

Introduction to:

GEOLOGY / GEOMORPHOLOGY

Geology:

Geo = Earth

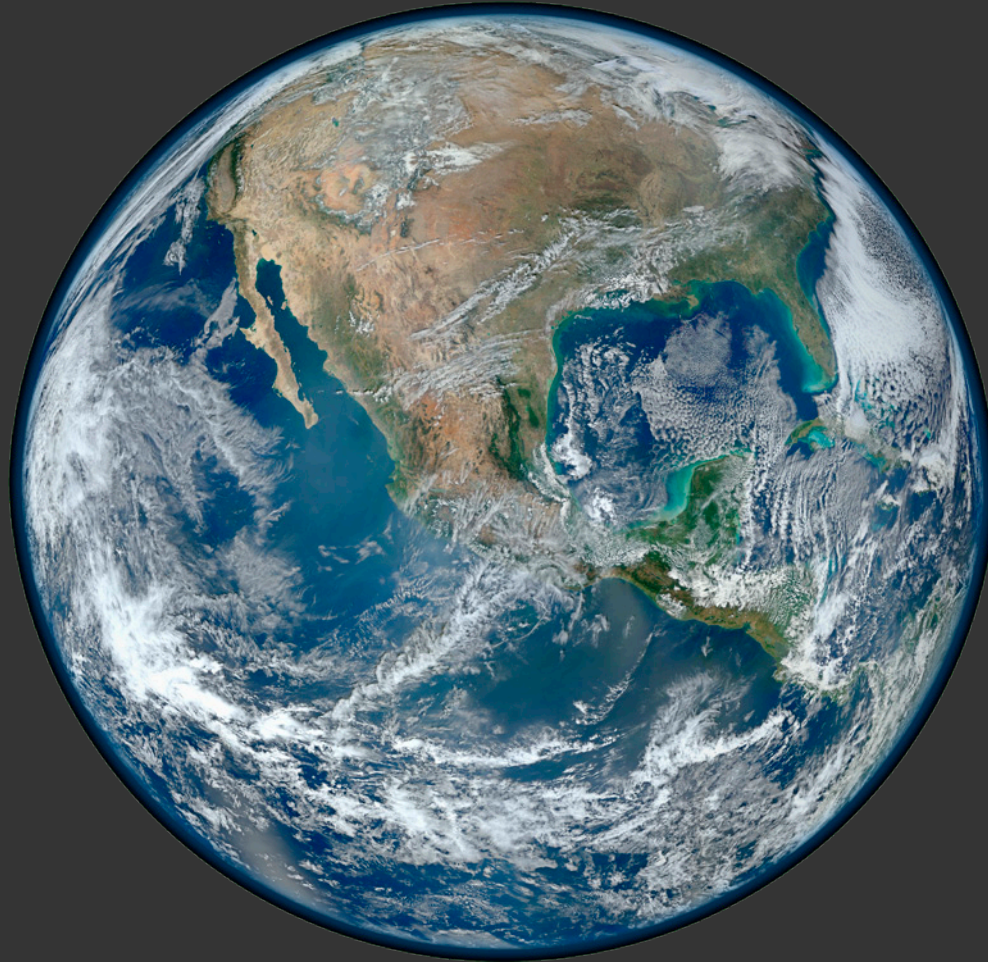
Study of the solid Earth

Geomorphology:

Geo = Earth; Morph = Form

Study of landforms and the processes that shaped them

Formation of the Dynamic Earth



Age of the Dynamic Earth

Age of Universe ~ 12 billion years

Age of Solar System ~ 4.6-4.7 billion years

Age of Lithosphere ~ 3.9 billion years

Age of Biosphere ~ 3.8 billion years

Age of Hydrosphere ~ 2 billion years

Age of Atmosphere ~ 1 billion years

What does the Earth consist of?

1. Elements:

Forms of matter that cannot be subdivided by temperature or reactions

2. Minerals:

Naturally occurring, Inorganic, Solids, Have definitive chemical composition, Have a crystal structure

3. Rocks: Aggregates of minerals

Igneous: Molten

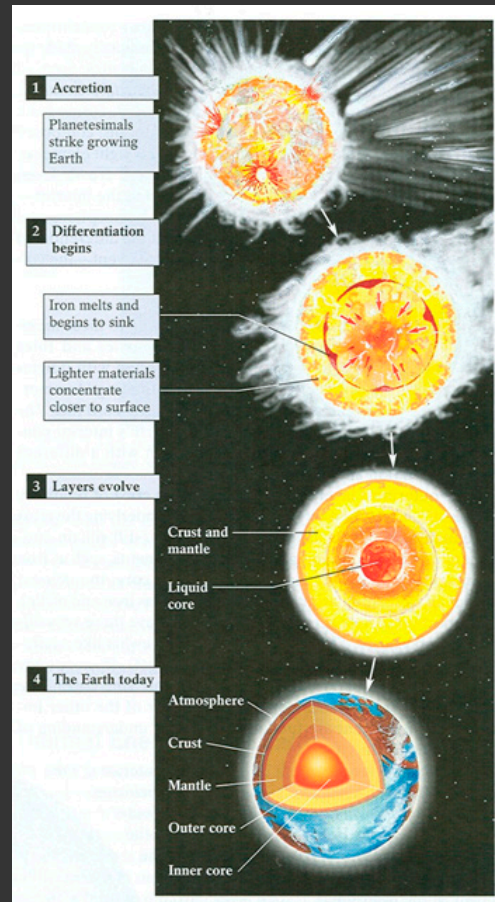
Sedimentary: Reworked

Detrital: Small pieces of rock

Chemical/Biochemical: Dissolved and reprecipitated

Metamorphic: Changed in SOLID STATE by heat, pressure, and/or chemical activity

Dynamic Earth Evolution of Lithosphere



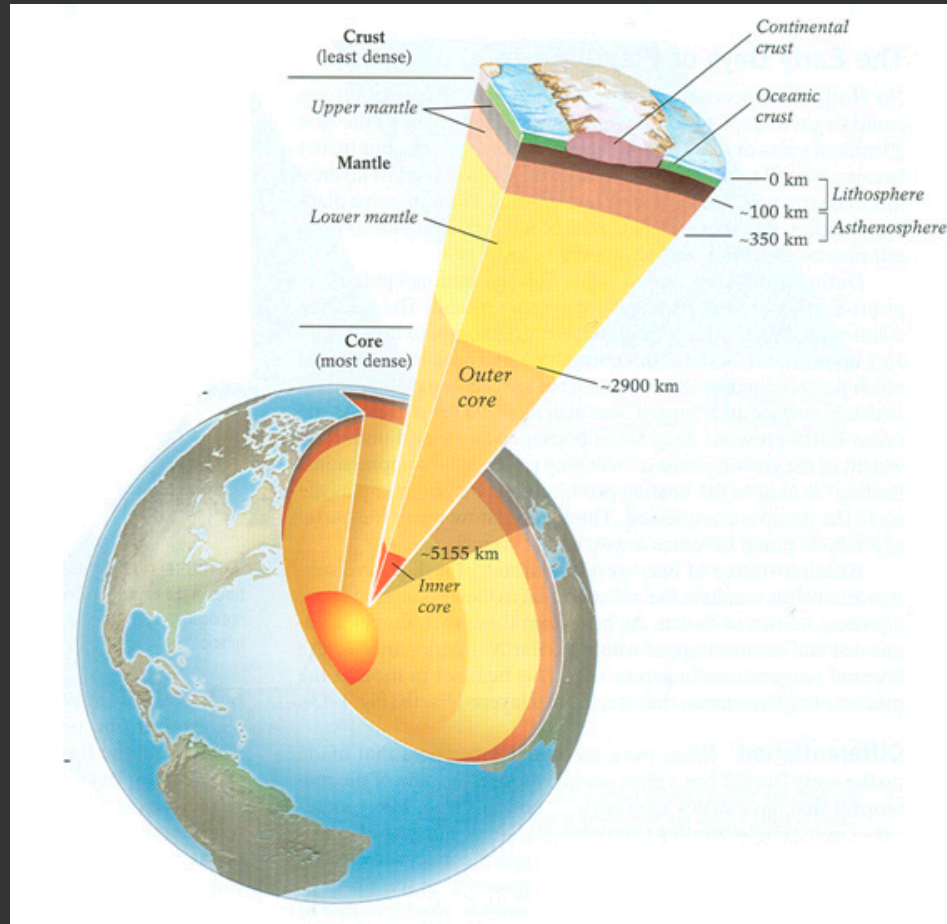
Accretion

Differentiation begins

Layers evolve

Earth today

Stratified Earth

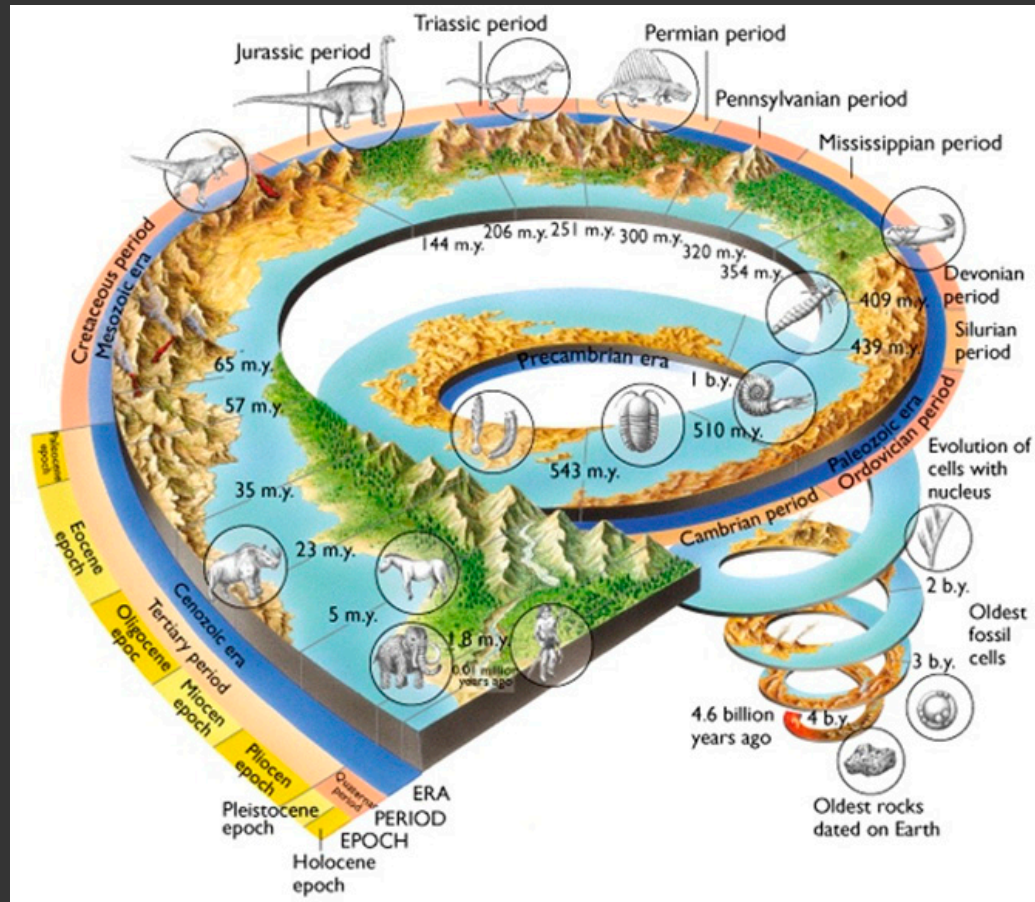


Crust: <1%, Brittle

Mantle: >50%, Plastic

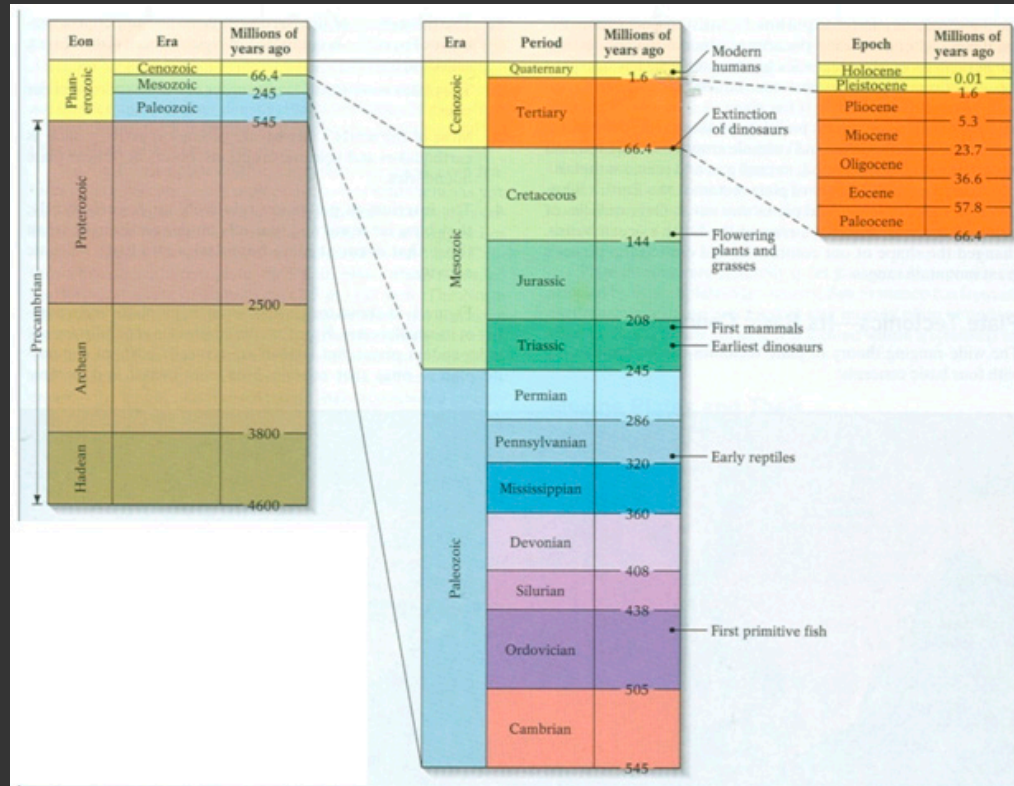
Core: <50%, Plastic with Solid Center

GEOLOGIC TIME



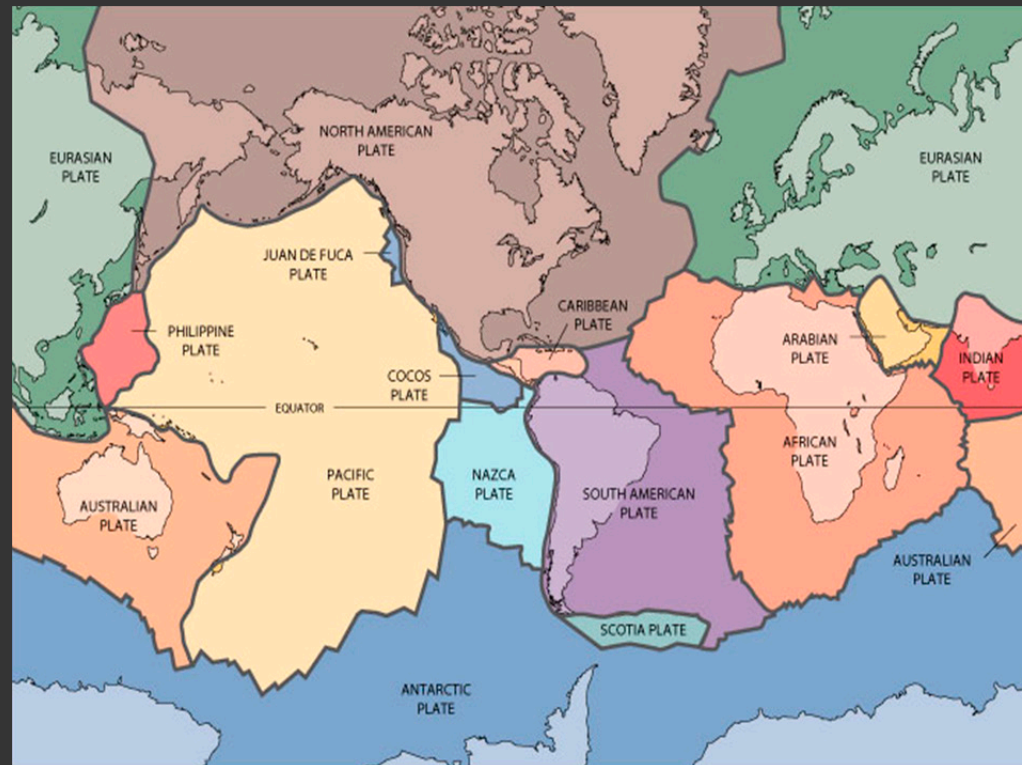
Ozark Plateau

GEOLOGIC TIME SCALE



*Oldest Continental Crust ~ 4.3bya; Oldest Oceanic Crust ~ 200mya

PLATE TECTONICS

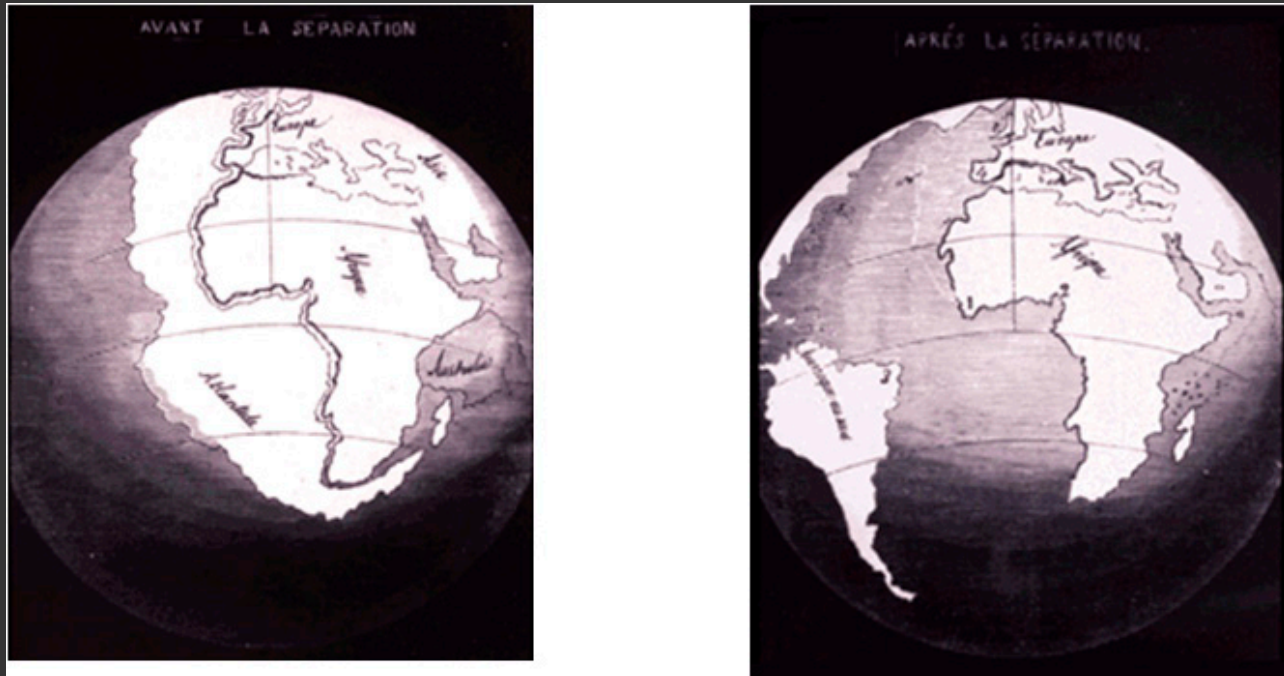


7 major plates and 8 minor ones

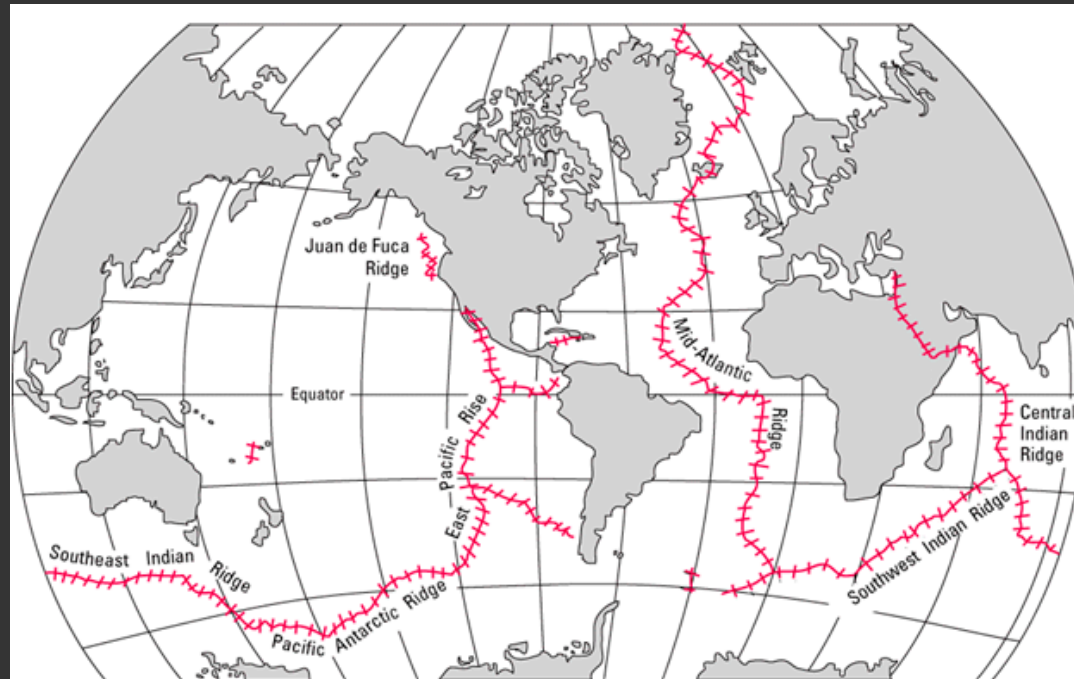
Apparent Fit

1596 cartographers noticed how continents seemed to fit together like a puzzle

1858 this first rendition was produced

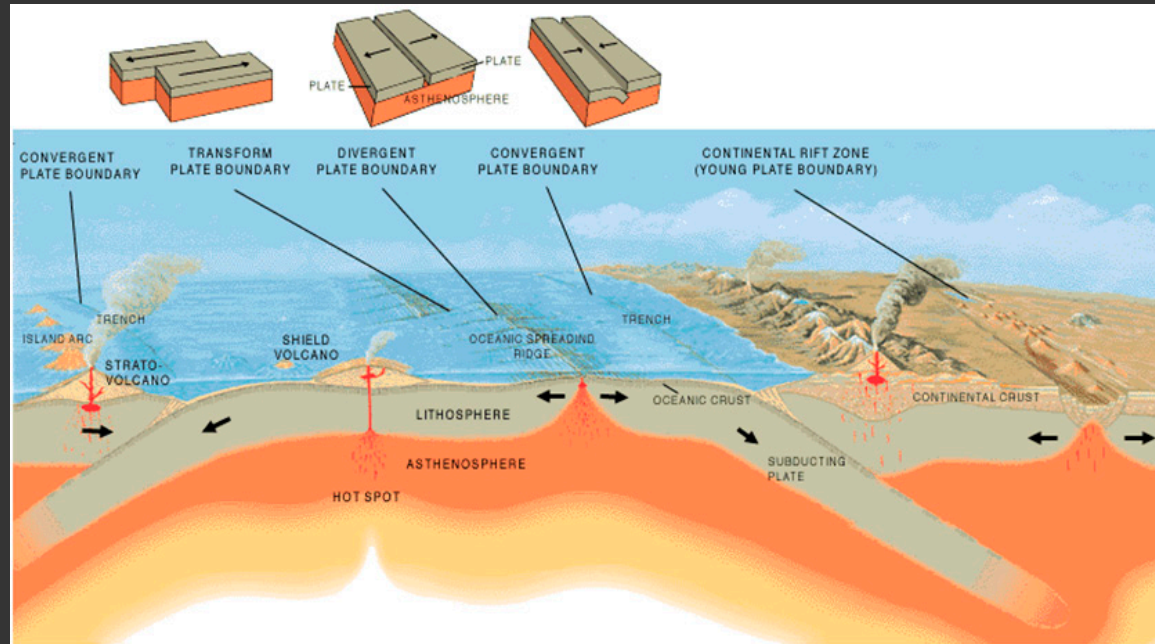


Mid Oceanic Ridges



Sonar used in WWII found the Mid Atlantic Ridge, a mountainous ridge where new oceanic crust is produced

3 Primary Plate Tectonic Boundaries

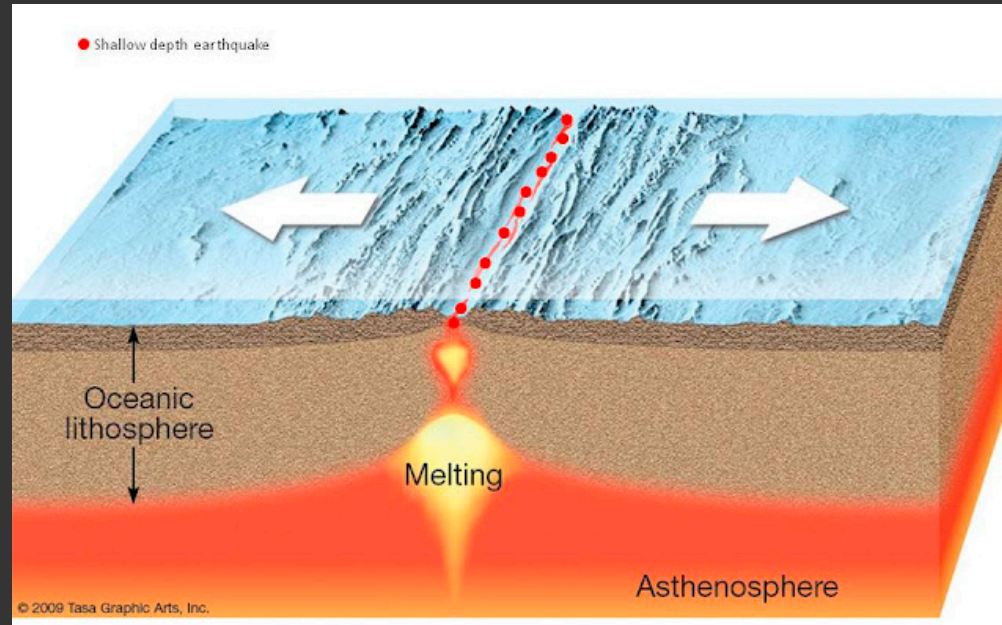


Divergent Plates

Convergent Plates

Transform Plates

Divergent Plate Boundaries



Found primarily in ocean basin

Forms from thinning of lithosphere

Generally are rift valleys, represent ~50% of ocean floors

Rift mountains are high areas adjacent to rift

Volcanism (primarily hydrothermal/not explosive), earthquakes

Transform Plate Boundaries



Plates slide laterally past each other
Substantial vertical aspect
Earthquakes & minor volcanism
Primarily associated with MOR/divergent plates

Convergent Plate Boundaries

Much more complex than Divergent or Transform

Three different types:

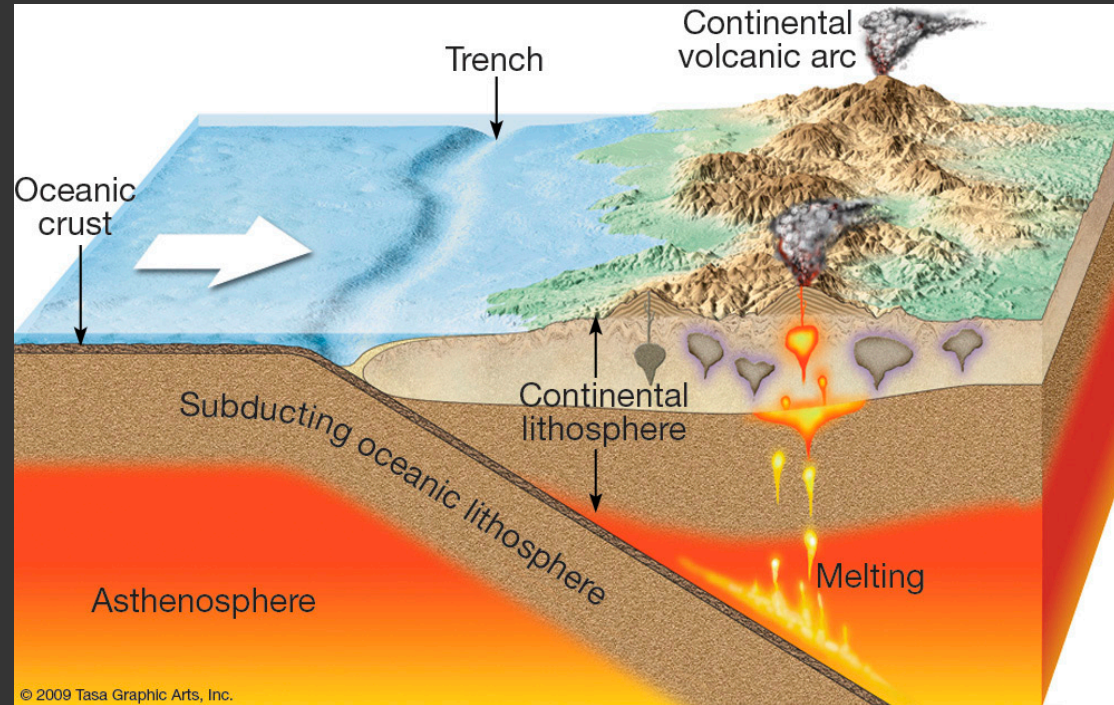
- Ocean crust/Continental crust

- Ocean crust/Ocean crust

- Continental crust/Continental crust

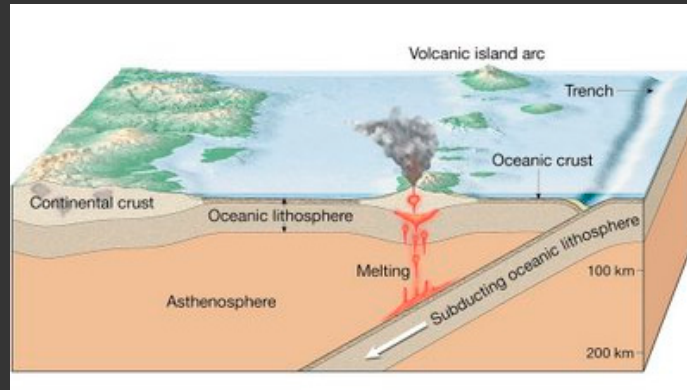
Oceanic crust is more dense than Continental crust

Ocean/Continent Convergent Plates



Two parallel mountain ranges form; Accretionary & Volcanic
Considerable volcanism (explosive)
Massive seismicity
Extensively faulted from subduction

Ocean/Ocean Convergent Plates

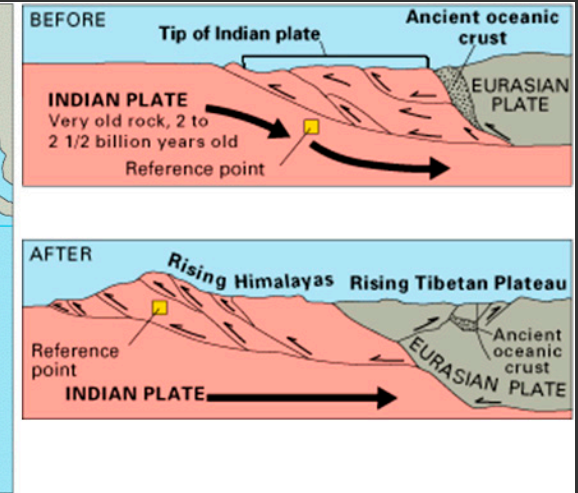
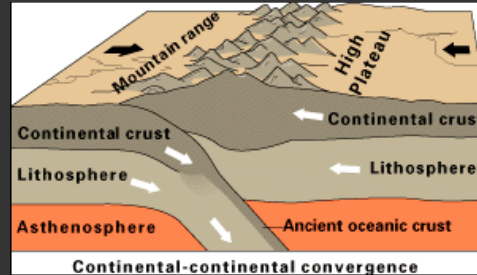


Western Pacific is classic example

Volcanic island arc form on downthrown side

Violent volcanism

Continent/Continent Plate Boundaries



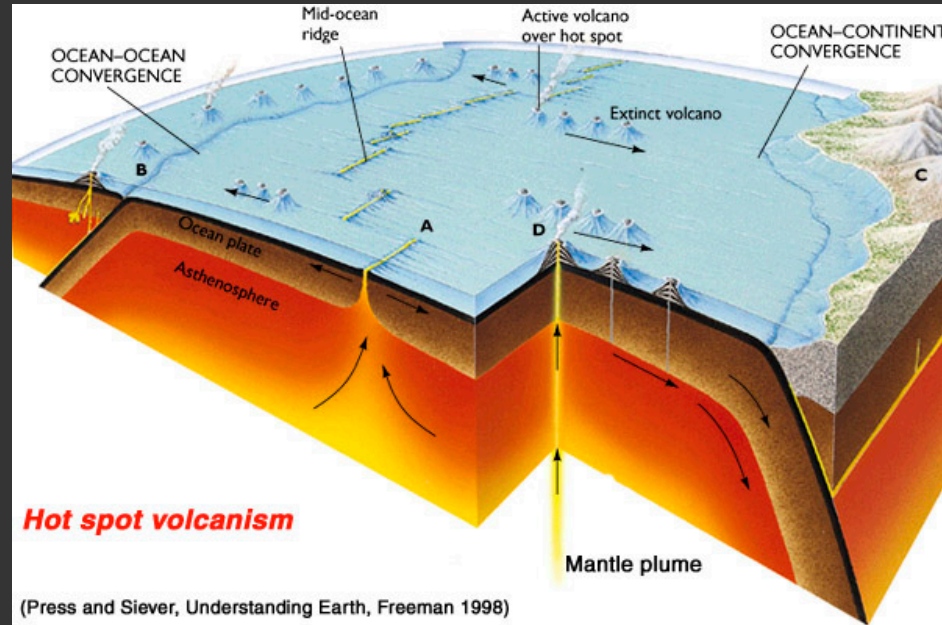
Major deformation of lithology

Rapid uplift

Nominal volcanism

Himalayas, Alps, Appalachian, Davis, & Ouachita Mountains

Hot Spots



Hot Spots are stationary in the Lithosphere (thin)
Located within plate interior
Volcanoes are active but typically not explosive
Hawai`i & Yellowstone/Snake River

Passive Continental Margins



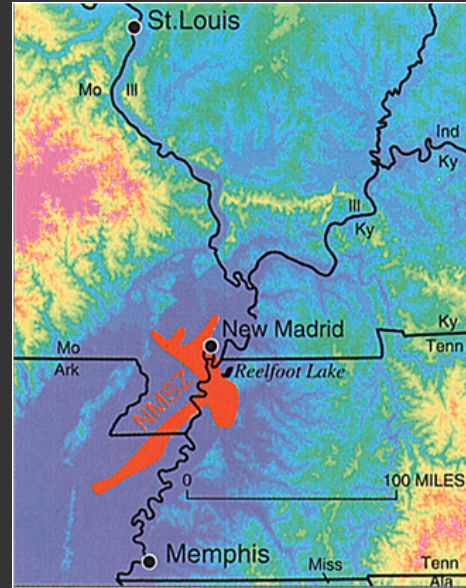
Great Escarpments (Drakensburg), Southern hemisphere

Broad coastal plains

Low relief due to inactive geologic processes

Cratons or older rocks in non-glaciated areas

New Madrid Seismic Zone



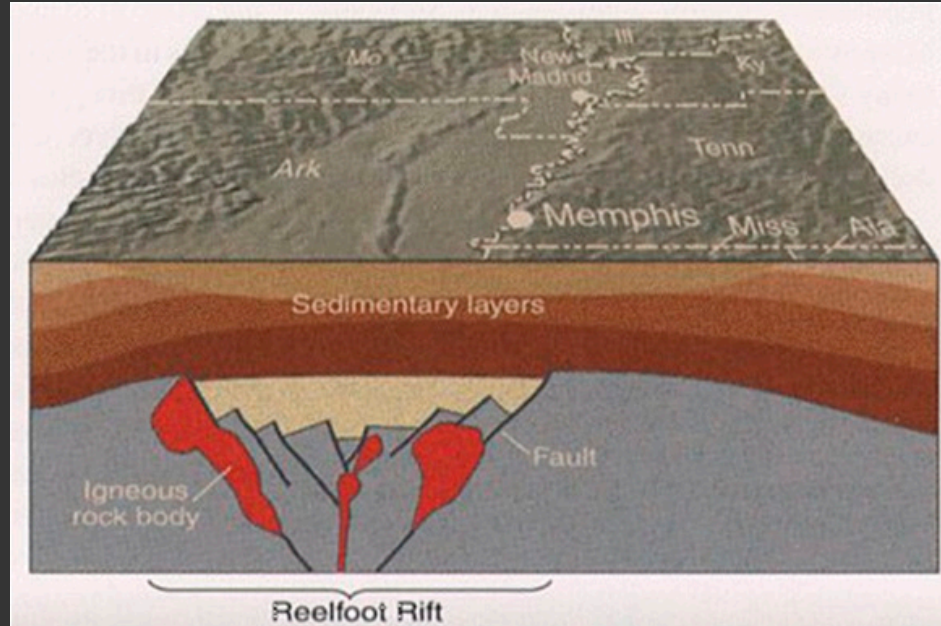
Covers portions of TN, AR, & MO

Largest recorded earthquake in 1811; magnitude ~7 - 8

NMSZ is an intraplate fault system

The Reelfoot Rift is the structural feature responsible for the seismic activity in the NMSZ.

Reelfoot Rift of NMSZ

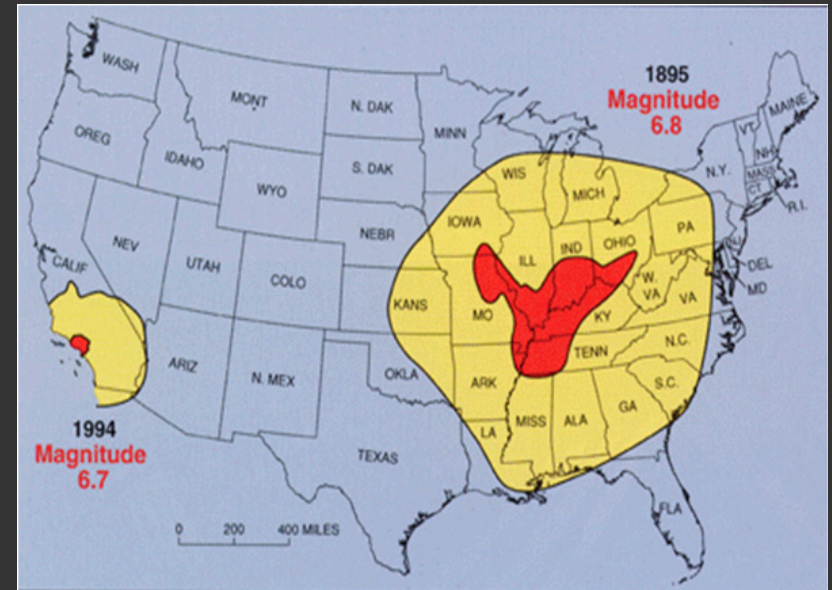
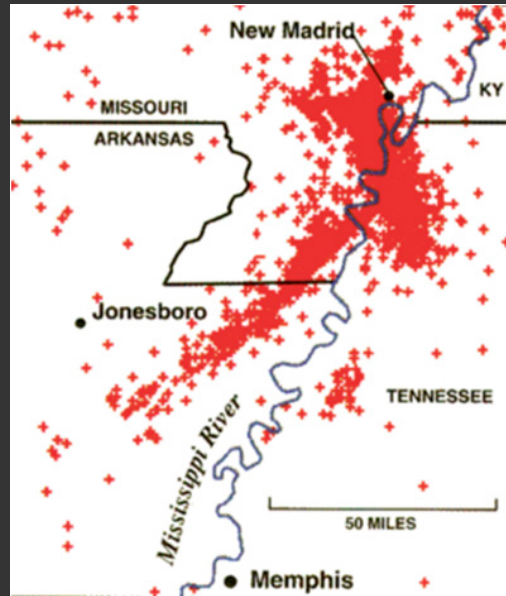


The Reelfoot Rift is a failed rift valley (Divergent Plate)

There was a weak area in the continental crust where a plume of magma caused rifting to begin

Then, for a still largely unknown reason, the rifting stopped

Seismic Activity of NMSZ



Recorded seismic activity in the NMSZ since 1974

Comparison: the 1895 Charleston, Missouri, earthquake in the NMSZ with the 1994 Northridge, California, earthquake. Red indicates areas of structural damage, yellow indicates areas where shaking was felt.



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GEOGRAPHICS

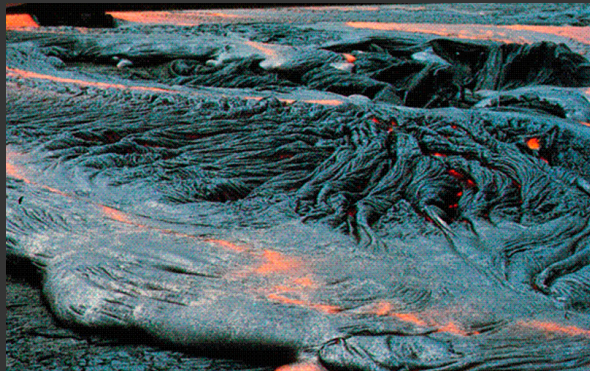
VOLCANISM

3 Principal Product Types; Classification of Volcanoes

1. Lava (two main types): Magma that reaches surface



Aa Lava: Highly viscous (a lot of silica), can stand at great angles



Pahoehoe Lava: Highly fluid (lack of silica), solidifies in thin sheets

3 Principal Product Types; Classification of Volcanoes

2. Pyroclastics: Dominates explosive volcanoes



Ash: Predominately glass shards (silica), very fine little lithics



Scoria: Predominately fragmented lithic material. Degassed so it is light, pumice



Volcanic Bombs: Cobble/boulder sized with spiral shapes. Not degassed so heavy

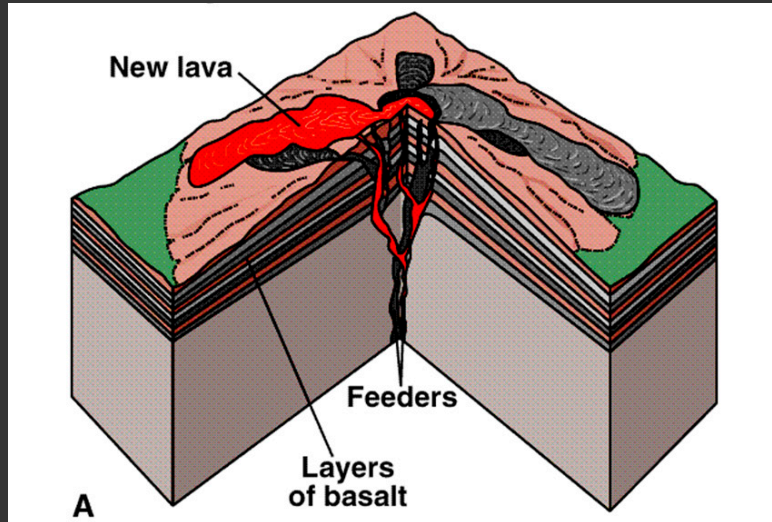
3 Principal Product Types; Classification of Volcanoes



3. Volatiles: Water vapor and other gases; sulfur, methane, chlorine, hydrogen sulfide

Three Primary Forms of Volcanoes

SHIELD VOLCANOES



Columbia Plateau Basalt Layers



Basic lava (no silica), very fluid (Pahoehoe Lava)

Slopes are very gentle

Dominates ocean floor volcanism (Rift Valleys)

Can form extensive basaltic plateaus

Three Primary Forms of Volcanoes

CINDER CONES

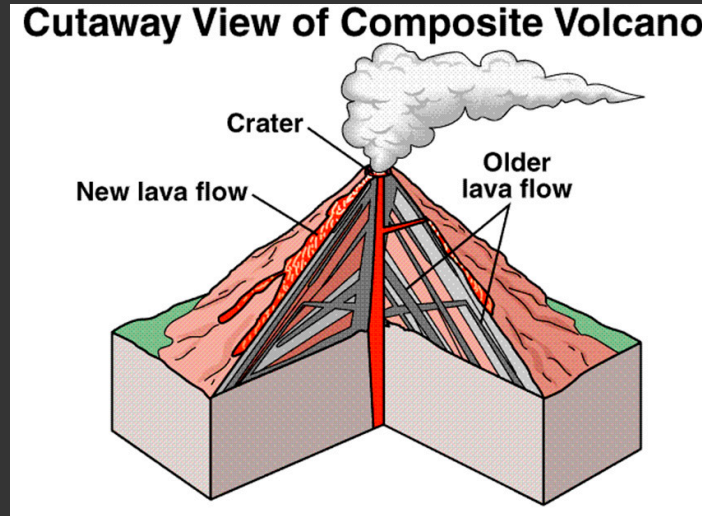
**Cerro Negro, a
Cinder Cone in
Nicaragua**



- Dominated with pyroclastic material
- Very steep sided, angle of repose ($\sim 34^\circ$)
- Short lived/duration
- Very explosive (high silica)
- Continental margins (subduction zones)

Three Primary Forms of Volcanoes

COMPOSITE/STRATA VOLCANOES

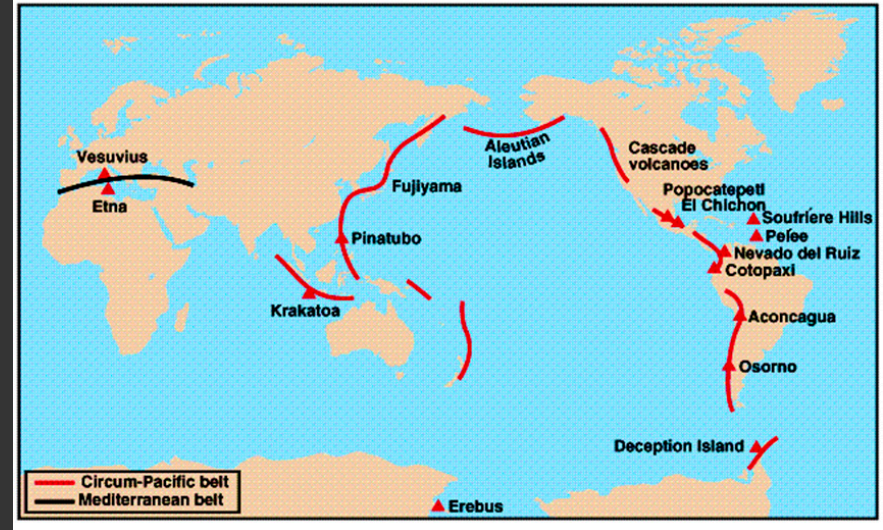


Consists of both Lava & Pyroclastics
Alternating/mixed layers of Lava/Pyroclastics
Intermittent eruptions over long time span
Continental margins (subduction zones)
Cascades, Andes, Pacific Rim, Fuji, Etna

Composite / Strata Volcanoes



World's Major Volcanic Belts



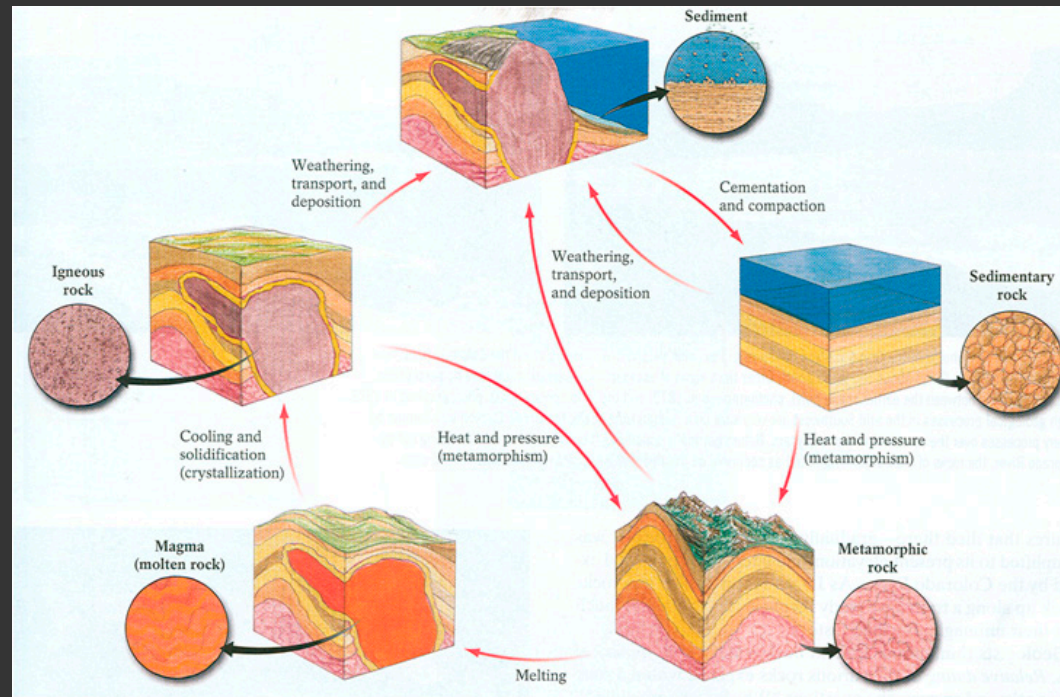
Physical World Map



ROCK TYPES

Three Rock Types: Igneous, Sedimentary, & Metamorphic

Igneous



Sedimentary

Metamorphic

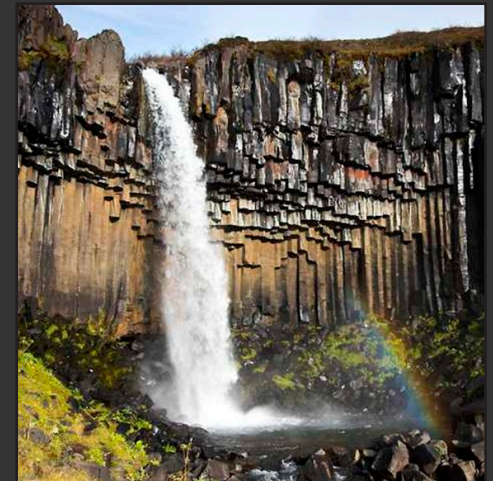
Rock Cycle: How various rocks are formed

Igneous Rocks

Formed from magma; Intrusive or Extrusive

Intrusive: Plutonic rock; Gabbro, Diorite, & Granite
Cools slowly in Earth, and forms large crystals

Extrusive: Lava; Basalt, Andesite, & Rhyolite
Cools quickly on surface, microscopic crystals



Sedimentary Rocks

Formed from weathering, erosion, & precipitation from solution and then litified by compaction, cementation, or crystallization

Three types of Sedimentary Rocks: Clastic, Chemical, & Organic



Clastic: Made up of fragments; Sandstone (coarse grain), shale, siltstone, & mudstone (fine grain)

Chemical: Carbonate rocks (Limestone / Dolomite), Chert, & Evaporites (Gypsum & Rock Salt)

Organic: Coal (develops from peat)

Metamorphic Rocks

Formed deep within the lithosphere from extreme pressure and/or heat

Metamorphic rocks form in a solid state and the composition is change chemically (usually from hot water)

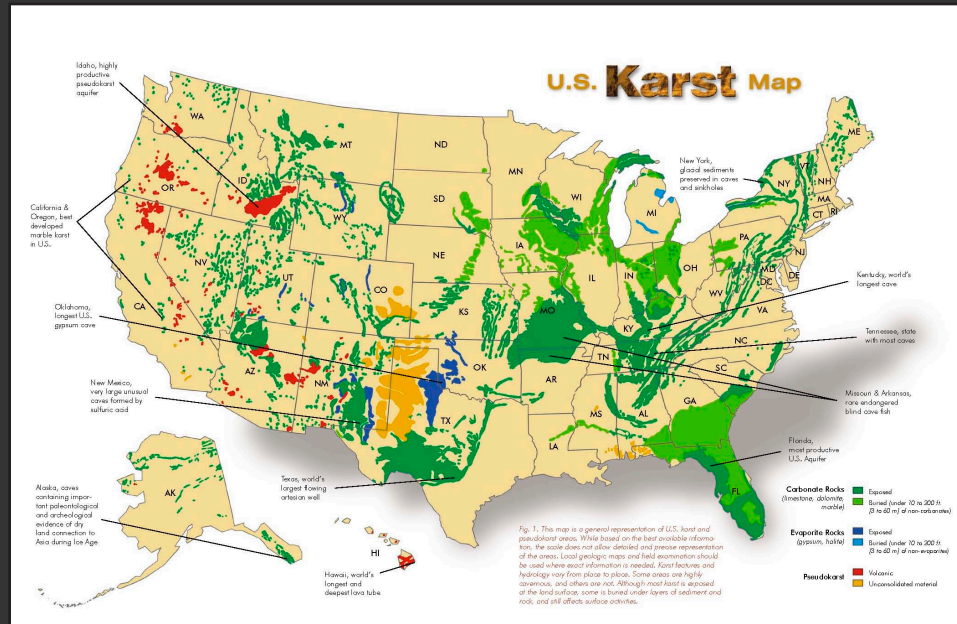
Examples: Limestone to Marble, Shale to Slate, Granite to Gneiss

Rocks are usually warped, with a lot of banding



KARST

Geological formation formed by dissolution of soluble bedrock, typically carbonate rock of Limestone / Dolostone



Karst Features

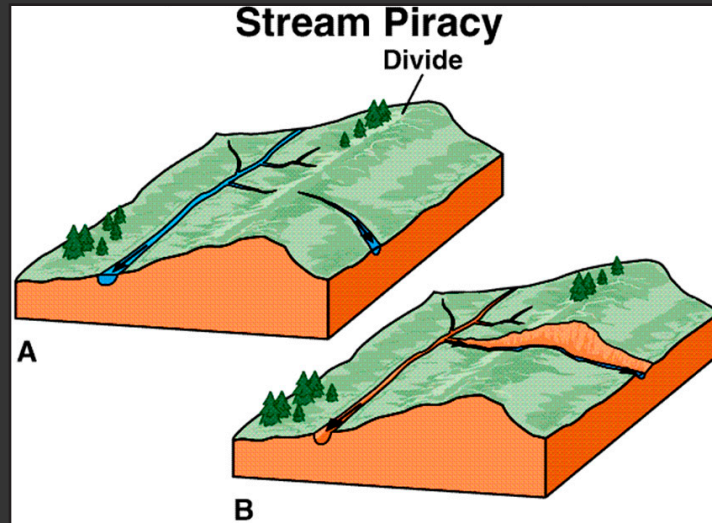
Caves: Subterranean limestone/dolostone caverns



Sinkholes: Also known as Dolines forms as slightly acid water dissolves soluble rock as it percolates to an aquifer

Karst Features

Stream Piracy: Stream diverted from its own bed and flow into a neighboring bed



Losing Stream: Stream loses water as it flows downstream, usually to subterranean aquifer (opposite=Gaining Stream)

Karst Features

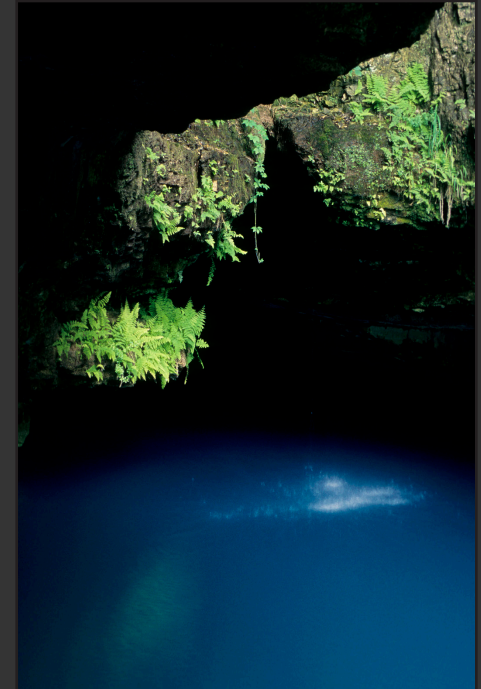
Sinkhole Plain: Extensive plain/plateau with many sinks that forms in well developed karst landscapes



Why is this not expressed in NW Arkansas?

Karst Features

Springs: Water percolates vertically down through porous rocks until it reaches an impermeable layer and then travels horizontally to the surface



Dissolved Loads: Dissolved calcium carbonate is transported in streams, aqua-blue color

Questions?



Ozark Plateau

