

Dynamic Earth

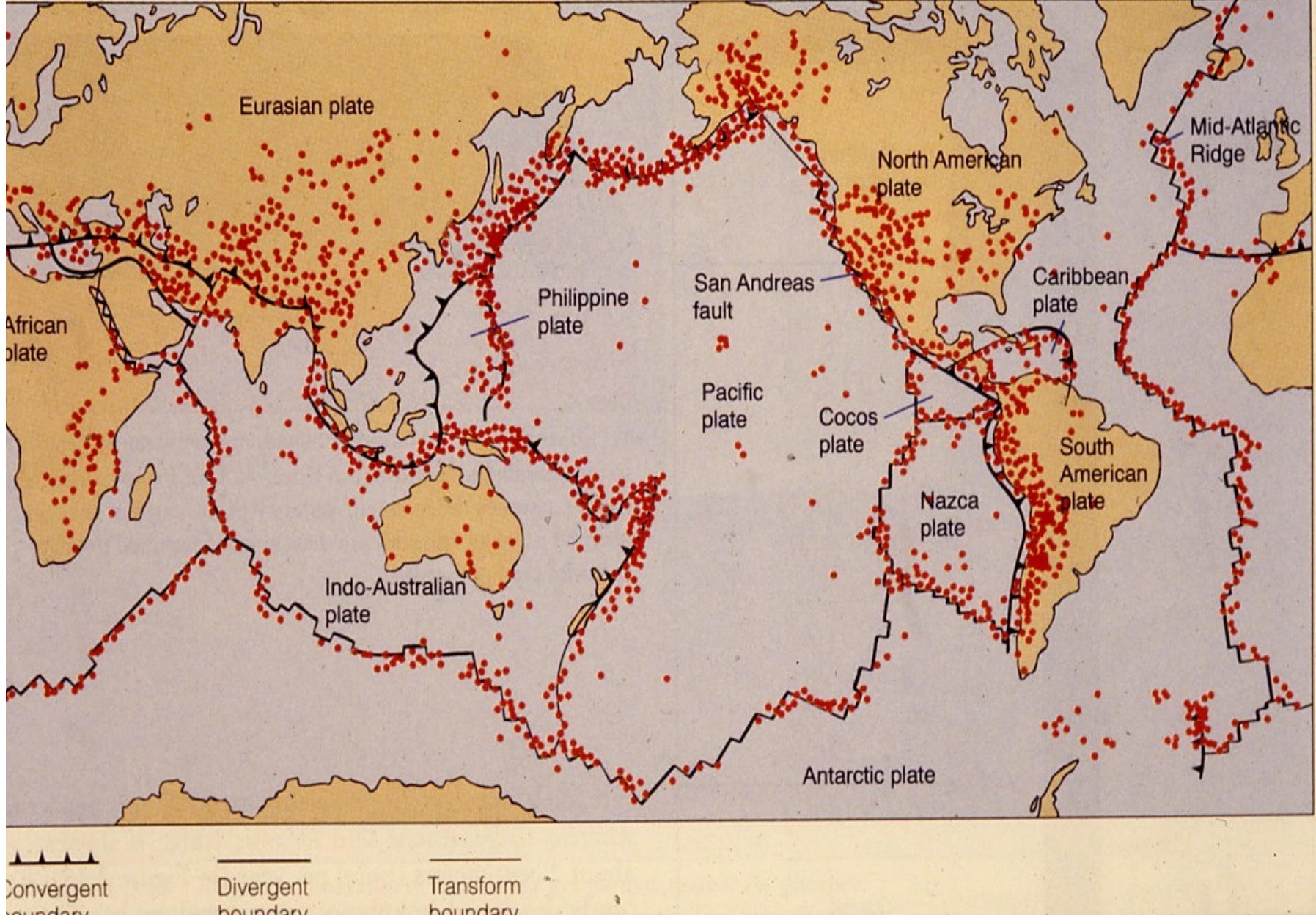


LA12 Environmental Science for Sustainable Development

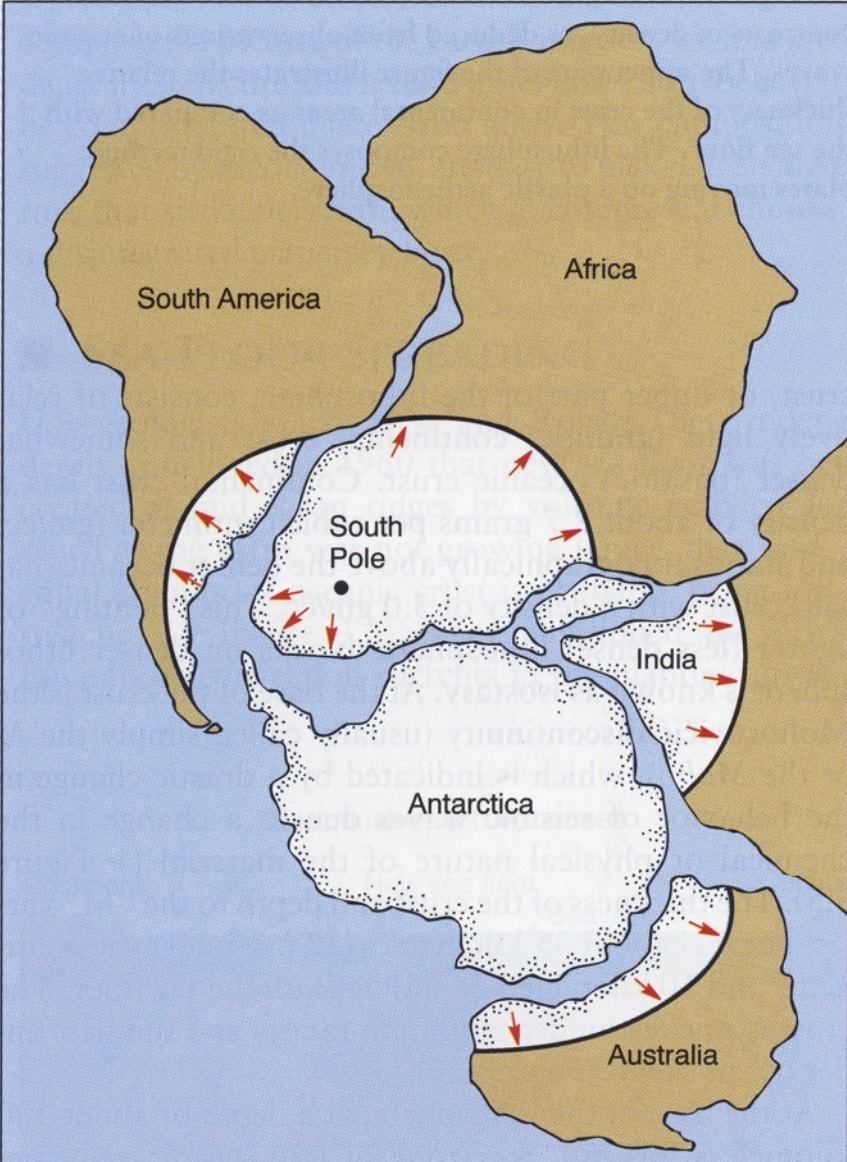
Outline

- Earth structure & plate tectonics
- Geothermal energy
- Earthquakes
- Natural hazards: inevitability & risk perception

- **Earth structure & plate tectonics**
- Geothermal energy
- Earthquakes
- Natural hazards: inevitability & risk perception

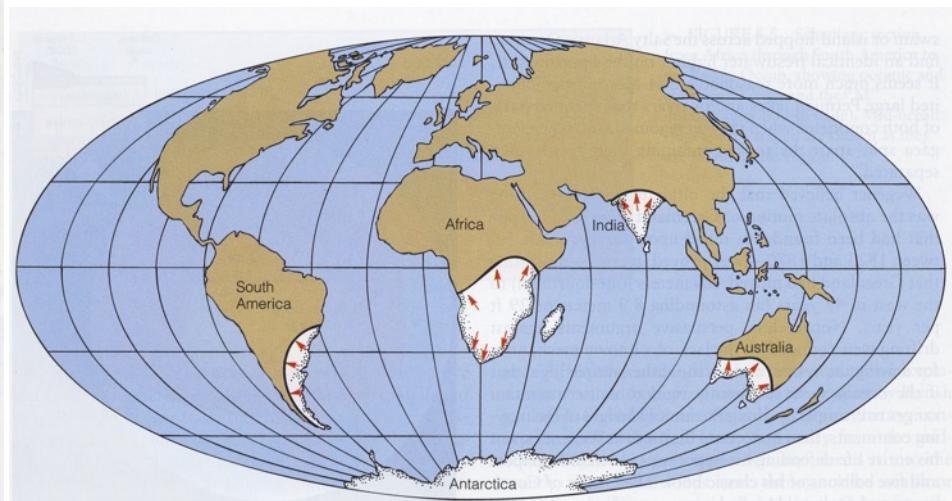


Earthquakes concentrated in certain zones – boundaries between rigid plates (tectonic plates).



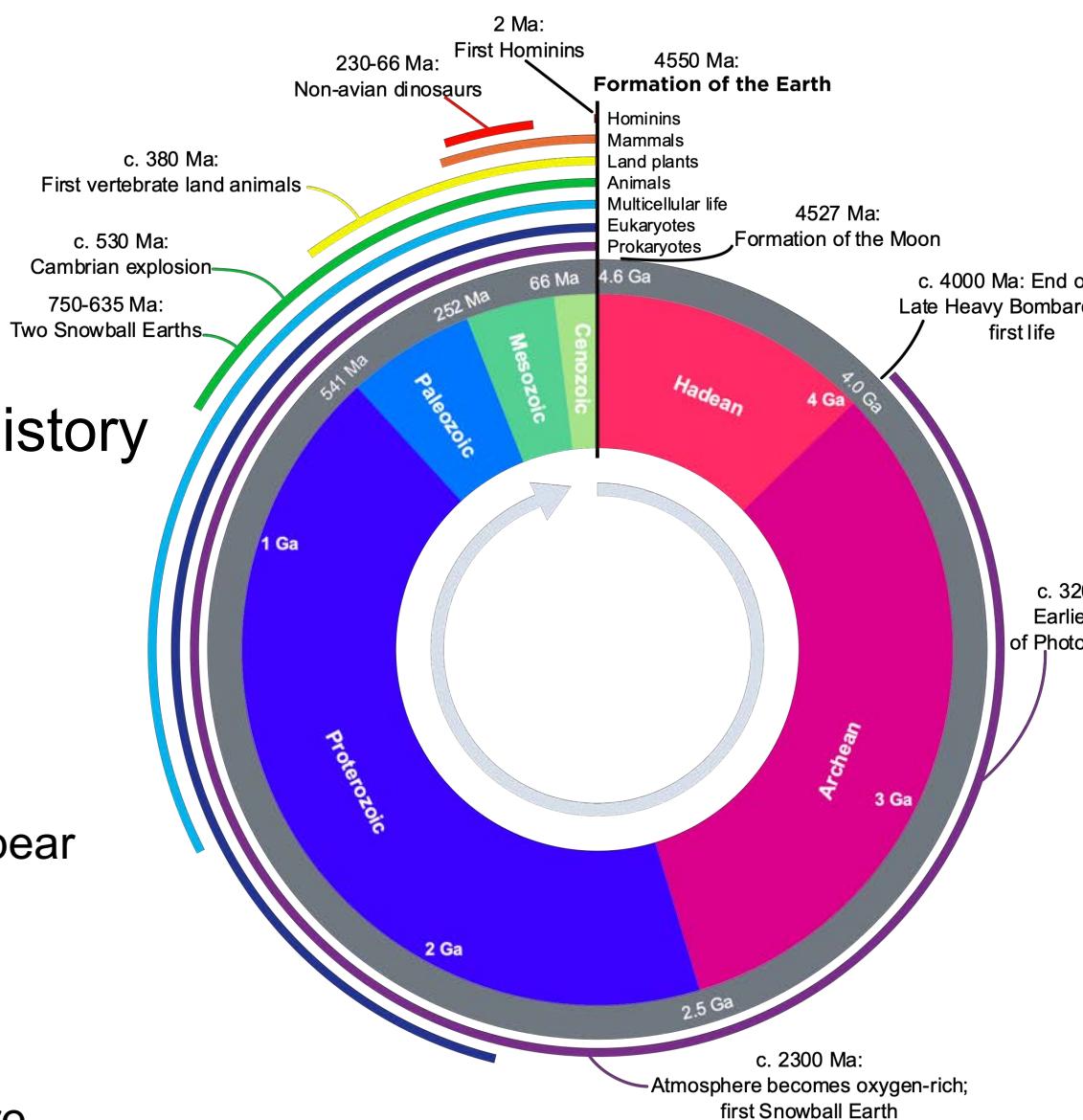
Glaciated area
Arrows indicate the direction of glacial movement based on striations preserved in bedrock.

The plates are moving relative to one another, and they have moved a lot over geologic time.



Gondwanaland and its breakup

Geologic time



Compress 4.6By of earth history
into 1 calendar yr:

March - First life in sea

December 15-26: dinosaur era

Dec 31 evening - First hominids appear

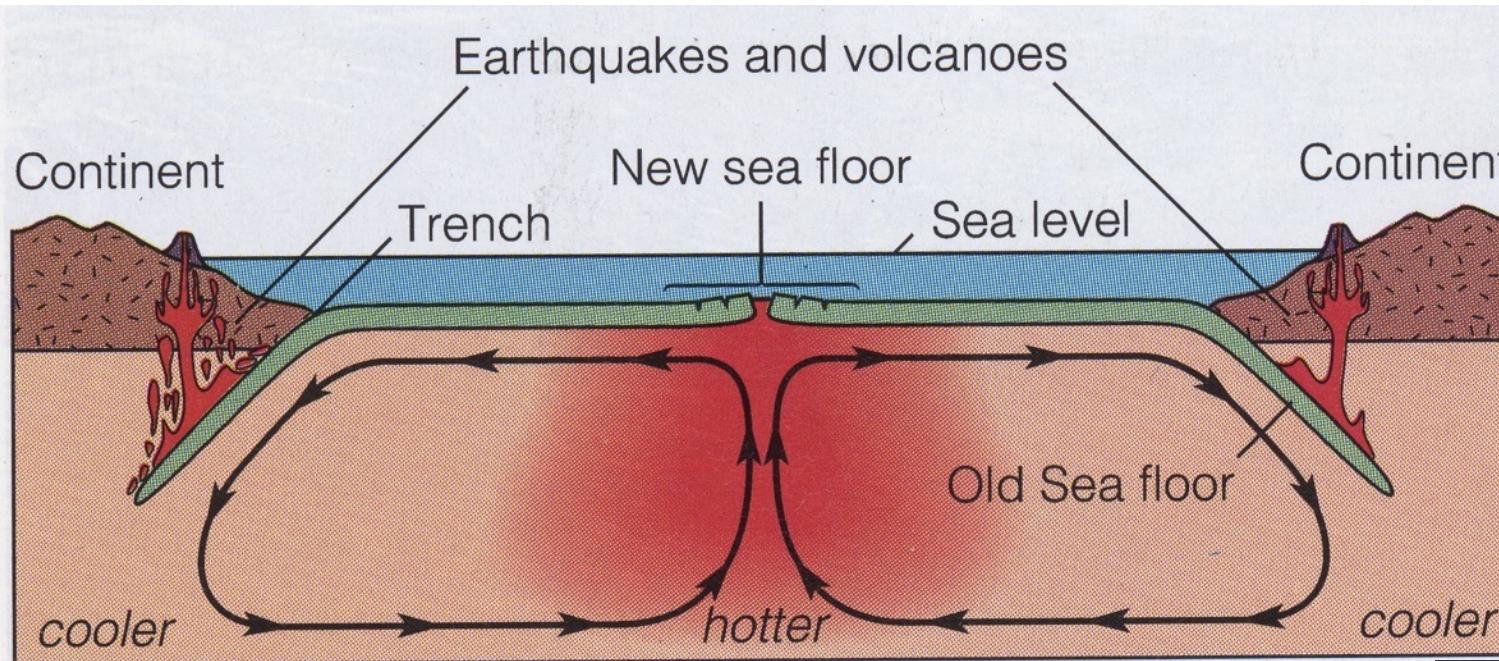
11:58:45 – End of the last ice age

11:59:45-11:59:50pm on Dec 31st
– rise and fall of the Roman empire

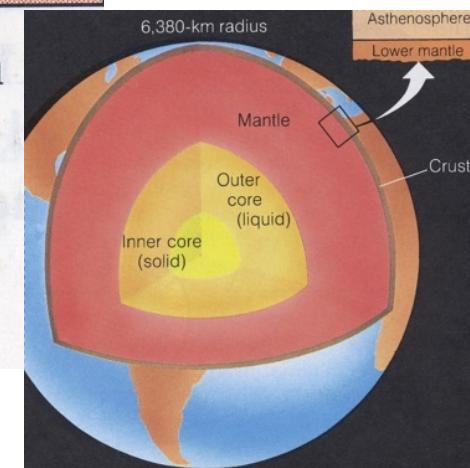
11:59:57 – Columbus 'discovers' new world

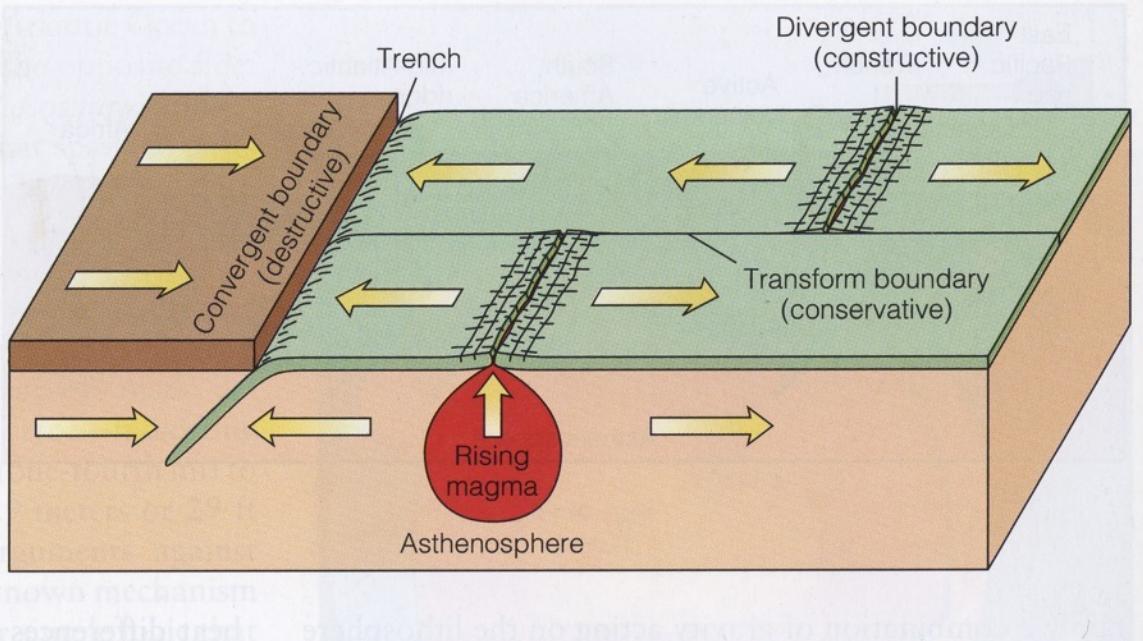
Plate tectonics:

Spreading centers, creation of new crust, and consumption of crust in subduction zones.



➤ FIGURE 3.6 Sea-floor spreading driven by convection currents. New crust forms at ridges and is consumed at trenches. Volcanic activity and earthquakes are generated along the sinking oceanic crust.



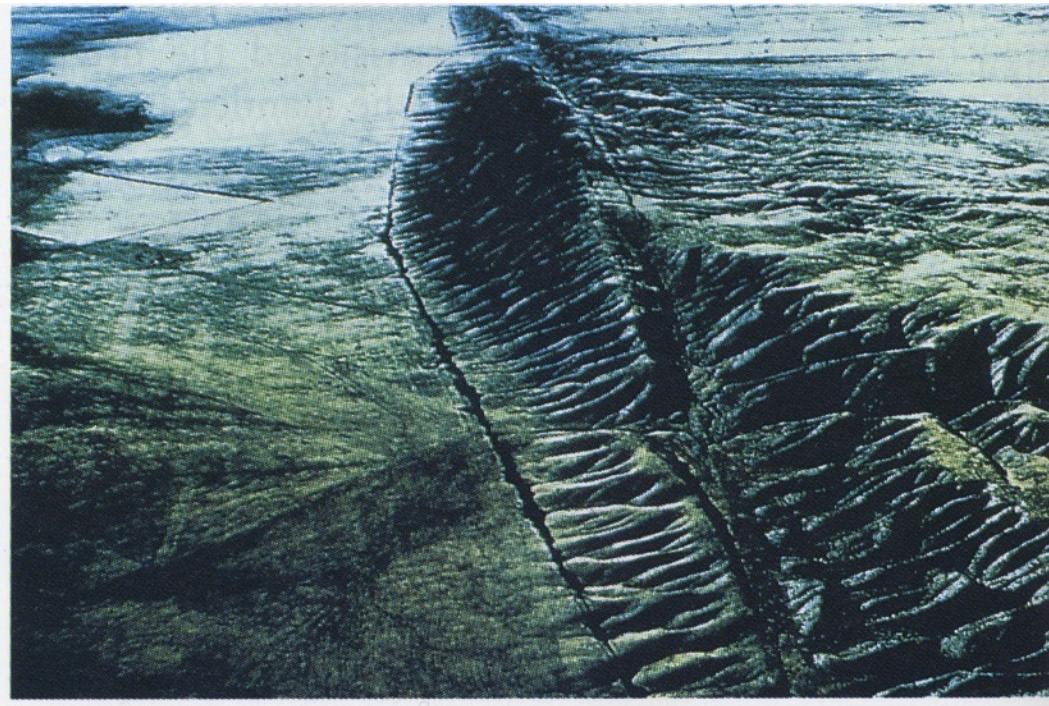


Convergent & divergent boundaries (subduction zones & spreading centers)

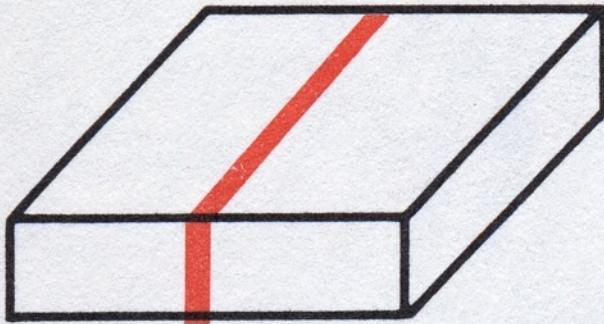
Transform boundaries

A transform boundary:
the San Andreas Fault
system.

Mostly the plates are
sliding by each other, so
strike-slip faulting
dominates.

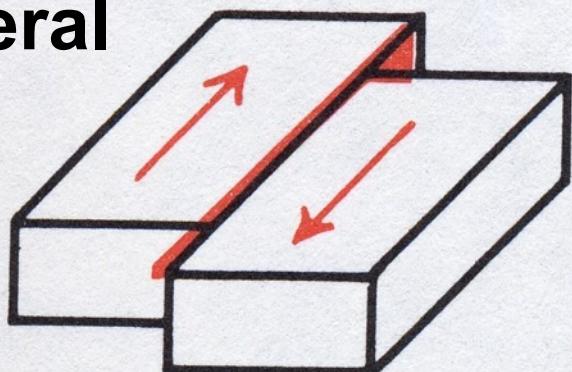


Fault Movement



Fault movements must always be expressed in relative terms, since it is impossible to tell which side actually does the moving.

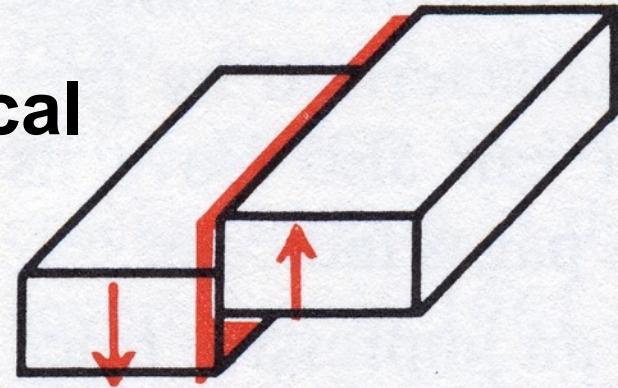
Lateral



Horizontal movement can be either left- or right-lateral (shown here). The San Andreas and related faults all move right-laterally. The greatest single shift was 20 feet during the 1906 earthquake.

Fault Movement

Vertical

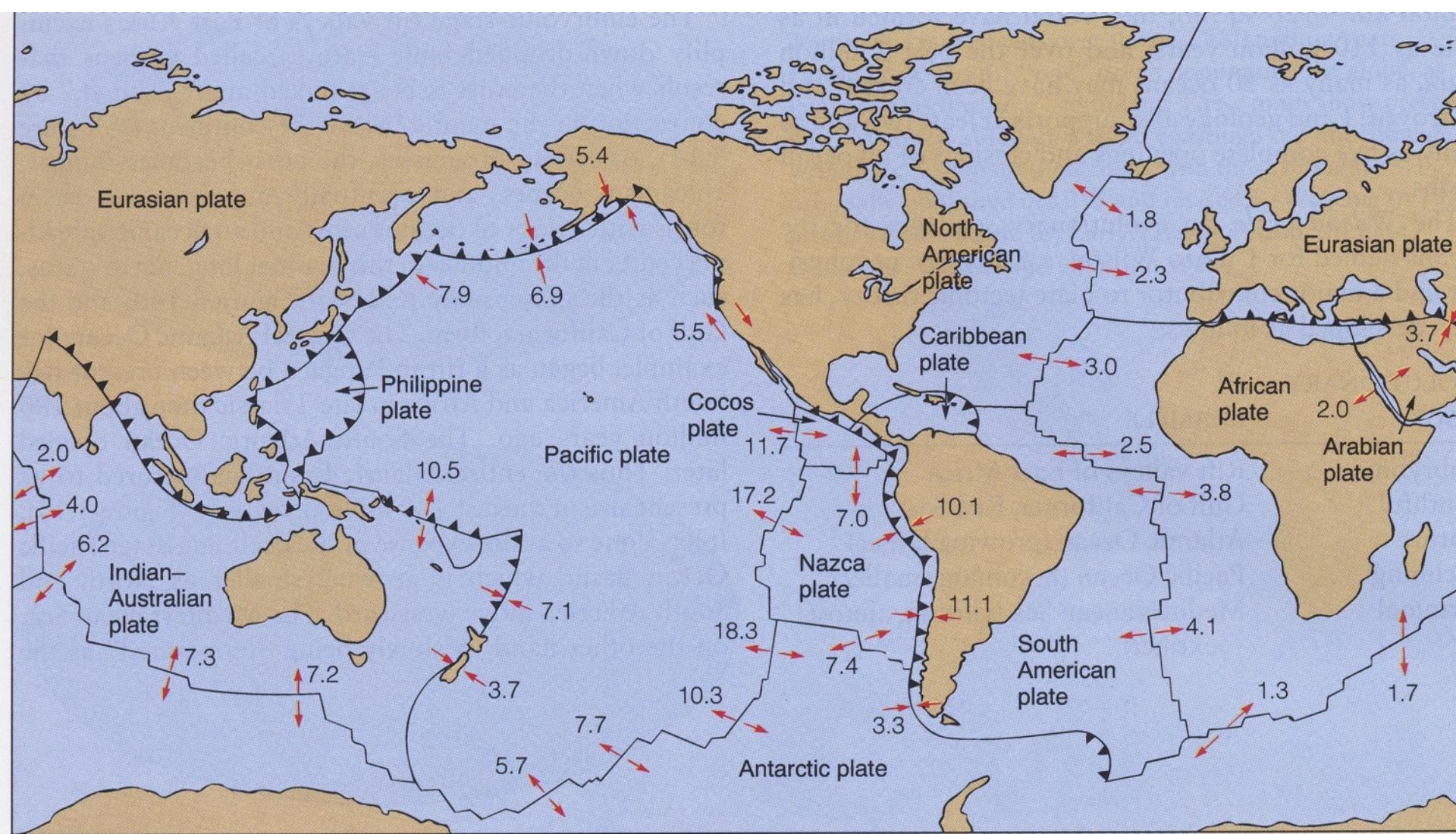


Vertical displacement can be created by either an upthrust of one block or a downthrow of the other. Most California earthquakes during historic times have been characterized by vertical shifts of only a few feet.

Thrust



In thrust faulting, one block moves up and over another. This type of movement characterizes the White Wolf and San Fernando fault systems, which caused the 1952 and 1971 earthquakes.



Average motion (relative) of plates on Earth's surface
Pacific Plate moving northward relative to North American Plate
5.5 cm (>2 in) per year

The overall movement of 5.5 cm/y is spread out over the San Andreas strike-slip fault system, and “normal faults” creating “pull-apart” basins in the Great Basin (Nevada-Utah)



Pacific Plate

North
American
Plate



Looking at the west coast rotated 45° to the right , so San Andreas Fault system is vertical on the slide:

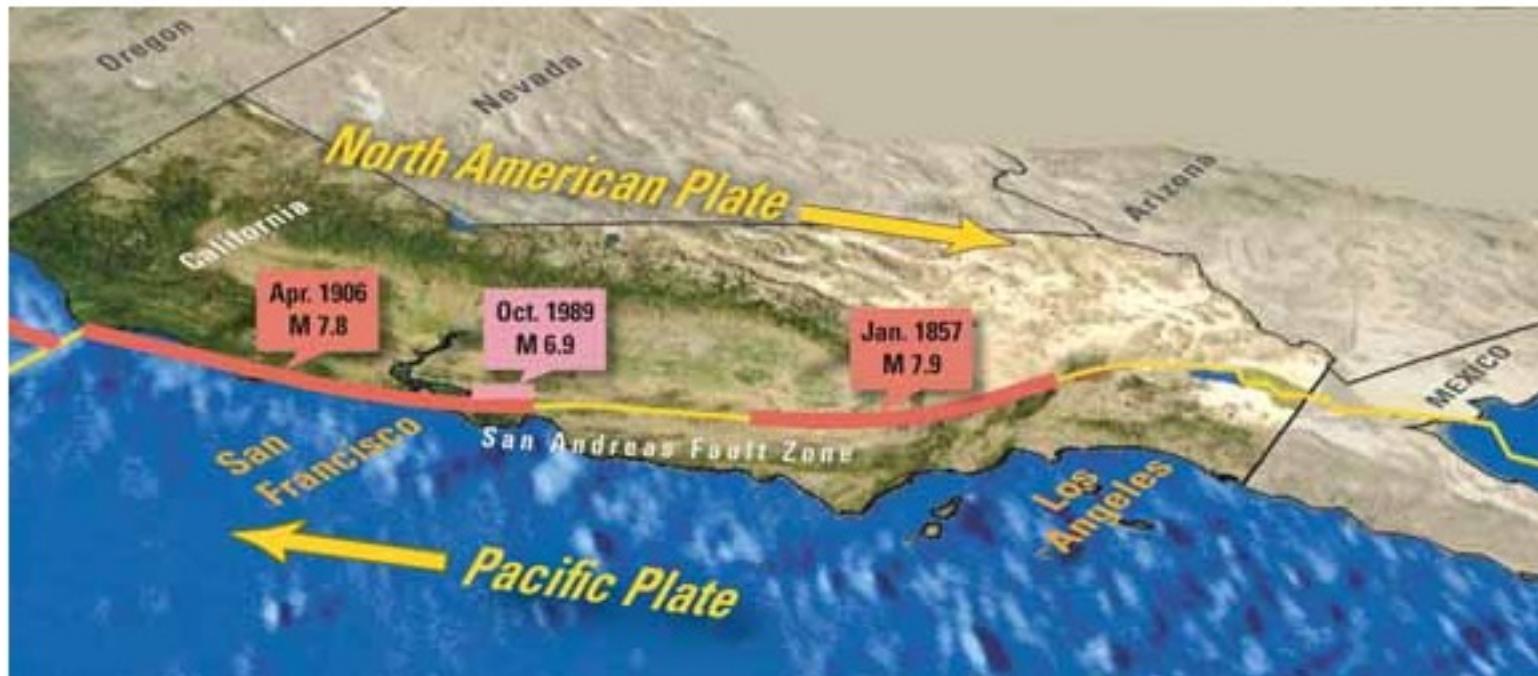
About $\frac{3}{4}$ of the movement is accommodated by the San Andreas Fault system



The other $\frac{1}{4}$ of the movement is accommodated by pulling-apart of the Great Basin

Los Angeles is moving north at a rate of around 50km/million years.

At this rate, in only 12 million years, Los Angeles will be adjacent to Berkeley!



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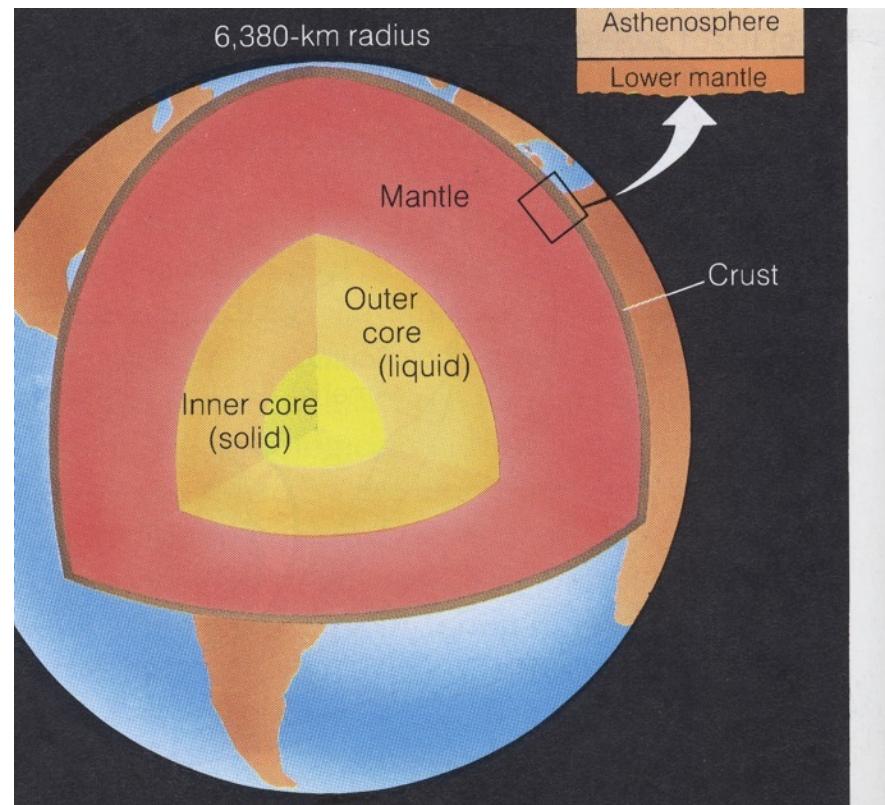
Heat Flux

- There is a continual *flux* of heat energy outwards from the center of the earth towards the surface
- This drives plate tectonic movement
- On the surface, this results in
 - Volcanoes
 - Earthquakes
 - Hotsprings
 - Geysers

Flow rate = transfer per unit time
[e.g., Watts = Joule/s]

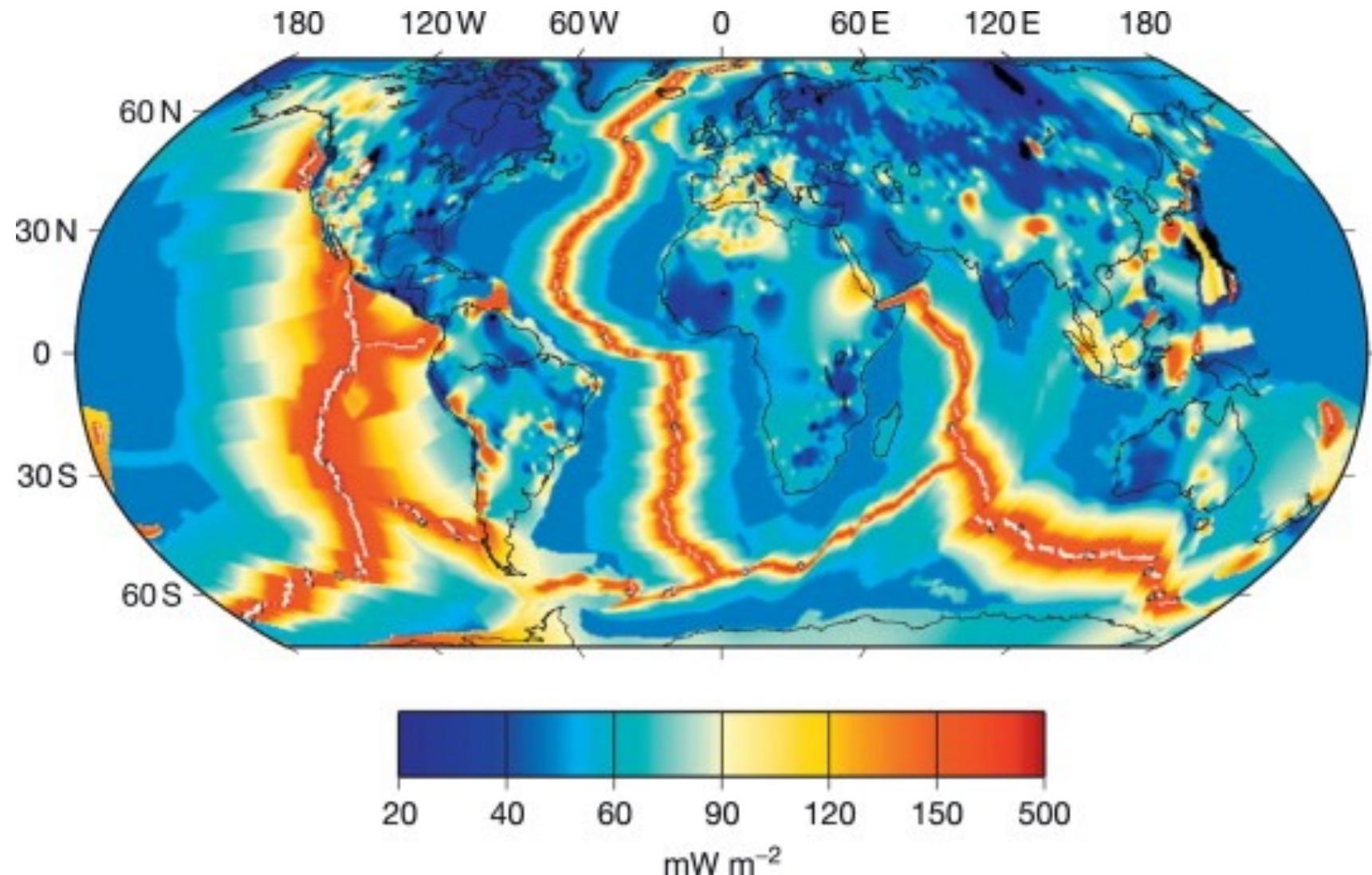
Flux = rate per unit area [e.g., W/m²]

Internal energy source?
- Radioactive decay



Global heat flux of the Earth combining heat flux measurements on land and continental margins

Source: <https://www.sciencedirect.com/science/article/pii/B9780444538024001263#f0010> (Jaupar et al., 2015)



Geothermal Energy

- Harnesses the heat that flows from Earth's core
- Used in 21 countries, including the USA
- Today world-wide production of geothermal energy is ~9,000 MW (about the same as 9 coal-burning power plants)
- Two categories:
 - Deep-earth, high density
 - Shallow-earth, low density

Geothermal Energy

Shallow earth, low density

- Actually a form of solar energy
- When the sun warms the surface soils, water, and rocks, some of this heat energy is transmitted down into the ground

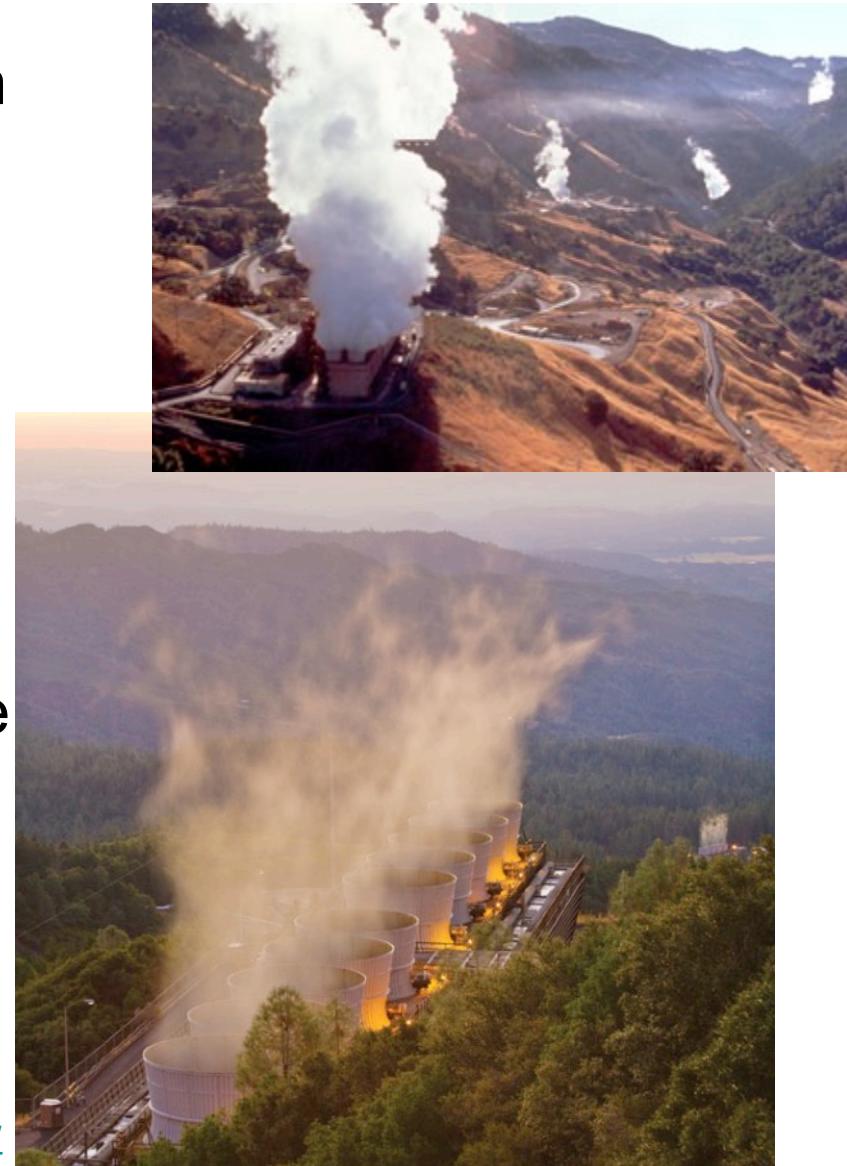
Deep earth, high density

- Natural heat from interior of the earth
- Mined and used to heat buildings and generate electricity
- Common type of system include hydrothermal convection, where the circulation of steam and/or hot water transfers heat from the depths to the surface

California

Deep, high-density geothermal energy

- 43 operating deep-earth geothermal power plants with an installed capacity of 2,700 MW (megawatts)
- Geyers Geothermal Field, north of San Francisco is the largest geothermal power operation in the world. Supplies 60% of electricity needed from Golden Gate Bridge north to Oregon line
- The hot water is maintained in part by injecting treated wastewater from urban areas into hot rocks.
- More info:
http://www.energy.ca.gov/almanac/renewables_data/geothermal/

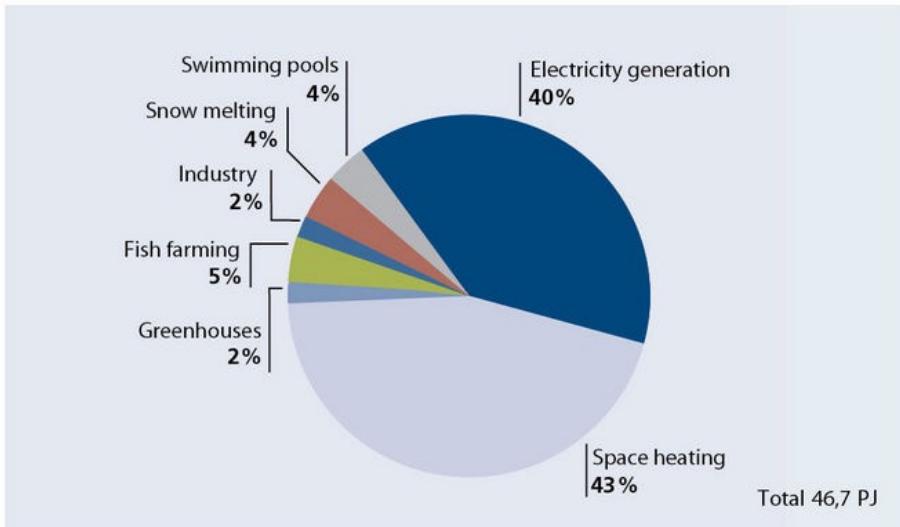


Iceland

On the mid-Atlantic Ridge, magma close to the surface
High-density geothermal

- Deep-earth geothermal power facilities generate 30% of Iceland's total electricity production (the rest is hydroelectric)
- 90% of households heated with aeothermal energy

| Iceland Utilization of Geothermal Energy (2013)



Low-density geothermal energy

- Most groundwater can be considered a source of shallow-earth, low density geothermal energy
- Normal heat flow from sun to Earth keeps temperature of groundwater at ~55°F in Florida
- Can help heat a house in winter; can help cool a house in summer
- Increasingly used in Florida for cooling

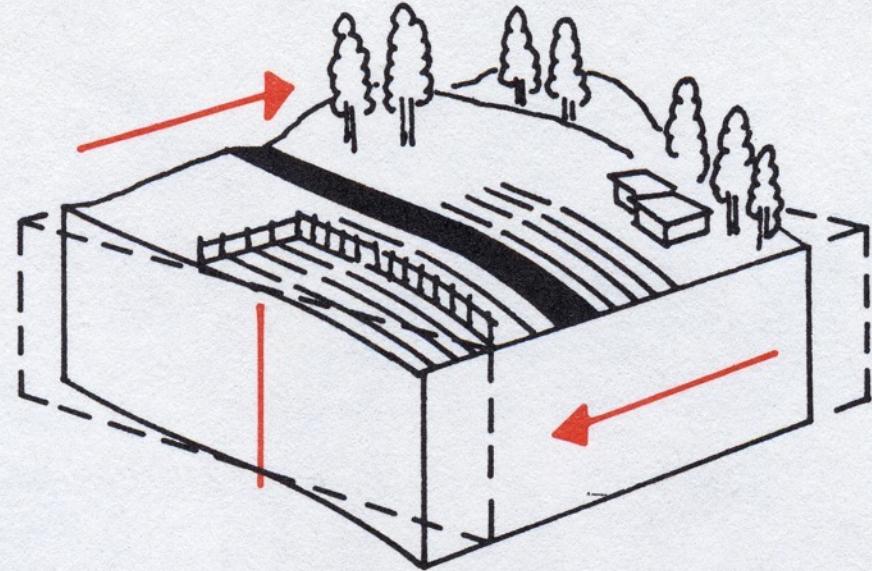
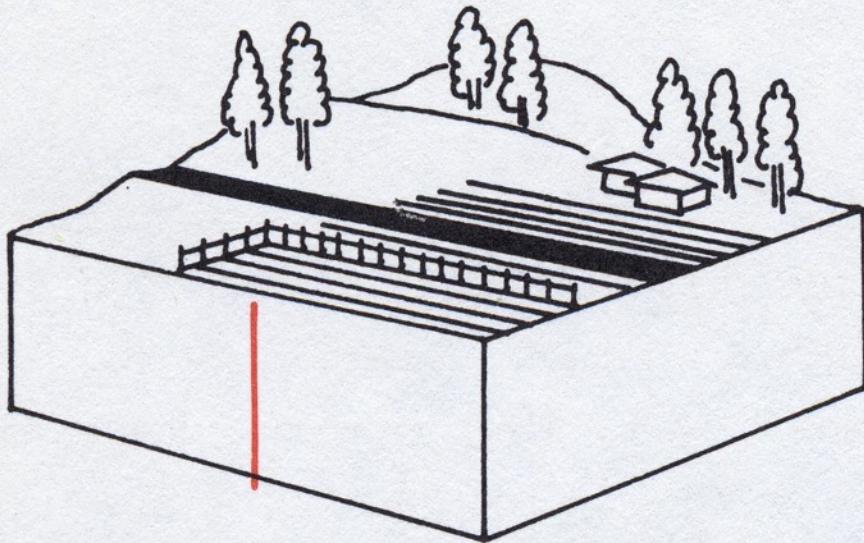


Geothermal impacts

- Deep-earth, high-density produces considerable thermal pollution from hot wastewater, may be saline or corrosive
- Also: noise, gas emissions, land disturbance, disposal sites, roads and pipelines, power plants
- BUT deep-earth, high density geothermal energy releases ~90% less CO₂ and SO₂ than burning coal to produce the same amount of energy
- Overall impacts are much less than other sources

Outline

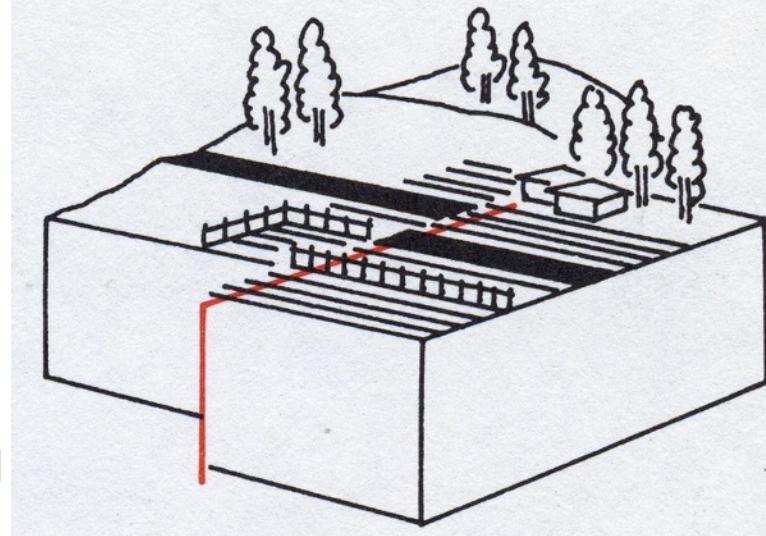
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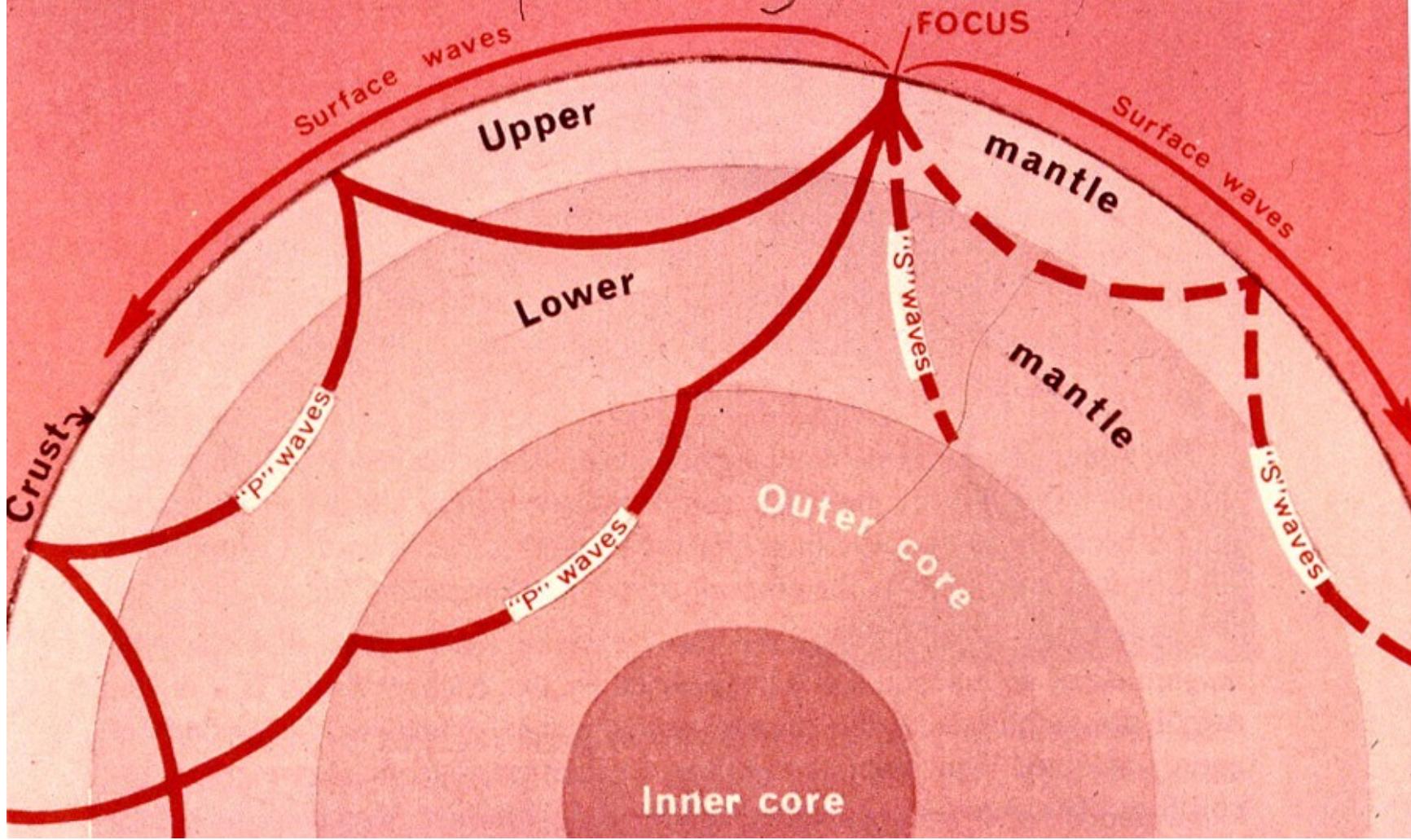


The movement of plates is not even over time, but occurs in spurts (which produce earthquakes)

The Elastic Rebound Theory

- Strain builds up, finally overcoming frictional resistance
- Movement creates shock waves



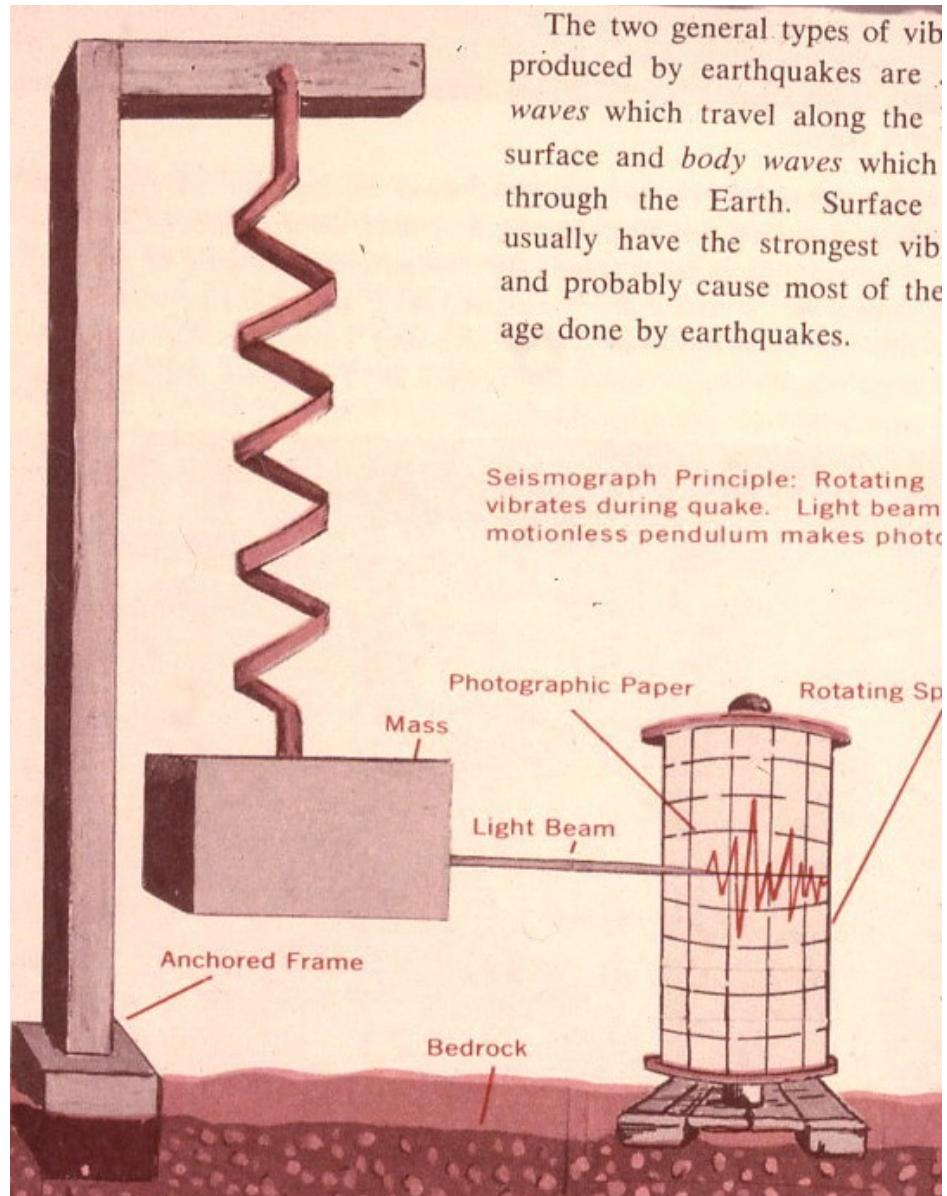


- The ‘focus’ (*focal point*) is where rupture along the fault begins, and from which seismic waves emanate outward.
- The point on the earth’s surface above the focal point is the *epicenter*.

How to measure?

How a seismograph works:

- A mass is suspended separate from earth.
- Its inertia means it stays still compared to the chart, which is fixed to the earth.
- As the earth moves, it traces a line on the chart.



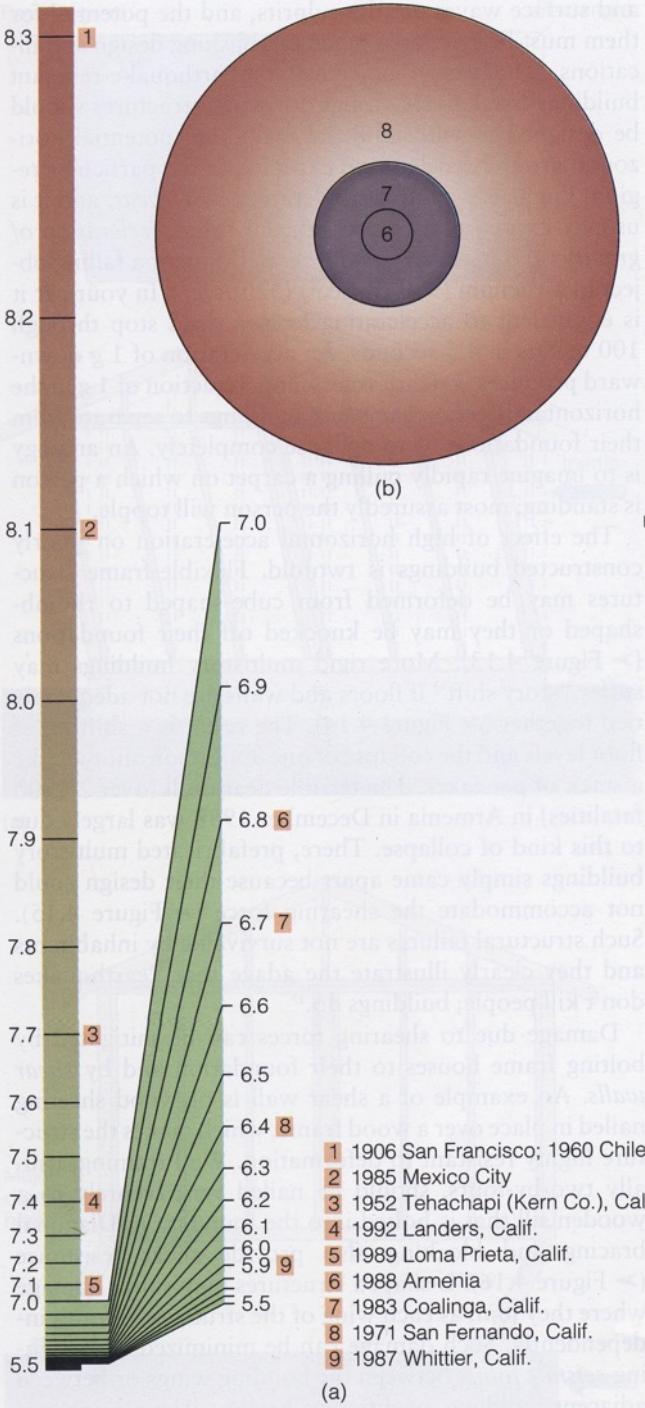
How to measure?

Richter *Magnitude*

- Amplitude of ground motion produced by earthquake at a standard distance from the epicenter
- *Logarithmic scale*: P-Wave amplitude goes up by factor of 10
- Energy released goes up 30 x with each unit

Contrast with *Intensity*

- A measure of earthquake effects
- Mercali Intensity Scale



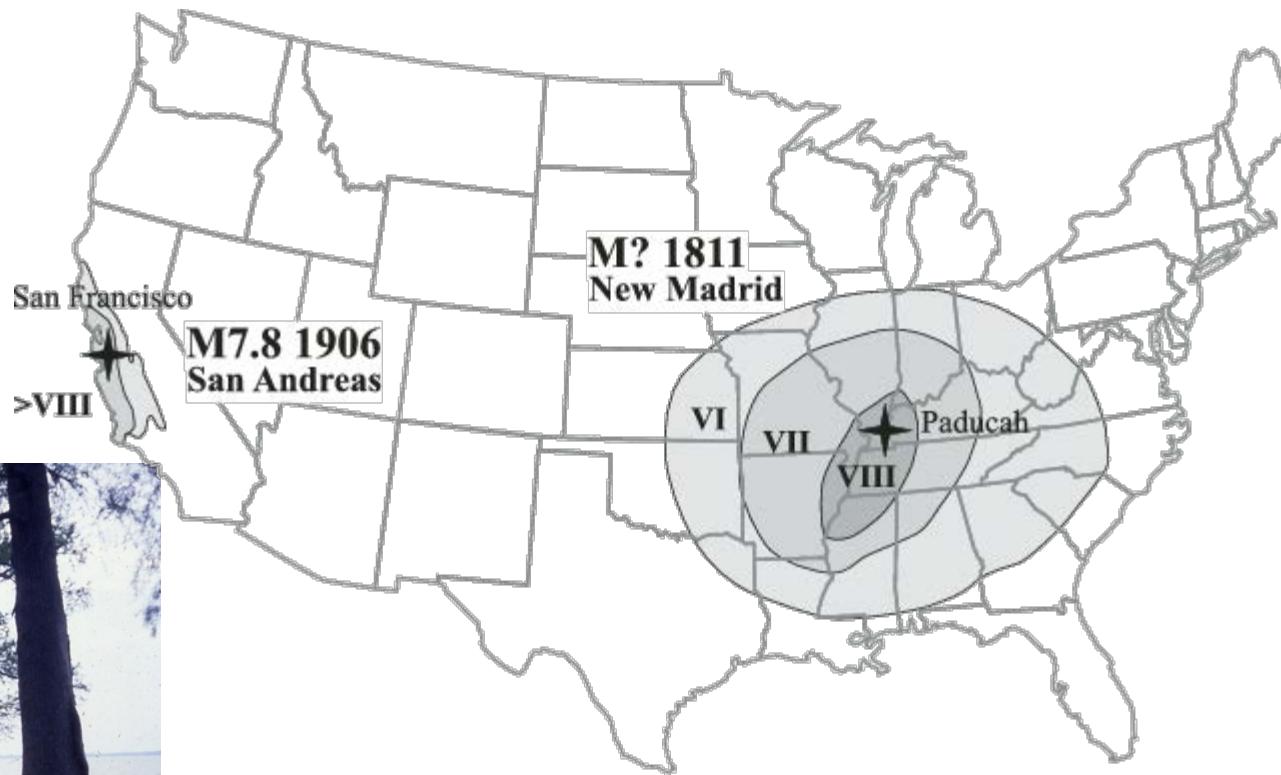
Modified Mercalli Intensity Scale (of earthquake effects)

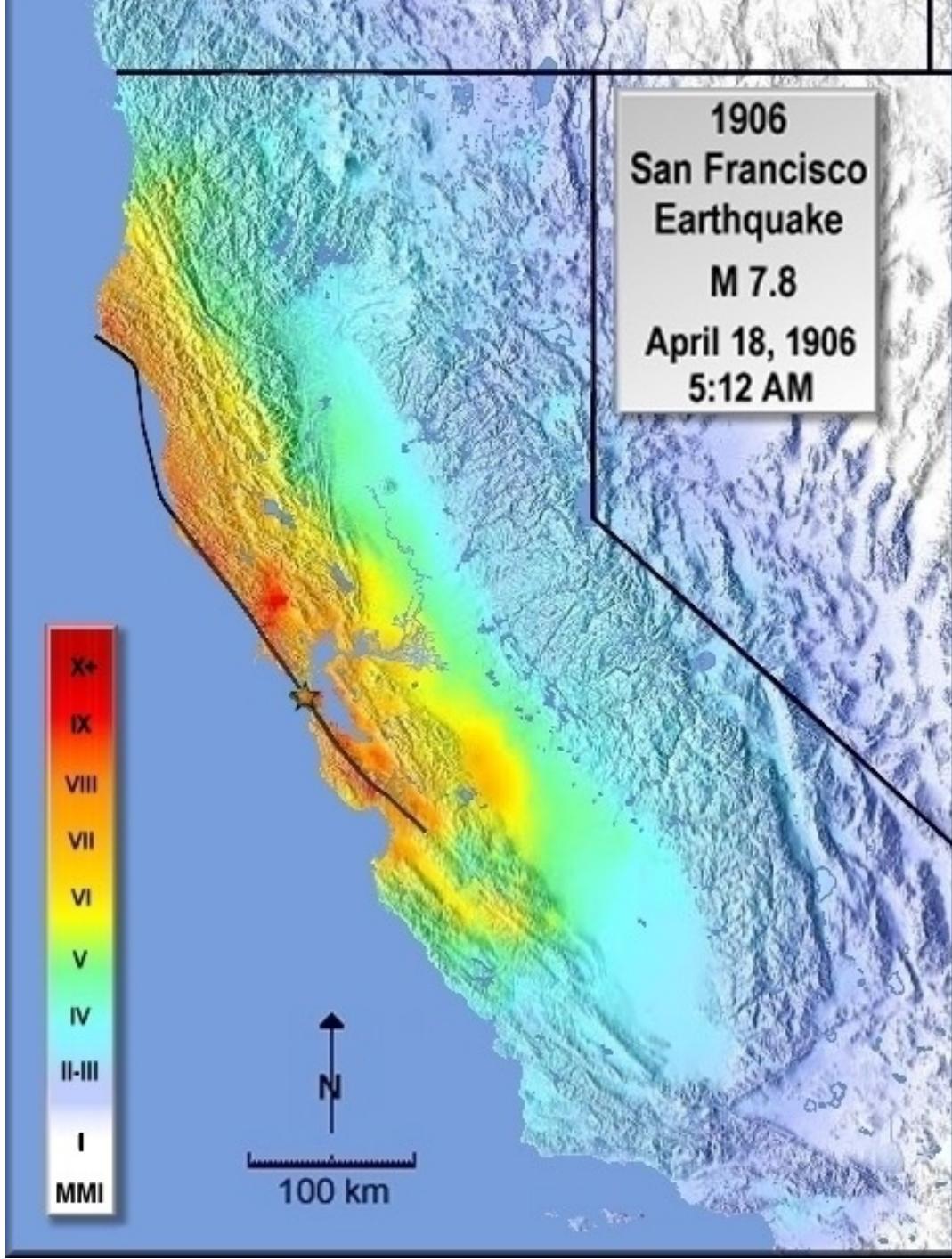
Intensity	Shaking	Description/Damage
I	Not felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV	Light	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Very strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Severe	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Violent	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

Intensity Maps

Comparing Intensity Maps

1906 SF earthquake vs. 1811 New Madrid earthquake





Intensity Map for
SF earthquake
April 1906

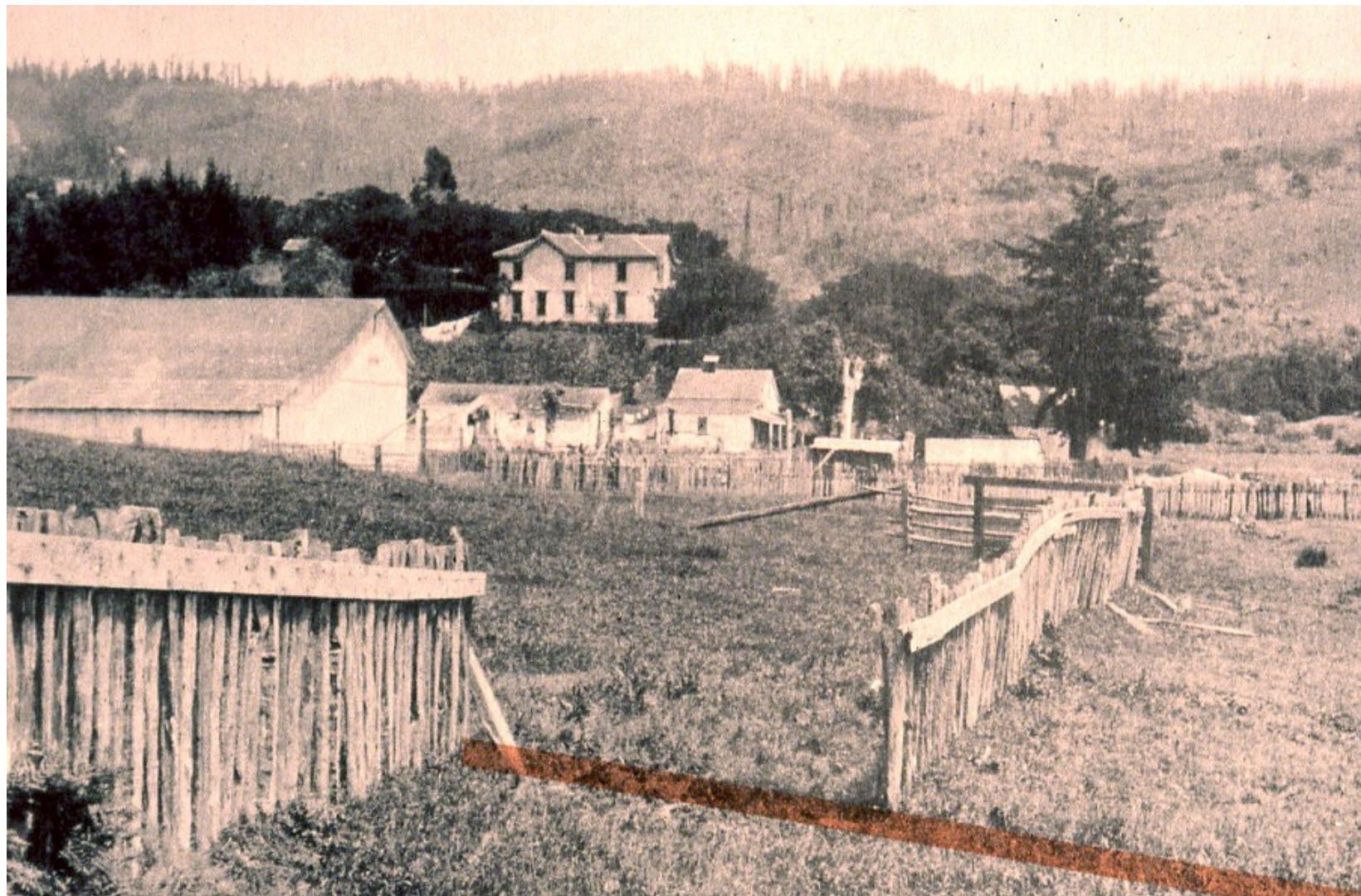
Intensity map for 1989 Loma Prieta earthquake



Effects of earthquakes

1. Fault offset
2. Shaking
3. Landslides
4. Liquefaction (Sand boils)
5. Tsunamis

Effects of earthquakes: *Offset along fault trace*



Fence offset by 1906 earthquake, Olema, California

Effects of earthquakes: *Shaking*

Shaking
causes far
more damage
than fault offset
because it is
more
widespread.



House lifted from its foundation by the 1868 Hayward earthquake, Oakland



House lifted from its foundation by the 1989 Loma Prieta earthquake (Santa Cruz Mountains)



House lifted off its foundation and destroyed by 1989 earthquake, SantaCruz Mts

Shaking-induced failure: Cypress Structure of the I-880 Freeway in Oakland (1989)



...and of the Embarcadero Freeway in San Francisco (1989)





These Santa Cruz mountain residents were briefly famous for the crack in their driveway in Oct 1989



When our environmental geology class visited two weeks later, the crack had been filled – so you'd never know! But if you turned around...



The crack was still there. It continued under the road.



The crack created a 1-ft dropoff in the road surface. Note the apparent left-lateral offset. This reflects local shifting of blocks relative to one another, not the sense of fault movement.

Effects of earthquakes: *Landslides*



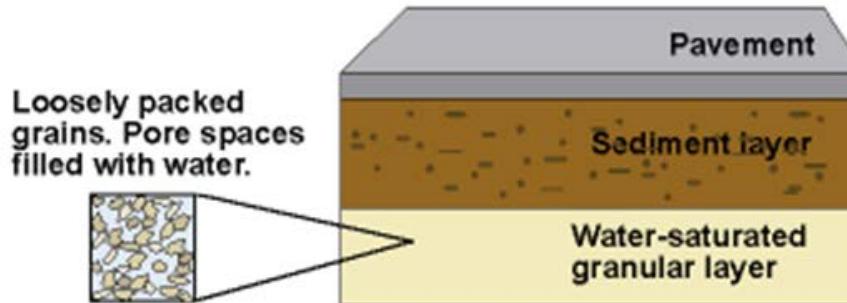
Landslides triggered by the 1987 earthquake in the Andes of Ecuador



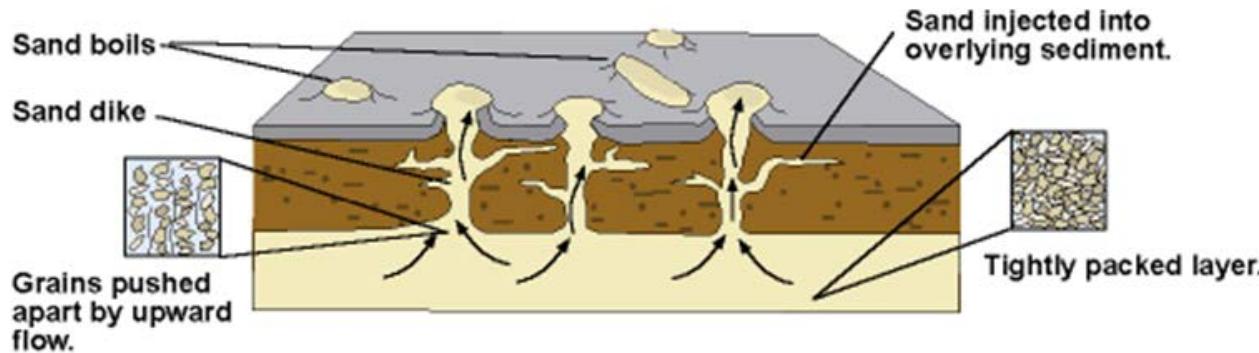
Landslide in the Santa Cruz Mts triggered by the earthquake in 1989 blocked traffic on Hwy 17 for 3 days until CalTrans could clear the debris.

Effects of earthquakes: *Liquefaction*

Before the earthquake



During the earthquake

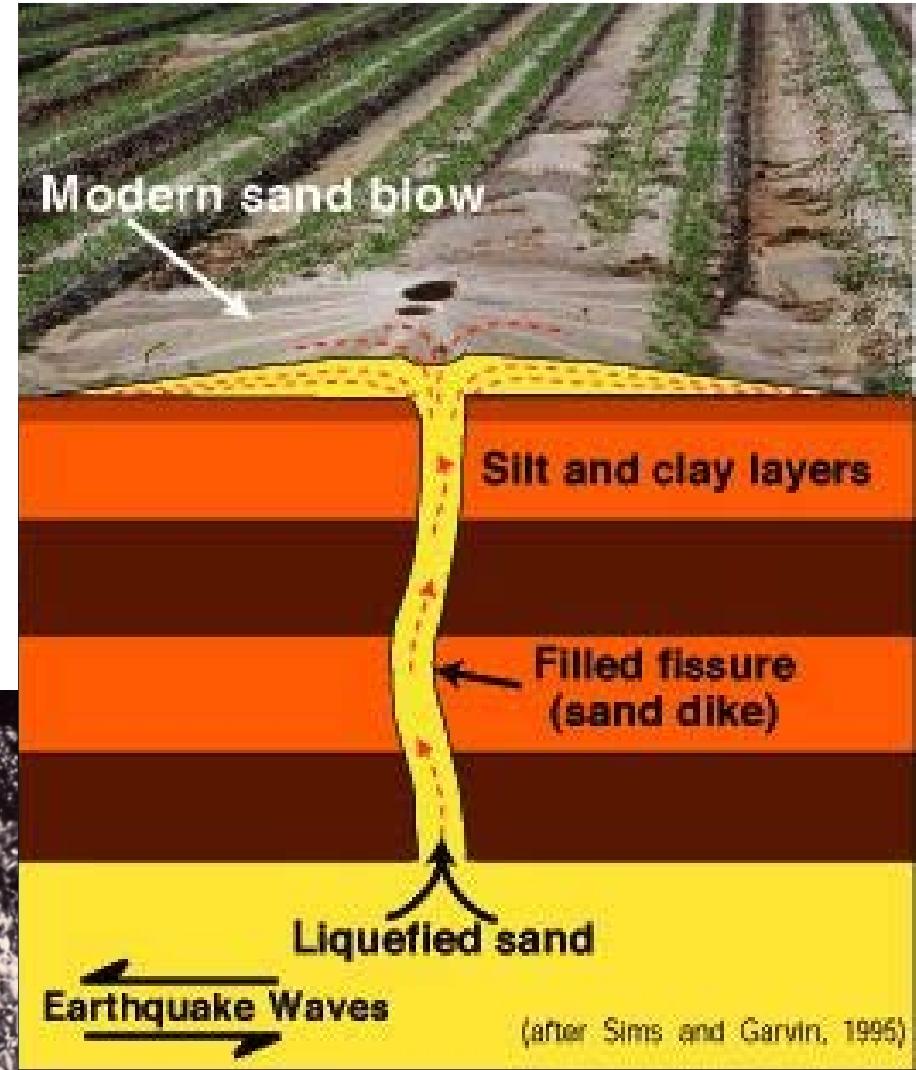


EARTHQUAKE-INDUCED LIQUEFACTION

Liquefaction occurs when a saturated sediment (typically sand) loses shear strength from water in pores.
(Waterbed analogy)

Liquified sediment moves up through a fracture in overlying sediments.

Commonly evidenced by:
‘Sand boils’ (also known as ‘sand blows’, or ‘mud volcanoes’)



An example from the 1906 earthquake near Salinas...

...and the 1989 Loma Prieta earthquake



Sand boils on the approach to the Bay Bridge
(The toll plaza was built on artificial fill.)



Santa Rosa City Hall
After the 1906 Earthquake

Downtown Santa Rosa was built on saturated alluvium, which amplified seismic waves and liquefied, so the ground no longer supported buildings



The Marina district: built on artificial fill post-1906,
liquefied in 1989

Effects of earthquakes: *Tsunamis*



High water. A giant Cascadia quake may have triggered a tsunami like one thought to have inspired Hokusai's "The Wave."

Usually triggered by massive submarine landslides that fail due to shaking during large earthquakes, especially along subduction zones



The Fukushima earthquake and tsunami resulted from movement on the subduction zone fault offshore. Subduction zone earthquakes can exceed 9 on Richter scale

Summarizing effects of earthquakes

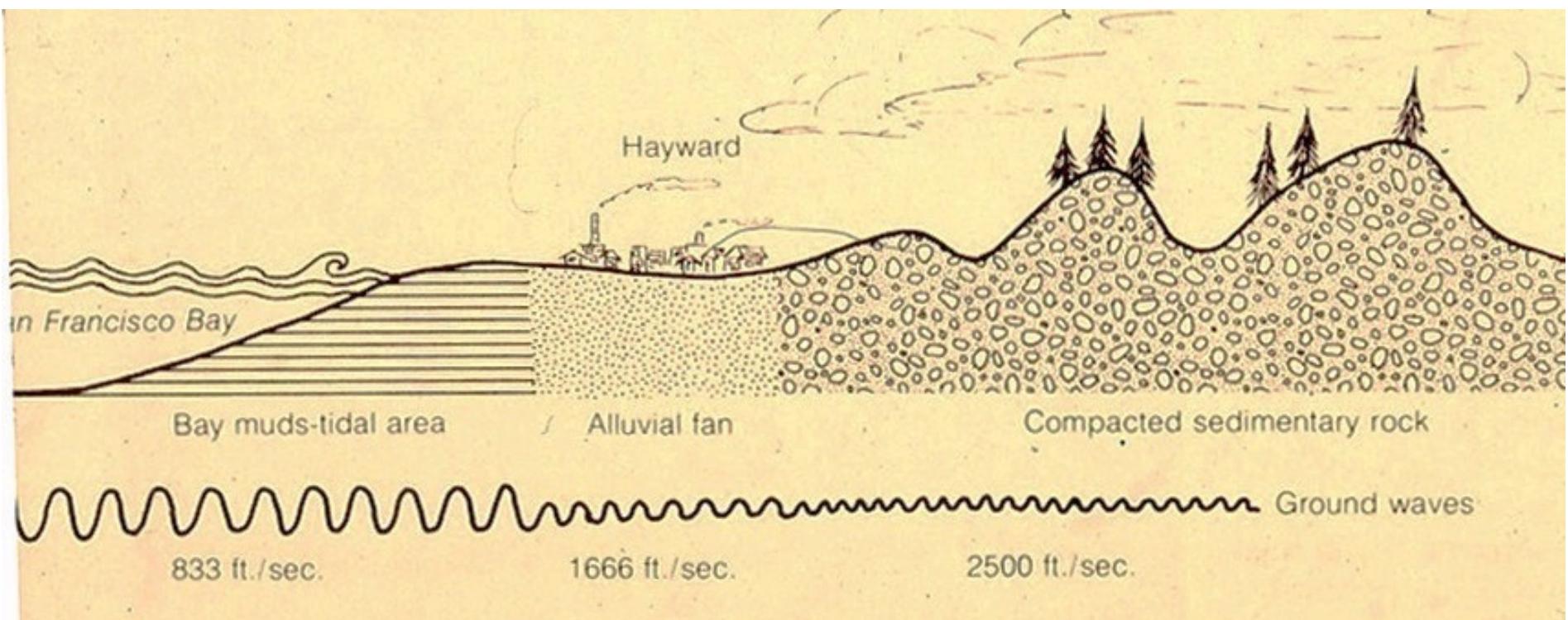


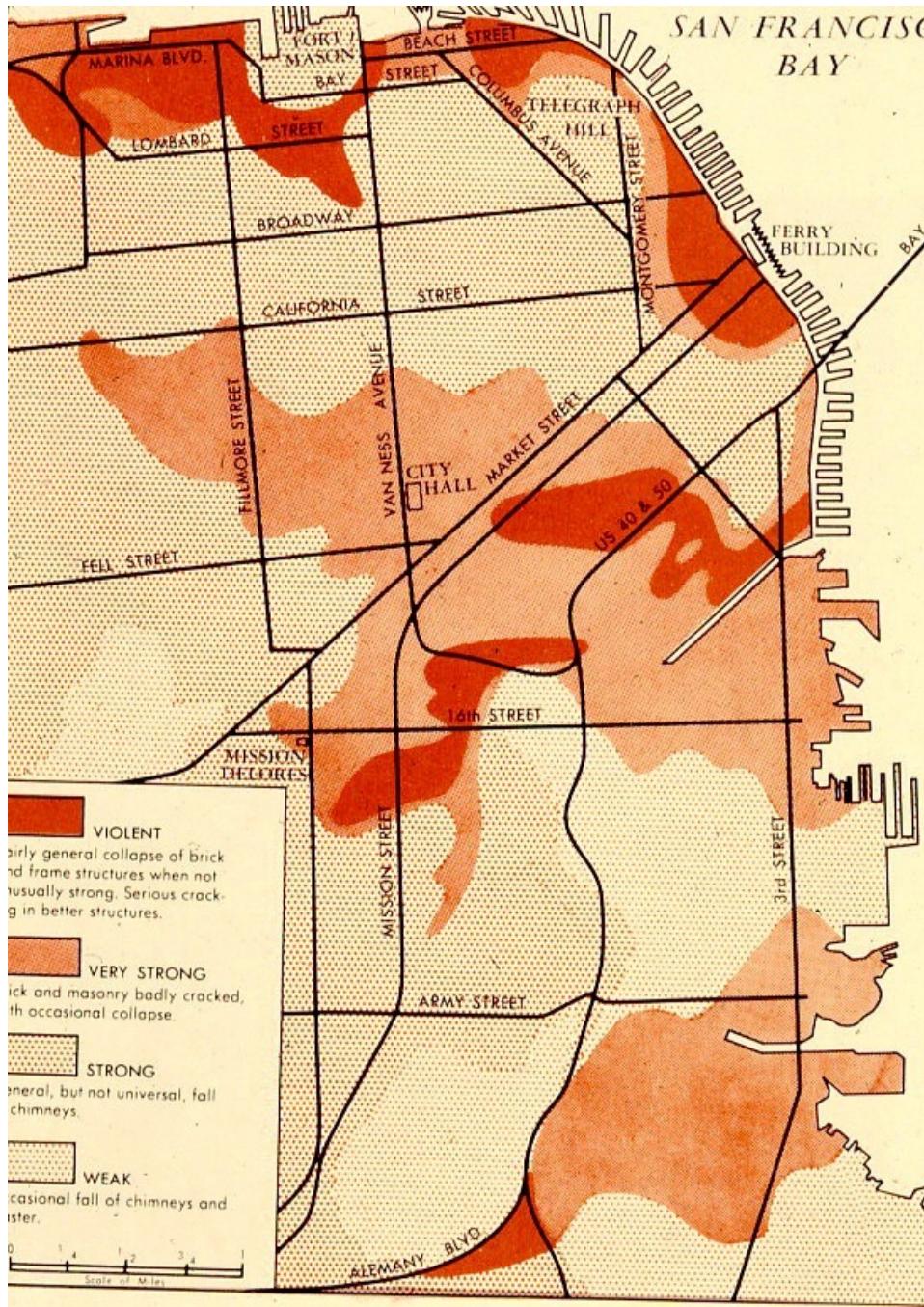
- **Shaking** is the single greatest effect of earthquakes.
- Landslides, liquefaction, tsunamis triggered by shaking
- The 1906 fire was a consequence of shaking, with sparks from falling bricks igniting gas lines, etc.
- Shaking also causes secondary impacts from flying objects.

How strong is earthquake shaking at a point?

Factors:

- Magnitude of the earthquake (Richter scale)
- How close to the fault
- What kind of substrate (ie, soil/rock type):
Hard rock shakes less than soft sediment, artificial fill



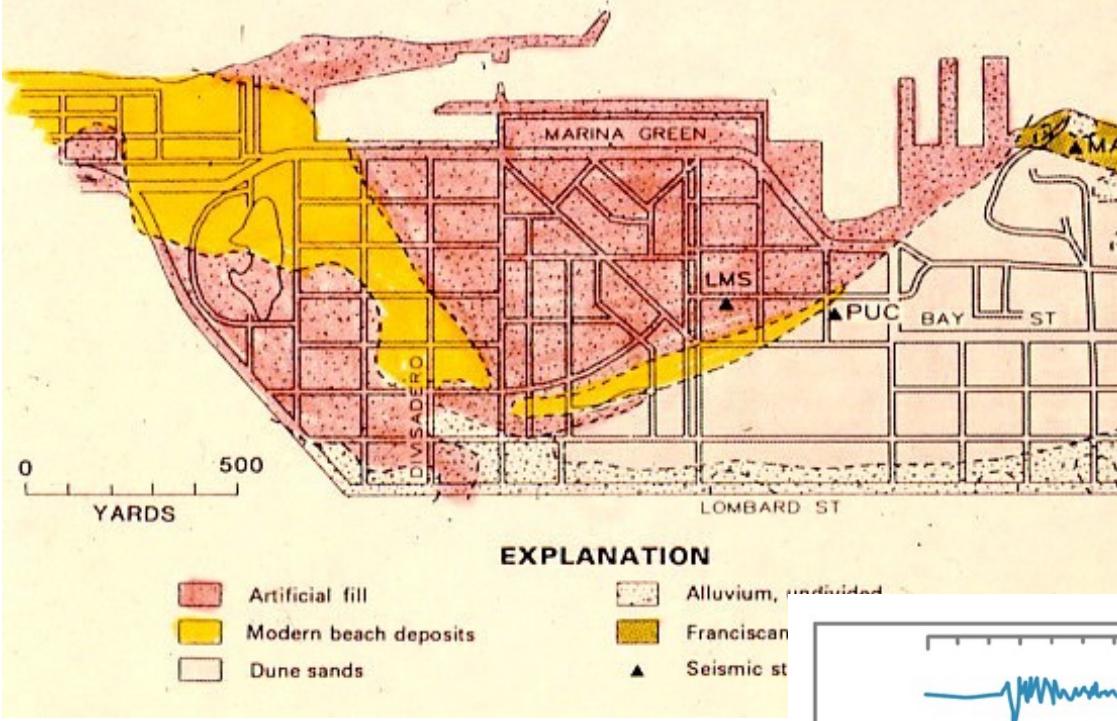


Map predicting areas of strongest shaking based on soil/rocktype.

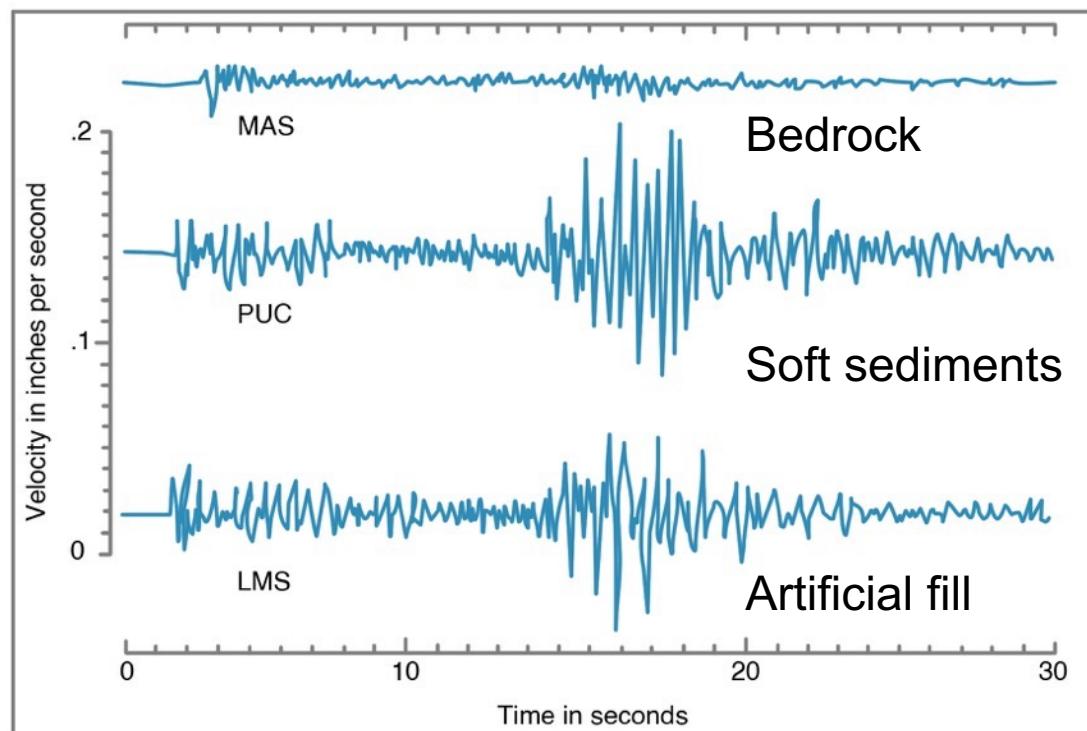
Map developed *before* 1989 earthquake, but predicted exactly where shaking was most severe in 1989.

Red = violent shaking, all on areas of artificial fill

SAN FRANCISCO BAY



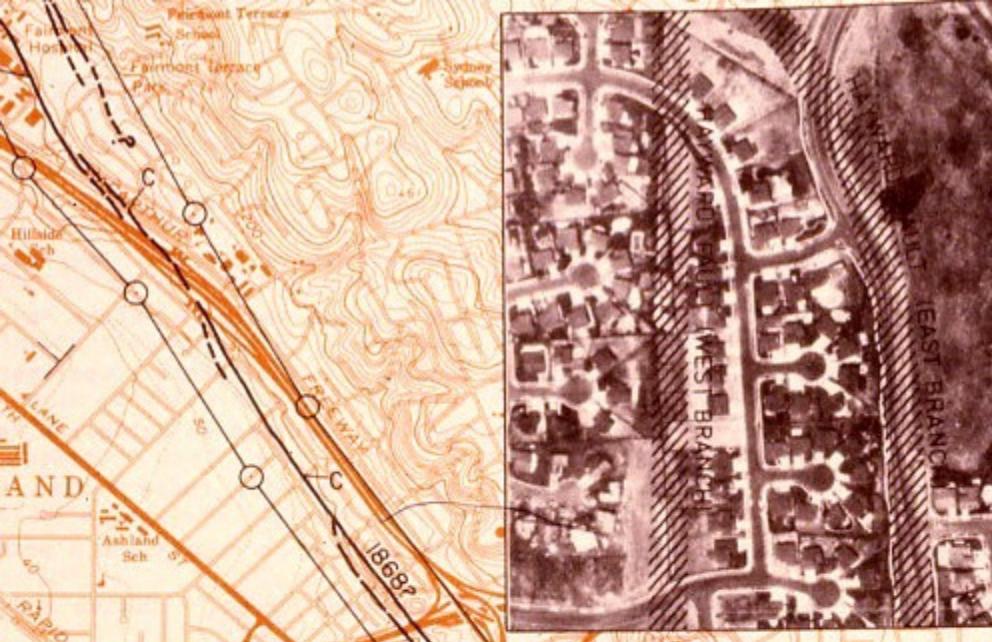
Aftershocks from the 1989 earthquake were much greater on artificial fill & alluvium than on bedrock



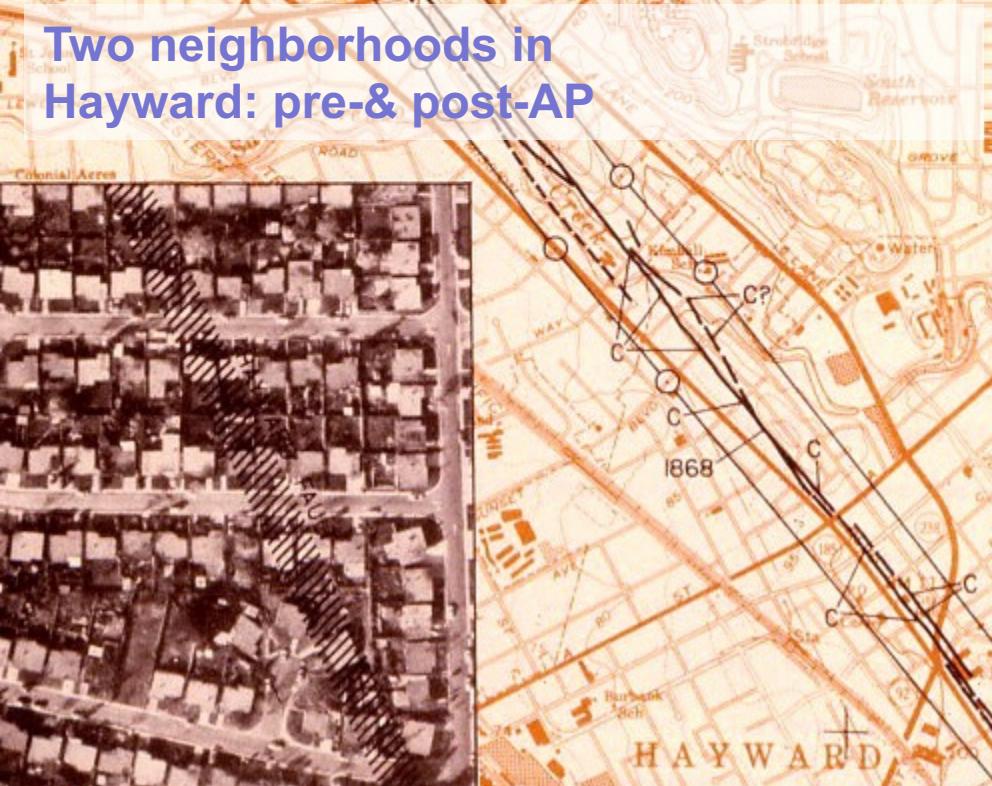
The 1971 San Fernando Valley earthquake was very influential in California, as the first 'big' earthquake in many decades. It resulted in the Alquist-Priola Act.



The collapse of Olive View Hospital



Two neighborhoods in
Hayward: pre-& post-AP

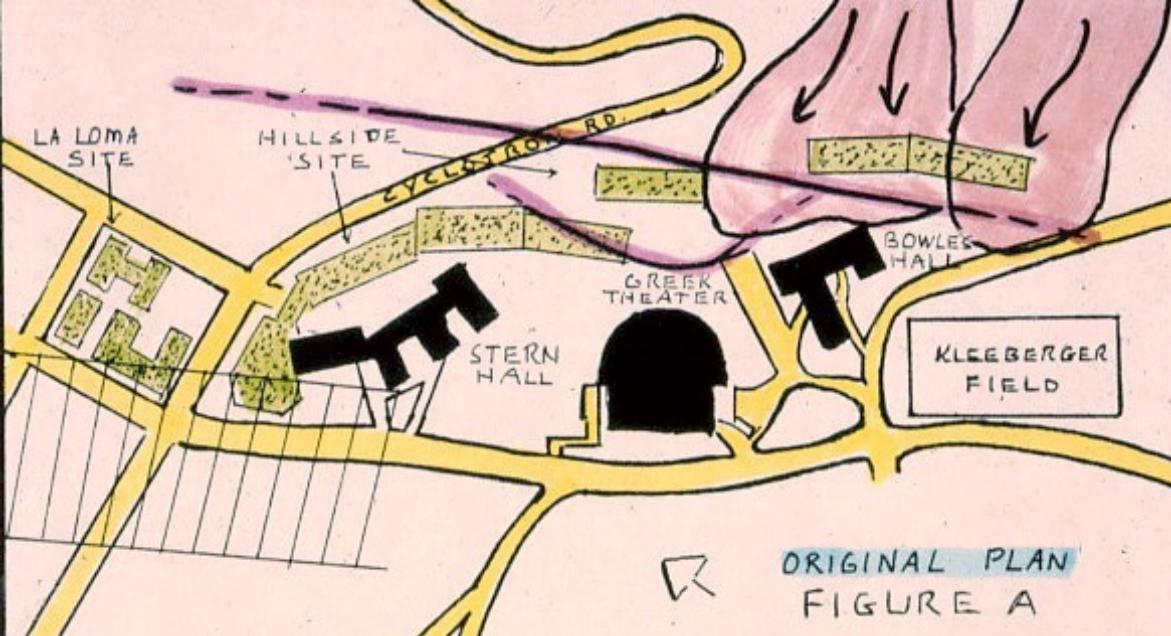


AP Act requires the State Geologist to make maps of the active fault traces & 'special studies' zone around the fault.

Within the zone, any Development > 4 units must have a geologic study done to look for the fault. Buildings must be set back.

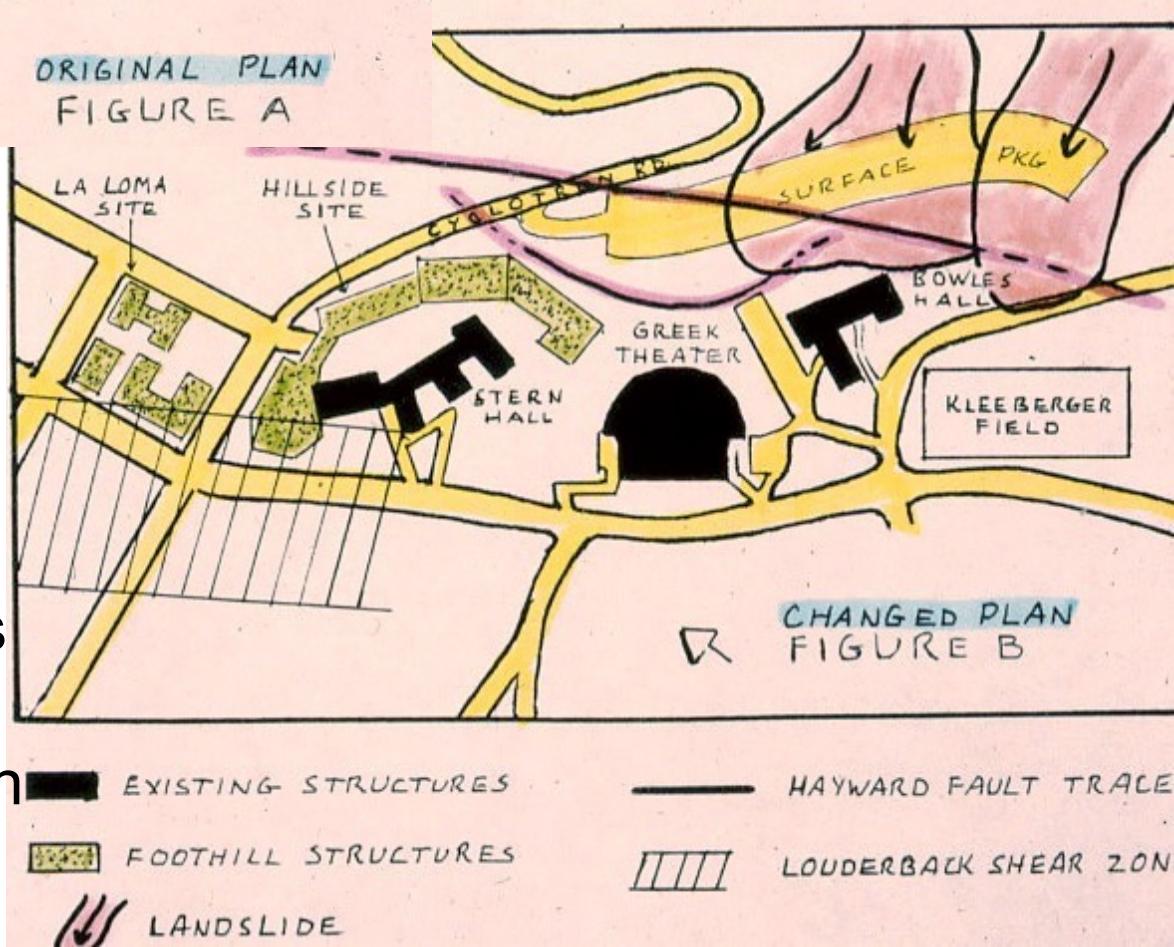
People buying property near a fault must be informed that their property is located near a fault zone

Foothills Complex: How layout changed due to geologic hazards information



Original plan: buildings on a landslide and very close to active traces of the Hayward Fault

Changed Plan: Buildings moved off landslide & fault. Parking lot now on landslide.



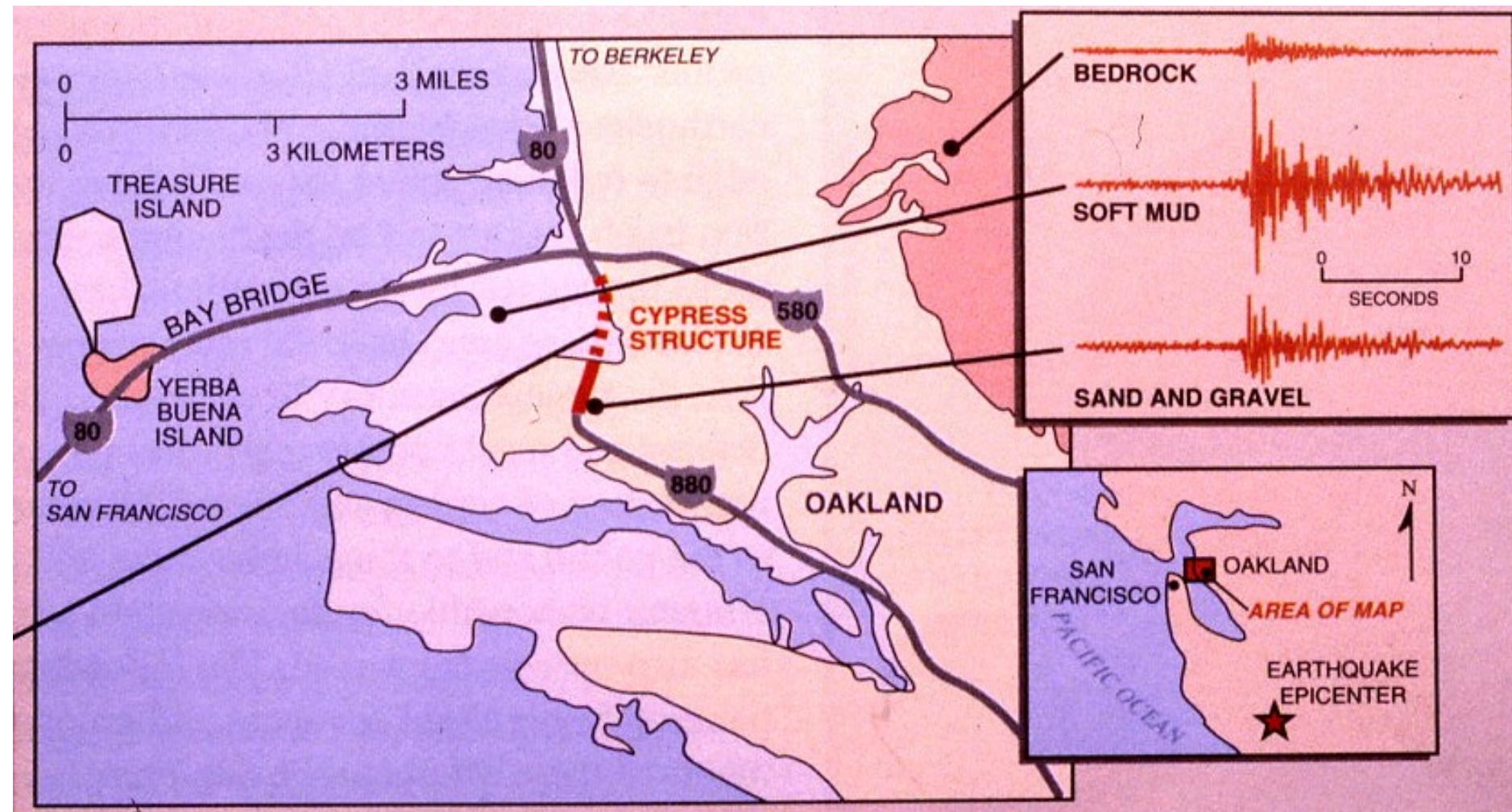


The AP Act only regulates around the fault itself, but where is shaking most intense?

The double-decker Cypress Freeway collapsed miles from the fault (1989)



The state geologist active fault map for the West Oakland quadrangle



Cartoon: “The dawn of the disclosure statement”



How well do the disclosure requirements under the Alquist-Priola Act work?
Are residents truly informed?



An illustrative case study:

Westview Drive, Daly City

A subdivision built before the Alquist-Priola over the trace of the San Andreas Fault.

How well do the disclosure requirements work to inform residents of their risk?



Houses on failing cliff – lost one by one...

When asked if there were any geologic issues, real estate agents replied that there had been some issues with ‘settlement’ and erosion, but that they had been ‘taken care’ of!



Lots of evidence that the ground is unstable and moving:
Repaired cracks in the asphalt

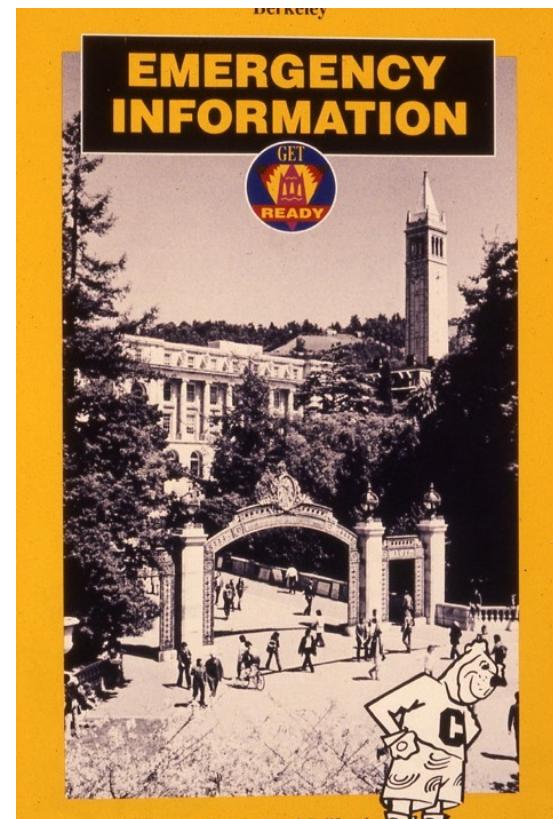
...and buckling driveways



Despite all the evidence of unstable ground, the residents our students spoke to were not aware of the hazard. They liked living there (relatively cheap for the SF Bay area, near the coast). None were informed by a real estate agent that there was a hazard from the fault.

How about on campus? What are our risks? How well do we understand them?

Shaking during earthquakes will turn loose items into projectiles. What's on your shelves, especially up high? See if your bookshelves are bolted to the wall, so at least the whole bookshelf won't fall down on you.



The sunshades on Wurster Hall are each held in place by two bolts near the back. They will surely snap off during a serious earthquake and fall to the ground below.

If you are in Wurster Hall in an earthquake, go the the assembly point in front of the main door.

Don't go to the courtyard!



Tremendous power released by earthquakes...

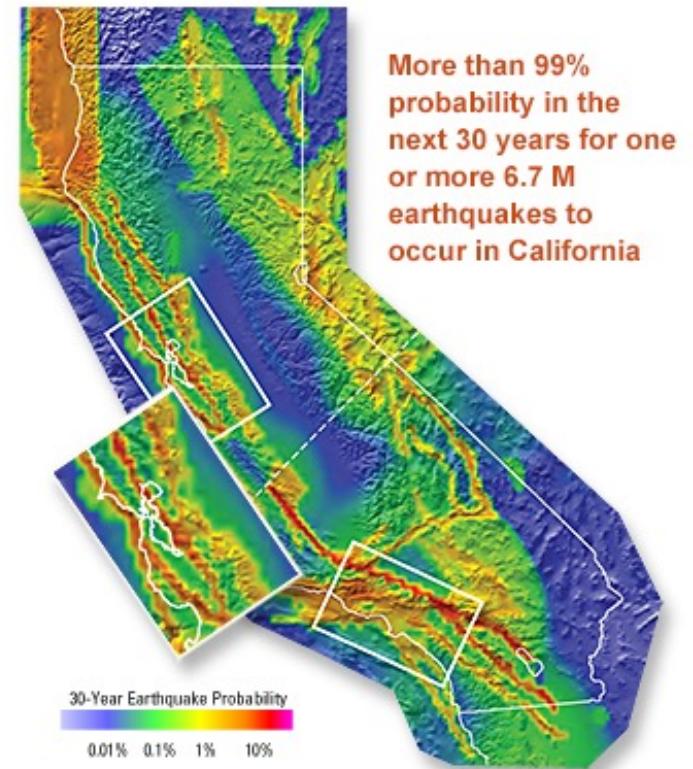


Rails bent by 1906 earthquake near Salinas

Question: What is the probability of an earthquake of magnitude 6.7 or greater in California in the next 30 years?

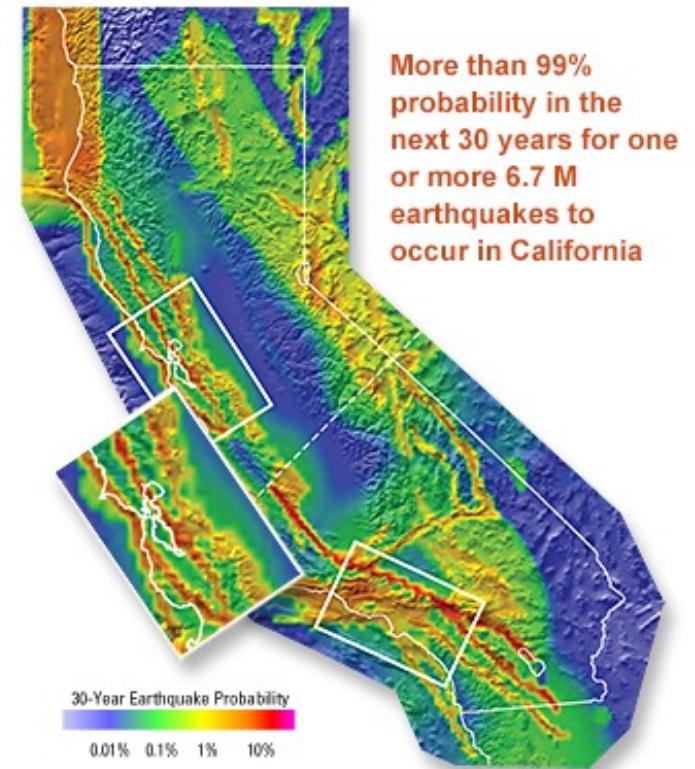
The probability of an earthquake of magnitude 6.7 or greater in the next 30 years?

- in California ?
- in SF Bay region?



The probability of an earthquake of magnitude 6.7 or greater in the next 30 years?

- in California ? 99%
- in SF Bay region? 72%

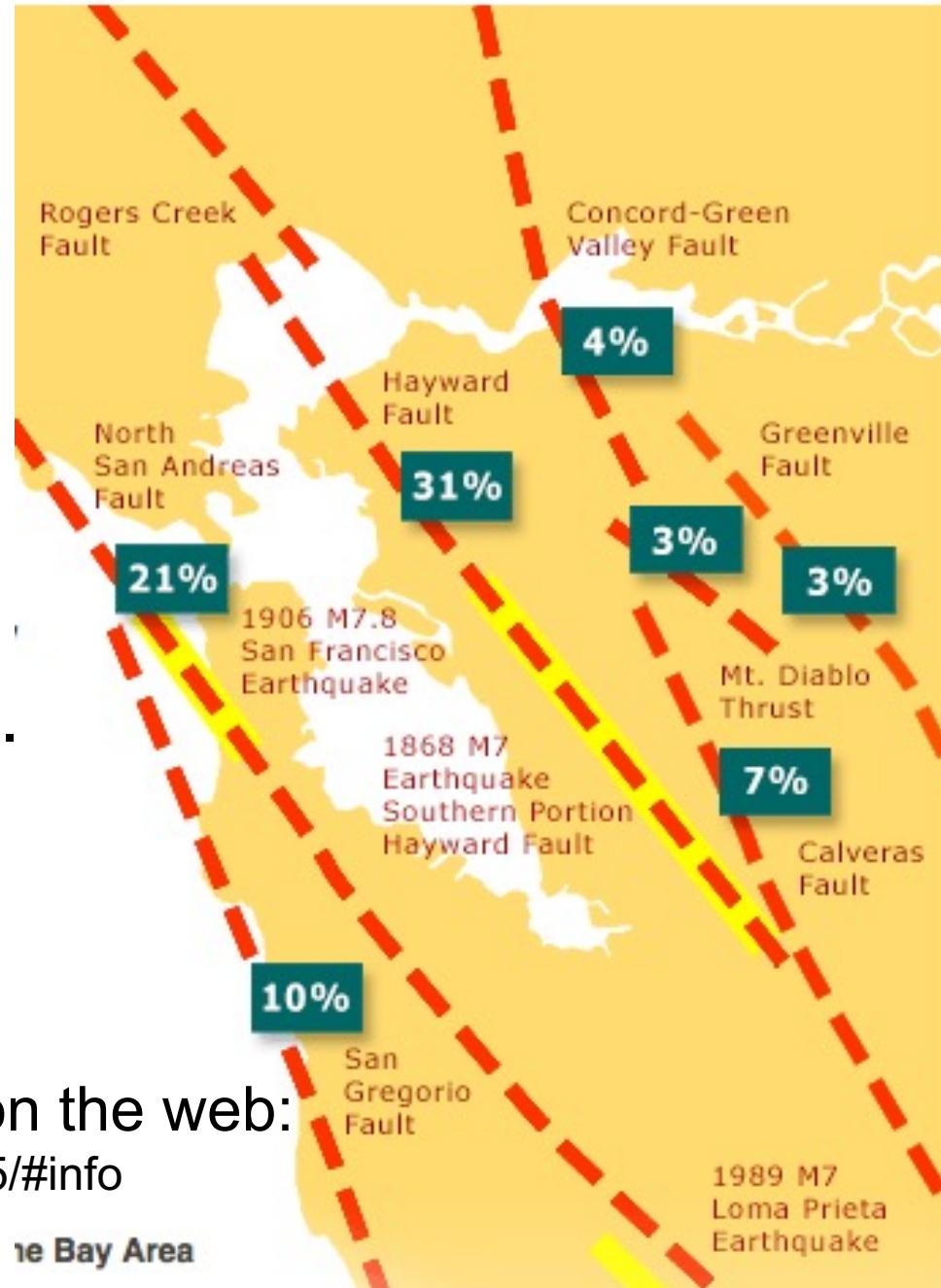


The threat comes from multiple faults...

Former estimate of 62% chance in 30 years was recently revised upward to 72%.

Source: Working Group on Calif Earthquake Probabilities 2016

Earthquake information on the web:
<https://pubs.usgs.gov/gip/2005/15/#info>



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- Earth structure & plate tectonics
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- **Natural hazards: inevitability & risk perception**

Natural hazards: inevitability and risk perception

Natural hazard

Natural hazards are a natural occurring event

Natural disaster

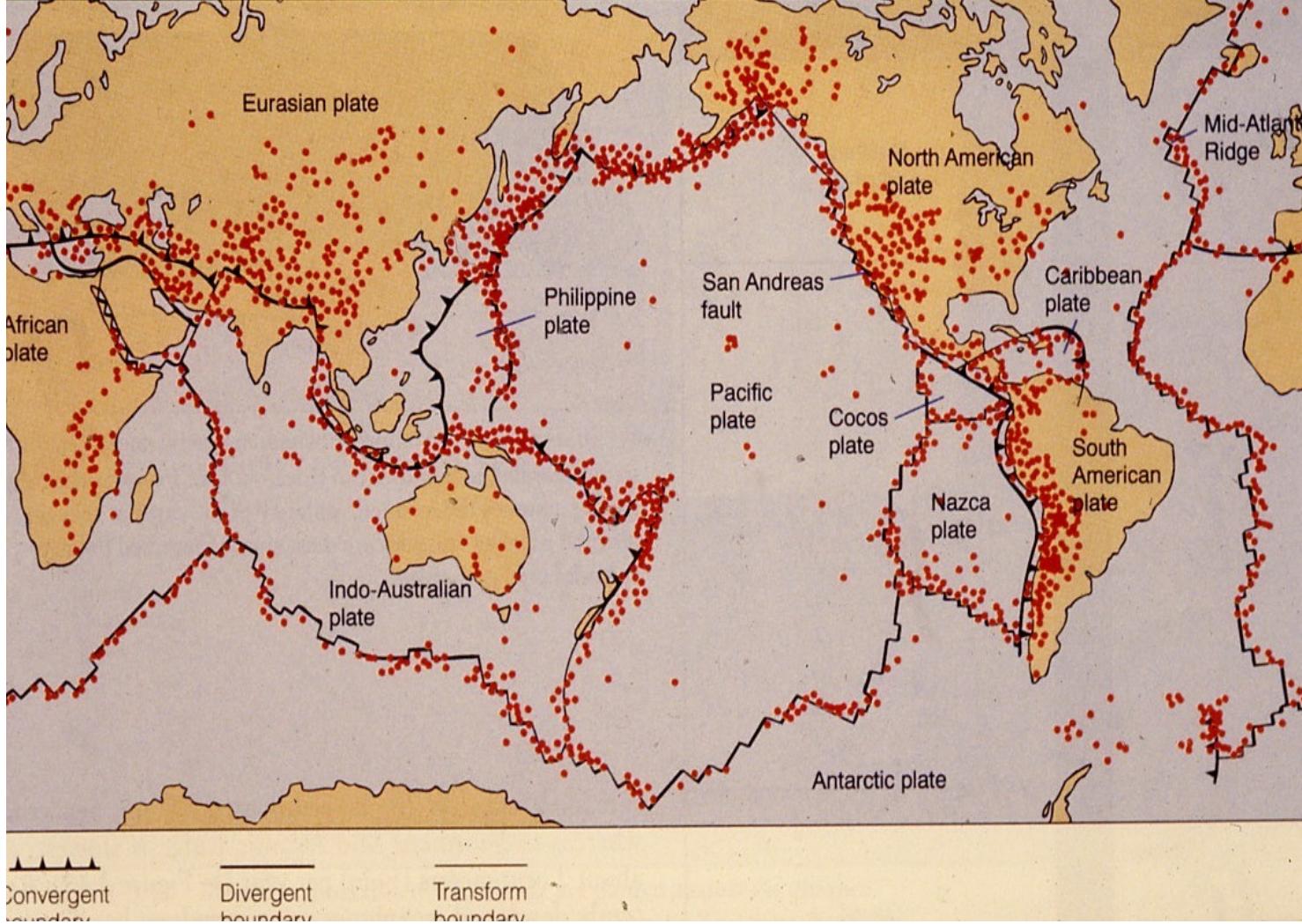
When a natural hazard negatively impacts humans

....without humans, there would be no “natural disasters”

Natural hazards

- Earthquakes
- Volcanic Eruptions
- Tsunami
- Landslides
- Subsidence
- Floods
- Droughts
- Hurricanes
- Tornadoes
- Asteroid Impacts



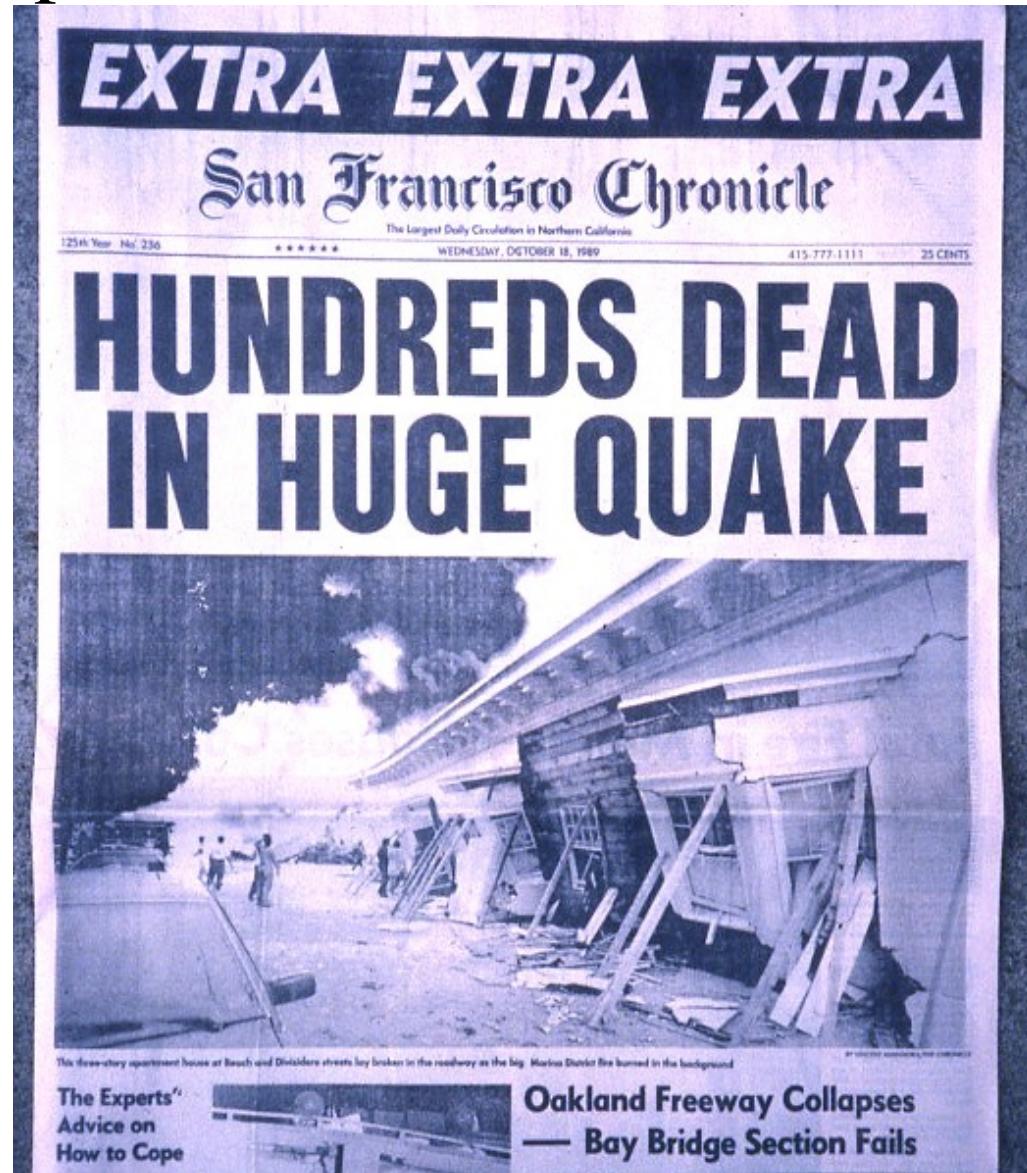


Remember: when the plates move, there are earthquakes.
There is nothing that Congress, or the President, or anyone
can do about the inevitability of earthquakes.
Still, humans tend towards denial.

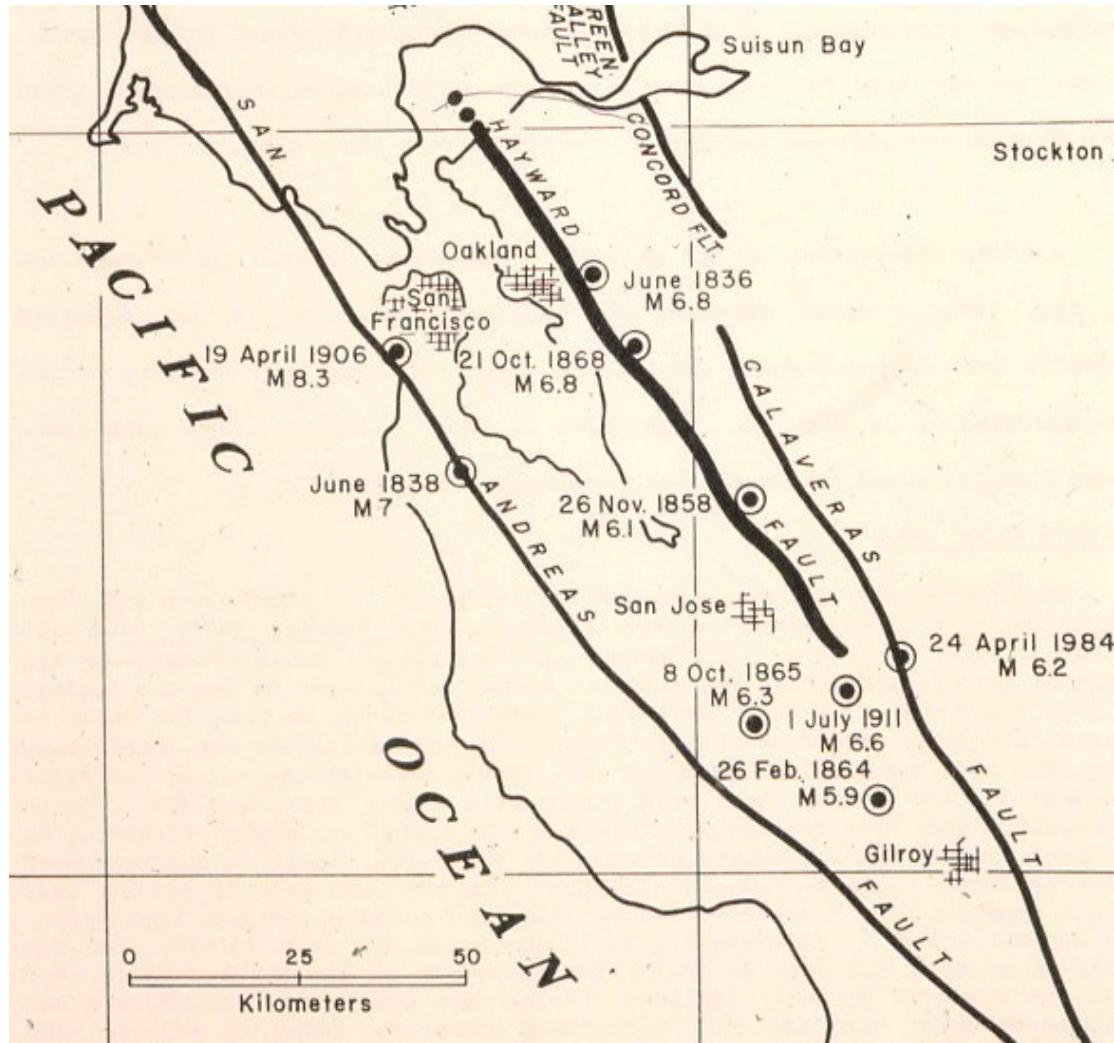
How do humans perceive risk from natural hazards?
How do the media present natural hazards?

SF Chronicle
Headline for
1989 Loma
Pieta earthquake

*Actual deaths: 67
damages: \$5B*



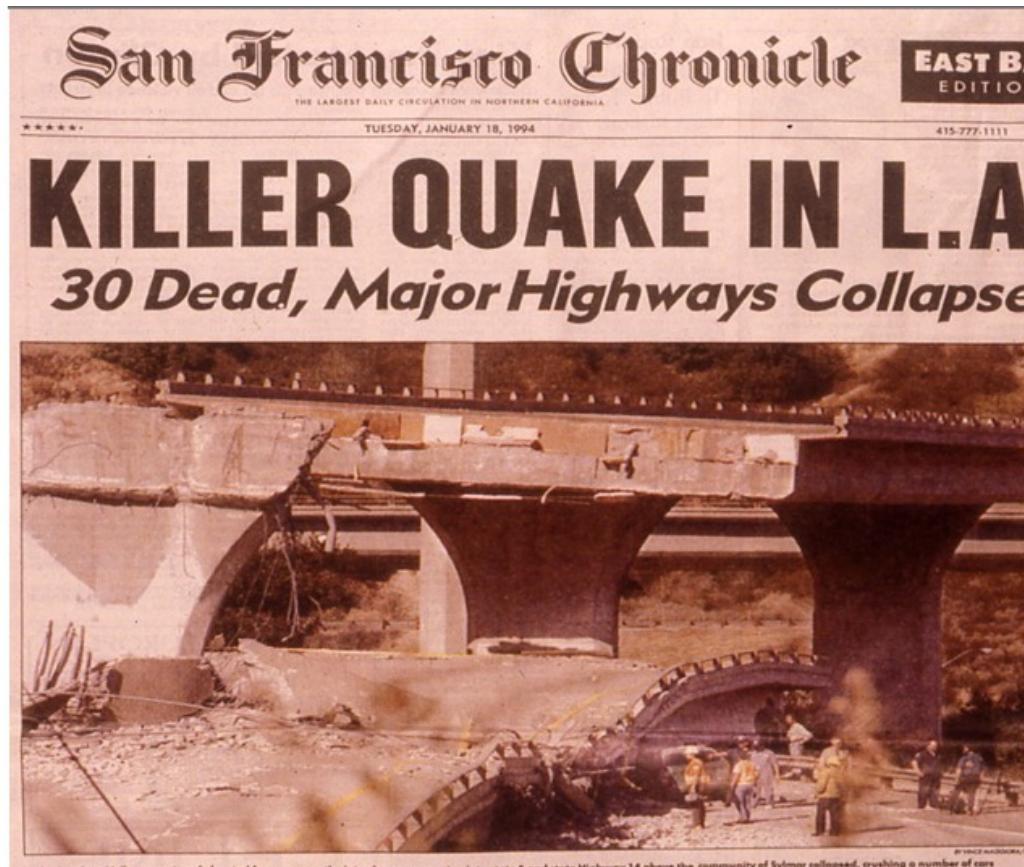
Earthquakes were more common in the 19th and early 20th centuries. Today, however, many people don't have the direct experience of a quake, and thus don't believe it will happen.



Time Scales for Natural Hazards and Human Perception

Natural hazard	Time scale (years)
Earthquake and tsunami, Japan ^a	450
Strike-slip earthquake, Hayward Fault, California ^b	50–100
Hurricane, New York area ^c	25–50
Hurricane, southeast Florida ^c	5–7
Major fire ^d	5
Cold weather in northeast/Midwest US ^d	2
Human perception	Time scale (years)
Human life ^e	70
Typical planning horizon for real estate development ^f	5–10
Term of office, elected official ^g	2–4
Government budget ^h	1
Attention span of media ⁱ	0.02

Taking Jan 1994 Northridge earthquake (San Fernando Valley of Los Angeles) as an example of media attention span...



TUESDAY, JANUARY 18, 1994

415-777-1111 50

KILLER QUAKE IN L.A.

30 Dead, Major Highways Collapse



In the Antelope Valley, a section of elevated freeway near the interchange connecting Interstate 5 and state Highway 14 above the community of Sylmar collapsed, crushing a number of cars.

18 Jan 1994

Day 1:
All front-page
stories are
about the
earthquake

■ WHERE 15 DIED Chaos, Ruin In Northridge Apartments

By April Lynch, Glen Martin
and Paul L. Wilson
Chronicle Staff Writers

Northridge

First, Erik and Susan Pearson fell from their fifth-story balcony, and then they fell 12 feet down to where the bed rested in the pile of rubble that had been their apartment at Northridge Meadows.

When they clambered out of their third-floor unit in the sprawling complex, they had to jump only 15 feet from their balcony to the ground because the bottom floor of the structure had been squashed out of existence by yesterday's earthquake.

"At first, the couple did not know others were dying around them. They knew only what terror

■ TRANSIT OUTLOOK I-5 Closed — Freeway System Devastated

By Ben Wildavsky, Jeff Pellegrini
and Jamie Beckett
Chronicle Staff Writers

Los Angeles

Los Angeles suffered a blow to its transportation system when the sprawling city's extraordinary transportation web was attacked by forces it could not withstand. Two major north-south freeways, the Santa Monica and the Golden State, were rendered unusable by yesterday's earthquake. When news of the quake came, causing more than 600 miles of freeway in Los Angeles during the evening rush hour, Angelenos are extremely dependent on public transit and the consequences could be crippling.

"One can predict mobility chaos," said Frank Francois, executive director of the American Association of

FREeways. Page A12 Col. 5



6.6 Jolt Injures Hundreds In San Fernando Valley

By Rick DeVicchio, Bob Blasberg and Aurelio Rojas
Chronicle Staff Writers

Los Angeles

A violent predawn earthquake jolted the Los Angeles basin yesterday, crumbling several of the nation's busiest freeways, killing 57 people and injuring almost 3,000 others, and causing a series of landslides. At least 30 people were killed and hundreds more injured.

The devastating temblor, measuring 6.6 on the Richter scale, was centered beneath the San Fernando Valley just west of the San Gabriel Ridge, but it caused damage from Orange County to the San Gabriel Valley and extended nearly 30 miles away in Los Angeles.

The quake struck at 4:31 a.m. and turned placid residential communities into scenes of terror.

The odor of leaking natural gas filled neighborhoods in the gas center. The fast fed raging fires

that burned scores of torched cars and lit the blazes for miles around. More 200 powerful aftershocks struck the region late last night, blowing out plate-glass windows and doors.

More Quake Coverage
Starts on Page A

dows, toppling furniture and leaving hundreds of terrified families returning to their homes.

The most horrifying

unfolded at an apartment complex in the Reseda area, where the structure collapsed, killing 15 people and trapping a other terrified residents who had to crawl down pipes to safety at the complex.

The odor of leaking natural gas filled neighborhoods in the gas center. The fast fed raging fires

QUAKE: Page A12 Col. 1

SPORTS

Dallas Elliott Smith may take a shot in his injured shoulder for the first time since he was injured.

Page D1

BUSINESS

Microsoft is about to make its first entry into the video game market.

Page B1

Books

Bridge
Letters
Classified
Autos
Jobs

Obituaries
Personal
Comics
Sports

Page C1

INSIDE

Jazzin' America
Special Report • Second of Three Parts



Tonya Harding
Fund Linked
To...
Page A12

THURSDAY, JANUARY 20, 1994

415-777-1111 50 CENTS

Clinton Visits Quake Scene

Damage Estimates Climb as High as \$30 Billion



After a gas explosion, Maria Partlow sifted through the rubble of her in-laws' Grenada Hills home for what remained of a miniature train collection.

■ LOMA PRIETA UPDATE

Bay Bridges Still Not Quakeproof

By Greg Lienau and Vicki Kershner
Chronicle Staff Writers

Sacramento

More than four years after the Loma Prieta earthquake shut down the Bay Bridge, all but one of the Bay Area's major spans are still vulnerable to collapse, according to several state road builders insist saved some Los Angeles overpasses.

In fact, if the Northridge earthquake had hit the Bay Area, its major bridges could have been



A glum President Clinton toured the quake damage areas with workers from the L.A. water department.

■ CLASSROOM CRISIS

Expensive Jolt To L.A. Schools

By Aurelio Higgins and Ninette Alvarado
Chronicle Staff Writers

Los Angeles

The Northridge earthquake dealt an expensive blow to students in Los Angeles, plagued by AIDS and other diseases, and hundreds of millions of dollars in damage and destruction as many as 15 schools.

School officials estimated yesterday that repairs will approach \$700 million in the Los Angeles school district alone, enough to rival the cost

SCHOOLS: Page A15 Col. 1

Cold Snap Kills 87 — Power Rationed in East

Chronicle Wire Service

New York

An Arctic chill gripped the East and Midwest yesterday, plunging temperatures to a 119-year low for the day in Detroit. Conditions were so bad utility companies in ration power to hundreds of thousands of customers and sharply curtailed service to the nation's capital government in Washington.

At least 87 deaths were blamed on the cold during a six-day period, and nearly half of the victims were killed on icy roads or suffered heart attacks, shooting above others snuffed from their beds.

Schools and businesses were shut throughout the region and airline flights were canceled as far west as San Francisco.

— BY RICHARD HODGKINSON
INDIANA STATE POLICE

into skating rinks, and ice fishing was suspended on Lake Erie.

Skaters and their families

were forced to leave the lake because of the wind chill factor.

When you walk out in it, it's like someone hitting you in the chest!

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So what are football fans everywhere asking? This is what: Can he do it again? "He" is Joe Montana, and "it" is leading his new team to the Super Bowl.

SEE PAGE E1



The excitable Ricky Watters is one of the keys to the 49ers-Cowboys game this weekend; the question is, who will be excited the most, Dallas or San Francisco?

SEE SCOTT DIAZ, PAGE E1

Which is the real 49ers defense? The one that dismantled the Giants last week, or the one that stranded for much of the season?

SEE PAGE E1



San Francisco Chronicle

THE LARGEST DAILY CIRCULATION IN NORTHERN CALIFORNIA

EAST BAY
EDITION

FRIDAY, JANUARY 21, 1994

415-777-1111 50¢

Body Found — Probably Jockey's

His car was abandoned Oct. 2 on San Mateo Bridge

By Peter Fimrite
and Larry Blumen
Chronicle Staff Writers

The healthy 45-year-old body of a man who police believe is missing jockey Dan Hansen was found yesterday in a salt marsh near the his home bridge.

The driver of Hansen's car, a woman in her late 20s, drove south of a mile south of the bridge in Hayward, apparently losing a way. She then drove north to baffled police, private investigators and the horse racing world.

Investigators said they have found no obvious signs of foul play.

Hansen, one of Northern California's top jockeys, vanished October 2 after a high-speed crash on the San Mateo-Hayward bridge. His car was found abandoned on the bridge with his wallet inside, but empty. Hansen, who was known for his lightning-quick turns both on and off the track, was big, Maya, very fast.

All indications yesterday that the body has not been positively identified that he was Hansen were strong. In the six days for about three months and was in "an advanced state of decomposition."

The body was laid out in jeans and a shirt and remained with JOCKEY. Page A1 Col. 2

Yeltsin's New Cabinet Loses Reformer

By Fredrik Reinfeldt
Washington Post

Moscow Russian President Boris Yeltsin named a new cabinet yesterday that is far more committed to free-market economic reforms than the previous one, but which is unlikely to bring about more toward capitalism will slow even further at staff divisions.

Indeed, from the cabinet was Finance Minister Boris Yeltsin, the strongest remaining pro-market reformer in the government. He was replaced by Vagit Alekperov. Following in the footsteps of Deputy Premier Yegor Gaidar, the architect of Russia's reforms, who quit last month.

Reformers predicted the new RUSSIA. Page A10 Col. 1

New L.A. Fear — Rain and Cold



Moya Aguilera, shown with granddaughter Larissa, is living in a cardboard-and-plastic tent in Newhall Park in Santa Clarita.

Prosecutor to Question Clintons Under Oath

He pledges thorough Whitewater inquiry

By Michael Dukoff
Washington Post

Washington Newly named special prosecutor Fredrik B. Pederick Jr. yesterday agreed to "a rough, rapid, thorough and impartial" inquiry that he "expects" to be completed within 90 days, he told Senate Republicans and Hillary Rodham Clinton yesterday.

A prominent New York lawyer and former U.S. attorney in Manhattan during the Ford and Carter administrations, Pederick quickly asserted his independence, insisting he would not be swayed by politics or personal relationships with Hillary Clinton or Mrs. Hillary Rodham Clinton's relationships with the Clintons.

Pederick, whose appointment comes as the first anniversary of Clinton's inauguration, said at a news conference that he intends to set up an office in Little Rock and to hire a staff of 10. He also appointed current Justice Department prosecutors working on the case with a "solid

team" of top-flight outside lawyers with prosecutorial expertise.

He also emphasized that he was given free rein by Attorney General Janet Reno to root out and expose wrongdoing in any way possible.

Pederick also pledged to keep the Whitewater inquiry separate from the independent counsel investigation of the Clintons.

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MORE ON THE AFTERMATH OF THE QUAKE

■ A strange new world of unmarked deaths, homeless people, described hotels and airports as "hellholes," and emergency workers racing to and from Los Angeles along the Grenada and Sepulveda freeways. Page A12.



An undamaged house stood behind ruins of two others.

■ The city of Santa Clarita has found itself cut off from the rest of the greater Los Angeles area by the collapse of Highway 140, which closed Monday night.

Page A12.

■ Preliminary structures were the worst hit in the Fernando quake, and investigators are trying to determine whether they were built to code. Page A12.

Page A12.

An undamaged house stood behind ruins of two others.

Sweeping Plan to Remake State Courts

By Harriet Chong
Chronicle Legal Affairs Writer

Sacramento

Judges will be a scarce commodity in California unless the court system undergoes major reform, including decentralizing some functions and creating a single state supreme court and a state appellate court.

A state commission unveiled an ambitious and sweeping plan yesterday to restructure the state's 100-plus county courts. The commission, offering more than a decade of recommendations to solve a growing backlog of cases, may be on the brink of collapse.

Achond, the victim of a parasite that caused him to eat his own brain, was awarded \$1 million in damages by a San Francisco jury yesterday. Achond, 26, was found guilty of assault and battery, and was awarded \$1 million in damages by a San Francisco jury yesterday.

After two years of state hearings, public comment and numerous meetings with the 43 county judges — lawyers, judges and citizens — offered a still-polymerized plan for the streamlined court system.

At yesterday's press conference, the commission urged the Legislature "to move forward" — and even admit it did not agree with all its recommendations. "The true COURTS. Page A12-A13

Page A12

Page A13

San Francisco Chronicle

THE LARGEST DAILY CIRCULATION IN NORTHERN CALIFORNIA

THURSDAY, JANUARY 27, 1994

415-777-1111 50 CENTS

Aussie Fires Blanks at Charles



Prince Charles resumed an outdoor ceremony in Sydney with beefed-up security after a young man fired blanks

No One Hurt in Bizarre Incident

Chronicle Wire Services

Sydney

Britain's Prince Charles, eager to boost his image after the breakup of his marriage to Princess Diana, has proved once again he can stay calm under fire.

The 45-year-old heir to the throne hardly flinched yesterday when a young man ran out of a crowd, lunged at him and fired two blank shots from a starter's pistol during an outdoor ceremony marking Australia's national day.

The prince saw the man run toward him and froze momentarily as the shots rang out. Afterward, he calmly adjusted his cufflinks.

Within minutes of the man's arrest, Charles, unharmed, carried on with his speech. He joked with the crowd and later

drizzled gunfire at a cocktail party that he was fine.

"He played it cool. He wants everyone to know he's OK," said Sir Henry Lord May or Frank Sartor, one of the dignitaries on stage during the incident. Others on stage were knocked from their seats in the commotion.

Police said the assailant, 23-year-old university student David Kang, wrote Prince Charles last month to complain about the treatment of the nearly 100,000 Cambodian refugees held in detention camps. The prince's staff had written back to Kang, who could not become involved in the matter.

Kang, who police said was Australian-born of Korean parents, was jailed. He will face six charges under a federal law to CHARLES. Page A12 Col. 1

Charles' wife, Camilla Parker-Bowles, was not present.



Australian police grappled with 23-year-old college student David Kang after the shooting

Yugoslav Troops Observed Inside Bosnia, U.N. Source Says

By John Kifner
New York Times

Brussels

Yugoslav army units have been operating in Bosnia in recent weeks in an apparent attempt to counter recent advances by the forces of the Muslims and Croats. The United Nations and Yugoslav journalists say.

"We have seen troops movements of the Yugoslav army in areas where they are not supposed to be and military vehicles," said a U.N. official who requested anonymity because of potential ramifications. "We believe they are there for a pre-emptive attack coming."

Despite repeated denials by the Brusilov government, it has long been suspected that the Yugoslav army is secretly supporting the forces of only Serbia and Montenegro, who have been giving direct support to the Serbs in nationalists fighting in Bosnia. It was in an attempt to pressure



Belgrade denies supporting Serbian nationalists in Bosnia

Belgrade into halting such assistance that the U.N. Security Council imposed the economic embargo on Yugoslavia. Page A12 Col. 1

✓ NEW BELIEVERS IN DATA SUPERHIGHWAY

By Kenneth Howe
and Michael McCabe
Chronicle Staff Writers

Los Angeles

With one devastating jolt last week, highway-addicted drivers and businesses became sudden believers in the so-called information superhighway.

"The modem is going to save me at least two hours in traffic each day," says Michael Niles, a public education specialist for the Santa

formation superhighway.

Some who had been thinking about, but not using, the superhighway last Sunday in here, Mary Sue Maser of Santa Monica said she started telecommuting Monday from her office in the downtown Los Angeles.

"This modem is going to save me at least two hours in traffic each day," says Michael Niles, a public education specialist for the Santa

Information superhighway.

"The modems have shaken people up, but sometimes you hit them over the head with a modem and they don't even notice it," he said.

Before they'll listen to Jack Niles, a telecommuting consultant

at San Francisco City Hall, Maxine expressed enthusiasm for the extended project.

Planes are up, a plan is set and now the first level. They said a downtown extension would more than double the number of daily passengers (44,000).

IN THE QUALITY OF LIFE HERE IN LOS ANGELES.

For those who can, telecommuting usually means working from home, using a computer, telephone and fax.

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Table 2 Front-page headlines in the days following the Northridge earthquake of 1994, San Francisco Chronicle

Headlines			
Days	Total	Quake-related	Lead headline
1	6	5	KILLER QUAKE IN L.A. 30 Dead, Major Highways Collapse
2	6	3	15,000 Homeless in L.A. Quake
3	6	4	Clinton Visits Quake Scene
4	6	1	New L.A. Fear—Rain and Cold
5	7	2	Lorena Bobbitt Acquitted—Temporary insanity verdict
6	7	1	Bentsen Offers Compromise on Health Care
7	6	0	Harding's Admission: She says she knew more after attack

DEATH TOLL IN JAPANESE QUAKE NEARS 2,000; HUNDREDS TRAPPED IN RUINS AS FIRES RAGE

Mexican Parties Sign Accord On Shift to Full Democracy

By TIM GOLDEN
Special to The New York Times

MEXICO CITY, Jan. 17 — The Mexican Government and the ruling political party agreed today with the main opposition parties to negotiate changes to fully democratize the country's political system and defuse bitter conflicts over recent elections in two southern states.

In a pact signed here this evening, President Ernesto Zedillo Ponce de León and leaders of the country's four largest parties pledged to conclude "definitive" reforms of federal and state election laws and to respect the outcome of voting conducted under fair conditions.

Mr. Zedillo said the changes should include controls on political

Clinton Presses Rescue of Peso

Countering growing opposition from President Clinton's own party to its \$40 billion rescue plan for Mexico, the Administration told leaders of Congress that the number of illegal immigrants crossing the border into Texas and California would increase by about 430,000 this year if the Mexican financial crisis deepened.

Article, page A3.

Continued on Page A3, Column 1

Congress, in Session's First Bill, Extends Workplace Laws to Itself



In Kobe, residents fled a burning residential area yesterday with whatever belongings they could carry. Reuters

KOBE IS HIT WORST

Rescuers Search Rubble After Buildings and Highways Collapse

By NICHOLAS D. KRISTOF
Special to The New York Times

TOKYO, Wednesday, Jan. 18 — Rescue teams dug frantically through the rubble in western Japan today as huge fires raged out of control and darkened the skies with smoke, the aftermath of a catastrophic earthquake on Tuesday in which thousands of people were killed or injured.

The earthquake lasted just 20 seconds but heaved trains on their sides, toppled elevated highways and knocked over buildings, some as cleanly as if they had been severed with a knife.

Sections of Kobe, a city of 1.4 million people, are in ruins not unlike those in which it found itself at the end of World War II.

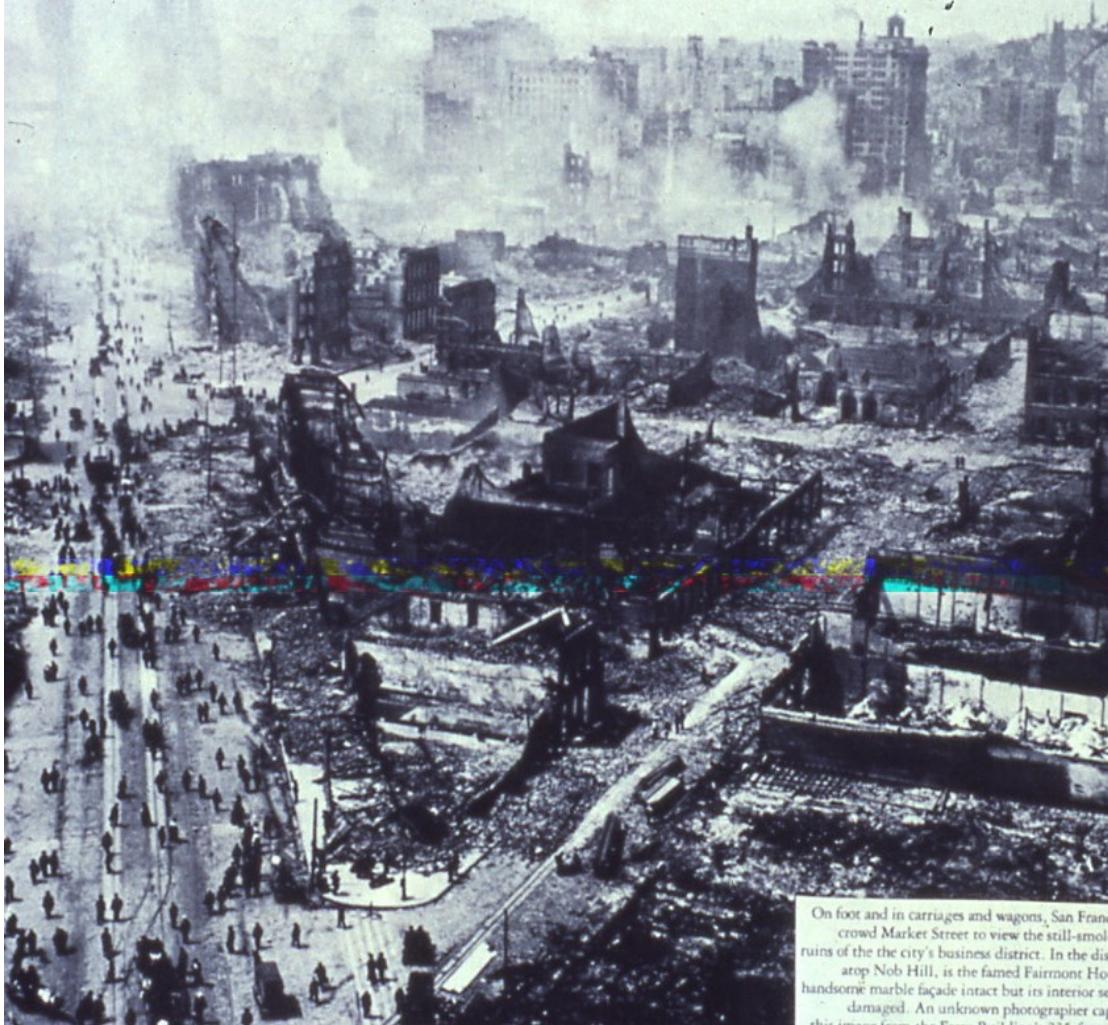
Japan's sixth largest city and a major commercial hub, Kobe (pronounced koh-beh) was engulfed by fires that raged out of control all day, some sweeping entire city blocks. Weary firefighters said they had no idea when the conflagrations could all be brought under control.

The police reported that as of 10 A.M. today (8 P.M. Eastern time Tuesday), 1,812 people had been confirmed killed and more than 6,300 injured. In addition, 966 people are unaccounted for, the authorities said, so the casualty lists are expected to grow.

One year later, the Kobe earthquake – very similar situation to SF Bay – but dropped off the front pages immediately. Over 6,000 deaths.



San Francisco now...



On foot and in carriages and wagons, San Franciscans crowd Market Street to view the still-smoldering ruins of the city's business district. In the distance atop Nob Hill, is the famed Fairmont Hotel, whose handsome marble facade is intact but its interior severely damaged. An unknown photographer captures this scene from the roof of the Bank of America building.

...And after the 1906 earthquake and fire

Business and civic interests suppressed reporting about the earthquake (bad for business) referred only to the ‘fire’ (which implied something more preventable, controllable)

In effect, our cities have been constructed in
the interval between major earthquakes.

Below: modern Athens





A different attitude among native Americans in SE Alaska and British Columbia. Big quakes every 100-200 years.



Cultural adaptations included sturdy log structures that would not fail in earthquakes, and annual earthquake rituals, with dances to simulate earthquake shaking

Summary – 1 of 2

- Fault movement can be lateral, vertical, or thrust
- The earth's plates are constantly in very slow motion (5.5 cm / year in San Andreas Fault system); movement is in spurts, which results in earthquakes
- Energy and heat flows to the surface from the core allows for geothermal energy, which draws heat from the Earth's core. Two types: Shallow earth, low density and Deep earth, high density
- Impacts of geothermal: thermal pollution from hot wastewater, noise, gas emissions, land disturbance, disposal sites, roads and pipes, power plants BUT releases 90% less CO₂ and SO₂ than coal
- Earthquakes are measured using seismographs
- Earthquakes cause fault offset, shaking, landslides, sand boils, liquefaction & tsunamis, infrastructure and building offset, buildings and infrastructure failures, fires, cracks, flooding

Summary – 2 of 2

- Impacts are not evenly experienced, soft surface rocks (like artificial fill and alluvial fill) can have greater shaking than bedrock even if further from epicenter
- We are starting to develop better building codes and regulations to improve our resilience to earthquakes (AP Act requires mapping of and studies for active fault traces, notification of land owners, buildings must be set back from fault)
- Natural hazards are naturally occurring events, which become natural disasters when they negatively impact humans (without humans, there would be no natural disasters!)
- Many types of natural hazards, the most destructive of which are geologic movement
- We are still in denial that these natural hazards can and will occur!

Lab Preview This Week:

Meet in your lab classroom (315 A or C Wurster Hall)
Into the field for carbon
uptake exercise at the
Campanile.

Measure size of leaves of
London Plane tree

Estimate carbon uptake for
a single leaf and entire tree





How many trees does it take to offset the CO₂ from one person?

Then we'll go to the top floor of the Social Sciences Building for an overview of campus and the SF Bay region, to consider the landscape produced by active faulting, the history of SF Bay, etc.

We have special permission to go out onto the balcony of the building. Stay together as a group, don't wander off.

*See you in
lab section!*



Questions?