

# Earthquake and Tsunami Preparedness



How to help your  
community be more  
prepared for  
earthquakes and  
tsunamis

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Oregon is at risk from several different types of seismic events:

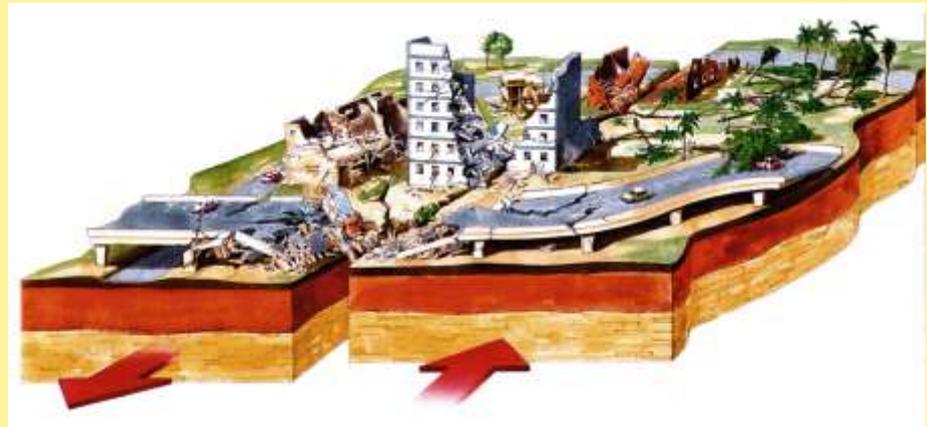


- ***Earthquakes***
- ***Tsunami***
- ***Volcanoes.***



# Earthquakes

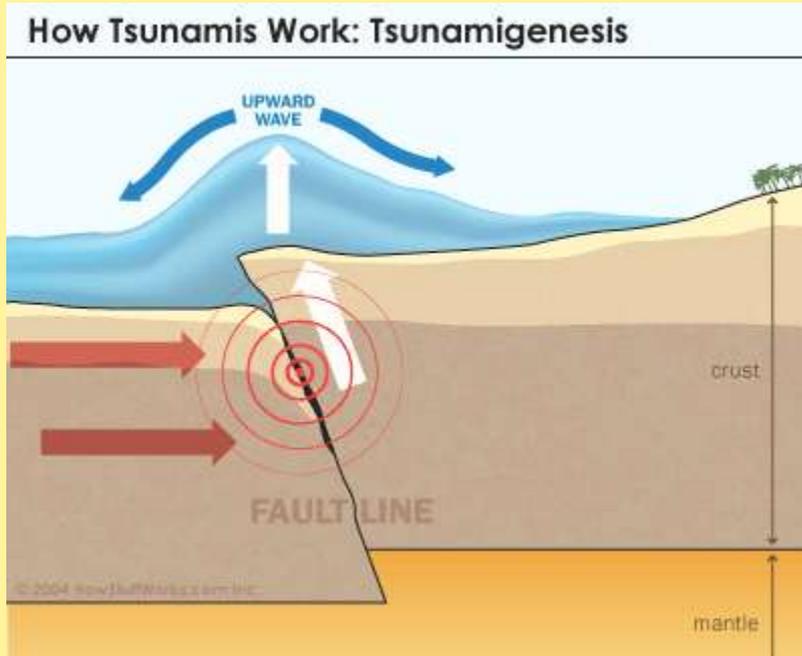
- **Earthquakes** occur when rock underground suddenly breaks along a fault. This sudden release of energy causes the seismic waves that make the ground shake.



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# Tsunamis



- **Tsunamis** are generated when geologic events cause large, rapid movements in the sea floor that displace the water column above.
- The Pacific Coast is at risk both from locally and distantly generated tsunamis.

# Volcanoes

- **Volcanic eruptions** occur only in certain places and do not occur randomly.
- In the Cascades volcanic chain, that extends from Lassen Peak in northern California to Meager Mountain in British Columbia, over 3,000 large and small volcanoes have erupted during the past five million years.



# Why are earthquakes dangerous?

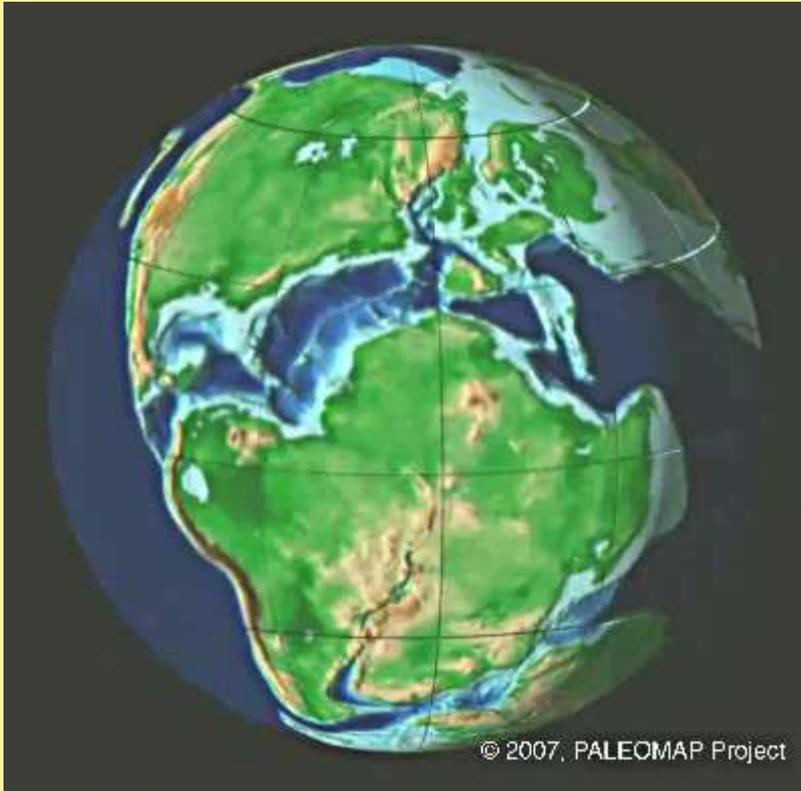
- Earthquakes can cause damage and injury in Oregon because they:
  - cause structural damage due to the shaking motion;
  - cause fires due to broken gas mains;
  - sometimes generate tsunamis (seismic sea waves);
  - can trigger landslides;
  - cause cracks in the ground.



# Everything you wanted to know about plate tectonics...

... in 30 seconds or less

- Tectonic Plates move around
- Tectonic Plates spread apart and create new land
- Tectonic Plates dive under each other
- Tectonic Plates roll over each other



SOURCE: <http://sos.noaa.gov/videos/Scotese.mov>

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# What Are the geologic hazards in Oregon?

- Earthquakes
- Volcanoes
- Tsunami
- Landslides



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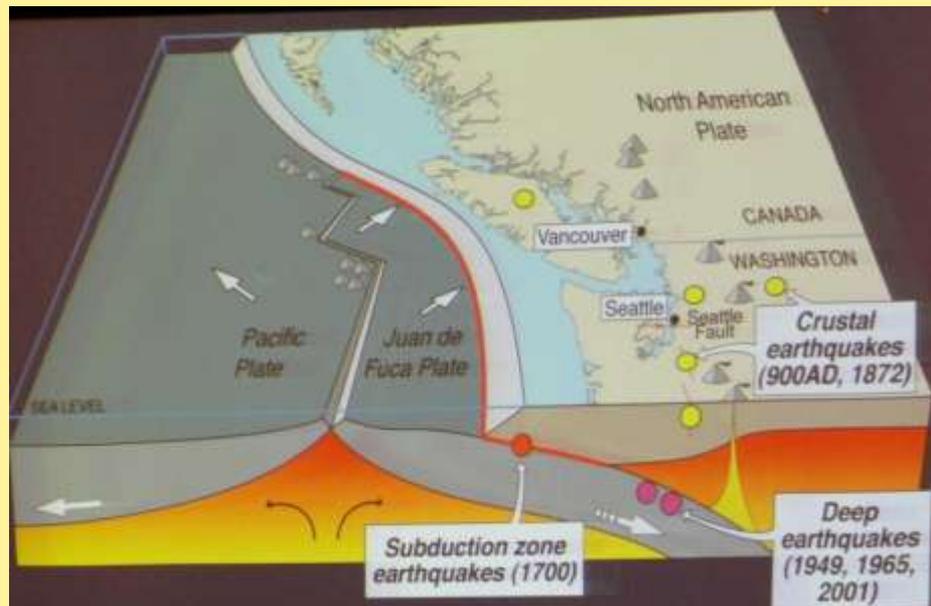


# What are the geologic hazards in Oregon?

- Earthquakes
  - Cascadia Subduction Zone
  - Crustal
  - Deep Intraplate
  - Volcanic
- Tsunami
  - Local (from subduction zone off our coast)
  - Distant (from subduction zone elsewhere)



# Deep / Intraplate

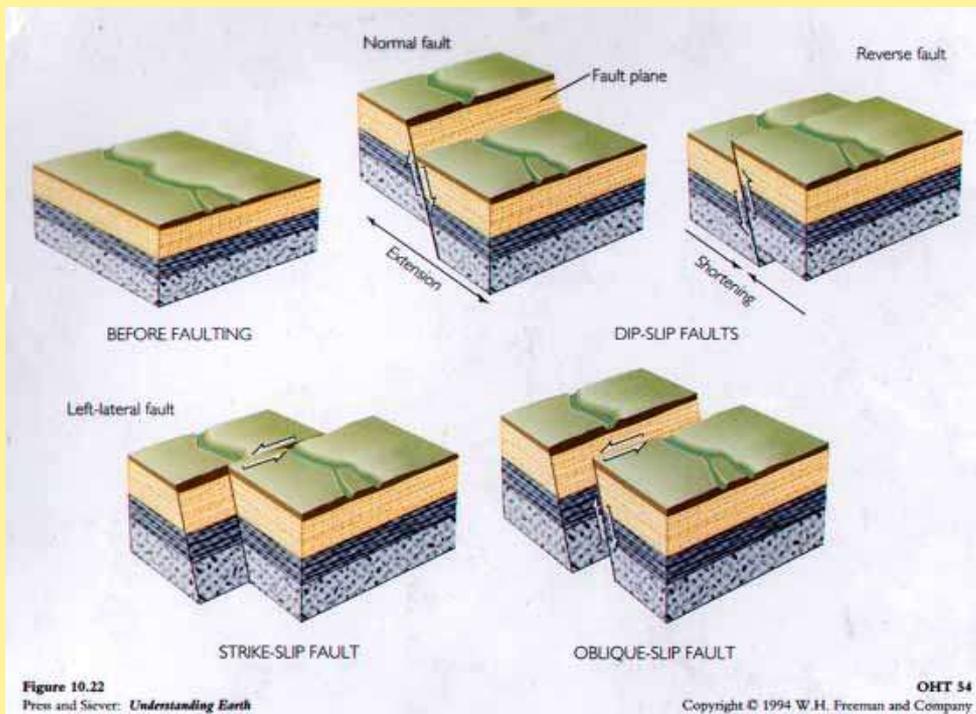


- Deep quakes are usually less than M7.5.
- The 2001 Nisqually, Washington quake (M6.8).
- Damaging deep earthquakes occur every 10-30 years.
- The seismic energy disperses over a much larger area. Damage is usually less than in a similar sized shallow quake.
- Few, if any, aftershocks occur.
- No tsunami expected, although landslides could trigger local tsunamis.

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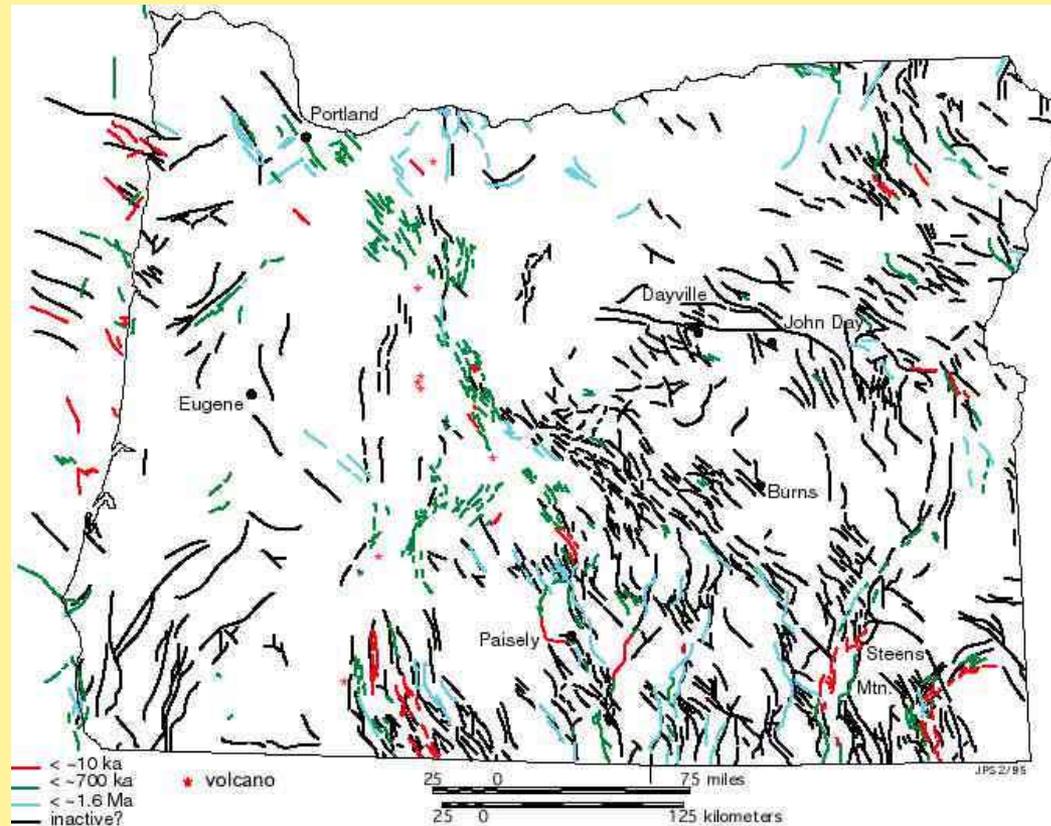
# Shallow / Crustal



- ✗ Aftershocks are common and may cause further disruption.
- ✗ No tsunami expected, although there could be a local tsunami from landslides.

# Shallow / Crustal

- Strong shaking is generally 20-60 seconds, although it could be longer in localized areas.
- Shallow quakes are usually less than magnitude (M) 7.4.



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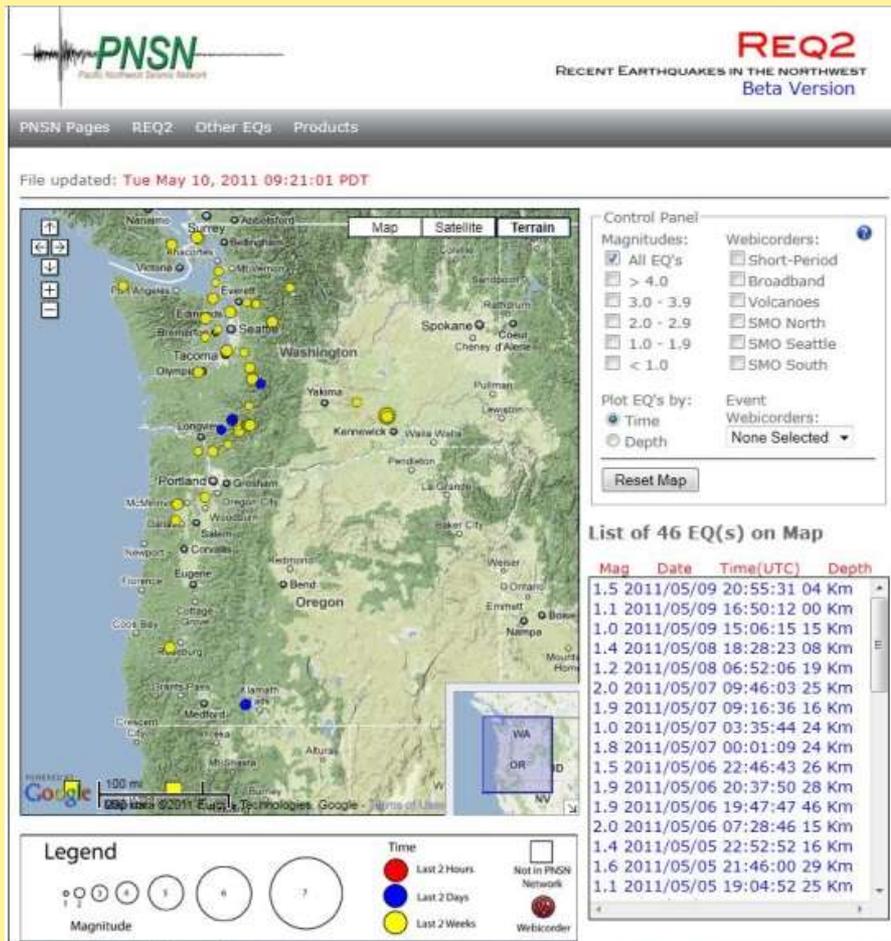
# Shallow / Crustal

- **(Incomplete) List of magnitude 4.0 or larger earthquakes in Oregon**

– 1873	6.3	67.2 km	SSW of Coos Bay, OR
– 1930	5.0	14.5 km	WNW of Salem, OR
– 1936	6.1	8.1 km	SSE of Walla Walla, WA (felt in OR)
– 1941	5.0	0.0 km	S of Portland, OR
– 1957	5.0	17.7 km	S of Tillamook, OR
– 1965	4.3	67.3 km	ENE of Baker, OR
– 1968	4.6	9.1 km	WNW of Adel, OR
– 2009	4.1	48.2 km	WNW of Grants Pass, OR



# Shallow / Crustal

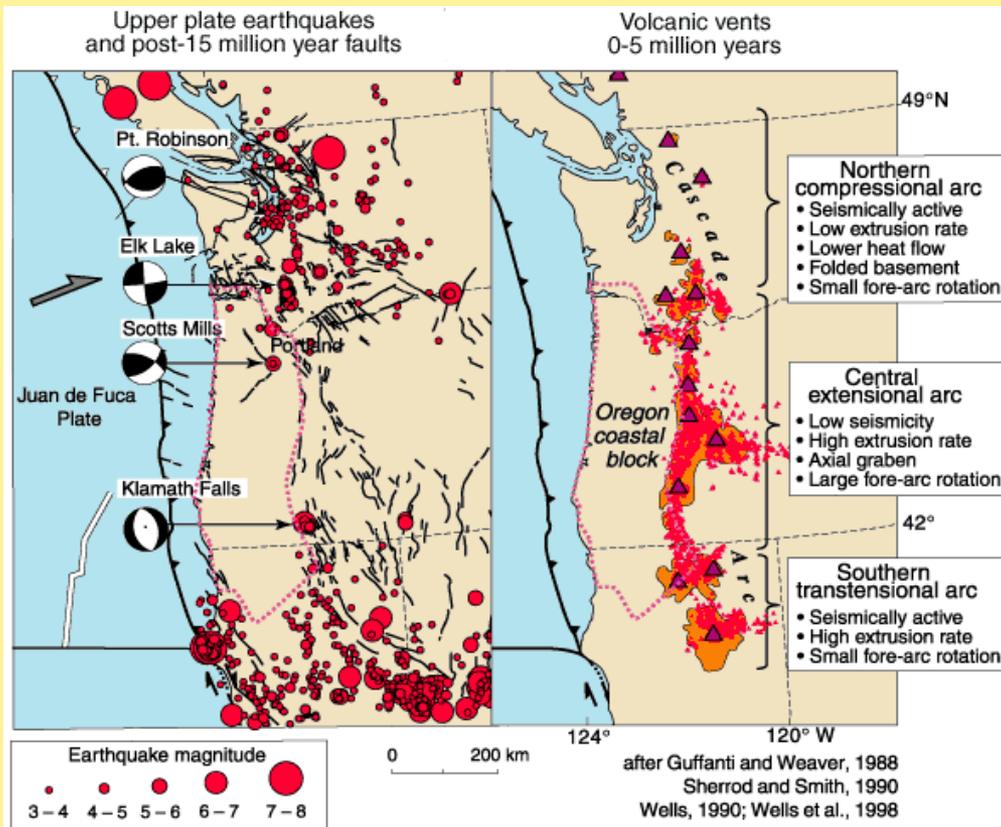


- ✗ <http://www.pnsn.org/req2/>
- ✗ Map showing earthquakes in last 48 hours
- ✗ Small shallow earthquakes are recorded every day in Cascadia; damaging quakes occur every few decades.

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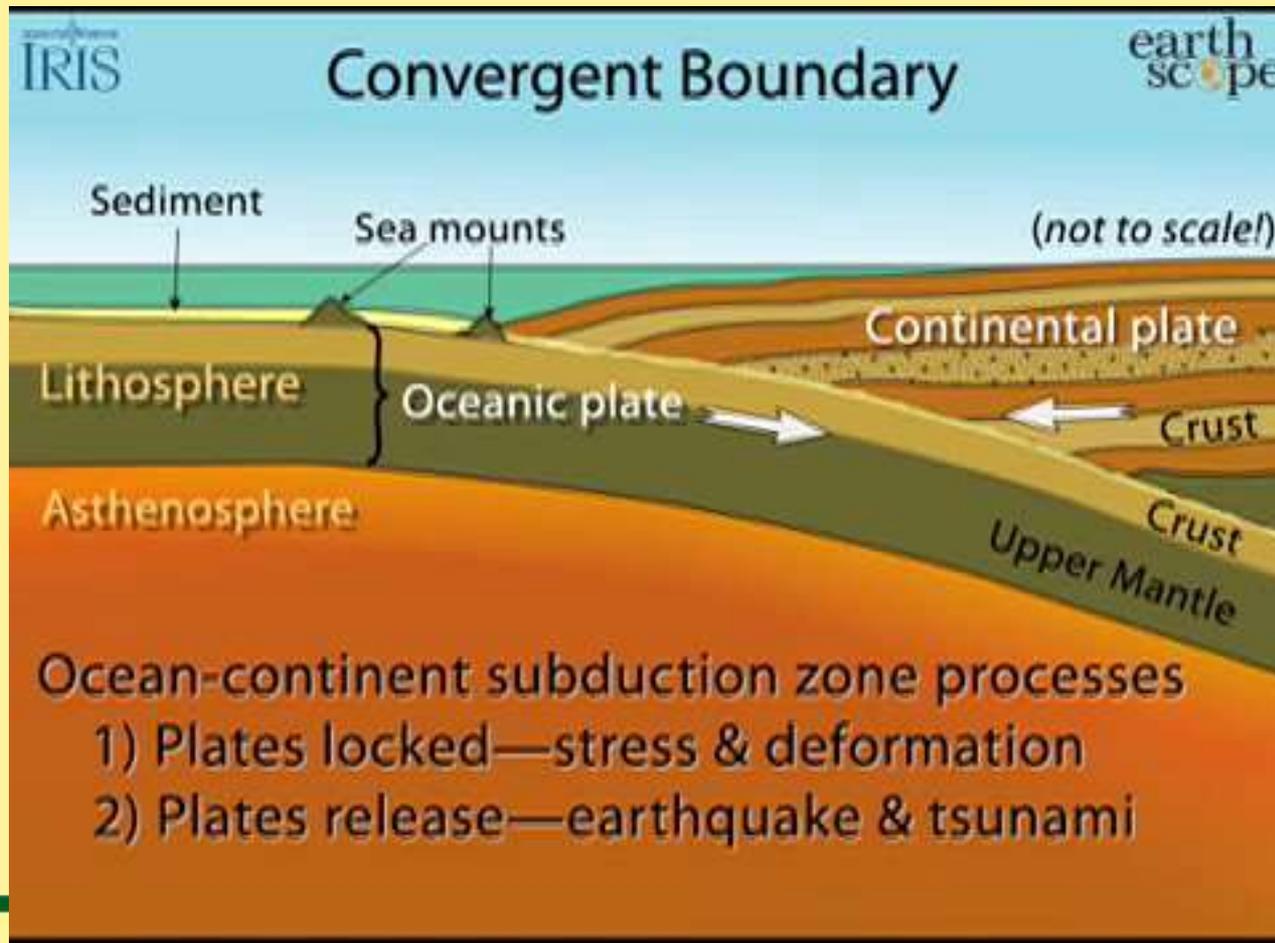
# Shallow / Crustal



- Most crustal quakes are shallow, Klamath Falls (6.0) and Scotts Mills (M5.6) in 1993.
- Damage can be very heavy in the area of the epicenter and along the fault.



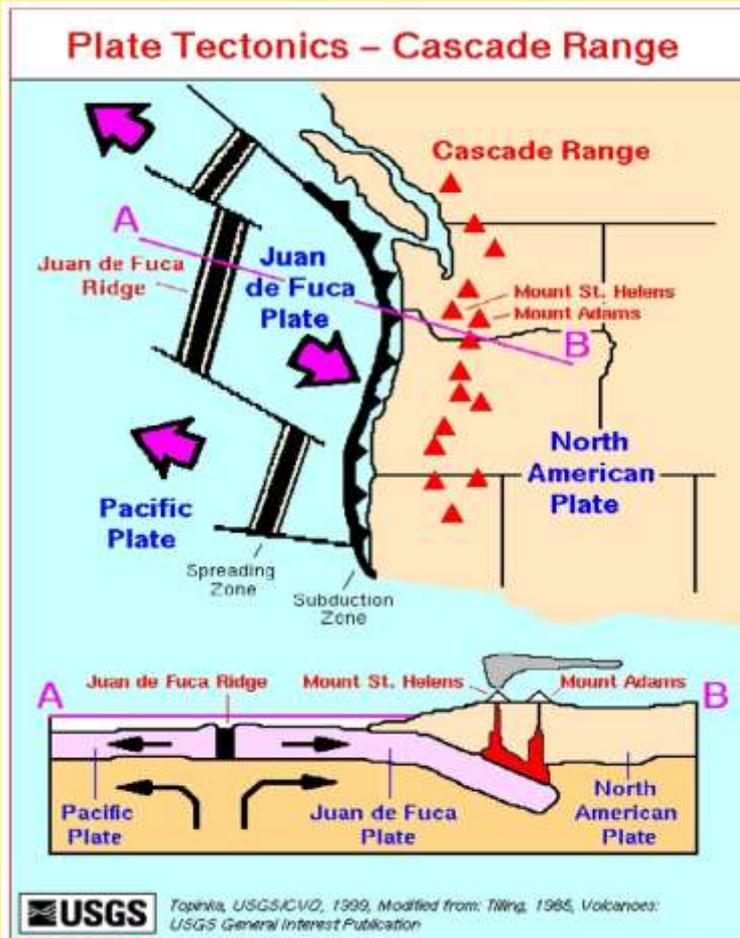
# What is the Cascadia Subduction Zone?



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# What is the Cascadia Subduction Zone?



- 600 miles long, from northern California to British Columbia
- Capable of producing very large earthquakes ( $M9+$ ) that impact a wide area
- Similar in size and impact to the 2004 Sumatra earthquake
- Can produce devastating tsunamis
- 10% chance of a mega-thrust earthquake in the next 50 years

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# What is the Cascadia Subduction Zone?

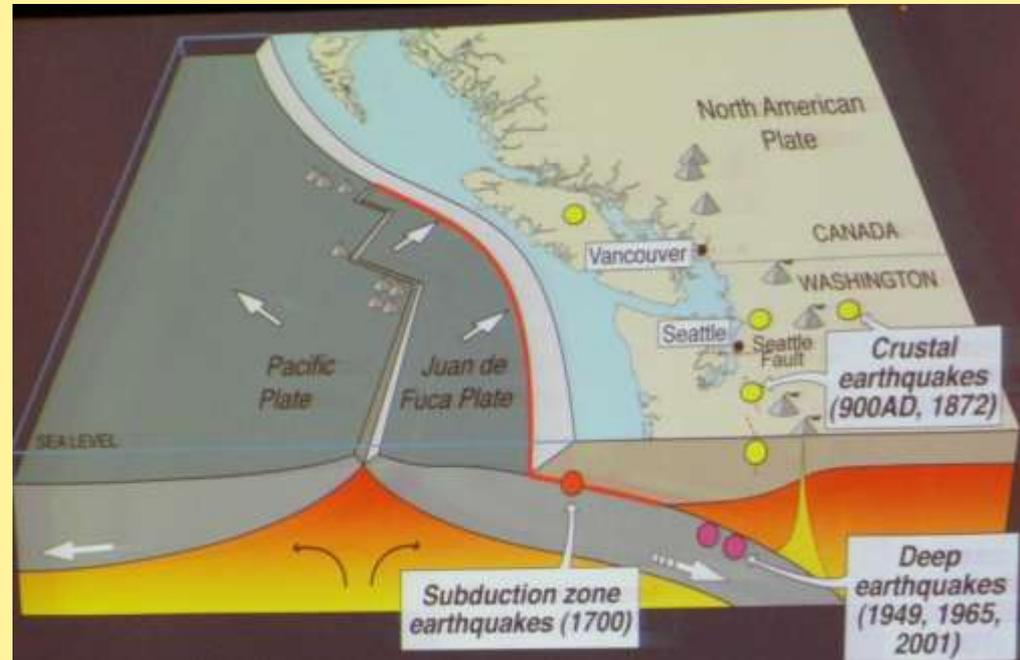
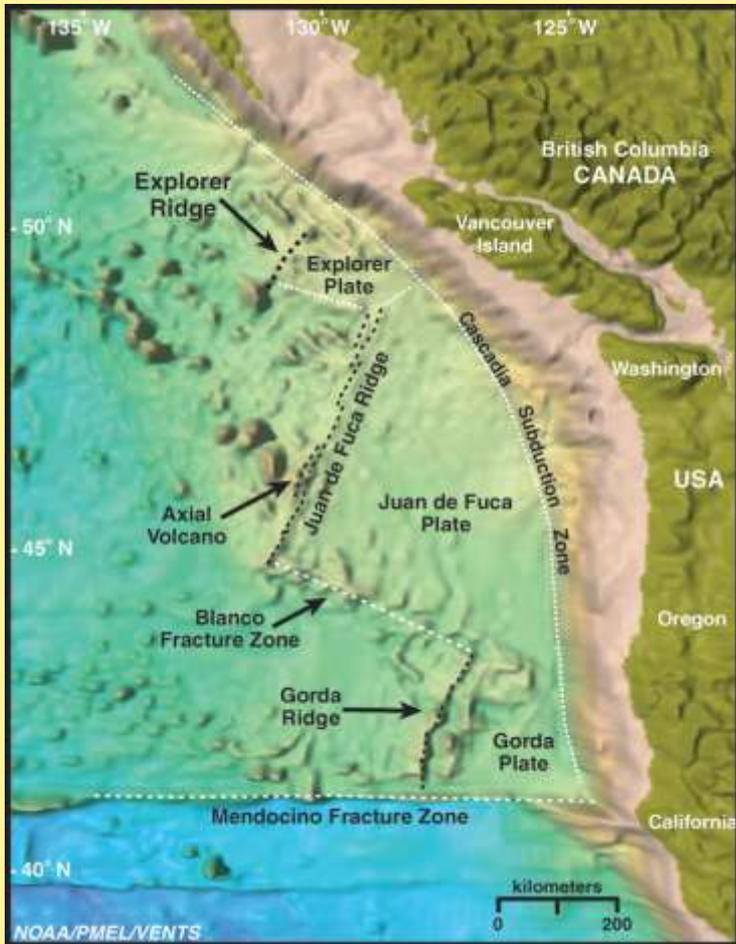


Ghost forest at Copalis River, WA

- Last Cascadia Subduction Zone earthquake occurred in 1700
- When will the next one occur?
  - We just don't know
- Average recurrence:
  - 240 years (southern portion)
  - 5-600 years (entire length)
  - 190-10,000 years between EQ
- We're in the Zone
- And it WILL happen again



# What is the Cascadia Subduction Zone?



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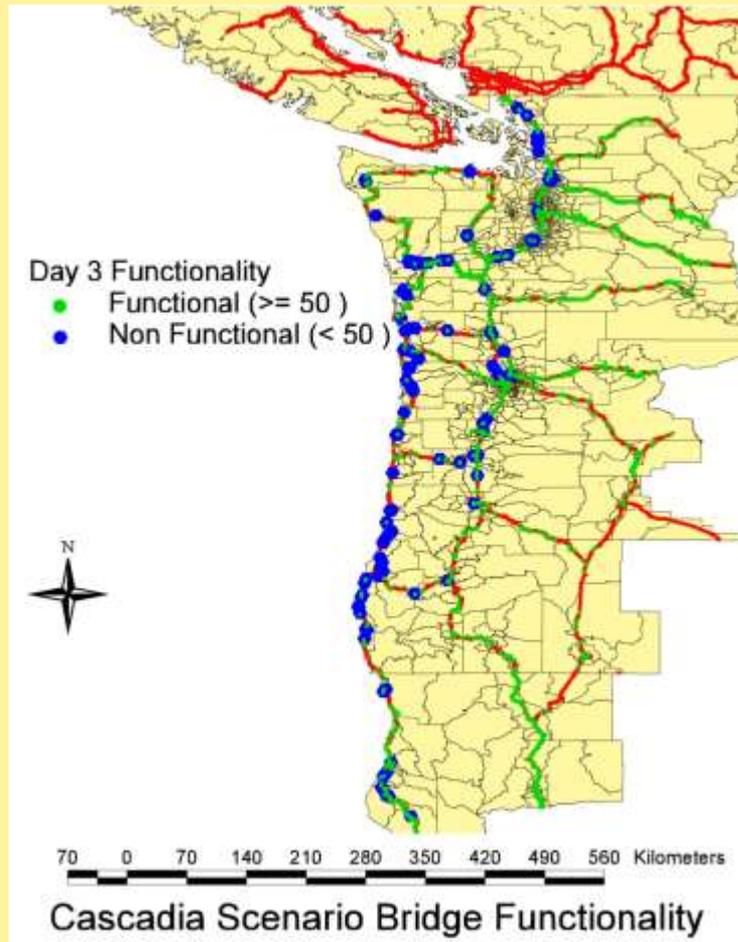
# Who is impacted by a CSZ EQ?

- Three metropolitan cities in impact zone
  - Portland
  - Seattle
  - Vancouver, B.C.
- Heavy urbanization along the I-5 corridor
- Approximately 9.5 million people live in the hazard zone in WA & OR



# What are the risks & impacts?

- Infrastructure and lifelines will be seriously damaged
  - In Oregon, 399 bridges would have totally or partially collapsed under an M 9.0 Cascadia Subduction Zone earthquake, and 621 bridges would have been heavily damaged.
  - Most state routes connecting Interstate I-5 with the Oregon Coast Highway would be closed. The estimated time of closure could be 3 to 12 months.
  - The restoration of the entire transportation network could take 3 to 5 years, and would require a nationwide effort.



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# What are the risks & impacts?



Schools and emergency facilities collapse

- Excluding hospitals, the estimated replacement value of this building stock totals approximately \$11.5 billion, led by the K-12 schools at 85%, community colleges 8%, fire 5%, and police 2%. (2007)



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# What are the risks & impacts?



- Hundreds of thousands of people will need food, water, and shelter to be supplied for the foreseeable future.

# What are the dangers from an EQ?

- Strong ground shaking
- Surface fault rupture
- Liquefaction
- Landslides
- Tsunami
- Coastal subsidence



# What are the hazards?

## ✘ Surface fault rupture



2010 Canterbury, New Zealand



2009 Wenchuan, China

# What are the hazards?

- Strong ground shaking



2010 Haiti earthquake



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# What are the hazards?

## ✘ Coastal subsidence



2004 Sumatra



Mainichi Shimbun, Reuters

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# What are the hazards?

## ✘ Landslides



Landslides in Ferndale, WA



2010 Taiwan

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# What are the hazards?

## ✗ Liquefaction



1964 Alaska

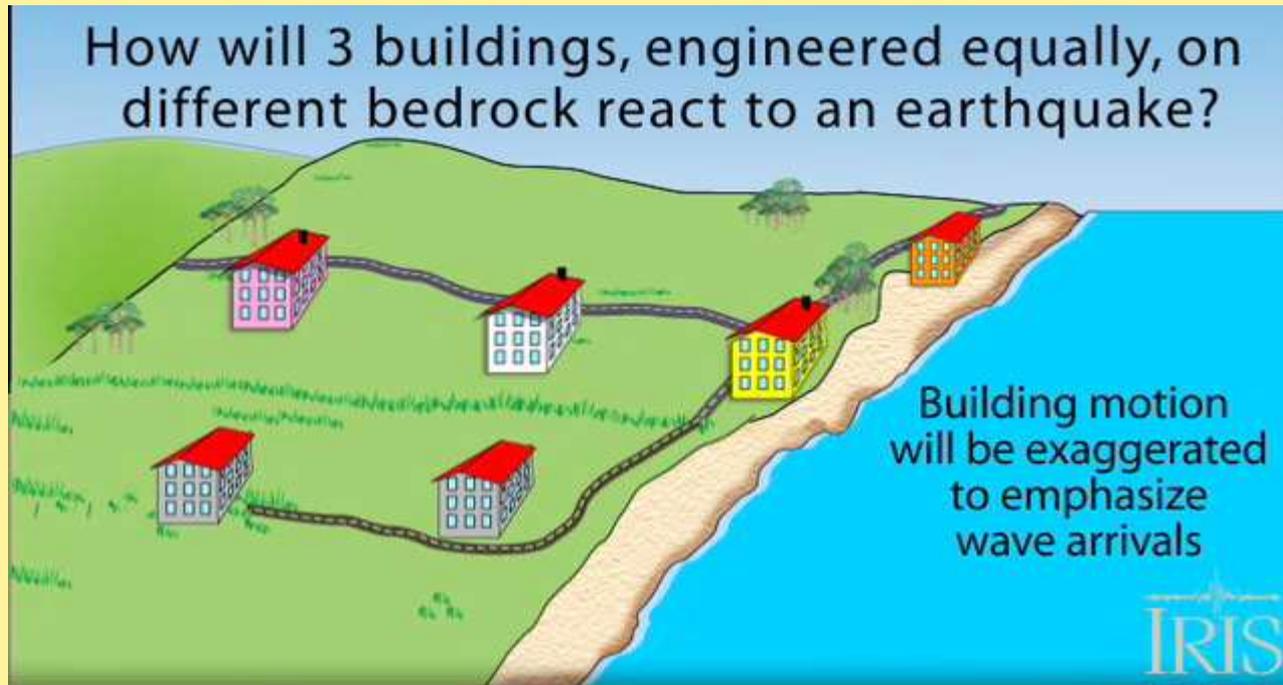


2011 Christchurch, New Zealand

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# What is liquefaction?



Two variables affect damage during earthquake:

- 1) Intensity of shaking (*felt motion, not magnitude*)
- 2) engineering

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# What are the hazards?

## ✘ Tsunami



2004 Indonesian tsunami



2011 Tohoku tsunami

# Dangers Associated With Earthquakes

- Partial building collapse, such as collapsing walls, falling ceiling plaster, dislodged light fixtures and pictures.
- Flying glass from shattered windows.
- Overturned furniture such as cabinets, floor lamps or book cases.
- Fires, broken gas lines and similar causes.
- Fallen power lines.
- Inappropriate actions resulting from panic.

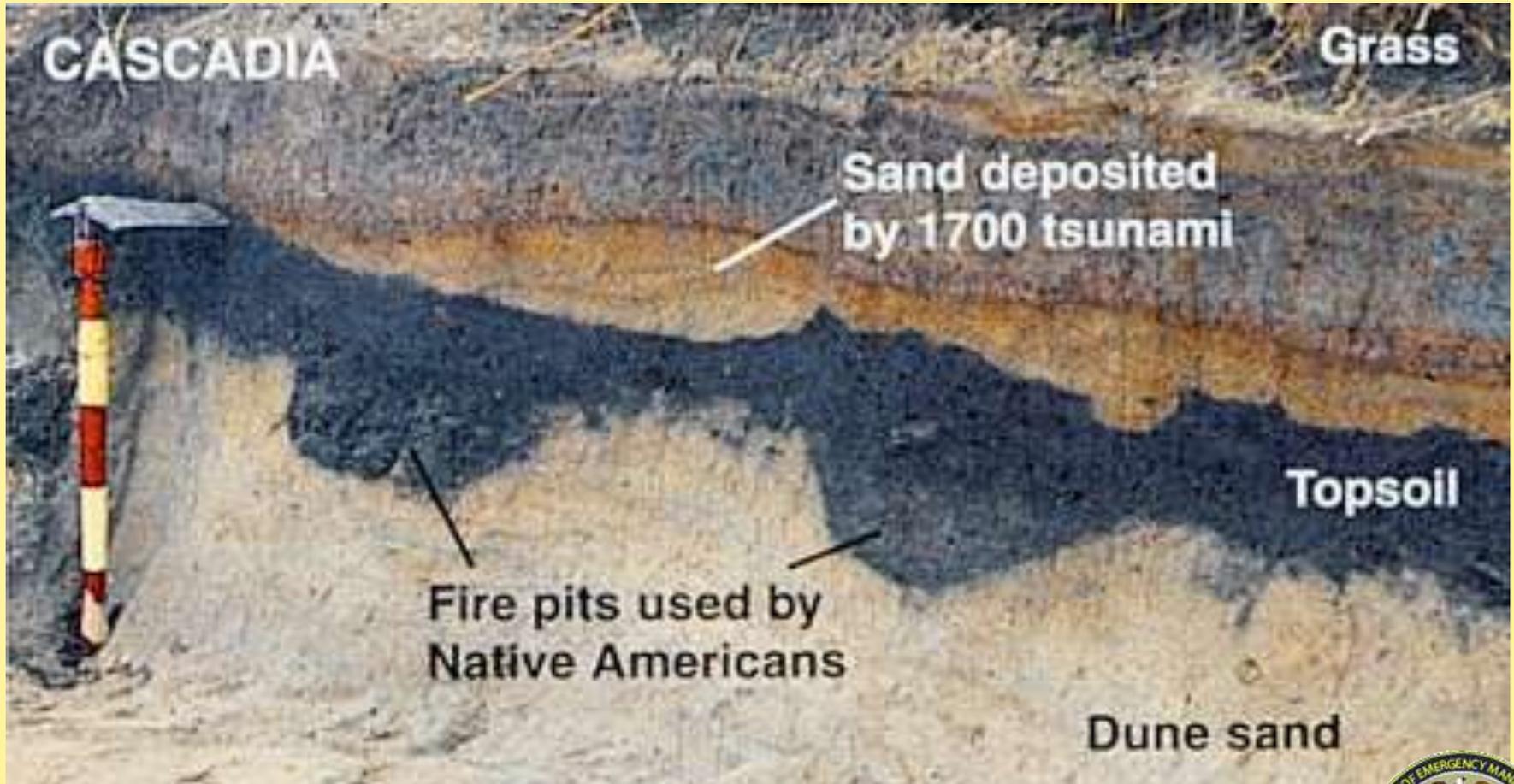


# Tsunami

- Local – Caused by a subduction zone earthquake near the Oregon shore
- Distant – Caused by a subduction zone earthquake far away from the Oregon shore



# Tsunami



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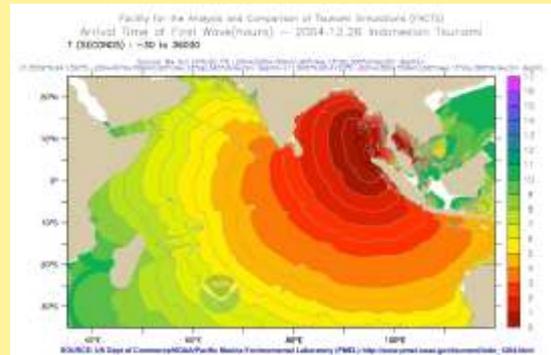
# Stages of a Tsunami

## Generation



How are tsunamis created?

## Propagation



How do they move through the ocean?

## Inundation

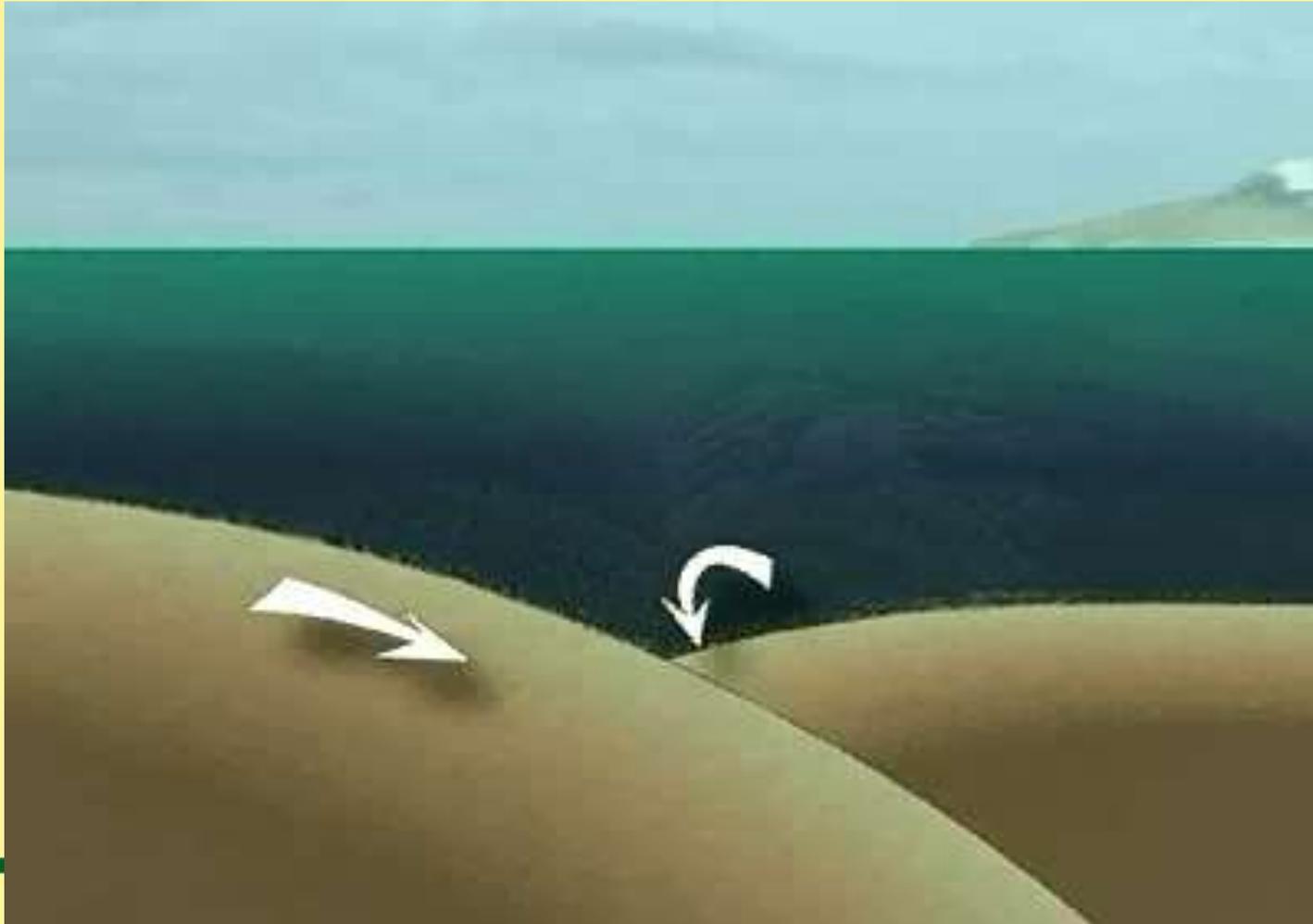


What happens when they hit land?

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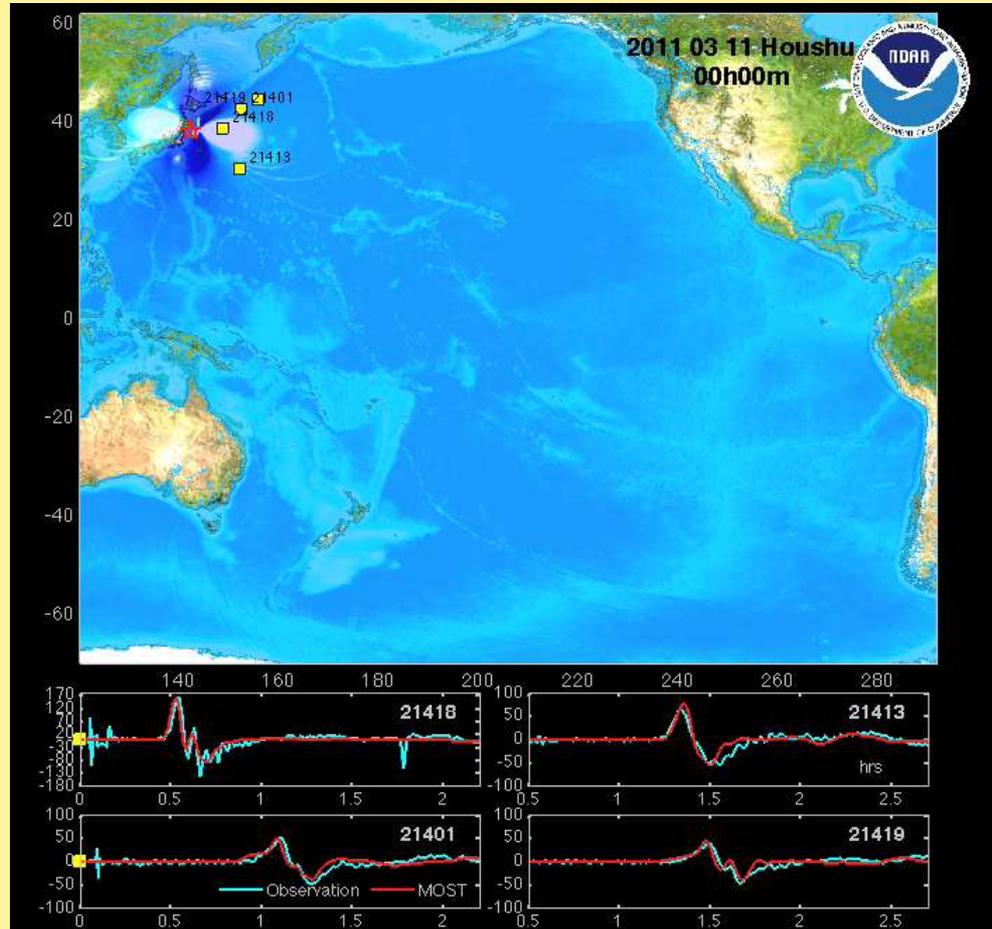
# Tsunami Genesis



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# Tsunami Propagation



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# Tsunami Inundation



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# Tsunami Damage



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# Tsunami Damage



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# What you really need to know about a tsunami

- Three Things
  - It is a series of waves
  - Stay away for 24 hours
  - Even small tsunamis can cause damage



# How do you know a tsunami is happening?

- Natural Warnings
  - Earth shaking
  - Water recedes
  - Loud roar
- Official Warnings
  - NOAA/NWS alerts



# How do you know a tsunami is happening?

- Local Tsunami (Big!)
  - Natural warnings
    - Earth shaking
    - Drop, Cover and Hold On!
    - Get to high ground immediately
    - Put your plan in action
- Distant Tsunami (Not so big, despite what you may see on tv)
  - Official Warnings
    - NOAA/NWS alerts
    - Seek out more information
    - Follow directions of local responders
    - Put your plan in action

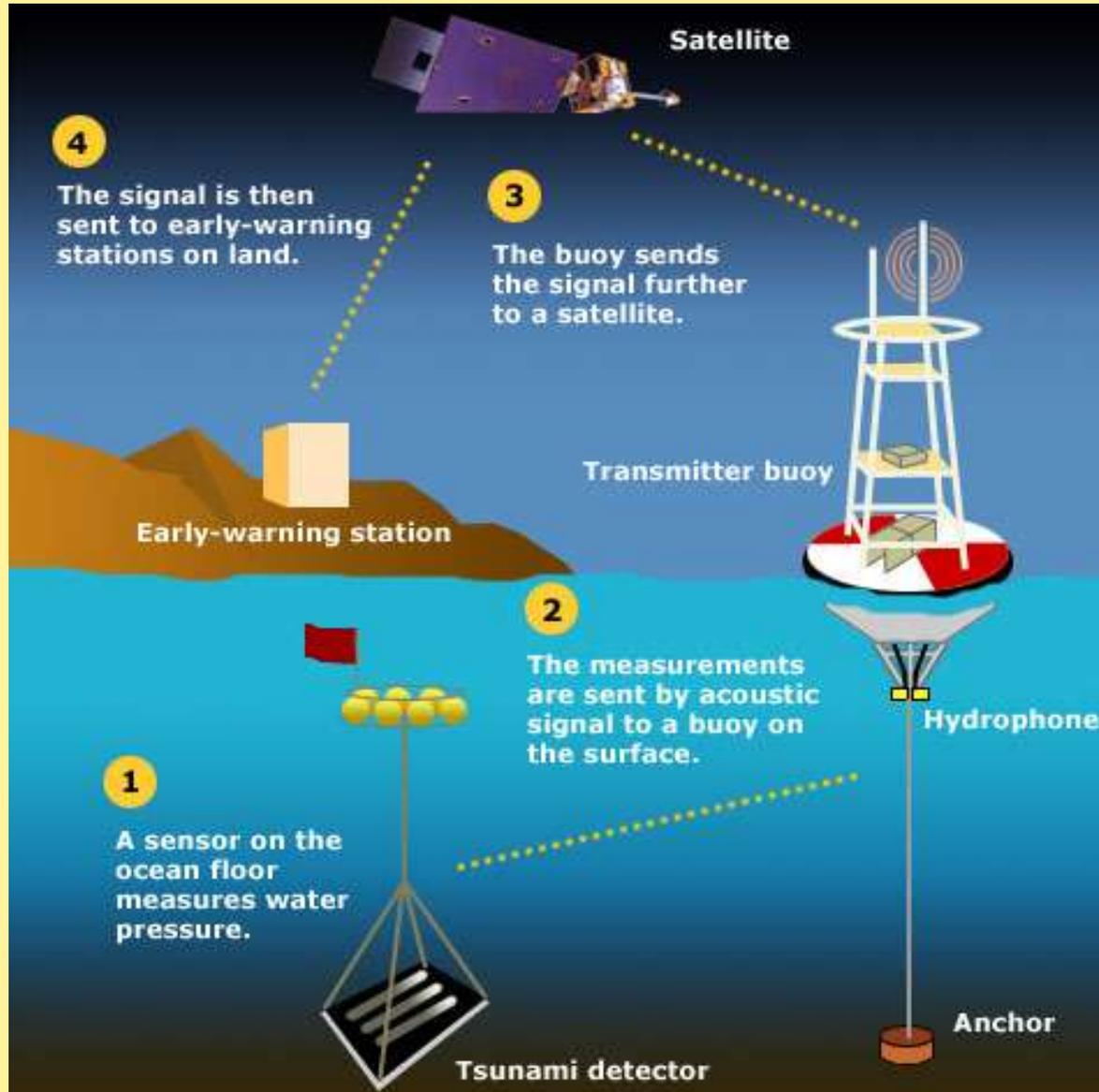


# DISTANT Tsunami warning system

- Earthquake happens somewhere in the Pacific
- Analyzed quickly
  - Usually within 5 minutes
- Tsunami Warning Center will issue bulletin
  - Information Statement
  - Watch
  - Advisory
  - Warning



## The Wave Watchdog



When an earthquake strikes on the bed of the ocean, millions of tons of water are suddenly pushed upwards -- or sinks dramatically downwards -- thus generating a powerful wave. In deep water, the wave travels at extremely high rates of speed. The wave can be identified by a tsunami detector, which then transmits a warning via satellite.

With the help of data received from transmitter buoys and prediction models, it is possible, even just 15 minutes after an earthquake strikes, to determine the path and the strength of a tsunami. Warnings can be sent out to the endangered regions immediately.

Source: DER SPIEGEL / NOAA

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# Tsunami Bulletins

West Coast & Alaska Tsunami Warning Center

4 Levels of Messaging

**WARNING**

- Danger!
- Run for High Ground!
- Follow Emergency Instructions.

**ADVISORY**

- Possible Strong and Dangerous local Currents.
- Stay tuned for local Emergency guidance.

**WATCH**

- Potential Danger.
- Stay tuned for more information.

**INFORMATION STATEMENT**

- Relax.
- No Danger.
- A distant ocean basin may be in danger.

WEST COAST & ALASKA TSUNAMI WARNING CENTER

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# What action is required?

- Information Statement (**Don't Panic**)
  - Relax, enjoy the beach.
- Watch (**Don't Panic**)
  - Stay tuned for more information.
- Advisory (**Don't Panic**)
  - Stay away from beach and harbors.
- Warning (**Don't Panic**)
  - Stay away from beach and harbors



# Break

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# Prepare in Seven Steps

- \* 1- Identify Hazards
- \* 2- Create a disaster plan
- \* 3- Prepare disaster kits
- \* 4- Identify and fix weaknesses
- \* 5- Protect yourself during earthquake
- \* 6- Evacuate if necessary
- \* 7- Follow your earthquake plan

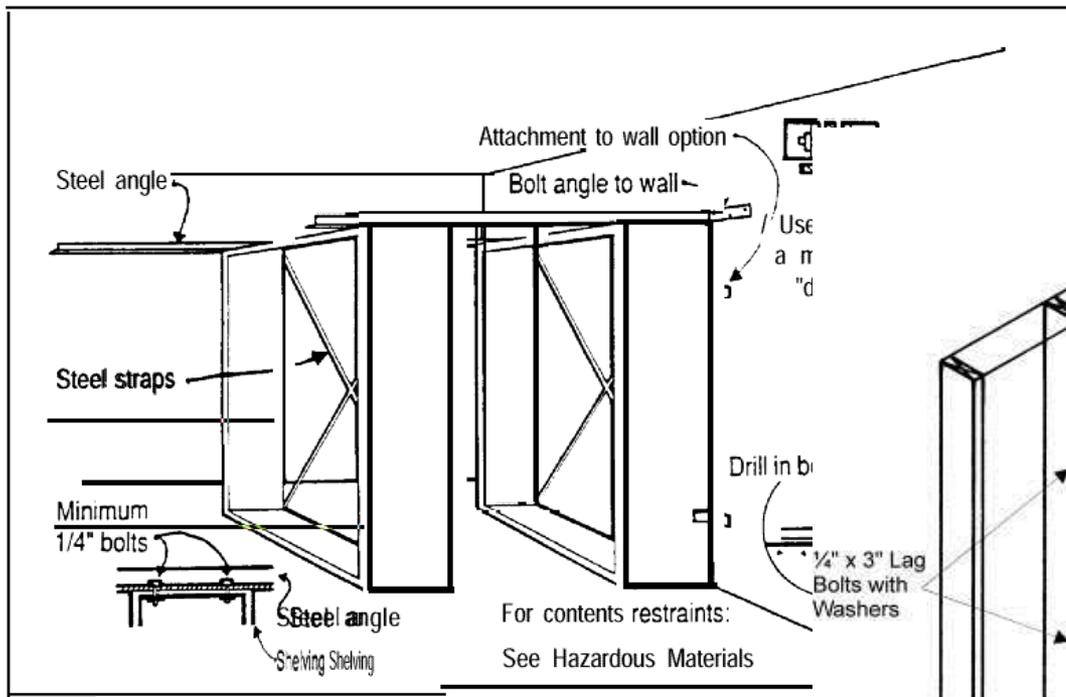


# Prepare in Seven Steps

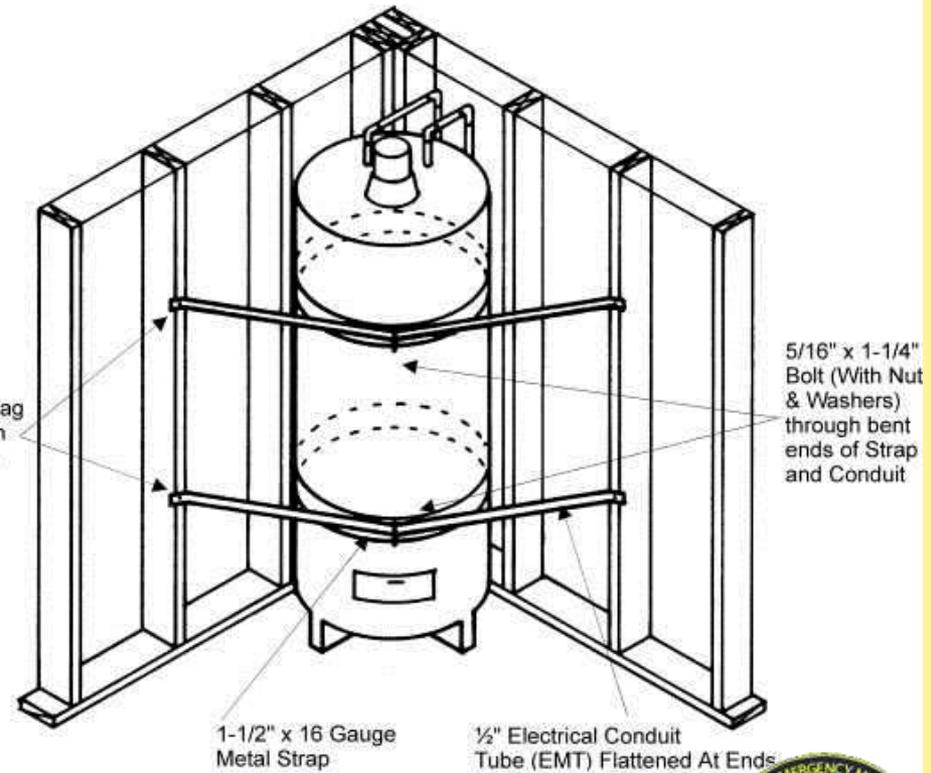
- \* 1 - Identify Hazards
  - \* Start now by identifying items that may fall, topple, or slide.
  - \* Secure potentially hazardous and valuable items.



# Secure Furnishings



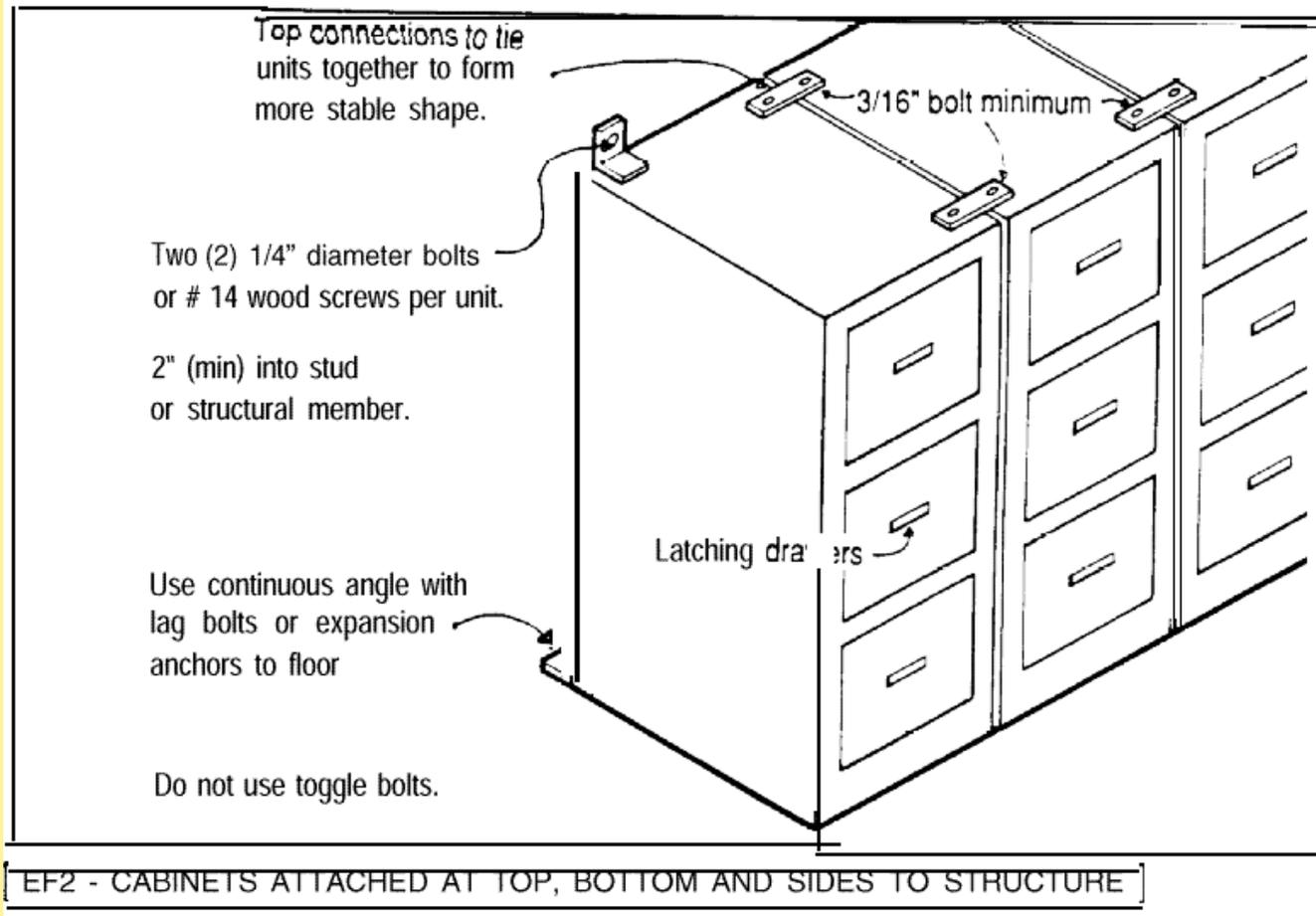
EF6 - BRACING OF LIBRARY SHELVING (STACKS)



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# Secure Furnishings



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# Office Hazards



- \* Look at office spaces to see if large objects or even heavy binders could fall and injure you.
- \* Move heavy objects to a lower shelf.

# Prepare in Seven Steps

- \* 2- Create a disaster plan
  - \* Practice Drop, Cover and Hold on.
  - \* Plan on how to respond after an earthquake or tsunami
  - \* Plan how to communicate and recover
  - \* Practice, practice, practice!



# But what can I do?

- Have a plan! Know what to do!
  - Who ya gonna call?
  - Where will my family be and how will I reach them?
    - Children at school or activities
    - Plan for pets and livestock
    - Have an out-of-town emergency contact
  - How are you going to contact your family if phone service is not available?



# But what can I do?

- Have a plan! Know what to do!
  - Where will I get medical help?
    - Take first aid and CPR classes
    - Plan for back-up if family needs life-saving medical equipment
  - Have you taken first aid classes?
    - What is in your home first aid kit?



# But what can I do?

- Have a plan! Know what to do!
  - Am I prepared to live without the essentials?
    - Food
    - Water
    - Medicine
    - Toilet paper/ Tooth brush/ Towel
    - Fill up the gas tank in your car frequently
  - How much toilet paper do you have in your house right now?



# But what can I do?

- Have a plan! Know what to do!
  - How will I pay for things?
    - Have cash on hand
    - ATMs/Plastic cards will likely not work
  - How much do you have on hand?



# Prepare in Seven Steps

- \* 3- Prepare disaster kits
  - \* Personal/Office
  - \* Household
  - \* Car



# But what can I do?

- Go-Kit – **minimum** of 72 hours
  - Car
  - Office
  - Home
    - Have 3 weeks worth of:
      - Food
      - Water
      - Medicine
      - Anything else you deem a necessity



- What do you consider a necessity? (got a pet?)
- <http://www.ready.gov/america/getakit/>

# But what can I do?

- National Weather Service Radio
  - Does it have batteries?
  - Is it turned on?



# Prepare in Seven Steps

- \* 4- Identify and fix weaknesses
  
- \* Common building problems
  - \* Inadequate foundations
  - \* Unbraced cripple walls
  - \* Soft first stories
  - \* Unreinforced masonry



# Prepare in Seven Steps

- 4- Identify and fix weaknesses
  - <http://www.fema.gov/library/index.jsp>
    - Incremental Seismic Rehabilitation of Retail Buildings : Providing Protection to People and Buildings
    - Recommended Seismic Evaluation and Upgrade Criteria for Existing Welded Steel Moment-Frame Buildings
    - An Action Plan for Reducing Earthquake Hazards of Existing Buildings
    - Anchoring Home Fuel Tanks
    - Designing for Earthquakes
    - Earthquake Preparedness: What Every Child Care Provider Needs to Know



# Prepare in Seven Steps

- \* 5- Protect yourself during earthquake
  - \* Drop, Cover and Hold on



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# What to do when the ground shakes?



- Drop, cover, and hold on.
- Get to high ground as soon as the shaking stops.
- Triangle of Life (or rather, Death)
- What would you do right now?



# Drop, Cover and Hold ON

- Stay away from windows and things that can tip, fall or drop on you.
- Do not go to a door opening unless there's no door.
- Get under a working surface, desk or table.
- If you can't get under a stable surface, get down low next to something like a chair, bed or something stable.
- Cover your head with your hands or arms.



# Prepare in Seven Steps

- \* 6- Evacuate if necessary
  - \* Know if you are in the Zone
  - \* Do not wait for an official warning
  - \* Check for injuries
  - \* Check for damage





# Prepare in Seven Steps

- \* 7- Follow your earthquake plan
  - \* Once safe, continue your disaster preparedness plan.
  - \* Be in communication
  - \* **If you cannot stay in your home...**
    - \* Tell a neighbor and your out-of-state contact where you are going
  - \* Check in with the Red Cross
    - \* [www.safeandwell.org](http://www.safeandwell.org)



# Great Oregon Shakeout

**Join Us**  
for the Largest  
Earthquake Drill  
in Oregon  
History.

October 18, 2012

[shakeout.org/oregon](http://shakeout.org/oregon)

The Great  
Oregon  
**Shake  
Out**<sup>™</sup>

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# Where to go to get more information

- OEM Website

- Informacion en Espanol

- [http://www.oregon.gov/OMD/OEM/plans\\_train/info\\_spanish.shtml](http://www.oregon.gov/OMD/OEM/plans_train/info_spanish.shtml)



# You can't prevent an Earthquake, but you can prepare for one

- Questions?
- Althea Rizzo
- [Althea.Rizzo@state.or.us](mailto:Althea.Rizzo@state.or.us)

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