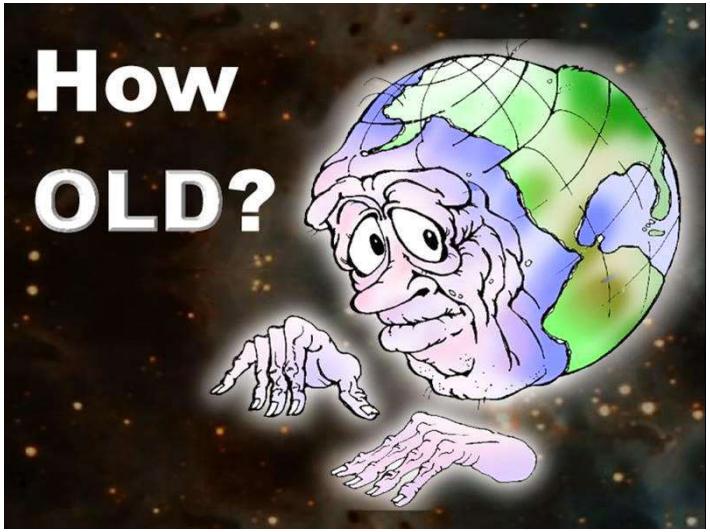
Brief Outline:

- Internal structure of the Earth
- Lithosphere
- Structure of the Crust
- Composition of the Earth Crust
- Minerals and Rocks
- Rock Cycle
- Structures related to rocks
- Plate Tectonics

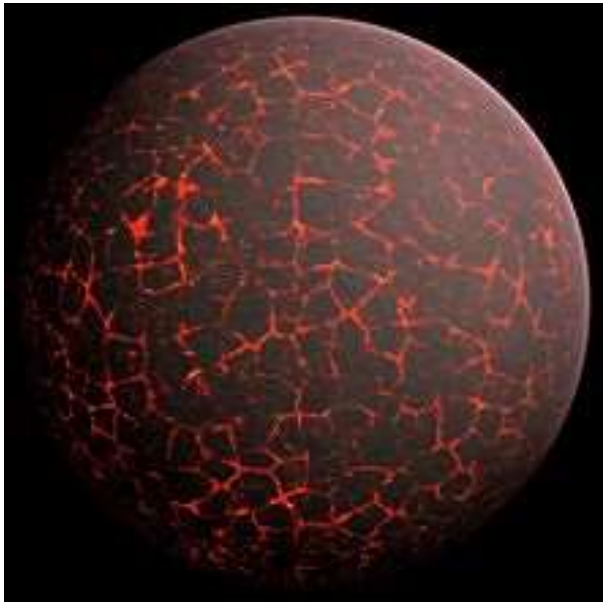
Unlike the Humans, the age of the Earth is not ~100-200 Years, but it is way beyond that.

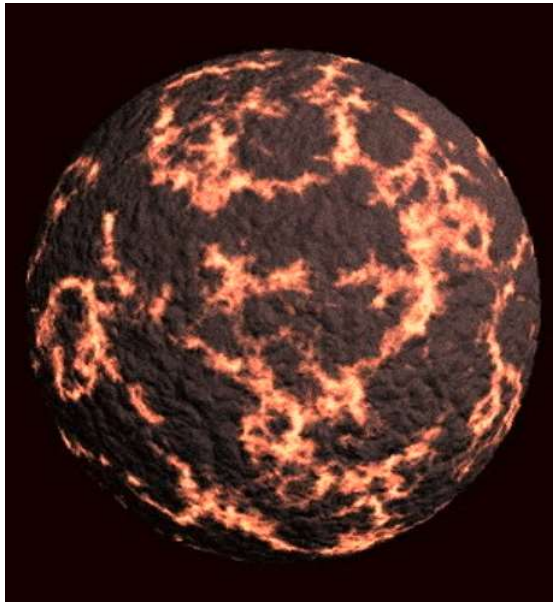
What is the age of the Earth?



My age is ~4.54 Billion Years

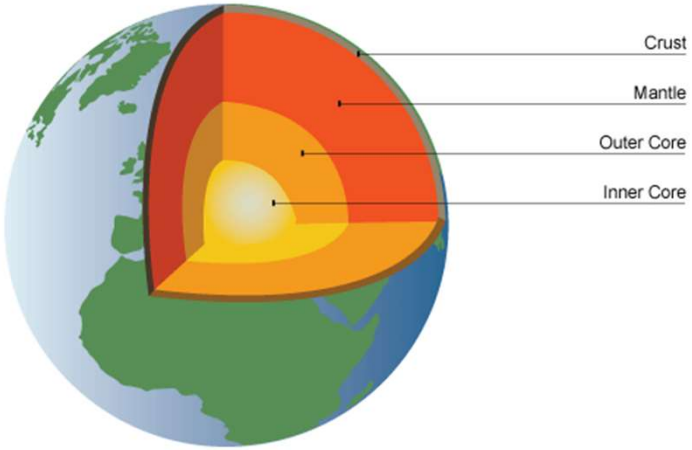
Possible stages of Earth

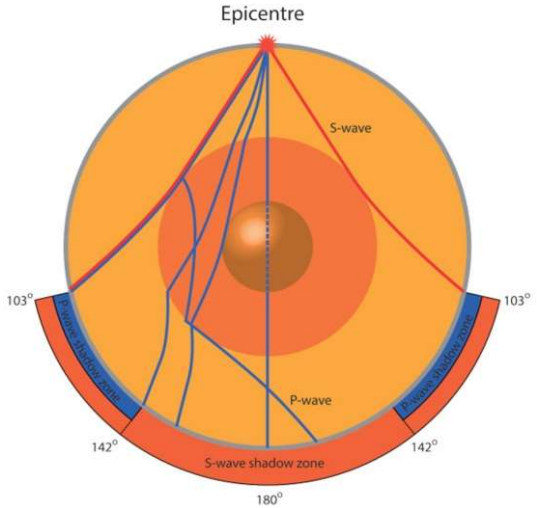




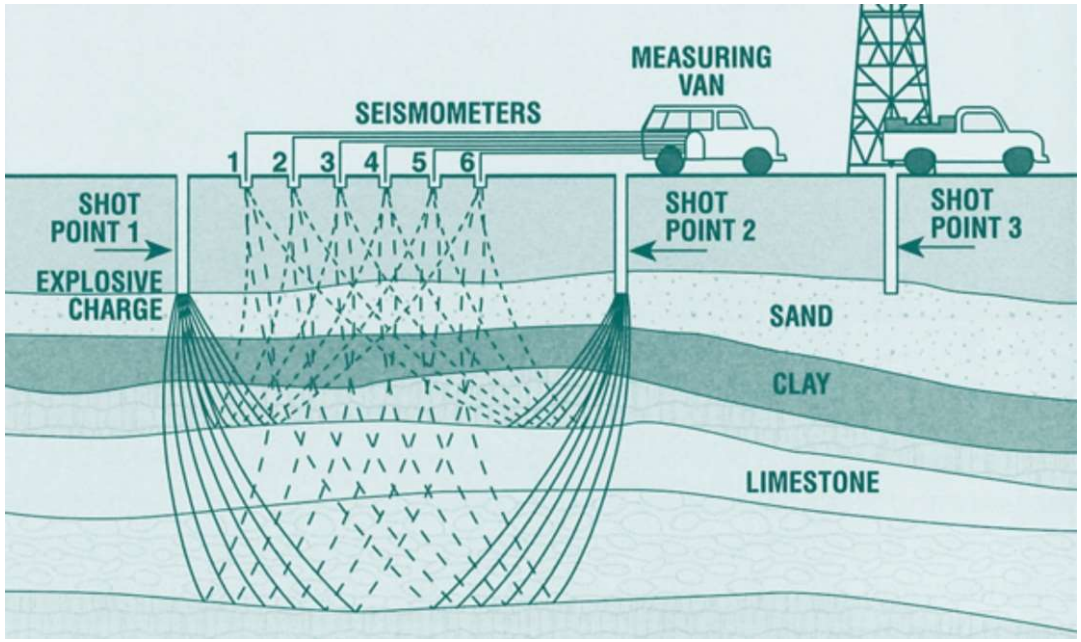
- Transfer of Energy (Heat)
- Decrease in Temperature with time
- Sun is the main source of energy
- Earth's elemental composition gave all the ingredient for which eventually provided its sustainability
- Accordingly all the sphere around earth start growing

INTERNAL STRUCTURE OF EARTH

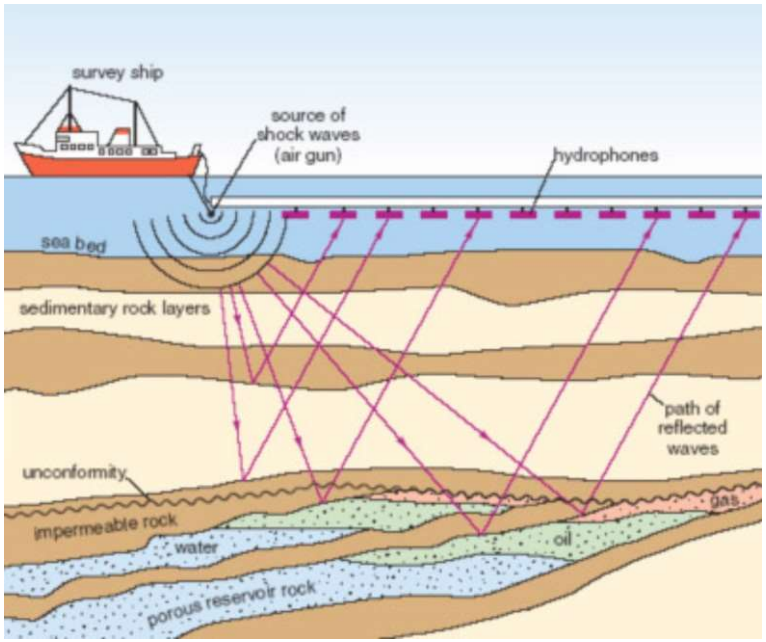




Seismic waves are used to differentiate the boundaries between layers beneath the surface of the Earth

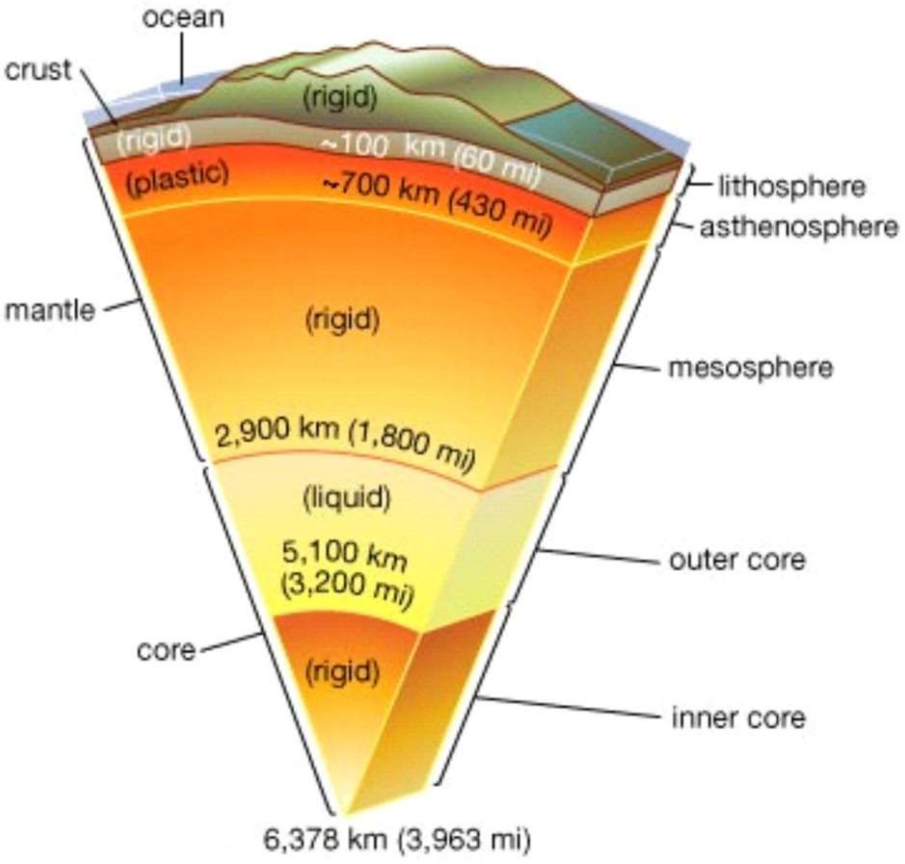


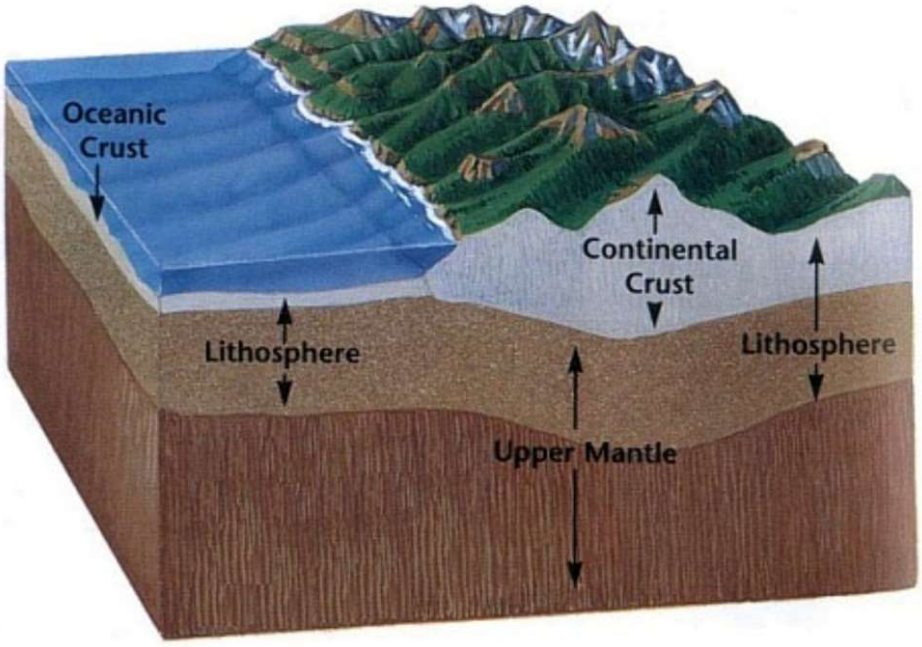
In Land

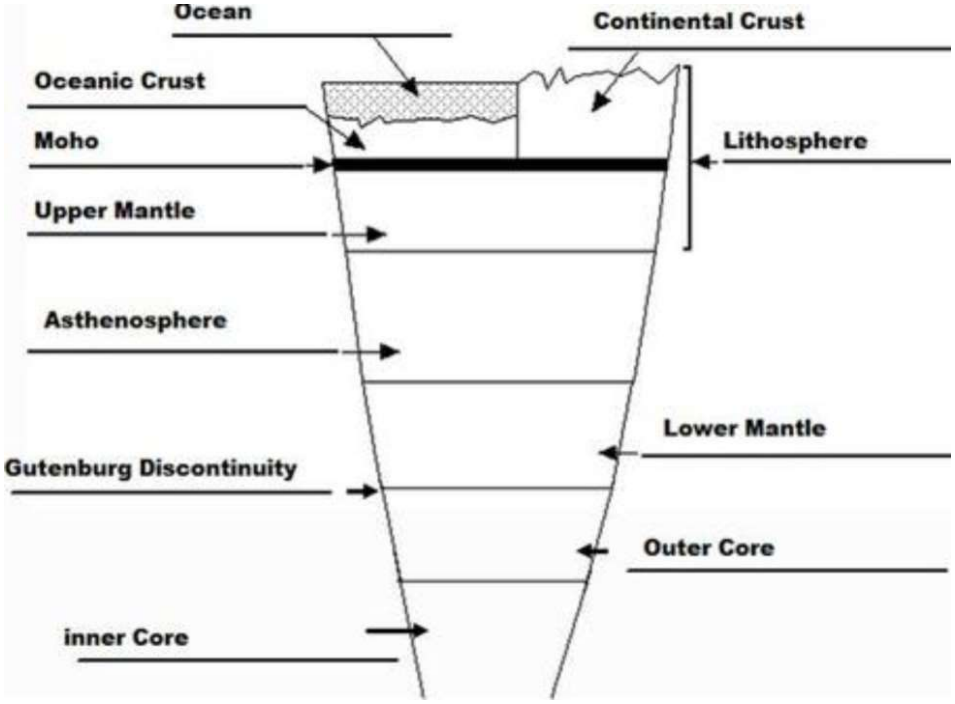


In Sea

INTERNAL STRUCTURE OF EARTH





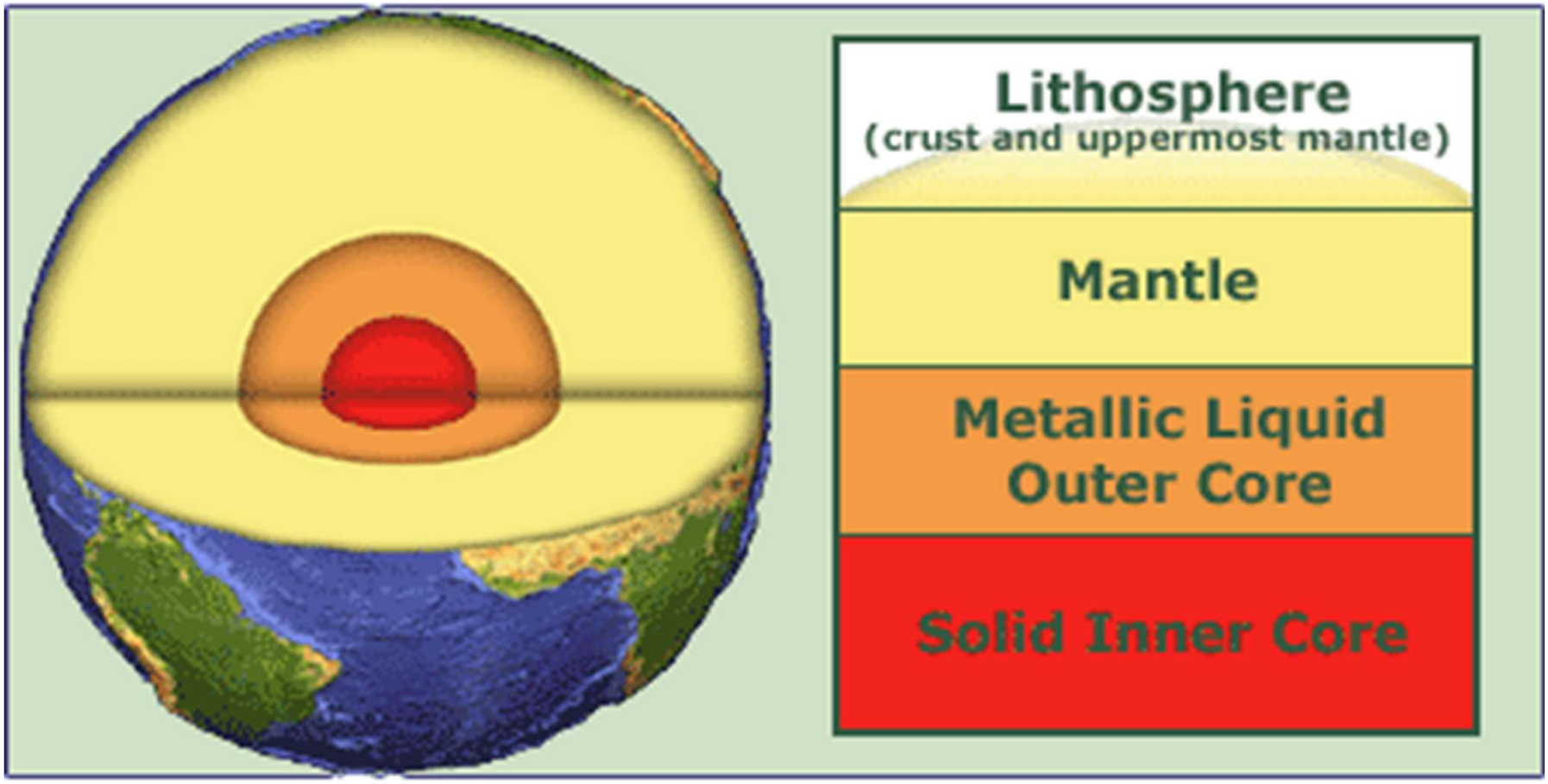


Mohorovicic Discontinuity: Boundary surface between the crust and the mantle

Gutenberg Discontinuity: Boundary surface between the mantle and core

LITHOSPHERE

- The Lithosphere is the solid rock portion of the earth that covers it.
- It includes the crust and the upper most rigid part of the upper mantle.
- All the rocks of the earth, from mountains to the sea floor composes the Lithosphere.

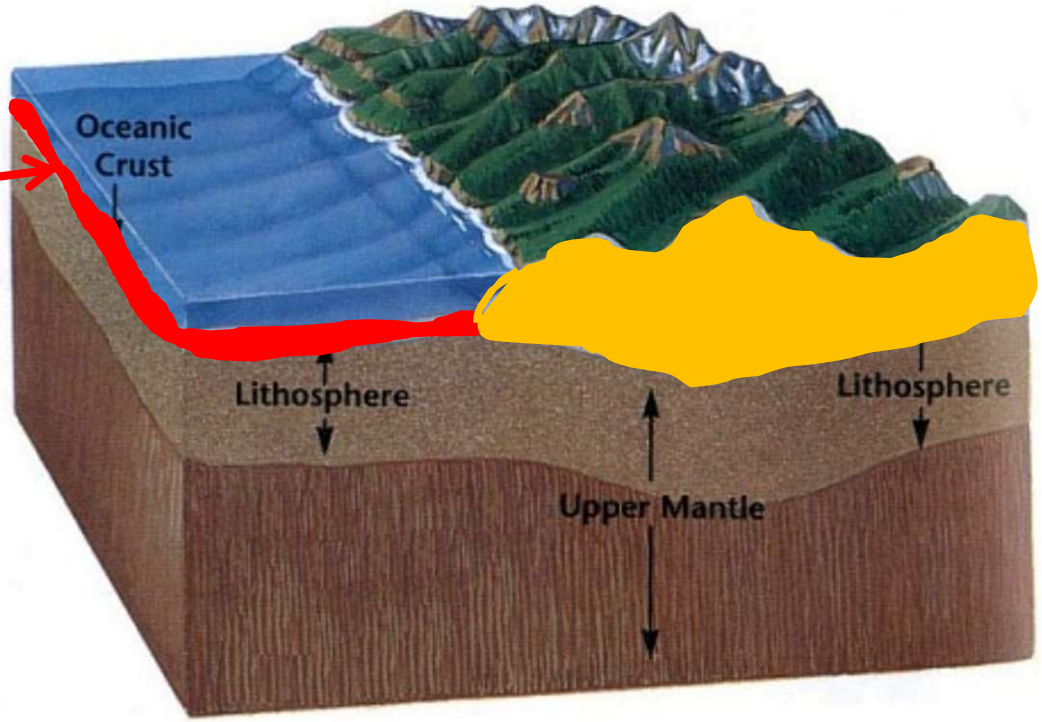


STRUCTURE OF THE CRUST

SiMg

SiAl

Basalt



Granite

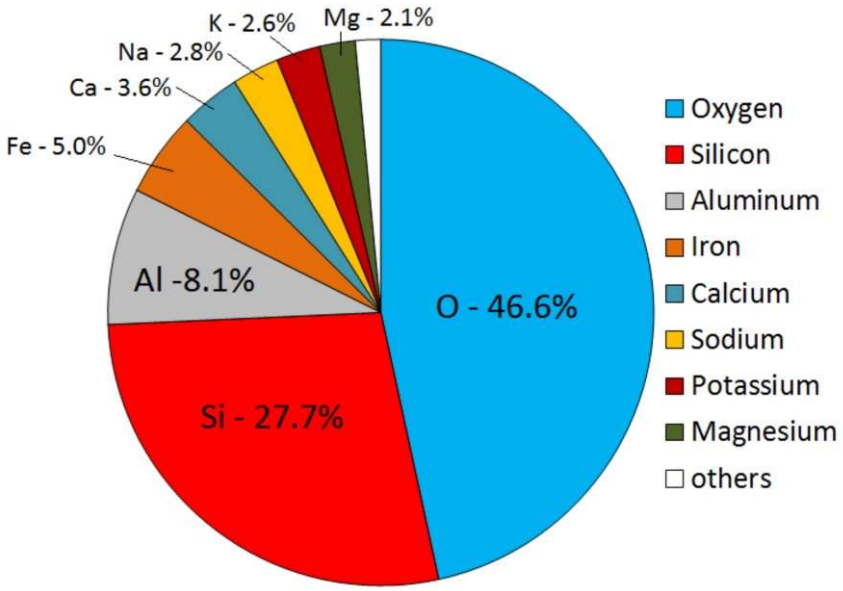
SiAl:

- Si: Silica, Al: Aluminium
- Uppermost layer of the crust
- Average Density: 2.7 gm/cc
- Composed of Granite
- Continental crust

SiMg:

- Si: Silica, Mg: Magnesium
- Layer below SiAl
- Average Density: 3 gm/cc
- Composed of Basalt
- Oceanic crust

COMPOSITION OF THE CRUST



Major Nine elements:
O, Si, Al, Fe, Ca, Na, K, Mg, and Ti

Mineral:
Naturally occurring, inorganic substance having a definite chemical composition.

E.g., Quartz, Feldspar, Olivine, Garnet, Kyanite, Biotite, etc.

- Most of the minerals are crystalline in form (i.e., with regular internal atomic structure).
- However, there are few minerals, which are amorphous (e.g., Opal, glass)

MINERALS AND ROCKS

Mineral:

- **Economic Minerals**
  - Fe: Magnetite, Hematite
  - Cu: Chalcopyrite
  - Pb: Galena
  - U: Uraninite
- **Rock Forming Minerals**
  - Quartz
  - Feldspar
  - Garnet
  - Amphibole

Properties of MINERALS

❑ Physical Properties

- ➢Color
- ➢Streak
- ➢Hardness
- ➢Specific Gravity
- ➢Cleavage
- ➢Fracture
- ➢Luster
- ➢Form
- ➢Magnetic

❑Optical Properties

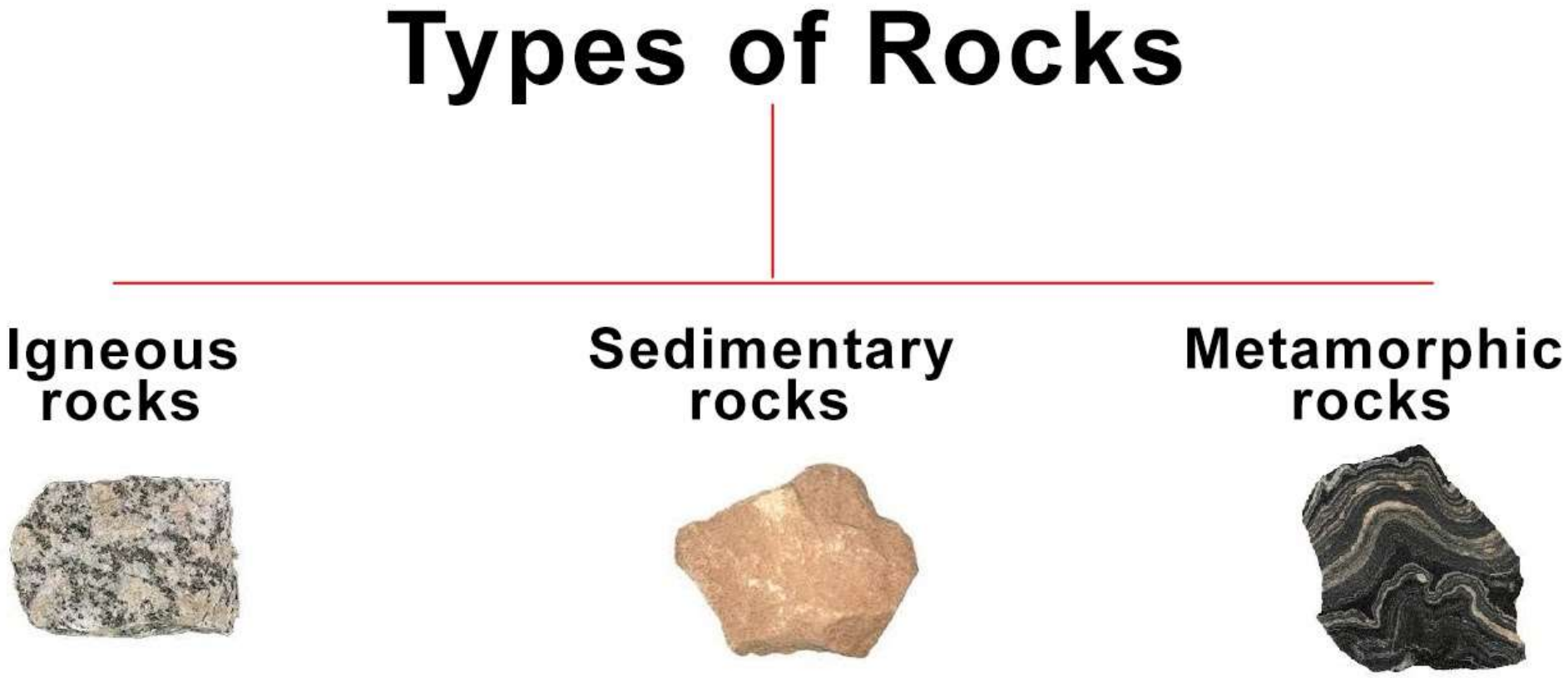
❑Chemical Properties

- ➢Reaction to HCl

Dr. Manoj Kumar Ozha
Dept. of EES
NIT Durgapur

ROCKS

A natural substance, a solid aggregate of one or more minerals or at time mineraloids.



ROCKS Exposure

Igneous

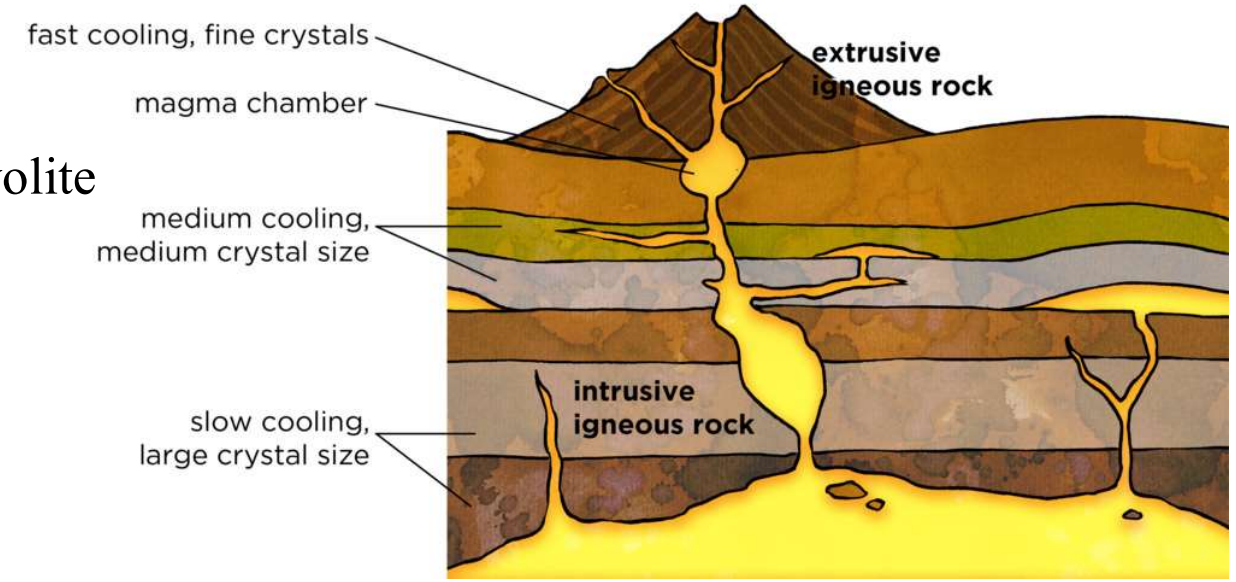
Sedimentary

Metamorphic

Igneous Rocks

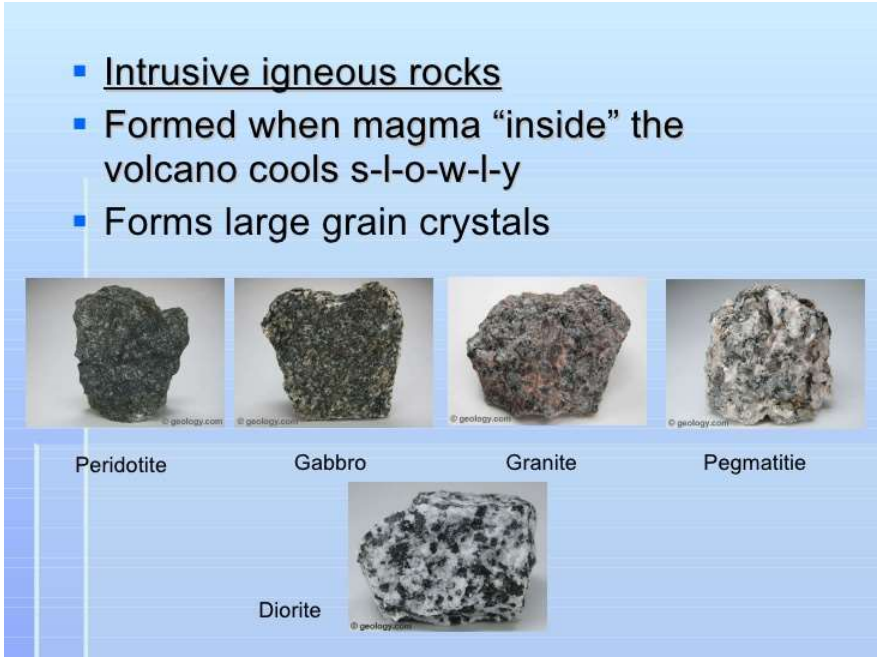
Igneous rocks are further subdivide into various types, which solely depend upon its:

- ❑ Place of emplacement
  - ➢ Extrusive/Volcanic
    - ✓ E.g., Basalt, Rhyolite
  - ➢ Intrusive
    - • Plutonic
      - ✓ Granite, Gabbro
    - • Hypabyssal
      - ✓ Dolerite

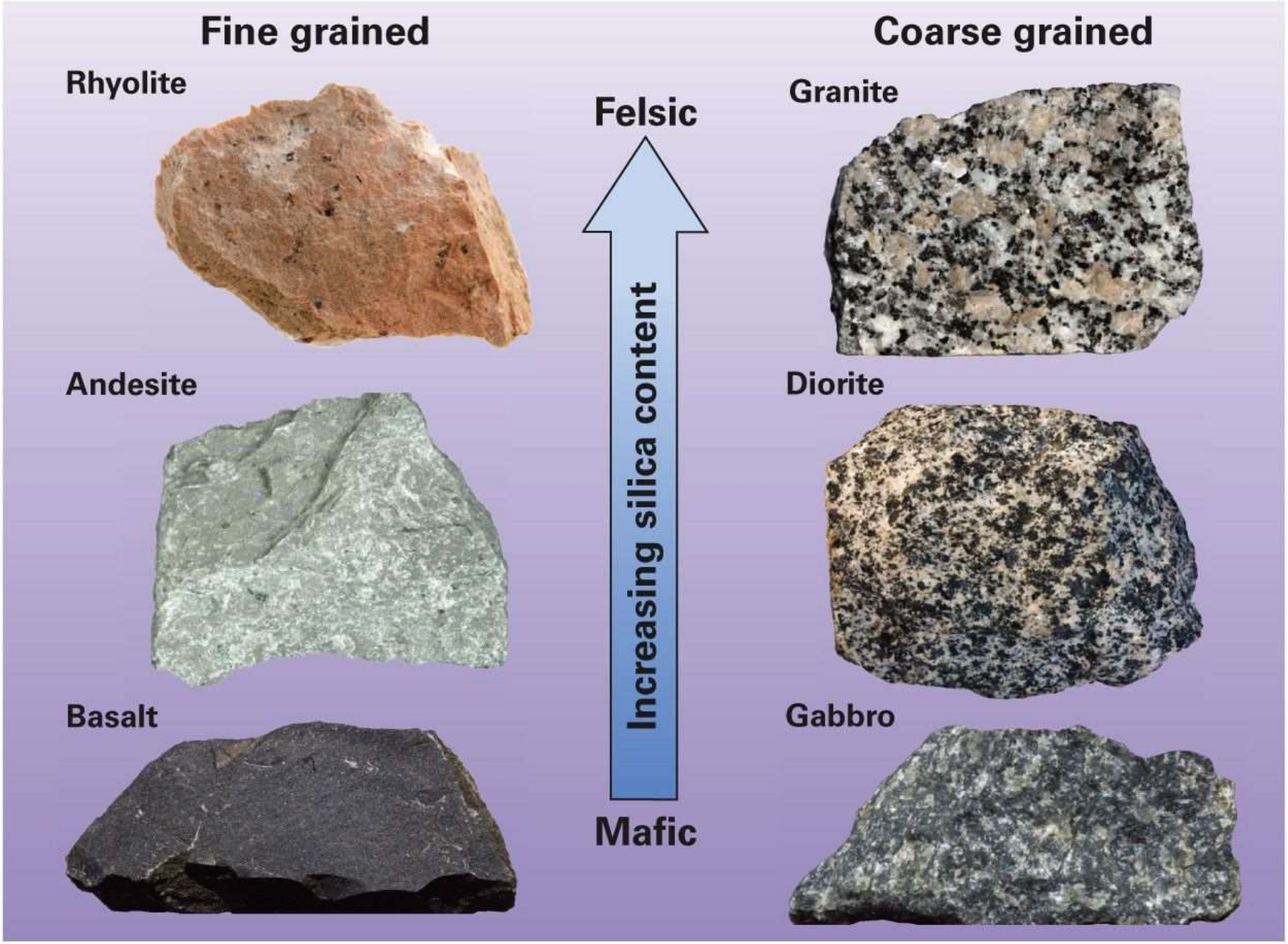


- ❑ Texture:
  - ➢ Fine
  - ➢ Coarse

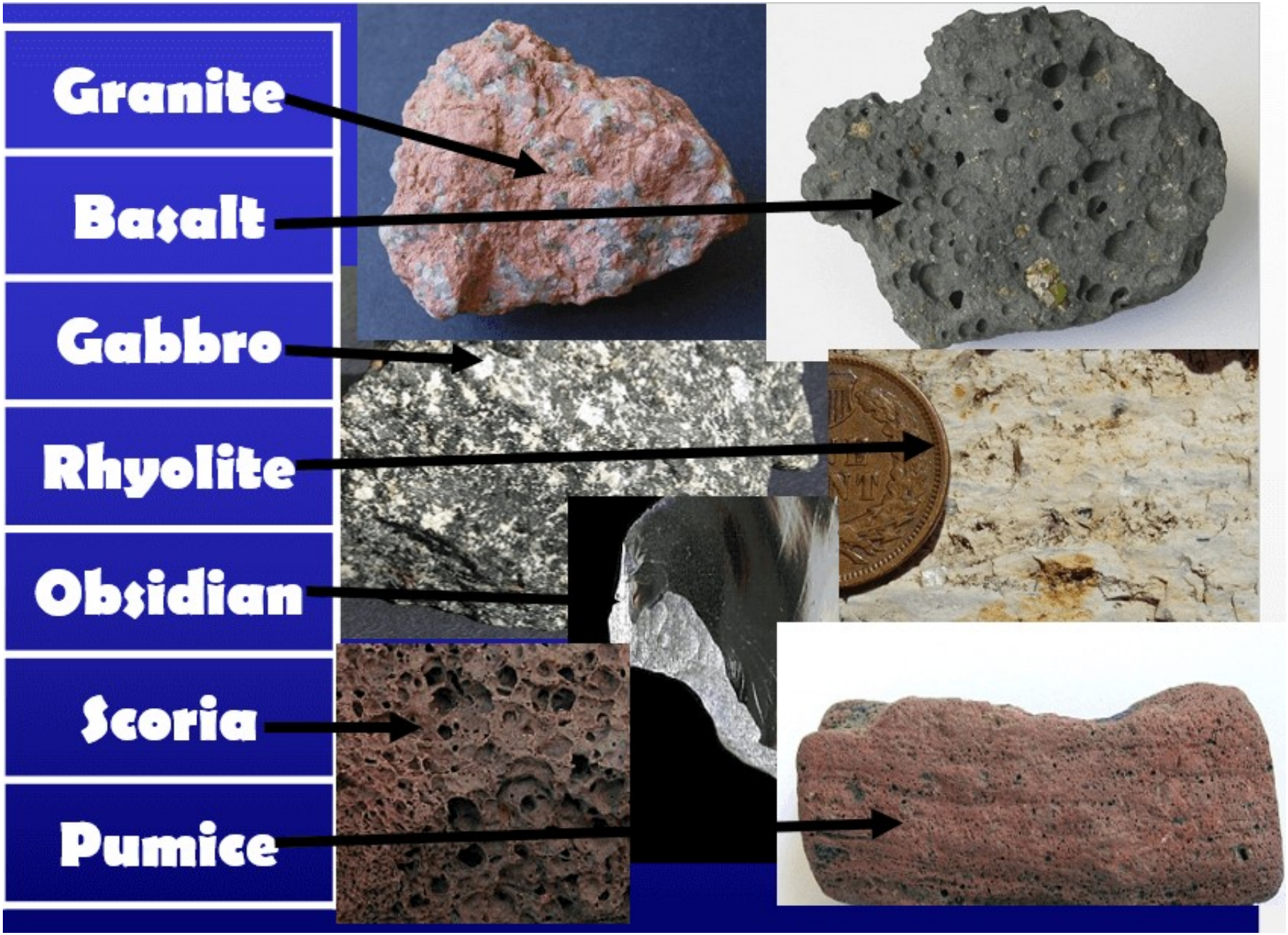
- ❑ Chemical Composition (Based on Silica)
  - ➢ Acidic (66% Silica)
  - ➢ Intermediate (66-55% Silica)
  - ➢ Basic (55-44% Silica)
  - ➢ Ultrabasic (<44% Silica)



Igneous Rocks



Igneous Rocks

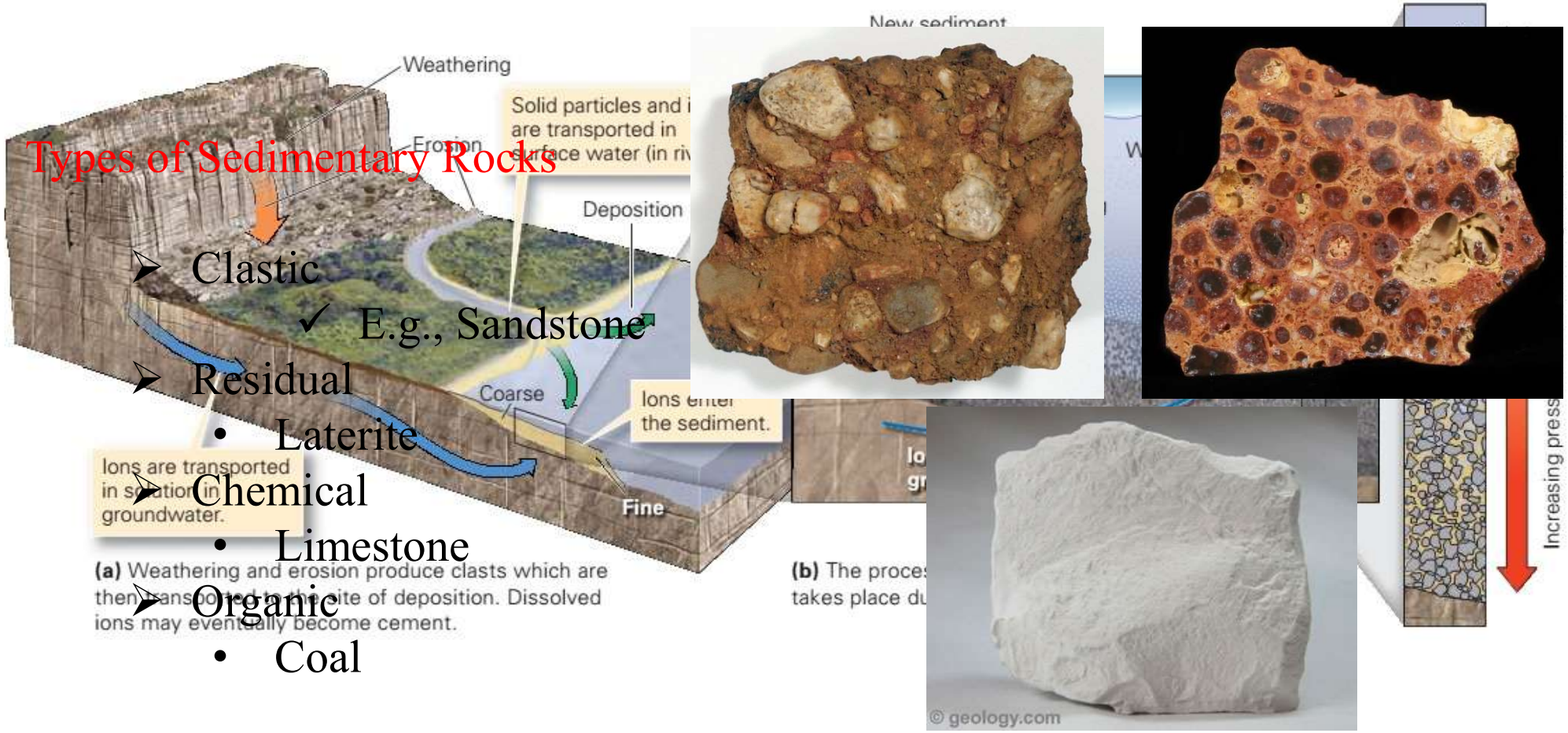


Sedimentary Rocks

- Natural agencies like wind, running water, peculating underground water, glaciers are always in motion, and accordingly cause continuous wear and tear.
- The products of such activities results sediment under favourable condition
- Compaction of these sediments results in sedimentary rocks or Secondary rocks

❑ Types of Sedimentary Rocks

- ➢ Clastic
  - ✓ E.g., Sandstone
- ➢ Residual
  - Laterite
- ➢ Chemical
  - Limestone
- ➢ Organic
  - Coal



Sedimentary Rocks

- Depending upon the grain size, the clastic sedimentary rocks are further sub divide into:

  - Rudaceous (> 2mm in diameter)
    - Boulders
    - Cobbels
    - Pebbles
    - Gravels
  - Arenaceous (2 to 1/16 mm)
    - Sandstone
    - Grit
  - Silt (1/16 to 1/256 mm)
    - Siltstone
  - Argilliceous (< 1/256 mm)
    - Shale
    - Mudstone

Metamorphic Rocks

- Metamorphism, which means "change in form"
- **Metamorphic rocks**: Arise from the transformation of existing rocks (i.e., the **Protolith**) where they experience different pressures and temperatures than those at which they formed
- The Protolith: Sedimentary, Igneous, or existing metamorphic rock
- During metamorphism the protolith is subjected to heat (temperatures >150 °C) and pressure >1000 bar
- This change in pressure and temperature causes physical or chemical change

Metamorphic Rocks

Factors/agents that are effects the protolith:

- Temperature (**T**)
- Pressure (**P**)
  - Uniform Pressure (hydrostatic)
  - Directed pressure (stress)/ Orogenic forces
- Chemically active fluids

Depending upon the dominance of one or other agencies, metamorphism can be broadly classified into:

T Dominating: Thermal/pyro/contact Metamorphism

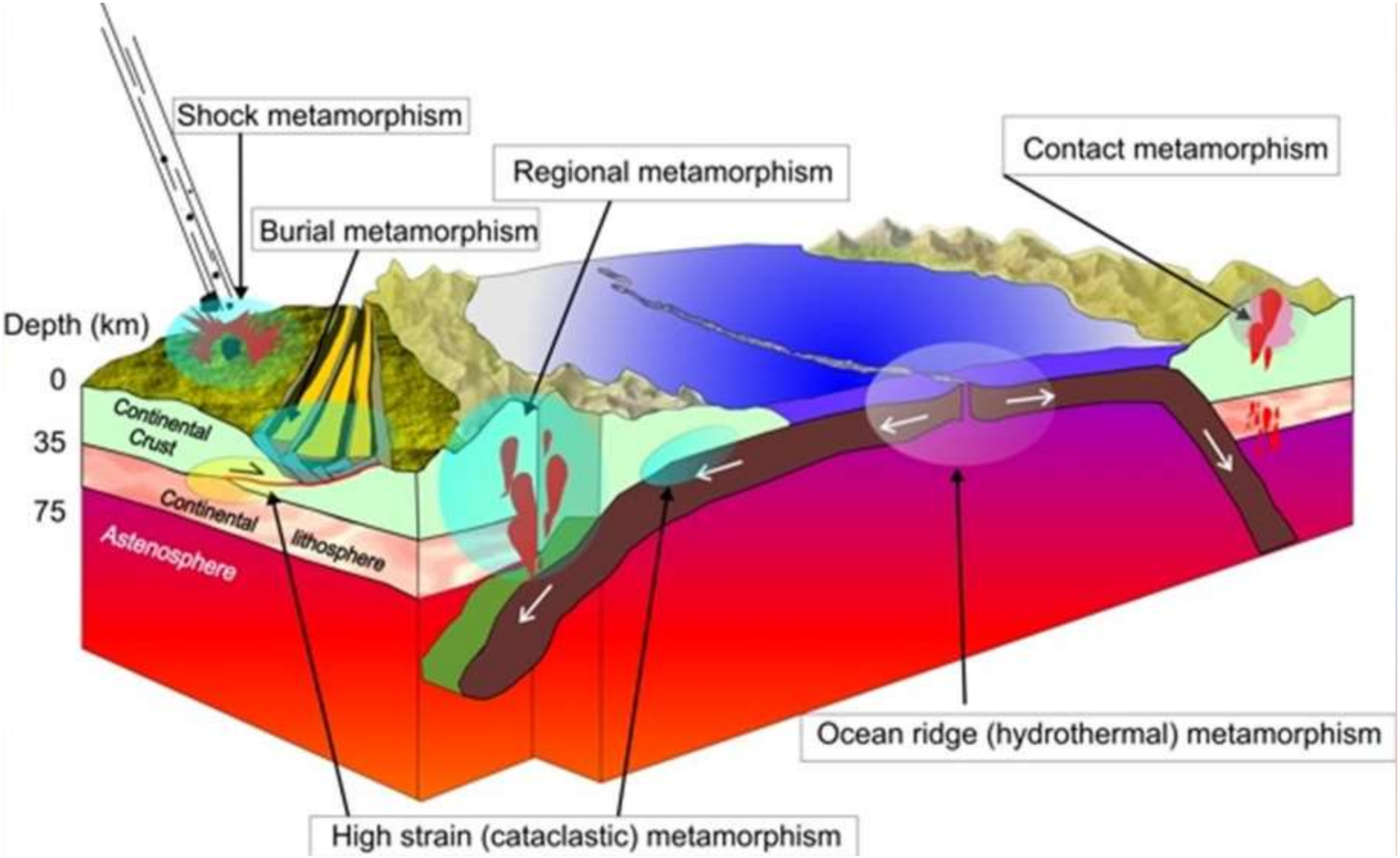
Uniform P and T: Plutonic Metamorphism

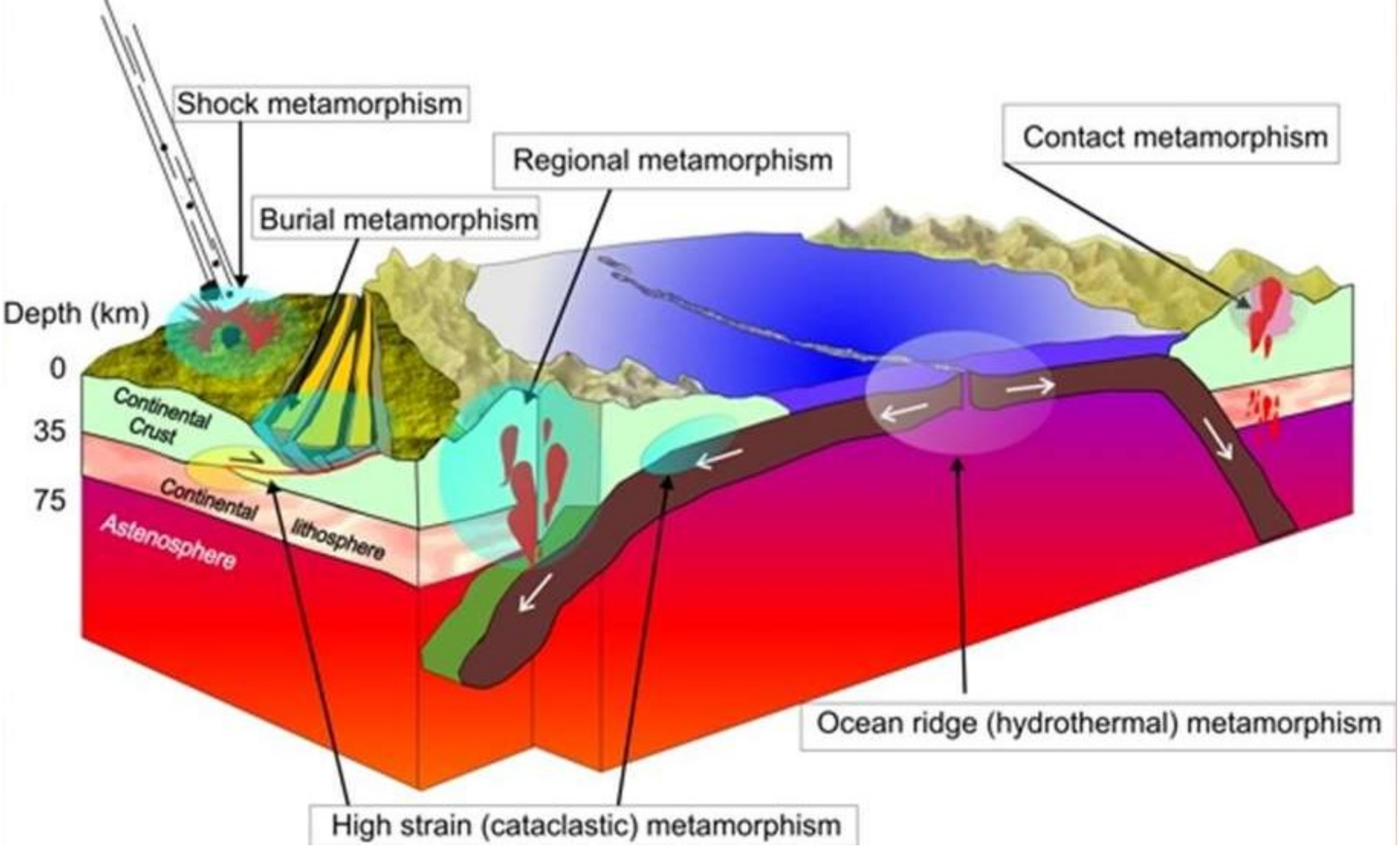
Stress dominating: Dynamic/cataclastic Metamorphism

T and Stress dominating: Regional Metamorphism

T and Chemical Fluids Dominating: Metasomatism

Metamorphic Rocks





T Dominating: Thermal/pyro/contact Metamorphism

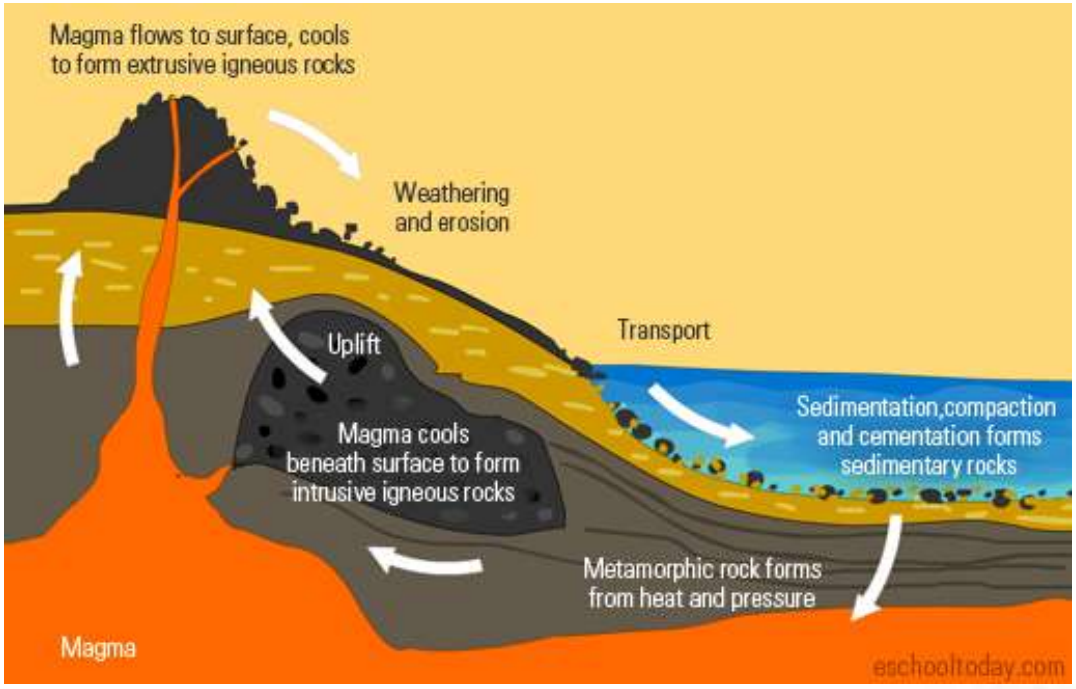
Uniform P and T: Plutonic Metamorphism

Stress dominating: Dynamic/cataclastic Metamorphism

T and Stress dominating: Regional Metamorphism

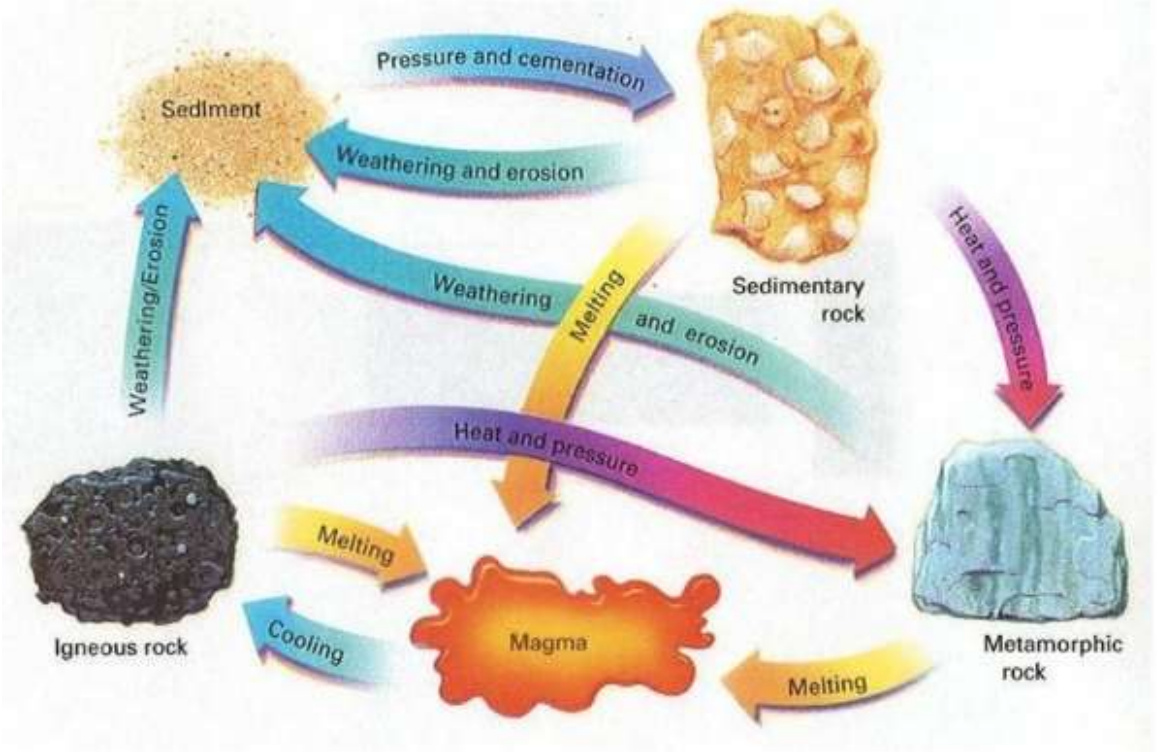
T and Chemical Fluids Dominating: Metasomatism

Rock cycle



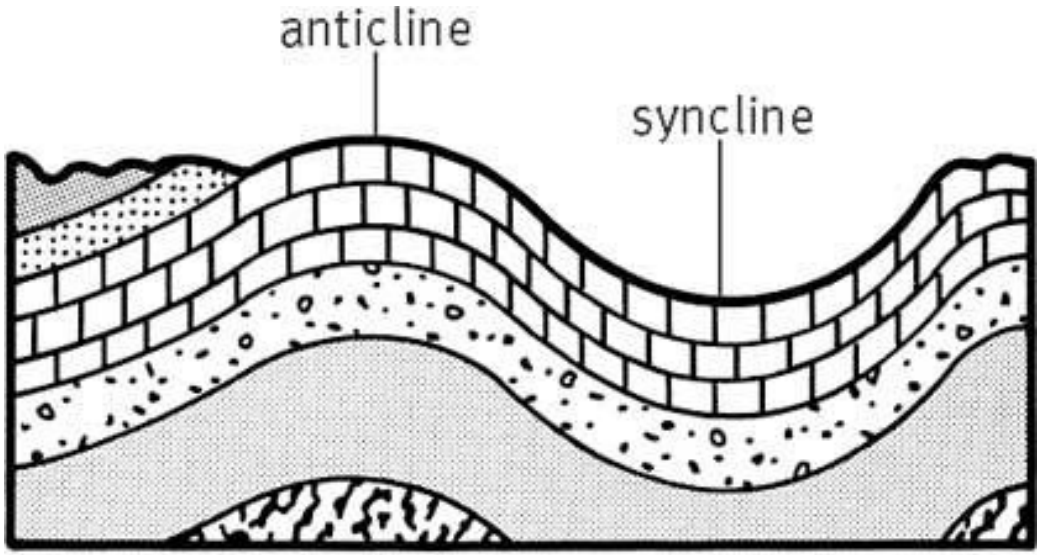
The scenarios

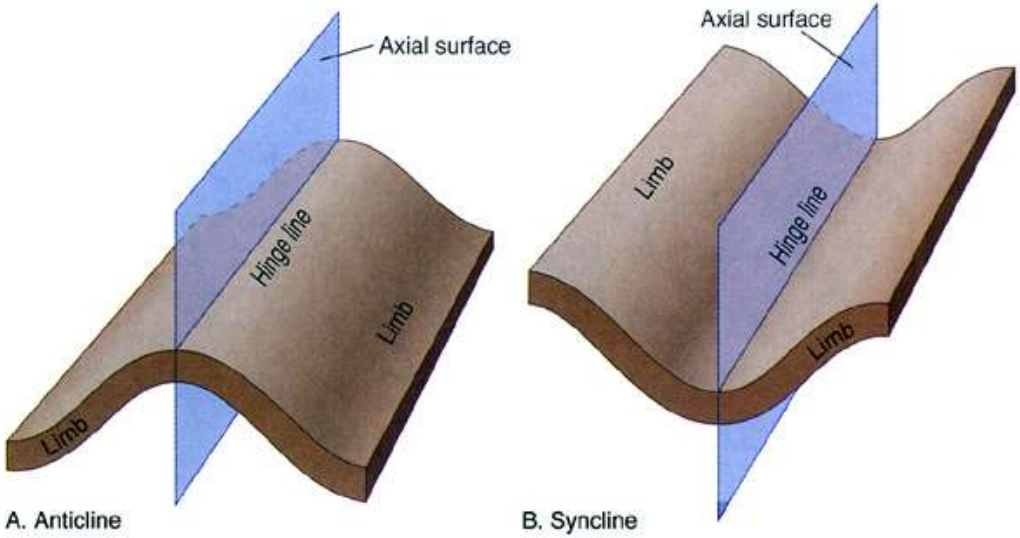
The processes



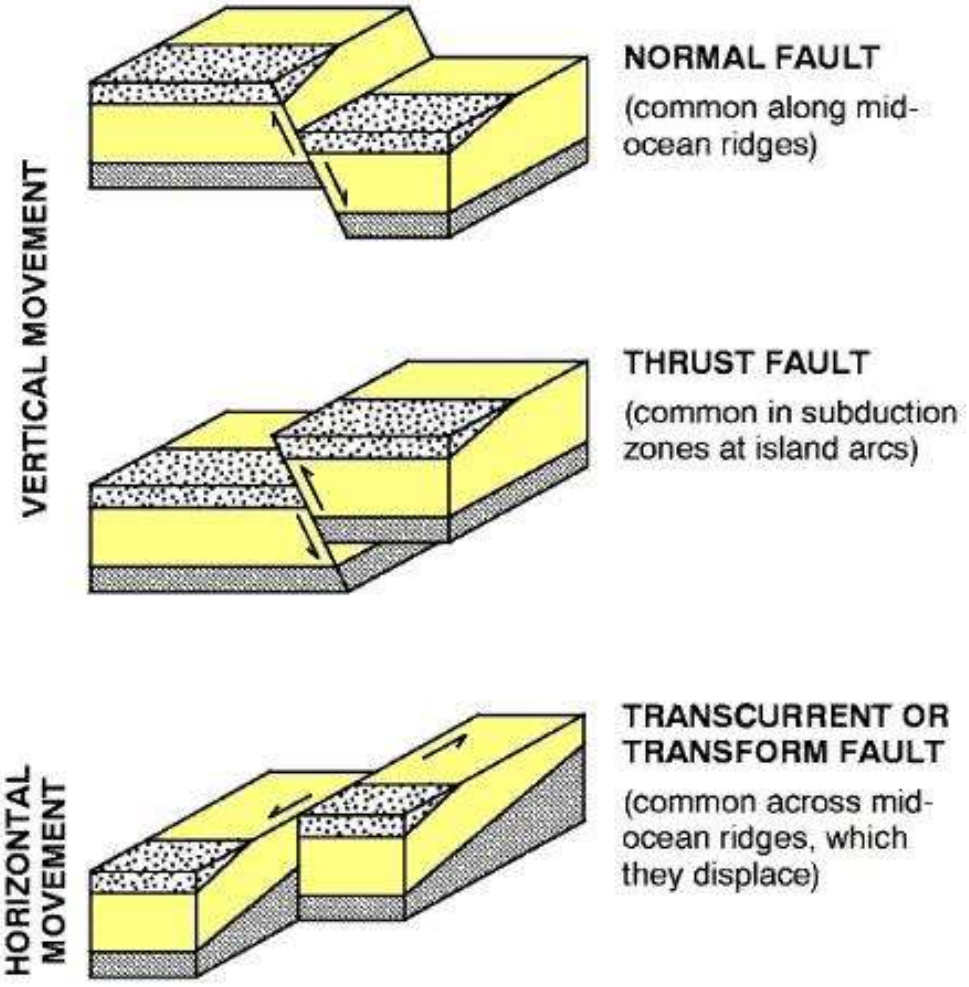
Structures resulted from Deformation

Fold



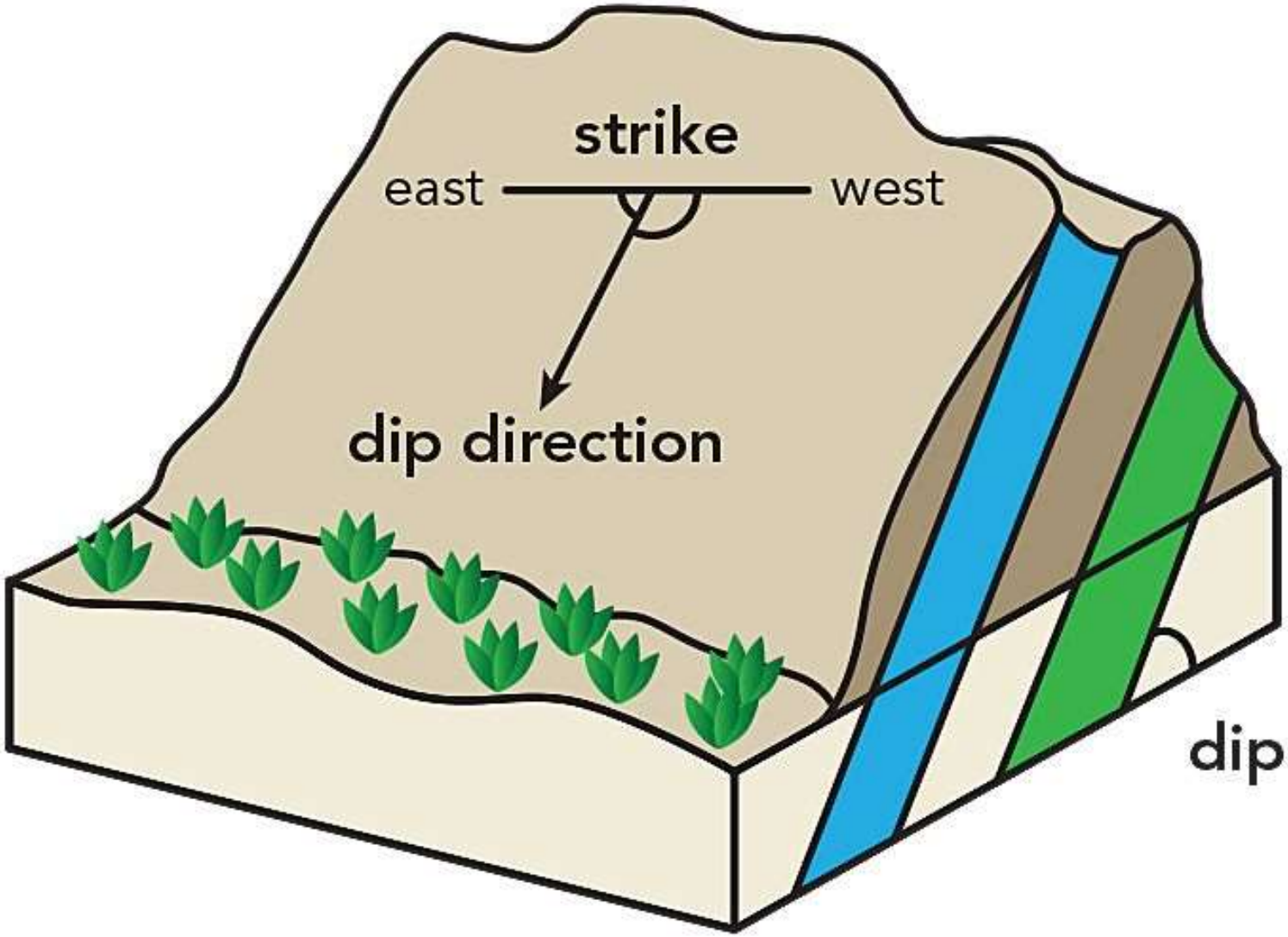


Fault



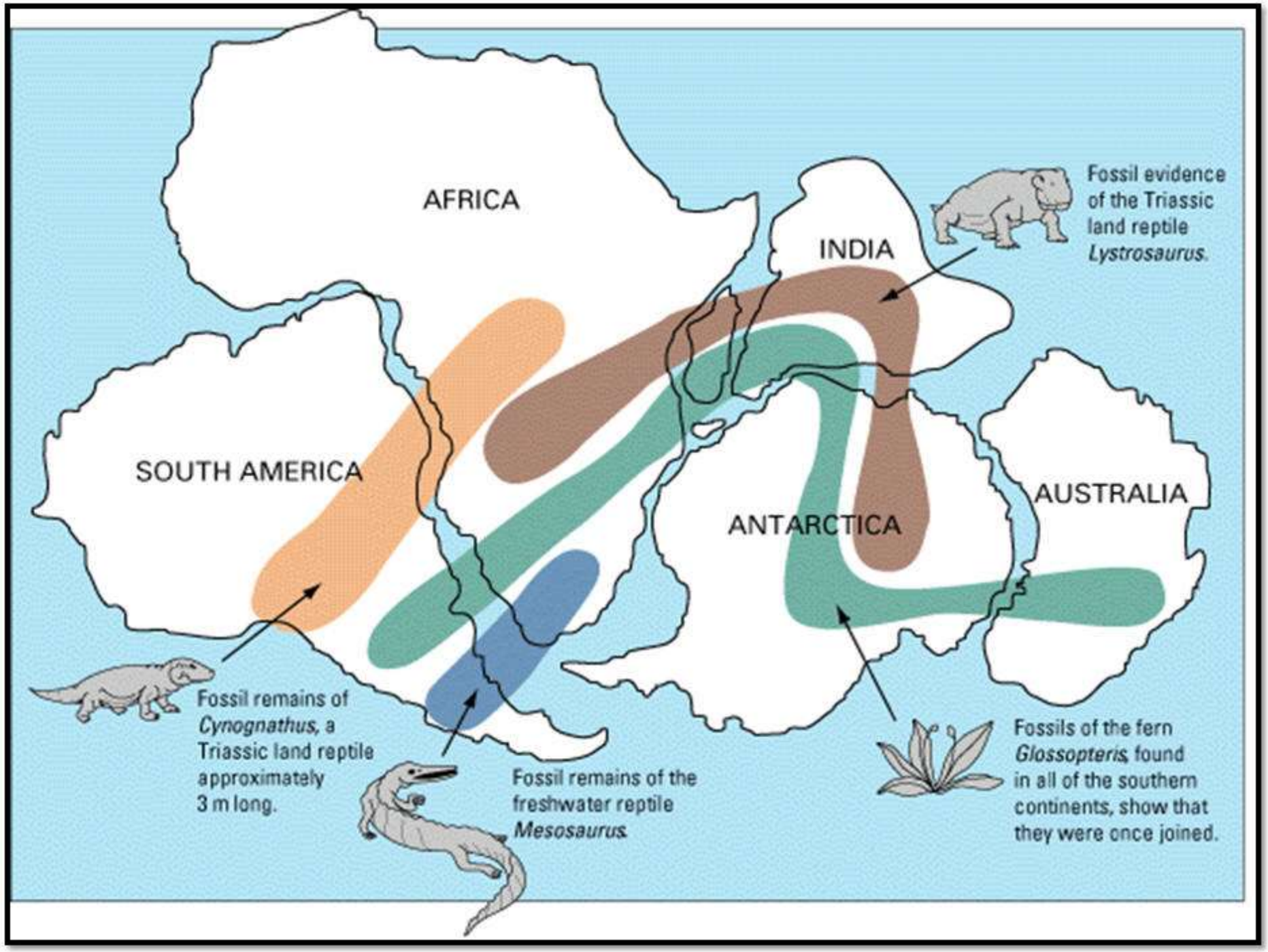
Structures resulted from Deformation

Dip and Strike



Continental Drift

Continental Drift

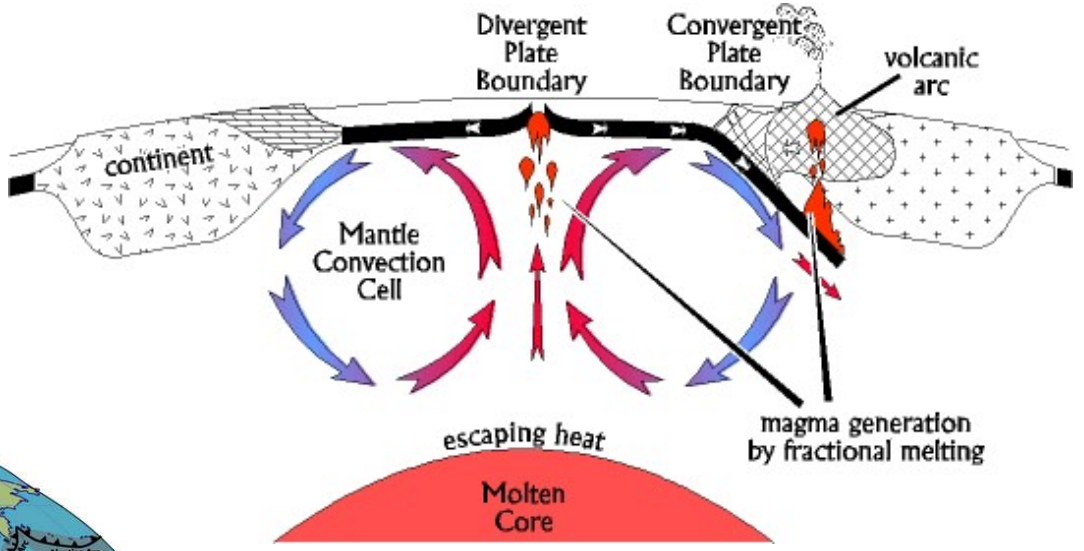


Continental Drift

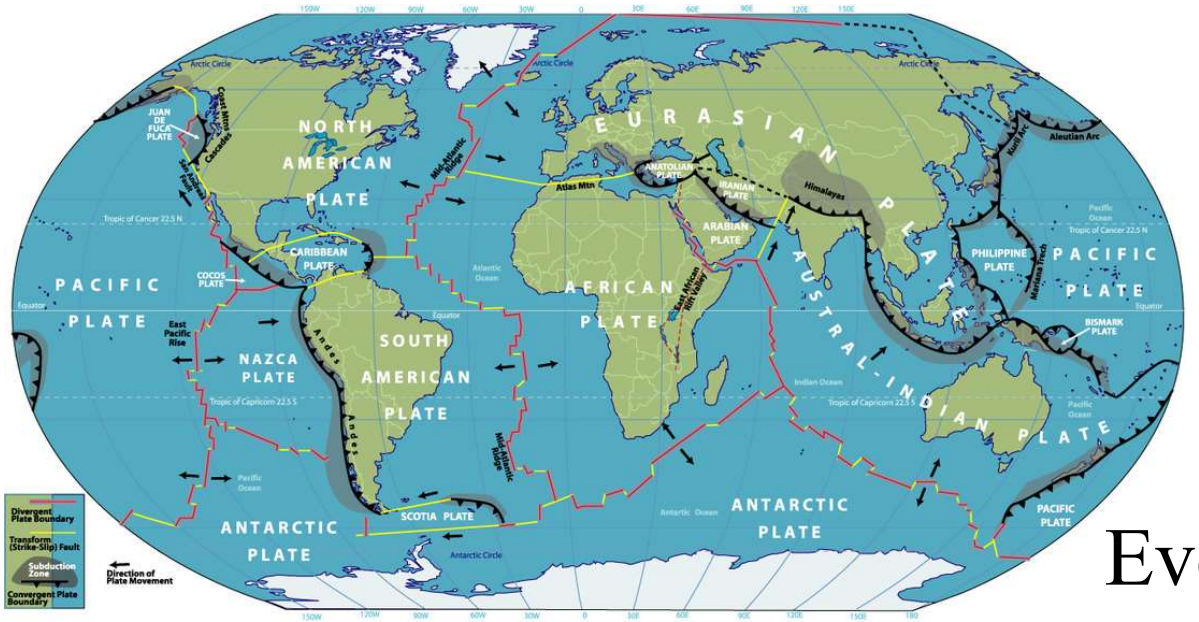
- Alfred Wagener (1910-15): First geographer to propose this theory.
- Single Landmass/Supercontinent: Pangea (0.25 Ga or Billion)

Plate Tectonics

- A plate represents a segmented part of the lithosphere that floats over the Asthenosphere
- The theory was first proposed by a group of scientist during 1960s
- It explains all the movements of plates and eventual development all different type of settings where rocks are formed and consumed
- Depending upon the composition of the rocks the plates are divided into:
  - **Oceanic plate**
  - **Continental plate**
- Types of Plate boundaries:
  - **Convergent/Consuming/Destructive**
  - **Divergent/Constructive**
  - **Transform**

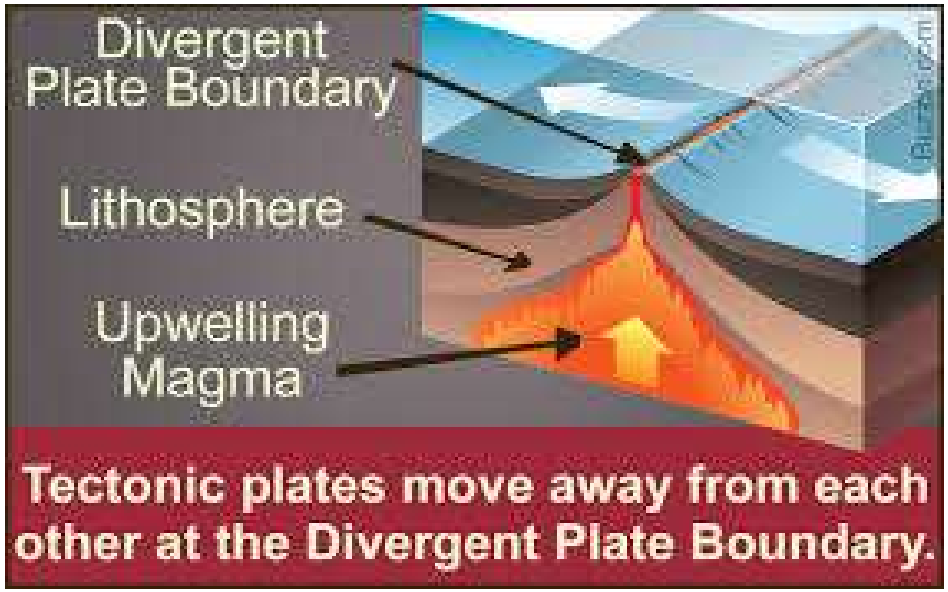


Process

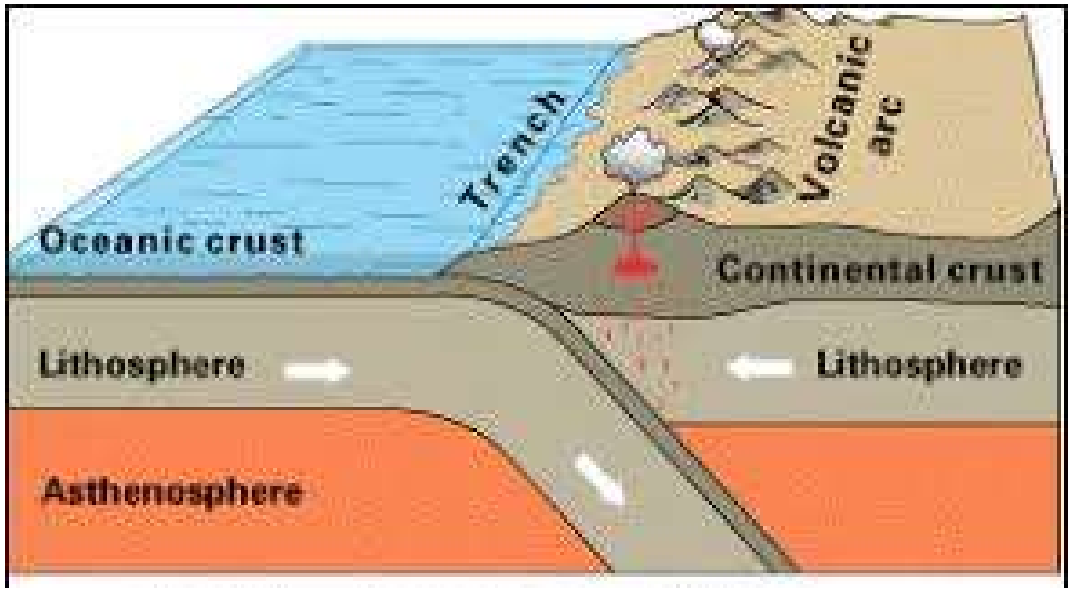


Eventual Architecture

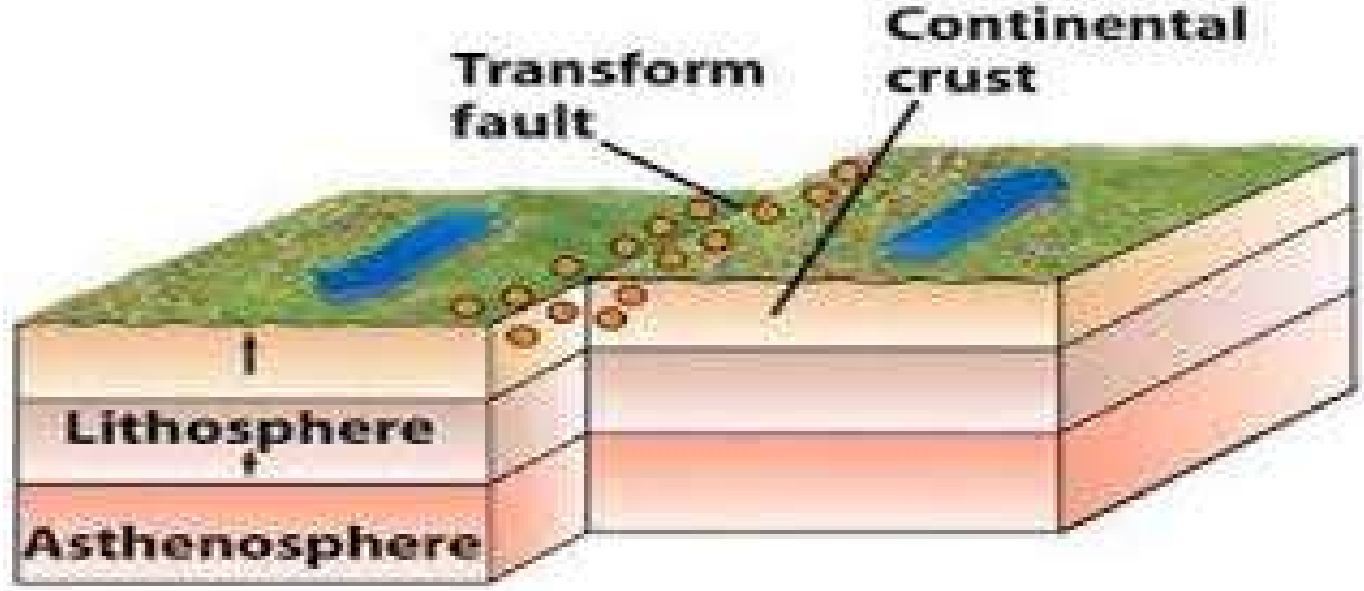
Plate Tectonics



Divergent/ Constructive

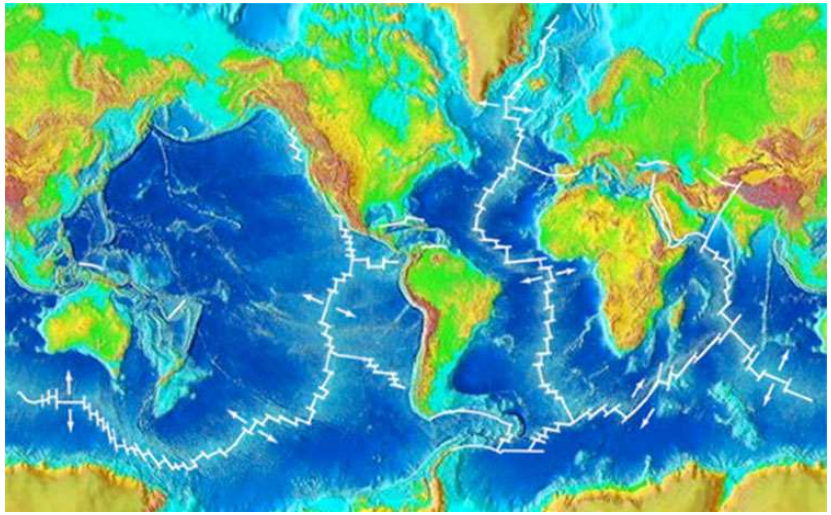


Convergent/ Destructive

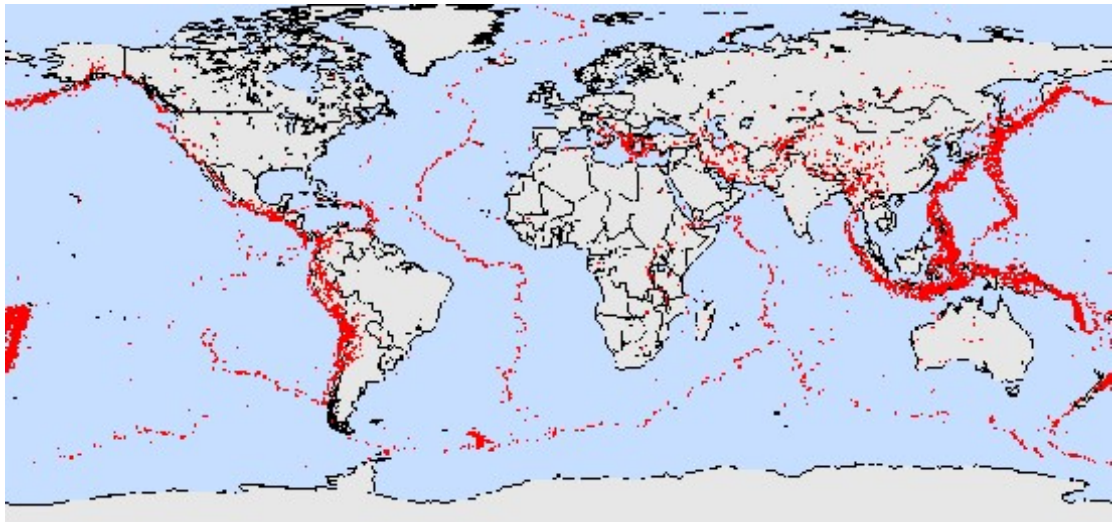


Transform/ Conservative

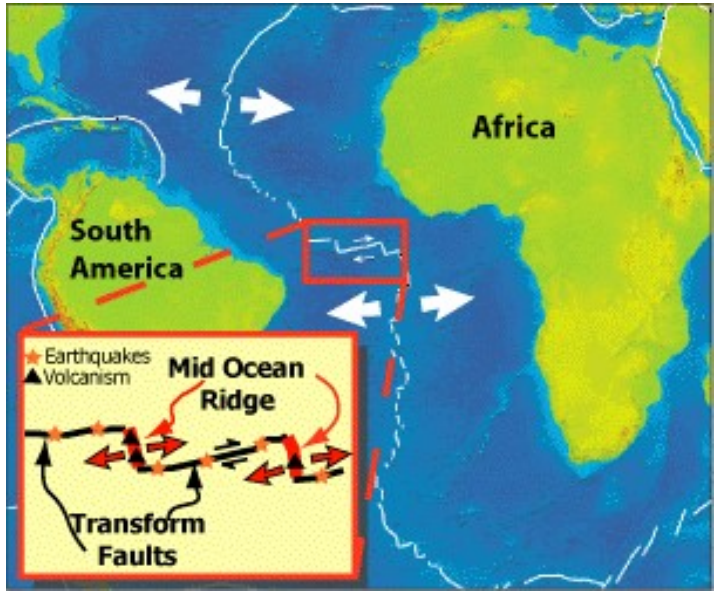
Plate Tectonics (Examples)



Divergent/ Constructive



Convergent/ Destructive



Transform/ Conservative