

Update on USGS Earthquake Hazards Program

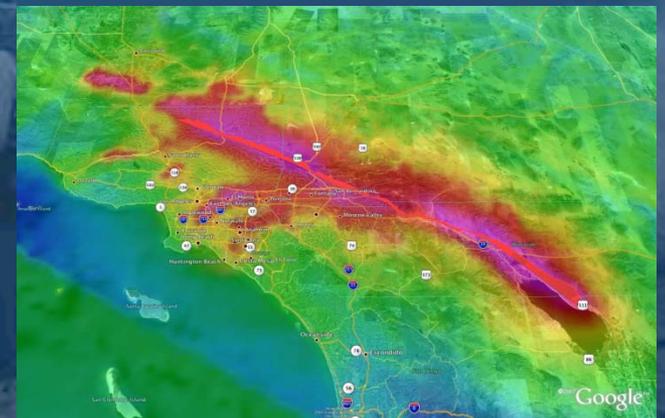
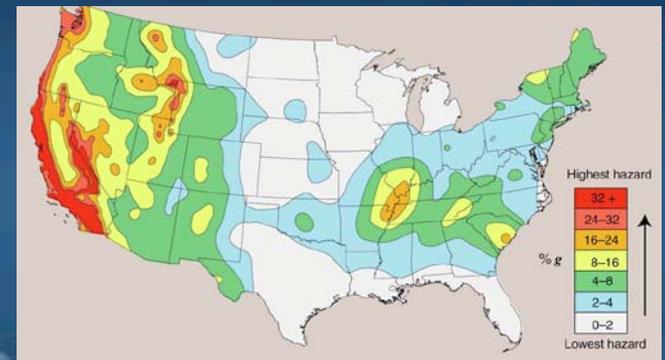
ACEHR Meeting

November 2009

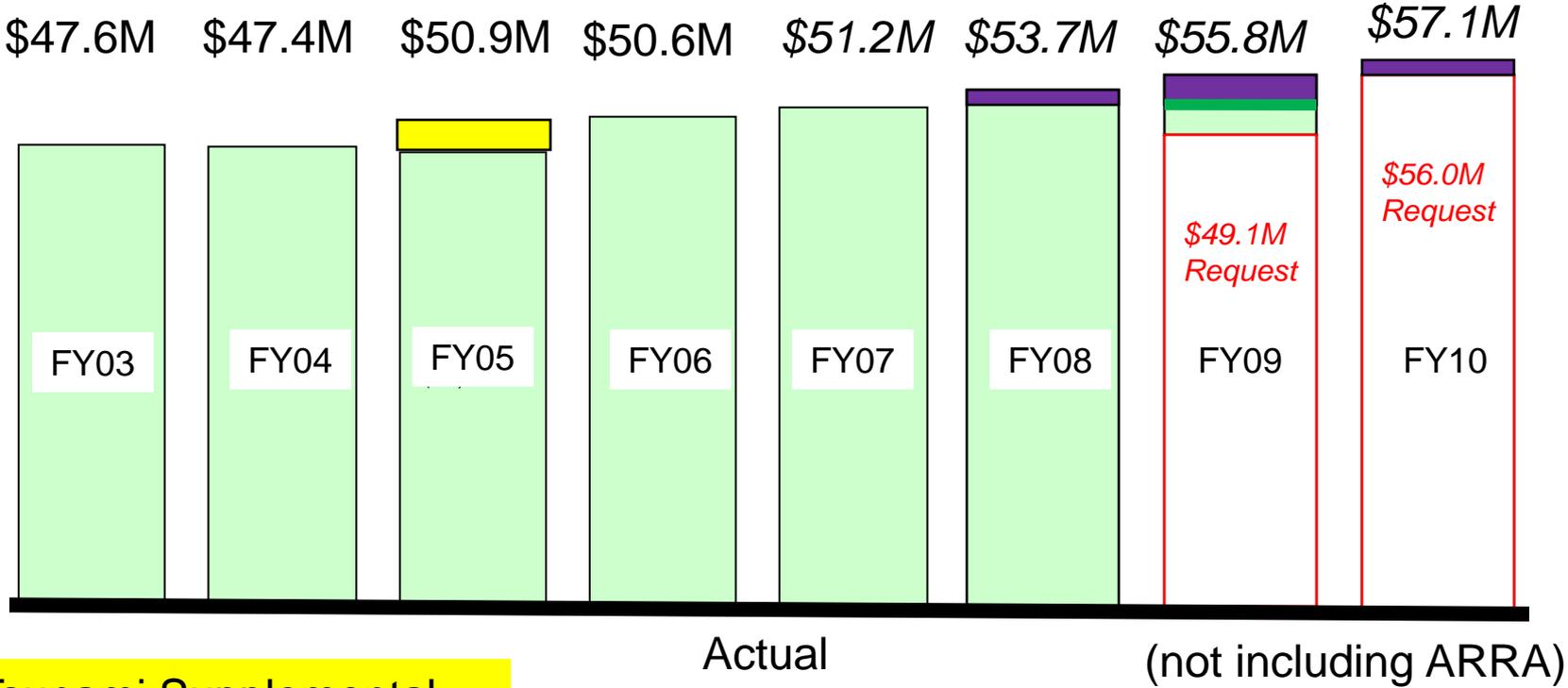
The USGS role in NEHRP

Statute: The United States Geological Survey shall conduct research and other activities necessary to characterize and identify earthquake hazards, assess earthquake risks, monitor seismic activity, and improve earthquake predictions.

- Provide earthquake monitoring and notifications,
- Assess seismic hazards, and
- Conduct targeted research needed to reduce the risk from earthquake hazards nationwide.



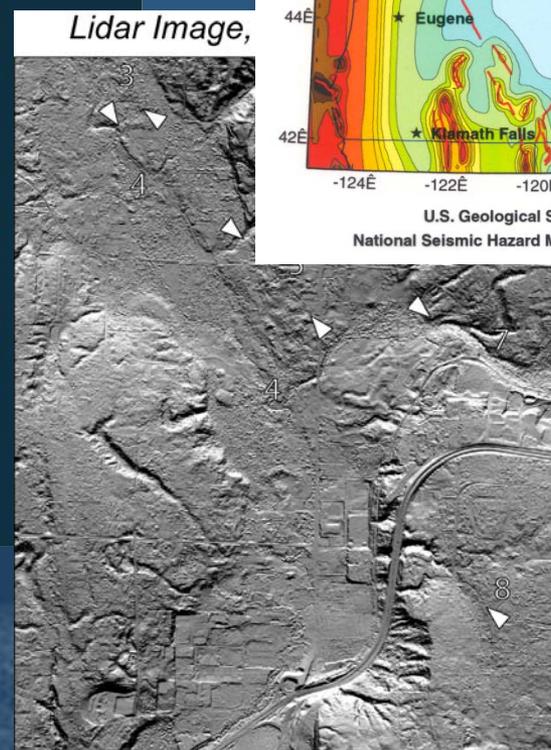
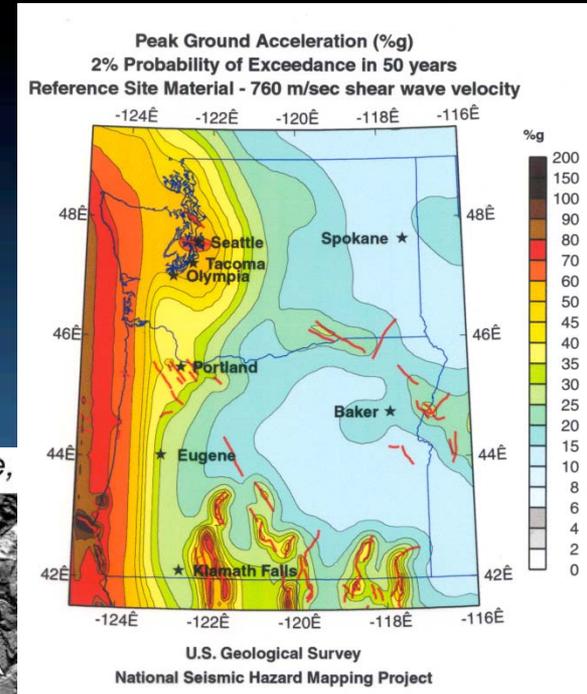
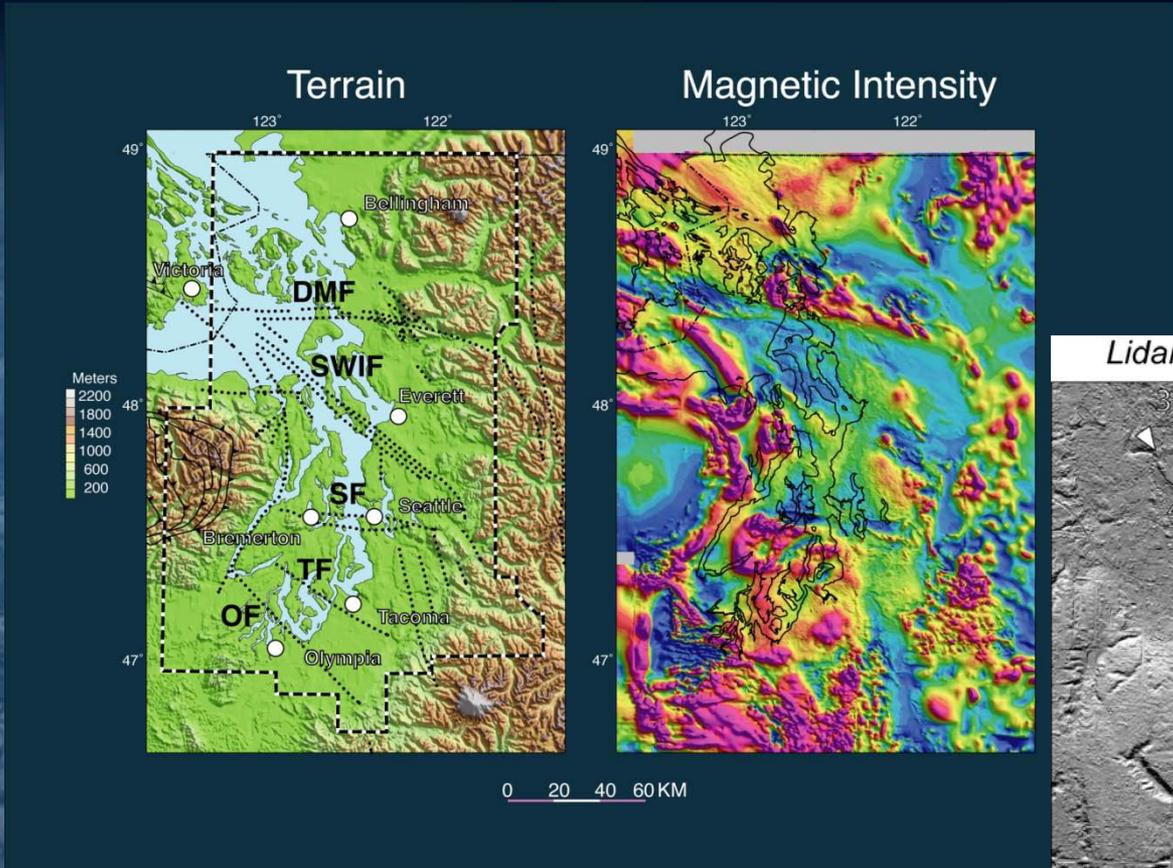
Recent Earthquake Hazards Program funding history including final FY10 appropriation



- Tsunami Supplemental (became part of base in FY06)
- Congressional adds for Multi-Hazards Initiative
- Arkansas earmark

FY10 House mark added \$1M above request for “critically needed LIDAR and other seismological studies of areas with high earthquake risk and community danger.”

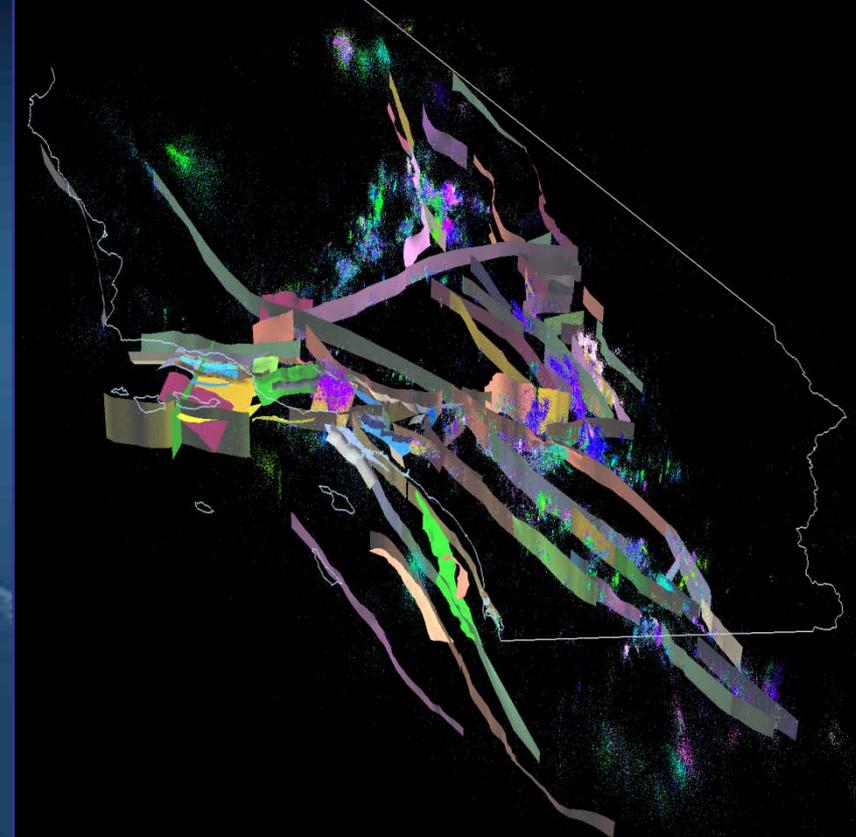
Taking the multi-hazard initiative on the road: Pacific Northwest



External funding is a key component of the Earthquake Hazards Program

- Approximately 25% of core program funds (\$14.1M in FY09)
 - Competitive grants (\$4.7M)
 - Seismic & Geodetic monitoring operations (\$7.2M)
 - Non-competitive agreements, including SCEC (\$2.2M)
- Gives flexibility and adds breadth of expertise to program
- Leverages support from other state and federal agencies, and universities

SCEC model of active faults in Southern California



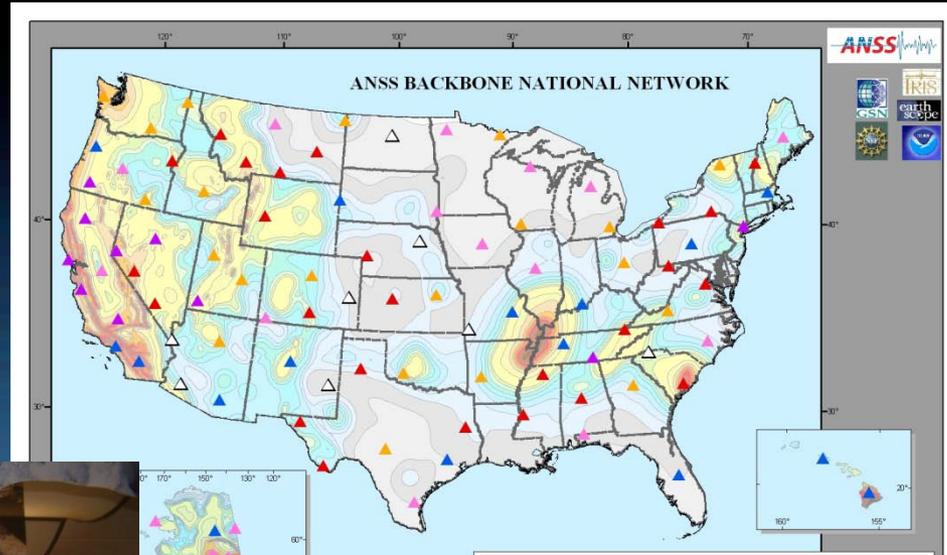
NEHRP Strategic Priorities

- **Fully implement the Advanced National Seismic System.**
- Improve techniques for evaluating and rehabilitating existing buildings.
- Further develop Performance-Based Seismic Design.
- Increase consideration of socioeconomic issues related to hazard mitigation implementation.
- Develop a national post-earthquake information management system.
- Develop advanced earthquake risk mitigation technologies and practices.
- Develop guidelines for earthquake-resilient lifeline components and systems.
- **Develop and conduct earthquake scenarios for effective earthquake risk reduction and response and recovery planning.**
- Facilitate improved earthquake mitigation at State and local levels.

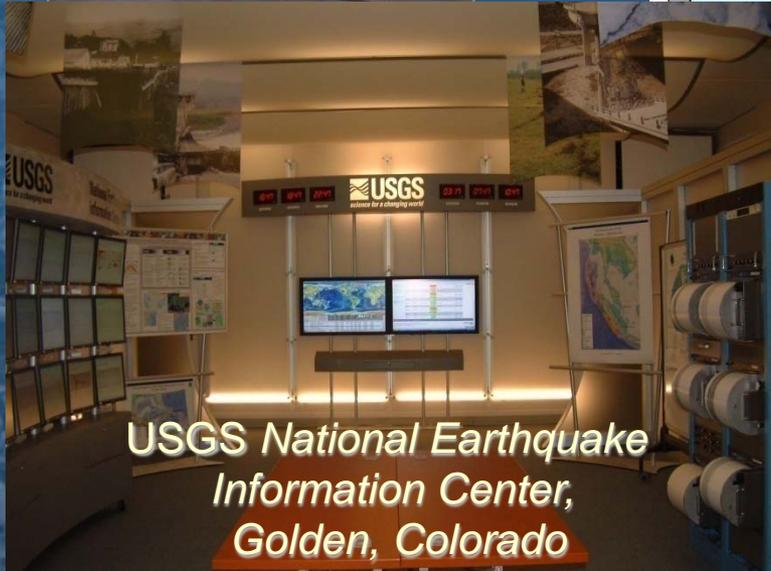


USGS is using Recovery Act and multi-hazards funds to make progress in these two areas

Advanced National Seismic System (ANSS)



ration having a 2% probability of
sars. For more information, see
gs.gov/research/hazmaps/



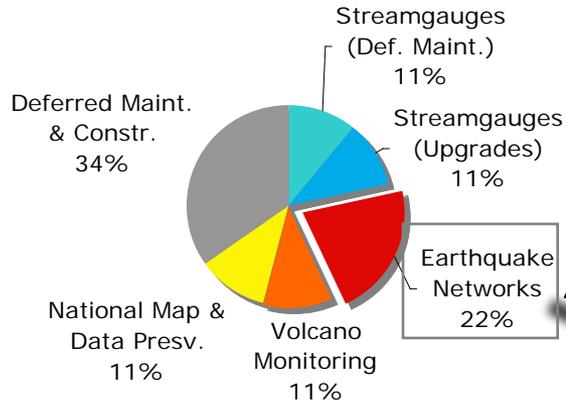
USGS National Earthquake
Information Center,
Golden, Colorado



ANSS Backbone completion with
support from NSF's EarthScope

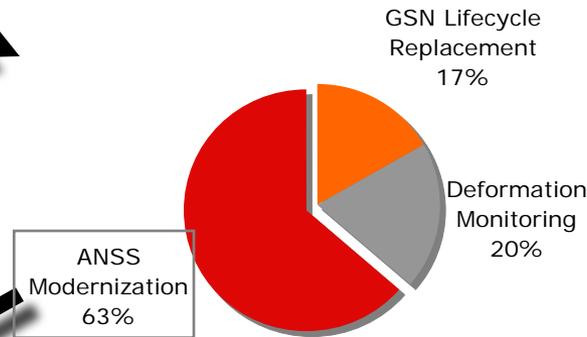


USGS Total: \$140M

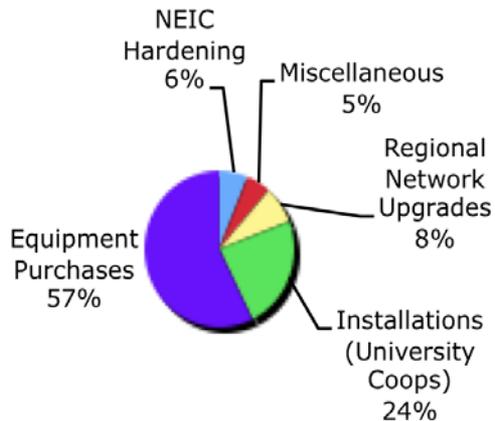


USGS spending plan for Recovery Act (ARRA) funding

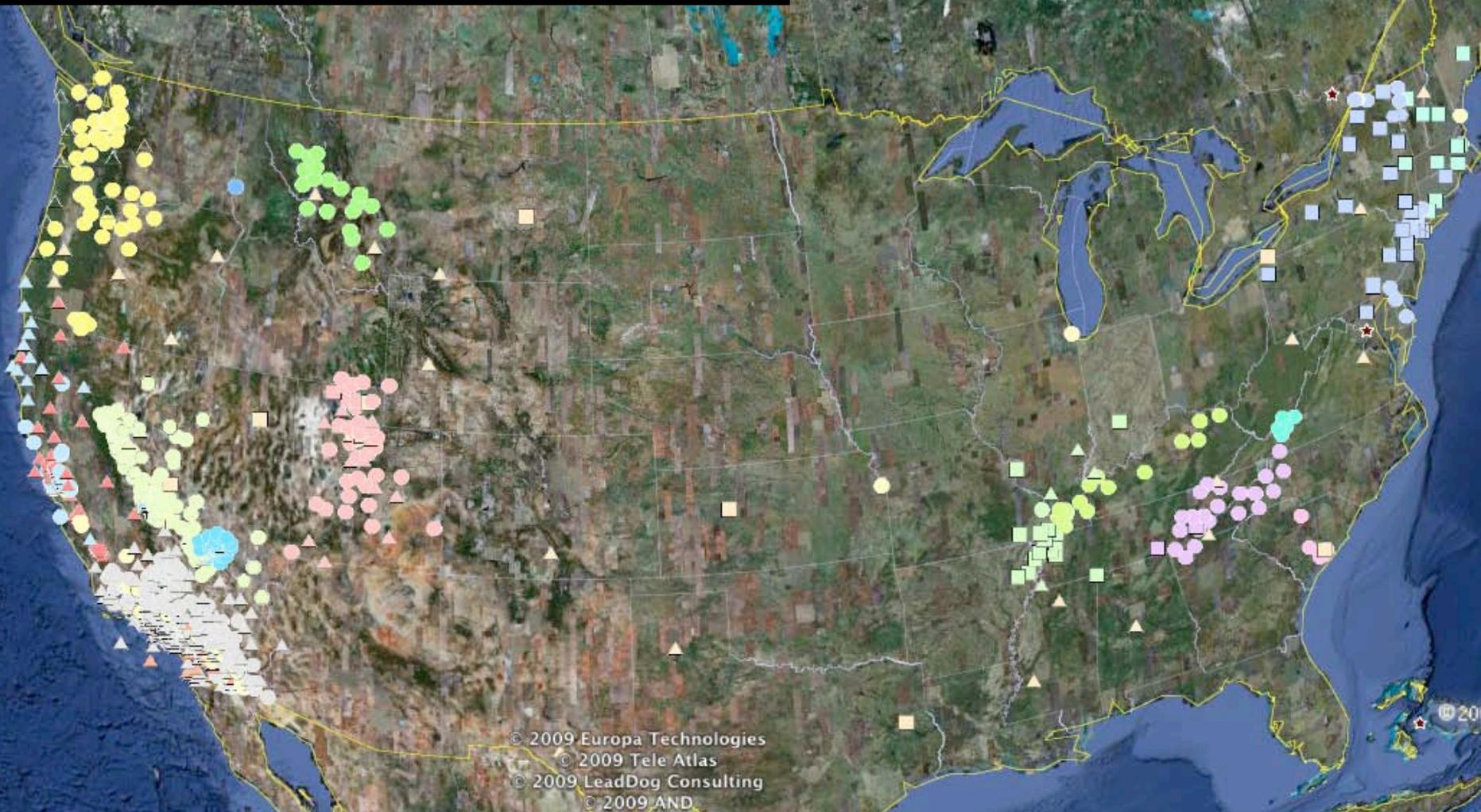
Earthquake Networks: \$29.4M



ANSS Modernization: \$19.2M



Existing seismic stations
targeted for upgrades
with ARRA funding



© 2009 Europa Technologies

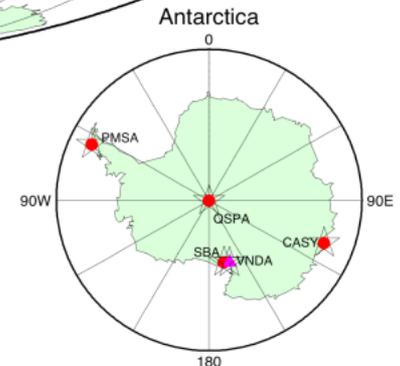
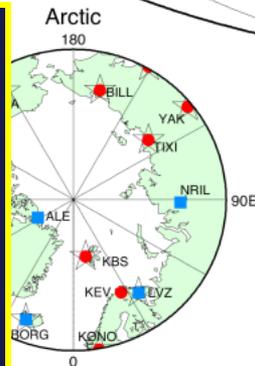
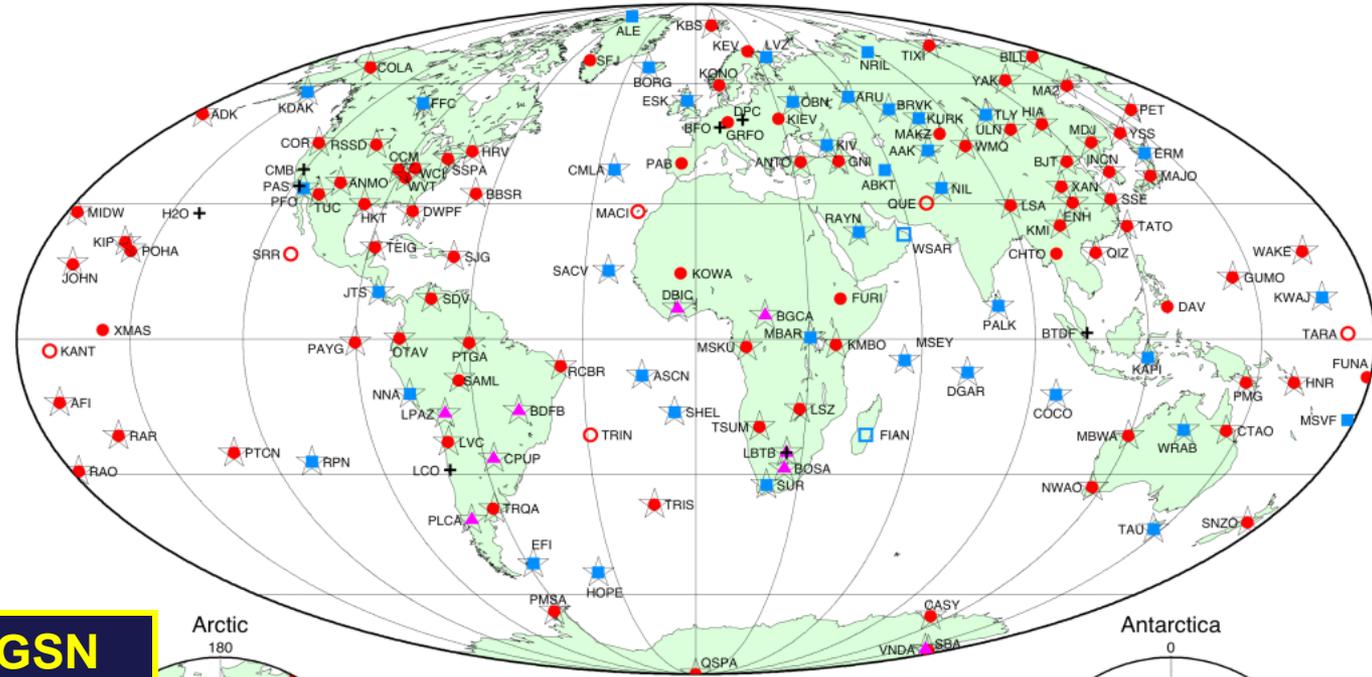
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Global Seismographic Network

Global Seismographic Network



- | Installed | Planned | |
|-----------|---------|-------------------------------|
| 85 ● | 6 ○ | IRIS/USGS Stations |
| 39 ■ | 2 □ | IRIS/IDA Stations (UCSD) |
| 8 + | | Other/Affiliated GSN Stations |
| 9 ▲ | | GTSN Stations (AFTAC) |
| 117 ☆ | | Telemetered stations |

USGS Albuquerque Seismological Laboratory
January 27, 2005 (crh/lw)

USGS Funding for GSN

FY 2005: \$3.4 million

FY 2005 post-Sumatra
supplemental: +\$4.1M

FY 2006: \$3.9M

FY 2007: \$3.9M

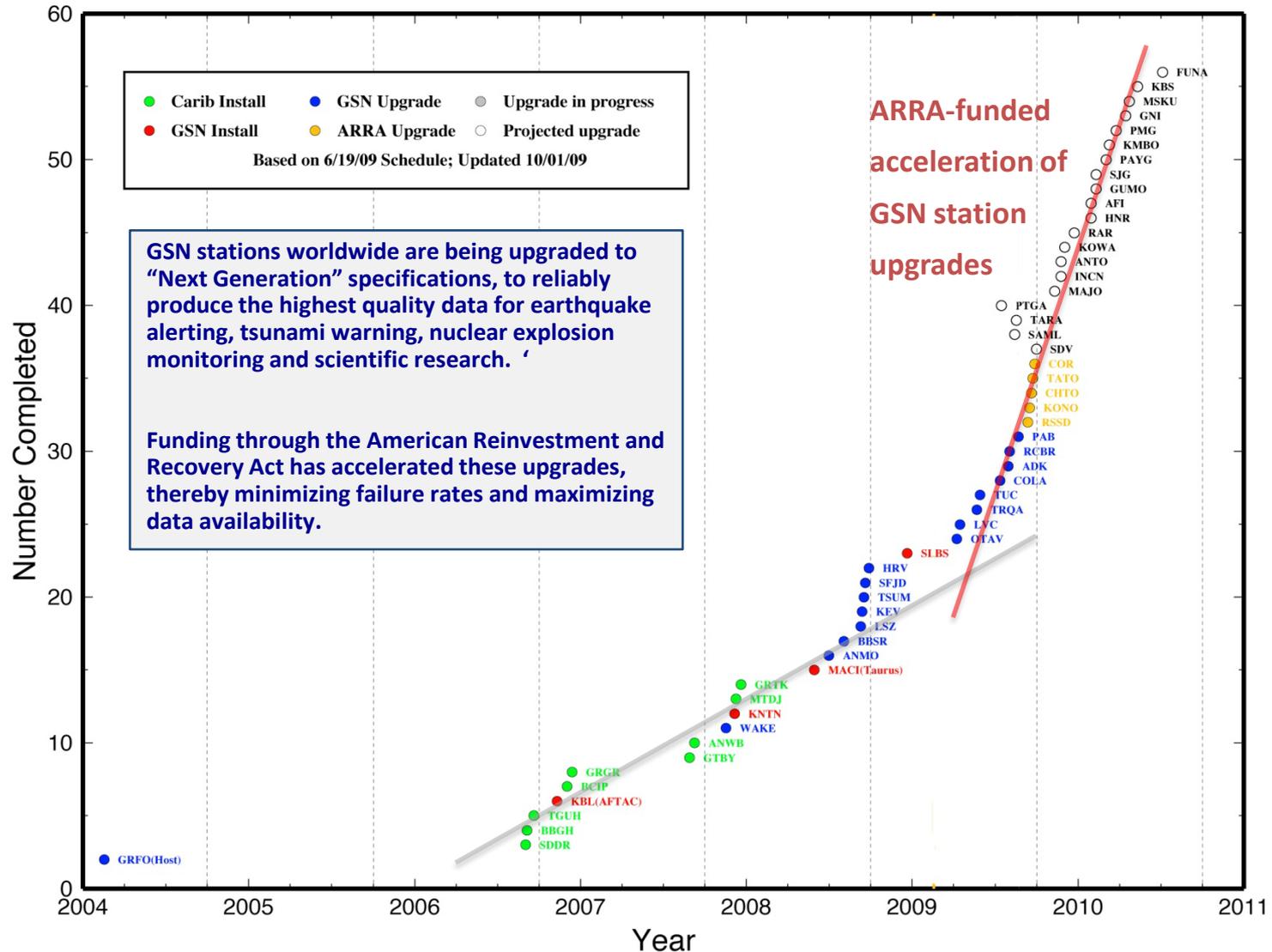
FY 2008: \$4.4M

FY 2009: \$5.4M + ARRA

FY 2010: \$5.7M + ARRA



Progress upgrading USGS-operated GSN stations



ShakeCast

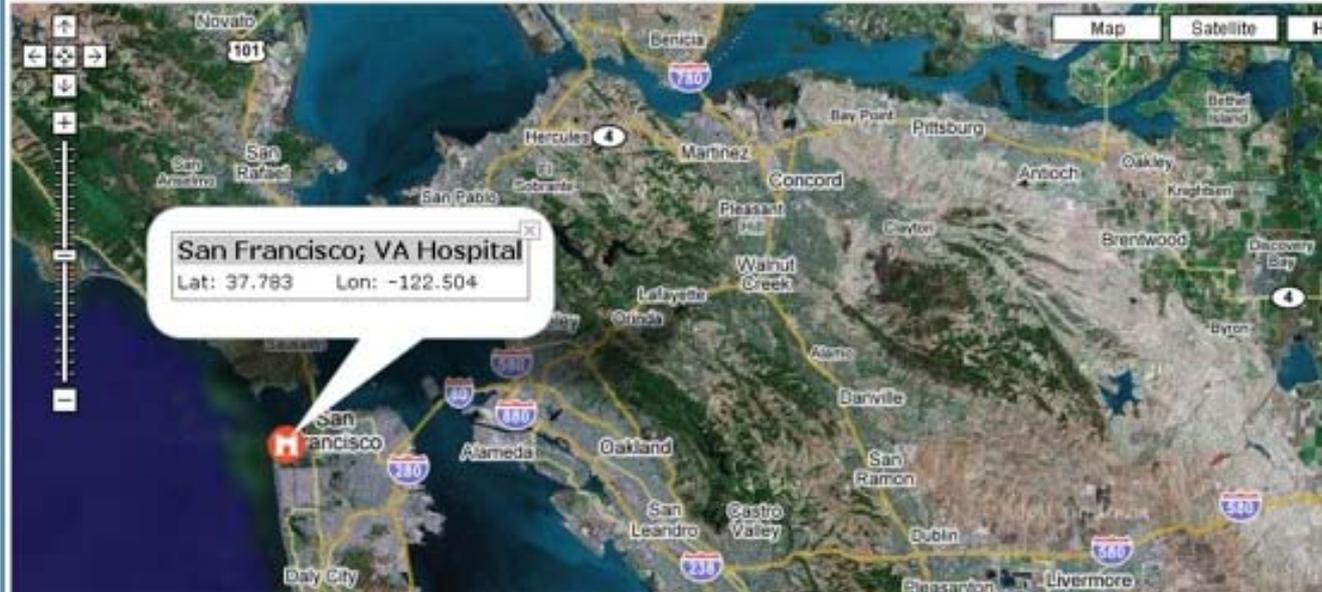


Automated notifications to operators of critical facilities



Caltans ShakeCast System

All VA_HOSP



Facility Damage Estimates from ShakeMap

Bridges presented in the table below are sorted in order of potential damage level.

Bridge Name	Bridge No	Dist-Cty-Rte-PM	Damage Level	Value	Exceedance Ratio
Pisgah Overhead	54 0689L	08-SBD-040-R37.41	RED	47.6856	1.163
Pisgah Overhead	54 0689R	08-SBD-040-R37.44	RED	47.6856	1.163
Lavic Road OC	54 0734	08-SBD-040-R41.91	YELLOW	56.4714	0.867
Ash Hill Wash	54 0758L	08-SBD-040-R54.75	GREEN	25.5495	0.887
Ash Hill Wash	54 0758R	08-SBD-040-R54.77	GREEN	25.5495	0.887
Argos Wash	54 0737L	08-SBD-040-R43.84	GREEN	48.8524	0.053
Argos Wash	54 0737R	08-SBD-040-R43.84	GREEN	48.8524	0.053

Done

Example Shakecast Users



Caltrans

CEA CALIFORNIA EARTHQUAKE AUTHORITY

PG&E Pacific Gas and Electric Company

Los Angeles Unified School District
Today's Learners, Tomorrow's Leaders

DEPARTMENT OF WATER RESOURCES

East Bay Municipal Utility District

State Gov't/Utilities



KAISER PERMANENTE

TRAVELERS

Sempra Energy

Sunoco Logistics™

Commerical/Business



IAEA.org
International Atomic Energy Agency

International



FEDERAL GOVERNMENT

FEMA

CBP.gov
Securing America's Borders

United States Northern Command
DEFENDING OUR HOMELAND

UNITED STATES DEPARTMENT OF VETERANS AFFAIRS

U.S. NRC

USGS
science for a changing world

PAGER

Prompt Assessment of Global Earthquakes for Response

5.3 million people in areas of moderate to heavy damage

M 7.0, PLE 4-09 Scenario

Origin Time: Wed 2009-10-21 18:00:00 UTC

Location: 37.55°N 121.99°W Depth: 10 km

PAGER
Version 1

Created: 12 mins, 3 secs after earthquake

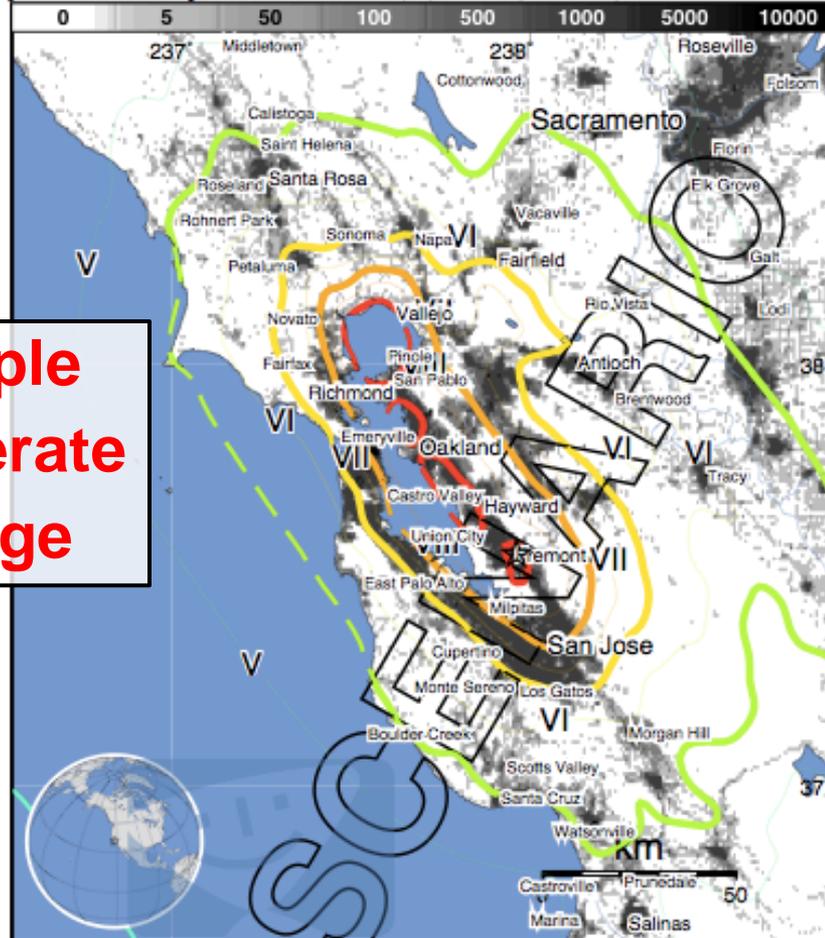
Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)	--*	--*	--*	2,434k*	2,111k	2,715k	1,921k	712k	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 2006

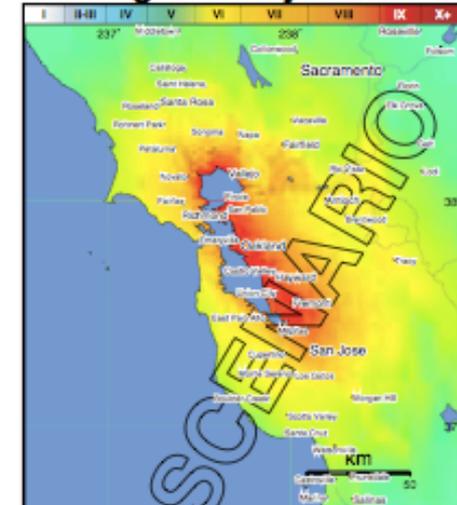


Selected City Exposure

MMI City	Population
IX Fremont	202k
IX Ashland	23k
IX San Lorenzo	23k
IX San Leandro	79k
IX East Richmond Heights	3k
IX San Pablo	31k
VIII Oakland	399k
VIII San Francisco	732k
VIII San Jose	894k
VI Stockton	289k
V Sacramento	467k

bold cities appear on map (k = x1000)

Shaking Intensity



Prototype LossPAGER coming soon



Red  Alert



PAGER
Version 1

Created: 1 year, 4 months after earthquake

M 7.9, EASTERN SICHUAN, CHINA

Origin Time: Mon 2008-05-12 06:28:01 UTC

Location: 30.99°N 103.36°E Depth: 19 km

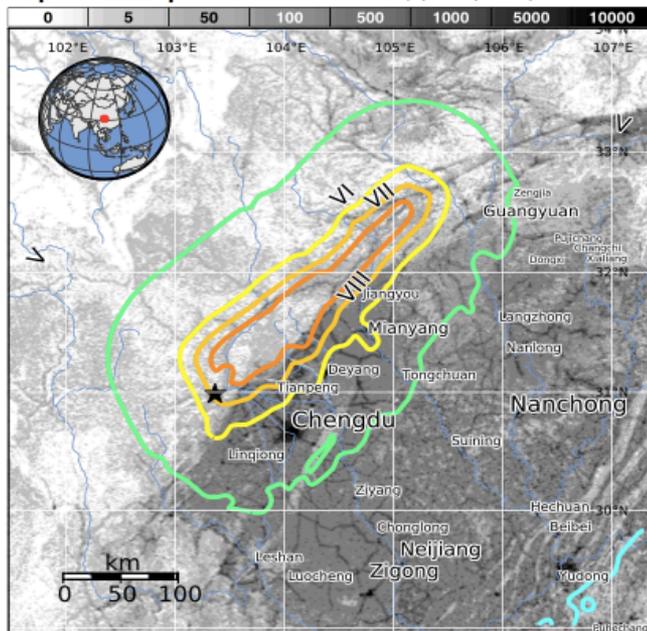
Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)	--	--*	1,514k*	63,388k*	18,723k	3,970k	1,236k	541k	2k	
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
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Population Exposure

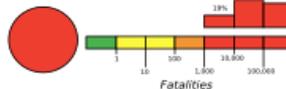
population per ~1 sq. km from Landsat



Overall, the population in this region resides in structures that are highly vulnerable to earthquake shaking, though some resistant structures exist. A magnitude 7.7 earthquake 271 km West of this one struck Luhuo, China on February 06, 1973 (UTC), with estimated population exposures of 31,000 at intensity IX or greater and 19,000 at intensity VIII, resulting in an estimated 2,199 fatalities. Recent earthquakes in this area have caused landslides that may have contributed to losses.

Estimated Fatalities

Alert Likelihood



Based on currently available data, this event is estimated to be a red alert level for fatalities. A red alert indicates high casualties are likely and the disaster is potentially widespread. Past events with this alert level have required a national or international level response.

Estimated Economic Losses

Alert Likelihood



Based on currently available data, this event is estimated to be a red alert level for losses. A red alert indicates widespread damage is likely and the disaster is potentially widespread. Past events with this alert level have required a national or international level response.

Selected City Exposure

MMI City	Population
VII Tianpeng	61k
VII Mianyang	264k
VII Jiangyou	127k
VI Chengdu	3,950k
VI Guangyuan	213k
VI Linqiong	56k
V Deyang	152k
V Tongchuan	58k
V Dongxi	4k
V Leshan	154k
IV Chongqing	3,967k

bold cities appear on map

(k = x1000)

Event ID: us2008ryan

This information was automatically generated and has not been reviewed by a seismologist.

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

Estimated Fatalities

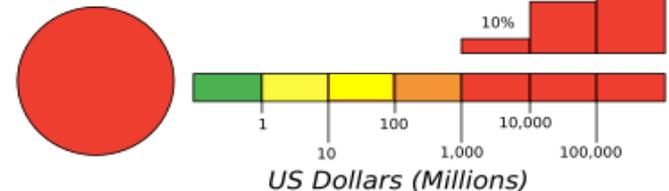
Alert Likelihood



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Estimated Economic Losses

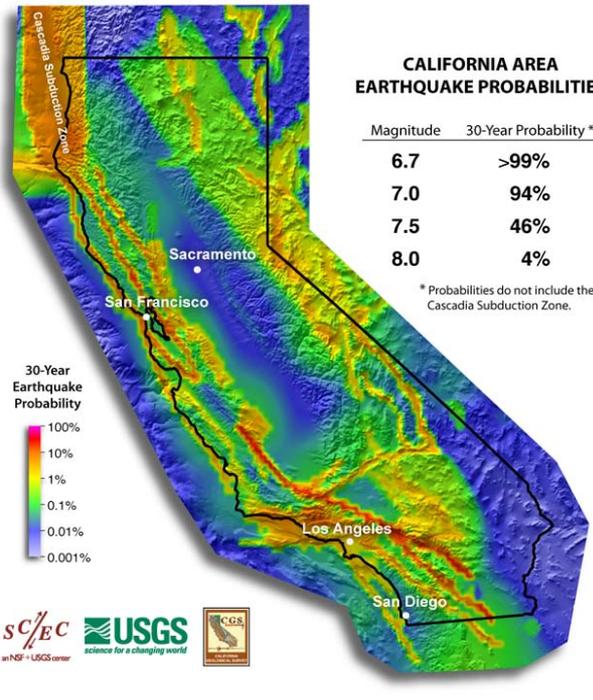
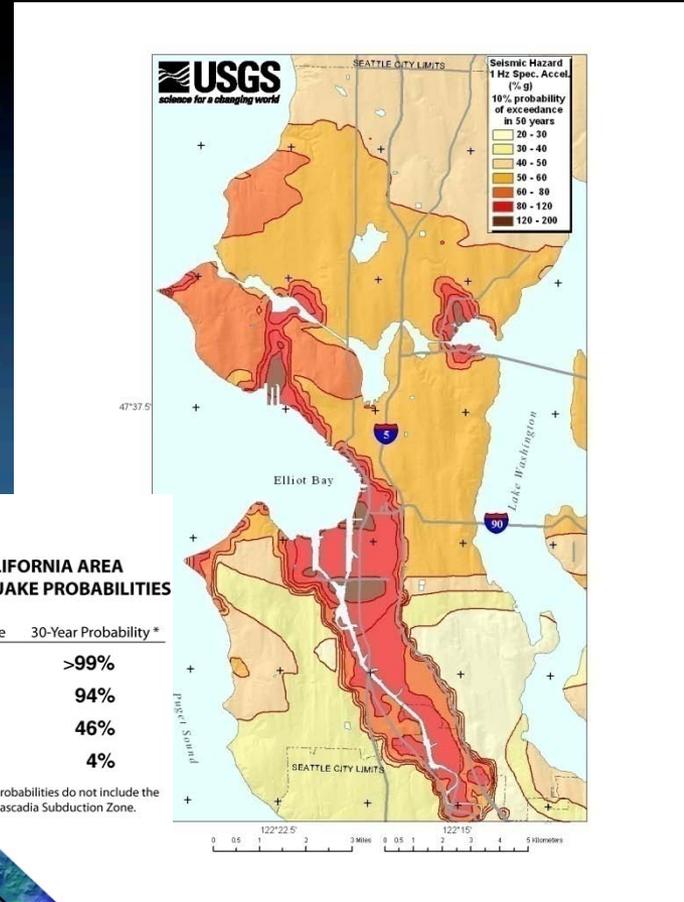
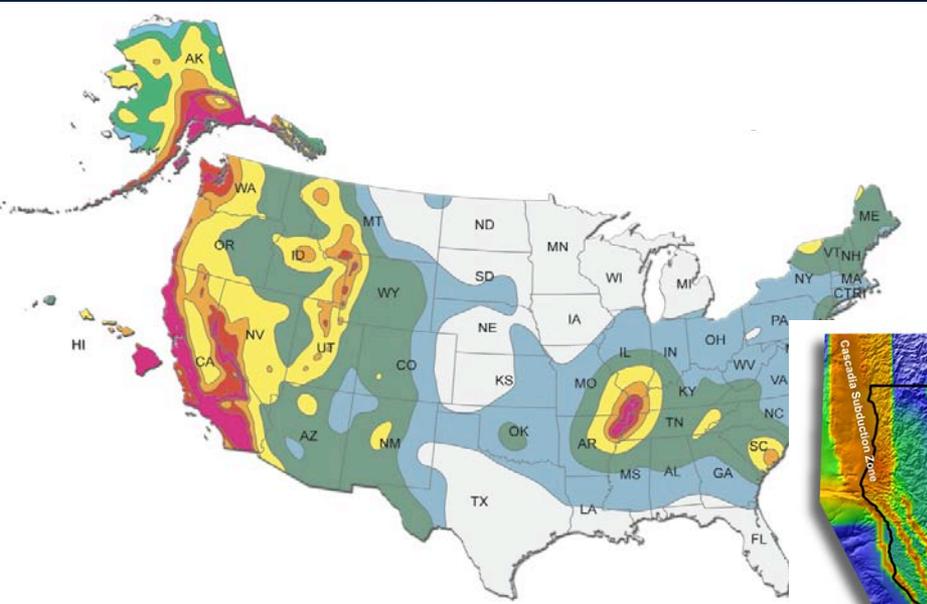
Alert Likelihood



Based on currently available data, this event is estimated to be a red alert level for losses. A red alert indicates widespread damage is likely and the disaster is potentially widespread. Past events with this alert level have required a national or international level response.

Seismic hazard assessments: National, regional, urban

U.S. National Seismic Hazard Maps



Uniform California Earthquake Rupture Forecast

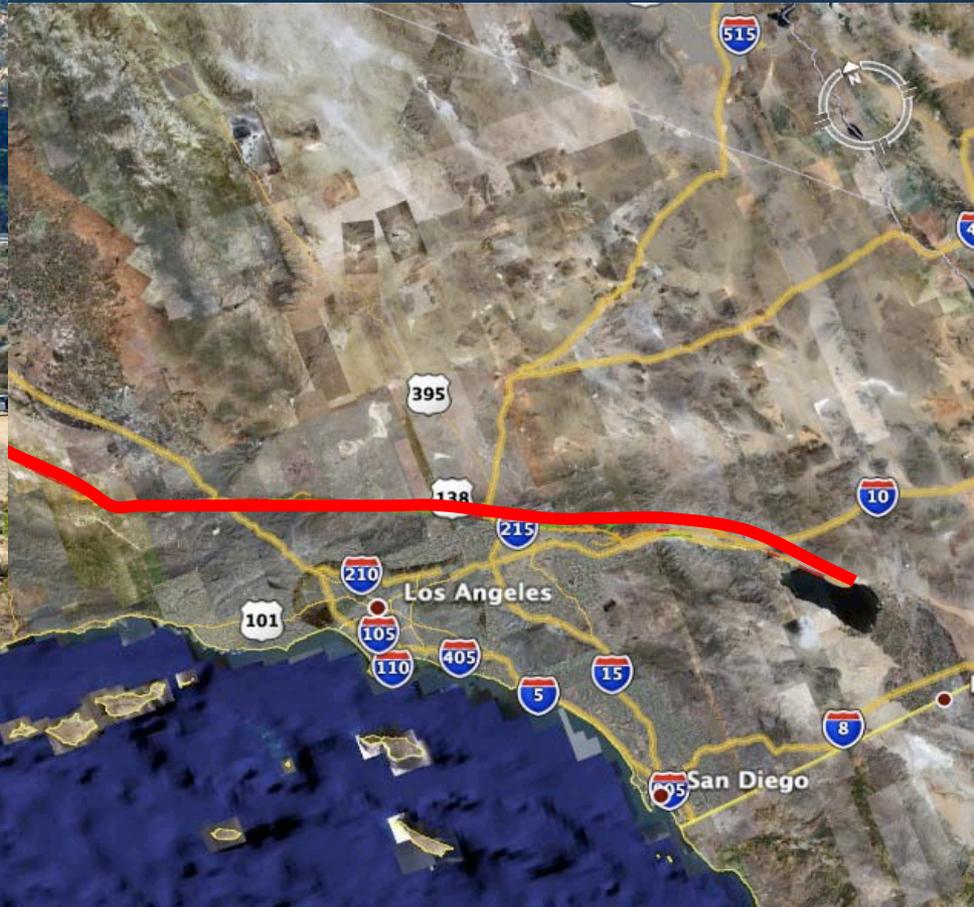


The Great Southern California ShakeOut

- November 13, 2008
- Golden Guardian DHS exercise
- Public drills
 - Schools earthquake drills
 - Business emergency drills
 - Faith-based communities
- City of Los Angeles Earthquake Safety conference
- Art Center Earthquake Spectacle



Actions from the ShakeOut – addressing critical infrastructure vulnerability



California-wide public preparedness drill



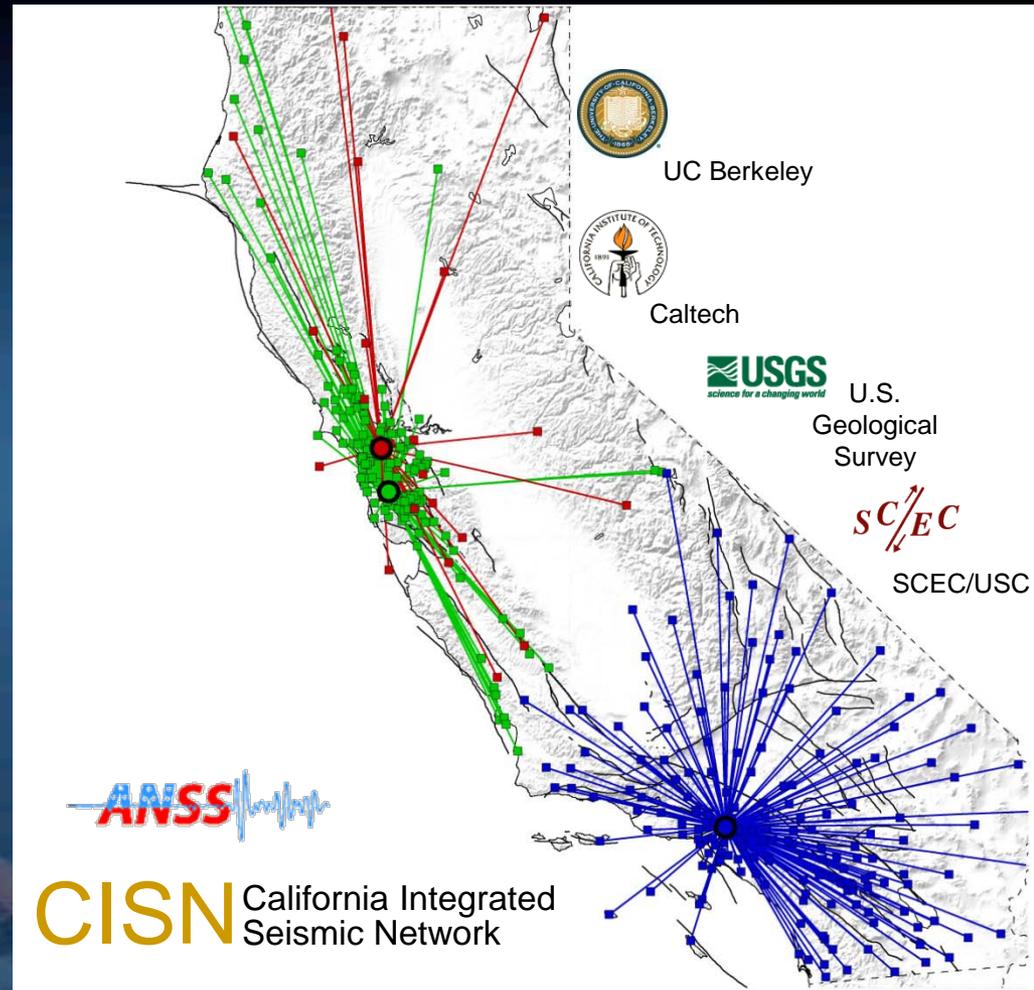
The Great California Shake Out

October 15, 2009



Earthquake early warning – getting ahead of strong ground shaking

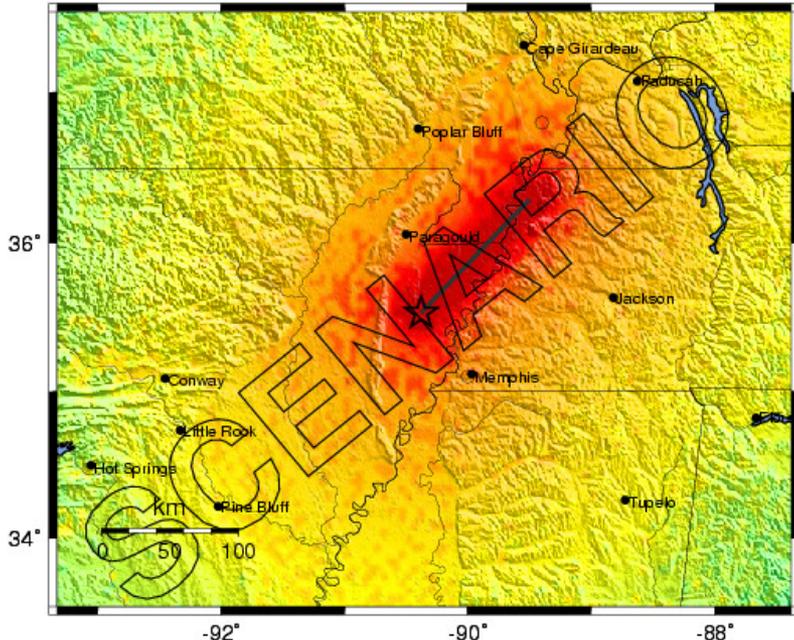
- USGS/CISN Phase I (2007-2009) cooperative agreement supported algorithm testing
- Phase II (2010-2012) supports prototype development and identifies test users
- ARRA funding used to reduce datalogger delays
- EEW requirements:
 - rapid earthquake detection
 - early magnitude estimation
 - ground shaking prediction
 - robust monitoring networks
 - well-defined user community



New Madrid earthquake preparedness

-- Earthquake Planning Scenario --
ShakeMap for Newmadridms1 Scenario

Scenario Date: Tue Jun 19, 2007 14:00:00 GMT M 7.7 N35.53 W90.38 Depth: 10.0km



PLANNING SCENARIO ONLY -- Map Version 1 Processed Mon May 14, 2007 03:45:52 PM MDT

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+

Scenario ShakeMap and PAGER prepared for SONS emergency response exercise



M 7.7 New Madrid Scenario - First Main Shock (Finite Fault) PAGER Version 1
Origin Time: Tue 2007-06-19 14:00:00 UTC
Location: 35.53°N 90.38°W Depth: 10 km
Created: 5 hrs, 35 mins after earthquake

Estimated Population Exposed to Earthquake Shaking

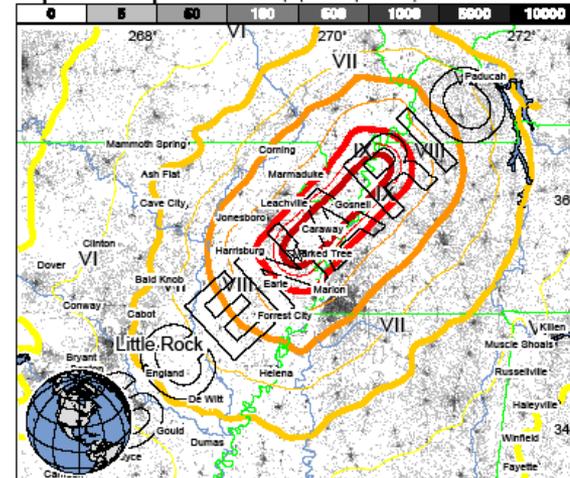
ESTIMATED POPULATION EXPOSURE (k = x1000)	---	---	---	---	---	---	1,584k	89k	79k	
ESTIMATED MODIFIED MERCALLI INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+	
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme	
POTENTIAL DAMAGE	Resistant Structures	none	none	none	V. Light	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 Landsat 2005

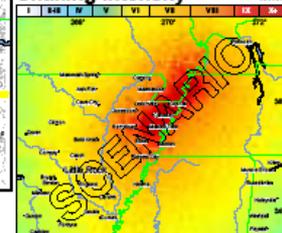
Selected City Exposure



MMI City	Population
X Caraway	1k
X Blytheville	16k
X Lepanto	2k
X Marked Tree	2k
X Gosnell	3k
X Luxora	1k
VIII Jonesboro	58k
VI Conway	51k
VI Little Rock	184k
VI Florence	36k
VI Hot Springs	37k

bold cities appear on map (k = x1000)

Shaking Intensity



Urban hazard mapping in the Central U.S. involves many local and state partners



St. Louis



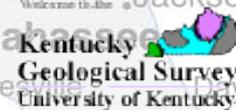
Memphis



Missouri Dept Of Natural Resources

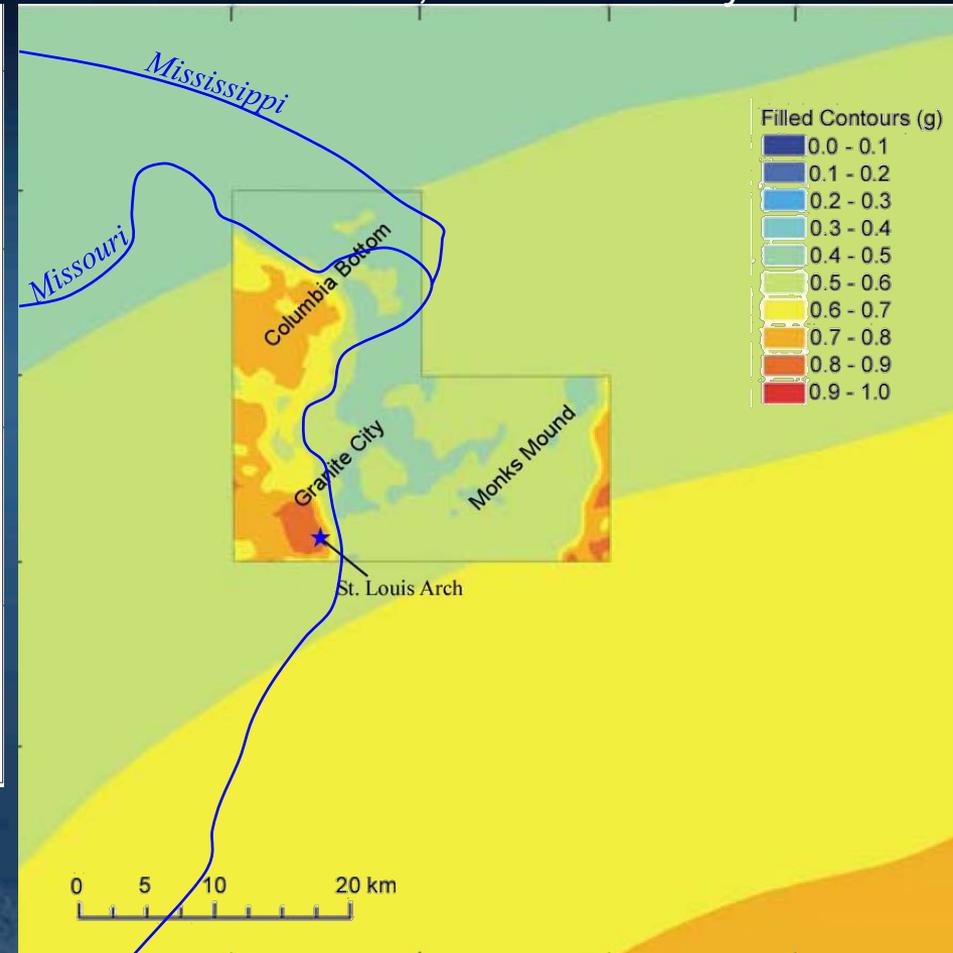
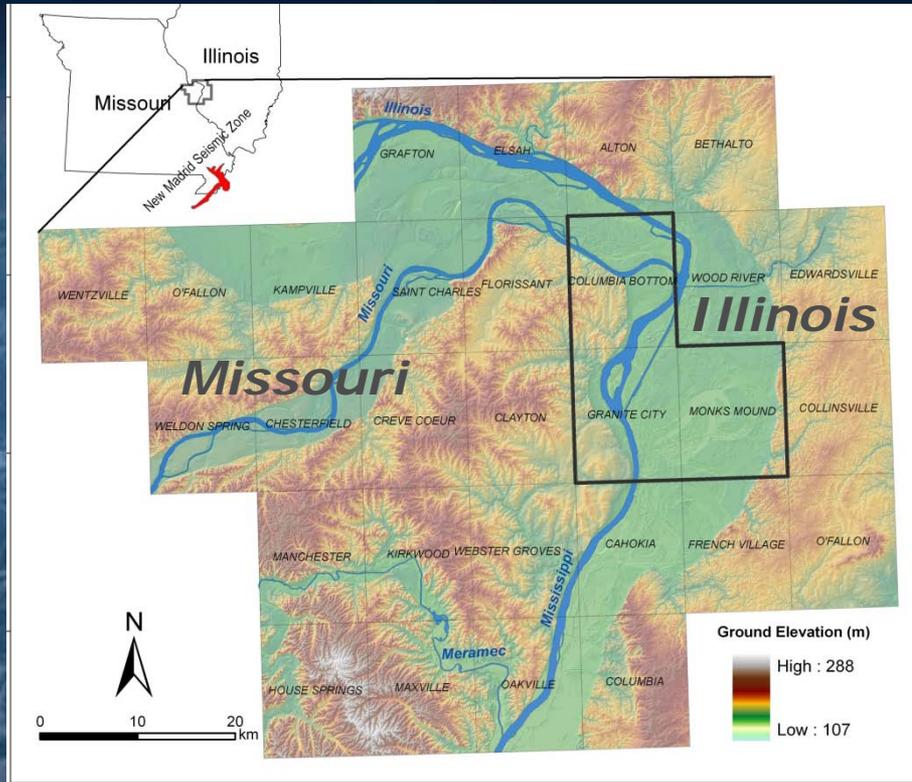


Evansville



USGS is currently collaborating with State Surveys and Universities to produce an urban hazard map for the St. Louis Area – multi-hazards funds will accelerate it

0.2 sec SA, 2% PE in 50 years



Preliminary results for 3 of 29 quads



Putting Down Roots in Earthquake Country

Sur de California Edición Primavera 2006

Echando raíces en tierra de terremotos

Desarrollado por:
SC/EC **CEA** CALIFORNIA EARTHQUAKE AUTHORITY
 an NSF-USGS center ... y muchas otras organizaciones

USGS
 science for a changing world

Putting Down Roots in Earthquake Country
 Your Handbook for the San Francisco Bay Region

General Information Product 15

Developed by:

- American Red Cross, Bay Area Chapter
- Association of Bay Area Governments
- California Earthquake Authority
- California Geological Survey
- Earthquake Engineering Research Institute
- Governor's Office of Emergency Services
- San Francisco Office of Emergency Services and Homeland Security
- Southern California Earthquake Center
- Structural Engineers Association of Northern California
- University of California Berkeley
- U.S. Department of Homeland Security, Federal Emergency Management Agency
- U.S. Geological Survey

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



Putting Down Roots in Earthquake Country
 Your Handbook for Earthquakes in Utah

Developed by:

- Utah Seismic Safety Commission
- Utah Division of Homeland Security
- Utah Geological Survey
- University of Utah Seismograph Stations
- Structural Engineers Association of Utah

In cooperation with the:

- U.S. Geological Survey
- Federal Emergency Management Agency

Putting Down Roots for the Central US (coming soon)

Utah Seismic Safety Commission
 American Red Cross, Pacific Gas & Electric and many more...

Any questions?

aplegate@usgs.gov
703-648-6714

