Geomorphology

- OLLI
- Loudoun Campus
- June 30 to July 14 2010
- Barry Haack
- GMU Geography

Geomorphology Outline

Earth Materials	Tectonic Forces	Gradational Forces	Landforms
Elements	Internal	External	Plains
Minerals	Increase Elevation	Lower Elevation	Plateaus
Rocks			Hills
Sedimentary	Vulcanism	Weathering	Mountains
Igneous			
Metamorphic	Diastrophism	Erosional Agents	
		Depositional Processes	

Geomorphology Controls

- Geologic Time Scale
- Uniformitarianism
- Continental Drift, Plate Tectonics

Geologic Time Scale

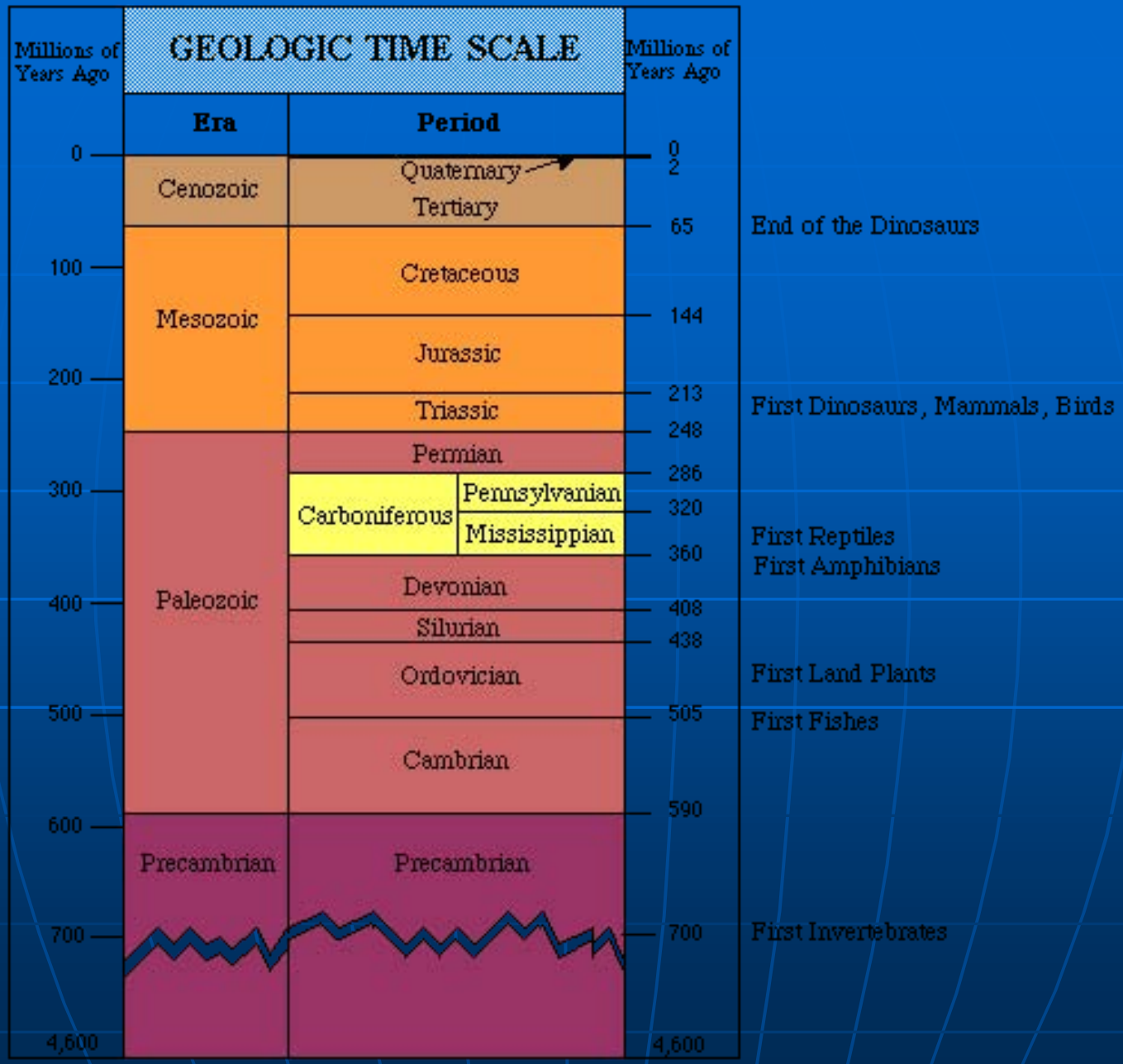
- Earth age ?
- Man as a species ?
- Civilized man ?
- Scientific man ?

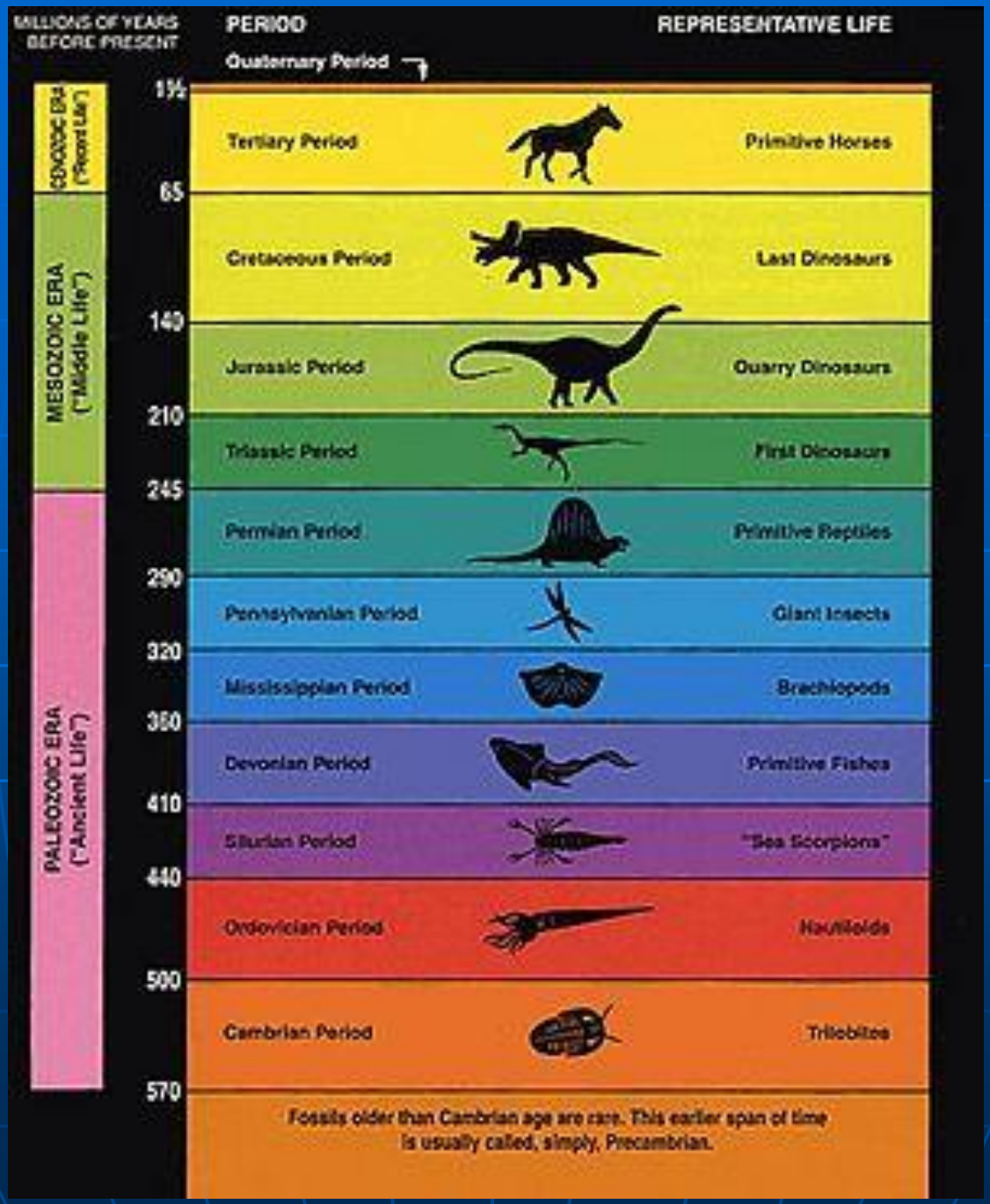
Geologic Time Scale

- Earth age, ~4.7 billion
- Man as a species, ~4-5 million
- Civilized man, 1-2,000 years
- Scientific man, 2-400 years

Geologic Time Scale

- Era, Period, Epoch
- Cenozoic Era, to 65 mi. yrs BCE
  Holocene epoch, Pleistocene epoch
- Mesozoic Era, 65-250 mi. yrs BCE
  Rocky Mt 135 mi yrs, Appalachians 225
- Paleozoic Era, 225-590 mi. yrs BCE
  Origin of life, ~590 mi. yrs BCE
- Pre-Cambrian, 590 to 4.7 bi. yrs BCE


GEOLOGIC TIME SCALE
Millions of Years Ago
Era
Period
Millions of Years Ago
0
100
200
300
400
500
600
700
4,600
Cenozoic
Mesozoic
Paleozoic
Precambrian
Quaternary
Tertiary
Cretaceous
Jurassic
Triassic
Permian
Carboniferous
Pennsylvanian
Mississippian
Devonian
Silurian
Ordovician
Cambrian
Precambrian
0
2
65
144
213
248
286
320
360
408
438
505
590
700
4,600
End of the Dinosaurs
First Dinosaurs, Mammals, Birds
First Reptiles
First Amphibians
First Land Plants
First Fishes
First Invertebrates


MILLIONS OF YEARS BEFORE PRESENT
PERIOD
REPRESENTATIVE LIFE
Quaternary Period
1½
Tertiary Period
Primitive Horses
65
Cretaceous Period
Last Dinosaurs
140
Jurassic Period
Quarry Dinosaurs
210
Triassic Period
First Dinosaurs
245
Permian Period
Primitive Reptiles
290
Pennsylvanian Period
Giant Insects
320
Mississippian Period
Brachiopods
360
Devonian Period
Primitive Fishes
410
Silurian Period
"Sea Scorpions"
440
Ordovician Period
Nautiloids
500
Cambrian Period
Trilobites
570
Fossils older than Cambrian age are rare. This earlier span of time is usually called, simply, Precambrian.
CENOZOIC ERA ("Recent Life")
MESOZOIC ERA ("Middle Life")
PALEOZOIC ERA ("Ancient Life")

Landform Processes

- Catastrophism
- Uniformitarianism

Earth Structure

- 4000 mile radius
- Core, 2200 mile radius
- Mantle, 1800 mile thick, magma
- Crust, 5-25 mile thick on surface

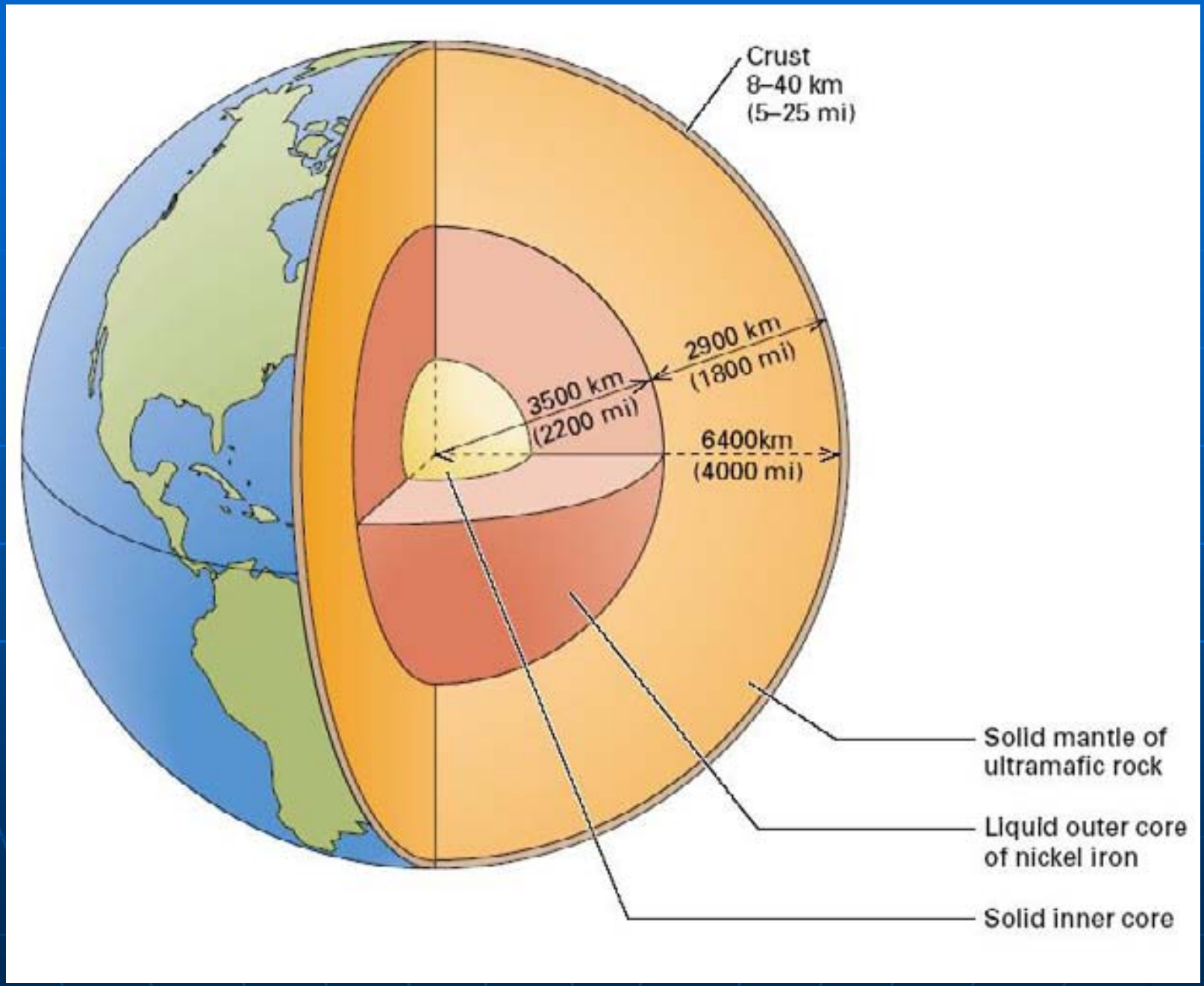

Crust
8–40 km
(5–25 mi)
2900 km
(1800 mi)
3500 km
(2200 mi)
6400km
(4000 mi)
Solid mantle of
ultramafic rock
Liquid outer core
of nickel iron
Solid inner core

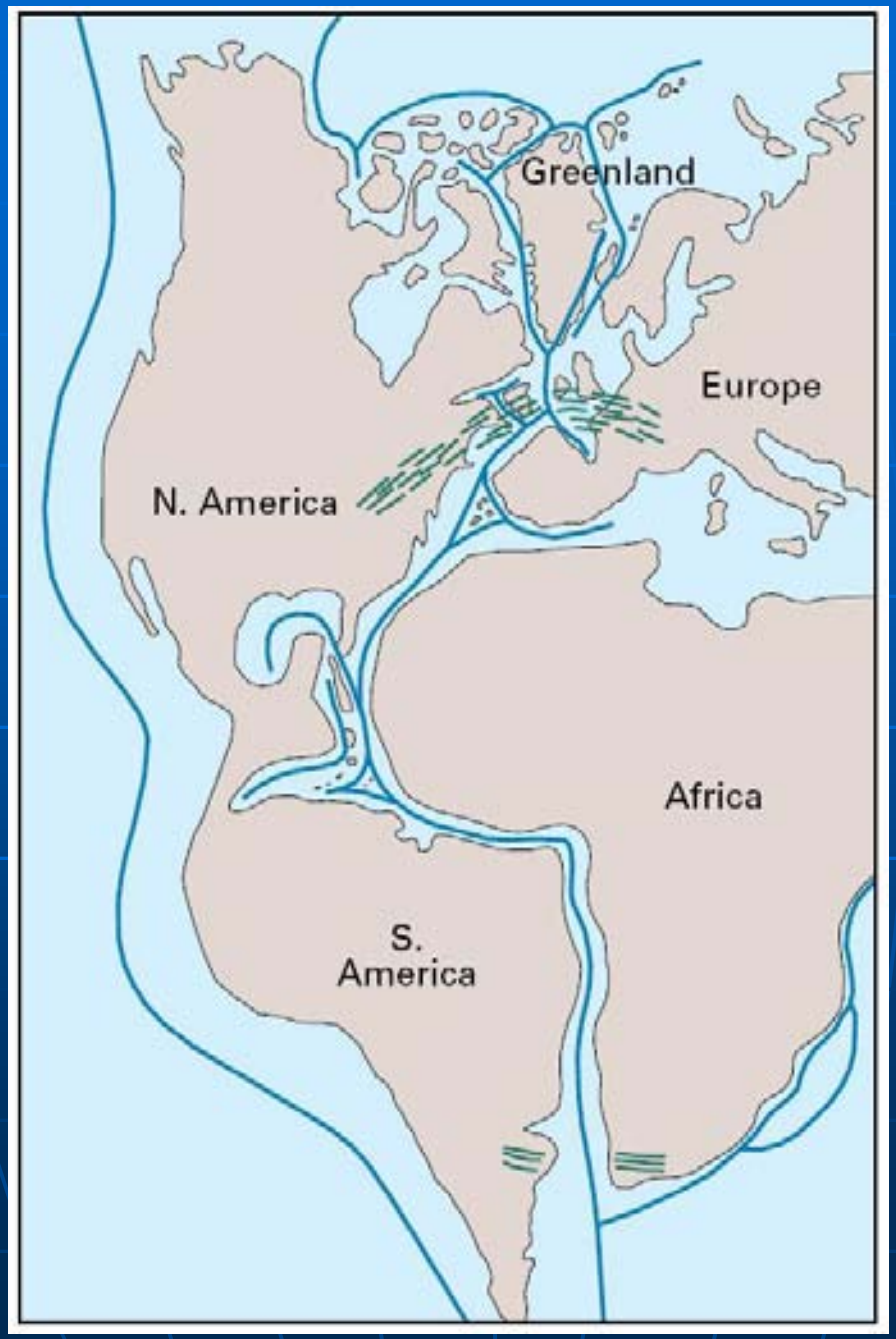
Plate Tectonics-Continental Drift

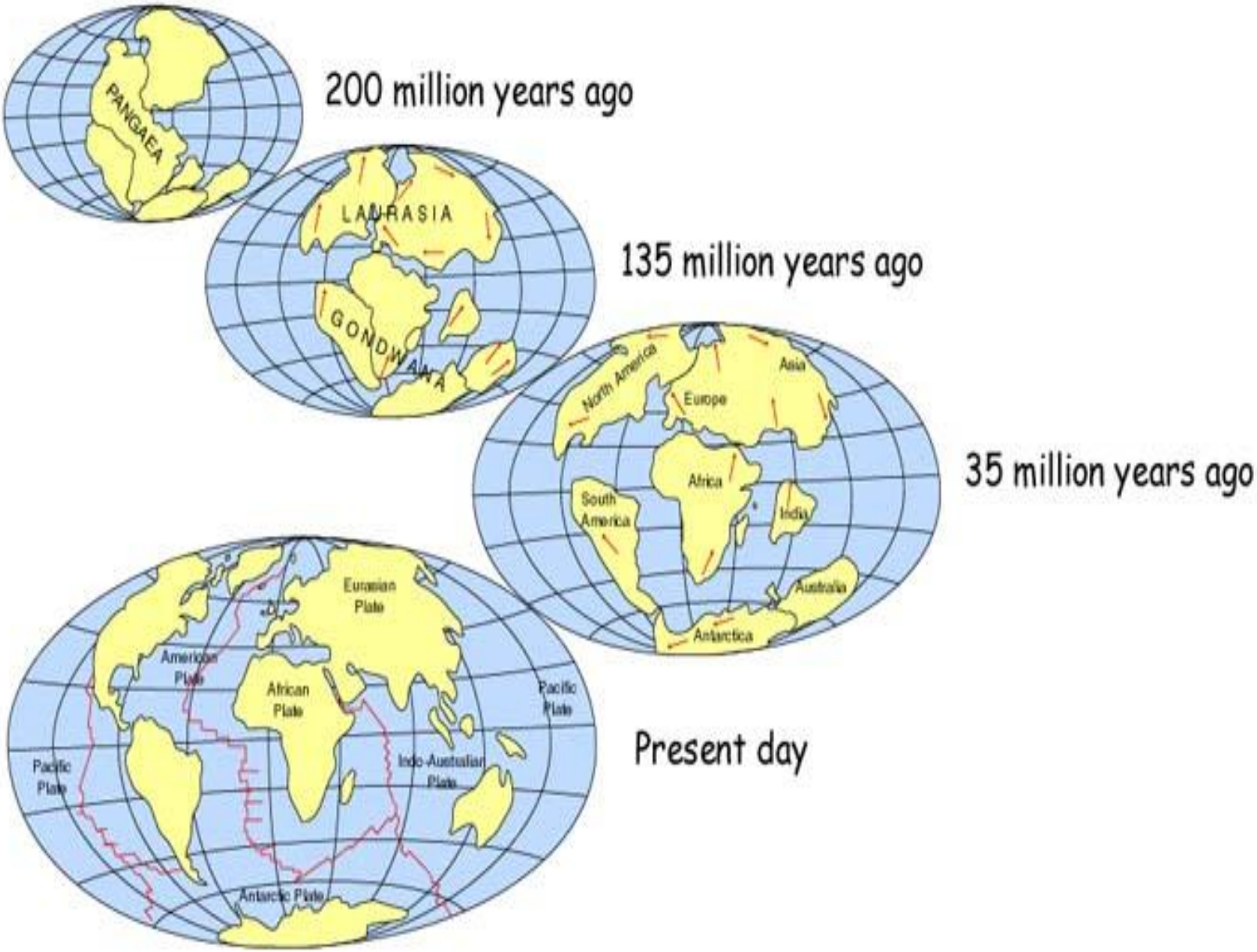
- 12 major plates, many smaller
- Multiple sources of evidence
- Pangea, all merged until 200 mi. BPE
- Plate boundaries

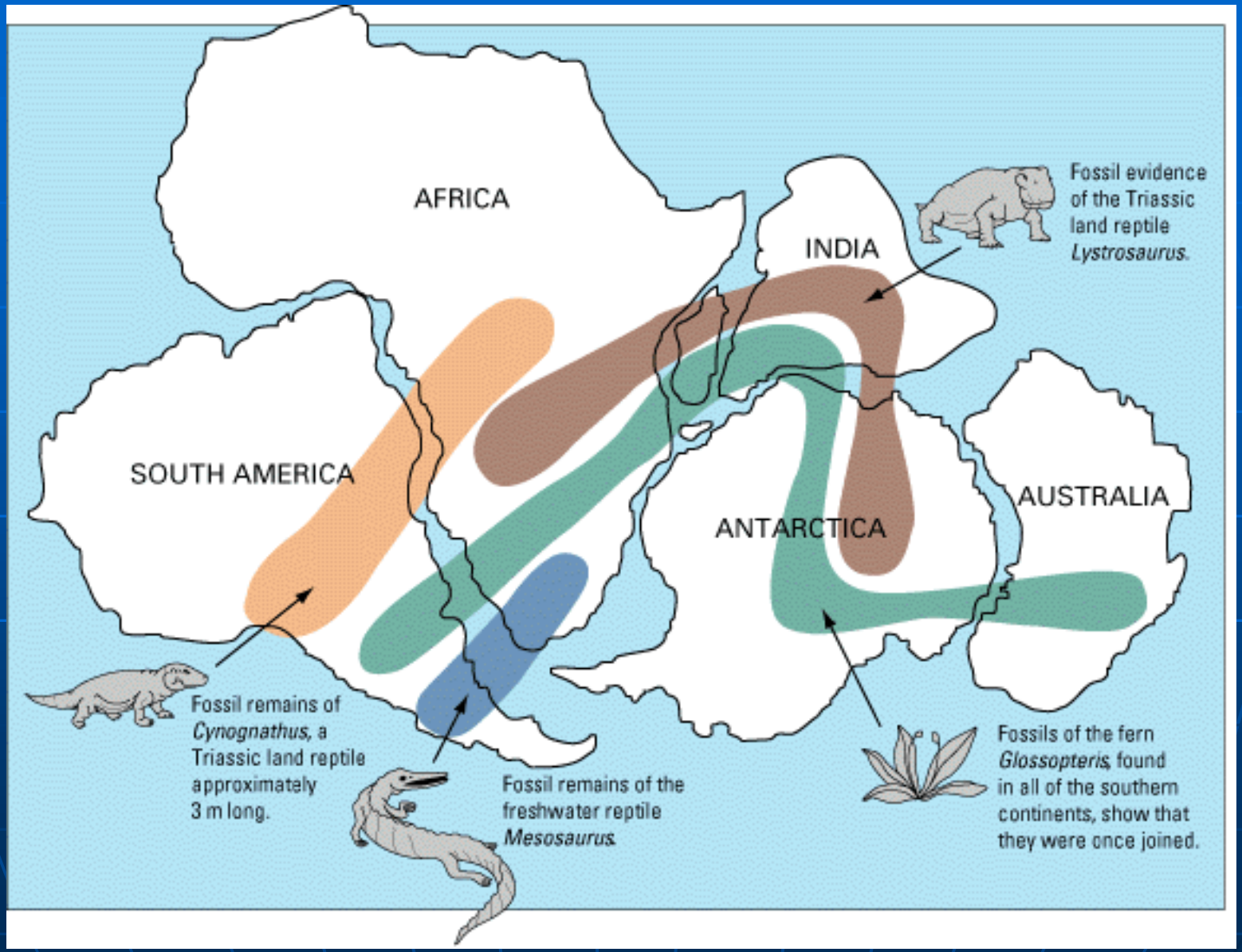
  spreading

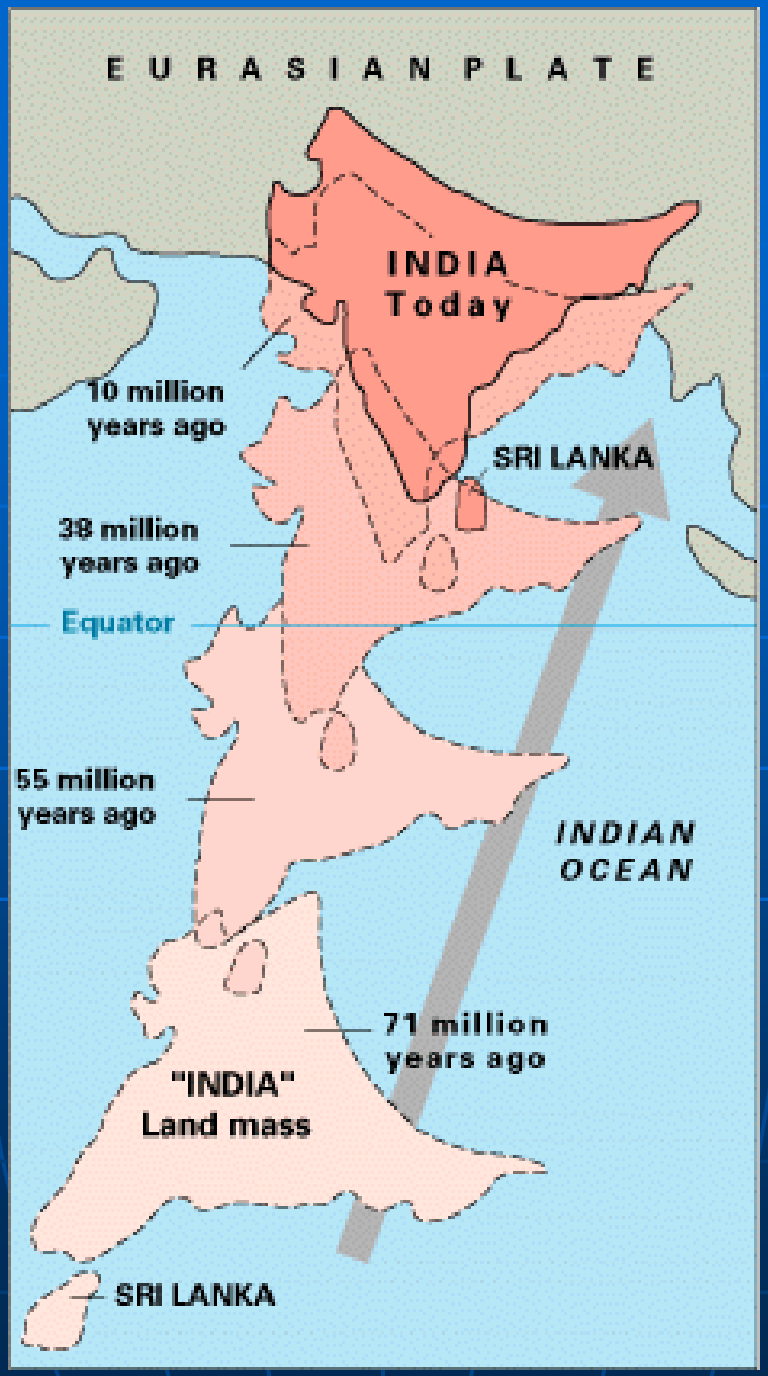
  converging

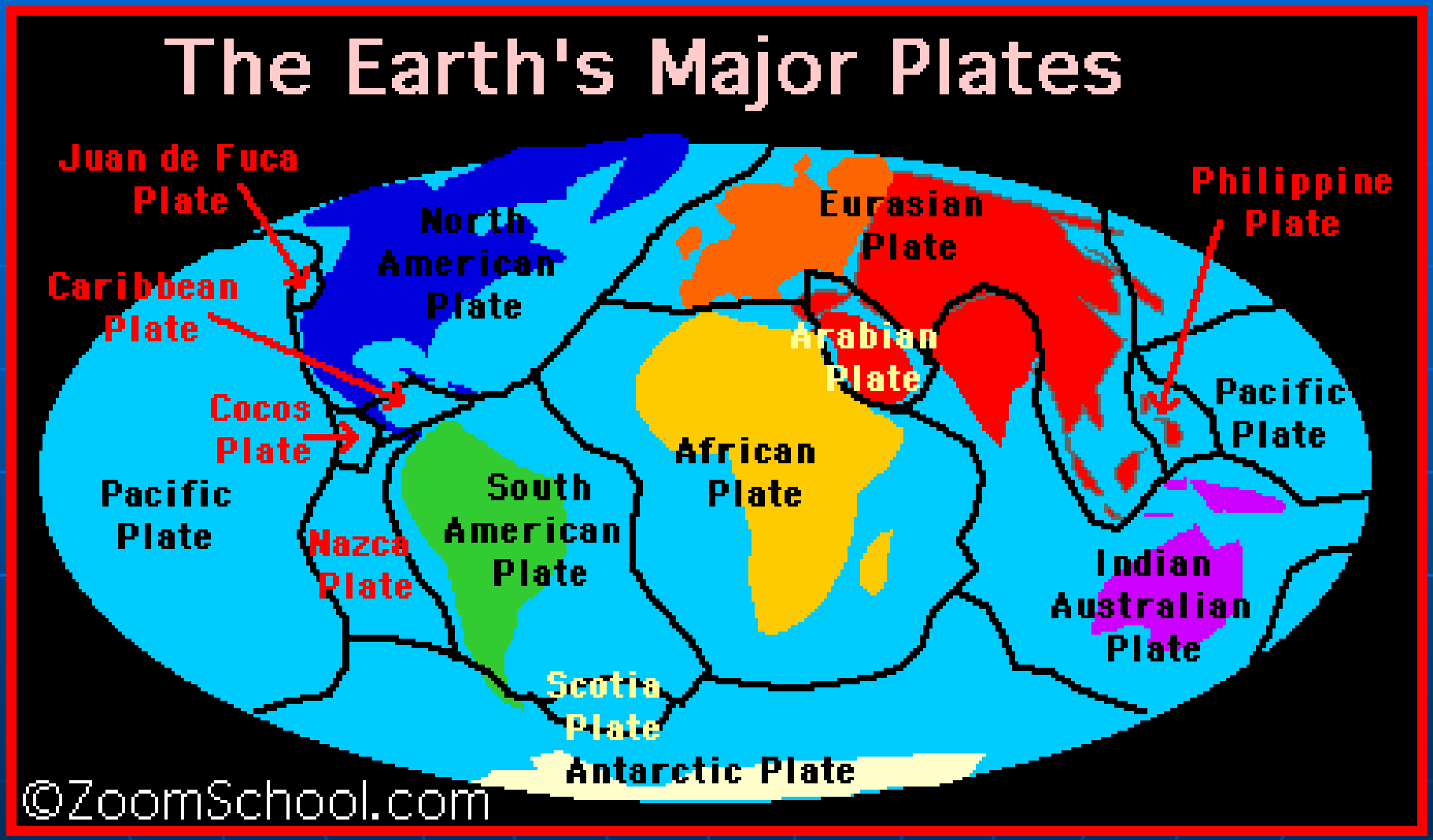
  transform

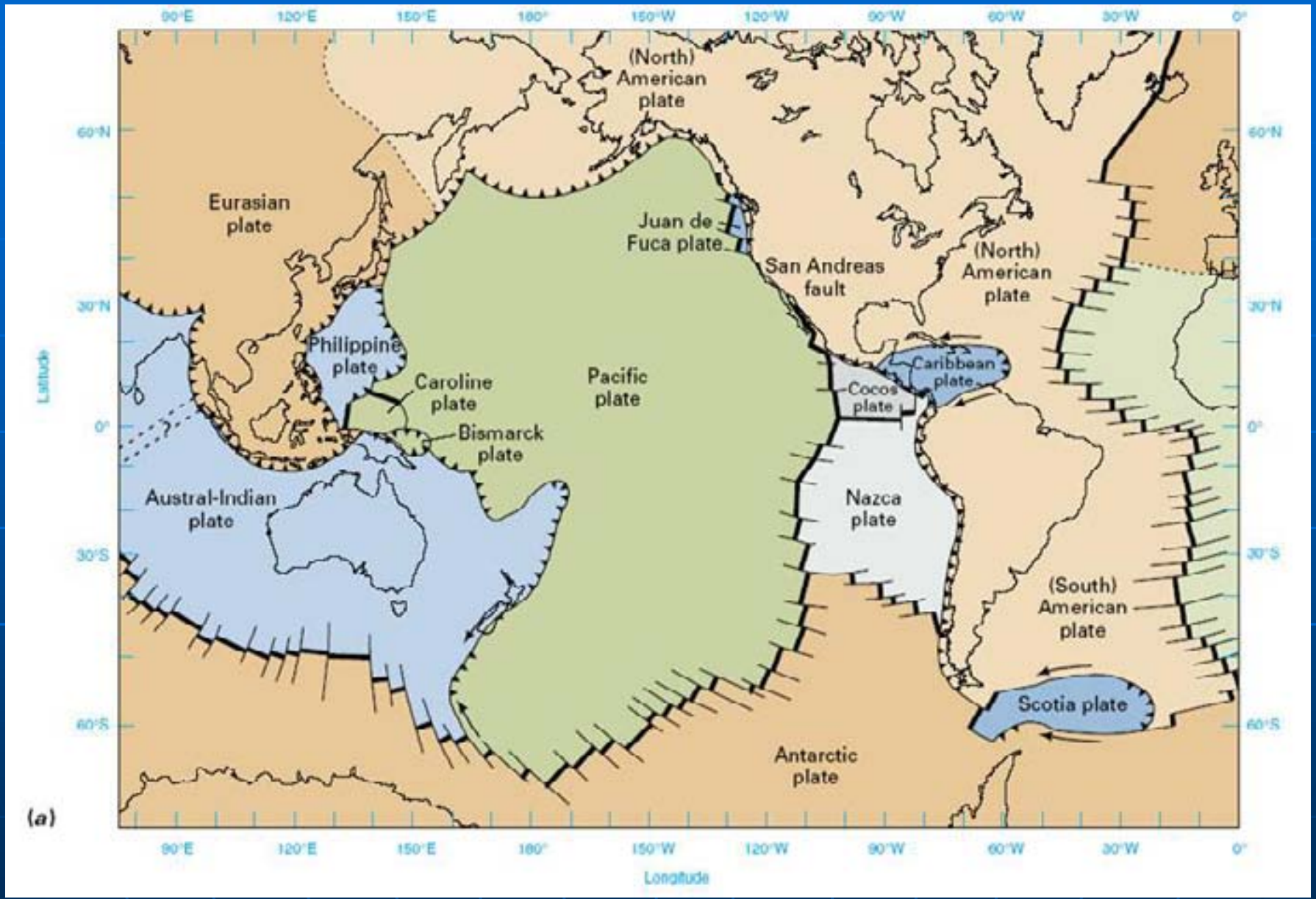

Greenland
Europe
N. America
Africa
S.
America

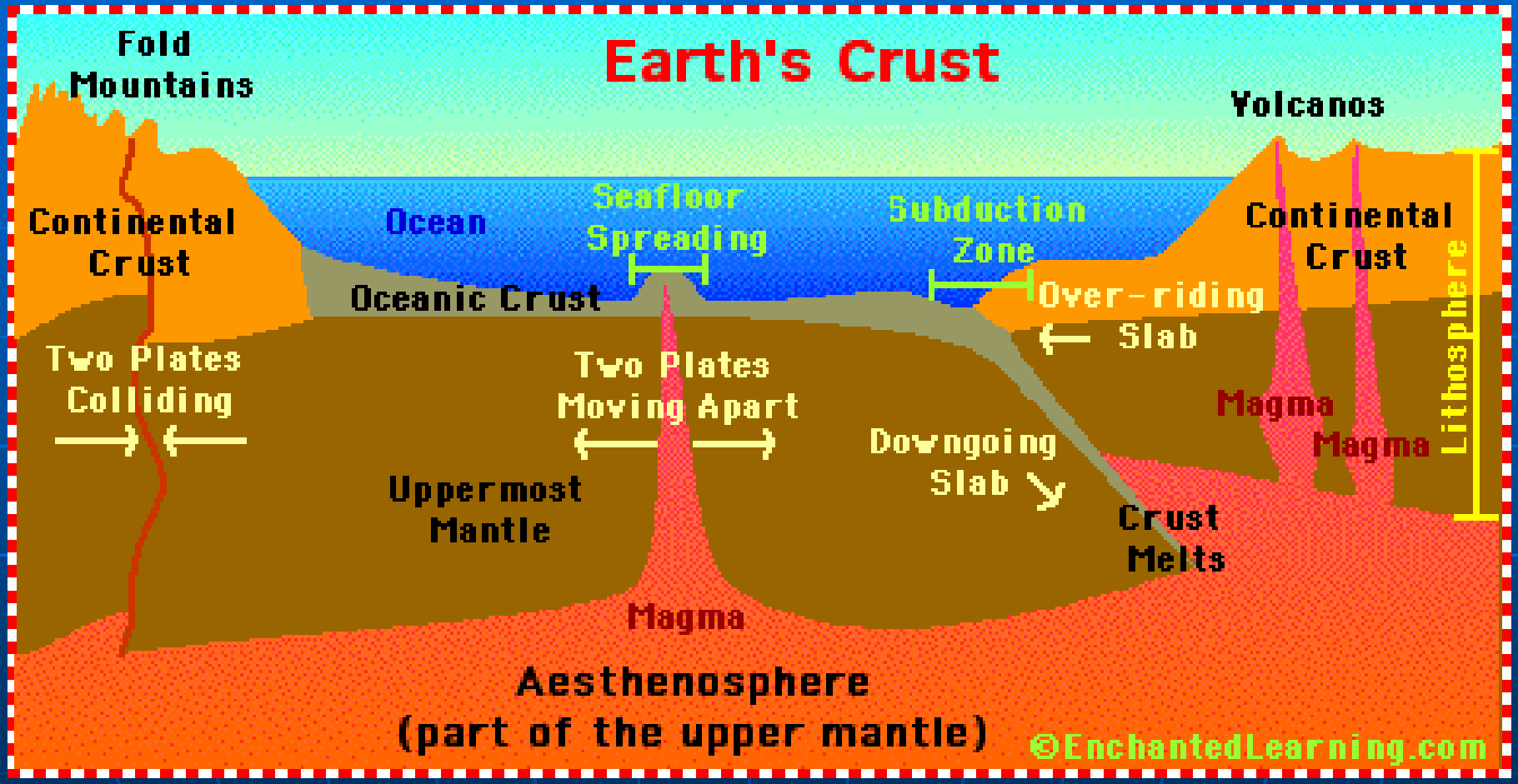

PANGAEA
200 million years ago
LAURASIA
GONDWANA
135 million years ago
North America
Europe
Asia
Africa
South America
India
Australia
Antarctica
35 million years ago
Eurasian Plate
American Plate
African Plate
Pacific Plate
Indo-Australian Plate
Pacific Plate
Antarctic Plate
Present day

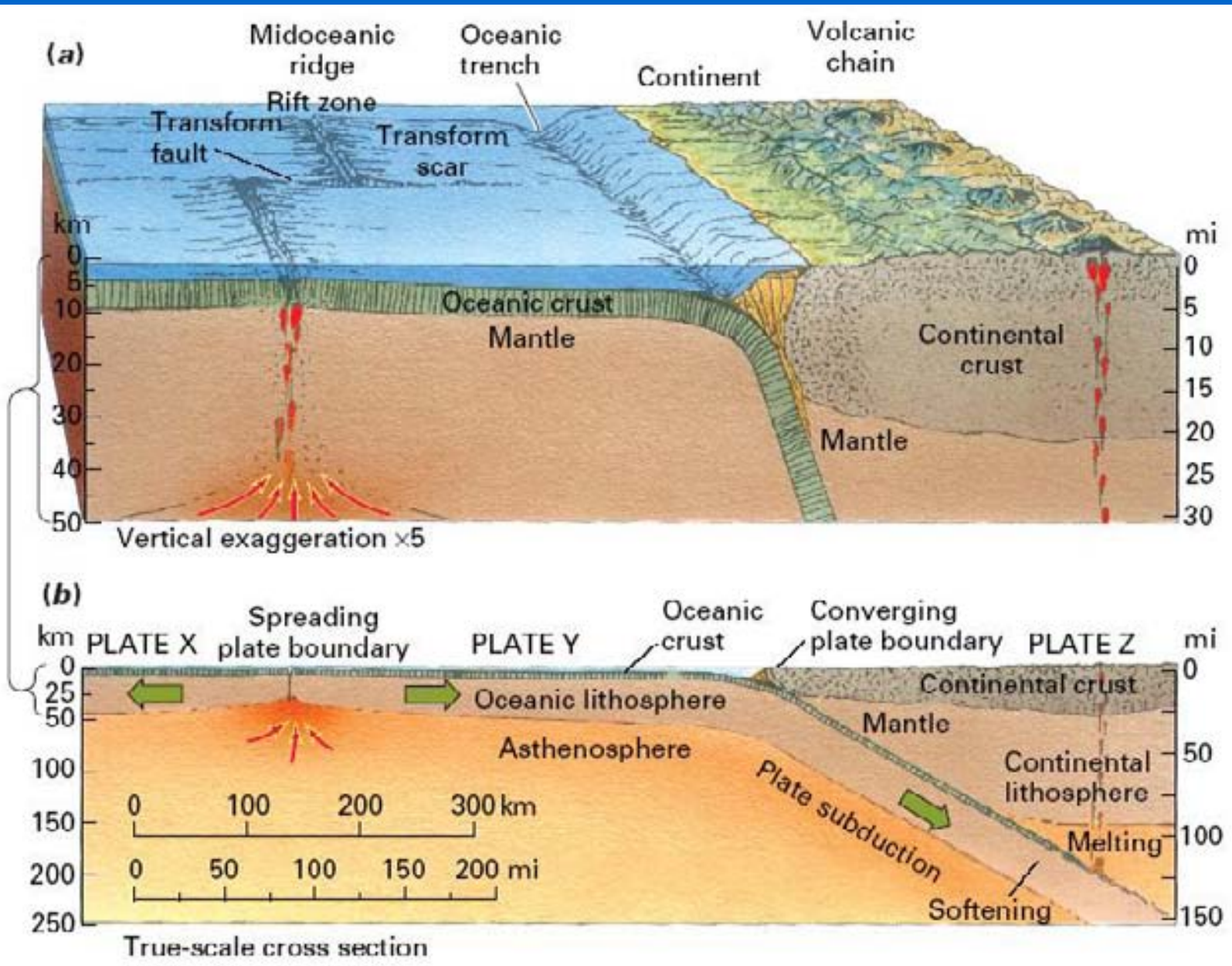

AFRICA
INDIA
SOUTH AMERICA
ANTARCTICA
AUSTRALIA
Fossil evidence of the Triassic land reptile *Lystrosaurus*.
Fossil remains of *Cynognathus*, a Triassic land reptile approximately 3 m long.
Fossil remains of the freshwater reptile *Mesosaurus*.
Fossils of the fern *Glossopteris*, found in all of the southern continents, show that they were once joined.

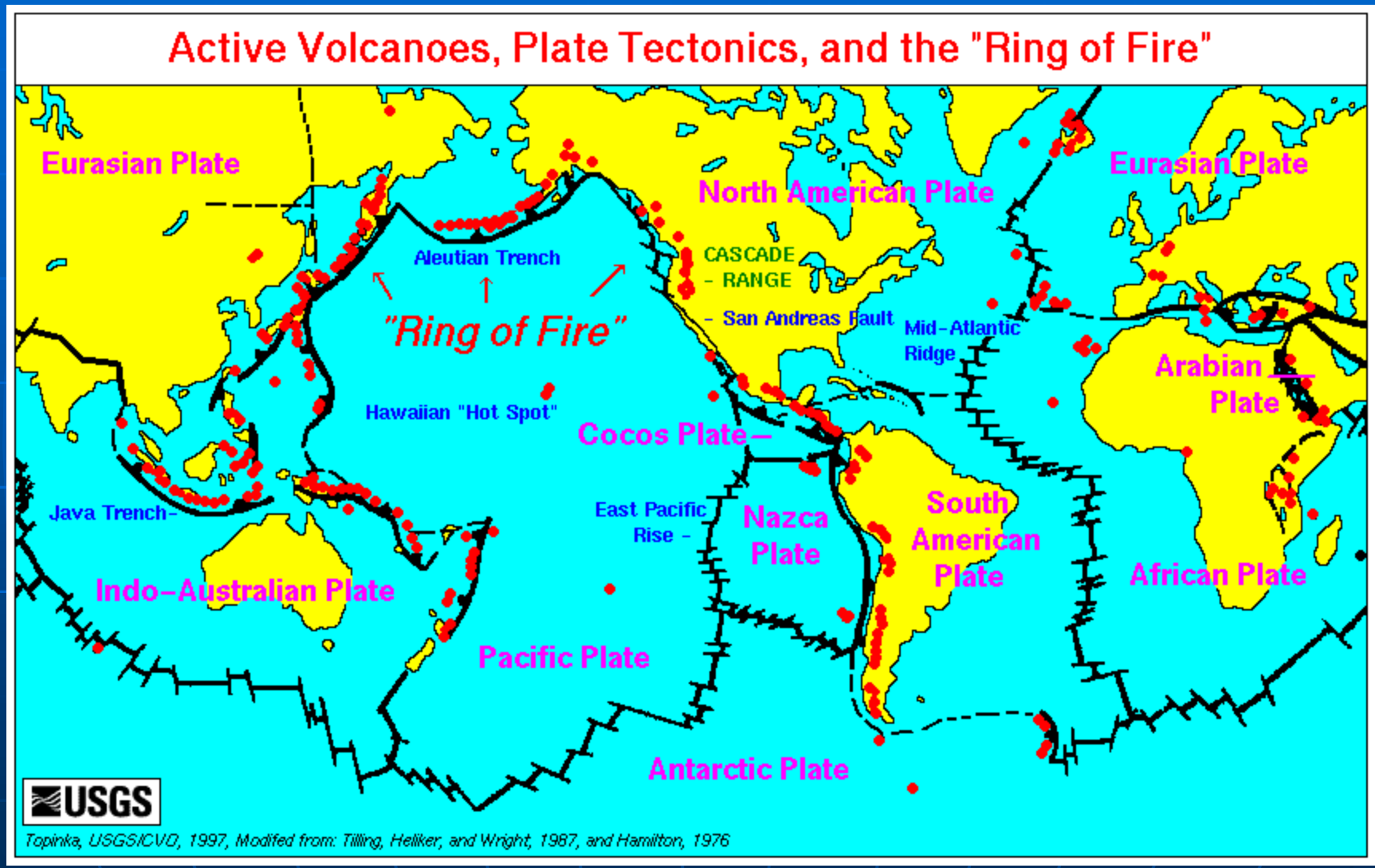

EURASIAN PLATE
INDIA
Today
10 million
years ago
SRI LANKA
38 million
years ago
Equator
55 million
years ago
INDIAN
OCEAN
71 million
years ago
"INDIA"
Land mass
SRI LANKA

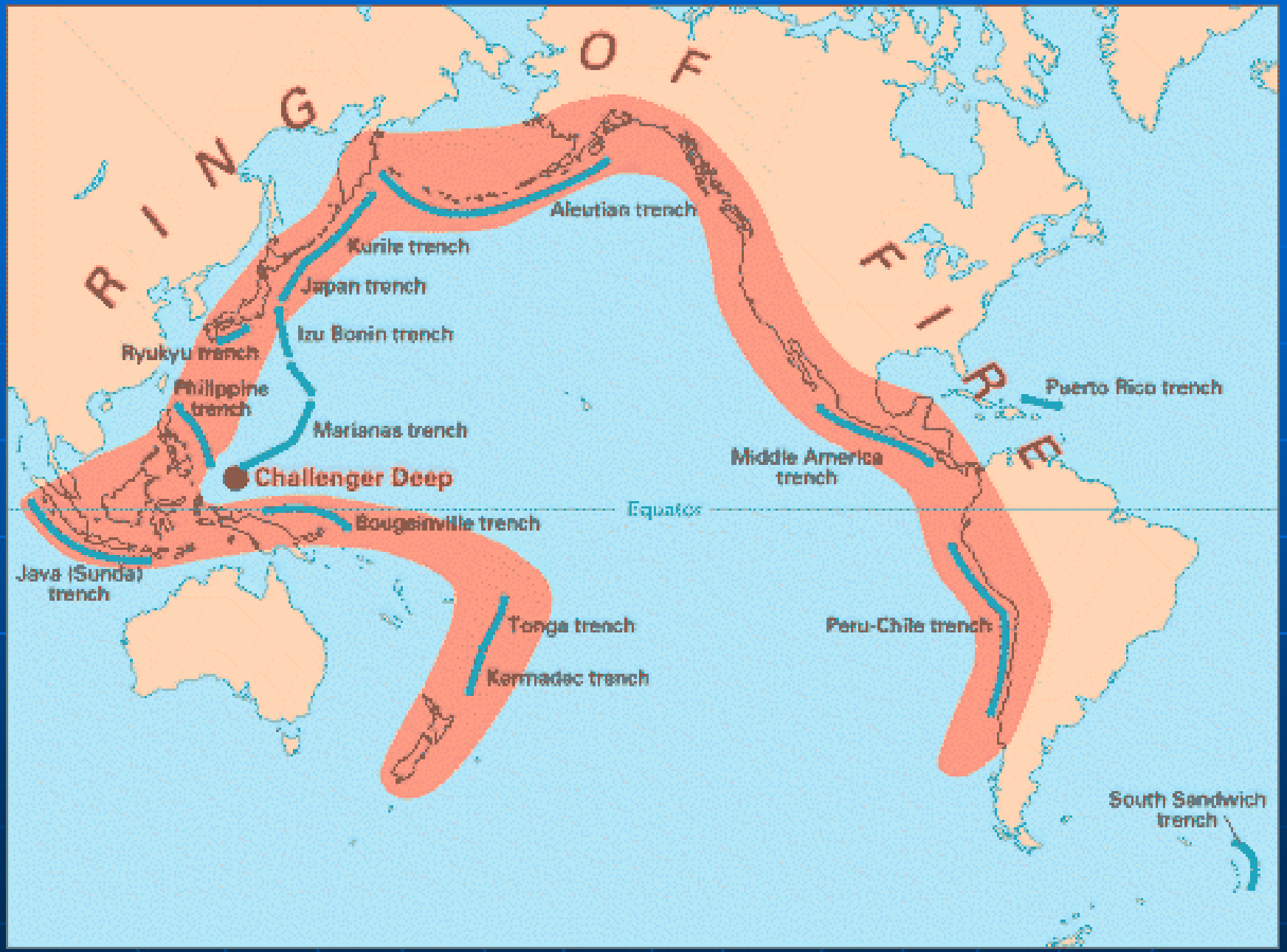

The Earth's Major Plates
Juan de Fuca Plate
Caribbean Plate
Cocos Plate
Pacific Plate
Nazca Plate
North American Plate
South American Plate
Eurasian Plate
Arabian Plate
African Plate
Philippine Plate
Pacific Plate
Indian Australian Plate
Scotia Plate
Antarctic Plate
©ZoomSchool.com

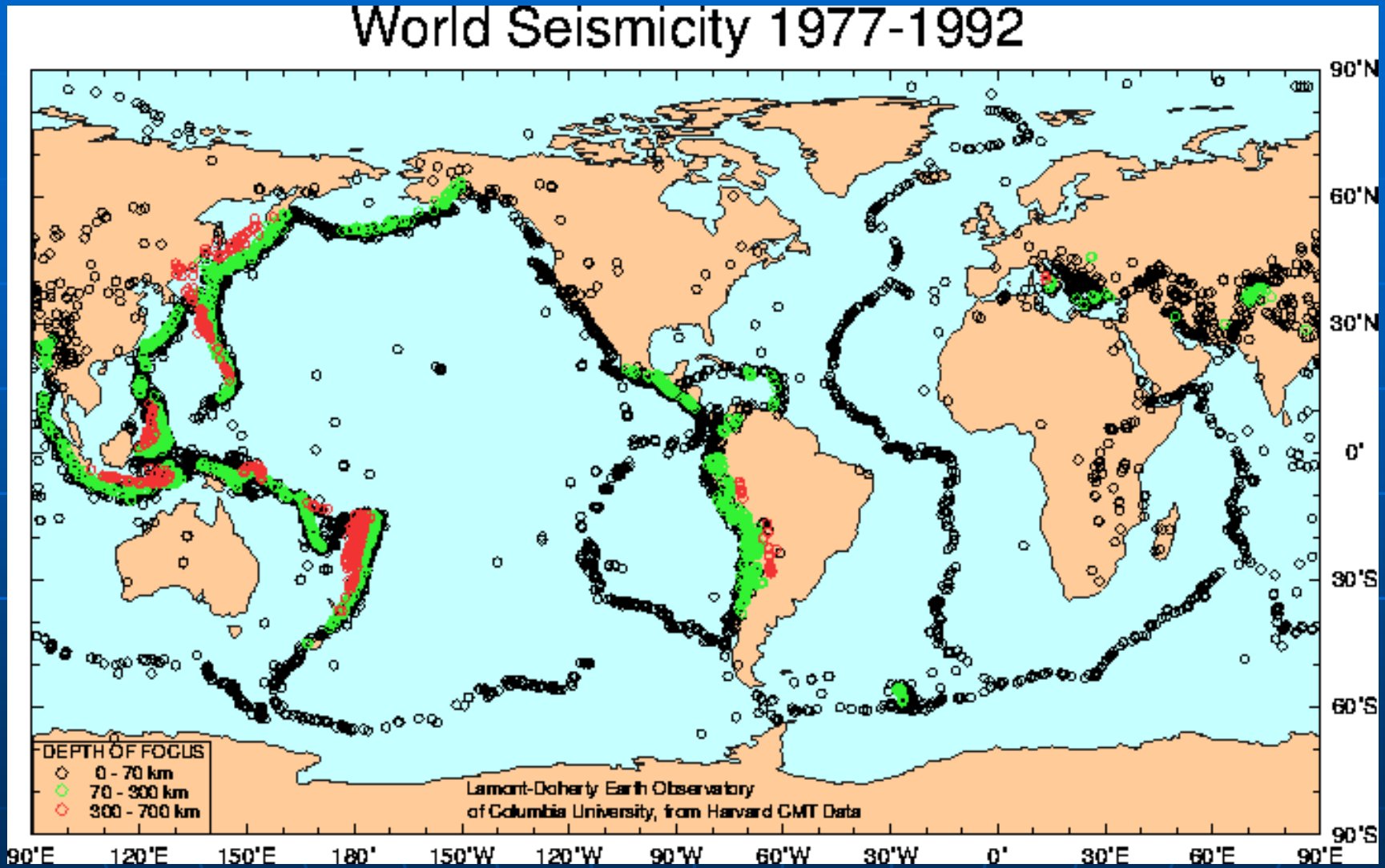

90°E
120°E
150°E
180°
150°W
120°W
90°W
60°W
30°W
0°
60°N
30°N
0°
30°S
60°S
Latitude
Longitude
(North) American plate
Eurasian plate
Juan de Fuca plate
San Andreas fault
(North) American plate
Philippine plate
Caroline plate
Pacific plate
Caribbean plate
Cocos plate
Bismarck plate
Austral-Indian plate
Nazca plate
(South) American plate
Scotia plate
Antarctic plate
(a)


Earth's Crust
Fold Mountains
Volcanos
Continental Crust
Ocean
Seafloor Spreading
Subduction Zone
Continental Crust
Oceanic Crust
Over-riding Slab
Lithosphere
Two Plates Colliding
Two Plates Moving Apart
Magma
Magma
Downgoing Slab
Uppermost Mantle
Crust Melts
Magma
Aesthenosphere
(part of the upper mantle)
©EnchantedLearning.com


(a)
Midoceanic ridge
Oceanic trench
Volcanic chain
Continent
Rift zone
Transform fault
Transform scar
km
0
5
10
20
30
40
50
mi
0
5
10
15
20
25
30
Oceanic crust
Mantle
Continental crust
Mantle
Vertical exaggeration ×5
(b)
km
PLATE X
Spreading plate boundary
PLATE Y
Oceanic crust
Converging plate boundary
PLATE Z
mi
0
25
50
100
150
200
250
Oceanic lithosphere
Asthenosphere
Continental crust
Mantle
Continental lithosphere
Plate subduction
Melting
Softening
0 100 200 300 km
0 50 100 150 200 mi
True-scale cross section


Active Volcanoes, Plate Tectonics, and the "Ring of Fire"
Eurasian Plate
North American Plate
Eurasian Plate
Aleutian Trench
CASCADE
- RANGE
- San Andreas Fault
"Ring of Fire"
Mid-Atlantic
Ridge
Arabian
Plate
Hawaiian "Hot Spot"
Cocos Plate
Java Trench
East Pacific
Rise
Nazca
Plate
South
American
Plate
African Plate
Indo-Australian Plate
Pacific Plate
Antarctic Plate
USGS
Topinka, USGS/CVO, 1997, Modified from: Tilling, Heliker, and Wright, 1987, and Hamilton, 1976


RING OF FIRE
Aleutian trench
Kurile trench
Japan trench
Izu Bonin trench
Ryukyu trench
Philippine trench
Marianas trench
Challenger Deep
Bougainville trench
Java (Sunda) trench
Tonga trench
Kermadec trench
Middle America trench
Puerto Rico trench
Peru-Chile trench
South Sandwich trench
Equator


World Seismicity 1977-1992
90°N
60°N
30°N
0°
30°S
60°S
90°S
90°E
120°E
150°E
180°
150°W
120°W
90°W
60°W
30°W
0°
30°E
60°E
90°E
DEPTH OF FOCUS
0 - 70 km
70 - 300 km
300 - 700 km
Lamont-Doherty Earth Observatory
of Columbia University, from Harvard CMT Data

Earth Materials

- Elements

  Oxygen 50%, Silicon 25%
- Minerals

  Silicon Dioxide SiO_2, Quartz
- Rocks

  Sedimentary

  Igneous

  Metamorphic

Igneous Sedimentary Metamorphic

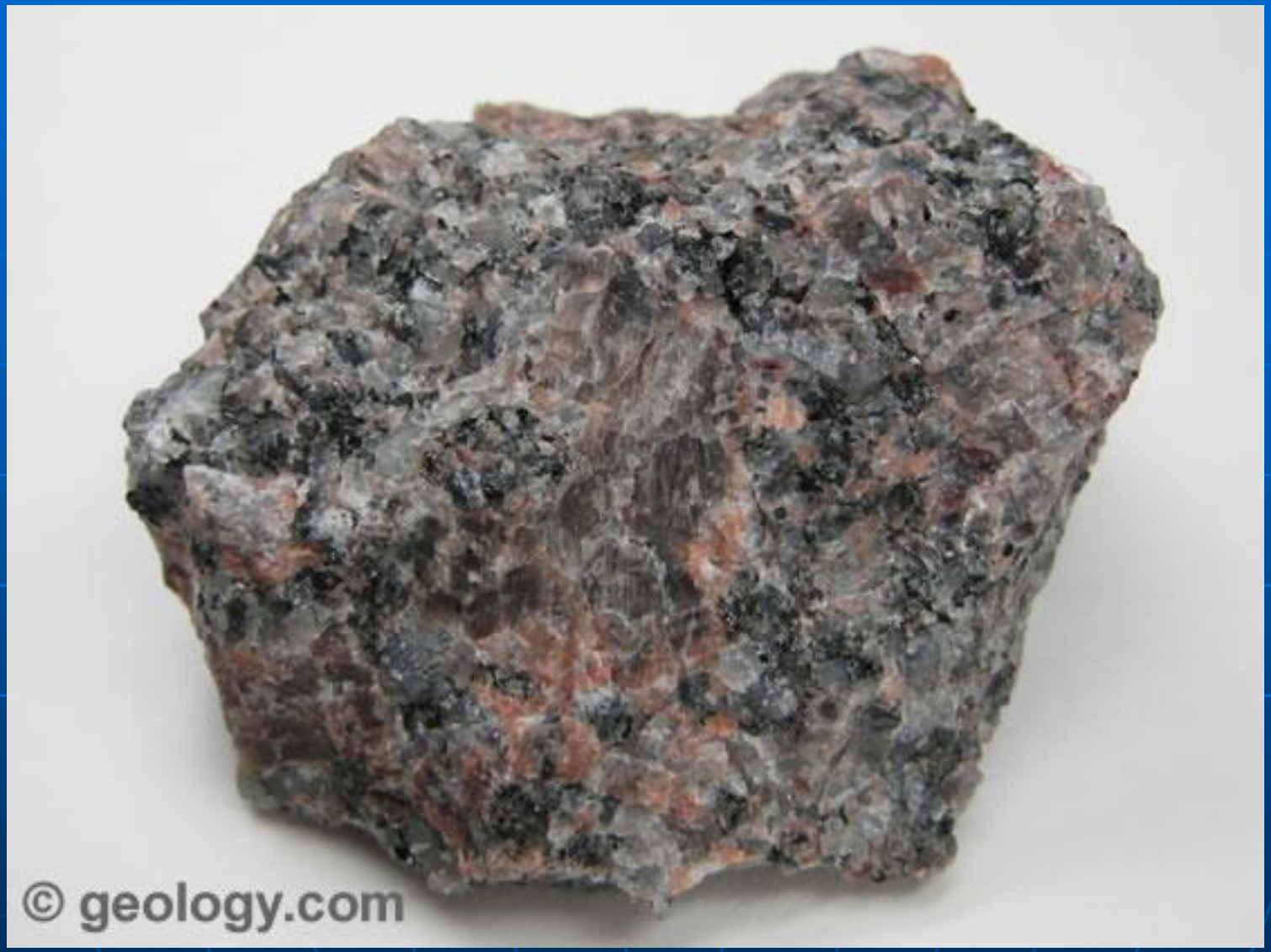
Intrusive
- Granite

Extrusive
- Basalt
- Obsidian
- Pumice

Sandstone
Shale
Conglomerate
Limestone

Gneiss
Marble
Slate
Quartzite

Quartz



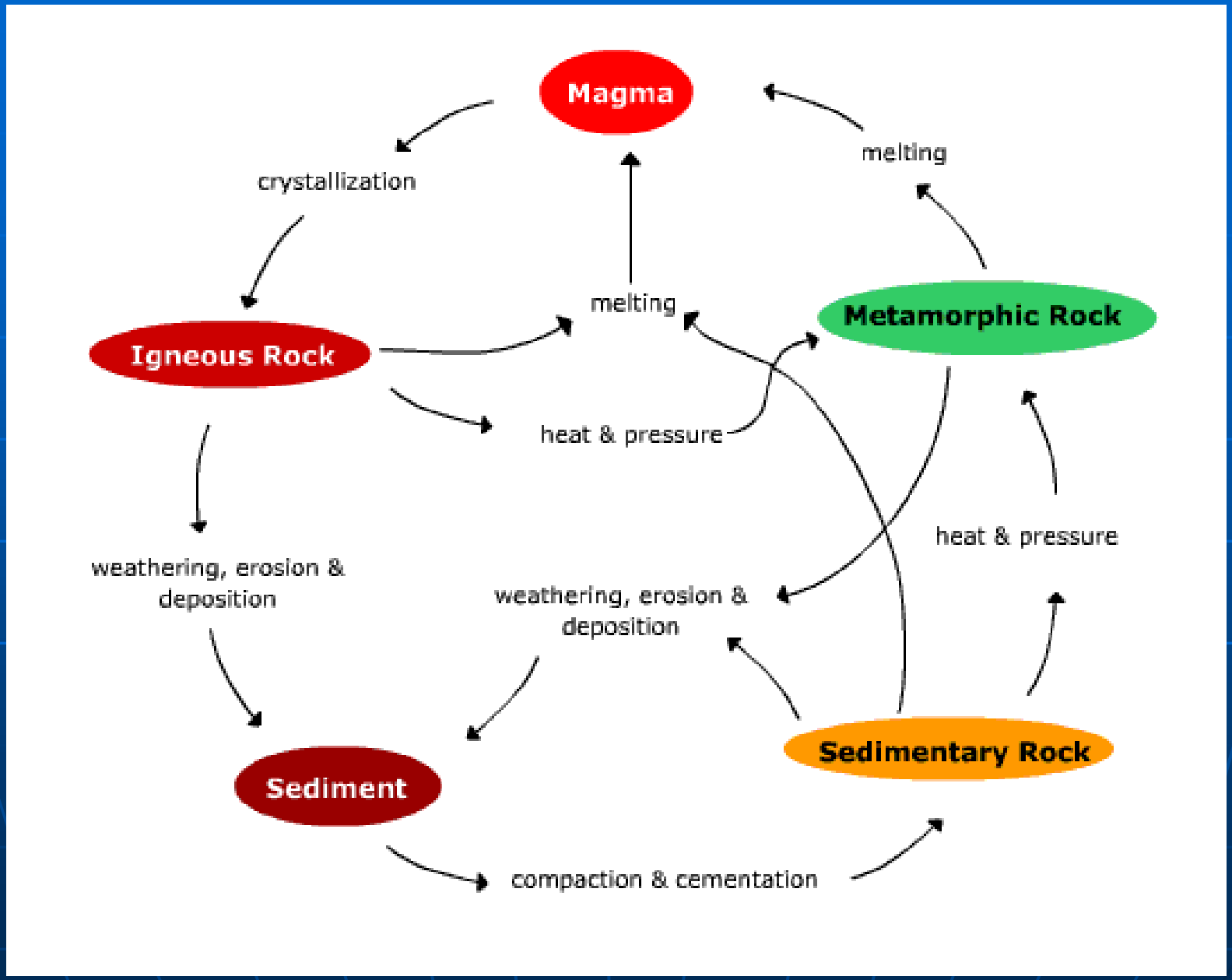
Granite

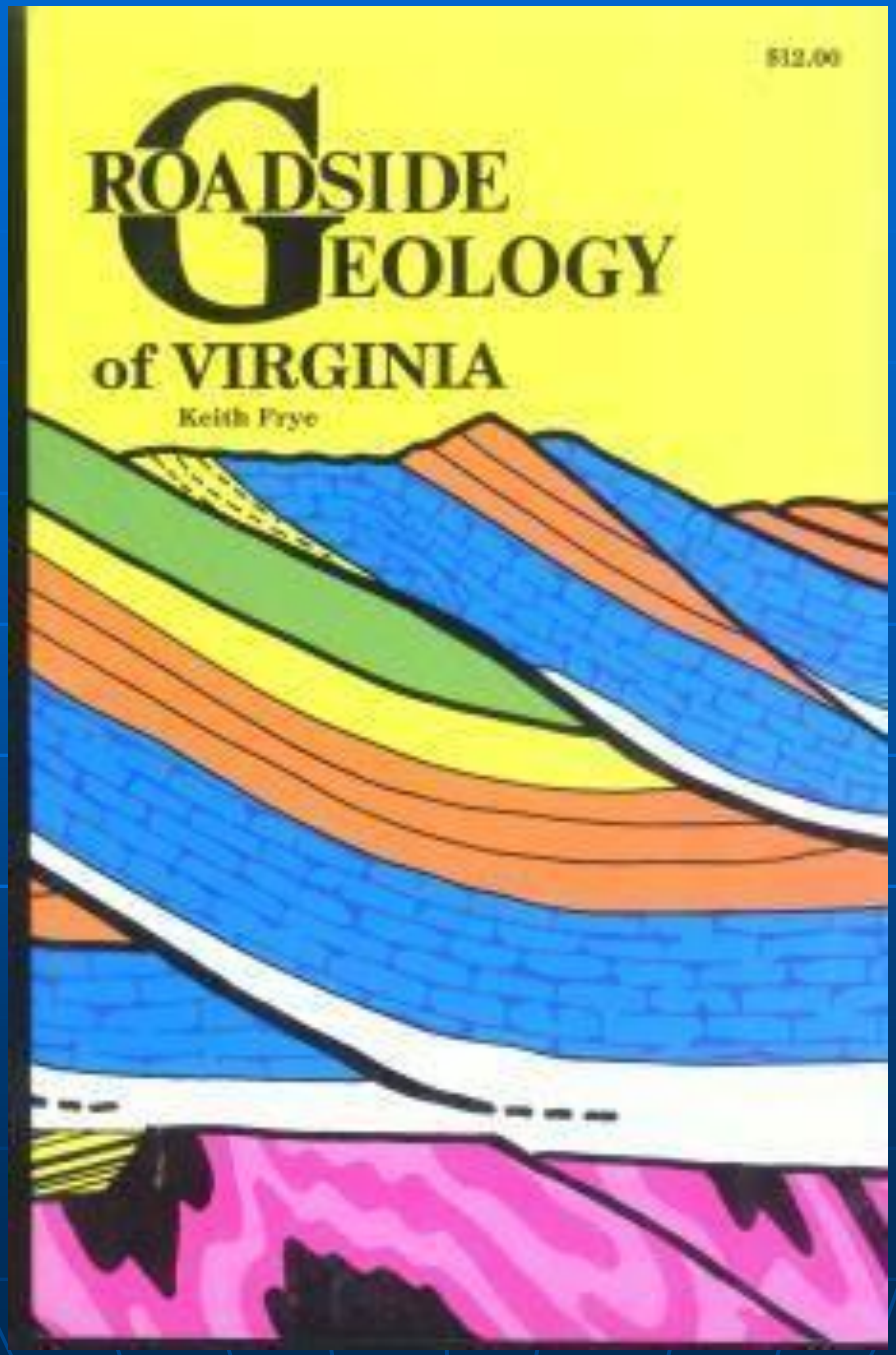
Basalt

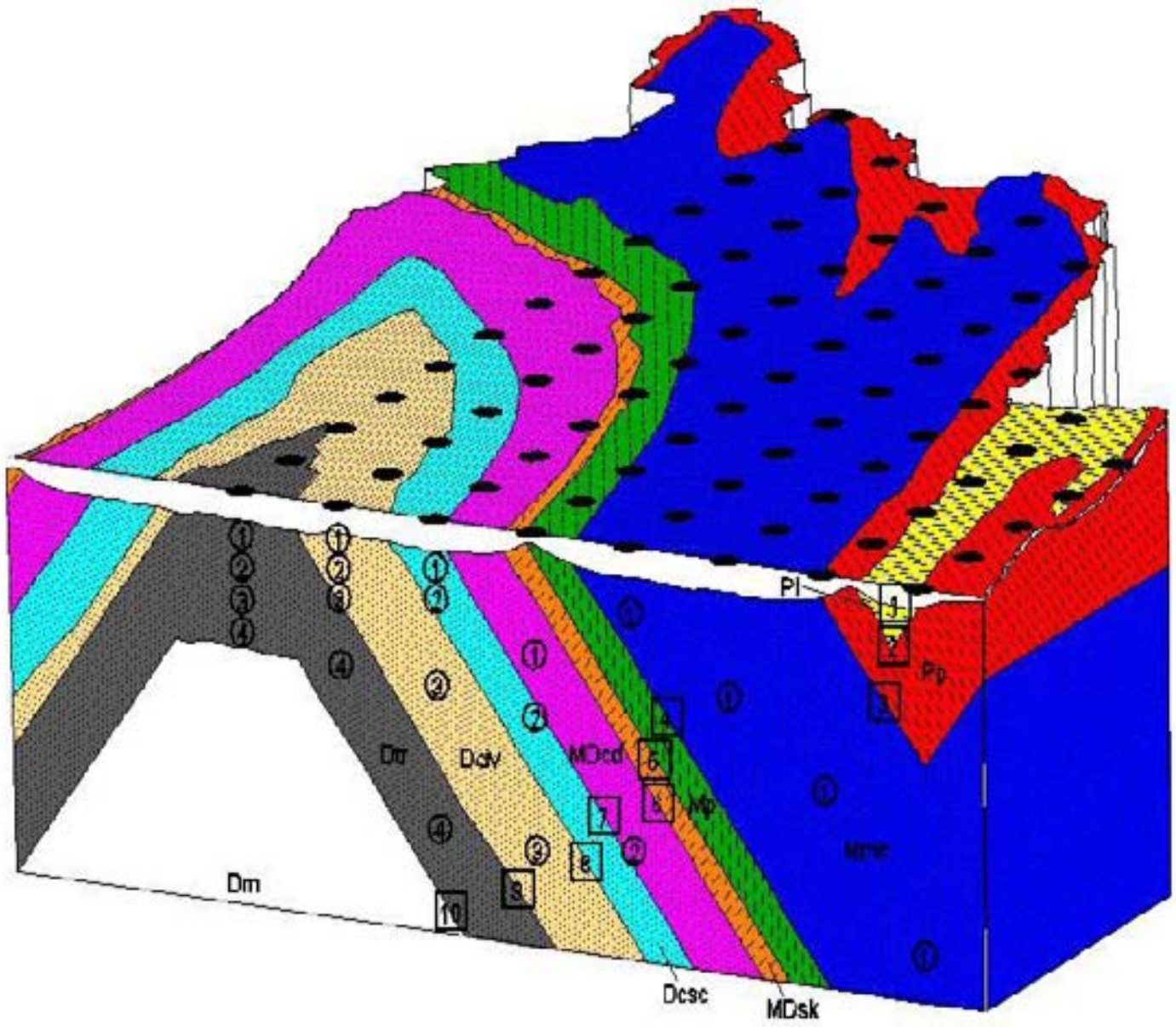
Sandstone

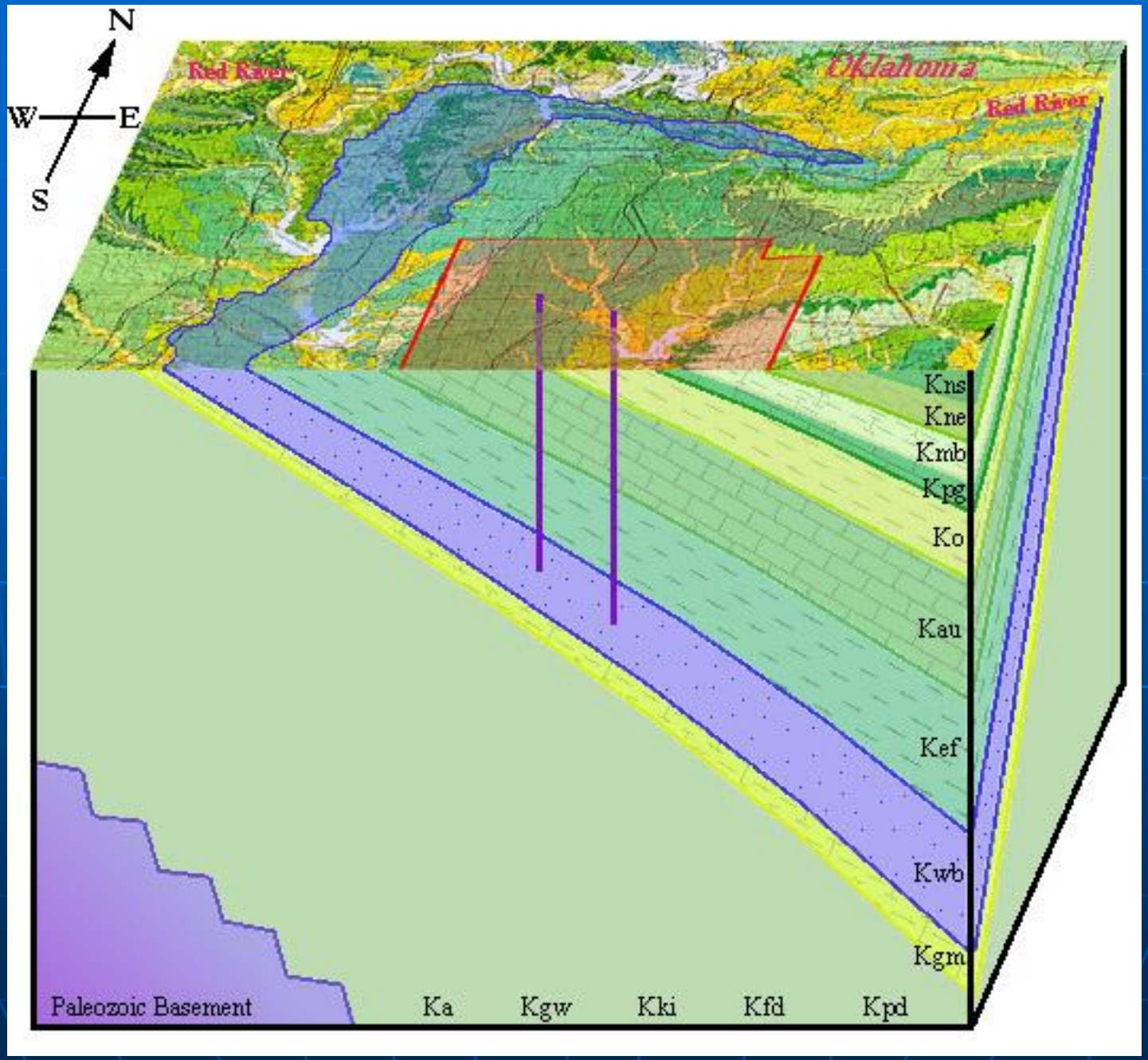
Limestone

Gneiss


Magma
crystallization
melting
Igneous Rock
melting
Metamorphic Rock
heat & pressure
weathering, erosion & deposition
heat & pressure
weathering, erosion & deposition
Sedimentary Rock
Sediment
compaction & cementation


$12.00
ROADSIDE GEOLOGY of VIRGINIA
Keith Frye


Pl
Pp
Dm
Dcsc
MDsk


N
W
E
S
Red River
Oklahoma
Red River
Kns
Kne
Kmb
Kpg
Ko
Kau
Kef
Kwb
Kgm
Paleozoic Basement
Ka
Kgw
Kki
Kfd
Kpd