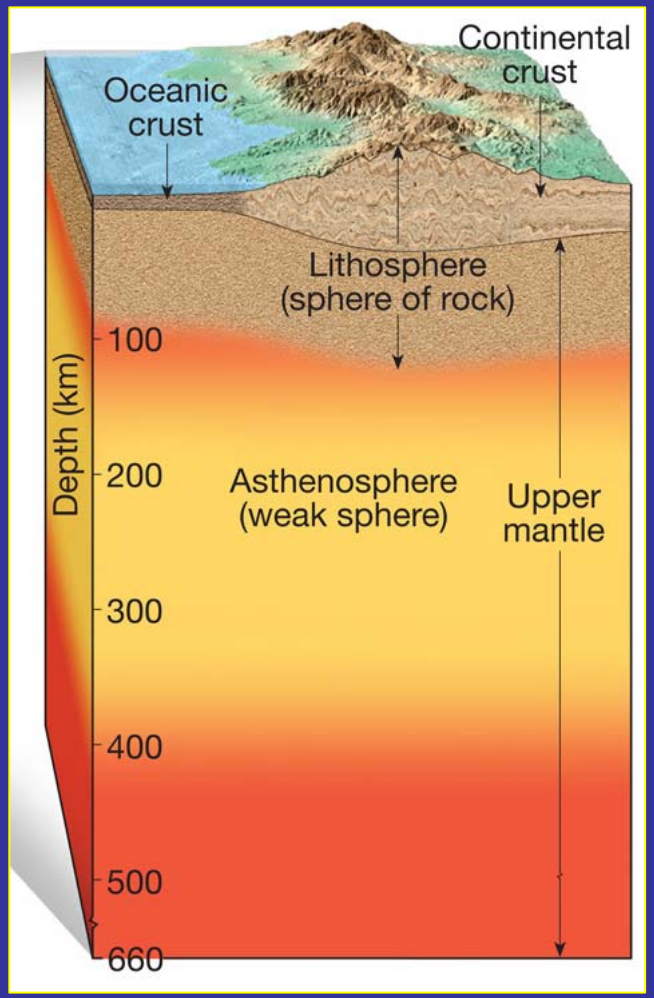
Plate boundaries

1. Lithosphere (crust) / asthenosphere (upper mantle)
2. Divergent boundaries
   - Oceanic Ridges and Seafloor Spreading
   - Continental Rifting
3. Convergent boundaries
   - Oceanic-continental convergence
   - Oceanic-oceanic convergence
   - Continental-continental convergence
4. Transform fault boundaries
   - Oceanic
   - Continental



Plates are lithosphere:

Crust + uppermost mantle

Solid

Oceanic: few-100km thick

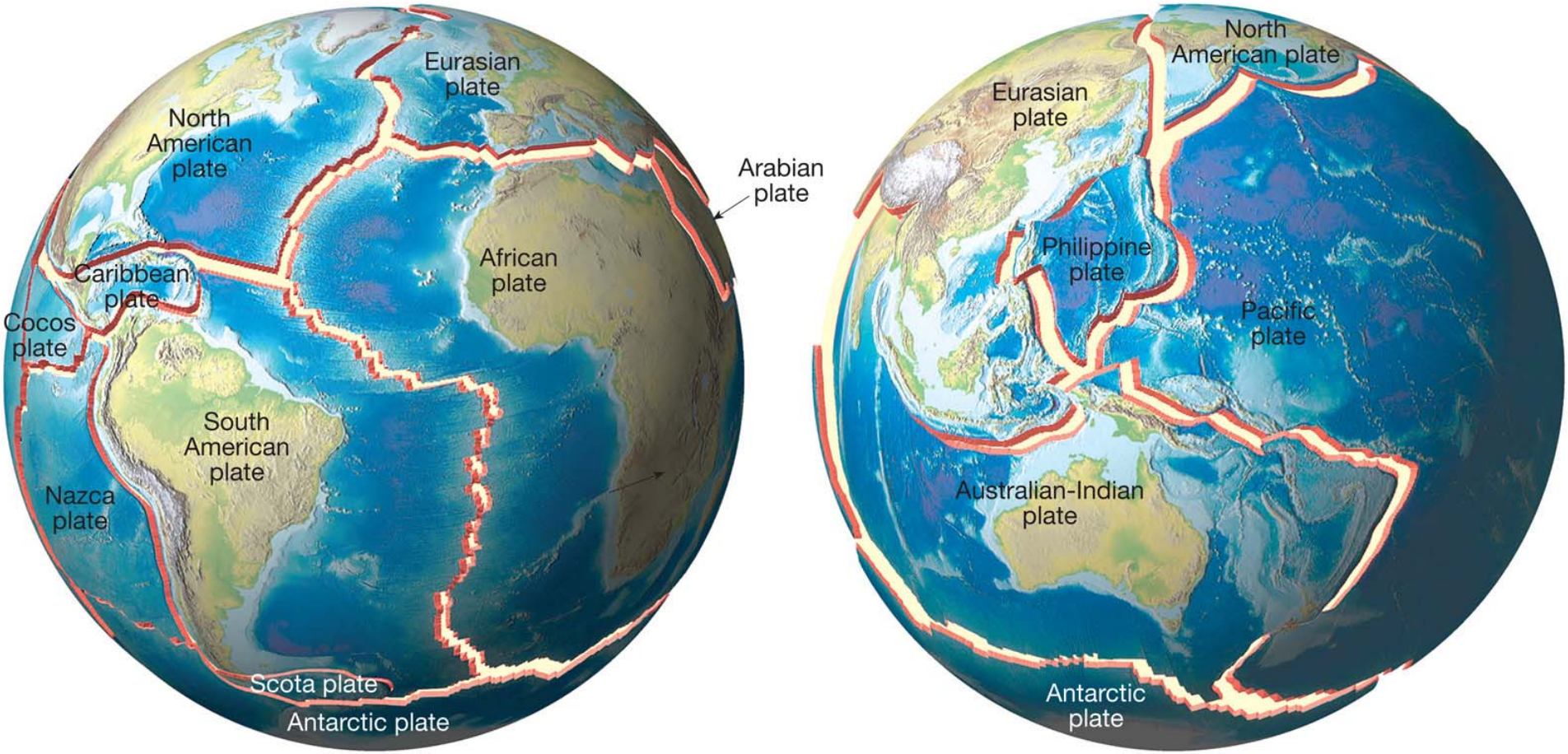
Continental: 100-250km thick

Plates ride on asthenosphere:

Upper mantle

Ductile

Rocks near melting temperature



7 major plates:

N. American, S. American, Pacific, African, Eurasian, Australian-Indian, Antarctic

7 intermediate plates:

Caribbean, Nazca, Philippine,Arabian, Cocos, Scotia, Juan de Fuca

12+ minor plates

=

26+ plates total

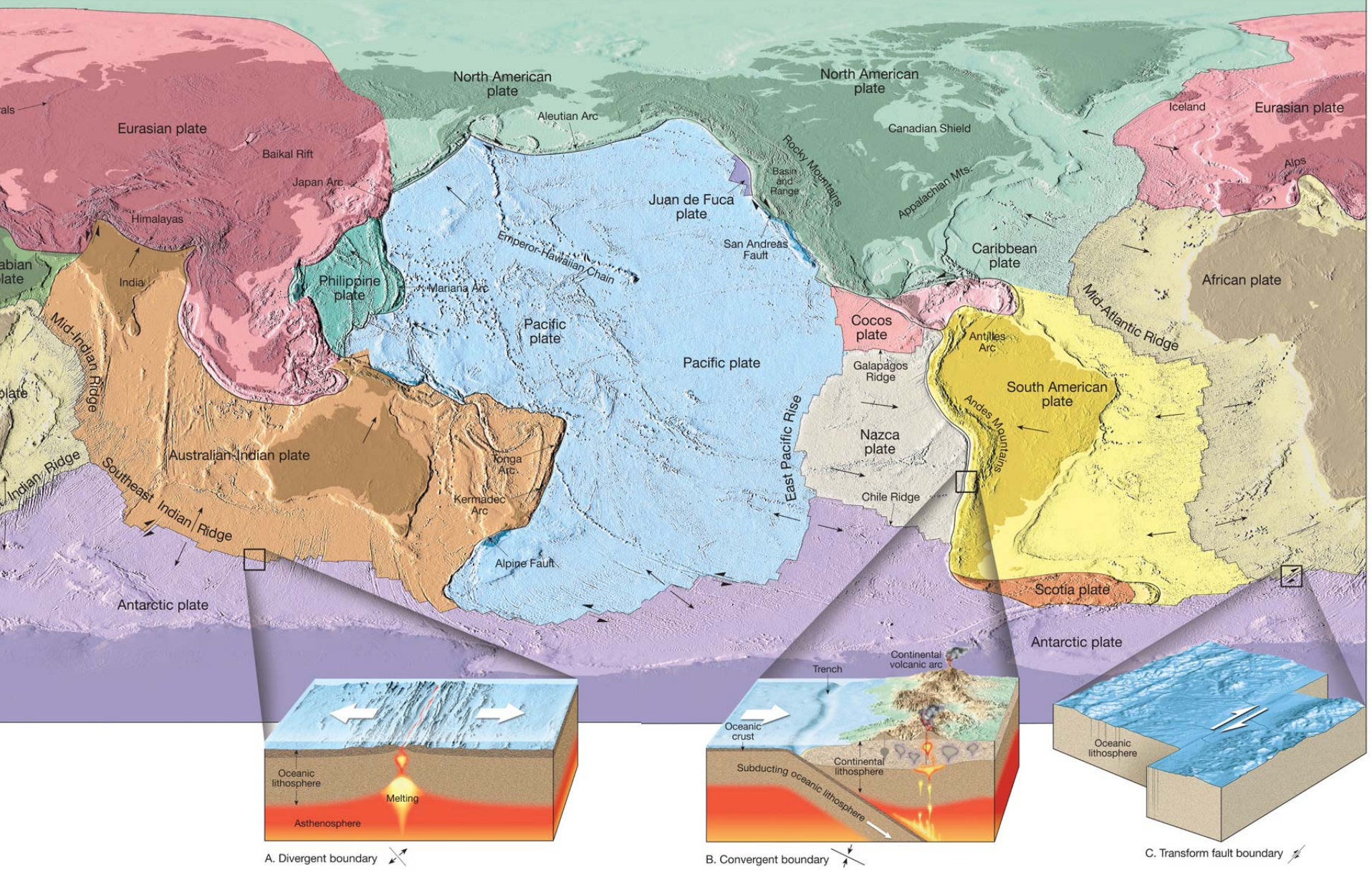
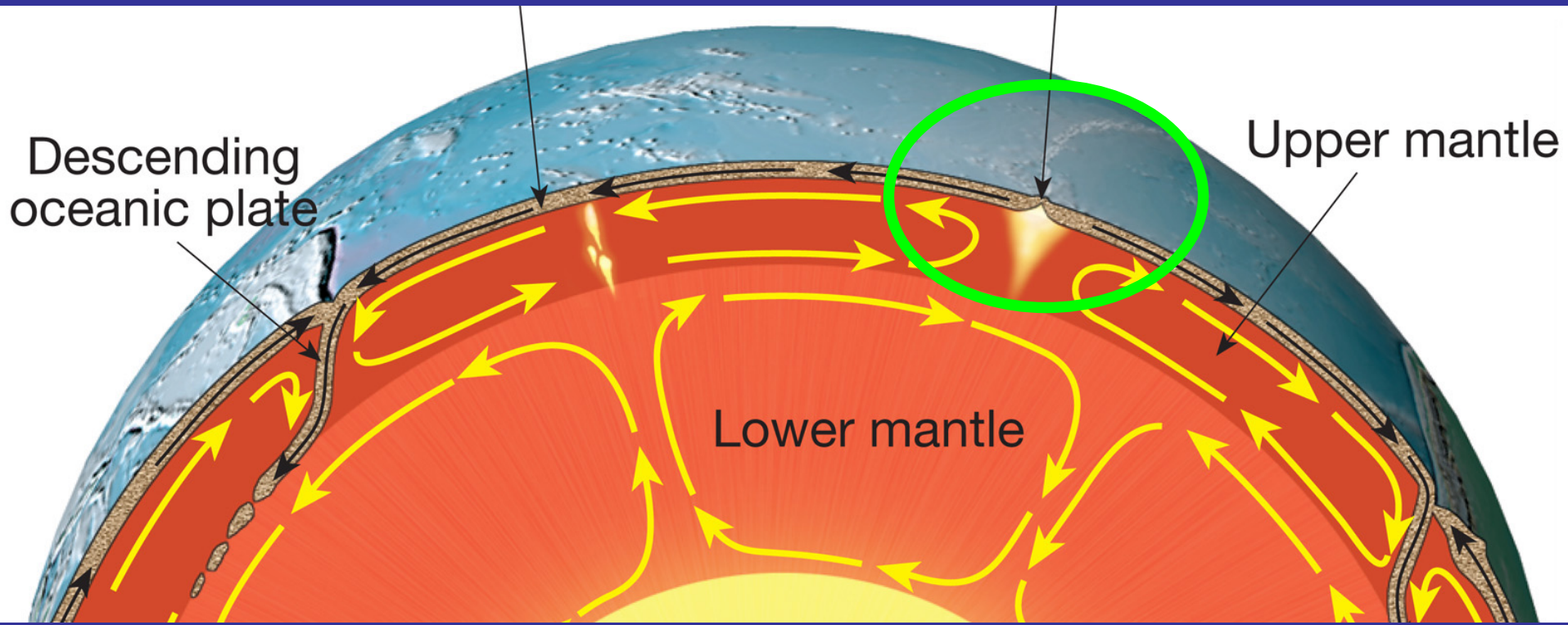


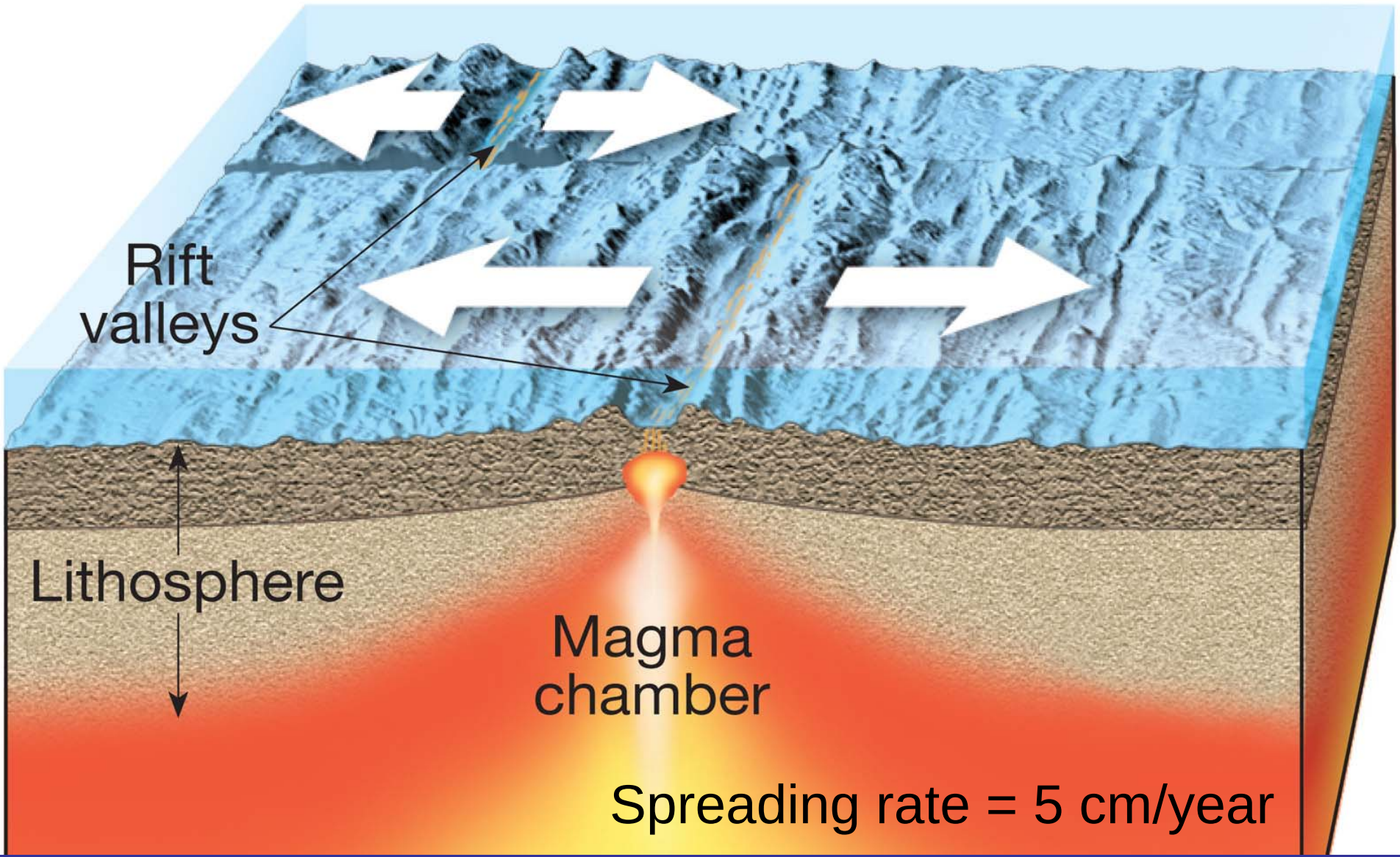
Plate boundaries: 1) Divergent, 2) Convergent, 3) Transform Fault

Divergent Plate Boundaries – "Constructive plate margins"

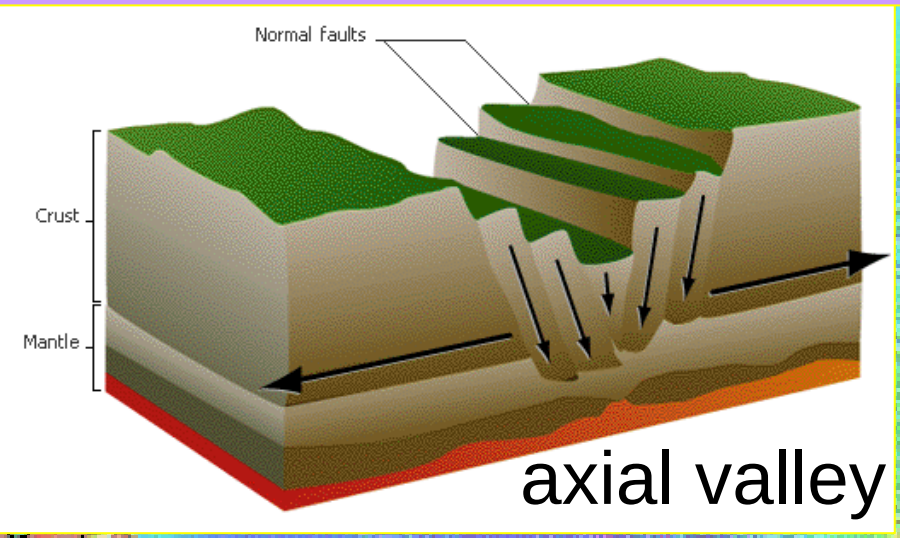
- Earth's crust is created
  1. Oceanic ridges and seafloor spreading
  2. Continental rifting



Divergent boundary – oceanic ridges and seafloor spreading



Divergent boundary – oceanic ridges and seafloor spreading



axial valley

oceanic “ridge”
70,000 km long
broad inflation feature

Divergent boundary – oceanic ridges and seafloor spreading



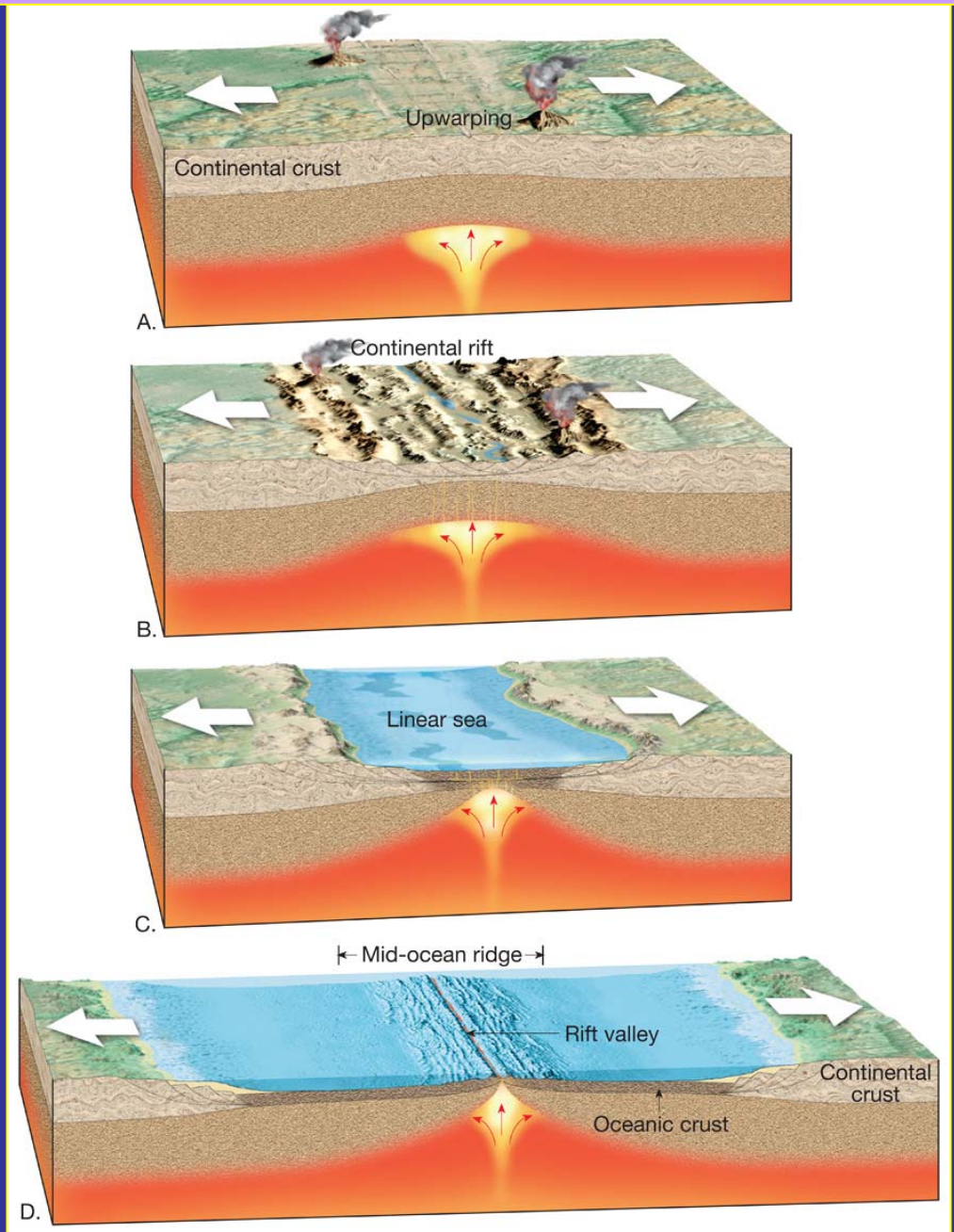
Cocos

Pacific

Nazca

Typical Example – East Pacific Rise

Divergent boundary – continental rifting



Upwarping, volcanism

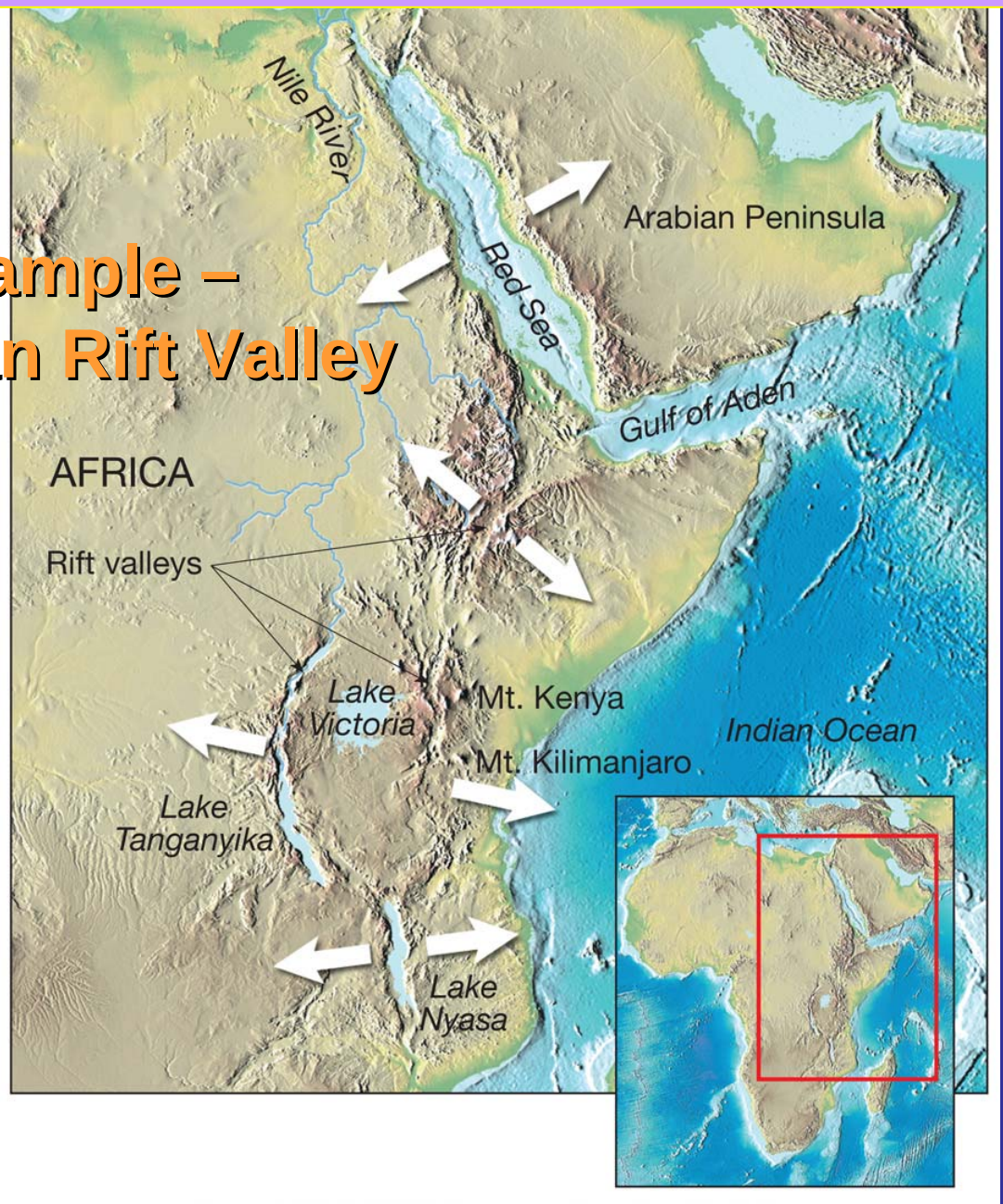
Elongated rift valley

Narrow, linear sea

Seafloor spreading

Divergent boundary – continental rifting

Typical Example –
East African Rift Valley



Divergent boundary – continental rifting





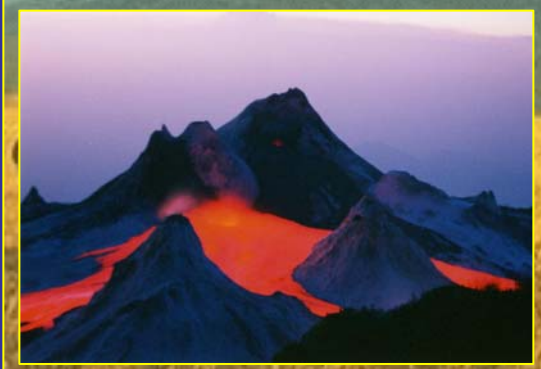


Divergent boundary – continental rifting



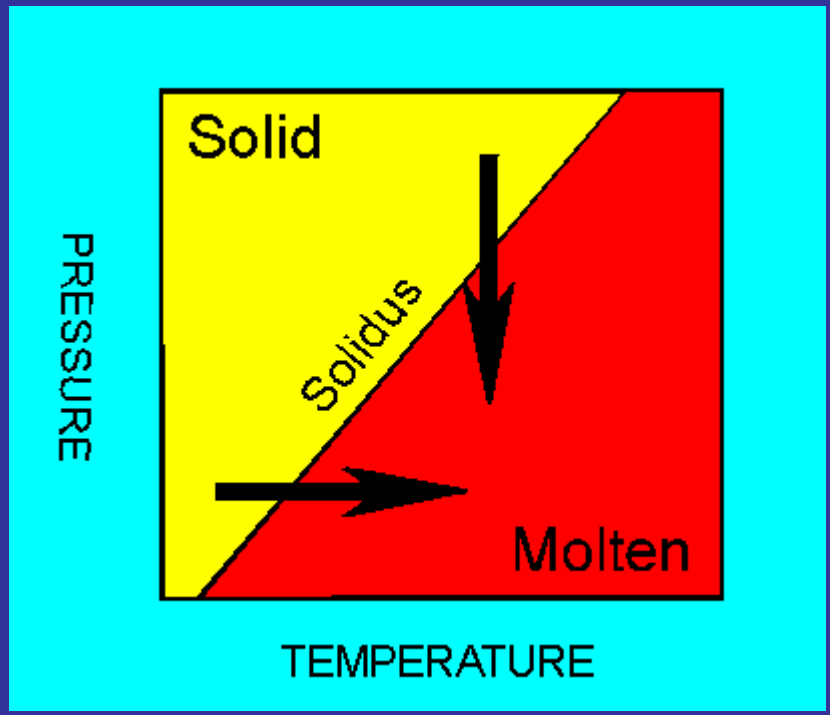
Natrocarbonatite lavas

Mt. Ol Doinyo Lengai
Tanzania



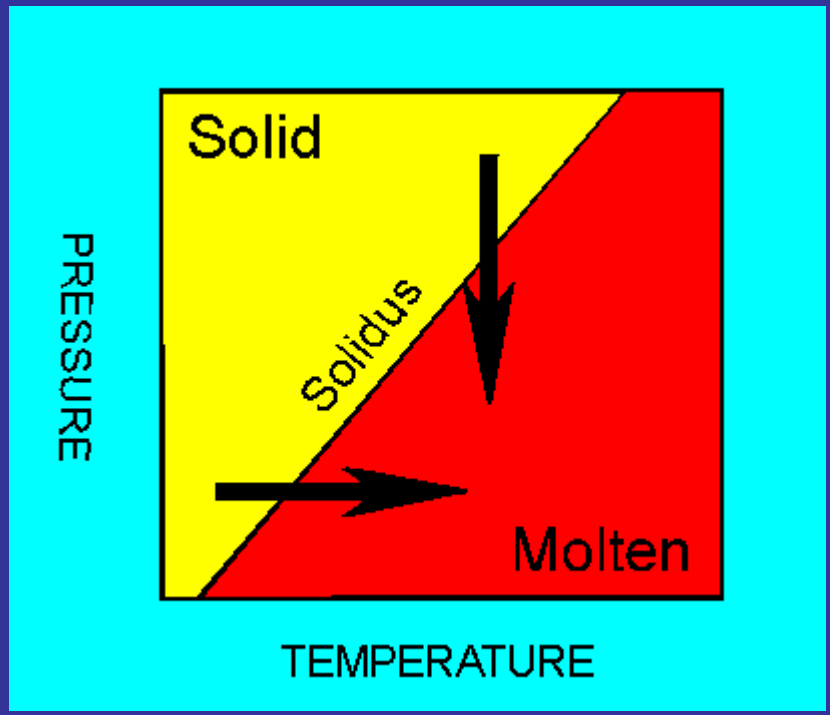
Two ways to melt rock?

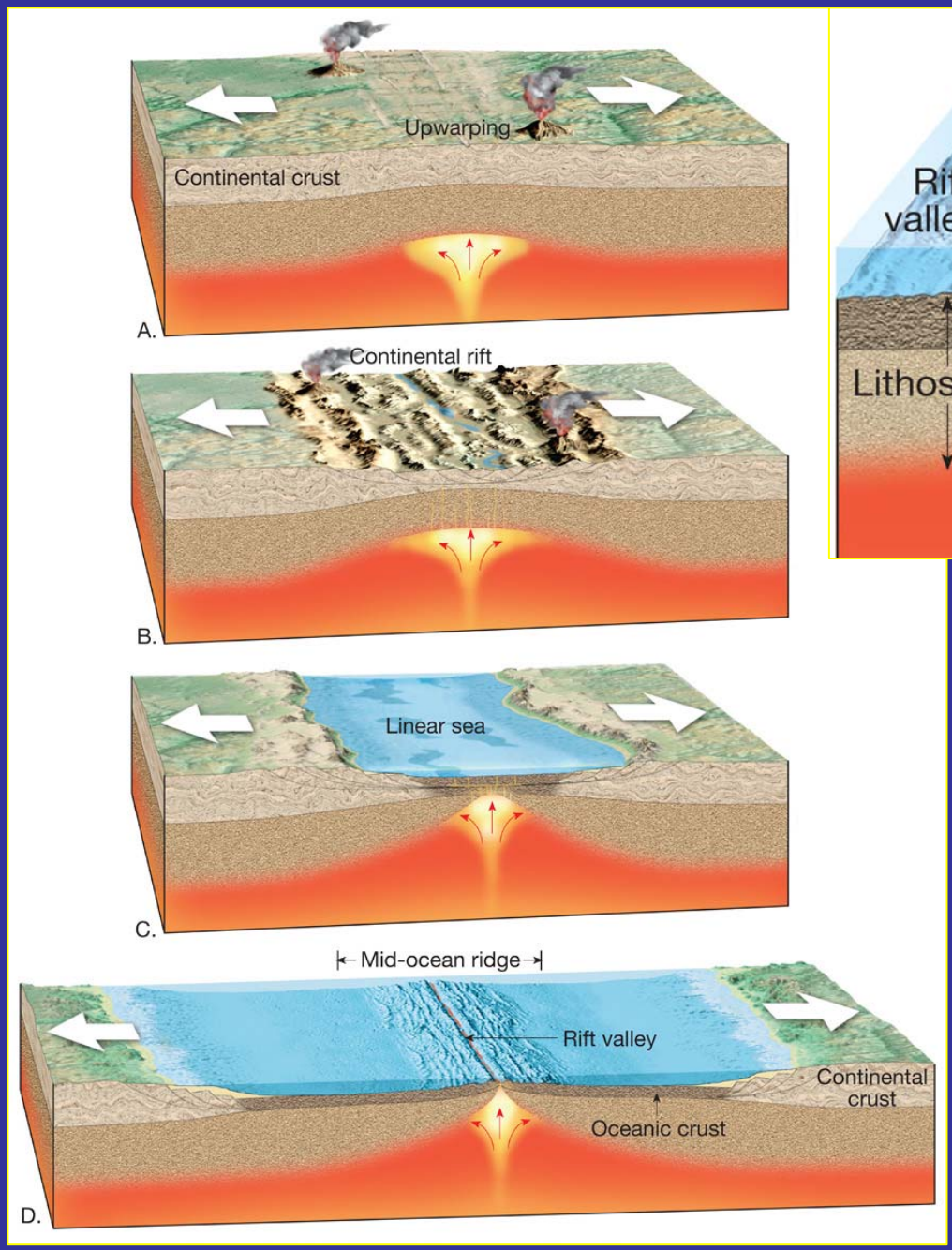
1) …
2) …

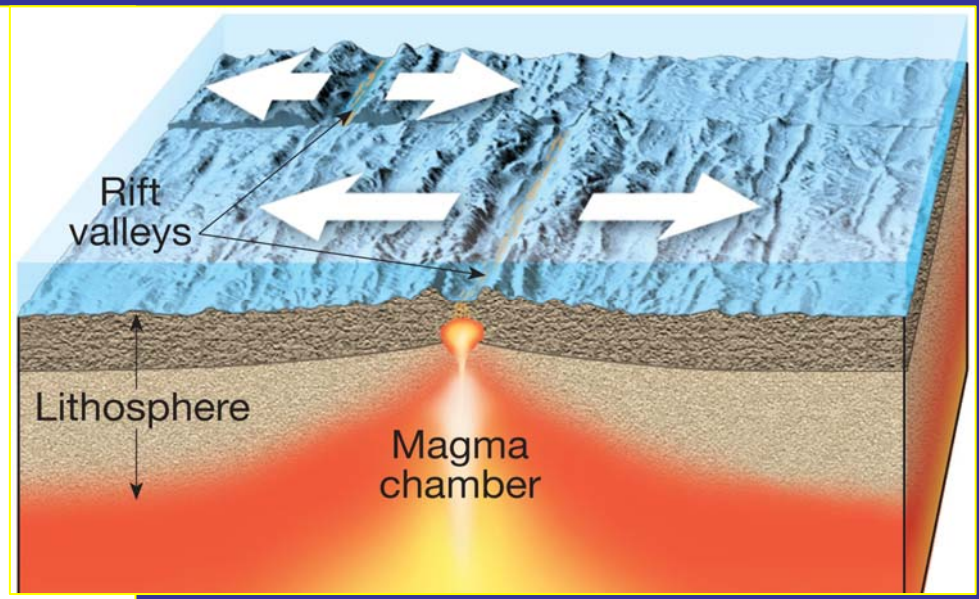


Two ways to melt rock:

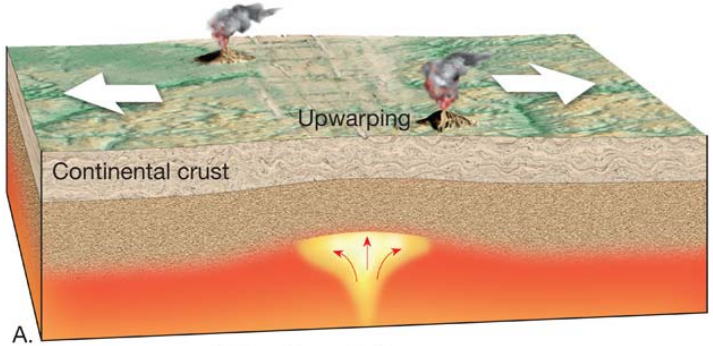
1) Increase temperature
2) Decrease pressure



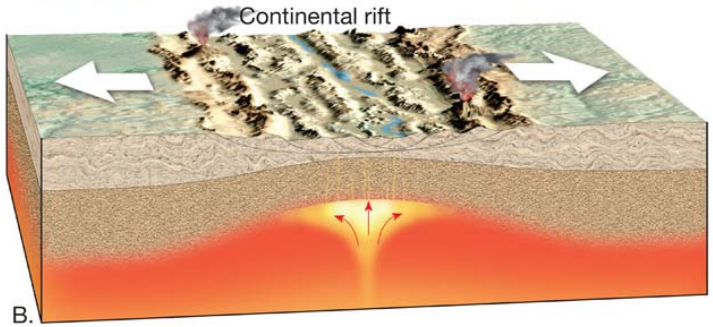




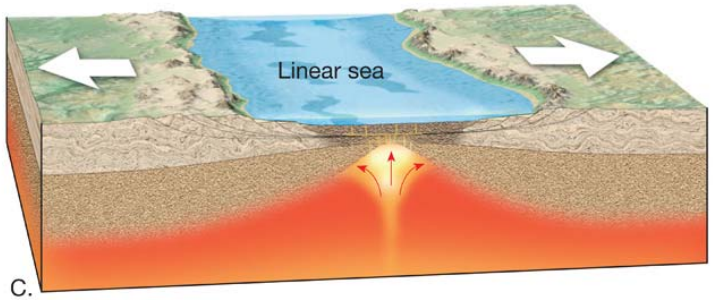
What causes mantle material to melt at divergent boundaries?


Upwarping
Continental crust

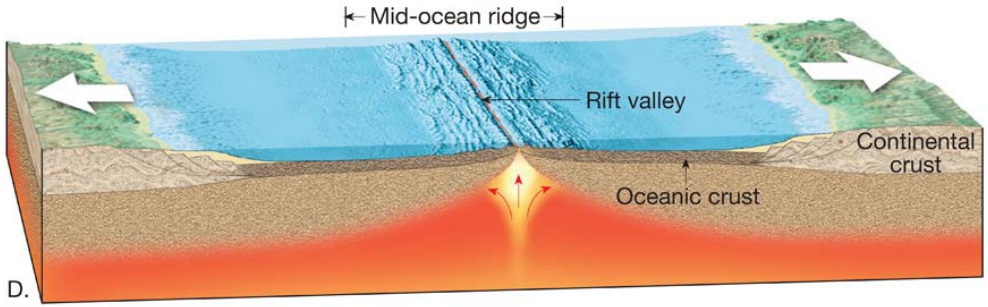
A.


Continental rift

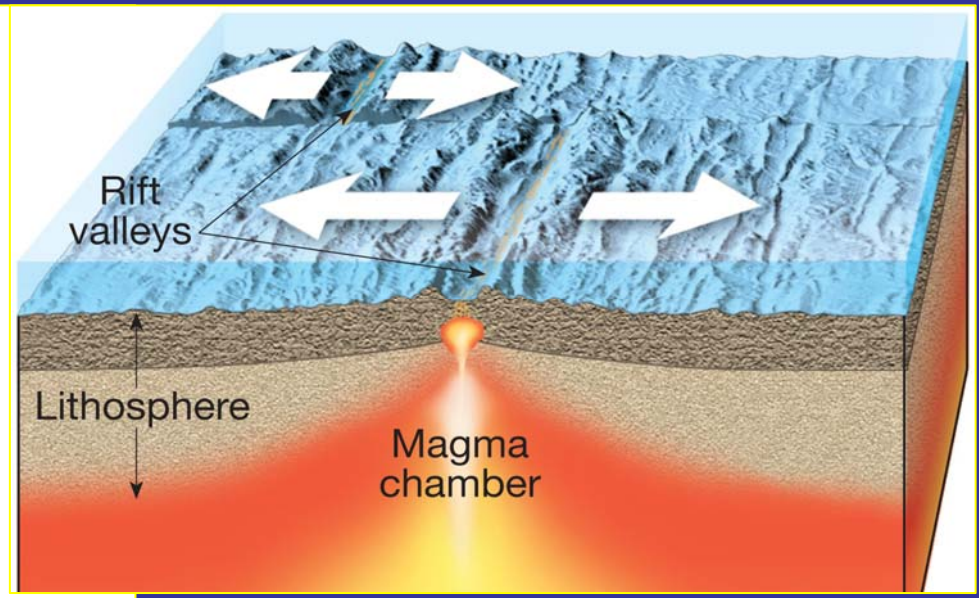
B.

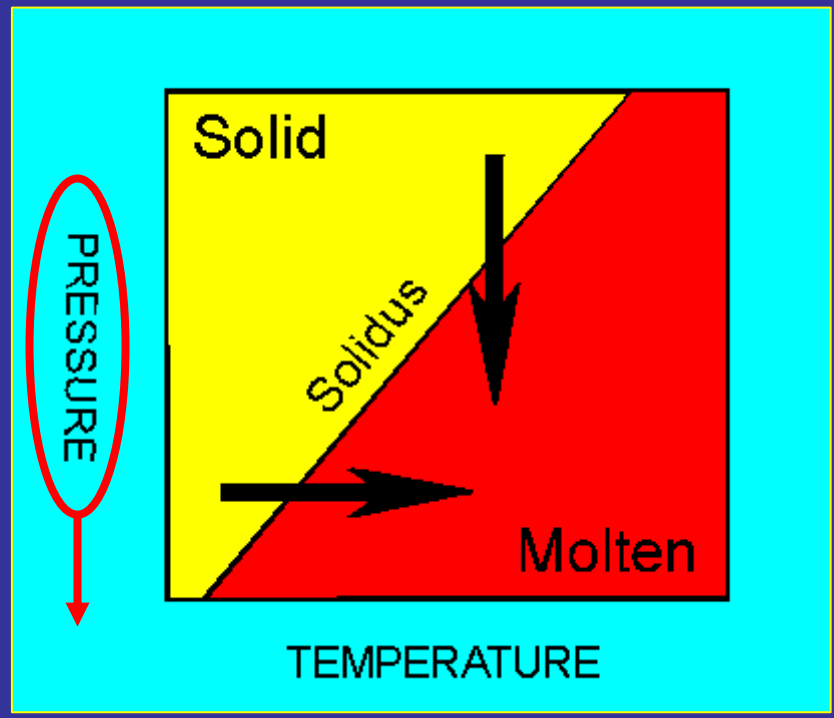

Linear sea

C.


Mid-ocean ridge
Rift valley
Continental crust
Oceanic crust

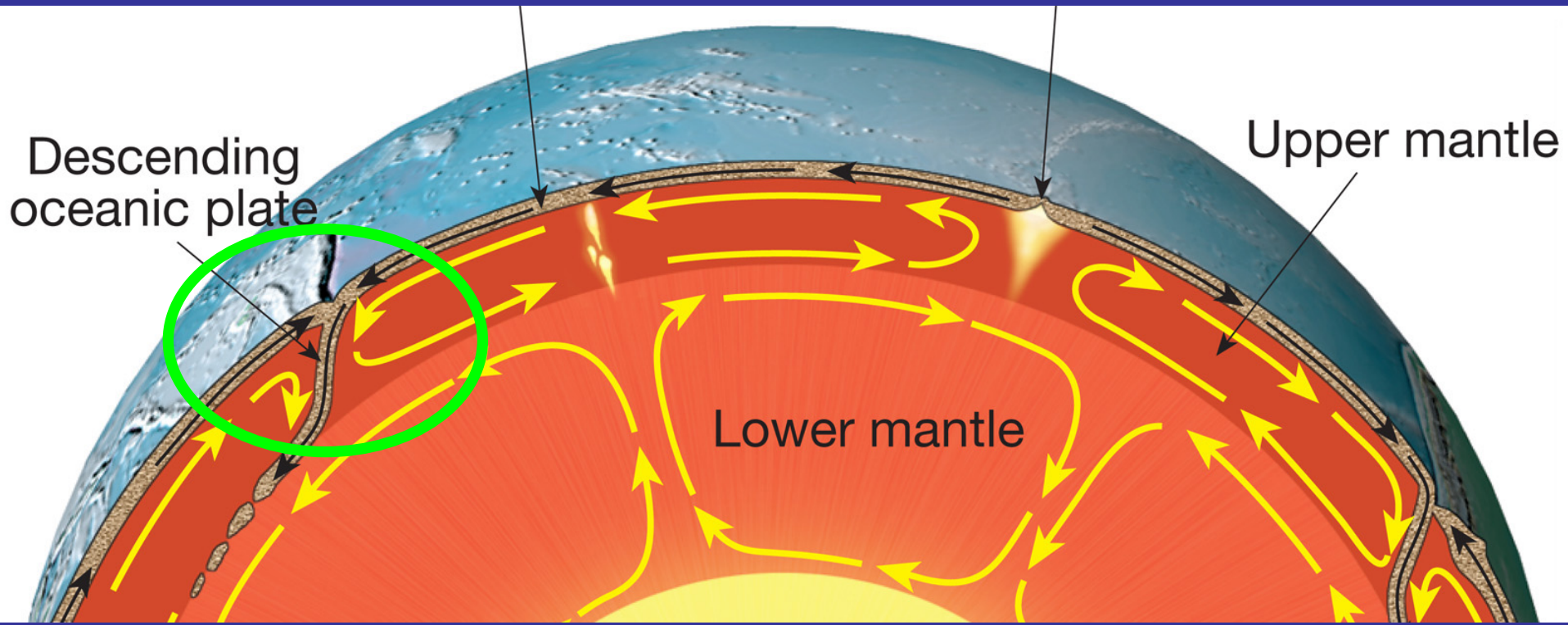
D.


Rift valleys
Lithosphere
Magma chamber

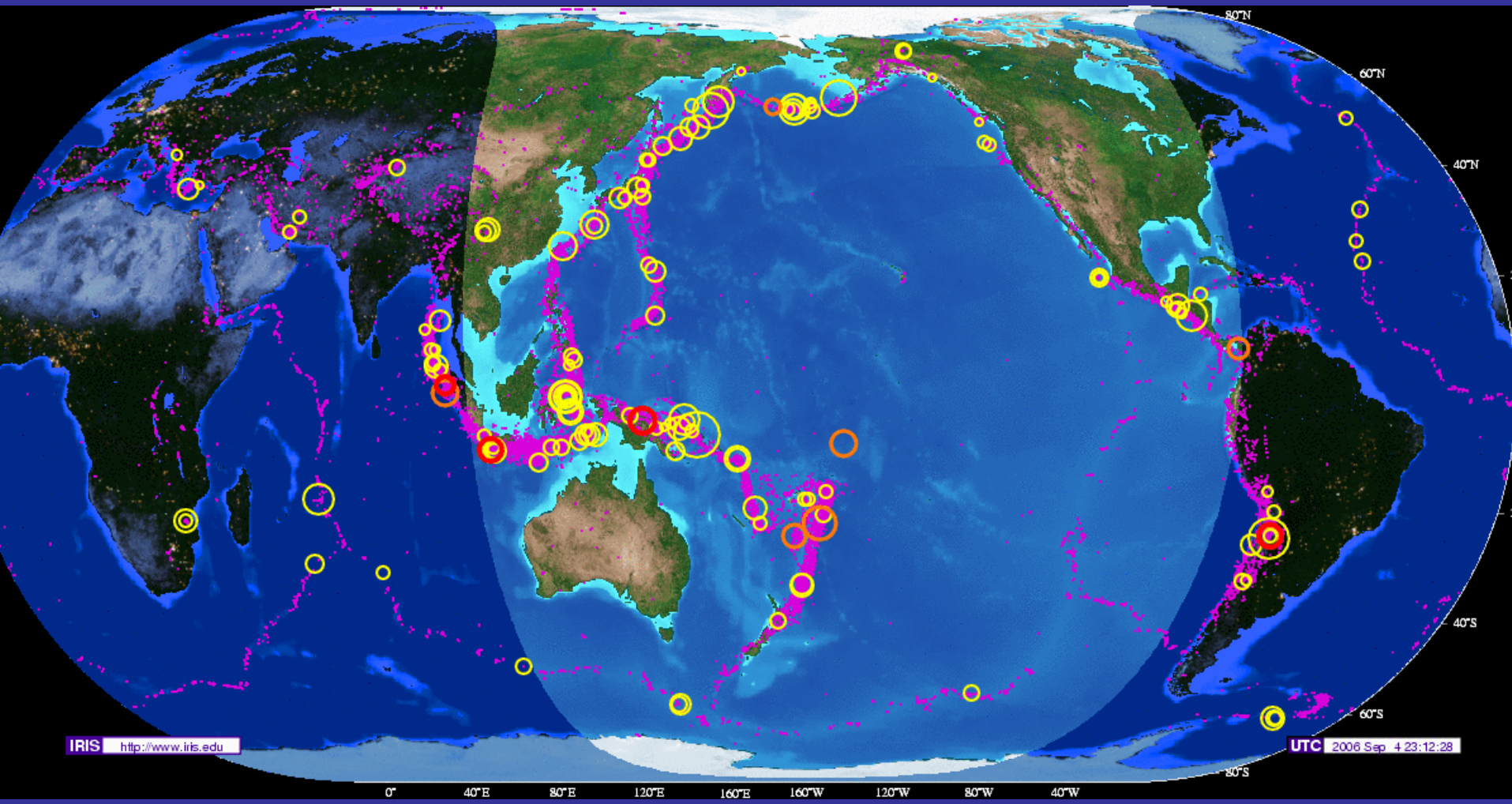

Solid
Solidus
Molten
PRESSURE
TEMPERATURE

Convergent Plate Boundaries – "Destructive plate margins"

- Earth's crust sinks into mantle
  1. Oceanic-continental
  2. Oceanic-oceanic
  3. Continental-continental

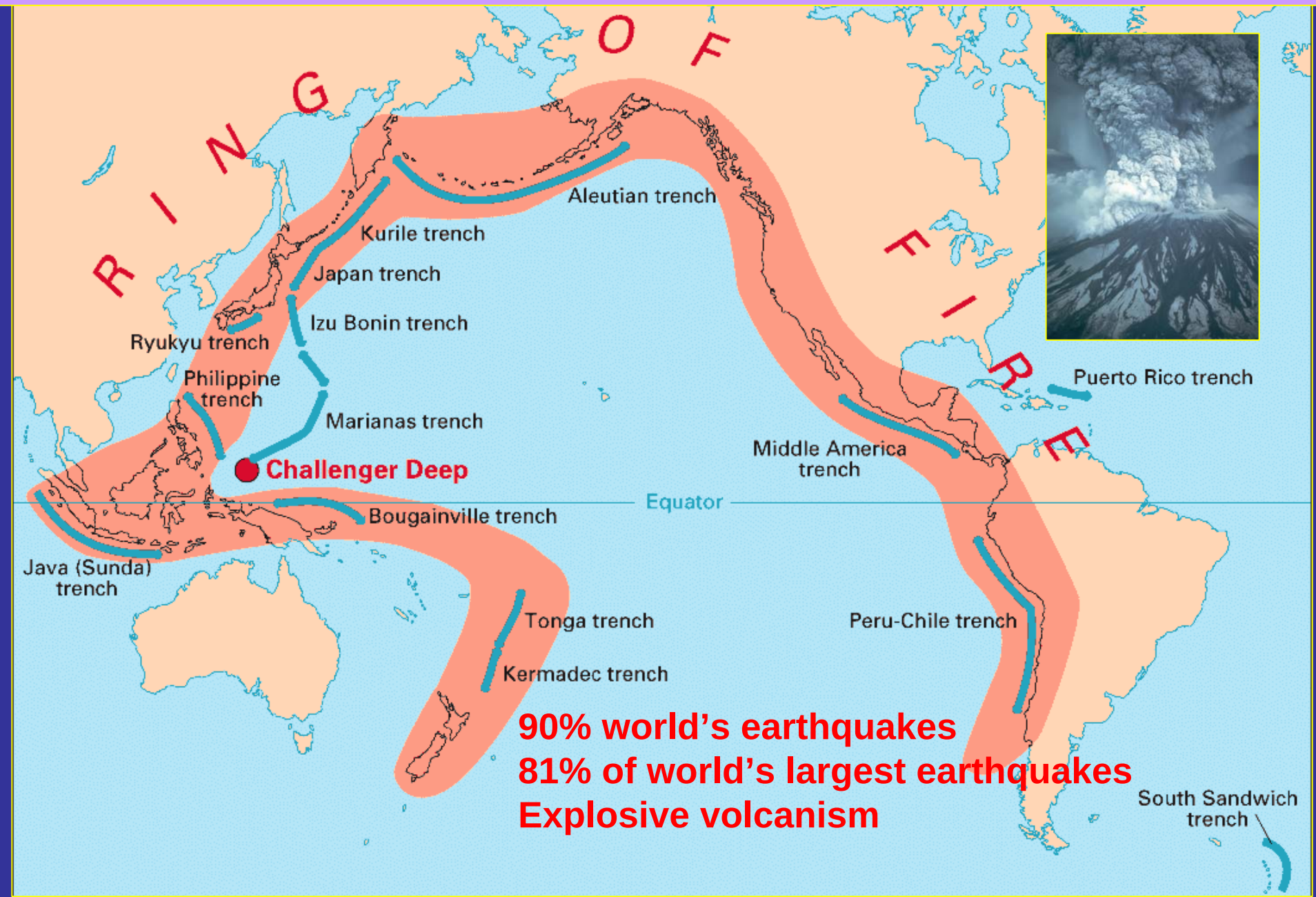


How do you find a convergent boundary?



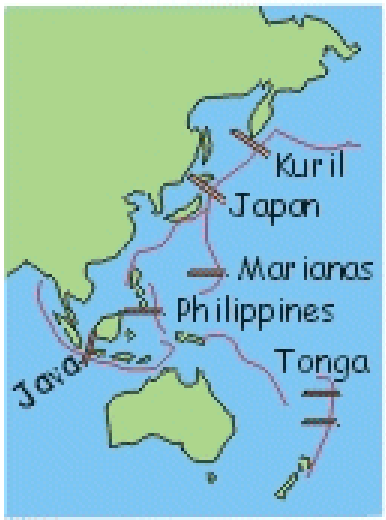
Today, Yesterday, Past 2 weeks, Past 5 years

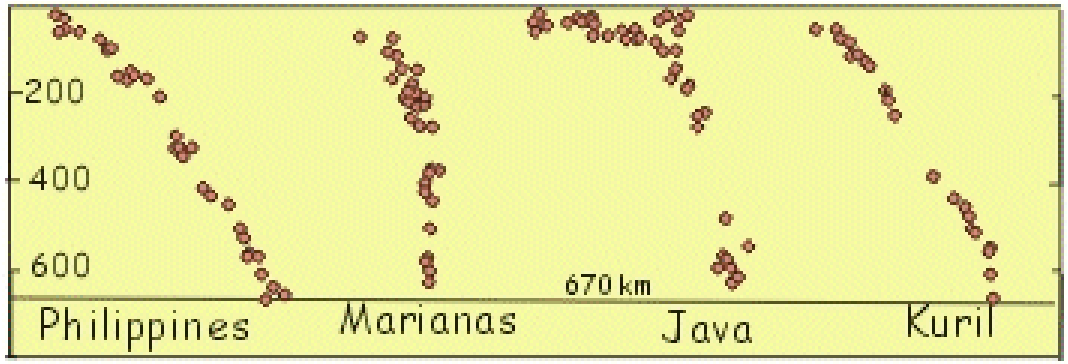
Convergent boundary – “Ring of Fire”

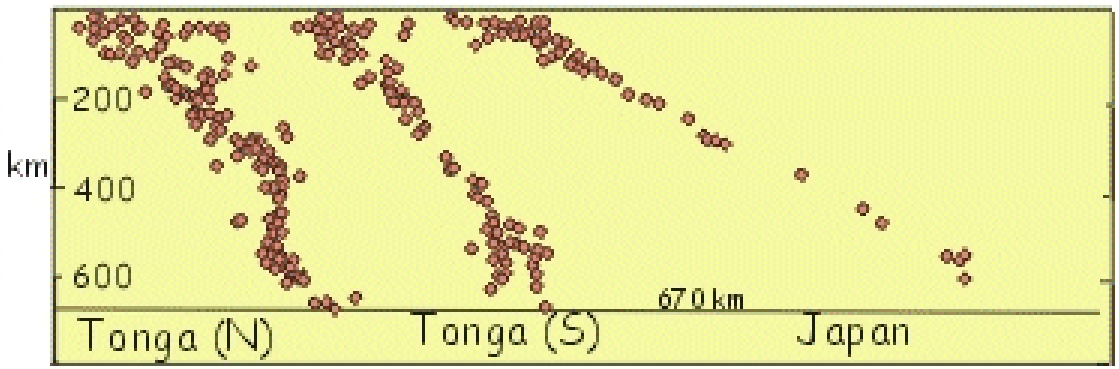


Convergent boundary – Wadati-Benioff zone

Earthquakes and the dip of Wadati-Benioff seismic zones





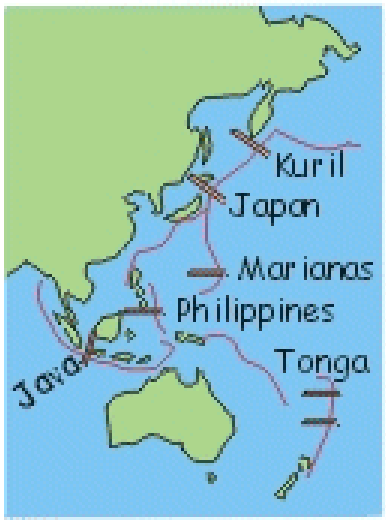


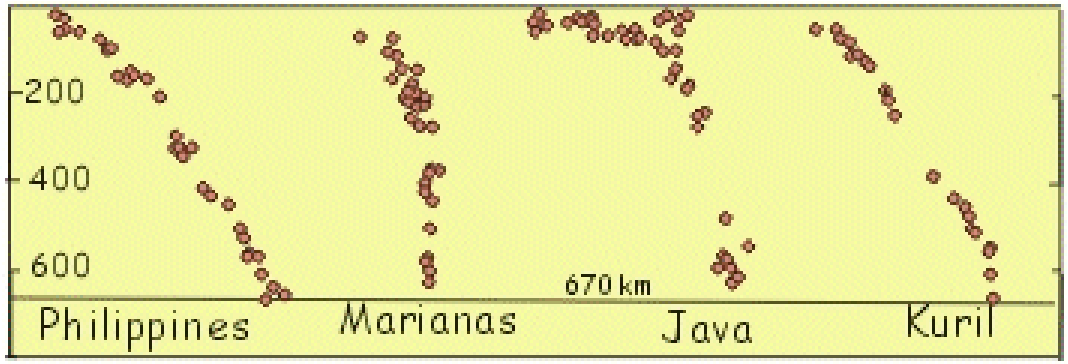
vertical and horizontal scales equal

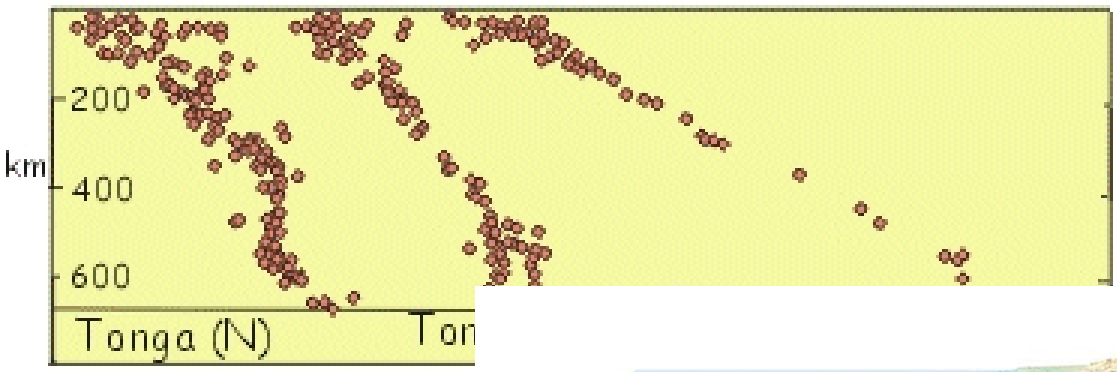
What subsurface structure are these earthquakes mapping?

Convergent boundary – Wadati-Benioff zone

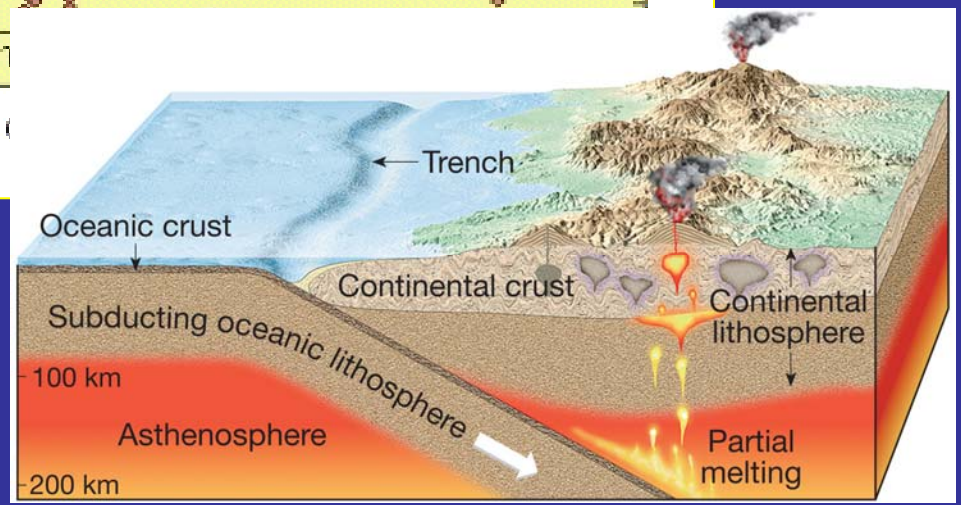
Earthquakes and the dip of Wadati-Benioff seismic zones







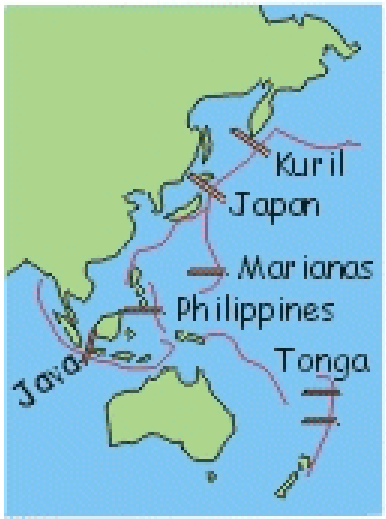
vertical an

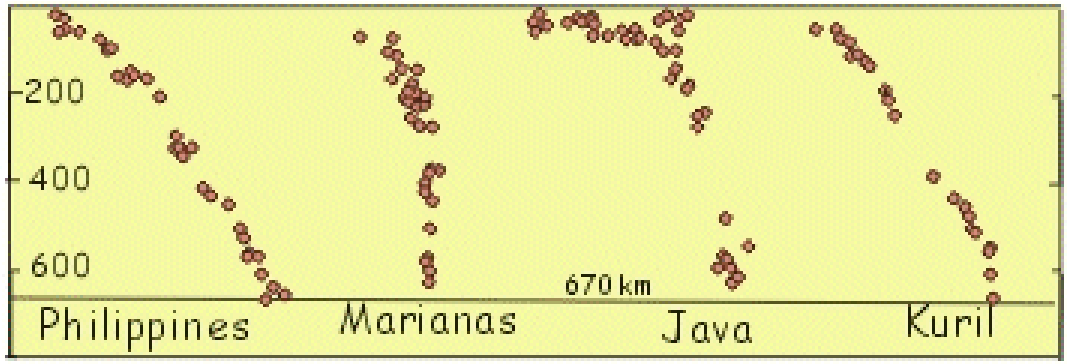


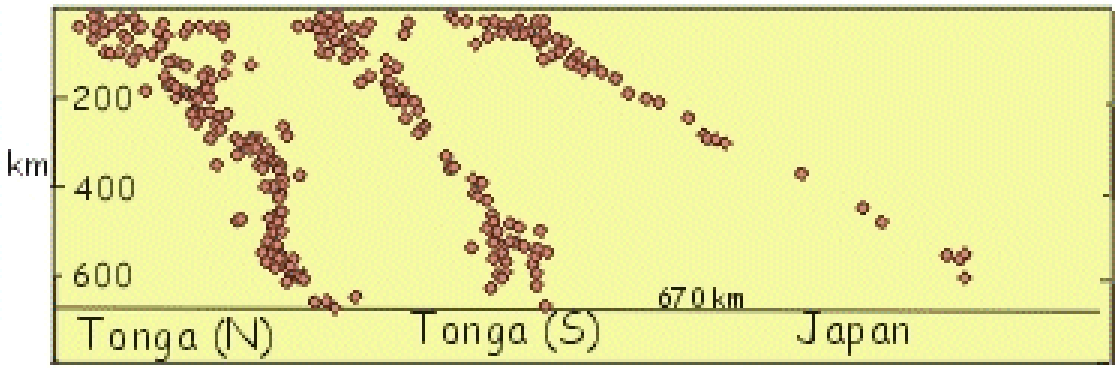
Subducting oceanic crust

Convergent boundary – Wadati-Benioff zone

Earthquakes and the dip of Wadati-Benioff seismic zones





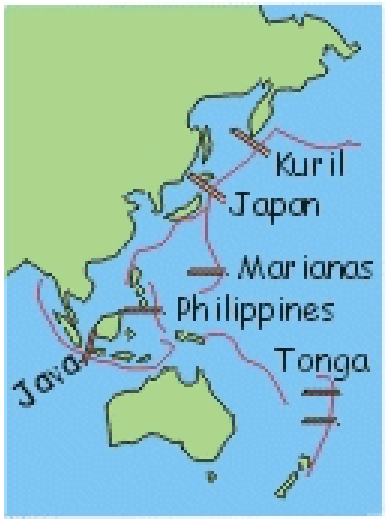


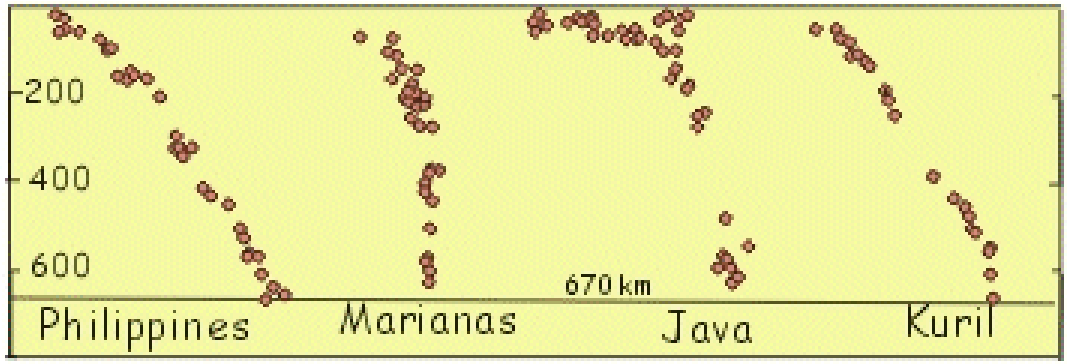
vertical and horizontal scales equal

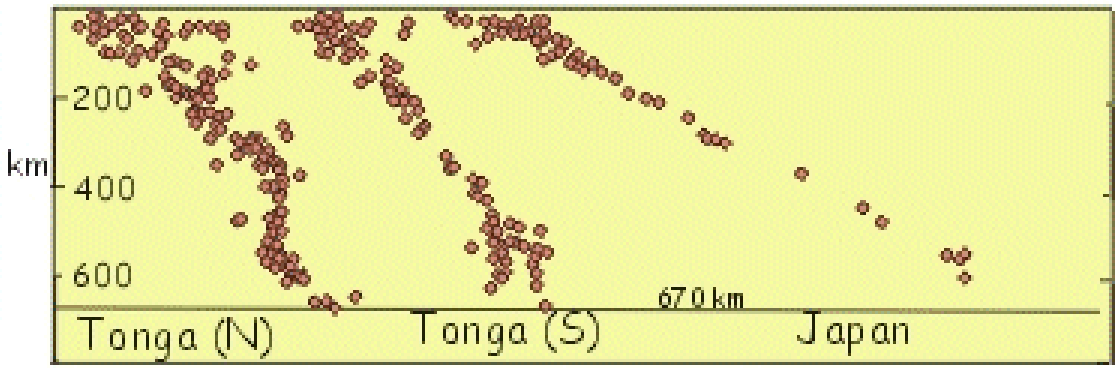
Which is the oldest oceanic plate?

Convergent boundary – Wadati-Benioff zone

Earthquakes and the dip of Wadati-Benioff seismic zones







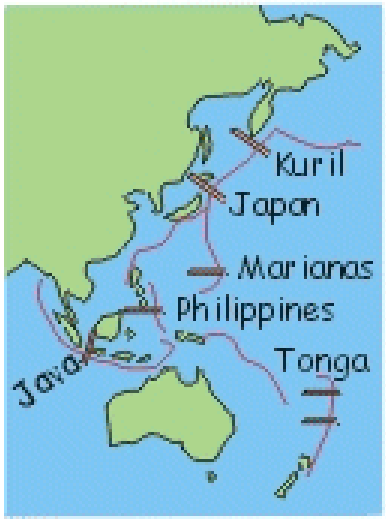
vertical and horizontal scales equal

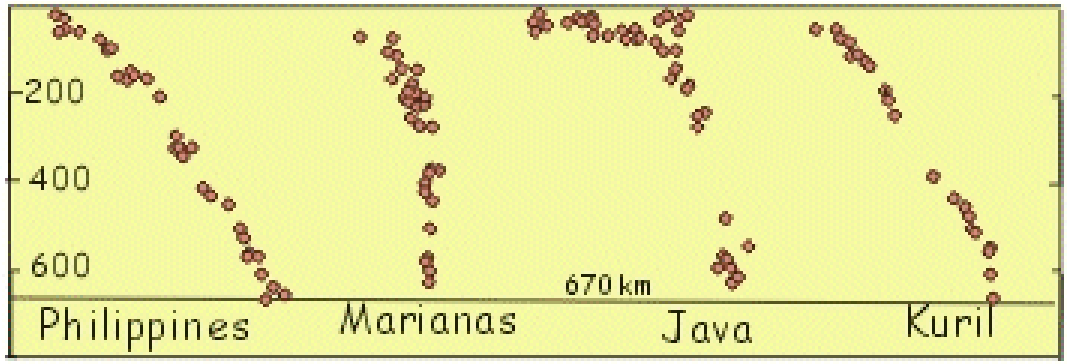
Which is the oldest oceanic plate?

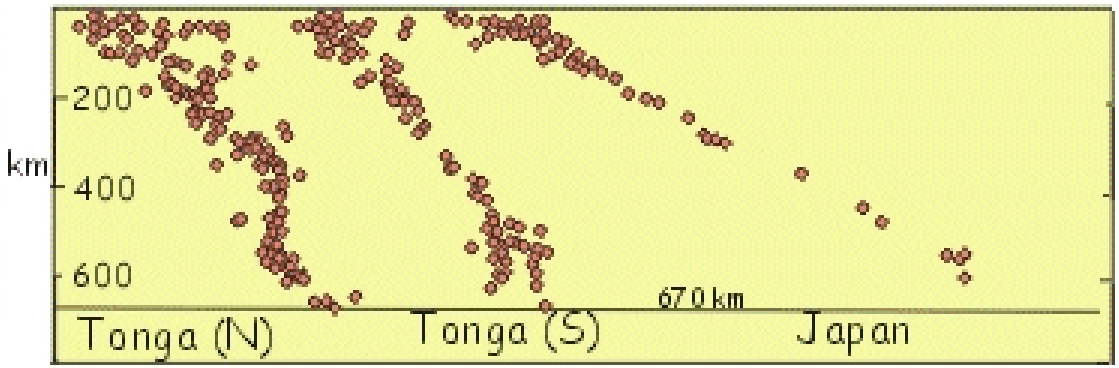
– Marianas (oldest/densest/most vertical)

Convergent boundary – Wadati-Benioff zone

Earthquakes and the dip of Wadati-Benioff seismic zones



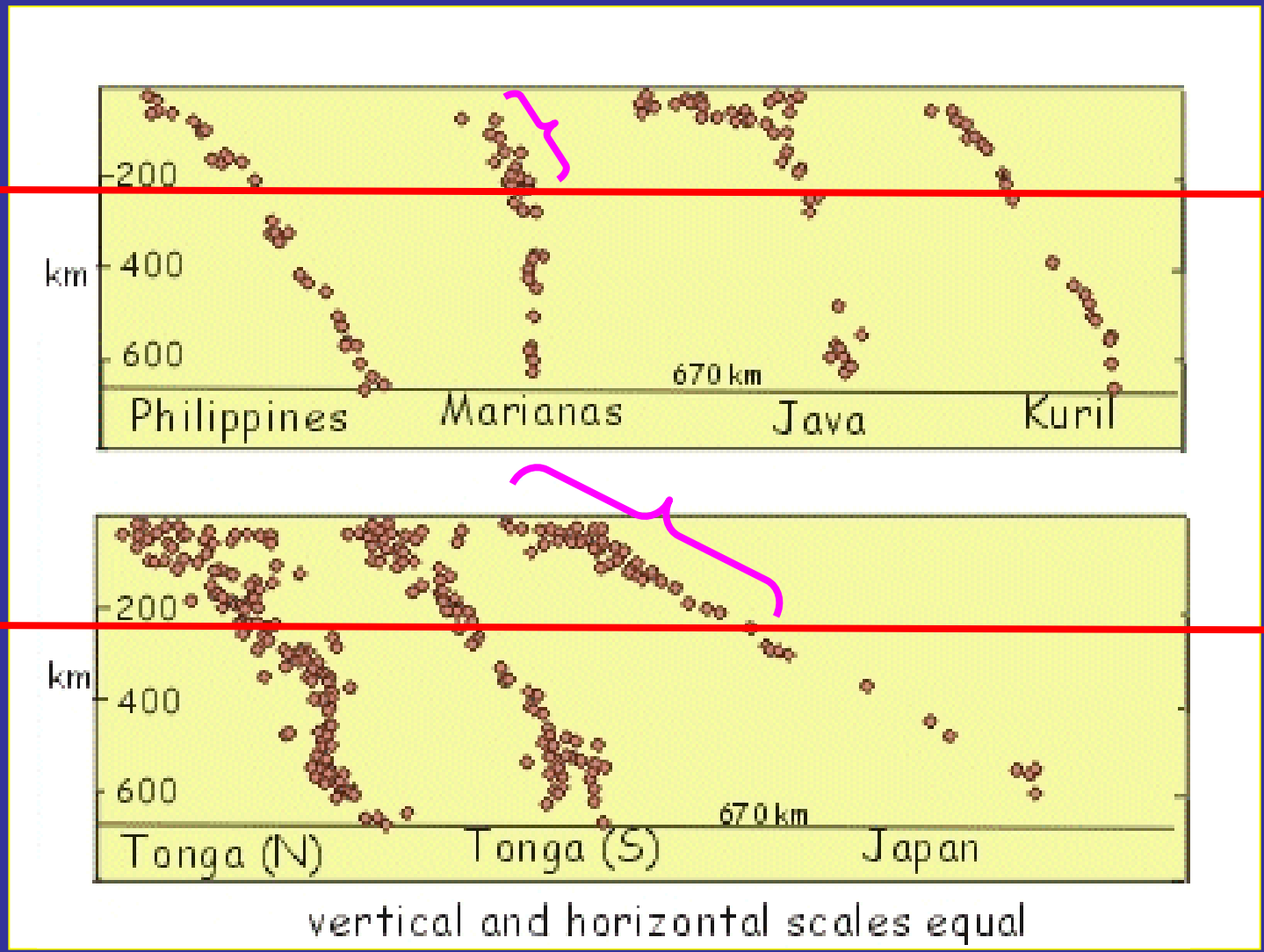




vertical and horizontal scales equal

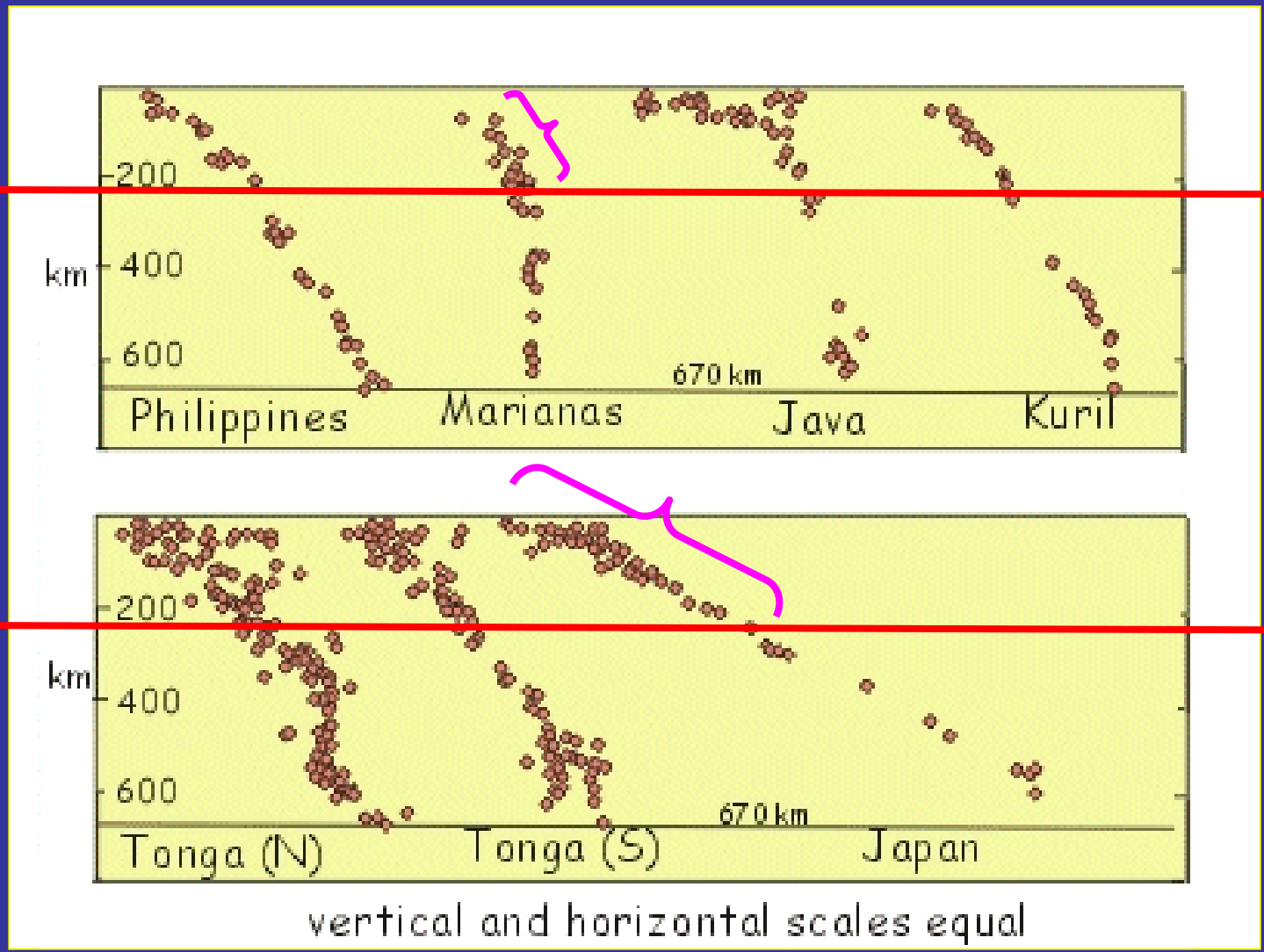
Which has the most violent earthquakes?

Convergent boundary – Wadati-Benioff zone



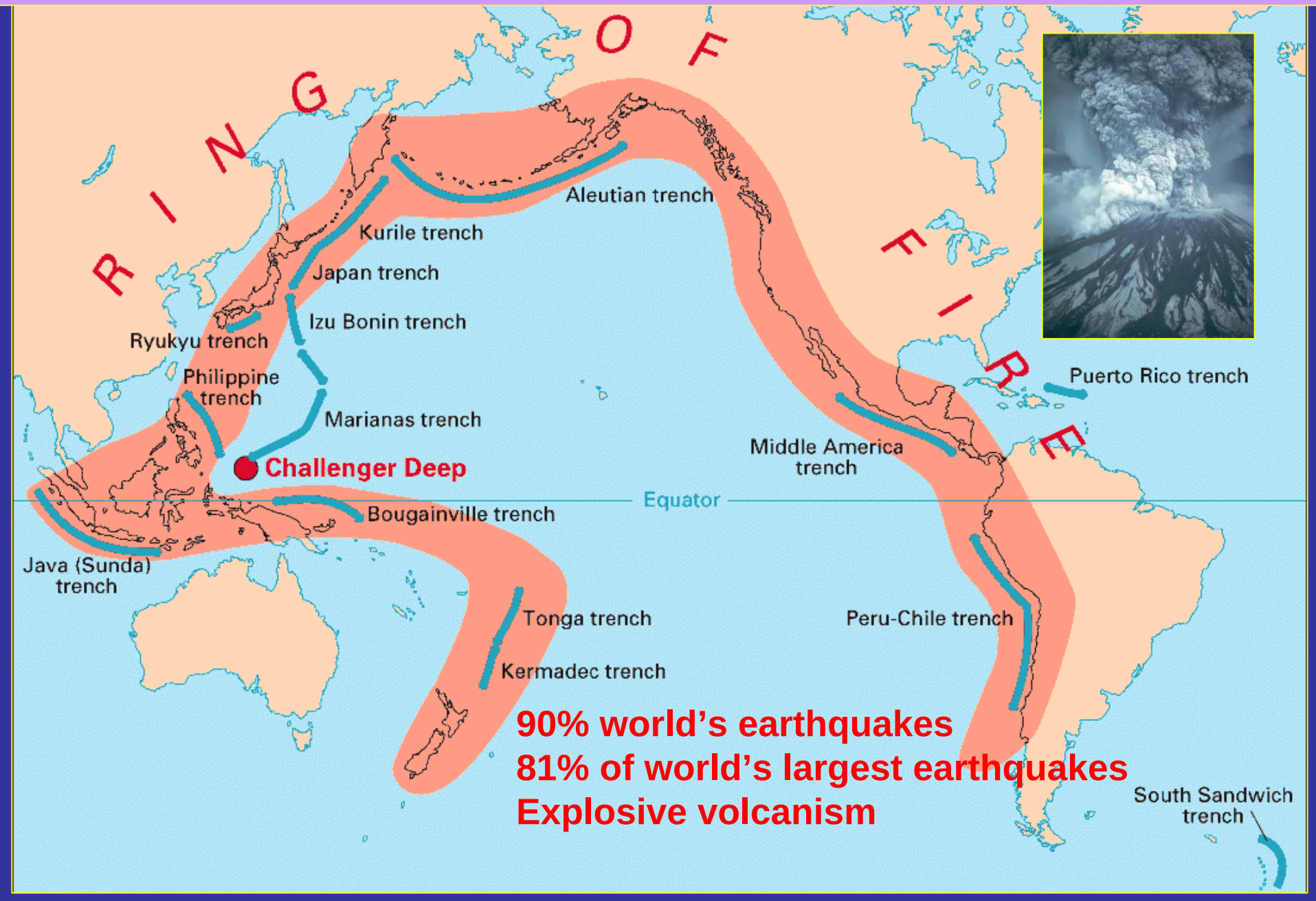
Which crustal material travels farthest in lithosphere?

Convergent boundary – Wadati-Benioff zone



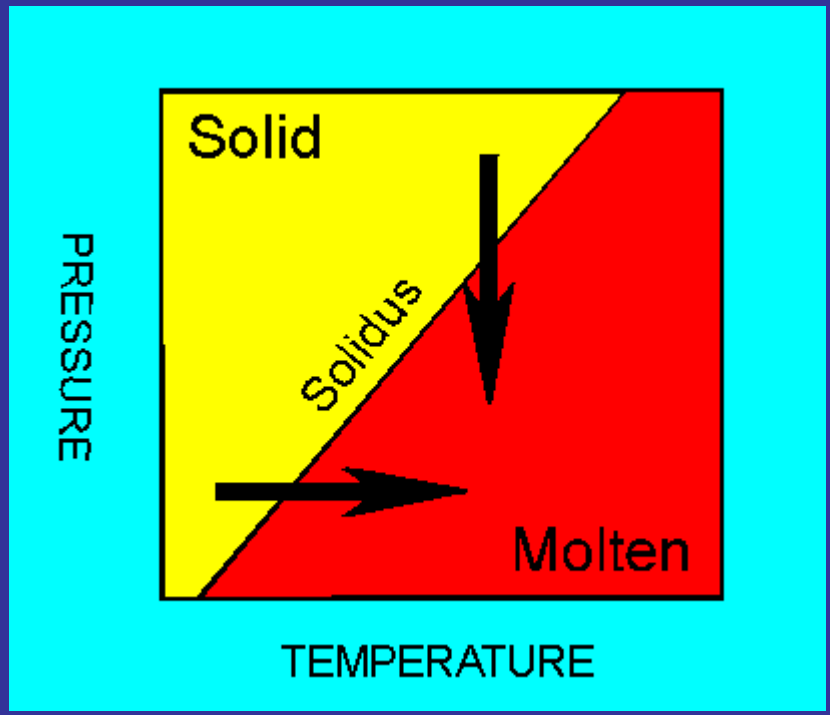
Shallow subduction angle - large frictional earthquakes

Why do we call this the “Ring of Fire”?

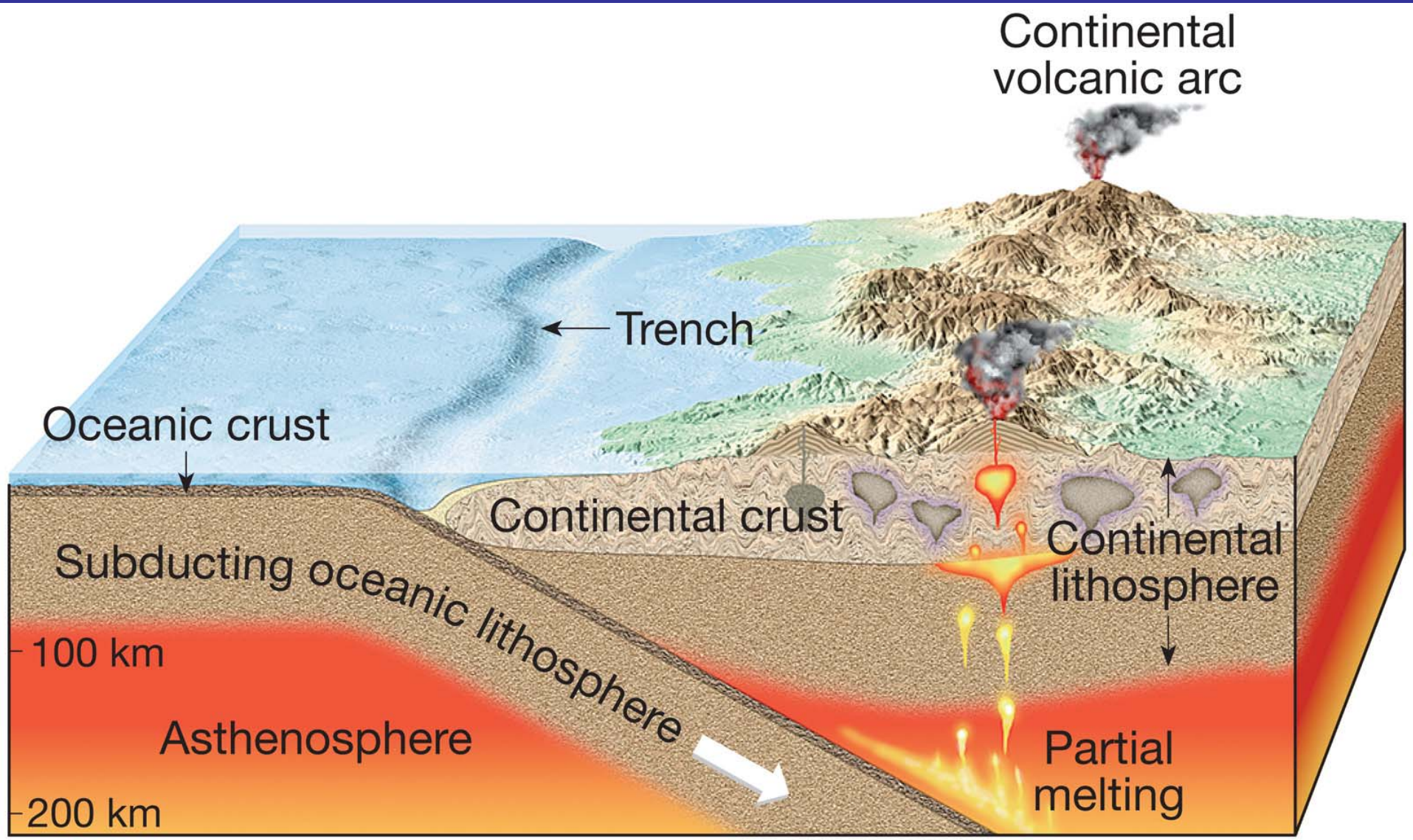


How do you melt rock at a convergent boundary?

1) Increase temperature
2) Decrease pressure

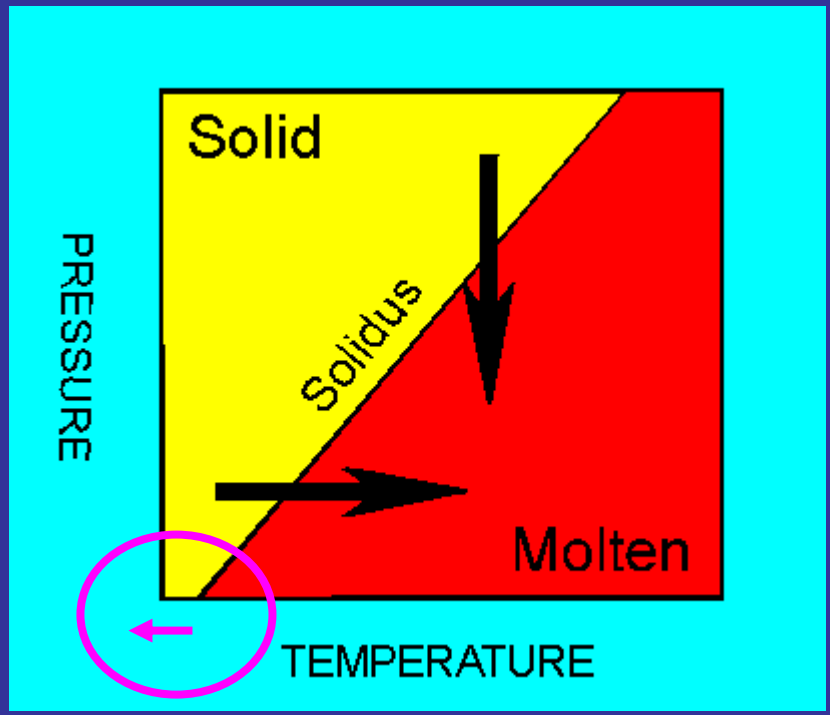


Convergent boundary – oceanic material decreases melting temperature



How do you melt rock at a convergent boundary?

1) Decrease temperature at which melting initiates



Crust alone - 1200°C

Crust plus oceanic material (water/sediments) - <1200°C

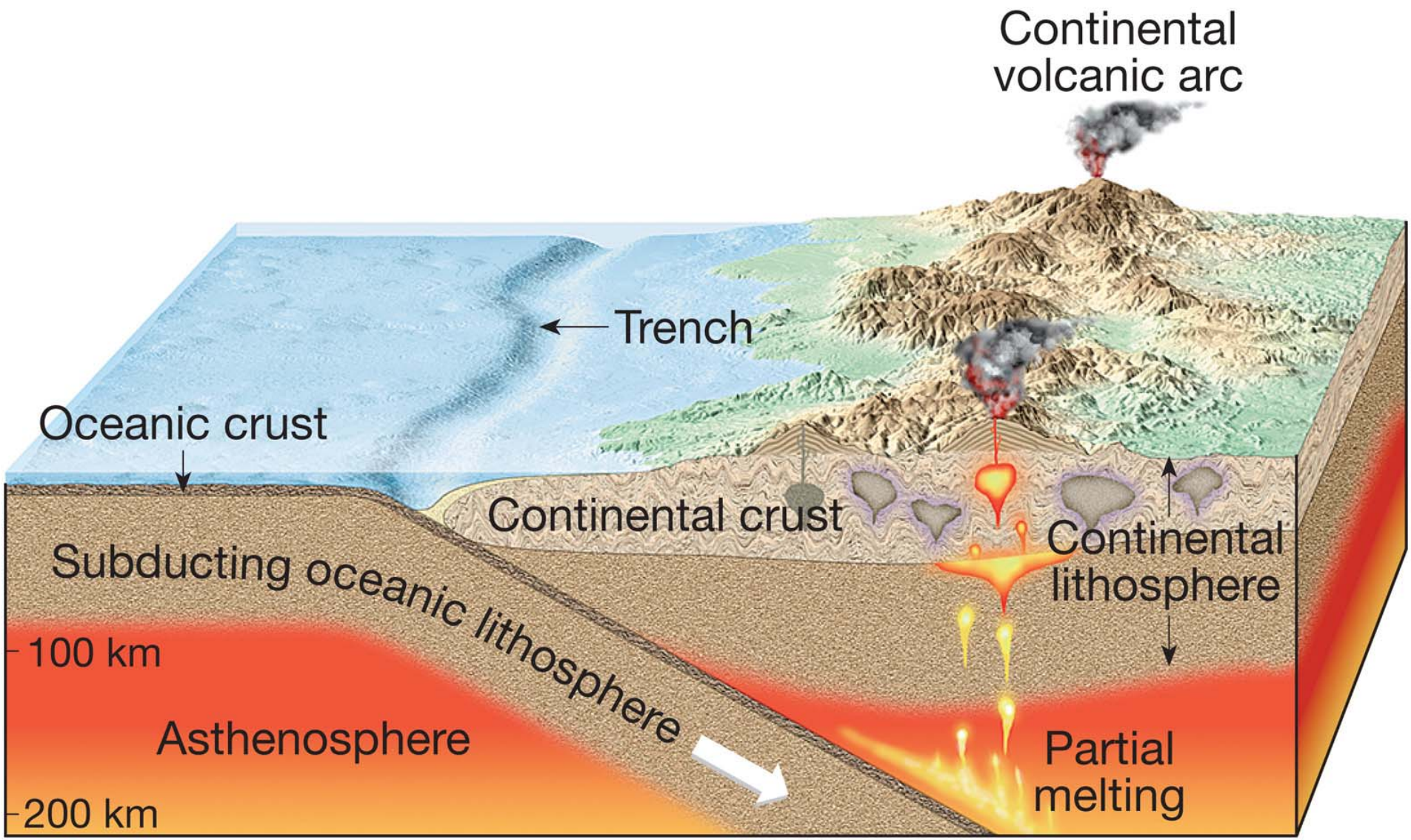

REMINDER:
March 2-4
Big Island Field Trip
$75 deposit due by FRIDAY
Cash or check to “Geology Club”

Convergent boundary – summary (all types)

1) Produce most of world's earthquakes
   - Old plates have steep subduction angle
   - Young plates have shallow subduction angle
   - Young plates produce violent earthquakes

2) Produce volcanoes on overriding plate
   - Decreased melting temperature due to incorporation of oceanic material

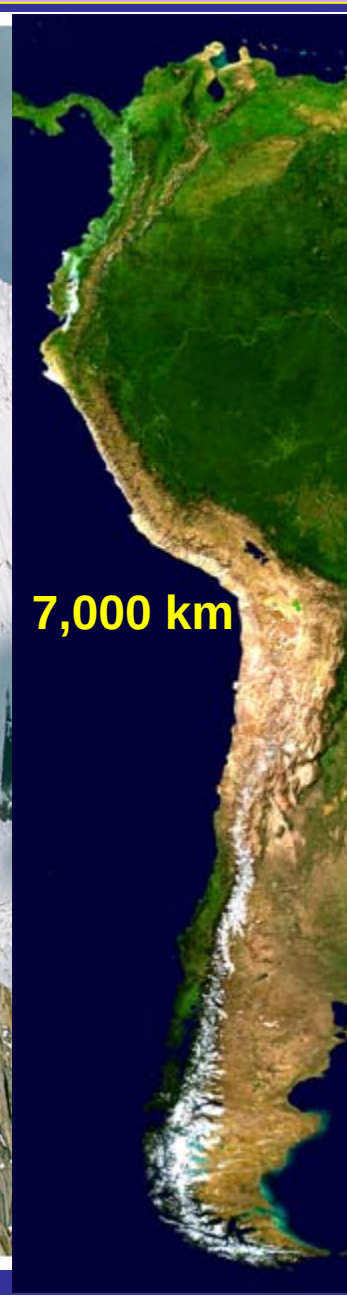
Convergent boundary – oceanic-continental



Convergent boundary – oceanic-continental

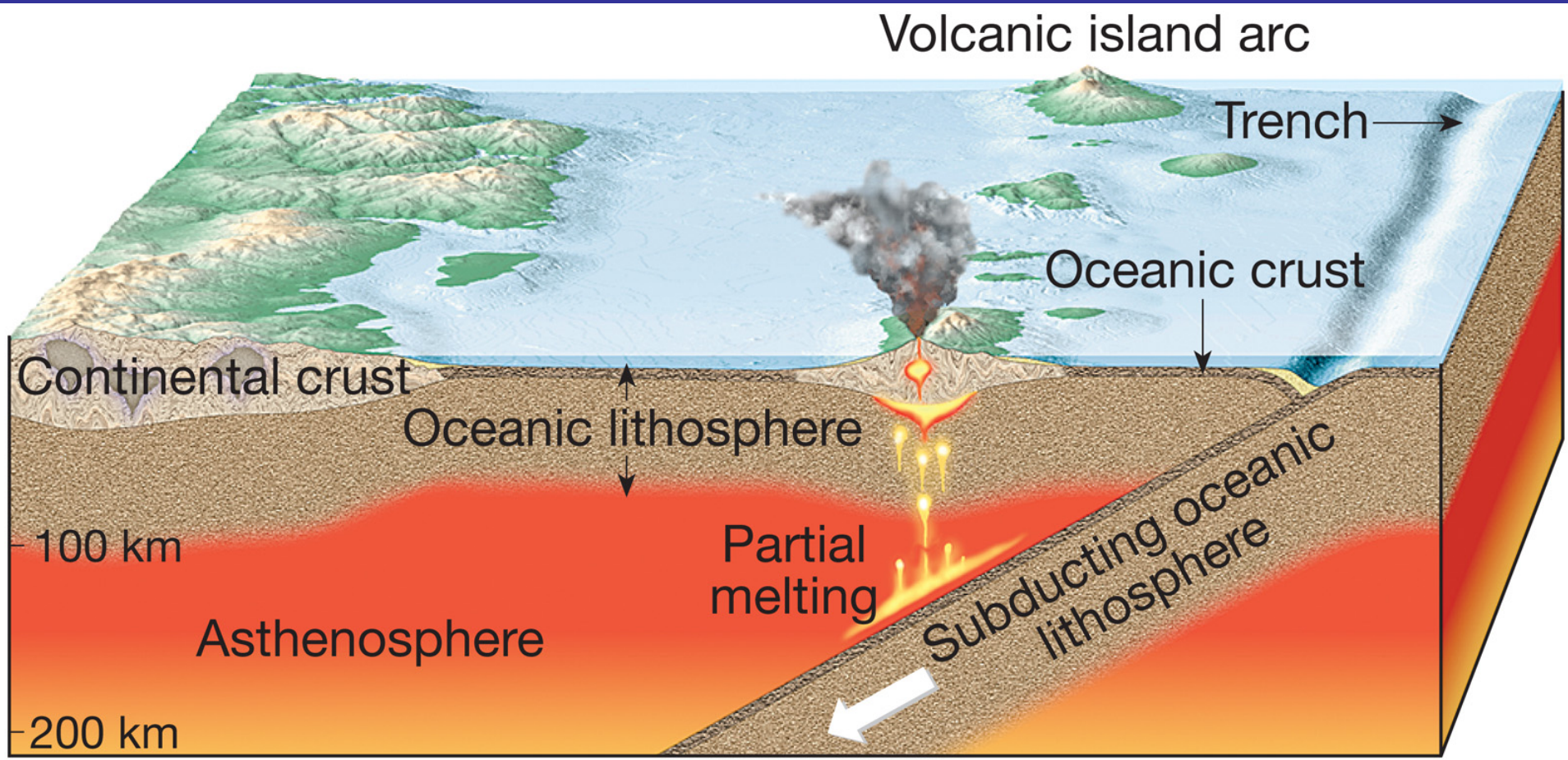


Typical Example –
Andes mountain range

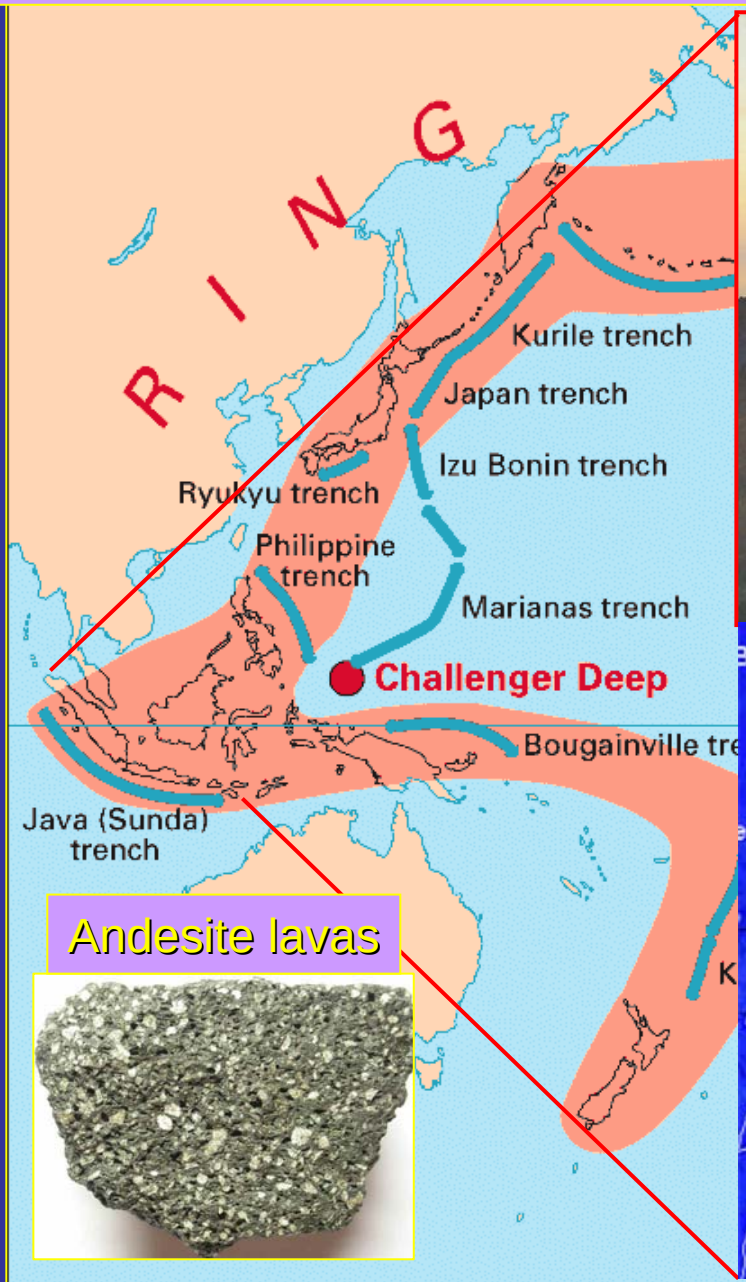


Andesite lavas

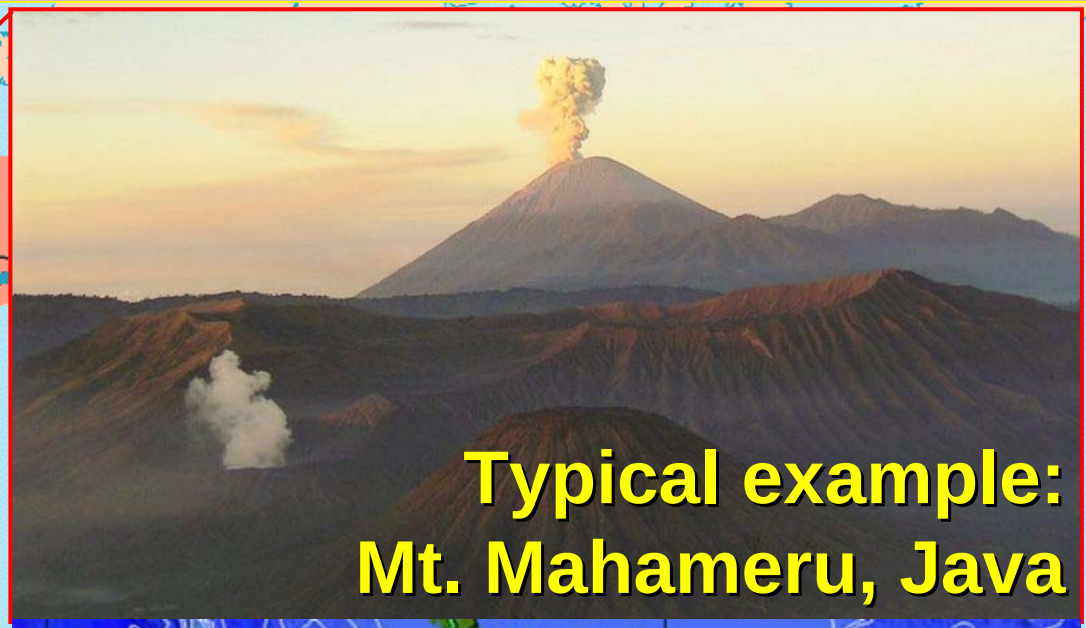
Convergent boundary – oceanic-oceanic



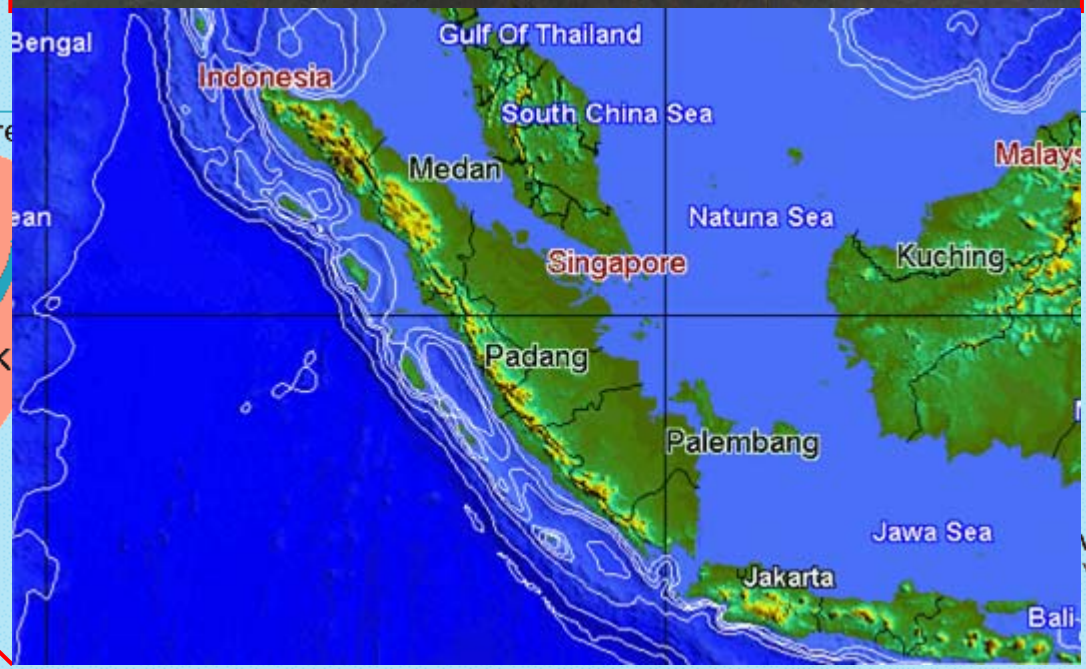
Convergent boundary – oceanic-oceanic



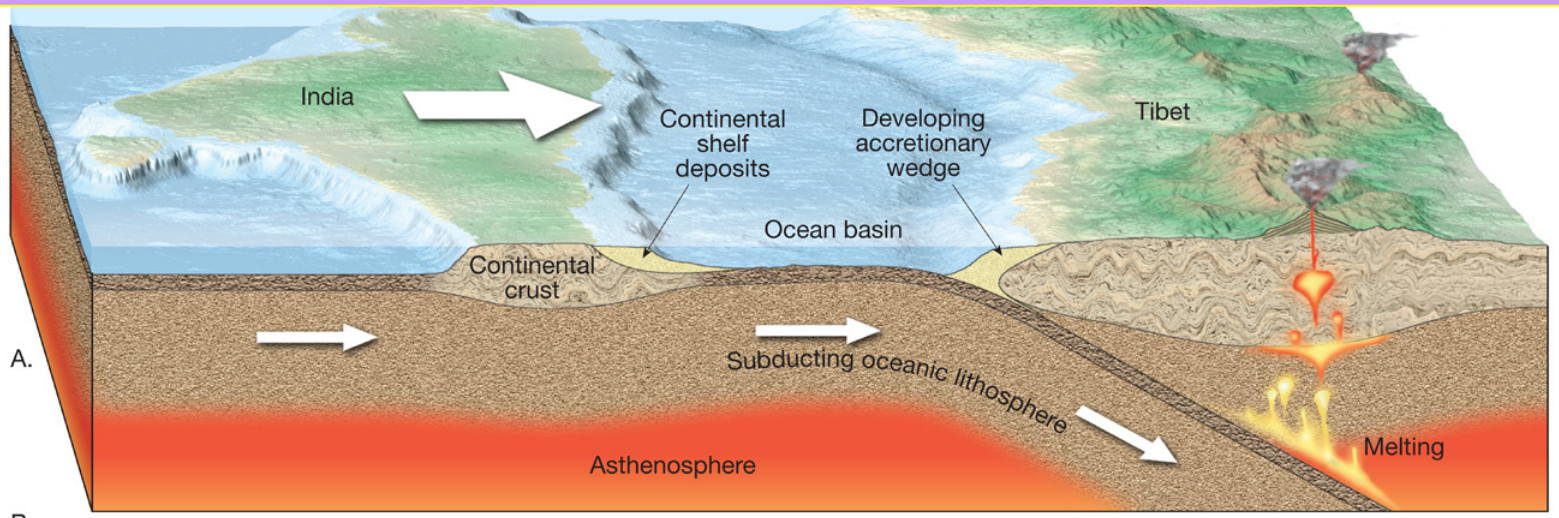
Andesite lavas

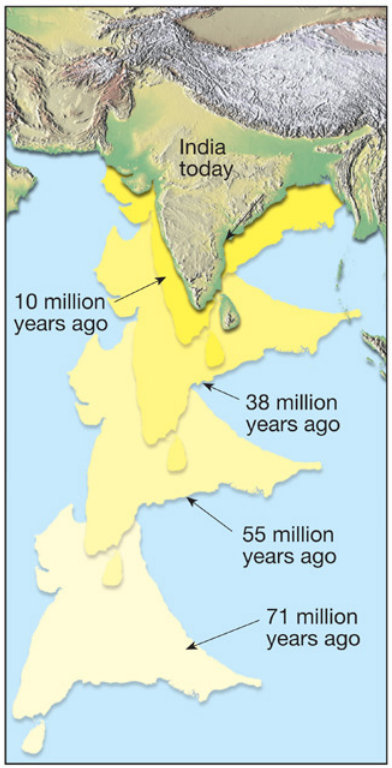


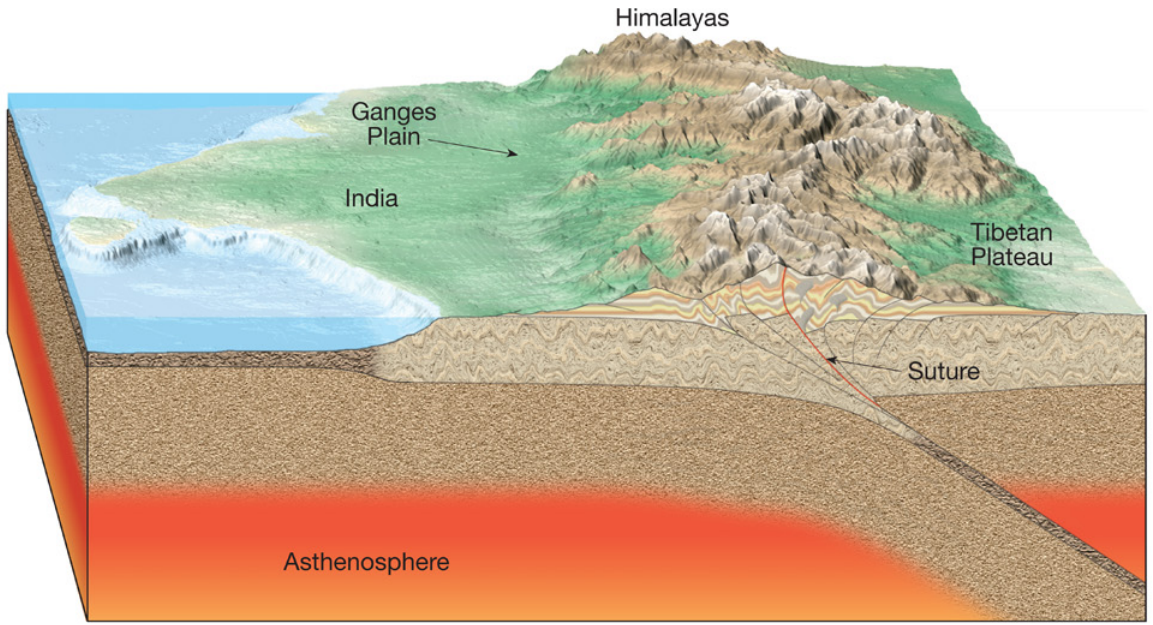
Typical example: Mt. Mahameru, Java

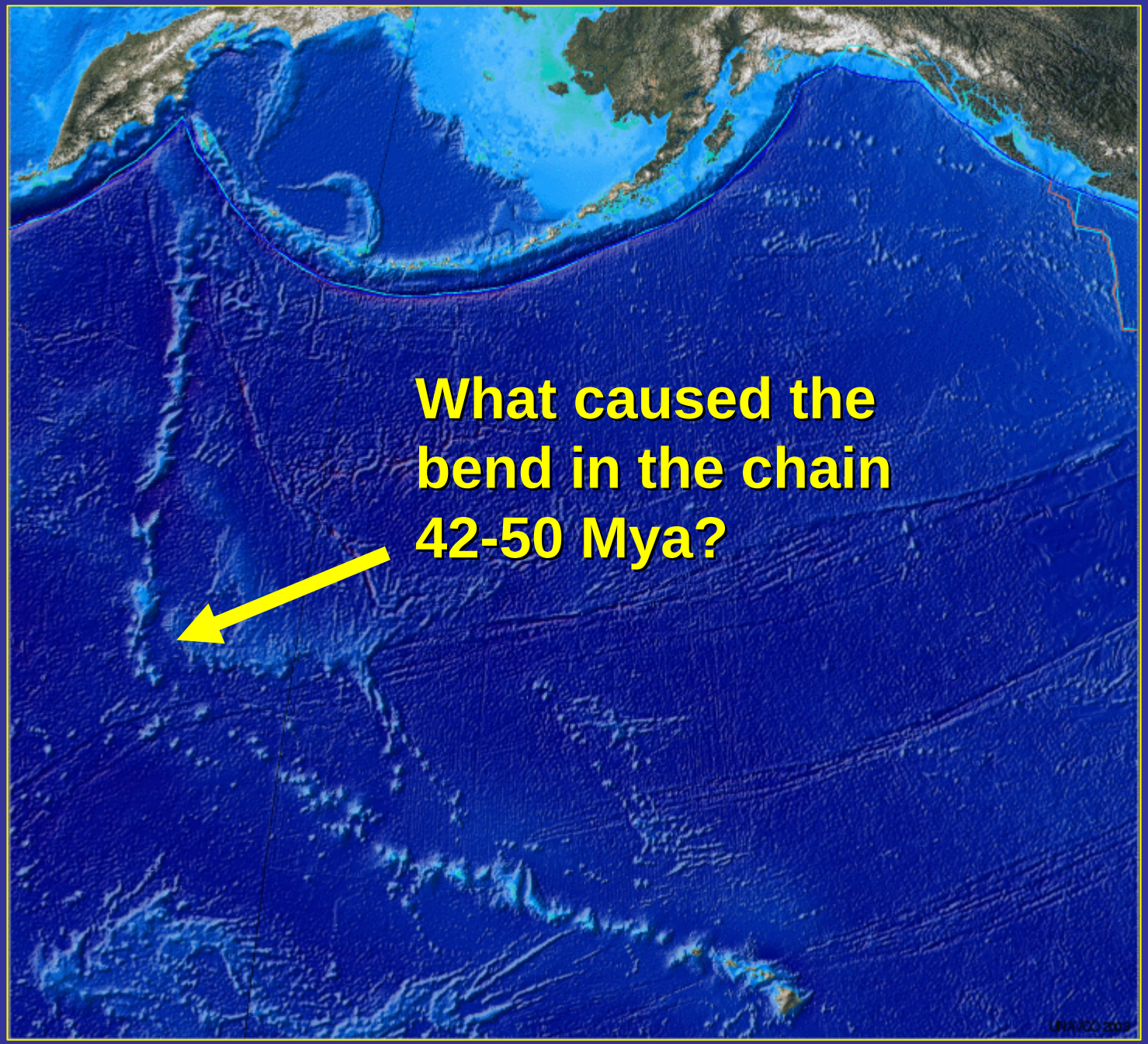


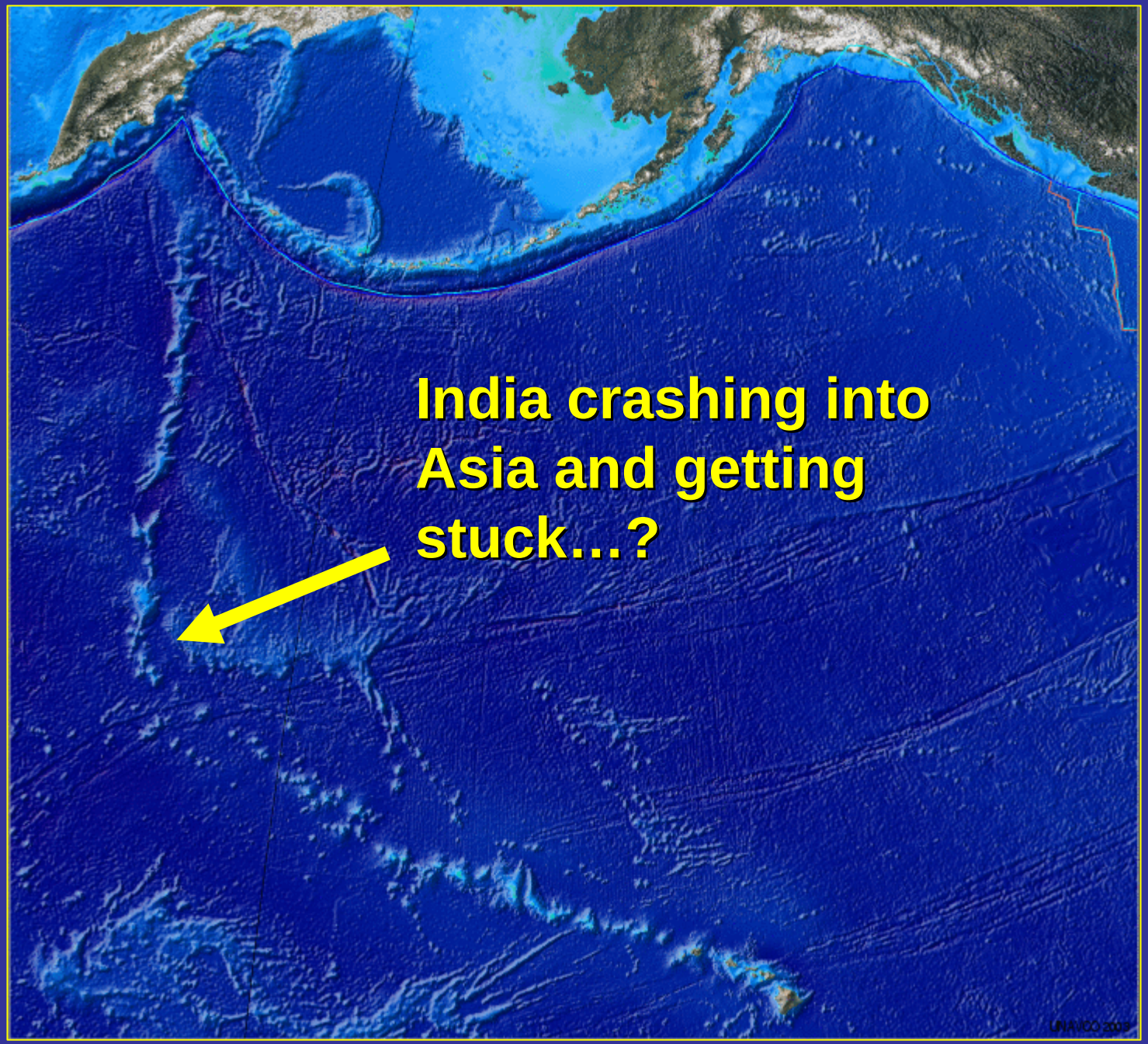
Convergent boundary – continental-continental



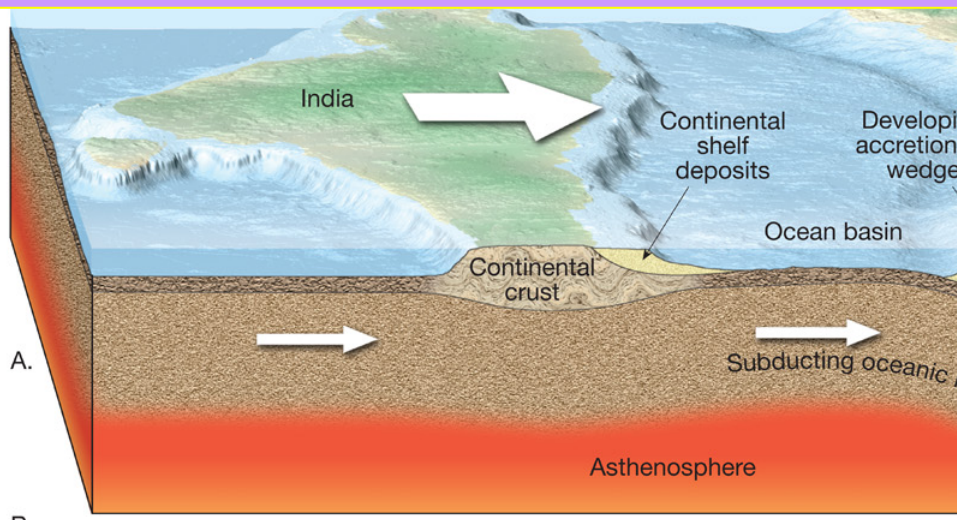


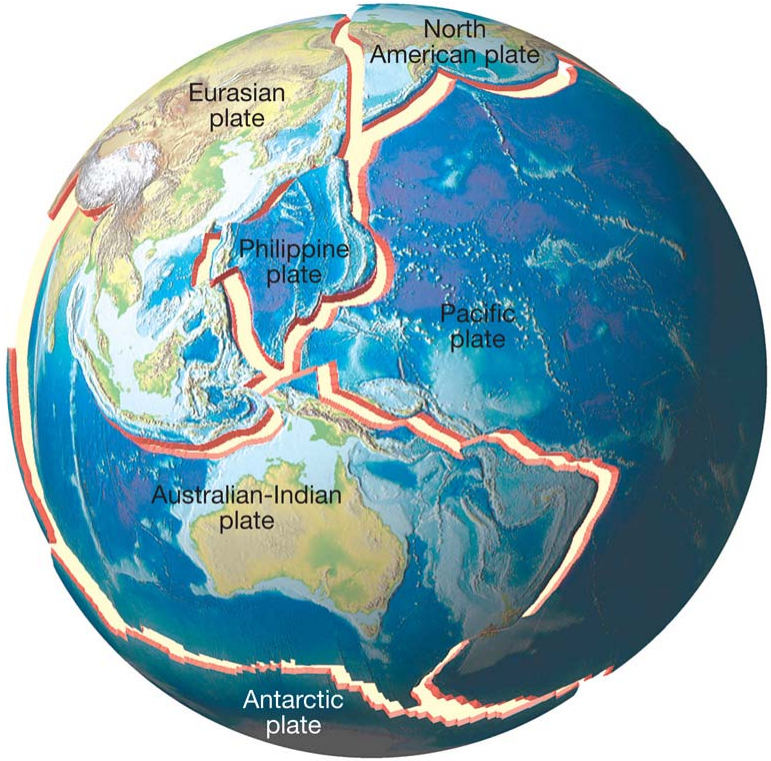



What caused the bend in the chain 42-50 Mya?


India crashing into Asia and getting stuck…?

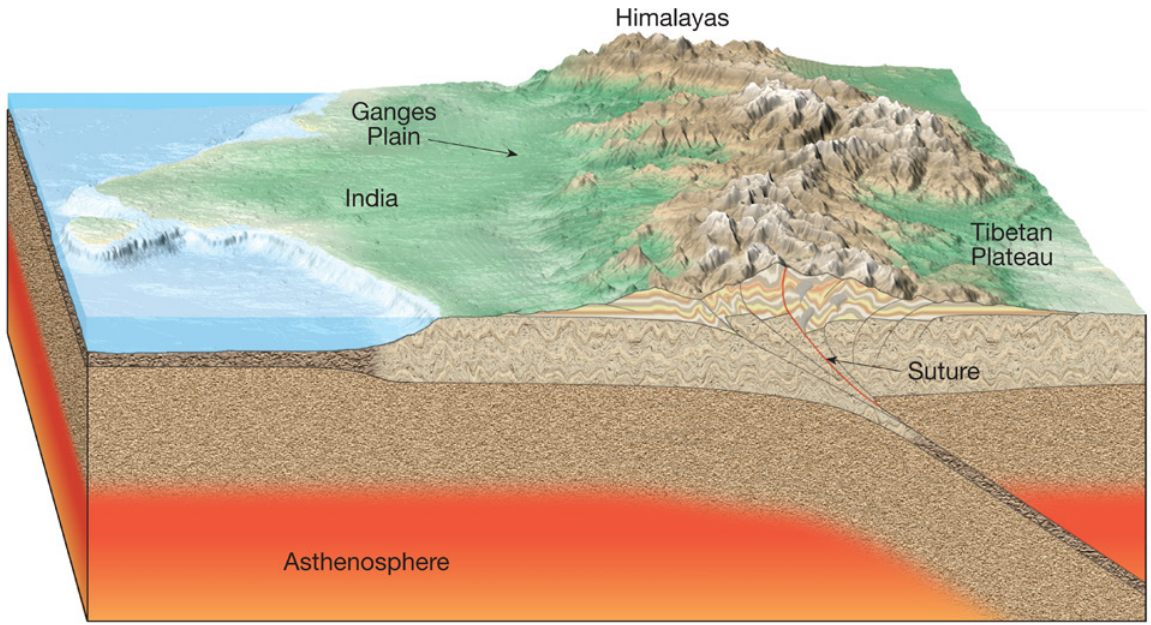
Convergent boundary





B.





C.

Convergent boundary – continental-continental

Gneiss - metamorphic



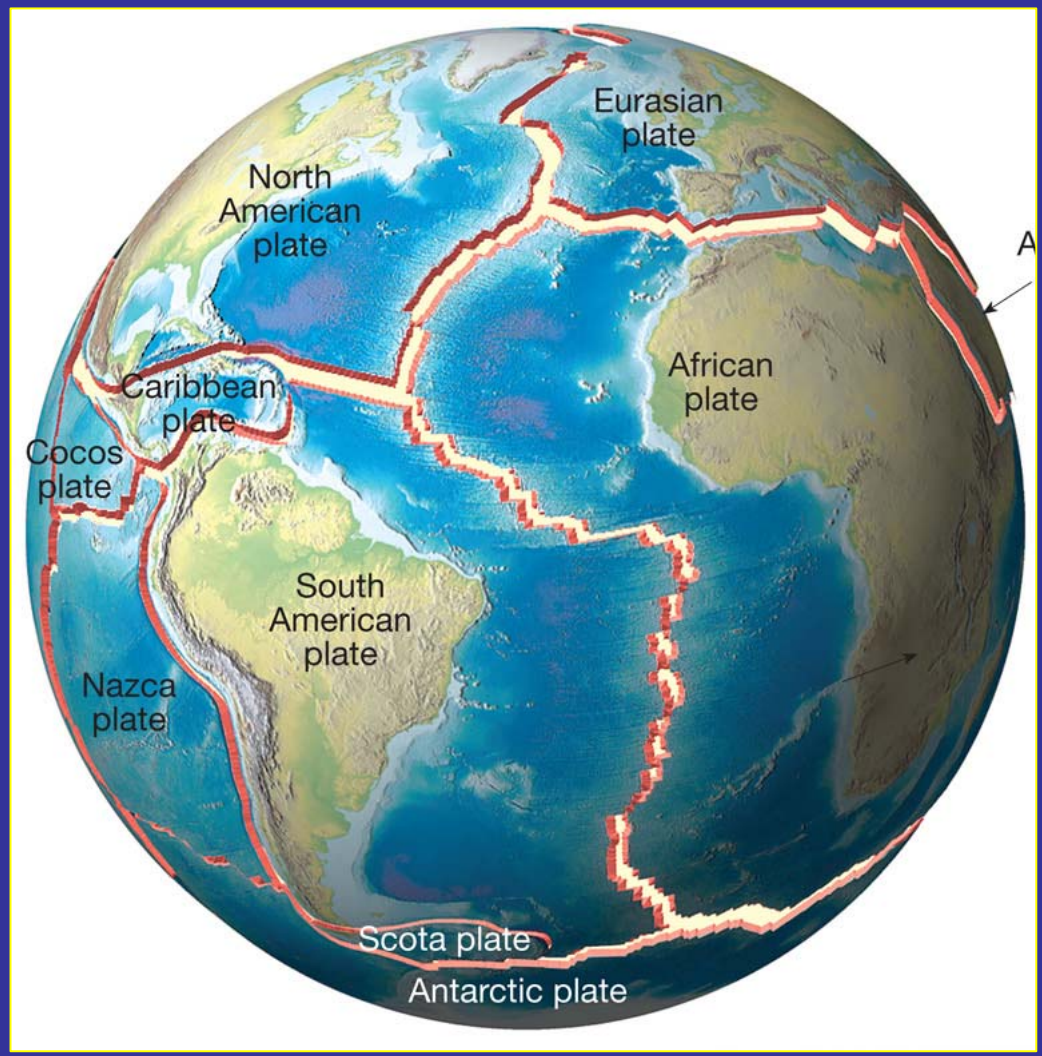
Typical example - Mt. Everest, Nepal

Transform Fault Boundaries – "Conservative plate margins"

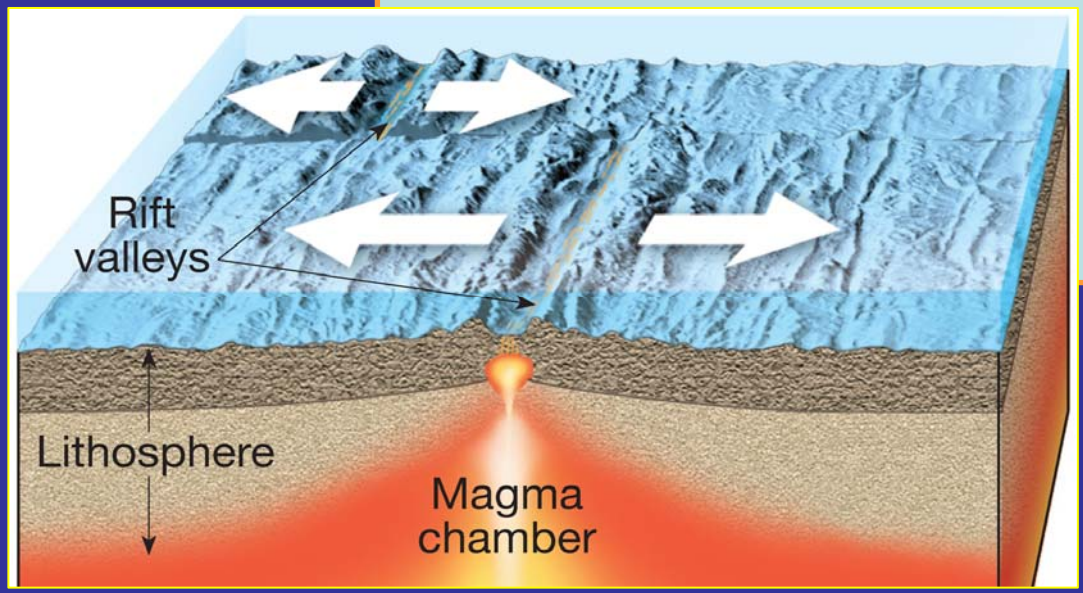
- Earth's crust is neither created nor destroyed

1. Oceanic transforms

2. Continental transforms



Transform fault boundary – oceanic



Spreading
ridges

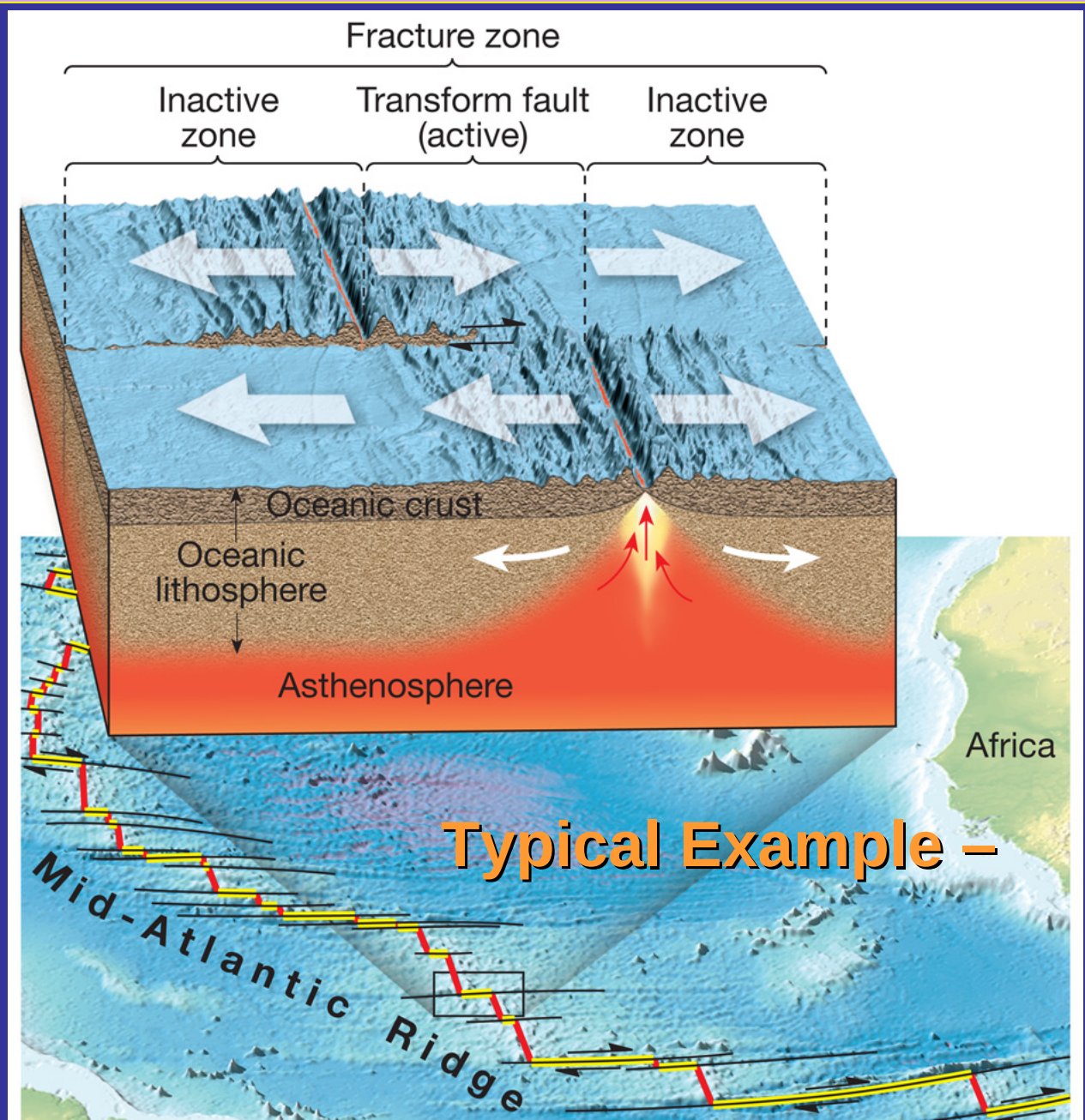
Transform fault vs. seafloor lineation

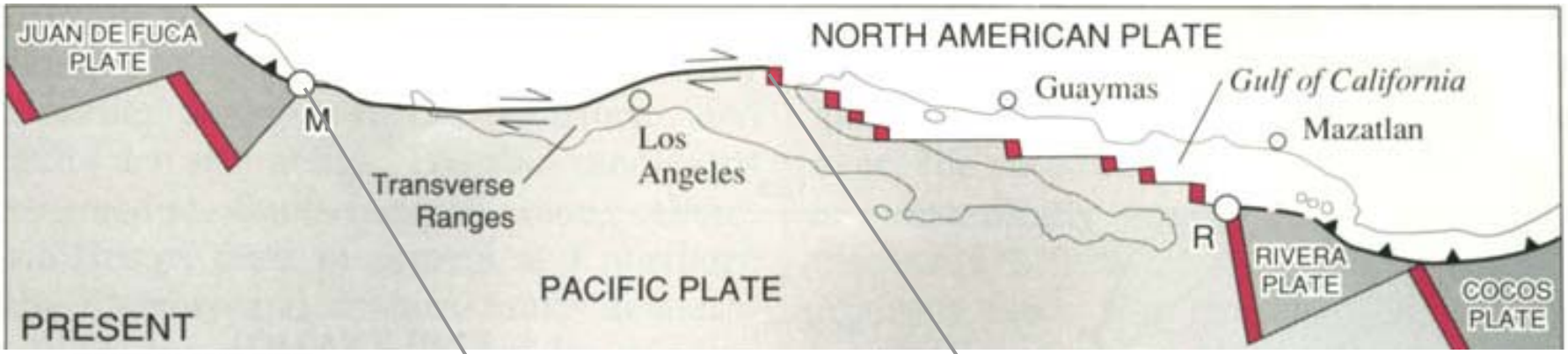
Accommodates transverse spreading geometry



Allows continents to split into irregular shapes

Transform fault boundary – oceanic





EXPLANATION

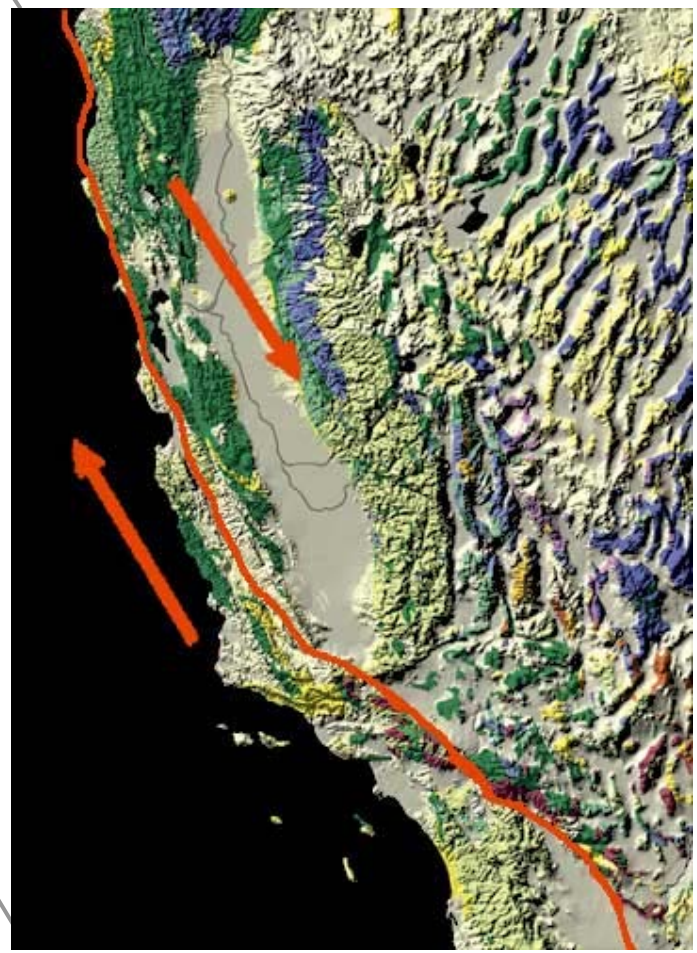
Spreading center

Subduction zone—Dashed where approximately located. Sawteeth on upper plate

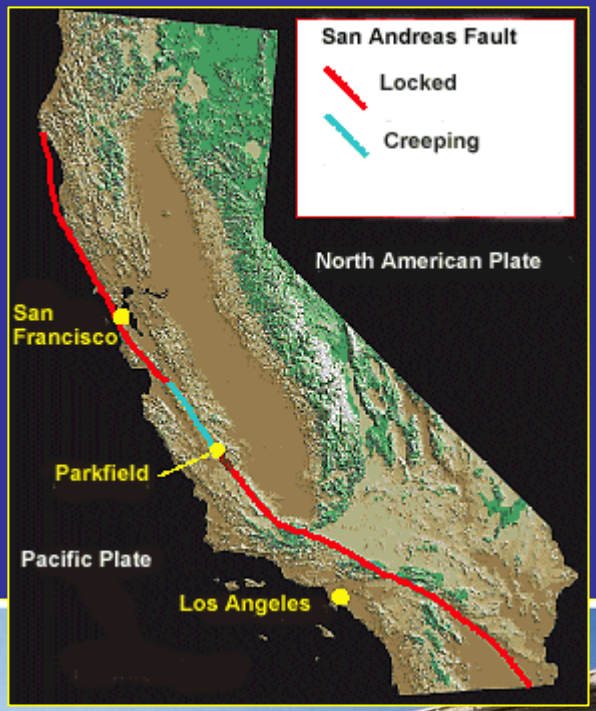
Fault—Dashed where approximately located. Arrows indicate direction of relative movement

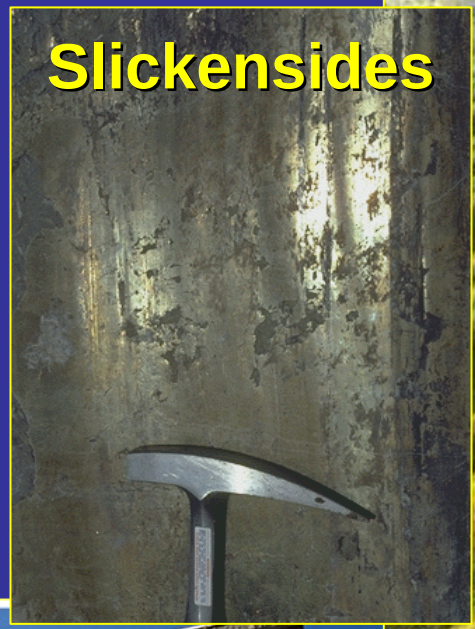
Transform faults can also occur on land

San Andreas separates Pacific and North American Plates

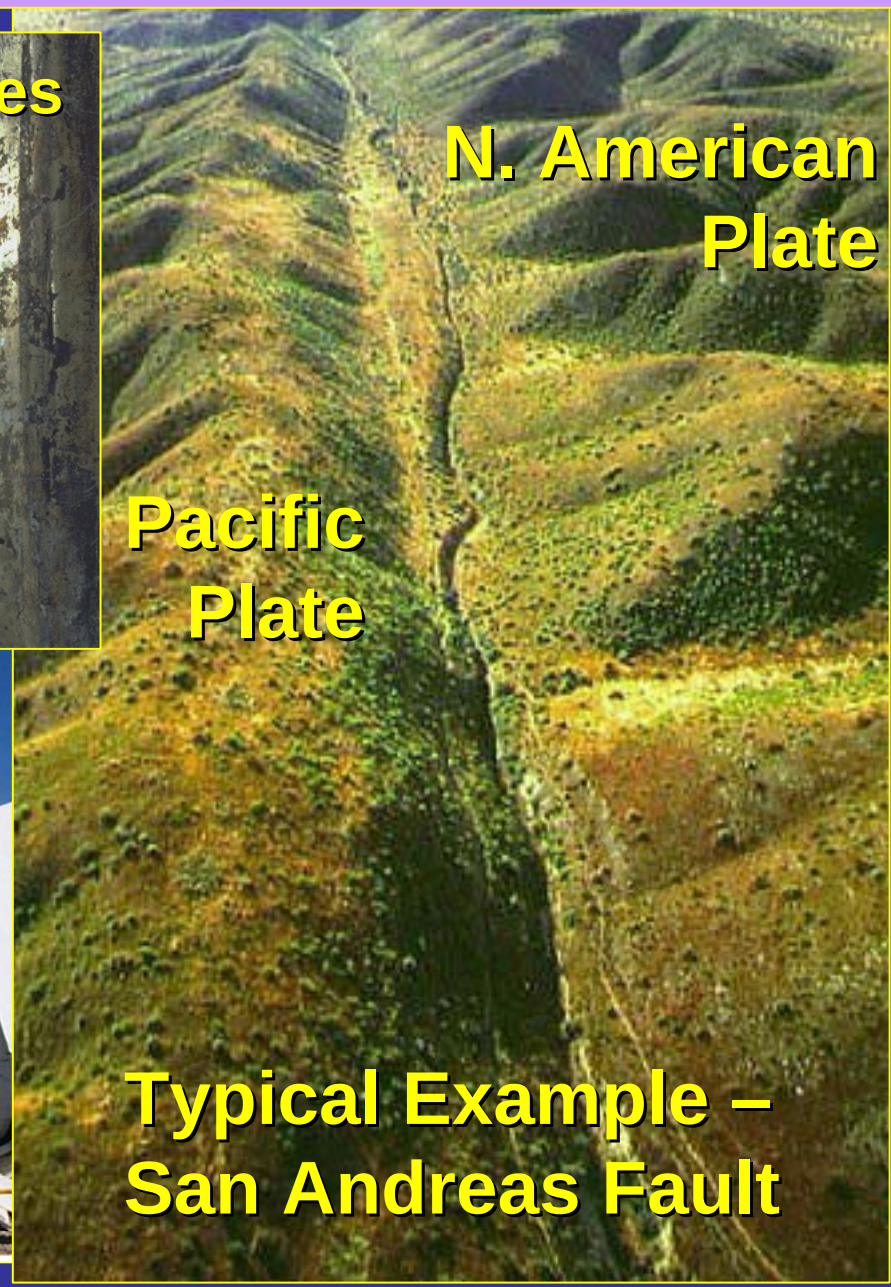


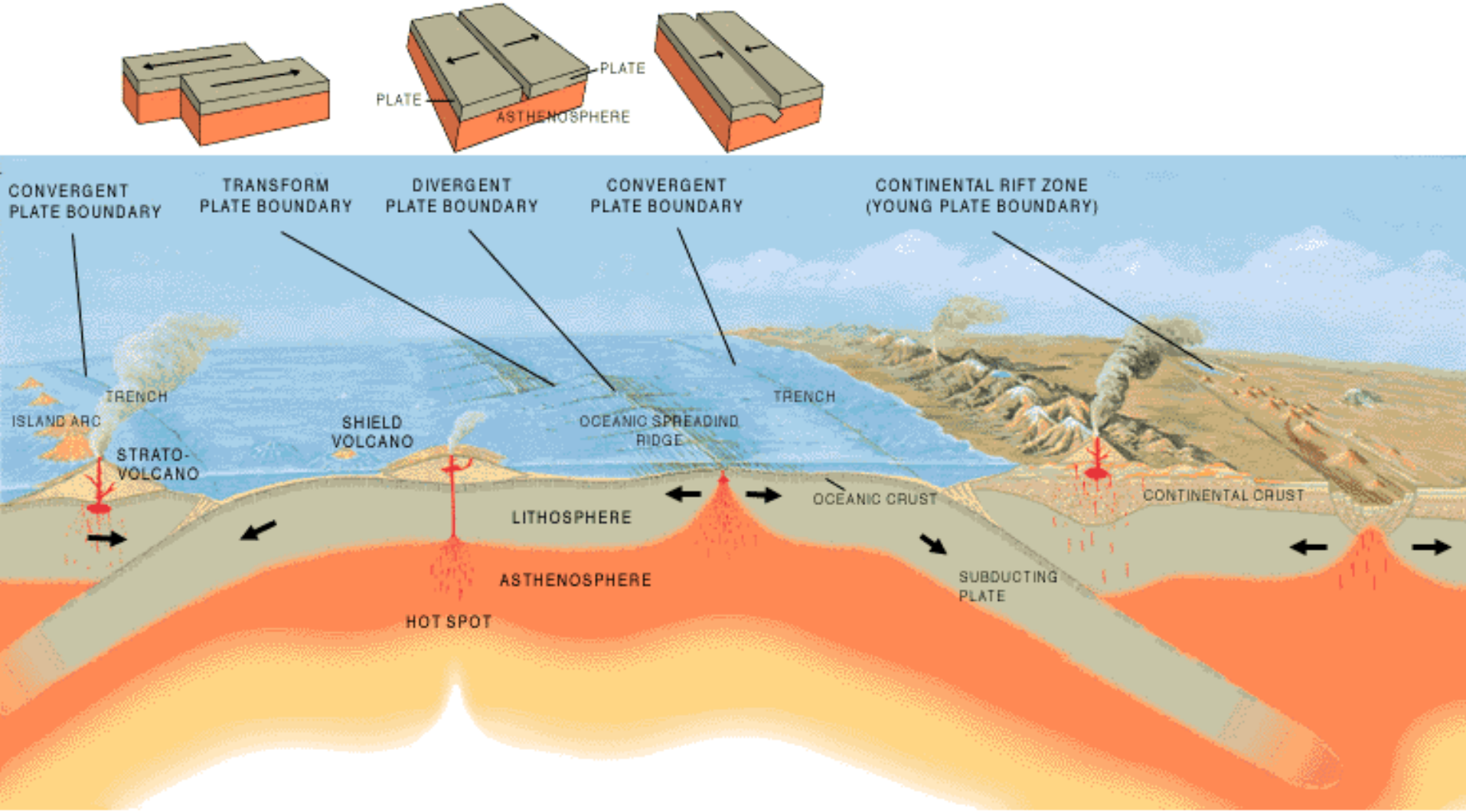
Transform fault boundary – continental











Main Types of Plate Margins:

Divergent
Convergent
Transform