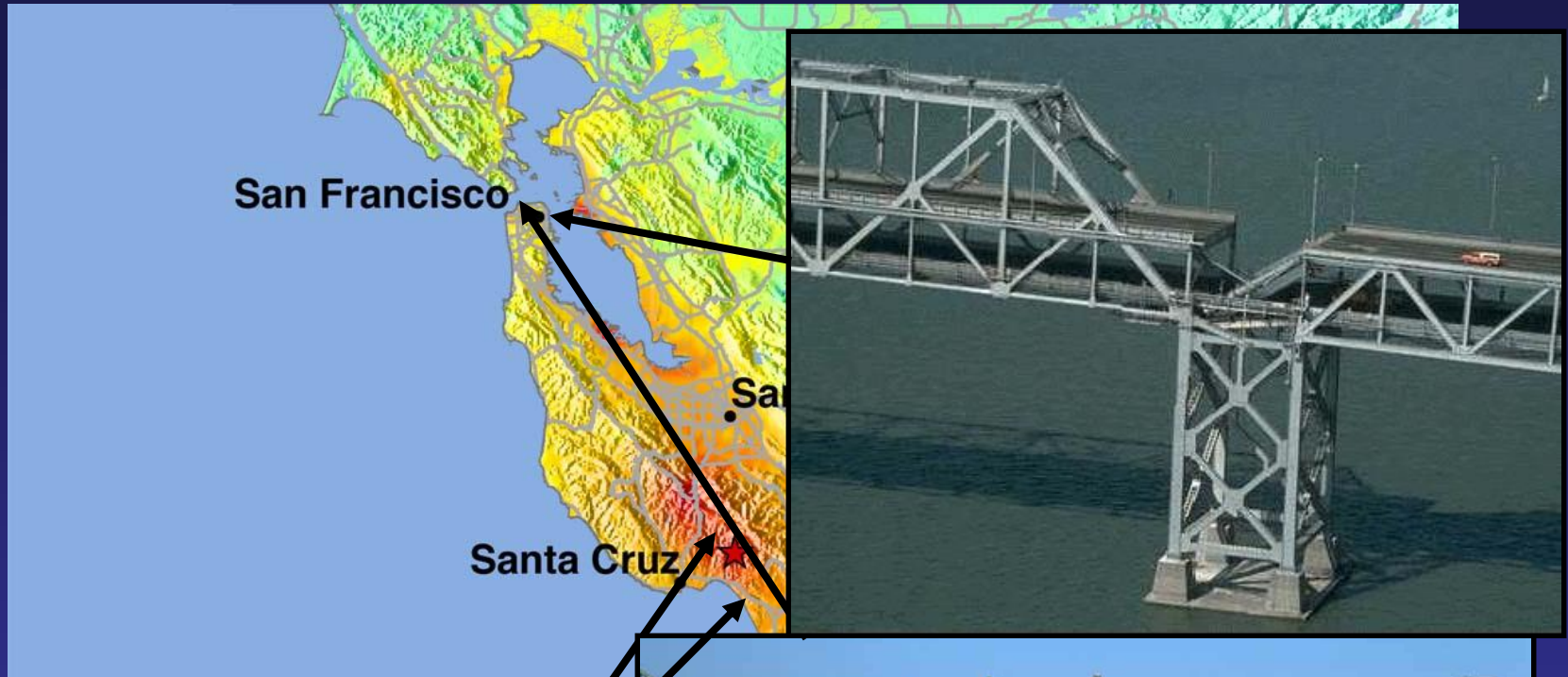


# Moving Beyond Magnitude and Epicenter ....

# USGS/UCB/CDMG *ShakeMap*: Magnitude 6.9



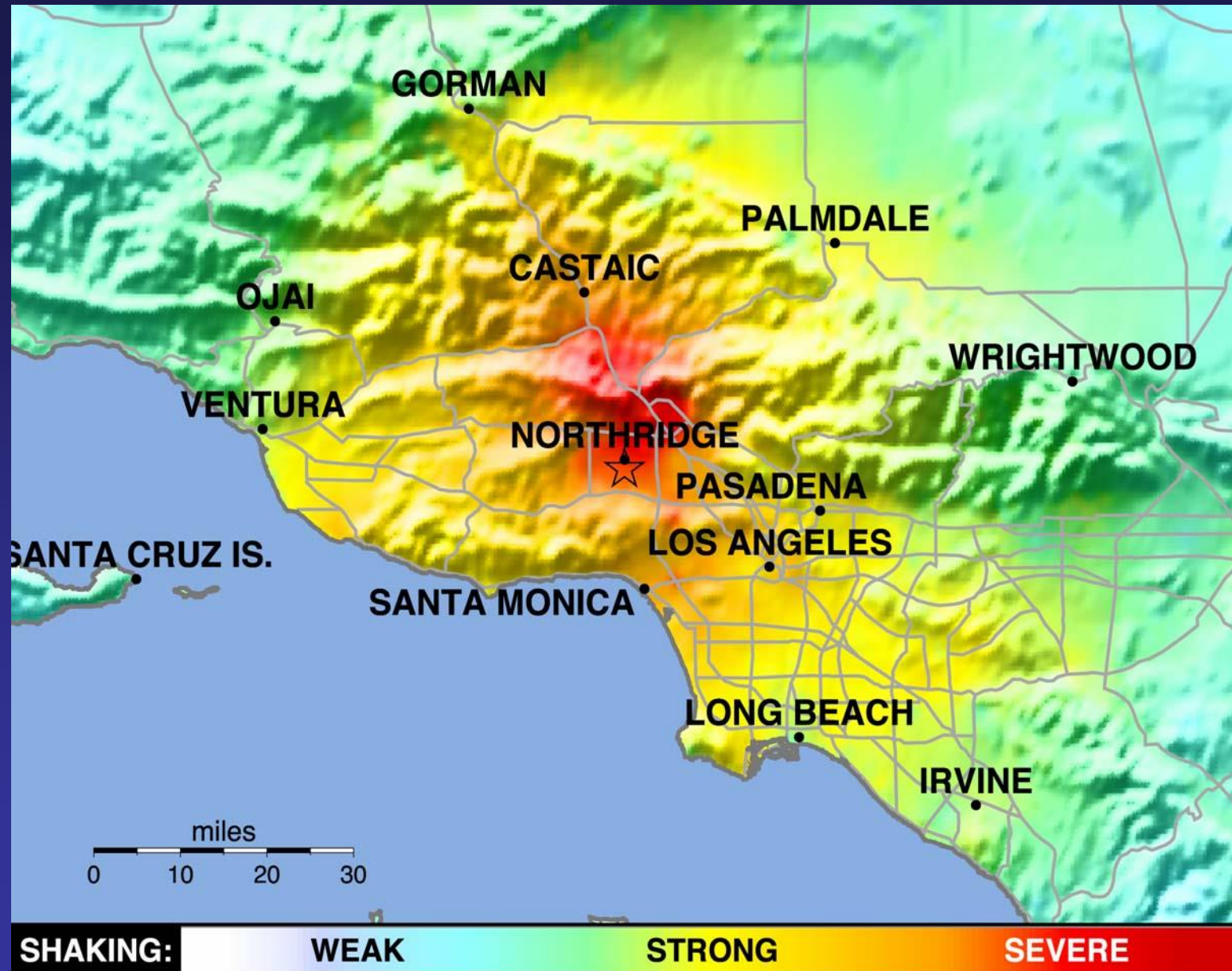
# USGS/UCB/CDMG *ShakeMap*: Magnitude 6.9



# 1994 Northridge Earthquake (Magnitude 6.7)



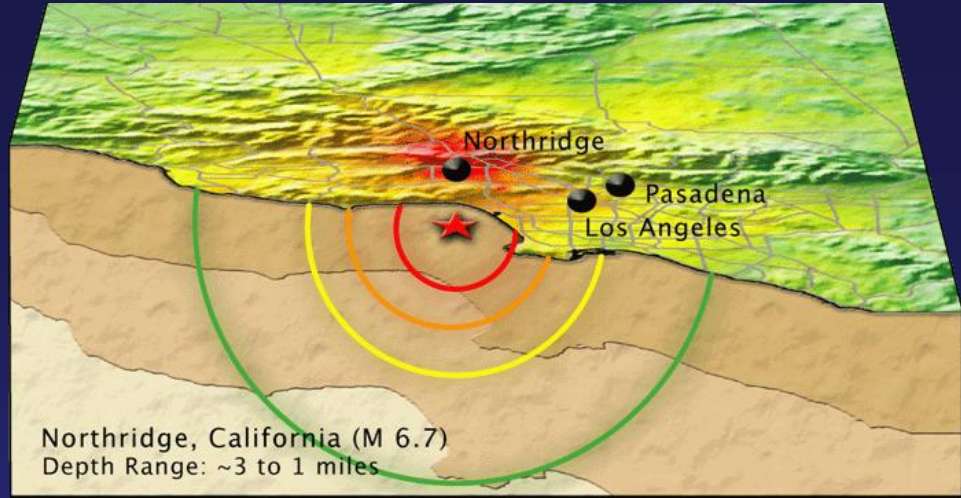
# 1994 Northridge Earthquake (Magnitude 6.7)



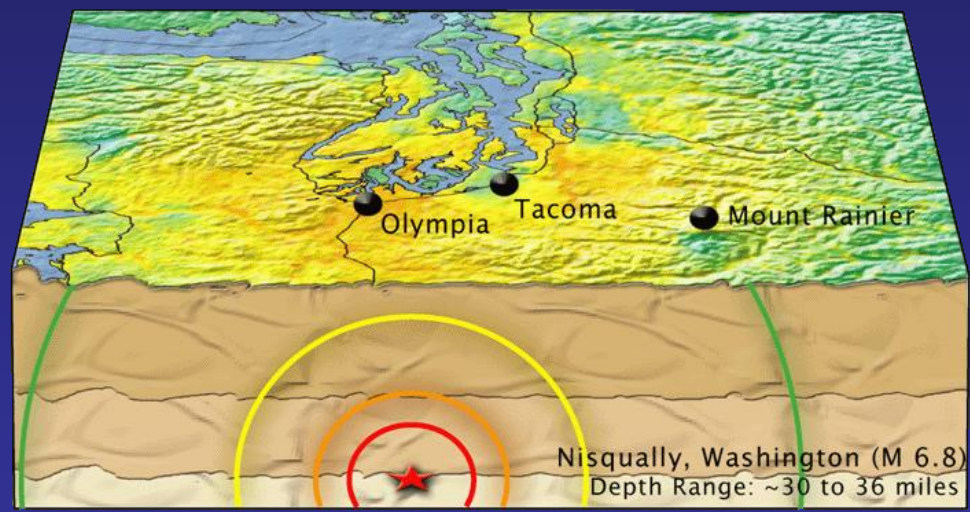


# Effect of Earthquake Depth

Northridge, California  
 Magnitude 6.7  
 Depth ~ 10 km



Nisqually, Washington  
 Magnitude 6.8  
 Depth ~ 50 km



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	.17-14	1.4-39	3.9-92	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

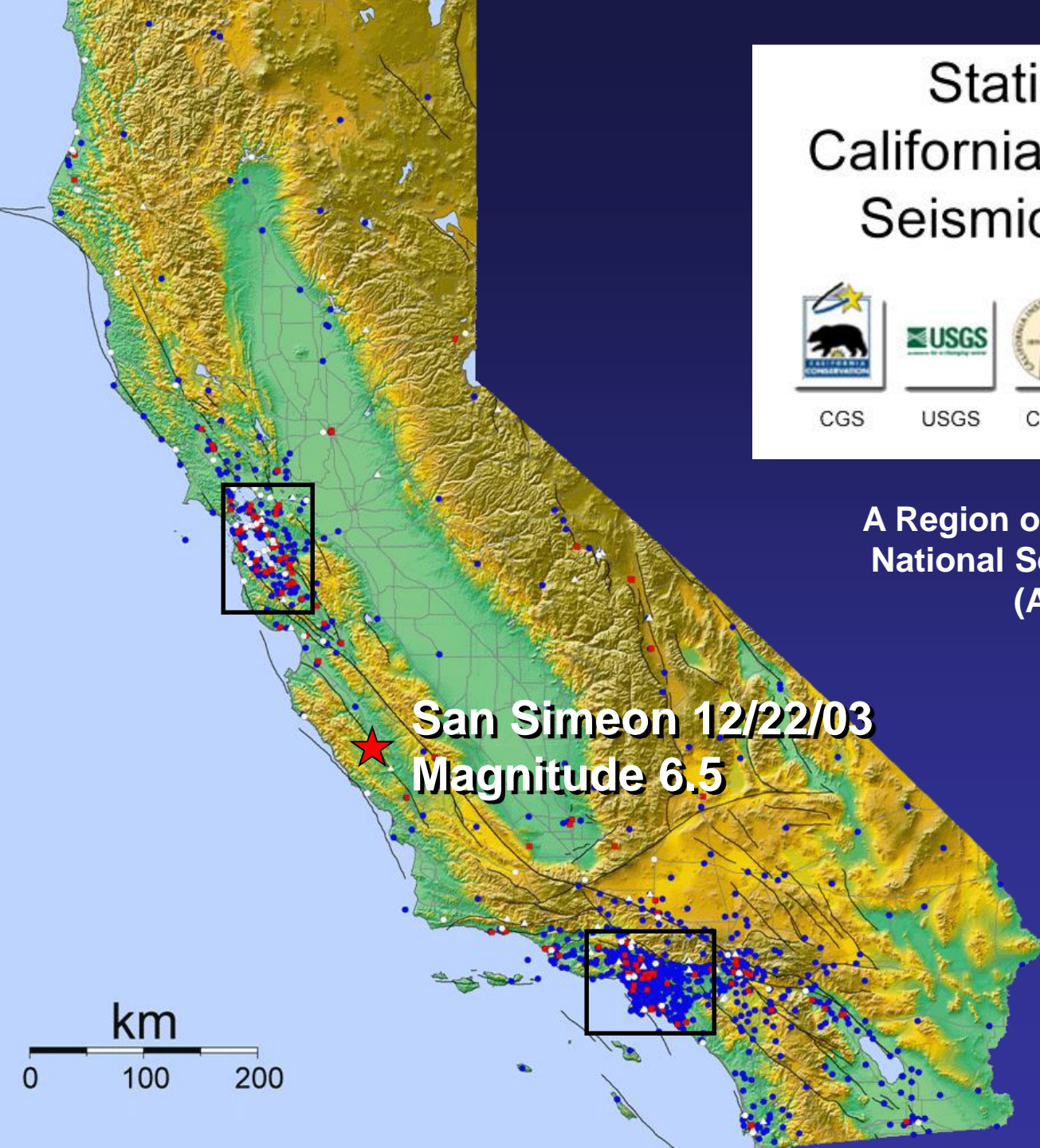
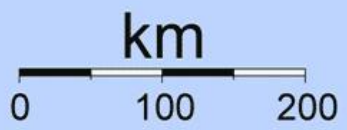
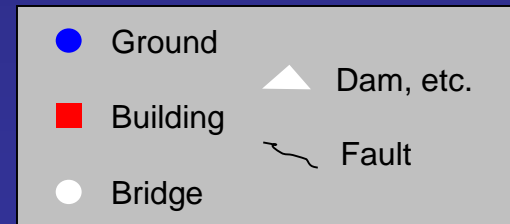
# Making a *ShakeMap* ....

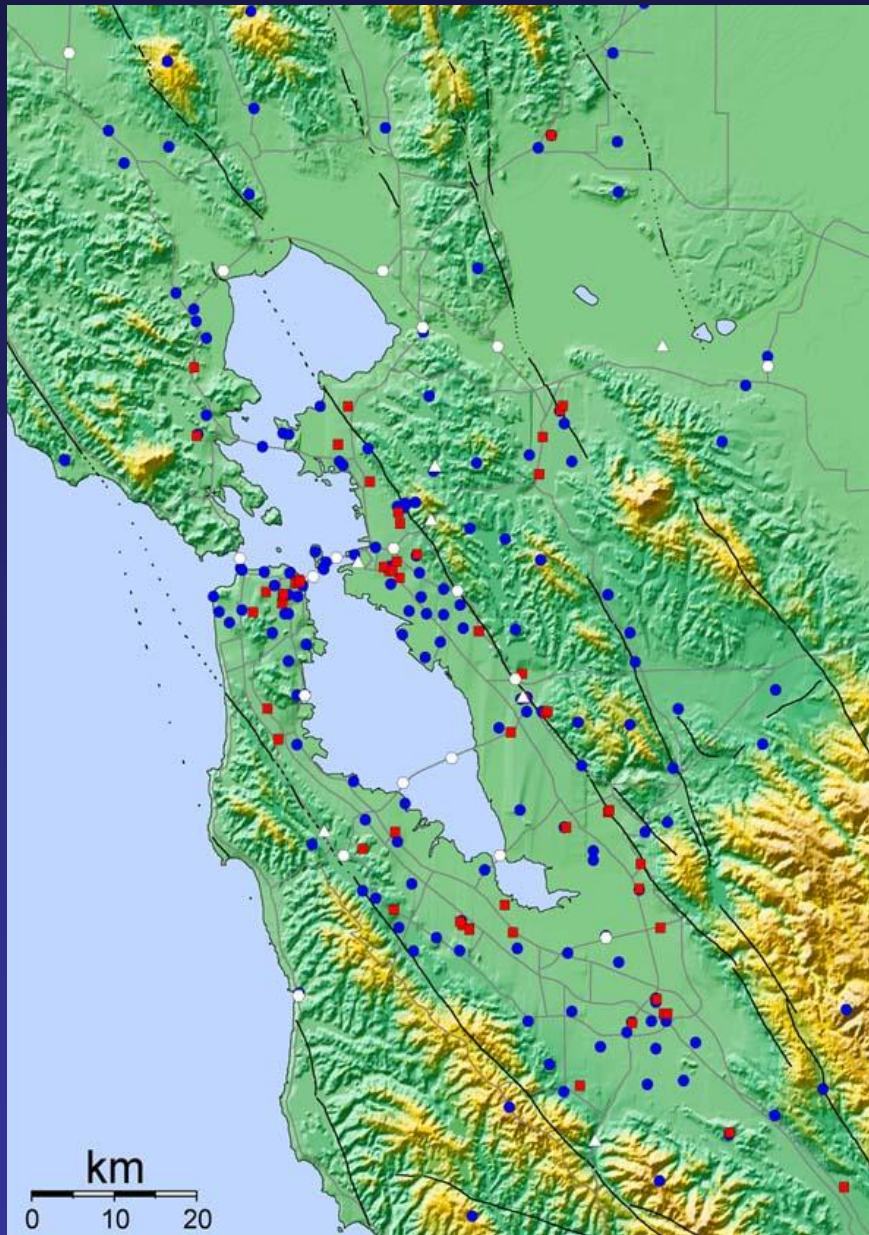
# Stations of California Integrated Seismic Network



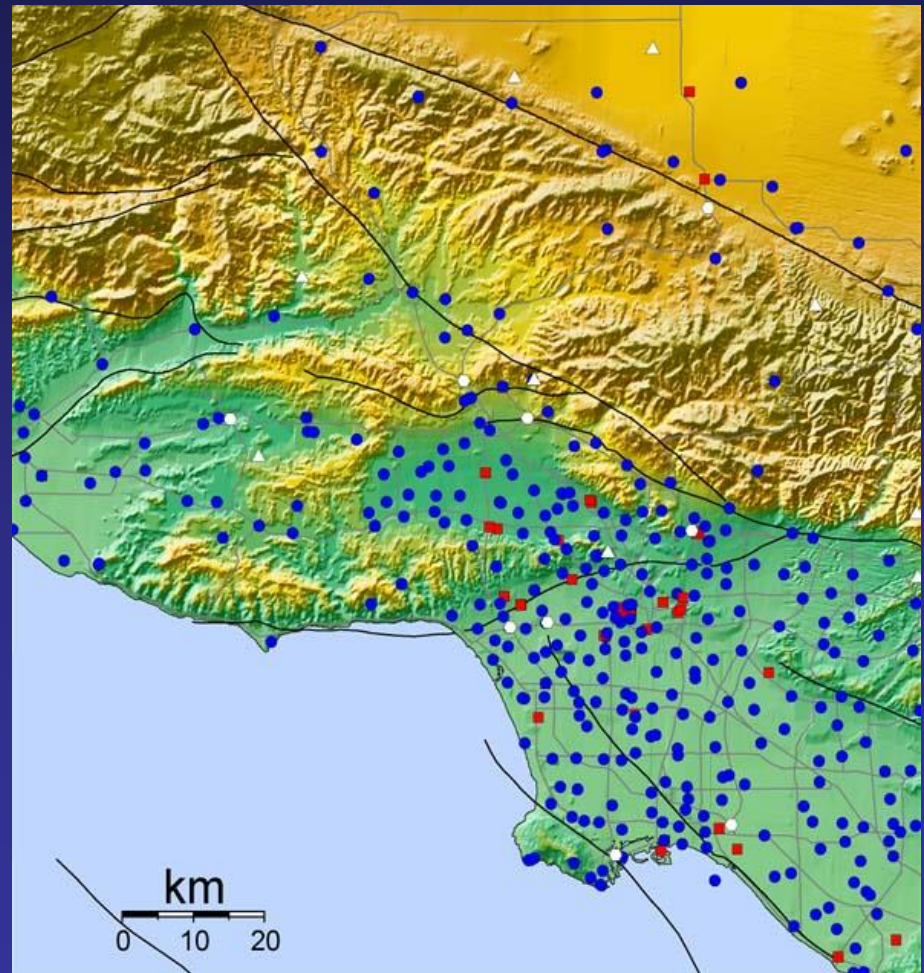
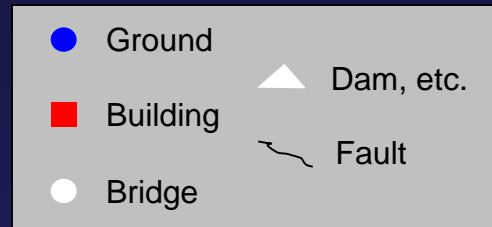
A Region of the Advanced  
National Seismic System  
(ANSS)

**San Simeon 12/22/03  
Magnitude 6.5**





**SAN FRANCISCO BAY AREA**



**LOS ANGELES REGION**

# Typical Seismic Station

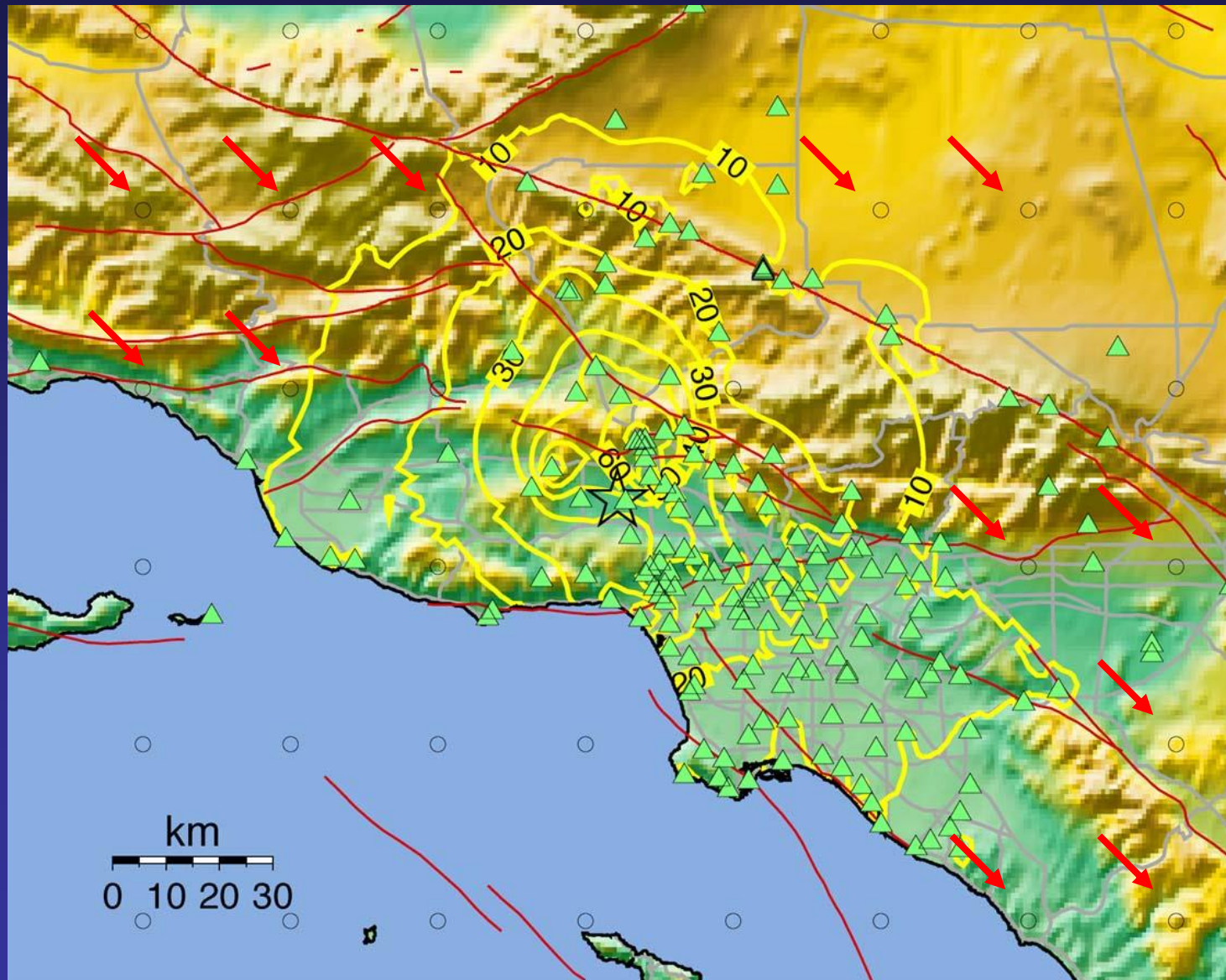


# Seismic Station Equipment



# 1994 Northridge Earthquake (Magnitude 6.7)

## TriNet Peak Acceleration Map (in %g)



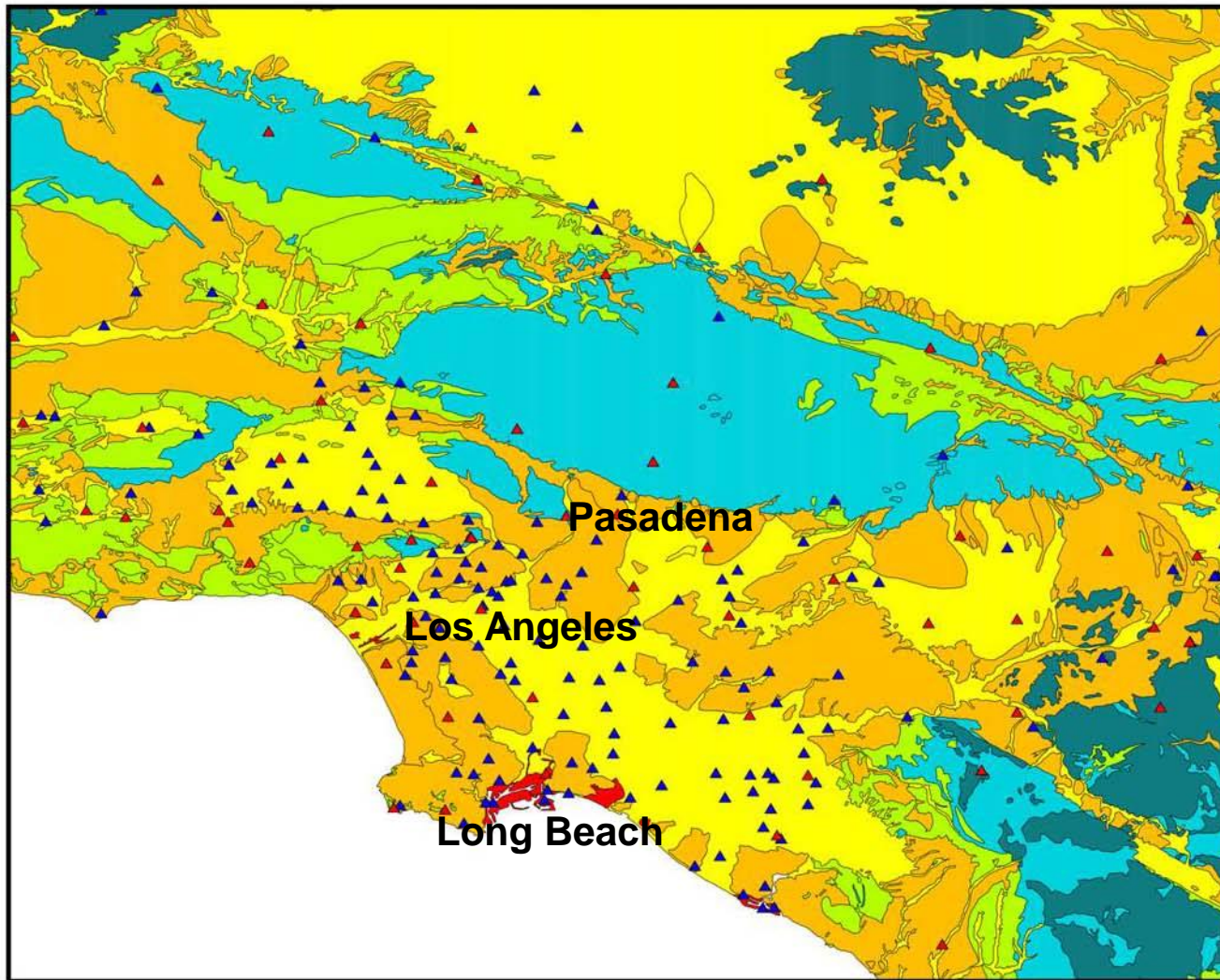
# California Statewide Site Classification Map

California Division of Mines & Geology  
(CDMG)

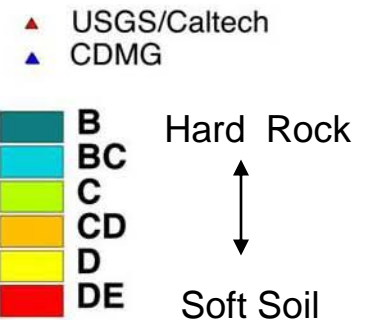




# A Portion of the CDMG Preliminary Statewide Site Condition Map of California

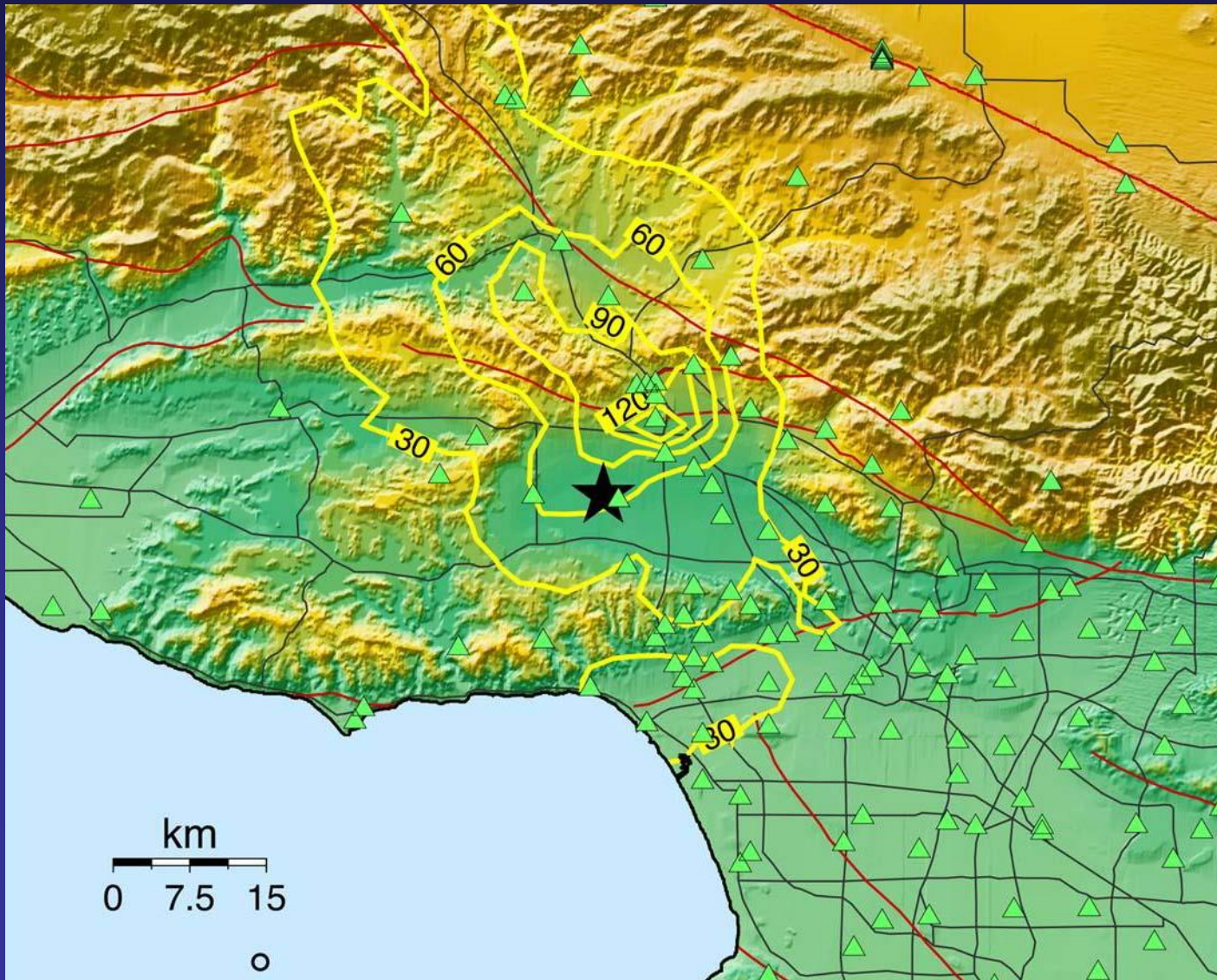


ShakeMap incorporates information from the Preliminary Statewide Site Condition Map of California (PSSCM) which is protected by the US Copyright Law. The PSSCM can be only reproduced with the written consent of the State of California. For Information, contact the California Dept. of Conservation, Div. of Mines and Geology. Also see Wills *et al.*, this Session.



# 1994 Northridge Earthquake (Magnitude 6.7)

## TriNet Peak Velocity Map (in cm/sec)



Processed: Tue Jun 20 12:05:29 PM PDT, Produced by ShakeMap V2

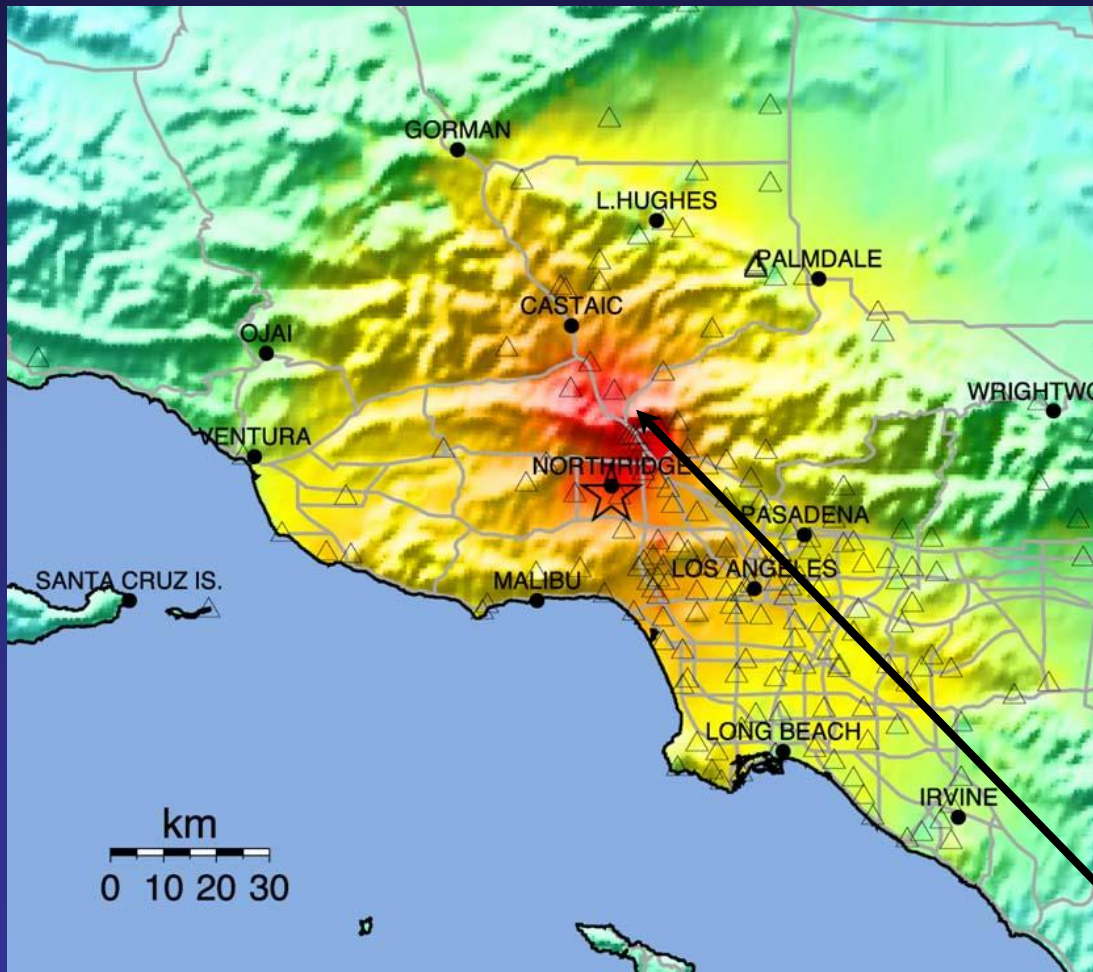
# INSTRUMENTAL INTENSITY SCALE

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+

Wald et al., 1999, *Earthquake Spectra*

# 1994 Northridge Earthquake (Magnitude 6.7)

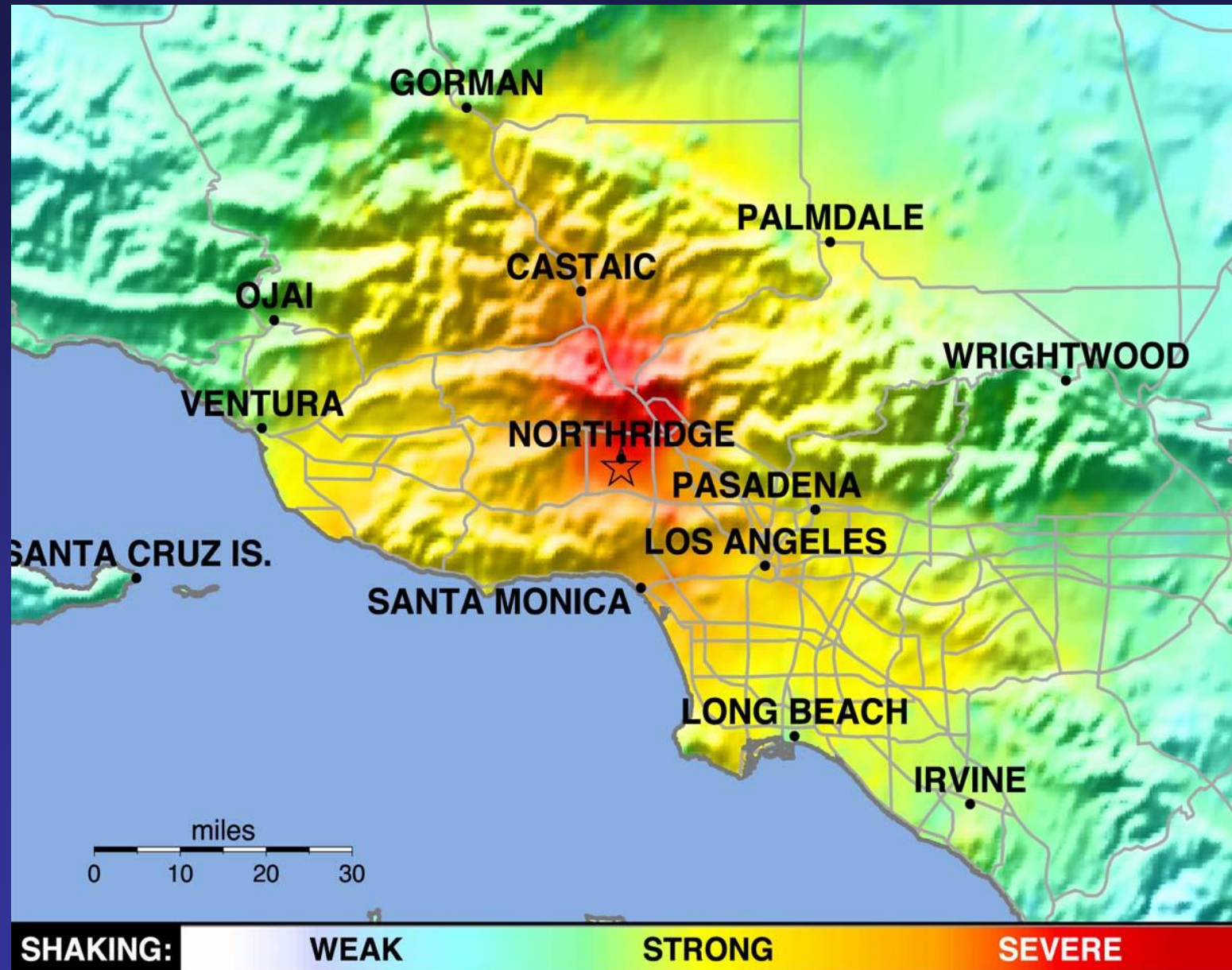
## TriNet Rapid Instrumental Intensity Map



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+

**Newhall: Intensity IX**  
**Collapse of Overpass**

# 1994 Northridge Earthquake (Magnitude 6.7)



<http://earthquake.usgs.gov/shakemap>

## Earthquake Hazards Program

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[Hazards & Preparedness](#)

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### Earthquake Activity

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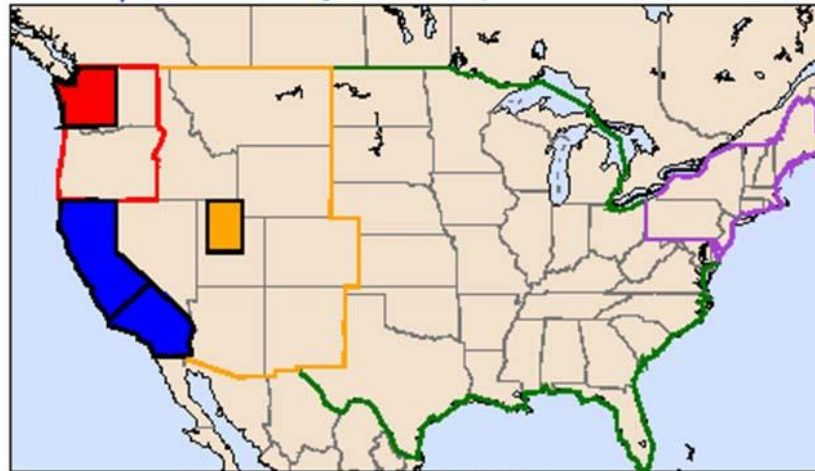
[Utah &](#)

[Yellowstone](#)

#### [Data Sources](#)

### ShakeMap

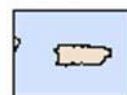
Select Region from Map or List Below



CONTINENTAL 48 STATES



ALASKA



PUERTO RICO &  
US Territories



HAWAII

Currently, the following areas (color-filled on above map)

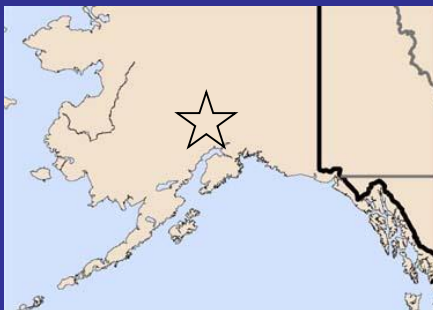
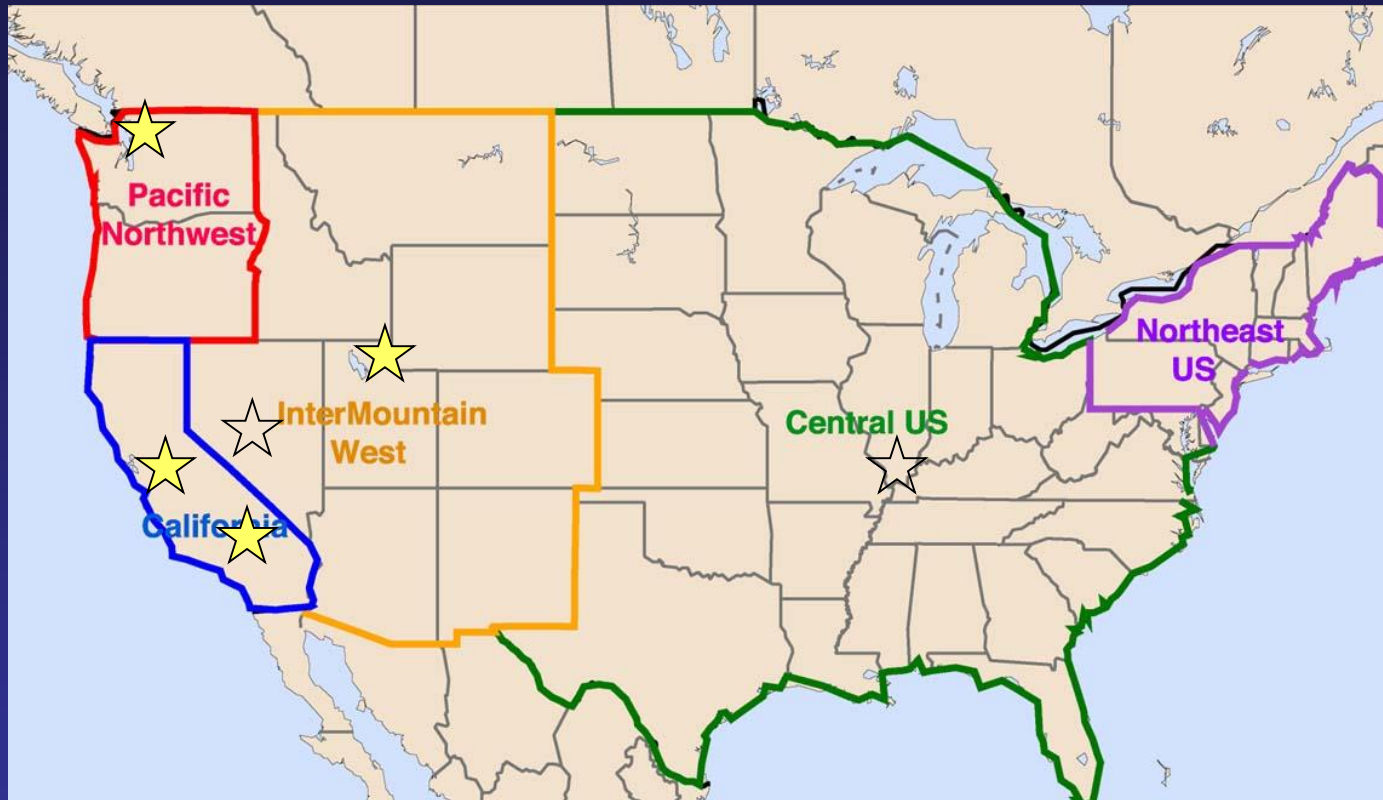
#### [Pacific Northwest](#)



#### [Northern California](#)



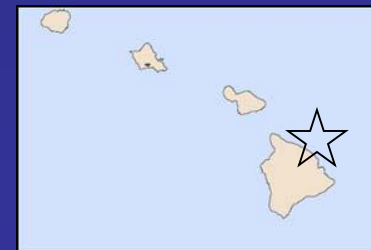
# Advanced National Seismic System (ANSS) Regions



Alaska



Puerto Rico  
and U.S. territories



Hawaii

# What are the Primary *ShakeMap* Uses?

1. Rapid, post-earthquake emergency response & general information
2. Enhanced post-earthquake loss estimation
3. Response planning, preparedness, education
4. Scientific and engineering studies



# Loss Estimation

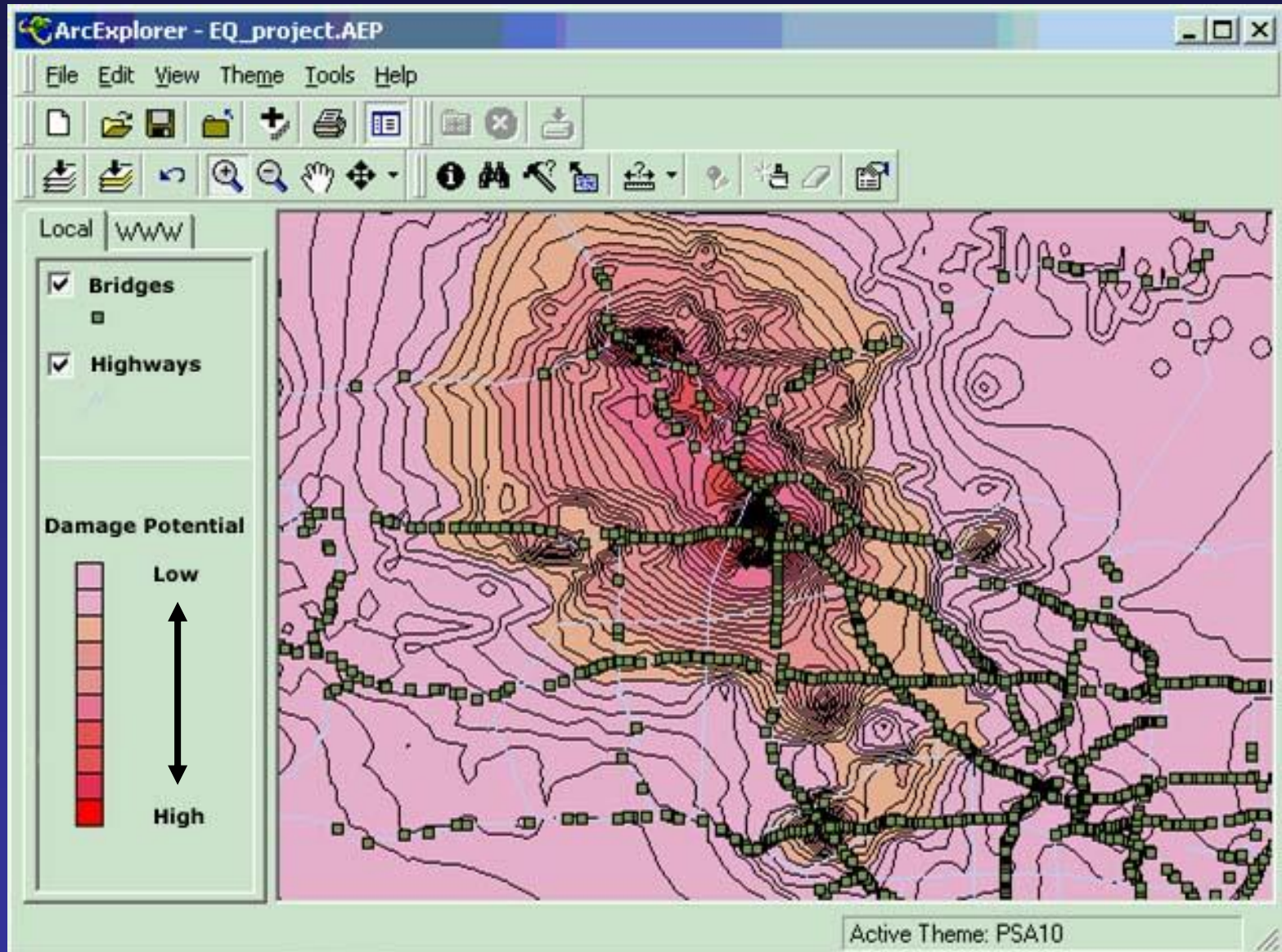
- *ShakeMap* records shaking levels; it does not give losses. Losses must be estimated separately with a knowledge of building/infrastructure inventory and its vulnerability
- **The Federal Emergency Management Agency (FEMA)** and the **California Office of Emergency Services (OES)** can now use *ShakeMap* in HAZUS (Natural Hazard Loss Estimation Methodology) for direct loss estimation from recorded ground motions, rather than from magnitude and epicenter alone
- **Loss estimates guide federal/state response efforts**

**CALTRANS  
OAKLAND  
TMC**

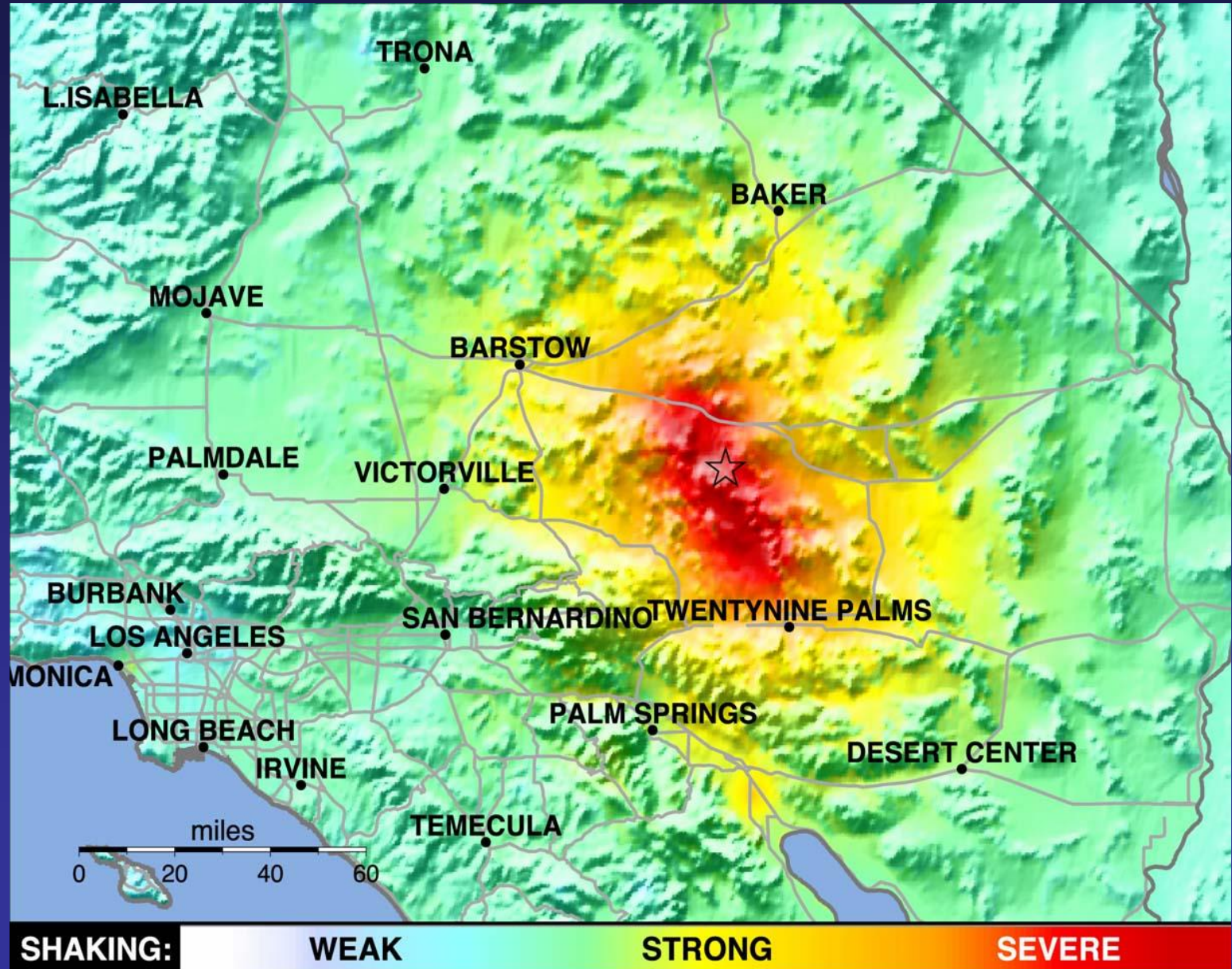


**EMERGENCY RESPONSE**

# Caltrans GIS (Geographic Information Systems) Map of Highway Bridges and Overpasses



# 1999 Hector Mine, California Earthquake (Magnitude 7.1)

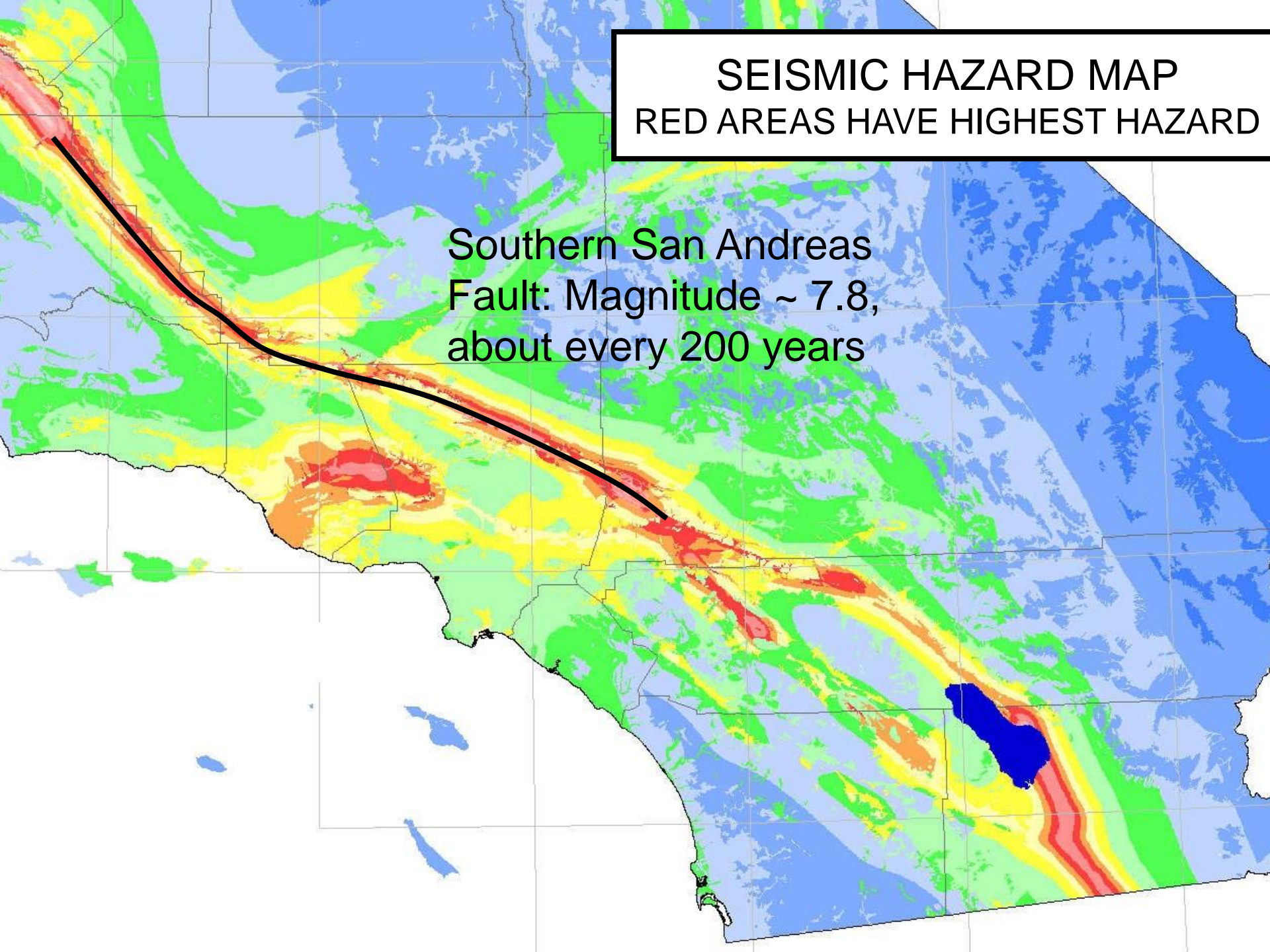


# Earthquake Planning: Scenario Earthquakes

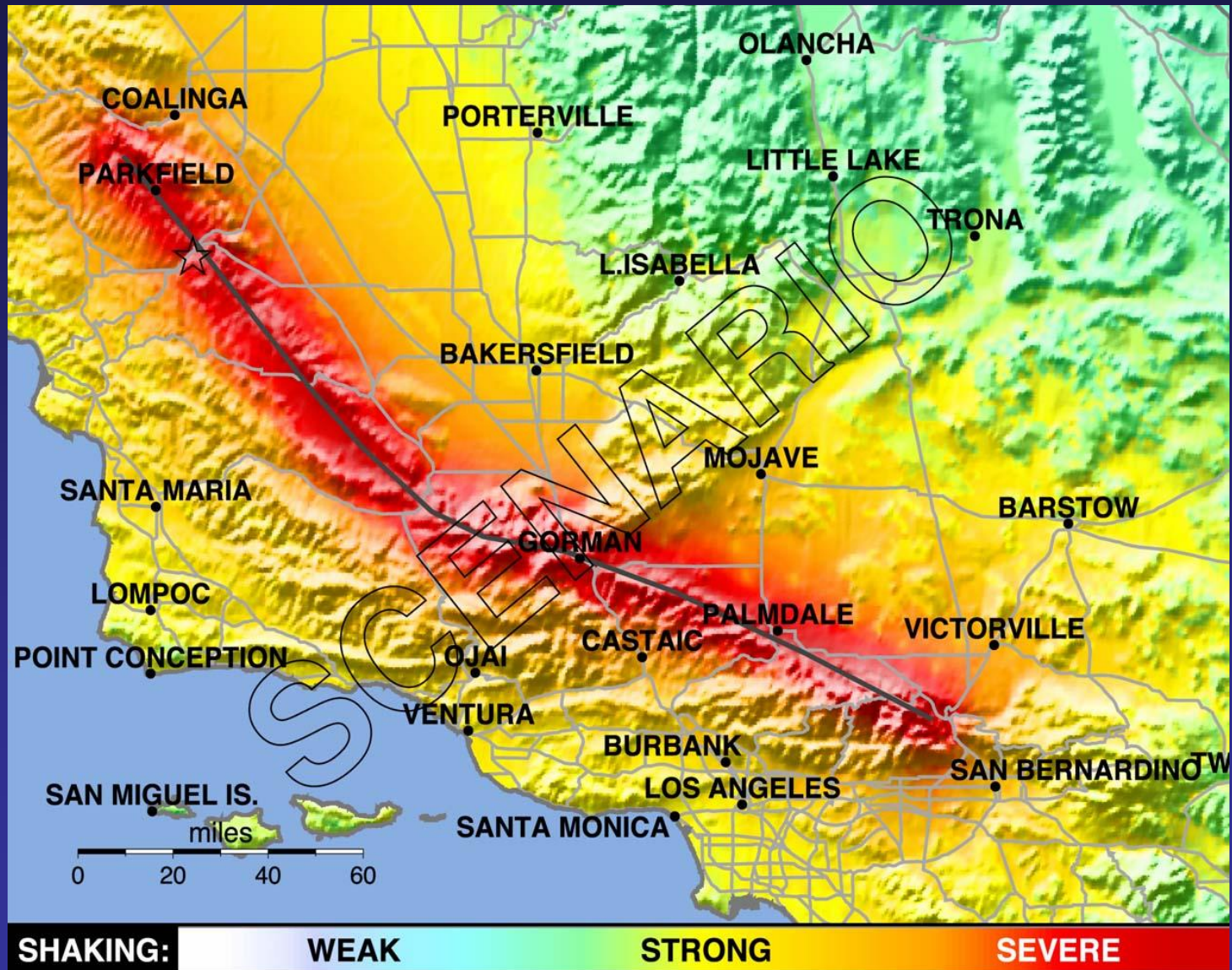
# SEISMIC HAZARD MAP

RED AREAS HAVE HIGHEST HAZARD

Southern San Andreas  
Fault: Magnitude ~ 7.8,  
about every 200 years



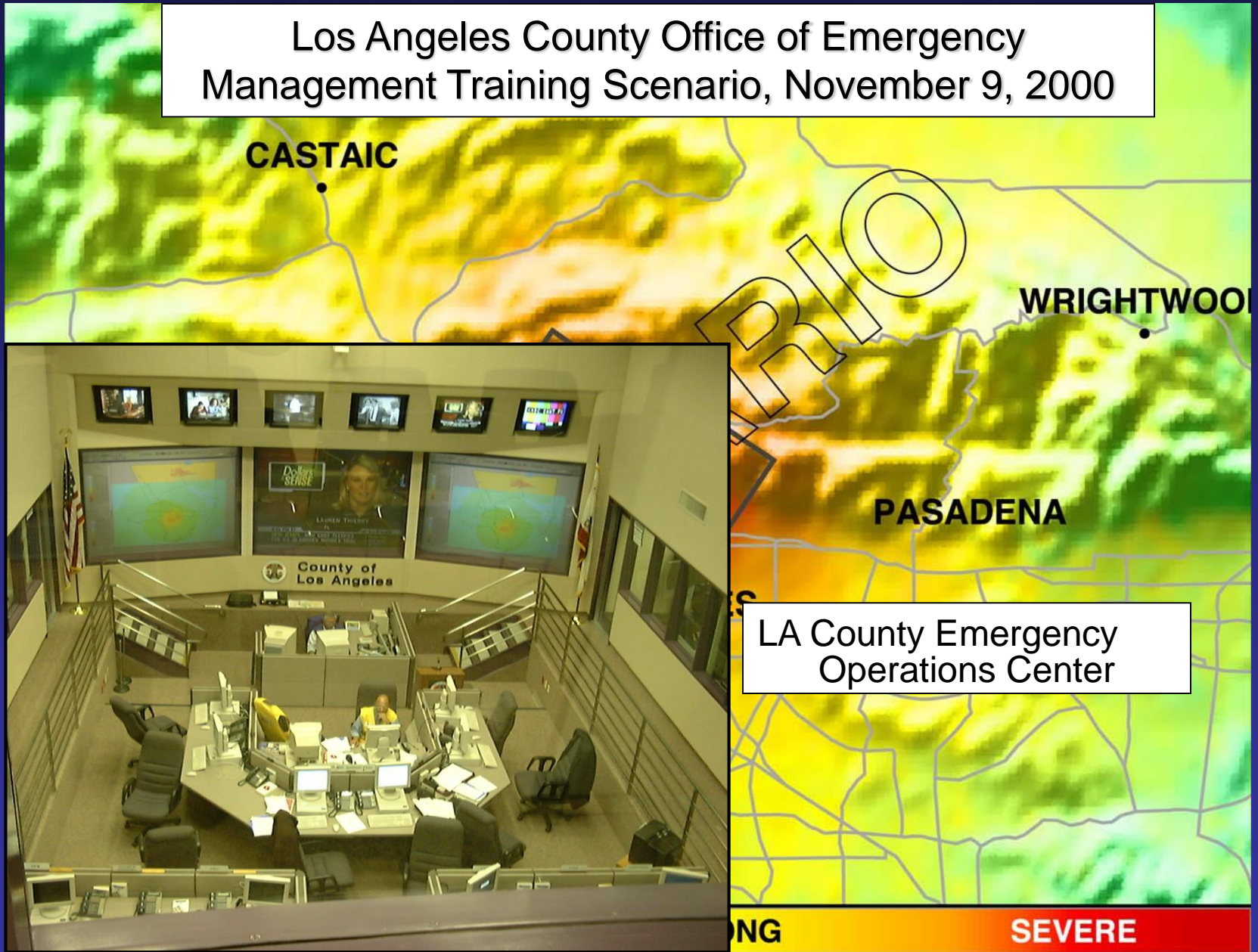
# Scenario *ShakeMap*: San Andreas Fault (Magnitude 7.8)



PLANNING SCENARIO ONLY – PROCESSED: Fri Feb 15, 2002 11:35:47 AM PST

# Scenario *ShakeMap*: Verdugo Hills Fault (Magnitude 6.7)

Los Angeles County Office of Emergency Management Training Scenario, November 9, 2000



LA County Emergency Operations Center

NG

SEVERE



# Community Internet Intensity Maps (CIIM)

*“Did You Feel It?”*

*(DYFI?)*



citizen science

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... Birds | Amphibians & Reptiles | Mammals | Butterflies | Get Involved | 1998 Loon Report | **Citizen Science** Events **Citizen Science** Events at VINS ... [www.vinsweb.org/conservation/citizenscience/csevents.html](http://www.vinsweb.org/conservation/citizenscience/csevents.html) - 7k - [Cached](#) - [Similar pages](#)  
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[The PathFinder Science Network for Student and Citizen Science](#)

PathFinderScience Network for Student and **Citizen Science**;  
The KanCRN Collaborative Research Network. May 12, 2003. ...  
Description: **Science** education programs for students of all ages in biology, chemistry, and earth **science**. GIS...  
Category: [Science > Educational Resources](#)  
[pathfinderscience.net/](http://pathfinderscience.net/) - 22k - [Cached](#) - [Similar pages](#)

[Citizen Science](#)

... **Citizen Science**. BY JONATHAN MILLER. Non ... The Ornithology Lab's **Citizen Science** initiative seeks to tap into that tradition. Coordinator ... [cornell-magazine.cornell.edu/Archive/2002julaug/features/Feature.html](http://cornell-magazine.cornell.edu/Archive/2002julaug/features/Feature.html) - 29k - [Cached](#) - [Similar pages](#)

[Audubon Citizen Science- Be part of the solution](#)

Conservation Leadership :: **Citizen Science**. Want to help the Earth?- be part of the solution in your community! Getting involved ... [www.audubonofflorida.org/leadership/citizen.htm](http://www.audubonofflorida.org/leadership/citizen.htm) - 10k - [Cached](#) - [Similar pages](#)

[Avian Ecology at SERC: Citizen Science](#)

Avian Ecology. ... [www.serc.si.edu/migratorybirds/citizen\\_science.htm](http://www.serc.si.edu/migratorybirds/citizen_science.htm) - 7k - [Cached](#) - [Similar pages](#)

[Welcome to the Online Citizen Science Base Camp](#)

**citizen science** program in the Adirondacks of northern New York State to allow everyone to participate in the collection of data, monitoring of natural events ...  
Description: Educational program using the Adirondack mountains. Includes areas for contributing data, reporting...  
Category: [Science > Earth Sciences > Education](#)  
[www.adkscience.org/](http://www.adkscience.org/) - 7k - [Cached](#) - [Similar pages](#)

citizen science



# Research Citizen Science Conservation Education

Lab Programs > Citizen Science

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## The Power of Citizen Science

All across North America, thousands of people of all ages and backgrounds are participating in the Cornell Lab of Ornithology's research projects. From backyards and city streets to remote forests, these people represent the world's largest research team. We call them citizen scientists.



**House Finch Disease Survey**  
Participants monitor their backyard bird feeders and report the presence or absence of House Finch eye disease, a form of conjunctivitis caused by the bacterium *Mycoplasma gallisepticum*. Thanks to citizen scientists, Lab researchers have been able to track the occurrence and spread of the disease across eastern and central North America.

[Click here »](#)



**Project FeederWatch**  
Join over 16,000 other citizen scientists who periodically count the birds that visit their bird feeders from November to April. Your counts will help scientists track the distribution and abundance of birds in winter. Anyone can participate in Project FeederWatch.

[Click here »](#)



Home:  
U. S.  
Canada

# Project FeederWatch

Cornell Lab of Ornithology



Overview

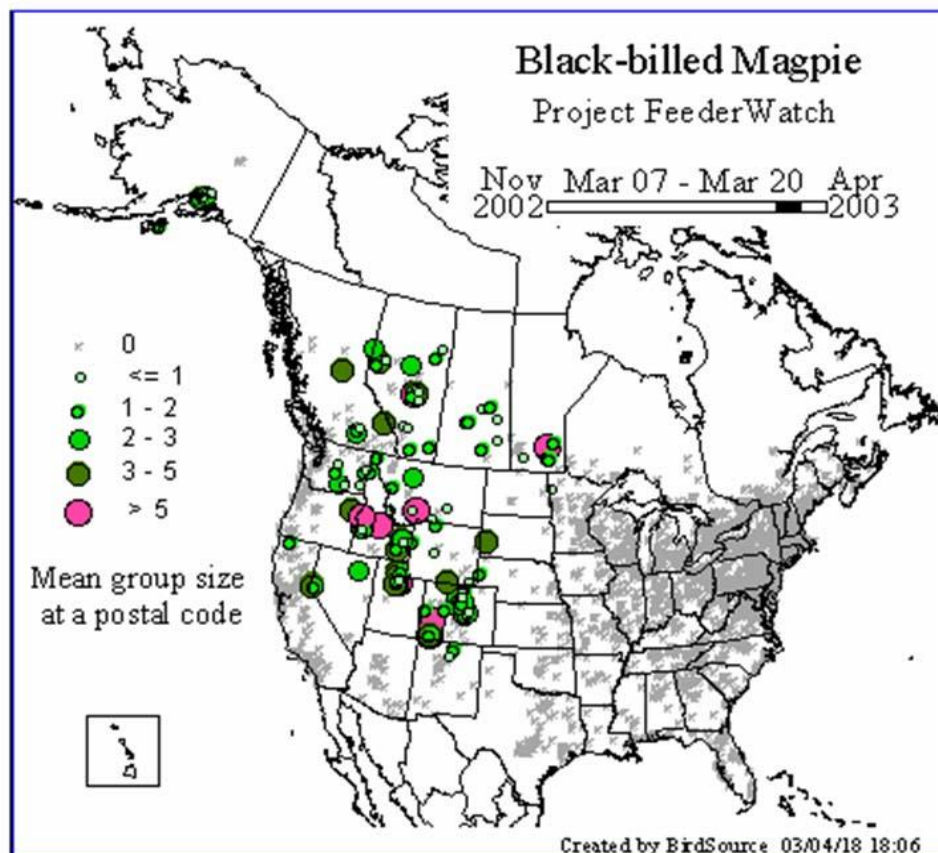
Instructions  
& Updates

Data Entry

Data Retrieval

News

About Birds &  
Bird Feeding





### Earthquake Hazards Program

- Earthquake Activity
- EQ Facts & Education
- Products & Services
- Hazards & Preparedness
- Earthquake Research
- Regional Websites
- Seismic Networks

**Report an Earthquake**

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[Western Mountain](#)

[Pacific Northwest](#)

[Northeast](#)

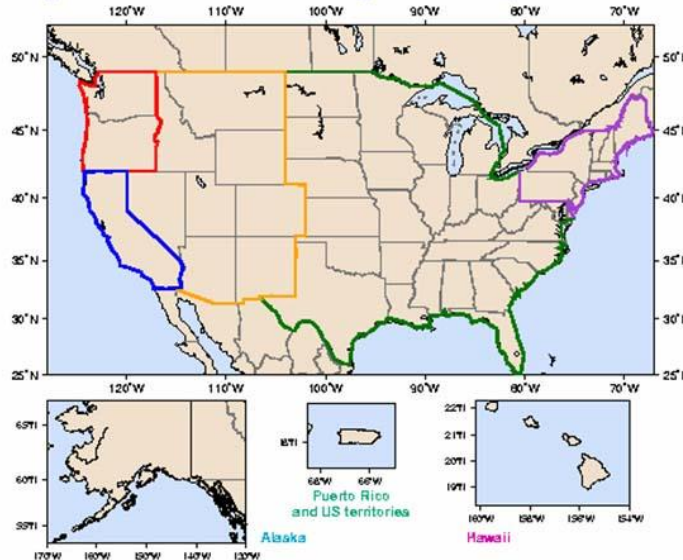
[Central US](#)

[Puerto Rico & US Territories](#)

[Canada...](#)

**Other countries**

Did you feel it? [Select Region from Map or List](#)



This is a [U.S. Geological Survey](#) project to collect information about ground shaking following significant earthquakes. Following an earthquake, please tell us what you felt by filling out the questionnaire for the appropriate earthquake.

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U.S. Geological Survey, a bureau of the [U.S. Department of the Interior](#)  
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 Last modification: 2.5.2002  
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## Did You Feel It?

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## Recent significant events in the Northeast region

Did you feel it? Select an earthquake from the list to view a map of how intensely other people felt it, and submit your own report. If you can't find the quake you felt, look at our main [map of the US](#) to find a nearby region, or search the [archives](#). If you still can't find it, fill out an [unknown earthquake form](#).

Want to see more maps? Check out our [Top Ten Lists](#), which rank our most felt earthquakes ever. Also, look for earthquakes which have been [geocoded](#) (look through the [archives](#) to find out which ones).

**NOTE: We cannot take Canadian postal codes at this time.** If you were in Canada at the time of the event, please go to the [Canadian Geological Survey form](#).

SELECT EARTHQUAKE			
LOCATION	DATE	TIME	MAGNITUDE
<a href="#">18 miles SW of Plattsburgh, New York</a> (ID <i>daan</i> )	APR 20 2002	07:04:41 EDT	4.0
<a href="#">17 miles SW of Plattsburgh, New York</a> (ID <i>deam</i> )	<b>APR 20 2002</b>	<b>06:50:45 EDT</b>	<b>5.1</b>
<a href="#">44 miles E of South Yarmouth, Massachusetts</a> (ID <i>bqai</i> )	MAR 12 2002	02:13:26 EST	3.0
<a href="#">28 miles NNW of Massena, New York</a> (ID <i>azay</i> )	FEB 24 2002	16:38:33 EST	3.0
<a href="#">9 miles NNW of Ashtabula, Ohio</a> (ID <i>luag</i> )	JAN 25 2001	22:03:19 EST	4.5
<a href="#">Upper East Side of Manhattan, New York</a> (ID <i>aany</i> )	JAN 17 2001	07:34:20 EST	2.5
<a href="#">New Earthquake...</a>			<a href="#">Archives...</a>

# DID YOU FEEL IT? REPORT IT HERE!

You can help provide information about the extent of shaking and damage for earthquakes in the United States, and you may provide specific details about how your area may respond to future earthquakes.

You can help by filling out the questionnaire below. **Even if you did not feel the earthquake, but were in the general region of the epicenter, please respond!** (We would like to know the areas over which the earthquake was felt and not felt). In the future, for other earthquakes that occur in your area, please do the same. Your input will be used to make maps of shaking intensity distribution.

USGS scientists may use the information you enter in this form to provide qualitative, quantitative, or graphical descriptions of damage in USGS publications. If you would object to this possible usage of your data, please do not fill out this form.

Finally, please consider filling out a questionnaire for other historic events that occurred in your region. After submitting this form, go to the [archives](#) to see other events.

**Your ZIP code is REQUIRED!** All other identifiers (name, e-mail, phone, and location) are optional, but we need your ZIP code to locate the intensity in your area. The other data may be critical for further resampling, if needed.

**QUESTIONNAIRE FOR THIS EVENT:  
Good Friday  
MAR 27 1964 17:36:14.2**

- Please make sure you are filling out this form for the right event. -

For other events or historic events, or to view other regions, go to the [archives](#) To report an event not yet in our database, go to the [New or unknown event questionnaire](#).

Name:

E-mail:  Phone:

Your location *when the earthquake occurred:*

Street Address:

Nearest Cross Street:

City:  County:  State:

Country:

Zip code:

Please note: a US zip code is REQUIRED to be on the map. If you don't know your zip code at the time of the earthquake, [look it up](#).

[Favorites](#) | [History](#) | [Search](#) | [Scrapbook](#) | [Page Holder](#)

**Earthquake effects:**Did you notice the swinging/swaying of doors or hanging objects? Did you notice creaking or other noises? Did objects rattle, topple over, or fall off shelves? Did pictures on walls move or get knocked askew? Did any furniture or appliances slide, tip over, or become displaced? Was a heavy appliance (refrigerator or range) affected? Were free-standing walls or fences damaged? 

If you were inside, was there any damage to the building? Check all that apply.

- No damage
- Hairline cracks in walls
- A few large cracks in walls
- Many large cracks in walls
- Ceiling tiles or lighting fixtures fell
- Cracks in chimney
- One or several cracked windows
- Many windows cracked or some broken out
- Masonry fell from block or brick wall(s)
- Old chimney, major damage or fell down
- Modern chimney, major damage or fell down
- Outside wall(s) tilted over or collapsed completely
- Separation of porch, balcony, or other addition from
- Building permanently shifted over foundation

If you know the type of building (wood, brick, etc.)

**Additional Comments:**

You may use the next box to clarify answers or to make first-person descriptions of how the earthquake affected you. You may also use this box to give first-person descriptions of how the earthquake affected you. Parts of some first-person accounts may be reproduced in USGS publications.

- Answers to these specific questions are very diagnostic of earthquake intensity
- The system is calibrated against intensities from past earthquakes
- The responses are averaged for each zip code area, and color-coded for the intensity in that zip region

**To submit your completed form, press this button:**

Be sure you are filling out the right event!  
Good Friday MAR 27 1964 17:36:14.2



## Thank you! We got your input.

If you answered all the questions under *Your experience* and *Earthquake effects*, we can compute an estimated digital intensity based on your answer alone.

Note that the maps are computed using **all** the responses in your area, which may be different from yours. Also, community intensities are more accurate with a higher number of responses (say, 10 or more.) See the [scientific background](#) section for more details on how these maps are made, or the [FAQ](#) for questions about the maintenance of this site. If you still have questions, fill out our [comment form](#).

Your estimated intensity	<b>IV</b>
<b>Intensity for your zipcode</b>	<b>IV</b>
<b>Responses in your zipcode</b>	<b>1</b>

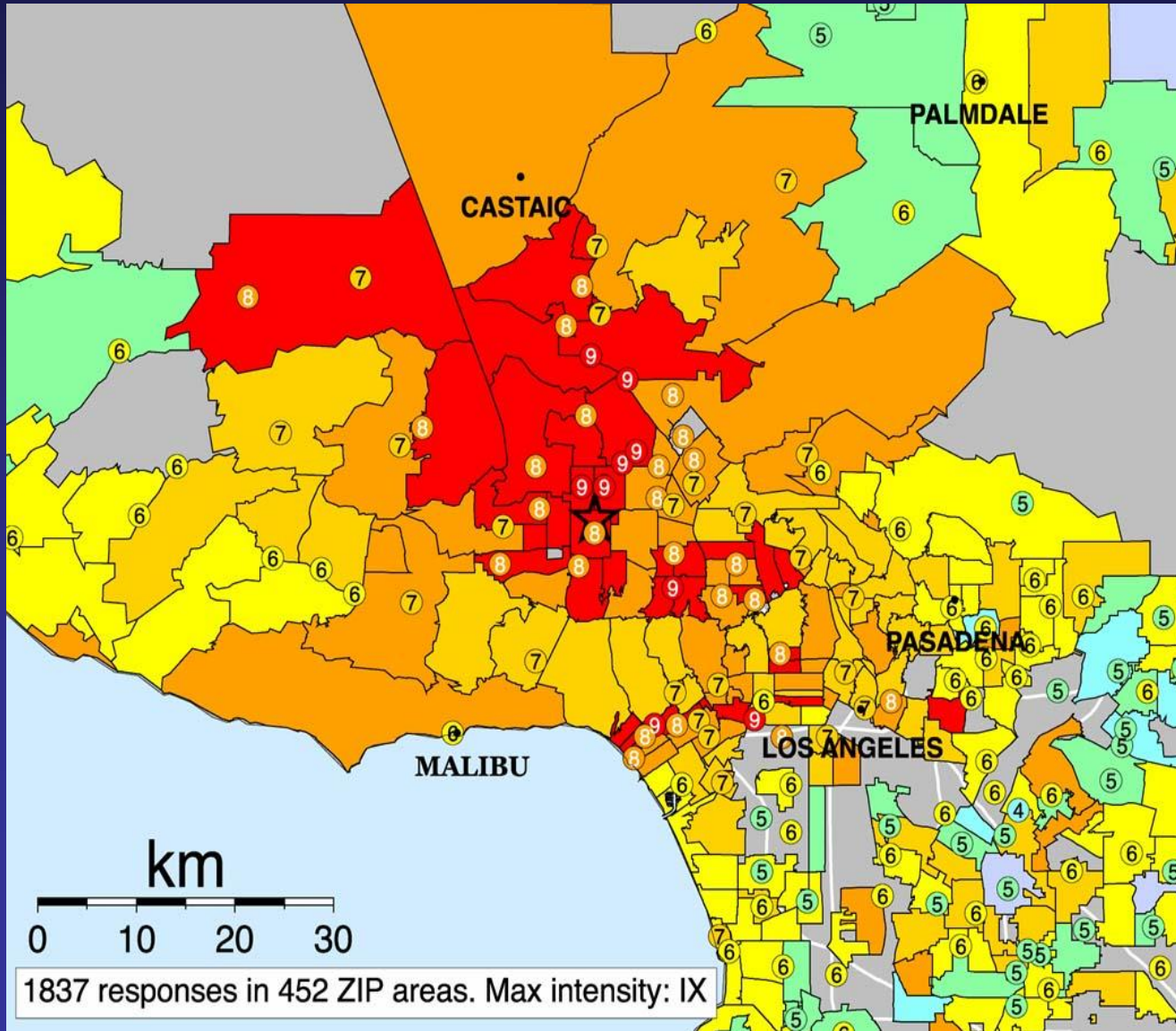
<b>Event</b>	test_ca
<b>Zip</b>	80401
<b>Zip area</b>	GOLDEN
<b>Name</b>	David Wald
<b>E-mail</b>	wald@usgs.gov
<b>County</b>	Jefferson
<b>City</b>	Golden
<b>State</b>	CO
<b>Country</b>	United States
<b>Location</b>	Office

How did other people feel it? [View the map](#) or look at a list of [statistics](#) by zip code. (Note that it may take up to five minutes before the map is changed to reflect your response. Please see our [FAQ](#) for more details.)

We are also collecting information about major historical earthquakes that you may have felt. Please visit our [Archives](#) or return to the [home page](#).

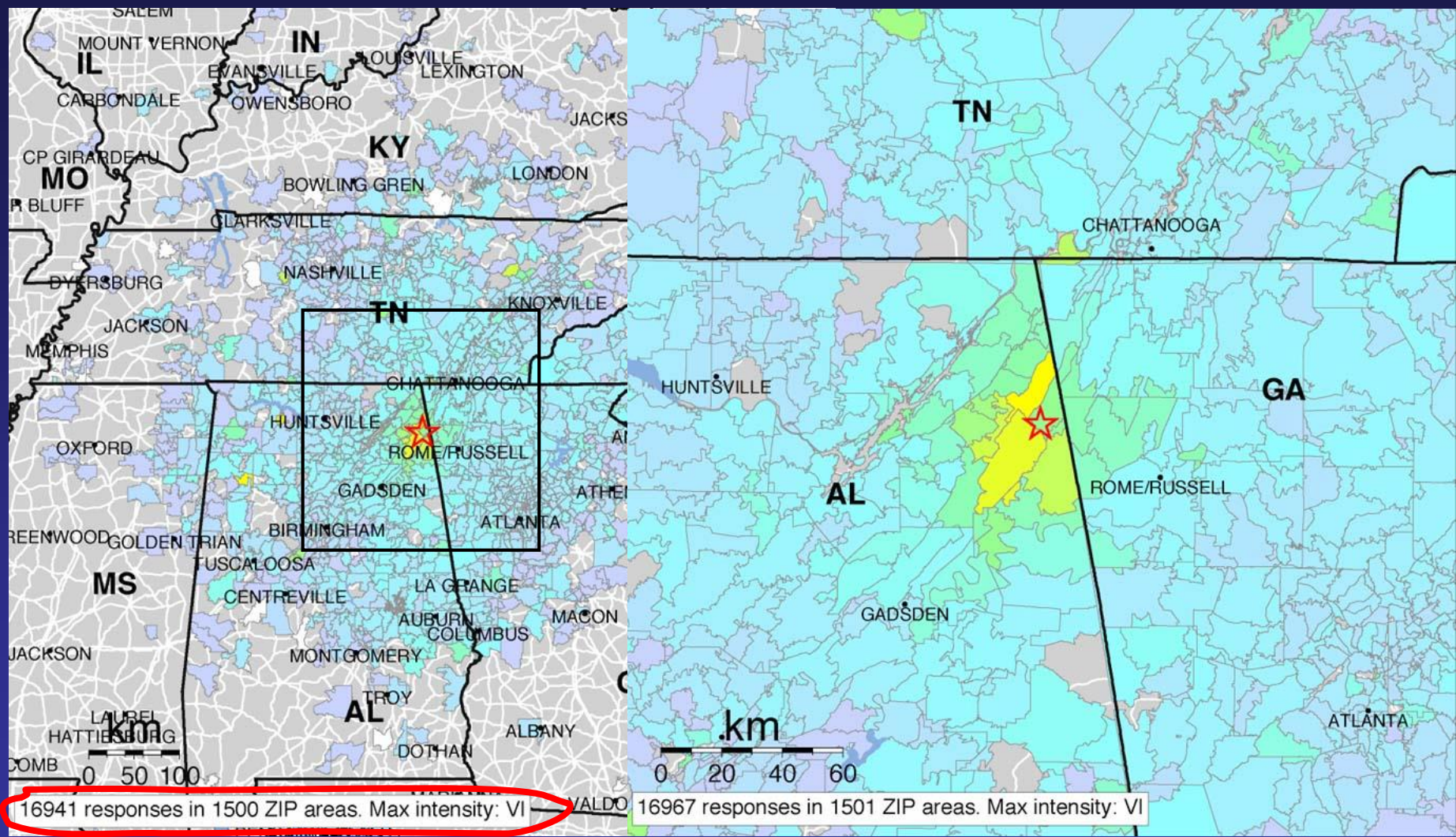
# 1994 Northridge Earthquake (Magnitude 6.7)

Comparison of USGS Modified Mercalli Intensity (Colored Circles) with USGS Community Intensity (*DYFI?*; Colored Zip Codes)



# Community Internet Intensity Map (DYFI?)

8 miles ENE of Fort Payne, Alabama (Magnitude 4.6)



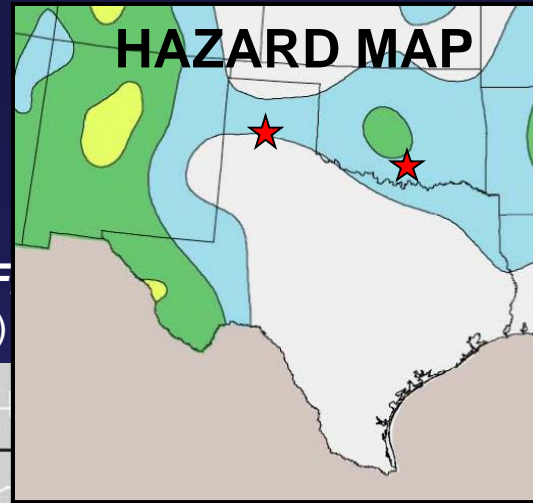
INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy

# Earthquakes in Texas???

**Community Internet Intensity Map (DYFI)**  
10 miles N of Amarillo, Texas (Magnitude 3.9)



INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy



**Community Internet Intensity Map (DYFI?)**  
Oklahoma Magnitude 3.3



INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy

• The Gleaner • News • Sports • Business • Lifestyle • Entertainment

**Earthquake intensity based on Internet response**

**The New York Times**  
 ON THE WEB

Online earthquake information the next best thing to being there



**San Francisco Chronicle**  
 NORTHERN CALIFORNIA'S LARGEST NEWSPAPER



**Arkansas Democrat - Gazette**  
 Northwest Arkansas Edition

**Earthquake sleuths use Net, volunteers to track temblors**

BY KENNETH HEARD  
 Posted on Monday, June 16, 2003  
 Shake, rattle and download.

Intensity	Shaking	Damage
I	Not felt	
II-III	Weak	
IV	Light	
V	Moderate	
VI	Strong	
VII	Very strong	
VIII	Severe	
IX	Violent	
X+	Extreme	

Source: <http://p...>

**Kentucky New Era**

www.kentuckynewera.com  
 ONLINE  
 YOUR news source for Friday, June 13, 2003  
 Hopkinsville, Kentucky

**HOME** News Article  
**News** Online survey helps scientist predict earthquake damage  
**Sports**  
**Living** By DARYL TABOR [dtabor@kentuckynewera.com](mailto:dtabor@kentuckynewera.com)  
**Calendar**

Did you feel it?

Internet Access Delivered Daily  
 Hopkinsville ONLINE  
 Kentucky New Era  
 Chronicle Graphics

**STL TODAY.com**  
 ST. LOUIS POST-DISPATCH

Vacation Getaways on DIS  
 STL TODAY.com Destination

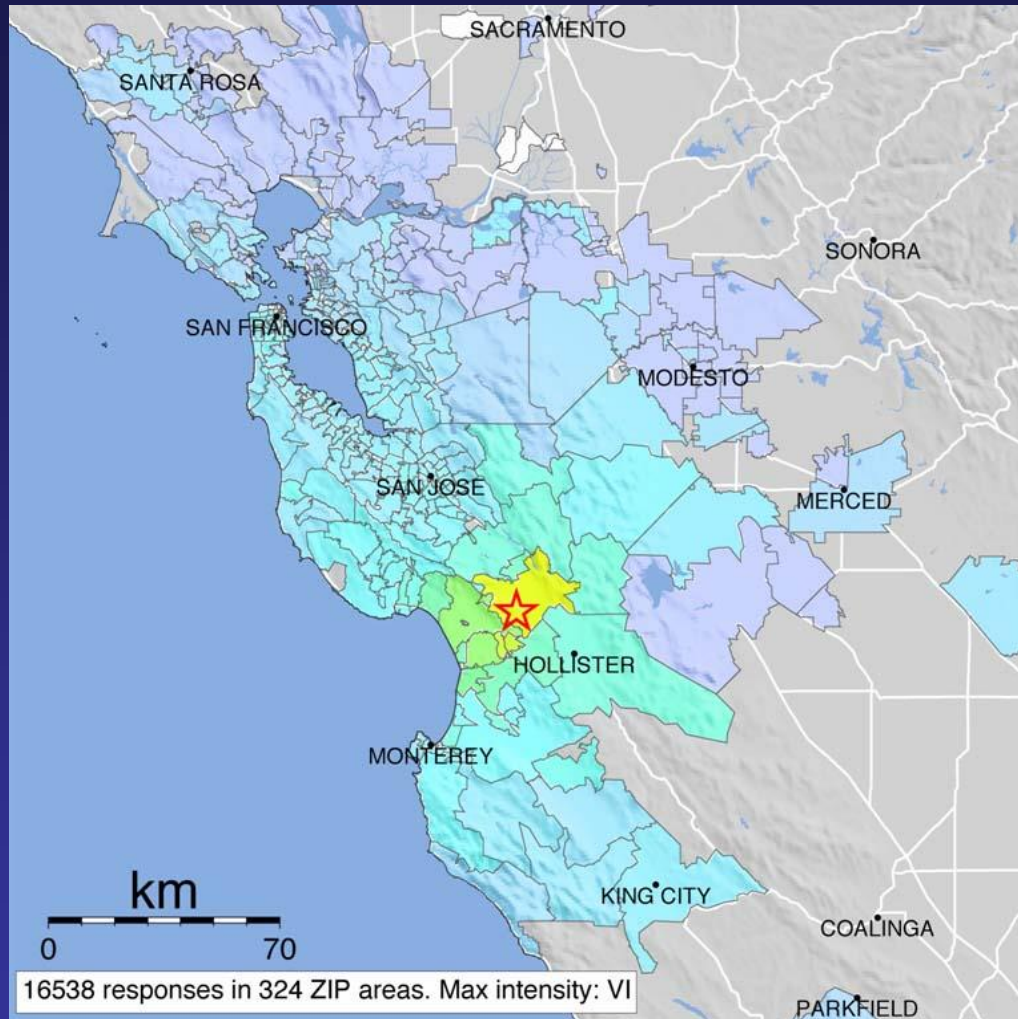
**Web site invites folks to report in when quakes hit**

BY SUSAN SKILES LUKE Associated Press  
 updated: 06/16/2003 12:15 AM

CAIRO, Ill. - Not long after an earthquake shook Cairo, Bobby Mayb...  
 telling the U.S. government about it.

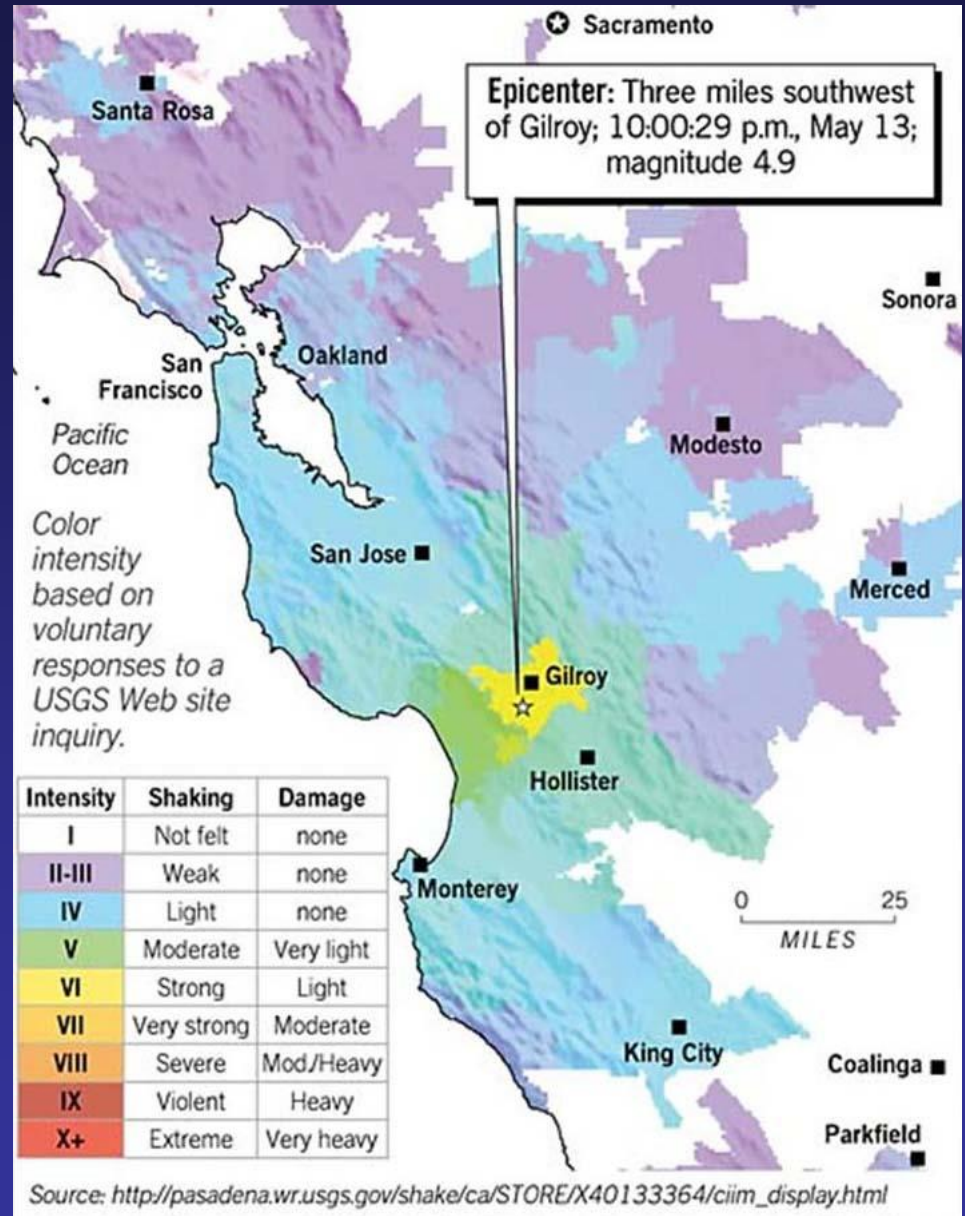
# Community Internet Intensity Map (*DYFI?*)

3 miles SW of Gilroy, California (Magnitude 5.2)



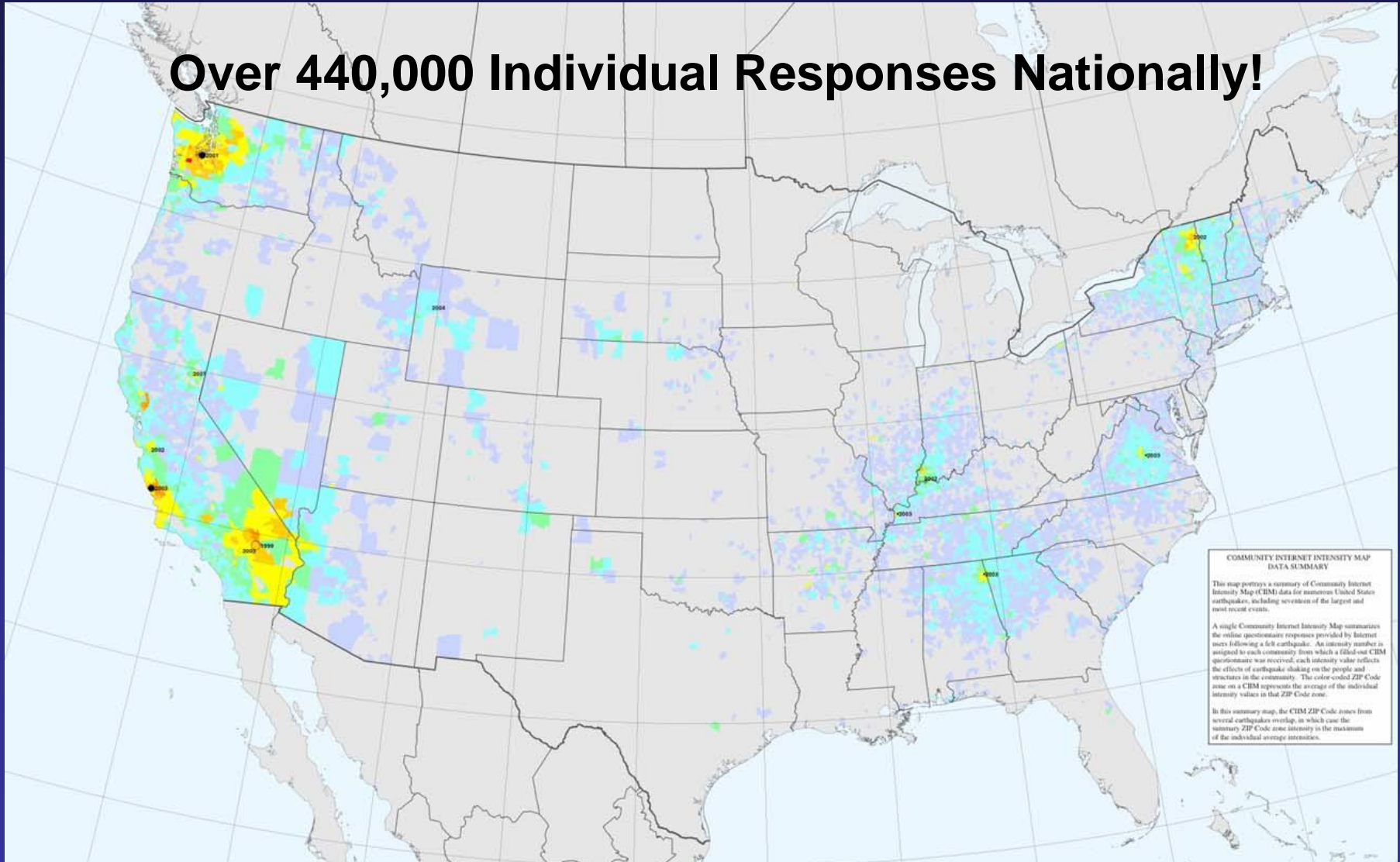
INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy

# Earthquake Intensity Based on Internet Response



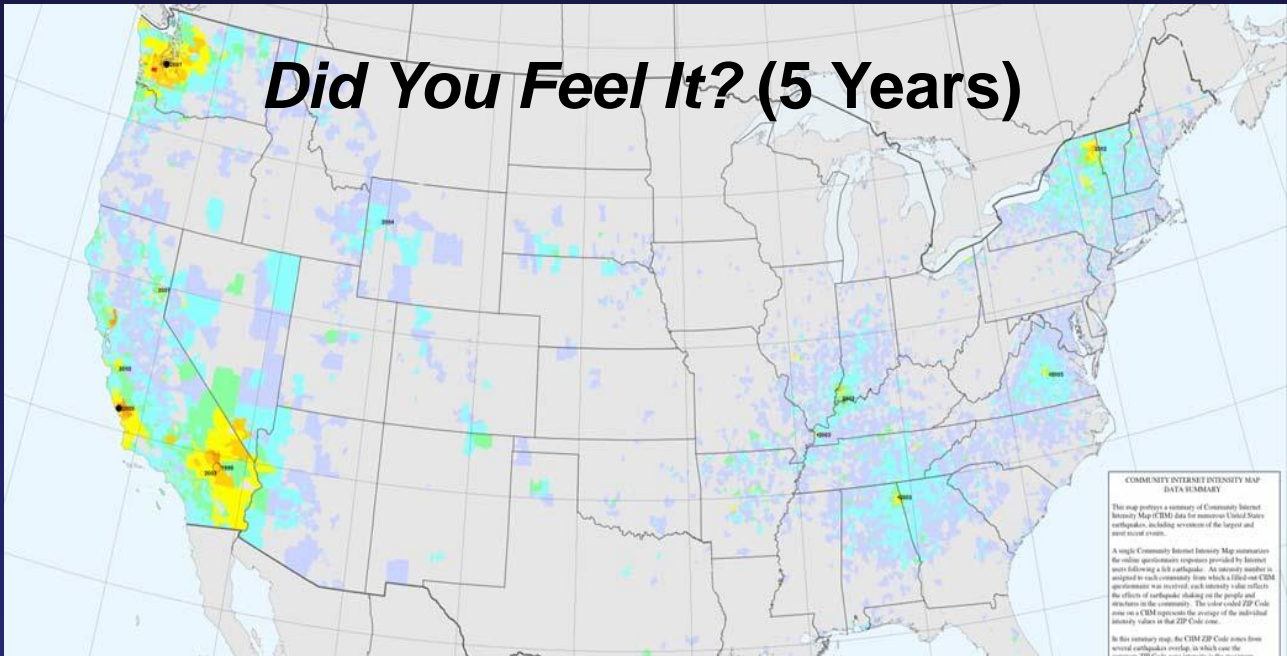
# 5 Years of Community Internet Intensity Data (DYFI?)

**Over 440,000 Individual Responses Nationally!**

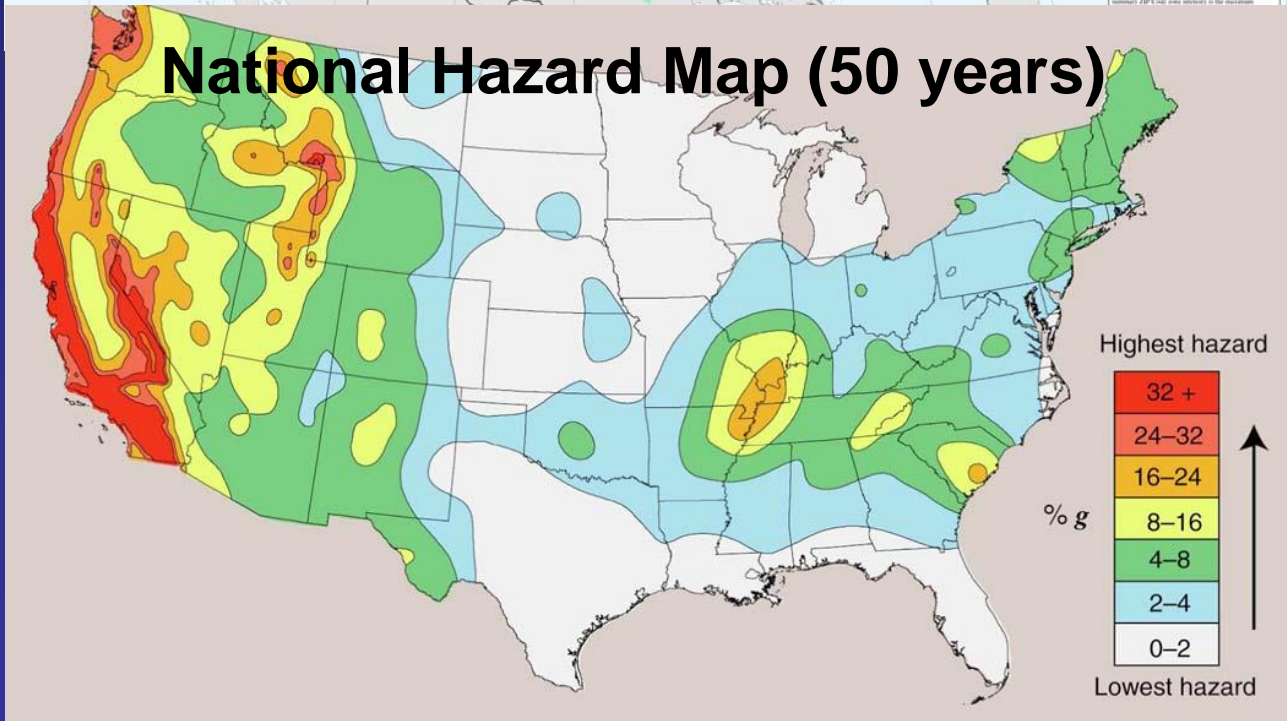




# Did You Feel It? (5 Years)



# National Hazard Map (50 years)

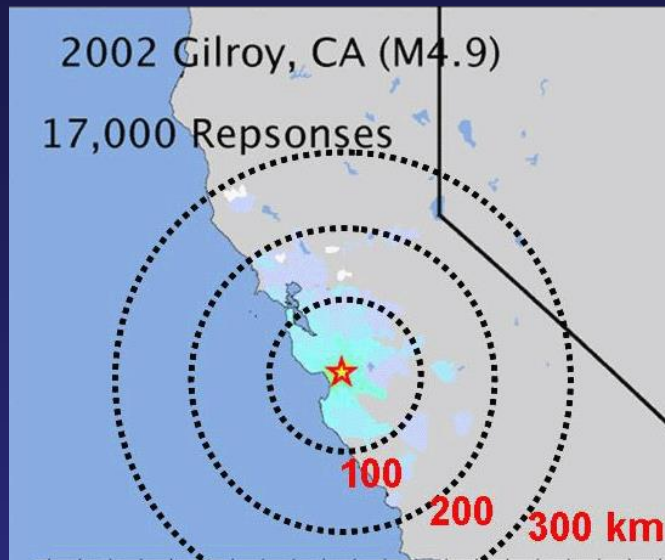


# Most reported Earthquakes

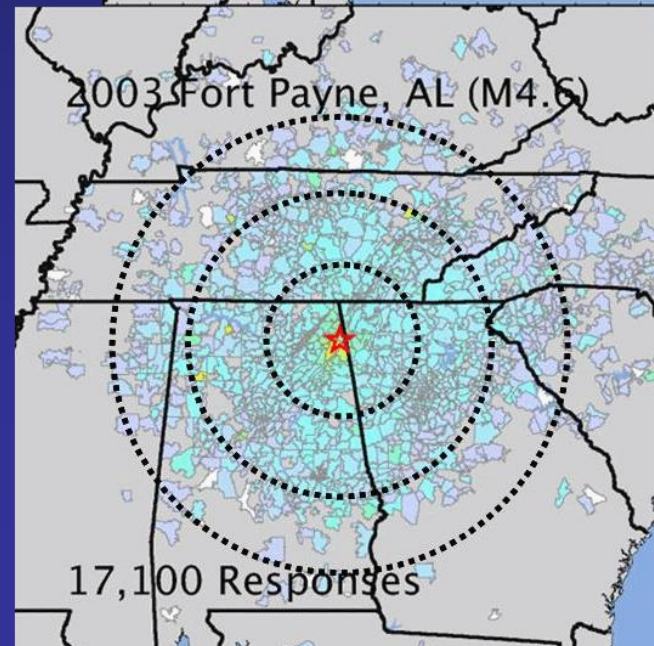
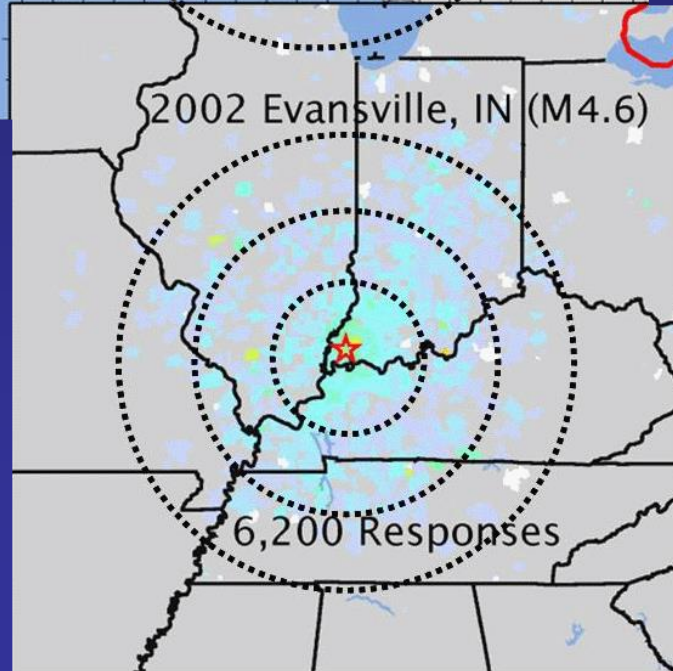
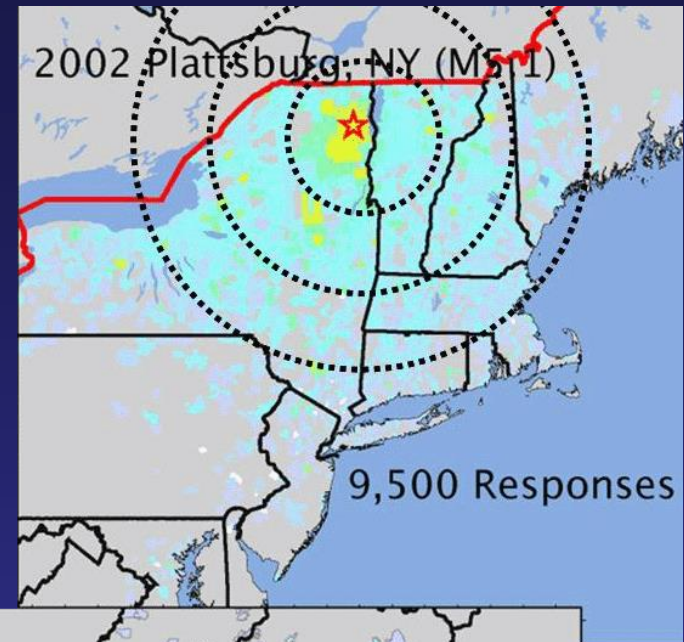
<u>Region</u>	<u>Name</u>	<u>Date</u>	<u>Magnitude</u>	<u>Number</u>
1. California	Hector Mine	OCT 16 1999	7.1	25,215
2. Central US	Fort Payne, Alabama	APR 29 2003	4.6	17,076
3. California	Near Cambria	DEC 22 2003	6.5	17,204
4. California	Gilroy	MAY 13 2002	4.9	15,721
5. Central US	Columbia, VA	DEC 9 2003	4.5	14,426
6. Pacific NW	Nisqually, WA	FEB 28 2001	6.8	12,476
7. Northeast	Near Plattsburgh, NY	APR 20 2002	5.1	9,547
8. California	Yorba Linda	SEP 3 2002	4.4	7,812
9. California	Napa Valley	SEP 3 2000	5.2	7,698
10. California	Big Bear City	FEB 22 2003	5.4	7,530
11. Central US	Evansville, Indiana	JUN 18 2002	5.0	6,692
12. California	San Jose	FEB 25 2002	4.4	5,108

**621 Responses in Redmond, WA ZIP Code  
(Microsoft Headquarters!)**

# How Far Away Can You Feel an Earthquake?

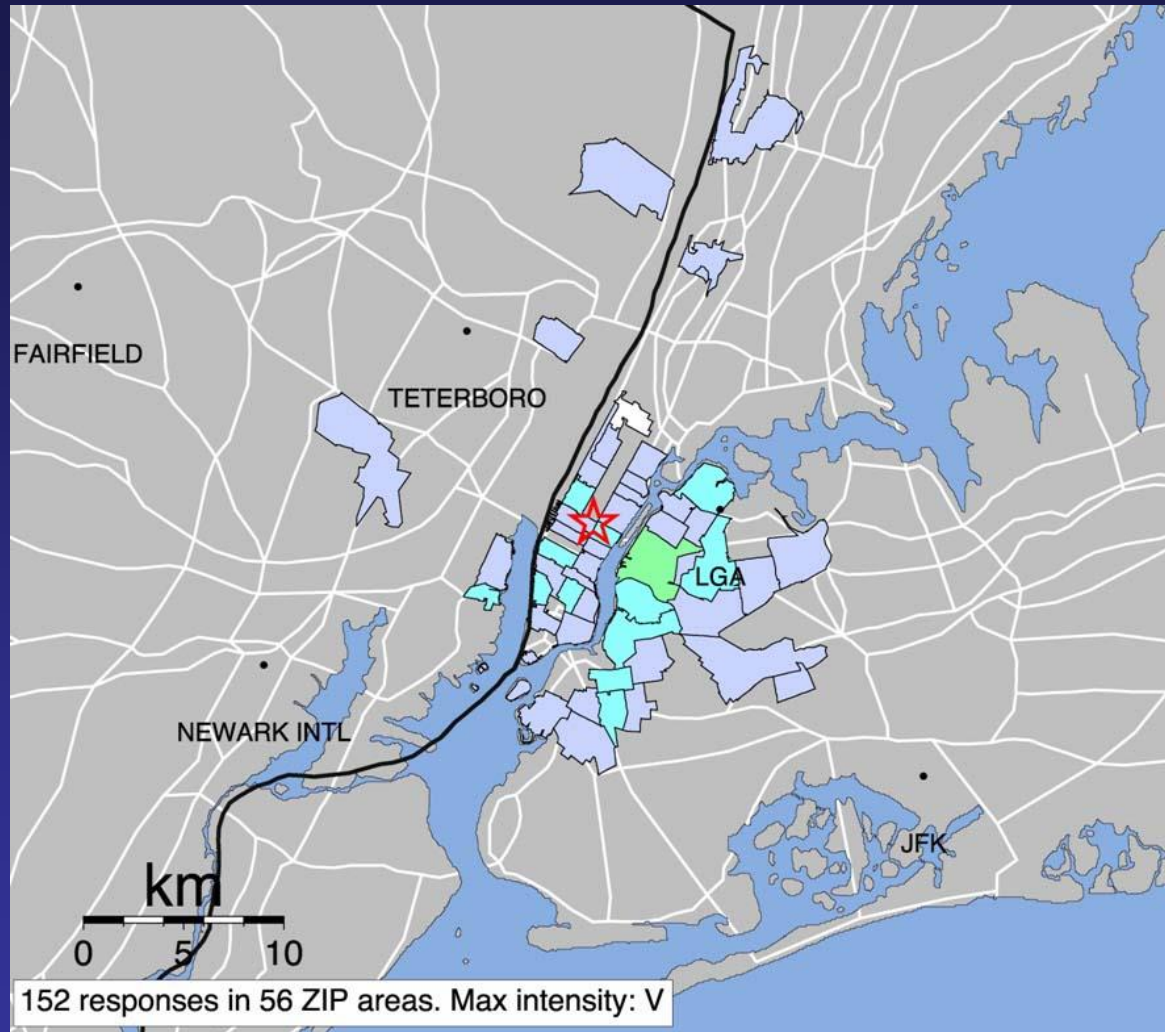


250 km



# Community Internet Intensity Map (*DFYI?*)

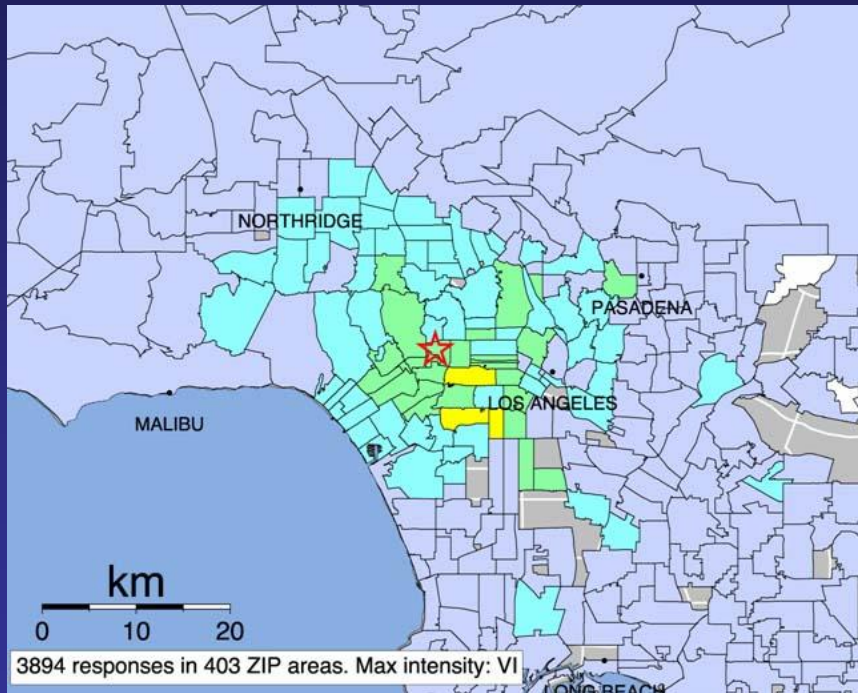
New York City, NY (Magnitude 2.6)



INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy

# Community Internet Intensity Map (DYFI?)

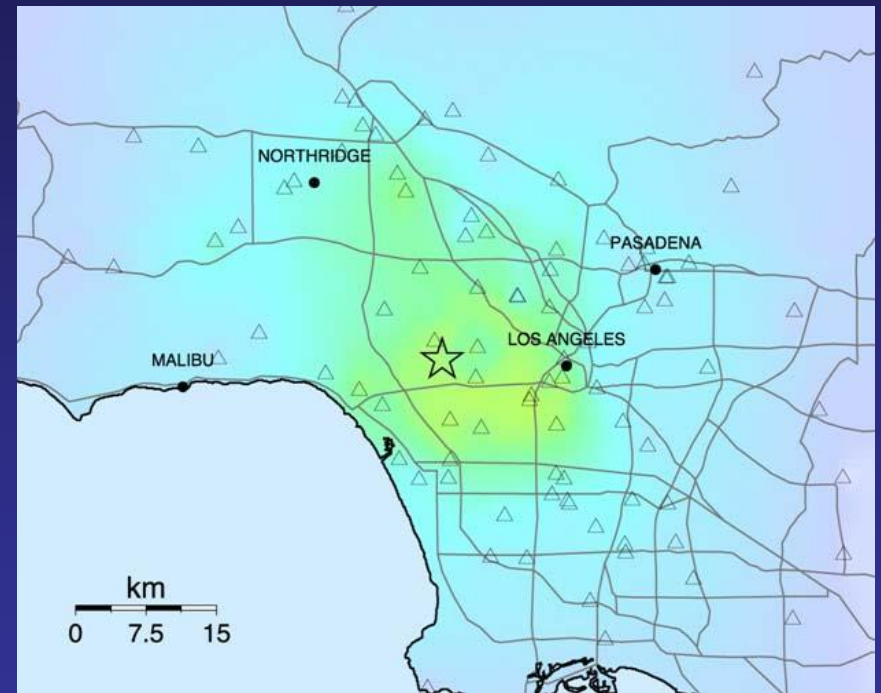
Community Internet Intensity Map (DYFI?)  
2 miles SW of West Hollywood, California



INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy

# ShakeMap

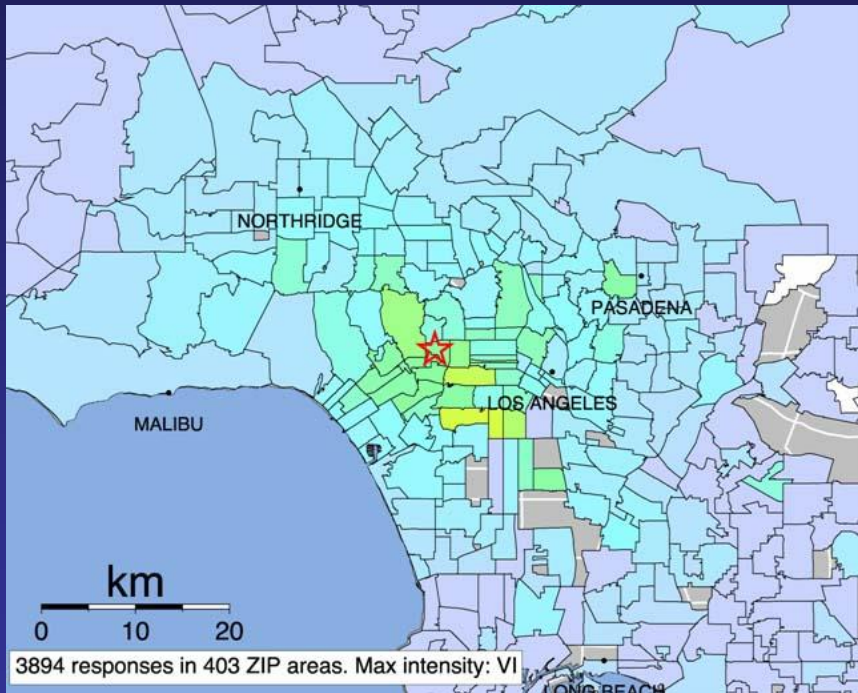
TriNet Rapid Instrumental Intensity Map Epicenter  
1.1 miles SE of Beverly Hills, California



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+

# Community Internet Intensity Map (DYFI?)

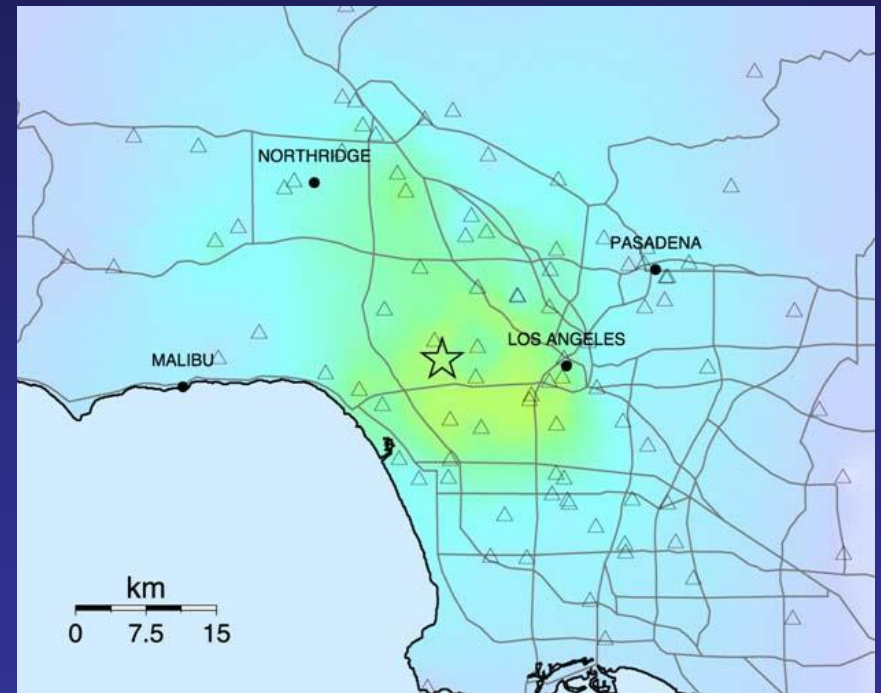
Community Internet Intensity Map (DYFI?)  
2 miles SW of West Hollywood, California



INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy

# ShakeMap

TriNet Rapid Instrumental Intensity Map Epicenter  
1.1 miles SE of Beverly Hills, California



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+

# INSTRUMENTAL INTENSITY SCALE

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+

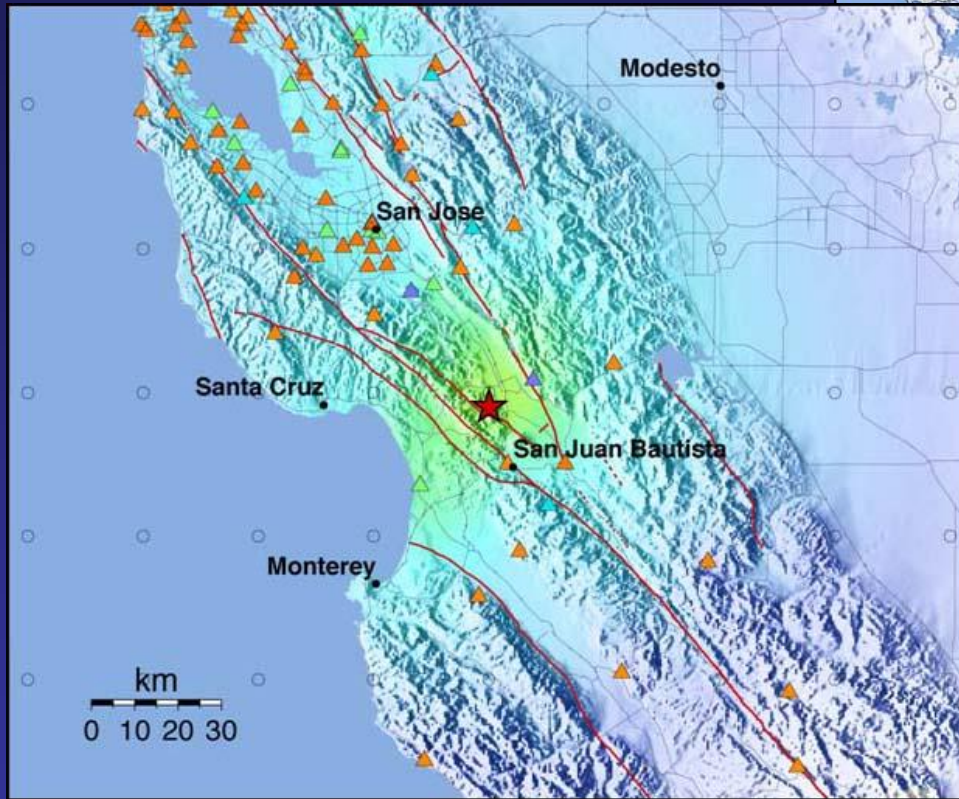
Wald et al., 1999, *Earthquake Spectra*

# 2002 Gilroy, California Earthquake (Magnitude 5.2)

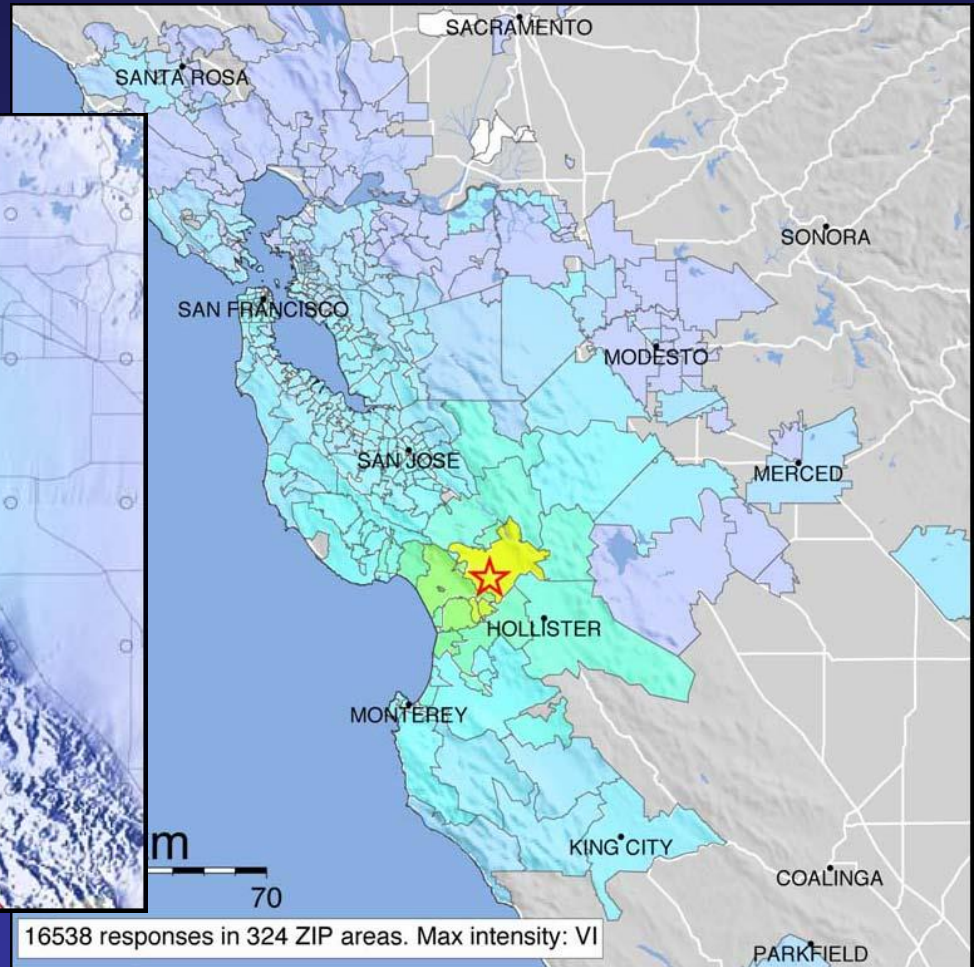
**DYFI?**

## ShakeMap

USGS/UCB/CDMG Rapid Instrumental Intensity Map



Community Internet Intensity Map (DYFI?)  
3 miles SW of Gilroy, California



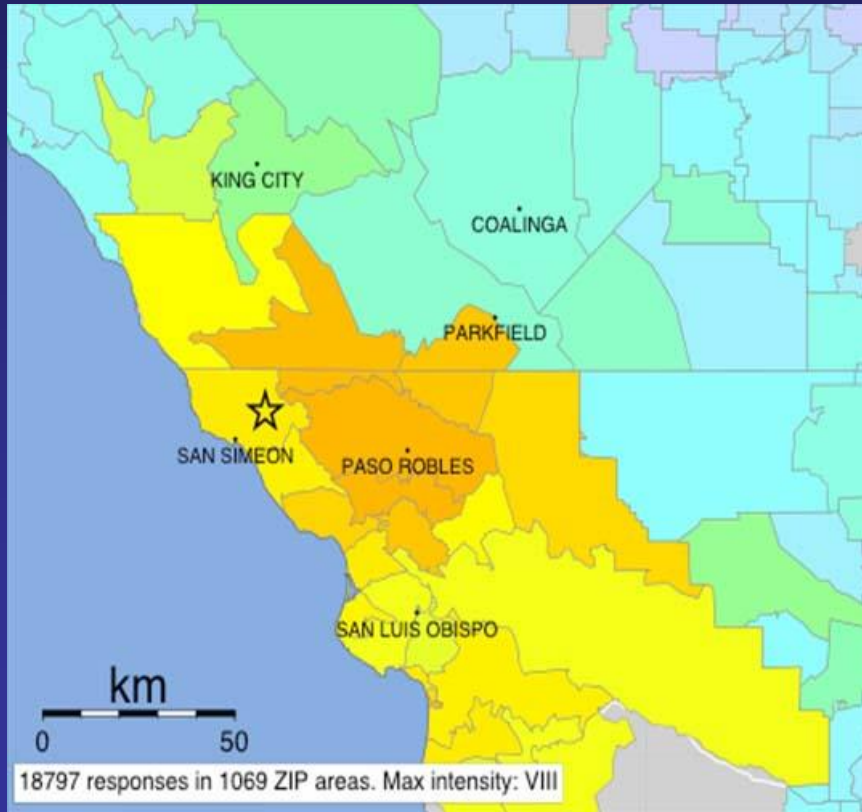
INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy



# San Simeon, California Earthquake Dec. 22, 2003 (Magnitude 6.5)

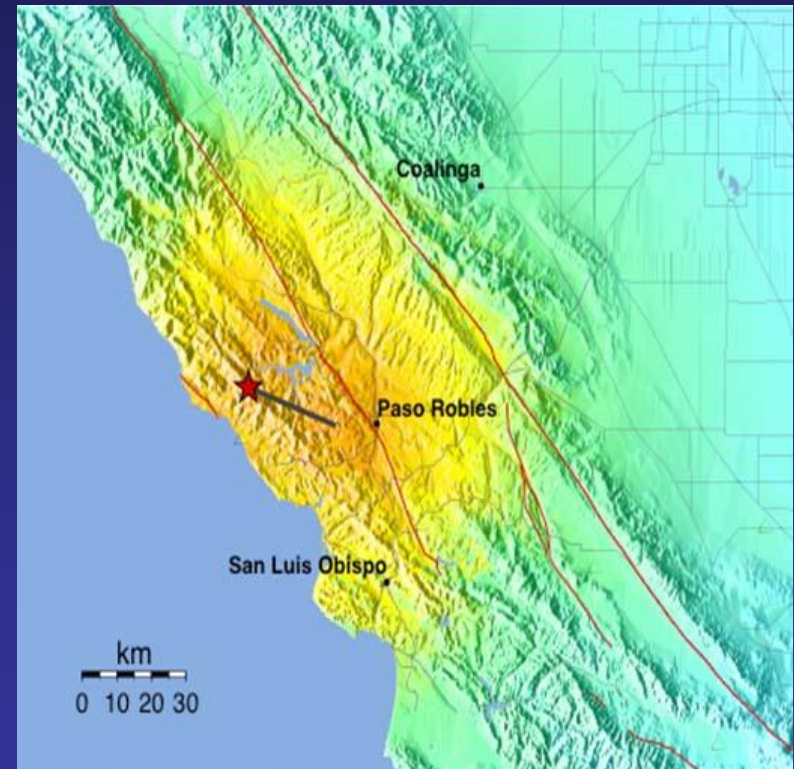
## Community Intensity Internet Map (*DYFI?*)

11 miles N of Cambria, California



## ShakeMap

CISN Rapid Instrumental Intensity Map Epicenter  
11 km NE of San Simeon, California



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+

# Community Internet Intensity Map (DFYI?)

## 11 miles N of Cambria, California

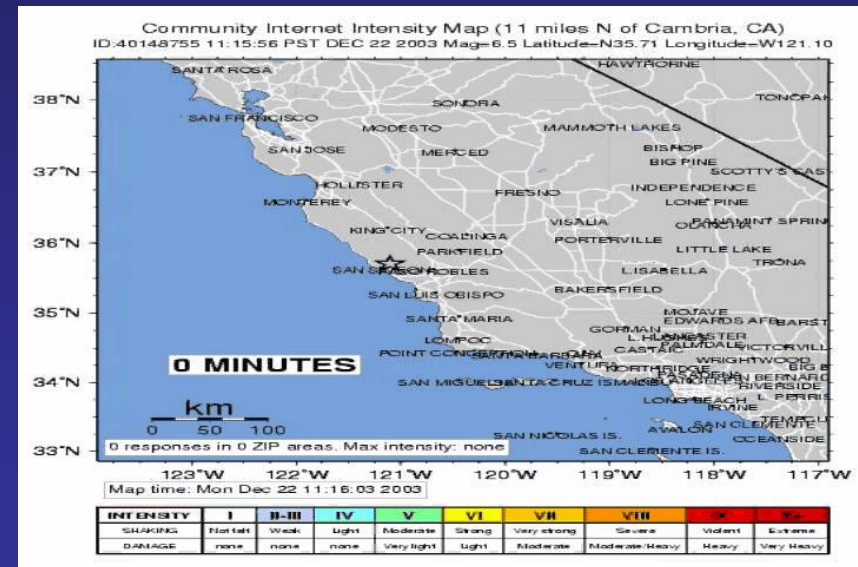


# San Simeon, California

## Dec. 22, 2003

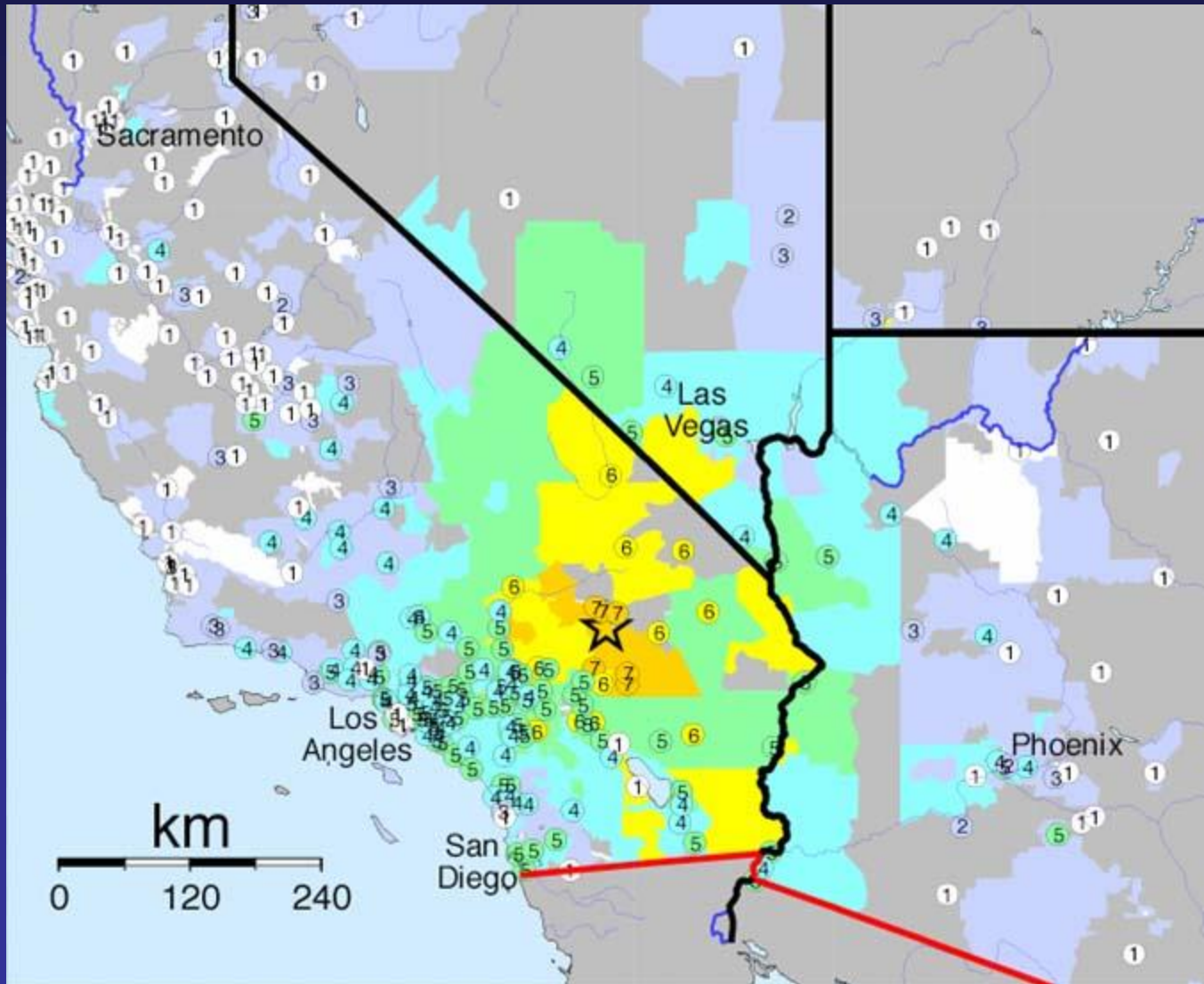
### (Magnitude 6.5)

## Movie of Responses



INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy

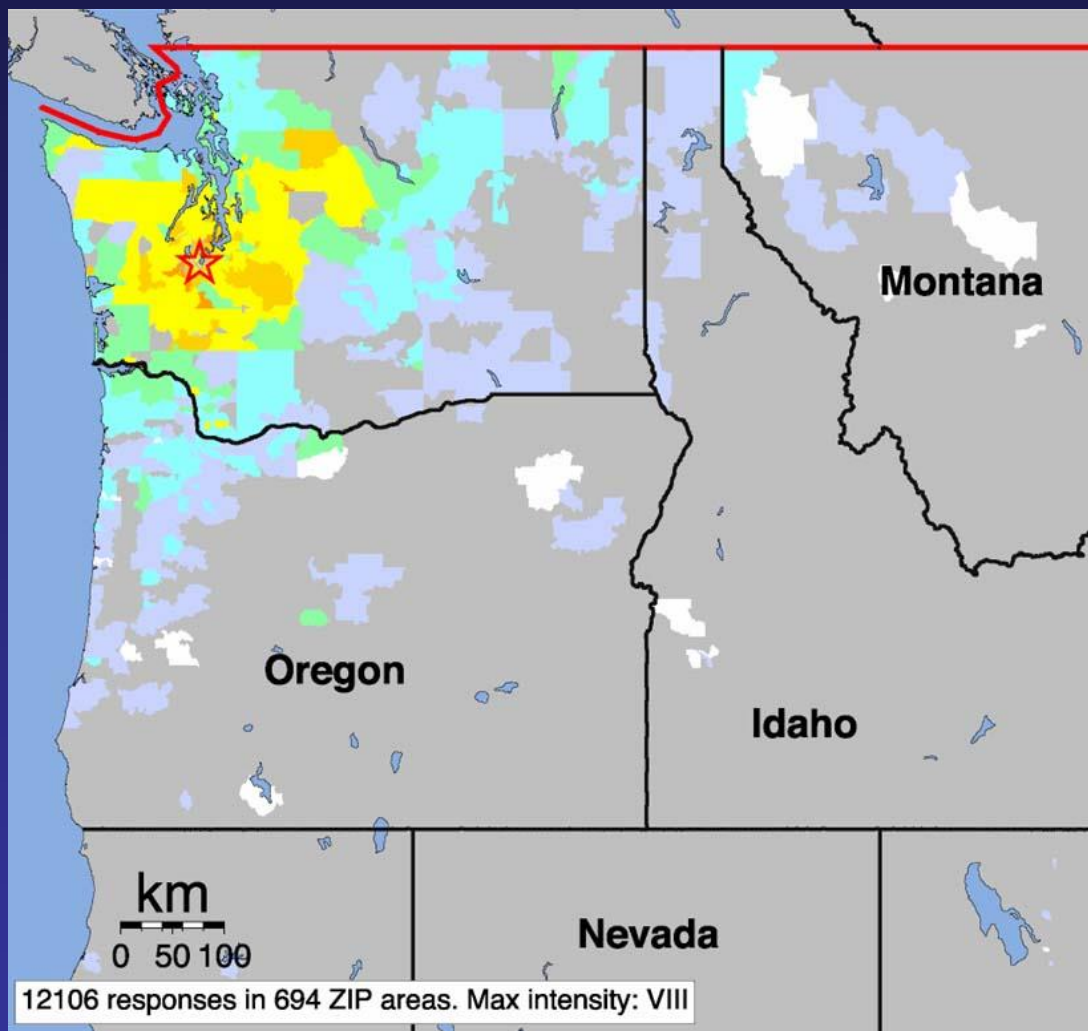
# Comparison of USGS Modified Mercalli Intensity (Colored Circles) with USGS Community Intensity (*DYFI?*; Colored Zip Codes)



25,000 Internet Responses in 1,116 ZIP Codes

# Community Internet Intensity Map (*DYFI?*)

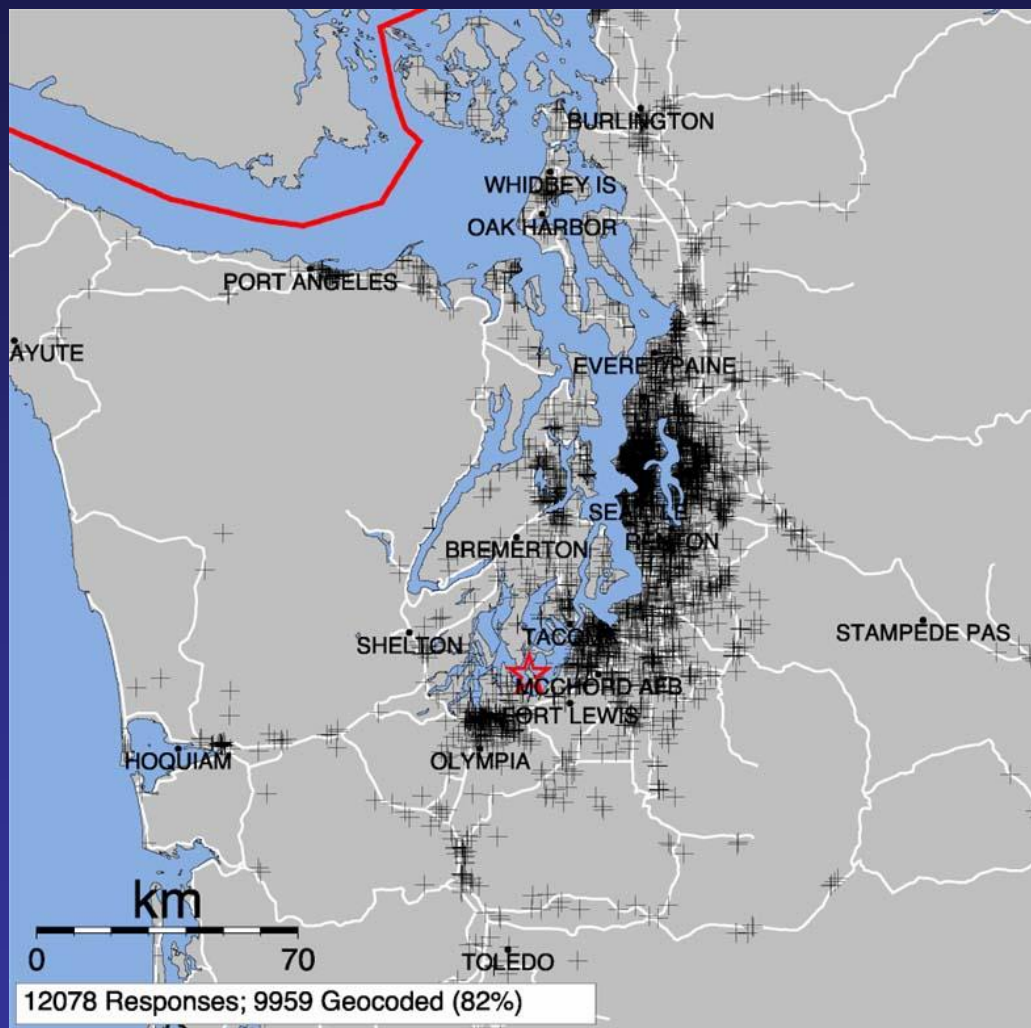
10 miles NNE of Lacey, Washington



INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy

# Community Internet Intensity Map (*DYFI?*)

10 miles NNE of Lacey, Washington

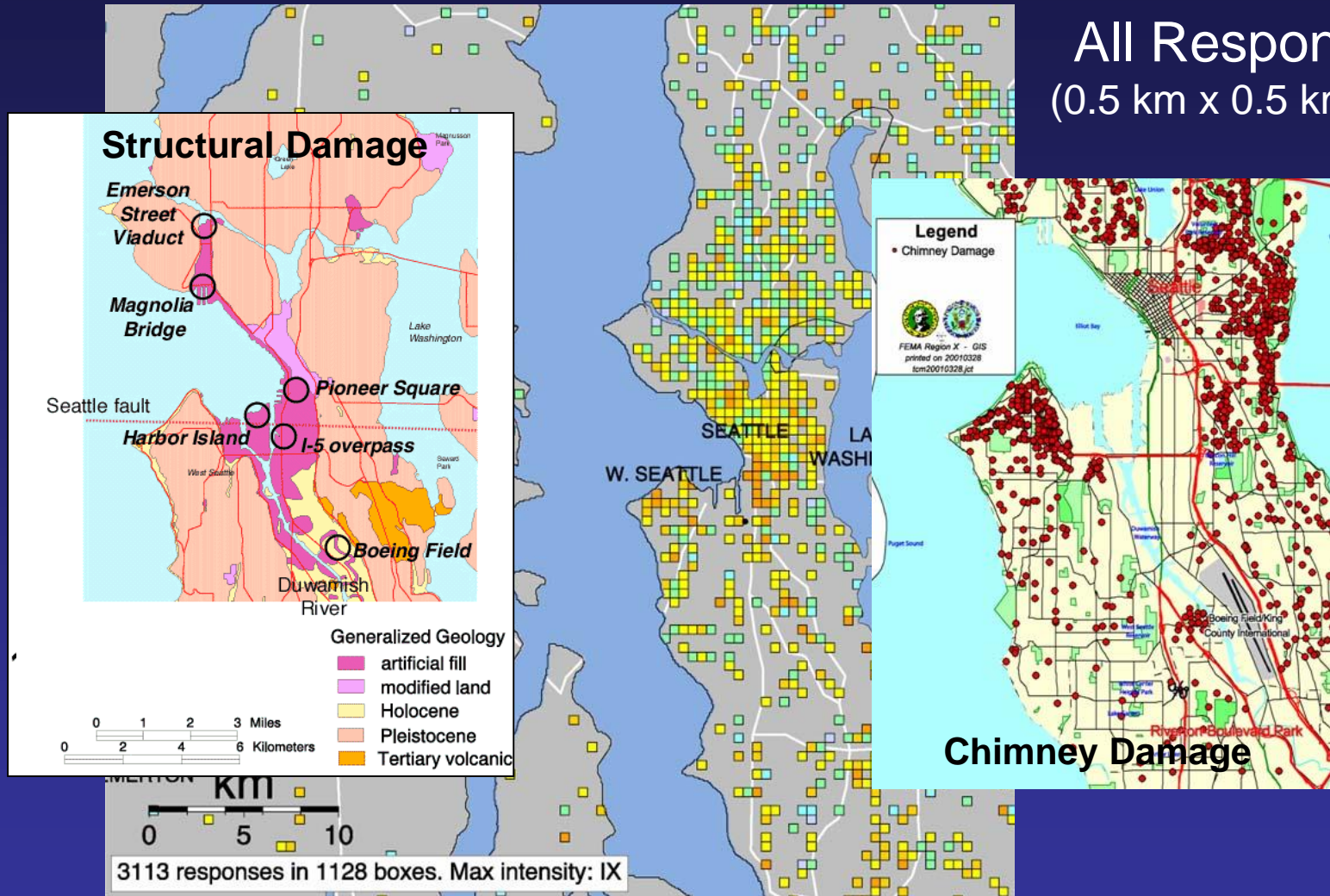


INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy

# Community Internet Intensity Map (*DYFI?*)

10 miles NNE of Lacey, Washington

All Responses  
(0.5 km x 0.5 km grid)



INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy

# How *ShakeMap* and *DYFI?* Complement Each Other

- Combined data allow for improvement of relationships between intensity and instrumental recordings
- *DYFI?* can provide information where no stations are present (Most of the US!), and add thousands of data points for both scientific and sociological analyses
- *ShakeMap* provides robust rapid response; *DYFI?* provides **human element** as well as **direct** damage observations
- *DYFI?* response data is used by the USGS to streamline and enhance the ordinary means of assigning intensity

# The End



# Follow Up Web Resources

US Geological Survey's earthquake program:  
<http://earthquake.usgs.gov>

*ShakeMap:*

<http://earthquake.usgs.gov/shakemap>

*"Did you feel it?"*

<http://earthquake.usgs.gov> under "Did you feel it?"

Earthquakes for teachers:

<http://earthquake.usgs.gov/4teachers>

Earthquakes for kids:

<http://earthquake.usgs.gov/4kids>

# Dr. David Wald



Dr. David Wald received his Ph.D. in Geophysics in 1993 from the California Institute of Technology. Dr. Wald's research includes the evaluation of ground motion amplification in basin environments, the estimation of rupture process from earthquakes; analysis of ground motion hazards, and earthquake source physics. Dr. Wald was involved in Real-time Seismology including the generation of real-time ground motion shaking and intensity maps for damaging earthquakes. He developed and managed both the ShakeMap system and the Community Internet Intensity Maps (popularly called "Did You Feel it?") for post-earthquake response and information.

Dr. Wald was awarded the Southern California Emergency Services Association's Diamond Award for outstanding service and support to the Field of Emergency Management in 2000 and was the Associate Editor for the Bulletin of the Seismological Society of America from 1996 to 2000. Articles and broadcast about his work have appeared in New York Times, Los Angeles Times, Christian Science Monitor, USA Today, San Francisco Chronicle, Associated Press, PBS, CNN, FOX, ABC, CBS, MS-NBC, Learning Channel, History Channel, TechTV, BBC, NHK, NPR and Voice of America.