Earthquake - Tsunami Room

Remembering the Quakes of 1992

Living on SHAKY GROUND
HOW TO SURVIVE EARTHQUAKES AND TSUNAMIS IN NORTHERN CALIFORNIA

Redwood Coast Tsunami Work Group
a member of the Earthquake Country Alliance
We're all in this together

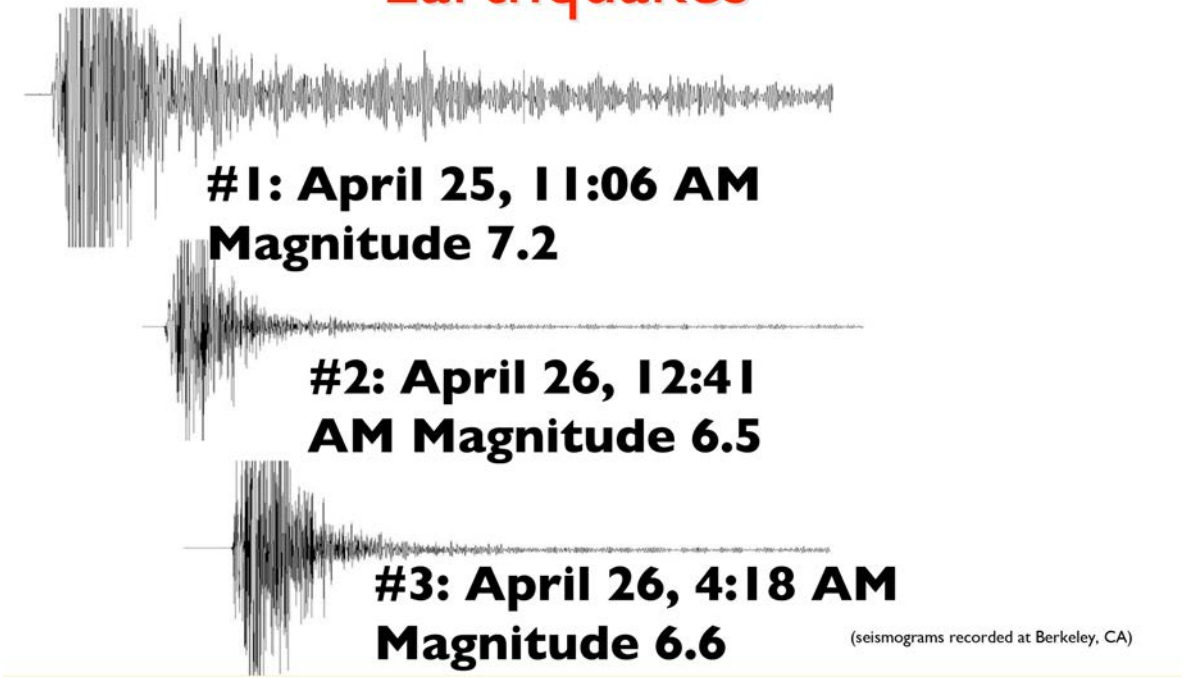
Cal OES GOVERNOR'S OFFICE OF EMERGENCY SERVICES

CGS CALIFORNIA GEOLOGICAL SURVEY

NATIONAL WEATHER SERVICE

HUMBOLDT STATE UNIVERSITY

The 1992 Cape Mendocino Earthquakes



Twenty-five years after - what have we learned?

Our great staff – always eager to assist

The Most Important Take-Away Message

Protecting yourself from injury during the earthquake is where it all begins. You can't evacuate if you are injured during the shaking!

As soon as it is safe to move, get your "grab and go" kit and walk to high ground or inland away from the coast. Take the time to put on shoes as debris may make walking hazardous. Practice the evacuation route before hand so you know where to go.

Tsunamis are TRICKY! Just when you think the waves are done, another damaging surge may arrive. The largest waves may arrive many hours after the first. Stay away from the coast until officials say it is safe to return.

Why is the Cape Mendocino earthquake important?

- First Humboldt County earthquake to be declared a major disaster by the President.
- First large earthquake in historic times to:
  -be related to the Cascadia subduction zone
  -produce a local tsunami
- Largest magnitude onshore north coast earthquake in historic times.

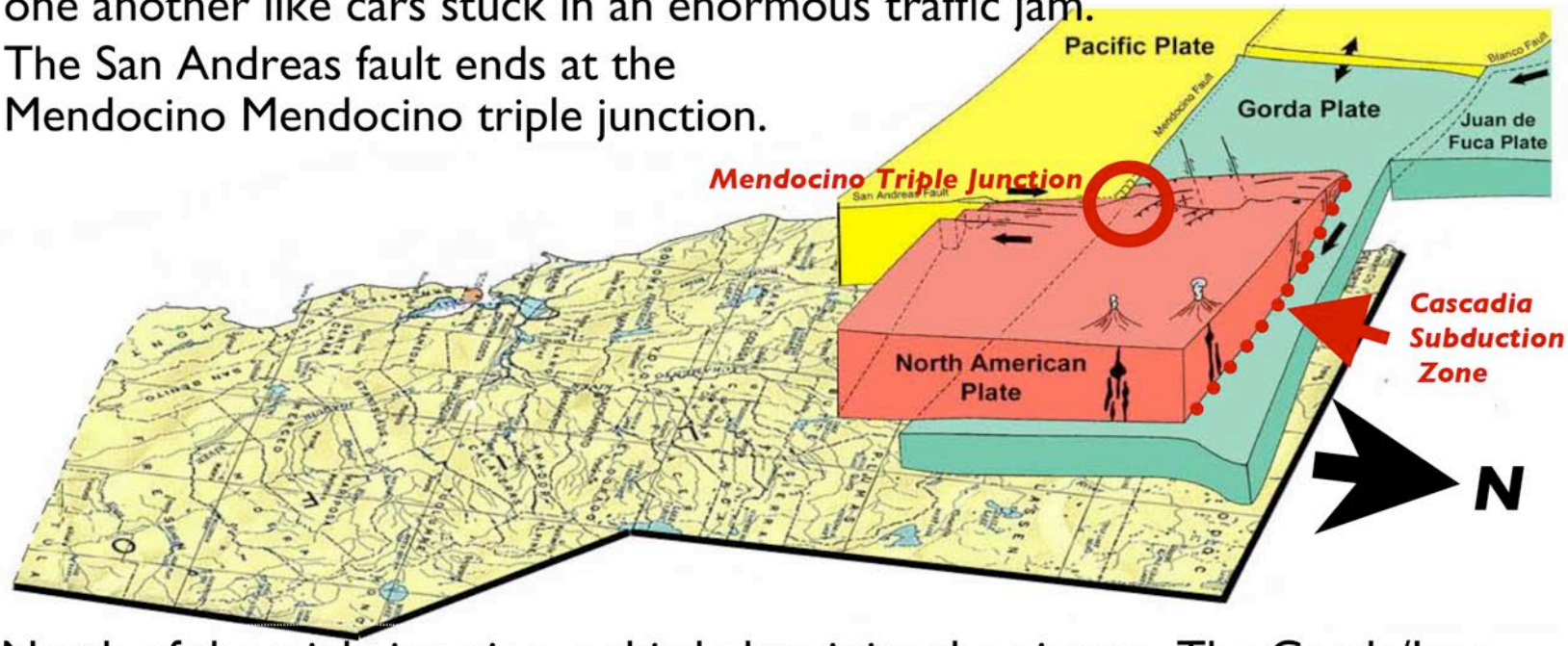
The earthquake demonstrated that the Cascadia subduction zone is capable of producing earthquakes and tsunamis. It reinforced the scientific consensus that local tsunamis are a potential hazard that emergency managers and the public must be prepared for.

Remembering the Cape Mendocino Earthquakes of April 1992

Geologic Setting

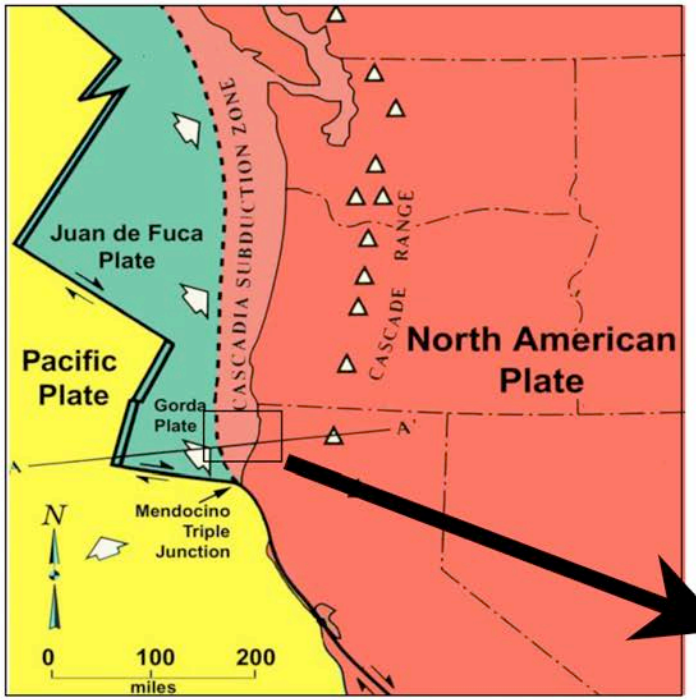
California is earthquake country because of the many faults that cut across it. The most well known is the San Andreas fault where two large plates - the North American plate (red) and the Pacific plate (yellow) - slowly grind past one another like cars stuck in an enormous traffic jam.

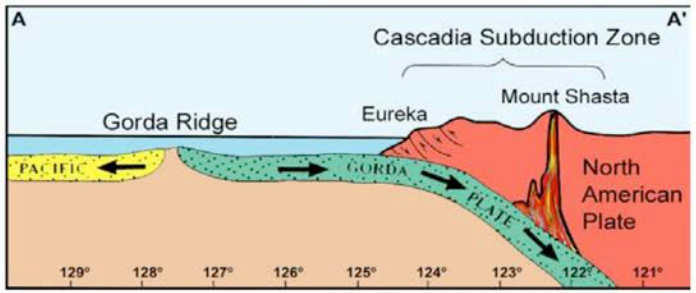
The San Andreas fault ends at the Mendocino Mendocino triple junction.



North of the triple junction, a third plate joins the picture. The Gorda/Juan de Fuca plate (green) moves slowly beneath the North American plate along the Cascadia subduction zone.

Unique Geologic Setting



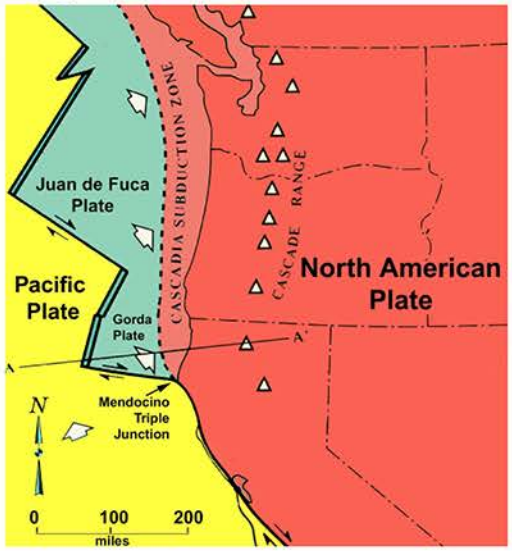


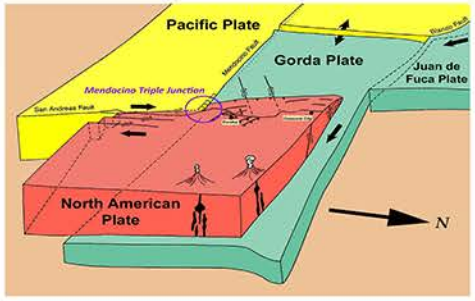
The Cape Mendocino earthquakes were located close to the Mendocino triple junction where three plates, the Gorda, the Pacific and the North American, meet.

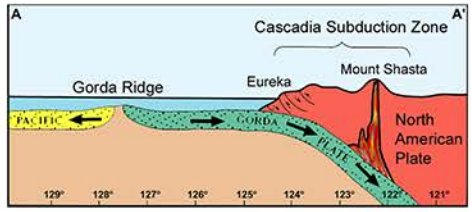
Remembering the Cape Mendocino Earthquakes of April 1992

What is a Cascadia Subduction Zone Earthquake?

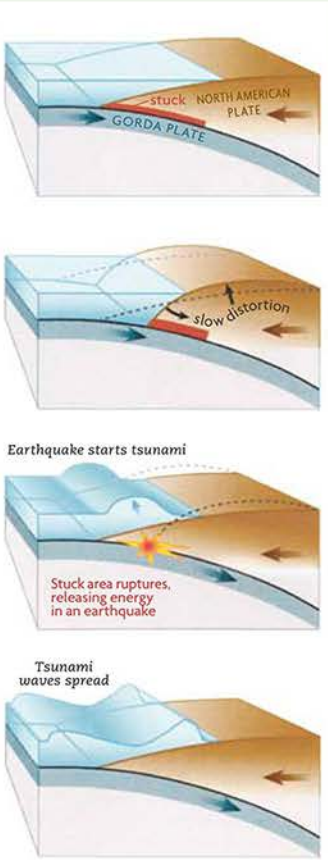
The Cascadia subduction zone is a nearly 700 mile long boundary where the Gorda and Juan de Fuca Plates are pulled beneath the North American plate. The upper part of this boundary is locked. When the accumulated stress overcomes the strength of the locked zone, an earthquake in the magnitude 8.5 to 9 range results.







• **Tsunami** A Cascadia rupture will deform the sea floor lifting the water above it and producing a tsunami. The tsunami will travel outwards in two directions sending surges towards the coast and outwards into the Pacific. The first surges will arrive in as little as ten minutes in Northern California.

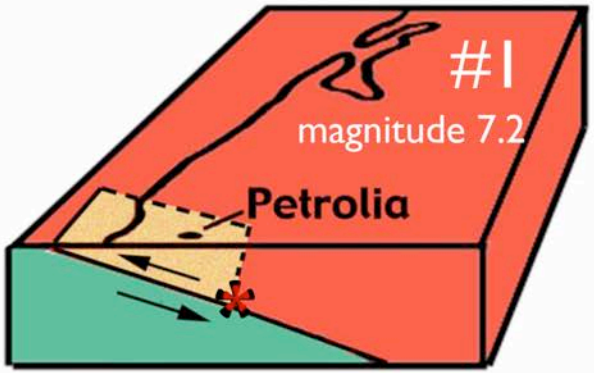


• **Shaking area and length** A full rupture of the Cascadia subduction zone will last more than a minute and be felt in California, Oregon, Washington and British Columbia. It might not be any stronger than an onshore earthquake, but will go on for much longer. The extent of damage to roads, bridges and other infrastructure means it will take longer for help to reach you.

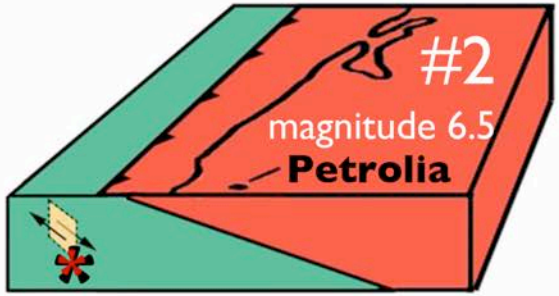
Planning efforts for a Cascadia earthquake in California are based on a full rupture - magnitude 9.

The 1992 M7.2 was in the complex zone of faults near the Mendocino triple junction. It was not on the Cascadia interface but made scientists and and planners much more aware of what a Cascadia earthquake would be like.

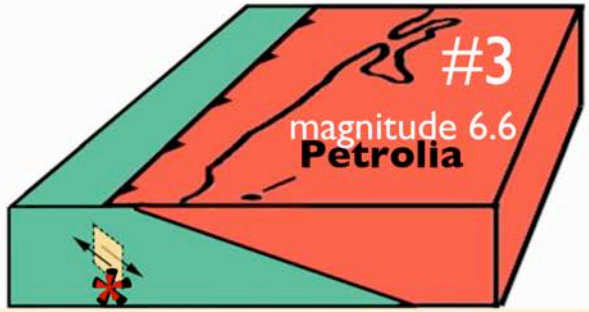
The Sequence:



#1: The first earthquake at 11:06 AM was the largest. The epicenter was on shore, 3 miles east of Petrolia. The rupture started at a depth of about 8 miles beneath the surface pushing the rock on top up and over the rock beneath. This is called a thrust fault. The rupture was close to the Cascadia subduction zone interface.



#2: The first major aftershock and the third largest earthquake in the sequence was at 12:41 AM the next day. It was centered offshore 17 miles WNW of Petrolia on a strike-slip fault within the Gorda plate. The rupture started at a depth of about 13 miles and the rock on each side moved horizontally relative to each other.



#3: The second major aftershock and the second largest earthquake was at 4:18 AM, more than 3 hours after #2. It was centered offshore 16 miles west of Petrolia at a depth of 14 miles. The faulting was similar to earthquake #2.

Remembering the Cape Mendocino Earthquakes of April 1992

Which earthquake was the strongest?
It depended on where you were!

Households reporting items off shelves:

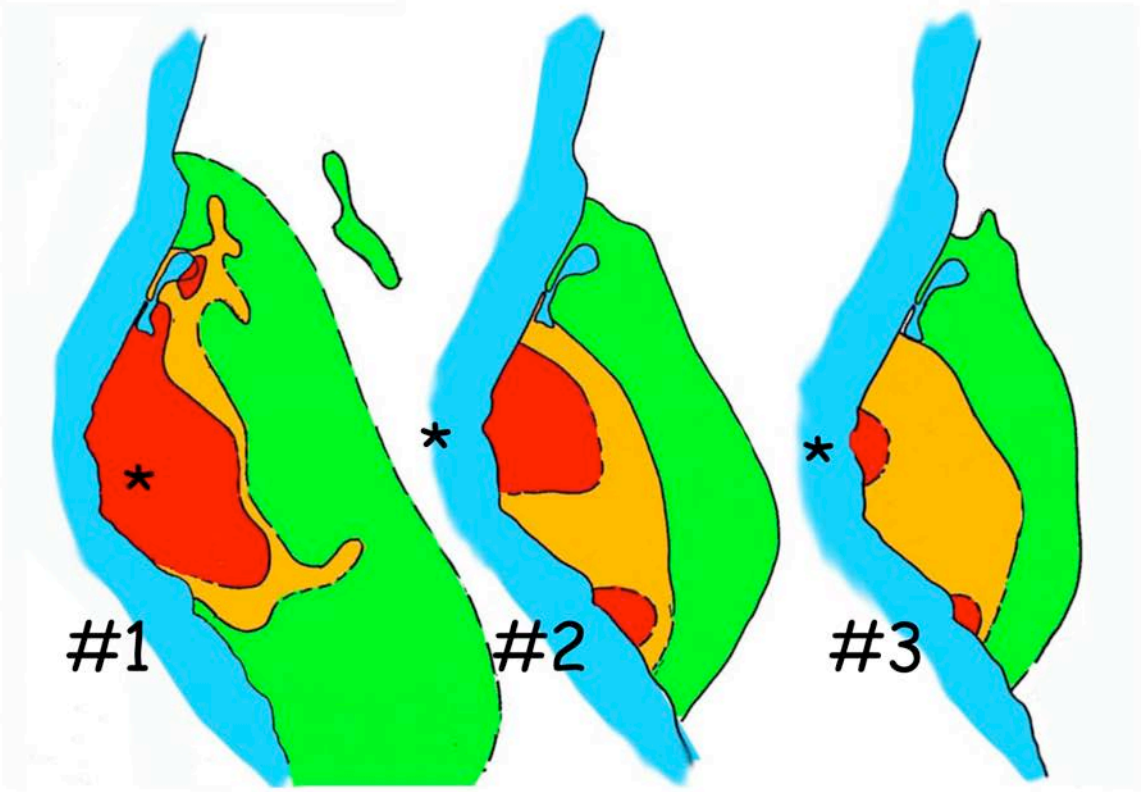
All: 95 - 100%

Most: 70 - 95%

Many: 15 - 70%

Few: 0 - 15%

The Mainshock was the most widely felt and did the most damage. But the aftershocks were felt more strongly in areas to the south. Earthquake #3 woke sleepers in Salinas!



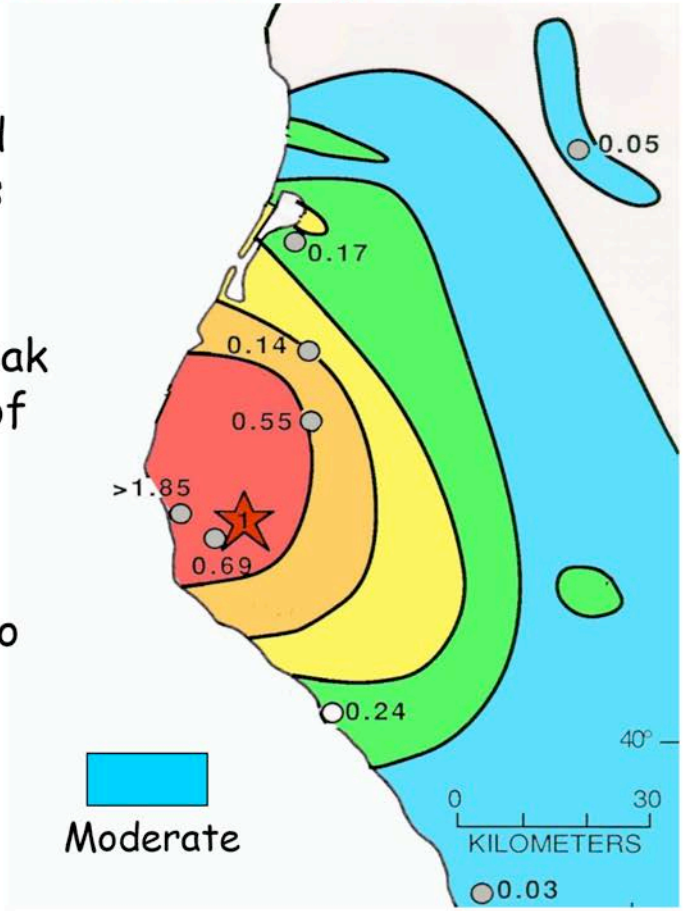
Remembering the Cape Mendocino Earthquakes of April 1992

How strong did the ground shake?

The mainshock produced the highest ground motion ever recorded in a California earthquake.

This is an *isoseismal map* of the Mainshock. It is based on damage and reports from people. The gray circles are the locations of strong motion instruments that record ground acceleration. The numbers are the peak recorded values expressed in terms of gravitational acceleration.

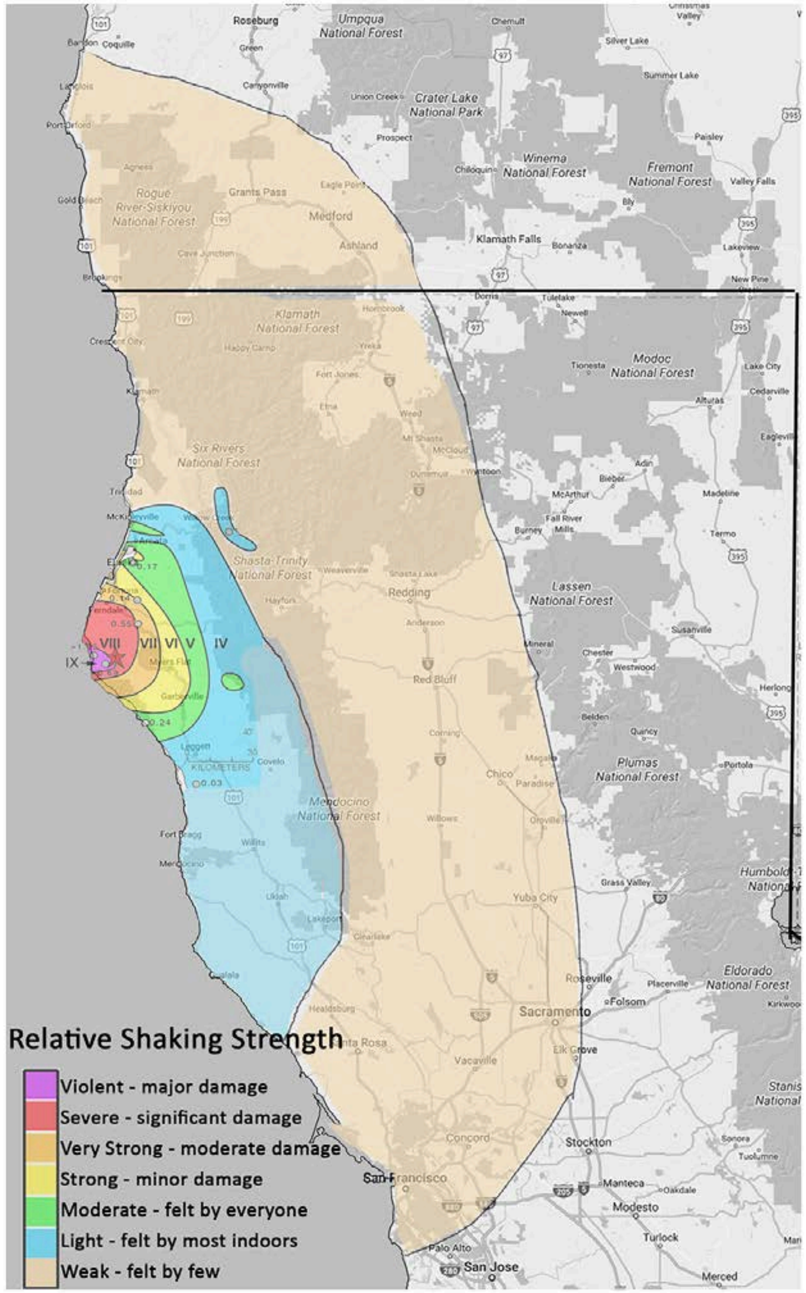
At Cape Mendocino, the acceleration was strong enough to throw items into the air!



Violent | Severe | Very Strong | Strong | Moderate

Remembering the Cape Mendocino Earthquakes of April 1992

Where were you in '92?



This is an isoseismal map. It shows the general pattern of shaking during the April 25, 1992 magnitude 7.2 earthquake. Were you in this area during the earthquake? Let us know what you experienced.

Typical observations

<u>Violent</u> - unable to stand, major damage to buildings, most very frightened
<u>Severe</u> - difficult to stand, some houses off foundations, everything knocked from shelves
<u>Very Strong</u> - chimney damage, cracks in buildings, many items off shelves
<u>Strong</u> - some items off shelves, felt by everyone, noticed by people driving cars
<u>Moderate</u> - felt by nearly everyone not driving, no damage
<u>Light</u> - felt by most people indoors
<u>Weak</u> - felt only by a few people sitting or lying down, swaying of lamps or ripples in ponds may be noticed

This map was compiled from the observations and comments of over 1500 people who responded to our requests for shaking information after the 1992 earthquake.

Brick buildings were particularly vulnerable


Valley Grocery (formerly the General Mercantile), Ferndale 1992

The walls of Ferndale's one brick building collapsed crushing a Volvo parked behind it.


General Mercantile, Ferndale 1906

1992 wasn't the first time. In 1906, the same building suffered nearly the same damage. It won't happen a third time, the building was torn down and replaced with a wooden one.

The car's only occupant, Schatzy, was miraculously unharmed!


Schatzy, Ferndale 1992


Behind the Valley Grocery, Ferndale 1992

The Most Dangerous Place to Be
In Between Inside and Outside

Every California earthquake teaches the same lesson. The most dangerous thing you can do during the shaking is to run from the inside of a building to the outside.

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Damage to buildings…

Houses moved off foundations:

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Non-Structural Damage

The most common type of damage and cause of injury in the 1992 earthquakes was non-structural damage. This includes windows, tiles, items on shelves - all of the elements in a building that are not part of the frame that supports the building. Non-structural damage in the 1992 quake included broken windows, toppled shelving, fallen wires and roofing, tipped over furniture and appliances, and broken pipes.

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During the strong ground shaking heavy objects were more likely to fall than lighter ones !

Heater and pipe pulled from wall.

Heavy bookshelves toppled over.

Paperback rack still standing!

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Strong ground shaking triggered slumps and landslides.

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Fire !!!


Post Office and Genral Store,Petrolia 1992

The mainshock caused a fire in Petrolia that destroyed the store, post office and gas station. The shaking jammed the doors on the fire station so that the fire truck couldn't get out.

The first large aftershock caused a fire in Scotia that destroyed the Shopping Center.

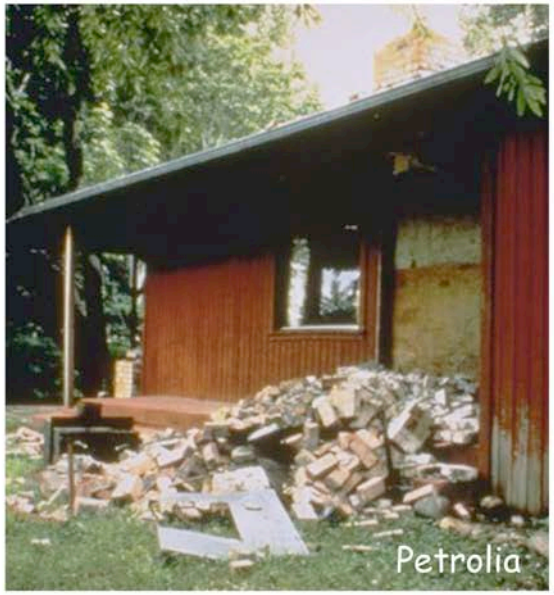

Mall, Scotia 1992

Brick Chimneys

were particularly vulnerable

Going...

Going...



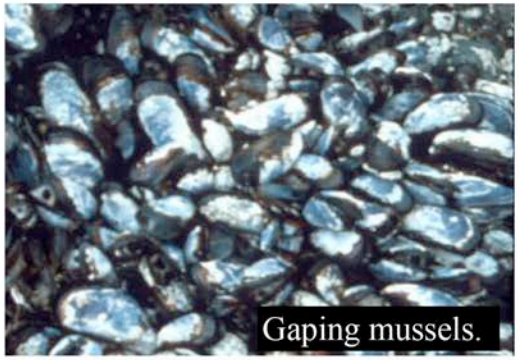
Gone...

Remembering the Cape Mendocino Earthquakes of April 1992

Coastal Uplift

Fault movement from the 1992 mainshock uplifted 12 miles of coastline between the mouth of the Mattole River and Cape Mendocino as much as 4.5 feet. The uplift devastated the intertidal ecosystem, killing sea urchins, seaweed, mussels, and barnacles.


Abandoned sea urchin sockets


Gaping mussels.

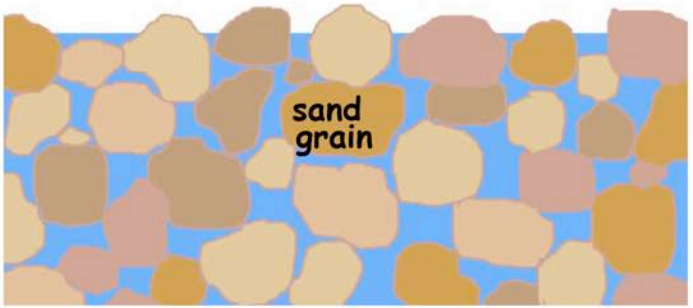

Dead seaweed.


Mussel Rocks.

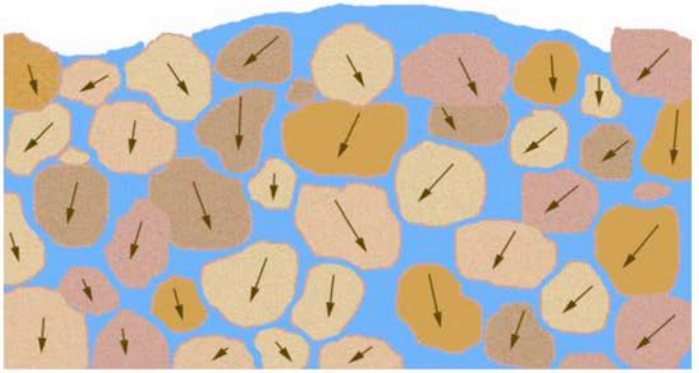
Remembering the Cape Mendocino Earthquakes of April 1992

Liquefaction

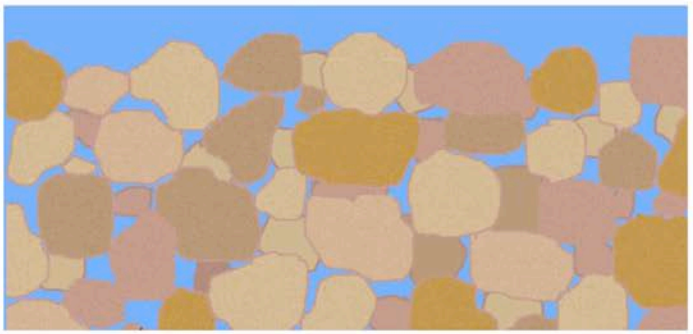
Before: Sand grains are loosely packed, resting on one another to form a solid layer. Water fills the pore spaces between the grains.



During: The shaking causes the sand to compact. As the grains move closer together, the water is forced up and around the grains and may even squirt onto the surface. The grains are no longer in contact with each other and the sand layer loses its rigidity.

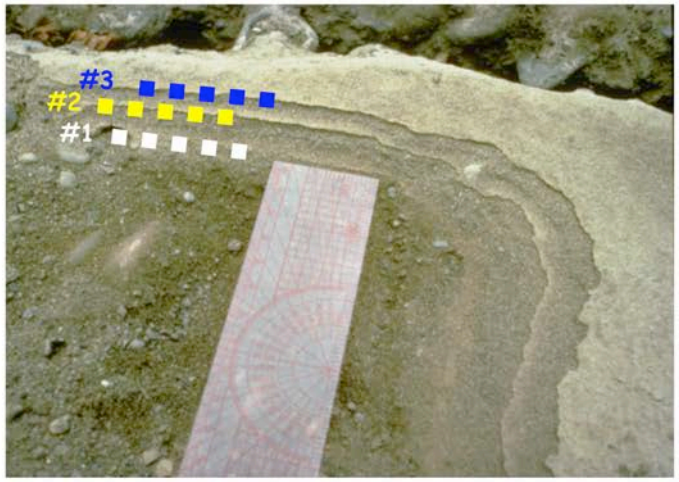


After: When the shaking stops, the sand grains settle into a new, more compact layer. Once again the grains are in contact and the layer is solid.



Strong ground shaking caused the ground to liquefy

Strong ground shaking in 1992 caused liquefaction on beaches and river valleys. Water squirted up producing sandblows and subsidence.



Each of the three largest earthquakes in 1992 caused liquefaction in the Mattole River estuary.

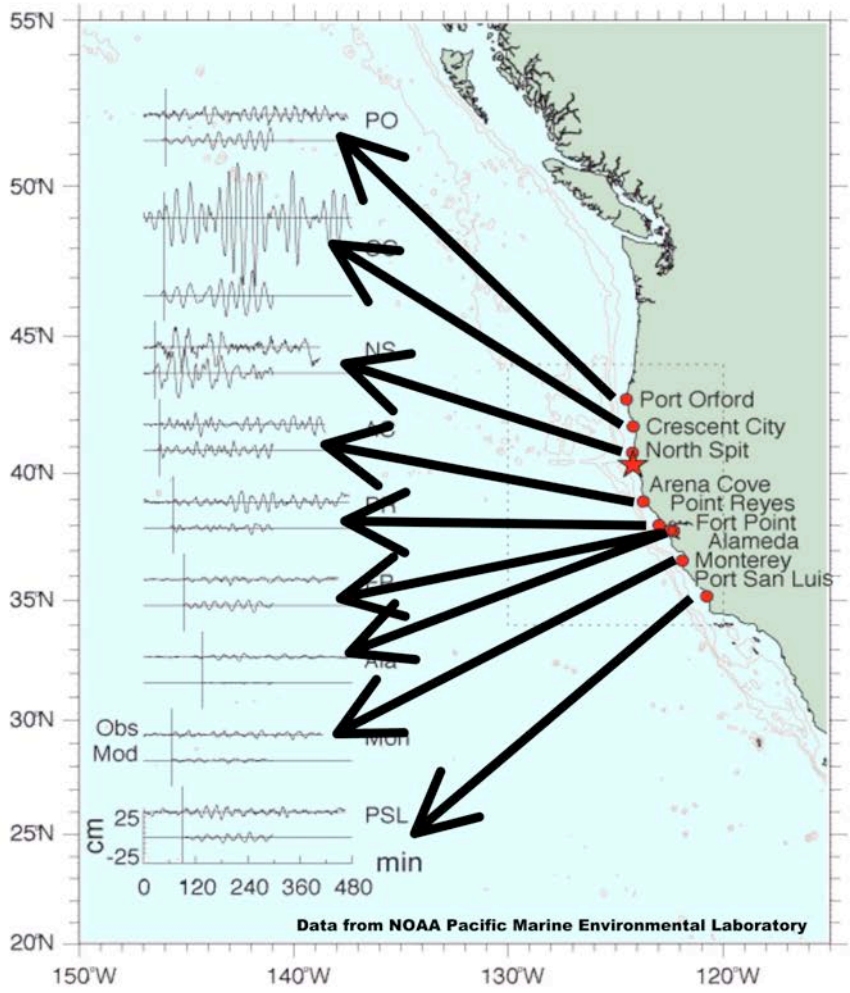

Sandblows, Mattole River, 1992


Ferndale 1906

Strong shaking from the 1906 San Francisco earthquake caused even greater liquefaction, spreading and slumping in the Eel River basin.

1992 Tsunami!

Earthquake #1 uplifted the seafloor offshore of Cape Mendocino causing a tsunami (tidal wave). The tsunami was detected on 9 tide gauges in California, Oregon and in Hilo, Hawaii. This was the first *Local Tsunami* ever recorded on the North Coast. Eye witnesses observed the tsunami as a swell about 3 feet higher than the ambient tide. Fortunately it coincided with low tide and caused no damage.

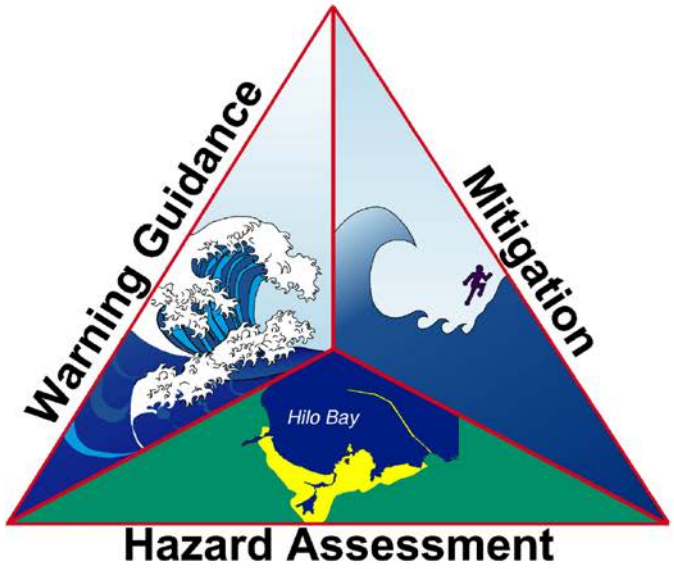


Remembering the Cape Mendocino Earthquakes of April 1992

The 1992 Earthquake Changed Perceptions of US Tsunami Threat

Began the National Tsunami Hazard Mitigation Program

Started Regional Organizations like the Redwood Coast Tsunami Work Group



Awareness of the Cascadia Earthquake and Tsunami Threat

Remembering the Cape Mendocino Earthquakes of April 1992

Impacts

Structures damaged/destroyed: 1,108

Injuries: 356, 9 hospitalized

Costs: $61 million

Deaths: zero

Why did no one die?

Location: The epicenter was in a lightly populated area with no large structures.

Construction: Most buildings affected were wood frame construction. These buildings are elastic - they bend and flex but rarely break. Even when damaged, they don't collapse.

Luck!

Remembering the Cape Mendocino Earthquakes of April 1992

Impacts

Ferndale:

36 homes seriously damaged, 20 homes knocked off foundations. 80 % of businesses damaged. Utilities disrupted. Cost: $11 million.

Remembering the Cape Mendocino Earthquakes of April 1992

Impacts

Petrolia: 5 homes destroyed, 28 homes experienced major damage. Post office, gas station and general store destroyed by fire. Cost $1 million.

Rio Dell: 12 homes destroyed, 57 homes experienced major damage. 75% of businesses damaged. Broken water mains and sewer pipes, water system contaminated. Cost: $11 million.

Remembering the Cape Mendocino Earthquakes of April 1992

Impacts

Scotia: Shopping Center destroyed by fire triggered by the first major aftershock. 50 homes damaged. Cost: $15 million.

Fortuna: Brick chimneys damaged. Many broken windows in business district. Damage to older store buildings.

The Saga of the Red House in Ferndale

Strong shaking caused the cripple walls to fail and the house slowly keeled over to the south

Contractor George Kurwitz put 47 homes in the Ferndale - Rio Dell area back on their foundations

The price tag? $47,000 in 1992 $$

This is one Victorian that withstood the strong shaking in Ferndale. Why? Because its foundation had been reinforced the year BEFORE the earthquake.

One of the Challenges of Response
Celebrity Visitors!

Hobart Brown presenting a "bent key" to Governor Pete Wilson

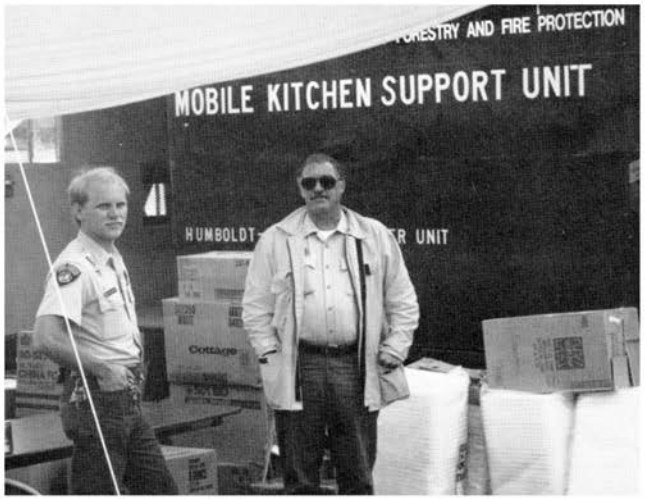
Marilyn Quayle - wife of VP Dan Quayle

Response and Recovery

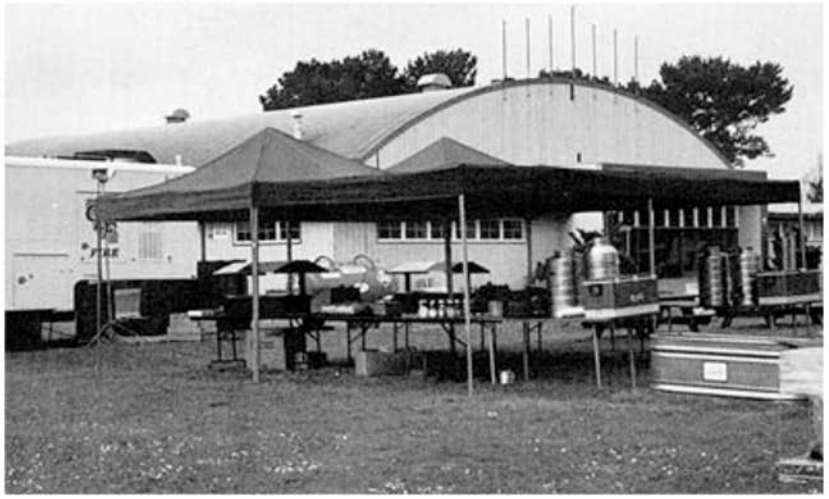
The only North coast earthquake to be declared a Federal Disaster

Rio Dell Disaster Assistance Center

Applying for disaster aid in Ferndale.



Coordinating supplies at the Fairgrounds

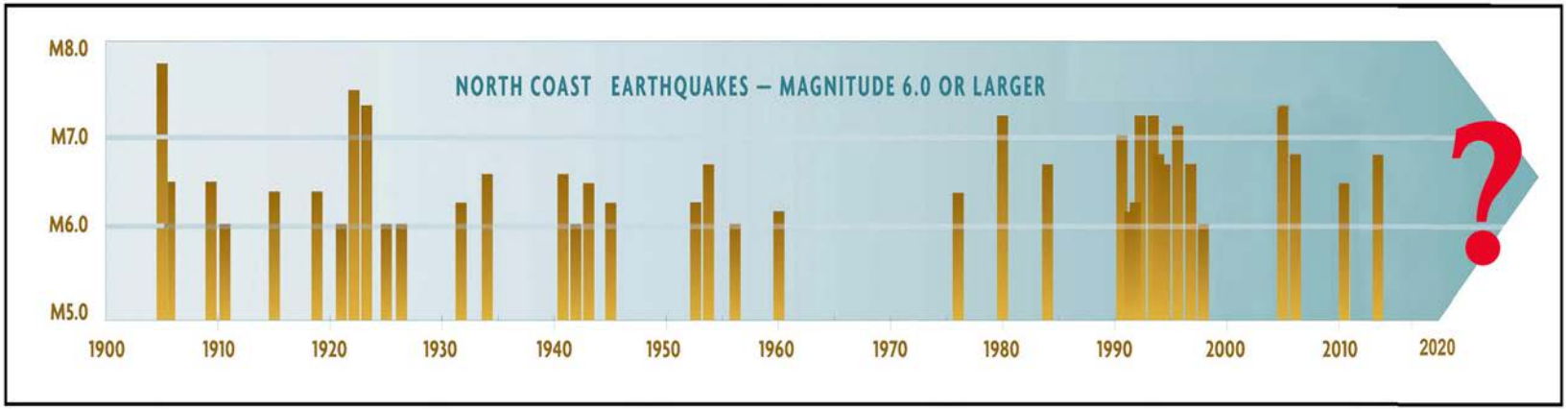


The Fairgrounds becomes the major relief center

Remembering the Cape Mendocino Earthquakes of April 1992

When will the next strong earthquake occur?
Sooner than you may think!!!

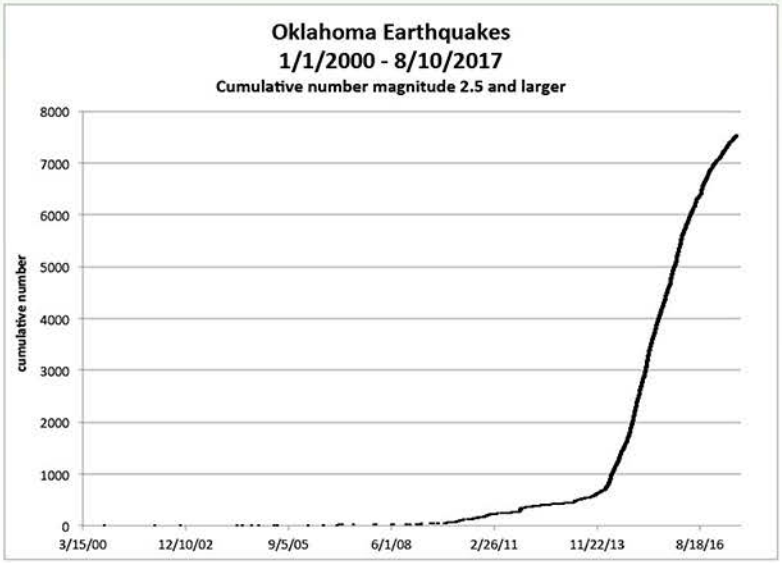
Are You Prepared ?



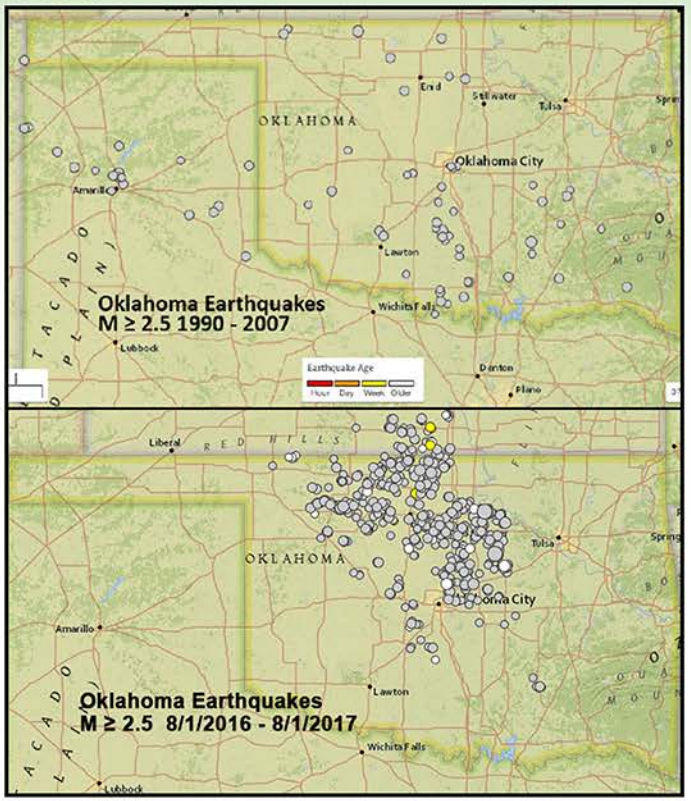
TRemembering the Cape Mendocino Earthquakes of April 1992

What is happening in Oklahoma?

For the fifth year in a row, Oklahoma leads the lower 48 in felt earthquakes. Since August of 2016, 44 earthquakes magnitude 4 or larger were detected in Oklahoma.



This graph shows the cumulative number of earthquakes from 2000 to the present. What changed around 2009? The requirement that fluid wastes from oil and gas drilling be disposed in deep waste water wells. More waste water has been injected as hydraulic fracturing (fracking) has increased.

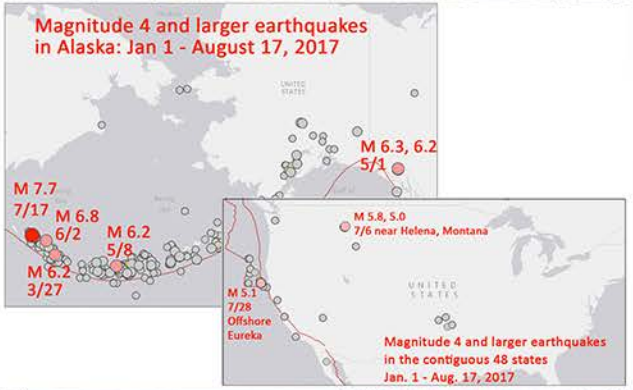


The rate of earthquakes in Oklahoma increased 1000-fold since 2014 compared to the long term pre-2008 rate.

In 2015, Oklahoma finally recognized the increased seismicity as human-caused and has reduced the rate and volume of fluid injection. The number of earthquakes appears to be decreasing.

Notable quakes of 2017 (to date):

- **Deadliest quake: Jan. 18 M 5.7 Italy, 34 deaths**
  Impacts exacerbated by a shaking-triggered landslide that hit resort areas in the Gran Fasso mountains.
- **Largest quake: Jan. 22 M 7.9 Papua New Guinea.**
  Centered in the western Solomon Islands near Bougainville. Three people killed and one injured.
- **Largest US quake: Jul. 17 M 7.7 Near Islands, Alaska** no damage.
- **Largest US quake in the lower 48: July 6 M 5.8 Montana**
  Strongest Montana earthquake since 1975, minor damage.
  Largest North Coast quake - July 28 M 5.1, felt by many, no damage.
- **Tsunamis:** 11 tsunamis detected, two caused damage. A landslide tsunami in Greenland reached almost 300 feet high and killed four. 11 buildings were washed into the water.
  A M 6.7 earthquake on July 20 triggered a 6-foot tsunami and strong currents in the Gulf of Gokova, damaging boats.



Nuugaatsiaq, Greenland | Gulf of Gokova, Turkey

Know Your Zone

HUMBOLDT BAY REGION

Tsunami Evacuation Map Index

Put a pin in the map where you live or work. If it is in the white area, you are safe. You do not need to evacuate. If it is in the yellow area, plan an evacuation route. Remember, the earthquake shaking is your warning. Head to high ground or inland as soon as the shaking subsides enough for you to safely move. Go on foot - the ground shaking is likely to have disrupted roads.

This map is designed to help you protect yourself from the biggest tsunami likely to hit our area – a magnitude 9 earthquake on the Cascadia subduction zone. It is based on the best currently available information about tsunamis in our region. The map does not show where the water is likely to flow. It shows safe areas (in white) and areas that may be at risk (in yellow). The map may be change as more information becomes available.

Living on SHAKY GROUND
HOW TO SURVIVE EARTHQUAKES AND TSUNAMIS IN NORTHERN CALIFORNIA

2015 Earthquake Tsunami Room Humboldt County Fair

Redwood Coast Tsunami Work Group

Thank You

What you see in this room is a result of the efforts of the Redwood Coast Tsunami Work Group (RCTWG), an organization of local, state and federal agencies, tribes, relief and service groups, land managers, and businesses from Del Norte, Humboldt and Mendocino Counties. The group was formed in July 1996 to define the needs of local jurisdictions to mitigate the North Coast earthquake and tsunami hazard and to promote a coordinated, consistent mitigation program for all coastal areas. The RCTWG is part of the California Earthquake Alliance, a state organization of regional work groups that foster preparedness throughout the state.

Special thanks our Earthquake – Tsunami Room Volunteers from:

NOAA/National Weather Service – Eureka Forecast Office
California Geological Survey
California State Parks
Cascadia GeoSciences
Humboldt County Public Works
Humboldt State University/Geology Department
Humboldt State University/CERT
Redwood State and National Parks
Pacific Watershed Associates
Redwood Coast Tsunami Work Group
U.S. Geological Survey