

# USGS Update

## Advisory Committee for Earthquake Hazard Reduction

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## High visibility for earthquake science

- Wenchuan, China, 2008
- Haiti, Jan. 2010
- Maule, Chile, Feb. 2010
- Baja Calif., Apr. 2010
- Christchurch, Feb. 2011
- Tohoku, Japan, 2011
- Mineral, Virginia, 2011



Christchurch (Reuters)

and several smaller but significant induced earthquakes!

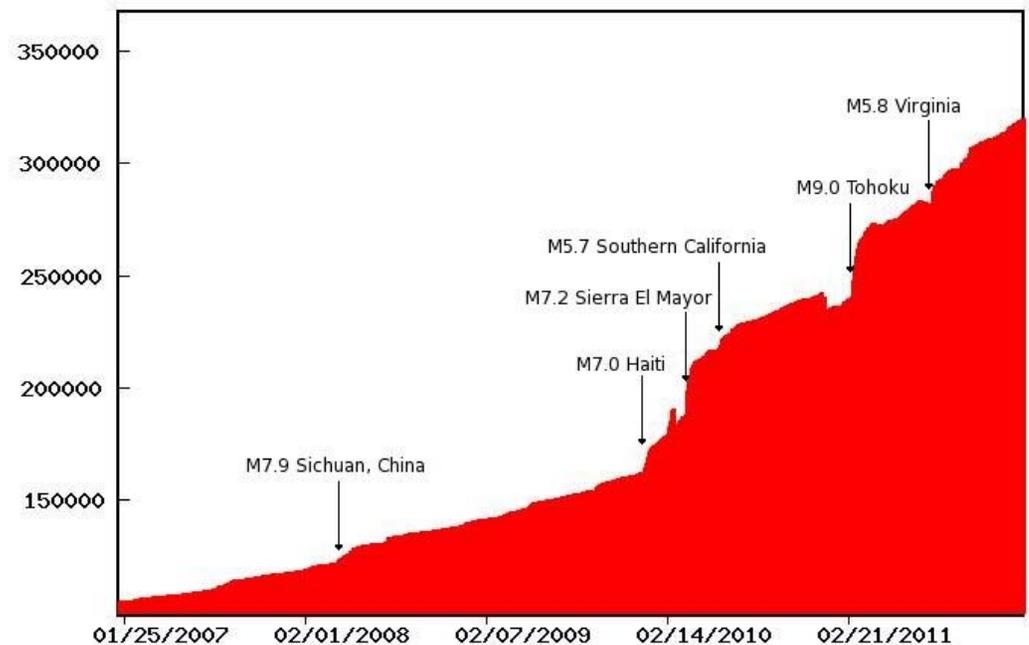
# Very High Public Exposure

- More than 500 million EHP web pages delivered by USGS in each of the past two years
- Growth of earthquake (ENS) notification subscriptions to over 350,000 and counting
- Congressional hearings and special events on tsunami, induced earthquakes, quake warning systems
- Presidential and National Level earthquake response exercises



ENS Subscriber Growth to Date

■ accounts





## SHAKEOUT REGIONS AND CURRENT REGISTRATION LEVELS

Great ShakeOut earthquake drills help people in homes, schools, and workplaces, and provide an opportunity for everyone to improve their own safety and that of your family, your co-workers and millions of others who will be affected by the next earthquake in your region! As of today, there are over 13.2 million people registered for the 2012, including over 8.7 million people, on October 18th.

To register or learn more, click a ShakeOut region map or click here.



**CALIFORNIA**

**10/18/2012**

As of today: 7.3 million  
(2011: 8.6 million)



**NEVADA**

**10/18/2012**

As of today: 130,000  
(2011: Over 190,000)



**SOUTHEAST**

**10/18/2012**

As of today: 390,000  
(First year)



**GUAM**

**10/18/2012**

As of today: 15,000  
(2011: Over 58,000)



# 2013 Research & Development Efforts

- National Seismic Hazard Maps
  - Incorporation of California dynamic earthquake probabilities (UCERF-3) and geodetic strain data
- Earthquake Early Warning Prototype
- Induced Seismicity Research
  - Part of broader USGS-DOE-EPA hydrofracturing initiative
- Eastern U.S. earthquake research (unfunded)
- Aftershock Probability Forecasts (OEF)

# NEO Assessments Results for USGS

## Natural Hazards Mission Area

*OSTP National  
Earth  
Observation  
System  
Assessment  
2012*

Thousands of Earth observing systems and activities were reviewed by “subject matter experts” from federal agencies

Major USGS systems ranked highly in the NEO impact assessment, both for the Disasters and the Space Weather Societal Benefit Areas

The ANSS Ranked 37<sup>th</sup> and in the top 100 systems having the highest impact across all benefit areas.

The Global Seismographic Network ranked as the highest impact system in the “solid earth” portion of the Disasters SBA

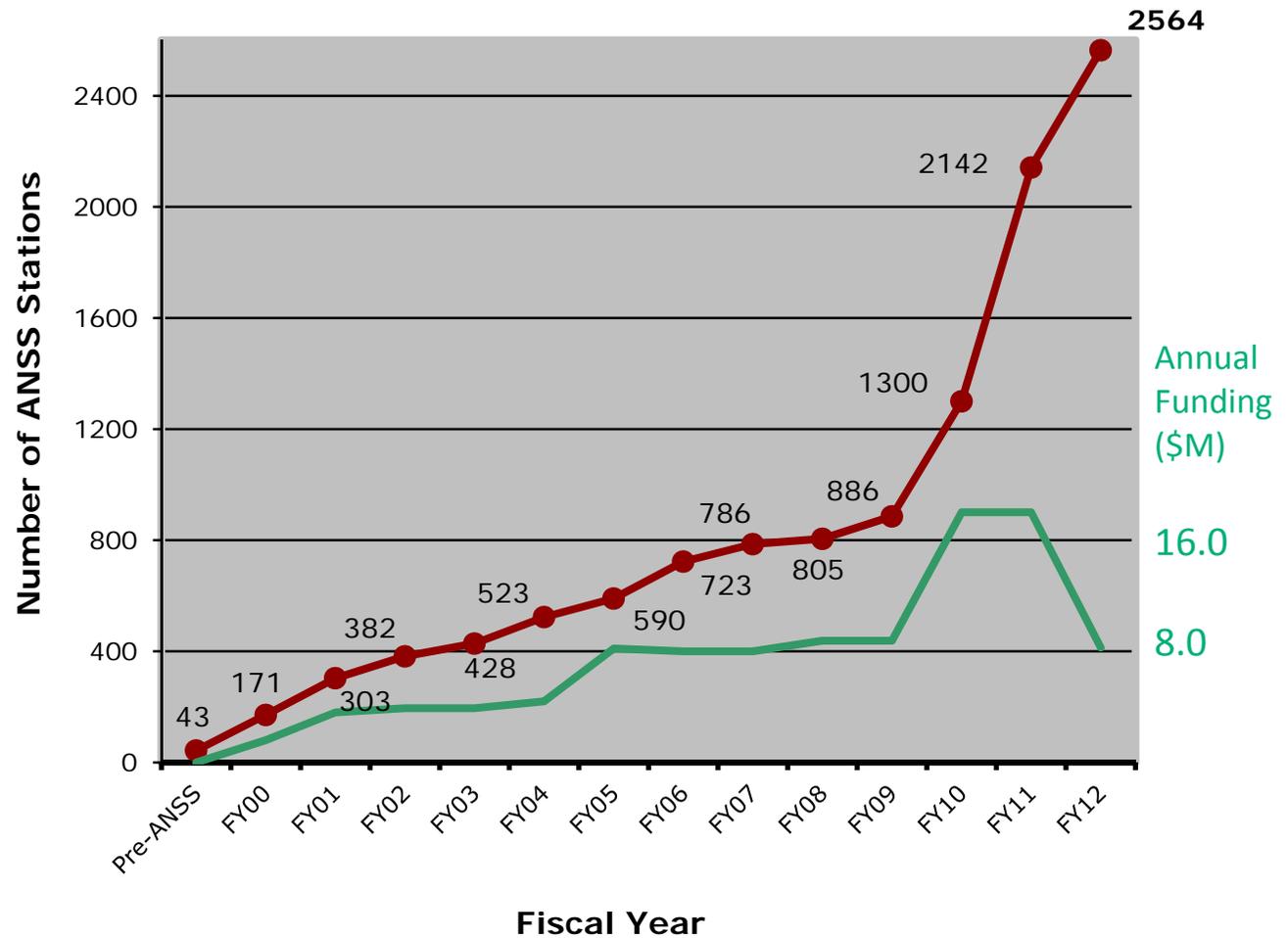
The USGS Geomagnetic Observatory network ranked second in impact, among dozens of space weather observation systems

The highest impact system, by far, was GPS



# ANSS Update

## Growth of ANSS Stations Since Inception



# ANSS – Recent Developments

- Increasing subscribers and usage
- New Product: TED – Tweet Earthquake Dispatch
  - Test Service: TEDEct (Twitter monitor)
- High interest in earthquake early warning
- Redesigned Web Pages, Catalog server
- New Mobile Earthquake Information App.
- Building Instrumentation
  - Expanded VA hospital instrumentation
  - One Rincon Tower cooperation

# Tweet Earthquake Dispatch and Twitter Event Detections

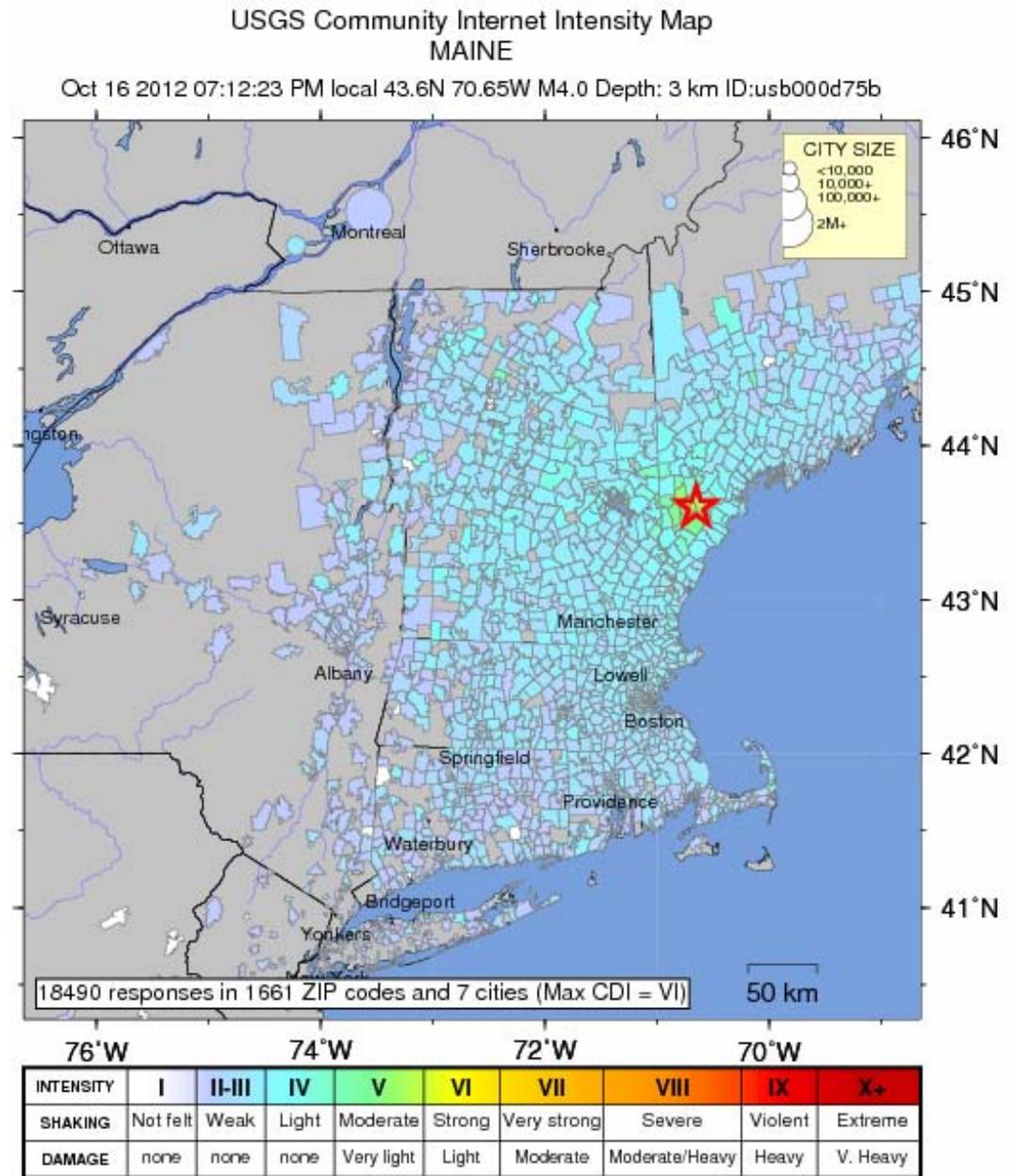
- @USGSted distributes alerts for quakes with magnitudes of  $\geq 5.5$
- Tweets contain a size estimate, location, origin time, and link to the event webpage.
- They also include the frequency of tweets in a region surrounding the event that contain the word “earthquake” or its equivalent in several languages.
- NEIC analysts also get an early indication of a significant quake –often before the system locates it!



A screenshot of a Twitter feed from the account @USGSted. The header shows the USGS logo and the name 'USGSted' twice. The feed contains four tweets, each reporting an earthquake event with details such as location, time, and tweet frequency. The tweets are: 1) 'USGSted Powerful earthquake, KURIL ISLANDS, Sep-9 05:39 UTC, 0 #quake tweets/min, on.doi.gov/OiPXTO' (8 hours ago); 2) 'USGSted Strong earthquake, COSTA RICA, Sep-8 20:29 UTC, 13 #temblor tweets/min, on.doi.gov/Ni3nyd' (17 hours ago); 3) 'USGSted Powerful earthquake, PAPUA, INDONESIA, Sep-8 10:51 UTC, 1 #gempa tweets/min, on.doi.gov/OhpFRU' (yesterday); 4) 'USGSted Strong earthquake, MARIANA ISLANDS REGION, Sep-8 06:54 UTC, 0 #quake tweets/min, on.doi.gov/NhcvXC'. At the bottom of the screenshot is a green bar with the Twitter logo and the text 'Join the conversation'.

# Recent Earthquake Response: Maine M4.0 Oct 16, 2012

- 40 sec. – TEdect alert
- 3 mins. – initial solution
- 10 min. – reviewed solution
- 11 min. – ShakeMap
- 12 min. – PAGER “Green”  
impact assessment



Processed: Sun Oct 28 18:48:21 2012





# CISN Earthquake Early Warning ShakeAlert

Status today:

Demonstration system

Next three years:

Demonstration → Prototype

Made possible thanks to a public-private-foundation partnerships



Receiving alerts today:

- 50 research scientists
- Google.org
- BART
- Metrolink
- Amgen
- SoCal Edison
- CalEMA
- SF DEM
- L.A. City
- L.A. County
- UC Berkeley OEP
- *more...*



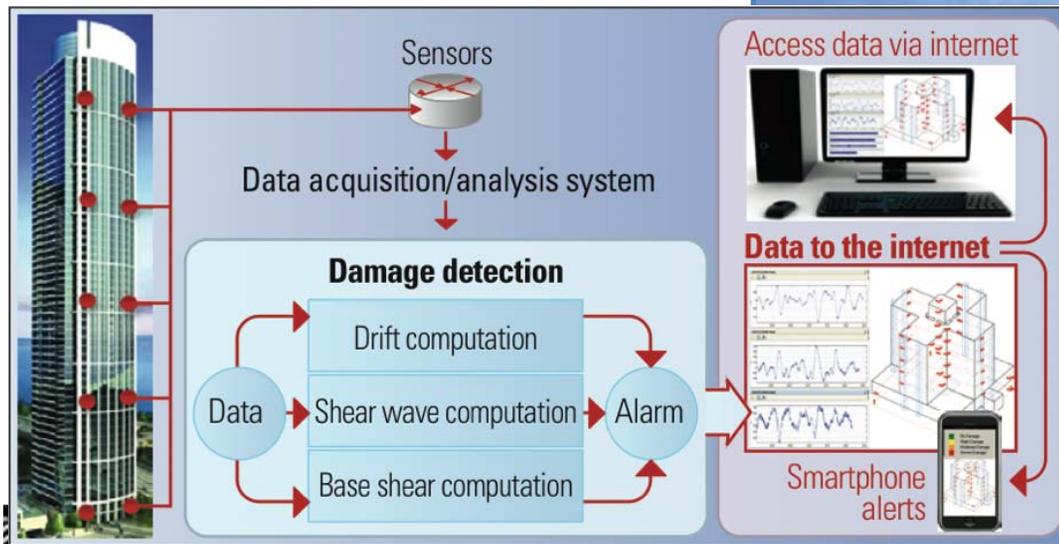
# One Rincon Tower – A Joint USGS-CGS Structure Instrumentation Project

64 stories – 641 ft.

Concrete core construction

72 channels of real-time strong  
motion

Automated damage detection  
analysis





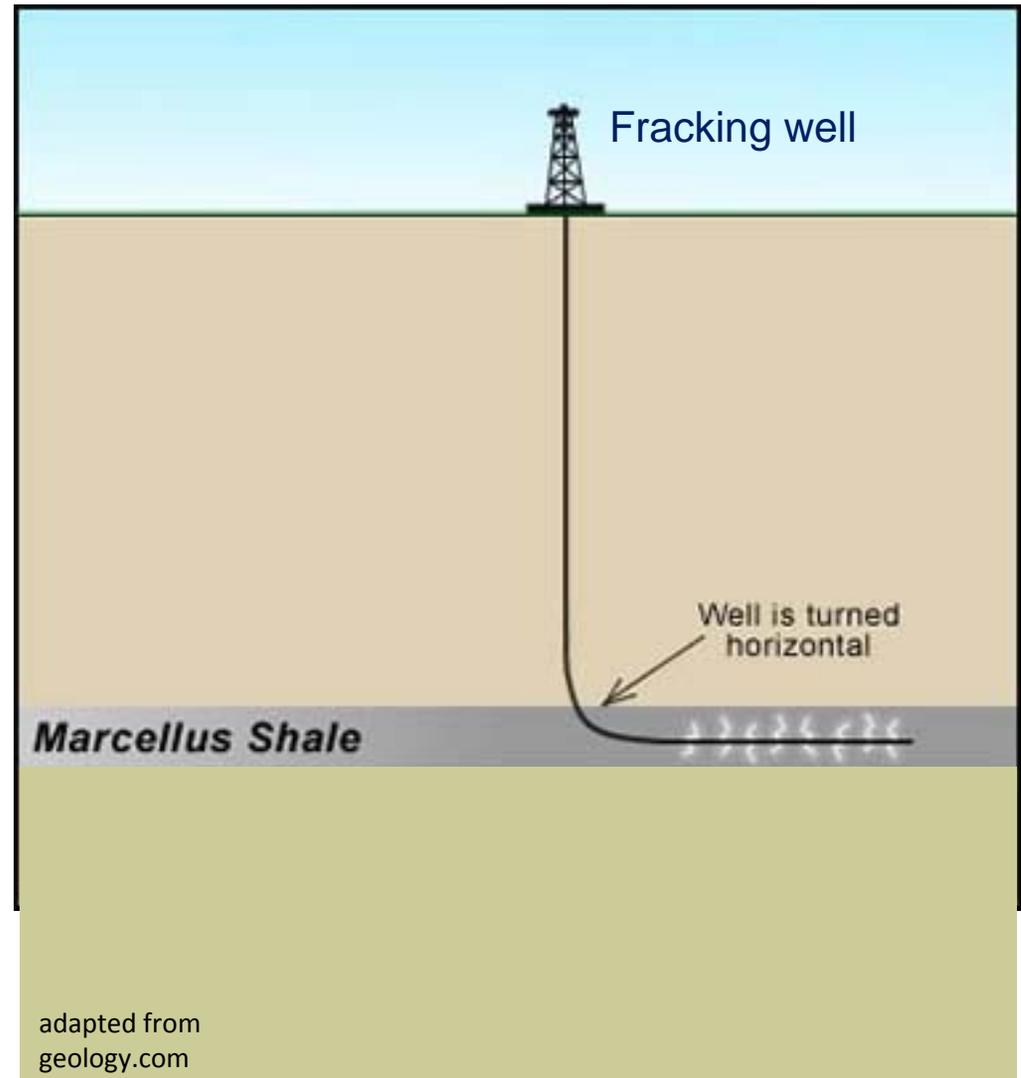
# USGS Induced Seismicity Project

- Statistical analyses of induced seismicity – Leader: Justin Rubinstein
- Hydrologic/geomechanical model studies – Leader: Steve Hickman
- Hazard and risk from induced earthquakes – Leader: Tom Hanks
- Geophysical framework of induced earthquake sites – Leader: Walter Mooney



# Hydrofracking and Induced Seismicity

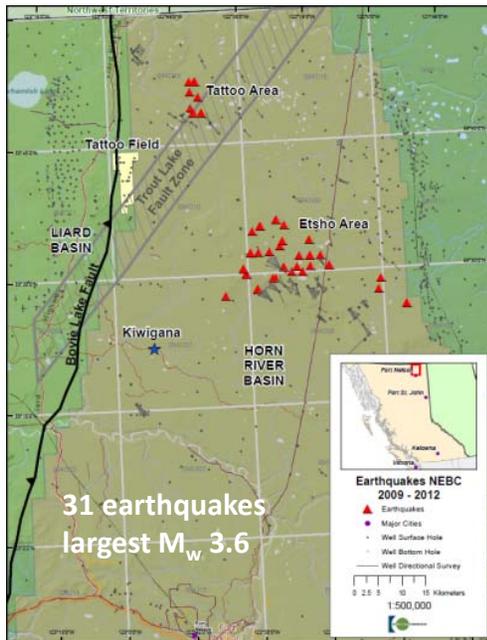
- Below a few kilometers depth, the Earth's crust is everywhere stressed.
- The Earth's crust is full of faults, both old and new.
- The fracking itself typically releases very little seismic energy.
- But, in many cases, the gas production comes with large volumes of formation water (brine), which must be treated or disposed of responsibly.



# Earthquakes and Fracking

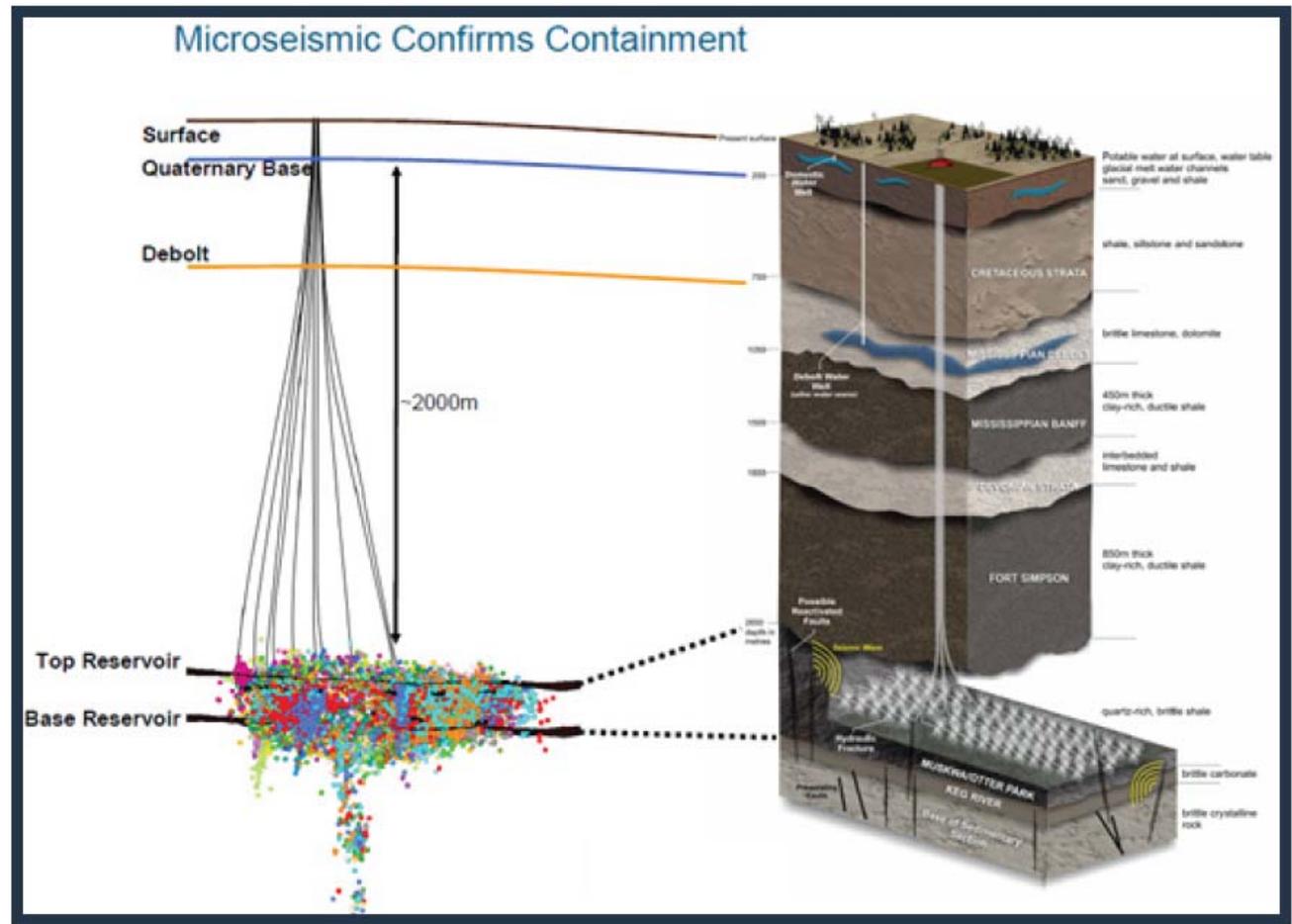
## Investigation of Observed Seismicity in the Horn River Basin

BC Oil and Gas Commission - August 2012



“The seismicity observed and reported by NRCan in the Horn River Basin between April 2009 and December 2011 was induced by fault movement resulting from injection of fluids during hydraulic fracturing.”

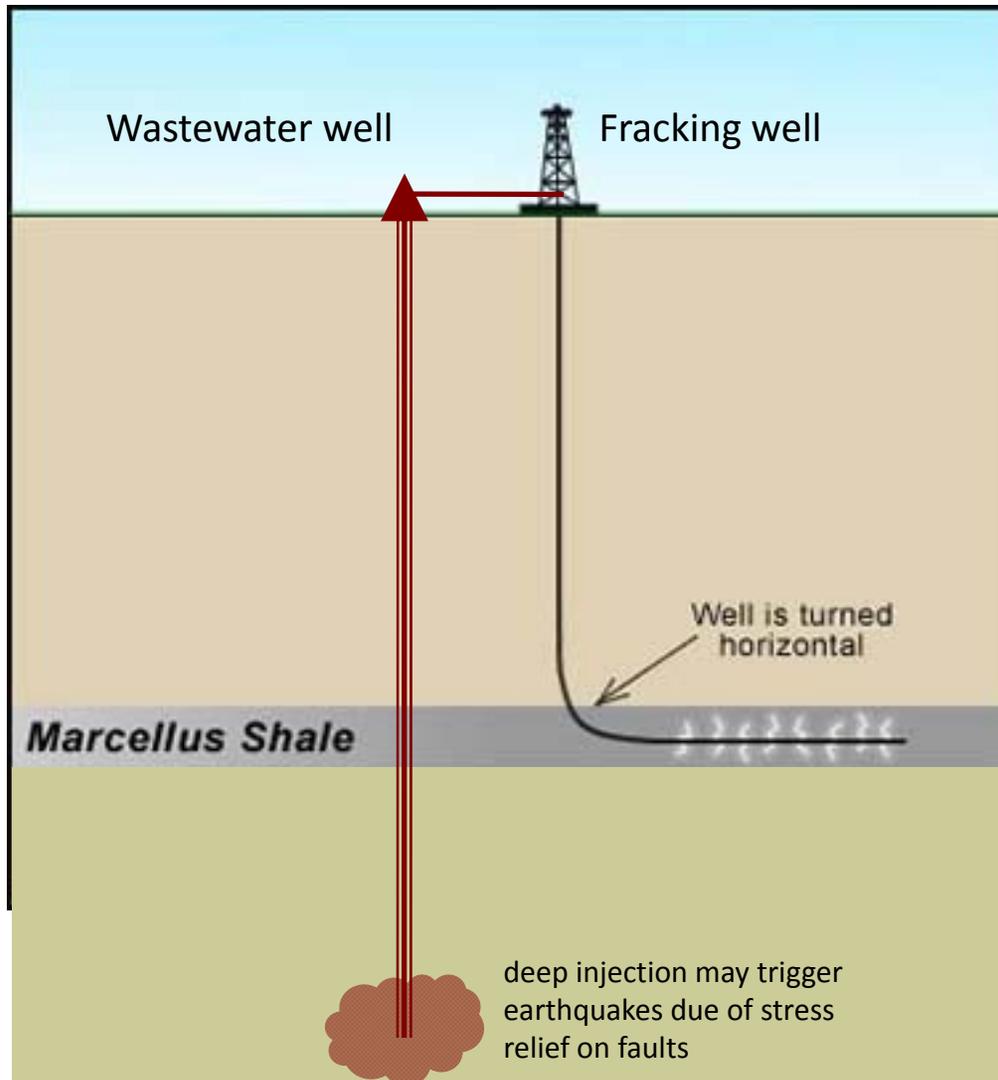
Figure 8: Cumulative microseismic plot for Kiwigana, coloured dots indicate contained micro-seismicity events caused by tensile and shear failure of intact shale. Trail of coloured dots suggest reopening or movement of pre-existing fault. Generalized stratigraphic column to right.



A by-product of the fracking operation is “produced water” (natural brine and fracking flowback).



# Disposal of Fluids from Fracking



Wastewater (brine) injection depths are usually deep, in rocks naturally stressed with faults capable of generating earthquakes



adapted from  
geology.com

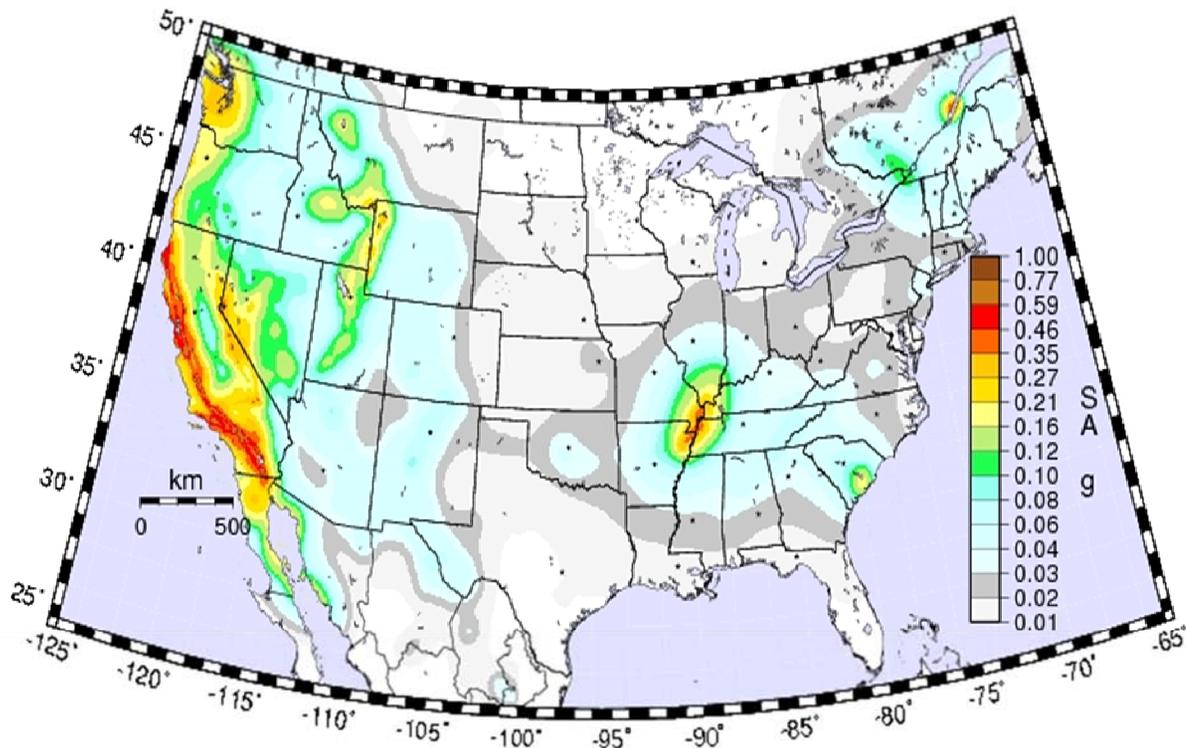
# Recent USGS Activities

- Interagency Agreement with the EPA – reported results of three studies concerning earthquake risk due to injection of wastewater at depth. Special focus in the Raton Basin of S. Colorado
- Mid-continent seismicity increase, starting in 2001, caused mostly by deep injection of wastewater from oil and gas production
- Paradox Valley (CO) brine disposal (BLM monitoring)
- Monitoring at sites of induced quakes in Arkansas, Colorado, Ohio
- Desert Peak (NV) EGS project – injected water to establish hydraulic connection from injection well to production well

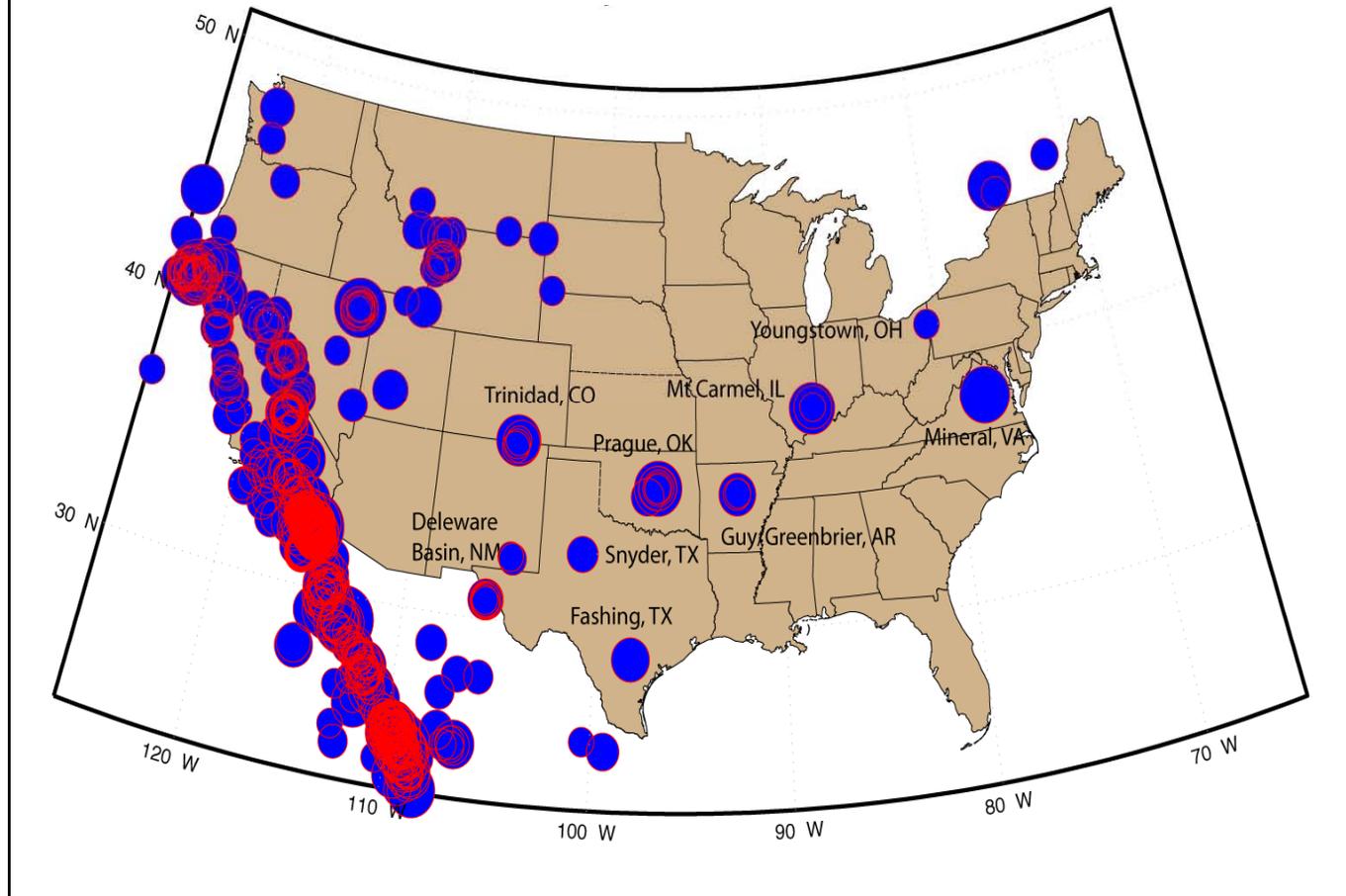
# How do induced earthquakes affect hazard maps, and therefore building codes?

## USGS National Seismic Hazard Map

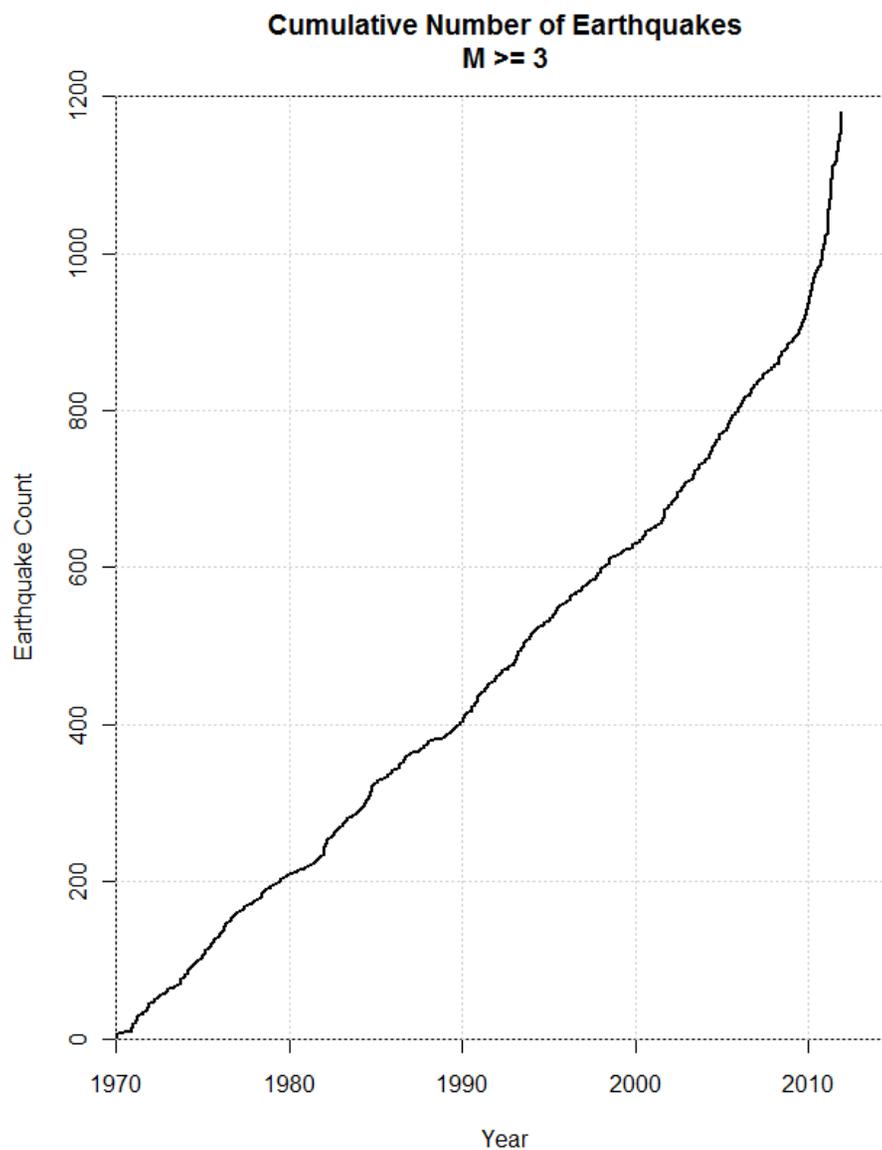
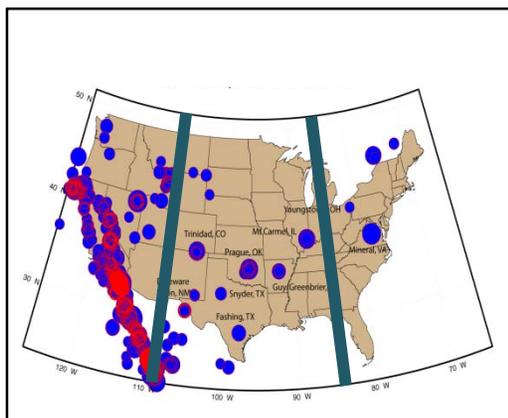
Peak Acceleration with 10% Chance of Exceedance in 50 years



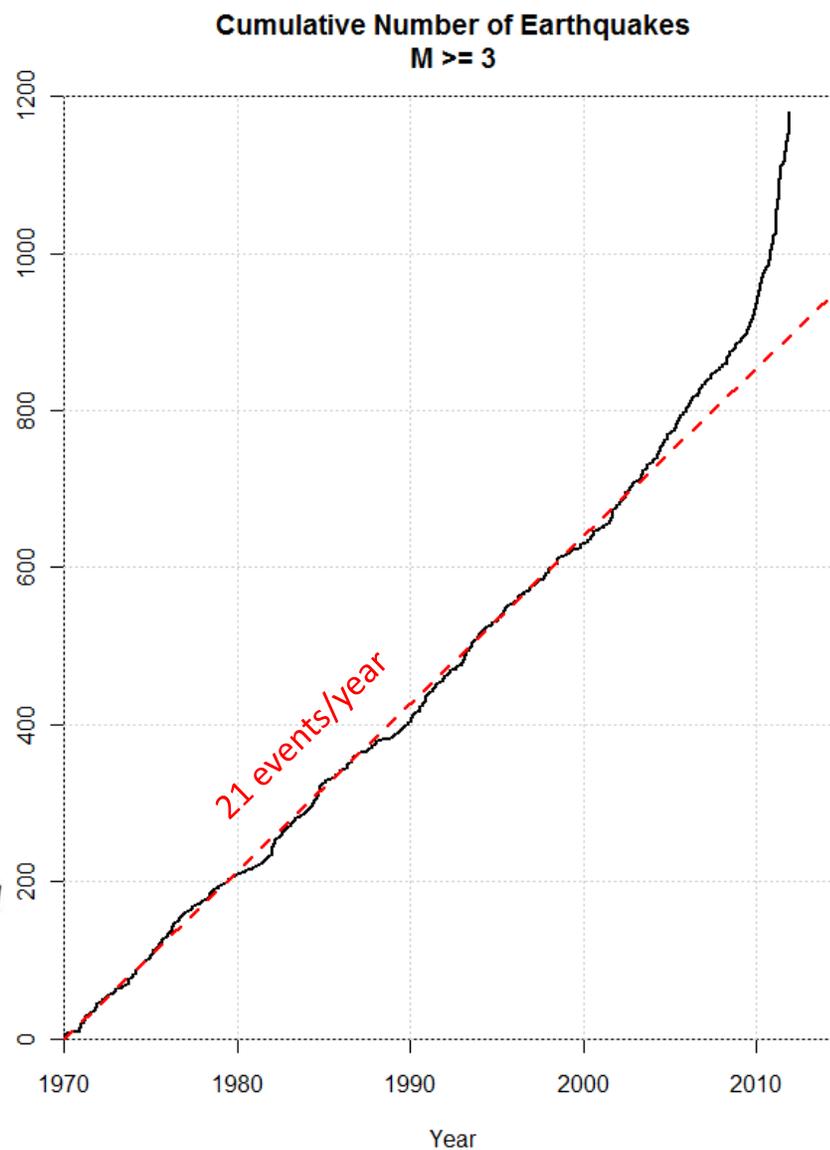
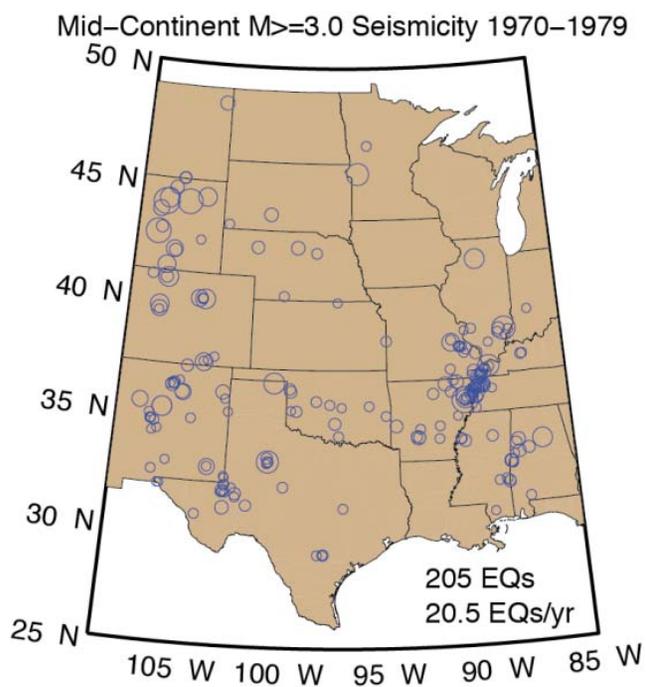
# Magnitude 4 and Larger Earthquakes 2008 - 2011



# Rate of Earthquakes in the Midcontinent



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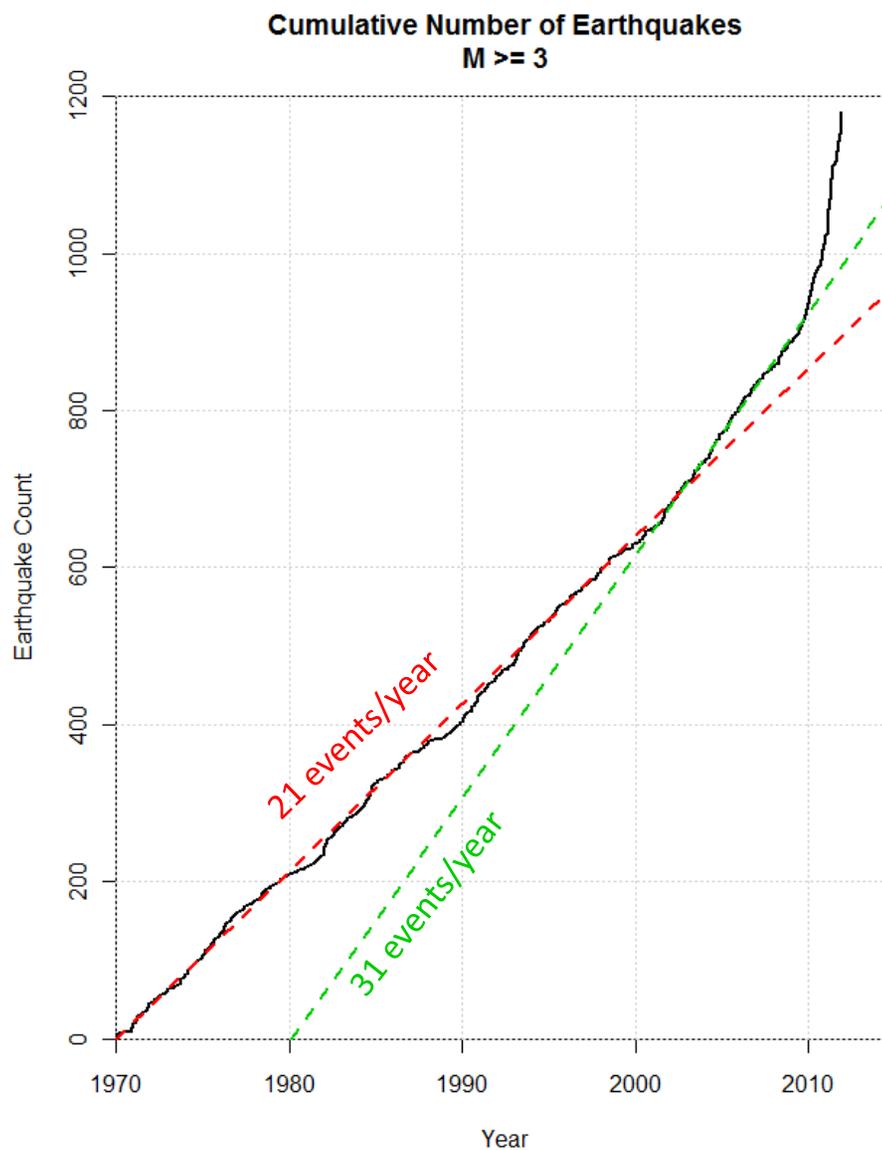
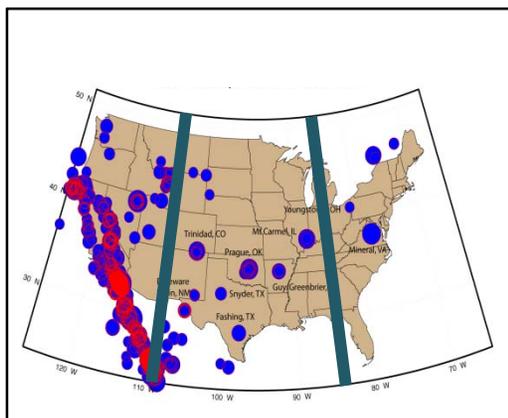


# Tectonic or Induced?

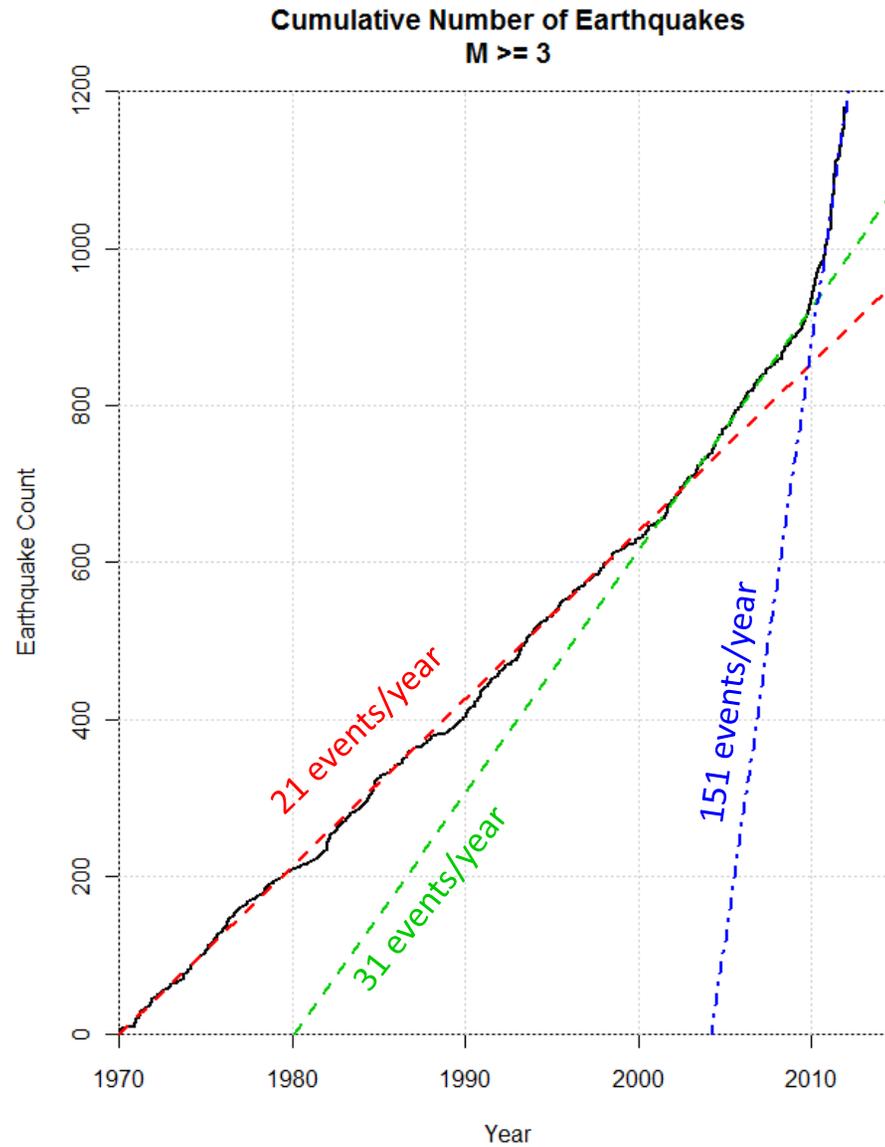
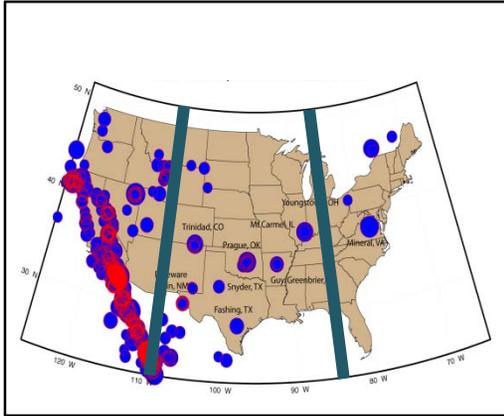
Eleven recent earthquakes of public concern

<u>Date</u>	<u>Location</u>	<u>M<sub>w</sub></u>
<del>8/23/2011</del>	<del>Mineral, VA</del>	<del>5.8</del>
11/6/2011	Prague, OK	5.6
<del>8/26/2012</del>	<del>Brawley, CA</del>	<del>5.5</del>
8/23/2011	Trinidad, CO	5.3
10/20/2011	Fashing, TX	4.8
5/17/2012	Timpson, TX	4.8
2/27/2011	Guy, AR	4.7
9/11/2011	Cogdell, TX	4.3
12/31/2011	Youngstown, OH	4.0
5/19/2011	Horn River Basin, BC	3.6
6/24/2012	Cleburne, TX	3.5
...		

# Rate of Earthquakes in the Midcontinent



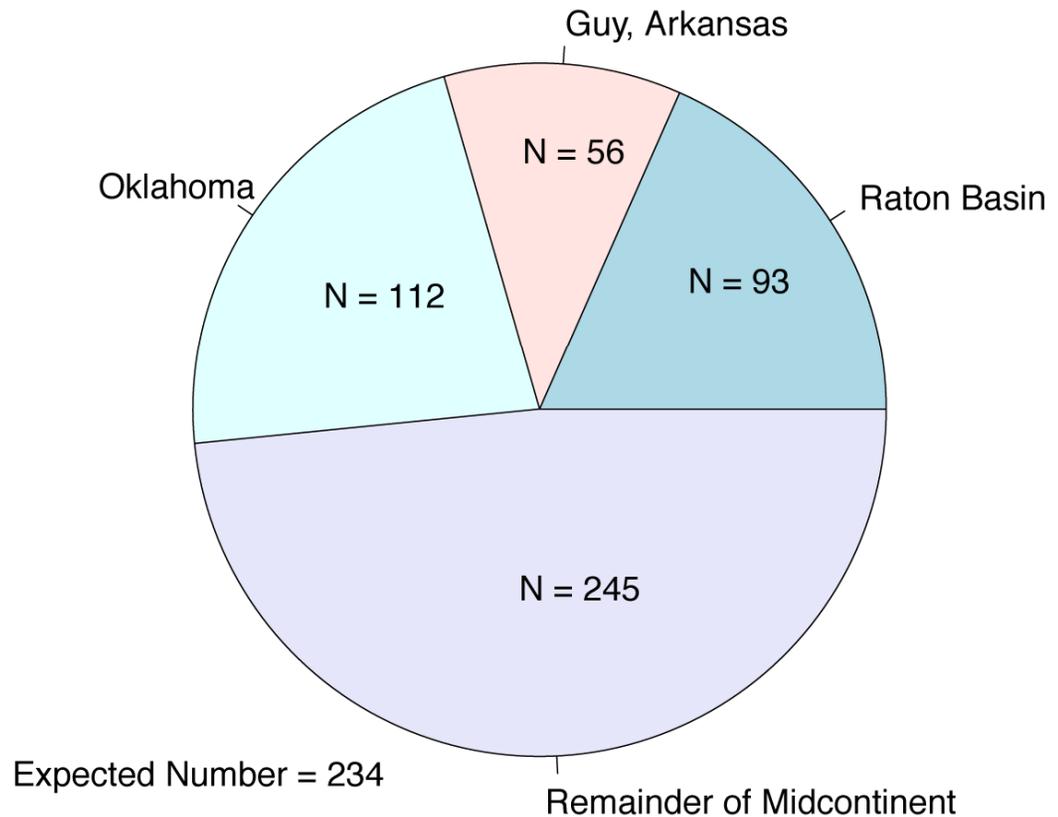
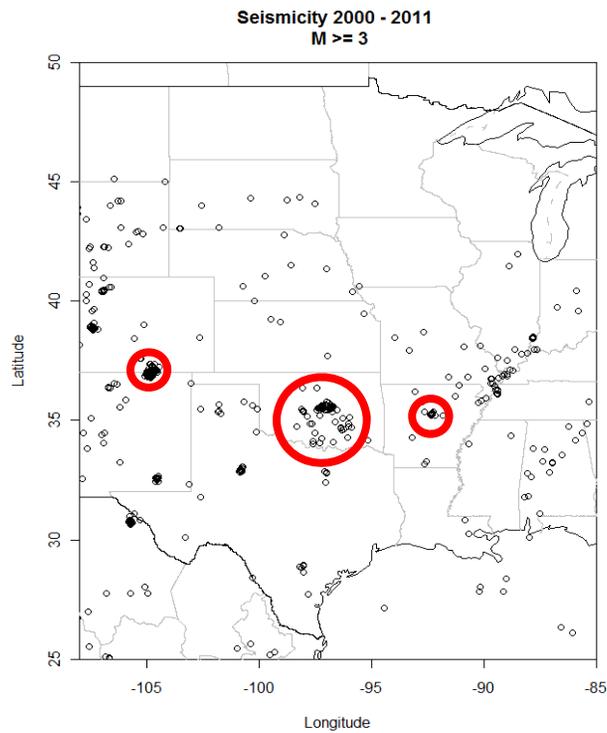
# Rate of Earthquakes in the Midcontinent



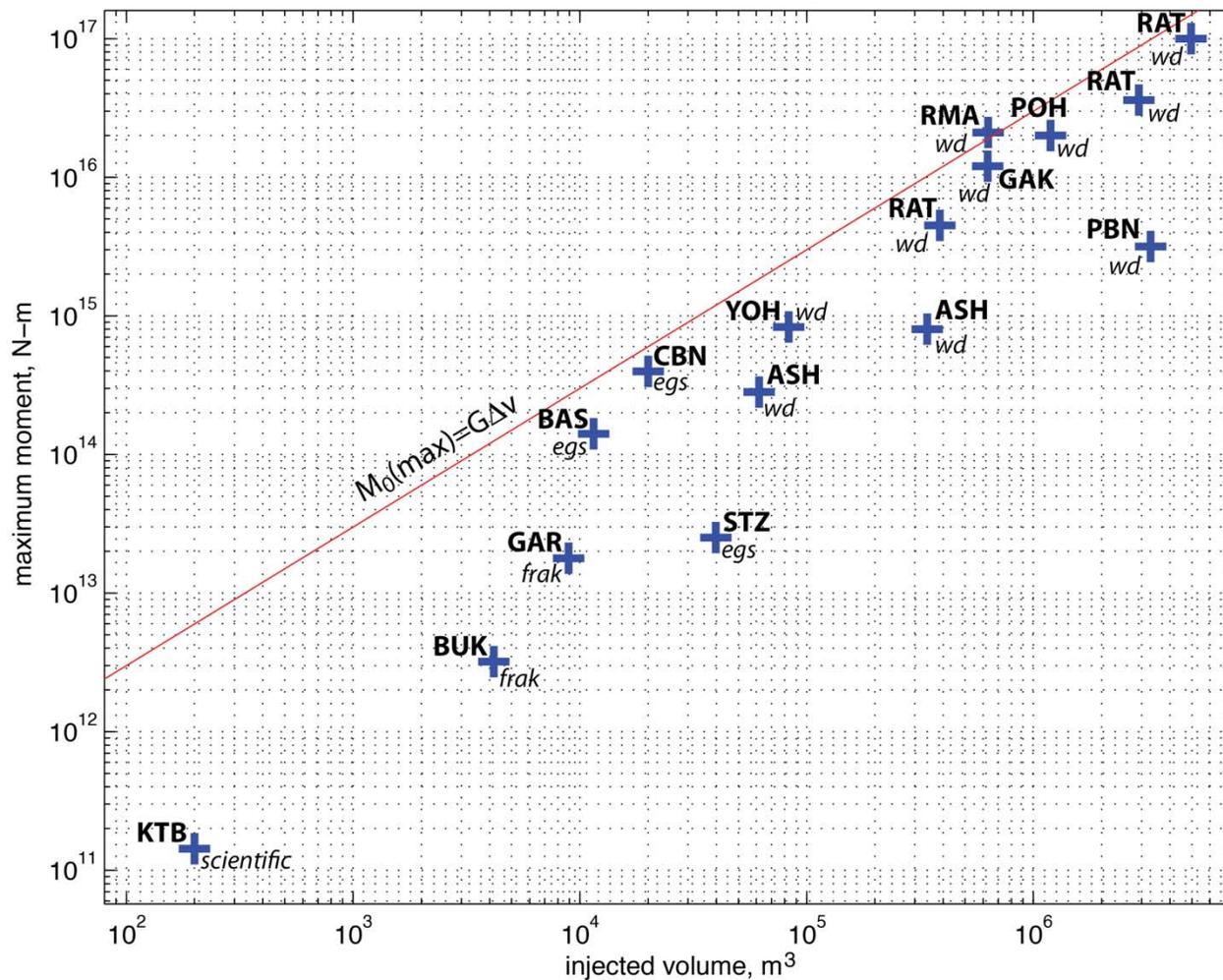
# Rate of Earthquakes in the Midcontinent

Sources of extra earthquakes in 2010 and 2011

506  $M \geq 3$  Earthquakes in the Midcontinent 2001 – 2011



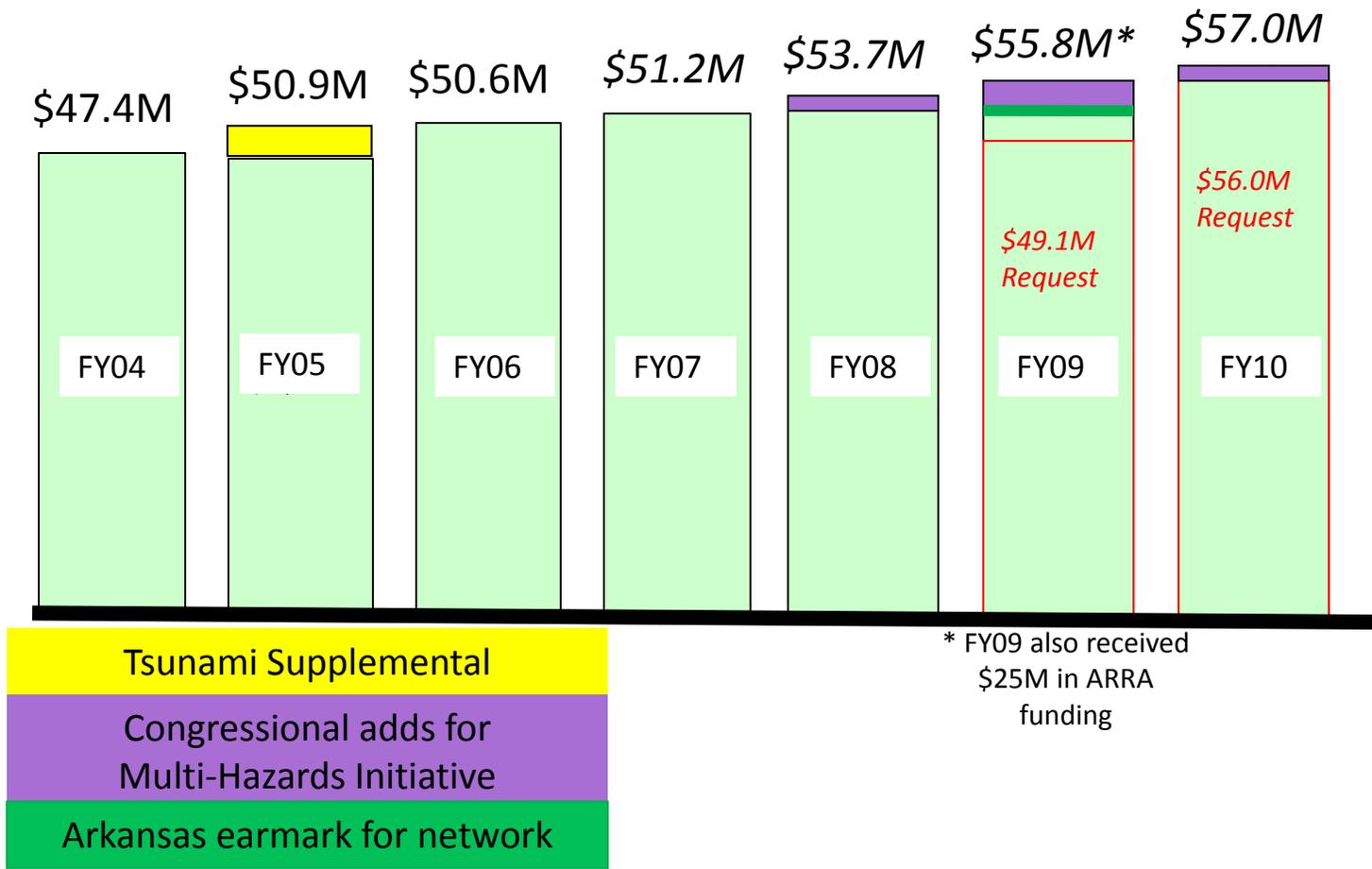
### Maximum Seismic Moment vs. Injected Volume



wd = waste disposal    egs = enhanced geothermal    frak = fracking



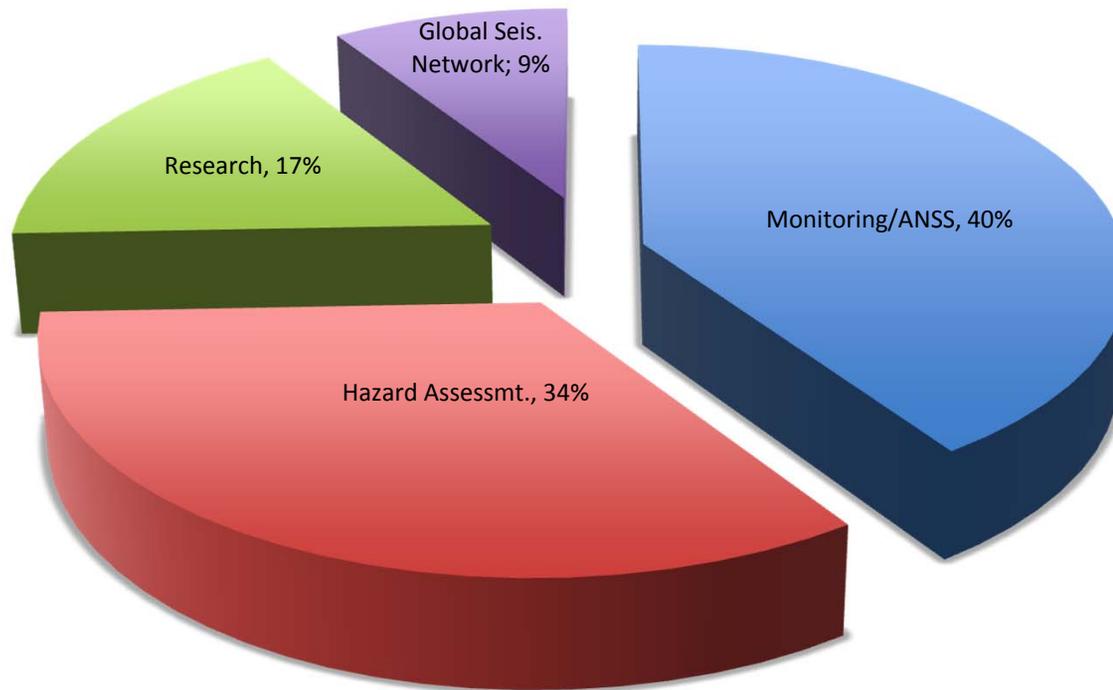
# 2004-2010: Congressional Interest and Funding



## 2010-2012: Contributing to deficit reduction

- Program funding down \$2.5M (-5%) since 2010
  - Reduced allocations to all internal projects, across-the-board in 2012
  - reduced grant and network funding (ANSS)
- House of Representatives, Committee on Appropriations has recommended 2013 funding at \$44M (20% reduction from 2012)
  - Proposed new funding level is below 1978 levels – which is, *before there was a NEHRP*

## Budget Breakdown by Major Activity (2012)



**Total 2012 budget  
\$60.4M**

**Amount distributed  
externally, \$14M**  
(grants, seismic net-  
works, geodetic net-  
works, SCEC and  
other coops).

**GSN amount, \$5.5M**  
is 60% of total network  
operational costs (NSF  
provides \$3.5M).

# Five 2013 Budget Scenarios

- President's Budget & Senate Mark - \$58.9M
  - Initiatives to Eastern U.S., Induced Seismicity and Early Warning
- Continuing Resolution at ~FY12 level
- Mission Area Planning Budget - \$53.2M
  - 2% below 2012; Detailed planning in place for this scenario
- Sequestration Budget – \$49.8 (-8.2%)
- House Committee Mark – \$44.0M

# What if? House Committee Mark - \$44M

- Elimination of research grants
- Elimination of some regional seismic networks; reductions in others
- Reductions in research coops
- End early warning development
- Consider ending 24x7 ops.
- Loss of non-permanent staff, including postdocs

