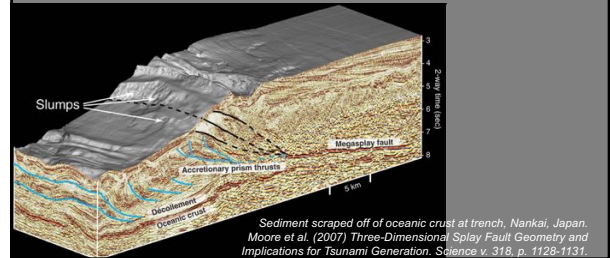


Introduction to Oceanography

- Lecture 8: Collisions, Transform Boundaries, and California Tectonics



Introduction to Oceanography



Types of Convergent Boundaries

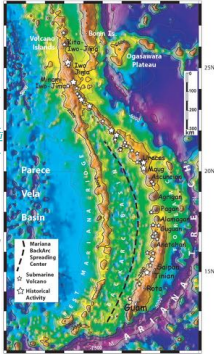
Ocean-Ocean: volcanic island arcs

Oceanic lithosphere subducts under ocean

i.e.,
Aleutians
Marianas

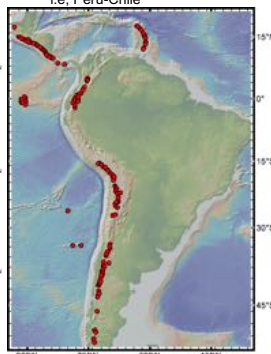
Marianas bathymetry
from Sandwell and
Smith (1997), courtesy
NOAA,
<http://oceanexplorer.noaa.gov/explorations/O3f/re/background/plan/maria/marianas.html>,
Public Domain

Right fig., South
America bathymetry &
volcanoes, created with
GeoMapApp, Creative
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<http://www.geomapp.org/>



Ocean-Continent: Mountain + arc

Ocean subducts under continent
i.e., Peru-Chile



Volcanism at convergent boundaries

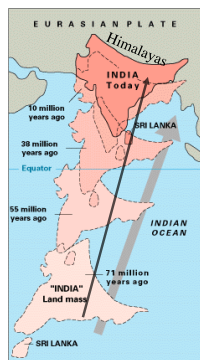


Water-rich fluid
released by
descending slab
fluxes
(i.e., lowers melting
temperature of the
overlying mantle)

Movie from NOAA, Public Domain,
http://oceanexplorer.noaa.gov/explorations/O3f/re/logs/subduction_320.mov

Continent-Continent Convergence

- India-Asia collision
- Himalayas
- Continental crust is too buoyant to subduct, crumples and thickens at the surface.
- Extra-thick continental crust ----> BIG mountains.



USGS image, Public Domain,
<http://commons.wikimedia.org/wiki/File:Himalaya-formation.gif>

Continent-Continent Convergence

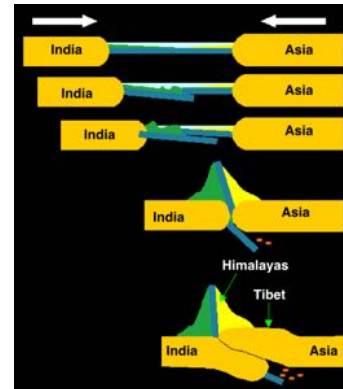


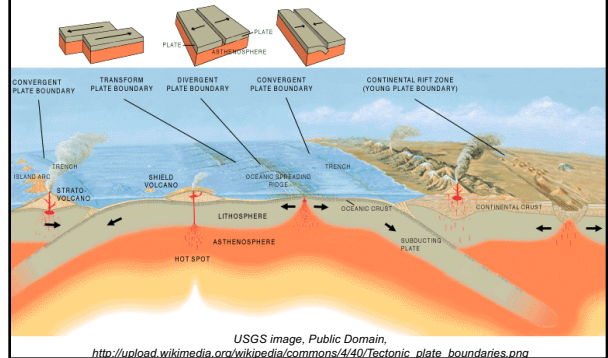
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<http://commons.wikimedia.org/wiki/File:Collision.PNG>

Continent-Continent Convergence



Crop of NOAA global relief map, Public Domain

QUESTIONS?



USGS image, Public Domain, http://upload.wikimedia.org/wikipedia/commons/4/40/Tectonic_plate_boundaries.png

Transform Boundaries

- Two plates sliding past each other horizontally
- Example: San Andreas Fault
- Transform portion: Seismically active part of Fracture Zone
- Usually between offset ridge segments
- Plates move parallel to plate margin

San Andreas Fault, Carrizo Plain, CA. Wikimedia Commons. Photo by Ian Kluff Creative Commons A S-A 3.0, http://commons.wikimedia.org/wiki/File:Kluff-photo-Carrizo-Plain-Nov-2007-Img_0327.jpg

Transform Boundaries

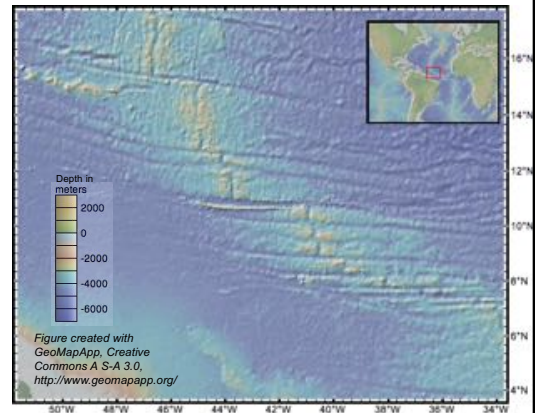
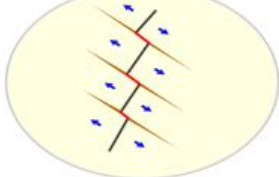


Figure created with GeoMapApp, Creative Commons A S-A 3.0, <http://www.geomapp.org/>

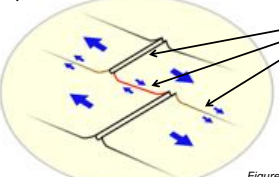
Map View



Transform Boundaries

Most common as more-or-less right-angle offsets of spreading segments along the mid-ocean ridge.

Oblique



Where do you expect to see earthquakes?

Figures by Los688, Wikimedia Commons, Public Domain, http://en.wikipedia.org/wiki/File:Transform_fault-1.svg

Transforms and seismicity (Mw > 5.0, 1973-2009)

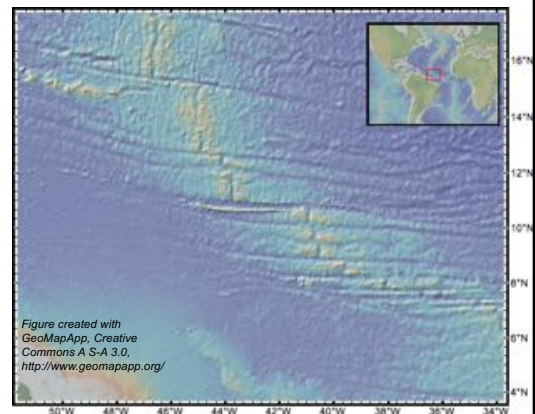
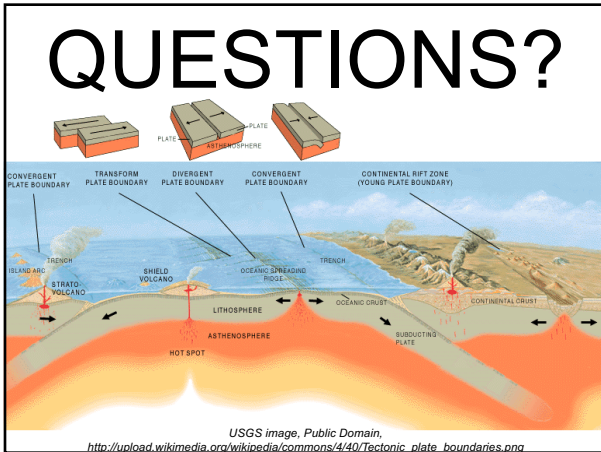
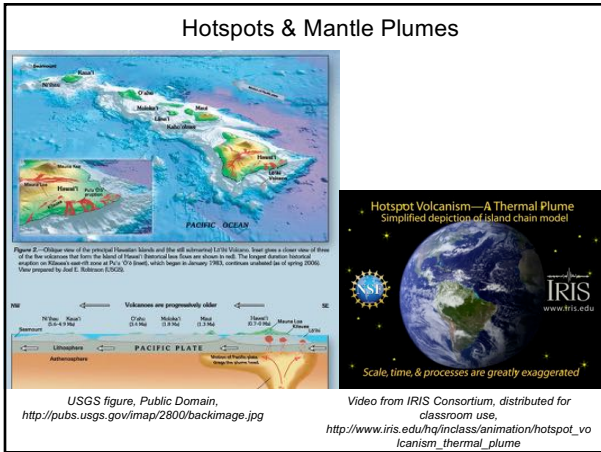
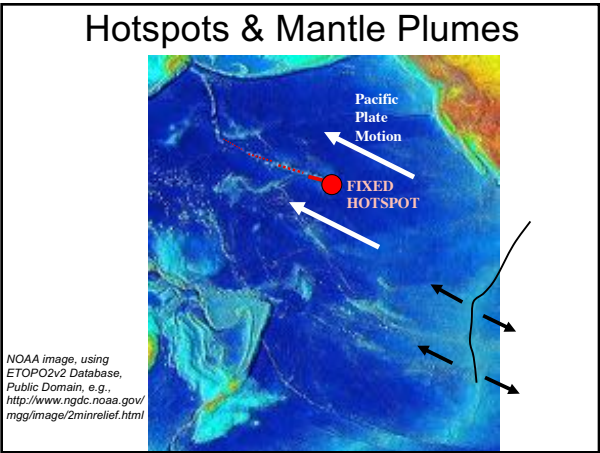
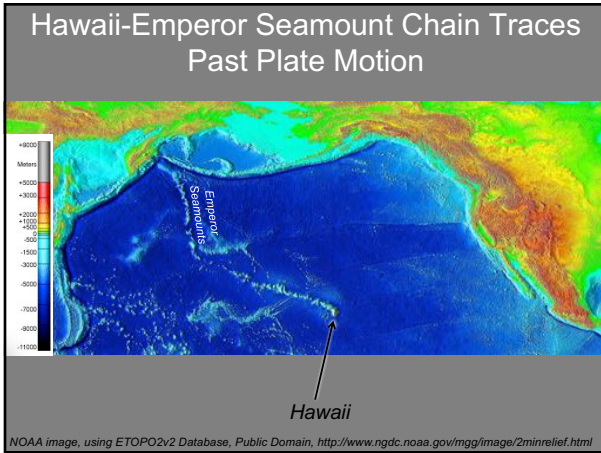


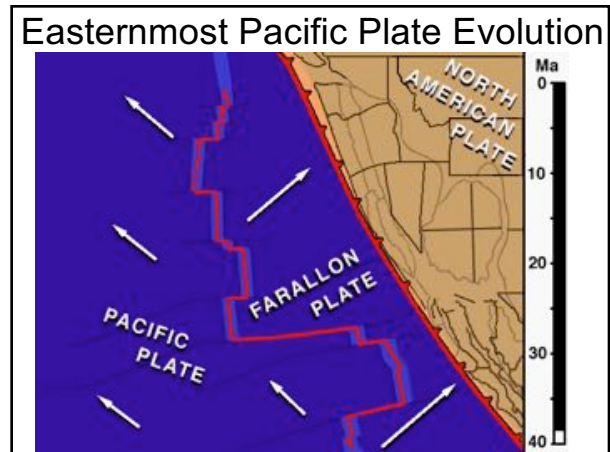
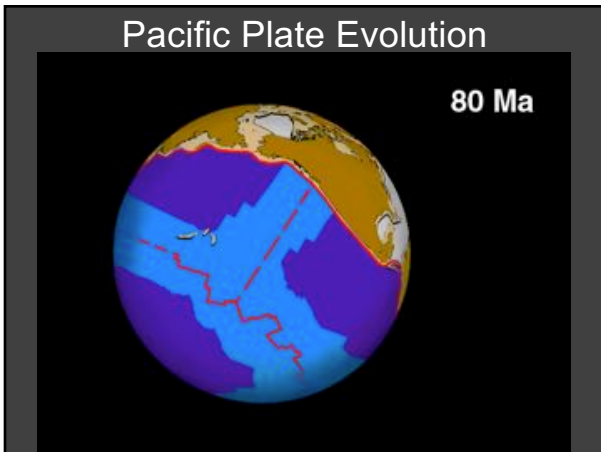
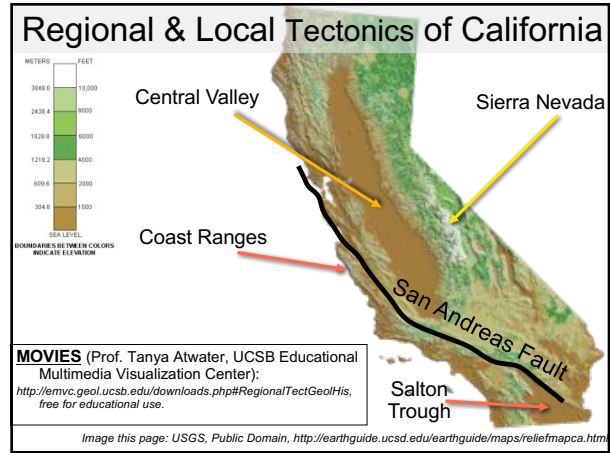
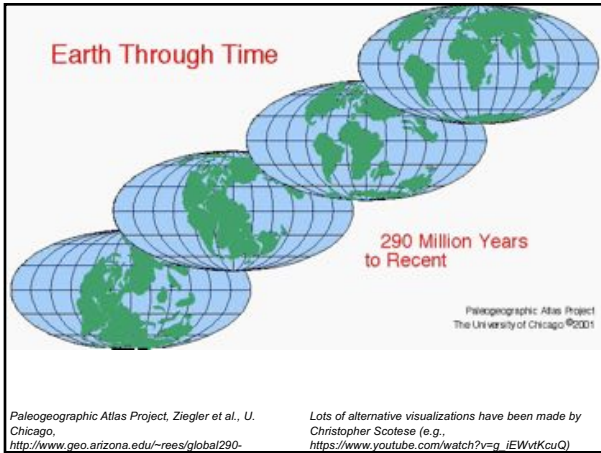
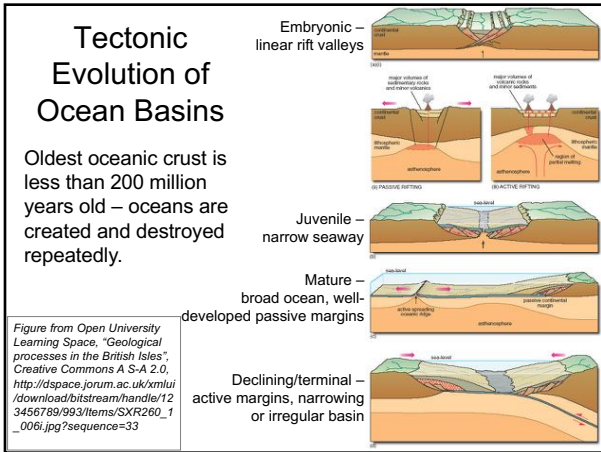
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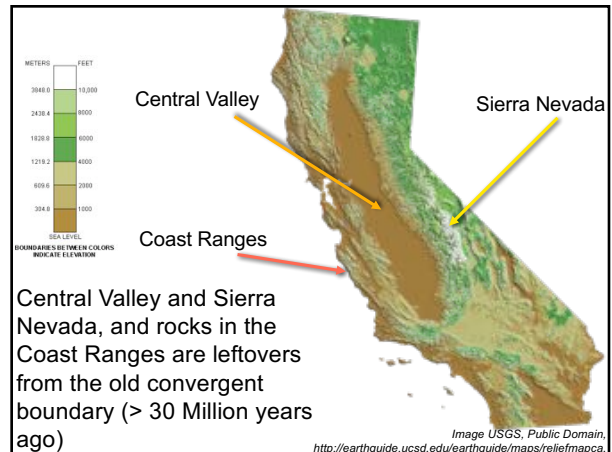
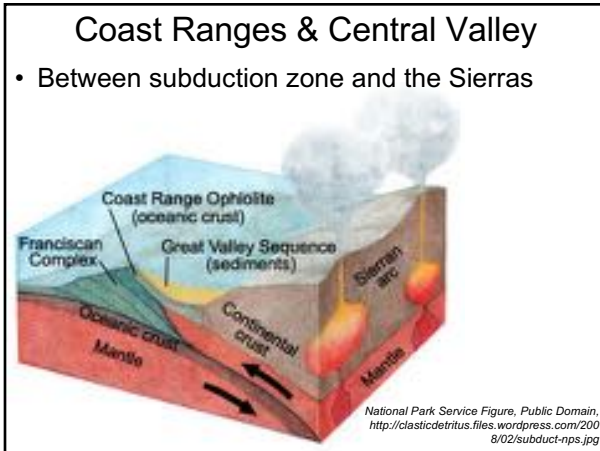
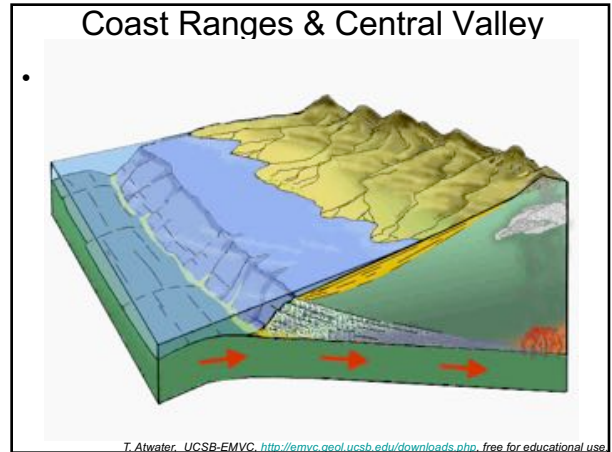
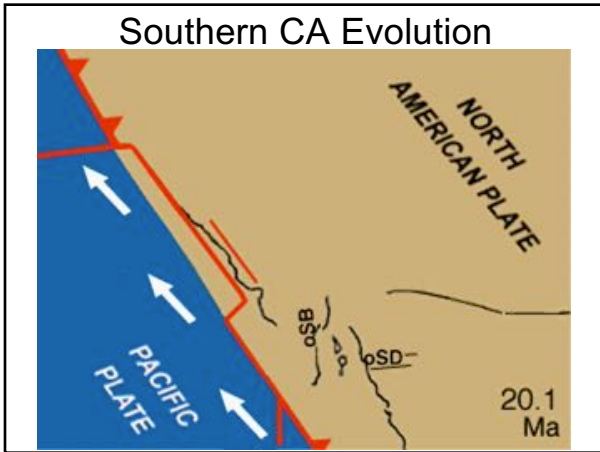


Hotspots & Mantle Plumes

- Stationary volcanic sources in mantle
 - Persist for $\geq 1 \times 10^7$ years
- Ocean Crust $\sim 10\%$ generated at hotspots
- Heat transfer: $\sim 10\text{-}30\%$ of mantle heat flux
 - May transport heat directly from the core
- Hotspot Island Chains
 - Hawaii-Emperor Chain
 - Stationary heat source tracks plate motions







Young features (< 30 Million years)
San Andreas, Salton Sea, Gulf of California, Santa Monica Mtns.

San Andreas: A transform boundary
 San Andreas forms a complex web of faults, including many in LA region
 Produces regions of tension and compression between active fault segments

Leads to

Transpressional ranges (Santa Monica Mtns.)
Pull-apart basins (LA Basin, Death Valley, Salton Sea)

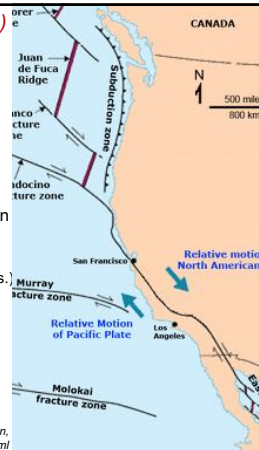


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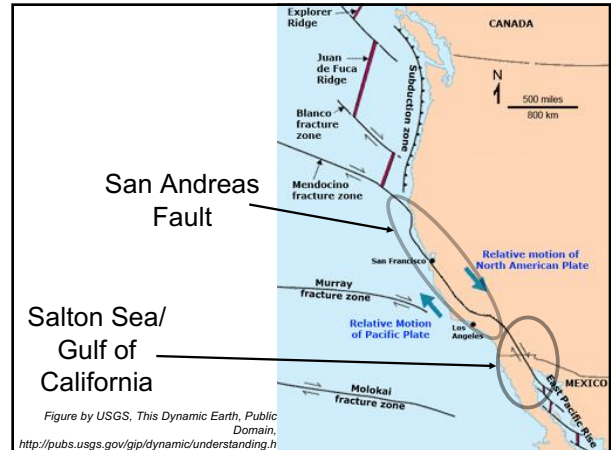
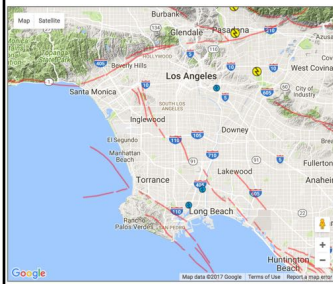
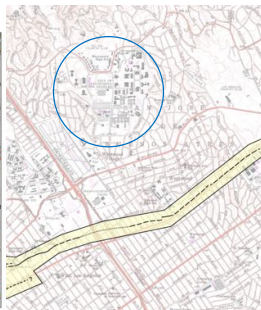


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The San Andreas isn't the only fault in Southern California



Southern California Fault Map, Southern California Earthquake Center. Authors Ihrig, Bhaskaran, and Marqui; based on data from Jennings, 1994. <http://scedc.caltech.edu/significant/index.html>



Preliminary map of Beverly Hills quadrangle, CA Government publication. http://gmw.conservacion.ca.gov/SHP/EZRIM/Reports/FER/259/FER_259_Plate3.pdf