
26 May 15
EPS 20:
Earthquakes in your backyard
& tsunamis
Summer Session
2015
Berkeley Seismological Laboratory
Horst Rademacher
Lect 1: Earthquakes:
The Basics
The Hayward Fault
http://earthquakes.berkeley.edu

Class organization

Instructor

Horst Rademacher - horst@berkeley.edu

Office hours: Tuesday 3-5 pm (after class)

Where: 213 McCone Hall or BSL Conference Room (2nd floor McCone)

Reader

Sarah M. Arveson - smarveson@berkeley.edu

Email announcements

Class announcements will be sent by email

➔ be sure that the registrar's office has the email address you use!

Class organization

Expectations

1. **Lecture attendance: T/T 12noon – 2:30pm in 265 McCone**

Lecture notes

except Thursday, June 11 10am-12:30pm

- **PowerPoint slides (PDFs) will be on website**

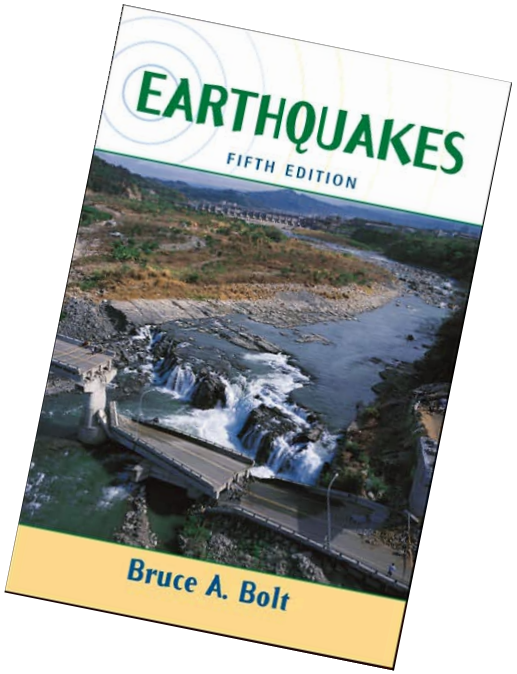
Required Readings

Required reading will be posted to the web

Suggested Reading

Textbook: **"Earthquakes" (5th edition) by Bruce Bolt. Published by Freeman.**

Seismo Blog:
http://seismo.berkeley.edu/blog/seismoblog.php



Class organization

Expectations

2. Assignments: Four during the semester

- Assigned after subject of assignment is discussed
- Due dates on the syllabus
- Can be completed individually or in groups

  You are encouraged to work together and discuss the problems, but then you should write down ***your own answers***

- Assignments should be on course website by the end of the week

Getting help:

- My office hours Email Study Groups

3. Field trip attendance and report

Field Trip: **The Hayward Fault**

4 June during class

Report due: 11 June

Class organization

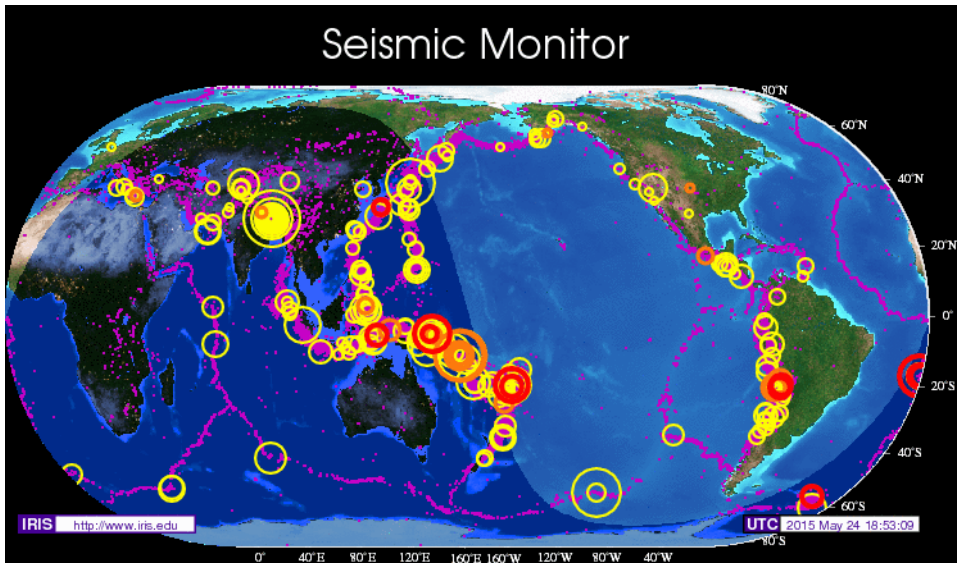
Expectations

4. Seismicity report

**First 15 minutes of every Tuesday's class,
look at past week's seismicity:
discuss interesting events, EQ in the news, etc.**

For California events:
http://earthquakes.berkeley.edu

For global events:
http://ds.iris.edu/seismon/
http://earthquake.usgs.gov/earthquakes/map/



Class organization

Grading

20 % - Midterm (16 June)

25 % - Final (2 July)

15 % - Field trip (4 June) & Report (due 11 June)

40 % - Assignments

Extra Credit: Seismicity report

No late work will be accepted unless **prior** approval

No electronic submissions unless **prior** approval

Class organization – website – sorry not yet

WILL BE UP AND RUNNING BY THURSDAY

click on:

"Syllabus" for an up-to-date version of the syllabus containing all due dates

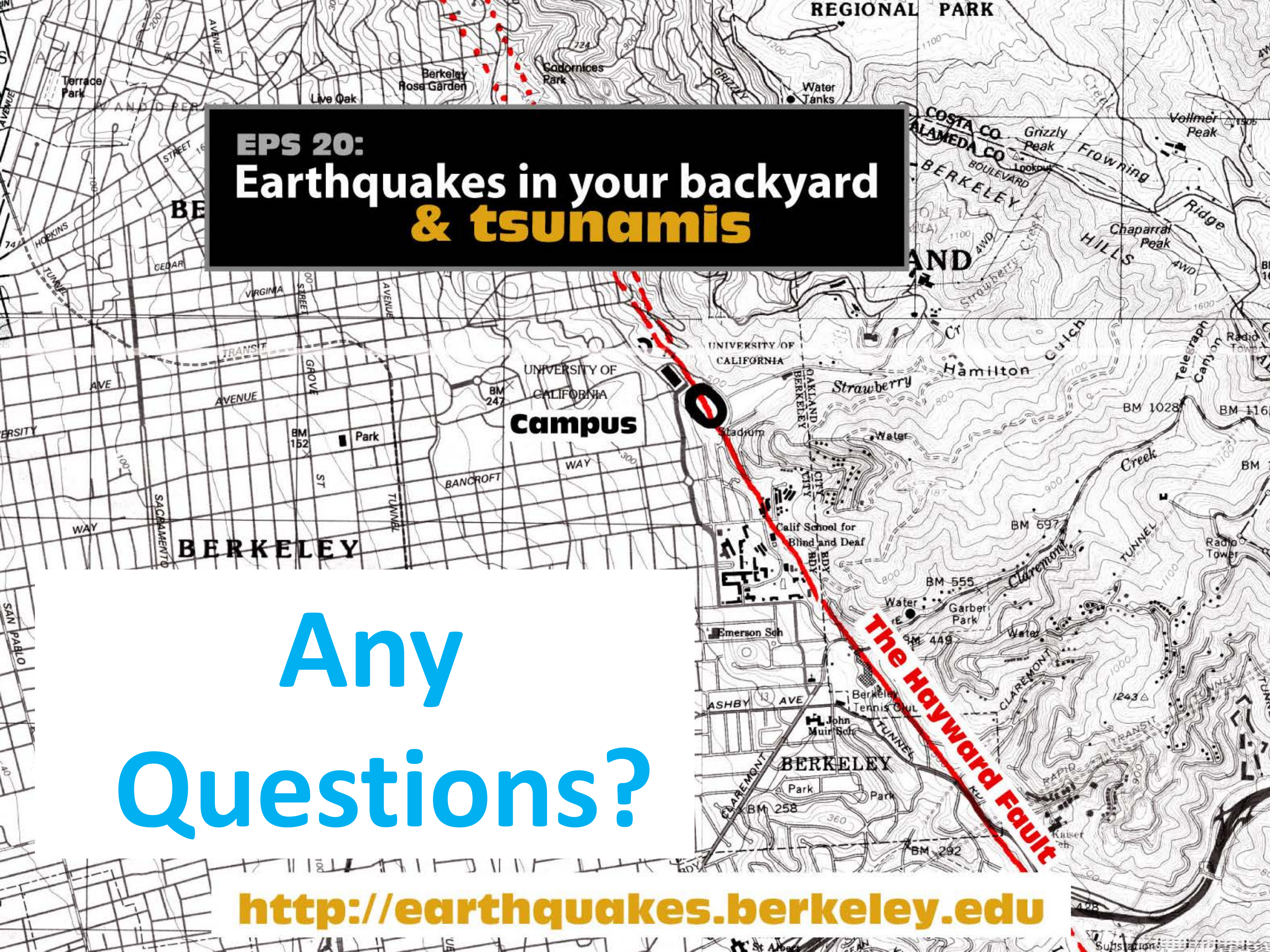
"Assignments" to download assignments

"Resources" for readings

"Gradebook" for your grades

EPS 20:

Earthquakes in your backyard & tsunamis



Any Questions?

http://earthquakes.berkeley.edu

Why does EPS offer this class?

1. fulfill undergraduate requirements in physical science

2. teach you the basics about earthquakes, tsunamis and volcanoes

3. want you to be prepared for earthquakes and their aftermaths

(simple test now)

Why do I teach this class?

….in addition to the first three points…

**4. to help you lose your fear of earthquakes –
but respect them as a major force of nature**

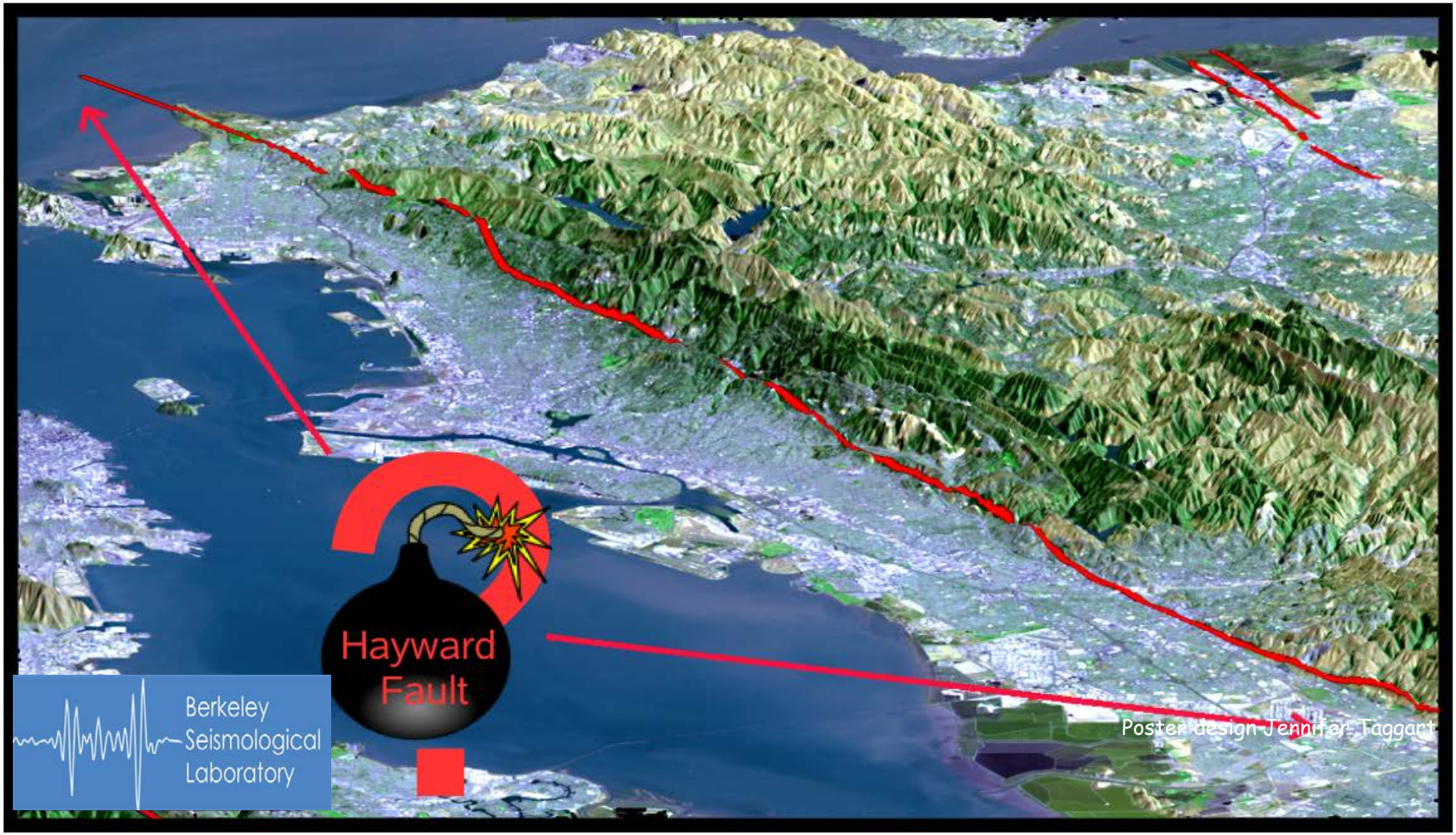
**5. to show that
Earth Science is fun**

and…….

Motivation

.....6. to show that we are sitting on a tectonic timebomb

The Hayward Fault is the most dangerous EQ Fault in the Bay Area



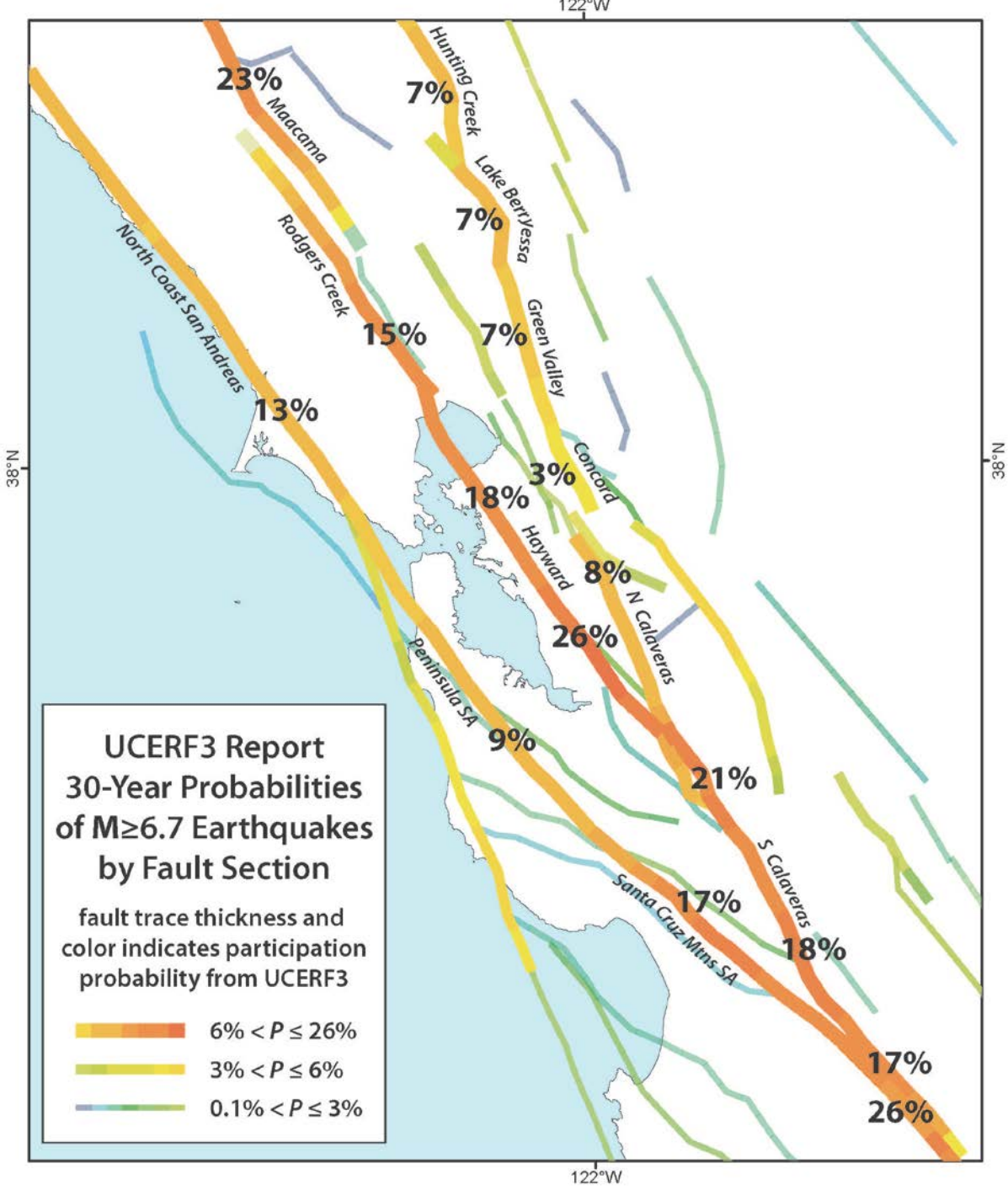

Appearance of Morse & Heslep's Flour Mill, Hayward's, as left by the Earthquake of Oct. 21, 1868. Loss $12,000.

Hayward Fault:
No big EQ since 1868:

Magnitude 6.8-7,
Focus under Hayward

For the last 147years tectonic stress is accumulating ……

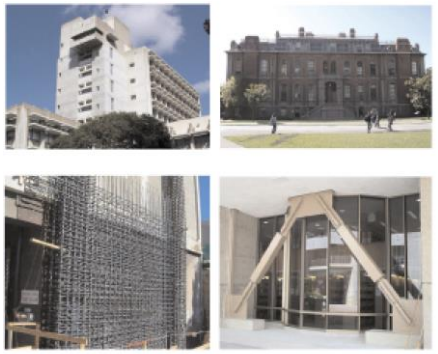
.....the fault is ready to go.....



more on the Hayward Fault
during lecture on
June 2 and field trip June 4

UC Berkeley: The only major university in the world sitting right on top of a dangerous earthquake fault

Starting in 2003 UC spent a billion dollars to retrofit major buildings



Some of the best research institutions in earthquakes in the world are on campus:

University of California Berkeley Seismological Laboratory

PACIFIC EARTHQUAKE ENGINEERING RESEARCH

.....and together we will ride out the Big One!

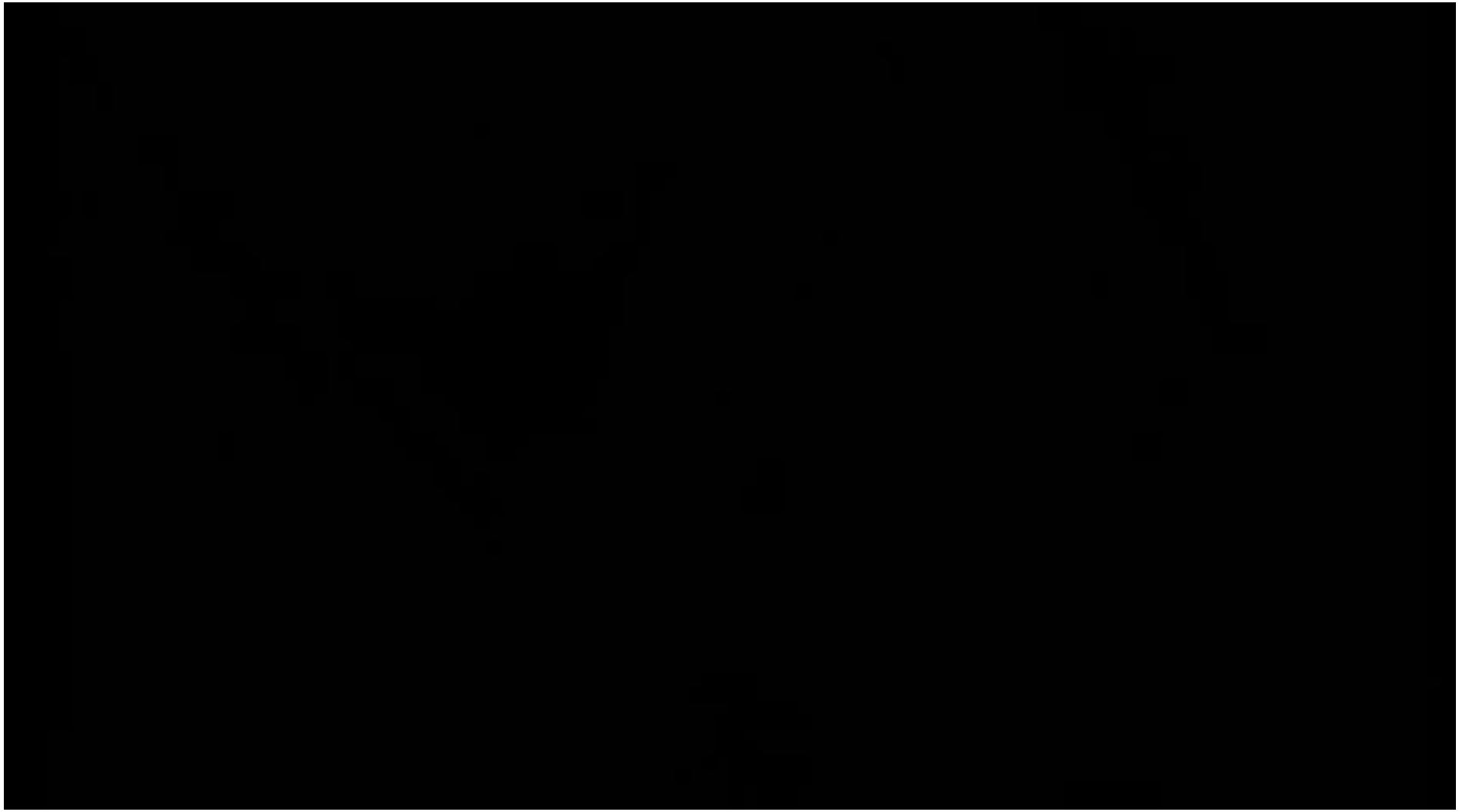
Earthquakes: The Basics

Who has ever felt an earthquake?

Earthquakes: The Basics

What is an earthquake?

Earthquakes: The Basics



Earthquakes: The Basics

How much was fact?

How much was fiction?

.....and now some reality

Earthquakes: The Basics

Great Hanshin Earthquake, Kobe, Japan, 17 Jan 1995, M = 7.3
Security Camera in NHK Newsroom

.....some more reality

Earthquakes: The Basics

Tohoku Earthquake, E of Honshu, Japan,
11 March 2011, M = 9.0 various clips

Earthquakes: The Basics

What is an earthquake?

Common/laymen's answer:

When the ground shakes where I am

Seismic waves

Scientific answer:

Seismic source

When the ground breaks along a fault

Both answers are correct!

Two different aspects of a seismic event

Earthquakes: The Basics

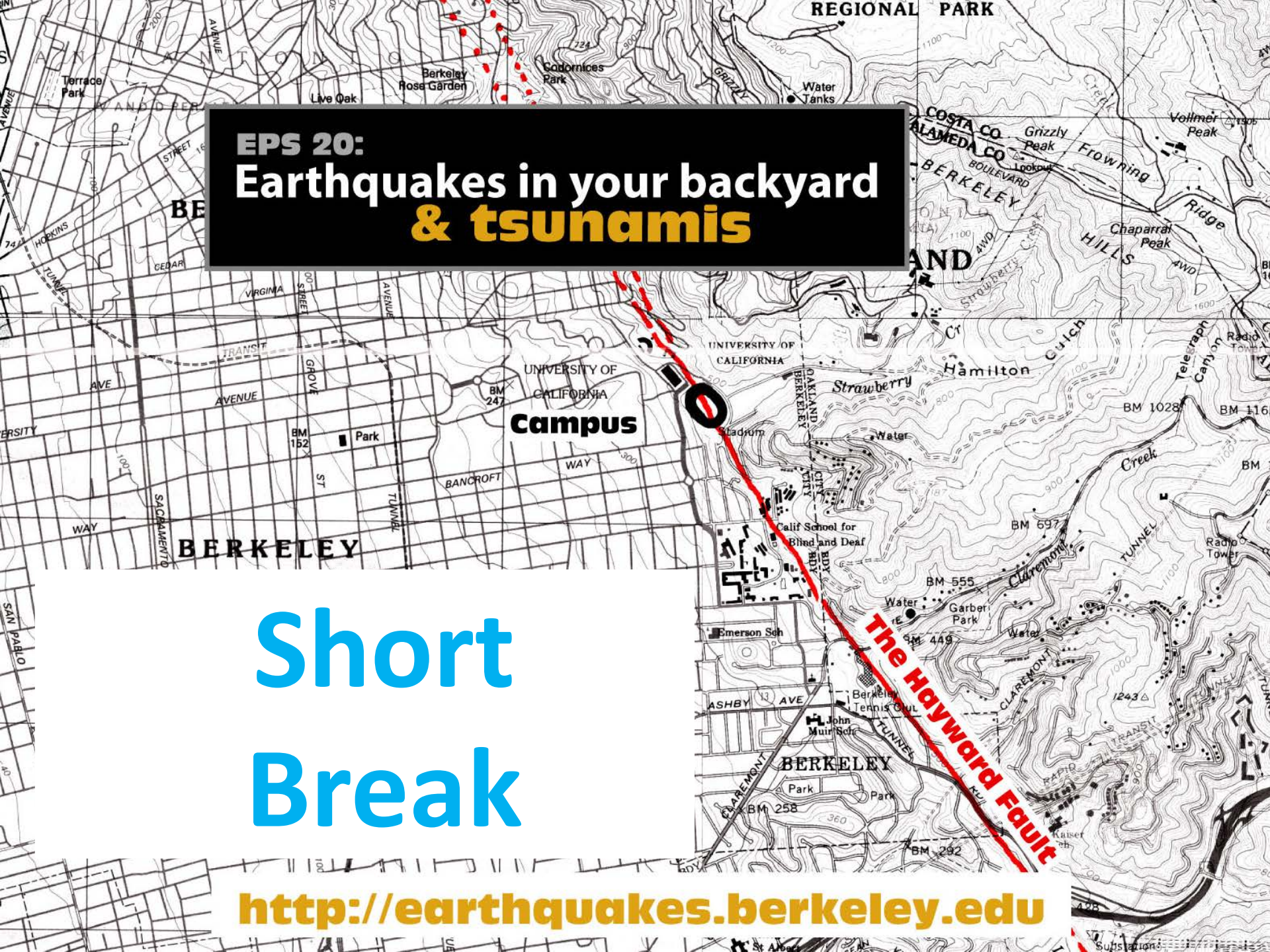
Seismic sources:

Where do earthquake occur?
How often do earthquakes happen?
Why earthquakes happen?
How do earthquakes happen?
Prediction, Forecast, Early Warning

All those topics will be touched on in this course

Seismic waves:

Seismic Monitoring
X-Raying the Earth – Structure of the Earth's interior
Looking for mineral resources, oil and gas
Response of buildings and structures
Earthquake Engineering


EPS 20:
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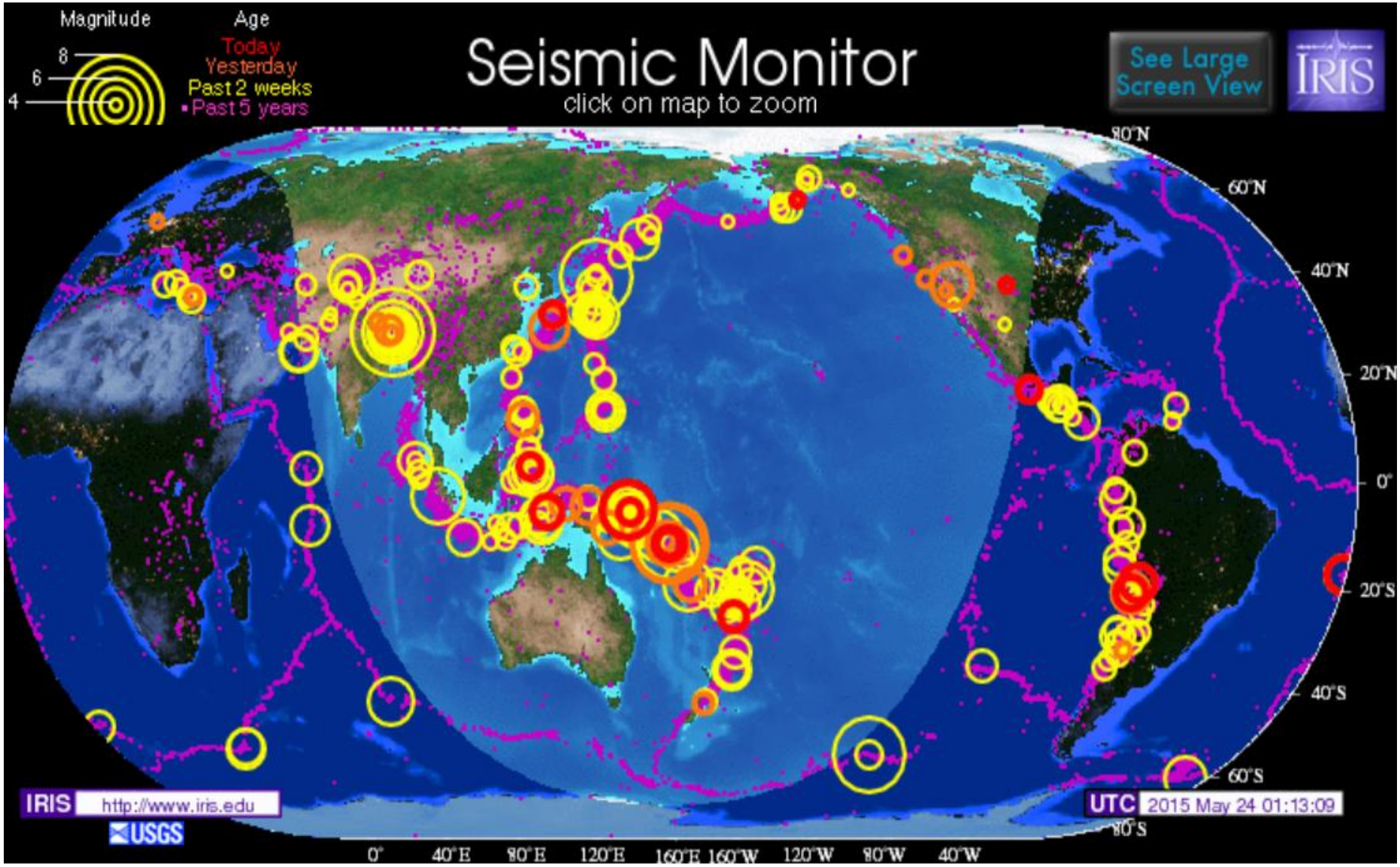
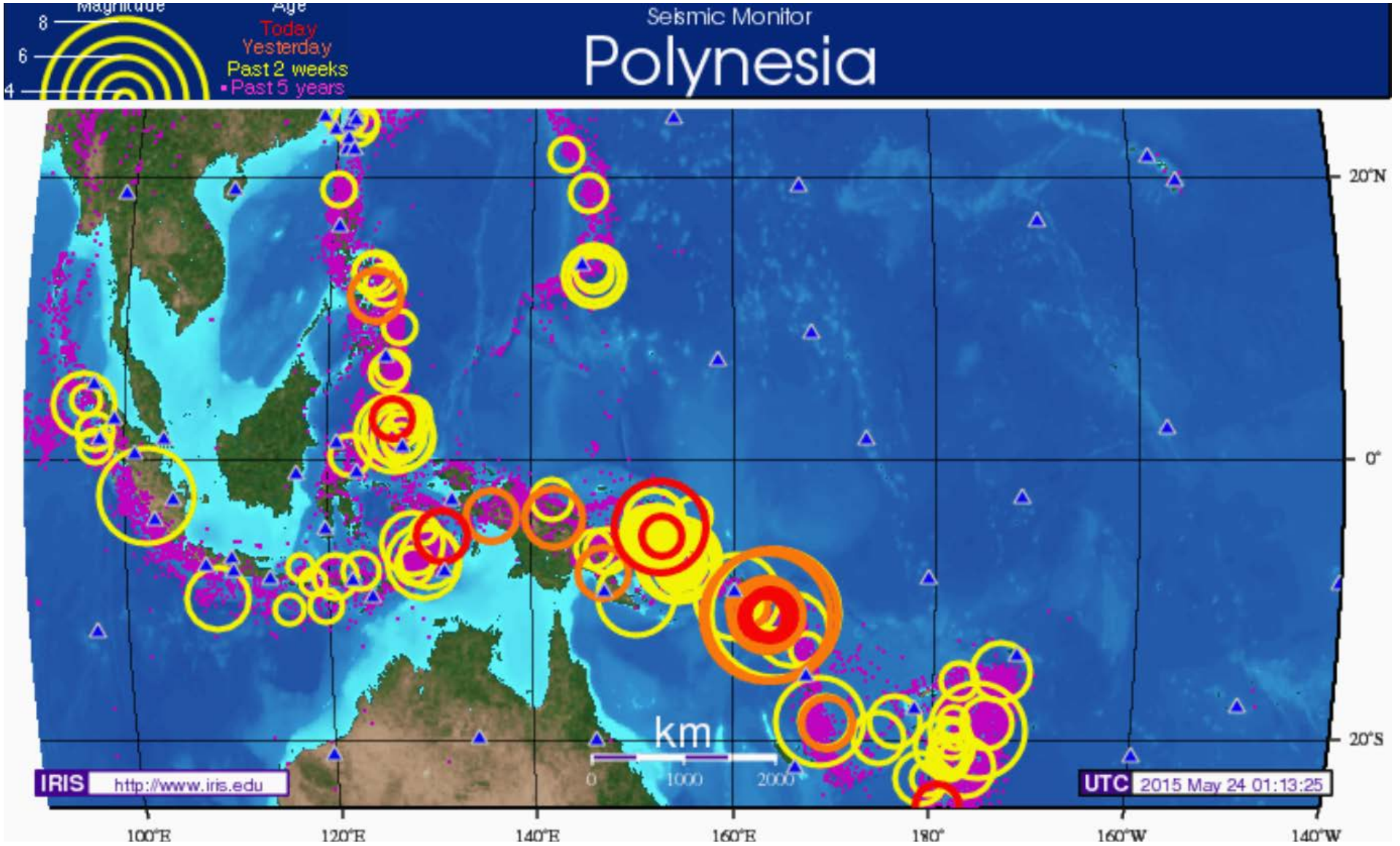
& tsunamis
Short
Break
http://earthquakes.berkeley.edu
The Hayward Fault
Campus
BERKELEY
UNIVERSITY OF CALIFORNIA
REGIONAL PARK
Berkeley Rose Garden
Codornices Park
Terrace Park
Live Oak
Water Tanks
Grizzly Peak
Vollmer Peak
Frowning Ridge
Chaparral Peak
Strawberry Creek
Hamilton
Telegraph Canyon
Stadium
Calif School for Blind and Deaf
Garber Park
Emerson Sch
John Muir Sch
Berkeley Tennis Club
Claremont
Radio Tower
BM 1028
BM 697
BM 555
BM 449
BM 258
BM 292
BM 247
BM 152
Park
Water
Substation
Kaiser

Where do earthquakes occur?

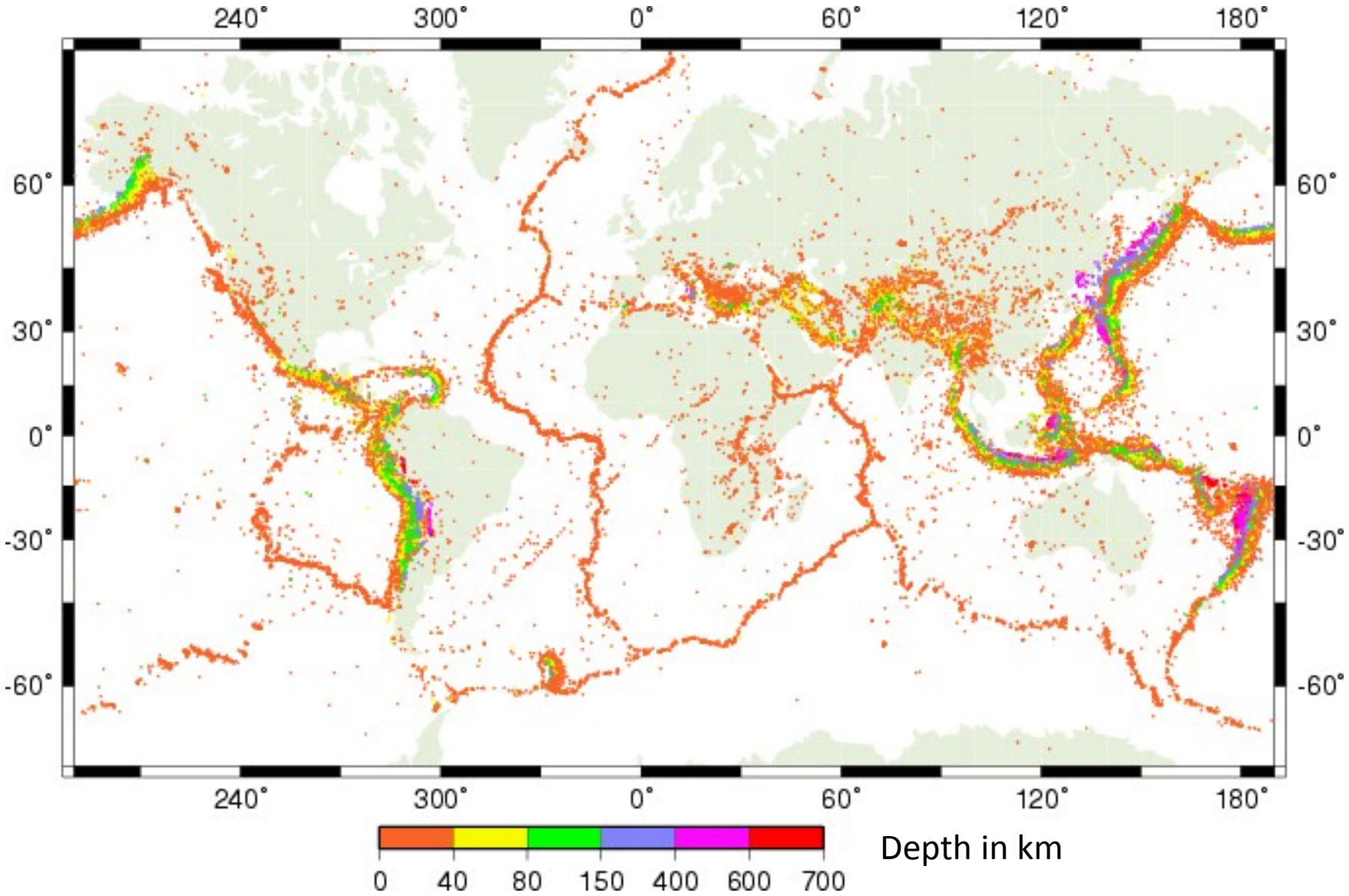


Where do earthquakes occur?



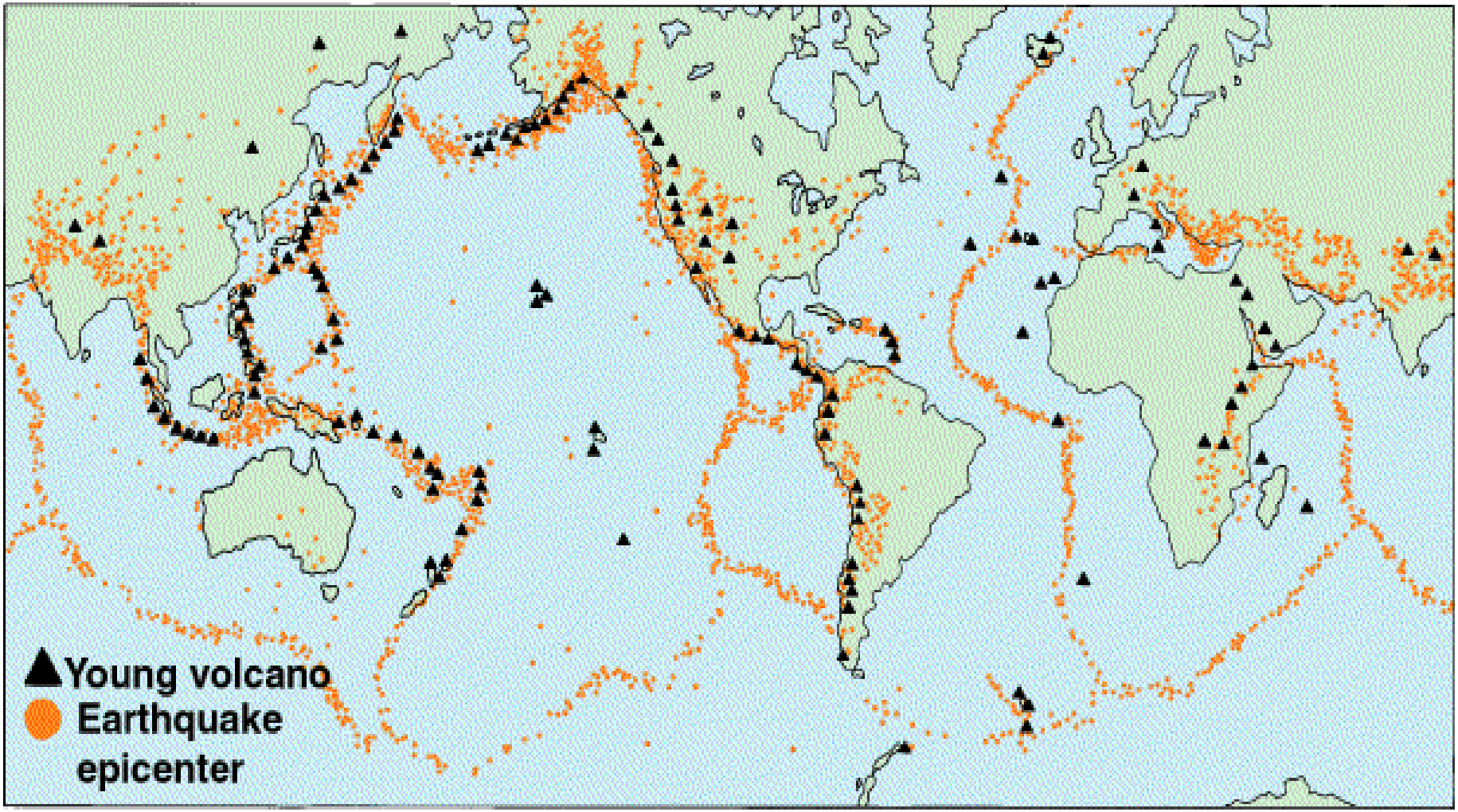
Where do earthquakes occur?

Global Seismicity



Where do earthquakes occur?

Earthquakes and volcanoes

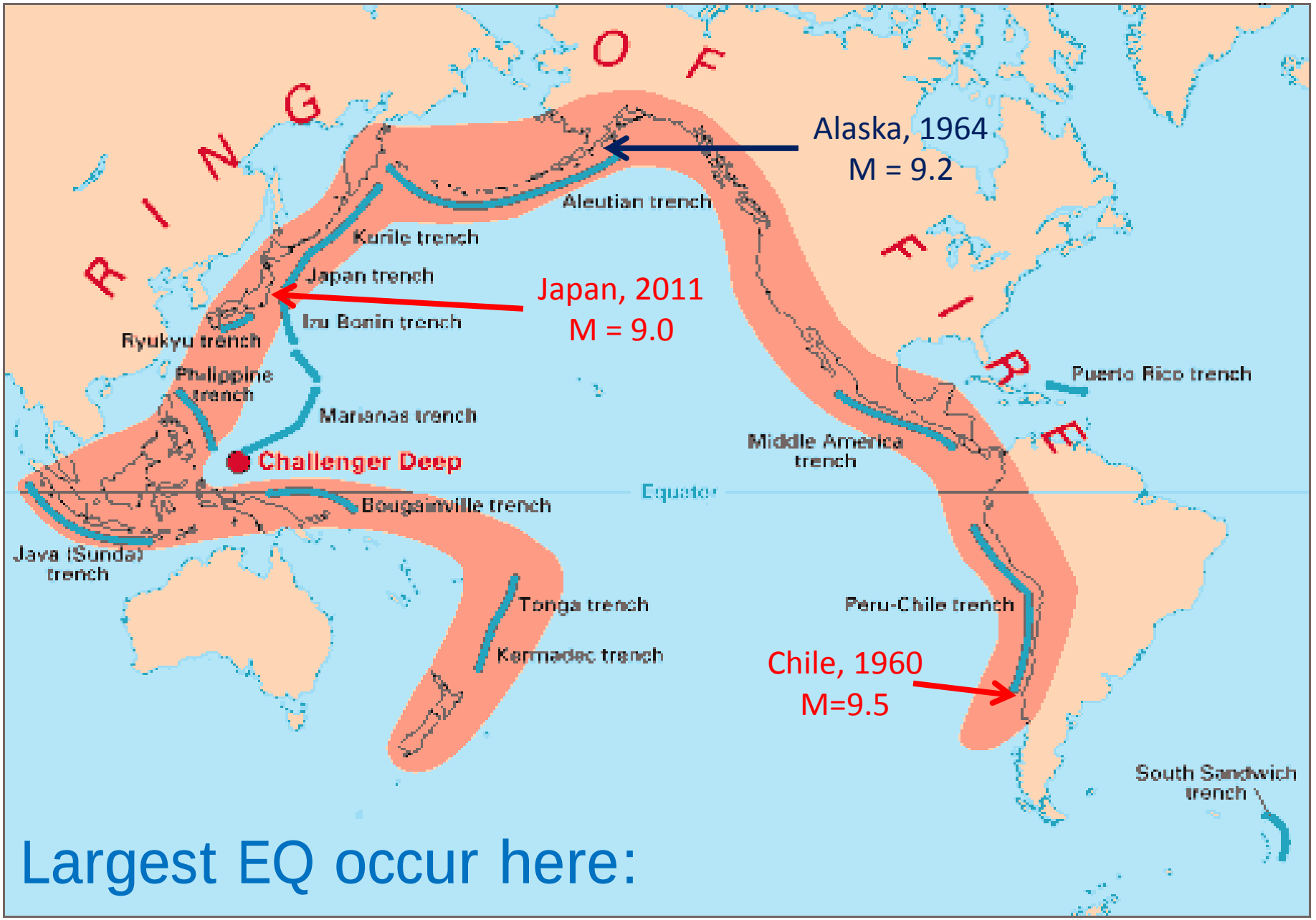


EPS20:

Earthquakes in your backyard & tsunamis

Where do earthquakes occur?

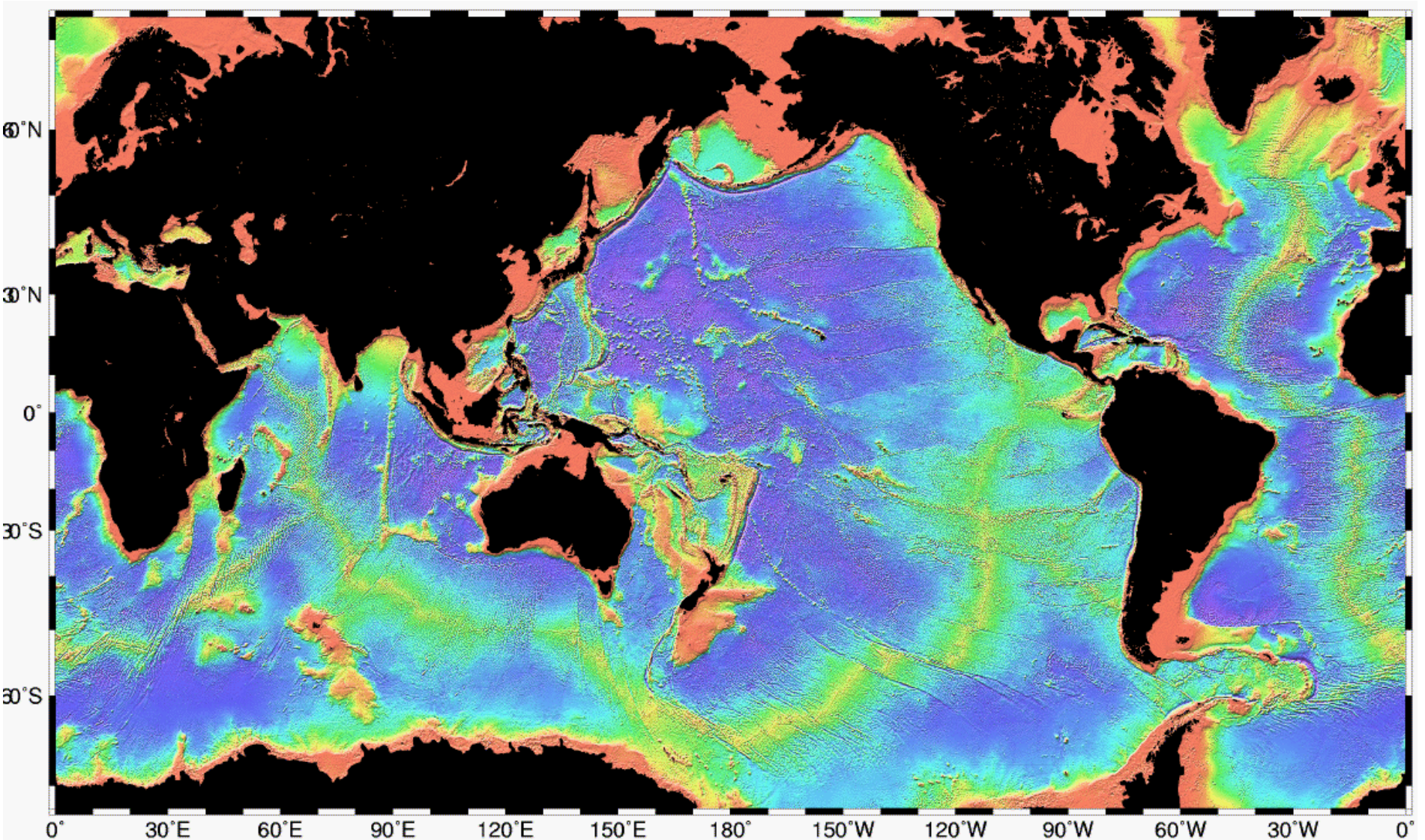
Pacific Ring of Fire



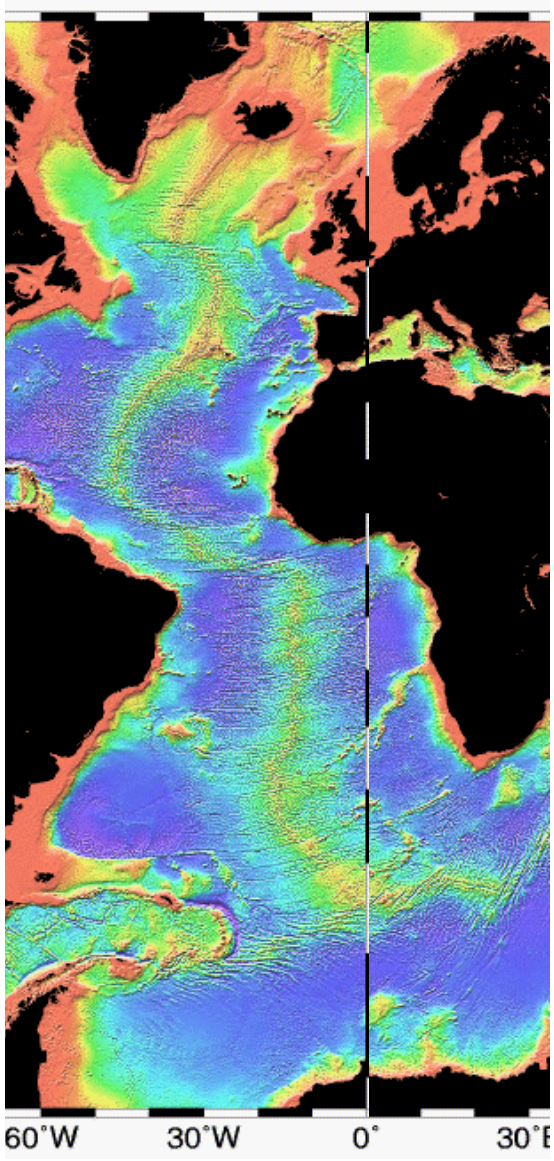
Largest EQ occur here:

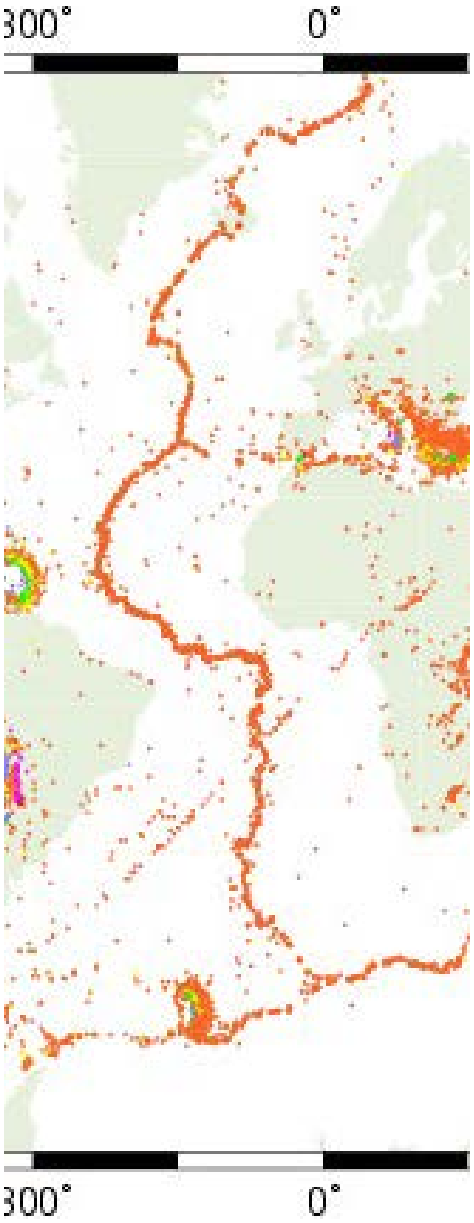
Where do earthquakes occur?

Global Bathymetry



Where do earthquakes occur?





.....like here along the Mid-Atlantic ridge

Plate Tectonics

How does this all fit together? Why do earthquakes occur in these specific regions?

For the answers thank this man

The Father of Continental Drift and Plate Tectonics

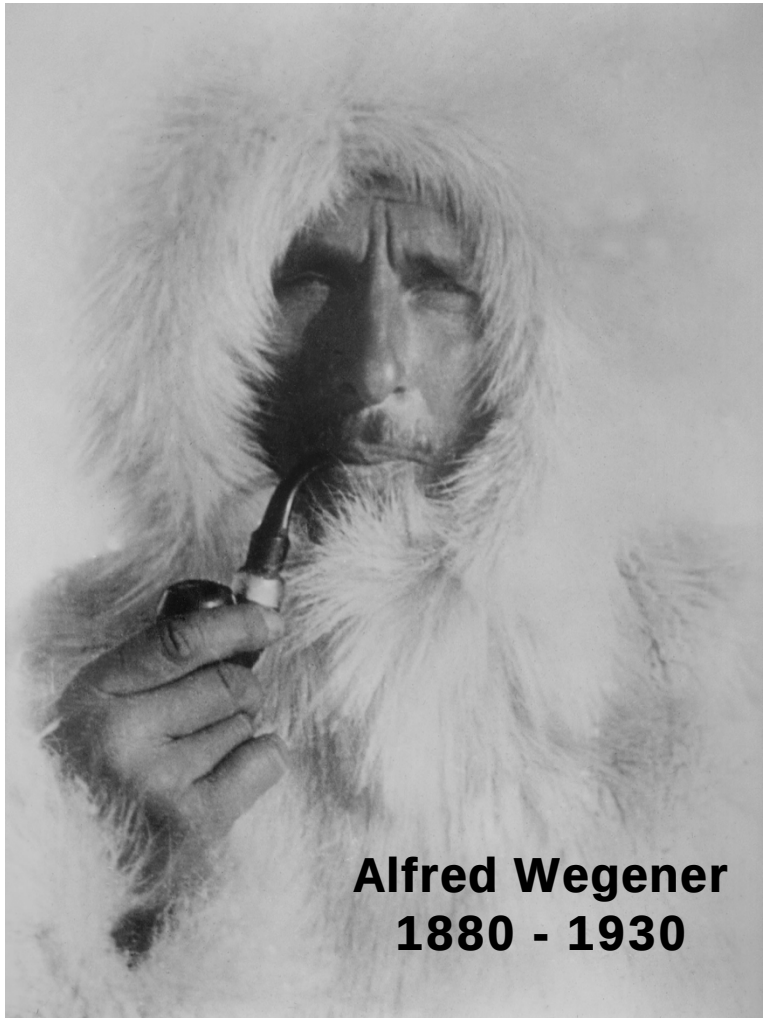
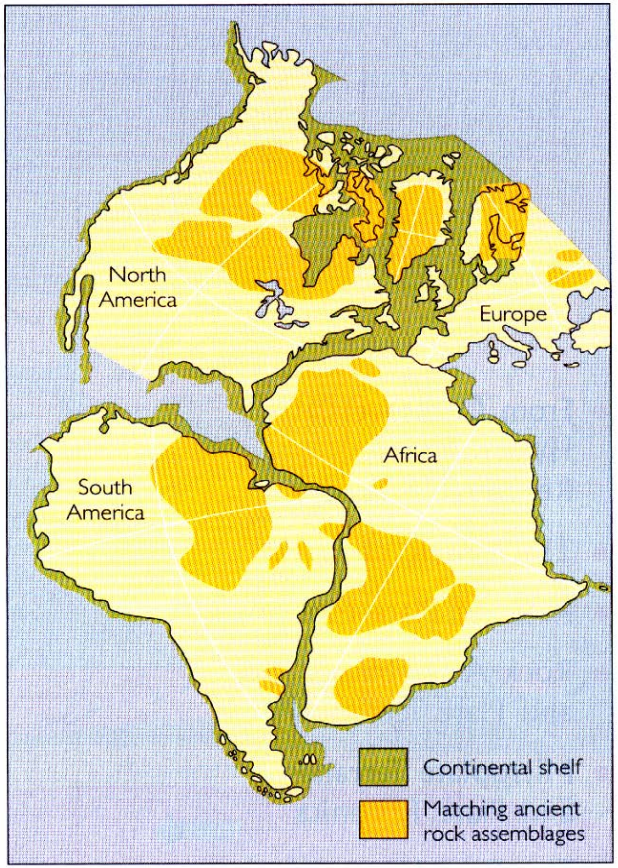
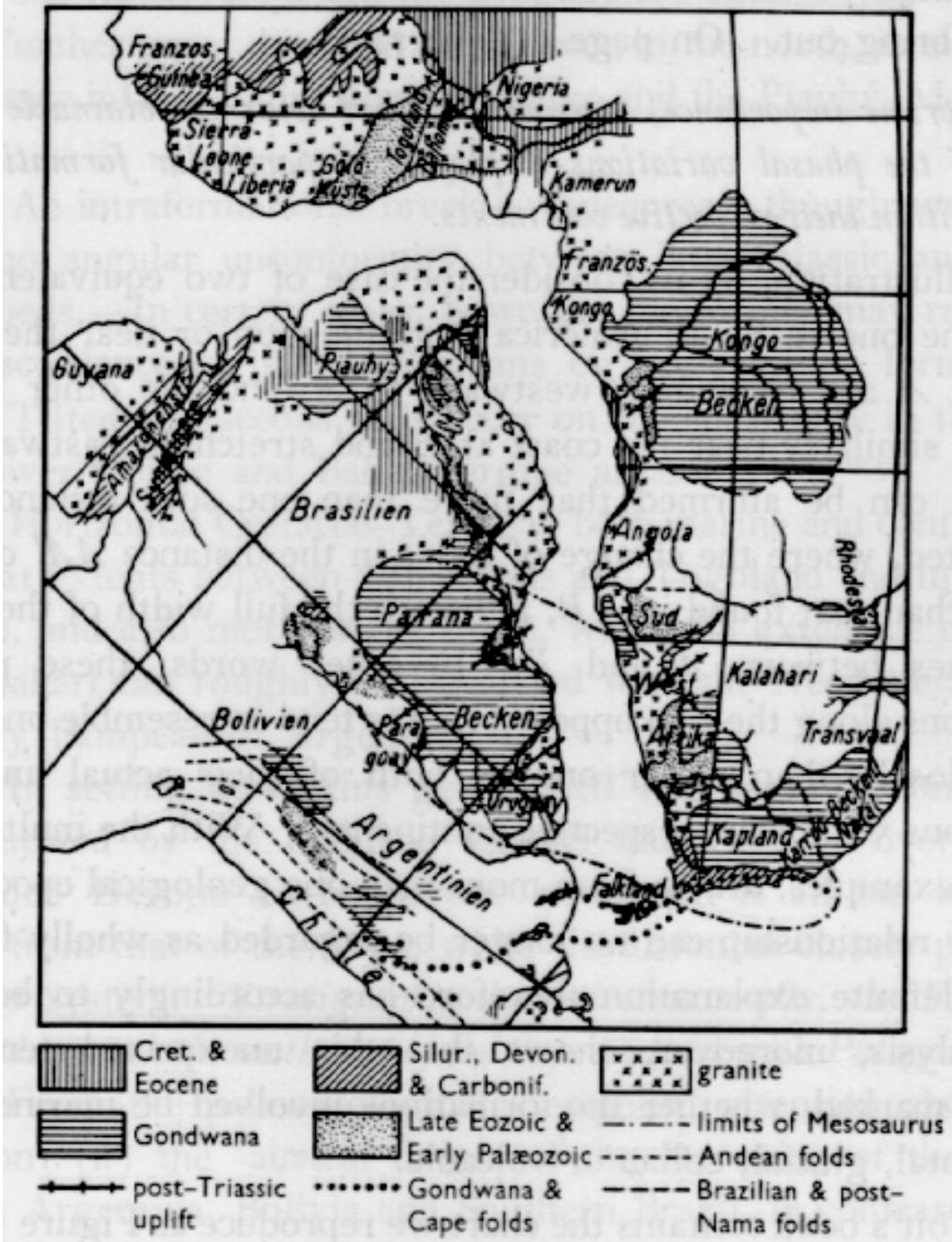


Plate Tectonics

Wegener 1912: concept of drifting continents

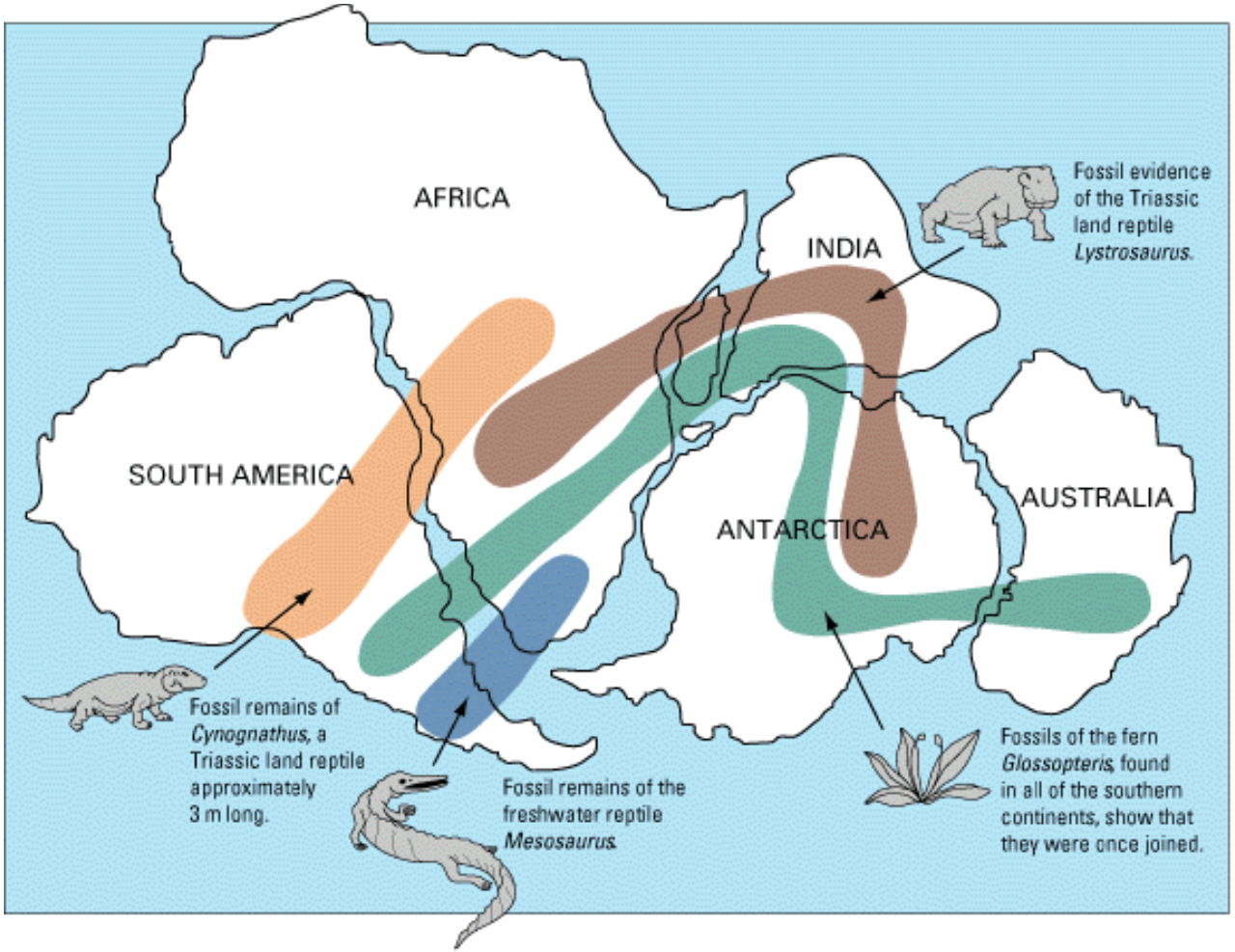




Evidence for plate tectonics

shapes of continents

fossils shared between different continents

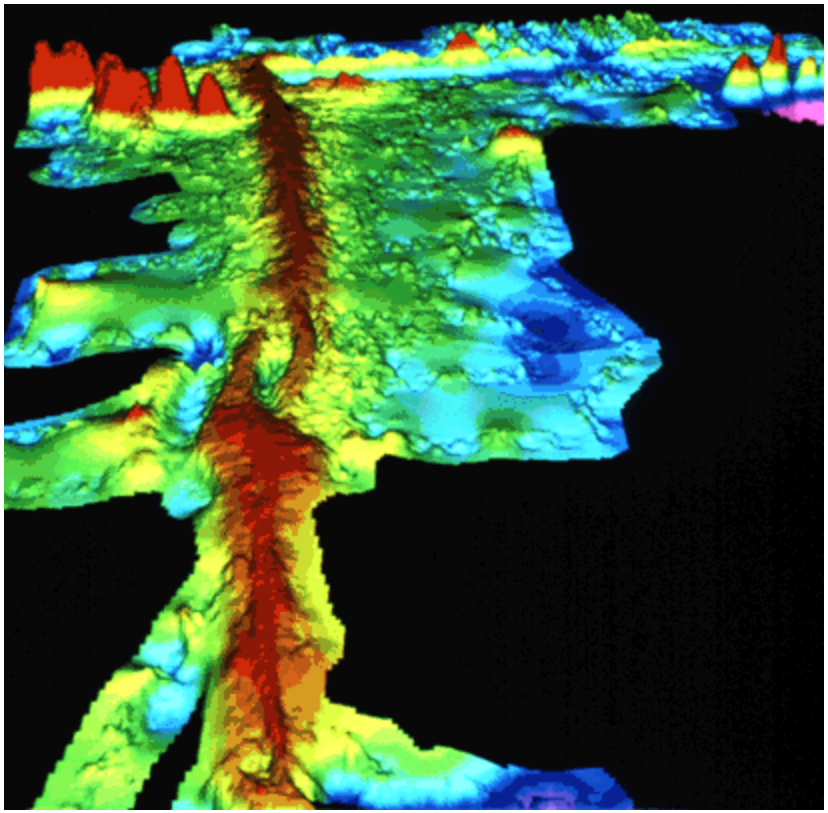


Evidence for plate tectonics

maps of the sea floor made using sonar (after WW I)

a ridge in the centers of most oceans

surprisingly small amount of sediment on sea floor



East Pacific Rise

Ocean Ridges

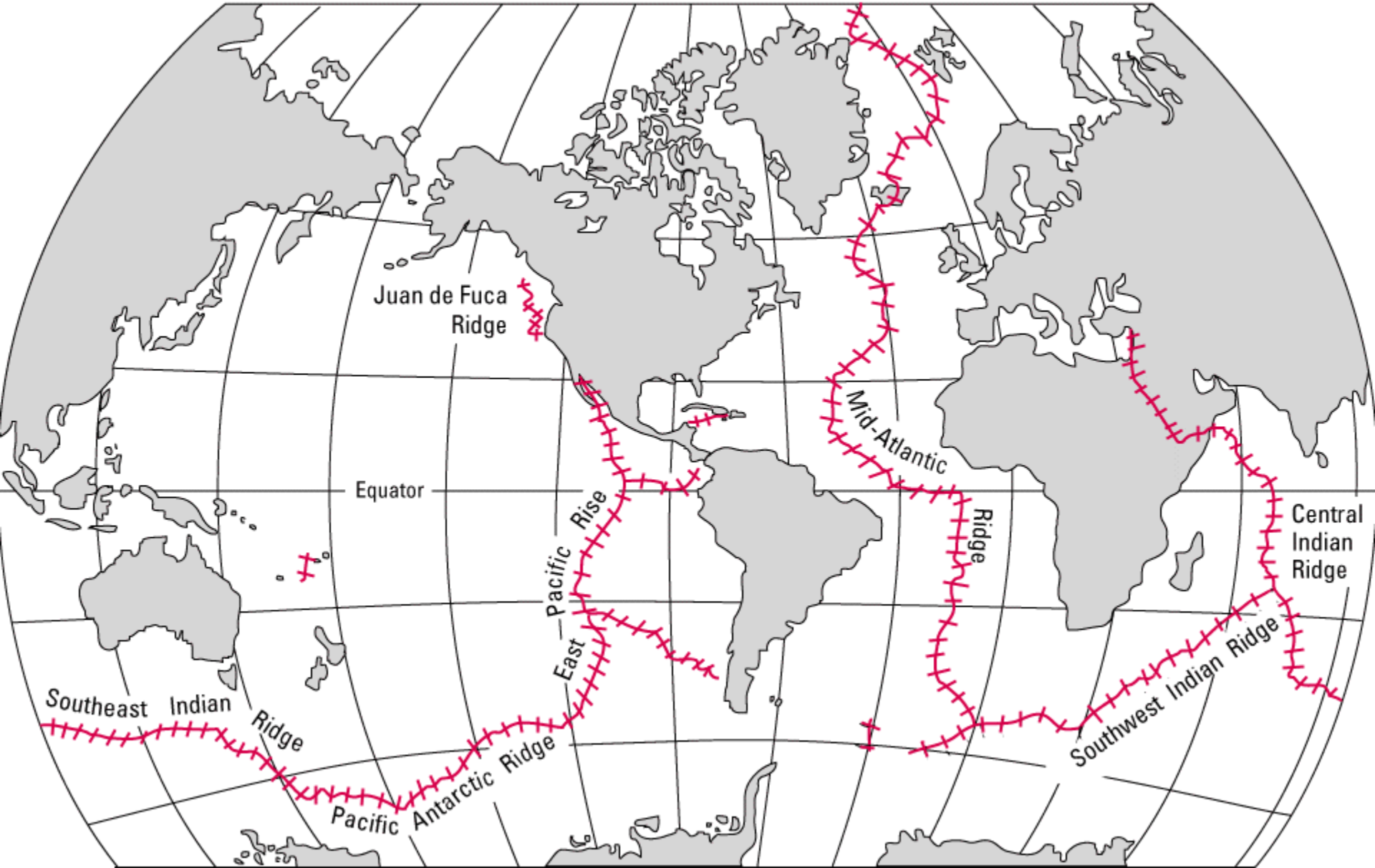
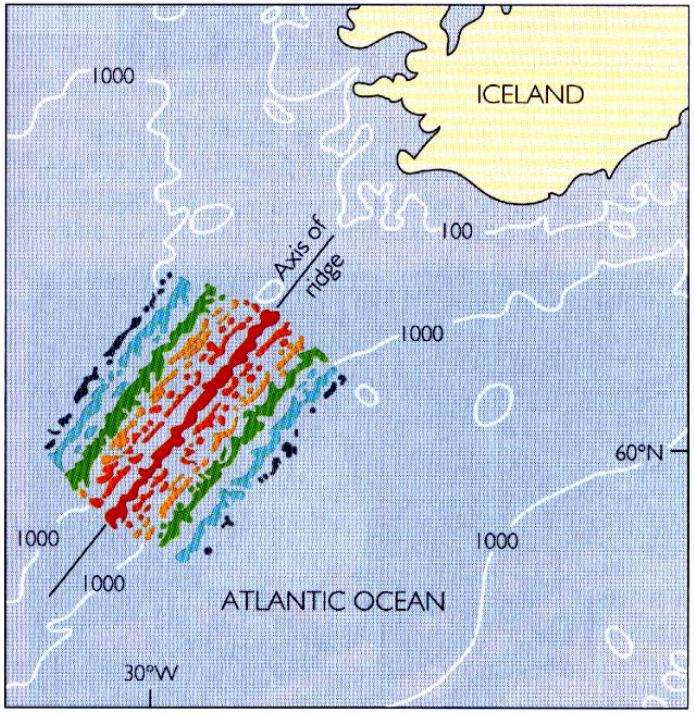
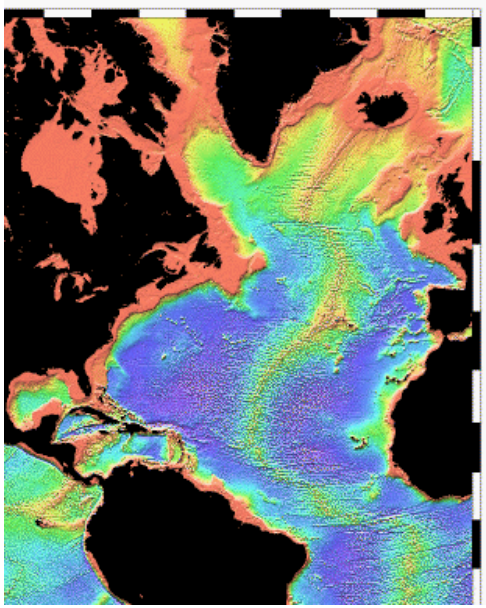


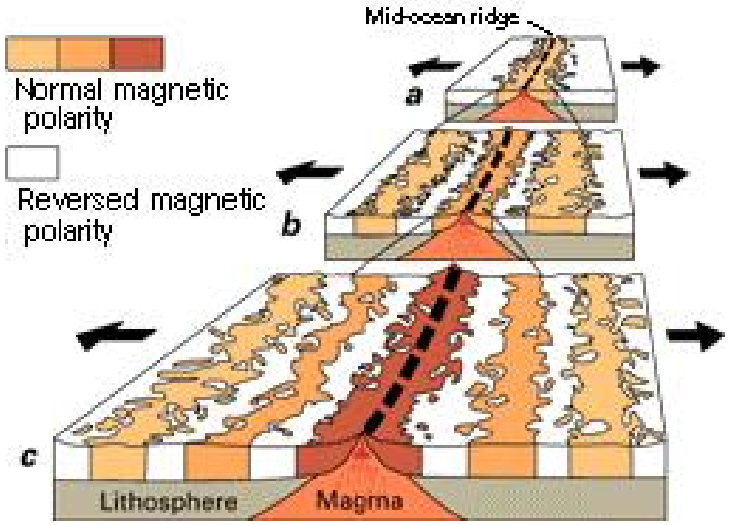
Plate Tectonics

Confirmation in 1963:
Discovery of magnetic stripes on the ocean floor



Periodic reversals of the Earth's magnetic field are recorded as stripes





Hypothesis: Ocean ridge spreading

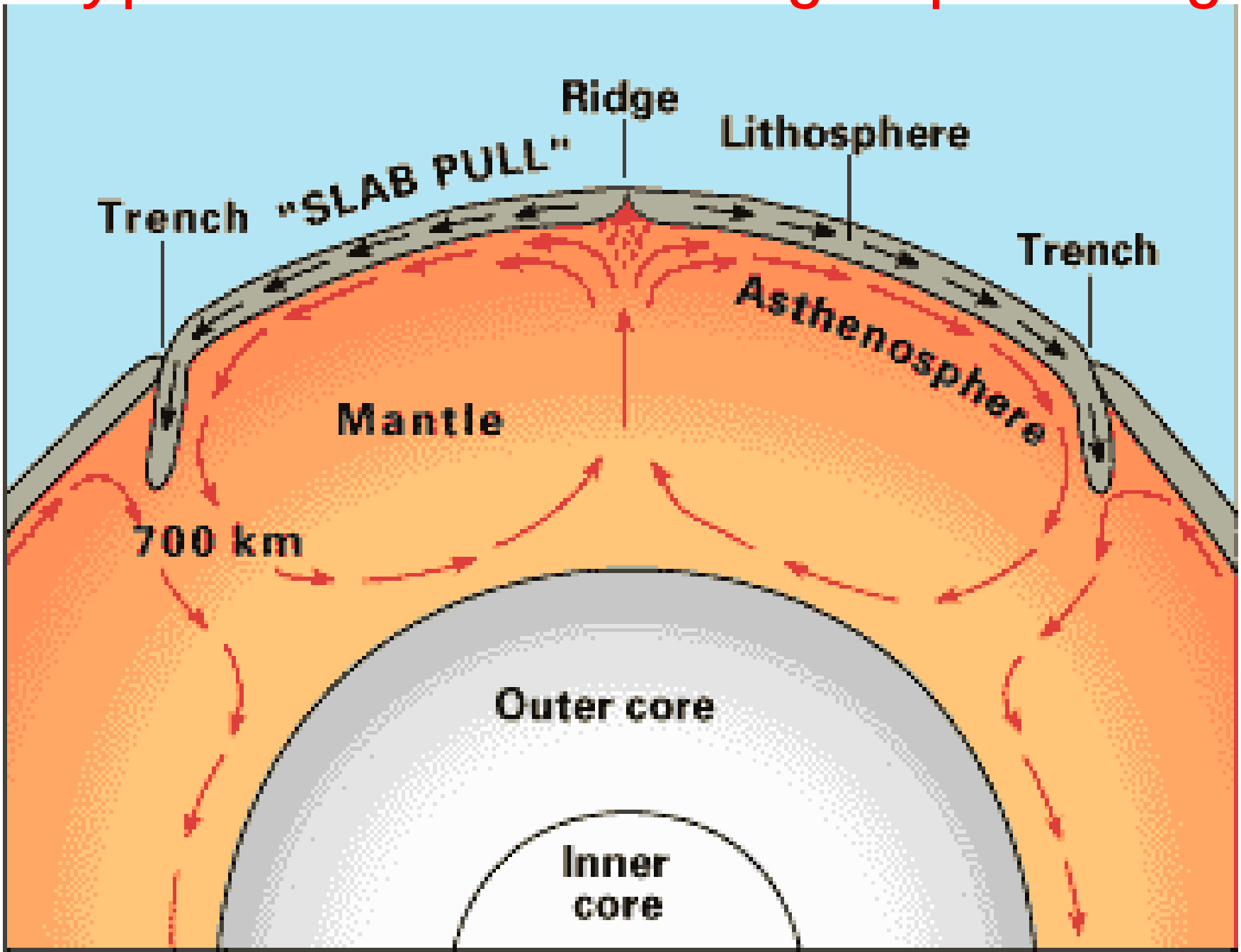
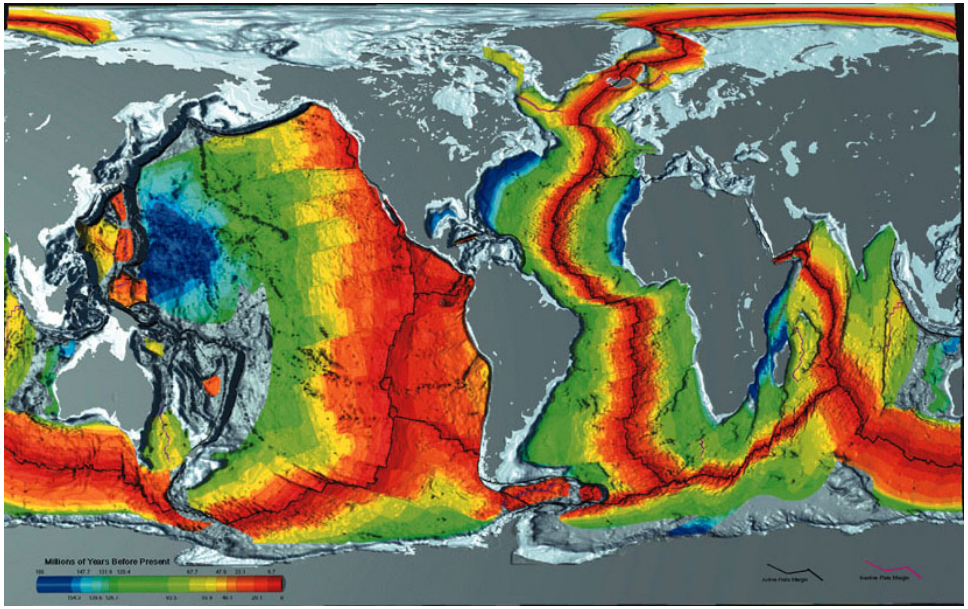


Plate Tectonics

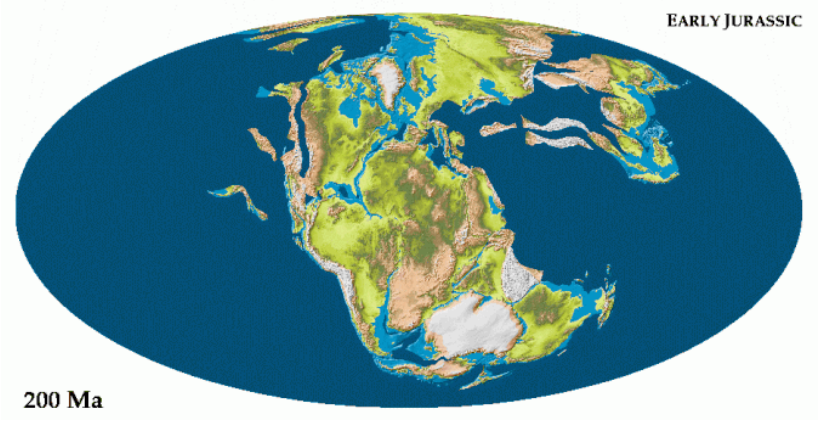
The magnetic tape recorder:

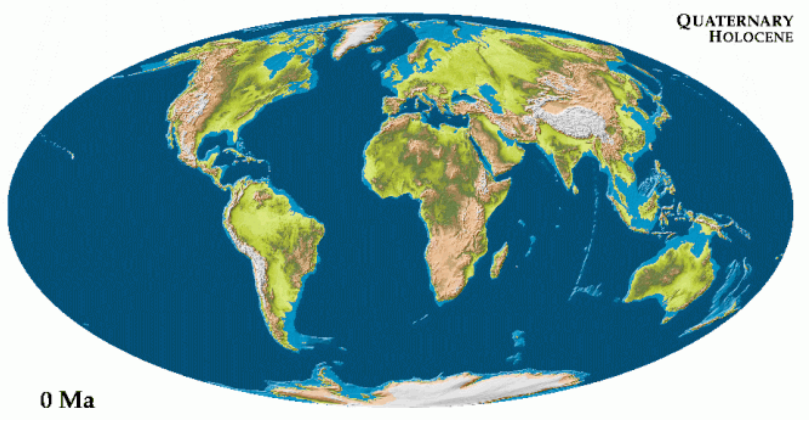
Given the oceanic record we can wind back the plates to see how the plates have been moving.



age of the ocean floor: red=young, green=old

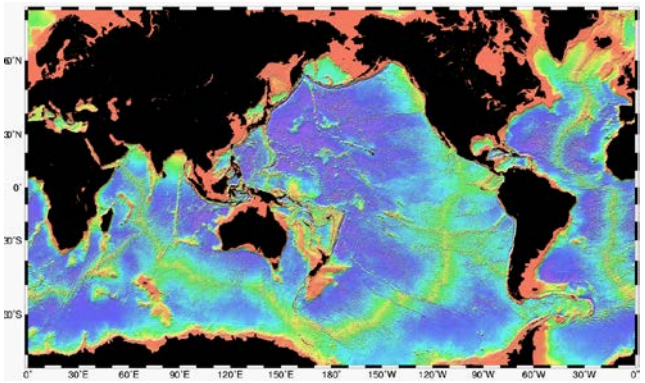
We can reconstruct past plate motion

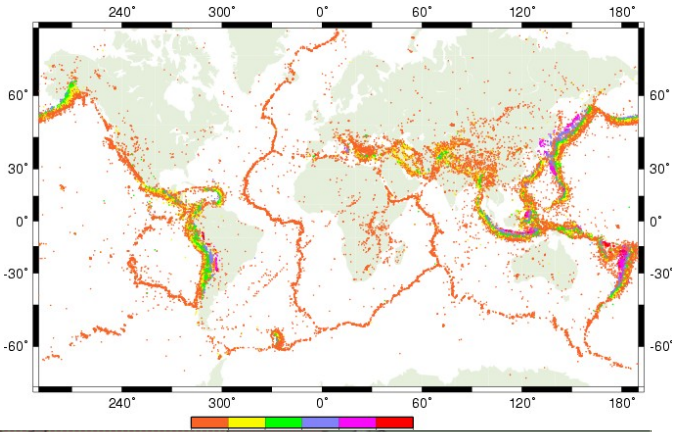




Pangaea supercontinent

Plate Tectonics

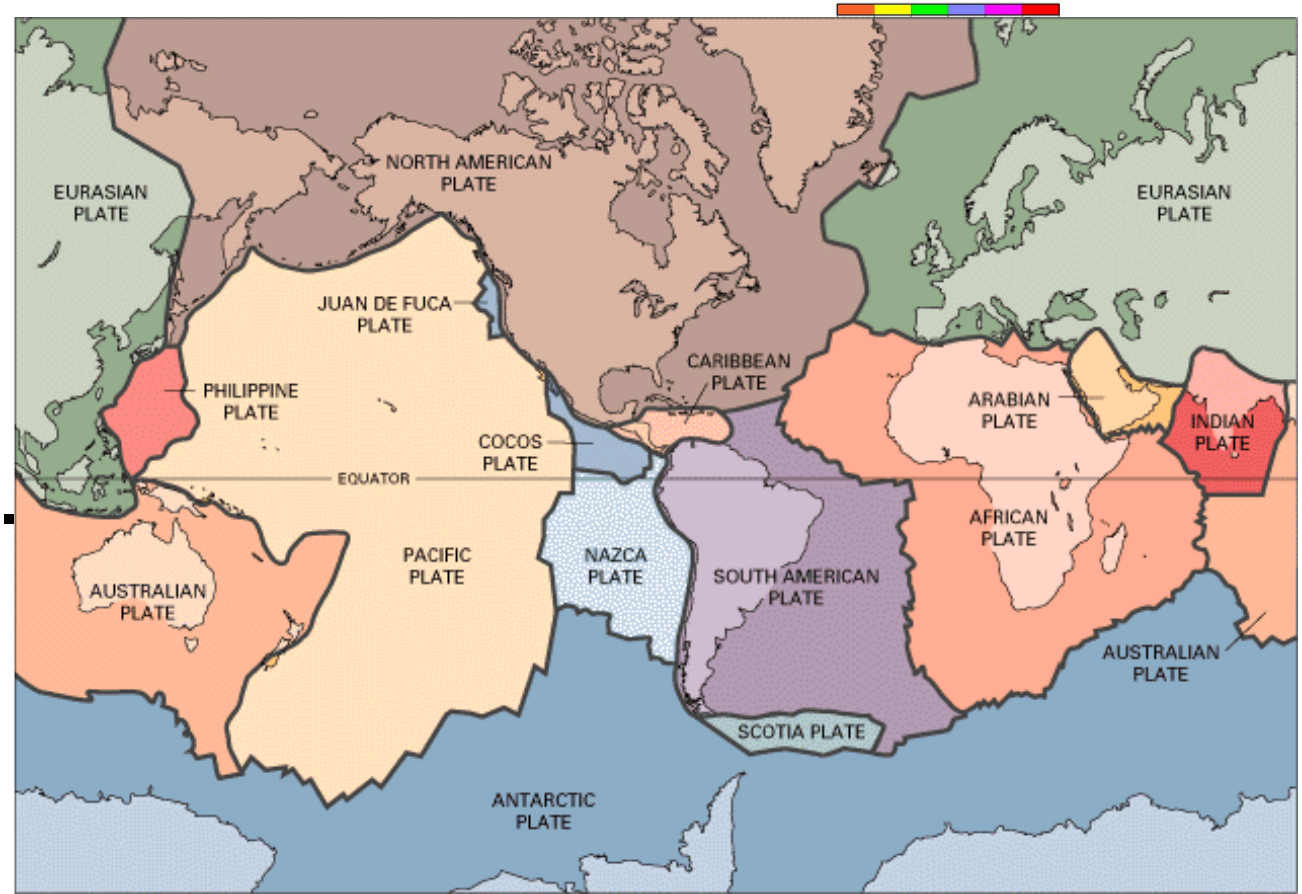




Today we have

14 major plates:

North American
Eurasian
Pacific
Antarctic
South American
African
Australian



The plates are rigid.

They are moving,

hence they collide

The Big Picture: How does it work?

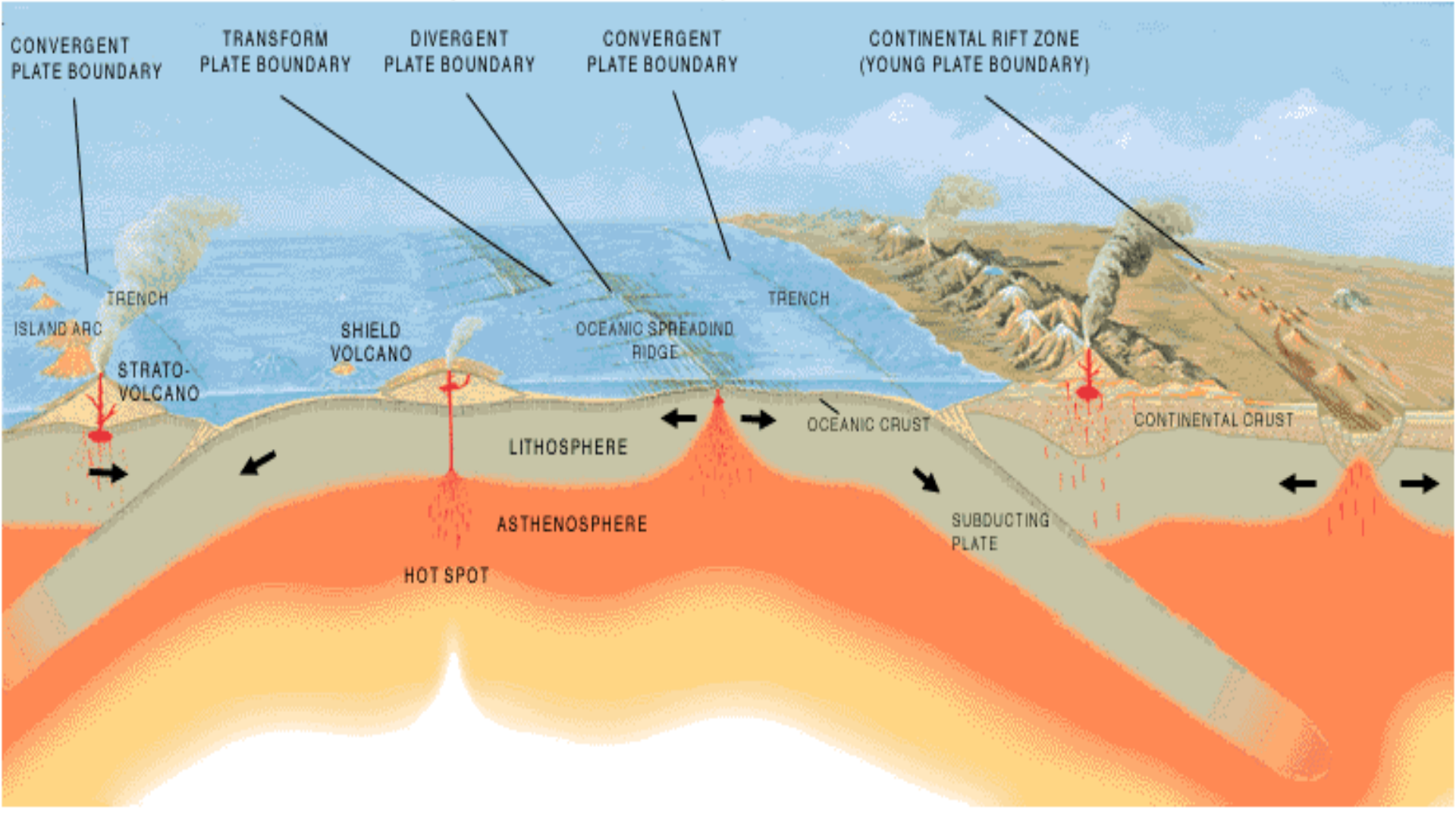


Plate Tectonics

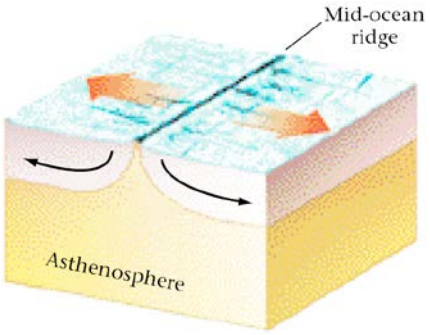
The tectonic action is along the plate boundaries

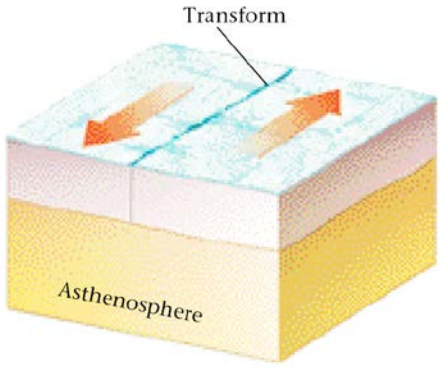
Categories of plate – plate interactions

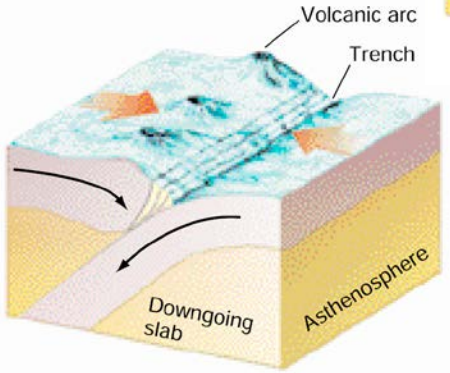
Divergent
- Established mid-ocean ridge
- New rift zone, new ocean

Transform
- Along mid-ocean ridges
- Across continents

Convergent
- Ocean – continent
- Ocean – ocean
- Continent – continent



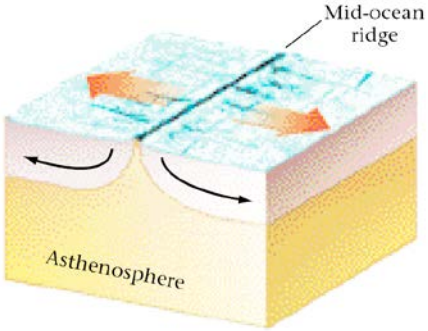




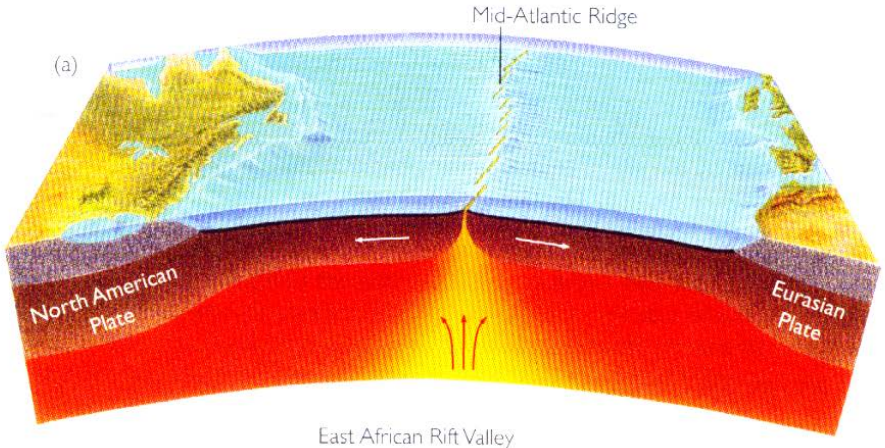
Let's look at them in more detail:

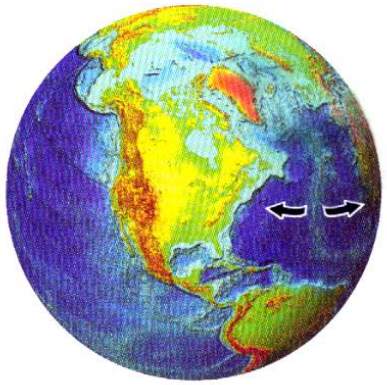
Plate Tectonics

Divergent boundaries:



Mid-Atlantic Ridge





East African Rift and Red Sea

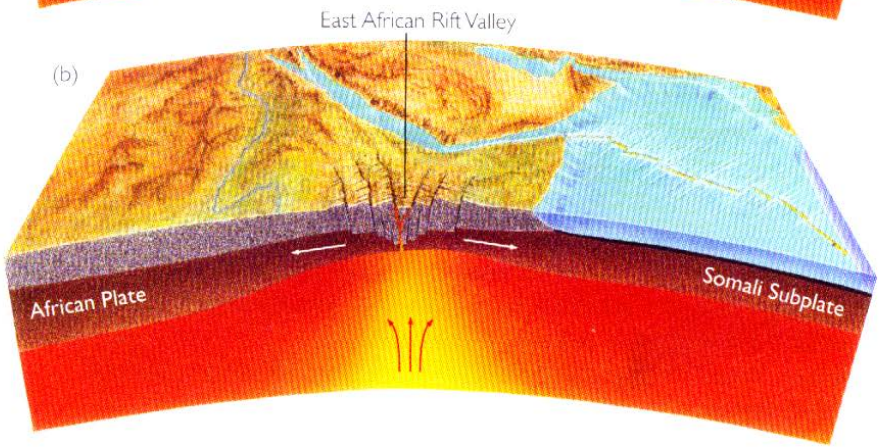


Figure 20.4 (a) Rifting and seafloor spreading along the Mid-Atlantic Ridge create a mid-ocean volcanic mountain chain and a coincident earthquake belt. (b) Initiation of rifting and plate separation within a continent. Characteristic features are rift valleys, with multiple normal faults, volcanism, and earthquakes. [*Color-shaded relief globes by Peter W. Sloss, NOAA-NESDIS-NGDC.*]

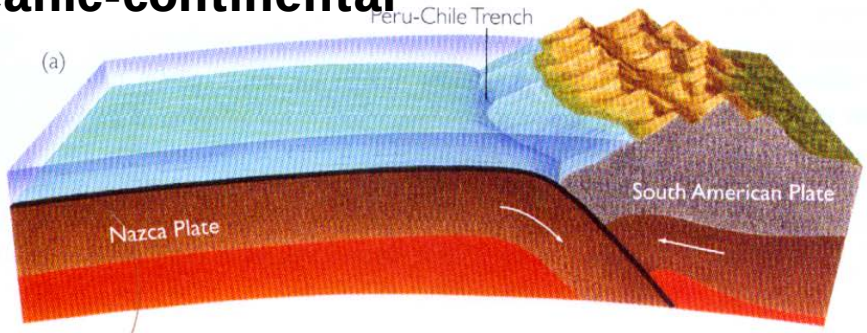
Plate Tectonics

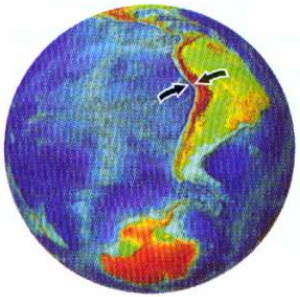
Convergent boundaries = collision

Cars: Deformation, Metal folding, Explosive release of energy
Earth: The right conditions for Earthquakes and Volcanoes

Three types of convergent plate boundaries:

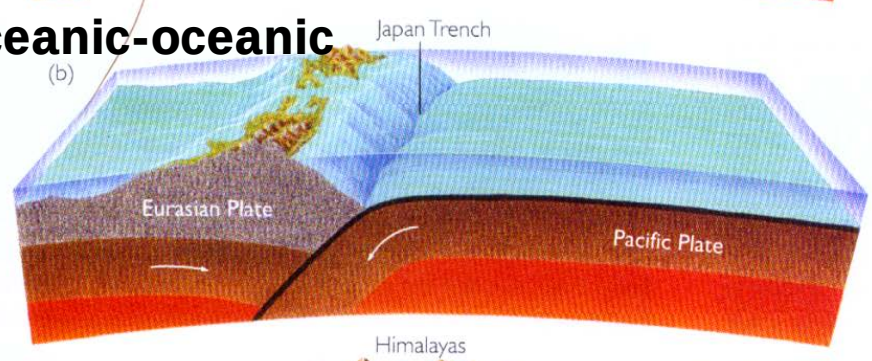
oceanic-continental

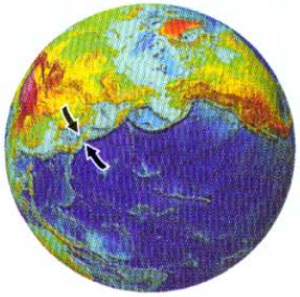




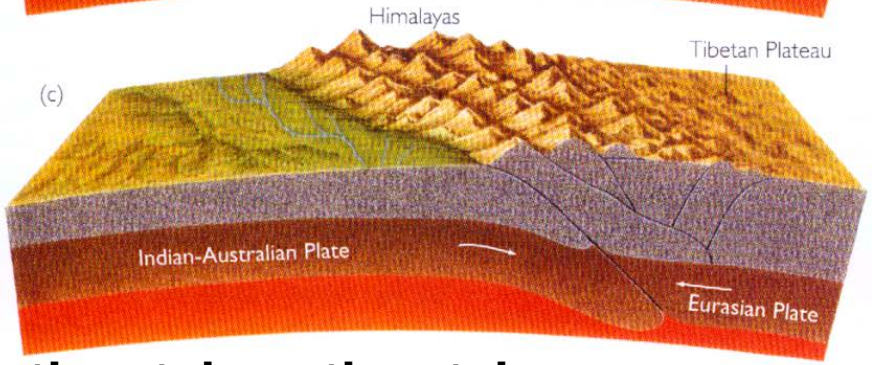
Western South America and the Pacific Northwest

oceanic-oceanic



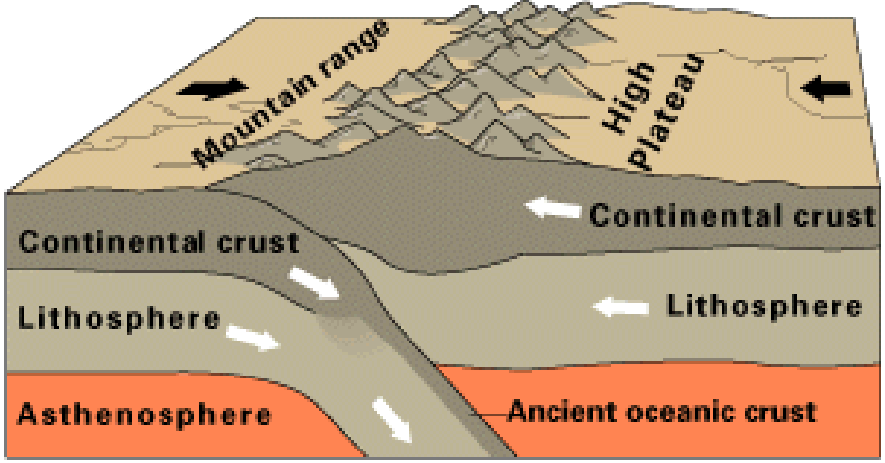


Japan

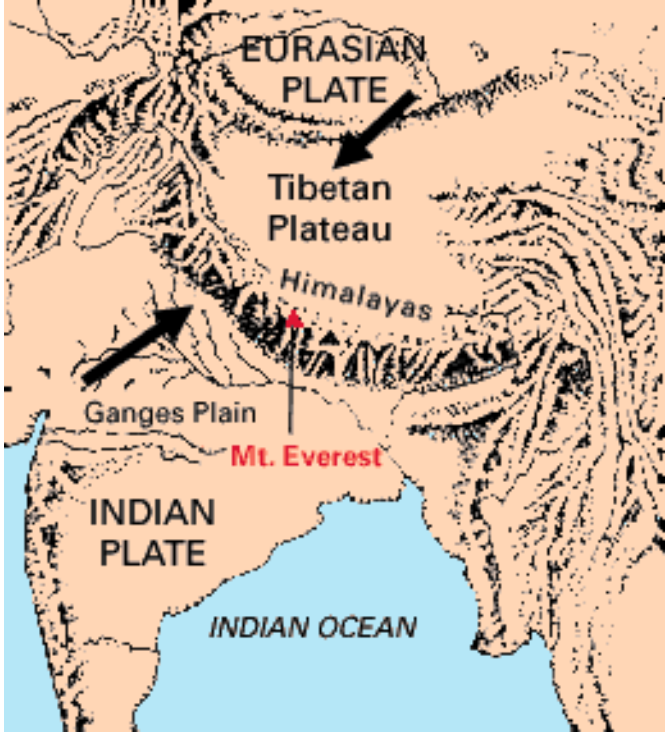


The Himalaya

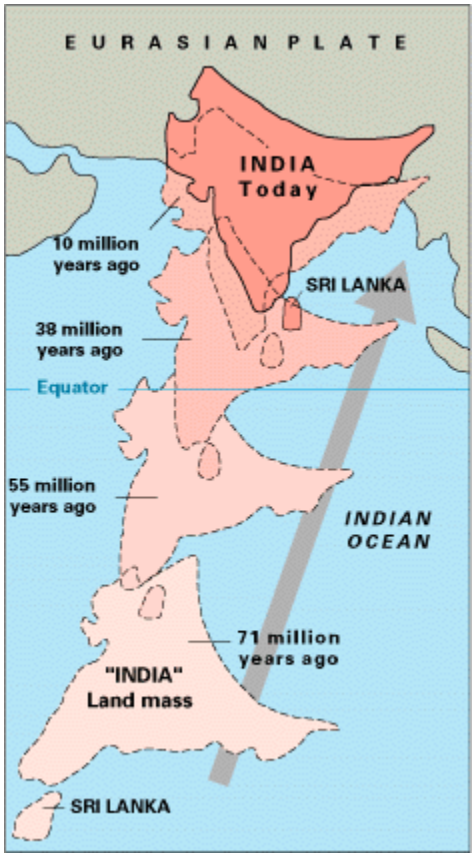
continental-continental



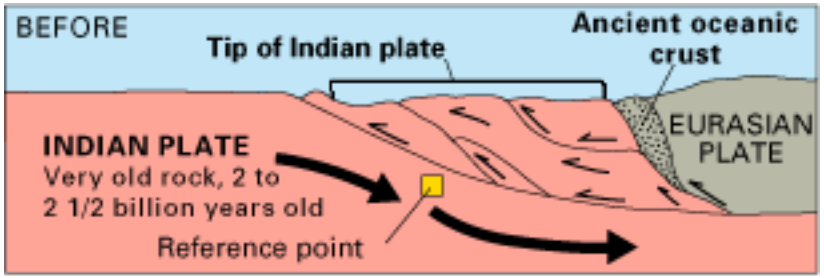
Continental-continental convergence



Example: Convergent boundary (continental-continental)



India and Asia



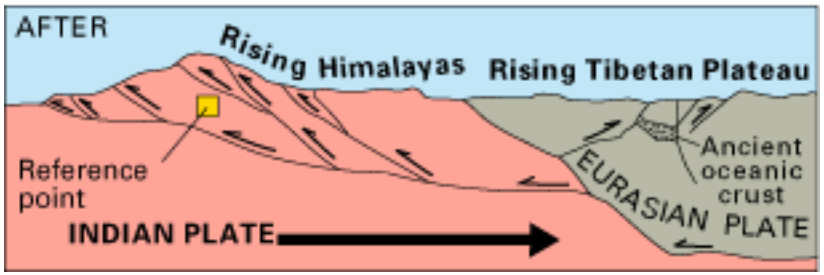
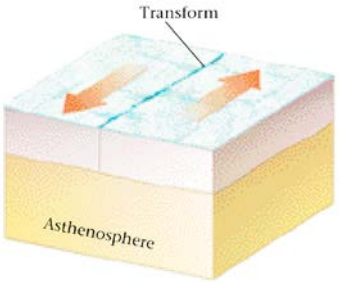


Plate Tectonics

Transform plate boundaries:

San Andreas Fault
The Mother of all Earthquake Faults



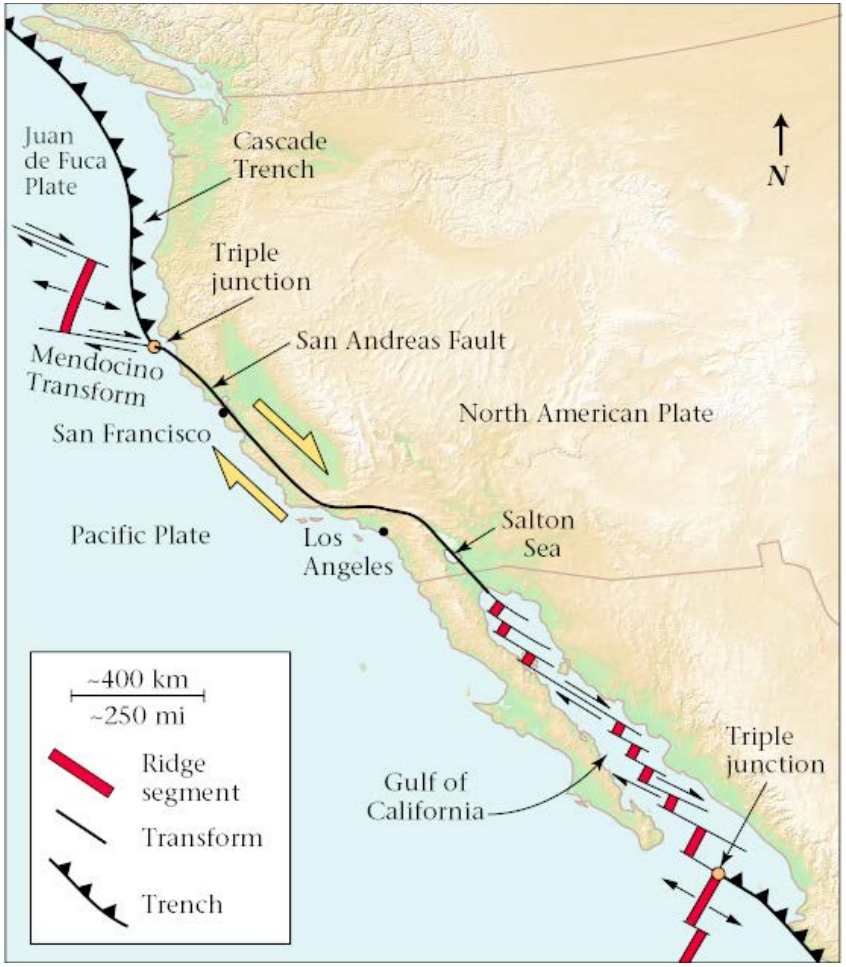
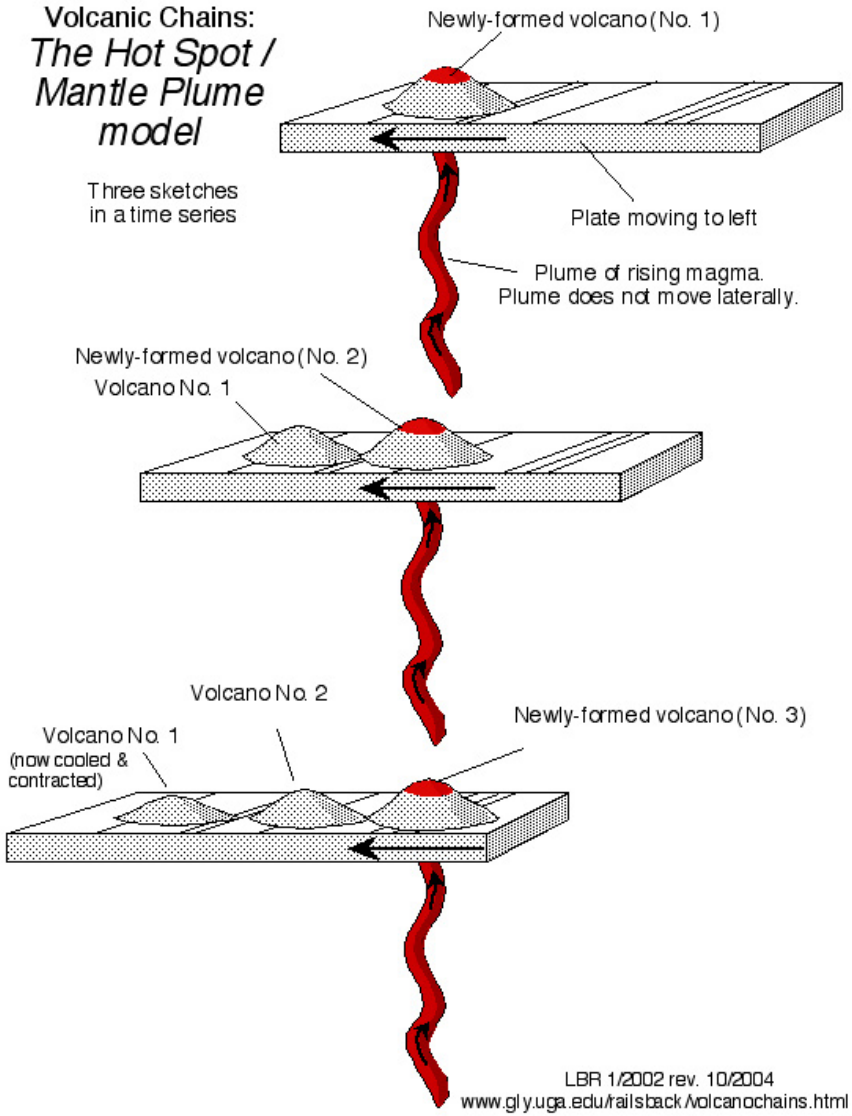
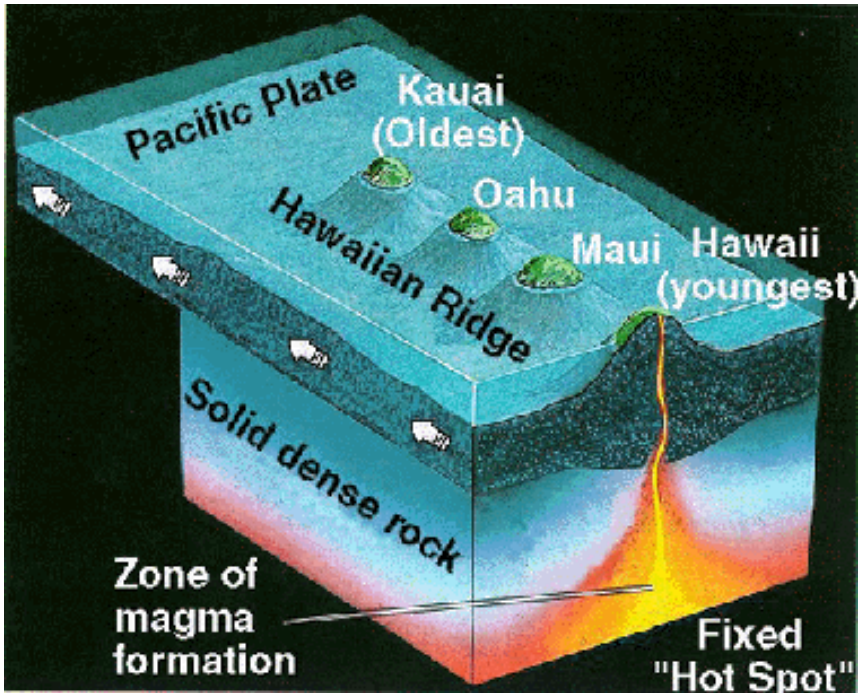


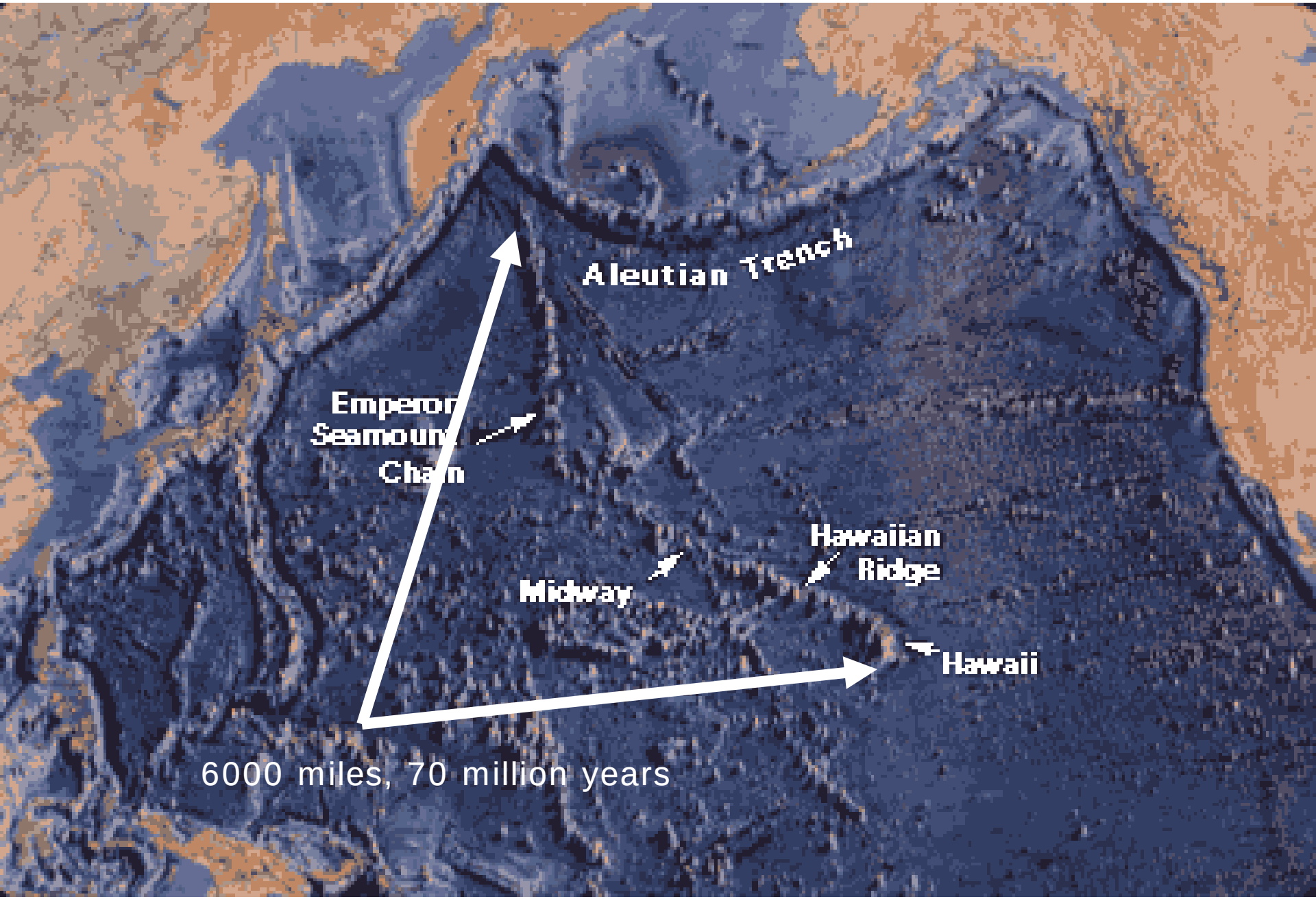
Plate Tectonics

Hot Spots





Magmatic Blow Torch


Aleutian Trench
Emperor
Seamount
Chain
Midway
Hawaiian
Ridge
Hawaii
6000 miles, 70 million years

EXPLANATION

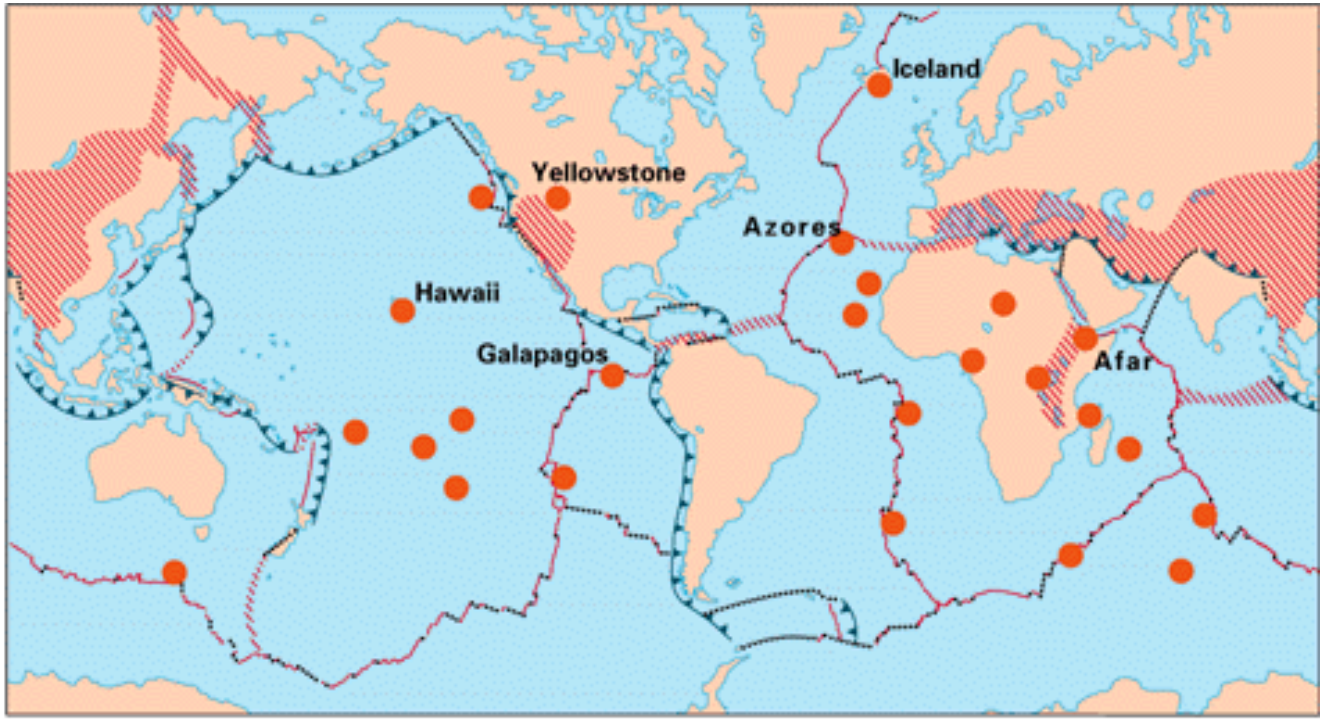
Divergent plate boundaries—Where new crust is generated as the plates pull away from each other.

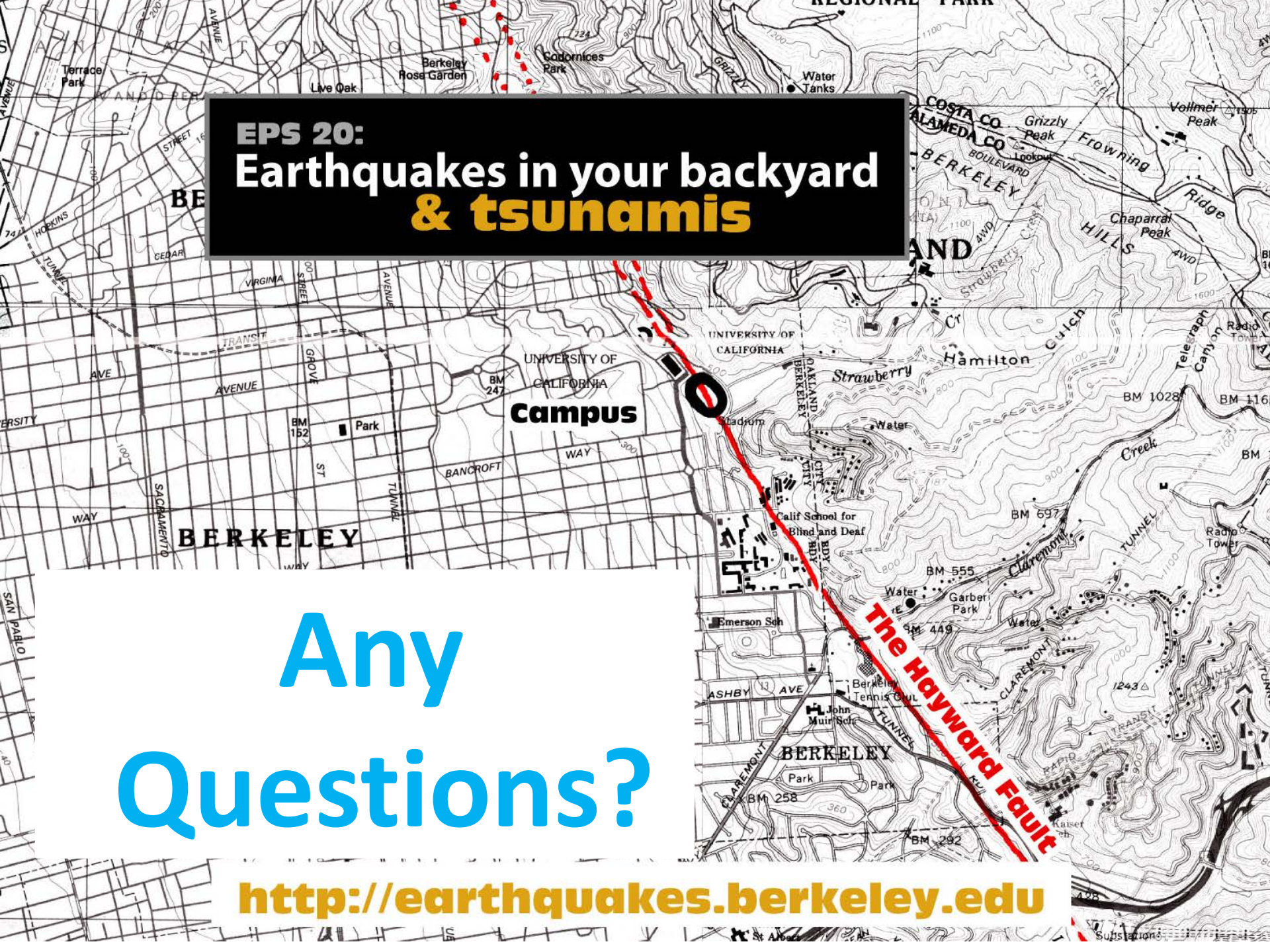
Convergent plate boundaries—Where crust is consumed in the Earth's interior as one plate dives under another.

Transform plate boundaries—Where crust is neither produced nor destroyed as plates slide horizontally past each other.

Plate boundary zones—Broad belts in which deformation is diffuse and boundaries are not well defined.

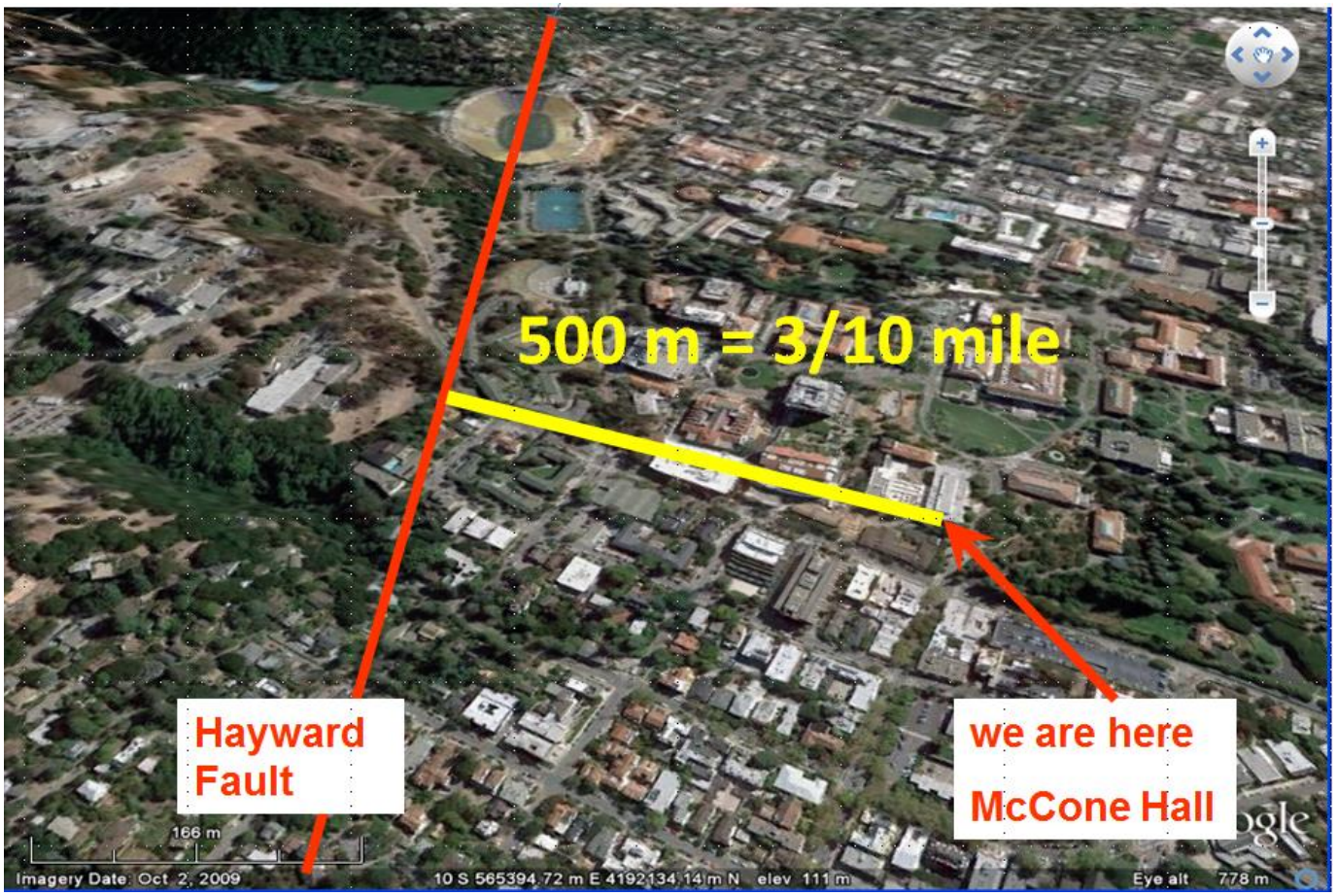
Selected prominent hotspots




EPS 20:
Earthquakes in your backyard
& tsunamis
Any
Questions?
The Hayward Fault
http://earthquakes.berkeley.edu

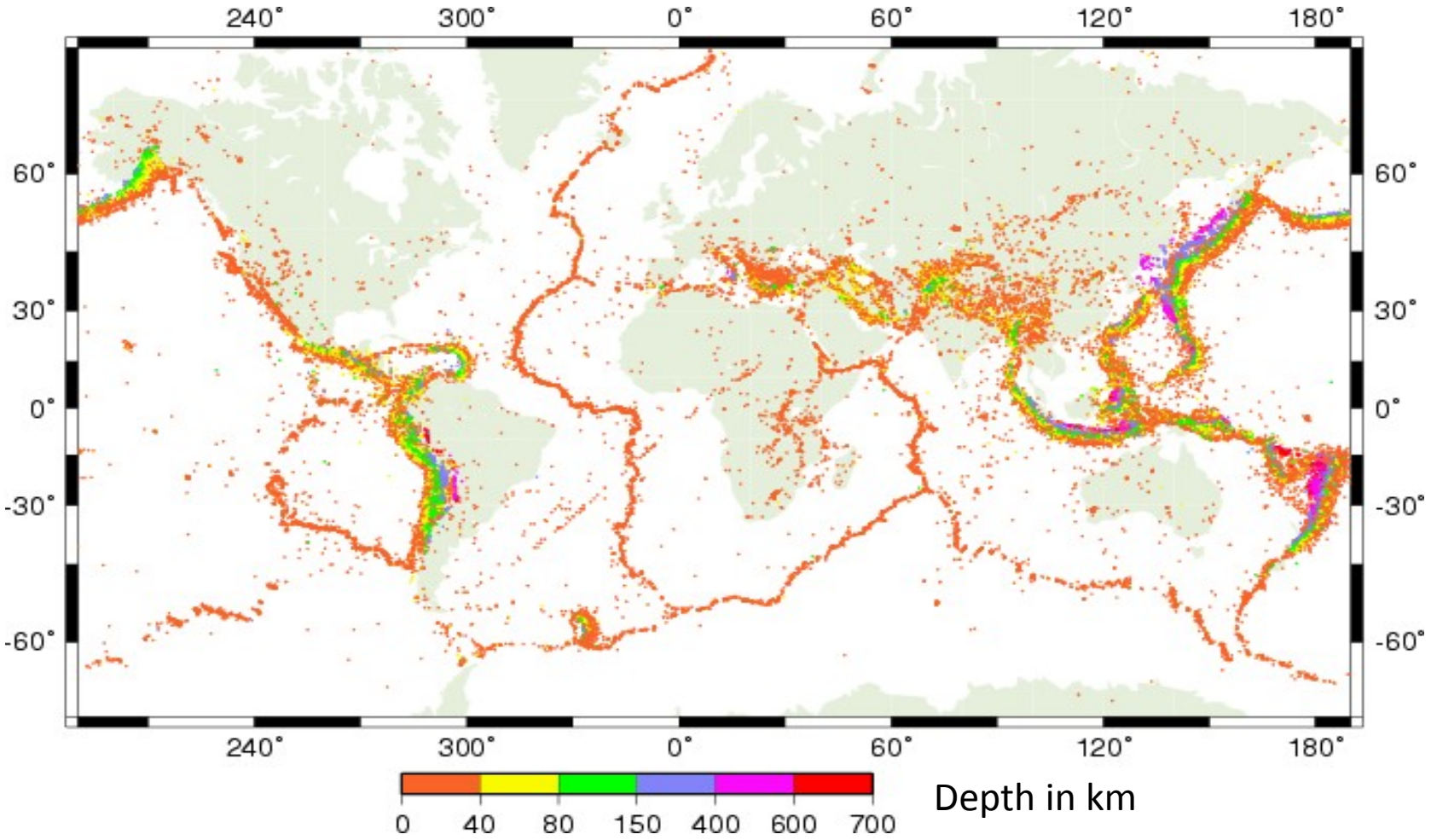
Things to remember I

We are sitting on a tectonic time bomb

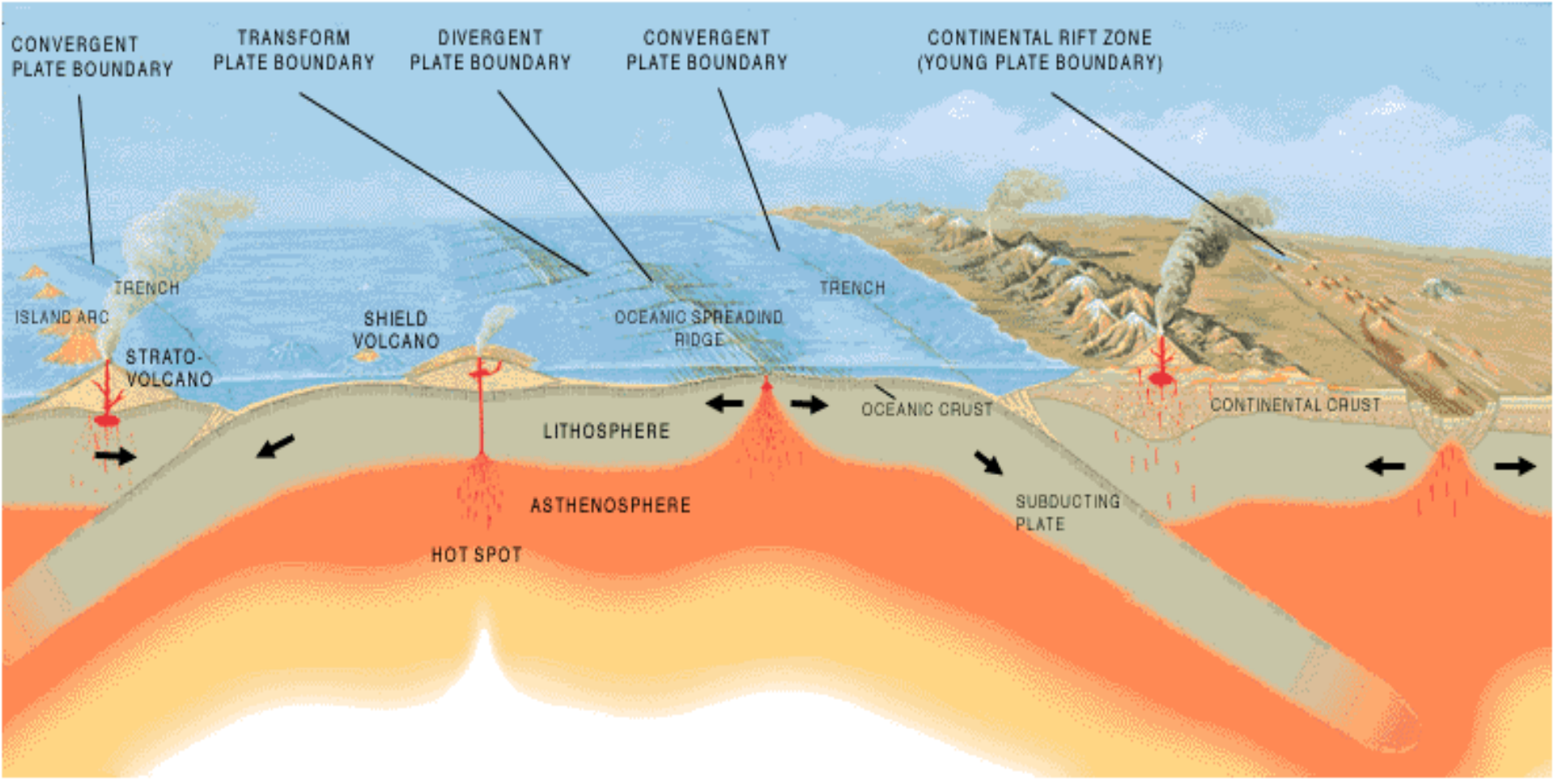


Things to remember II

Earthquakes around the world occur in a distinct pattern



The cause is Plate Tectonics



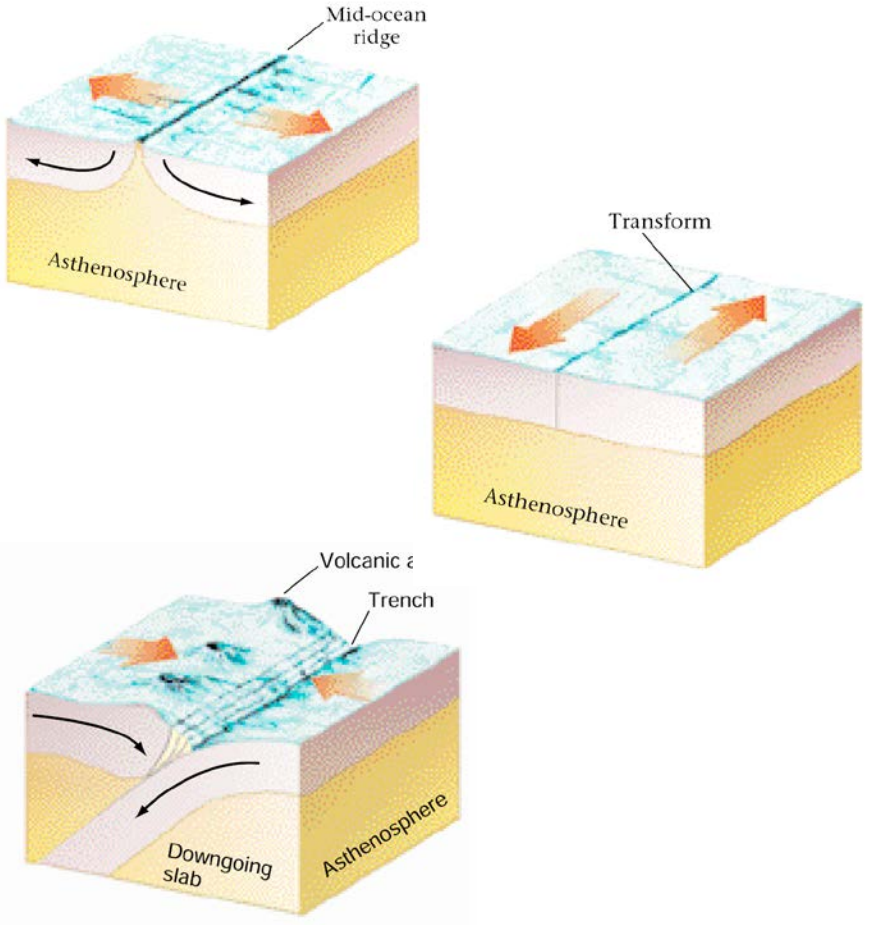
Things to remember IV

Three types of plate – plate interactions

Divergent
- Established mid-ocean ridge
- New rift zone, new ocean

Transform
- Along mid-ocean ridges
- Across continents

Convergent
- Ocean – continent
- Ocean – ocean
- Continent – continent



Thursday:

Earthquake Faults
Different types of Earthquakes