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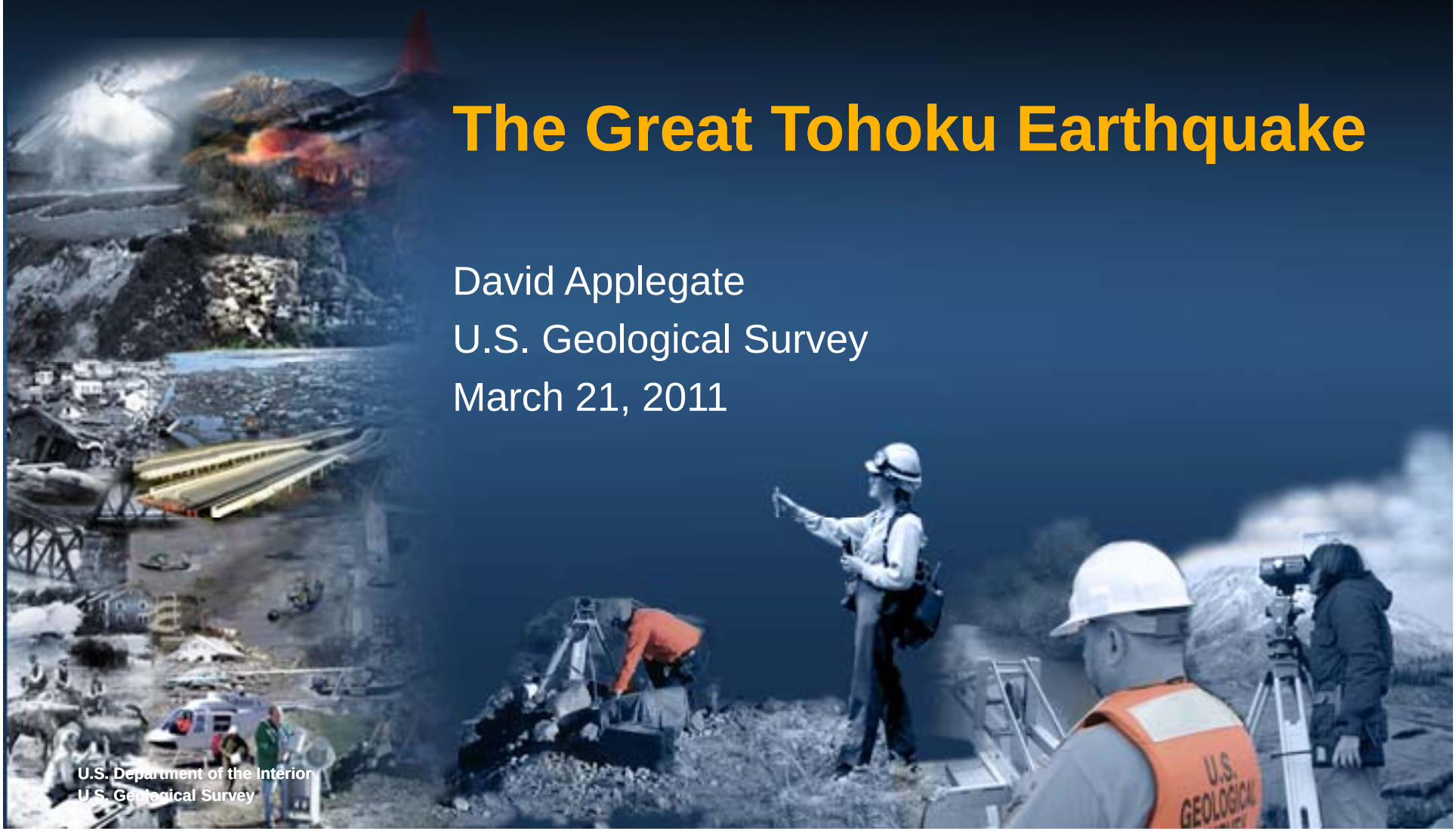
The Great Tohoku Earthquake

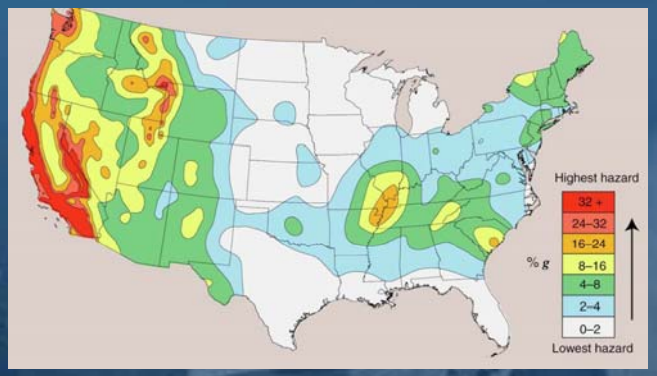
David Applegate
U.S. Geological Survey
March 21, 2011



The USGS role in the National Earthquake Hazard Reduction Program

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

USGS National Earthquake Information Center



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FEMA

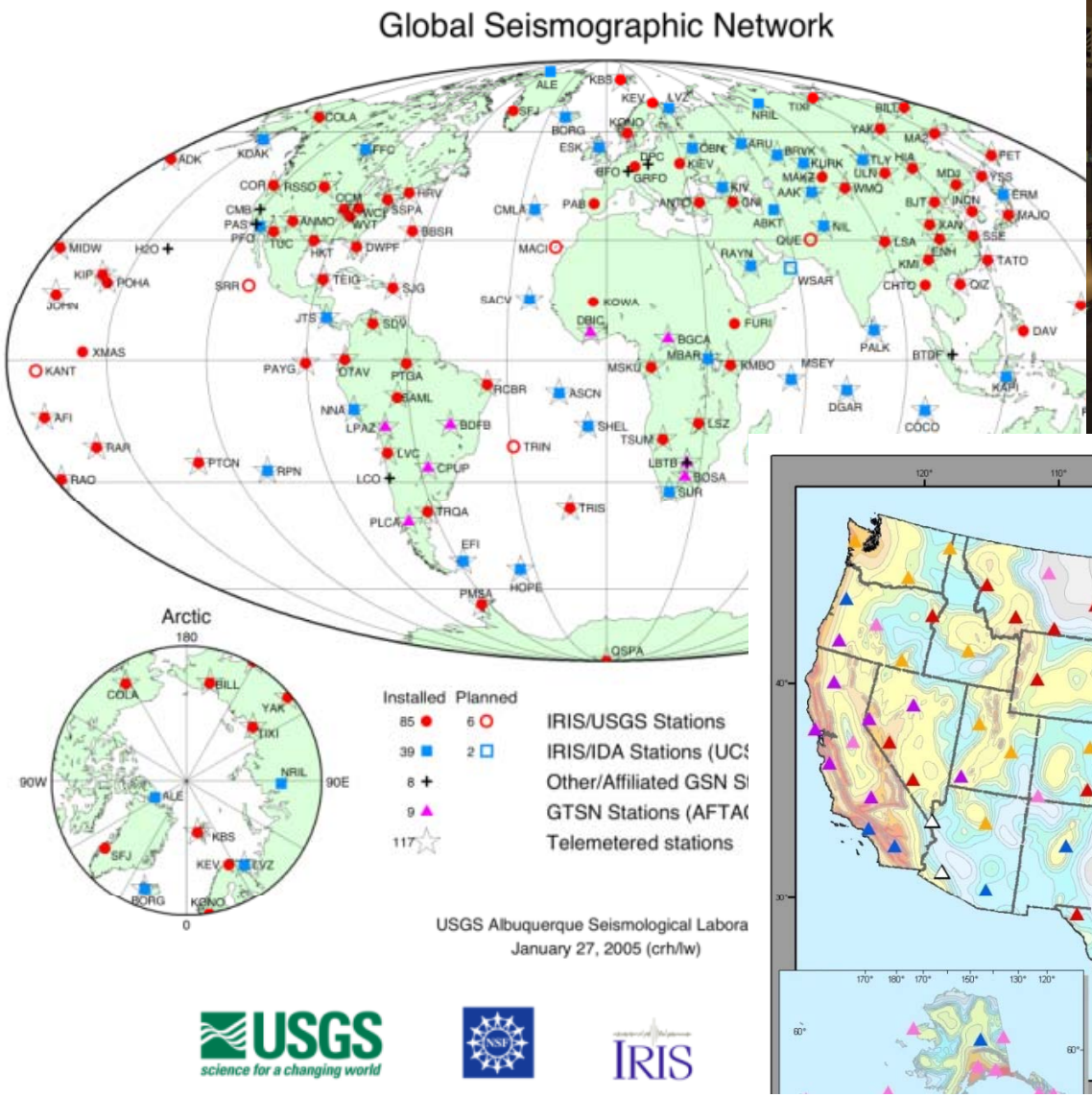
NIST National Institute of Standards and Technology

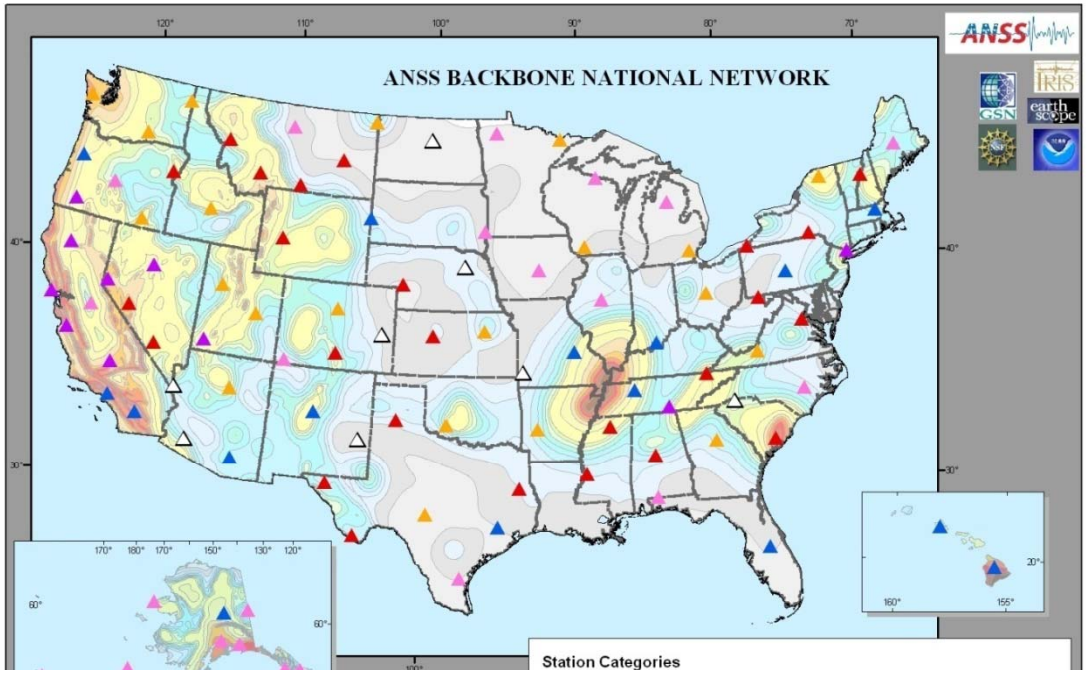
NSF

USGS science for a changing world

national earthquake hazards reduction program

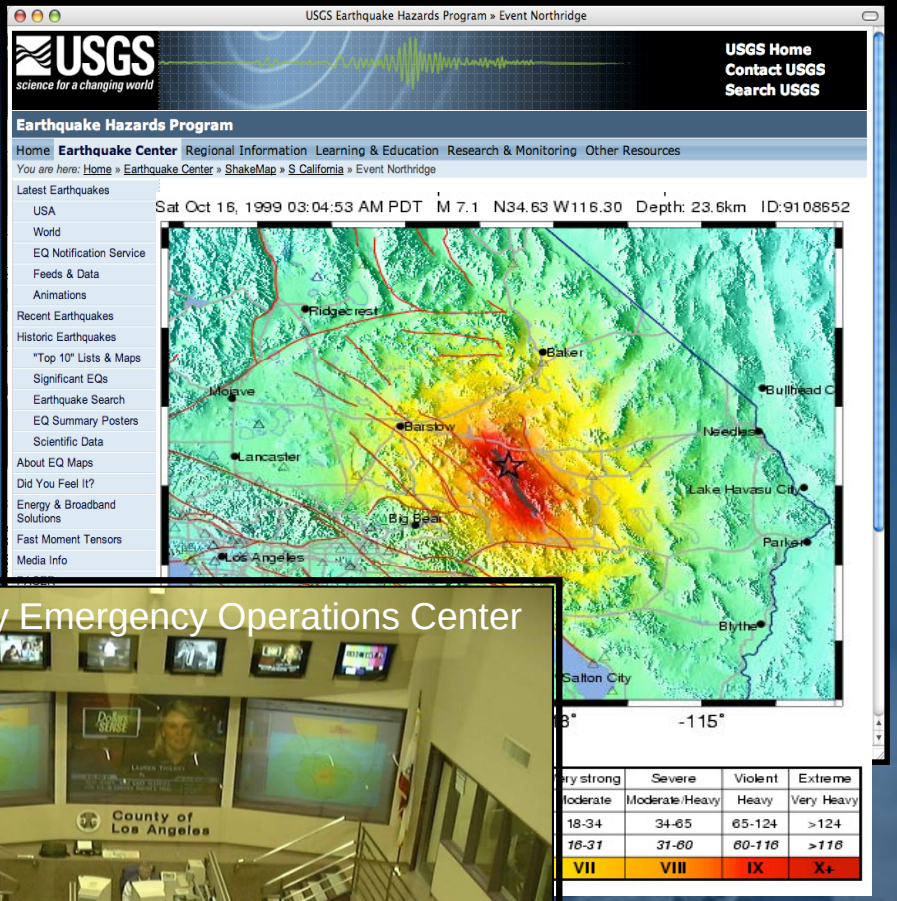
USGS provides rapid information on earthquakes worldwide

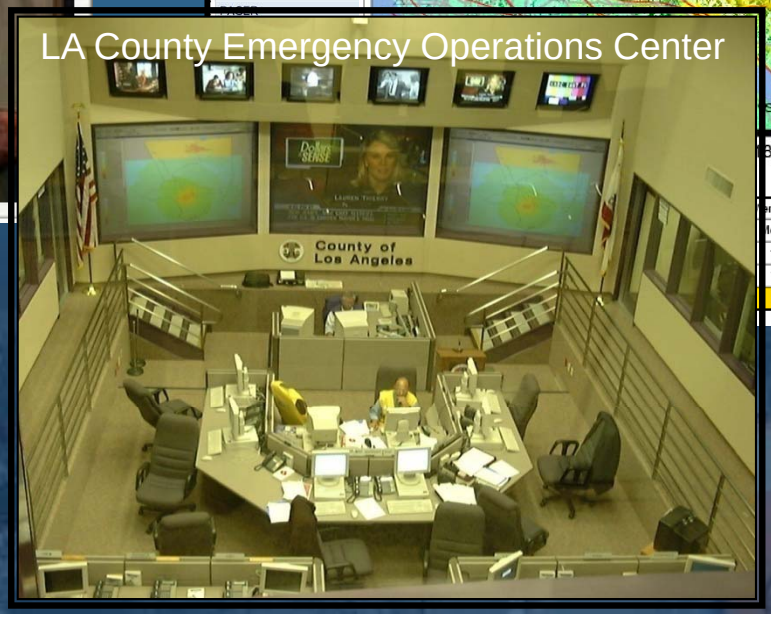




ShakeMap: A tool for rapid post-earthquake response, coordination, and situational awareness

California Governor Schwarzenegger pointing to ShakeMap at his press conference following the 2008 M5.4 Chino Hills earthquake that hit LA.





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New version of PAGER includes fatality and economic loss estimates

USGS
science for a changing world

Earthquake Shaking — Red Alert

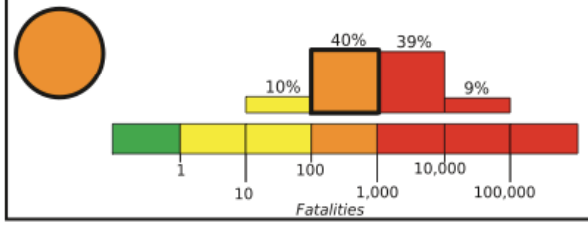
GSN ANSS USAID FROM THE AMERICAN PEOPLE

M 8.8, OFFSHORE MAULE, CHILE

Origin Time: Sat 2010-02-27 06:34:14 UTC (02:34:14 local)
Location: 35.85°S 72.72°W Depth: 35 km
FOR TSUNAMI INFORMATION, SEE: tsunami.noaa.gov

PAGER Version 3
Created: 3 hours, 10 minutes after earthquake

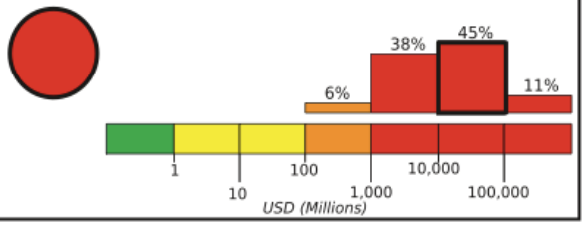
Estimated Fatalities



Red alert level for economic losses. Extensive damage is probable and the disaster is likely widespread. Estimated economic losses are 3-20% GDP of Chile. Past events with this alert level have required a national or international level response.

Orange alert level for shaking-related fatalities. Significant casualties are likely.

Estimated Economic Losses



Estimated Population Exposed to Earthquake Shaking

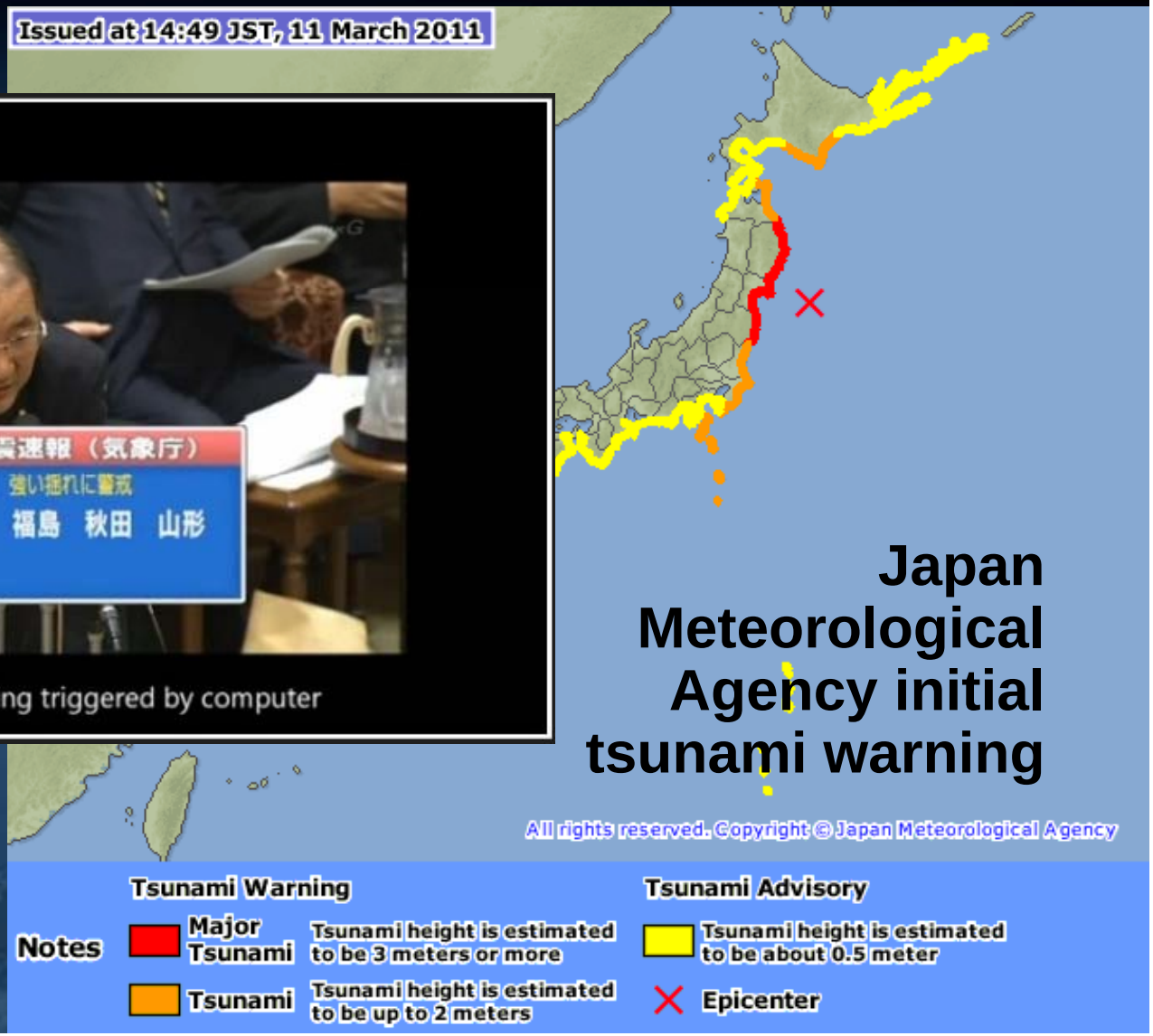
ESTIMATED POPULATION EXPOSURE (k = x1000)		- -*	- -*	487k*	2,147k*	3,657k	6,405k	3,083k	0	0
ESTIMATED MODIFIED MERCALLI INTENSITY		I	II-III	IV	V	VI	VII	VIII	IX	X+
PERCEIVED SHAKING		Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	Resistant Structures	none	none	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.

VIII Concepcion 215k
VIII Constitucion 38k

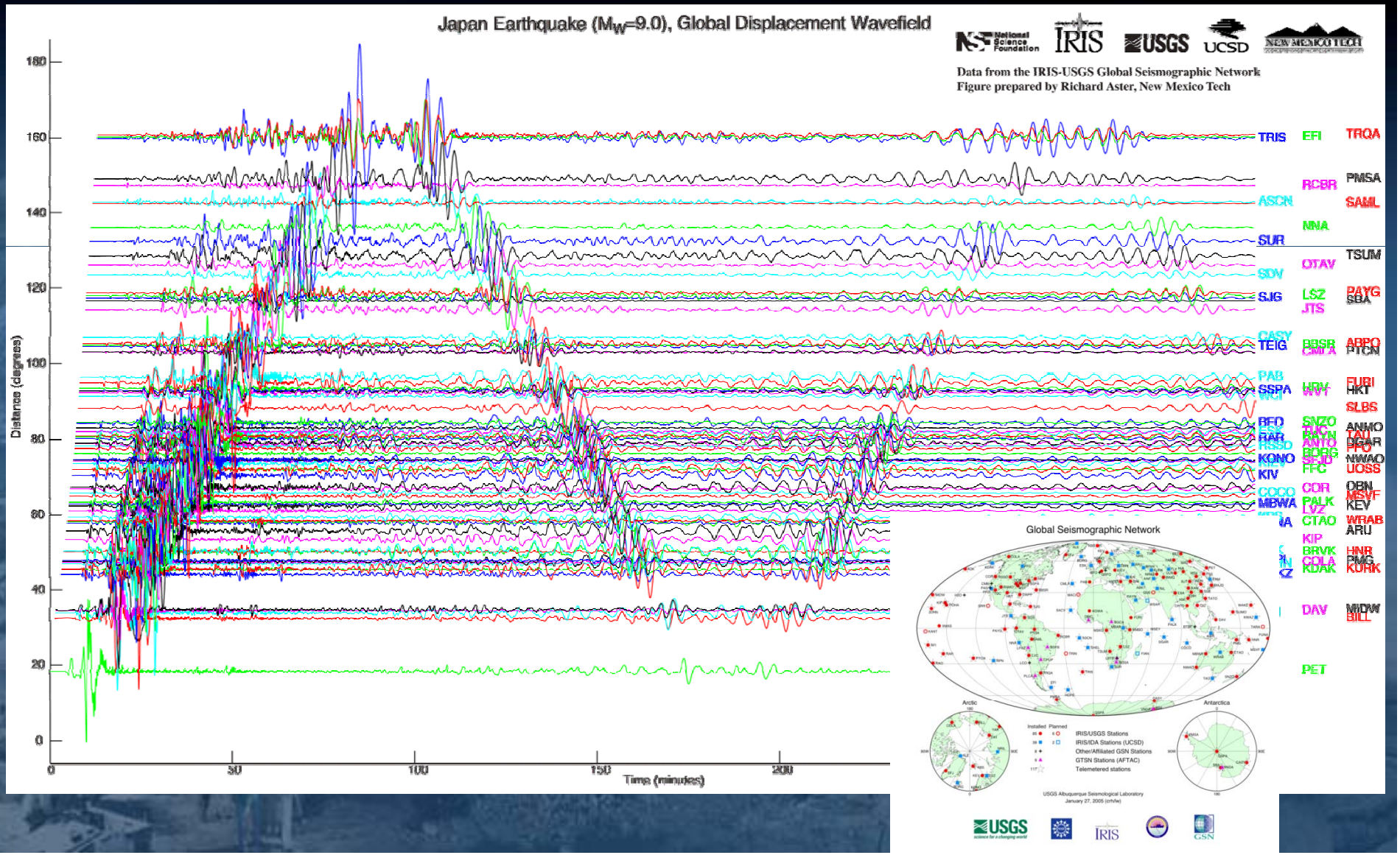
Japanese early warning systems

Automatic earthquake warning triggered by computer



USGS

Giant earthquakes ring the Earth like a bell



Red Alert PAGER issued for the Japanese Tohoku earthquake in less than 45 minutes

USGS science for a changing world

Earthquake Shaking — Red Alert

USAID FROM THE AMERICAN PEOPLE

GSN ANSS

M 8.9, NEAR THE EAST COAST OF HONSHU, JAPAN

Origin Time: Fri 2011-03-11 05:46:23 UTC (14:46:23 local)

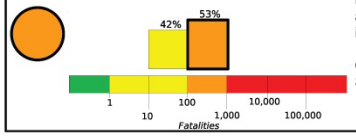
Location: 38.32°N 142.37°E Depth: 24 km

FOR TSUNAMI INFORMATION, SEE: tsunami.noaa.gov

PAGER Version 4

Created: 2 hours, 6 minutes after earthquake

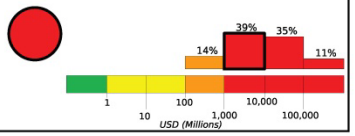
Estimated Fatalities



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 Japan. Past events with this alert level have required a national or international level response.

Orange alert level for shaking-related fatalities. Significant casualties are likely.

Estimated Economic Losses



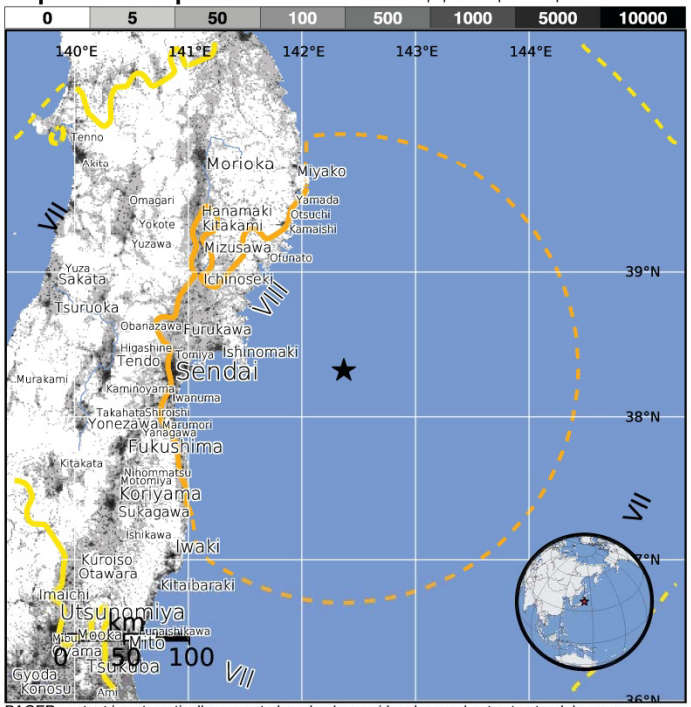
Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)		- -*	- -*	- -*	- -*	2,472k*	7,986k*	2,598k	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



Structures:
Overall, the population in this region resides in structures that are resistant to earthquake shaking, though some vulnerable structures exist. The predominant vulnerable building types are non-ductile reinforced concrete frame and heavy wood frame construction.

Historical Earthquakes (with MMI levels):

Date (UTC)	Dist. (km)	Mag.	Max MMI(#)	Shaking Deaths
1998-06-14	363	5.7	VII(428k)	0
1994-12-28	263	7.7	VII(132k)	3
1983-05-26	369	7.7	VII(174k)	104

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

Selected City Exposure

from GeoNames.org

MMI	City	Population
VIII	Ishinomaki	117k
VIII	Shiogama	60k
VIII	Yamoto	32k
VIII	Kogota	20k
VIII	Rifu	35k
VIII	Furukawa	76k
VIII	Yamagata	255k
VII	Morioka	295k
VII	Sendai	1,038k
VII	Fukushima	294k
VII	Utsunomiya	450k

bold cities appear on map (k = x1000)

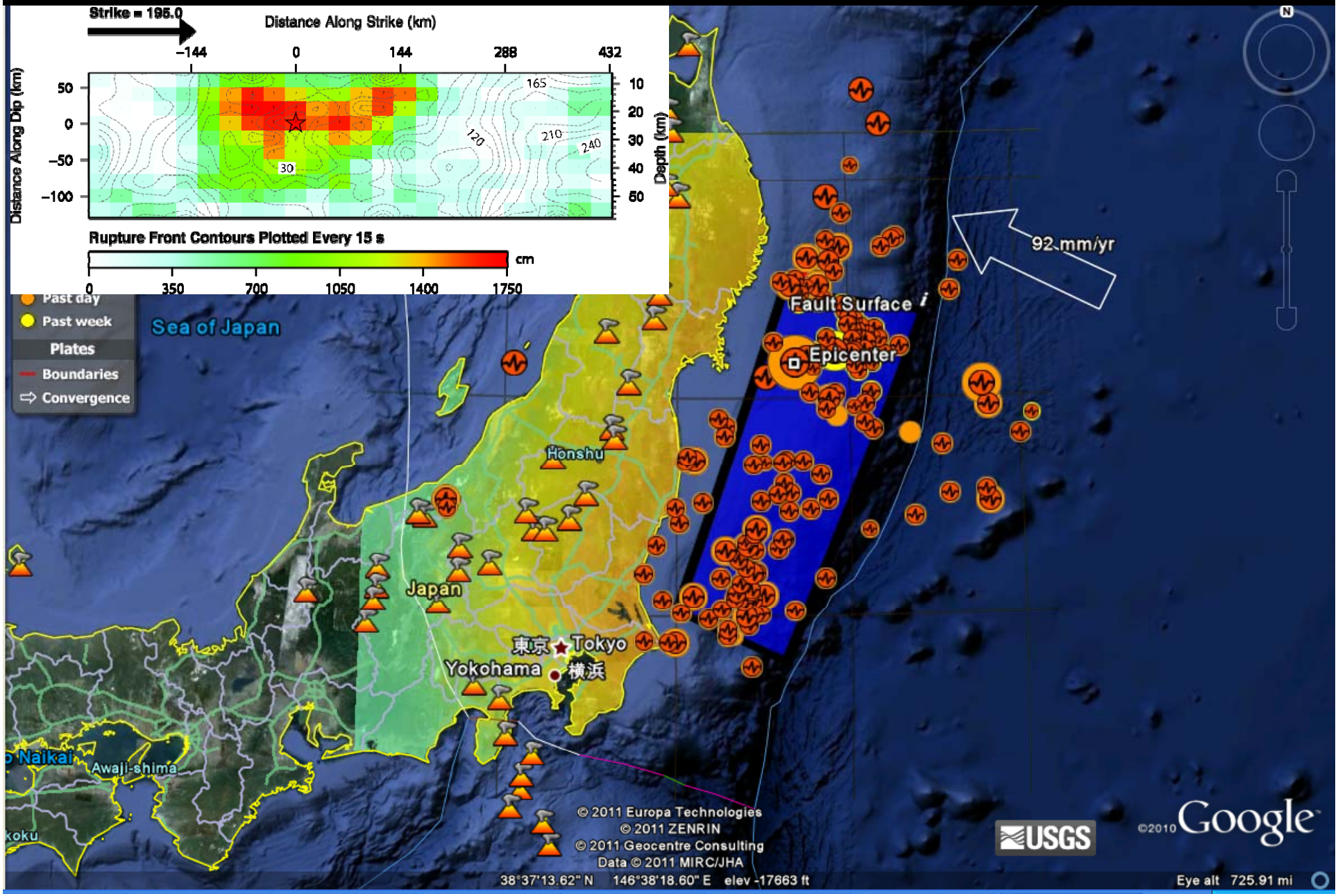
PAGER content is automatically generated, and only considers losses due to structural damage. Limitations of input data, shaking estimates, and loss models may add uncertainty.

http://earthquake.usgs.gov/pager

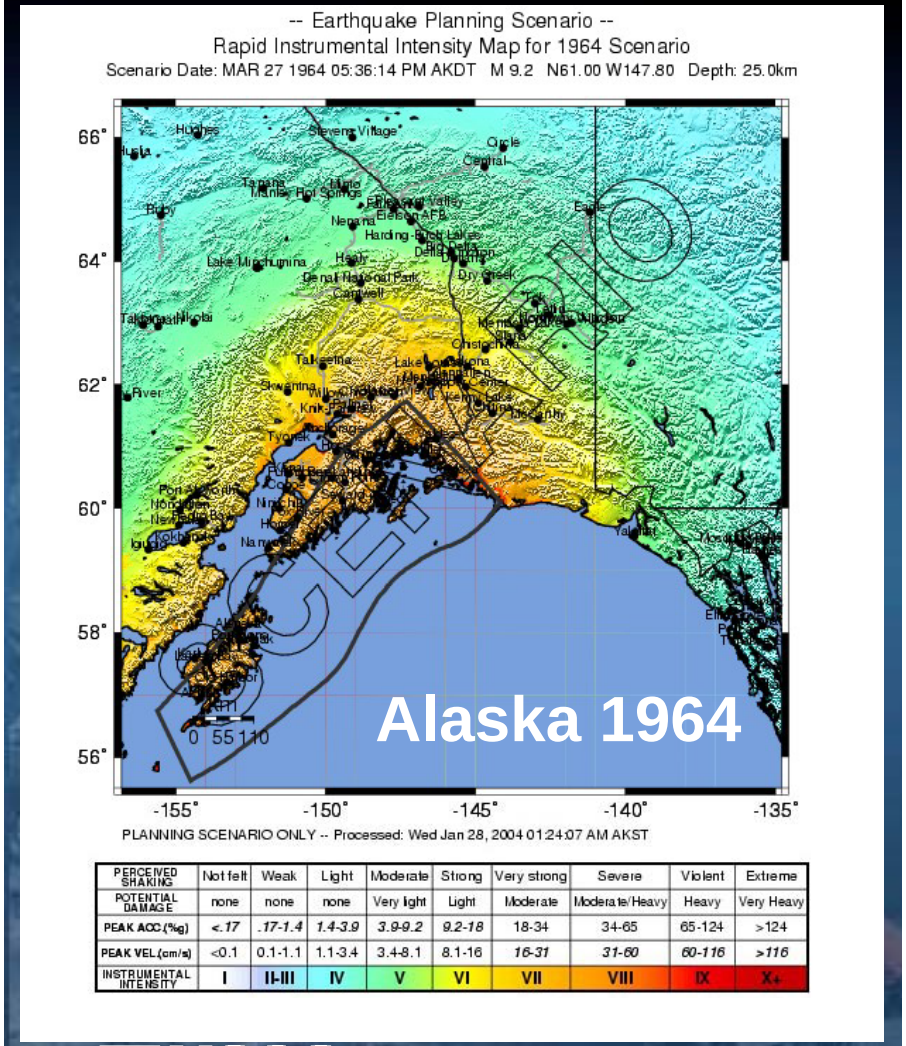
Event ID: usc0001xgp

USGS

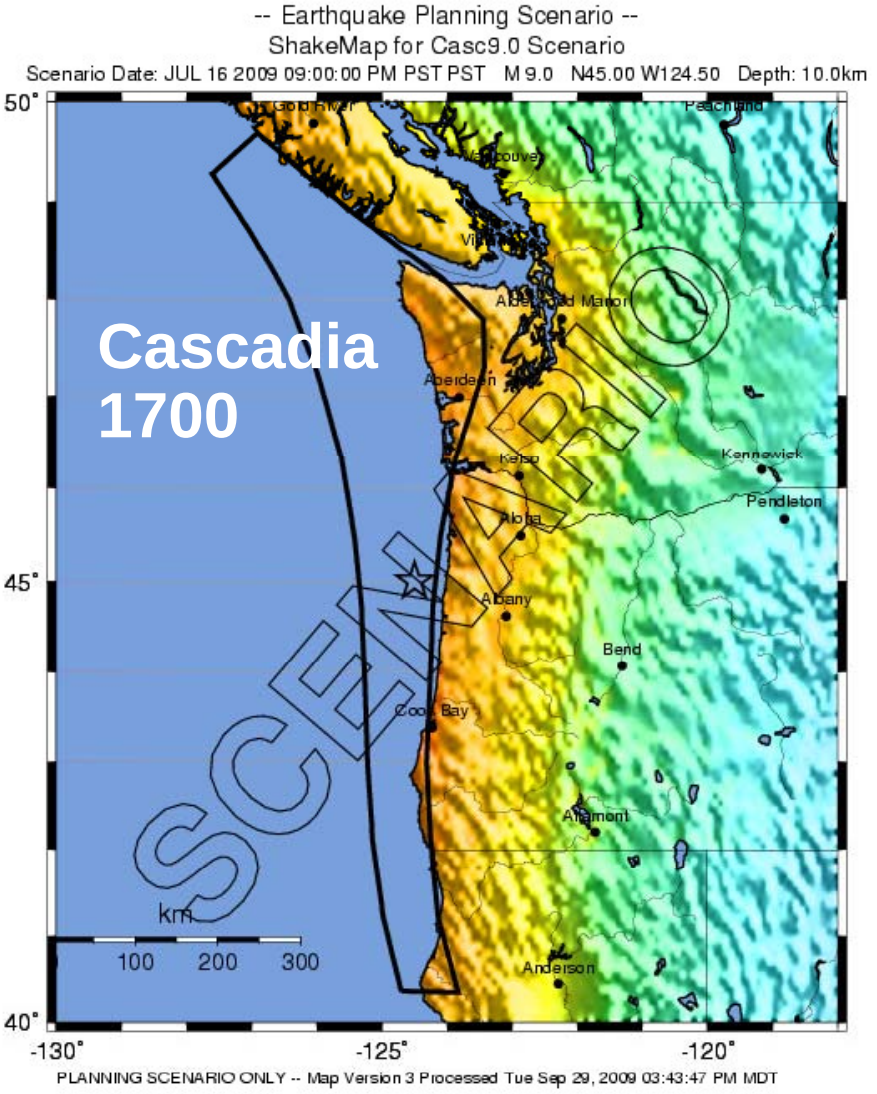
GoogleEarth feed from USGS showing fault rupture plane (blue rectangle), modeled shaking intensity and aftershocks



US subduction zones capable of magnitude-9 earthquakes



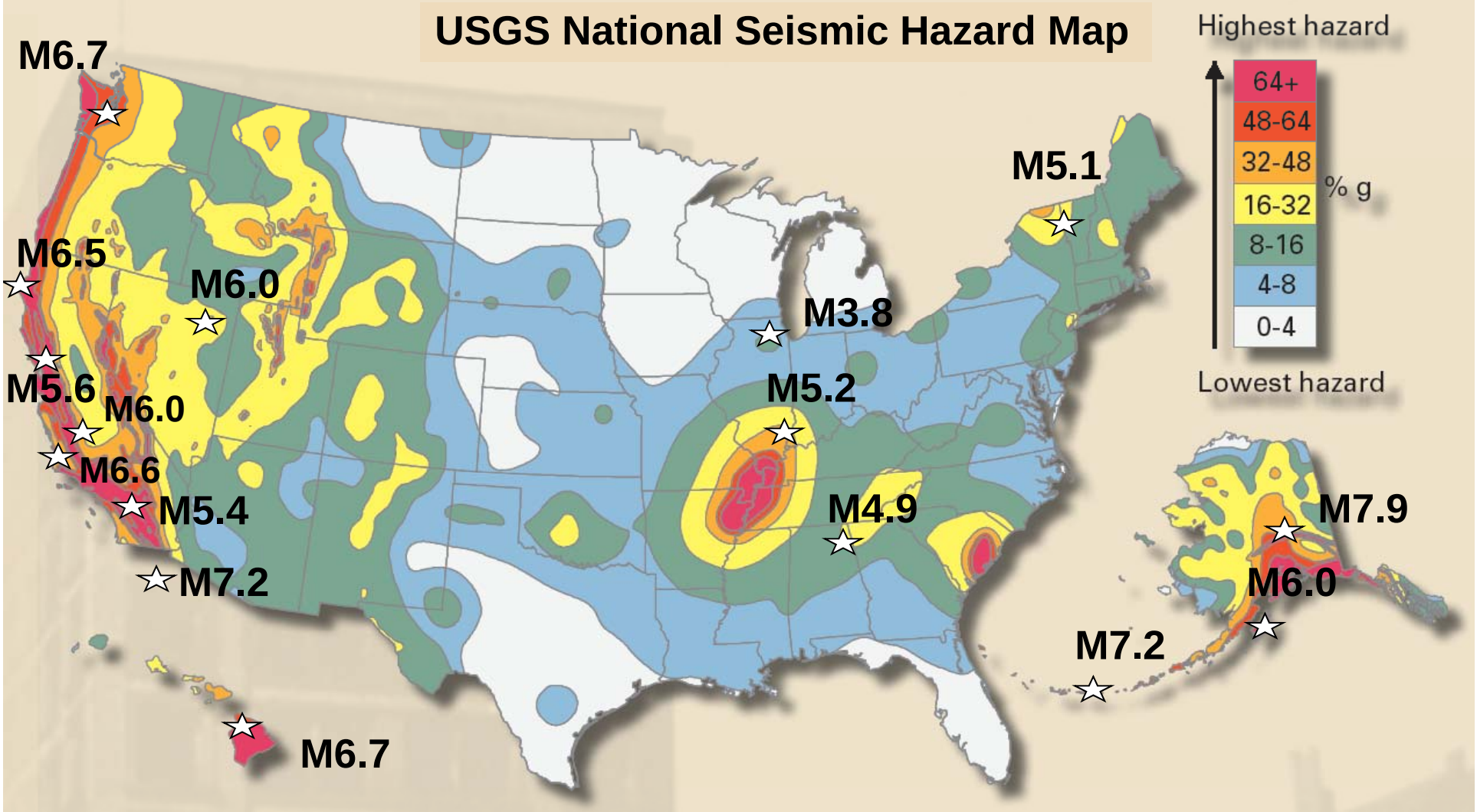
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1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



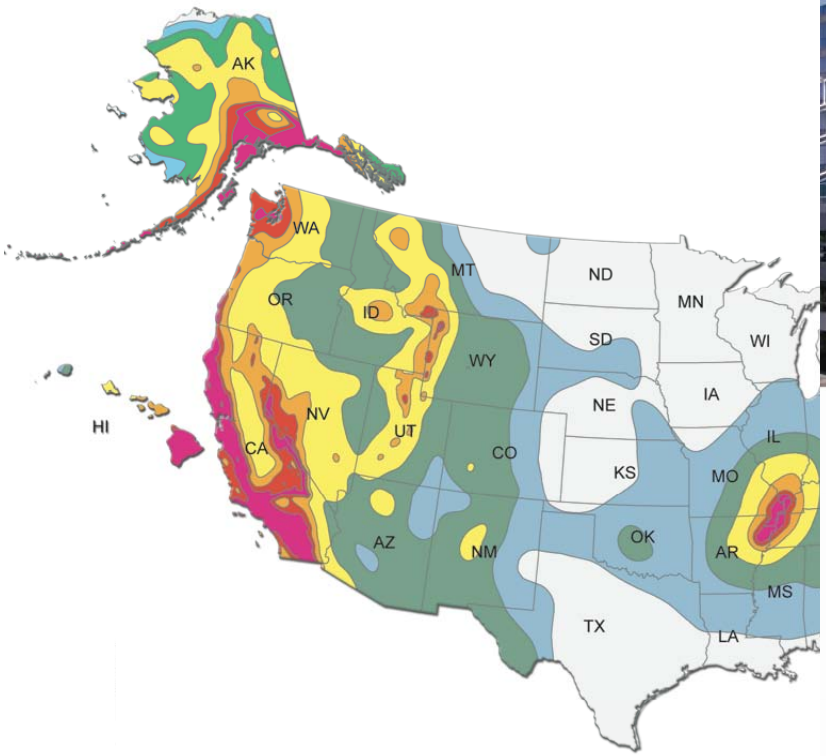
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1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

USGS

Earthquakes are a national hazard



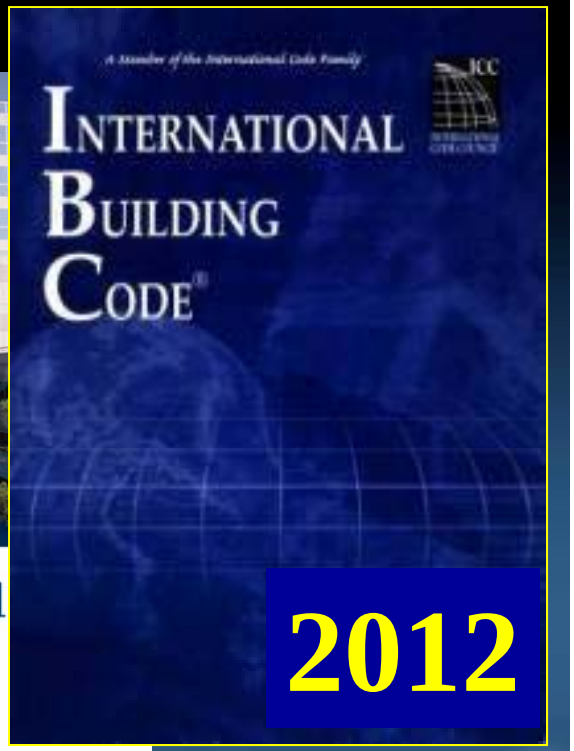
The heart of NEHRP: Translating USGS national hazard maps into model building codes



NEHRP Recommended Seismic Provisions
for New Buildings and Other Structures
FEMA P-750 / 2009 Edition

FEMA

nehrp



USGS nehrp

Seismic element of NEHRP Provisions and Int'l Building Code based on the USGS national seismic hazard map

California-wide public preparedness drill

The Great California ShakeOut

October 21, 2010

OES CALIFORNIA
Governor's Office of Emergency Services

USGS

SCEC
an NSF+USGS center

nehrp

Earthquake Country **Alliance**
We're all in this together.

FEMA

ShakeOut

The Great Central U.S. ShakeOut

Welcome to the Great Central U.S. ShakeOut! | OTHER SHAKEOUTS | SEARCH: GO

Be a Part of the ShakeOut
Register Now!
Log in

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- Overview
- Resources
- News and Events
- Media Center
- Partners
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GET READY TO SHAKEOUT!

Register now for the 2011 ShakeOut on April 28 at 10:15 a.m.!*

Participate in the Great Central U.S. ShakeOut to practice how to protect yourself during earthquakes, and to get prepared.

Learn how to participate below.

*Indiana will ShakeOut on April 19. Also, you can hold your drill at another time or day if best for your schedule.

Time to 2011 ShakeOut:
3 months, 7 days 21:35:48

ANNOUNCEMENTS

The Great Central U.S. ShakeOut is a linked event to NLE 2011

Who is Participating?

ShakeOut Resources: ShakeOut Drill Manuals, flyers, movies, and much more

Why Drop, Cover, and Hold On?

QUICK LINKS

How to plan your drill and get prepared:

Select your category...

Earthquake hazards in your state:

Select your state...

FAQ: Frequently Asked Questions

INTERACTIVE MAP

Over 1.1 million

Participants and Counting!

Click the map for details about each state

Other Areas

LEARN & PLAY

PLAY BEAT THE QUAKE

QUAKE QUIZ

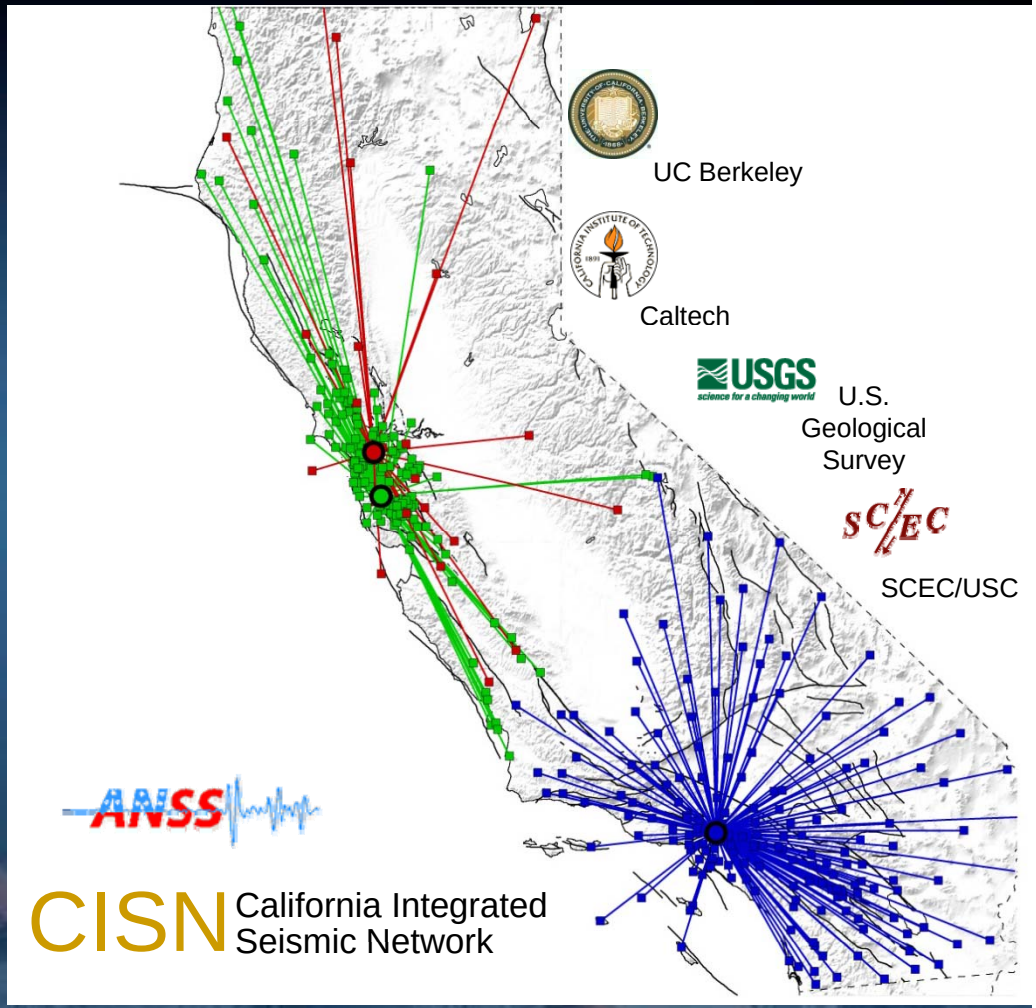
http://www.shakeout.org/centralus/

ARE YOU READY? > PREPARE > PROTECT > RECOVER

USGS | FEMA | nehrp | Ready (Prepare. Plan. Stay Informed.®) | American Red Cross | USGS science for a changing world

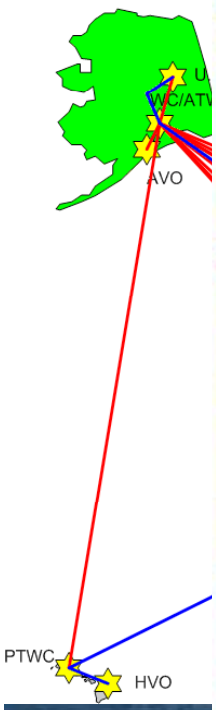
Earthquake early warning – getting ahead of strong ground shaking

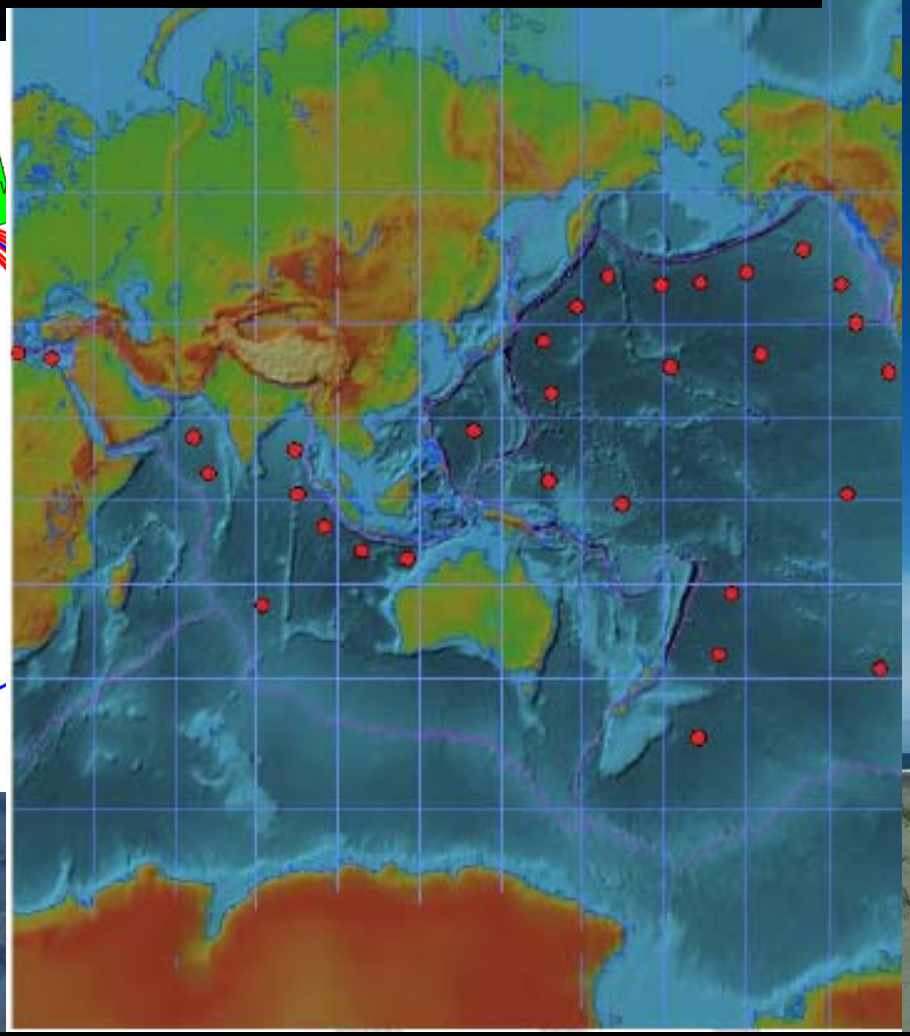
- USGS/CISN Phase I (2007-2009) cooperative agreement supported algorithm testing
- Phase II (2010-2012) supports prototype development and identifies test users
- ARRA funding used to reduce datalogger delays
- EEW requirements:
  - -- rapid earthquake detection
  - -- early magnitude estimation
  -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



USGS nehrp

For tsunamis, seismic is the start





All Hazard Alert Broadcast system installed at Ocean Shores, Washington.

Credit: Washington Emergency Management

The beach is the finish