Faults

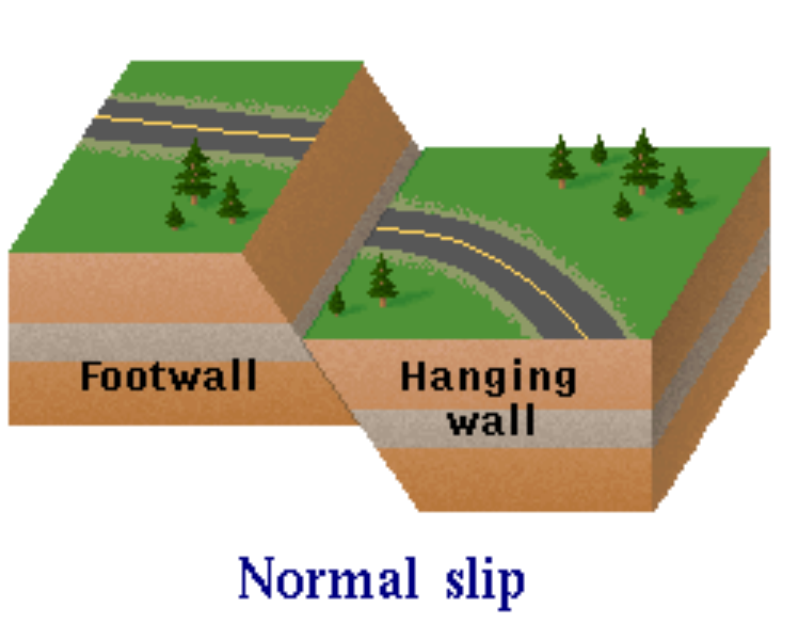
BASIC DEFINITIONS

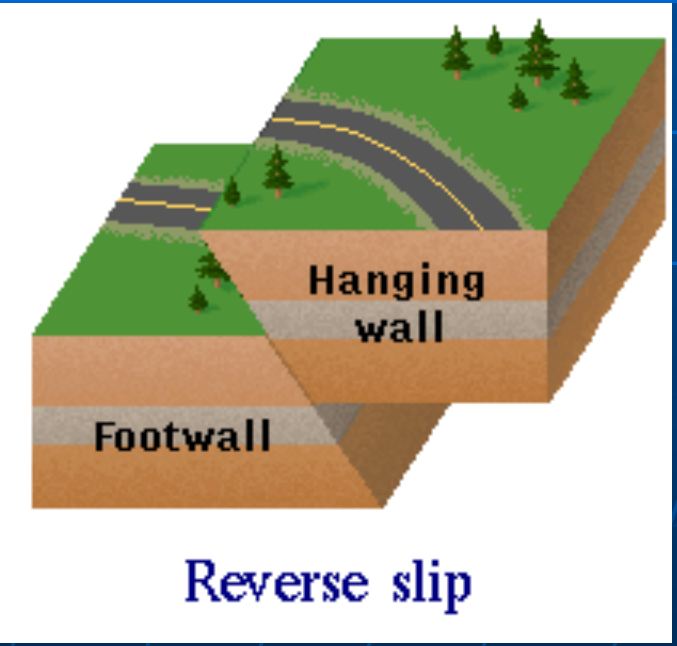
- *FAULT*: A surface or narrow zone along which one side has moved relative to the other.

- Faults are classified based upon their direction of movement.

HANGING WALL vs FOOTWALL

- A fault divides rock into two fault blocks
- For any inclined fault, the block above the fault is the hanging wall block, and the block below the fault is the footwall block

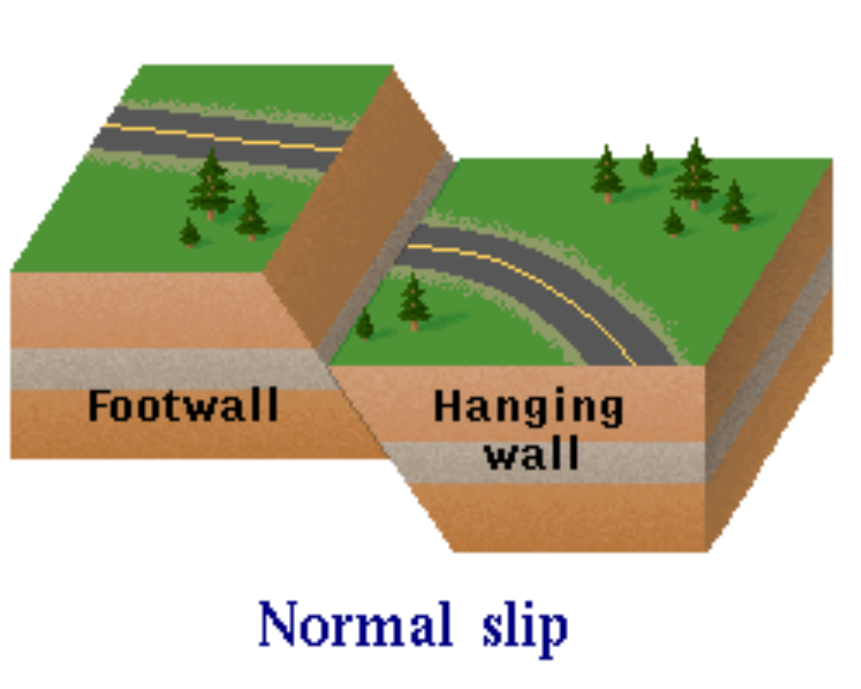




www.data.scec.org/Module/footnt02.html

CLASSIFICATION of DIP-SLIP FAULTS

- NORMAL FAULTS: Dip-slip faults on which the hanging wall moves down relative to the footwall
  - Place younger rocks on older rocks
  - Form in regions of lateral extension



www.data.scec.org/Module/footnt02.html

EXAMPLES OF NORMAL FAULTS

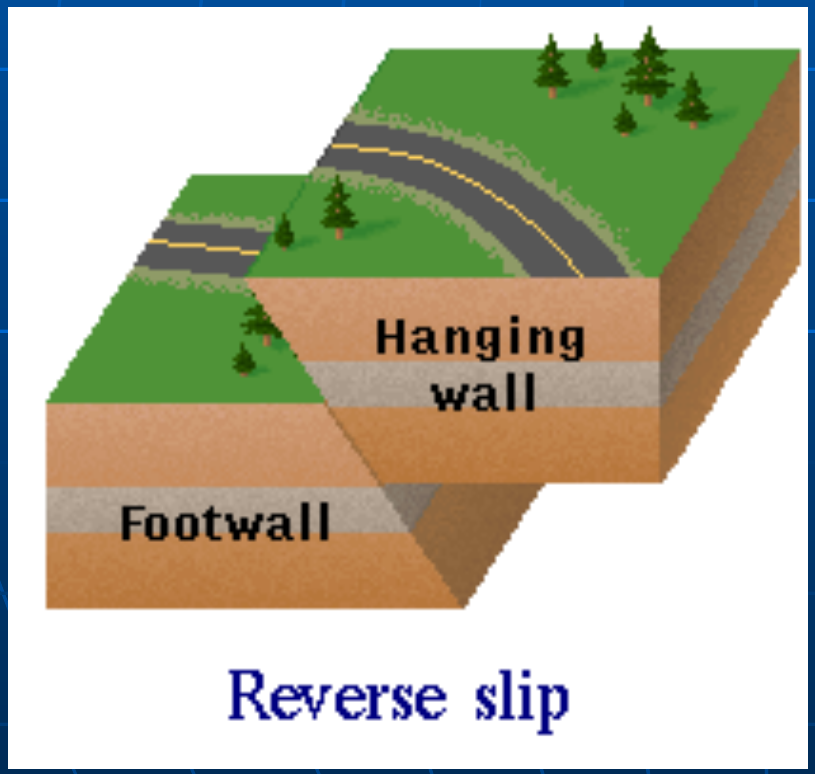
Outcrop scale normal faults

Conjugate Normal Faults,
Canyonlands National Park
darkwing.uoregon.edu/~millerm/conjN1.html

Normal Fault Scarps, Turkey
www.msnucleus.org/.../pt/hazards/4/pth4_1a.html

CLASSIFICATION of DIP-SLIP FAULTS

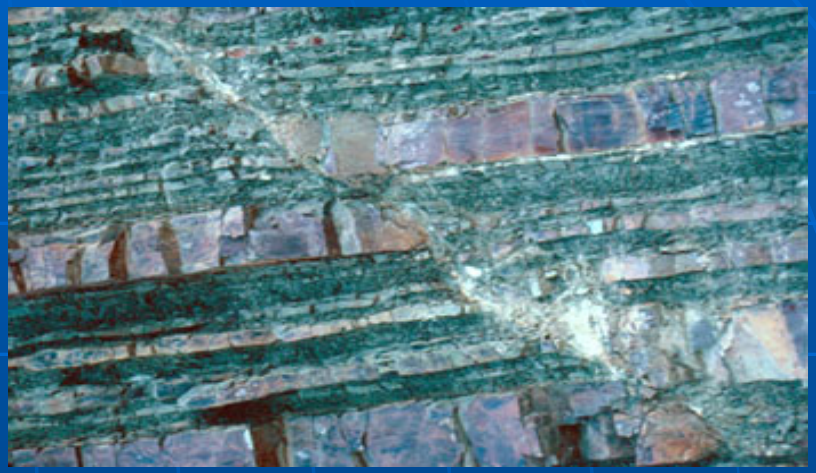
- THRUST or REVERSE FAULTS: Dip-slip faults on which the hanging wall moves up relative to the footwall
  - Place older rocks on younger rocks
  - Form in regions of lateral compression



www.data.scec.org/Module/footnt02.html

EXAMPLES OF THRUST FAULTS

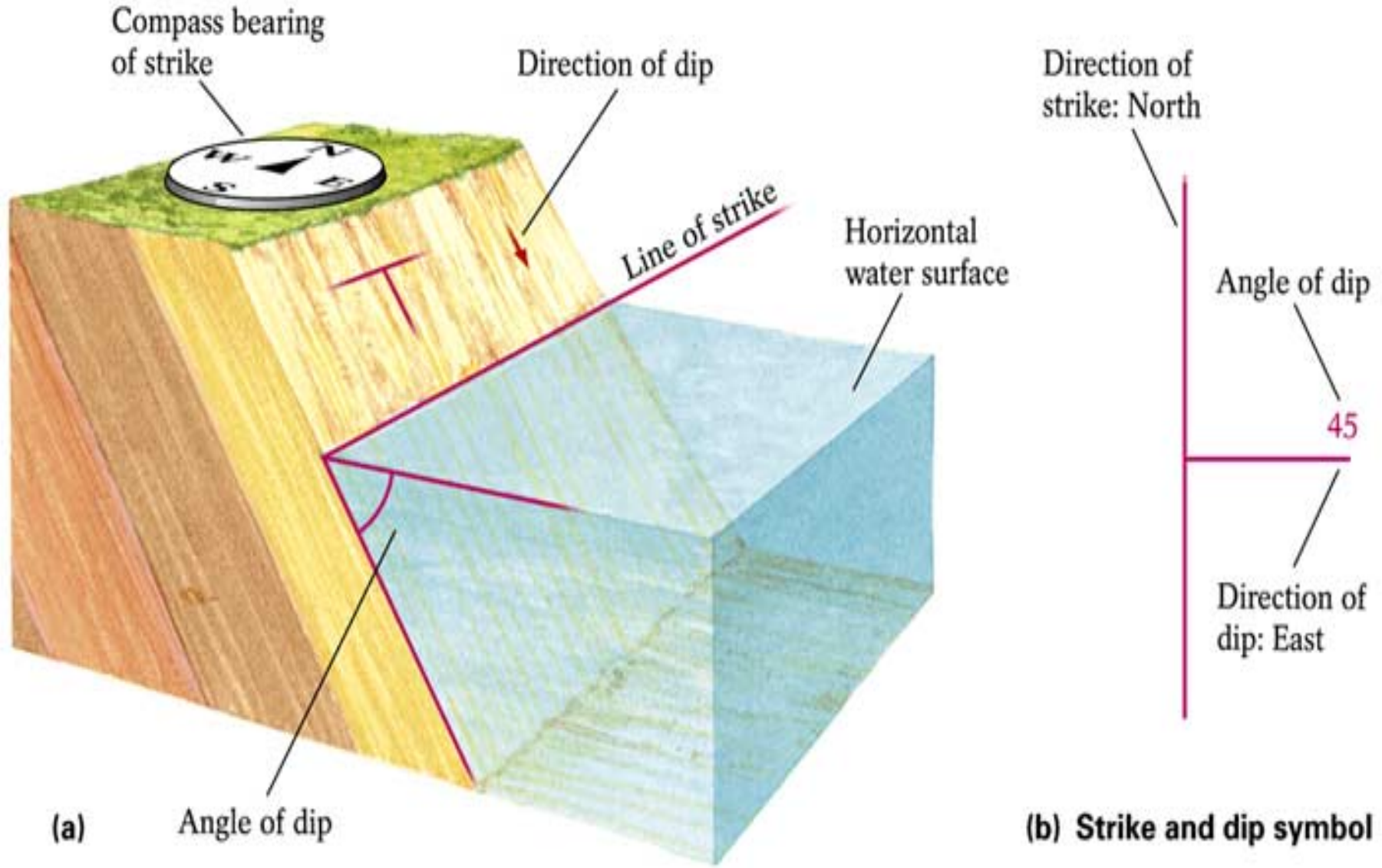
Outcrop scale thrust faults
www.pitt.edu/.../7Structures/ReverseFaults.html



Thrust Fault in Concrete from 1964 Quake, Anchorage, Alaska
www.ucmp.berkeley.edu/.../alaska/0709log.html

Thrust Fault in Sediments
www001.upp.so-net.ne.jp/fl-fg/05-01.htm

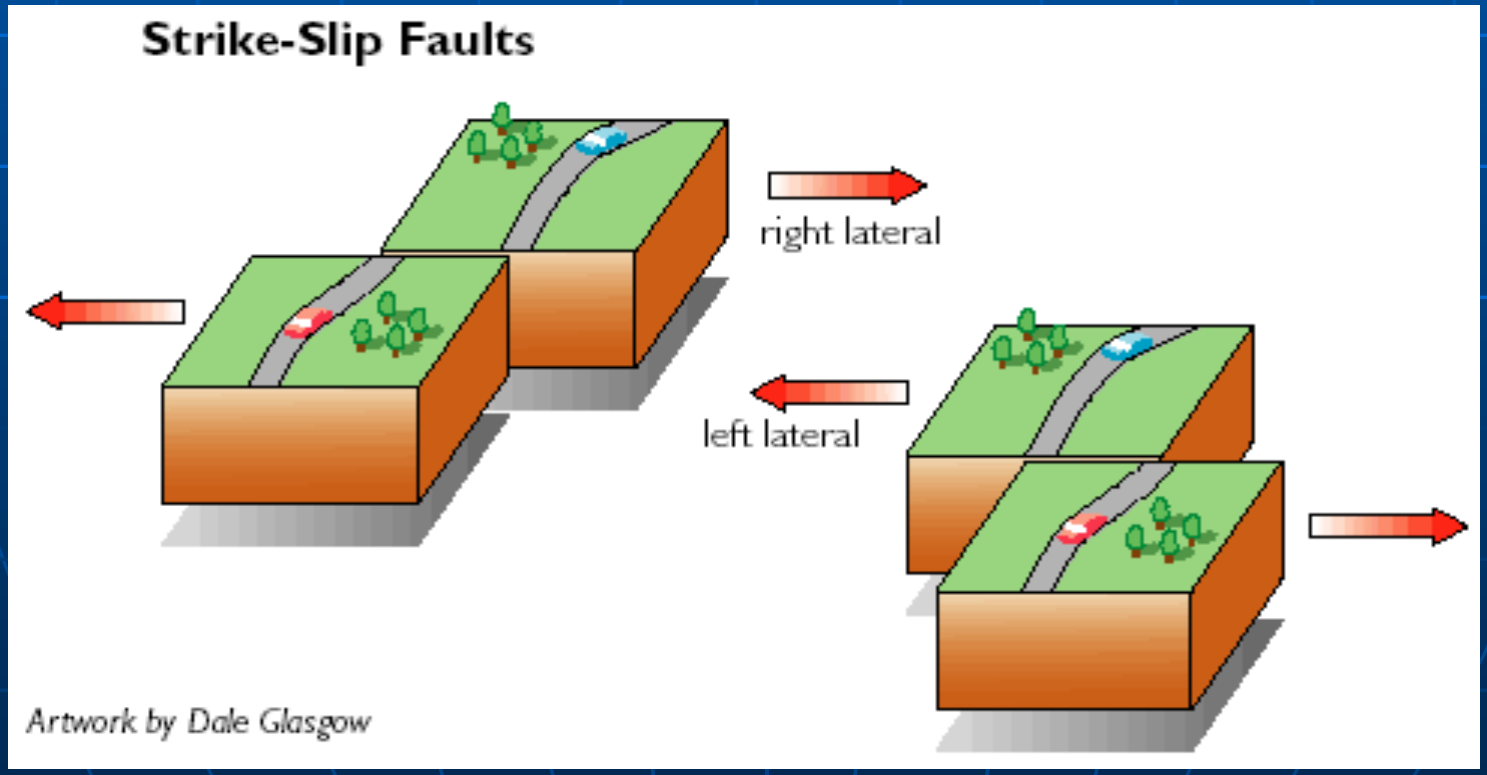
Strike and Dip



CLASSIFICATION of STRIKE-SLIP FAULTS

- RIGHT-LATERAL (DEXTRAL) FAULTS: Strike-slip faults across which the block moves to the right

- LEFT-LATERAL (SINISTRAL) FAULTS: Strike-slip faults across which the block moves to the right



EXAMPLES OF STRIKE-SLIP FAULTS

San Andreas Fault, CA
http://education.usgs.gov/california/pp1515/chapter2/fig2-21.jpg

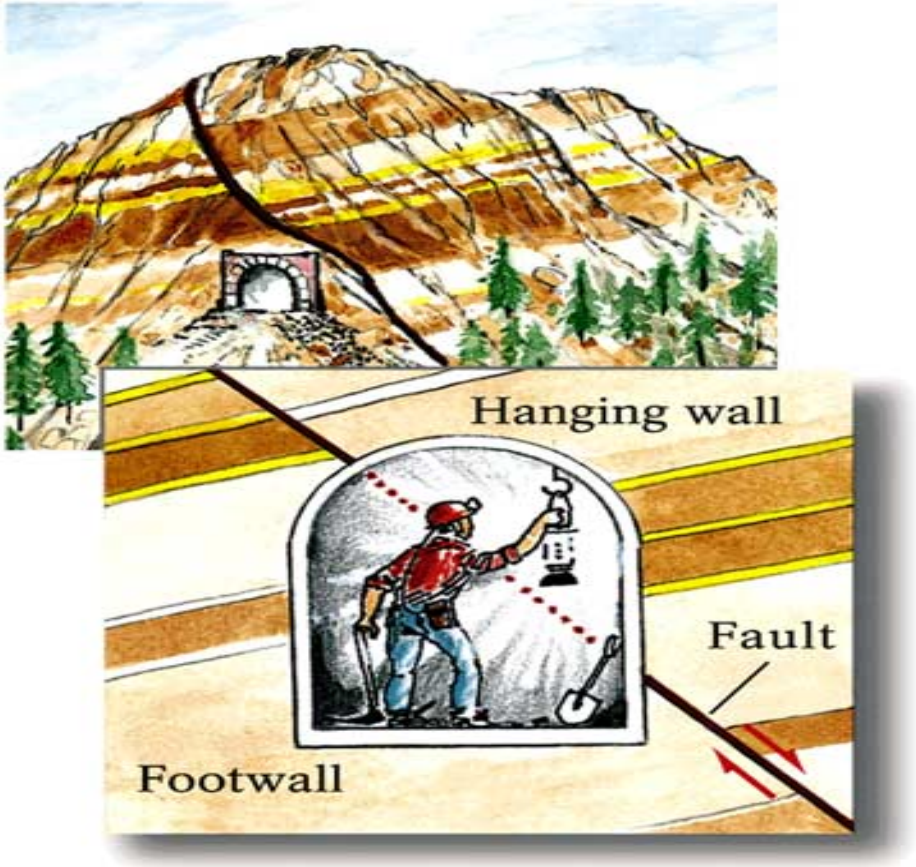
Right Lateral Fault in Asphalt
www.uwsp.edu/.../fault_transform_photo.html

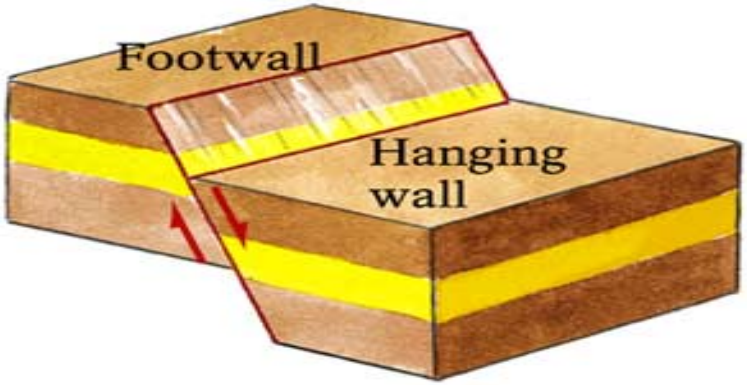
Right Lateral Slip, Izmit, Turkey, 1999 Quake
http://www.geo.uib.no/jordskjelv/index.php?topic=earthquakes&lang=en

Fault Type 1 - Dip-slip faults

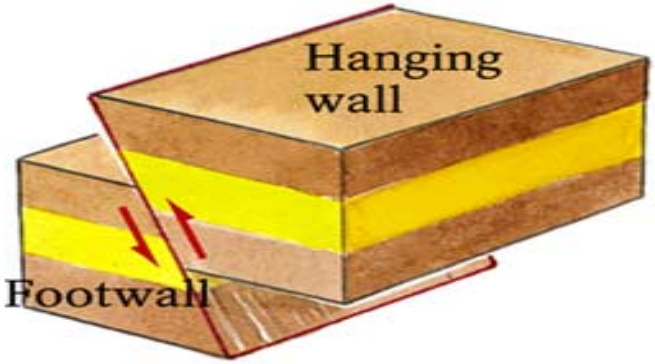
1) Terms: Hanging wall and footwall
2) Normal faults
   (a) Grabens
   (b) Horsts
3) Reverse faults
   a) low angle called Thrust faults
4) Oblique-slip faults

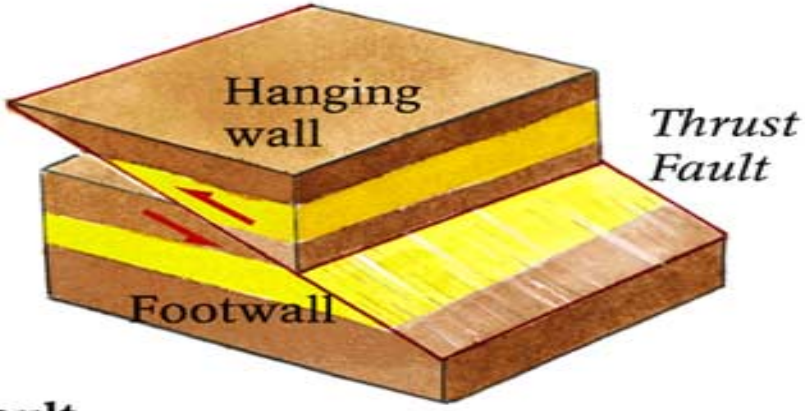
Dip-Slip Faults



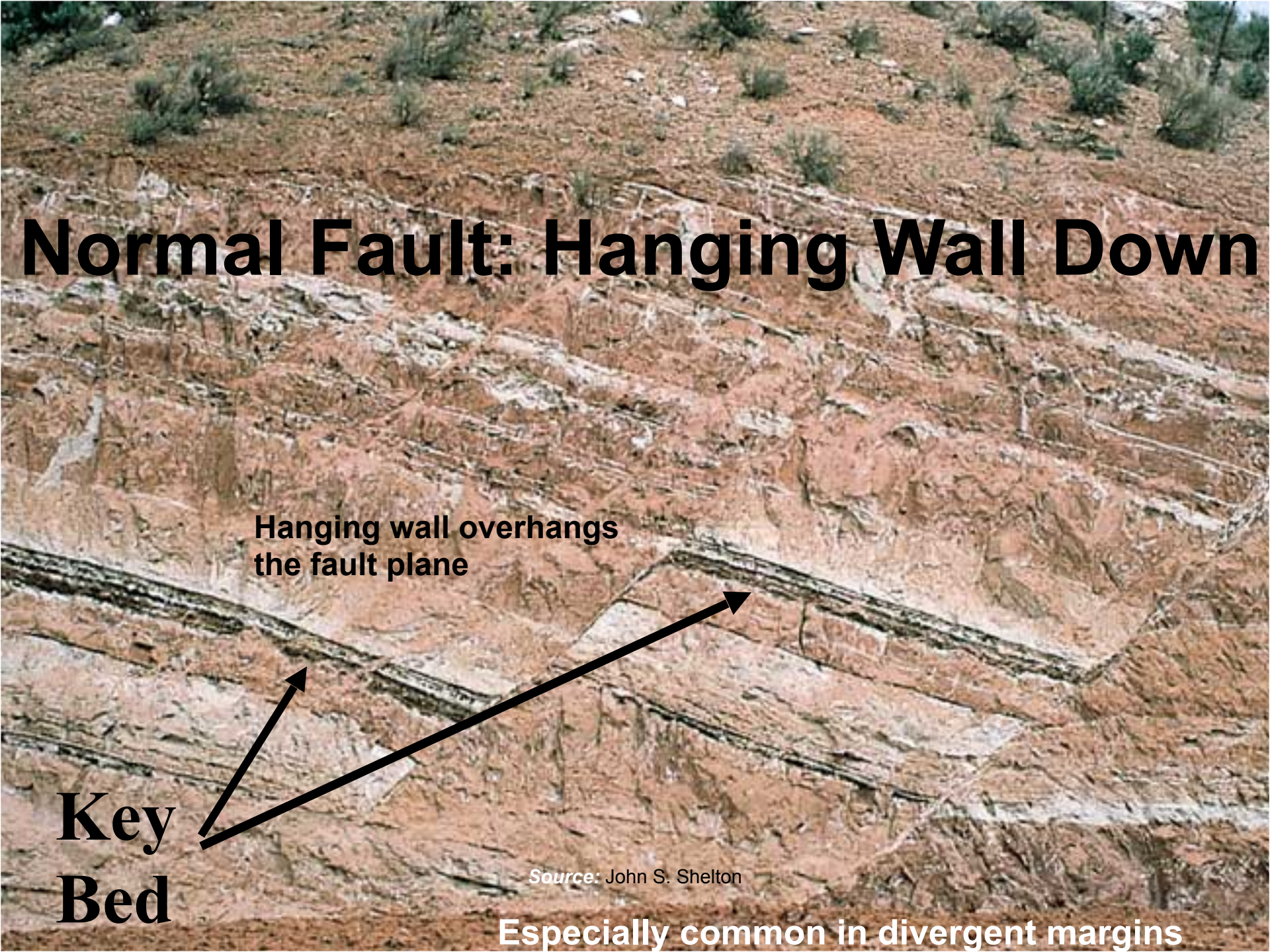


Normal Fault

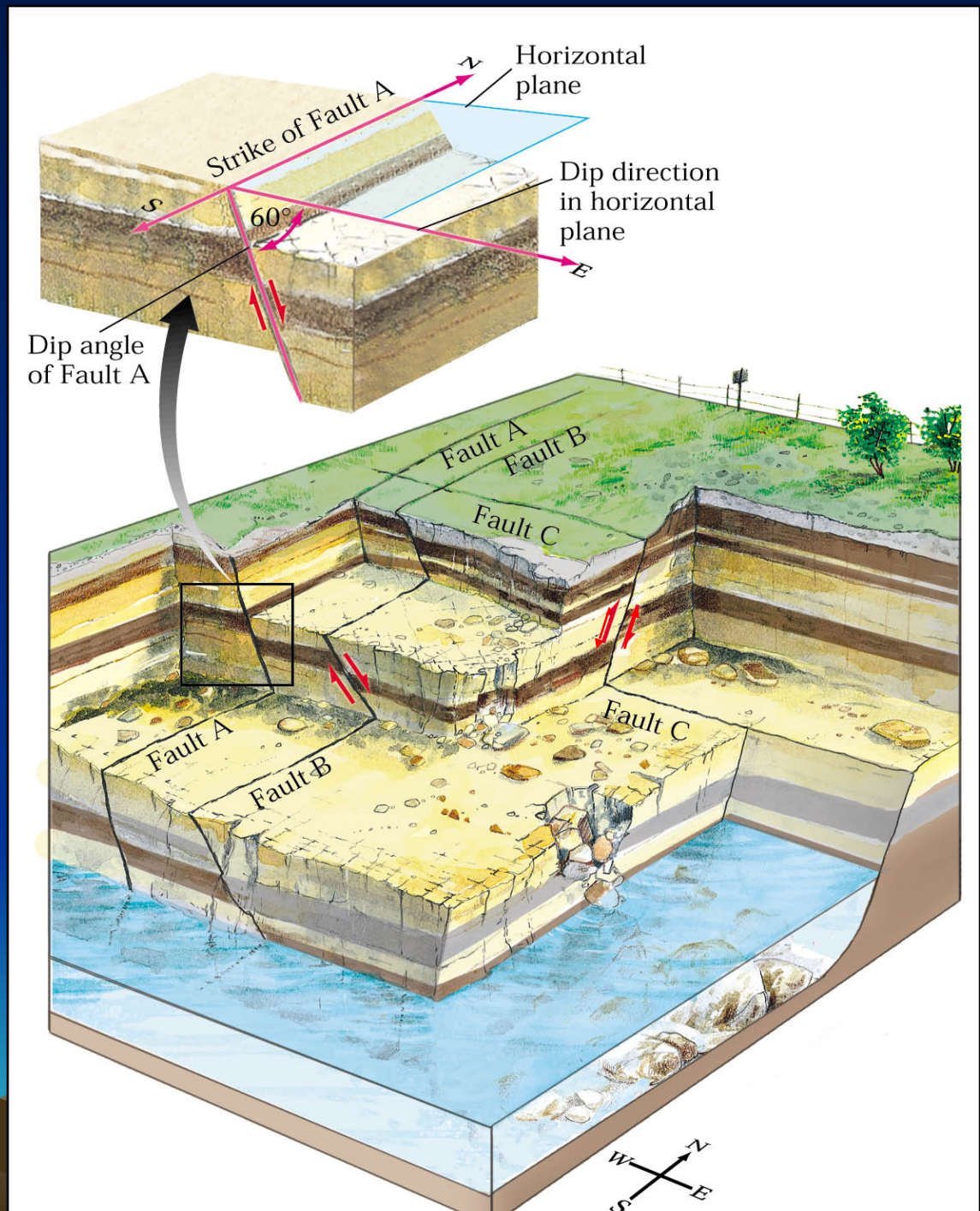




Reverse Fault


Normal Fault: Hanging Wall Down
Hanging wall overhangs
the fault plane
Key
Bed
Source: John S. Shelton
Especially common in divergent margins

Normal Fault (Hanging Wall down)



Reverse Fault

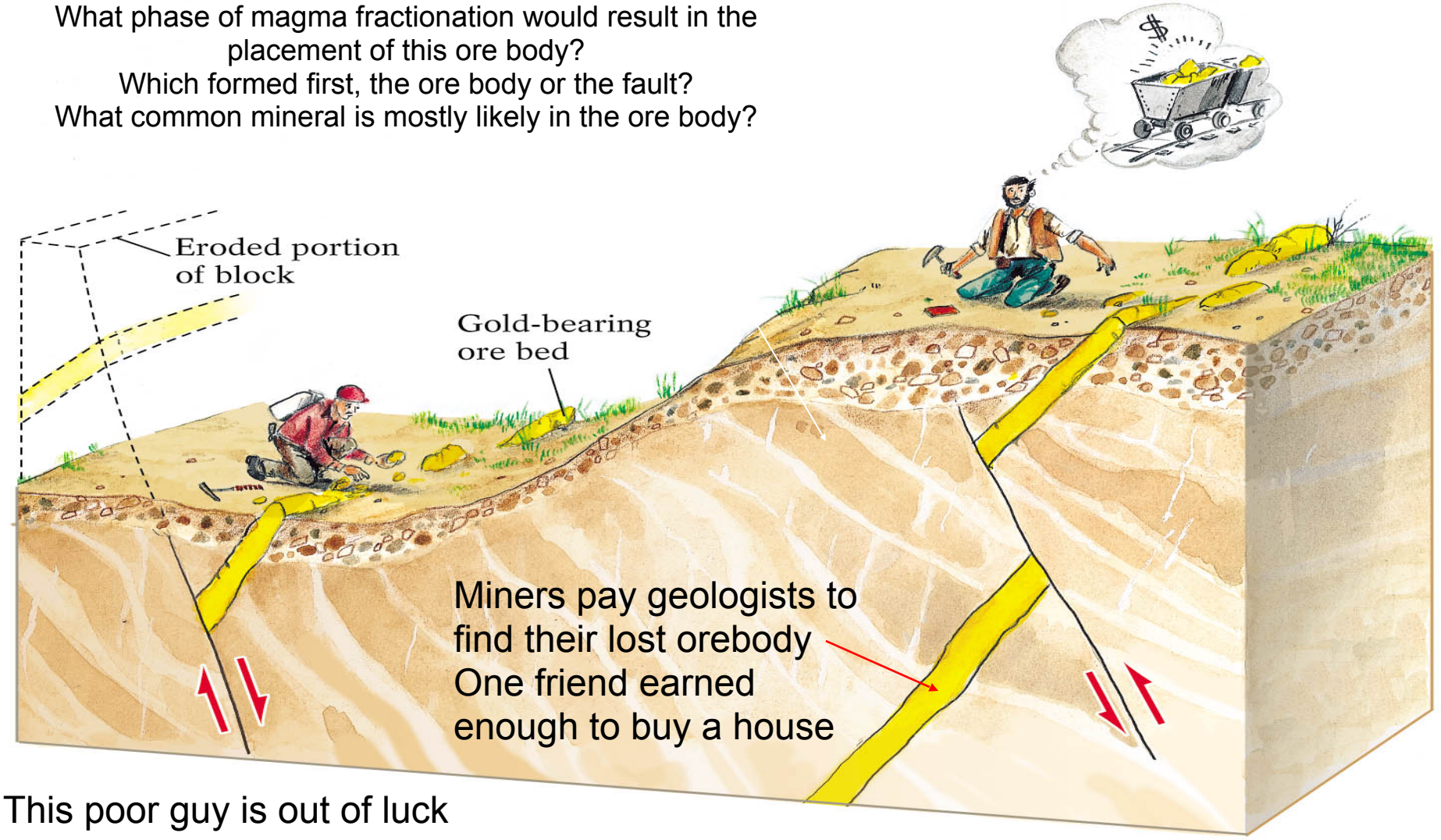
(called “Thrust Fault” if shallow angle)

Typical of convergent margins

Structural Geology is taught by Dr. Krall

(Hanging wall Up)

What phase of magma fractionation would result in the placement of this ore body?
Which formed first, the ore body or the fault?
What common mineral is mostly likely in the ore body?



This poor guy is out of luck

Evidence of faults

a) Visible displacement of rocks

b) Pulverised rock and “Slickensides”

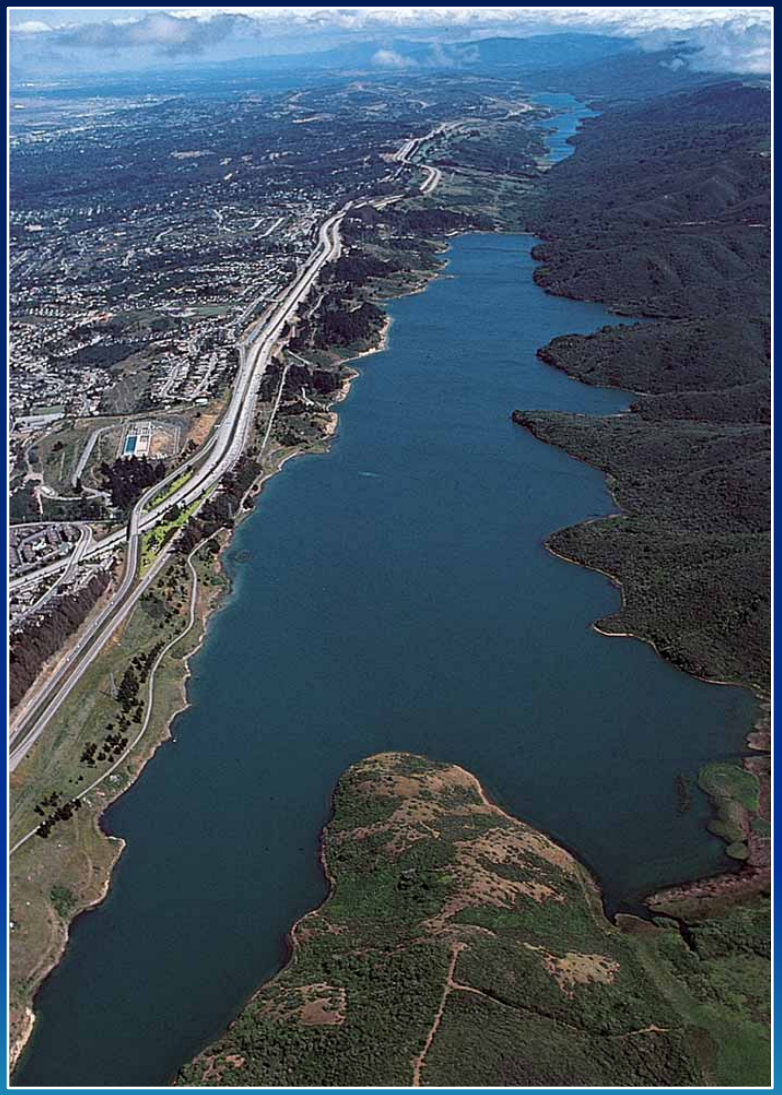
c) Key beds cut out by faulting reappear elsewhere.

Types of Faults - 2

- Strike-slip faults 1

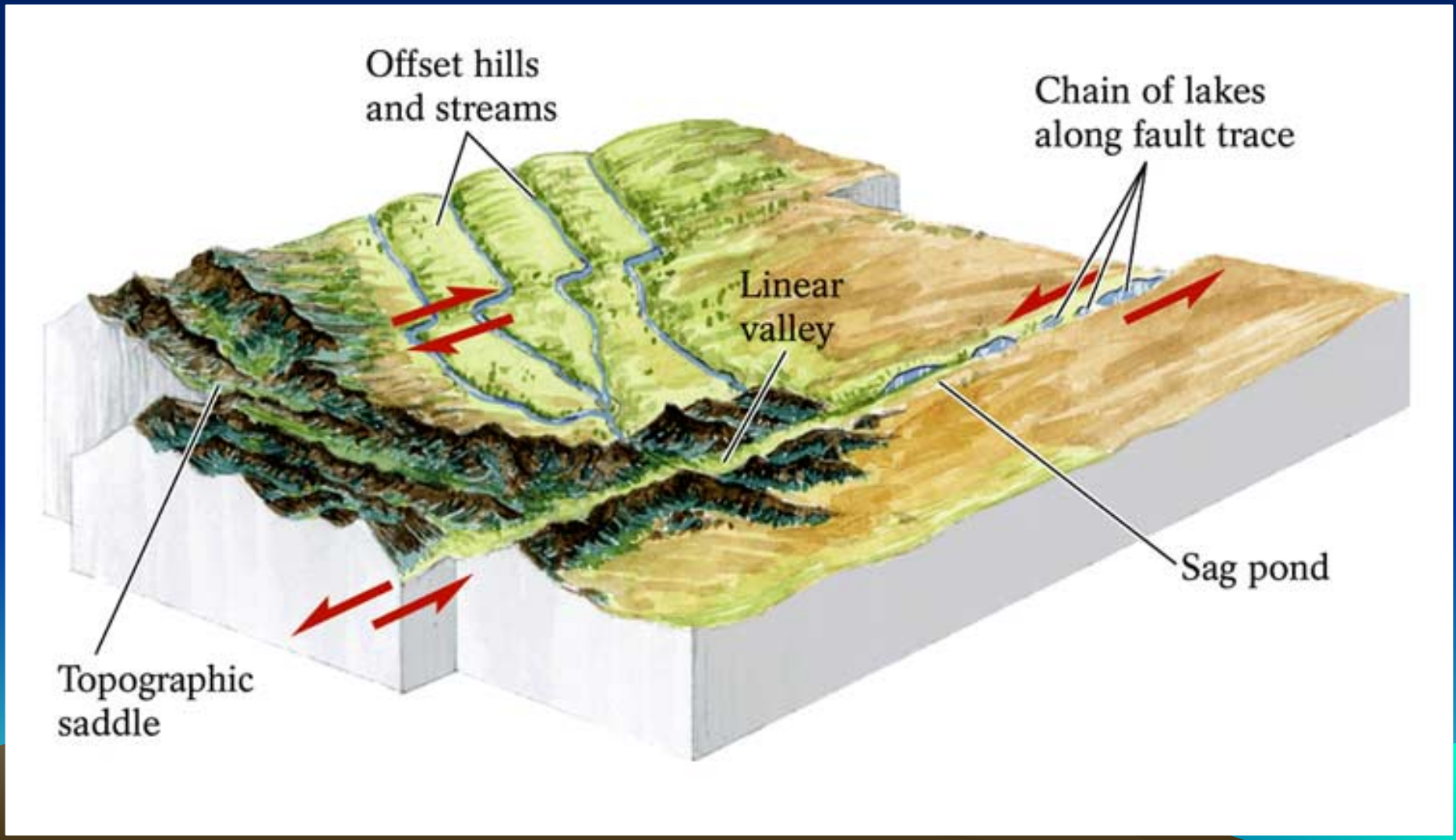
1) Example: San Andreas Transform fault
2) Distinctive landforms (linear valleys, chains of lakes, sag ponds, topographic saddles)
3) Fresh pulverised rock. Transform fault through granite: Arkose sandstone
4) Evidence of Shear stress

San Andreas Fault

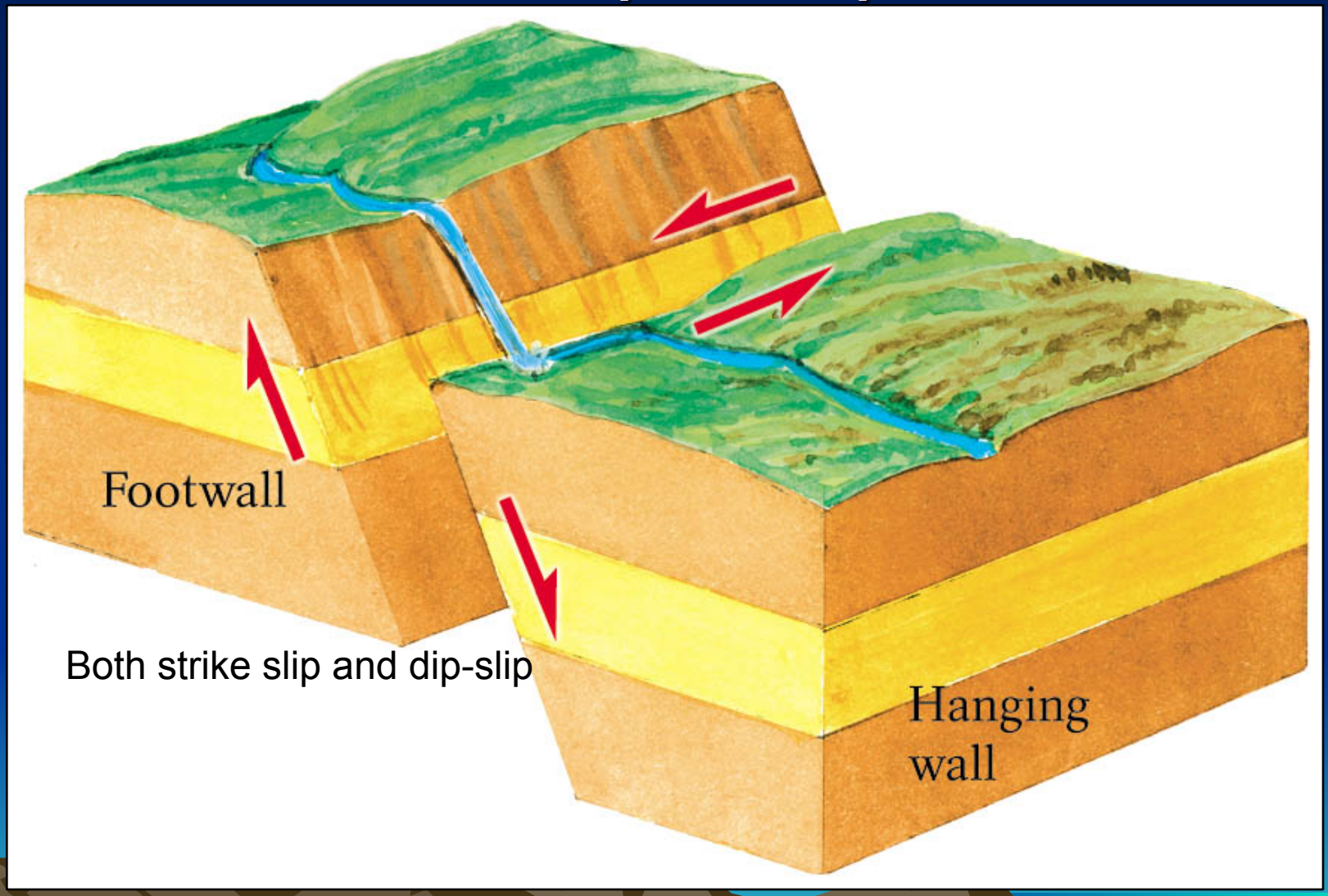


Source: Georg Gerster/Wingstock/Comstock

Horizontal Movement Along Strike-Slip Fault



Oblique Slip



Both strike slip and dip-slip

Also seen in Transform Faults such as San Andreas

Types of faults

- Strike-slip faults 2

1) Example: Mid-Ocean Ridge Transform faults
2) Small offsets in ridge

3) San Andreas is also ridge offset,
   but on a huge scale with a historical twist

Faults & Plate Tectonics

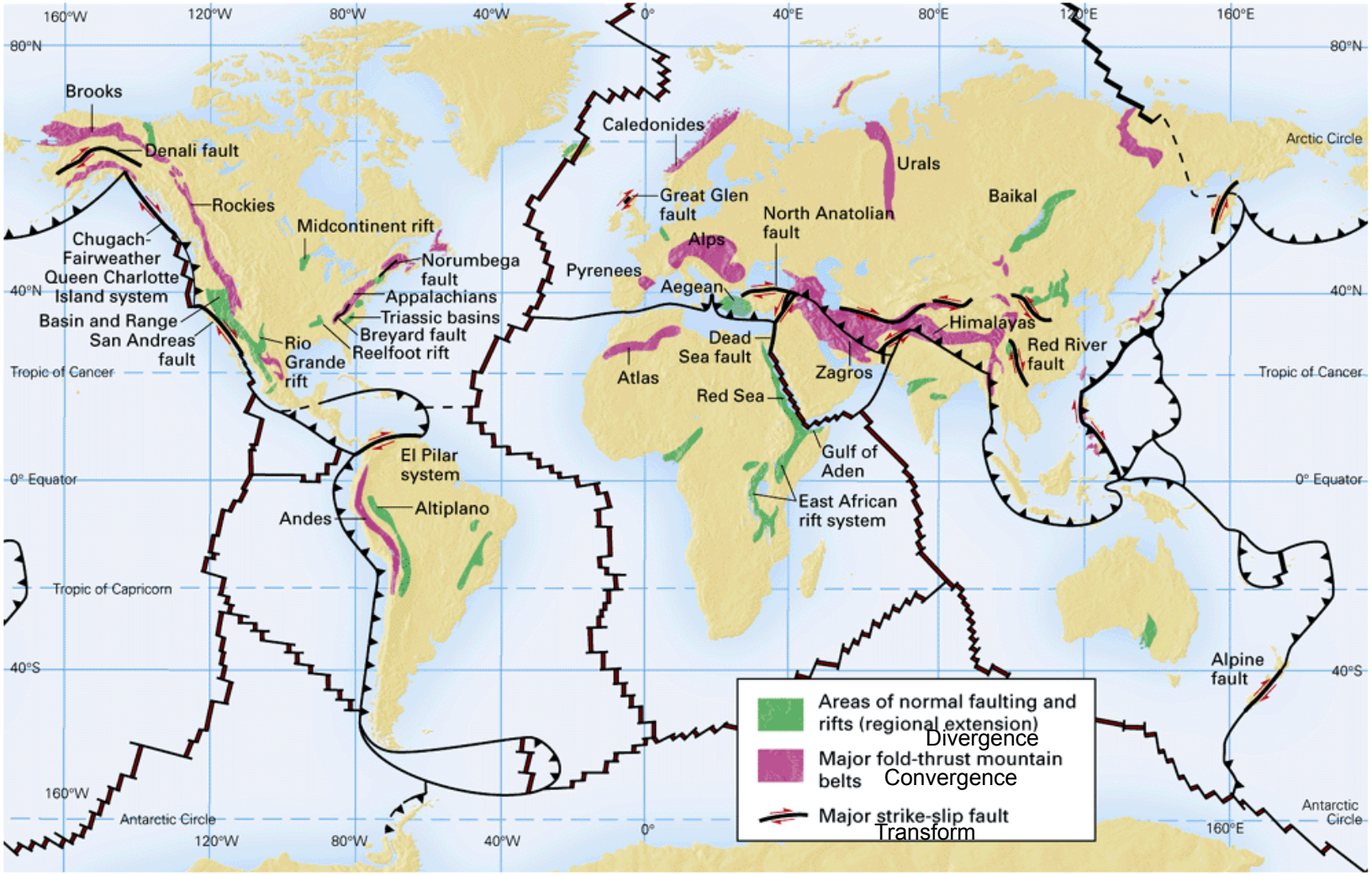


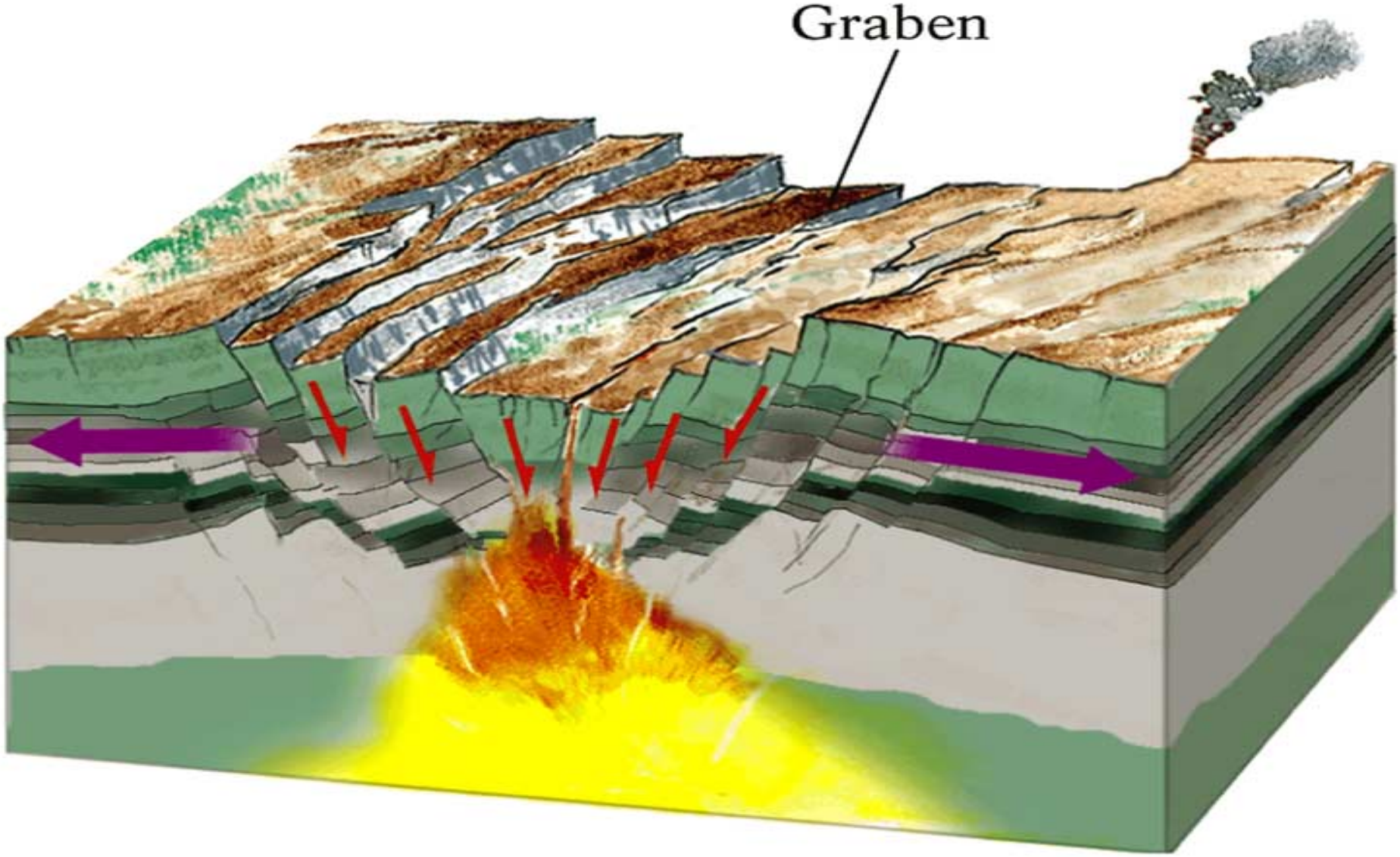
Plate tectonics and faulting

- Normal faults: mid-ocean ridges and continental rifts are the same thing.

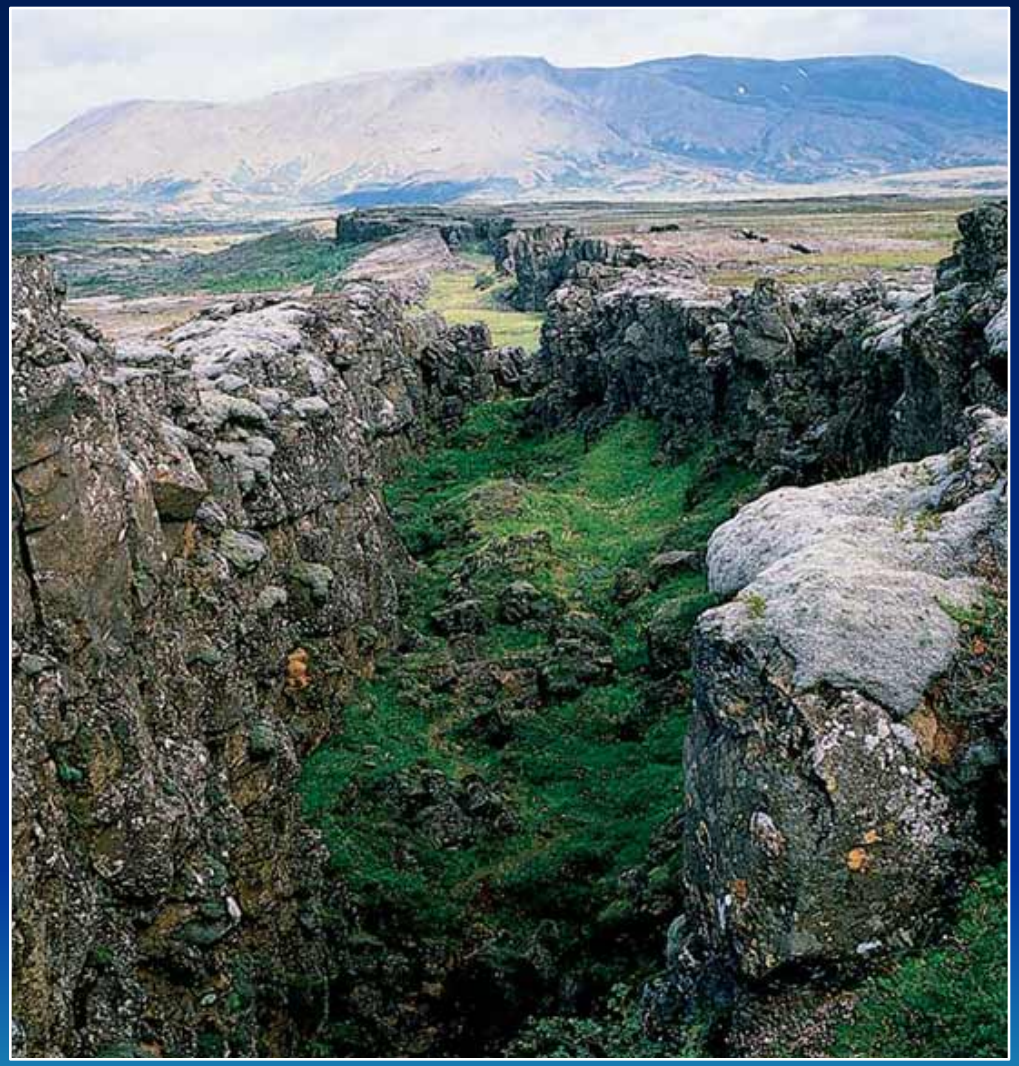
- Divergent Margins
  - Surface rock is pulled apart
  - Hanging wall drops down

Horst and Graben Formation

Horst and Graben Formation



Graben in Iceland

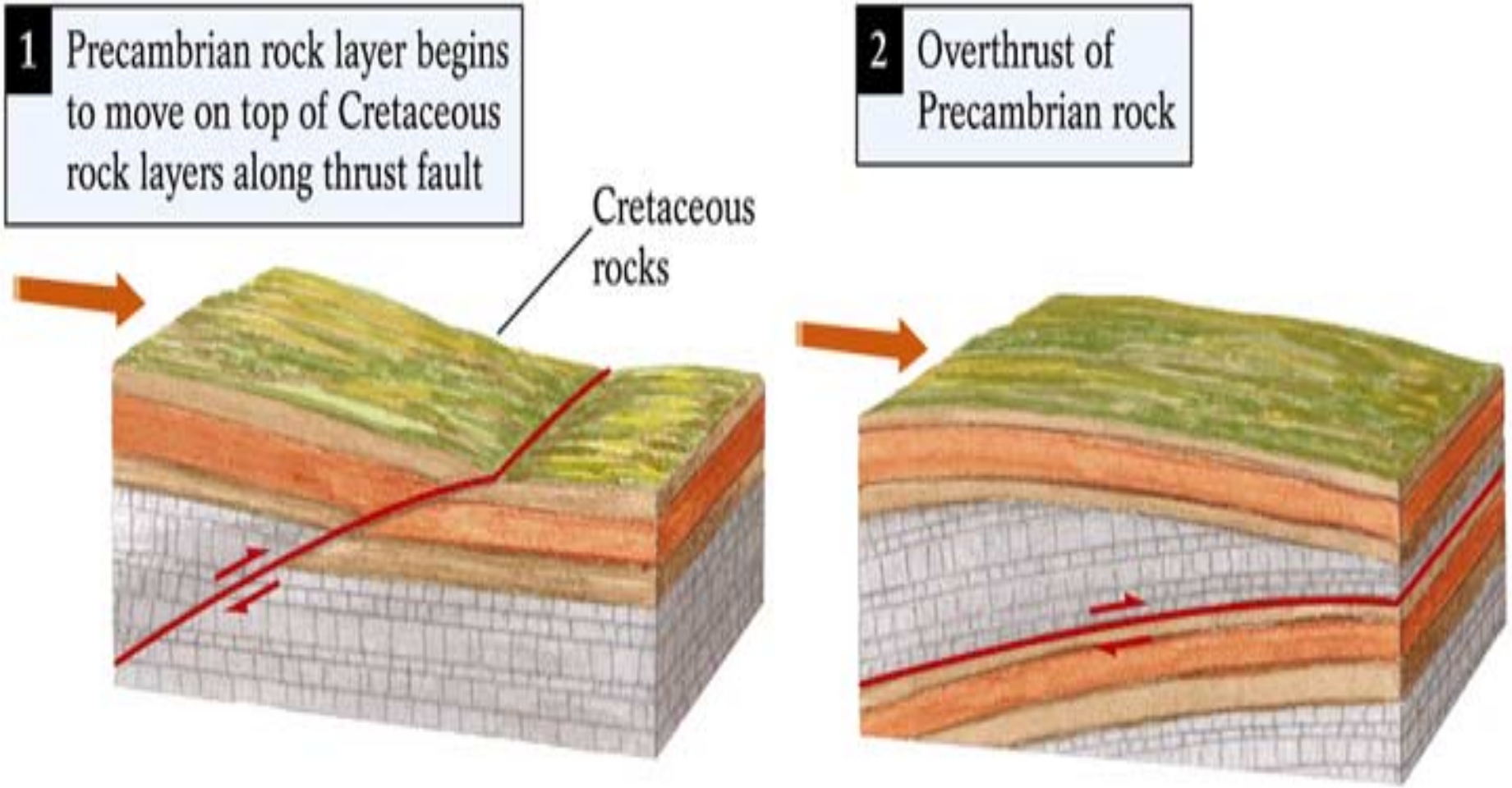


Source: Simon Fraser/Science Photo Library/Photo Researchers, Inc.

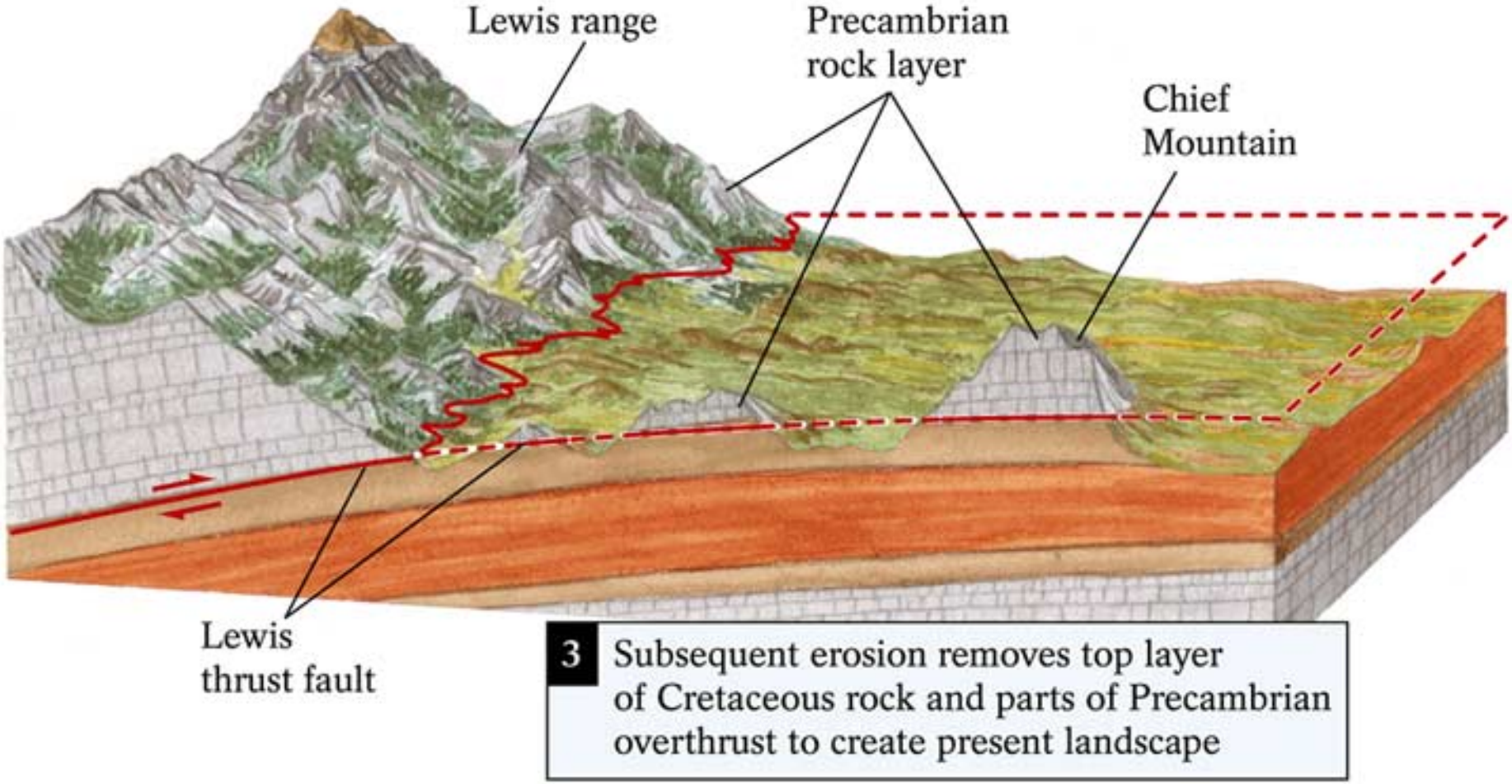
Plate tectonics and faulting

- Reverse and thrust faults: convergent plate boundaries
- Hanging Wall is pushed up.

Lewis Thrust Fault



Lewis Thrust Fault (cont'd)



Lewis Thrust Fault (cont'd)

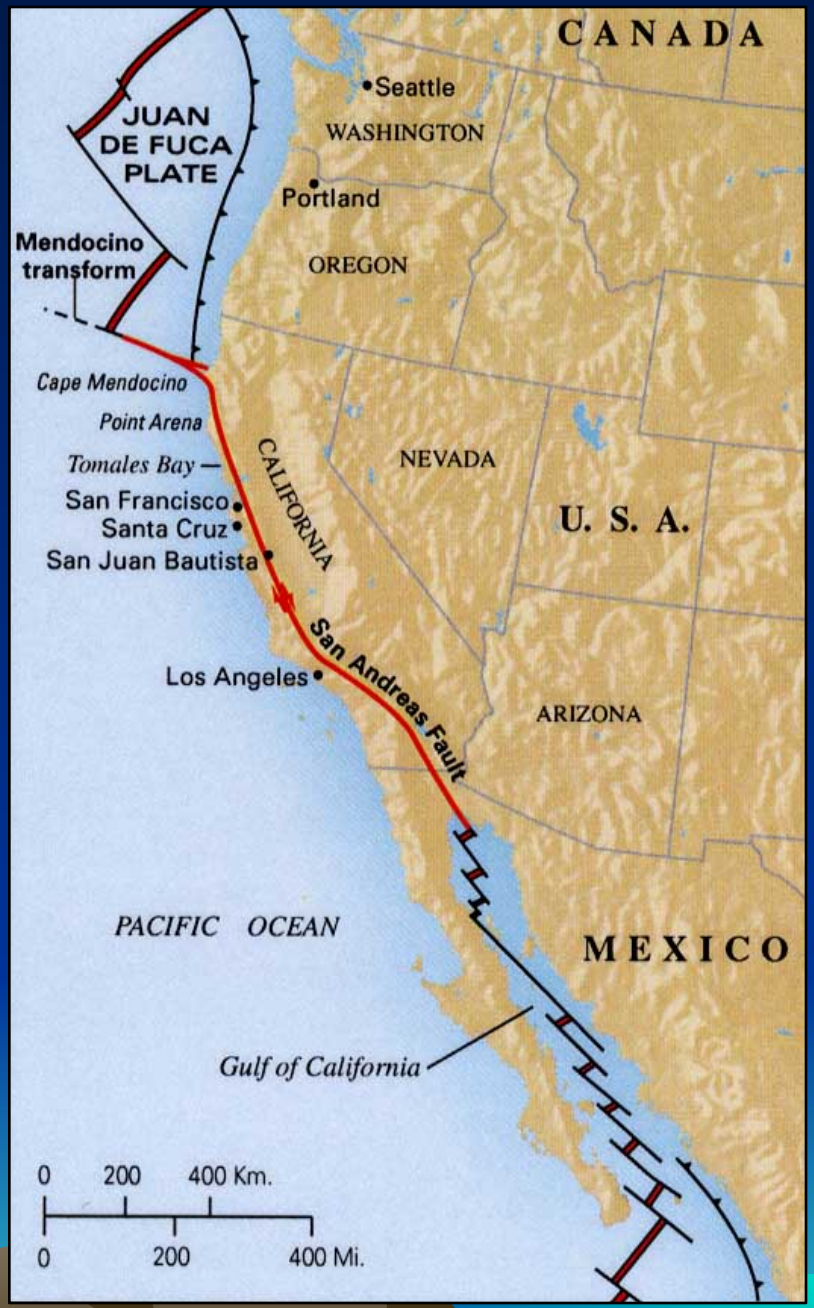
Source: Breck P. Kent

PreCambrian Limestone over Cretaceous Shales

Plate tectonics and faulting

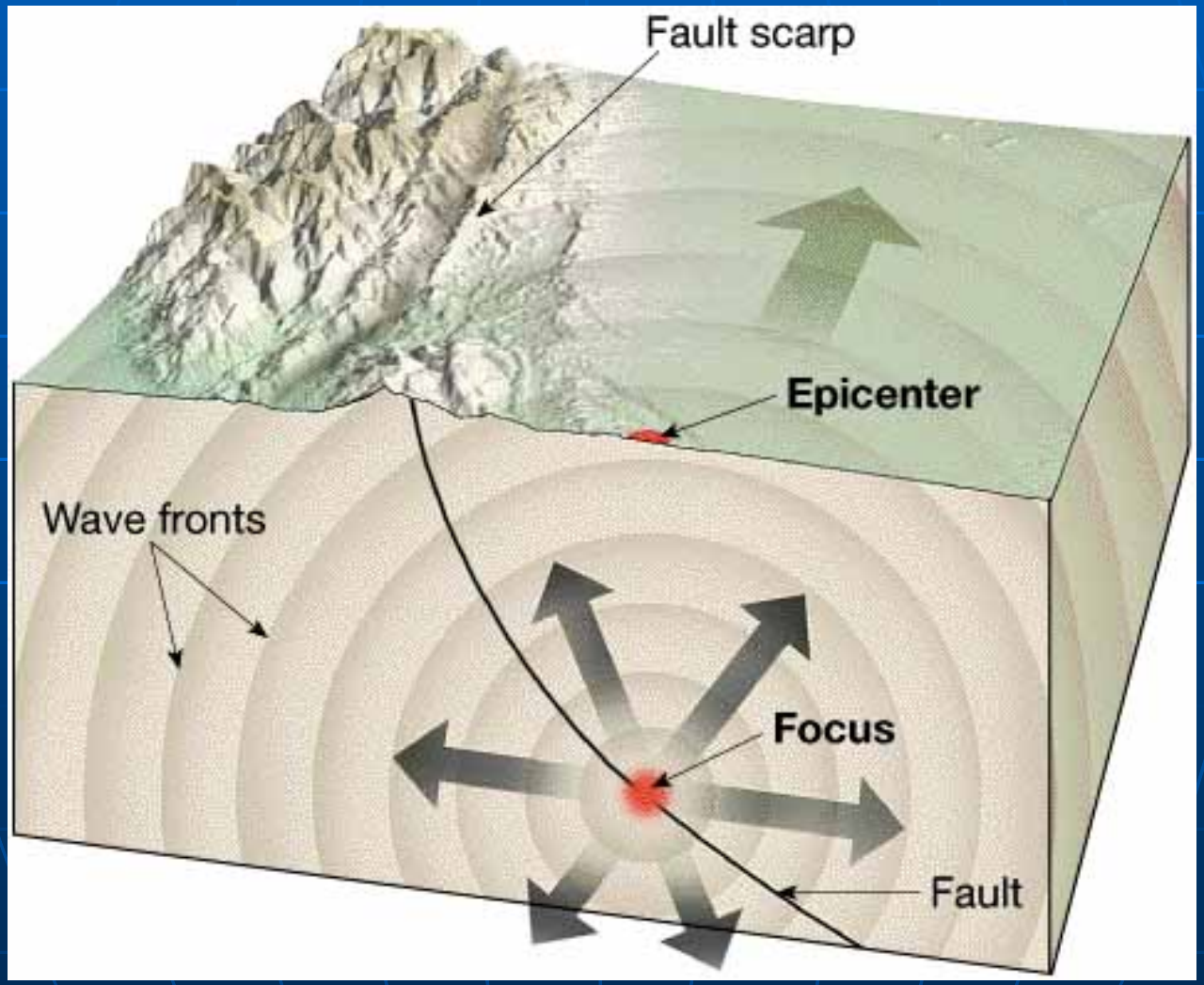
- c) Strike-slip faults: Transform Boundaries

San Andreas Fault

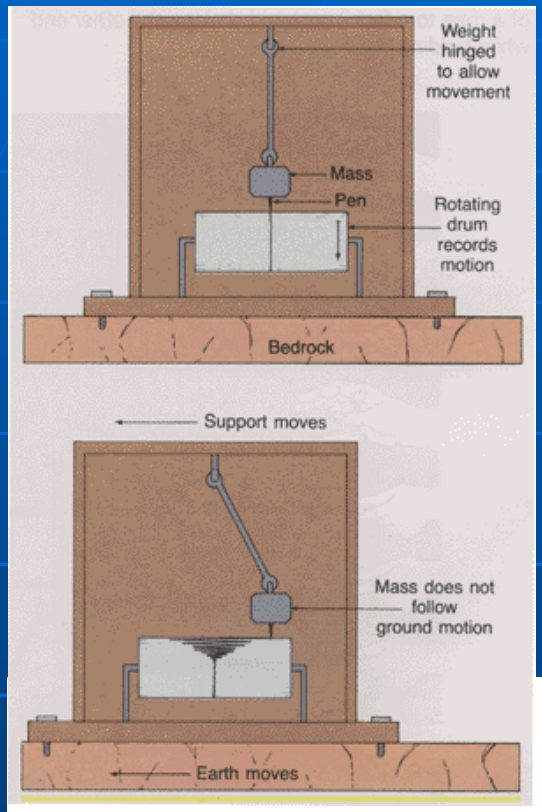


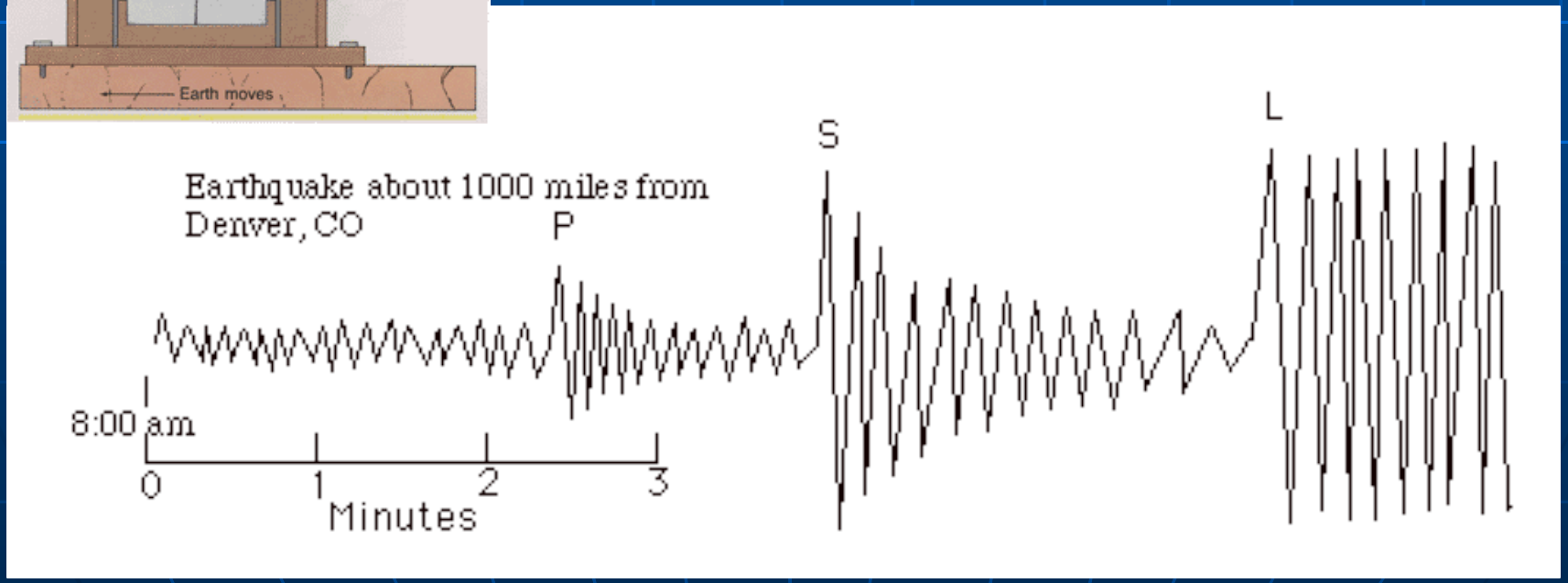
Faults and Earthquakes

Epicenter and Focus

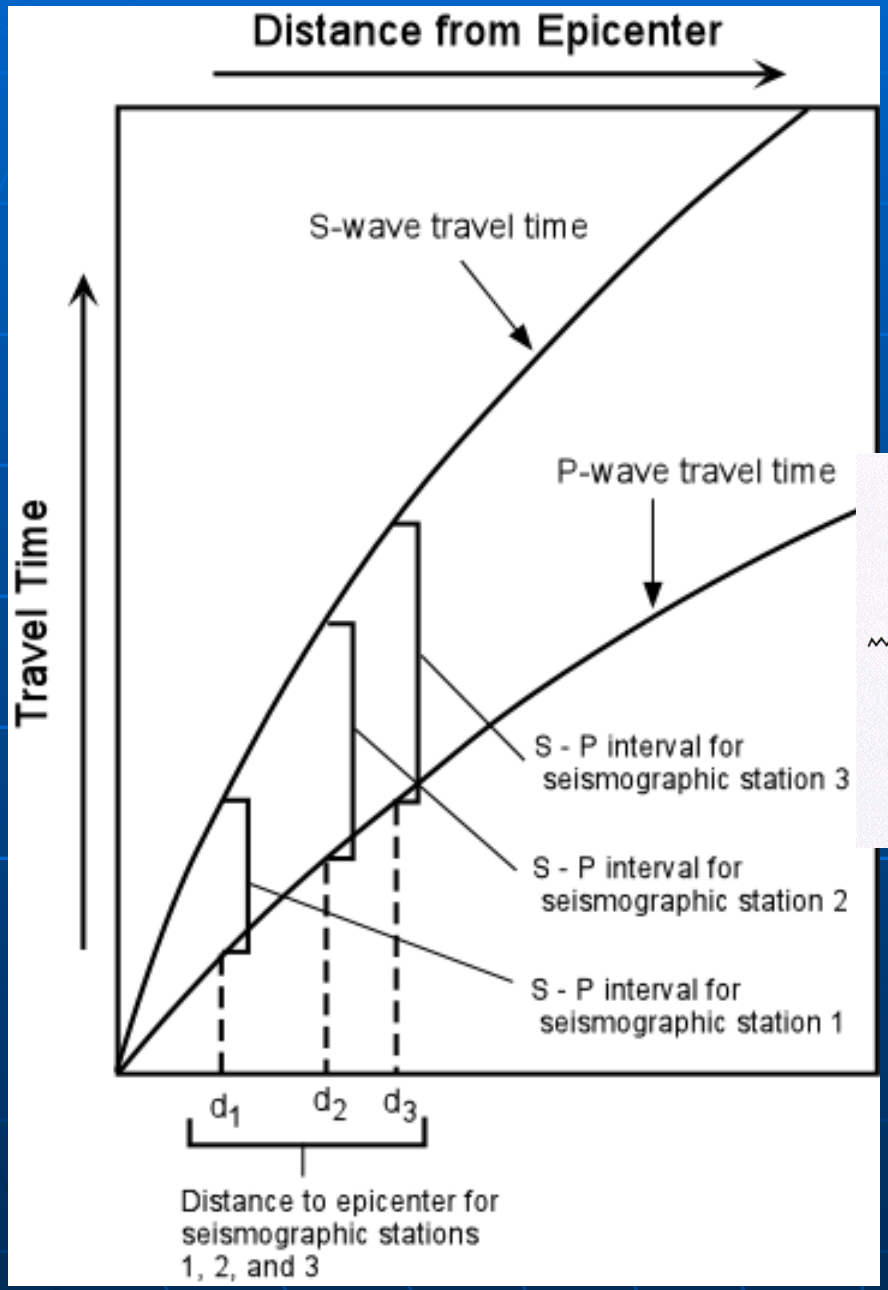


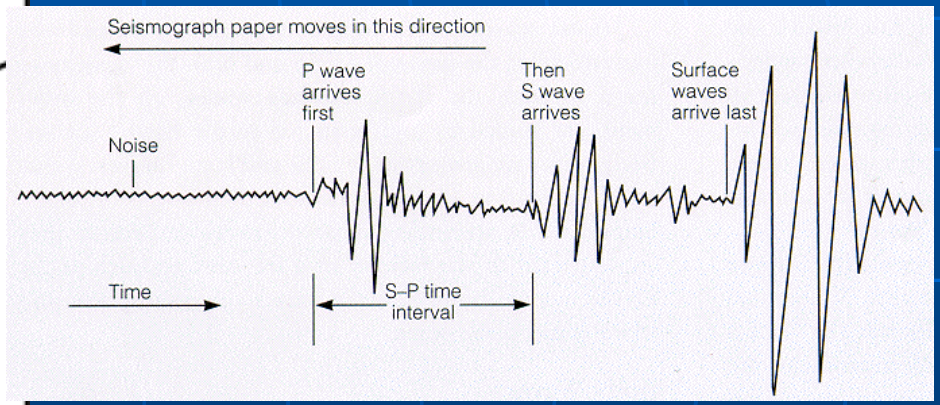
Seismograph and Seismogram



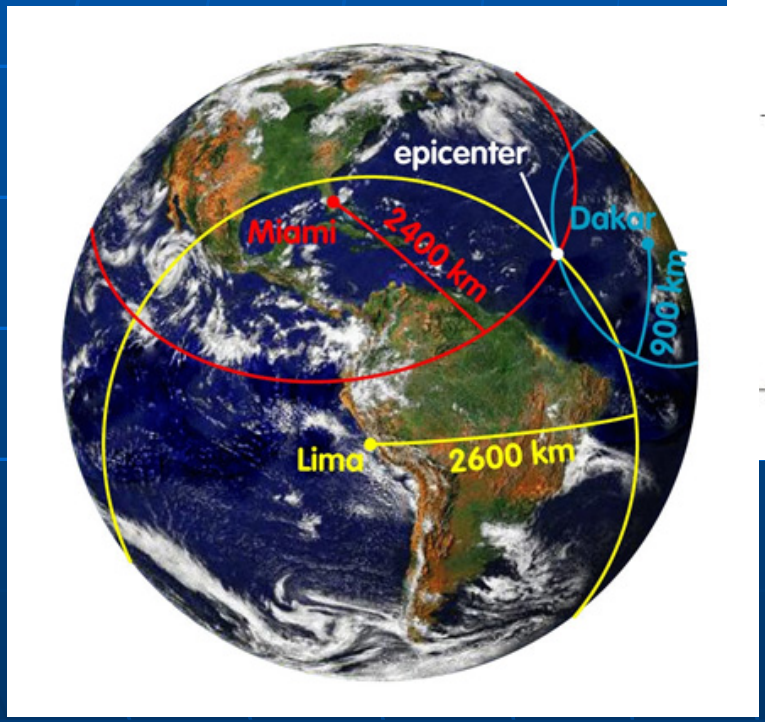


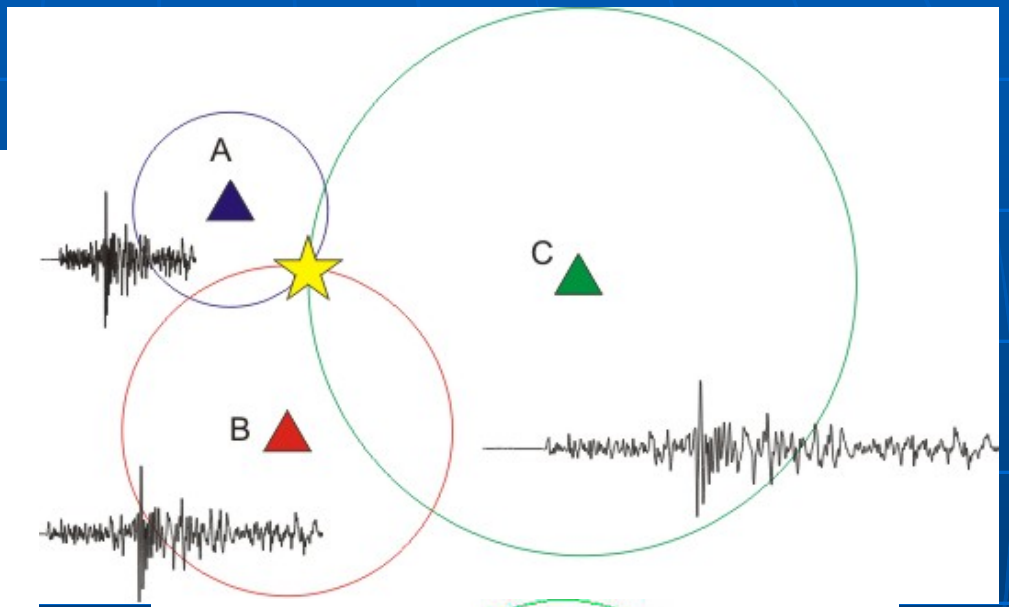
Determining Earthquake Distance

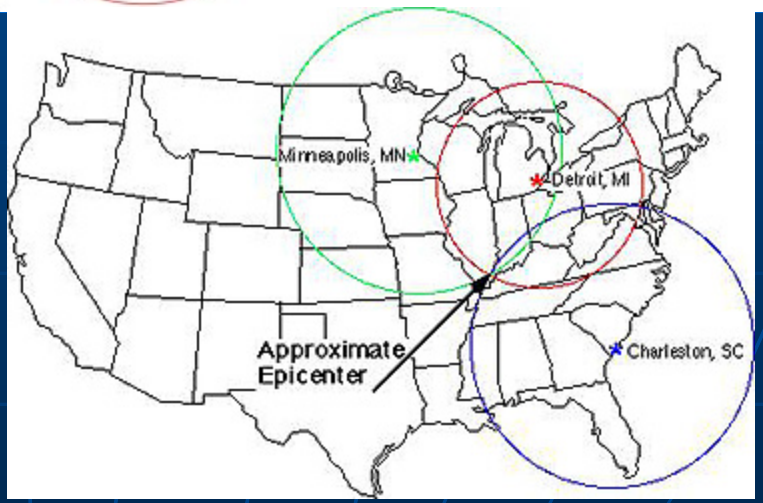




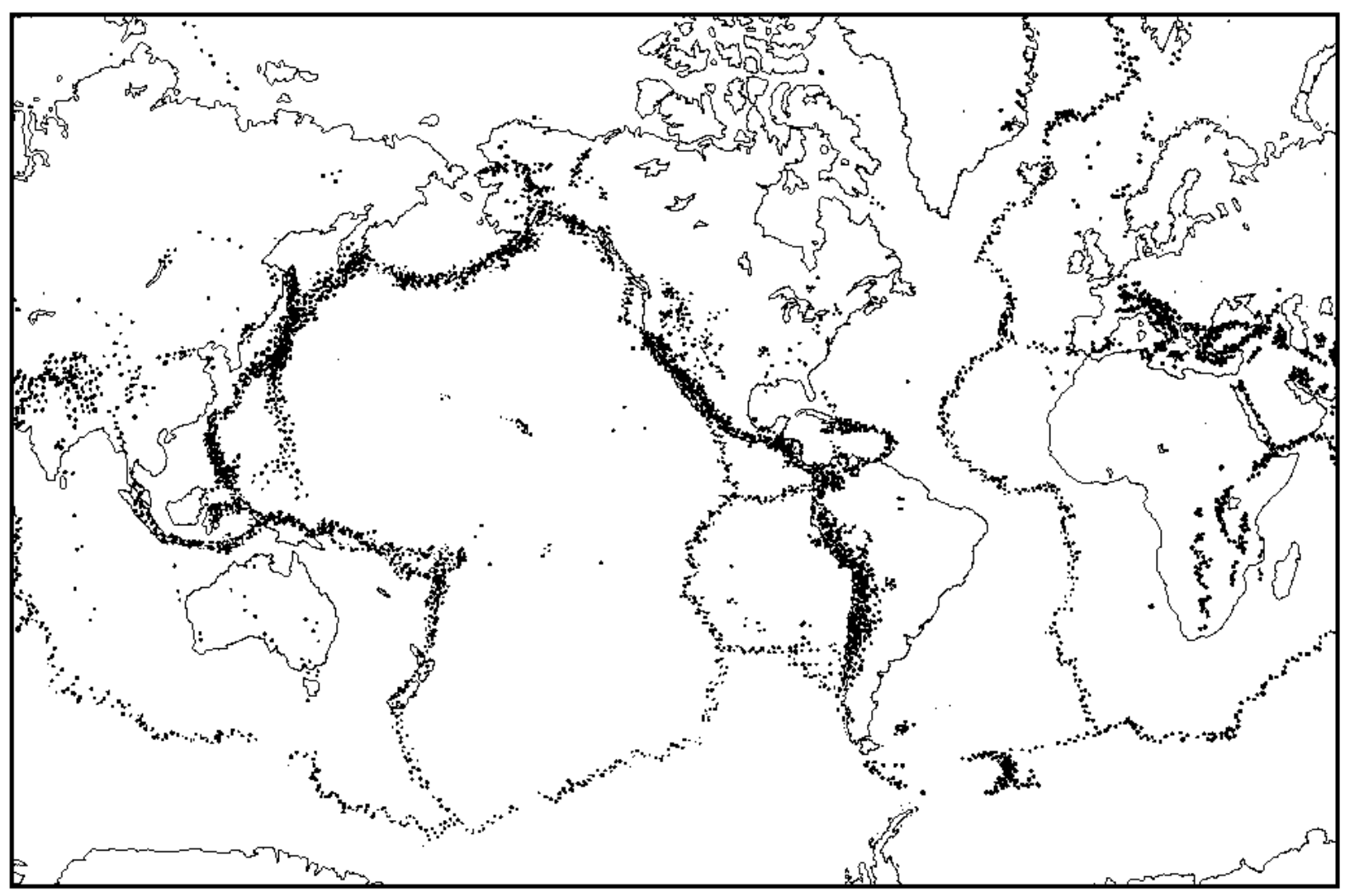
Locating an Epicenter



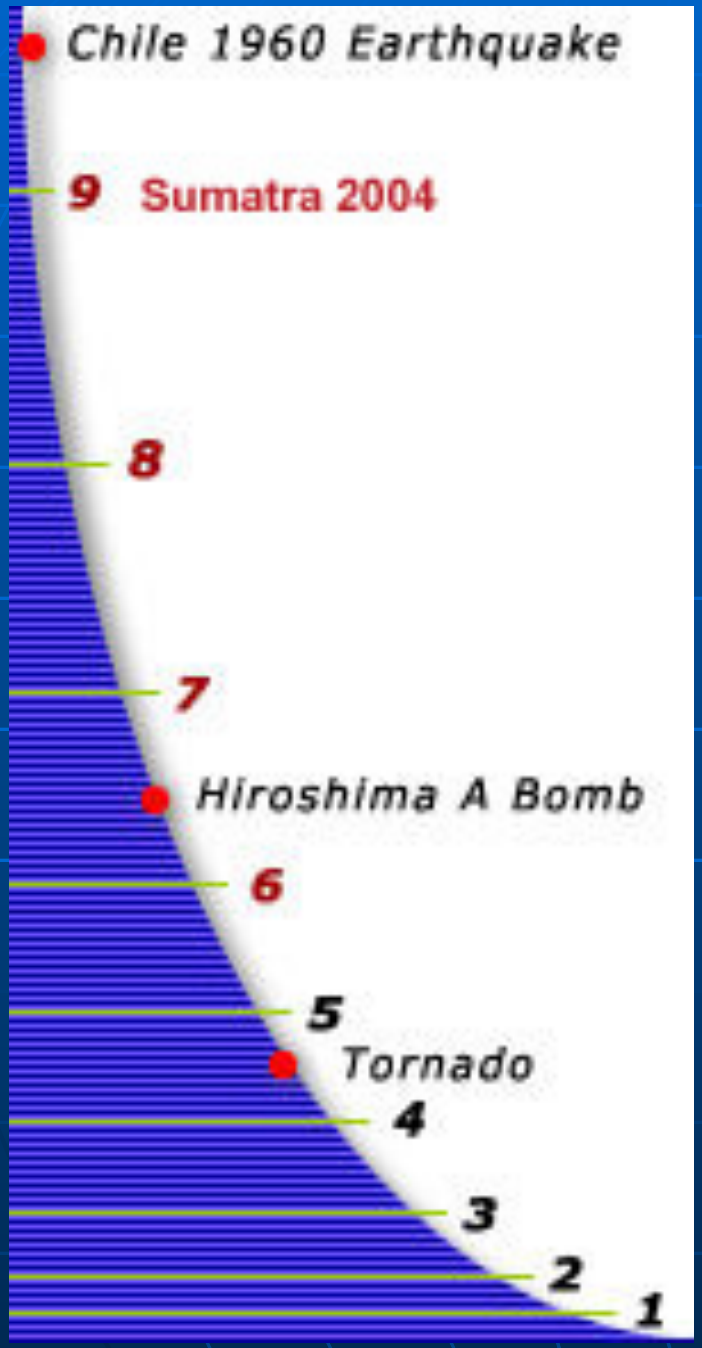


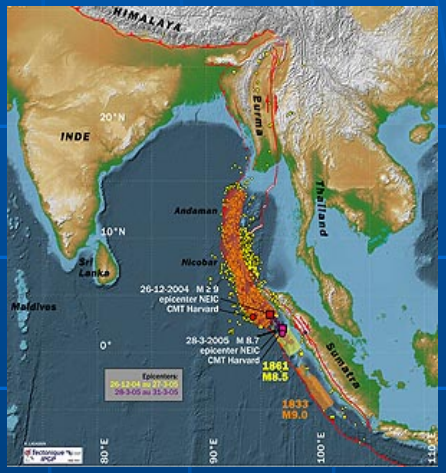


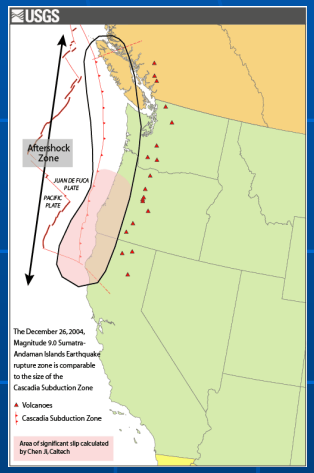
Global Seismicity

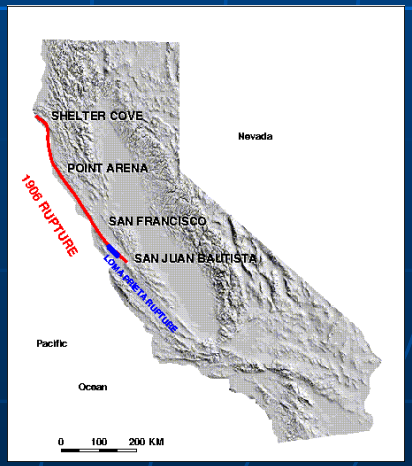


Richter Scale… A Measure of Earthquake Size

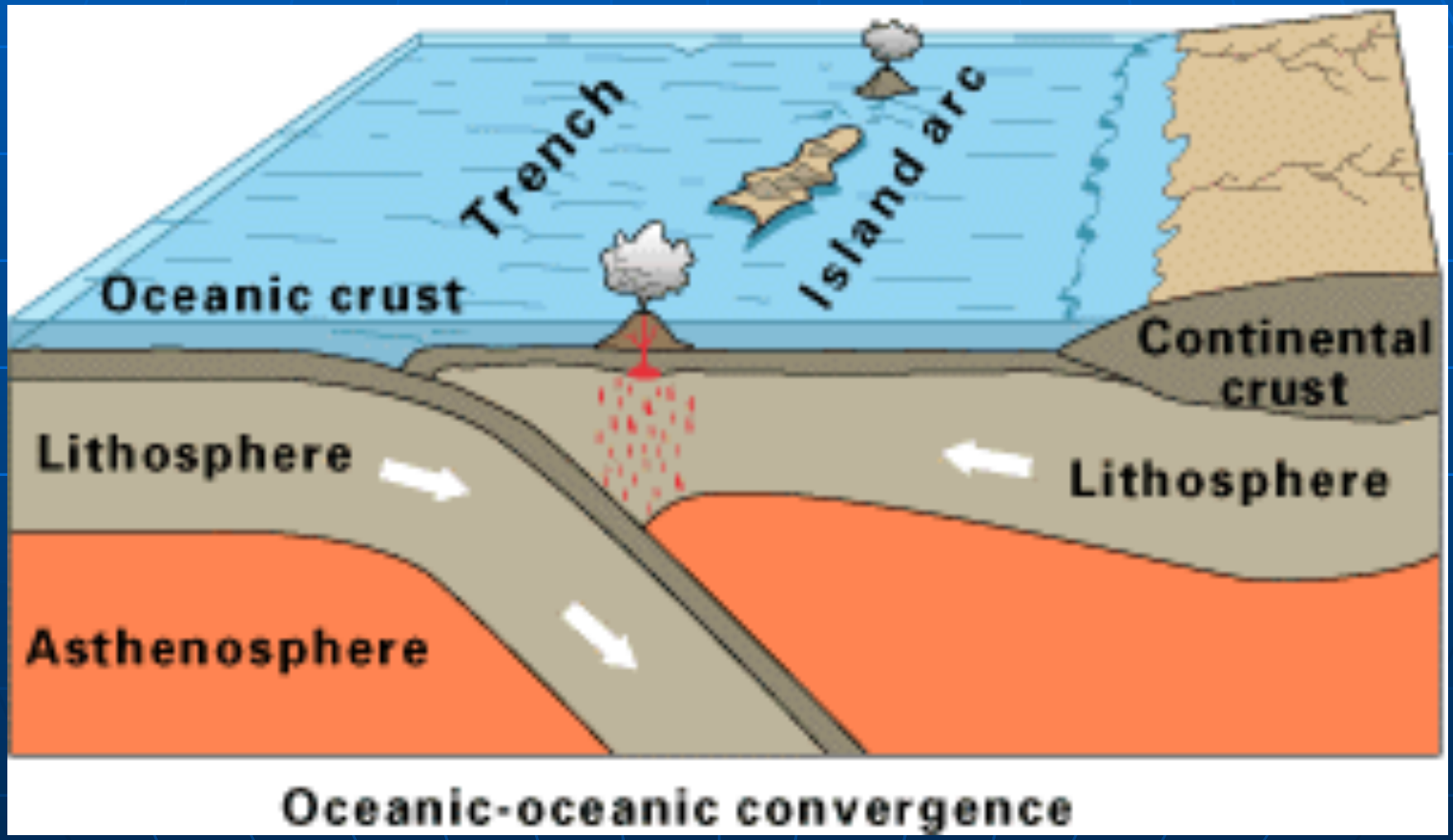


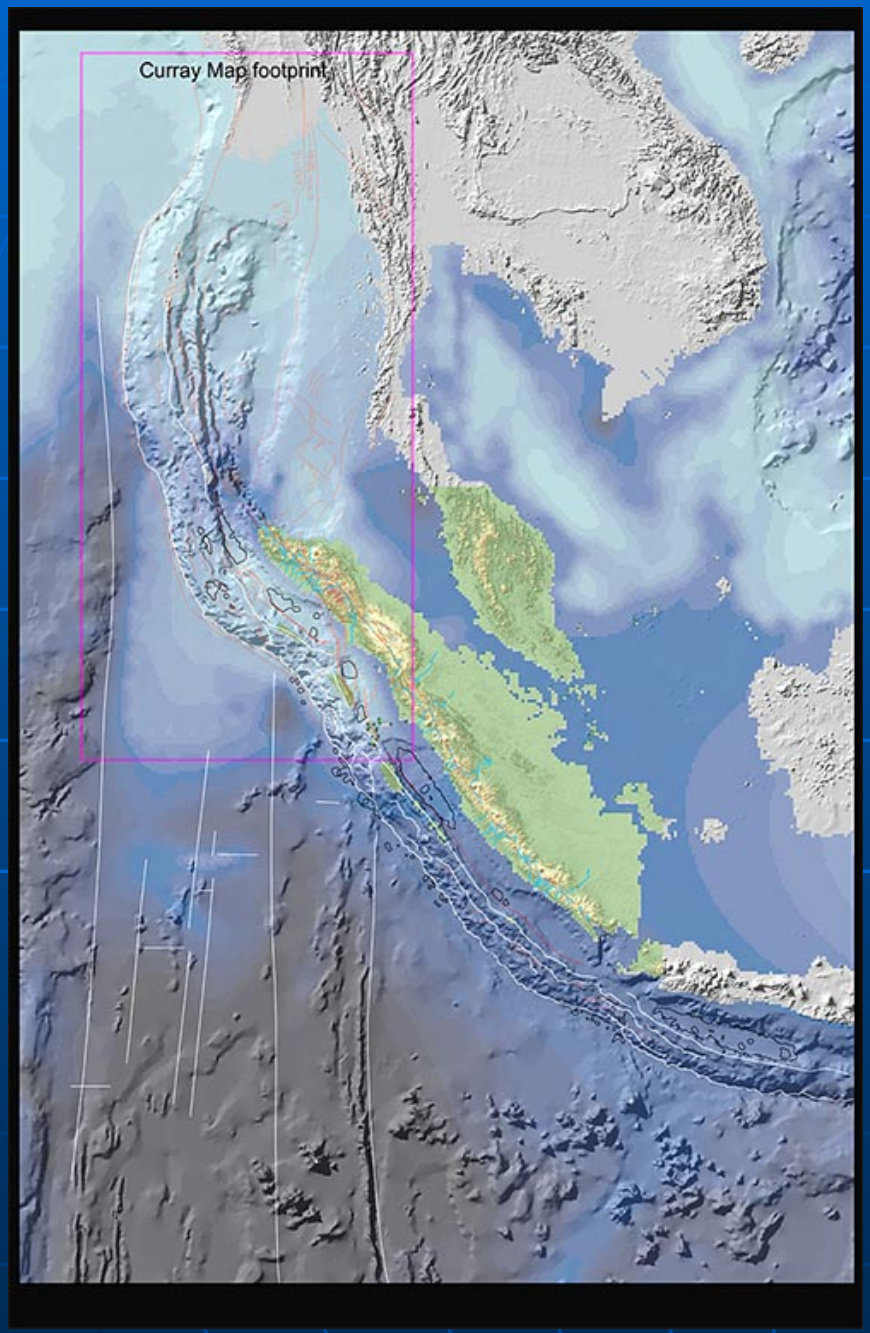






Convergent Plate Boundaries

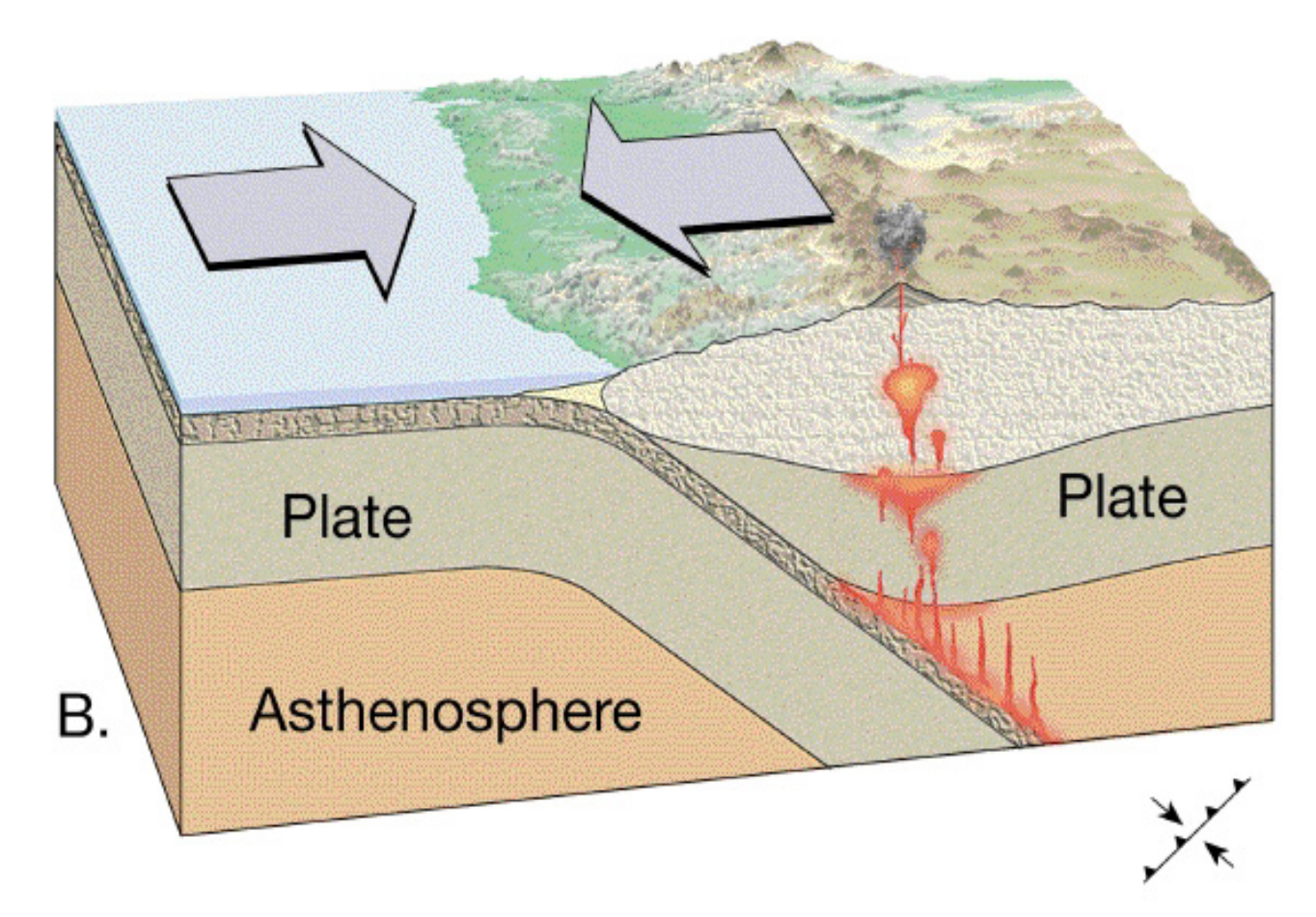


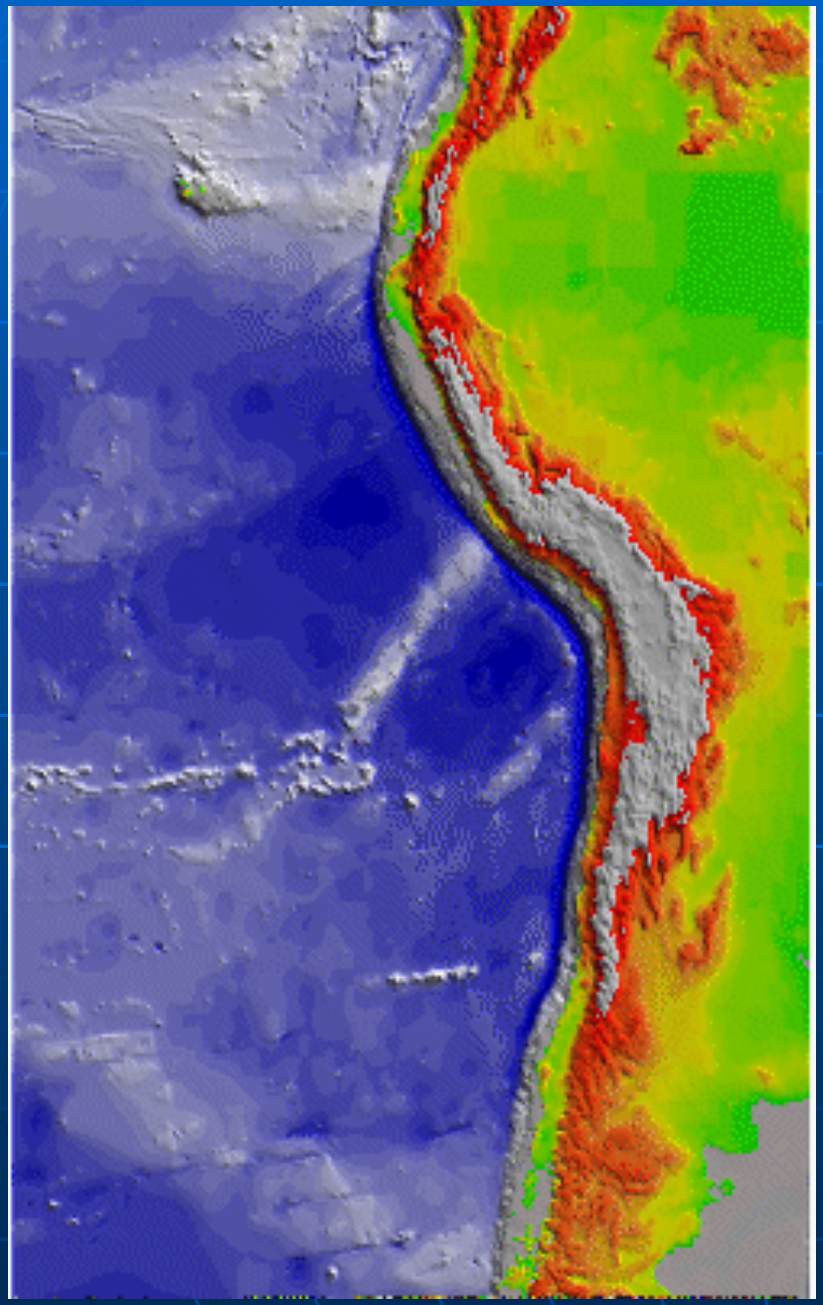


Sumatra

Site of M9.3 Earthquake, December 26, 2004

Convergent Plate Boundaries





Chile

Site of M9.5 Earthquake,

May 22, 1960

Convergent Plate Boundaries

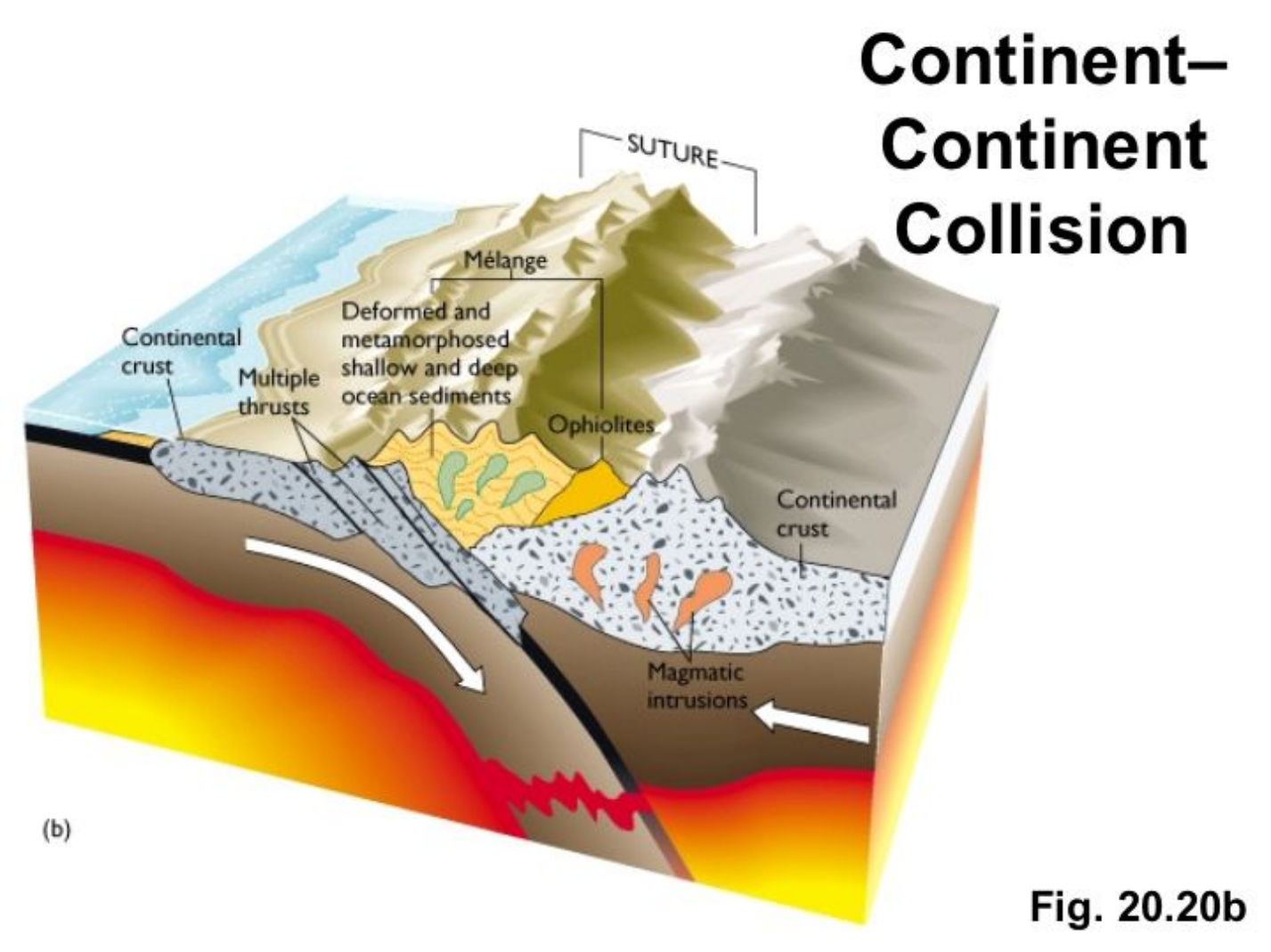
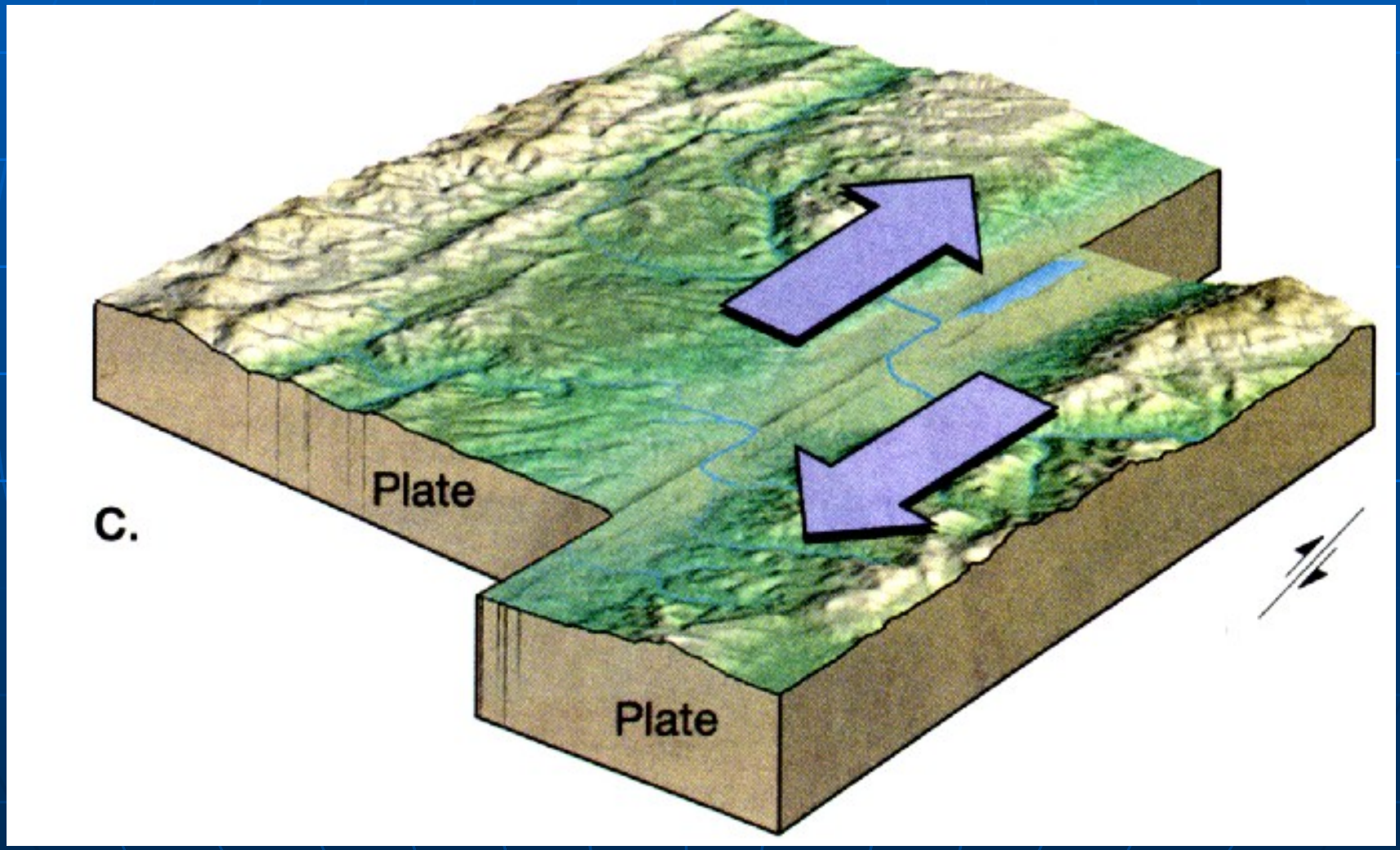


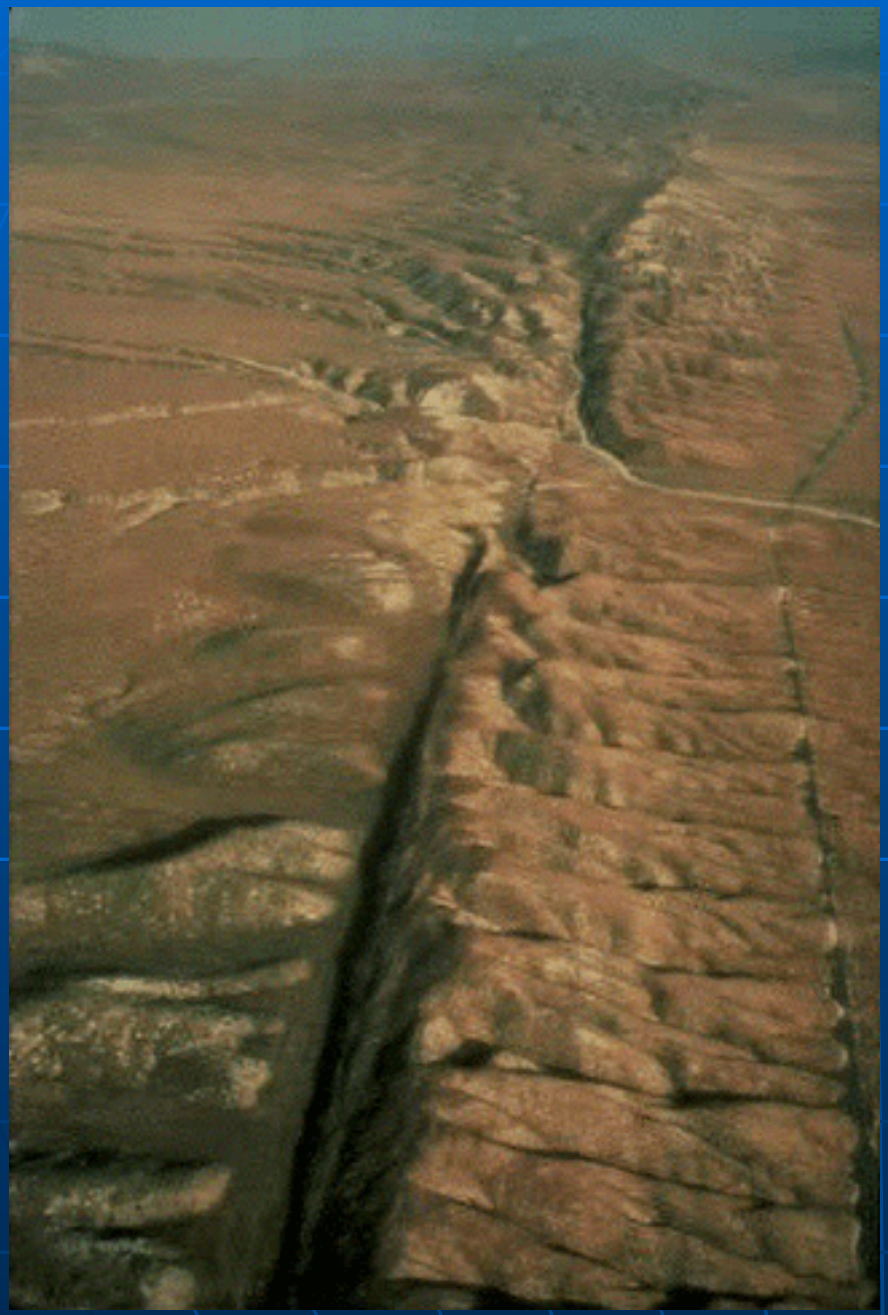
Fig. 20.20b

Transform Plate Boundaries



San Andreas Fault

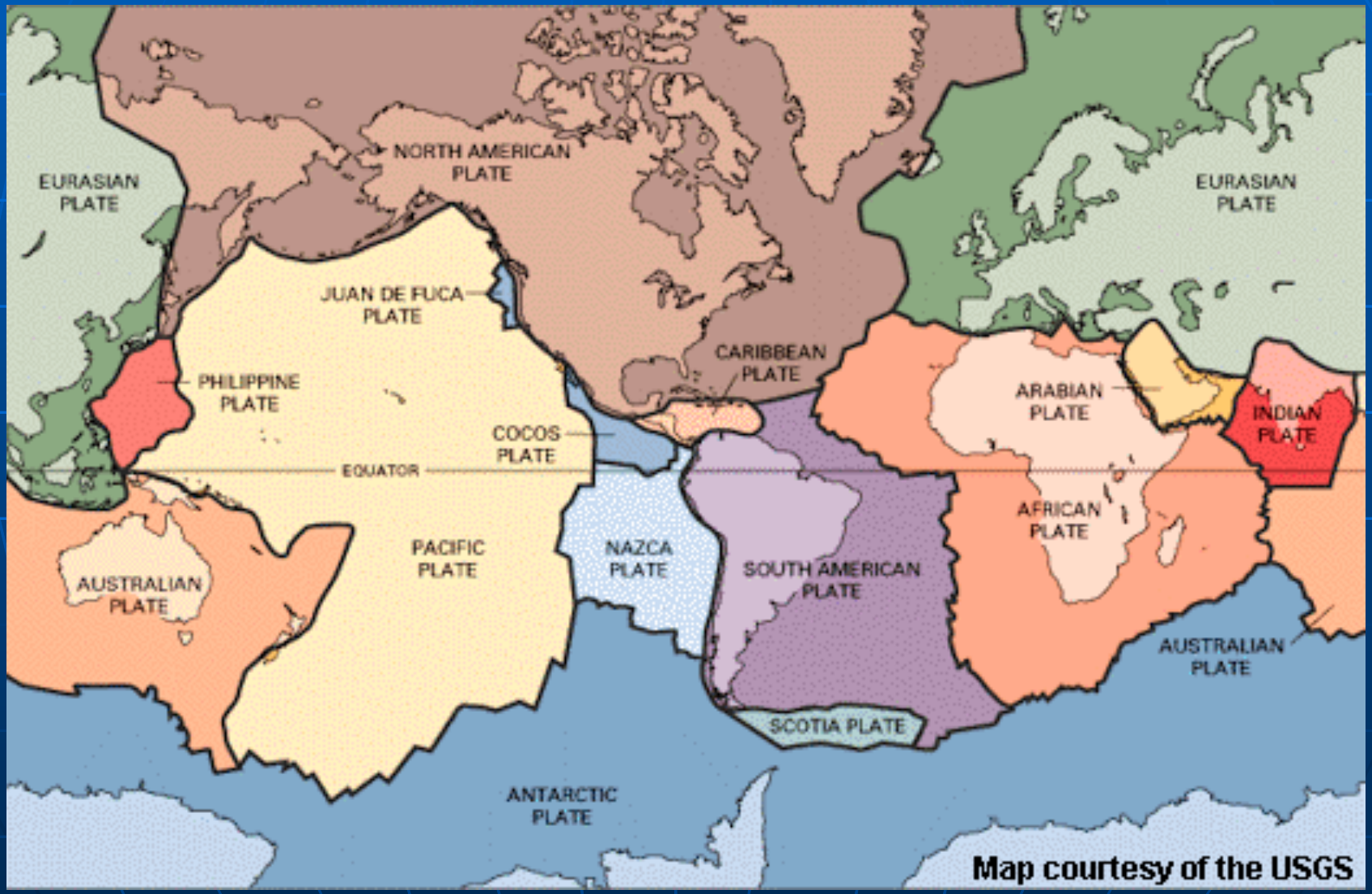
Boundary Between the North American and Pacific Plates



San Andreas Fault

San Francisco Site of M7.8 Earthquake, April 18, 1906

Plate Boundaries



Seismicity of the US, 1968-2003, M>3.5

Thanks