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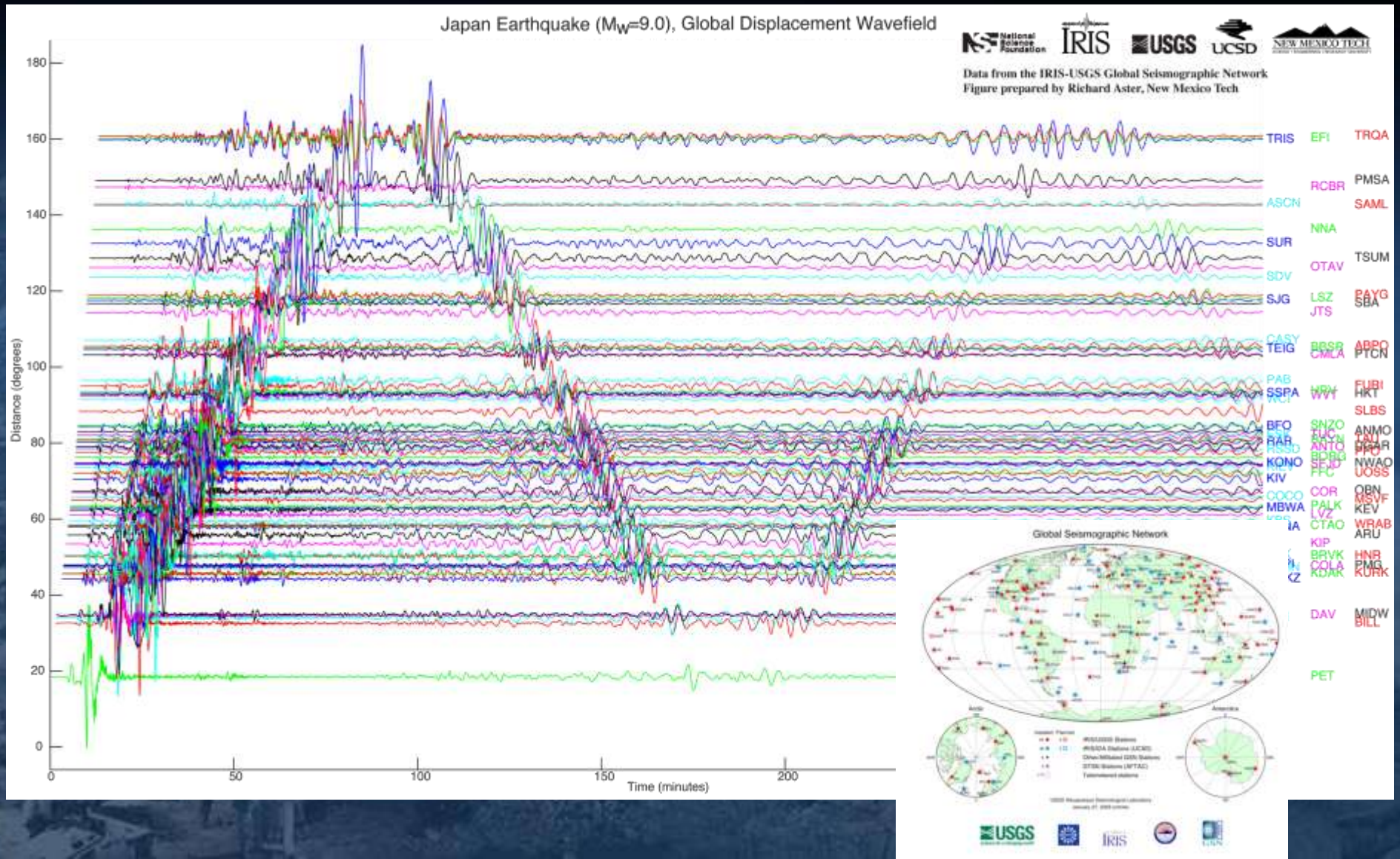
Update on the Great Tohoku Earthquake

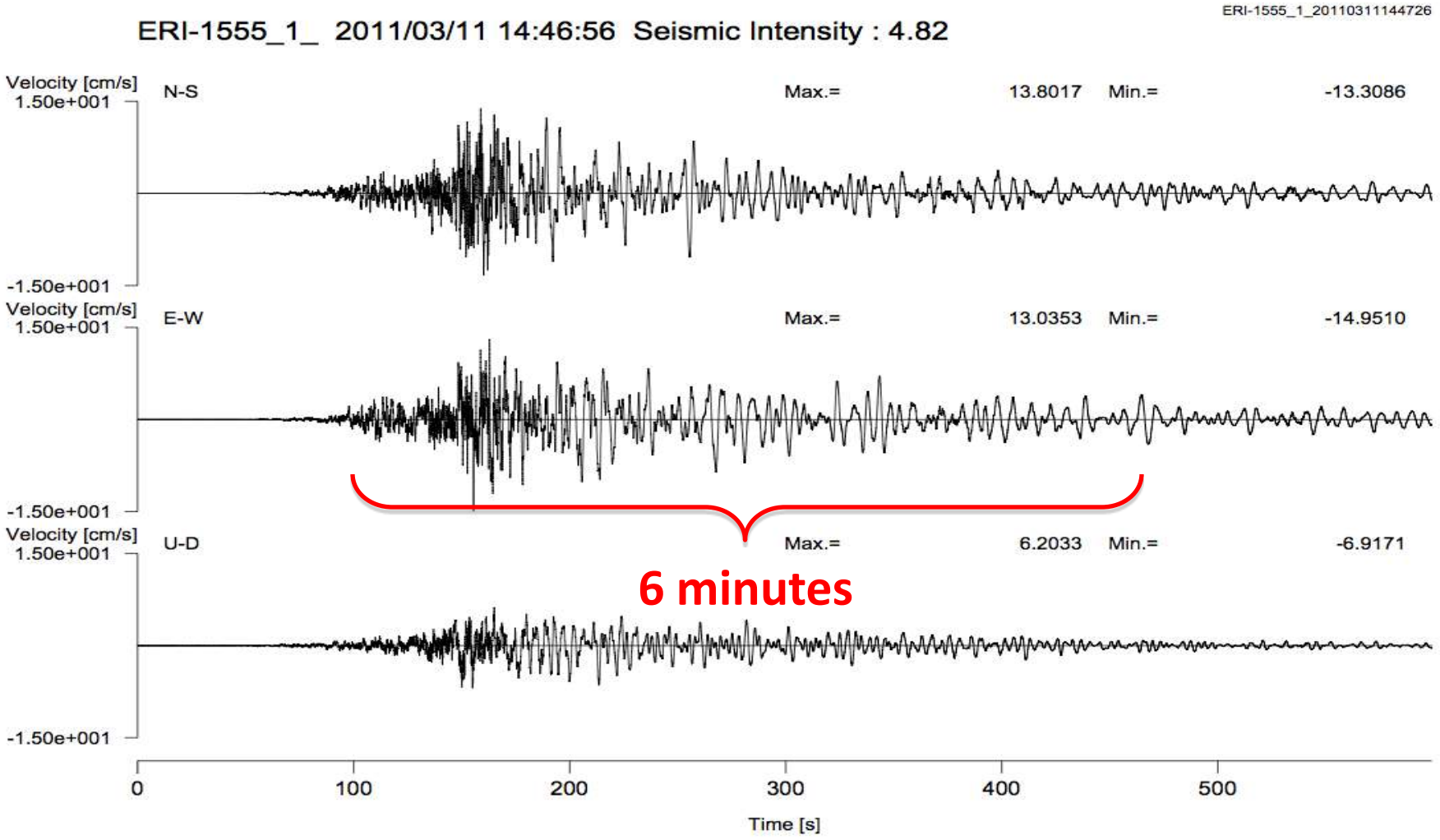
David Applegate
U.S. Geological Survey
April 7, 2011

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

Giant earthquakes ring the Earth like a bell

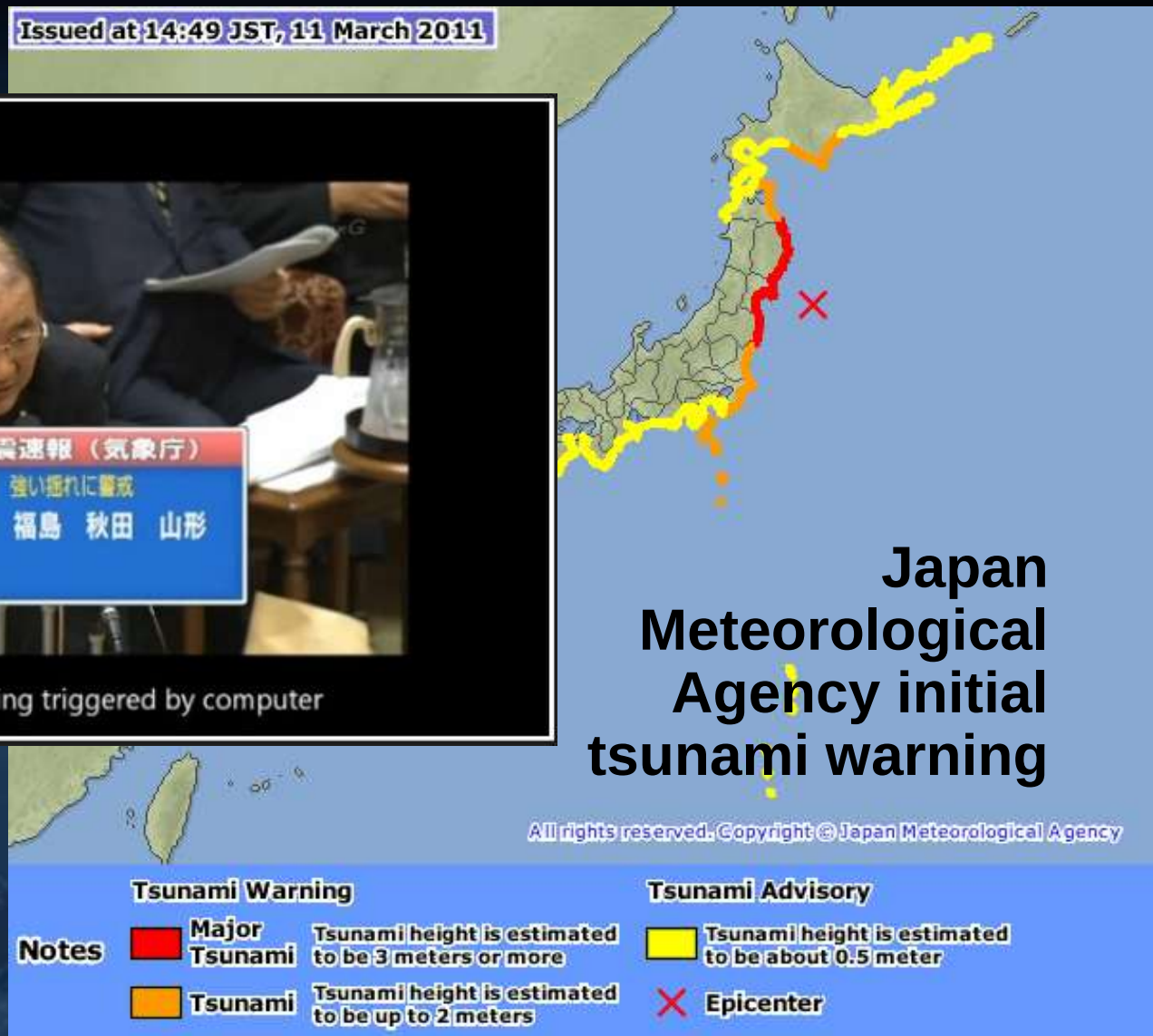


Shaking duration in Tokyo



Japanese early warning systems

Automatic earthquake warning triggered by computer



Japan Meteorological Agency initial tsunami warning

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Red Alert PAGER for the Tohoku earthquake issued in 42 minutes

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Earthquake Shaking — Red Alert

USAID FROM THE AMERICAN PEOPLE

GSN ANSS

M 8.9, NEAR THE EAST COAST OF HONSHU, JAPAN

PAGER Version 4

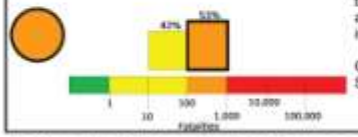
Origin Time: Fri 2011-03-11 05:46:23 UTC (14:46:23 local)

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

FOR TSUNAMI INFORMATION, SEE: tsunami.noaa.gov

Created: 2 hours, 6 minutes after earthquake

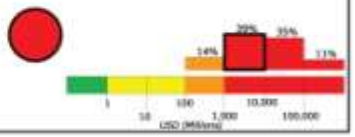
Estimated Fatalities



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



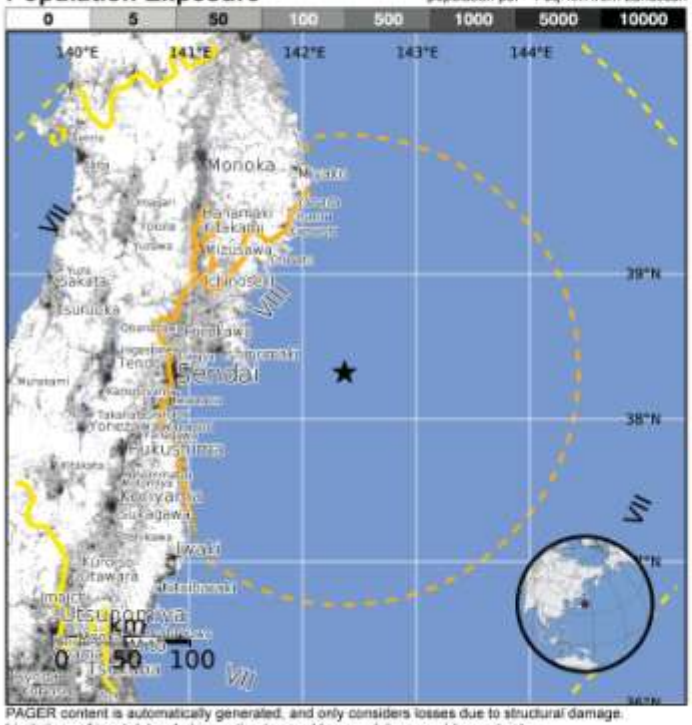
Estimated Population Exposed to Earthquake Shaking

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



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

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)

Event ID: usc0001xgp

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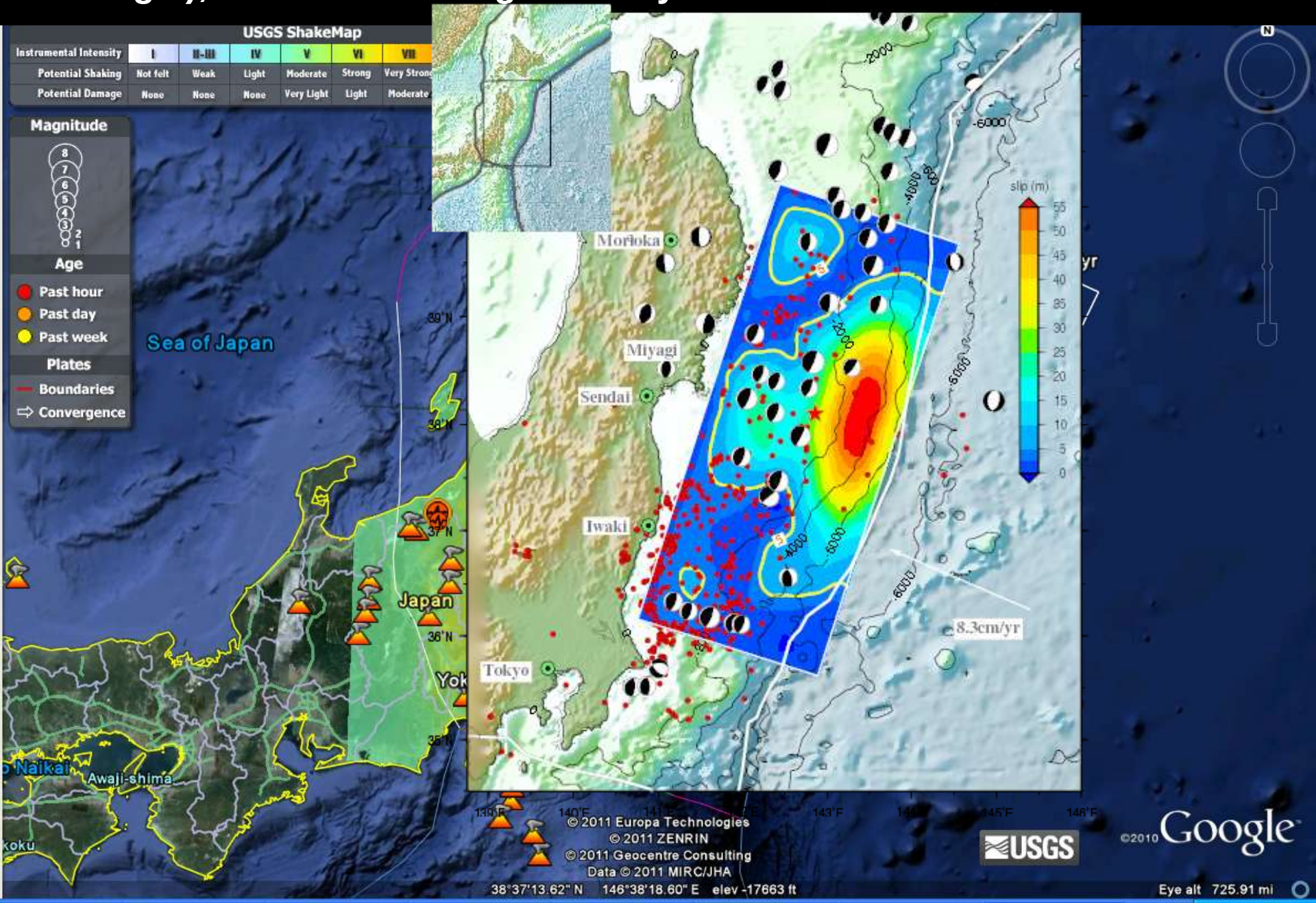
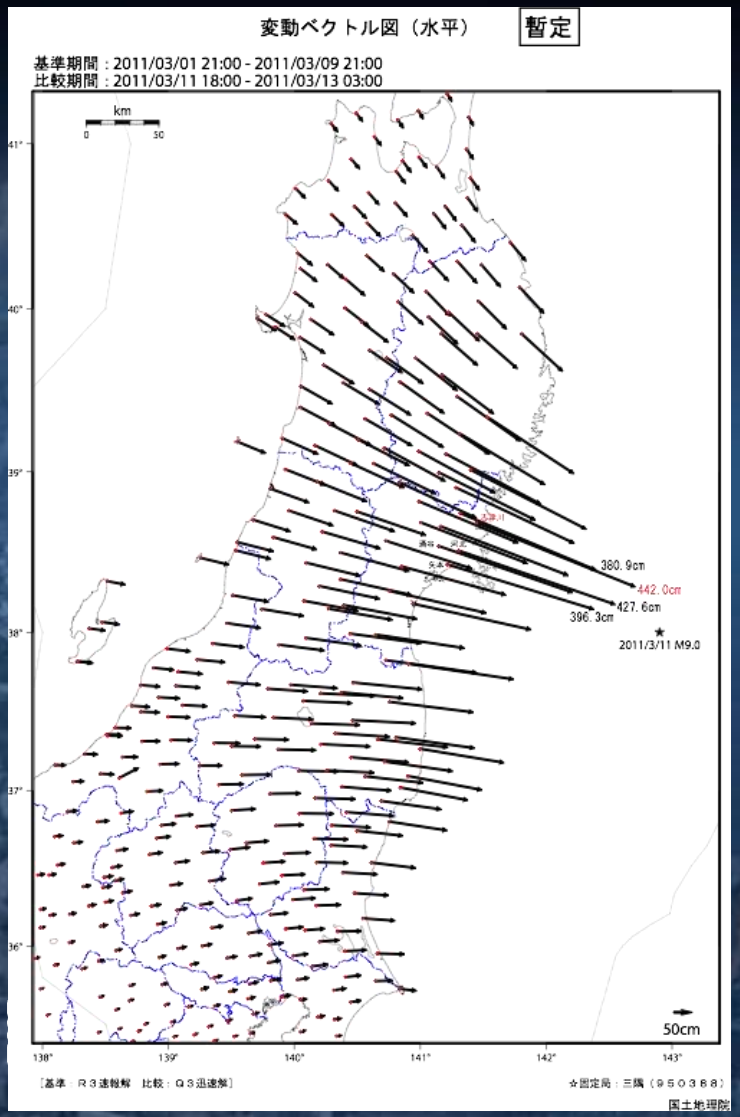
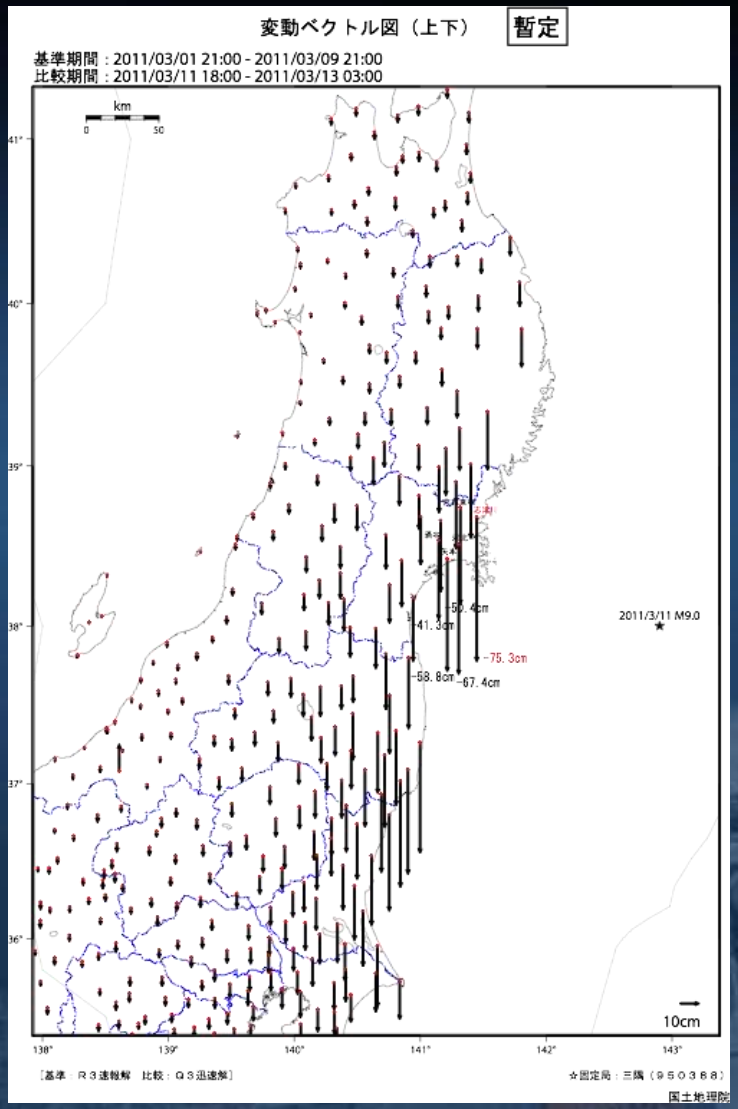
GoogleEarth feed from USGS showing fault rupture plane (blue rectangle), modeled shaking intensity and aftershocks

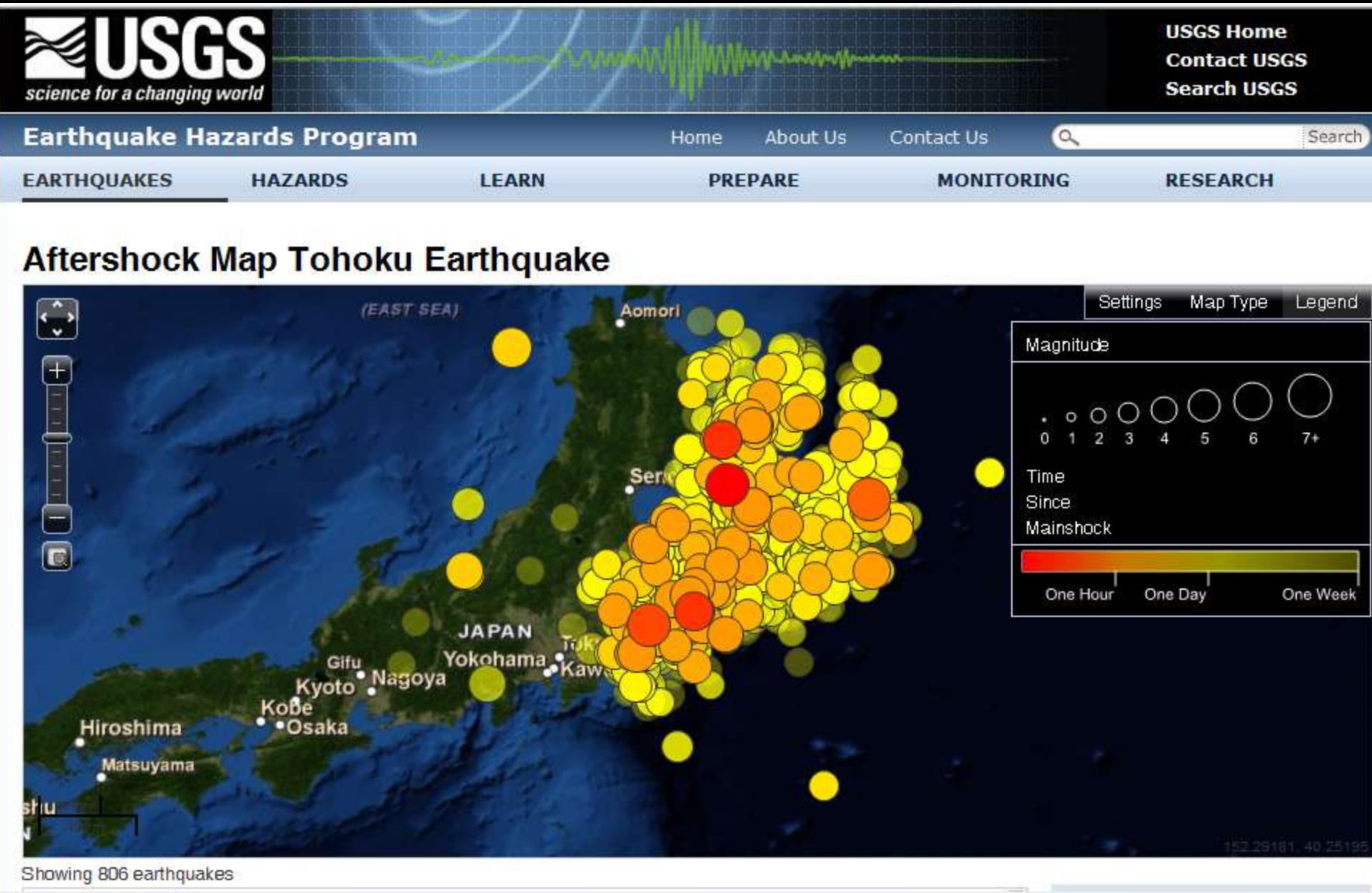


GPS Displacements from Geospatial Information Authority of Japan

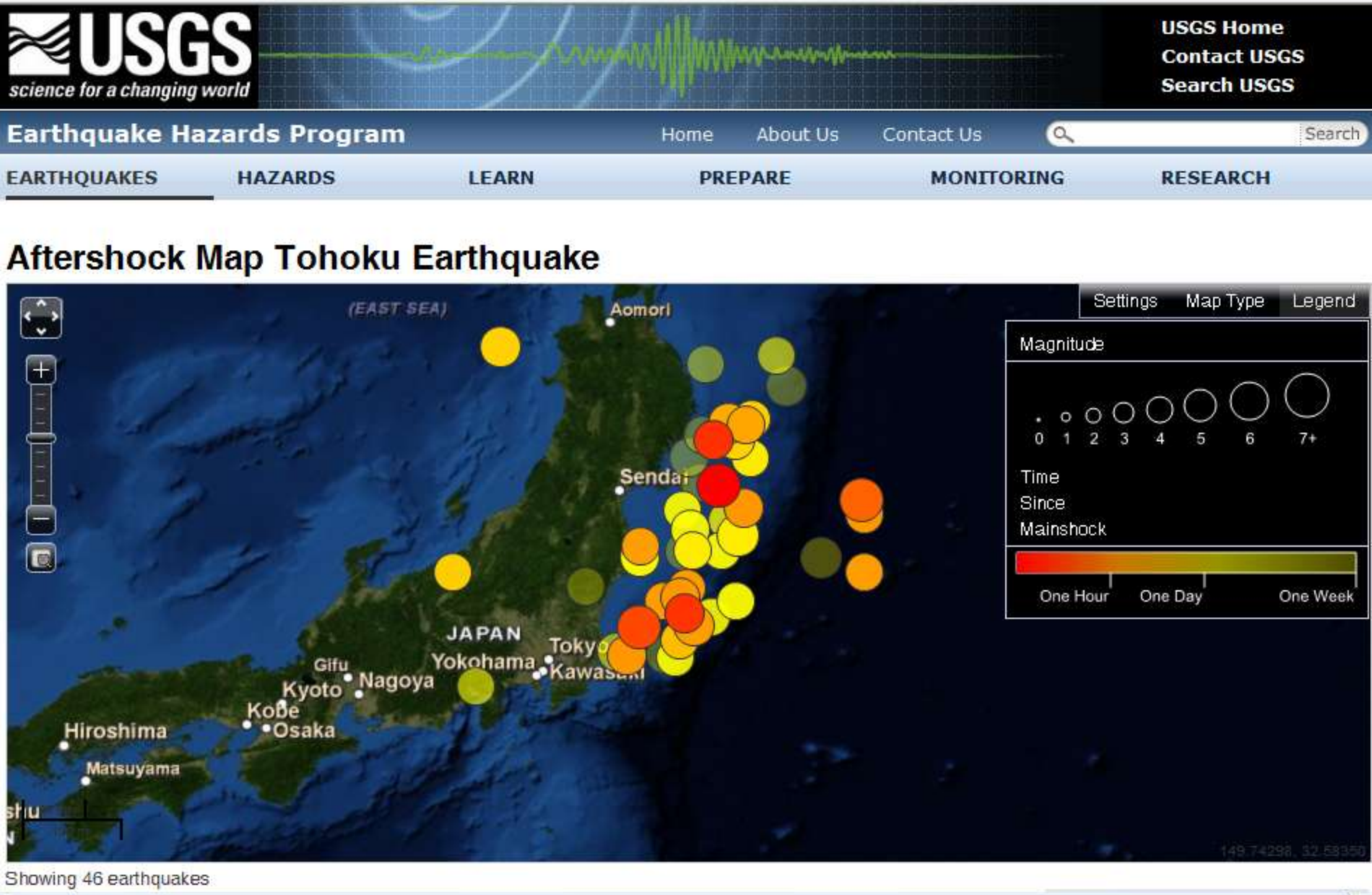




All aftershocks of Tohoku earthquake



Magnitude-6+ aftershocks



International Charter for disaster response

Volunteers from USGS, GISCorps, ImageCat, Rochester Institute of Technology, Penn State, Harvard, George Mason, and the USAID Office of Foreign Disaster Assistance responded to request from the Japan Aerospace Exploration Agency for imagery analysis.

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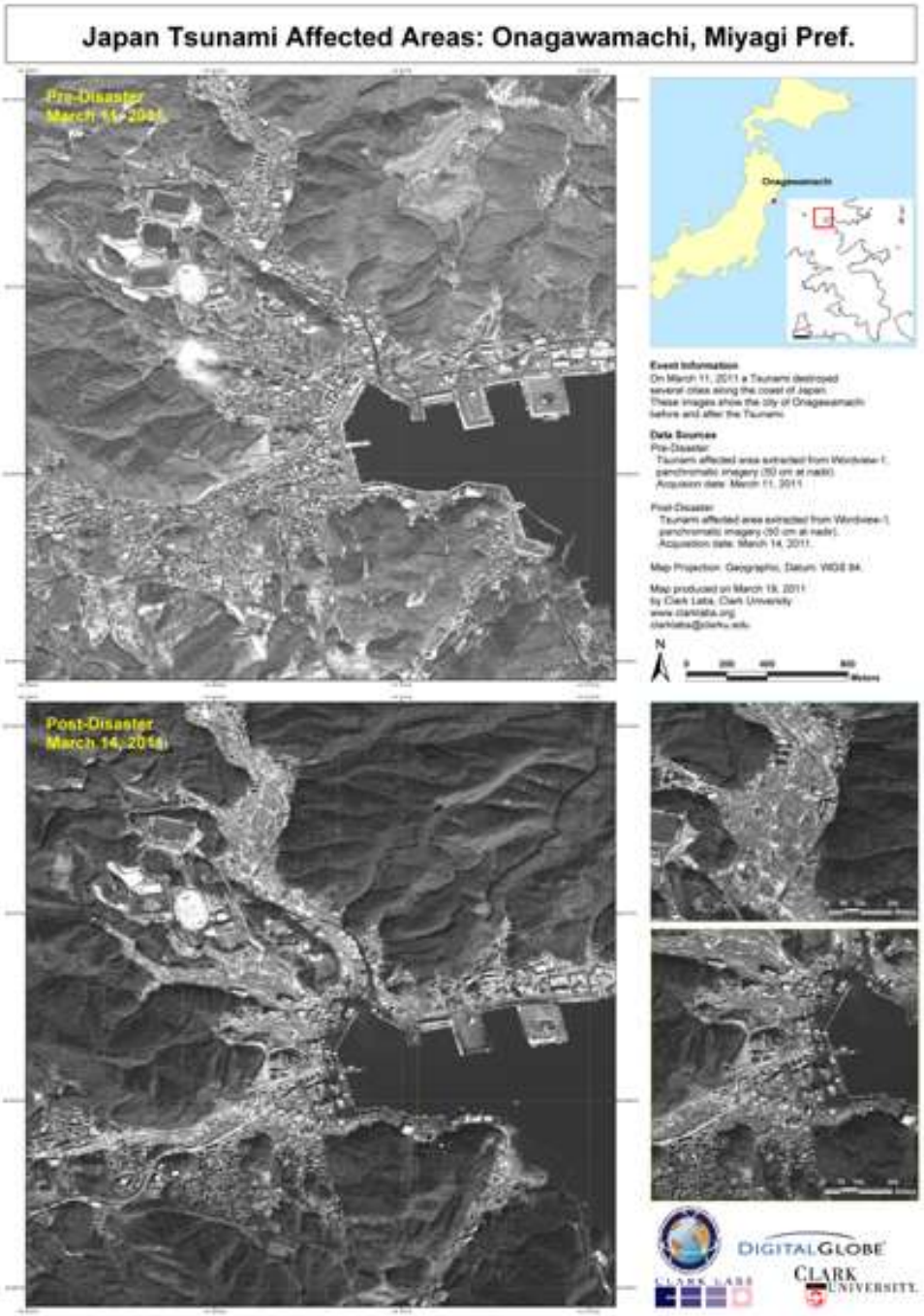
http://www.disasterscharter.org/



Effect on Mines and Mineral Processing Facilities in Northern Honshu, Japan

- Up to one-quarter of the world's iodine and one-third of Japan's cement production may be affected.
- Effects may come from direct damage and the damage done to the surrounding infrastructure, including electricity and transportation.
- Japan is the world's second leading iodine producer, after Chile. The eight affected refineries alone have the capacity to produce 25 percent of the world's iodine. Iodine is used primarily in LCD's.
- In addition to iodine, Japan is a leading source of titanium metal, and its facilities in the affected area have the ability to produce 10 percent of the world's titanium metal.

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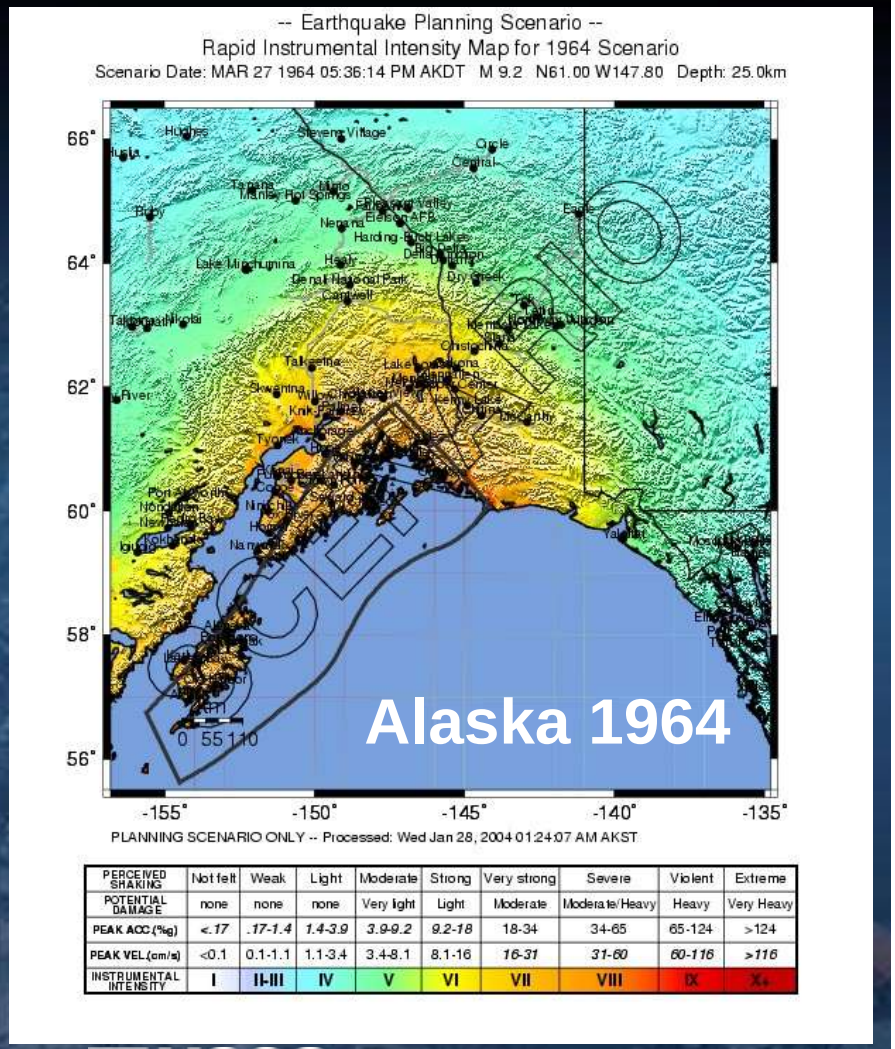
http://pubs.usgs.gov/of/2011/1069/

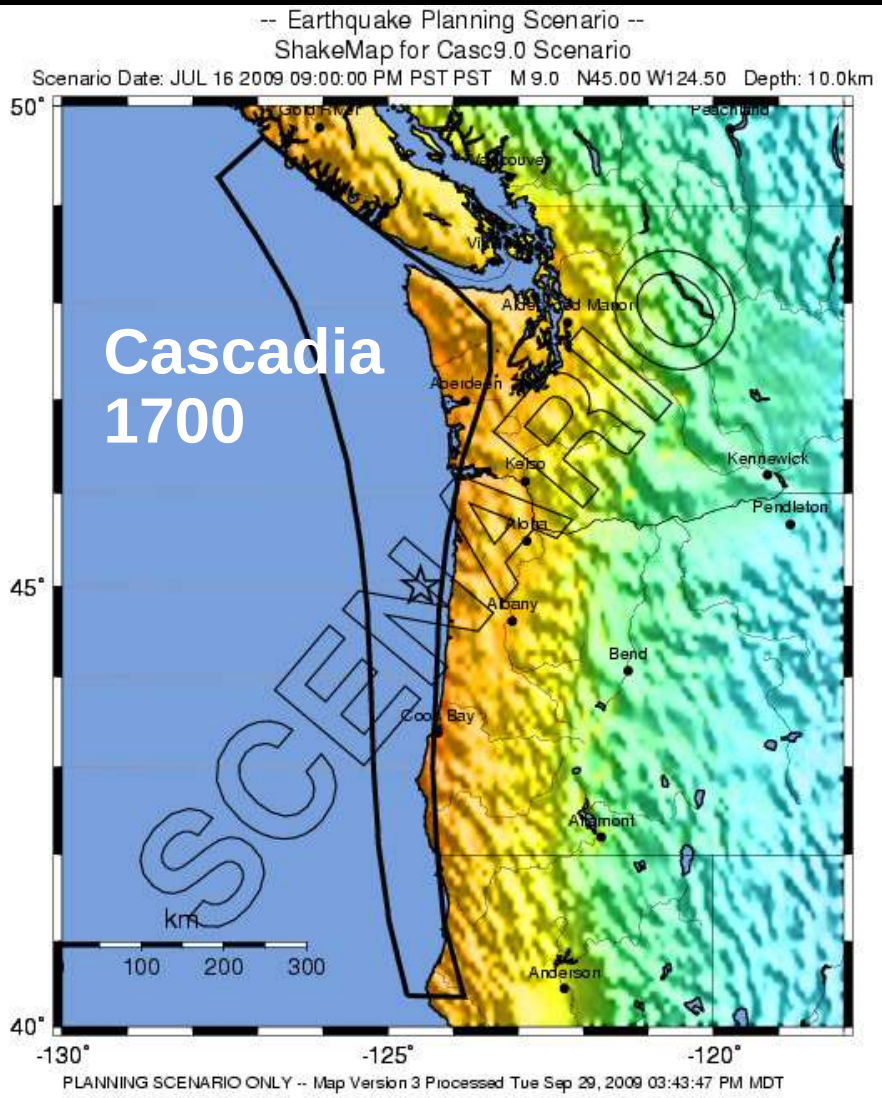
The mandate of the National Earthquake Hazard Reduction Program

- Develop effective measures for earthquake loss reduction;
- Promote their adoption;
- Improve the understanding of earthquakes and their effects on communities, buildings, structures, and lifelines.

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+



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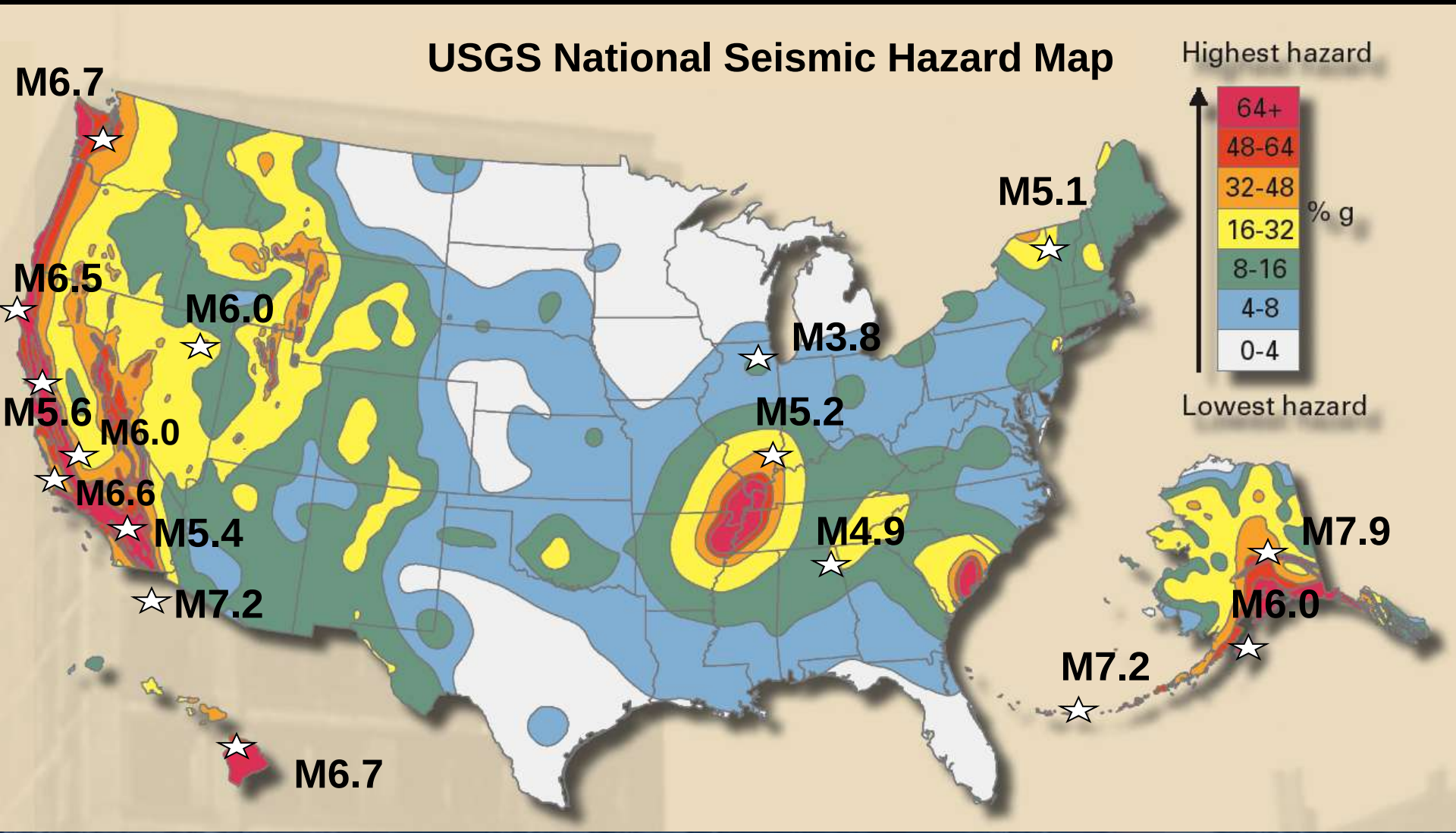
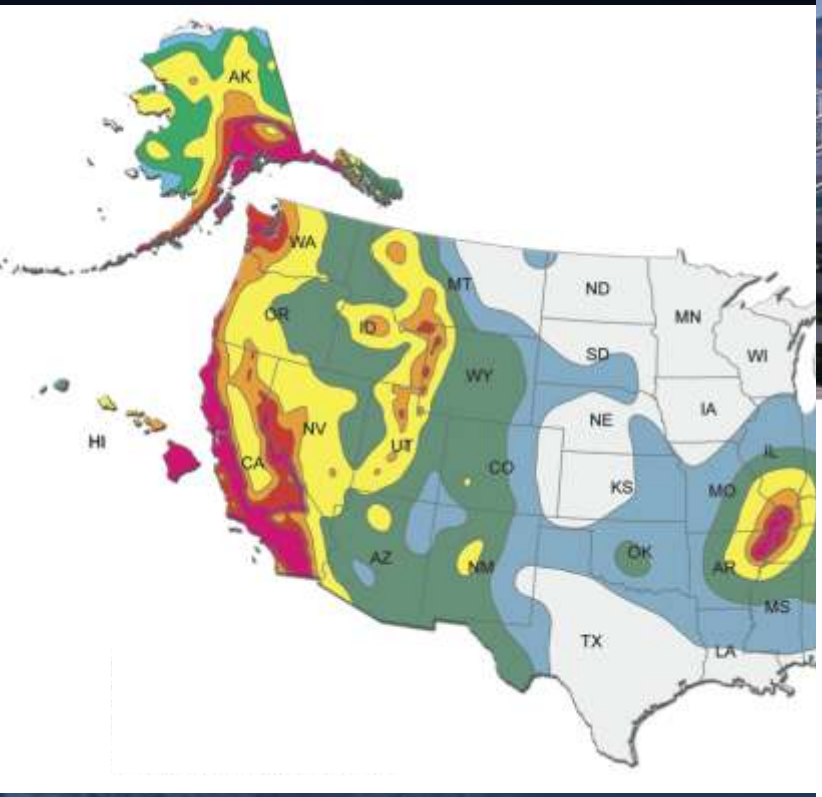
Earthquakes are a national hazard



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

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

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!
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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 1.7 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/

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Ready
Prepare. Plan. Stay Informed.®

American Red Cross

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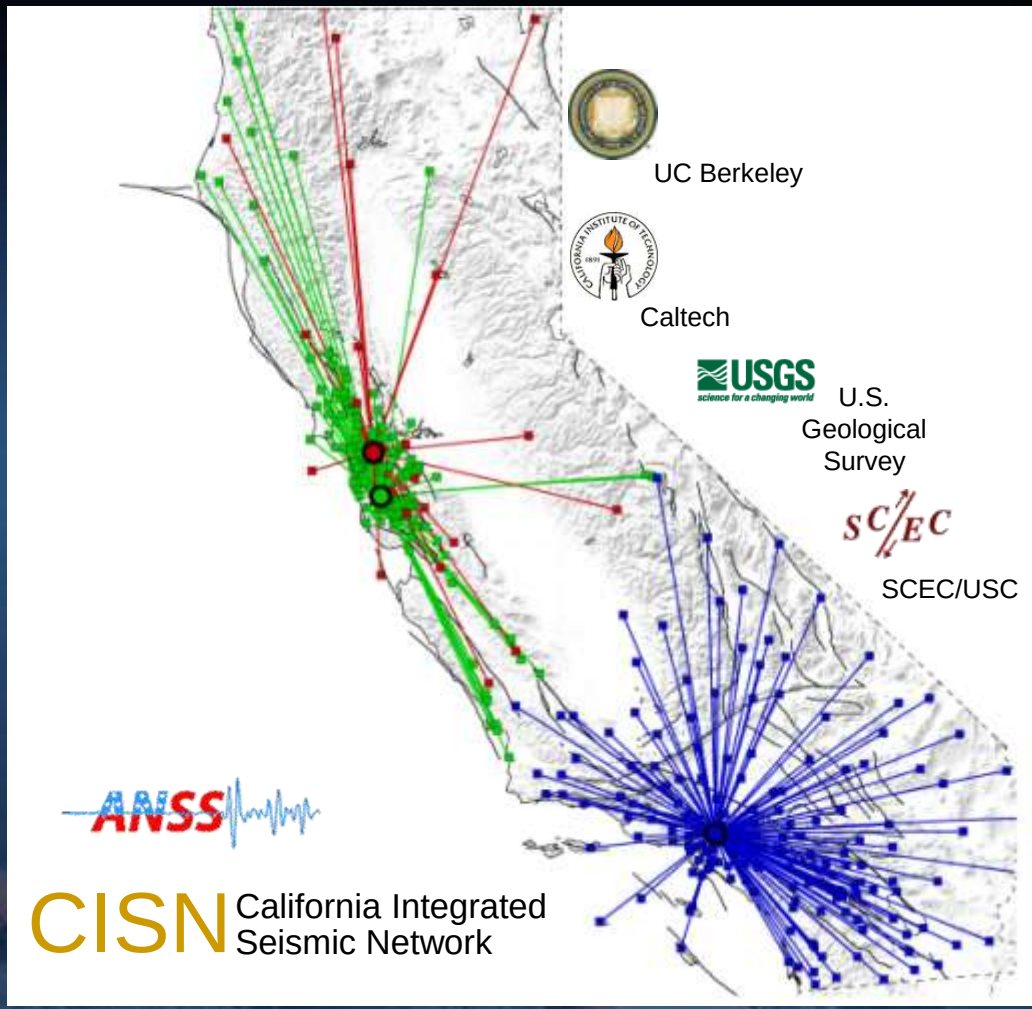
Earthquake early warning – getting ahead of strong ground shaking

- 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



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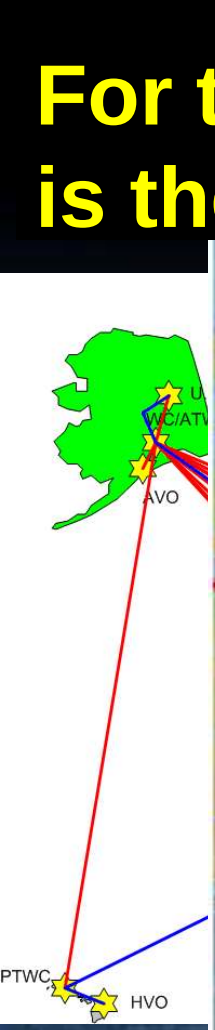
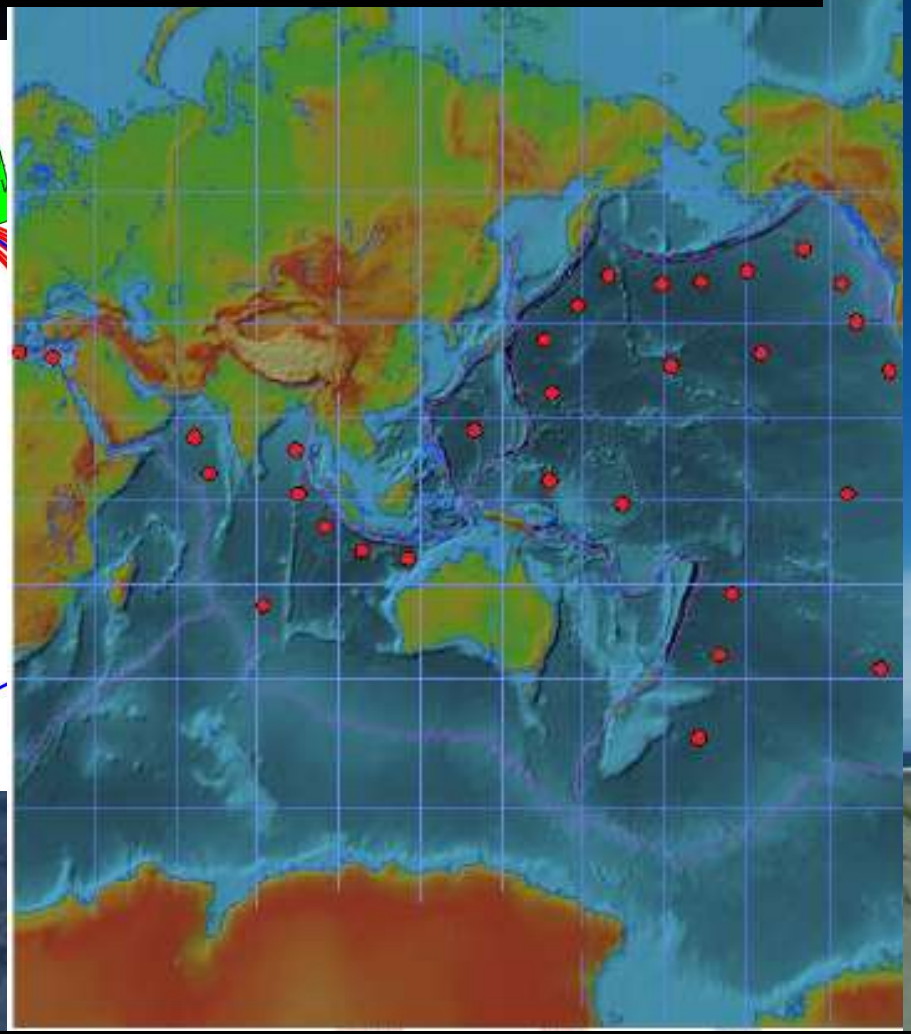
For tsunamis, seismic is the start





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

Credit: Washington Emergency Management

The beach is the finish