

Active Deformation of the San Francisco Bay Area

- **The Cause:** Plate tectonics in California
- **The Culprit:** The San Andreas fault system
- **The Consequences:** Earthquakes and the earthquake cycle along the San Andreas
- **The Connection:** Earthquakes and landscapes as a result of deformation along the San Andreas fault
- **The “Cure”:** Understanding, forecasting and living with earthquakes in the Bay area

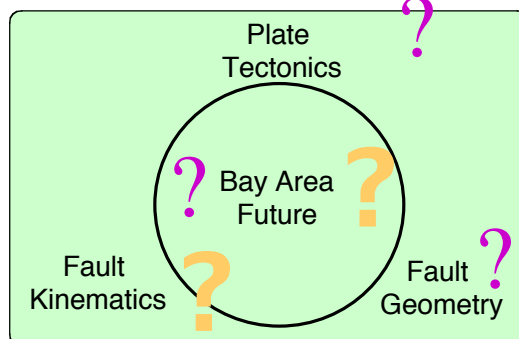
BASP Lecture - 08/13/2001

available @ : www.seismo.berkeley.edu/~burgmann/education.html



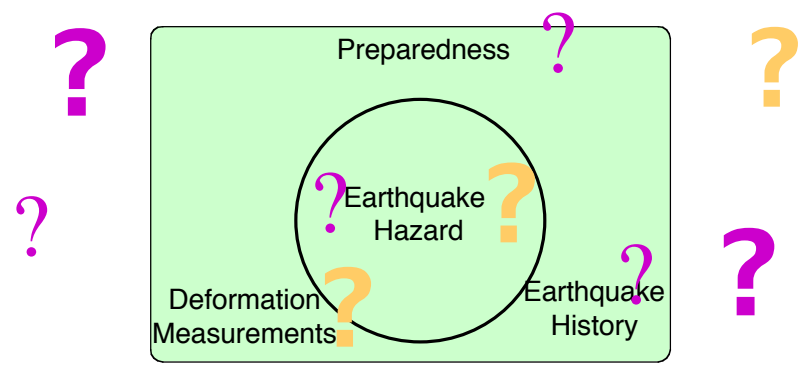
Fundamental Questions

- “Is California going to fall in the ocean?” or “What is the long-term tectonic development of the San Andreas fault system?”



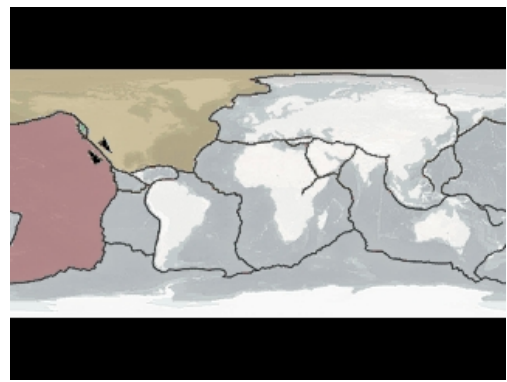
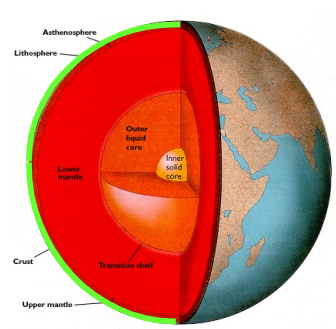
Fundamental Questions

- “When is the next Big One?” or
“Can we predict earthquakes based on our understanding of the history and mechanics of San Andreas faulting”?



The Cause: Plate Tectonics

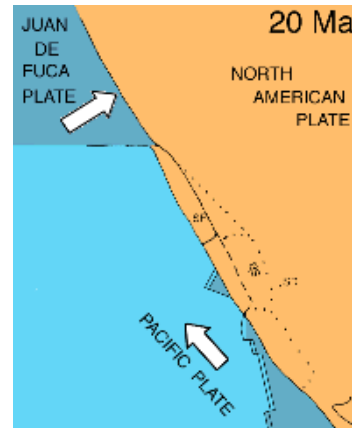
- Evolution of the Pacific - North America plate boundary



Press and Sievers, 2001

At the Root of it All: Plate Tectonics

- Evolution of the Pacific - North America Plate Boundary
- The San Andreas fault system



Tanya Atwater, UCSB

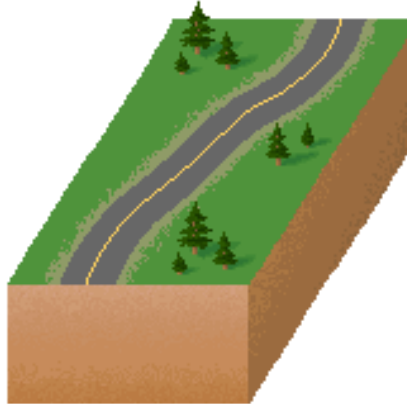
The Culprit: The San Andreas Fault System

- Where are the **faults** and how do they move?
- Plate tectonics predicts **lateral** motion between Pacific and North American plates
- Faults that move laterally (rather than up and down) are called **strike-slip faults**



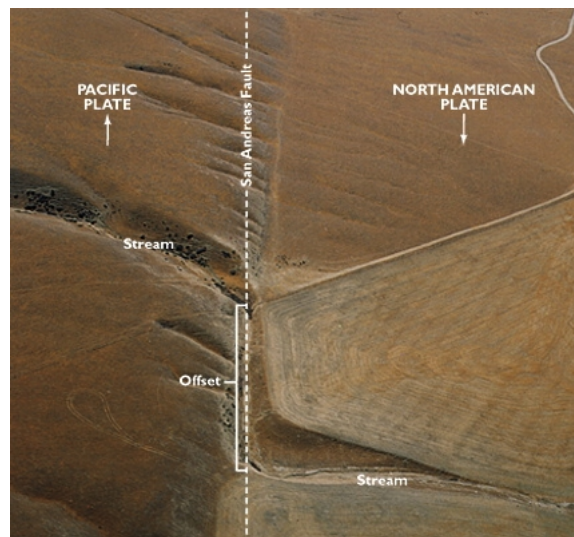
Strike-slip Faults

- No shortening
- No uplift

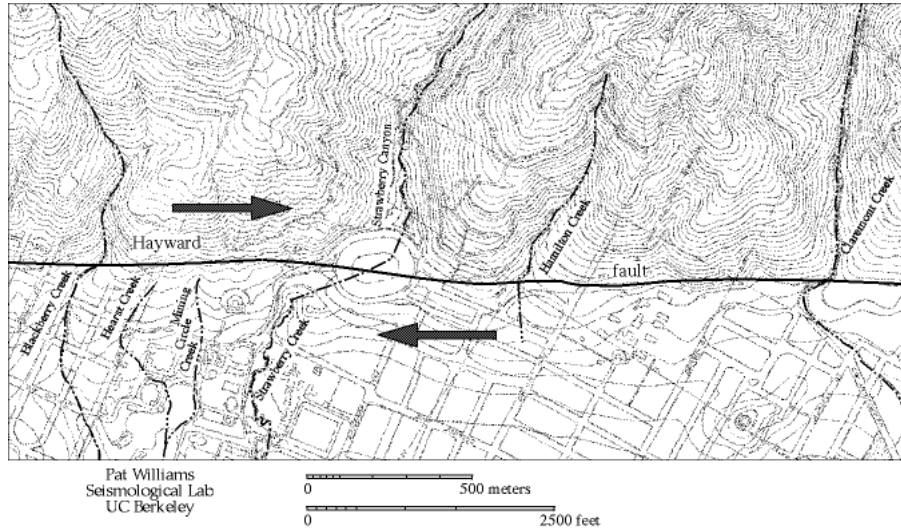


The San Andreas fault is a [right-lateral fault](#)

Strike-slip Faults

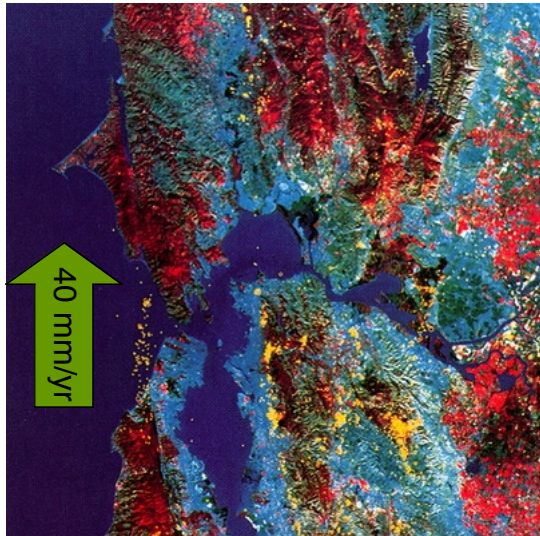


Right-lateral Hayward Fault



The SAF System in the Bay Area

- Where is deformation taking place in the Bay Area?
- Look at geology, landscapes, and location of earthquakes



Only Strike-slip Faults in Bay Area?

- Where do the hills come from?



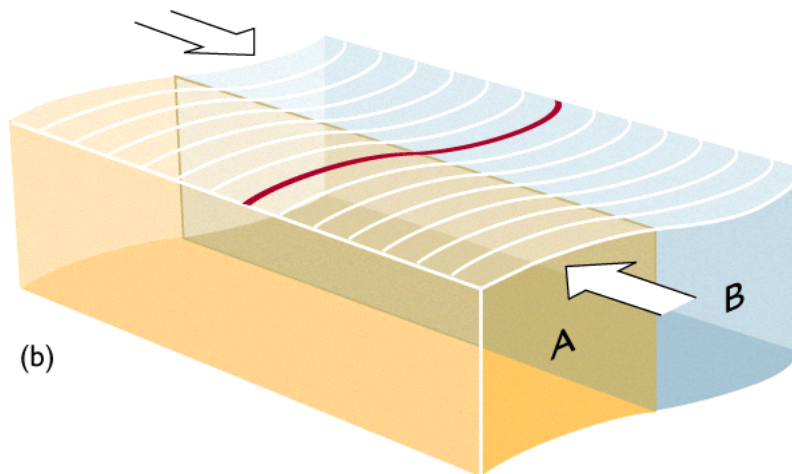
Thrust faults in the Bay area



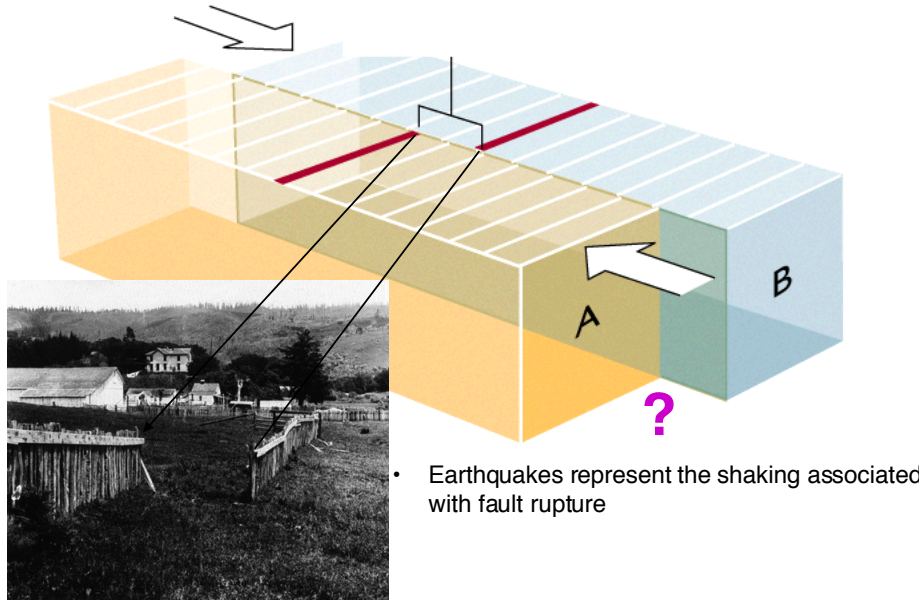
The Consequences: Earthquakes



Elastic Strain Accumulation



The Earthquake Cycle



Demonstrating the Earthquake Cycle

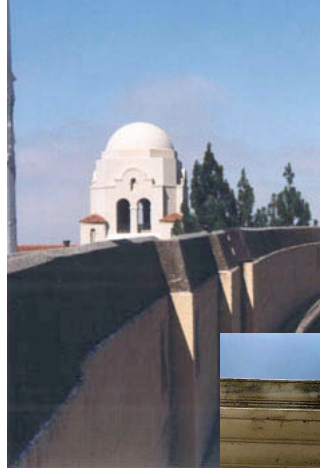
- You can produce steady sliding (creep) and stick slip (earthquakes) in a simple table top experiment



Earthquakes vs. Fault Creep

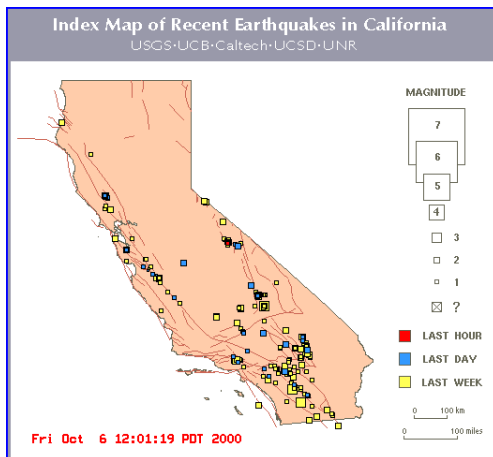


Downtown Hayward, 1868

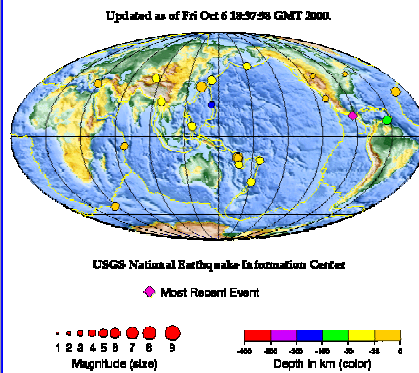


<http://www.seismo.berkeley.edu/seismo/geotour/stadium.html>

Current Seismicity Information at Your Finger Tips



quake.wr.usgs.gov/QUAKES/CURRENT/index.html
www.seismo.berkeley.edu/seismo/



neic.usgs.gov/neis/current/

The Connection: Earthquakes and the Bay Area

- The hills, the valleys, the Bay, the soils, the climate, flora, and fauna are all linked to earthquakes shaping the earth through geologic time



Why Study Earthquakes?

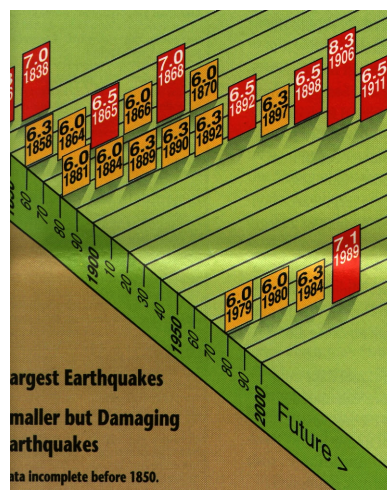
- Evidence of plate tectonics and the evolution of geology and landscapes
- Earthquake hazard and mitigation
- Earthquake forecasting and prediction

The “Cure”: Understanding Earthquakes in Bay Area



Bay Area Earthquake History

- 16 M > 6 Quakes in 80 years before 1906
- 5 M > 6 Quakes in 95 years after 1906
- Good or bad news?

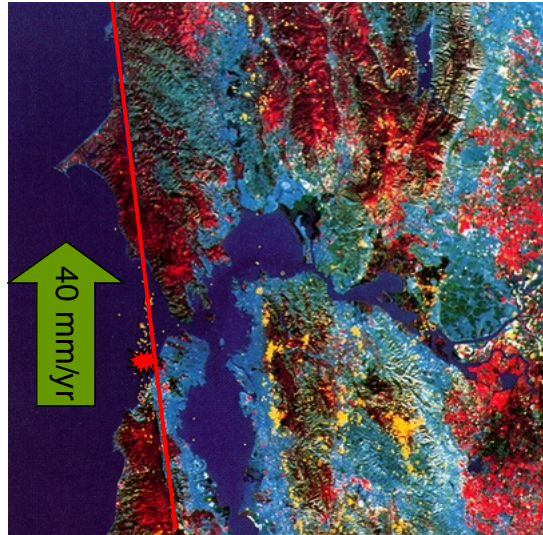


USGS

Living in an Earthquake's Shadow

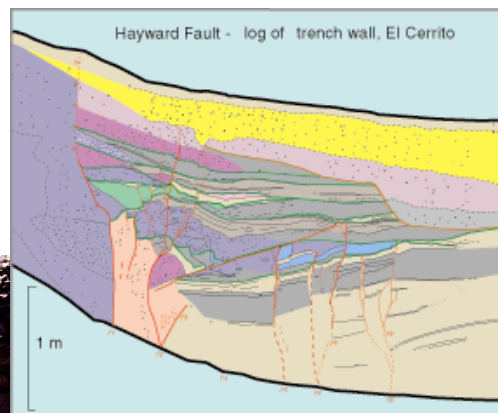
- **San Andreas F.**

- 1906 $M_w=7.7$
- Ruptured from San Juan Bautista to Cape Mendocino
- Relieved large amount of stress
- Is the spring loaded again?



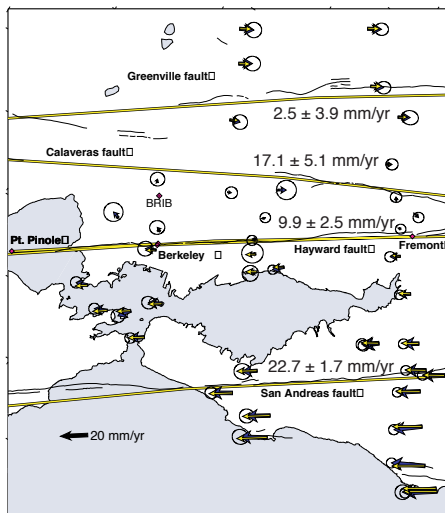
Dating Earthquake Fossils: Paleoseismology

- Digging up faults
- Date earthquakes using ^{14}C
Extend earthquake record
back 1000s of years



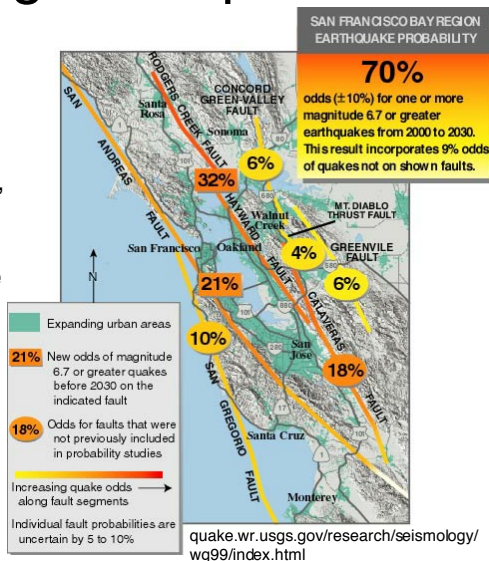
Geodesy Measures Active Strain Accumulation

- GPS allows us to measure strain accumulation
- We can determine fault slip rates



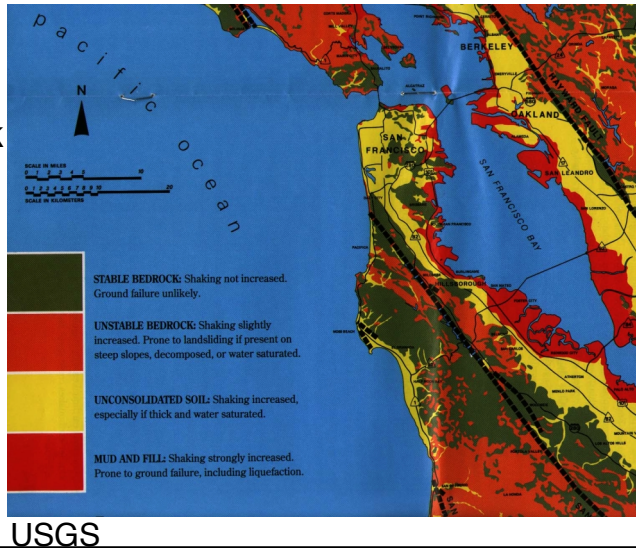
Forecasting Earthquakes

- We can not predict earthquakes.
- Using historic and pre-historic earthquake patterns, fault slip rates, and geodetic measurements we can estimate probability of future earthquakes



Earthquake Hazard Factors

- The substrate matters!
- Stable bedrock good
- mud and fill bad



Shaking Hazard Maps

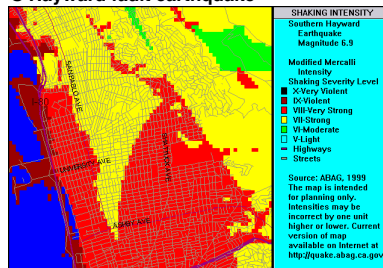
- Shaking hazard & damage depend on:

- Earthquake magnitude
- Distance to earthquake
- Quality of construction
- Soil properties

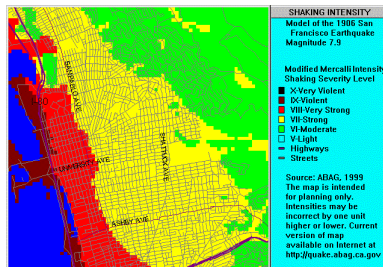
• You can view shaking intensities from many scenario earthquakes for all cities on the web.

• Of course, quality of construction is as important

S Hayward fault earthquake



San Andreas (1906-type) earthquake



www.abag.ca.gov/bayarea/eqmaps/eqmaps.html