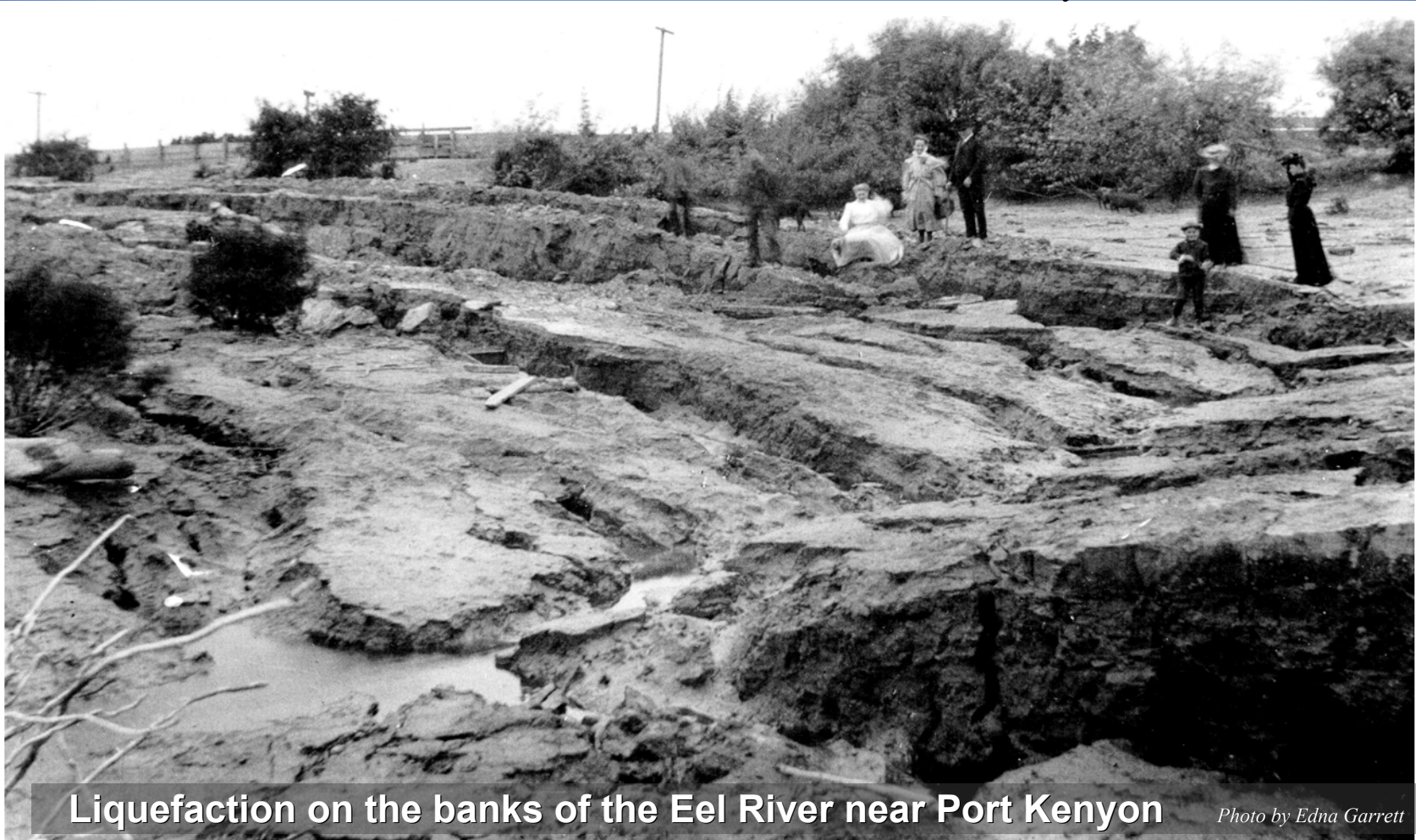


The Great 1906 Northern California Earthquake



Liquefaction on the banks of the Eel River near Port Kenyon

Photo by Edna Garrett

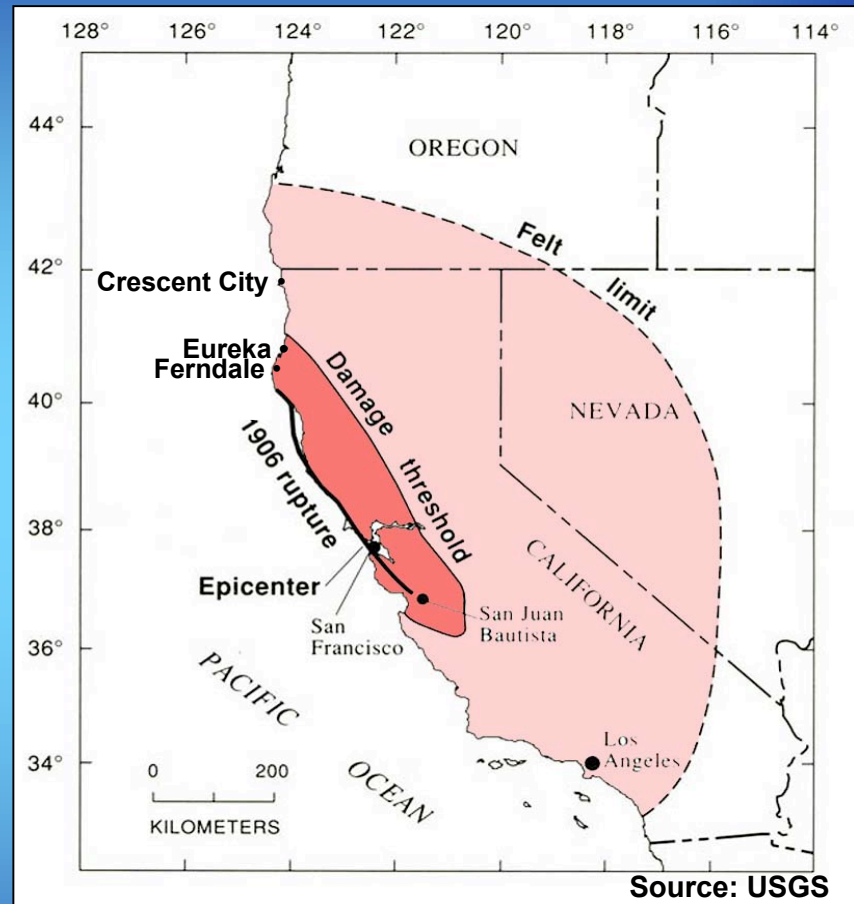
**The Strongest North Coast Temblor
in 150 Years of Written History**

1906 Earthquake on the North Coast - Humboldt & Del Norte County Fair EQ - Tsunami Display 2006

Why North Coast residents should be interested in the 1906 "San Francisco" Earthquake

The 1906 earthquake didn't just hit San Francisco.

- Major damage extended from Santa Cruz to Arcata
- The earthquake was felt in Southern Oregon and most of Nevada
- It was our strongest historic earthquake



Someday the northern San Andreas fault will rupture again, damaging buildings and cutting us off from the rest of the state for days or weeks.

1906 Earthquake

Largest California earthquake in the past 150 years.

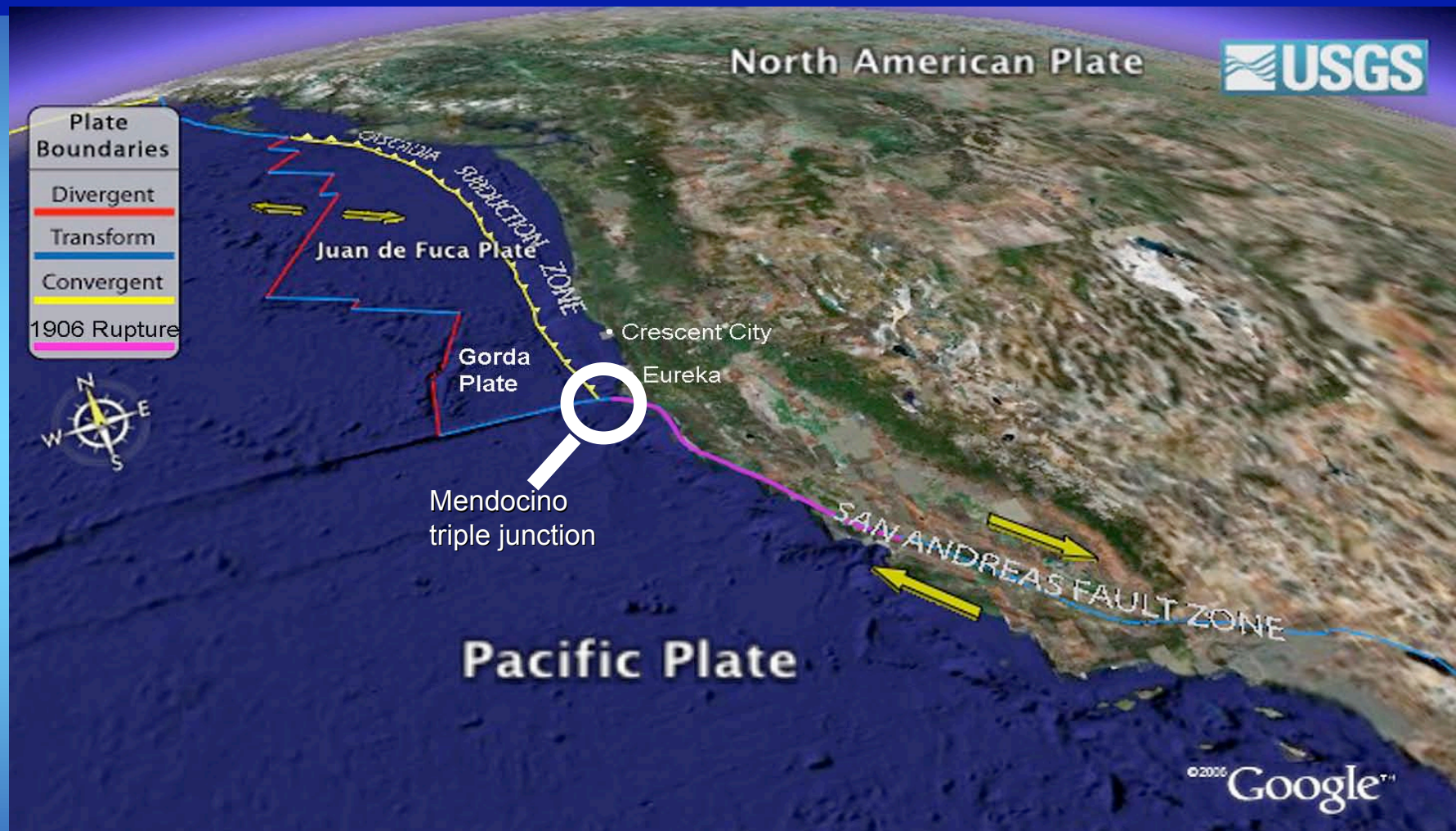
Humboldt and Del Norte Counties



The fault rupture extended nearly 300 miles —
from Santa Cruz to Southern Humboldt County

1906 Earthquake

Plate Tectonic Setting



The 1906 earthquake ruptured the transform plate boundary between the North American and Pacific plates

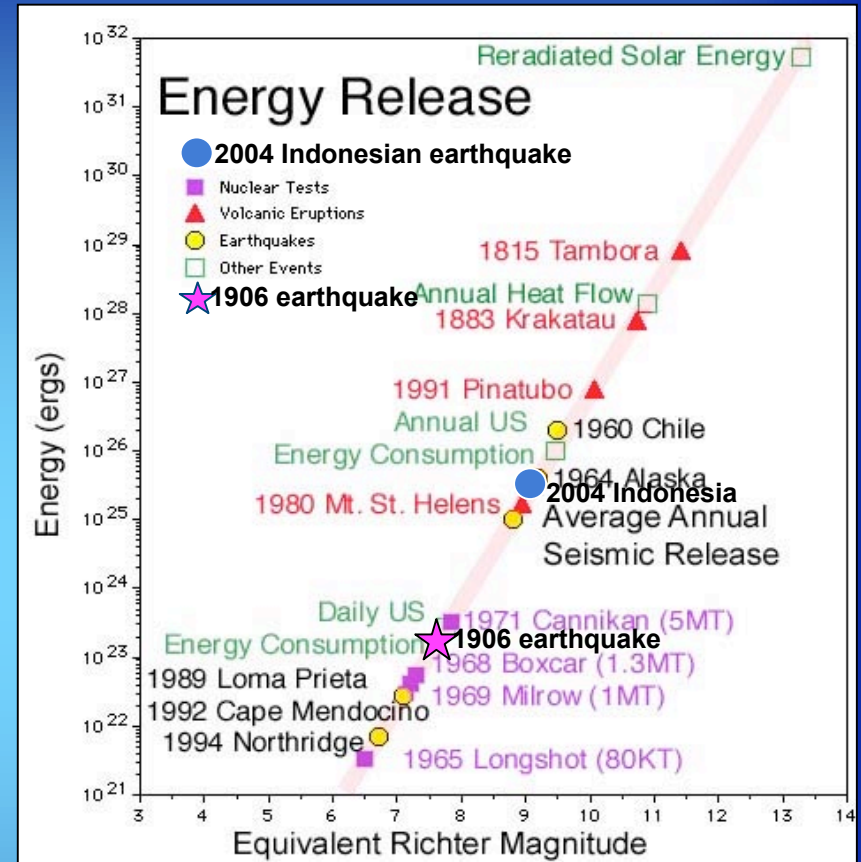
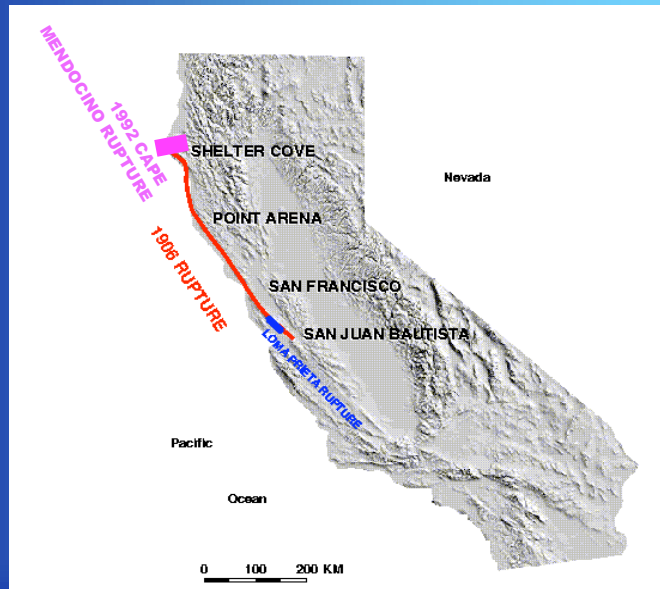
How big was the 1906 Earthquake?

ENERGY RELEASE

The 1906 earthquake was California's largest historic event. The currently accepted magnitude is 7.8.

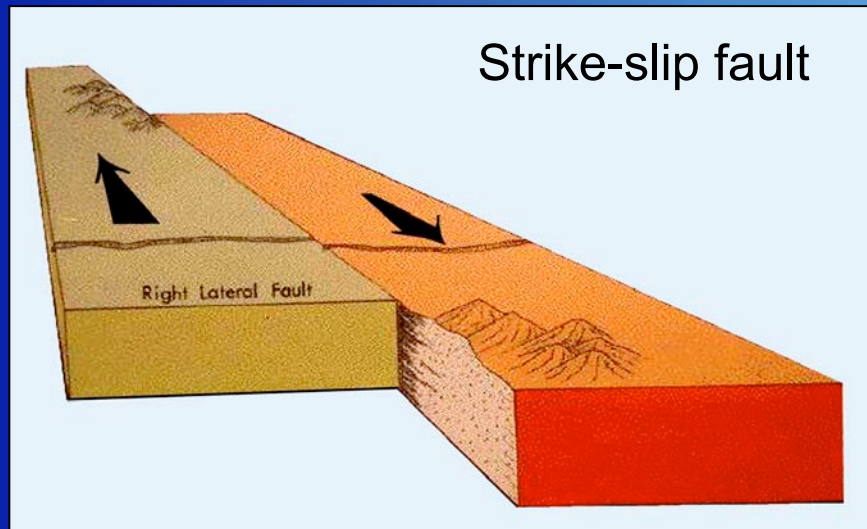
This earthquake was as big as:

- 500 Hiroshima bombs
- Half the eruption of Mt. St. Helens
- 11 Cape Mendocino earthquakes

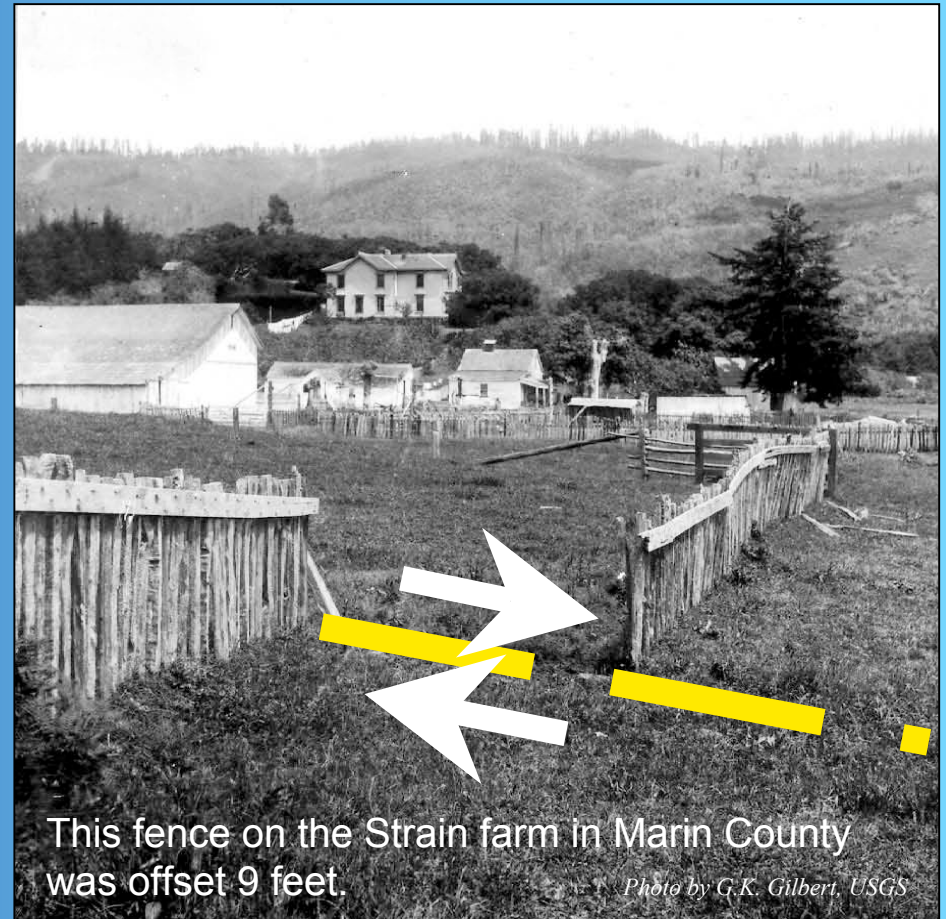


The 2004 Indonesian and the 1700 Cascadia earthquakes were over 100 times bigger!

How did the fault move?



- The San Andreas fault is a strike-slip fault.
- The ground on each side of the fault moved horizontally.
- Largest measured slip was 21 feet near Point Reyes.



Before the 1906 earthquake, most geologists thought all earthquakes involved vertical movement. 1906 demonstrated that large earthquakes could be pure strike slip.

What if the 1906 Earthquake happened now?

Scientists estimate that if the 1906 earthquake happened right now:

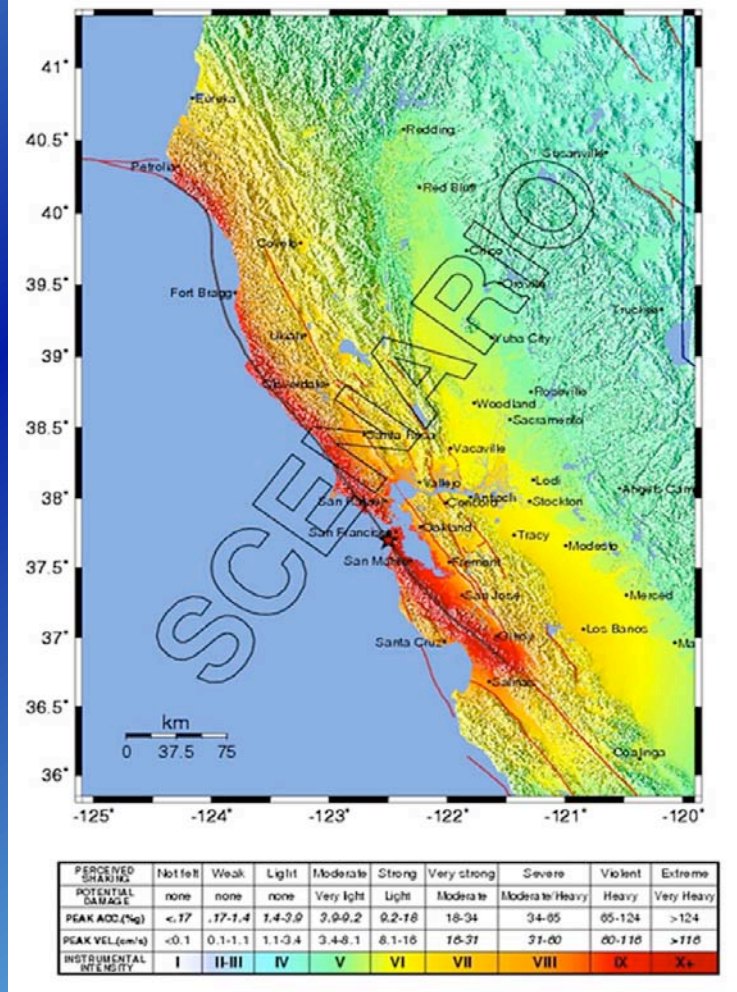
- 1,800 to 3,500 people would die
- 160,000 to 250,000 people would be displaced
- Would cost at least \$150 billion to repair damaged buildings

In Humboldt County The area of damaging shaking would be about twice as large as the 1992 Cape Mendocino earthquakes, disrupting pipelines, utilities, roads and bridges, and cutting us off from the rest of the state for days or weeks.

In Del Norte County People would feel the earthquake but there would be little damage. However, roads to the south would be impassable and power could be disrupted.

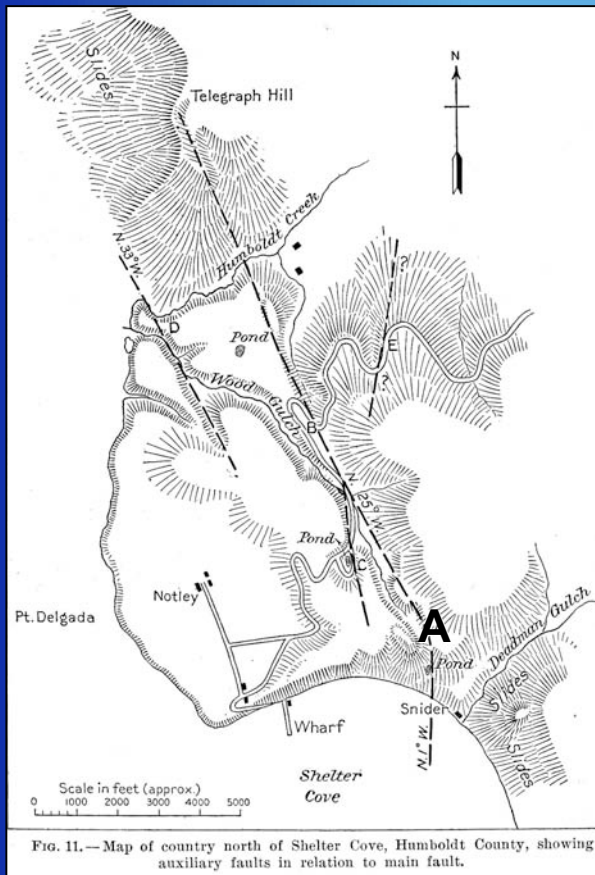
Someday the northern San Andreas fault will produce another great earthquake. Recurrence estimates are between 200 and 400 years.

MMI ShakeMap for the 1906 earthquake predicted by Working Group 2002



1906 fault rupture was mapped in Shelter Cove

After the earthquake, geologists studied the fault area from Santa Cruz to Humboldt County. F. E. Mathes mapped the Shelter cove area.



Mathes' map from the 1908 State Earthquake Investigation Report

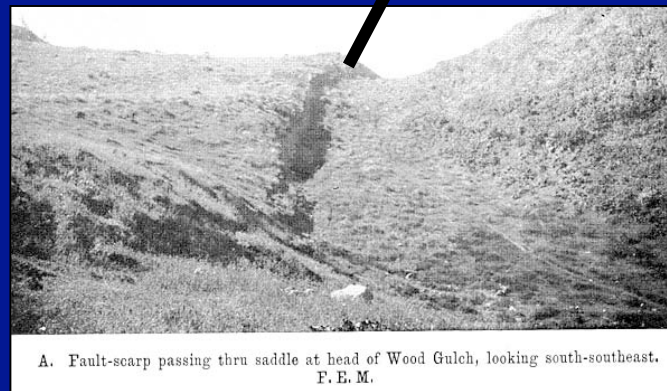


Photo of scarp interpreted as 1906 rupture.

From the 1908 State Earthquake Investigation Report



Same area in 1962

What happened in San Francisco?



More damage was caused by the fire in San Francisco than the ground shaking. Most of the city's water supply was disrupted by the earthquake. Dynamiting buildings to fight the fire caused even more damage.



Many spectators used boats of all sizes to watch the great conflagration including 17 year-old Cecile Clark, an undergraduate at UC Berkeley. Cecile founded Eureka's Clark Museum.



View of downtown earthquake and fire aftermath. Photo by Arnold Genthe, Print by Ansel Adams.

What happened in San Francisco?

Ground shaking and liquefaction was much stronger in areas of soft sediments and artificial fill.



Earthquake Information Bulletin photo, USGS

A small pocket of fill on Union Street caused the ground to liquefy and fail while nearby areas suffered little damage.

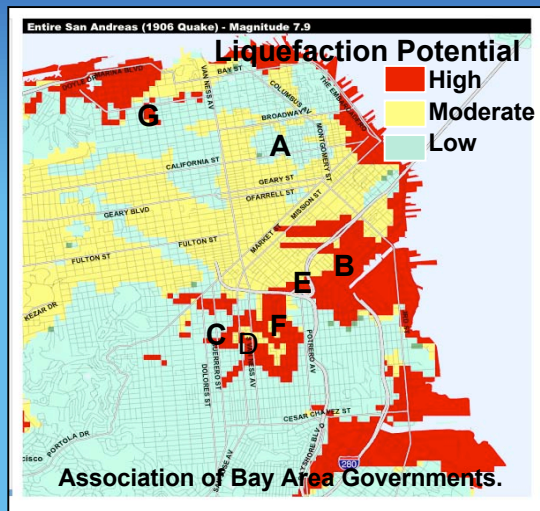


Photo Fairmont Hotel

The not-yet-opened Fairmont Hotel on the Franciscan bedrock of Nob Hill suffered little damage in the earthquake but was gutted by the ensuing fire.



Photo by G.K. Gilbert, USGS

Brannan and 9th Street near the boundary of filled ground.



Photo by G.K. Gilbert, USGS

Cracks caused by liquefaction of filled ground on Bluxome Street, near 6th Street.



Photo courtesy of City Museum of San Francisco

The three-story Valencia Hotel on Valencia Street, between 18th and 19th Street, toppled over, killing an estimate 200 residents. This section of town was built on the filled-in Mission River drainage.



Photo by G.K. Gilbert, USGS

Howard Street (now South Van Ness) between 17th and 18th Street. Many buildings tilted on their foundations as the ground liquefied.

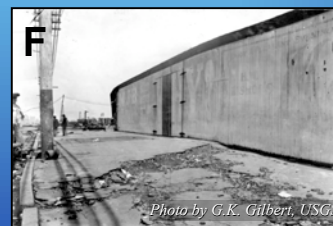


Photo by G.K. Gilbert, USGS

Spread failures on Bryant Street near 8th Street.

Impacts of the 1906 earthquake

- At least 3,000 people lost their lives
- Greatest single fire loss in US history - 522 city blocks destroyed
- More than half the population (~250,000) homeless
- \$524 million property damages (1906 dollars)



Stanford Campus, Palo Alto
Statue of French scientist
Louis Agassiz, fallen
from the arches above.

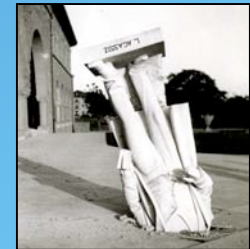


Photo SFMOMA

Howard Street, San Francisco



What happened elsewhere in the State?

Significant damage occurred in communities from Santa Cruz to Humboldt County

Point Reyes



Train thrown from rails at Point Reyes Station.

Tomales Bay



Water tank toppled over.

Oakland



The East Bay wasn't hit nearly as hard but some brick buildings were badly damaged.

Santa Rosa



Santa Rosa may have suffered the worst damage - almost all the buildings in town were badly damaged and the collapse of the City Hall (above) was spectacular.

Palo Alto

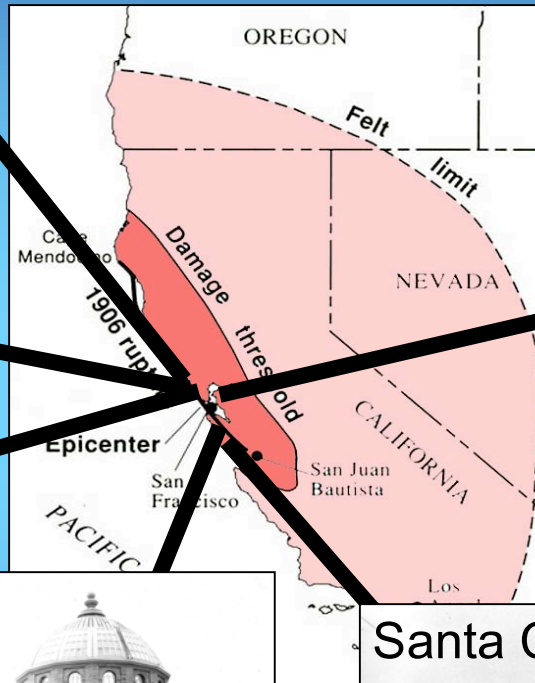


Damage was particularly severe at the new Stanford University campus in Palo Alto.

Santa Cruz



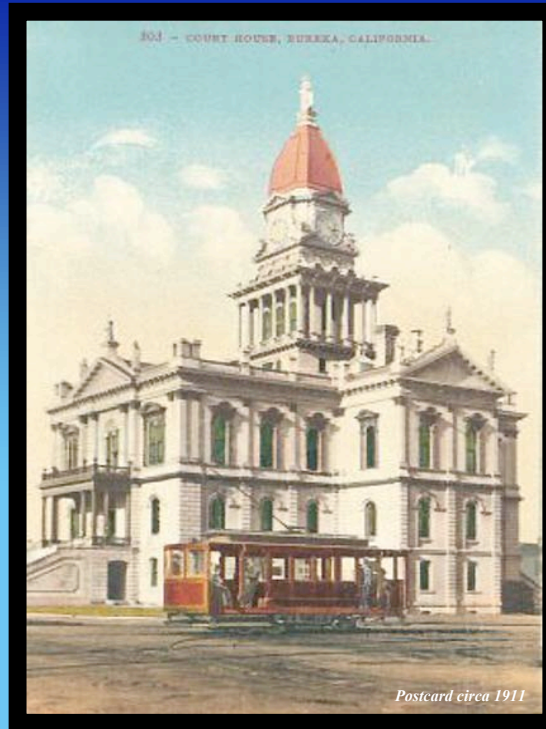
Wood house split in half by the fault rupture.



Eureka

(population ~10,000)

- Numerous downed chimneys
- Broken glass
- Water sloshed from tanks
- Many items knocked from shelves
- No major damage to structures



**Eureka Court House (5th & H St.)
Built 1900, demolished 1924**



Statue of Minerva knocked 45°

"...Daly's front were cracked into small fragments in that manner, as I saw when I went down to work at 8 o'clock. F Street looked quite wrecked. Daly's store especially. The goods were thrown from the shelves there and things thrown all over the floor. Our office had two panes of glass slightly cracked. It will be a long time before all the plate glass is replaced, for it will have to come from the East. Minerva on the Court House was tipped to nearly 45 degrees so she looks as if she were just ready for a high dive, but the Court House was not otherwise injured at all. They are starting now to put up scaffolding to restore Minerva; it will cost several hundred dollars to do it. The Grand Hotel lost most of the plaster from the first story. The Winship school escaped with a broken chimney, some cracked plaster (not very bad) and the upper half of the flag pole snapped short off. Nearly all the window glass was broken out of Ohman's old store, giving it an even more dilapidated appearance than usual..."

*Excerpt from letter written April 27, 1906 by Joseph Prince Tracy (1879-1952) to his sister, Edith, then a graduate student at Radcliff College, Cambridge, Massachusetts.
Courtesy of the Humboldt Historical Society*

A San Francisco Earthquake Survivor



Photo courtesy of Ericson Collection

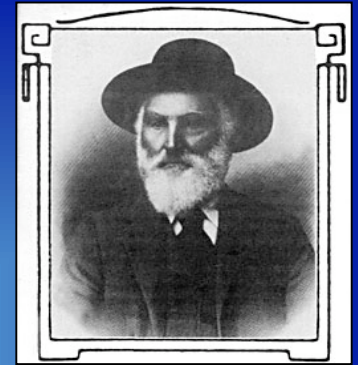
Arcata Plaza circa 1907



Photo courtesy of Peter Palmquist Collection

Preparing to install the statue, July 1906

Another centennial went unnoticed this year - the statue of President McKinley that stands in Arcata's Plaza.



George Zehndner,
*Courtesy of Humboldt County
Historical Society*

George Zehndner was an Arcata pioneer and an admirer of President McKinley. After McKinley's assassination in September 1901, he commissioned San Francisco sculptor Haig Patigian to cast a bronze statue of the fallen president for \$15,000. The statue had just been completed when the earthquake occurred. The earthquake knocked the statue over but fortunately its fall was broken by a plaster model nearby. The structure housing the statue burned to the ground and the statue was presumed melted. A week later, Patigian was allowed to return to the area and found a group of men standing with it. They had rescued it from the building before the fire consumed the building and left it, hand pointing upwards, in the street. It had taken some smoke damage, but the bronze sculpture was mostly unharmed. It arrived in Eureka on May 1, 1906 and was officially presented to the City of Arcata on July 4, 1906.

Humboldt Historian, Nov. Dec. 1987

*70% of the Ferndale buildings of 1906
are still in the town today!*



**APRIL 18,
1906**

PHOTO BY EDNA GARRETT,
COURTESY FERNDALÉ MUSEUM



**APRIL 8,
2006**

PHOTO BY ELLIN BELTZ

FERNDALÉ, CALIFORNIA - NORTH FROM 300 MAIN

Ferndale then and now

The White Front Store, 394 Main Street

(One of only two brick buildings in Ferndale in 1906)

"The store of the J. Gollober Co., formerly the Boynton and Hall place of business, was treated as badly, the bricks from the front covering the sidewalk to a depth of several feet. The sides were shaken down to some extent, and the tower in which hung the fire bell was thrown to the ground." *Ferndale Enterprise, April 20, 1906*



Photo by Edna Garrett, Courtesy of Peter Palmquist Collection



Photo L. Dengler

The White Front Store was demolished after the earthquake. The neo-classical Ferndale Bank that replaced it was built in 1911.



Photos by Edna Garrett, Courtesy of Ferndale Museum



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Ferndale then and now

Milwaukee Saloon, 393 Main Street

Built in the Eastlake-Stick style in 1896, in 1906 the building housed a saloon on the ground floor, a lawyers office and a house of ill-repute on the second floor. The lower floor tilted to the north in the earthquake and all of the downstairs windows were broken.



Photo by Edna Garrett, Courtesy of Ferndale Museum.



Photo L. Dengler

393 Main Street in 2006, currently Hobart Galleries. The Kinetic Sculpture Race began here in 1969.

369 Craig Street

The two-story wooden boarding house suffered severe damage to the upper floor, chimney and porch. The upper floor and bay window were subsequently removed, and the structure today is a modest home.



Photo by Edna Garrett, Courtesy of Peter Pamquist Collection



Photo E. Beltz

369 Craig Street, 2006

Ferndale then and now

339 Main Street

The General Mercantile (owned by the Russ, Early and Williams Co.) had been completed only four months before the earthquake and suffered complete loss of the brick parapet and all the glass windows.



The building was repaired and continued as a commercial establishment until 1992 when it suffered similar damage in the Cape Mendocino earthquake. It was demolished and replaced with a wood structure.



Ferndale then and now

Knights of Pythian Castle, 607 Main Street



Photo by Edna Garrett, Courtesy of Peter Palmquist Collection

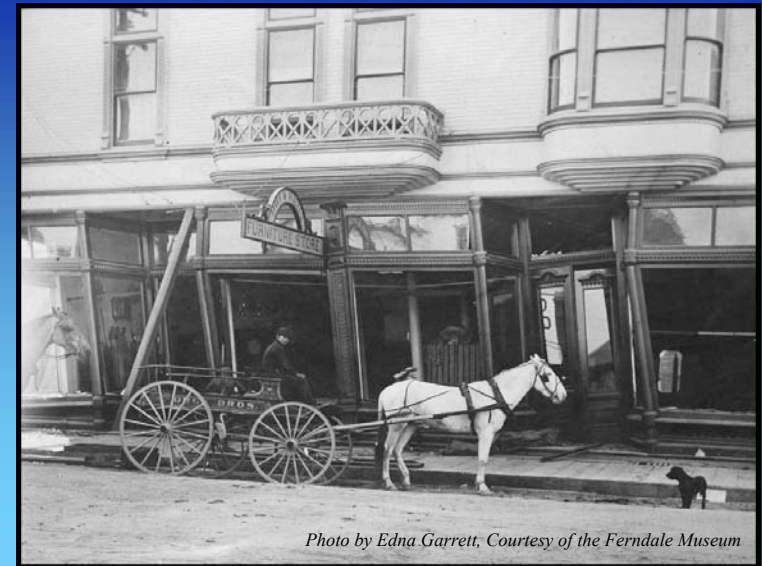


Photo by Edna Garrett, Courtesy of the Ferndale Museum

Ferndale's Pythian Castle was knocked out of kilter by the earth-quake. It was repaired and continued to function until 1926 when it was torn down for a gas station.



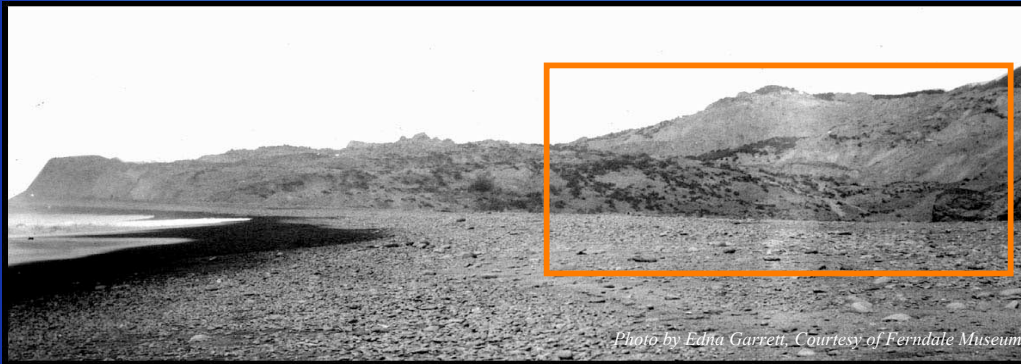
Photo by Edna Garrett, Courtesy of Ferndale Museum



Photo by L. Dengler

Today the Ferndale Pizza Company occupies the site.

Eel River Valley



Landslide (in box) at Centerville into Oil Creek near the mouth of the Eel River.



Bank failure on the Eel River near Port Kenyon due to liquefaction.



Liquefaction on the banks of the Salt River.



Photos by Edna Garrett, Courtesy of Peter Palmquist Collection

The Eel River Valley was hard hit by the 1906 earthquake. Fewer than 2% of chimneys in the Eel River Valley remained intact. Water tanks and windmills were thrown from foundations. Liquefaction was observed throughout the area. Land along the Salt River slid into the river and was cracked for several hundred feet on each side. At Centerville Beach a half-mile of hillslope slid into the Pacific.

Comparing 1906 and 1992

1906 was probably stronger

The 1992 magnitude 7.1 Cape Mendocino earthquake produced strong ground shaking throughout southern Humboldt County and caused over \$60 million in damages. The damage in 1906 was very similar. However, the 1906 impacts covered a larger area and were more severe. In 1906 liquefaction was observed in Loleta and Fields Landing and spectacular fractures were seen in the Eel River Valley. In 1992, liquefaction was more limited in extent and severity.



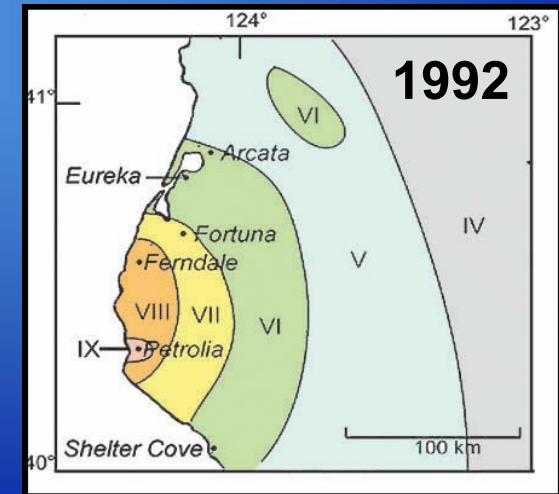
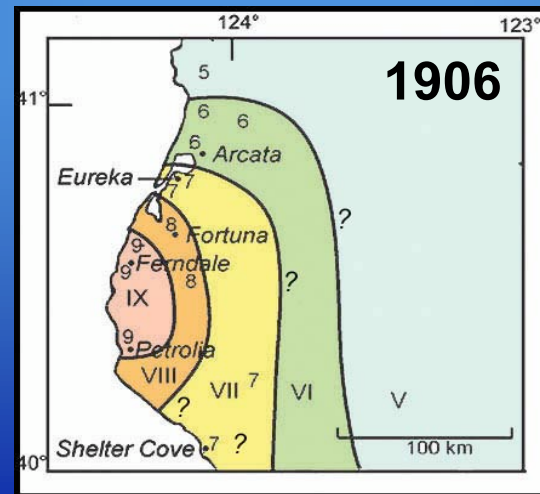
393 Main St. in Ferndale suffered similar damage in the 1992 and 1906 earthquakes. However more of the parapet wall fell and all of the windows were broken in 1906.



Liquefaction was observed along the Mattole River (above left) and locally in the Eel River Valley in 1992. In 1906 it was much more dramatic and widespread.

Shaking Strength

- IX Violent:** Well-built structures damaged
- VIII Severe:** Brick and masonry structures damaged
- VII Very Strong:** Chimneys toppled, heavy objects displaced
- VI Strong:** Windows broken, cracks, items knocked off shelves
- V Moderate:** Felt sharply, a few items toppled
- IV Light:** Felt by most, sleepers awakened.



Humboldt Bay Region

The Humboldt Bay region was not hit as hard as the Eel River Valley, but all the communities on the Bay experienced damage.

Arcata - 30 chimneys were knocked down and the walls at Brizard's store (Jacoby Storehouse) spread apart. A vast quantity of lumber on the Arcata wharf fell into the Bay.

Eureka - Damage similar to Arcata. Many chimneys were knocked down and numerous windows broken. Water towers toppled and water sloshed in the streets.

Samoa Peninsula - Two lumber warehouses on the Samoa Peninsula were badly damaged and machinery displaced.

Fields Landing - The most heavily damaged community on the Bay. Pacific Lumber Company's wharf dropped into the Bay with losses estimated at \$15,000.

Humboldt Bay Entrance - Off the entrance to the Bay, passengers on the steamer Alliance felt several strong bumps and thought the vessel had struck the bottom or logs in the water.



Photo courtesy of Ferndale Museum, photographer unknown

Pacific Lumber Company's wharf at Fields Landing.

Aftershocks

All large earthquakes are followed by aftershocks and 1906 was no exception. Numerous aftershocks were reported for two years following the earthquake and many of these were located on the North Coast.

In the six weeks following the 1906 earthquake:

- *At least 22 earthquakes were felt in Humboldt County including the largest aftershock anywhere in the state.*
- *On April 23, five days after the main shock, an earthquake of $M \sim 6.7$ occurred within the Gorda basin about 100 miles west of Eureka.*
- *Two additional large events, an $M \sim 6.3$ earthquake near Shelter Cove on 11 August 1909 and a $M \sim 6.7$ near Cape Mendocino on 28 October 1909 are also considered 1906 aftershocks.*

North Coast Aftershocks of the 1906 Earthquake		
Day	Hour	Description
17-Apr	5:22 AM	Slight and short duration, MMI III
17-Apr	12:25 PM	Slight and short duration
18-Apr	night	Slight shock in night
18-Apr	3:00 AM	slight
18-Apr	5:22 AM	slight
18-Apr	6:07 AM	slight
18-Apr	10:30 AM	slight
18-Apr	11:10 PM	Felt in Eureka
19-Apr	3:00 AM	Slight earthquake, duration 3 seconds
22-Apr	12:48 AM	Stopped clocks Trinidad and Cape Mendocino
22-Apr	1:10 AM	Quite a severe shock, stopped clocks, MMI VII, M 6.7
22-Apr	1:17 AM	Felt at Cape Mendocino
22-Apr	6:07 AM	Slight shock, lasted 4 seconds
22-Apr	6:30 AM	Severe in Ferndale
26-Apr	10:30 AM	Sharp shock, also reported in Ferndale
29-Apr	1:10 PM	Slight shock, felt in Eureka
29-Apr	10:58 PM	Felt at Cape Mendocino
8-May	7:25 PM	Slight shock, sufficient violence to shake buildings
8-May	9:30 PM	3 second duration in Ferndale
9-May	6:47 AM	Felt at Blocksburg, may be the same event as below
9-May	6:59 AM	Sudden jolt, 4 seconds duration, felt Eureka and Ferndale
17-May	8:30 PM	Felt at Cape Mendocino, may be the same event as below
17-May	8:54 PM	Slight at Ferndale
18-May	4:47 AM	Very slight at Ferndale
21-May	early AM	Very slight at Ferndale

Very few of these aftershocks were on the San Andreas fault. Most were located offshore in the Gorda basin. When the fault ruptured in 1906, much of the slip was concentrated at the northern end of the fault and exerted considerable stress on the Gorda plate.

Recording the 1906 Earthquake

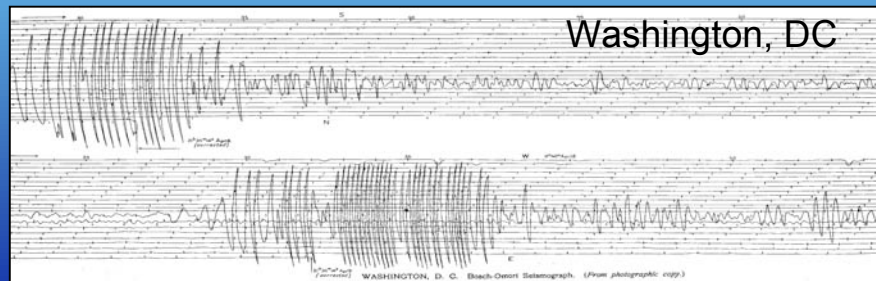
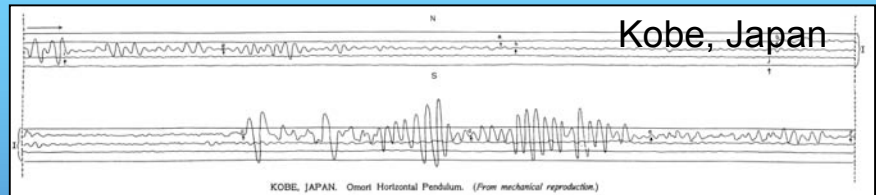
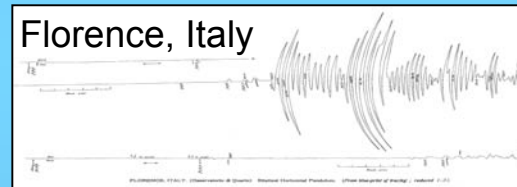
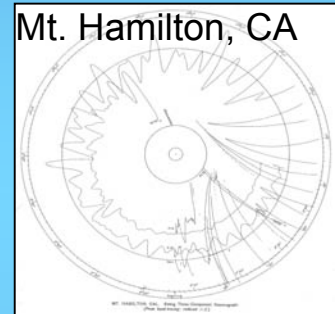
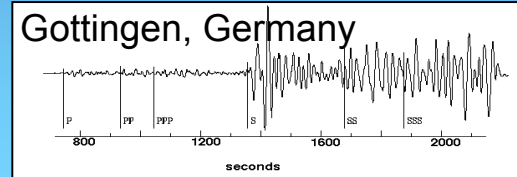
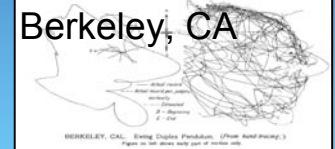
The 1906 earthquake was the first to be recorded by many seismographs all over the world. The instruments of the time were all based on heavy pendulums that stayed still while the ground shook. Two of the very few surviving seismographs of this era are still operating at the Ferndale Museum.



Richard Roberts changes the smoked drum daily.

Seismograms

from the State Earthquake Investigation Commission Report, 1908



Ferndale's Bosch-Omori seismograph. The Washington, DC recording of the 1906 earthquake was made on an identical instrument.

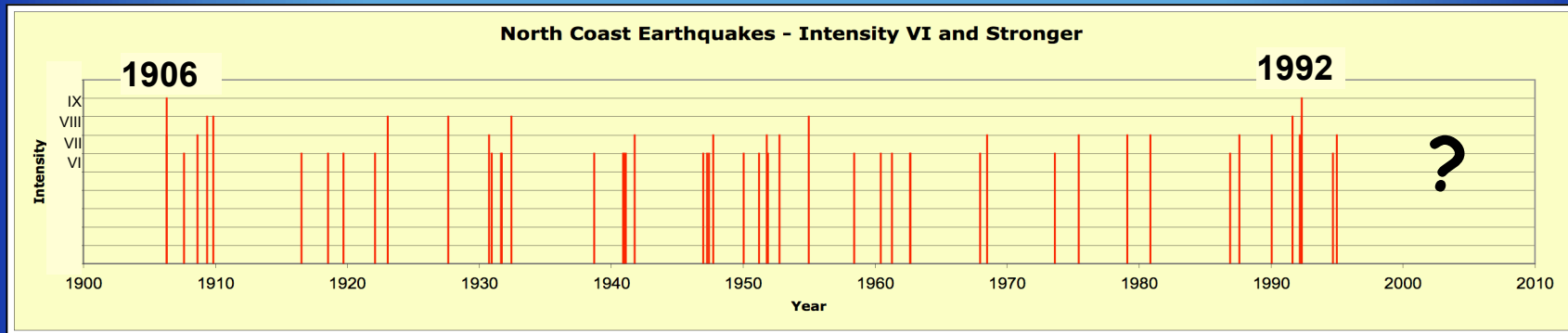


Ferndale's Bosch-Omori seismographs were built around the time of the 1906 earthquake and originally operated at Mare Island in San Pablo Bay. In 1933, the two horizontal instruments were installed in Ferndale. You can see them at the Ferndale Museum, Shaw & 3rd Street.

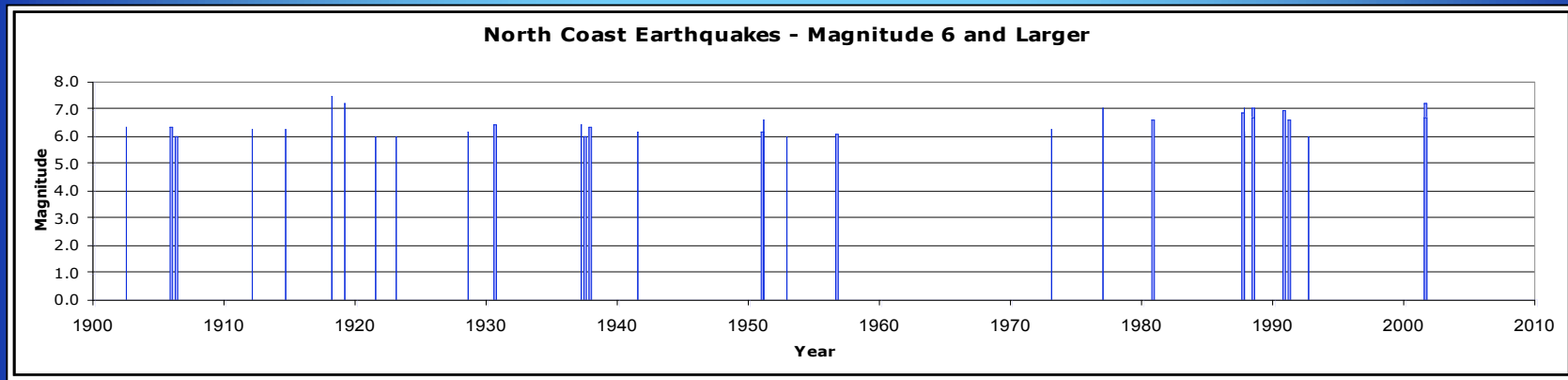
When will the Next Damaging Earthquake Strike?

A repeat of the 1906 earthquake probably won't happen soon, however there are many other earthquake sources in our area. On average, an earthquake with the strength to break windows and damage chimneys occurs about every 7 years.

We can't predict when the next earthquake will strike, but it is likely that an earthquake strong enough to cause some damage will occur in the next few years.



Intensity measures shaking strength. Intensity VI knocks items from shelves and causes minor damage. Only the 1906 and 1992 earthquakes reached the IX level where damage to well-built structures could occur. The last damaging North Coast earthquake was the December 26, 1994 M 5.4 offshore Eureka event.

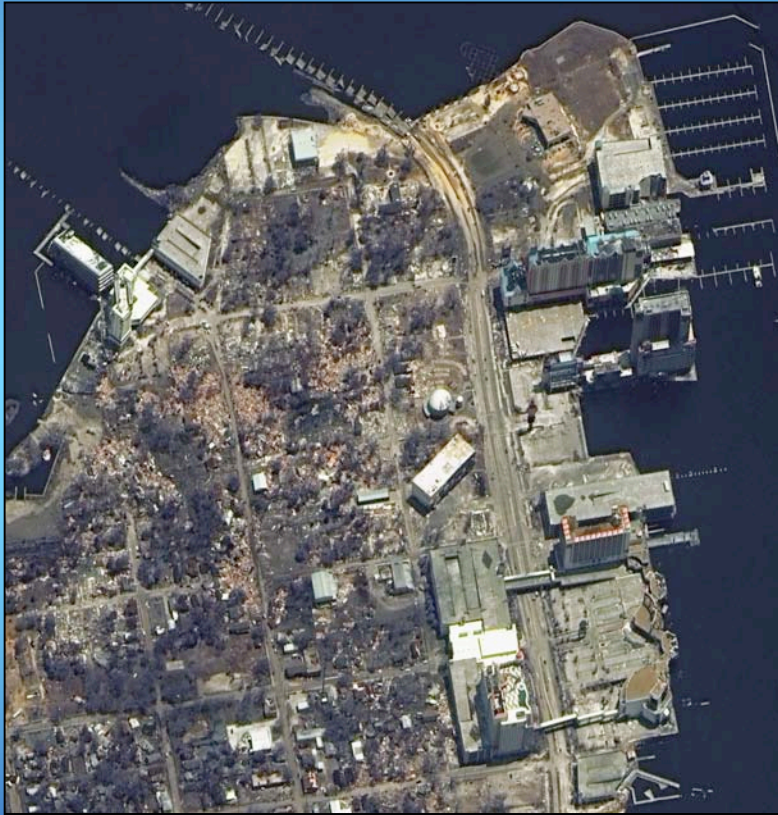


Magnitude measures the size of the earthquake source. The last major earthquake occurred on June 14, 2005 but it was 90 miles offshore and caused no damage.

1906 Earthquake on the North Coast - Humboldt & Del Norte County Fair EQ - Tsunami Display 2006

Lessons from 2005: Hurricane Katrina

Pay attention to hazardous weather. Find out if you live in an area of potential flooding or tsunami inundation. Develop a family evacuation plan. If official warnings are issued, respond immediately.



*When a major natural disaster affects an American city,
plan to be on your own for at least a week.*

Lessons from 2005: June 14 West Coast Tsunami Warning

On June 14, 2005 a magnitude 7.2 earthquake occurred about 100 miles off our coast. A tsunami warning was issued for the entire west coast.

There were many problems:

- *All telephone lines were jammed.*

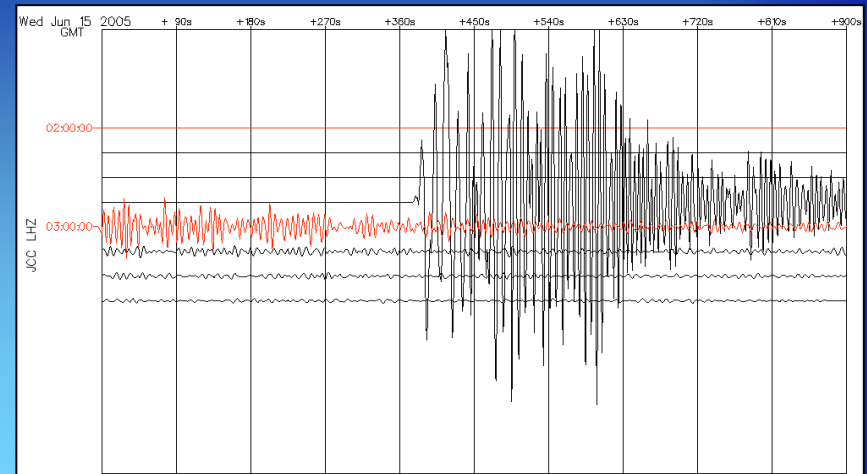
Use your radio or television to get information.

- *Many people did not know if they were in a tsunami hazard zone.*

Find out if your home or workplace is in a hazard zone ahead of time.

- *Many people in safe areas drove further inland adding to traffic jams and gridlock.*

If you are in a safe area, stay put.



Seismogram recorded at Berkeley's Jacoby Creek Station near Arcata



Evacuees at the Crescent City overlook on Highway 101

Lessons from 2005: The New Years Eve Day Storms

Earthquakes are not the only event that can cut us off from the rest of the state. The New Years Eve Day storm of 2005 caused widespread power outages and isolated many people for up to a week.



Photo by U.S. Coast Guard

Fernbridge looking south

In the storms, we were inconvenienced by power outages and reduced merchandise in stores.

A major earthquake will disrupt more than power. Some bridges will collapse and roads could be blocked for weeks.



Photo by U.S. Coast Guard

King Salmon



Photo by Humboldt County Sheriff's Dept.

HWY 211 south of Fernbridge



Photo by T. Nicolini, NWS

West of Hwy 101, Klamath



Photo by T. Nicolini, NWS

Klamath area

Lessons from 2006: July 17 M 7.7 Western Java

On July 17 a magnitude 7.7 earthquake occurred about 70 miles south of Indonesia's most populous island, Java. It produced a tsunami that struck heavily populated beach communities. Peak wave heights were only 5 to 10 feet and penetrated about 1500 feet inland in some areas. As of July 19, an estimated 541 people died and 270 were still missing.

A modest tsunami can be deadly in low-lying coastal areas.

- *Consider any tsunami potentially deadly.*

Almost everyone felt the earthquake but in most areas the ground didn't shake very strongly. Many also observed the water withdraw.

- *If you feel an earthquake when you are on the beach, no matter how small, move inland immediately. Wait until an official all-clear before returning.*

Indonesia has established a warning system on Sumatra but not on Java. Many people did not understand that natural warnings are just as important as official ones.

- *Don't wait for official warnings to respond.*

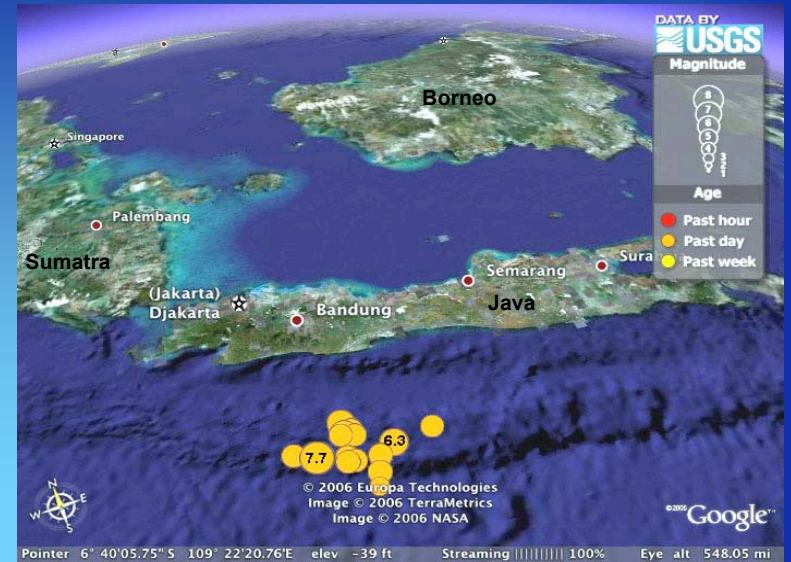




Photo by Edna Garrett., Courtesy of Peter Palmquist Collection

Acknowledgements

This year's earthquake - tsunami room display is the result of the efforts of many people and organizations. For information on the 1906 earthquake, we thank:

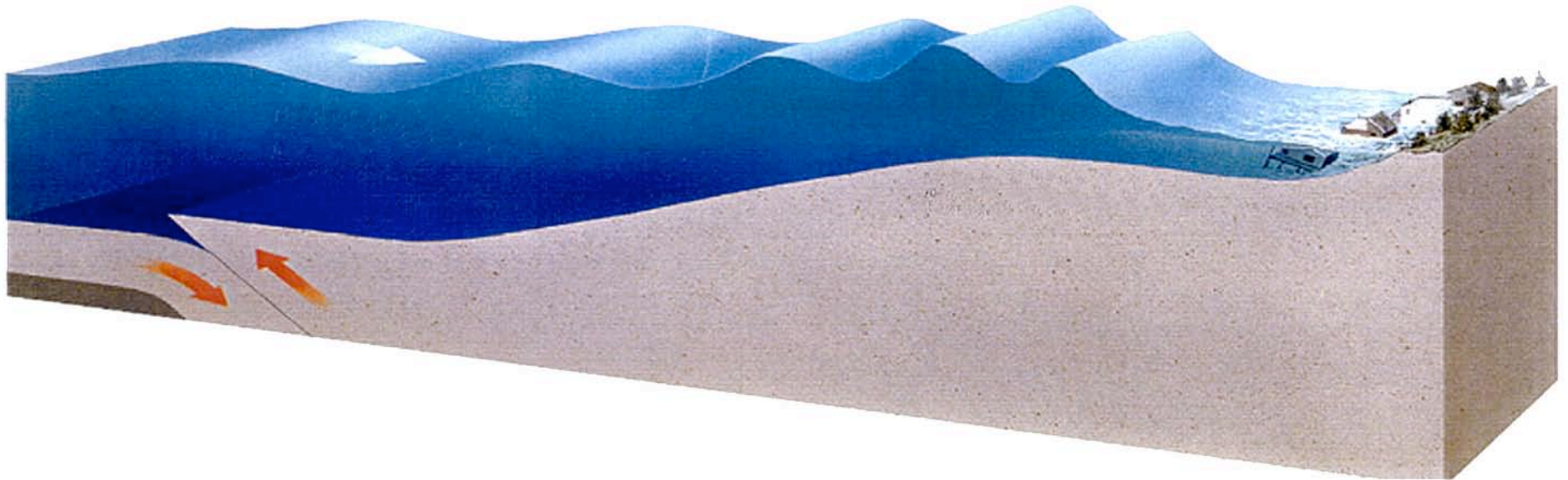
Jody Mielke, Ann Roberts, Ellin Beltz, Pam Service, Carol Prentice, Humboldt Historical Society, Ferndale Museum, Peter Palmquist Collection, Clarke Museum, HSU Humboldt Room, National Weather Service, U.S. Geological Survey

Much of the information for this exhibit came from:

The Report of the State Earthquake Investigation Commission, published by the Carnegie Institution in 1908 and articles in the Ferndale Enterprise, Humboldt Times, Humboldt Standard, Humboldt Beacon, Arcata Union, Blue Lake Advocate, Susie Baker Fountain Papers.

1906 Earthquake on the North Coast - Humboldt & Del Norte County Fair EQ - Tsunami Display 2006

Welcome to the Earthquake and Tsunami Room



Sponsored by the Redwood Coast Tsunami Workgroup

A compilation of posters from 2000 - 2007

From Earthquake Tsunami Room Displays at the Humboldt and Del Norte County Fairs