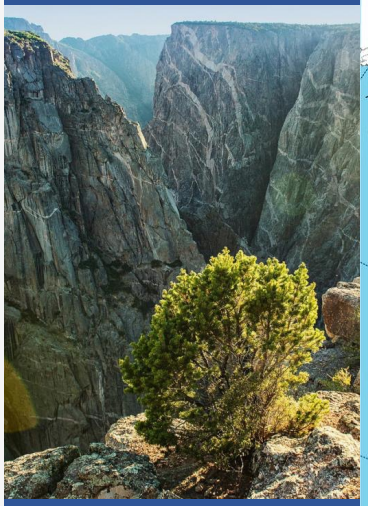
Geologic Evaluation of North America

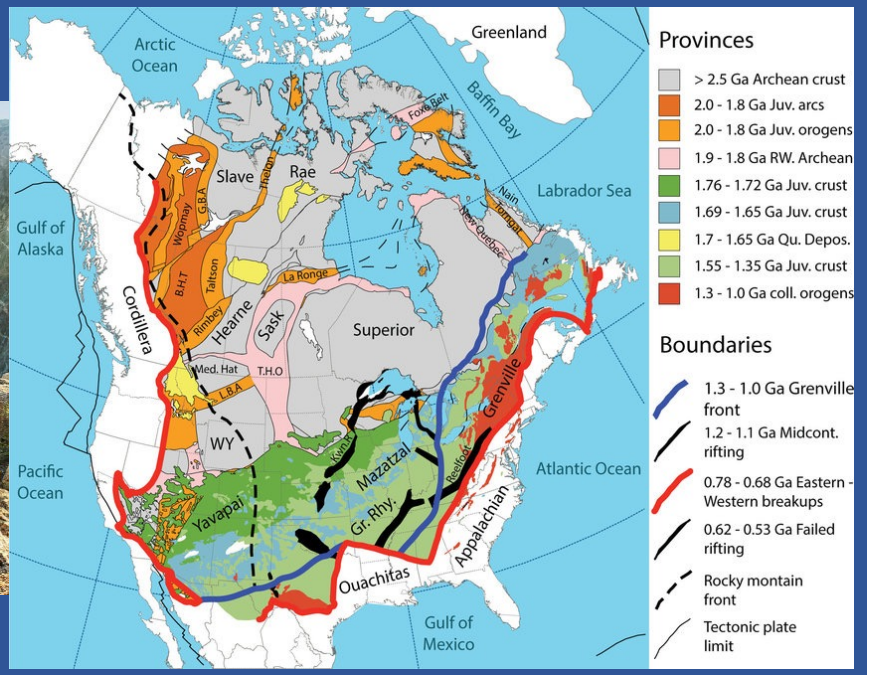
With a Focus on the US National Parks

with Nicole Myers

Week 1: The Origin of North America as Viewed From Unimpaired & Conserved Lands of the USA

https://www.appreciatingearth.com/olli



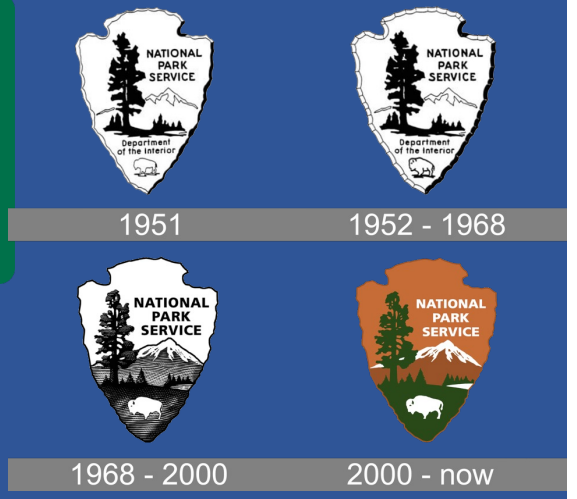


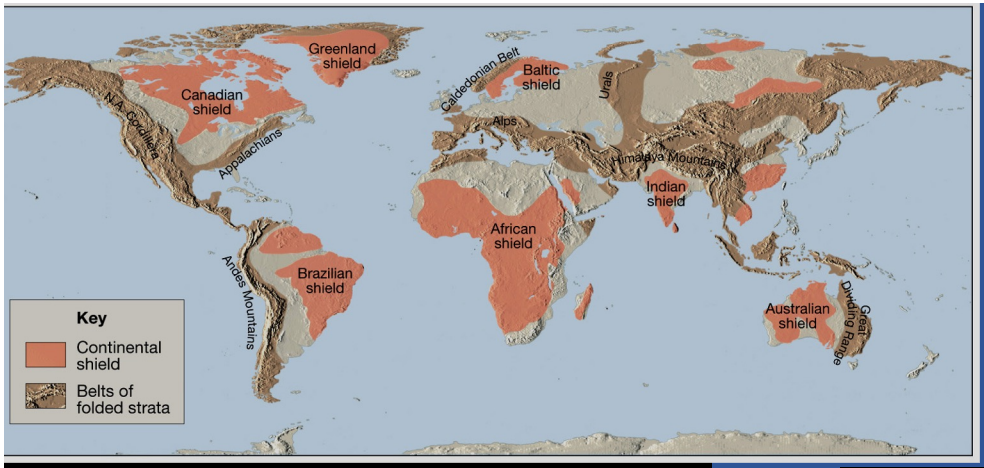
National Park Service & Conservation

Established in a 1916 Act of Congress to "conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." [National Park Service Organic Act of 1916]

- National Parks Conservation Association (NPCA) est. 1919 = citizen's watchdog for NPS
- Member of International Union for Conservation of Nature (IUCN) since 1966
- National Park System (NPS): >85 million acres in 433 NSP sites /units in the United States…that preserve geologic history of USA

NATIONAL PARKS CONSERVATION ASSOCIATION





Continental Formation

Continental rocks began to accumulate in the Archean Eon

Focus on the green shapes & watch North America slowly form

This map will show the continents colored by current location.

Africa

Antarctica

Australia & Oceania

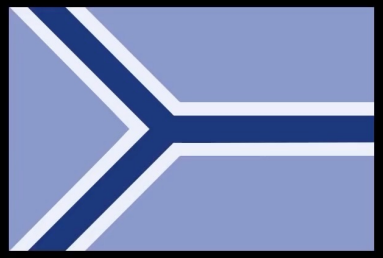
Eurasia

North America

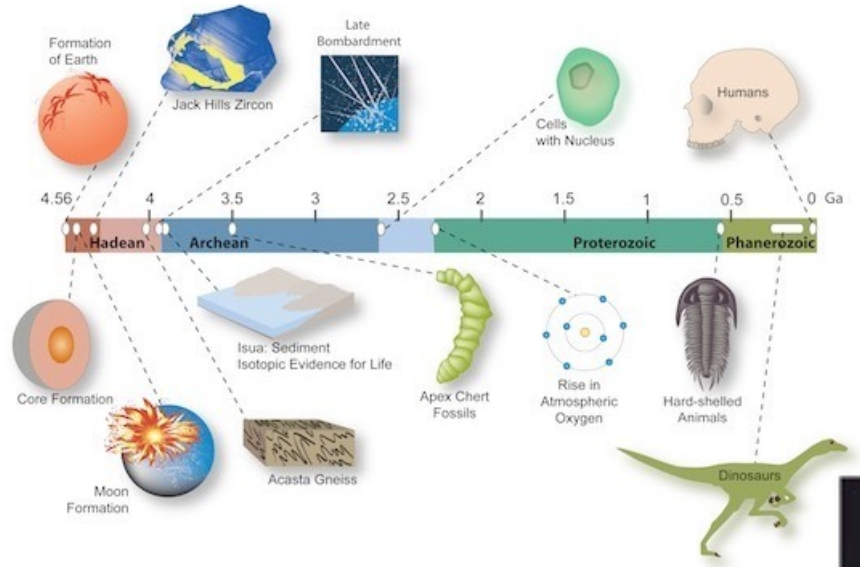
South America

Does not belong to any

3.3 Billion Years of Continental Drift

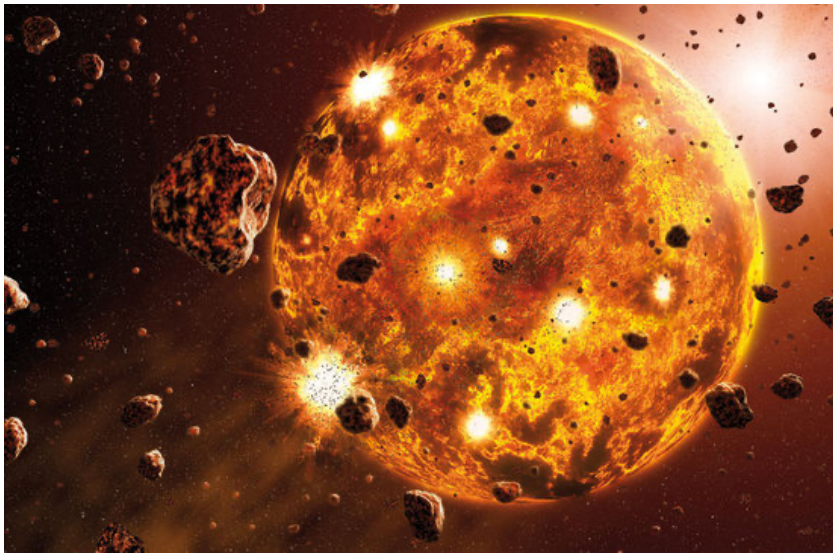


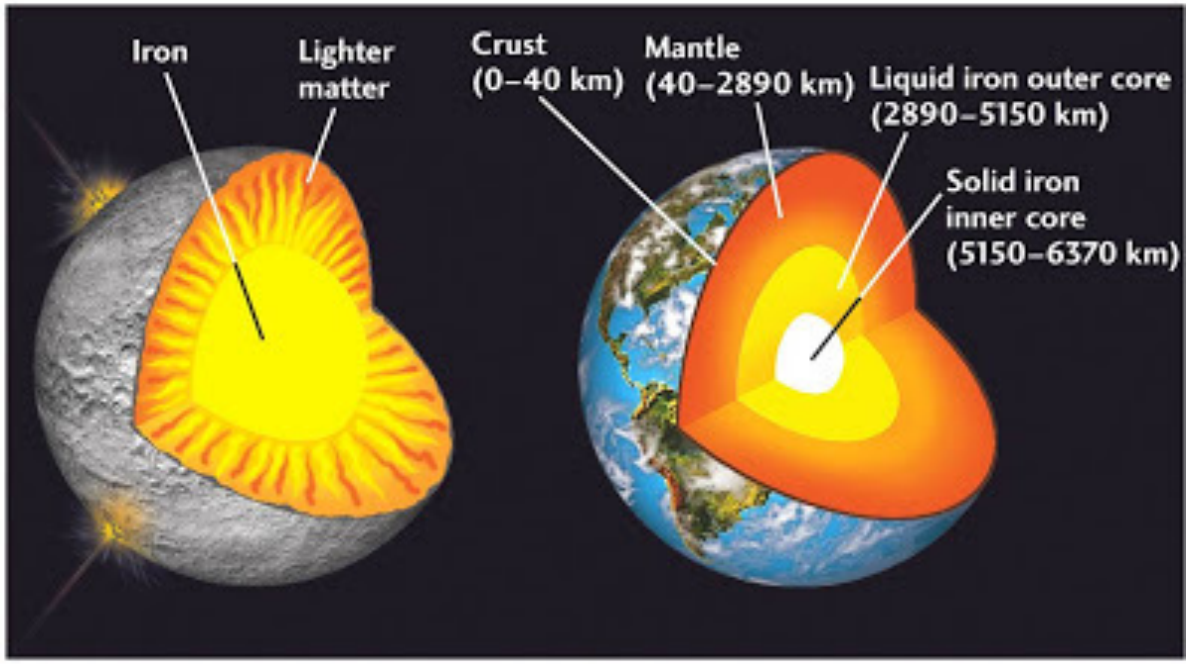
Created by: revrunnertech2772 (Algol)



Birth of the Earth

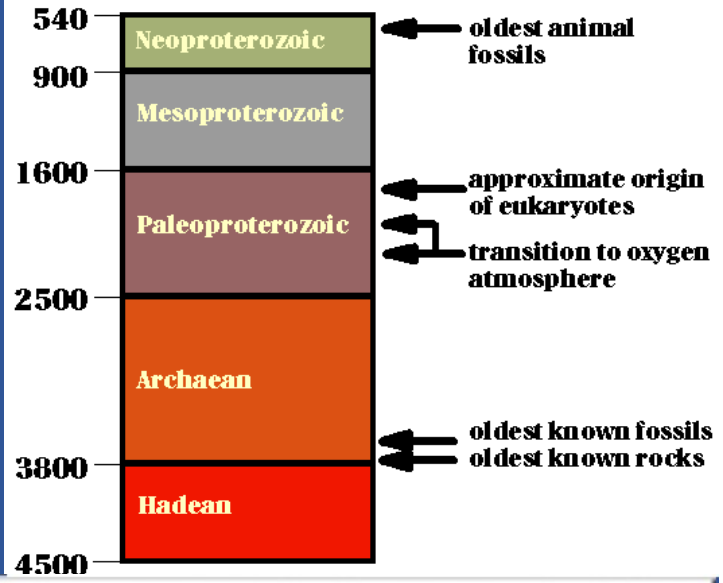
The beginning of a ~4.54 billion year history of planetary evolution starts with the formation of the first rocks as Earth layers formed

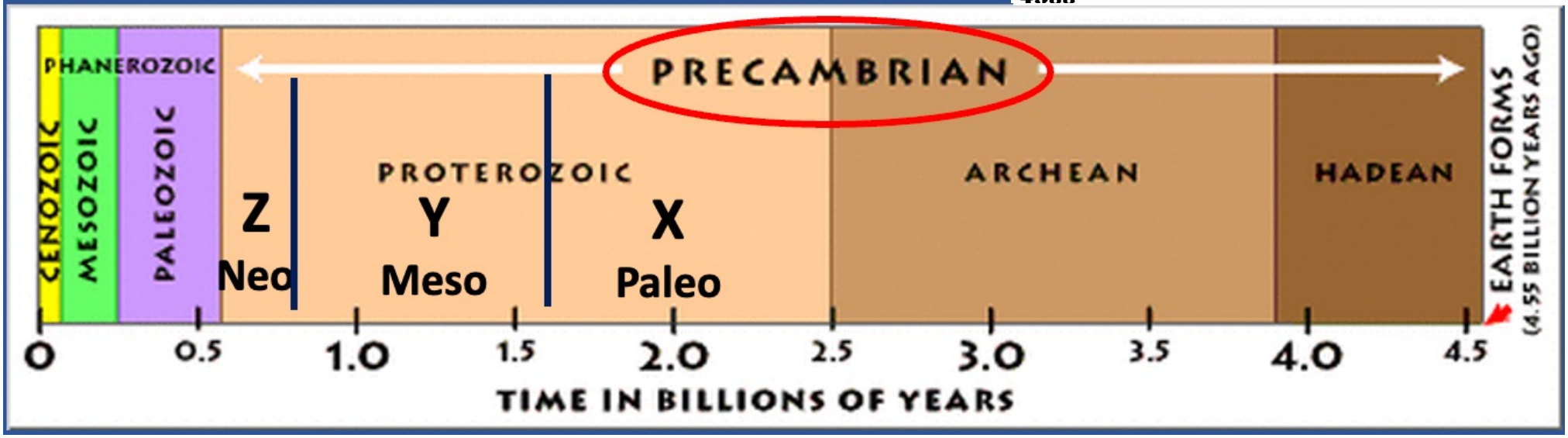




Geologic Time: Precambrian Super-Eon

Jan 1 → early Feb	Earth forms + Earth organized into core, mantle, and crust
Feb 21	Life evolves
Oct 25	Complex organisms, including those with shells and hard parts, evolve

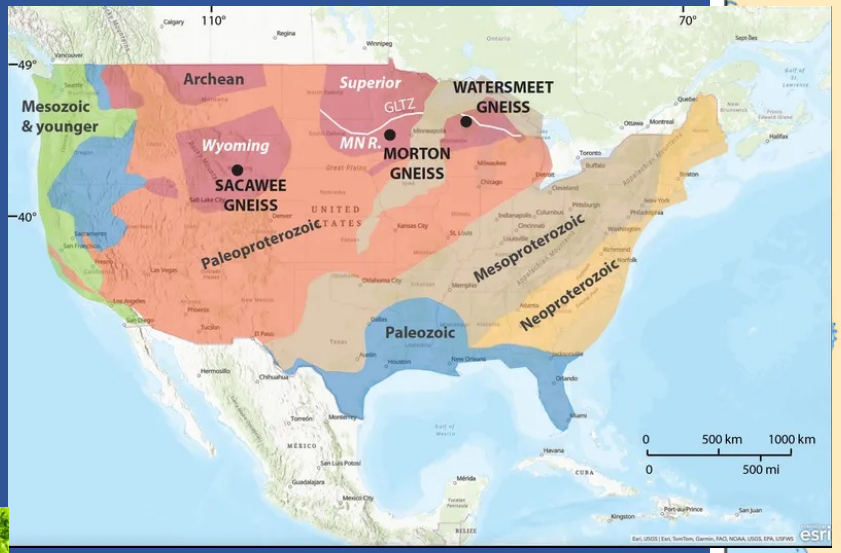


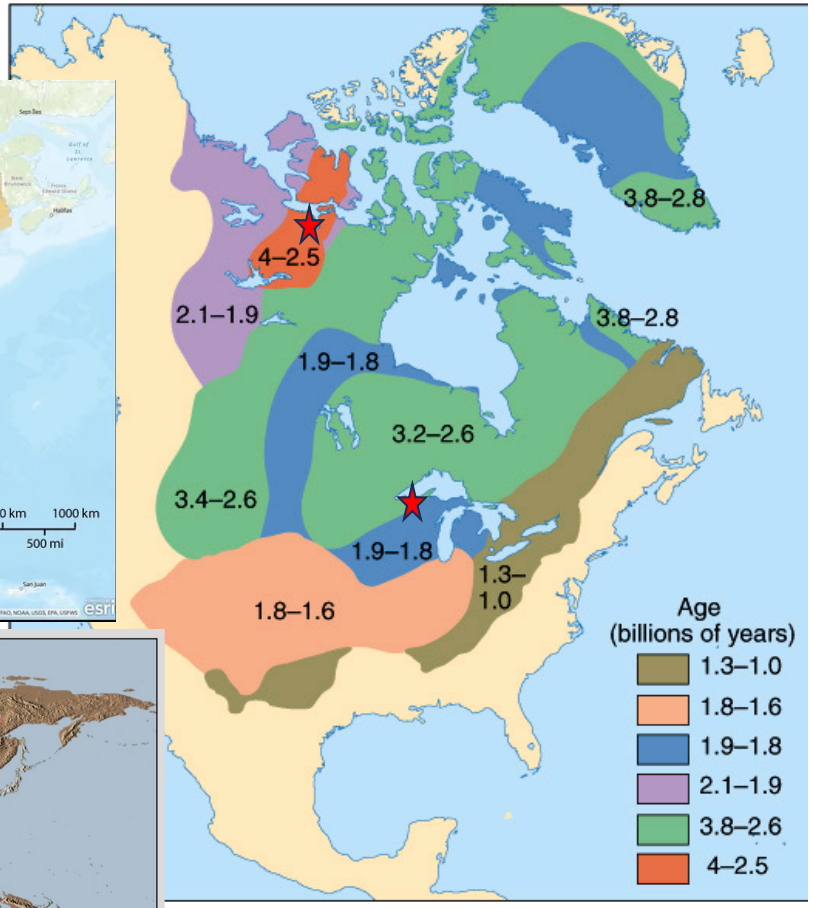


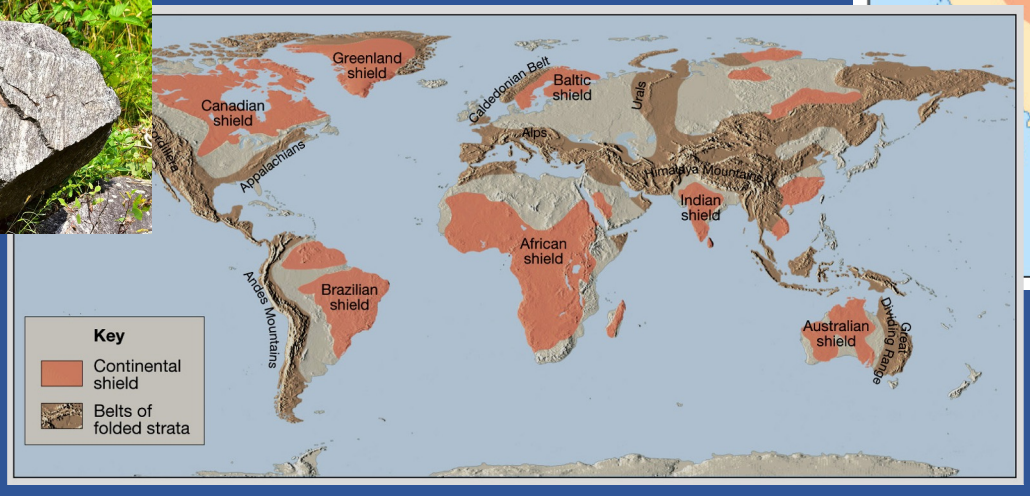
Oldest Rocks

- North America: 4.03Ga Greenstone

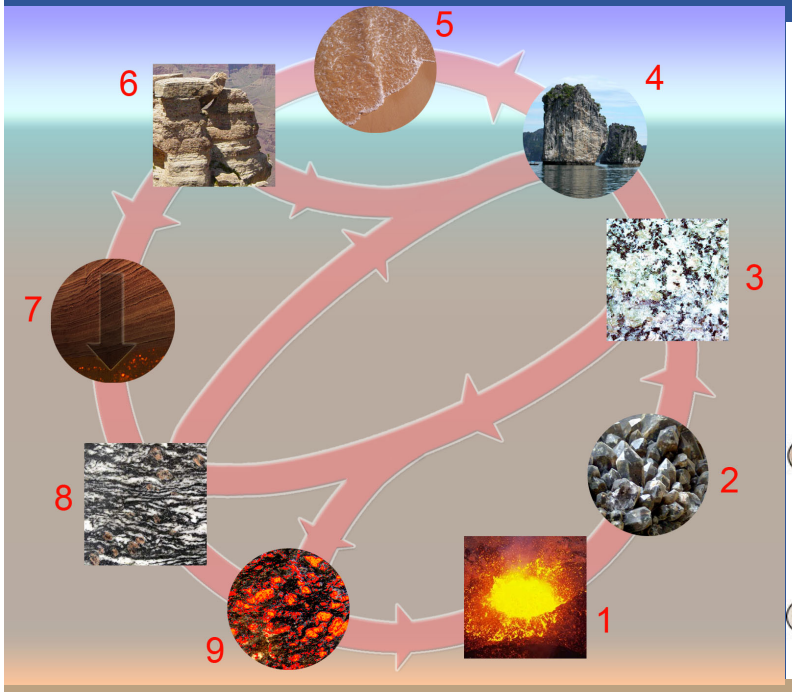
- USA: 3.6Ga Gneiss

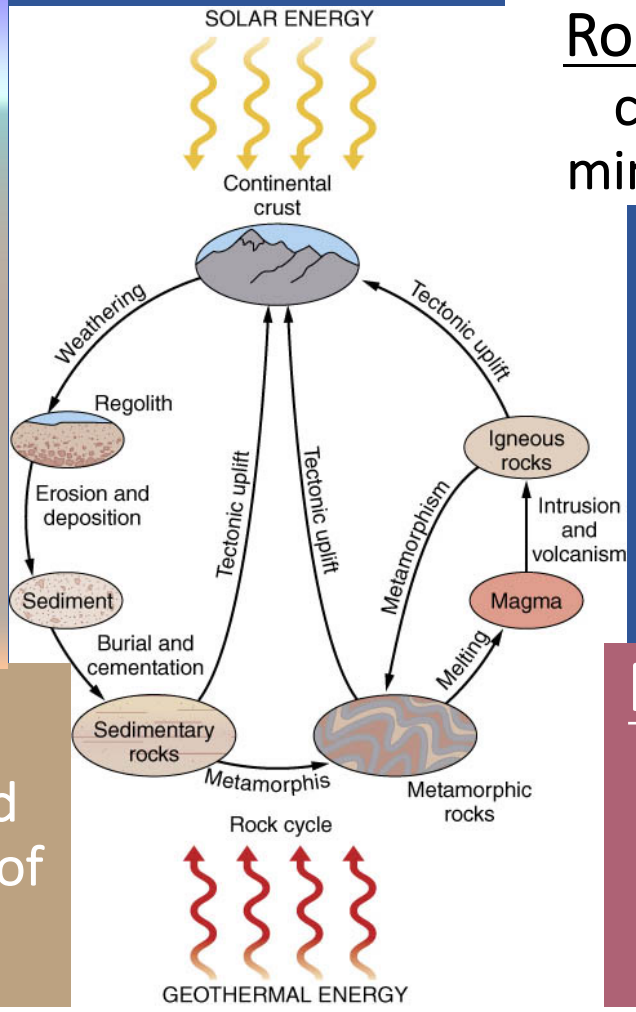






Earth Materials & The Rock Cycle





Rock: naturally occurring, coherent aggregate of minerals &/or mineraloids

Igneous Rock:

melting forms magma, which cools into a solid rock made of interlocking crystals &/or glass

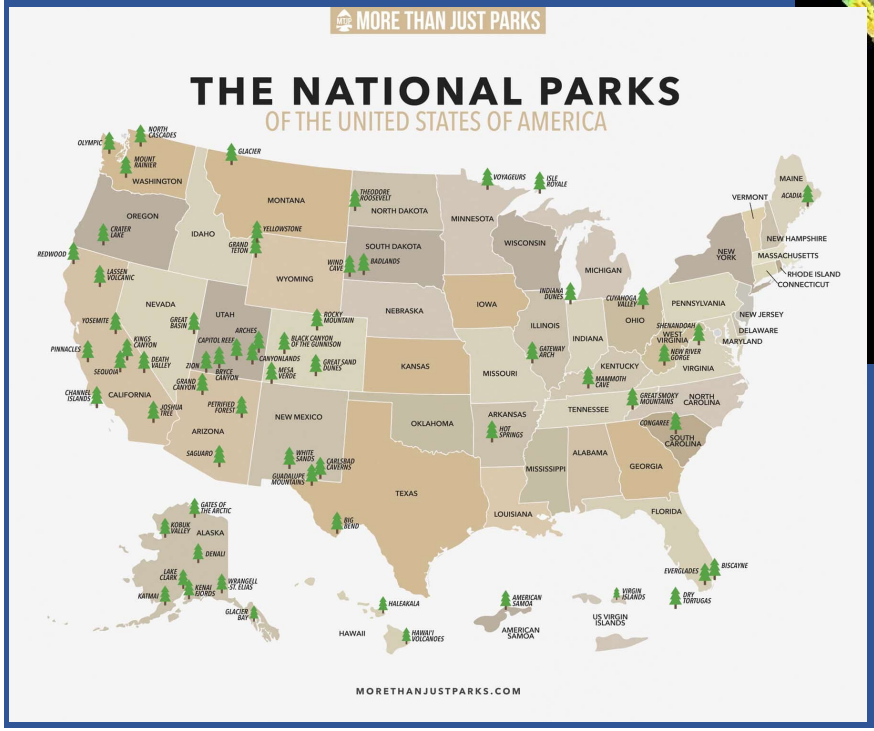
Sedimentary Rock:

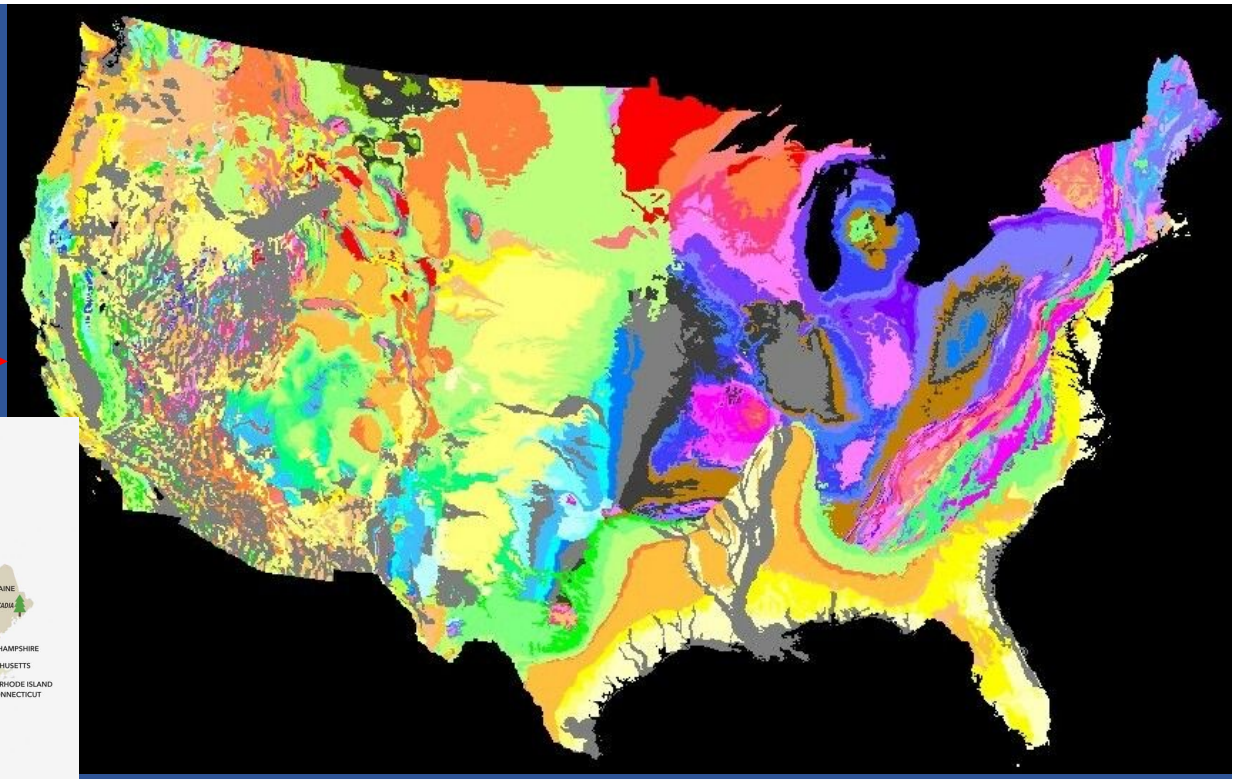
sediments buried & compacted into solid layers of rock formed of accumulated fragments

Metamorphic Rock:

deep burial reforms original rock (protolith) into patterns of crystals deformed by stress

Geologic Maps provide locations of Precambrian rocks, which are mostly within red & dark orange on the geologic map





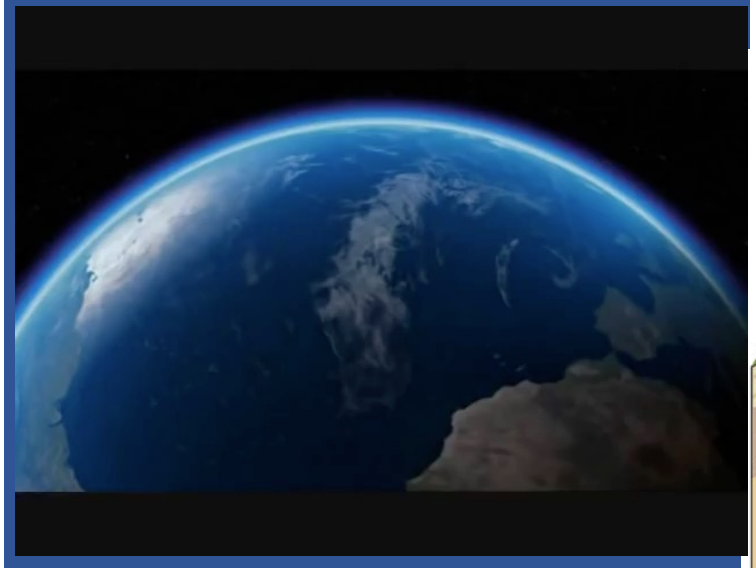
https://www.ldeo.columbia.edu/users/menke/envdata/quality/map/

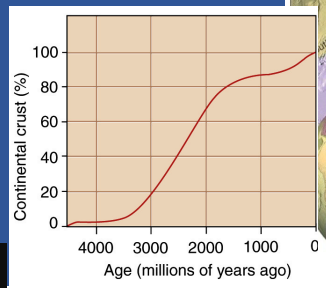
USA National Parks Record the Geologic History of North America's continental accretion, rock formation & plate tectonics

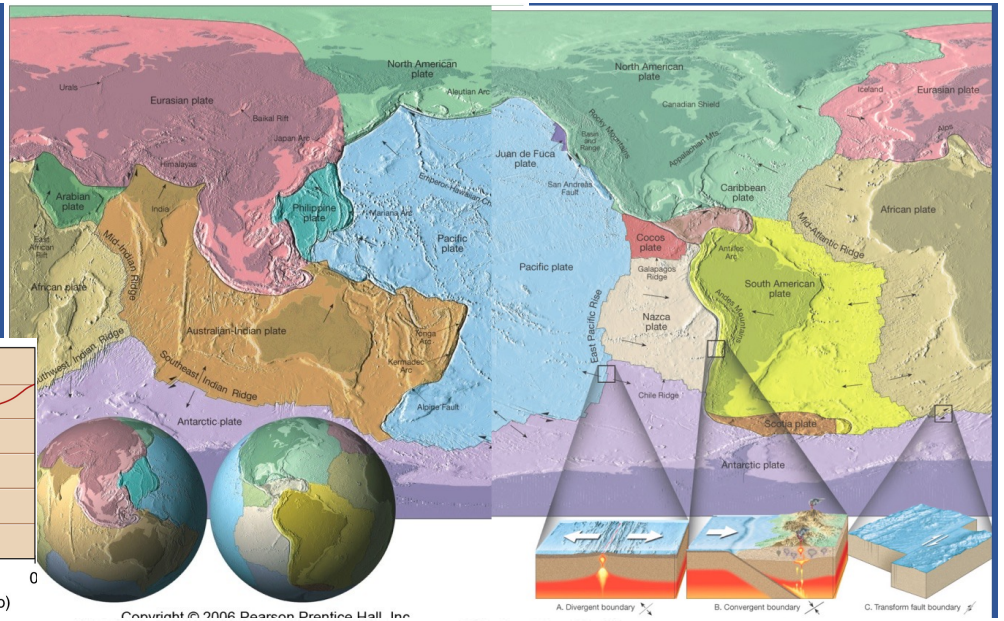
Plate Tectonics → Continental Growth

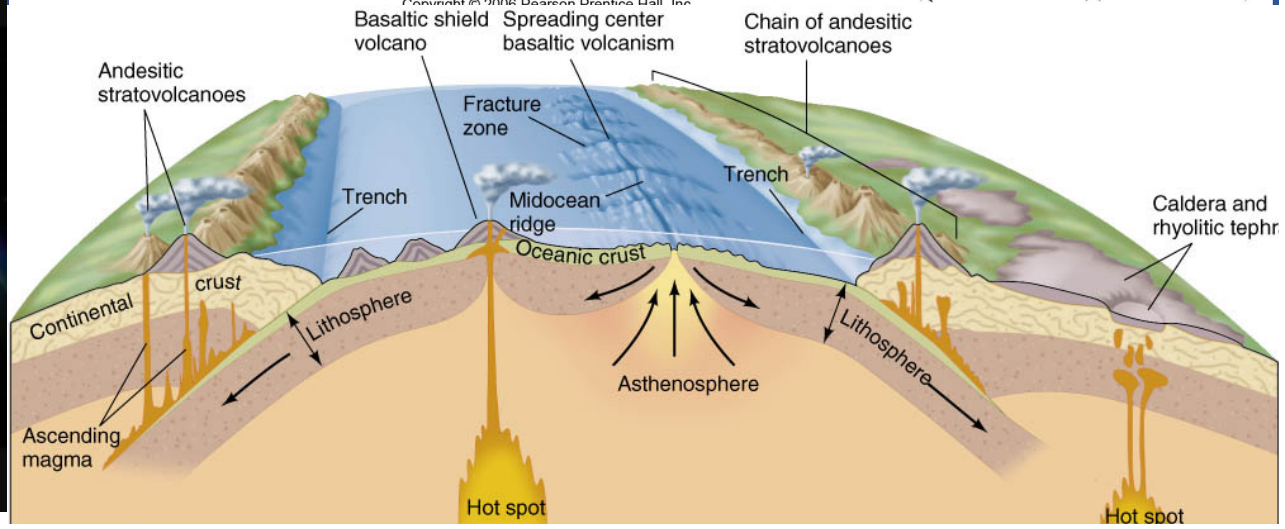
- Divergence: oceans grow & continents part
- Transform: plates slide/smear/translate
- Convergent: plates squeeze together & subduct, mountains form, rocks + cratons accrete → OROGENY

Video link: https://www.youtube.com/watch?v=ryrXAGY1dmE

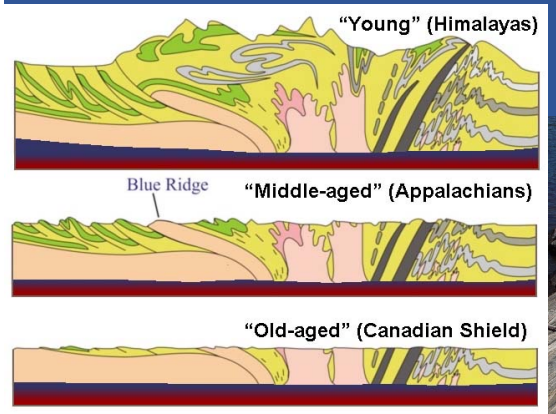


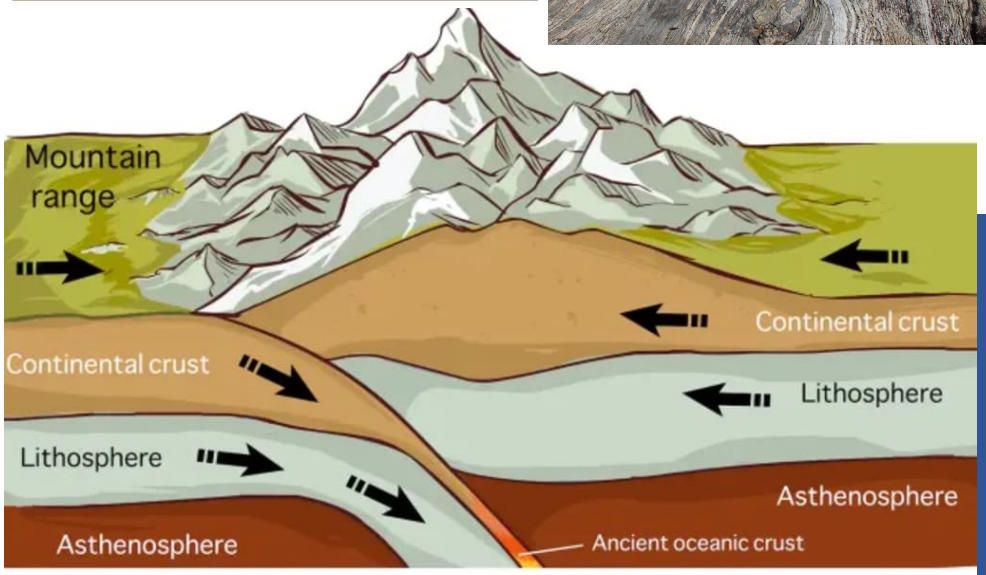


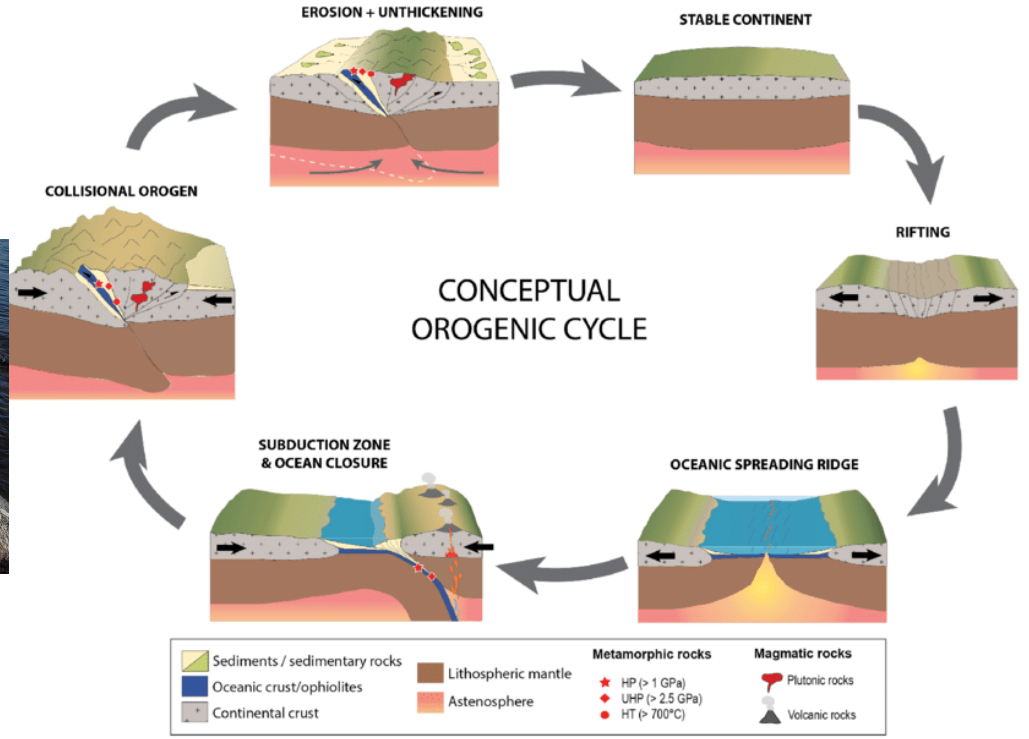




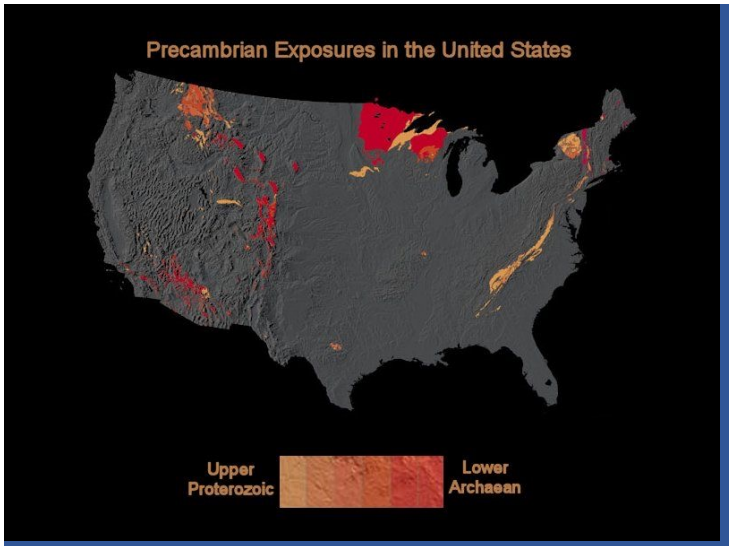
Orogenies







- Igneous Rocks: subduction volcanism at convergent boundaries
- Metamorphic Rocks: squeezing & thickening → higher pressure & temperature at convergent boundaries



This map will show the continents colored by current location.

Africa

Antarctica

Australia & Oceania

Eurasia

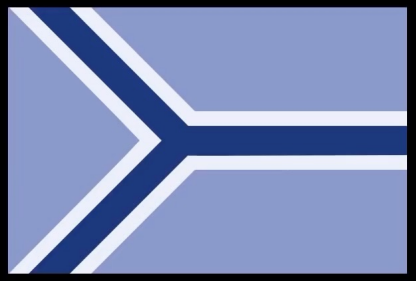
North America

South America

Does not belong to any

10 Minute Break!

3.3 Billion Years of Continental Drift

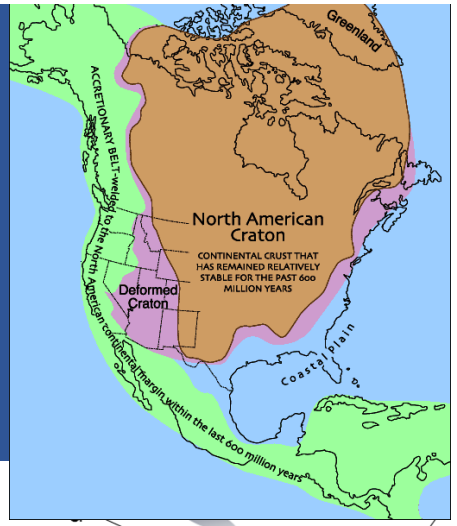


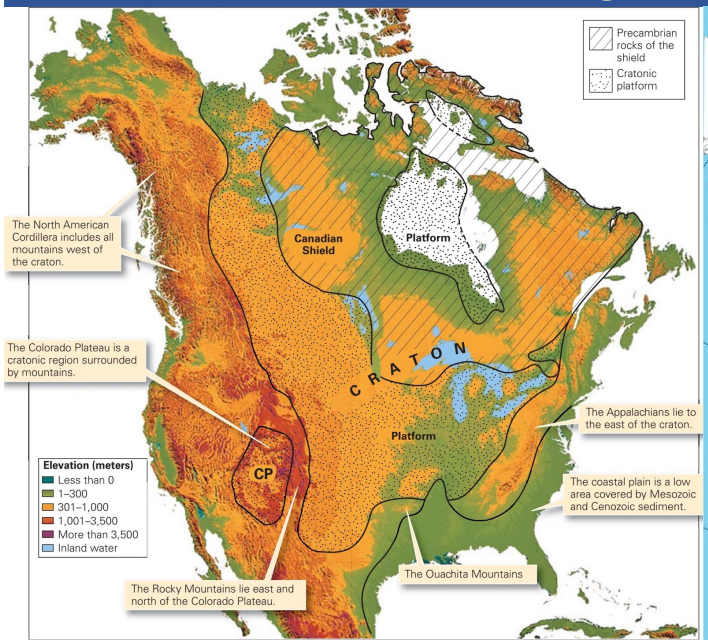
Created by: revrunnertech2772 (Algol)

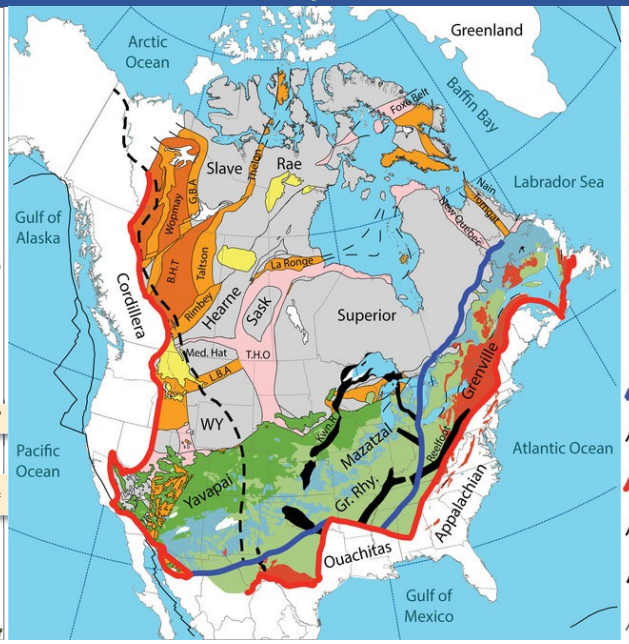
Ancient Cratons

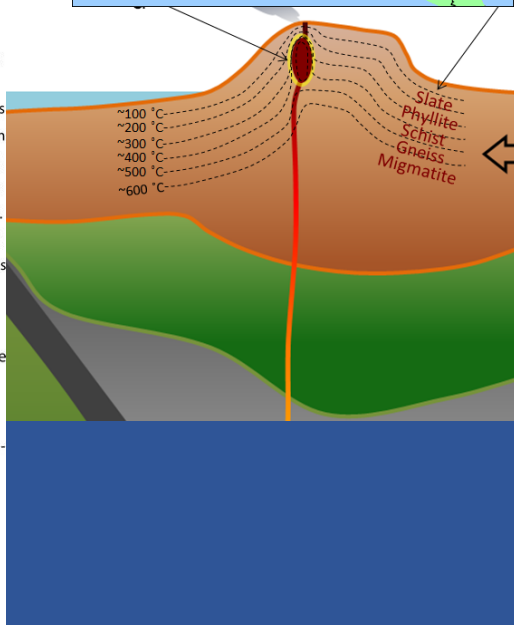
Oldest North American rocks are cratonic basement rocks made of ancient igneous & metamorphosed rocks:

- **Cratons converge = orogenies = continents grow**
- **Voyageurs**, Isle Royale, Wind Cave, Grand Teton, Pipestone, Rocky Mountains, Black Canyon of the Gunnison, Grand Canyon, Yellowstone, Glacier, Saguaro, Death Valley, Joshua Tree



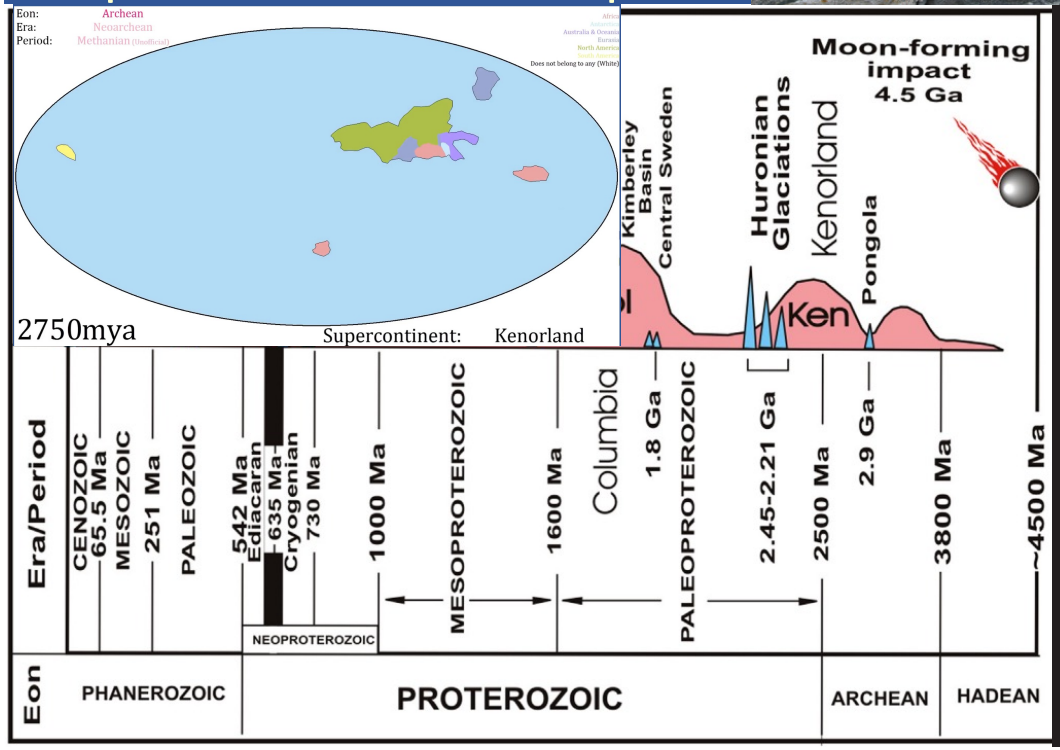


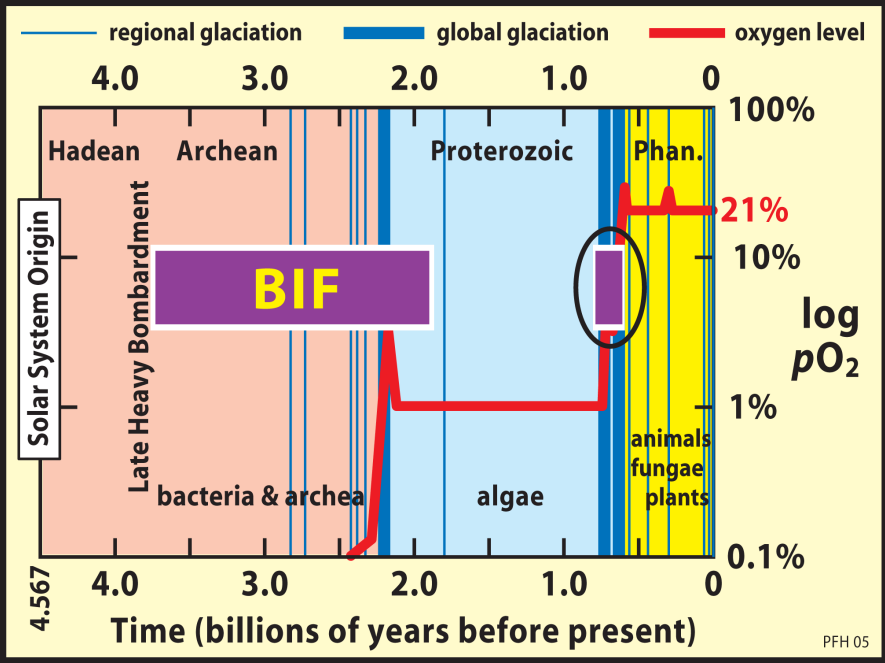




Archean Eon: Kenoran Orogeny

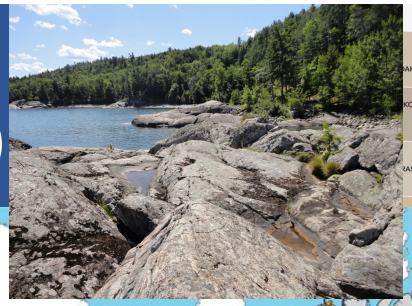
- 2.8-2.5Ga Kenorland Supercontinent formation
- ~2.4-2.2Ga Snowball Earth & supercontinent break up

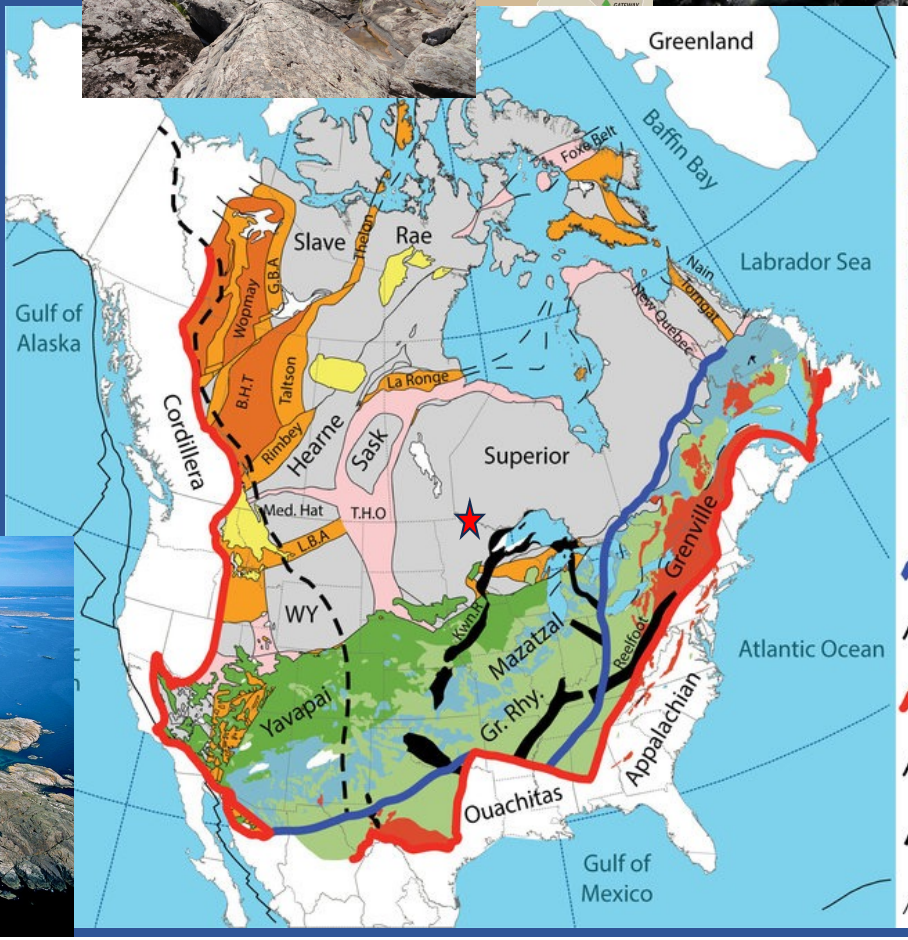


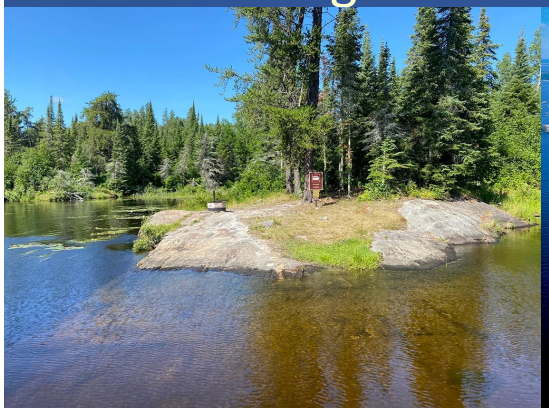


Superior Craton

- Oldest USA rock: 3.6Ga gneiss (met.)
- <u>Voyageurs National Park, MN:</u>
  1. Marine sediments (sed.) & submarine volcanism (ign.)
  2. 2.7-2.5Ga Kenoran Orogeny metamorphism → greenstone & gneiss
  3. 2.1Ga dikes (ign.) - hot spot + divergence



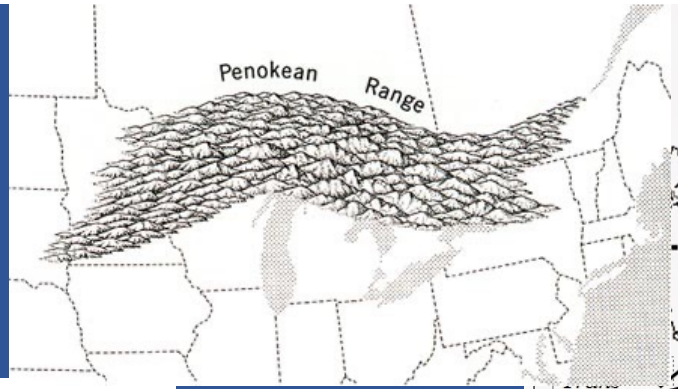


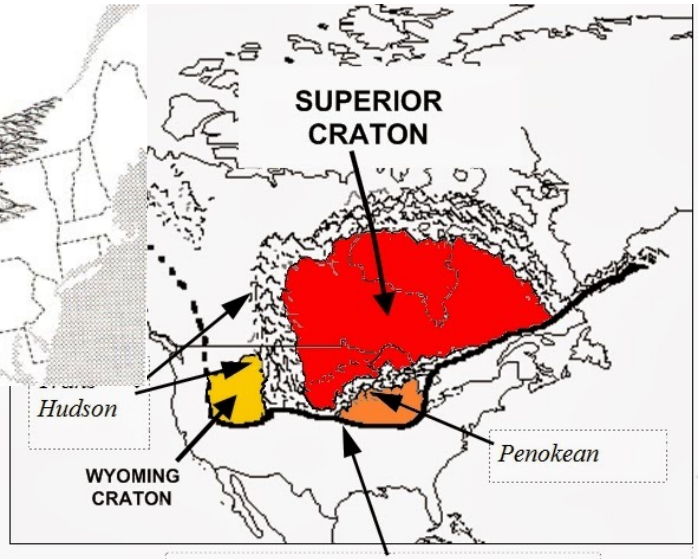


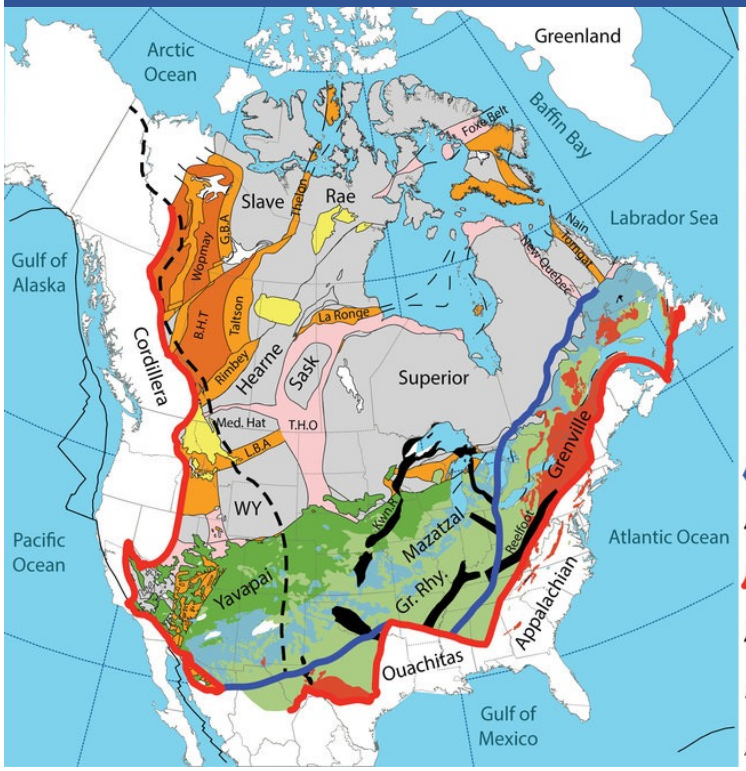
Penokean Orogeny

Proterozoic Eon ~1.9-1.8Ga:

- Oceanic terrane accreted
- Penokean Range







Provinces

- > 2.5 Ga Archean crust
- 2.0 - 1.8 Ga Juv. arcs
- 2.0 - 1.8 Ga Juv. orogens
- 1.9 - 1.8 Ga RW. Archean
- 1.76 - 1.72 Ga Juv. crust
- 1.69 - 1.65 Ga Juv. crust
- 1.7 - 1.65 Ga Qu. Depos.
- 1.55 - 1.35 Ga Juv. crust
- 1.3 - 1.0 Ga coll. orogens

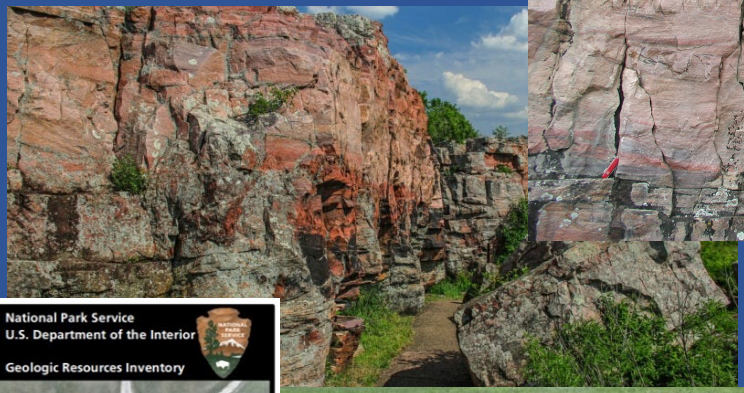
Boundaries

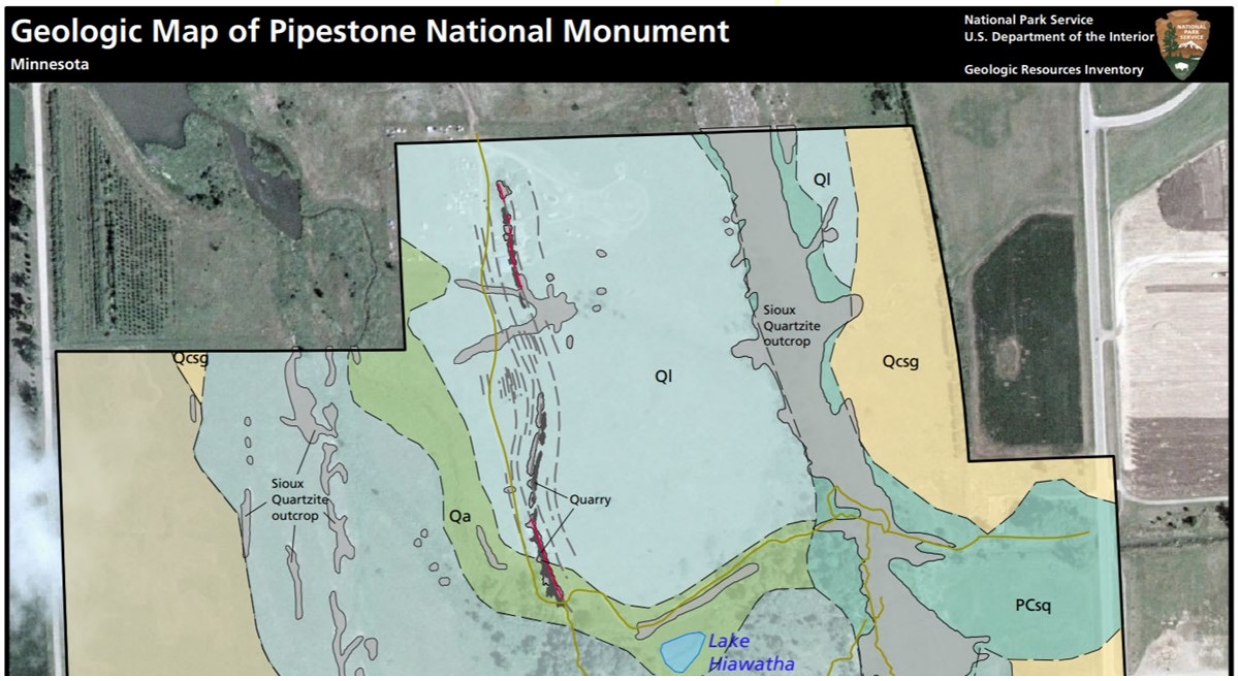
- 1.3 - 1.0 Ga Grenville front
- 1.2 - 1.1 Ga Midcont. rifting
- 0.78 - 0.68 Ga Eastern - Western breakups
- 0.62 - 0.53 Ga Failed rifting
- Rocky montain front
- Tectonic plate limit

Video: https://www.youtube.com/watch?v=M8PLEMKtOXo

Penokean Range Erosion

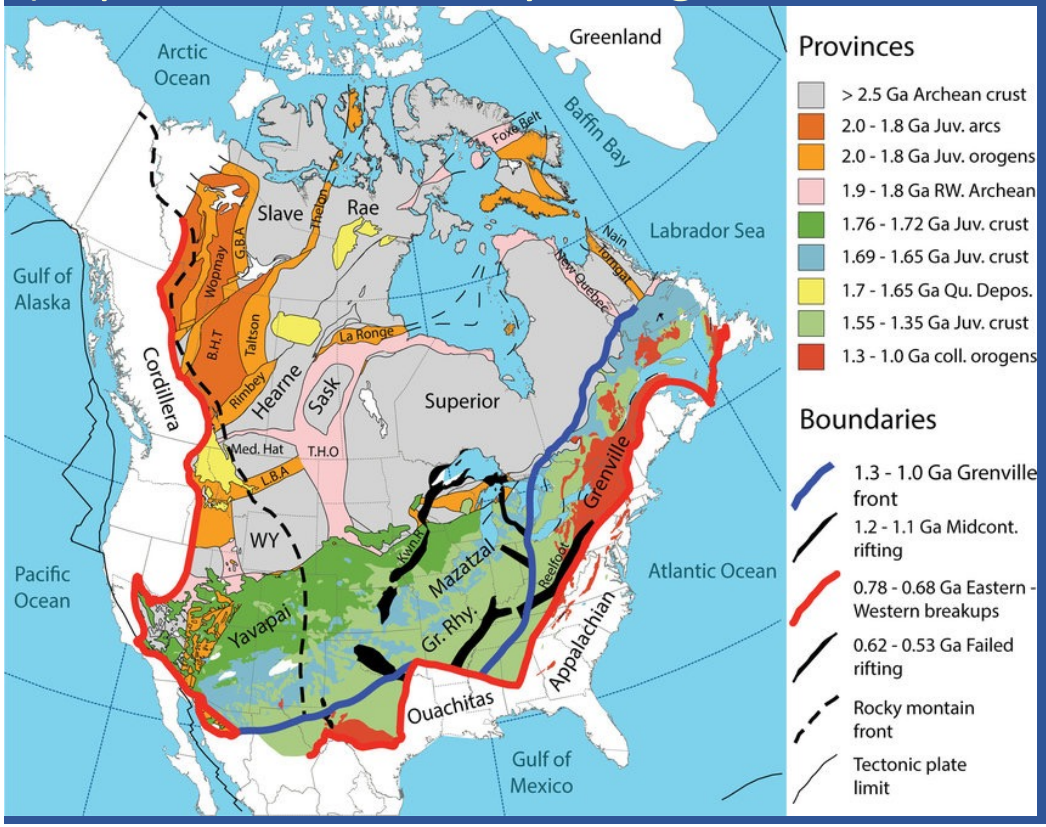
- Pipestone National Monument, MN
  - –1.75-1.63Ga Sioux Quartzite contains quartz-poor Catlinite (pipestone)
  - –River eroded sed. → met. by burial

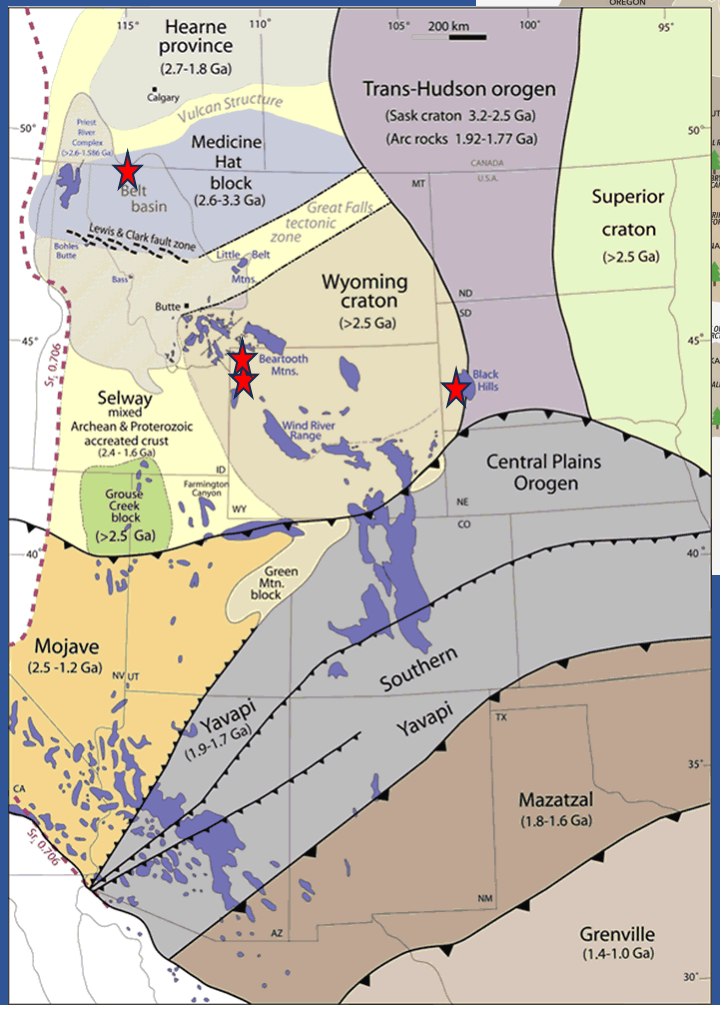


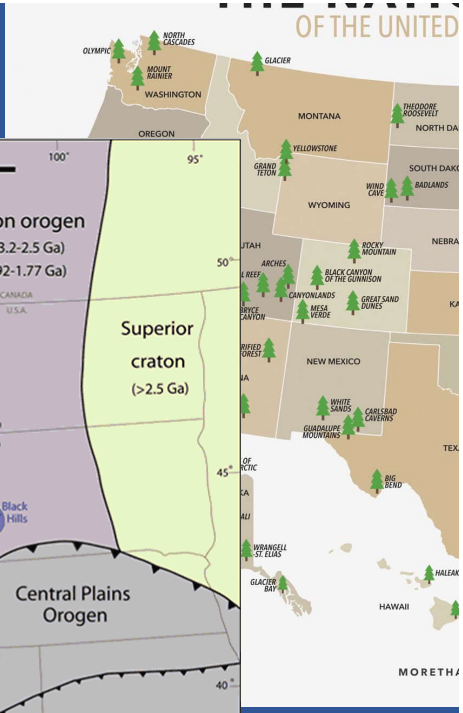


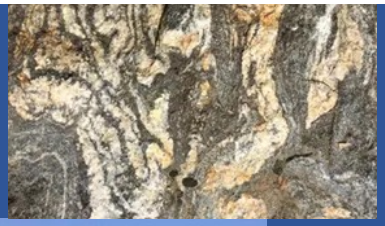
Proterozoic Eon: Trans-Hudson & Great Falls Orogenies

~2.0-1.4Ga Accretion of Archean cratons (Superior, Hearne, Wyoming, Medicine Hat)

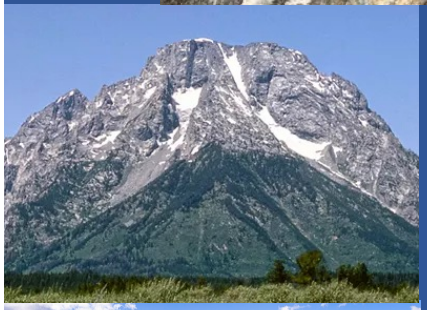






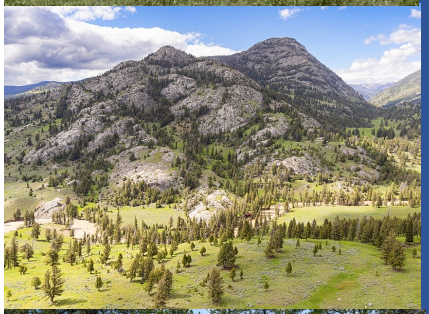


Wyoming Craton



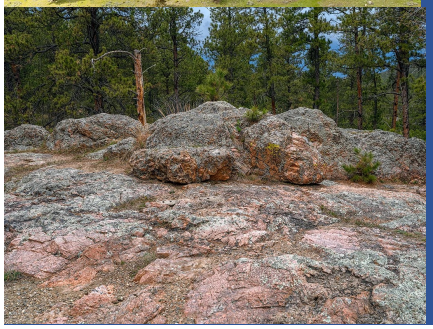
<u>Grand Teton National Park, WY</u>:

- 2.8-2.7Ga gneiss (met.) & granite (ig.)
  - Gneiss = older marine sediments & volcanic debris subducted



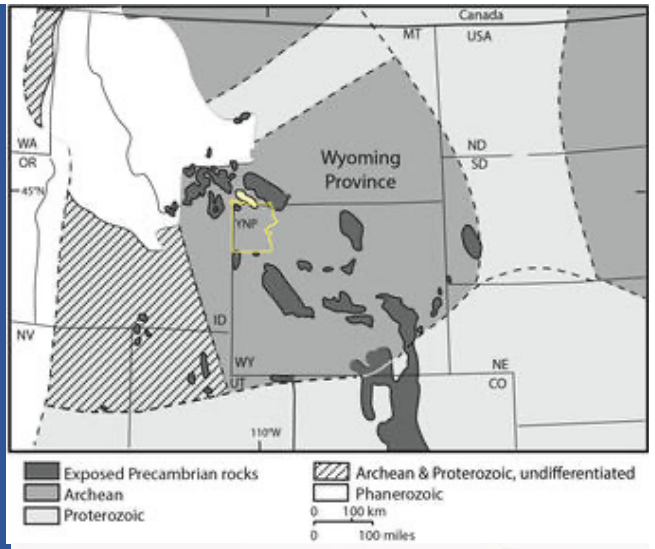
<u>Yellowstone National Park, WY/ID/MT:</u>

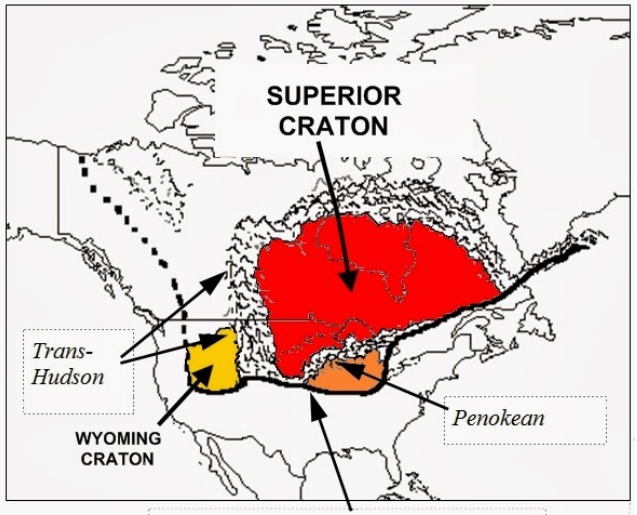
- 2.8Ga schist & gneiss (met.)



<u>Wind Cave National Park, SD:</u>

- 2-1.8Ga schist (met.) & pegmatite (ig.)
- 1.7Ga igneous intrusions with gold (Mount Rushmore granite 1.7-1.6Ma)

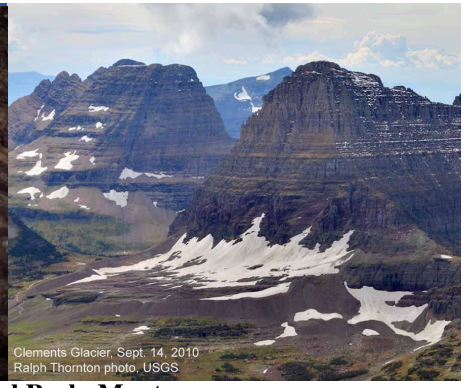


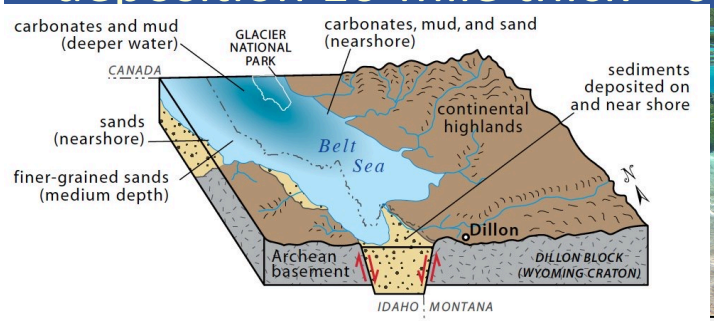


Medicine Hat Block

Waterton-Glacier International Peace Park, MT + Canada

- Belt Supergroup = inland sea 1.5-1.4Ga deposition 10-mile thick + stromatolites





Glacier National Park, Montana