

# Earthquake and Tsunami activities of the United States Geological Survey

## Presentation to the Ring of Fire Delegation

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USGS Earthquake Hazard Program  
August 28, 2010





# So many earthquakes... too many earthquakes?

## News Release

April 14, 2010

Dr. Michael Blanpied  
Clarice Nassif Ransom

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[cransom@usgs.gov](mailto:cransom@usgs.gov)

## Is Recent Earthquake Activity Unusual? Scientists Say No.

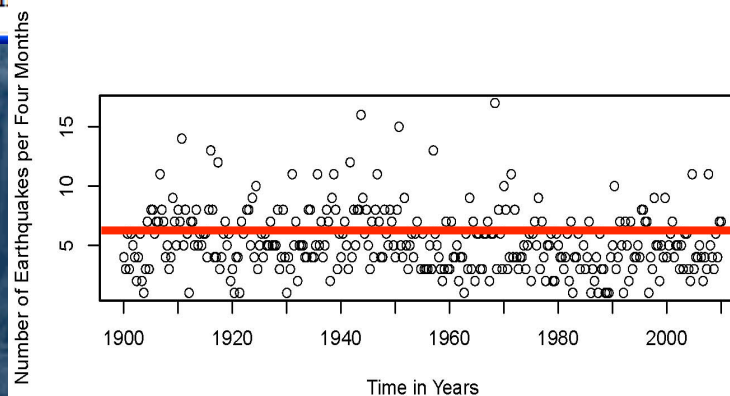
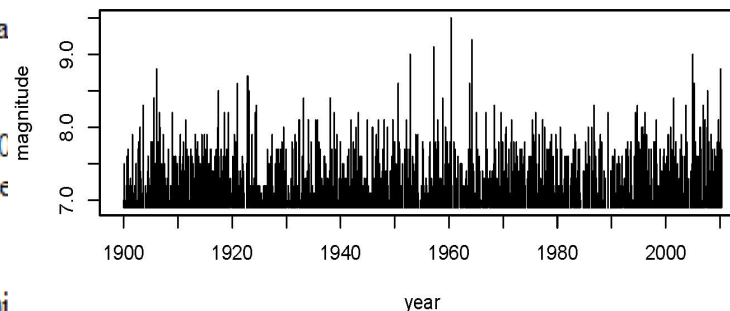
SHARE

China's tragic magnitude 6.9 earthquake on April 13 and the recent devastating earthquake in Haiti have many wondering if this earthquake activity is unusual.

Scientists say 2010 is not showing signs of unusually high earthquake activity. Since 1900, about 1,000 major earthquakes — the size that seismologists define as major — have occurred worldwide. In 1906, there were 10, while 1986 and 1989, while 1943 had 32, with considerable variability from year to year.

With six major earthquakes striking in the first four months of this year, 2010 is well within the range of 2009, to April 14, 2010, there have been 18 major earthquakes, a number also well within the range of 2009.

Real Data: Centennial and PDE Catalogs





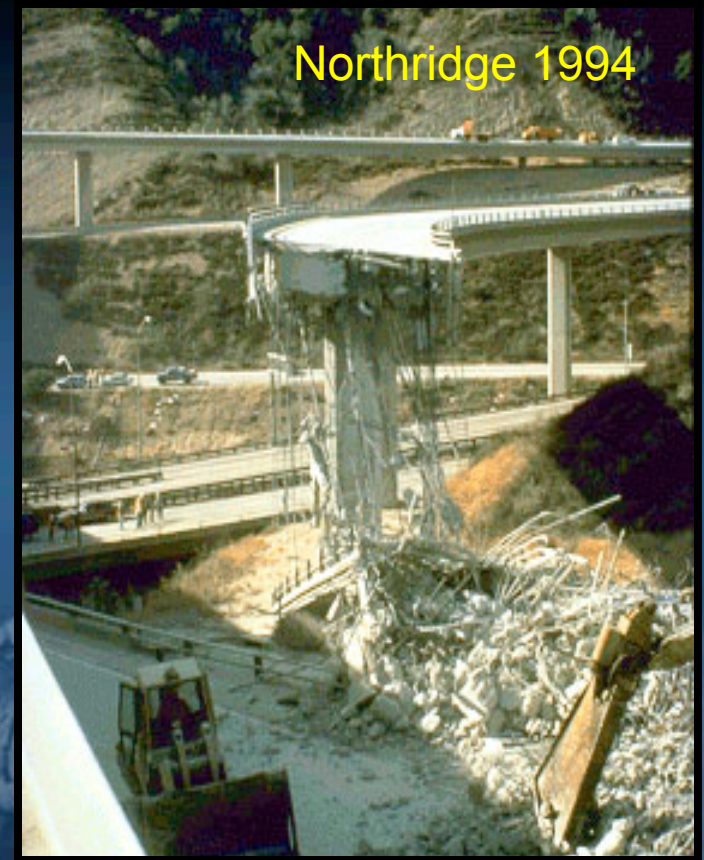
# USGS statutory roles and responsibilities

- USGS has the delegated federal responsibility to provide notification and warnings for **earthquakes**, **volcanoes**, and **landslides**.
- In addition, USGS seismic networks support NOAA in carrying out its **tsunami** warning responsibility; USGS streamgages and storm surge monitors support NOAA's **flood** and **severe weather** (including **hurricane**) warnings; our geomagnetic observatories support **solar storm** forecasts.
- USGS geospatial information supports response operations for **wildfire** and many other hazards.



# 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.



FEMA

NIST

National Institute of  
Standards and Technology



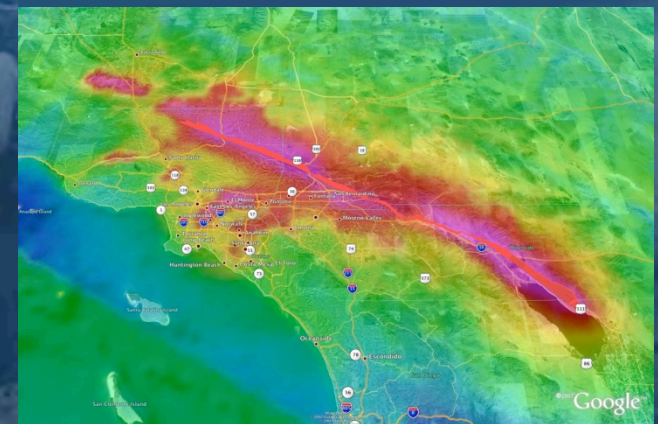
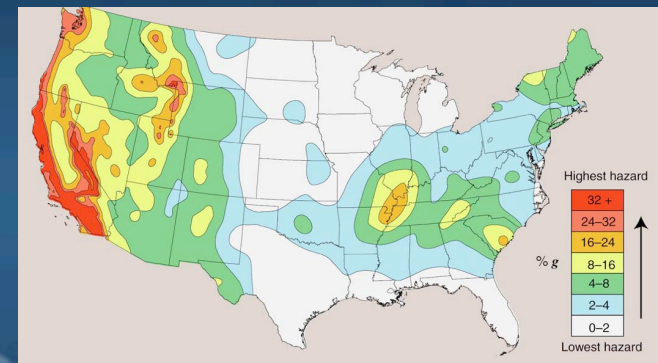
USGS  
science for a changing world

national **earthquake** hazards reduction program



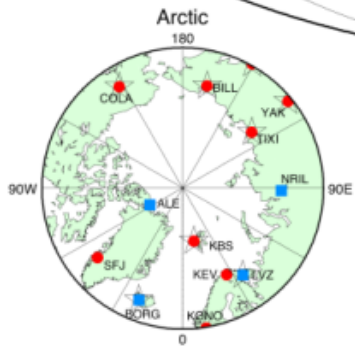
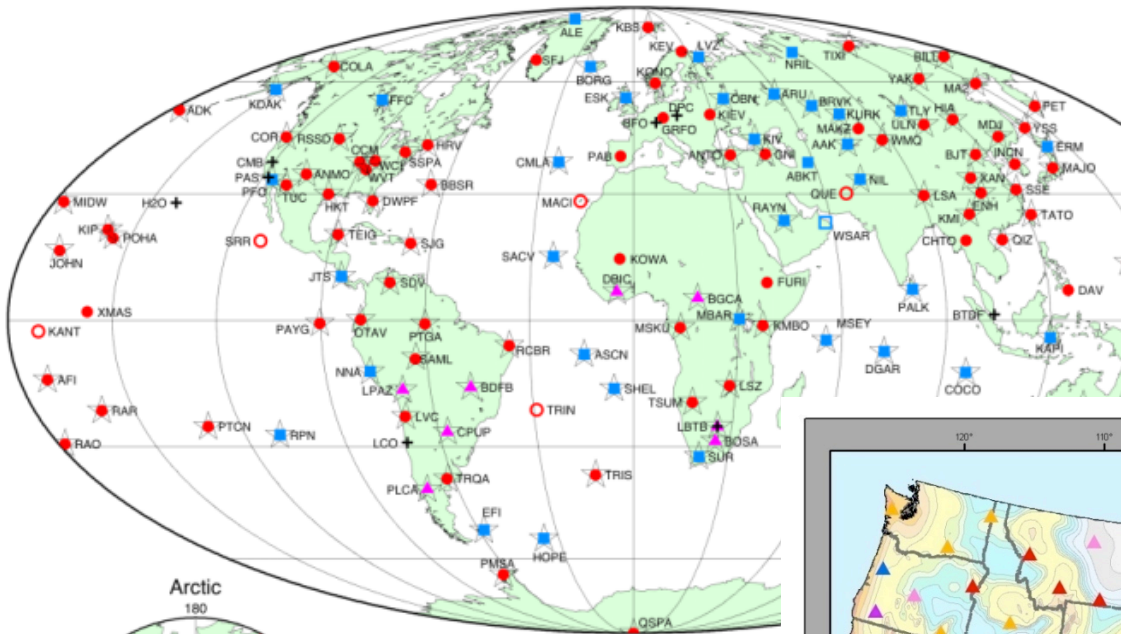
# The USGS role in NEHRP

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



# USGS provides rapid information on earthquakes worldwide

Global Seismographic Network

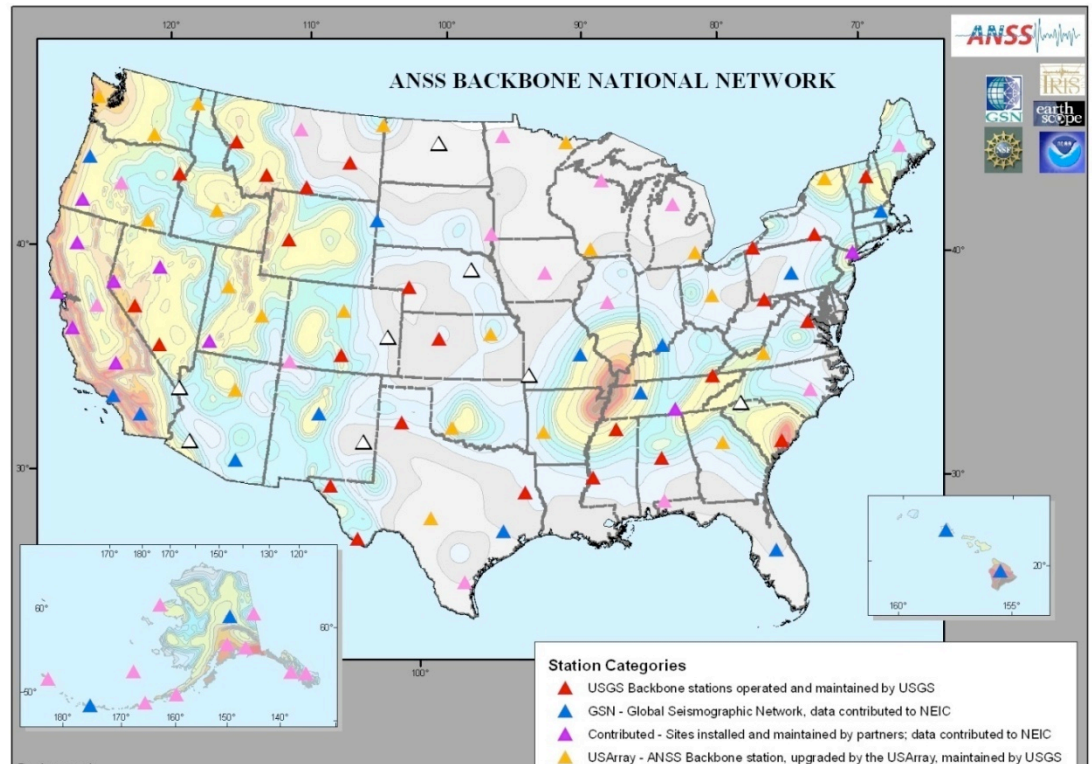


- |           |         |                        |
|-----------|---------|------------------------|
| Installed | Planned |                        |
| 85 ●      | 6 ○     | IRIS/USGS Stations     |
| 39 ■      | 2 □     | IRIS/IDA Stations (UC) |
| 8 +       |         | Other/Affiliated GSN S |
| 9 ▲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

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



USGS National Earthquake Information Center, Golden, Colorado



Station Categories

- ▲ USGS Backbone stations operated and maintained by USGS
- GSN - Global Seismographic Network, data contributed to NEIC
- ▲ Contributed - Sites installed and maintained by partners; data contributed to NEIC
- ▲ USArray - ANSS Backbone station, upgraded by the USArray, maintained by USGS



# USGS Earthquake Notification System

Over  
175,000  
users



USGS Earthquake Hazards Program » Earthquake Notification Service: Customizable Alerts

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science for a changing world

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## Earthquake Hazards Program

Home **Earthquake Center** Regional Information Learning & Education Research & Monitoring Additional Resources

Home » Earthquake Center » Earthquake Notification Service » Earthquake Notification Service: Customizable Alerts

### Latest Earthquakes

- USA
- World

### EQ Notification Service

- Feeds & Data
- Animations
- Recent Earthquakes
- Historic Earthquakes
- "Top 10" Lists & Maps
- Significant EQs
- Earthquake Search
- EQ Summary Posters
- Scientific Data
- About EQ Maps
- Did You Feel It?
- Energy & Broadband Solutions
- Fast Moment Tensors
- Media Info
- PAGER
- Seismogram Displays
- ShakeMaps

This system provides automated email notification for worldwide earthquakes. It's a free service offered by the U.S. Geological Survey.

[Introduction to ENS - What you need to know](#)

#### Manage Your Account

**Username:**

**Password:**

**OR**

#### Register for a New Account

[See recent events processed](#)

[Forgot your username or password?](#)

If you have questions or problems, [Send mail to the ENS Administrator.](#)

## http://earthquake.usgs.gov/ens/

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Accessibility FOIA Privacy Policies and Notices

U.S. Department of the Interior | U.S. Geological Survey  
URL: <http://earthquake.usgs.gov/eqcenter/ens/index.php>  
Page Contact Information: [Web Team](#)  
Page Last Modified: March 07, 2006 11:28:22 AM.

FIRSTGOV.gov  
The U.S. Government's Official Web Portal

TAKE PRIDE IN AMERICA

# ENS can be customized to suit your needs

The screenshot displays the USGS Earthquake Hazards Program website, specifically the 'Earthquake Notification Service: Customizable Earthquake Alerts' page. The page is titled 'Earthquake Notification Service: Customizable Earthquake Alerts' and features a navigation menu with options like 'Home', 'Earthquake Center', 'Regional Information', 'Learning & Education', 'Research & Monitoring', and 'Additional Resources'. The main content area shows a user's profile for 'waldjd' with two custom regions: 'Continental US' and 'World'. Each region has a map and a table of alert parameters.

**Continental US (Custom region)**

Depth:	0.00 to 800.00km
Networks:	CI, NC, NN, UU, UW, AK, NM, HV, AT, PR, SE, US, LD, MB, WY, AR
Geographic Bounds:	polygon
Day Mag:	4
Night Mag:	4.5
Day Begins:	08:00
Day Ends:	22:00
Address 1:	3036386000@vtext.com (short)
Address 2:	wald@usgs.gov (long)

**World (Custom region)**

Depth:	0.00 to 800.00km
Networks:	CI, NC, NN, UU, UW, AK, NM, HV, AT, PR, SE, US, LD, MB, WY, AR
Geographic Bounds:	rectangle
South Latitude:	-90.000
North Latitude:	90.000
East Longitude:	180.000
West Longitude:	-180.000
Day Mag:	5.7
Night Mag:	6.1

The right sidebar contains user information, including a welcome message, 'Log Out' button, 'Recent Events Sent to Me', 'Map of Recent Events', 'My Email Addresses' (listing 3036386000@mmode.com, 3036386000@vtext.com, and wald@usgs.gov), and 'Admin Functions' (Recent Events List, Recent Events Map, Admin Page).





# ENS can be customized to suit your needs

The image shows a screenshot of the USGS Earthquake Notification Service (ENS) website. The browser window title is "USGS Earthquake Hazards Program | Earthquake Center | Earthquake Notification Service | Earthquake Notification Service: Customi...". The page header includes the USGS logo and navigation links: "USGS Home", "Contact USGS", and "Search USGS".

The main content area is titled "Earthquake Notification Service: Customizable Earthquake Alerts". It features a "Welcome waldjd!" message with a "Log Out" link, and a "Recent Events Sent to Me" section. There are also links for "Map of Recent Events" and "My Email Addresses".

The "Profiles" section is active, showing "My Account" and "Notification Profiles Associated with waldjd's Account". Two profiles are listed:

- Profile 1:**
  - Depth: 0.00 to 800.00km
  - Networks: CI, NC, NN, UU, UW, AK, NM, HV, AT, PR, SE, US, LD, MB, WY, AR
  - Geographic Bounds: polygon
  - Day Mag: 4
  - Night Mag: 4.5
  - Day Begins: 08:00
  - Day Ends: 22:00
  - Address 1: 3036386000@vtext.com (short)
  - Address 2: wald@usgs.gov (long)
  - Buttons: DELETE PROFILE, EDIT PROFILE
- Profile 2:**
  - Depth: 0.00 to 800.00km
  - Networks: CI, NC, NN, UU, UW, AK, NM, HV, AT, PR, SE, US, LD, MB, WY, AR
  - Geographic Bounds: rectangle
  - South Latitude: -90.000
  - North Latitude: 90.000
  - East Longitude: 180.000
  - West Longitude: -180.000
  - Day Mag: 5.7
  - Night Mag: 6.1

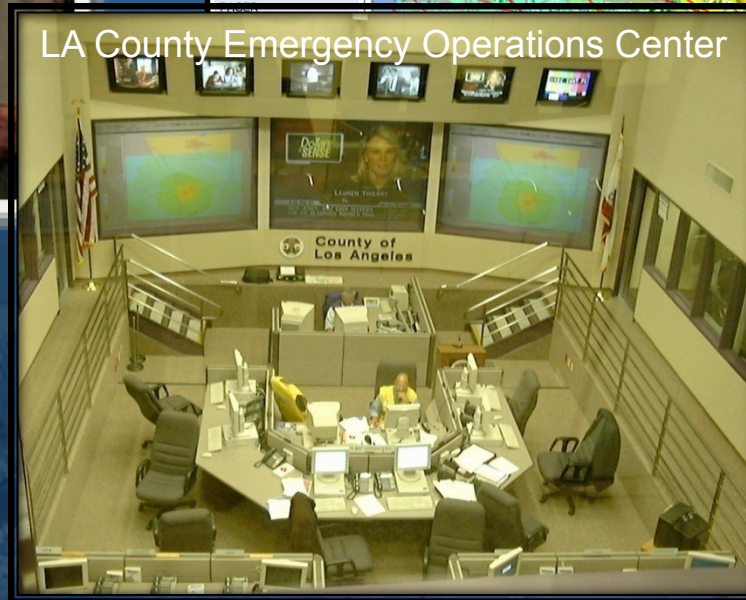
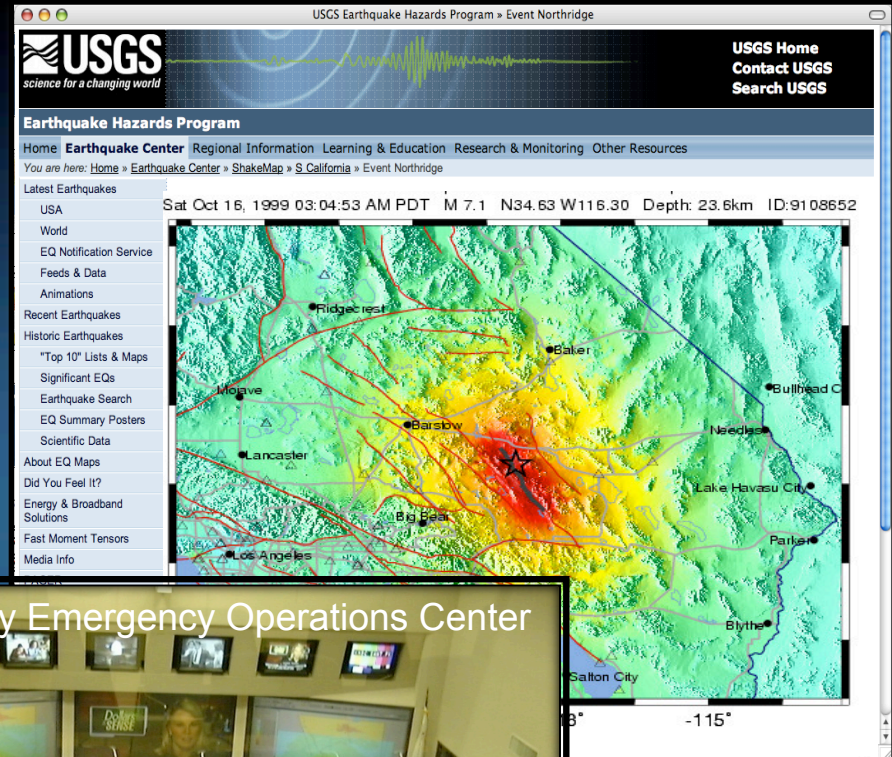
The "Admin Functions" section includes links for "Recent Events List", "Recent Events Map", and "Admin Page".

On the left, a "USGS ENS Map Input" window is open, showing a map of the United States with a red polygon boundary defined over the central region. The map includes a search bar, navigation controls, and a "Done" button. The text above the map reads: "Click on the map to define your polygon boundary. You may have up to 50 points in your polygon. Click 'Done' when finished." Below the map, there is a "Back up one point" button and a "Number of points: 7" field.

# 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.



Very strong	Severe	Violent	Extreme
Moderate	Moderate/Heavy	Heavy	Very Heavy
18-34	34-65	65-124	>124
16-31	31-60	60-116	>116
VII	VIII	IX	X+



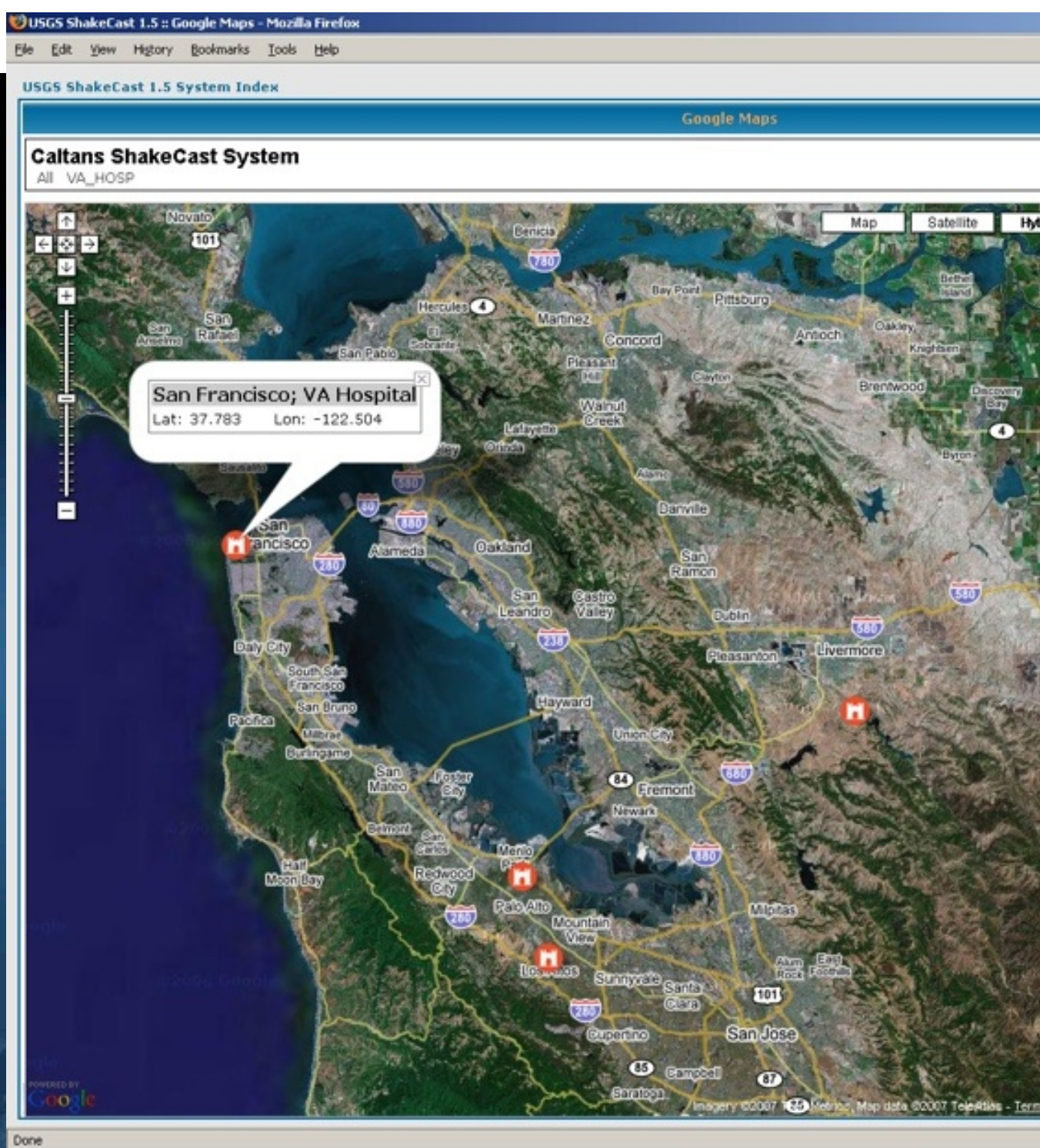
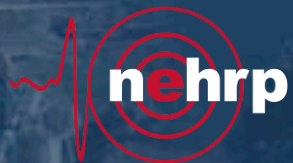


# ShakeCast



Automated  
notifications to  
operators of  
critical facilities

 USGS





# 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



# Situational awareness available in 20 minutes

## Prompt Assessment of Global Earthquakes for Response



### M 6.9, SOUTHERN QINGHAI, CHINA

Origin Time: Tue 2010-04-13 23:49:37 UTC

Location: 33.27°N 96.63°E Depth: 10 km

**PAGER  
Version 2**

Created: 37 minutes, 54 seconds after earthquake

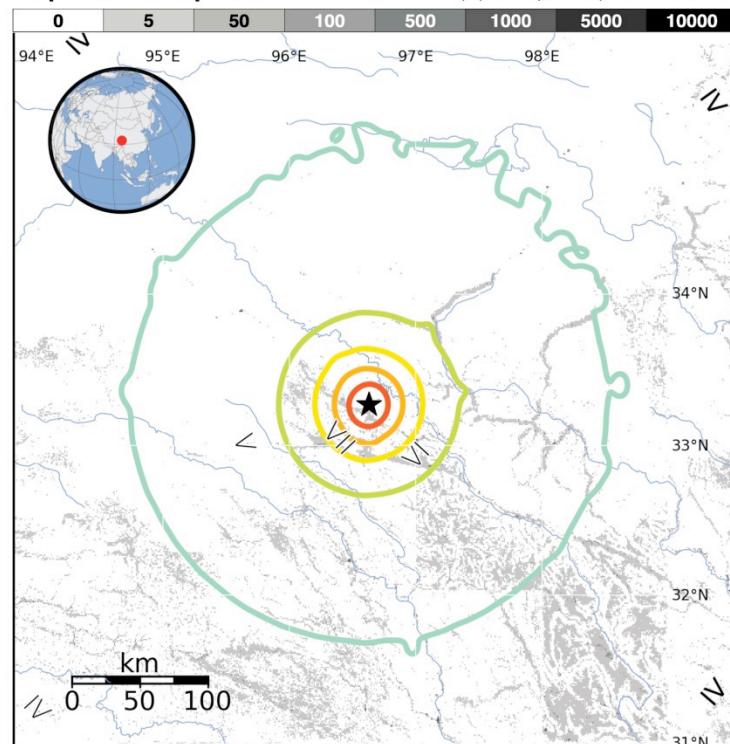
### Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)		--*	--*	540k*	237k	48k	9k	5k	3k	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

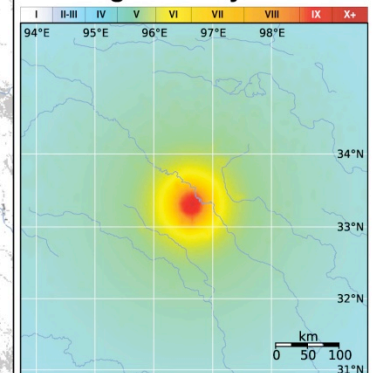
population per ~1 sq. km from Landsat



### Selected City Exposure

MMI City Population  
bold cities appear on map (k = x1000)

### Shaking Intensity



Overall, the population in this region resides in structures that are highly vulnerable to earthquake shaking, though some resistant structures exist. On June 15, 1982 (UTC), a magnitude 5.6 earthquake 338 km Southeast of this one struck China, with estimated population exposures of 1,000 at intensity VII and 2,000 at intensity VI, resulting in a reported 11 fatalities.



# Situational awareness available in 20 minutes

## Prompt Assessment of Global Earthquakes for Response



**M 6.9, SOUTHERN QINGHAI, CHINA**

Origin Time: Tue 2010-04-13 23:49:37 UTC

Location: 33.27°N 96.63°E Depth: 10 km



**USAID**  
FROM THE AMERICAN PEOPLE

**PAGER**  
Version 2

Created: 37 minutes, 54 seconds after earthquake

### Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)		--*	--*	540k*	237k	48k	9k	5k	3k	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.



**Summary Alert** ● **Orange**



**USAID**  
FROM THE AMERICAN PEOPLE

**M 6.9, SOUTHERN QINGHAI, CHINA**

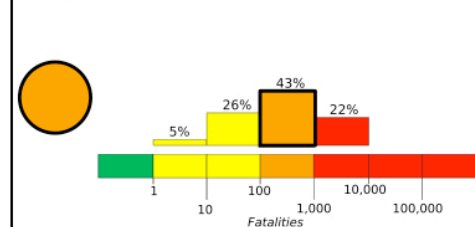
Origin Time: Tue 2010-04-13 23:49:37 UTC (07:49:37 local)

Location: 33.27°N 96.63°E Depth: 10 km

**PAGER**  
Version 2

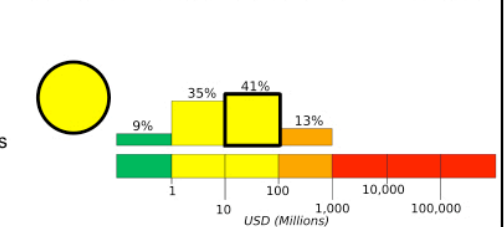
Created: 38 minutes, 39 seconds after earthquake

### Estimated Fatalities



Orange alert level for fatalities. Significant casualties are likely and the disaster is potentially widespread. Past events with this alert level have required a regional or national level response.

### Estimated Economic Losses



Yellow alert level for economic losses. Some damage is possible. Estimated economic losses are less than 1% of GDP of China.

### Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)		--*	--*	540k*	233k	50k	9k	6k	3k	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 Landsat

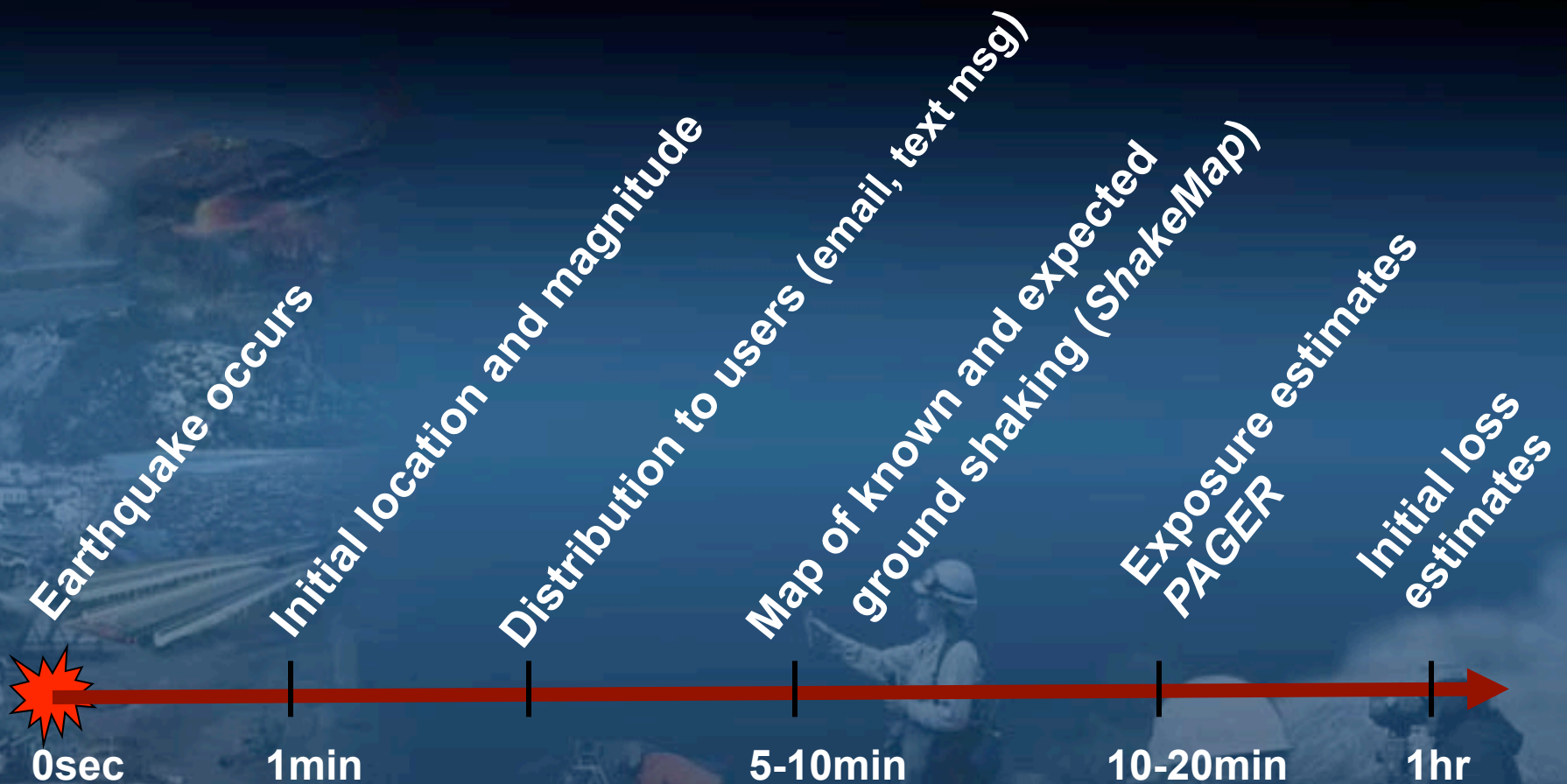
### Structures:

Overall, the population in this region resides

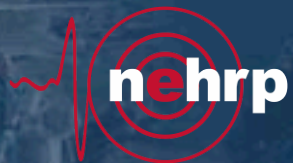
**Beta-test product:  
LossPAGER**



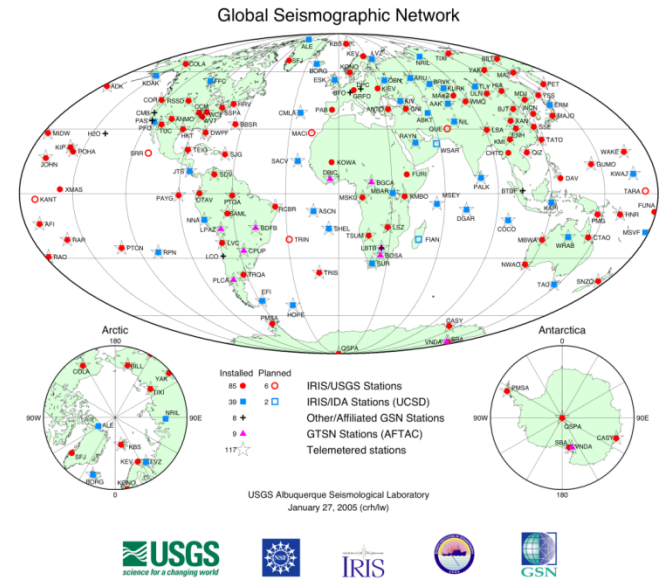
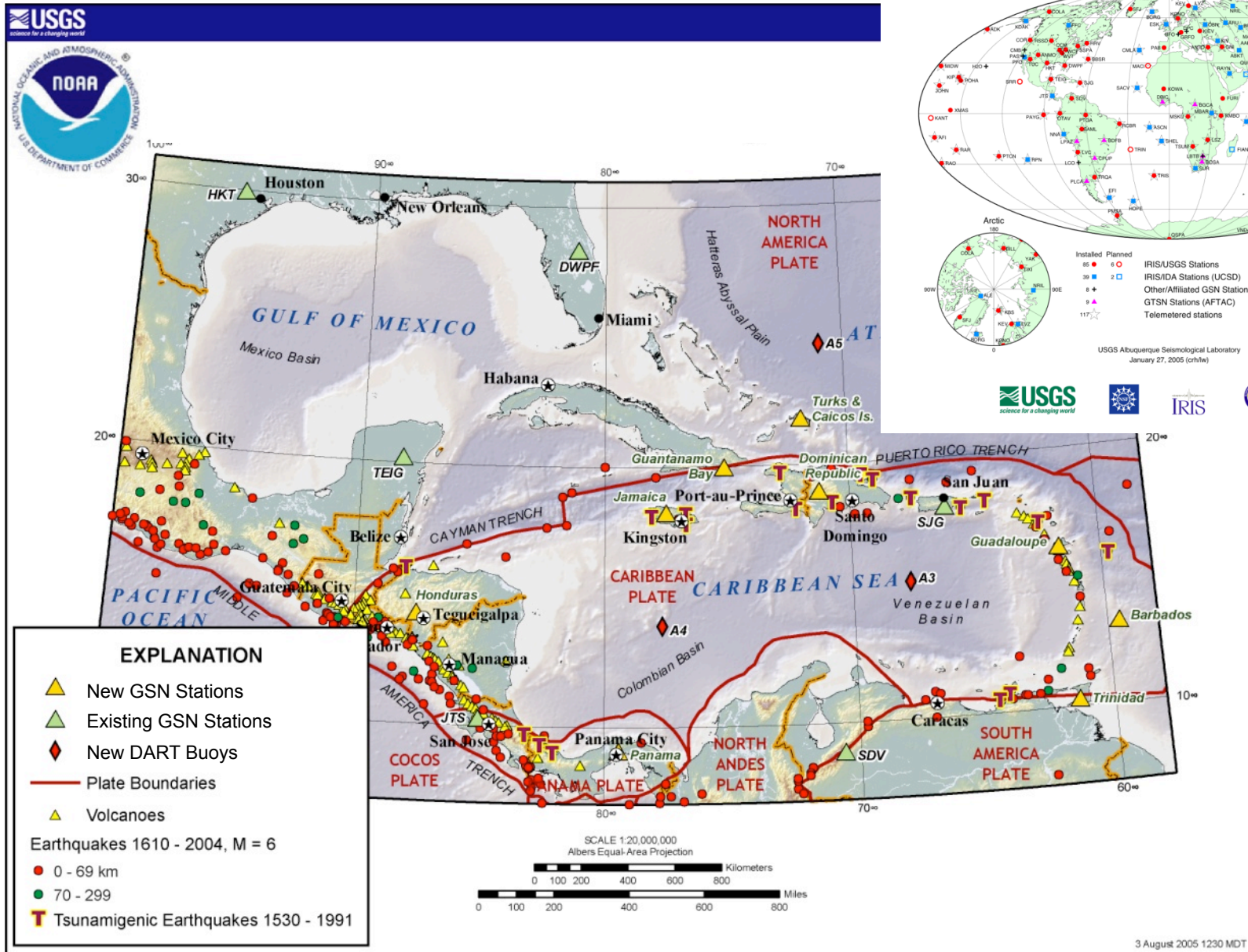
# An earthquake information timeline (domestic earthquake)



 USGS

 nehrp

# NOAA-USGS Post-Sumatra tsunami warning initiative





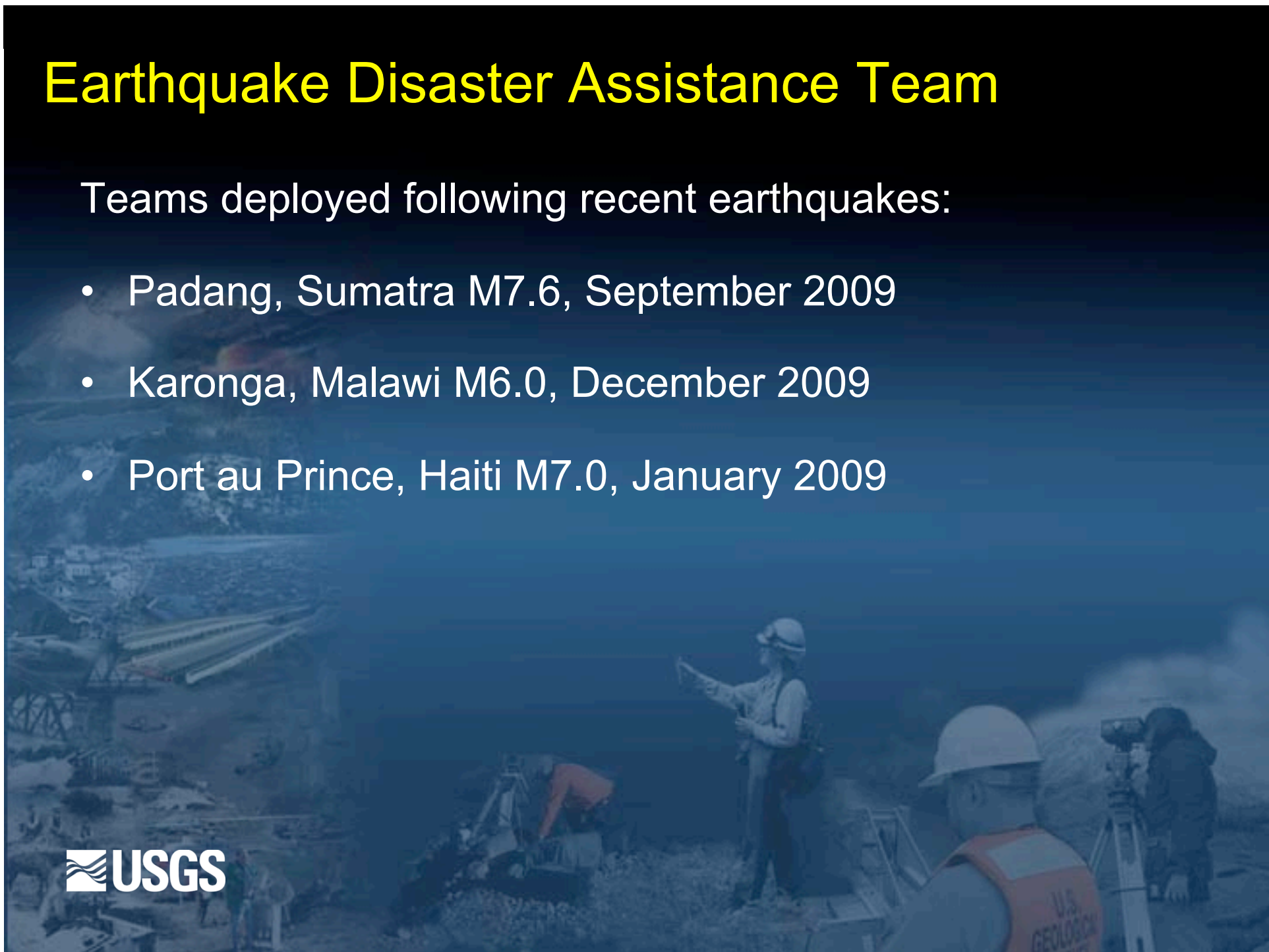
# Earthquake Disaster Assistance Team

- Cooperative program of the USGS and USAID's Office of Foreign Disaster Assistance (OFDA)
- Purposes:
  - Support OFDA's response activities to earthquake disasters in developing nations.
  - Make USGS experts or scientific services available to assist local geological agencies, when requested.
  - Conduct rapid assessment of earthquake, tsunami, and landslide hazards and impacts.
  - Provide advice and training to build capacity in monitoring, hazard asmt., microzonation, etc.
- Can also support mitigation and capacity-building projects.

# Earthquake Disaster Assistance Team

Teams deployed following recent earthquakes:

- Padang, Sumatra M7.6, September 2009
- Karonga, Malawi M6.0, December 2009
- Port au Prince, Haiti M7.0, January 2009





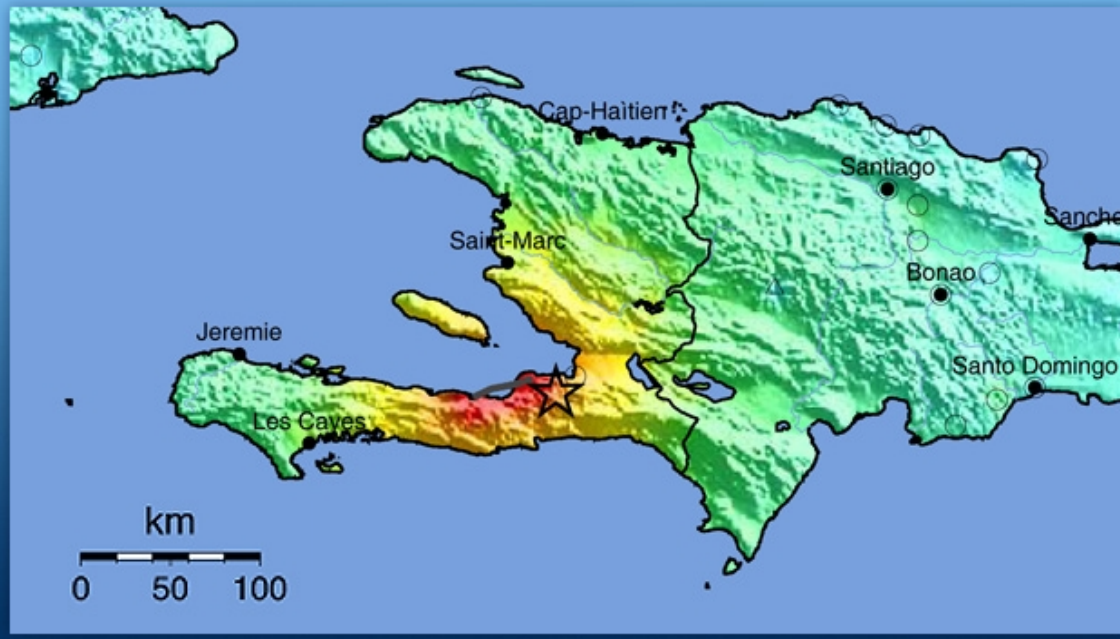


# HELP *for* HAITI

The President speaks on the urgent situation after the earthquake in Haiti and the government's response. Read his remarks and learn how to contribute to the relief effort.

[Learn More](#)

- 1
- 2
- 3
- 4



Map courtesy of USGS

## A NEW FOUNDATION



**The President's Plan for Health Insurance Reform**  
Cut through the rhetoric on health insurance reform. Read the essentials of the President's plan, and watch a video with highlights of his speech to Congress.

[Learn More](#)

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## SEARCH *the* SITE

## PHOTO *of the* DAY



## THE BLOG

January 13, 2010 at 9:53 AM EST

## FEATURED LEGISLATION

[Ryan White HIV/AIDS Treatment Extension Act of 2009](#)

# PAGER

## Prompt Assessment of Global Earthquakes for Response

Rapidly estimated that over 2 million people were exposed to violent shaking



### M 7.0, HAITI REGION

Origin Time: Tue 2010-01-12 21:53:10 UTC  
Location: 18.46°N 72.53°W Depth: 13 km



### PAGER Version 8

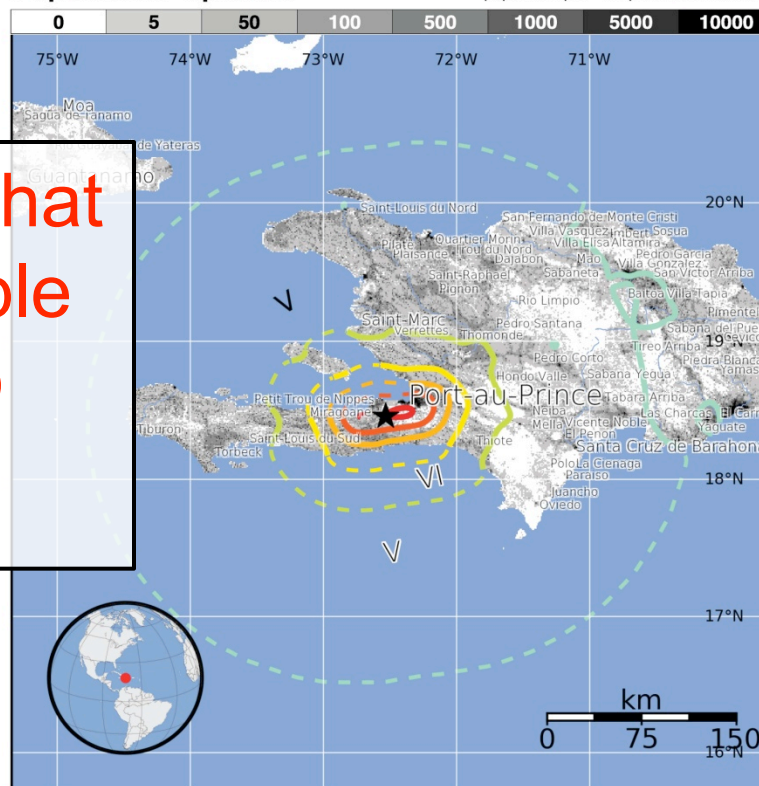
Created: 1 day, 20 hours after earthquake

### Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)	--*	--*	5,887k*	7,261k	1,049k	571k	314k	2,246k	332k	
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

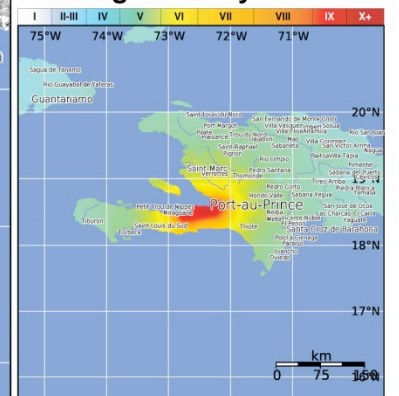


### Selected City Exposure

MMI City	Population
X Grand Goave	5k
IX Port-au-Prince	1,235k
IX Carrefour	442k
IX Petionville	108k
IX Delmas 73	383k
IX Croix des Bouquets	9k
VI Miragoane	6k
V Verrettes	49k
III Santo Domingo	2,202k
III Guantanamo	273k

bold cities appear on map (k = x1000)

### Shaking Intensity



Overall, the population in this region resides in structures that are vulnerable to earthquake shaking, though some resistant structures exist. On June 24, 1984 (UTC), a magnitude 6.7 earthquake struck the Dominican Republic, with estimated population exposures of 320,000 at intensity VII and 2,964,000 at intensity VI, resulting in 5 reported fatalities. Recent earthquakes in this





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# Earthquake Hazards Program

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- RESEARCH

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- [Earthquake Scenarios](#)
- [Prediction](#)
- [Probabilities](#)

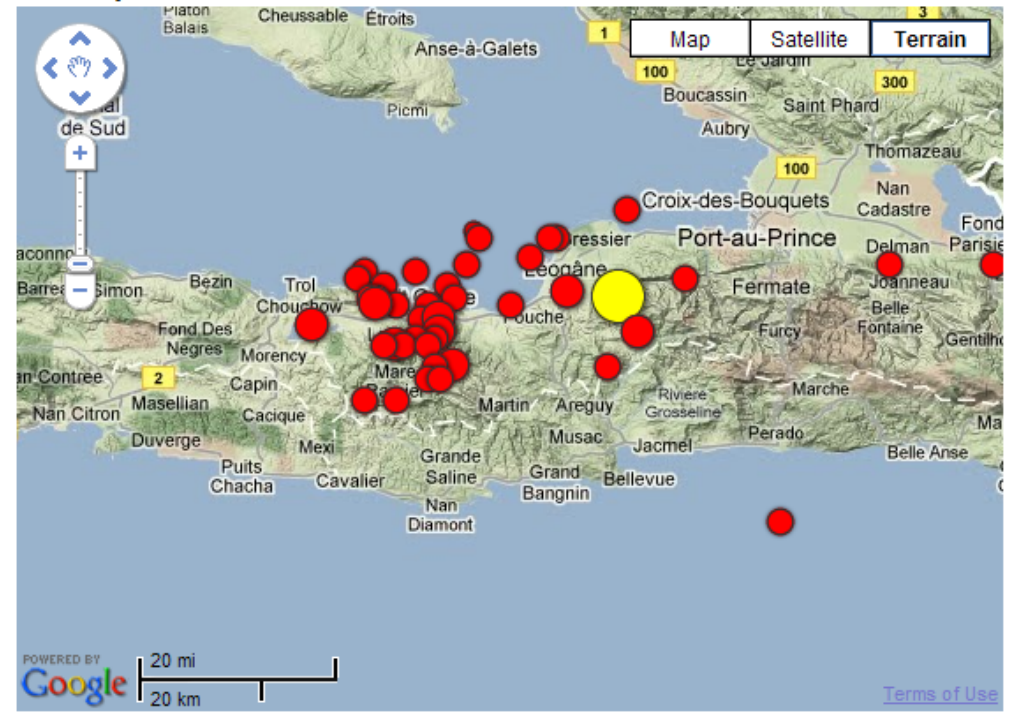
### Location

- [Info by State](#)
- [Info by Country/Region](#)

## Aftershock Mapping

### Aftershock Map - Mainshock and 42 Aftershocks

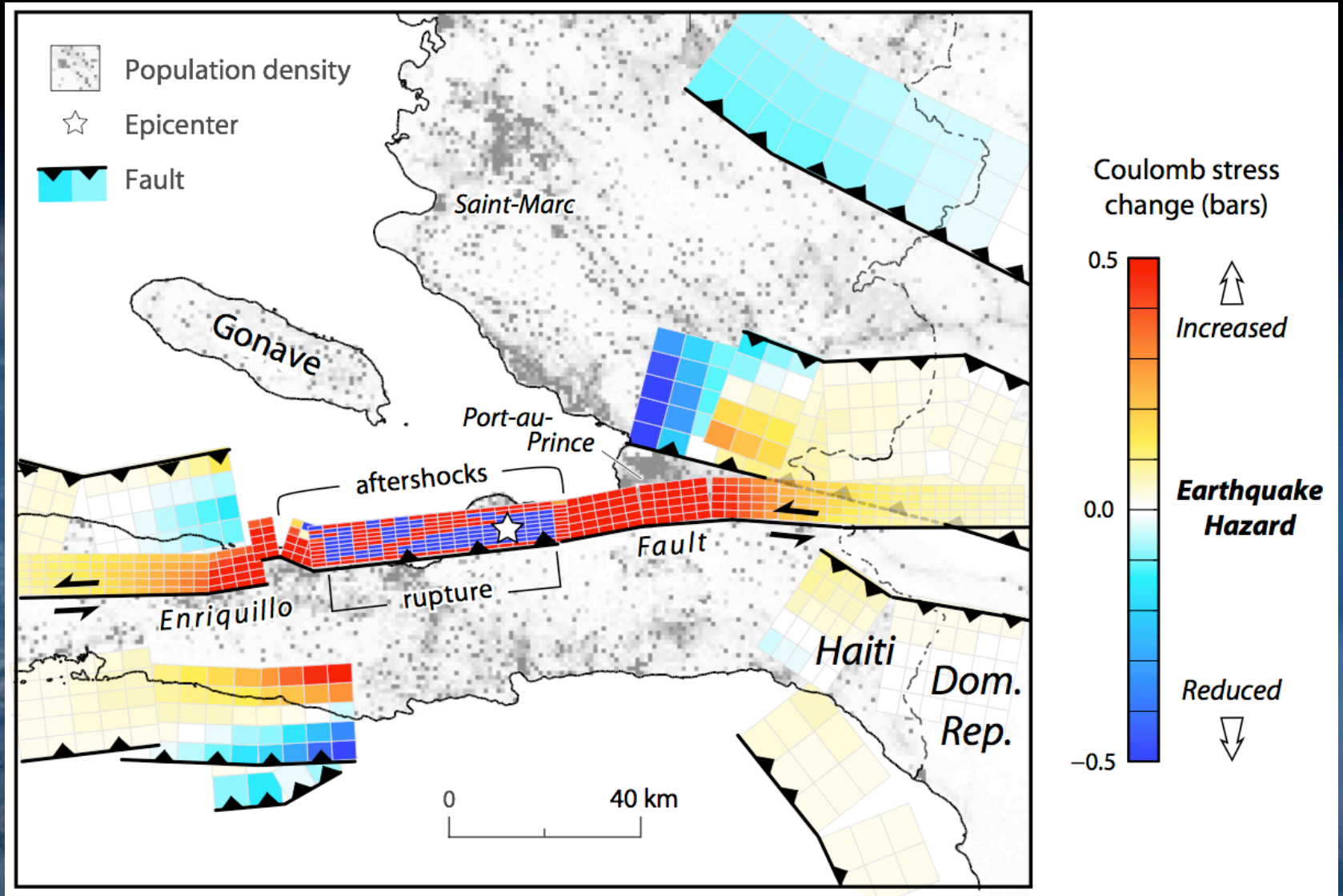
Last Updated: 04 March 2010, 00:08:59 UTC



### Legend

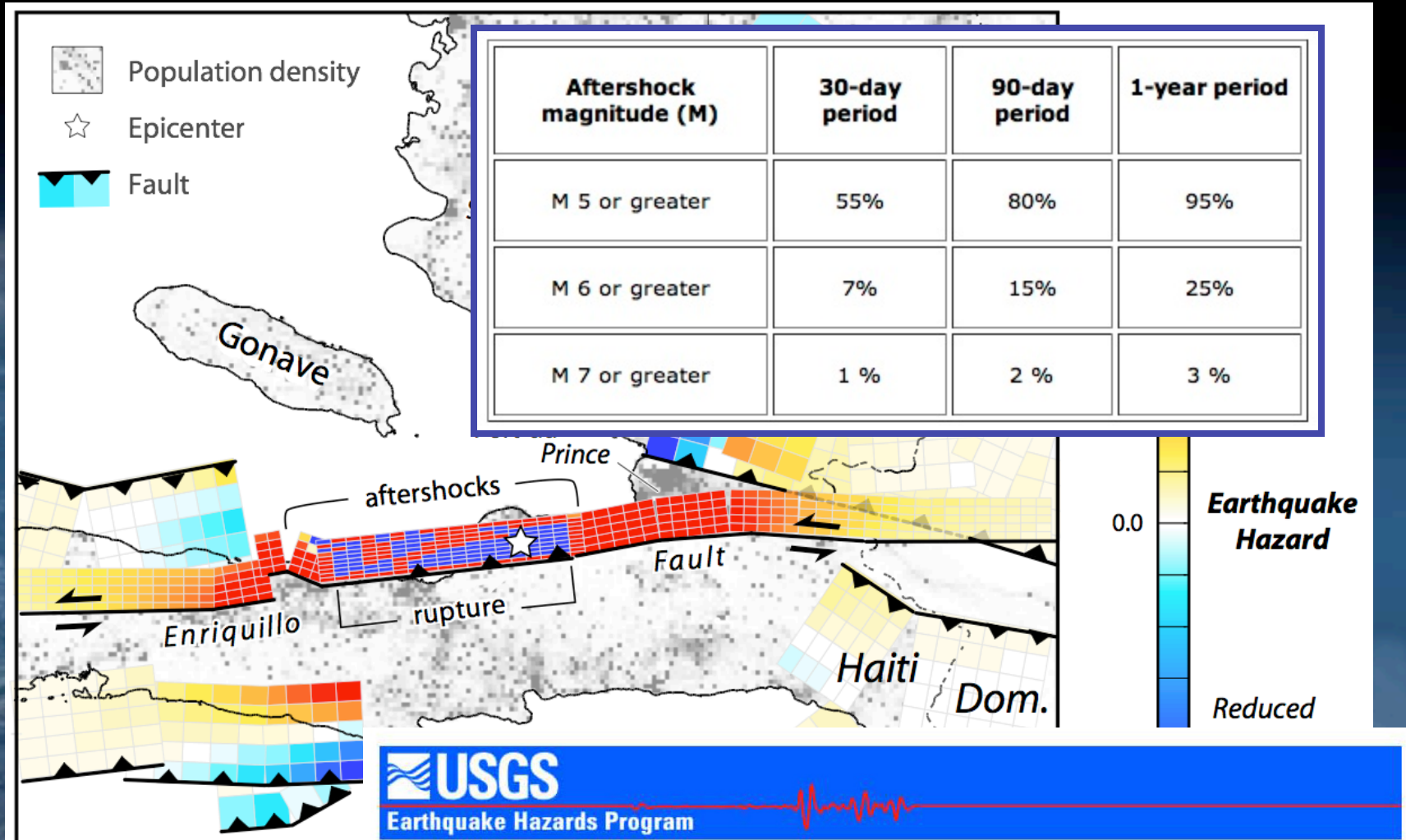


# Stress increase on Enriquillo & adjoining faults





# Stress increase on Enriquillo & adjoining faults



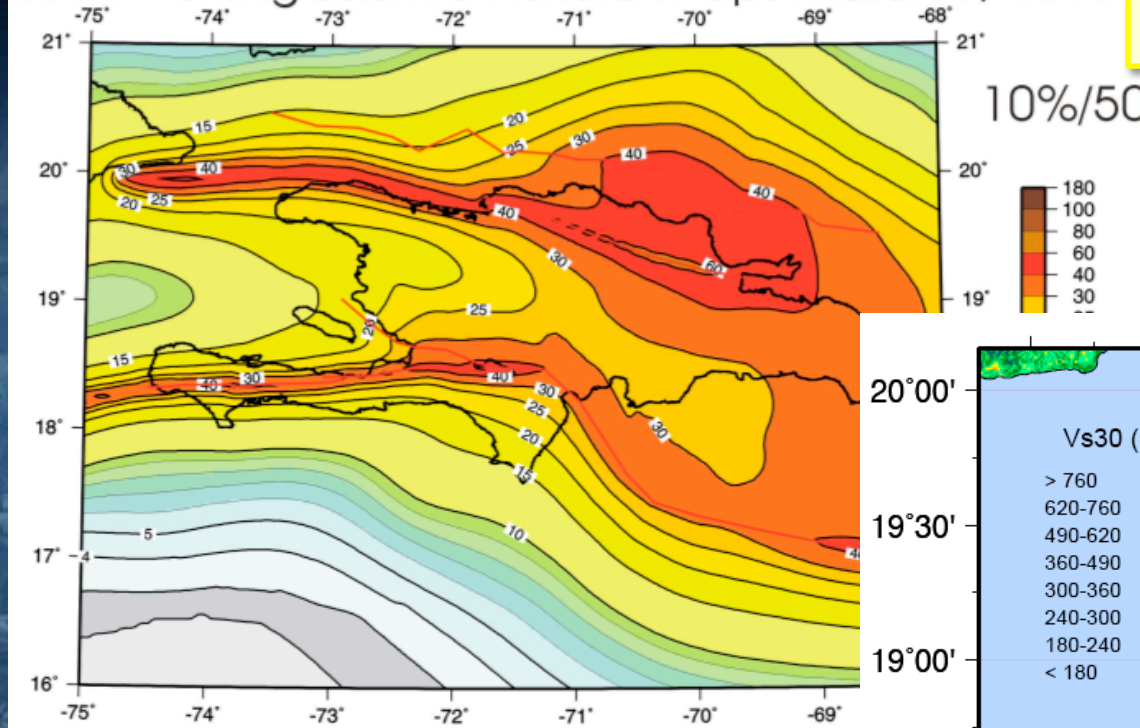
Information summary distributed in English, French, Spanish and Creole

Risk tranblemanntè ak mezu sékirité nan Péyi Dayiti ak tout zòn Karayib-la  
 Komuniké Sant enspéksyon jéolojik Étazini  
 28 janvyé 2010

Échèl Richtè, sé yon manyè pou mezuré puisans yon tranblemanntè.  
 Yon lòt mo pou di puisans yon tranblemanntè, sé mayitud.  
 Yon lòt mo pou di tranblemanntè, sé séyis, ou byen kataklis tou, ki pi jénéral.

# USGS/USAID Earthquake Disaster Assistance Team: Improved seismic hazard analysis

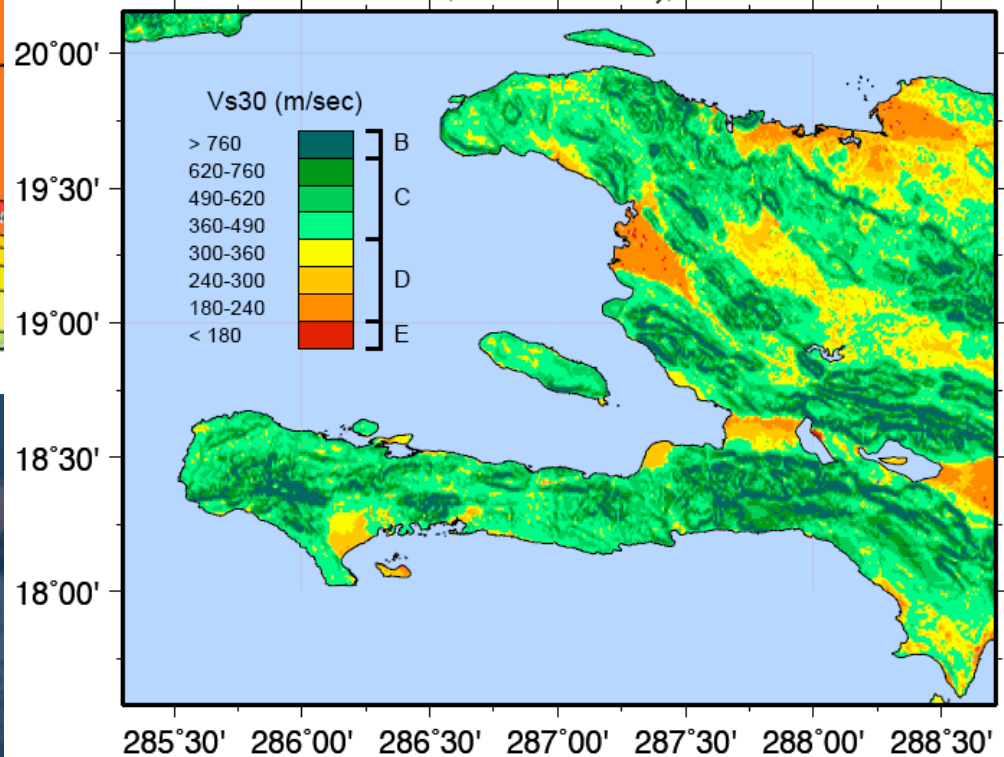
USGS working seismic hazard maps March 5, 2010



Shaking hazard

Shallow seismic wave speed

Vs30 (30-m shear velocity) m/s



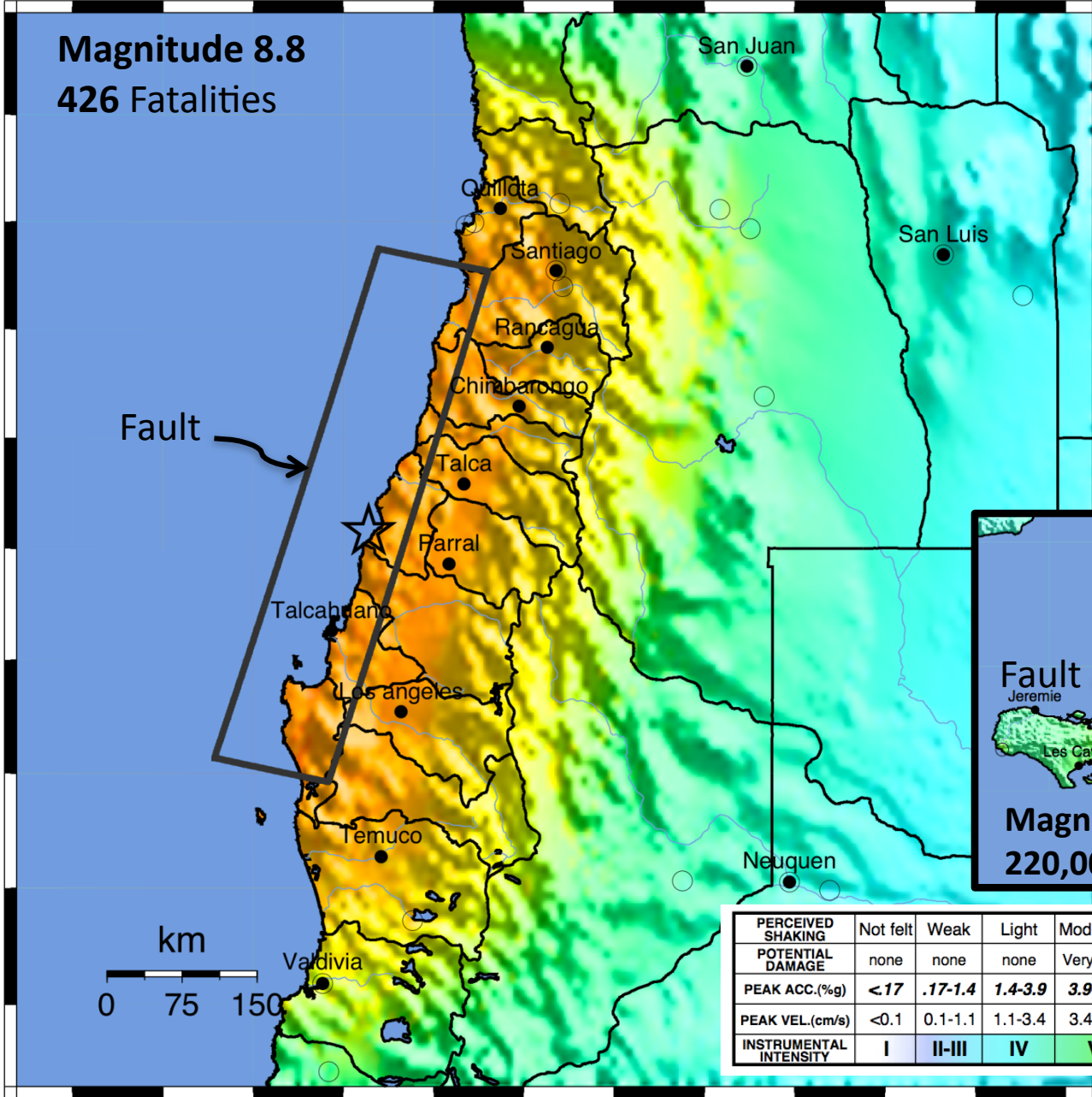


# USGS ShakeMap : OFFSHORE MAULE, CHILE

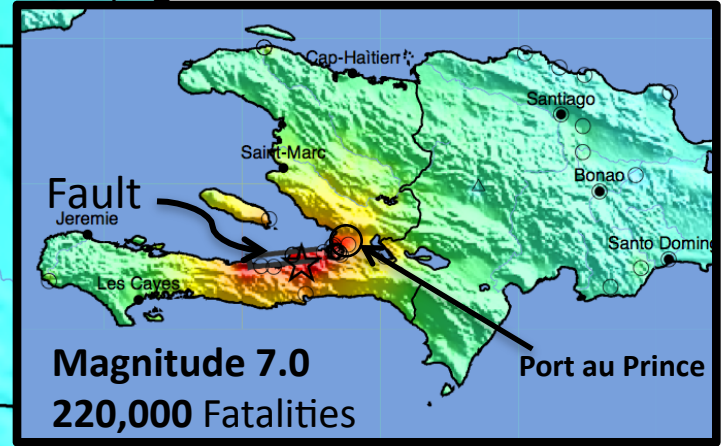
Sat Feb 27, 2010 06:34:14 GMT M 8.8 S35.85 W72.72 Depth: 35.0km ID:2010tffan

**USGS ShakeMap  
Estimated Shaking  
Intensities**

**Same Map Scale!**

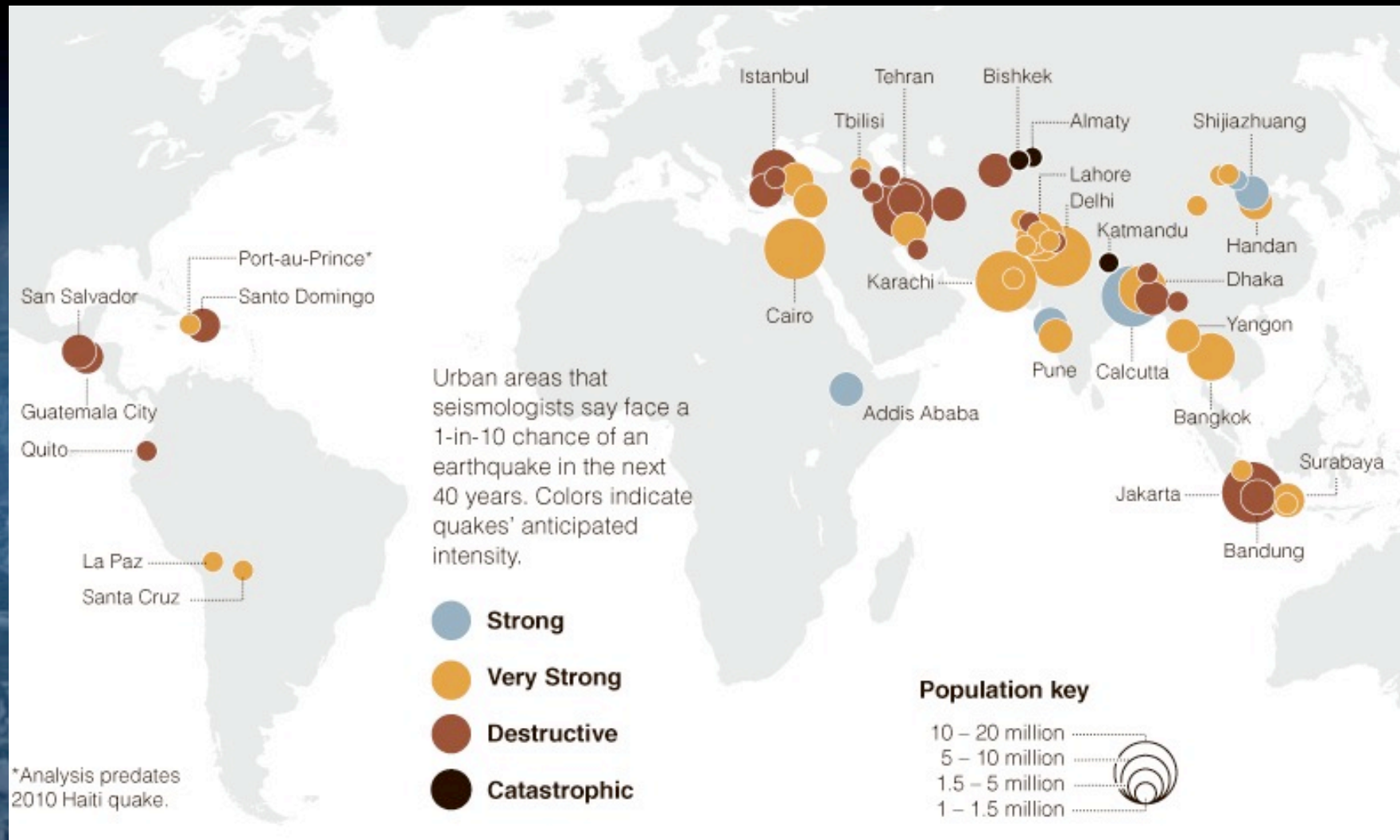


Haiti, Jan 10, 2010



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+

# Cities at risk: There will be more bulls-eyes



Graphic courtesy of *The New York Times*  
Data from Columbia University Earth Institute

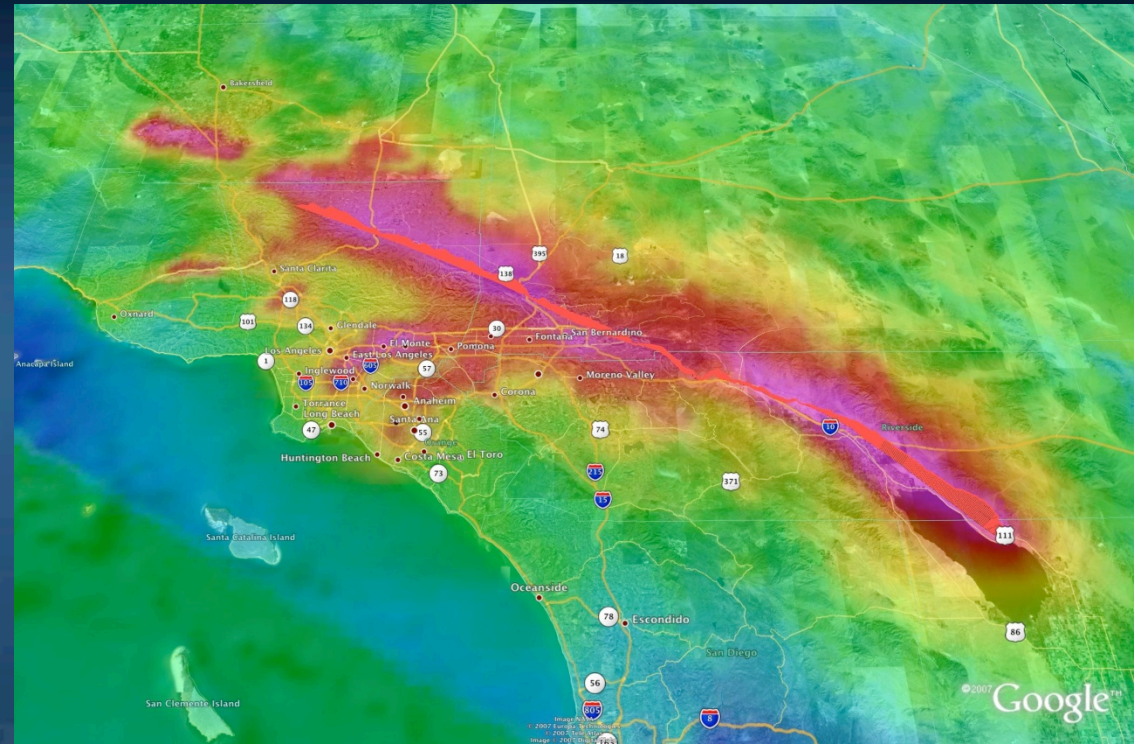


# San Andreas ShakeOut Scenario



- Top request of emergency managers
- Rallying point for community

- San Andreas 'Big One' simulated magnitude-7.8 earthquake; multi-hazard scenario
- Initiation near Bombay Beach, rupturing to the northwest
- Disruption of critical lifeline infrastructure (freeway, internet, power and gas lines) along surface rupture
- Strong shaking throughout region, including urban areas



# California-wide public preparedness drill



# The Great California Shake Out

October 15, 2009



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





# Putting Down Roots in Earthquake Country

Sur de California Edición Primavera 2006

Echando raíces en tierra de terremotos



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

General Information Product 15

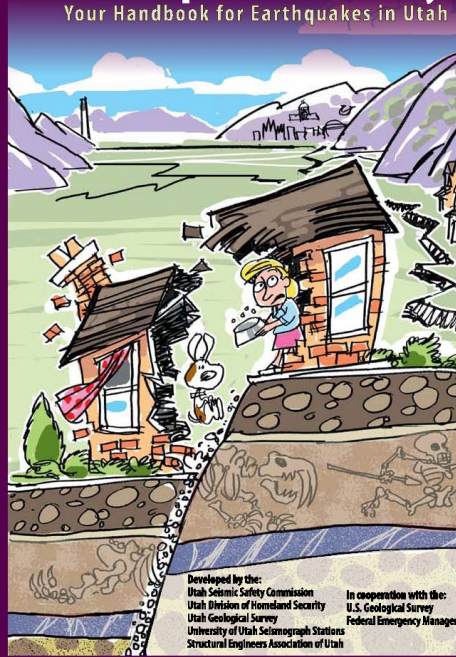
Developed by:  
 American Red Cross, Bay Area Chapter  
 Association of Bay Area Governments  
 California Earthquake Authority  
 California Geological Survey  
 Earthquake Engineering Research Institute  
 Governor's Office of Emergency Services  
 San Francisco Office of Emergency Services and Homeland 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

Desarrollado por:  
  
 an NSF-USGS center ... y muchas otras organizaciones



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

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



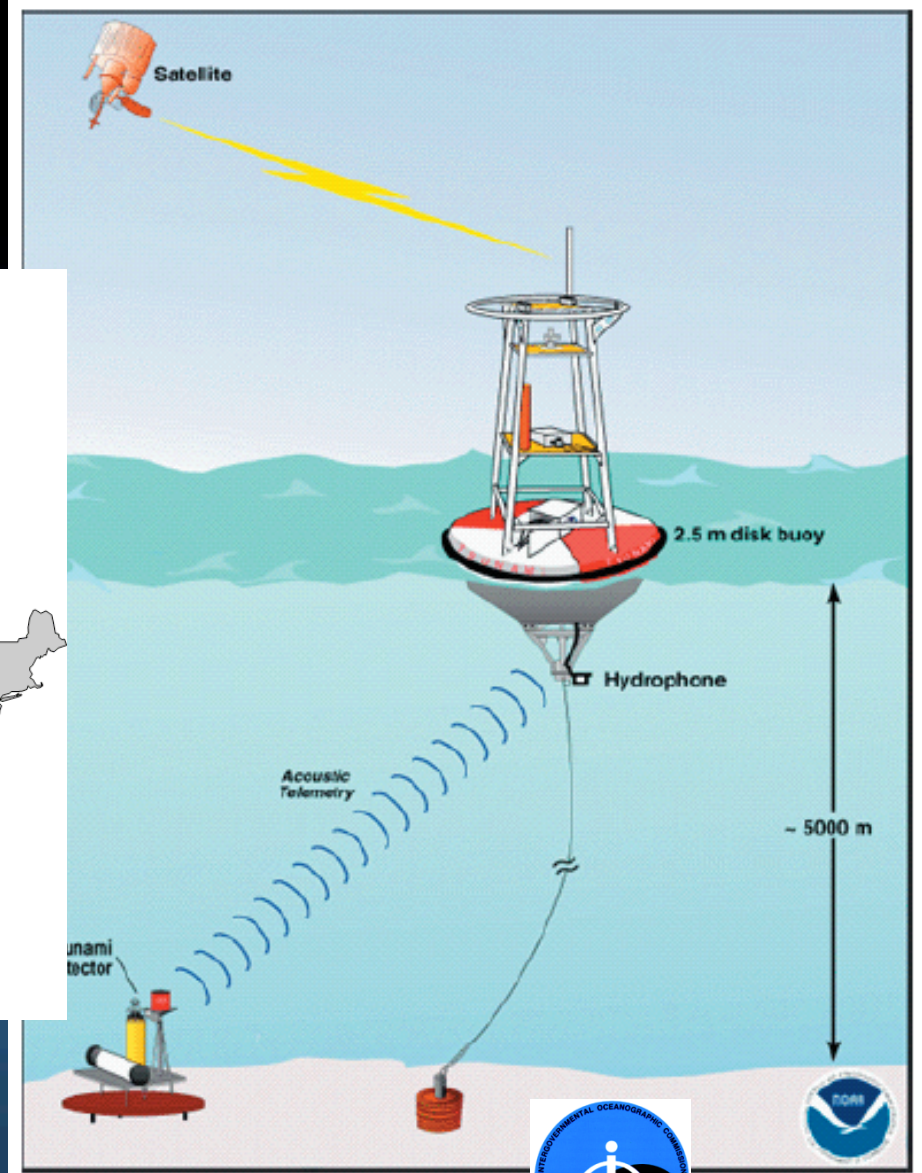
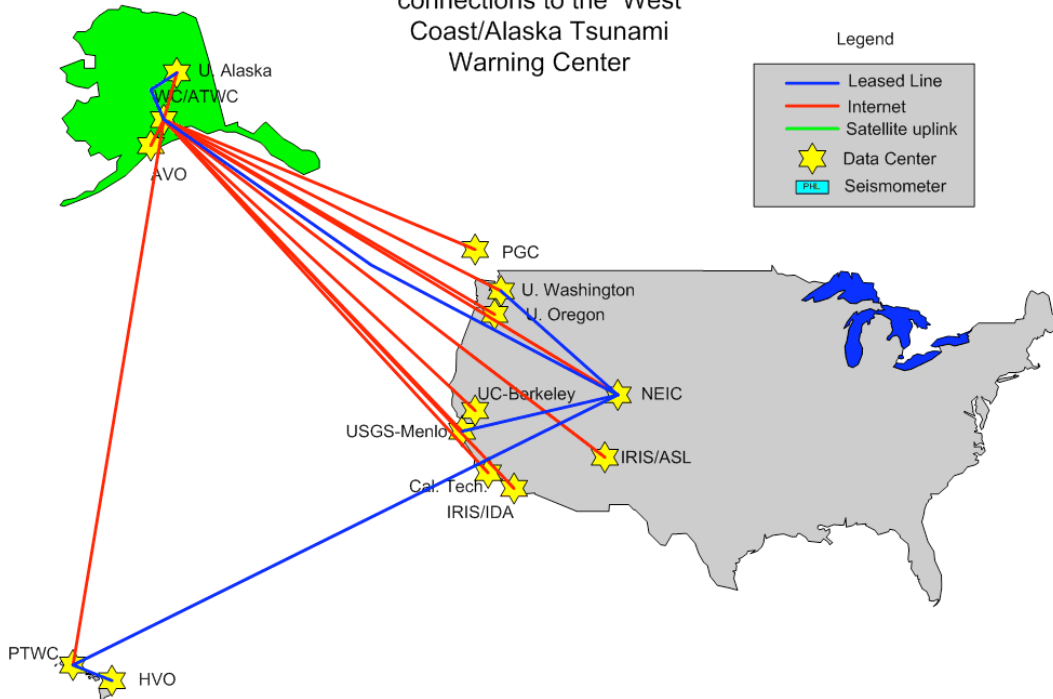
Developed by the:  
 Utah Seismic Safety Commission  
 Utah Division of Homeland Security  
 Utah Geological Survey  
 University of Utah Seismograph Stations  
 Structural Engineers Association of Utah  
 In cooperation with the:  
 U.S. Geological Survey  
 Federal Emergency Management Agency

**Putting Down Roots for the Central US**  
(coming soon)



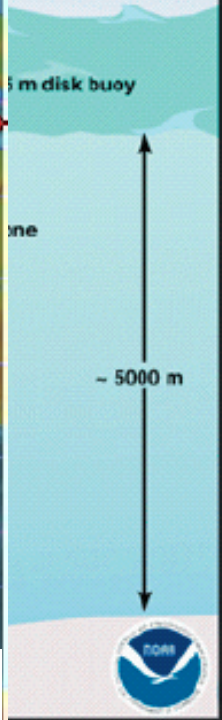
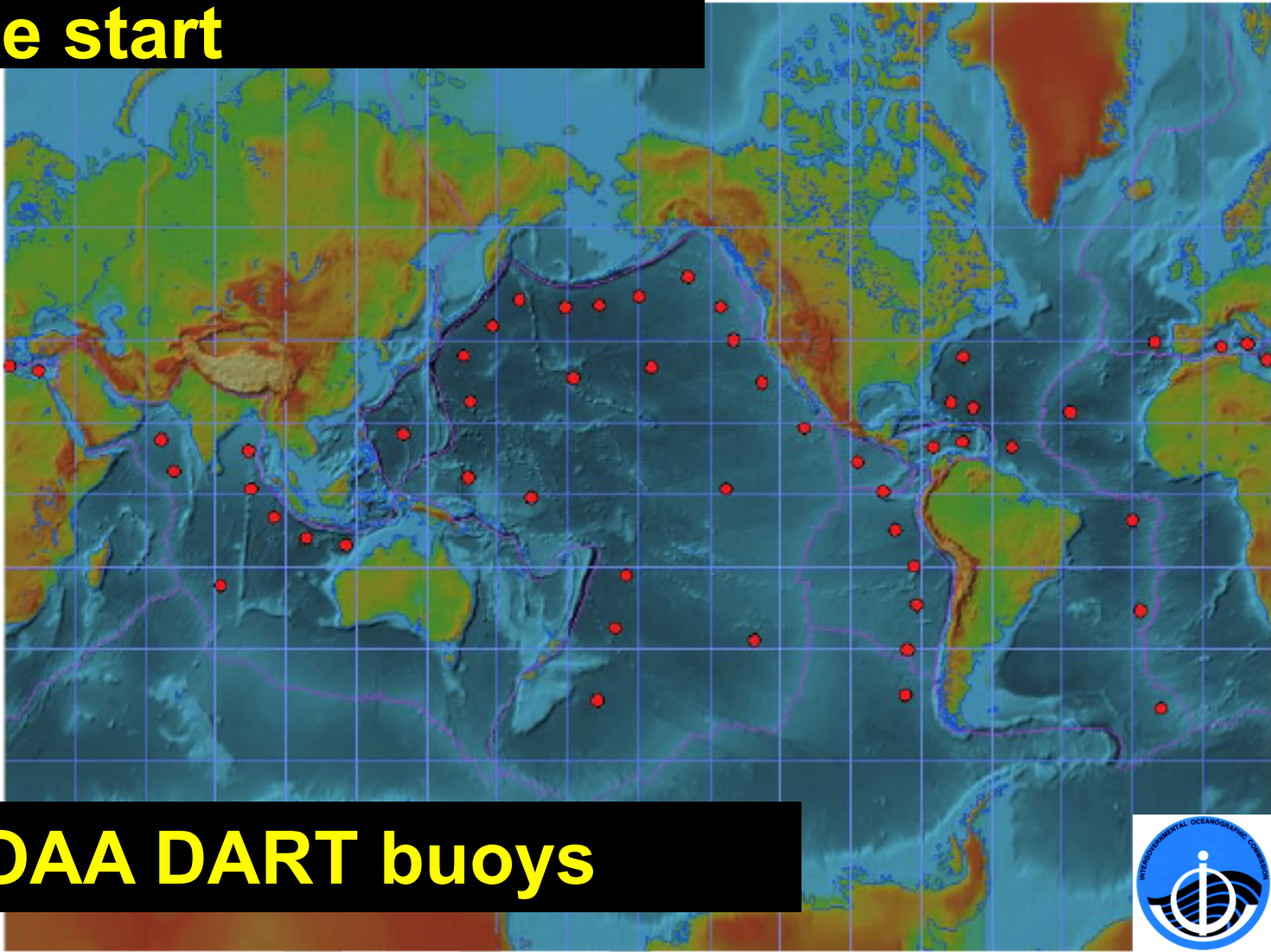
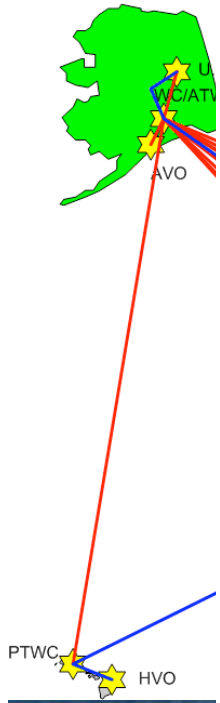
# For tsunamis, seismic is the start

Seismic Data Centers with connections to the West Coast/Alaska Tsunami Warning Center





**For tsunamis, seismic is the start**

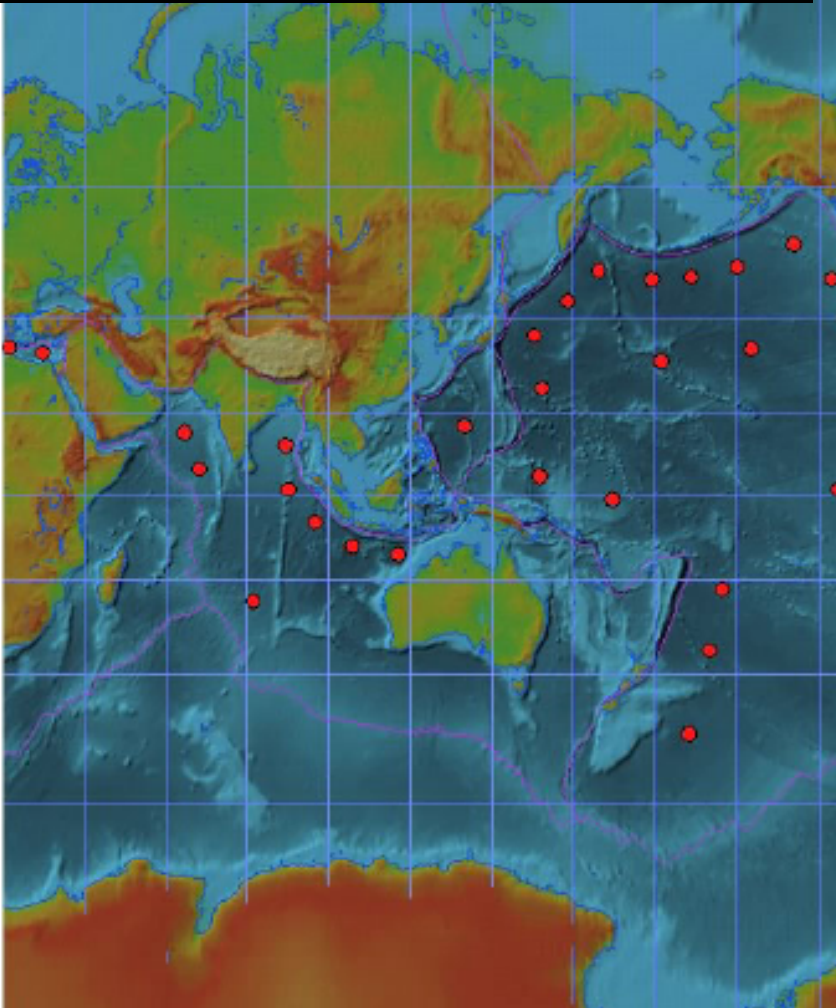
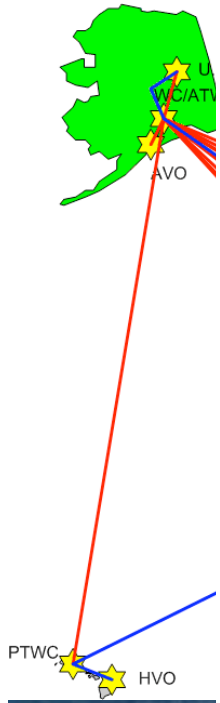


**NOAA DART buoys**





**For tsunamis, seismic is the start**



**The beach is the finish**



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

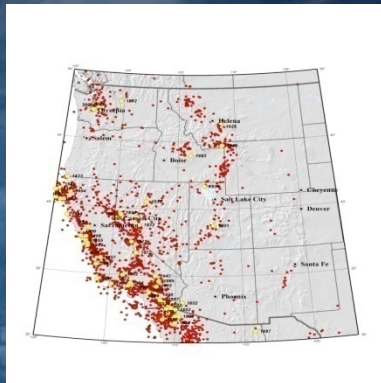


Credit: Washington Emergency Management



# National seismic hazard assessment inputs

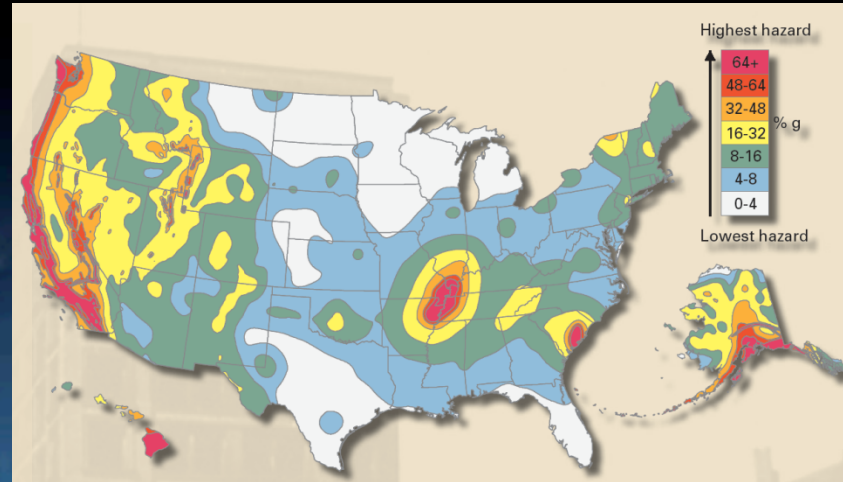
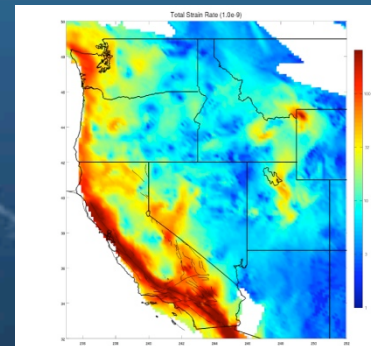
## Seismicity



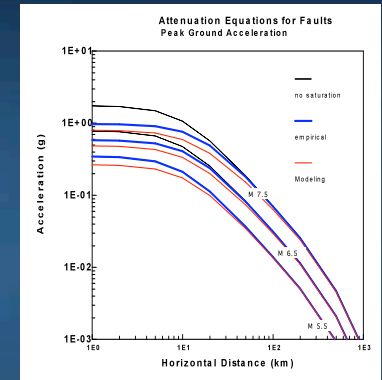
## Quaternary Faults



## Geodetics



## Attenuation Relations



Inputs are derived from regional geology, seismology, and crustal structure studies





For more information on recent earthquakes,  
earthquake hazards,  
and USGS earthquake monitoring,  
research and hazards assessments, see:

[\*http://earthquake.usgs.gov\*](http://earthquake.usgs.gov)

 USGS

