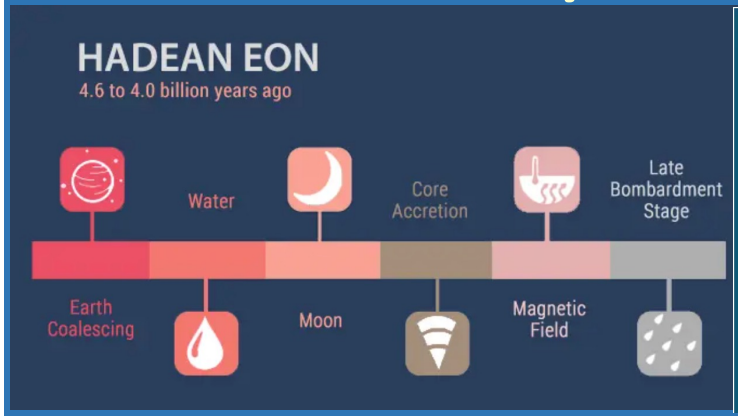
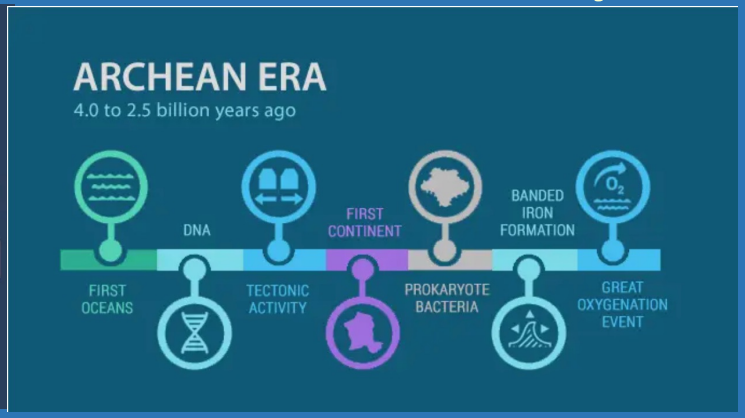
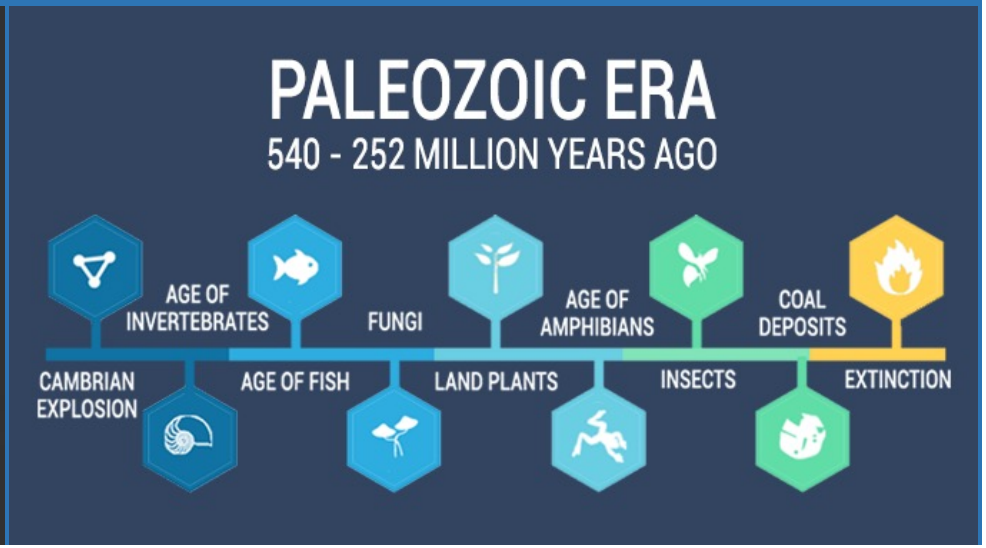
The Story of Earth Conveyed by Rocks





Presented by Nicole Myers

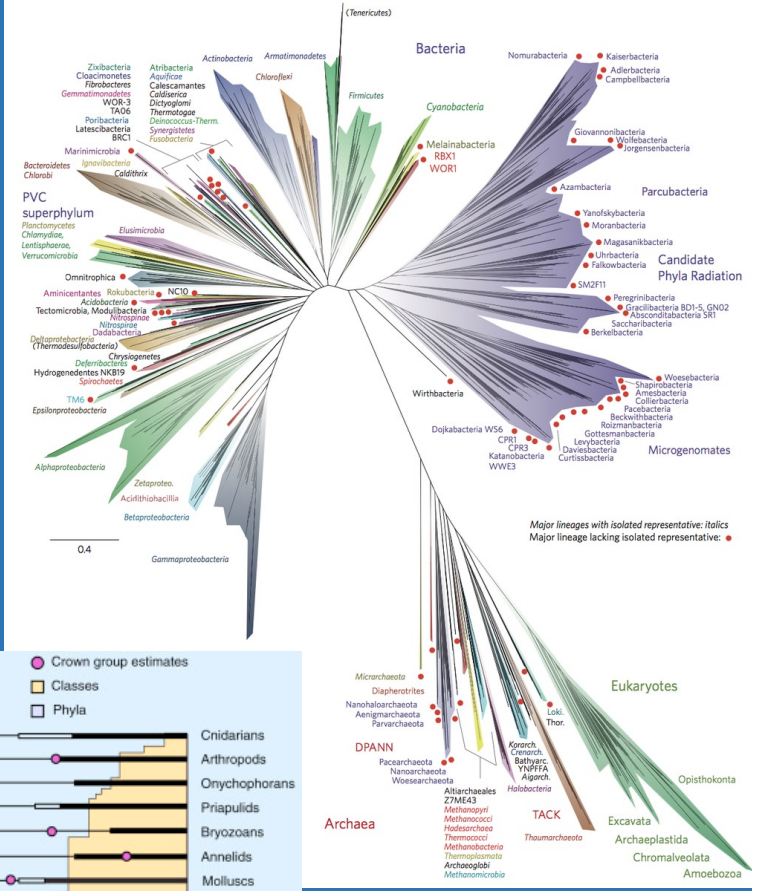
Lecture 3: Ocean Ecosystems Change Earth

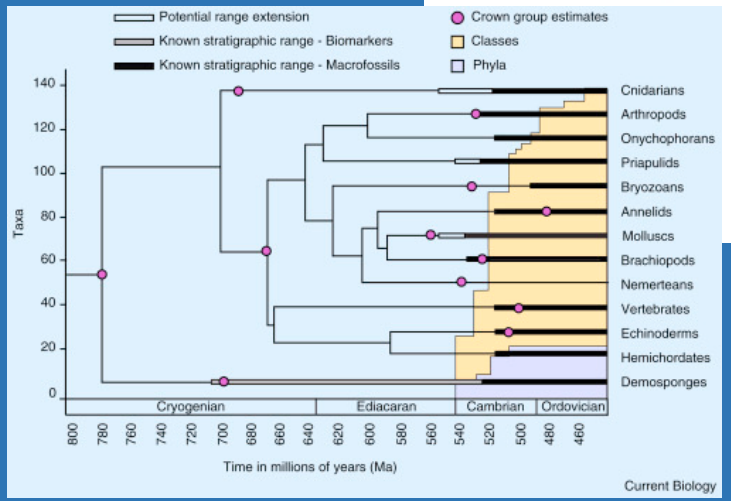


Timeline of the Evolution of Life

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

- Body & trace fossils
- Preserved organic molecules
- Geochemical fossils (biomarkers)
- Molecular Clocks - basal branching events using mutation rates of genes or protein sequences

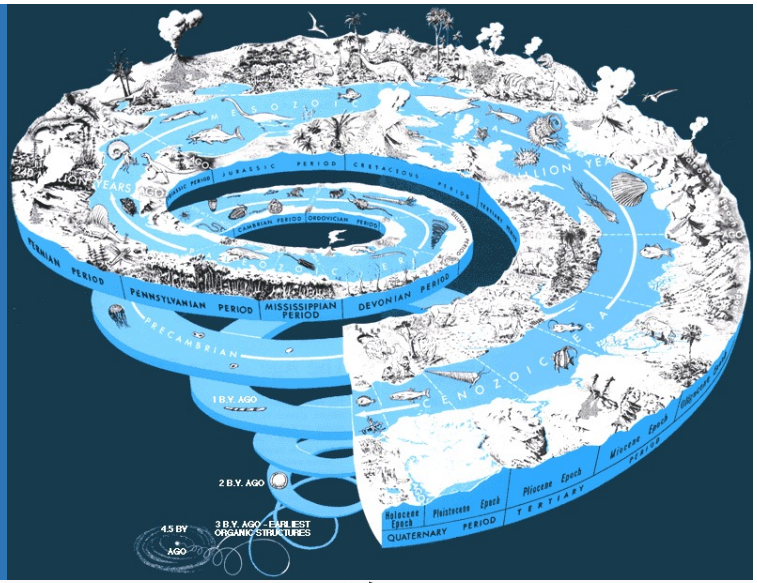


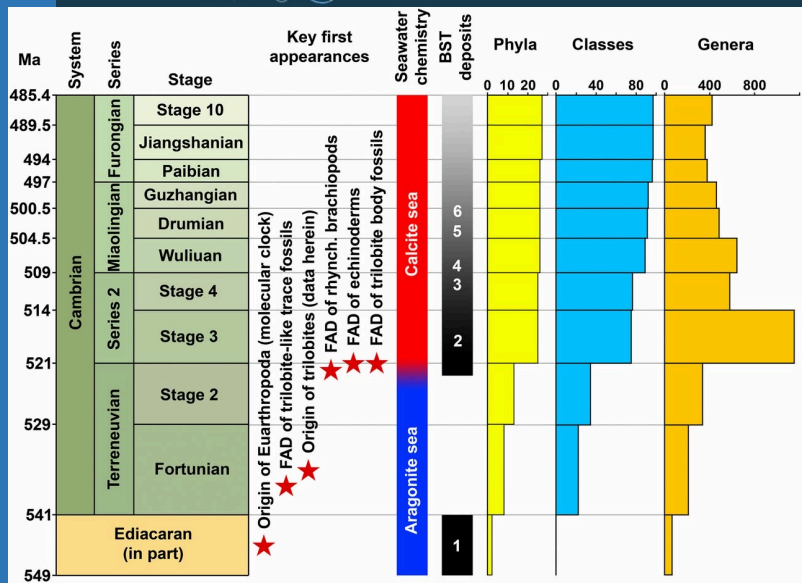


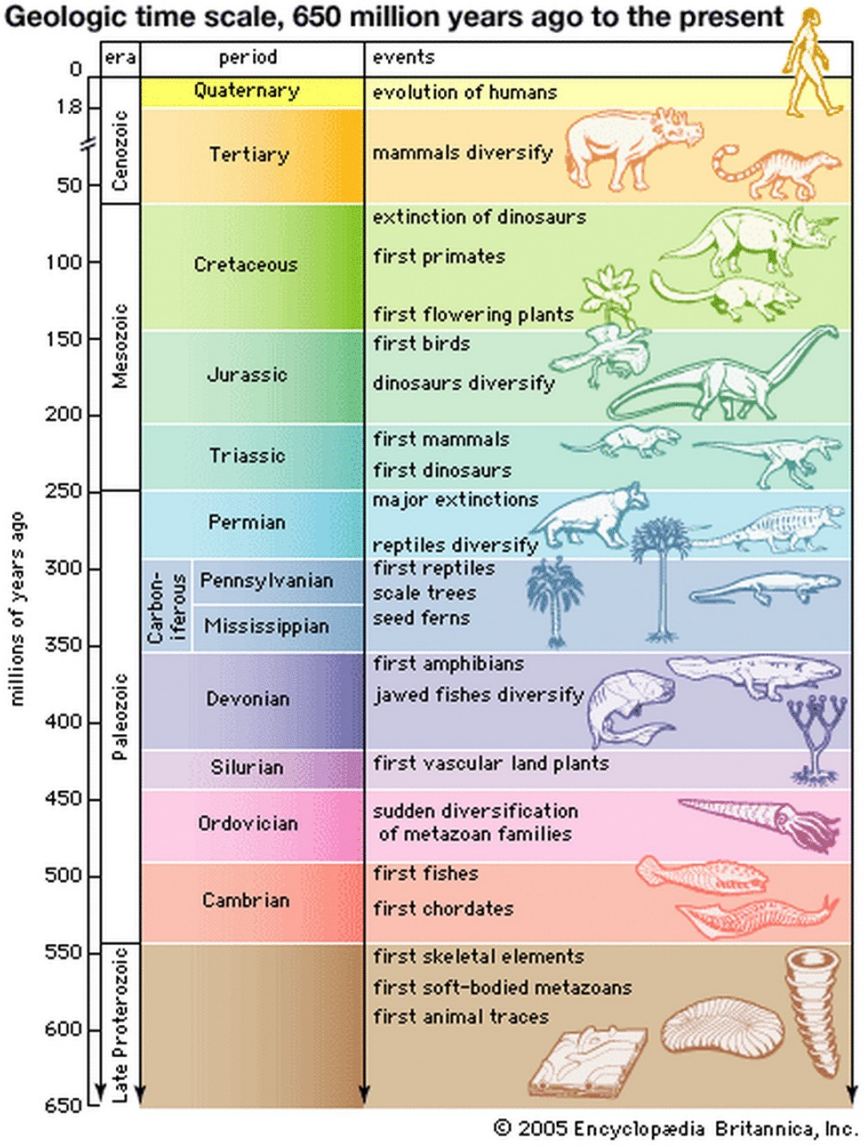
Origin of Life's Lineages

Oceanic Beginnings

- Archea
- Bacteria
- Ameobae
- Fungi
- Protists
- **Plantae**
- **Animalia**

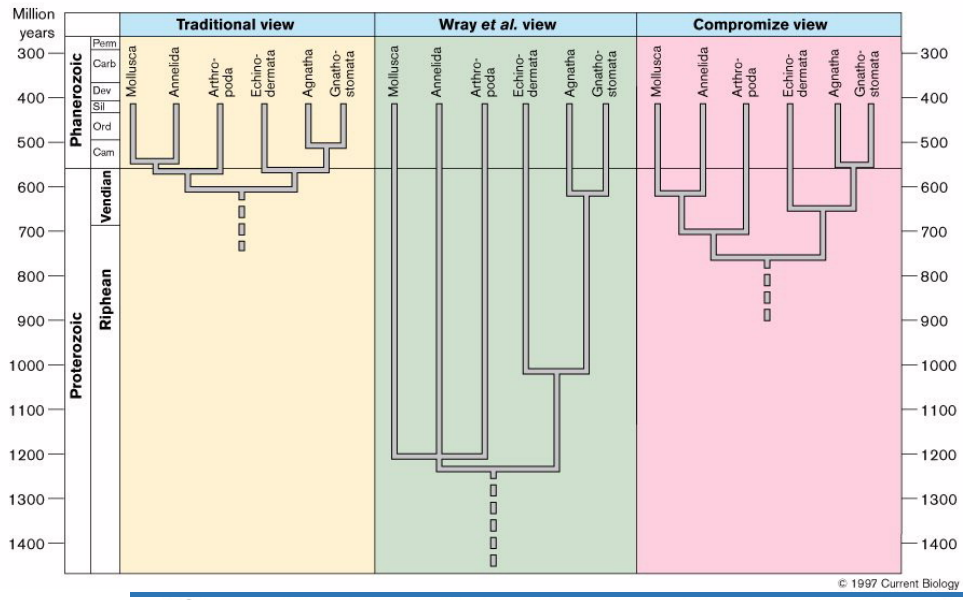


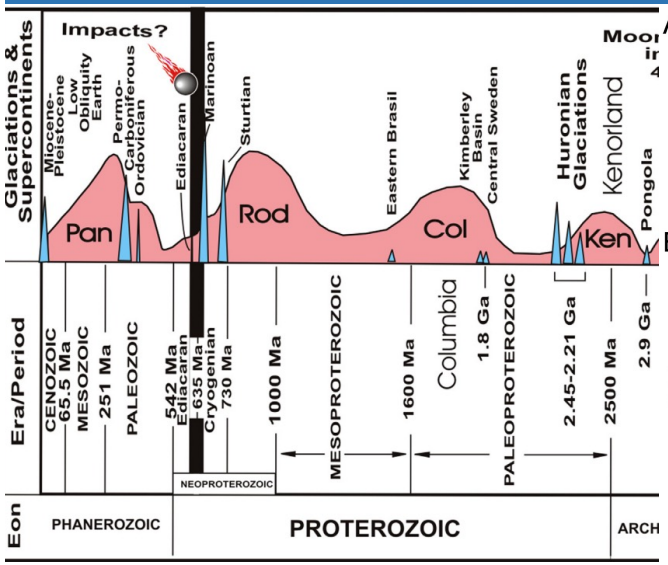


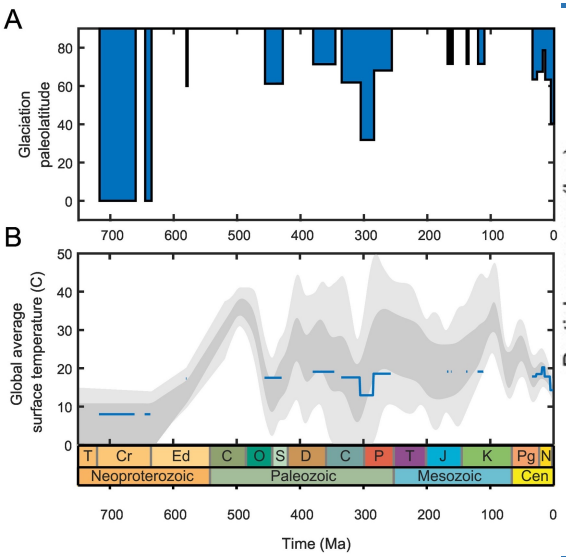


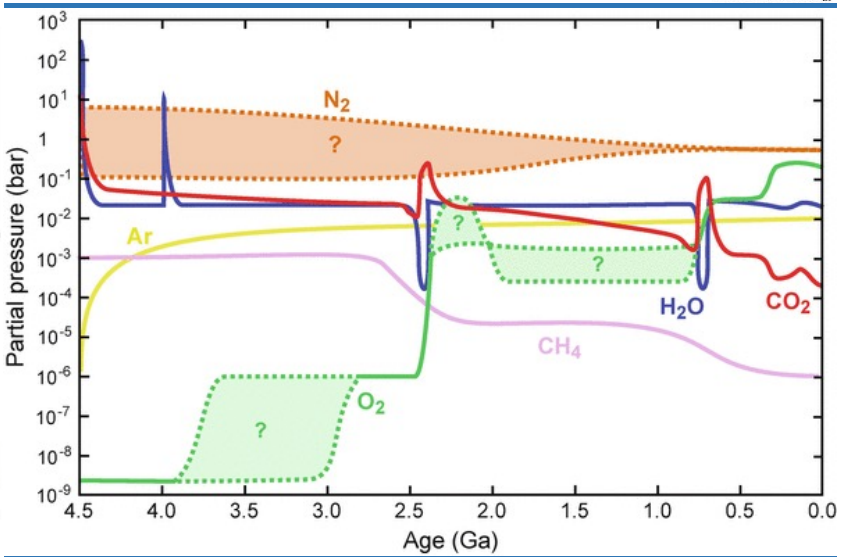
Late Proterozoic Conditions

- **Biosphere** diversity explosions
- **Atmosphere** oxygen rise
- **Cryosphere** final snowball Earths
- **Geosphere** break-up of Rodinia
- **Hydrosphere** oceanic oxygenation



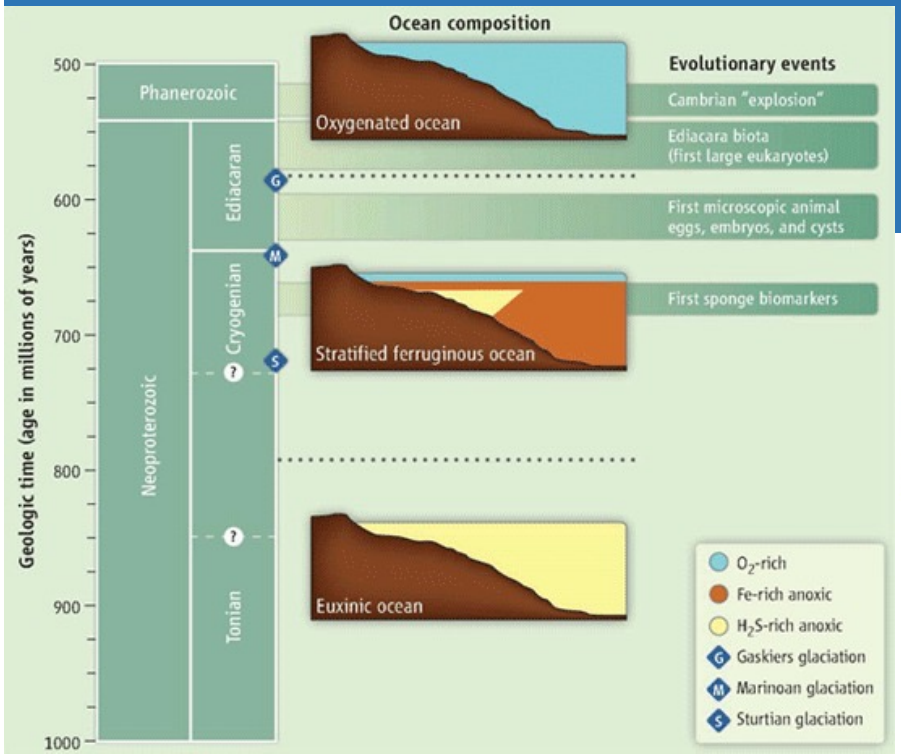


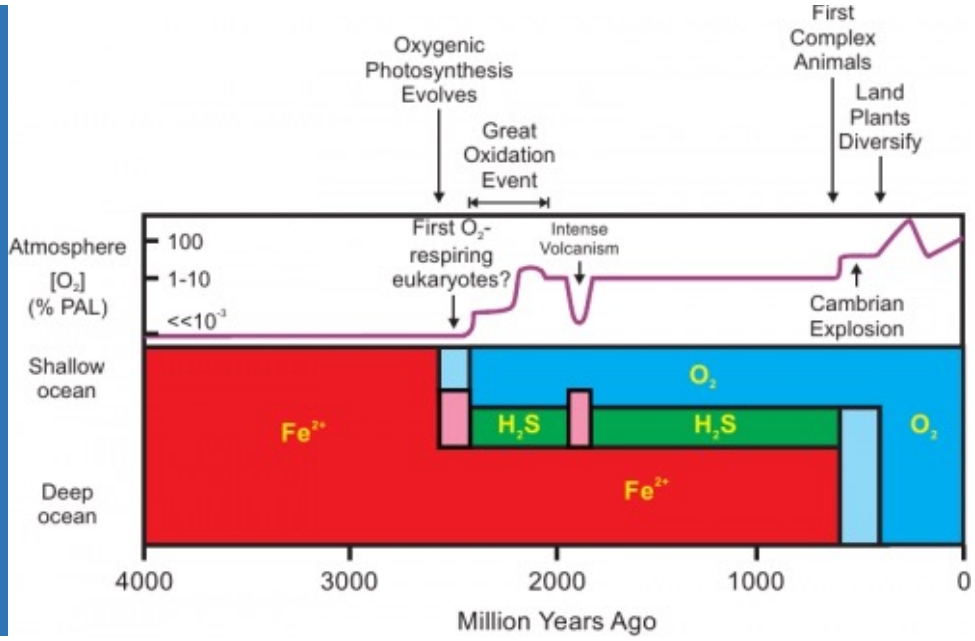


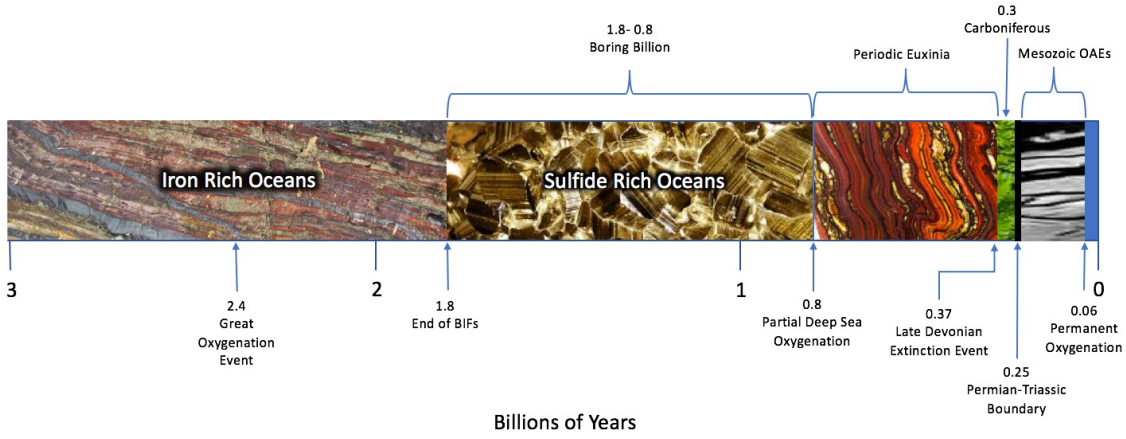


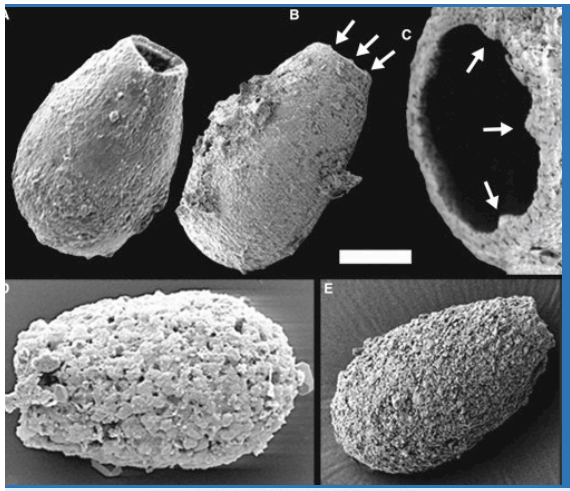
Late Proterozoic Oceans

- Cloudy & stratified
- Periodic anoxia
- Snowball Earth's



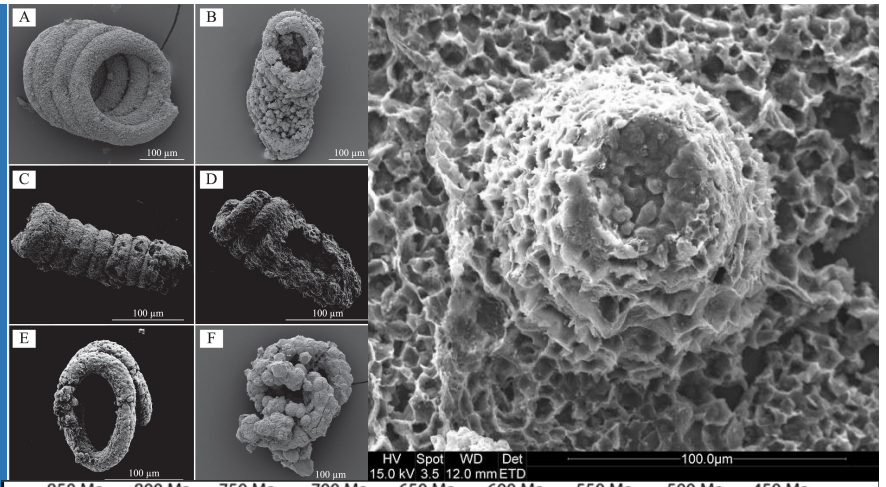


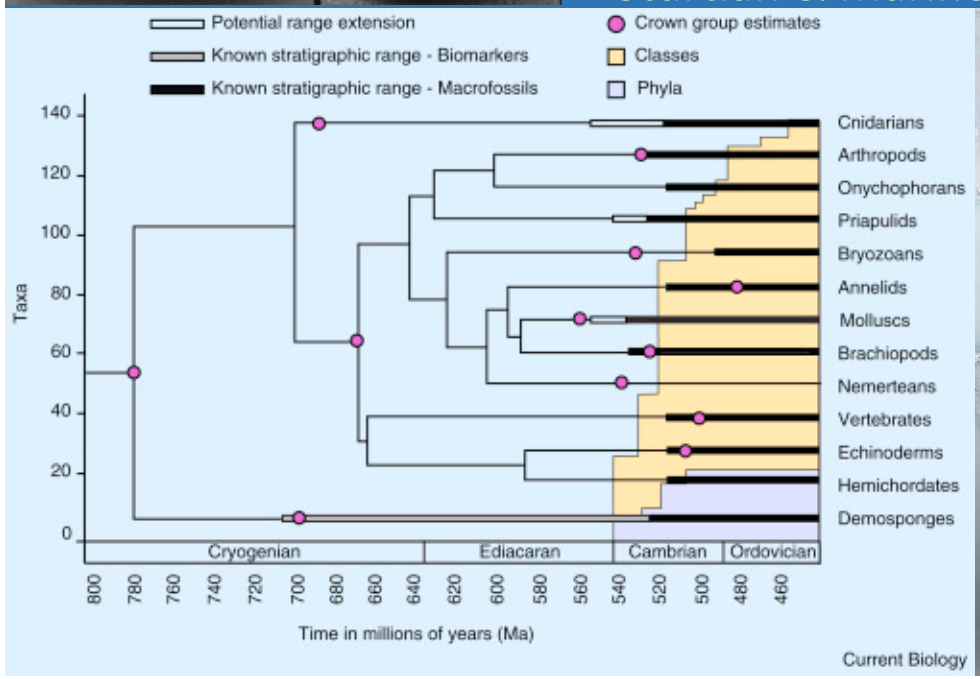


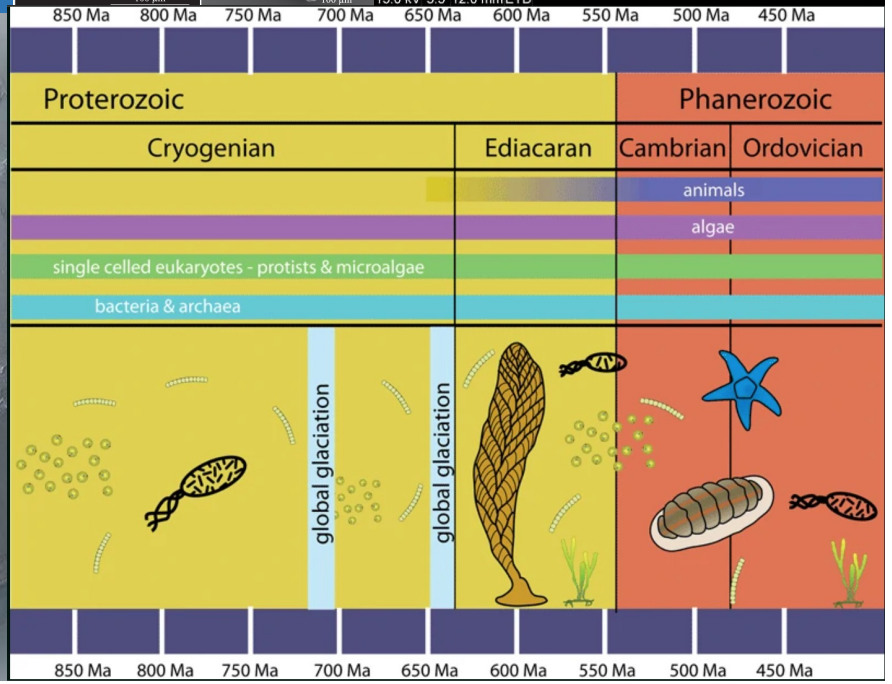


Cryogenian Period

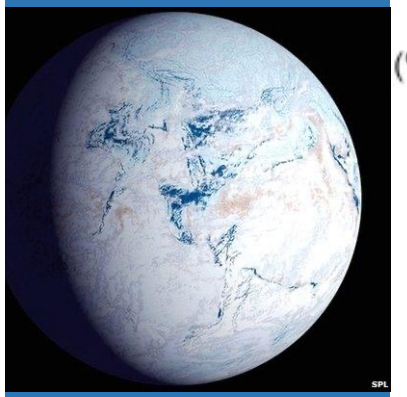
- 850-635Mya
- Oxygenation
- Amoebae fossils
- Pyritized cyanobacteria
- 2 Snowball Earths: Sturtian & Marinoan

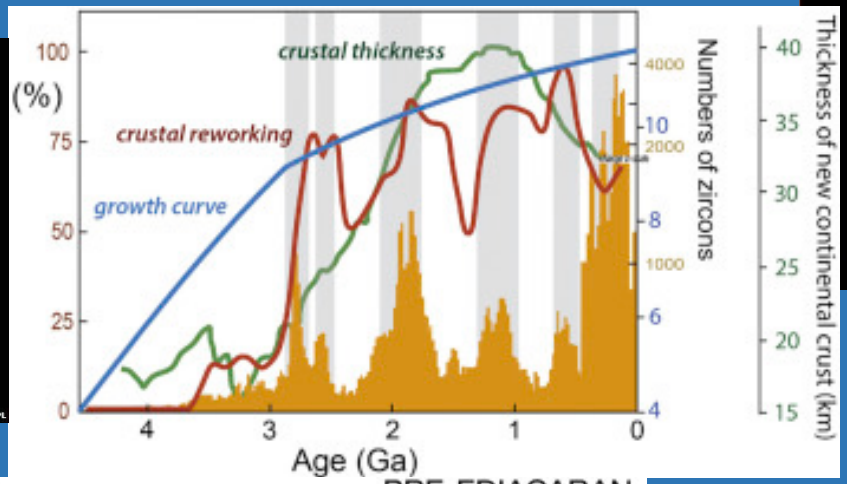


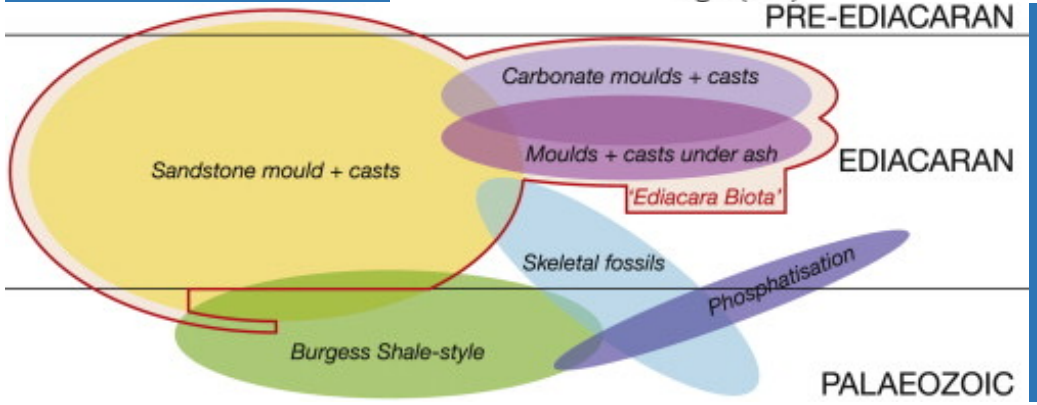


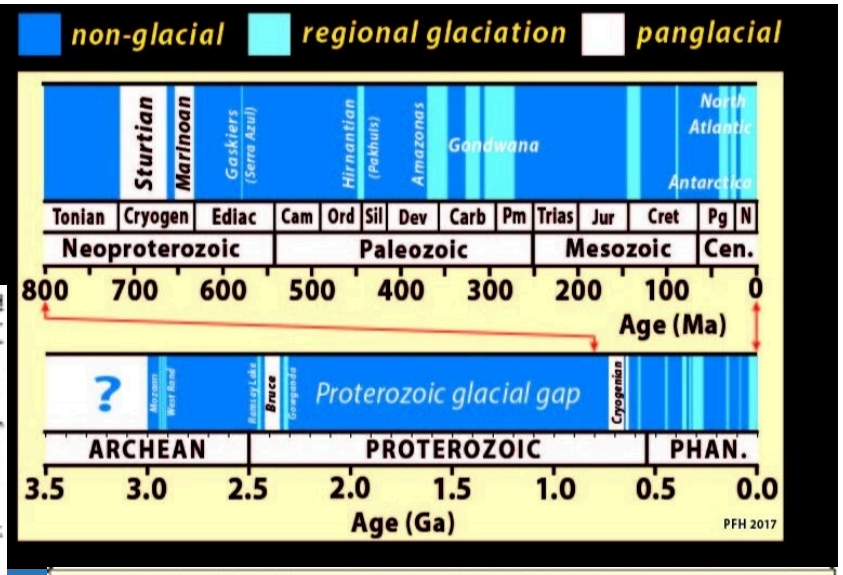


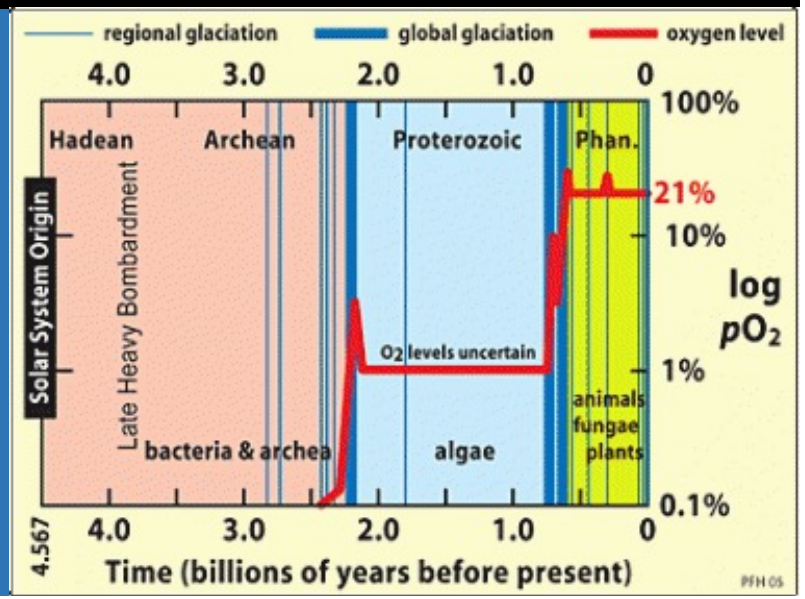
End of Snowball Earth & Rise of Macroscopic Life



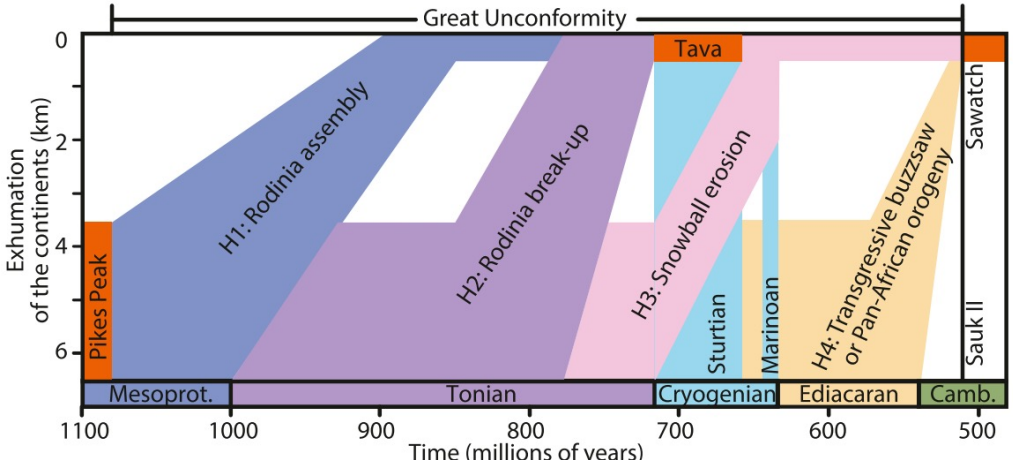


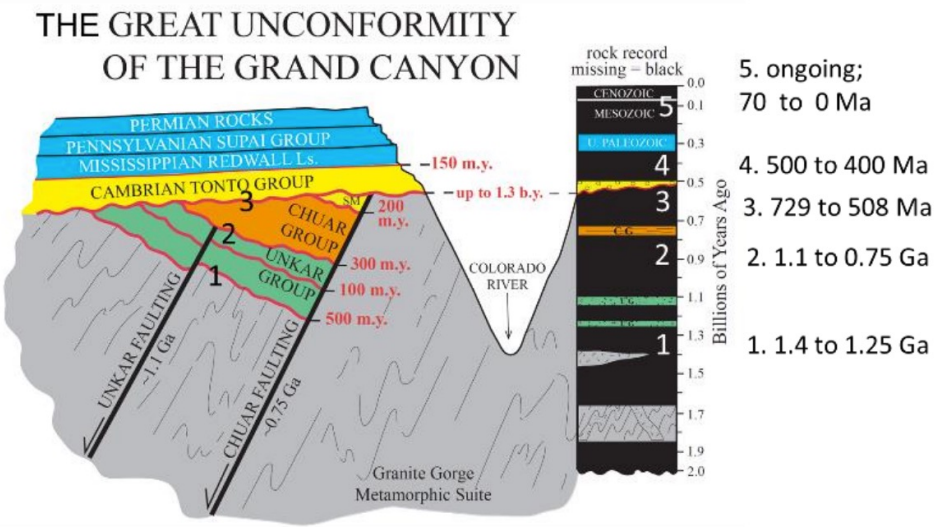






The Great Unconformity





5. ongoing; 70 to 0 Ma

4. 500 to 400 Ma

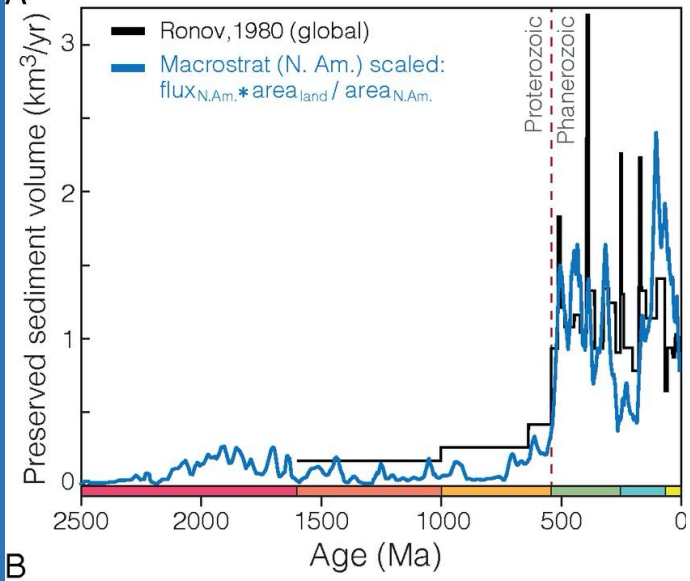
3. 729 to 508 Ma

2. 1.1 to 0.75 Ga

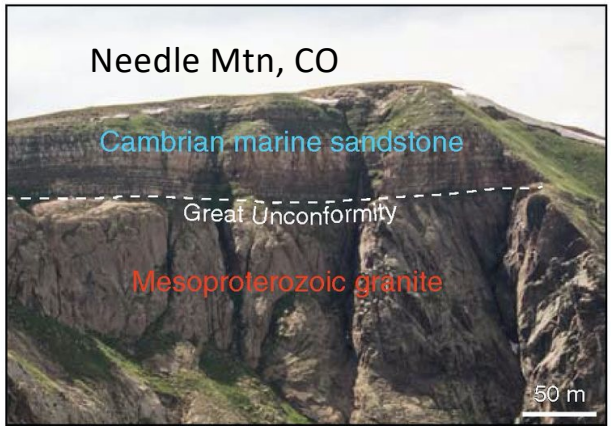
1. 1.4 to 1.25 Ga

- A gap of 175Ma to 1.6Ga long
- Global average of 3-5 vertical km of rock eroded
- May have triggered Cambrian Explosion by adding nutrients to ocean

A

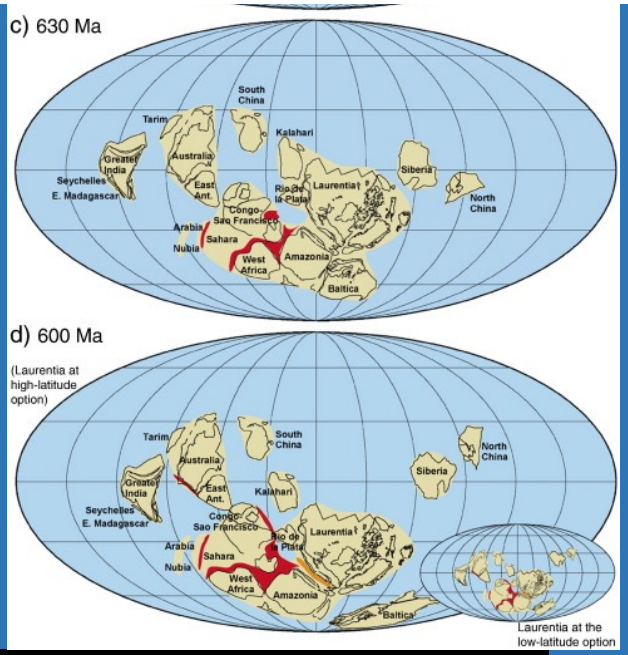


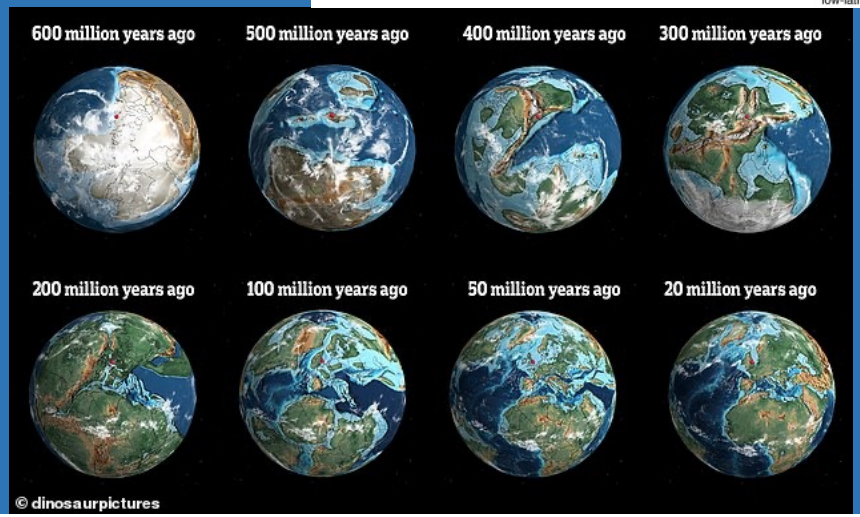
B



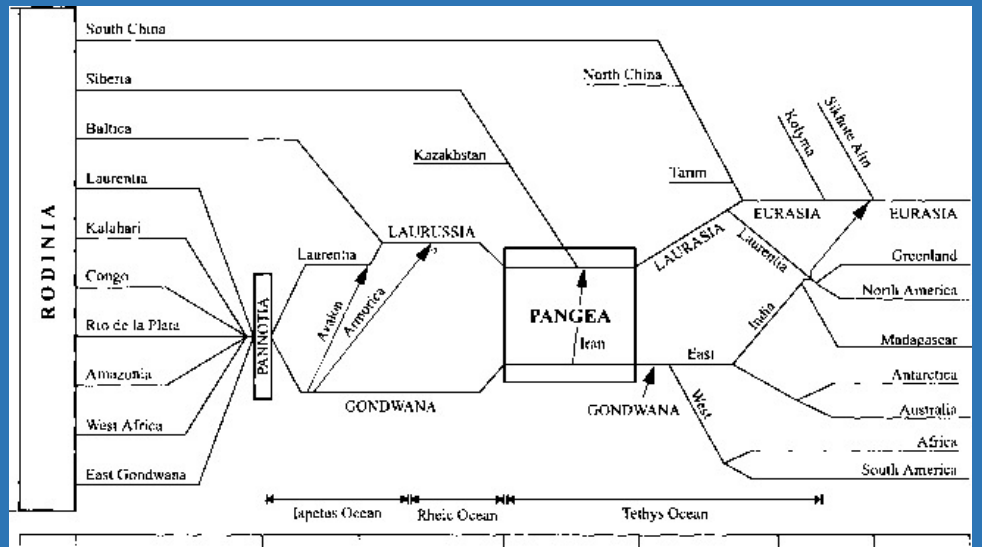
Super-Continents vs. Coastlines

Marine aerobic ecosystem = oceanic photosynthesis on continental shelves





Video 3.3Ga of continental drift:
https://www.youtube.com/watch?v=UwWWuttntio&t=83s

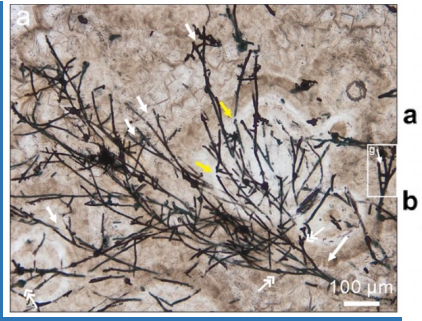


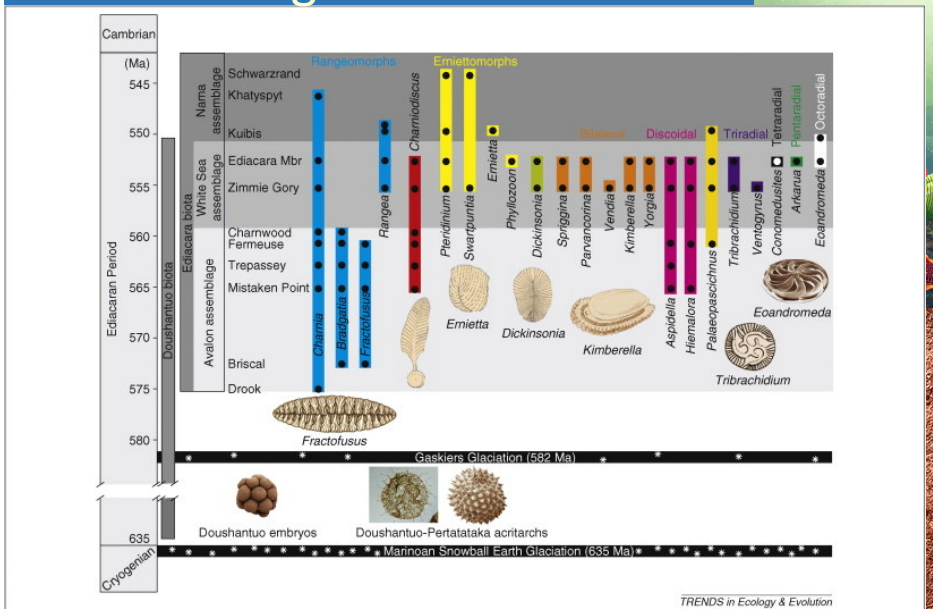
10 Minute Break!

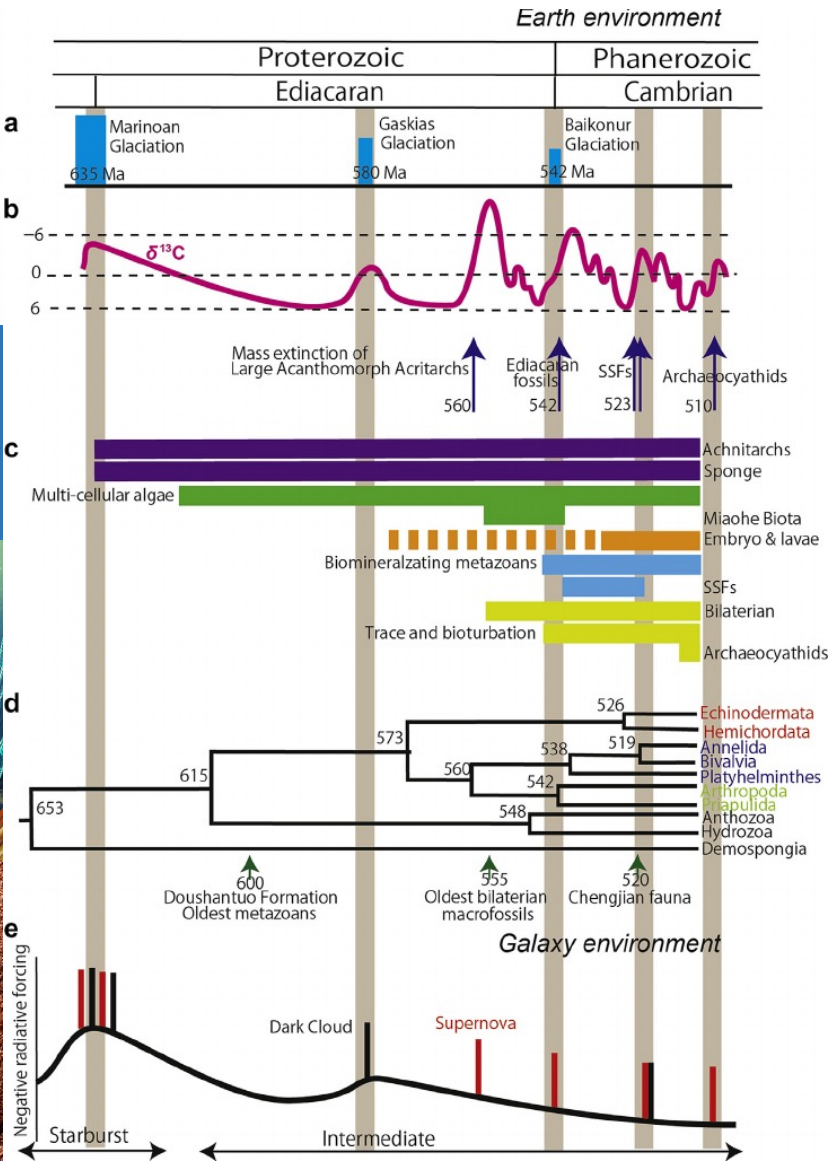
Video: https://www.youtube.com/watch?v=PTGxJyEA_C4

Edicarian Period

- 635-541Mya
- 635Ma possible oldest fossil fungi
- Avalon Explosion 585Mya
- Edicaran/Vendian fossils from >40 localities (global)
- Ancestors of phanerozoic animals OR a different extinct kingdom?

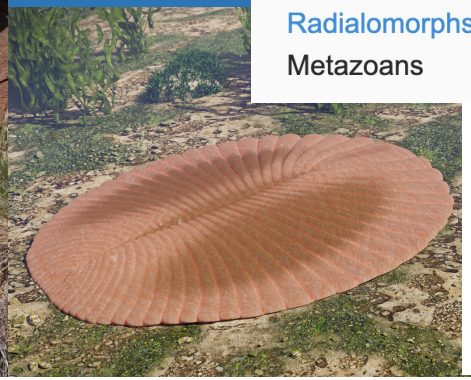






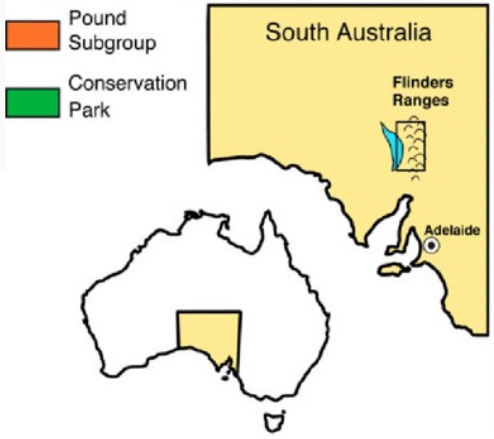
Edicara Hills Fossils

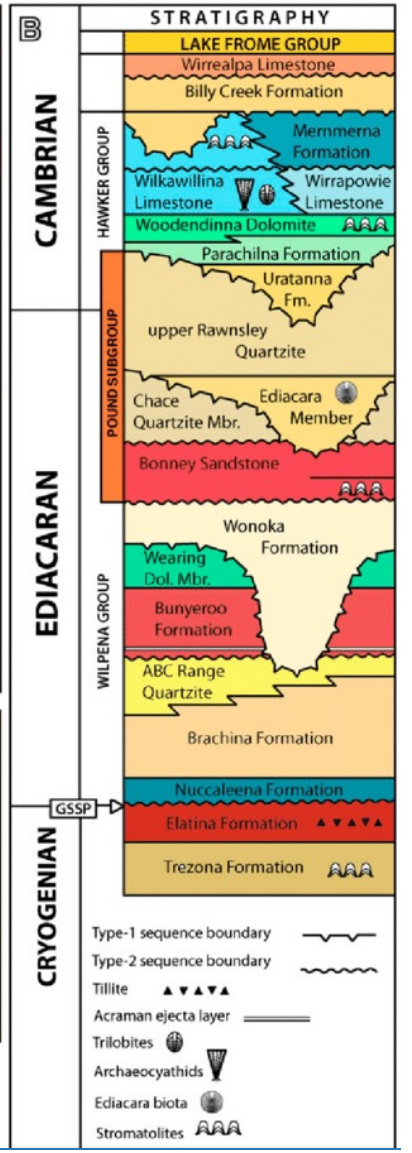
- ~560-550Mya, Ediacaran GSSP
- Dicksonia (soft tissue) grew to >4ft across
  - fungi, protist or animal?
  - Likely earliest animal because high cholesterols molecular composition
- >50 type of Ediacarans now known



Groups represented:

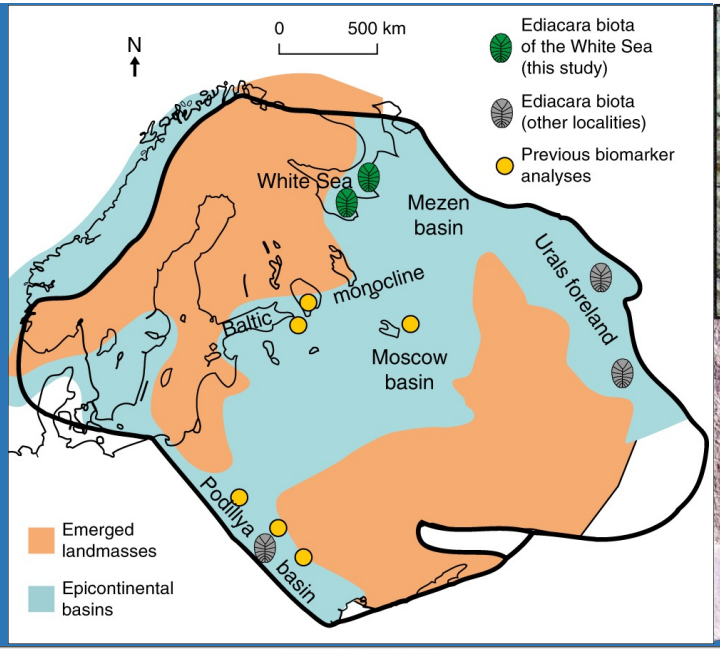
- Rangeomorphs
- Arboreomorphs
- Tubular body fossils
- Trace fossils
- Dickinsoniomorphs
- Bilaterian taxa
- Erniettomorphs
- Radialomorphs
- Metazoans

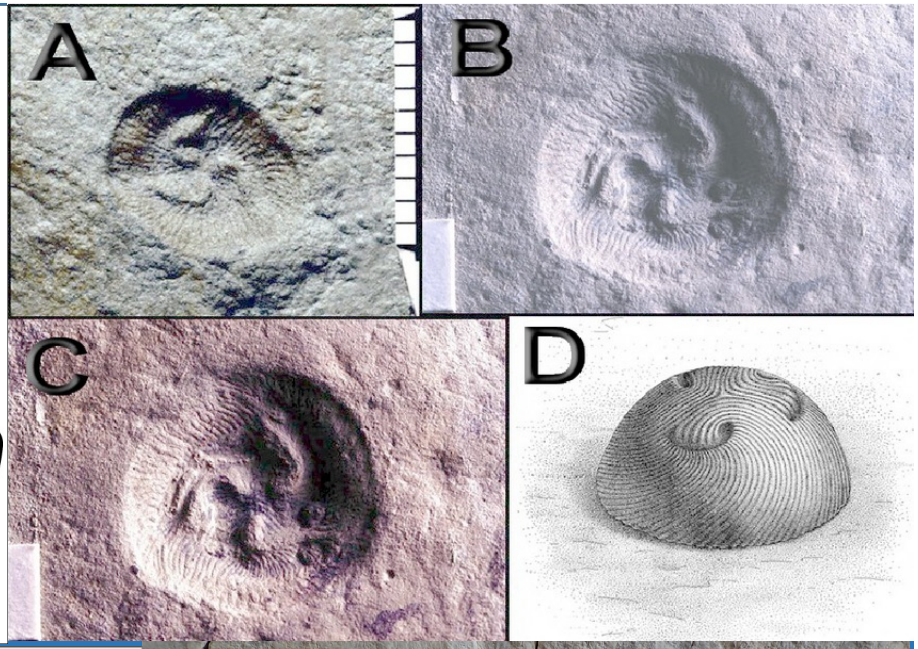


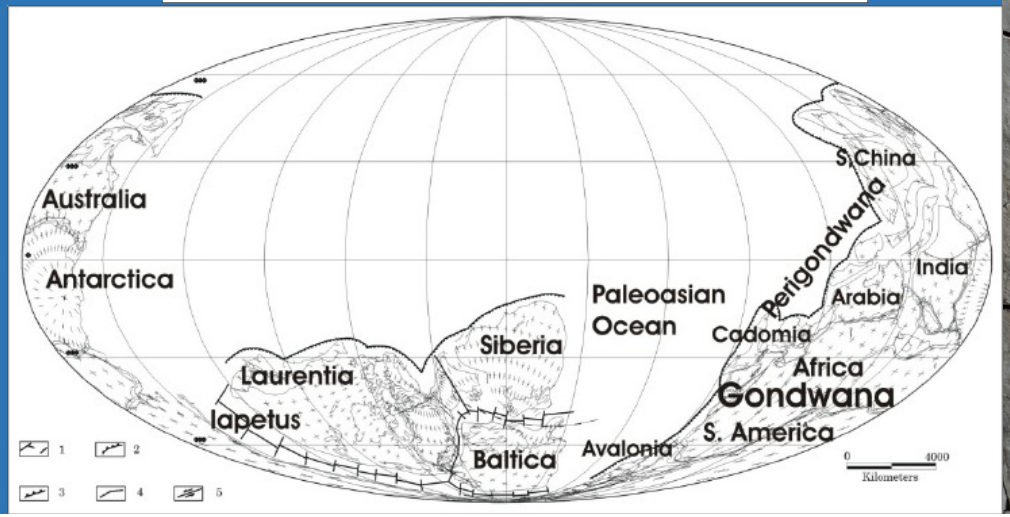


White Sea Coast Fossils

- Russia
- 560-550Mya
- Shallow water offshore ramp setting

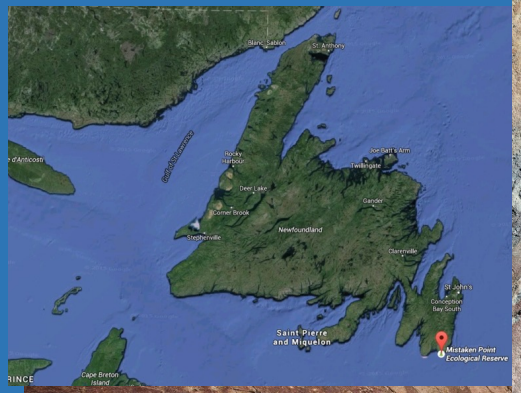


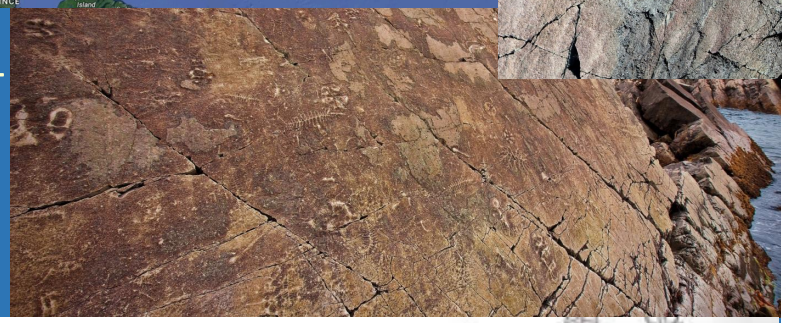


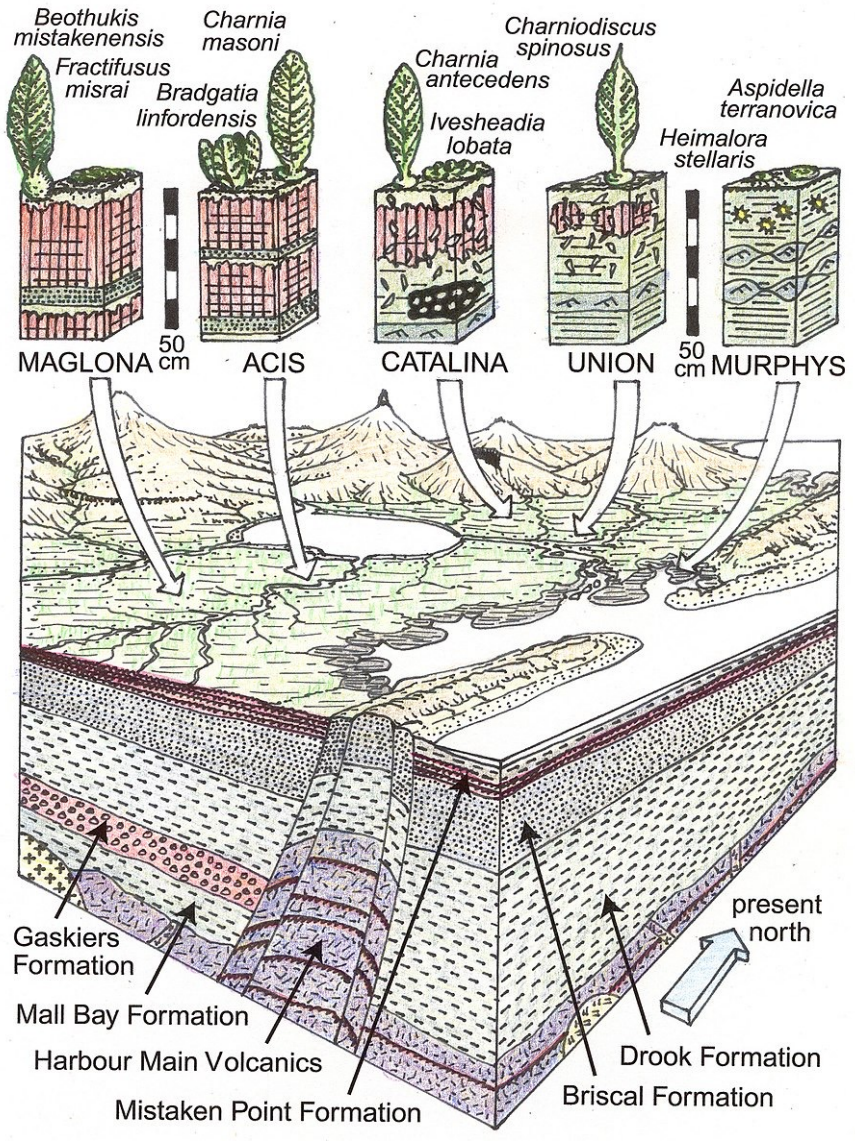


Mistaken Point

- Newfoundland, following 580Mya Gaskiers glaciation
- Avalon "explosion" assemblage 575-560Mya named for Avalon Peninsula
- Deep water environment
- In situ communities buried by ash, no trace fossils preserved



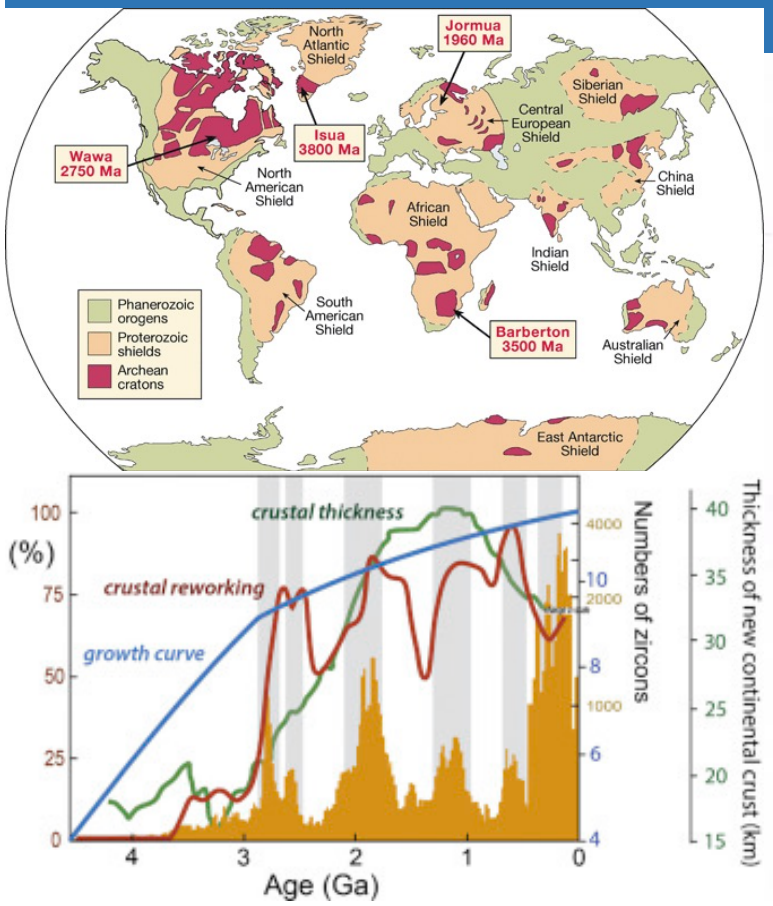


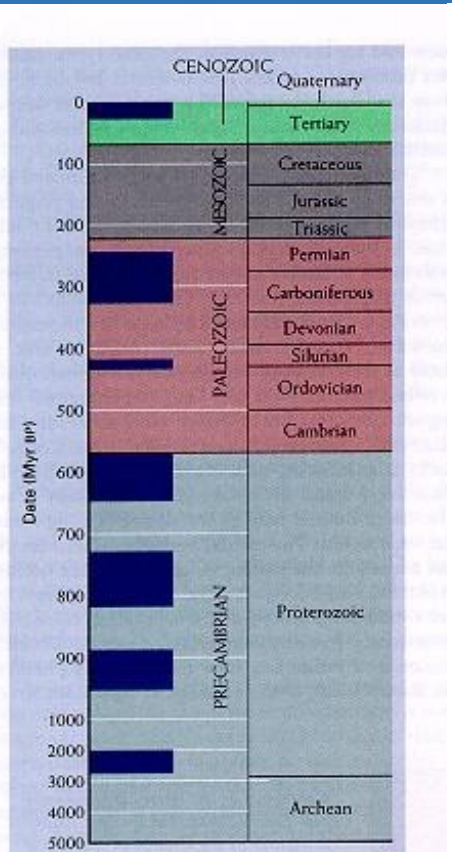


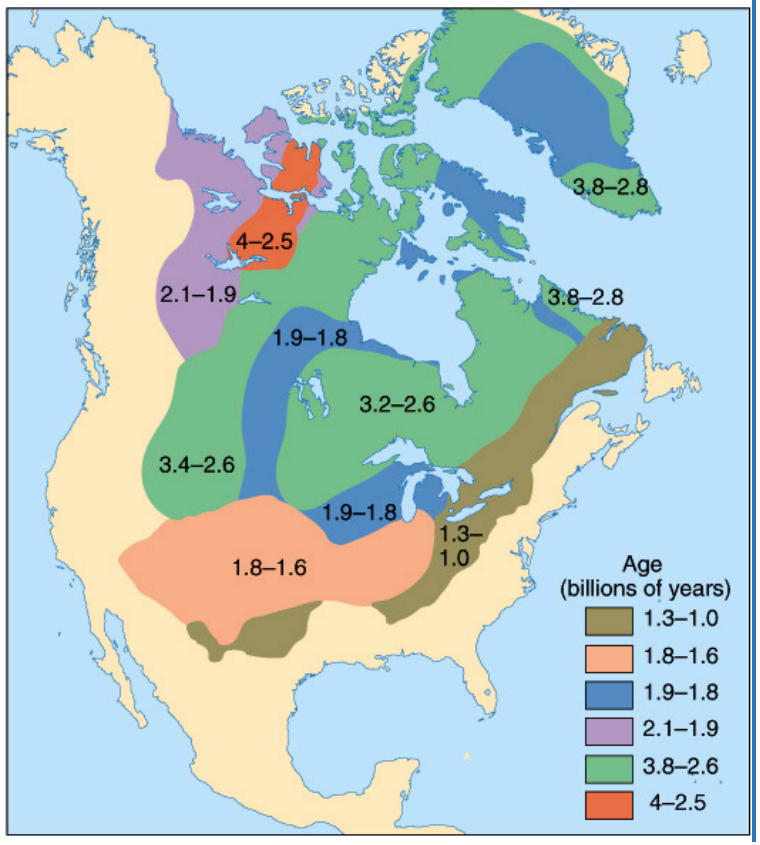
Phanerozoic Eon
538.8Ma to 0Ma

- VISIBLE LIFE
- Animals
- Plants
- Terrestrial Life

- Ecosystem Builders
- Plate Tectonics
- Ice Ages
- Gigantism



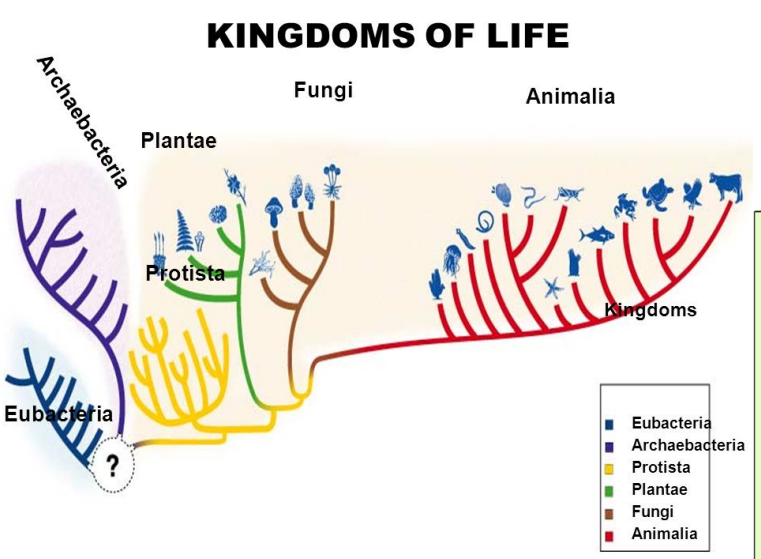


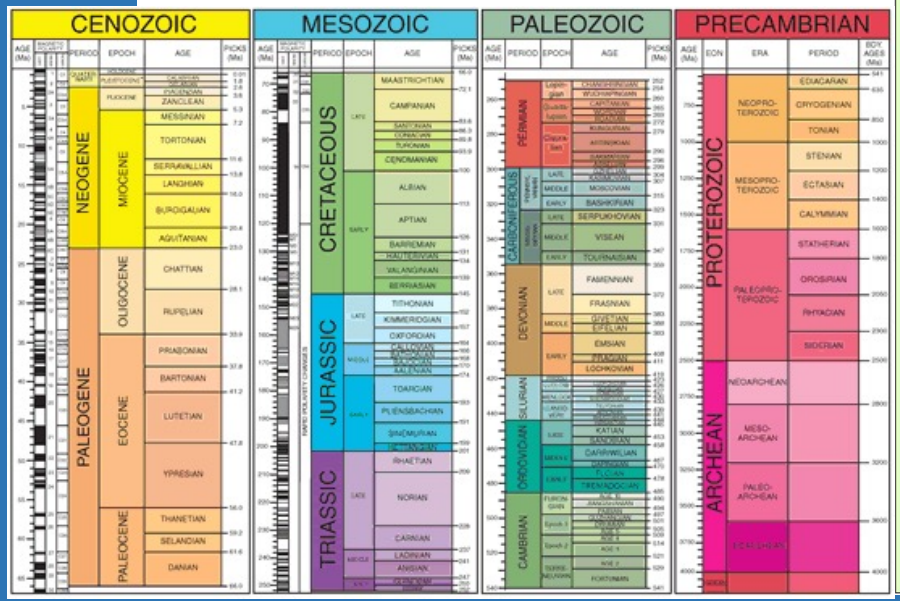


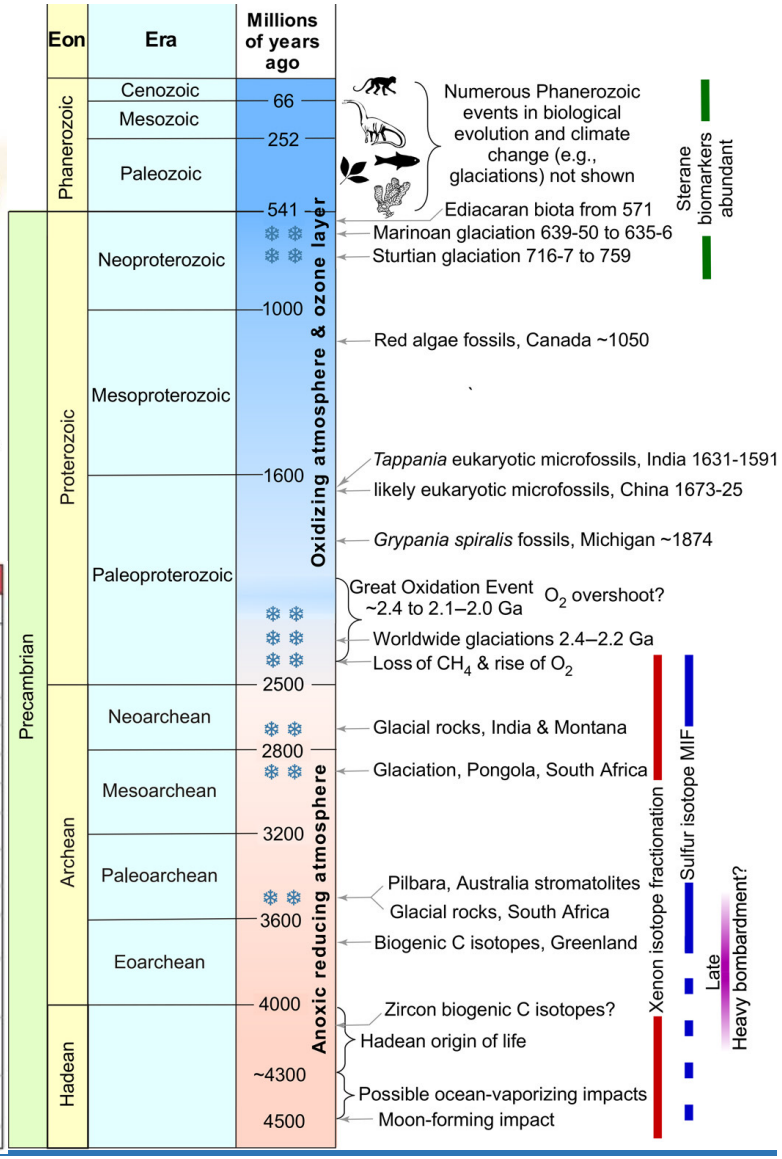
Phanerozoic Eon Evolution

Representatives of 3 Domains, divided into 6 Kingdoms still exist today

Whether unclassified fossils belong to extinct kingdoms/ domains remain to be seen

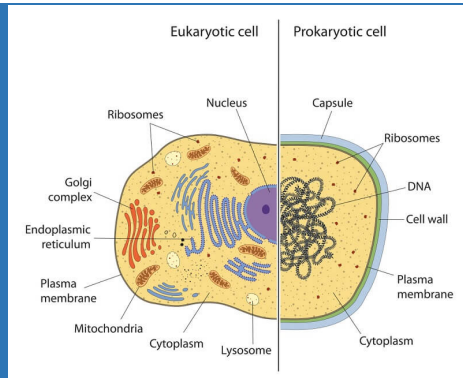


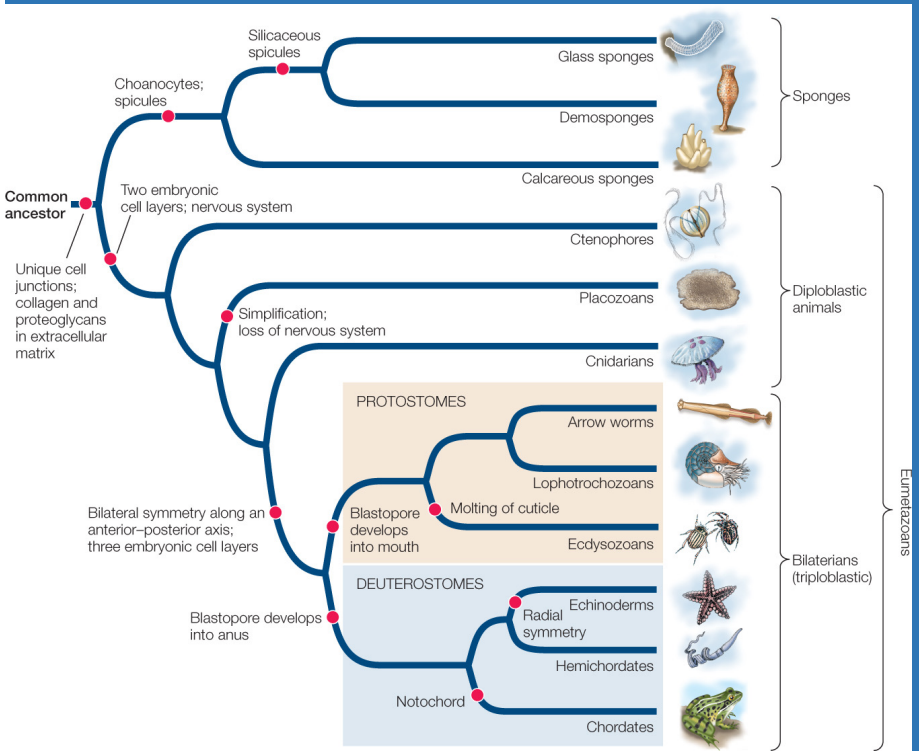


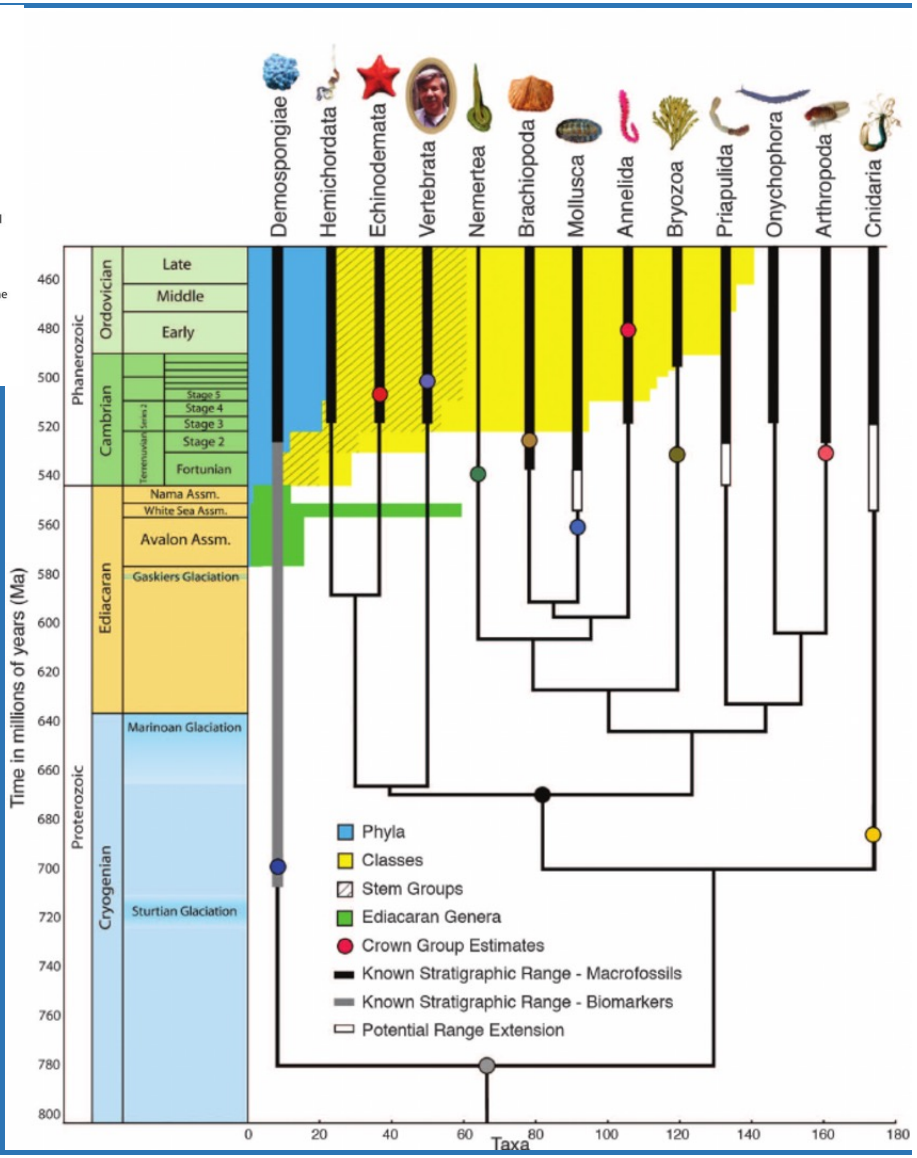


Evolution of Animalia

- Common ancestor ~650Mya
- Animalia = Metazoans
- Multicellular eukaryotes
- Majority - bilateria

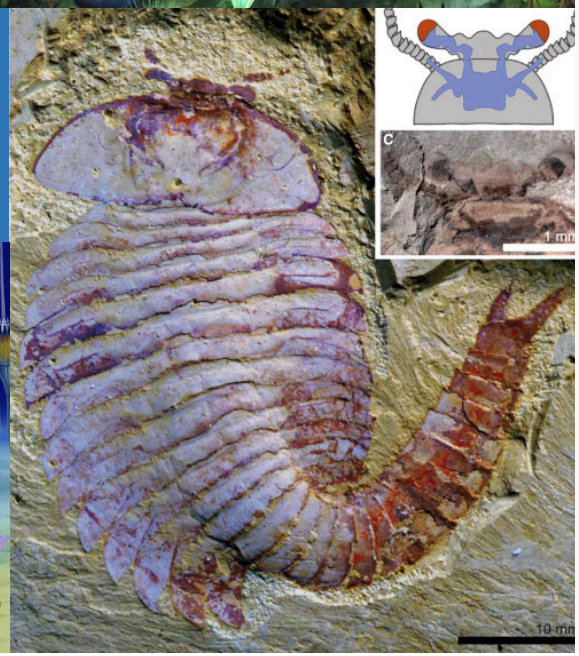


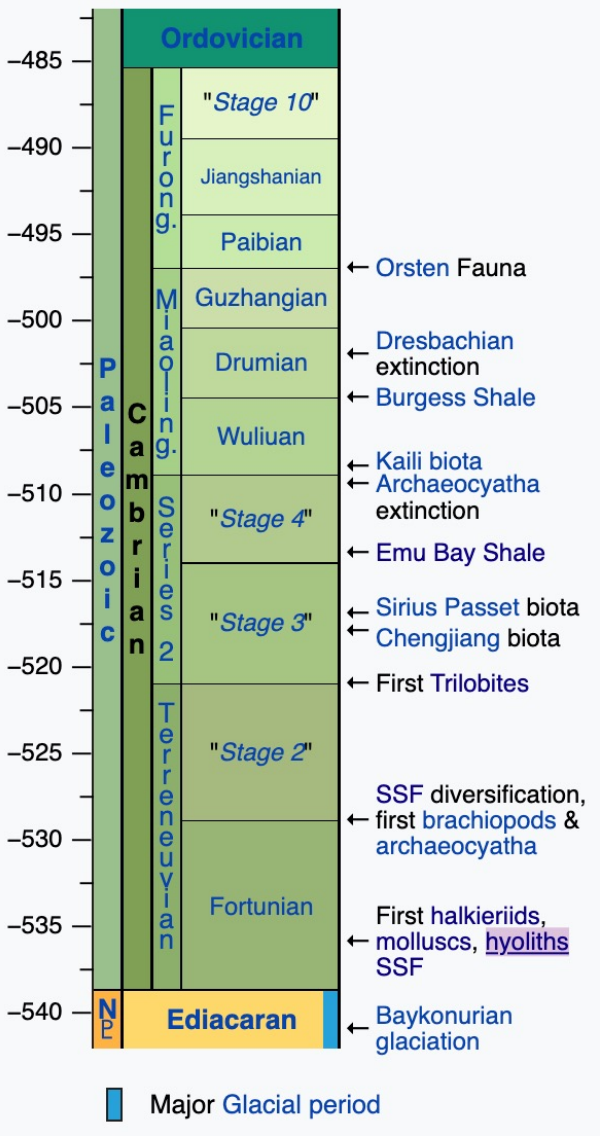




The Cambrian Explosion

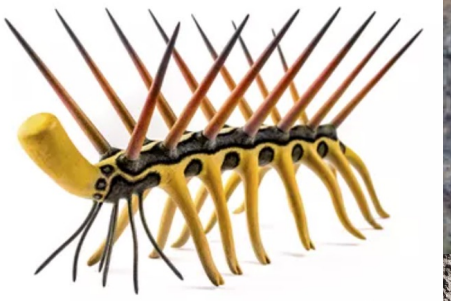
- ~541-530Mya
- Spectacular preservation
- Oldest shells & skeletons
- *~560-550Mya oldest known skeleton*
- *520Mya oldest known arthropod (5 eyes)*

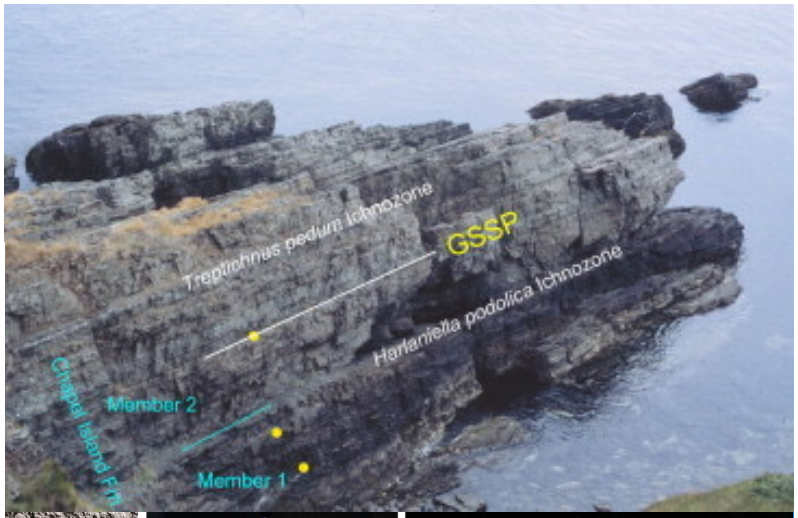


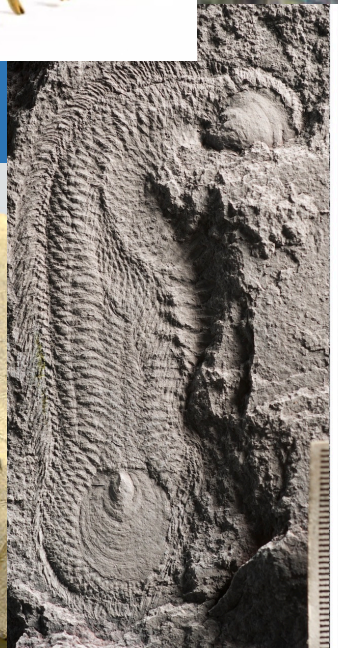


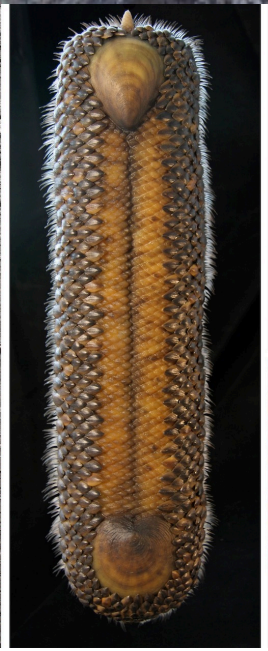
Cambrian Period

- 538.8-485.4Mya named for Cambria, Wales
- GSSP: Fortune Head, Newfoundland
  - Large scale global warming
  - Warmer oxygenated seas
  - Small shelly fauna
- 535-520Mya Anomalocaris: first apex predator (arthropod)
- 521-251Mya Trilobites: arthropod
- ~500Mya Possible first terrestrial aquatic plants: pond scum (molecular clocks)









The Burgess Shale

- 505Mya Middle Cambrian
- Yoho National Park, Canada
- Exceptional preservation conditions
  - Sulfate concentration low = suppressed decay bacteria
  - Sea water was unusually high in alkalis = early consolidation of sediments
  - >50 Burgess Shale Type (BST) deposits