

The Natural History of
DINOSAURS

<http://jdyeakel.github.io/teaching/>

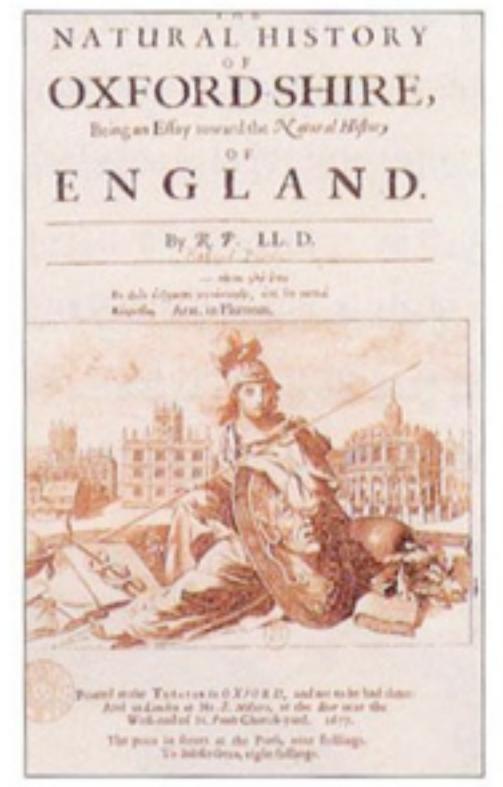
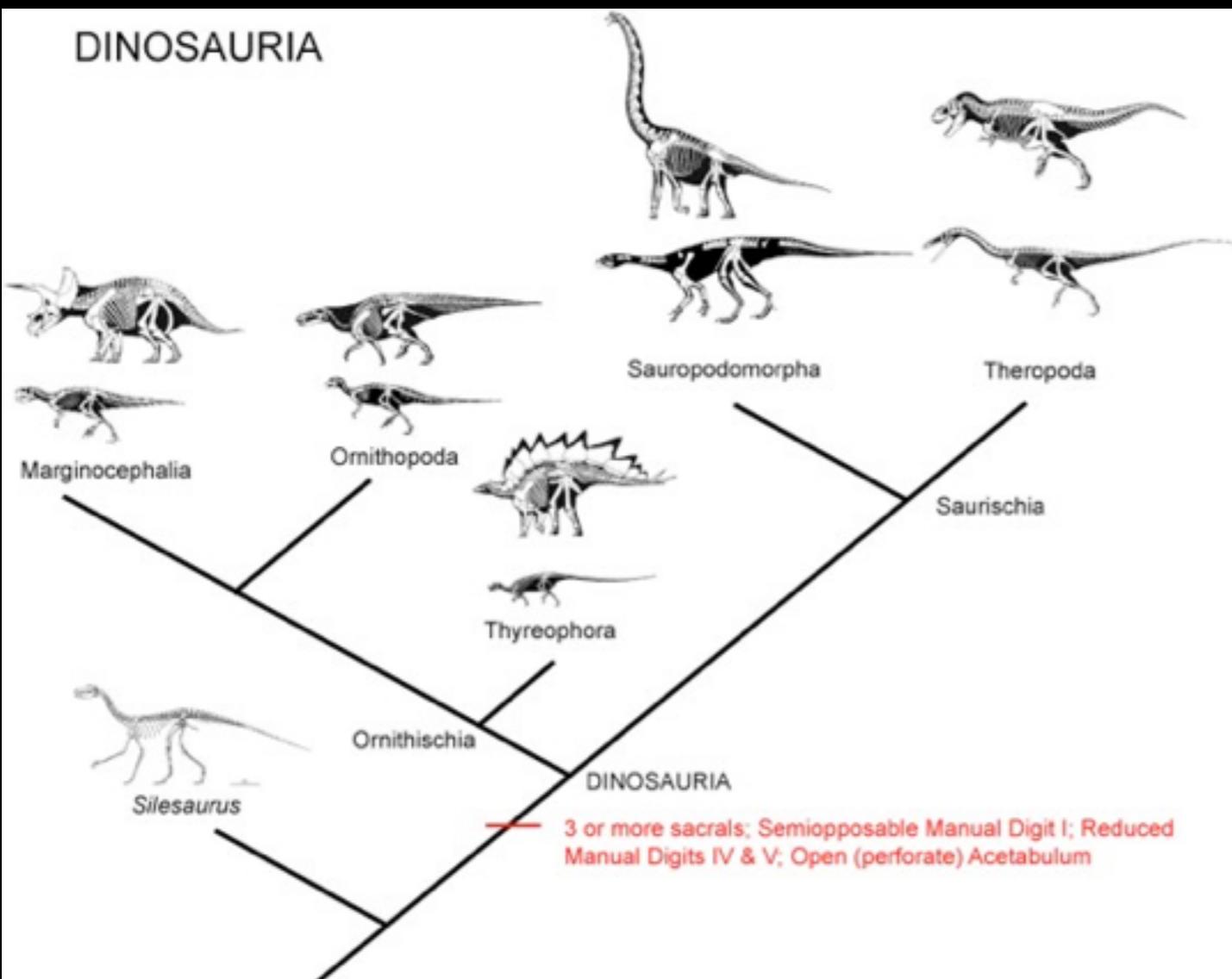


Scales: Space

Scales: Time

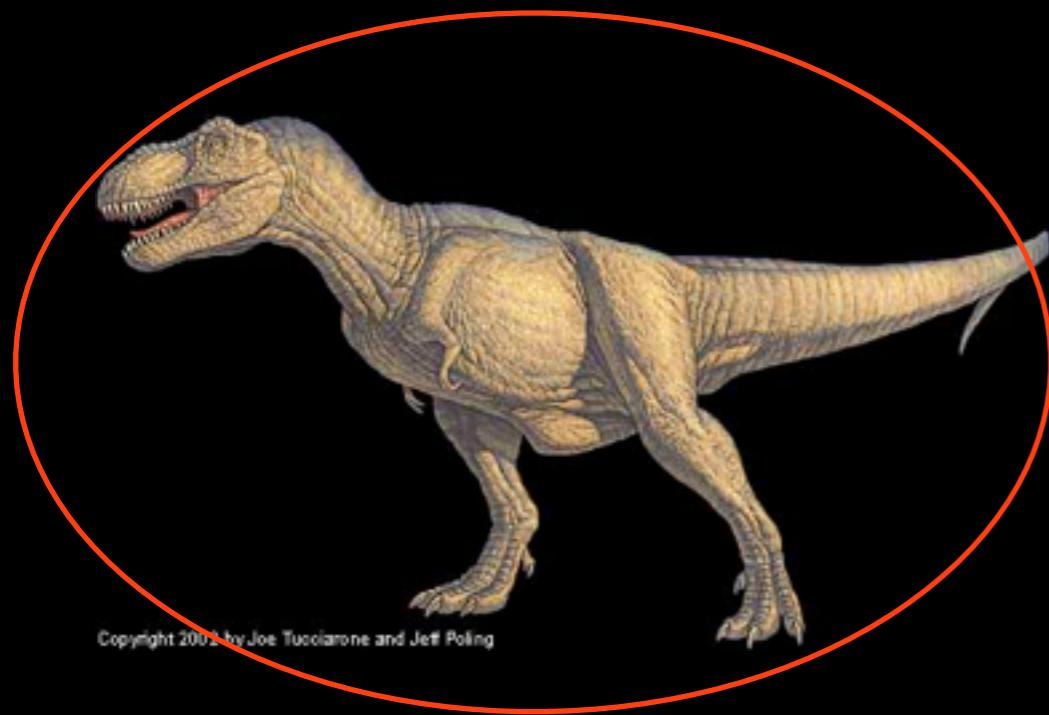
Where do Dinos fit in?

Fossilization and Taphonomy

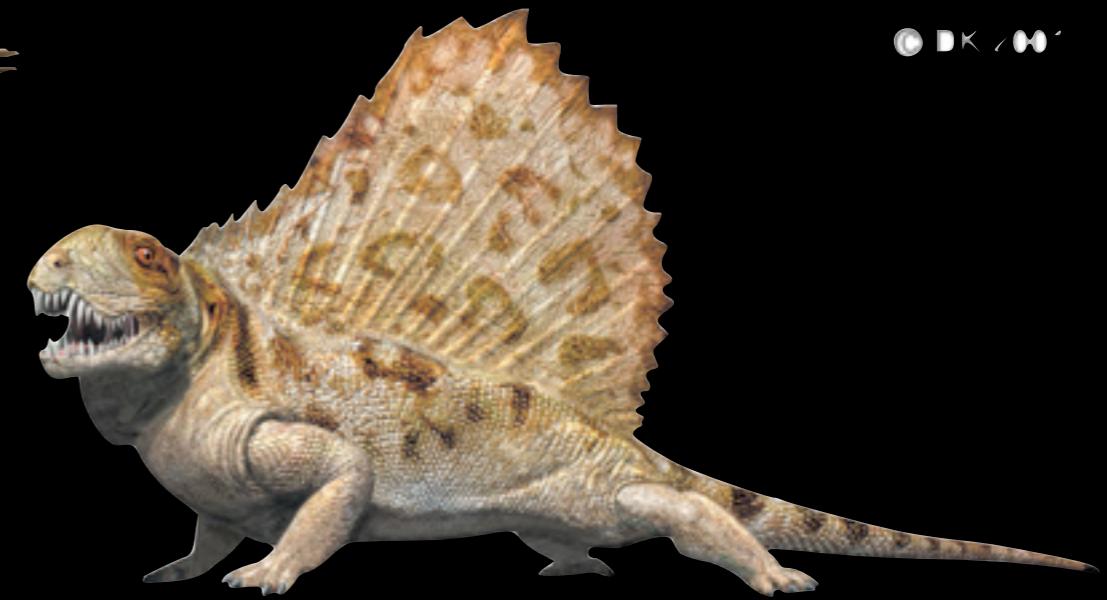


Dinosauria:
A monophyletic clade





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Dinosaur?

What is the age of the Earth?

- a) 6000 years old
- c) 20.2 billion years old
- b) 1.8 million years old
- d) 4.6 billion years old



When did dinosaurs first appear on Earth?

a) 1 million BC

b) 500 million years ago

c) 230 million years ago

d) 251 million years ago



Mesozoic dinosaurs are rare in California because:

- a) they are in rocks that are still buried beneath the surface
- b) California was too cold in the Mesozoic
- c) California was mostly underwater
- d) Dinosaurs don't like hippies



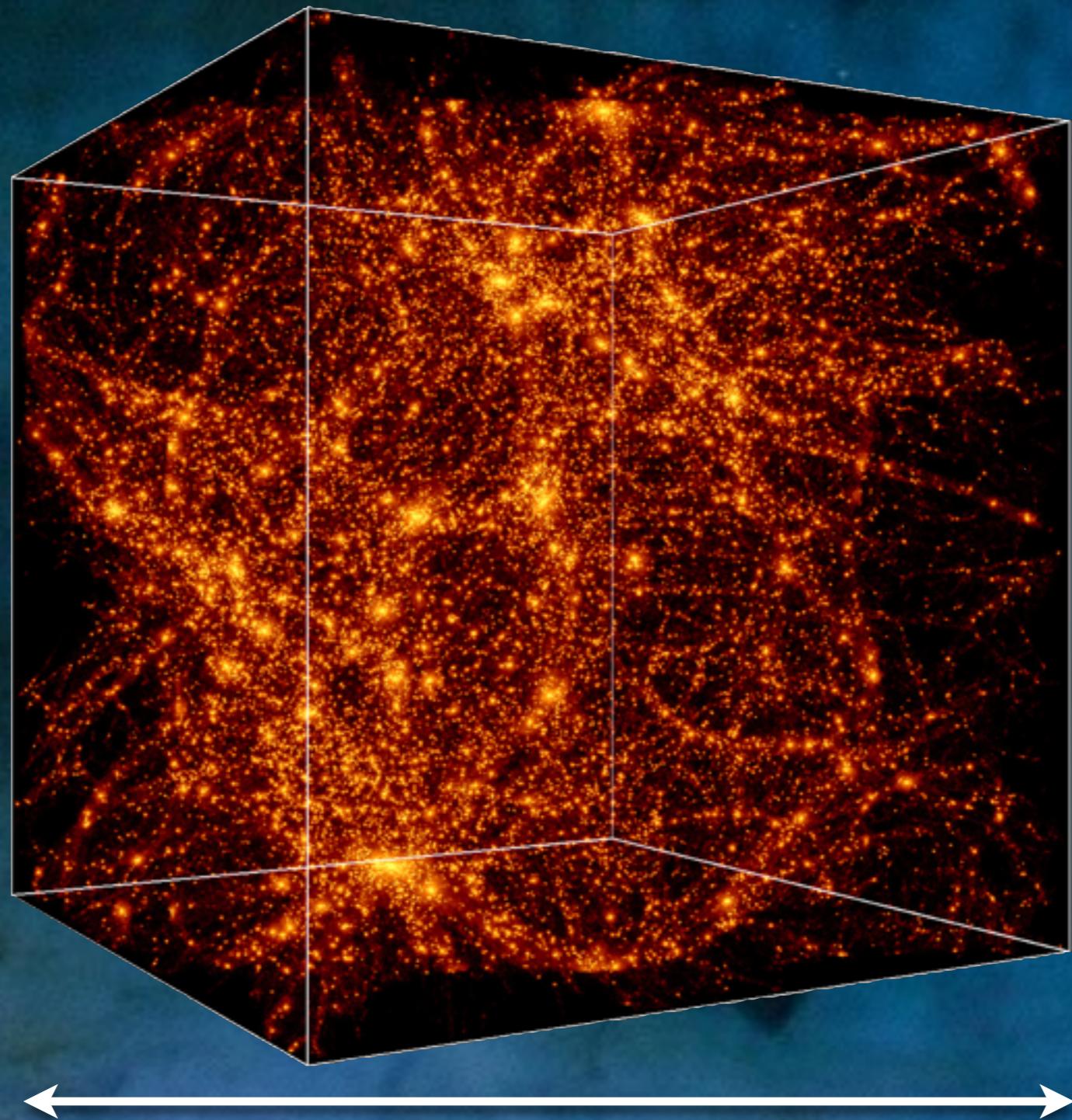
Orders of Magnitude

$$\begin{aligned}10^{10} &= 10000000000 \\&= 10 * 10 * 10 * 10 * 10 * 10 * 10 * 10 * 10\end{aligned}$$

$$\begin{aligned}10^{-10} &= 0.0000000001 \\&= .10 * .10 * .10 * .10 * .10 * .10 * .10 * .10 * .10\end{aligned}$$

Spatial Scales

Orders of Magnitude



Orders of Magnitude



10^{15}



Orders of Magnitude



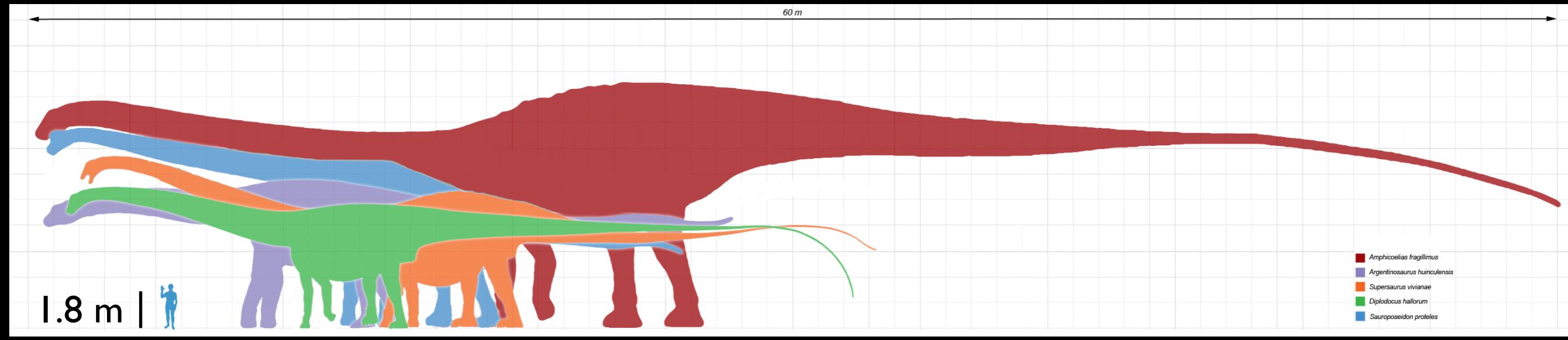
10^{10}



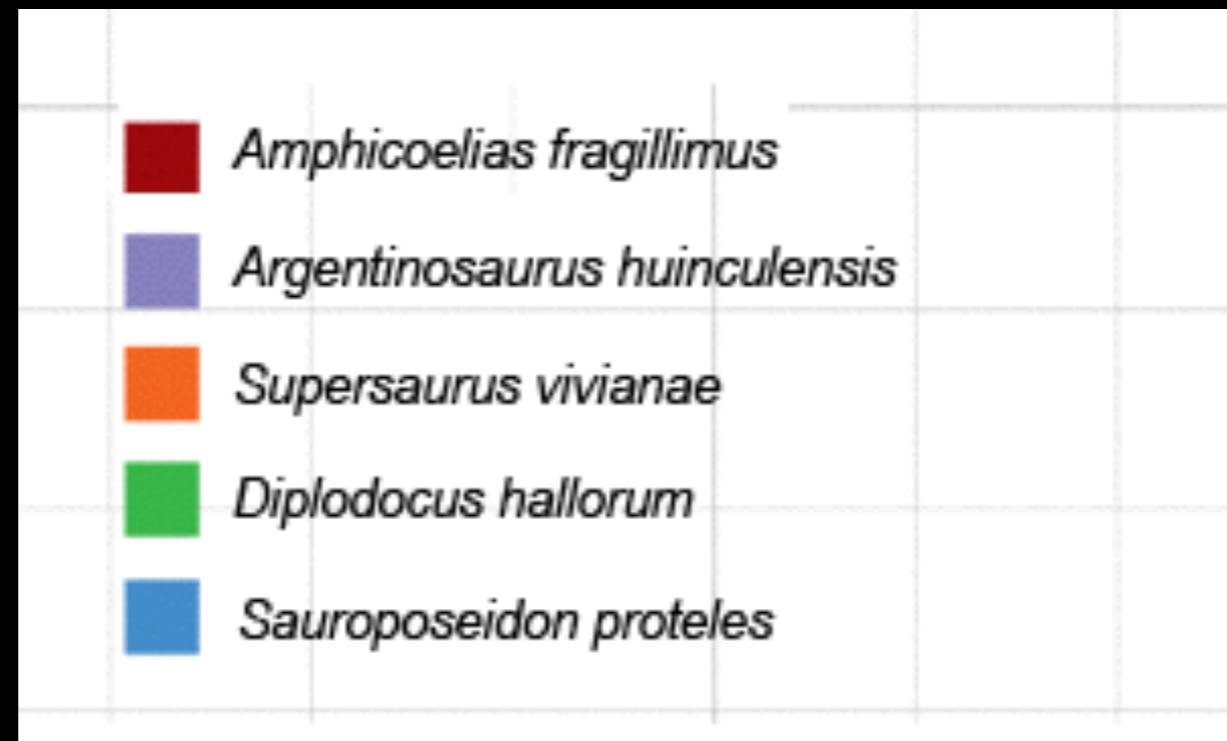
Orders of Magnitude



10^6



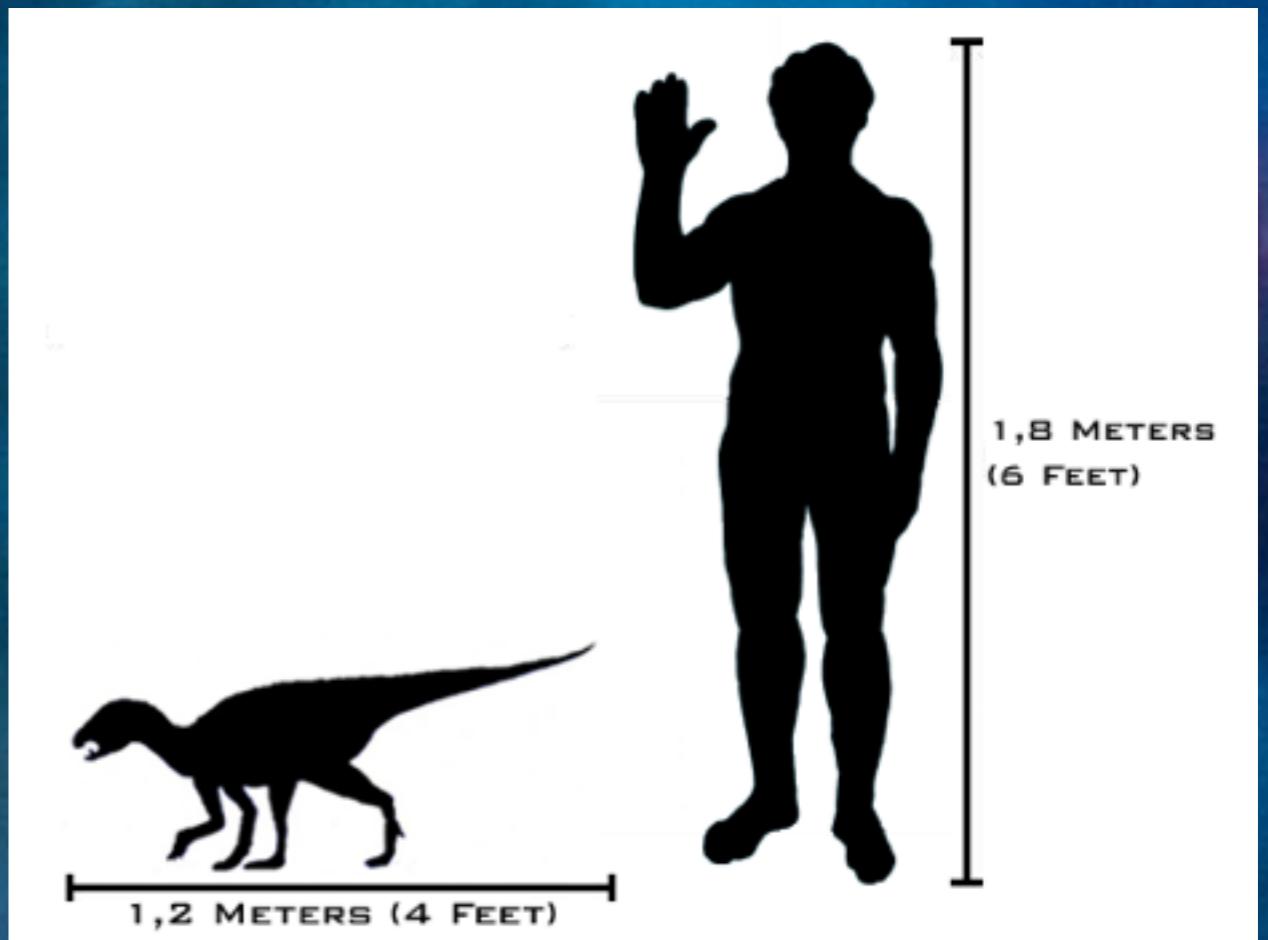
60 m



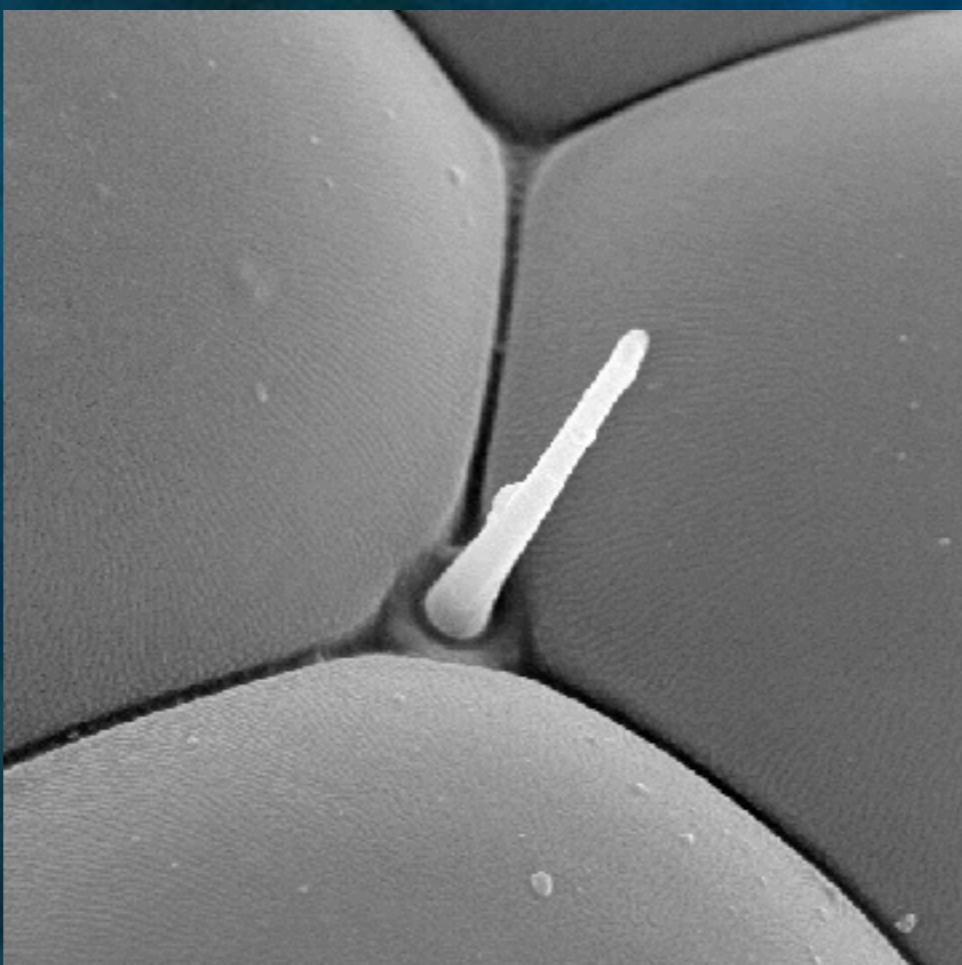
Orders of Magnitude



10^0

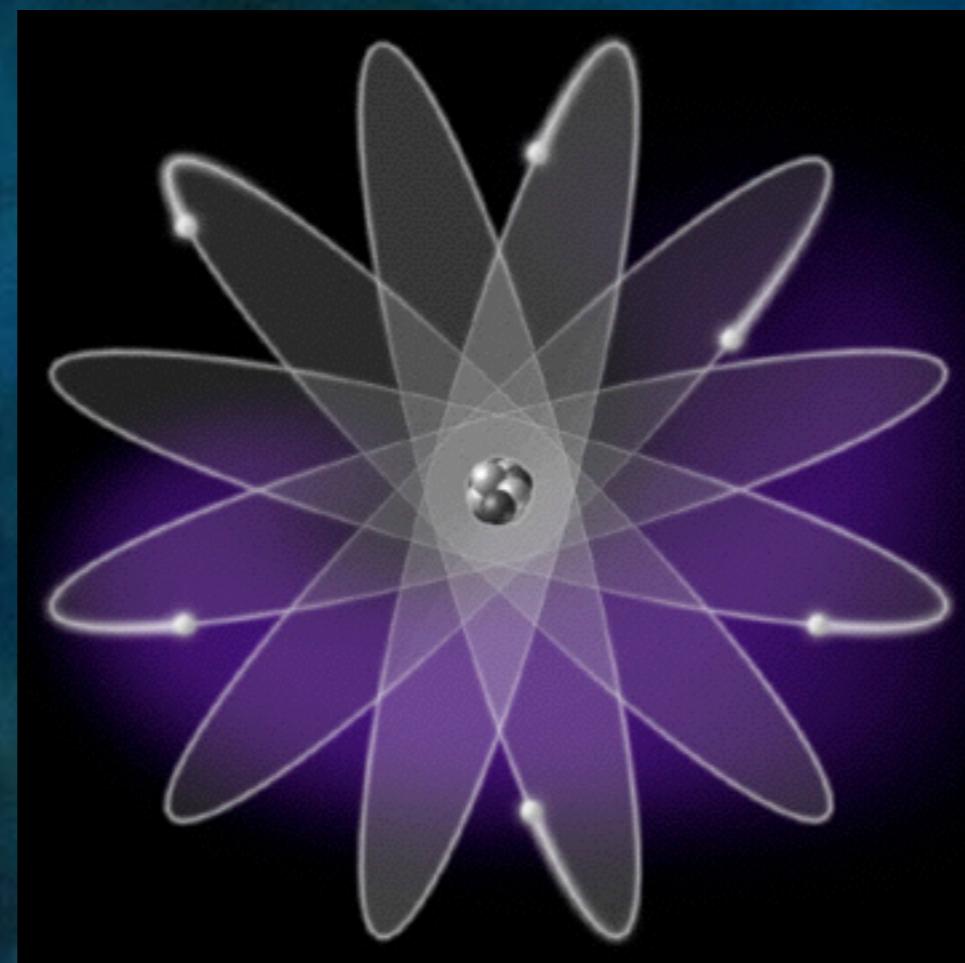


Orders of Magnitude



| 10⁻⁵

Orders of Magnitude



10^{-10}

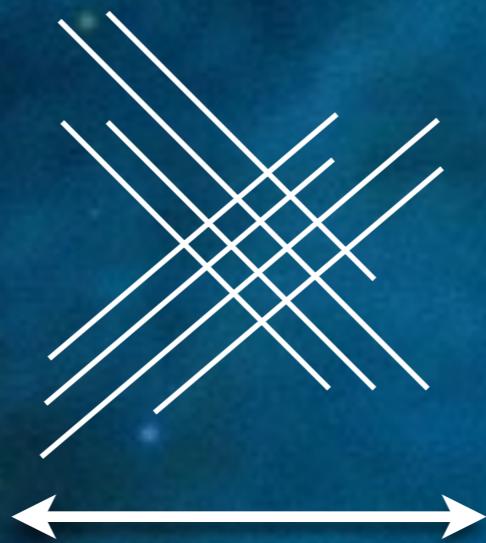
Orders of Magnitude

10^{-15}



Orders of Magnitude

10^{-34}



Plank's Constant
 $h = 6.63 \times 10^{-34}$

Temporal Scales

13.3-13.9 Ga

0

THE BIG BANG

INFLATION

COSMIC MICROWAVE
BACKGROUND
400,000 YEARS AFTER
BIG BANG

GALAXY EVOLUTION
CONTINUES...

FIRST STARS
400,000,000 YEARS
AFTER BIG BANG

THE DARK AGES

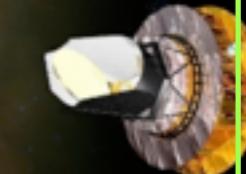
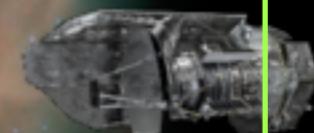
FIRST GALAXIES
1000,000,000 YEARS
AFTER BIG BANG

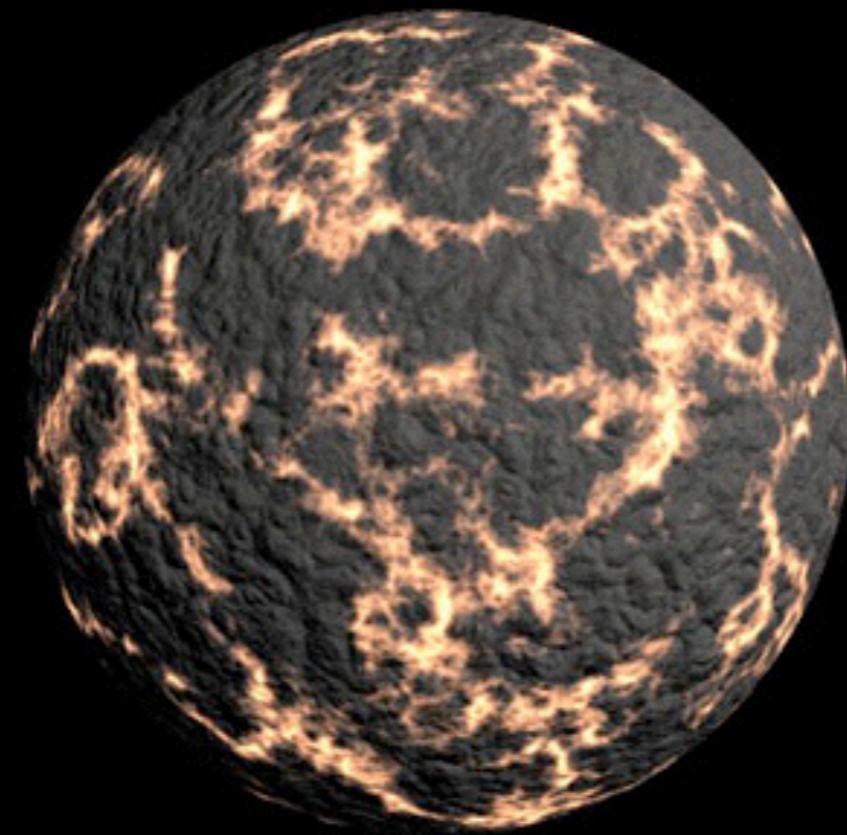
FORMATION OF
THE SOLAR SYSTEM
8,700,000,000 YEARS
AFTER BIG BANG

DARK ENERGY?

life

NOW
13,700,000,000 YEARS
AFTER BIG BANG





4.56 gyr



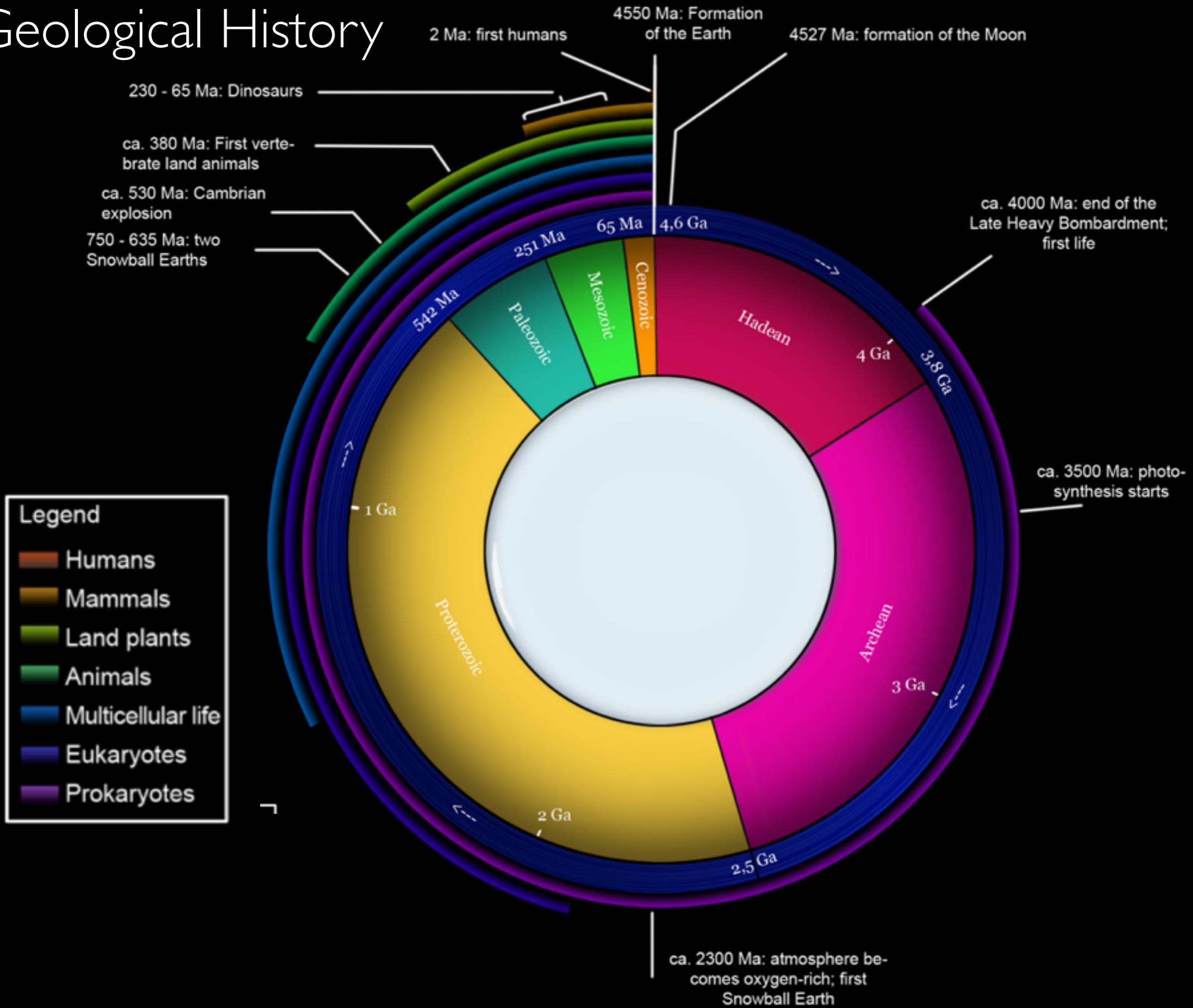
4.527 gyr



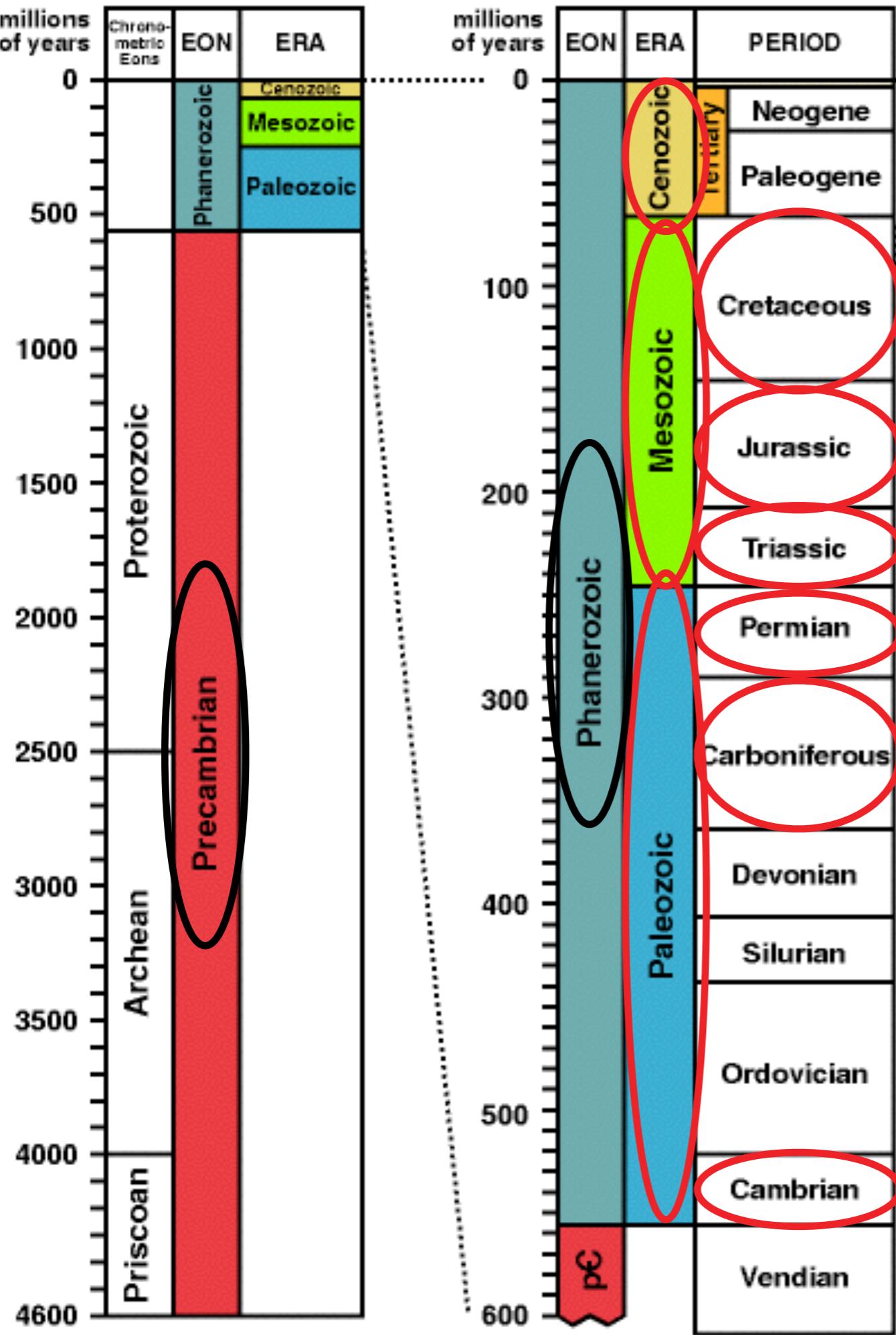
© Mark A. Garlick
space-art.co.uk

$> 4.527 \text{ gyr}$

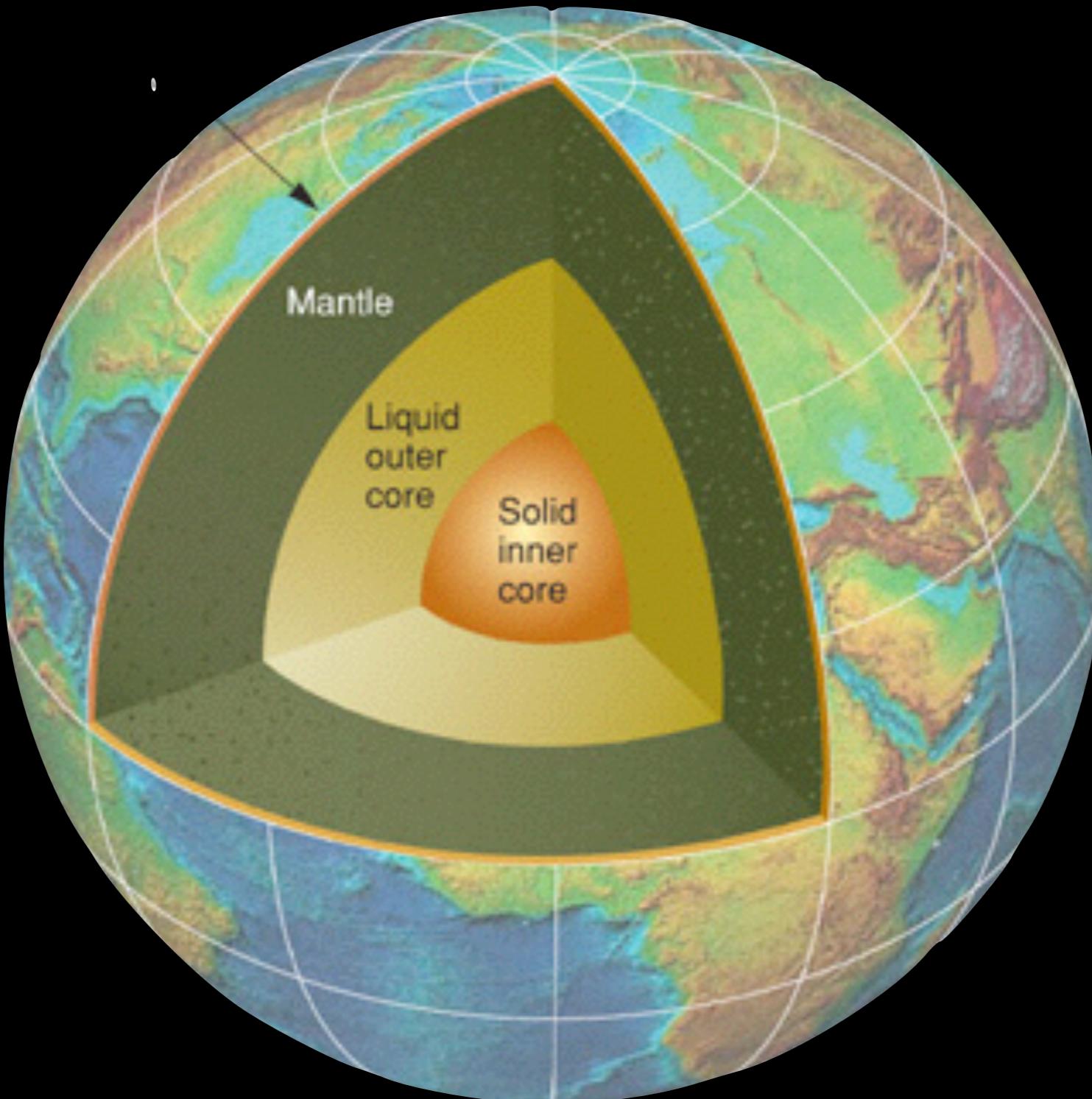
Geological History



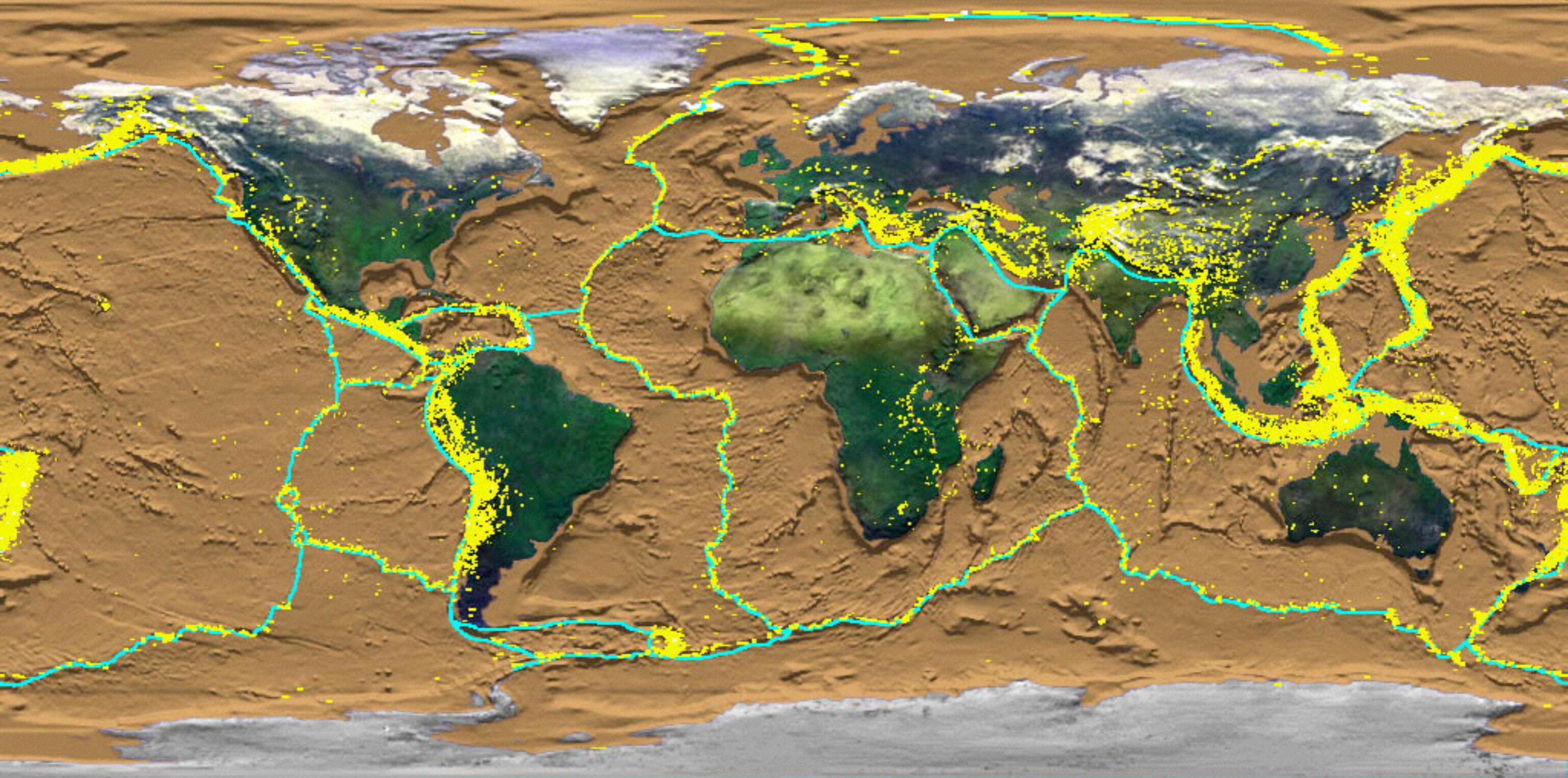
Be Familiar Know



- Precambrian Eon
- Phanerozoic Eon
- Paleozoic
 - Cambrian (542:488 Ma)
 - Carboniferous (360:299 Ma)
 - Permian (299:251 Ma)
- Mesozoic
 - Triassic (251:200 Ma)
 - Jurassic (200:146 Ma)
 - Cretaceous (146:65.5)
- Cenozoic (65.5:now)

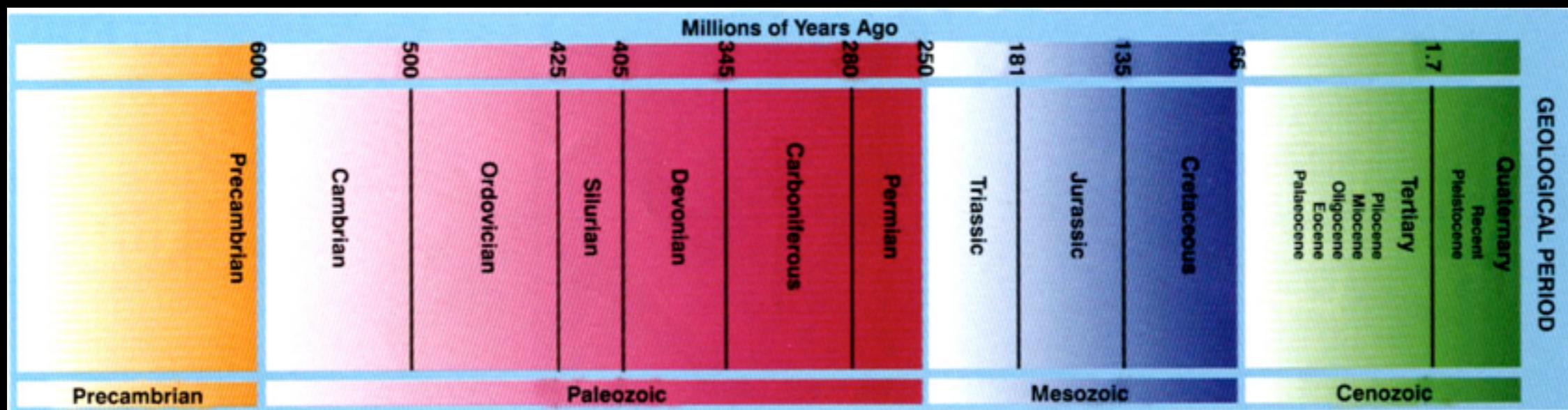
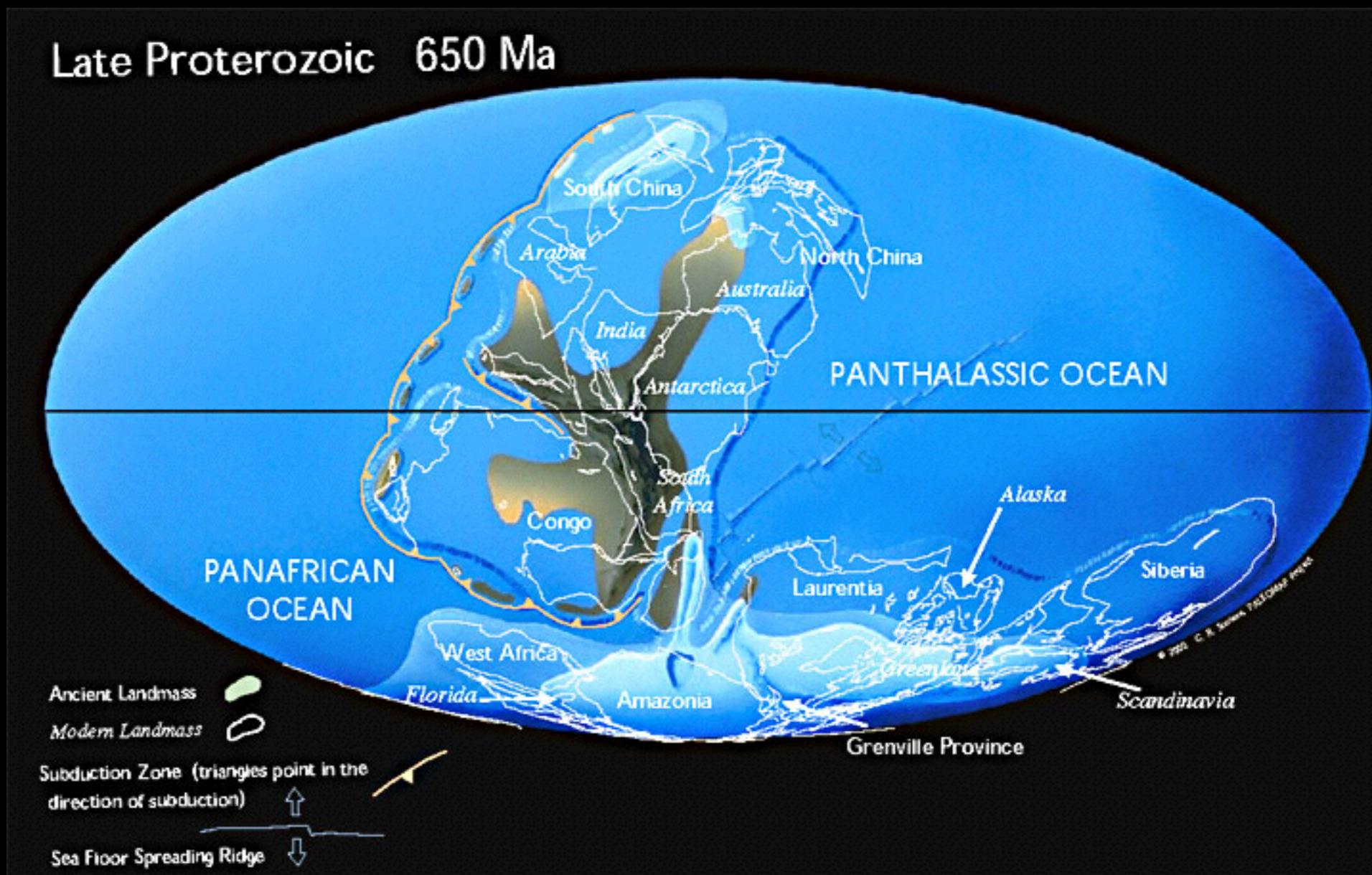


Continental Plates

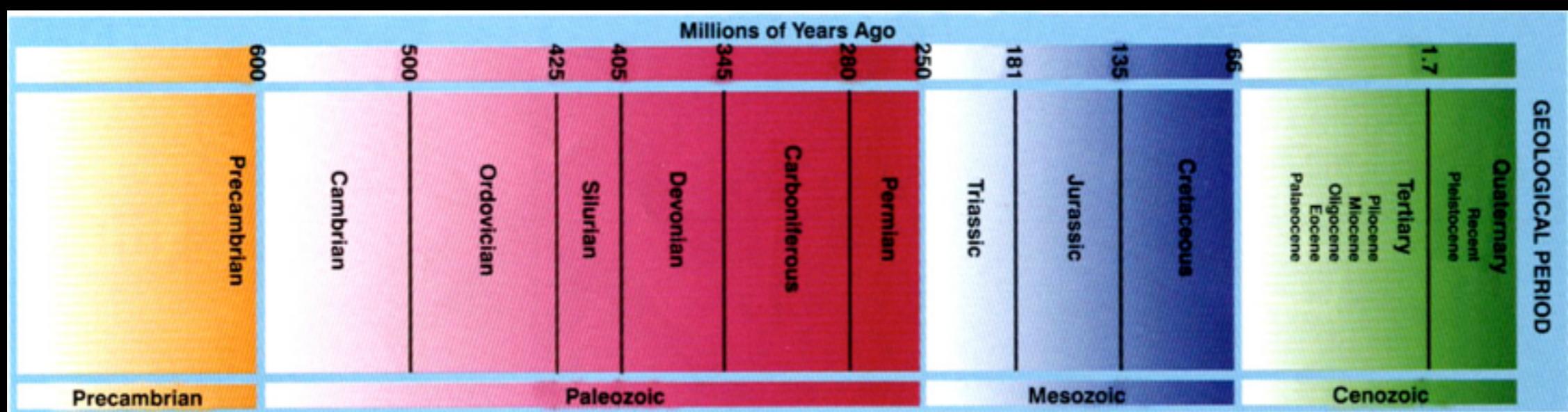
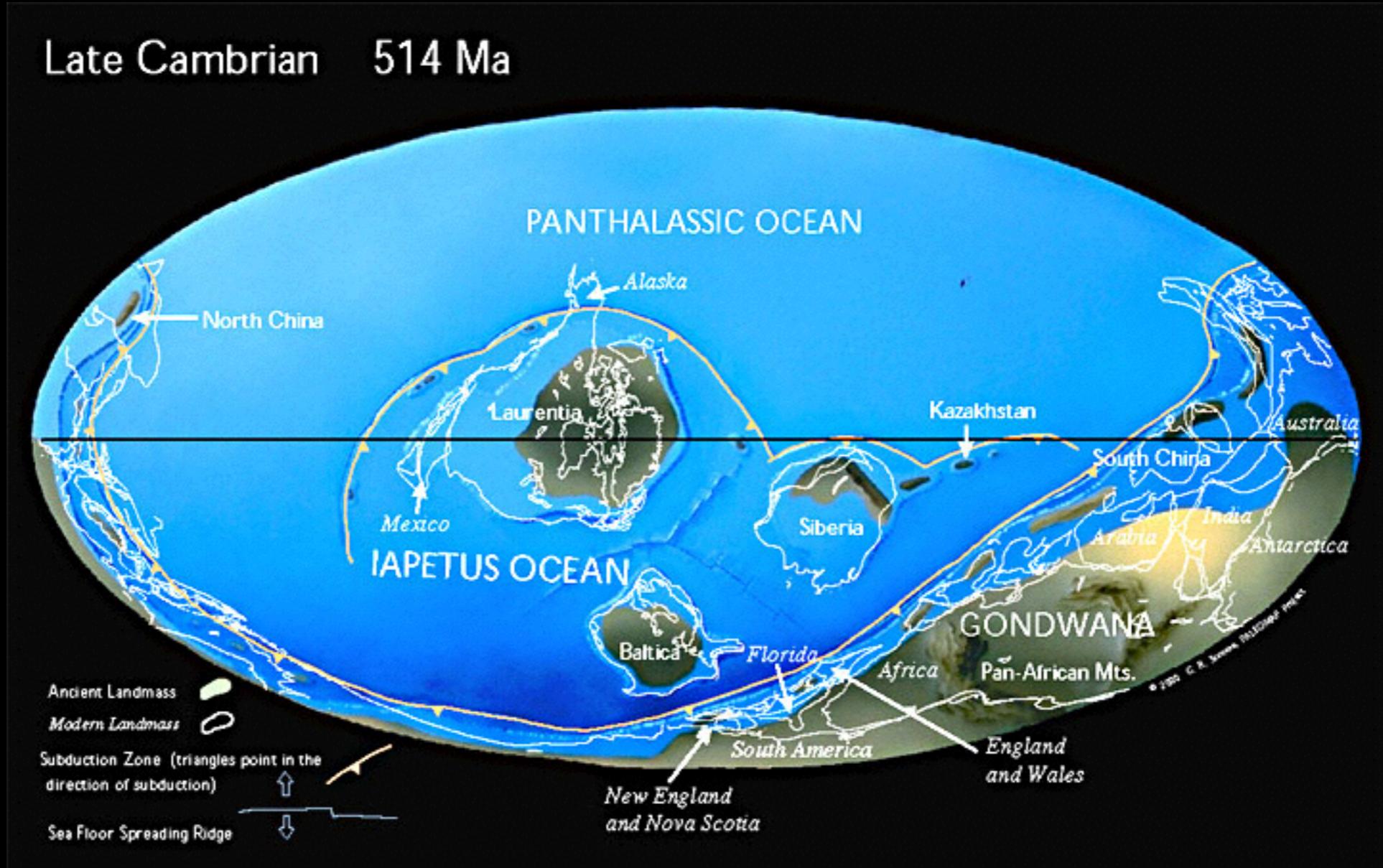


- = earthquakes

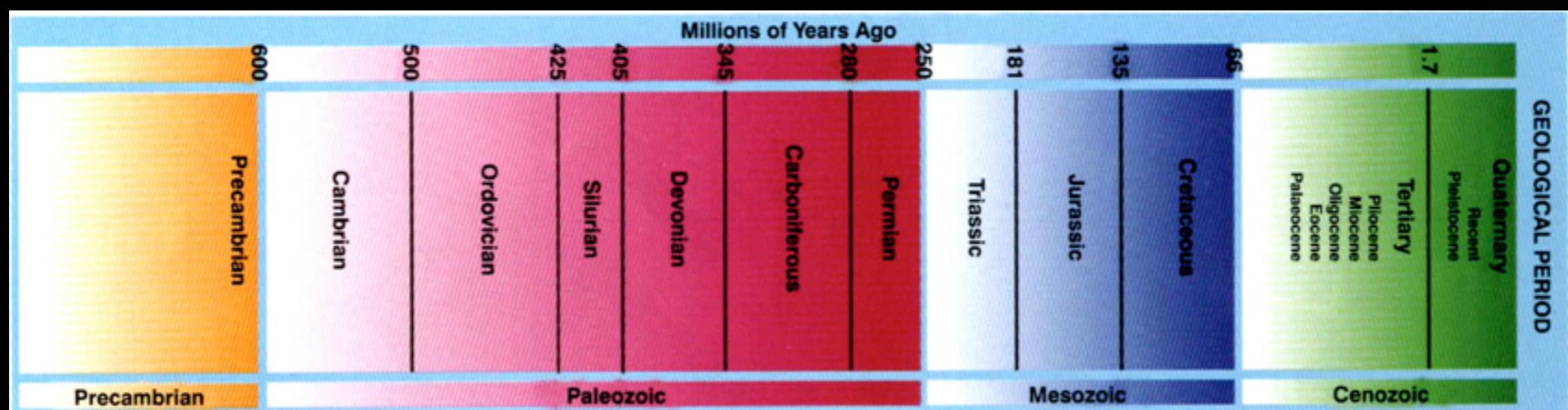
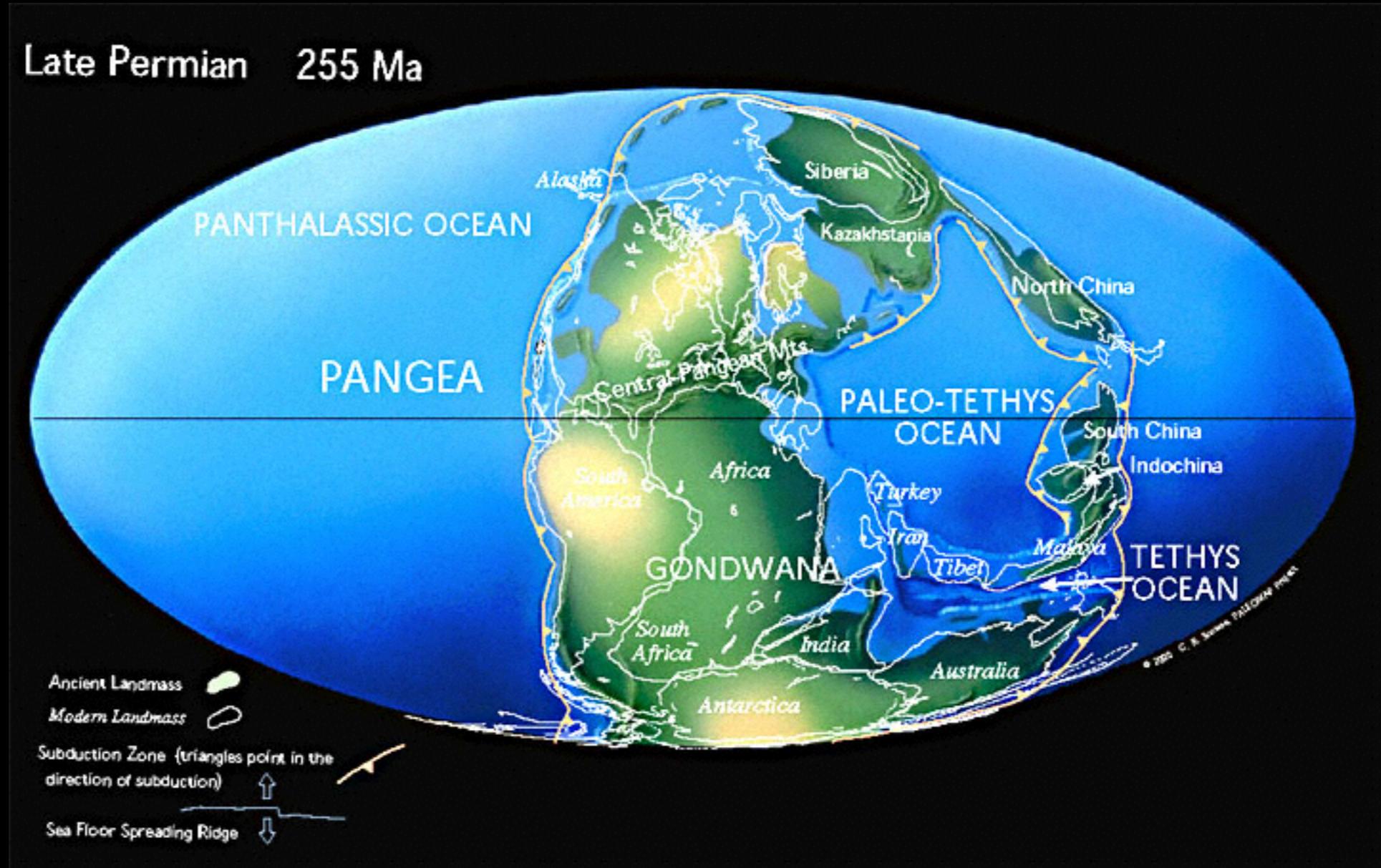
Late Proterozoic 650 Ma



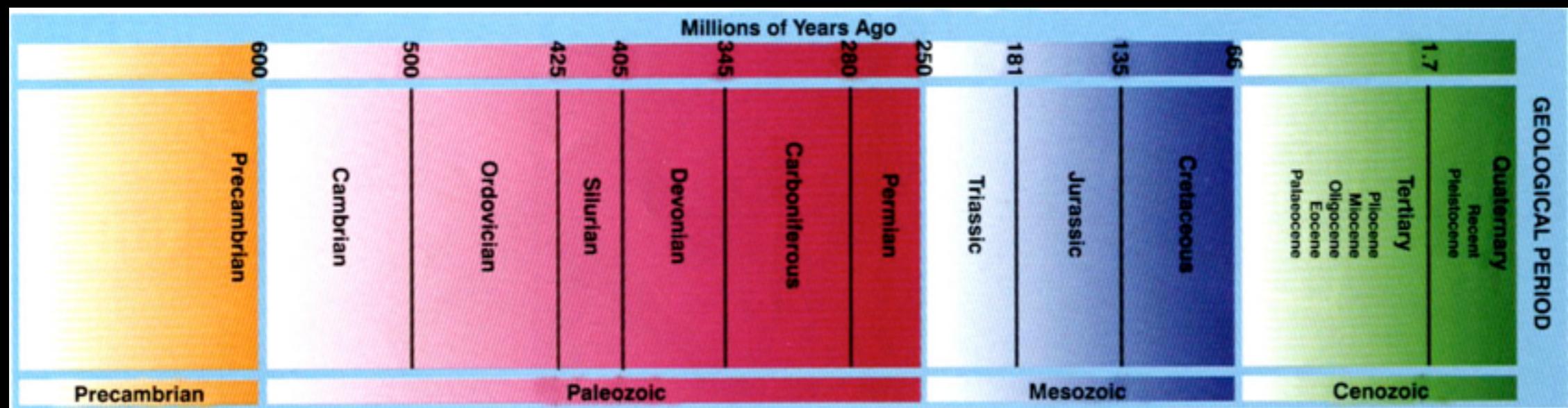
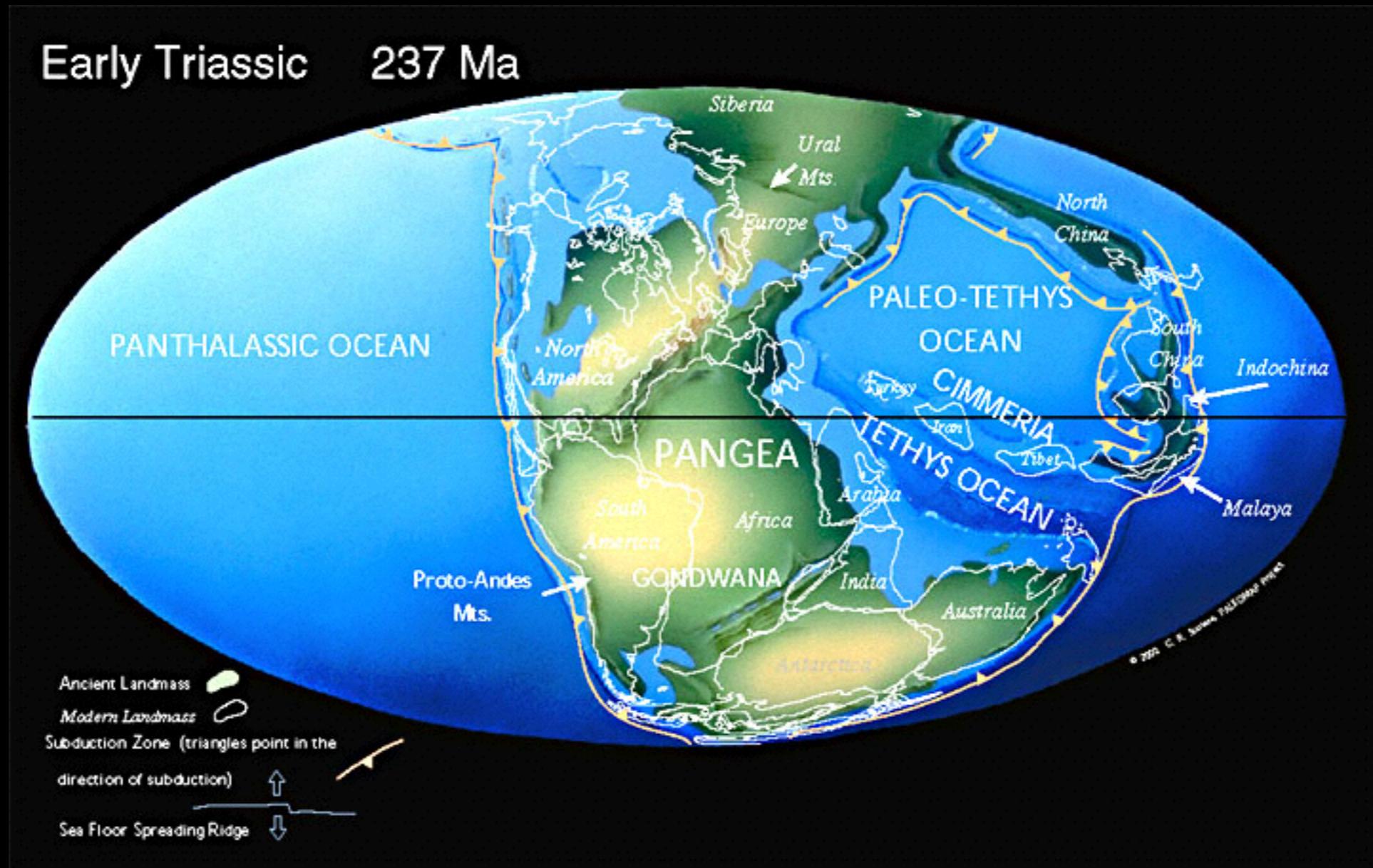
Late Cambrian 514 Ma



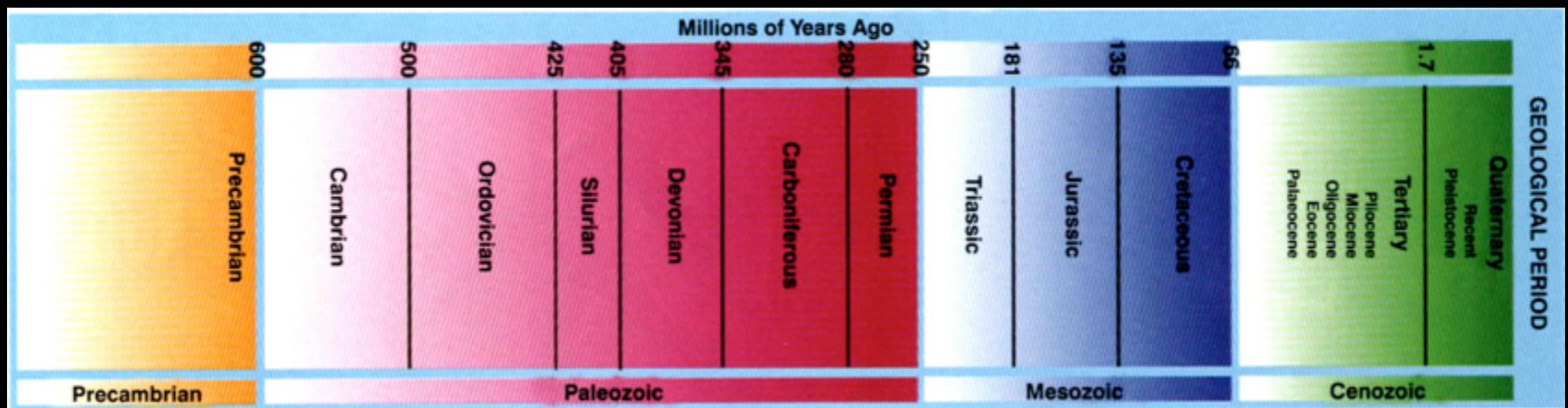
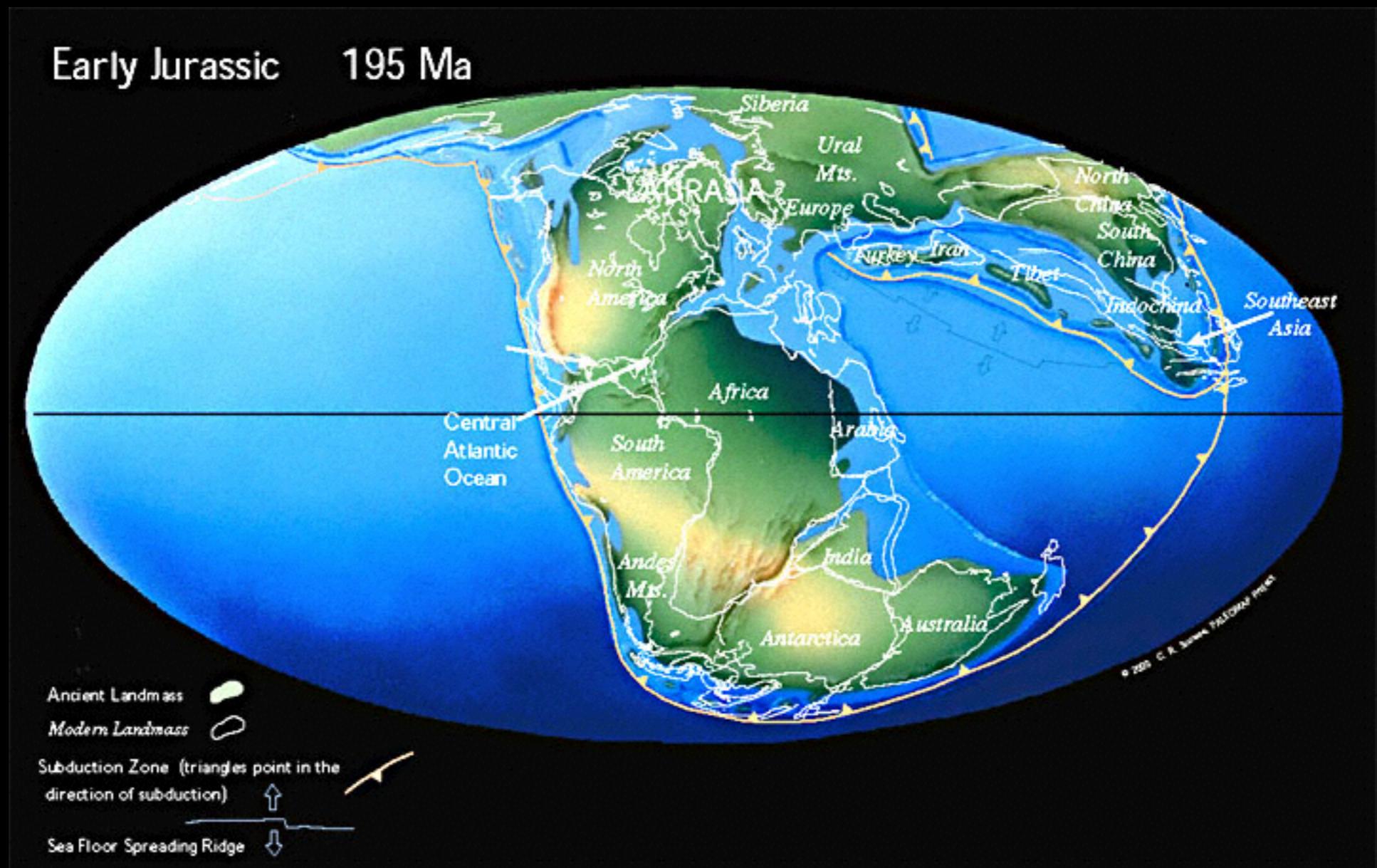
Late Permian 255 Ma

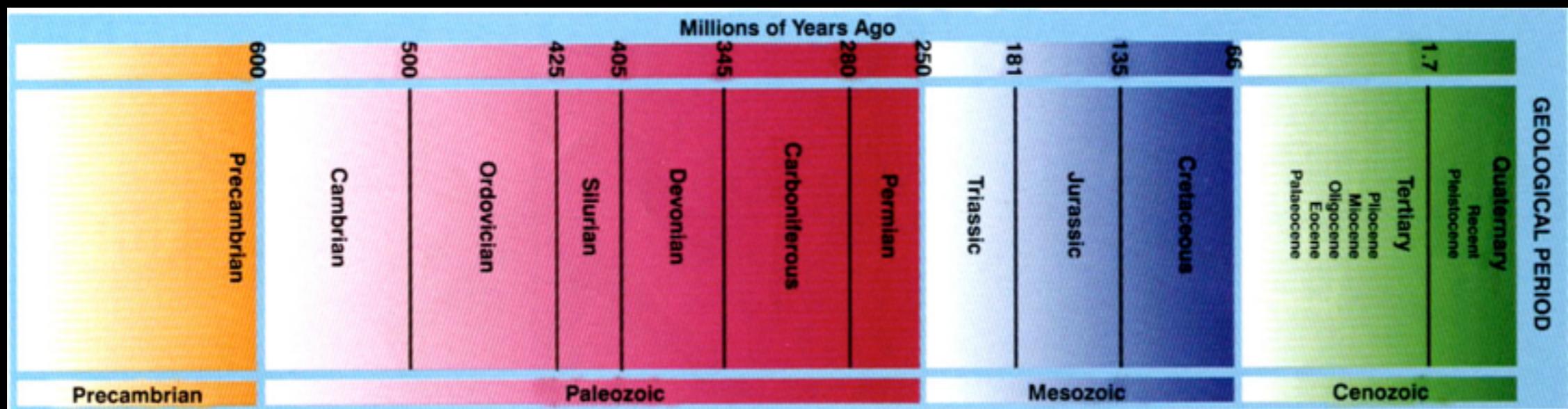
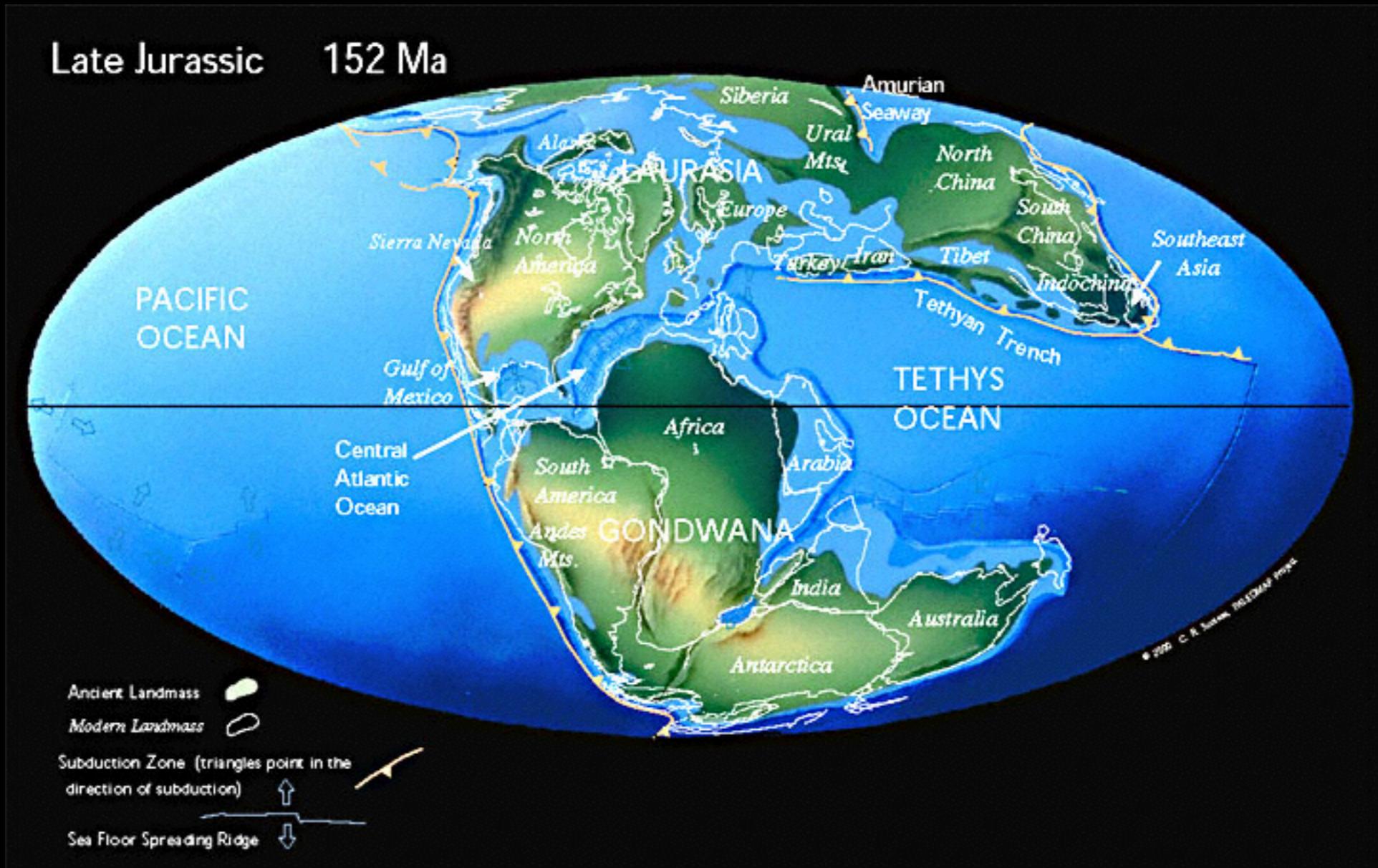


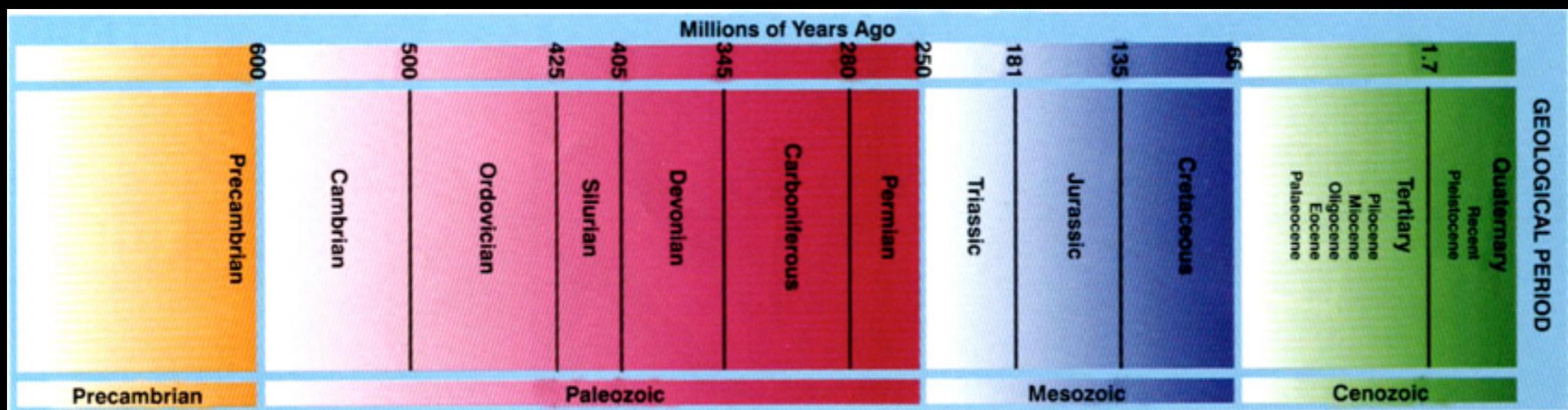
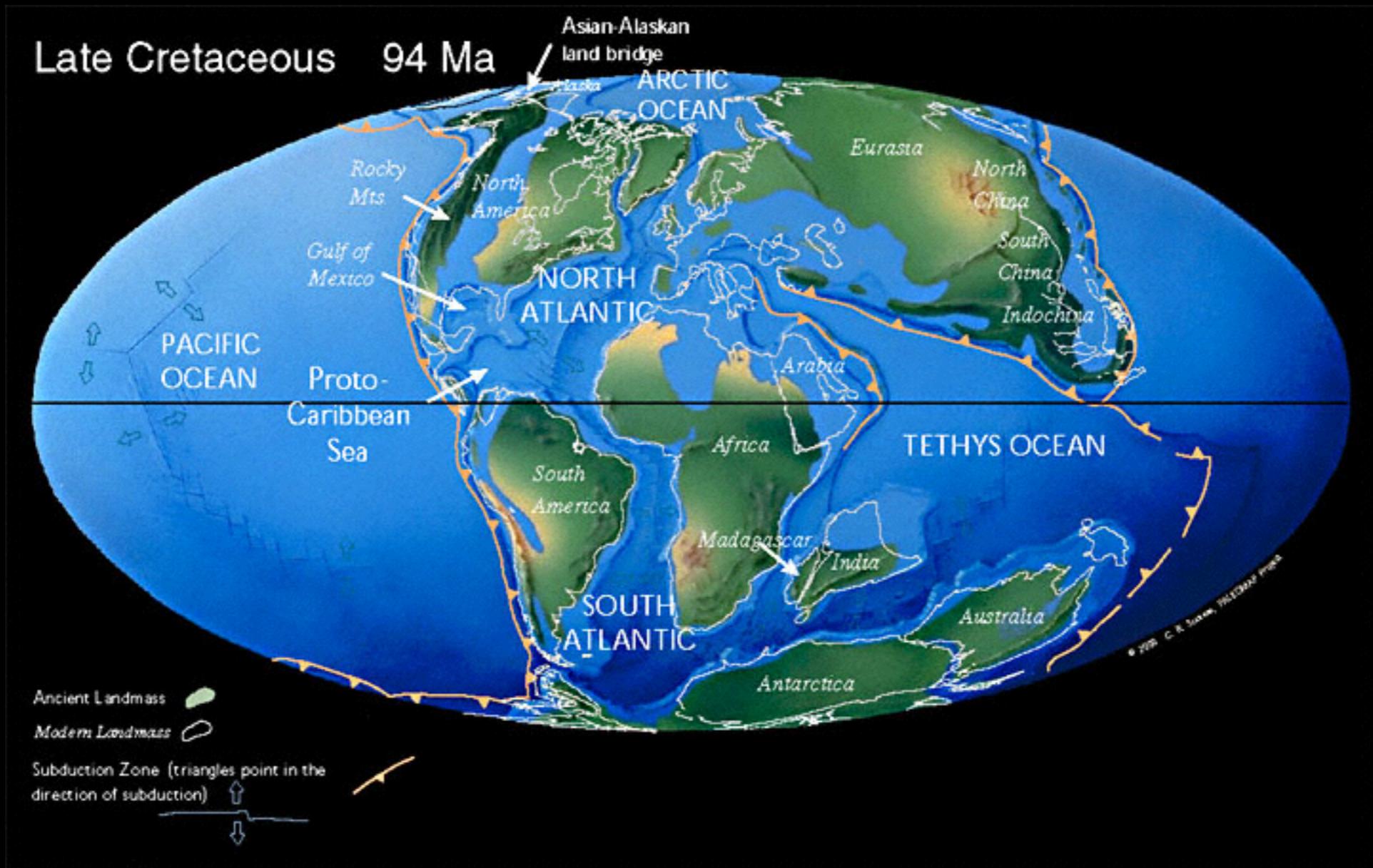
Early Triassic 237 Ma

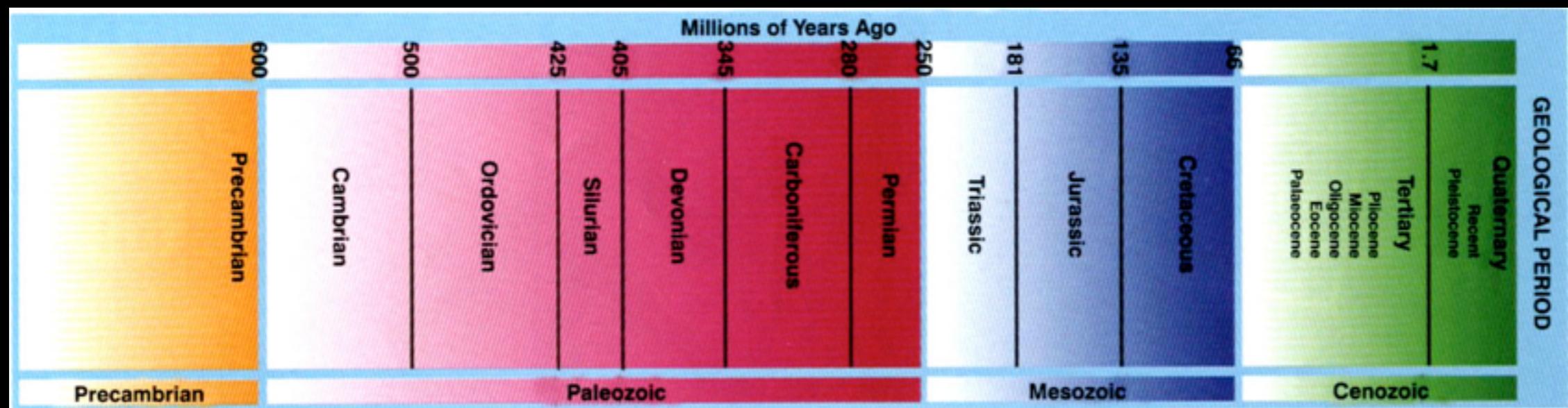
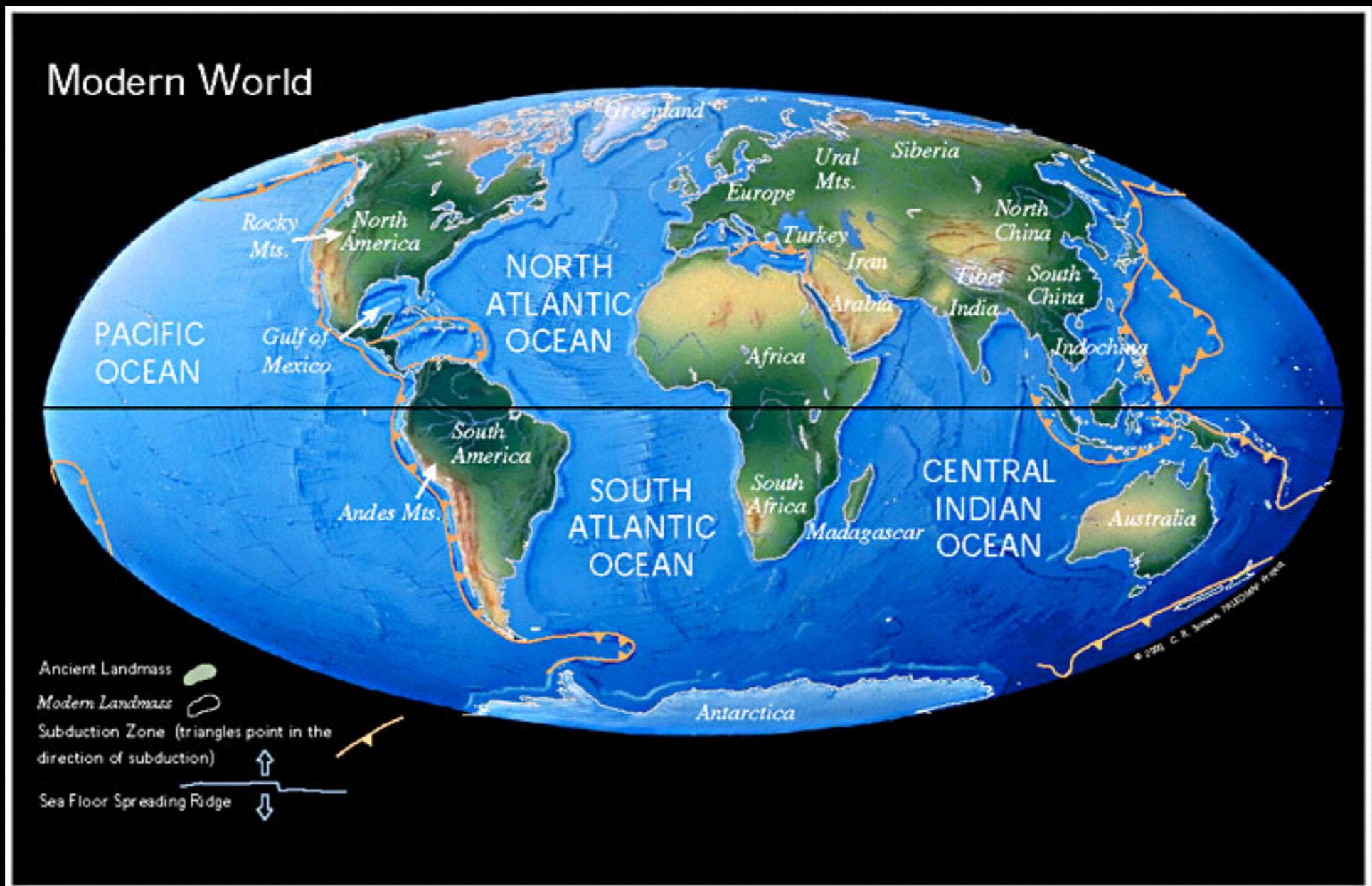


Early Jurassic 195 Ma

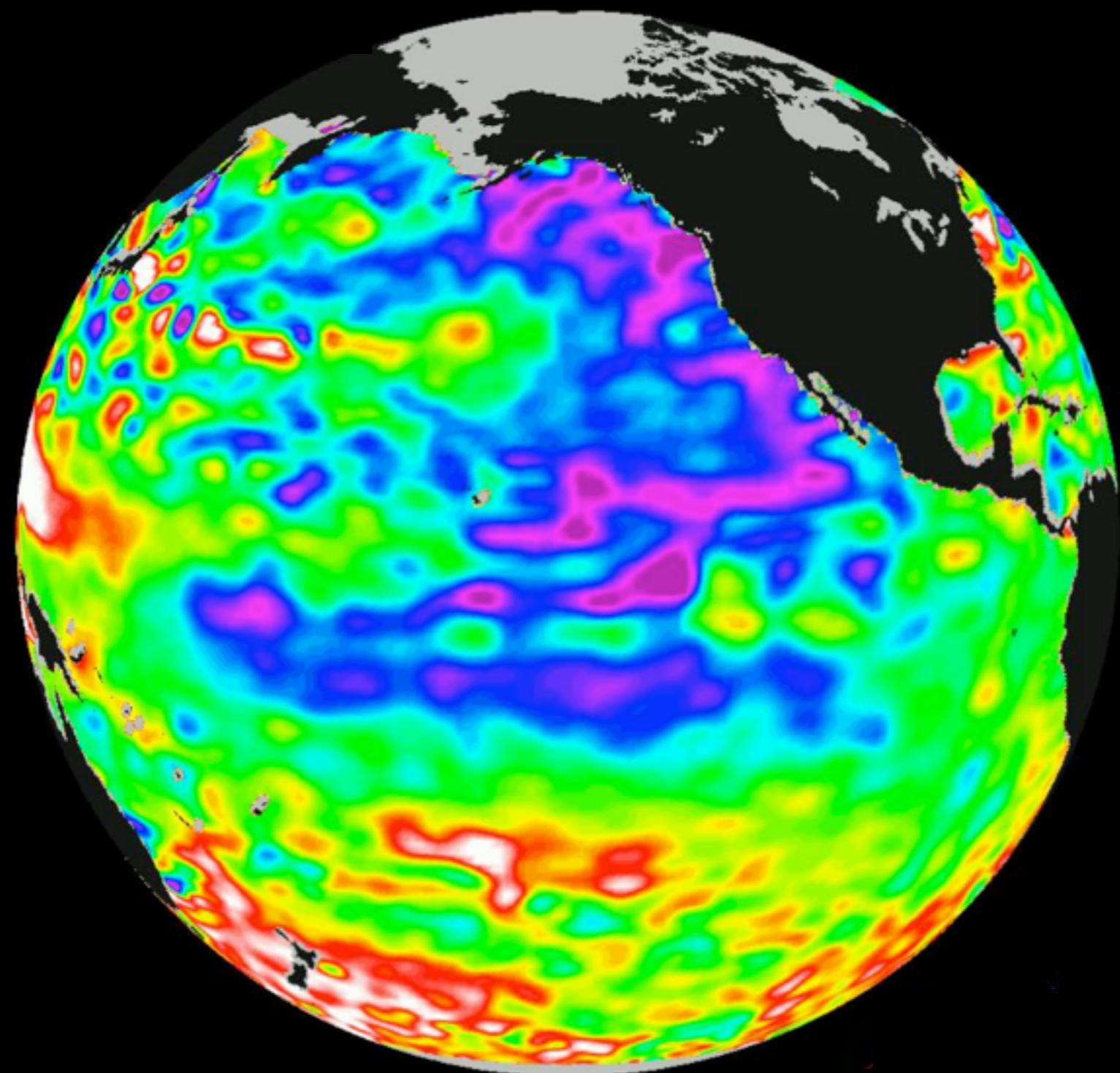








Why do we care?





“Being a paleontologist is like being a coroner except that all the witnesses are dead and all the evidence has been left out in the rain for 65 million years.”

Mike Brett-Surman, 1994



Herrerasaurus



Fossils and Preservation:



Many meanings... types of fossils

Trace Fossils
Poo (Coprolites)
Gastroliths
Trackways



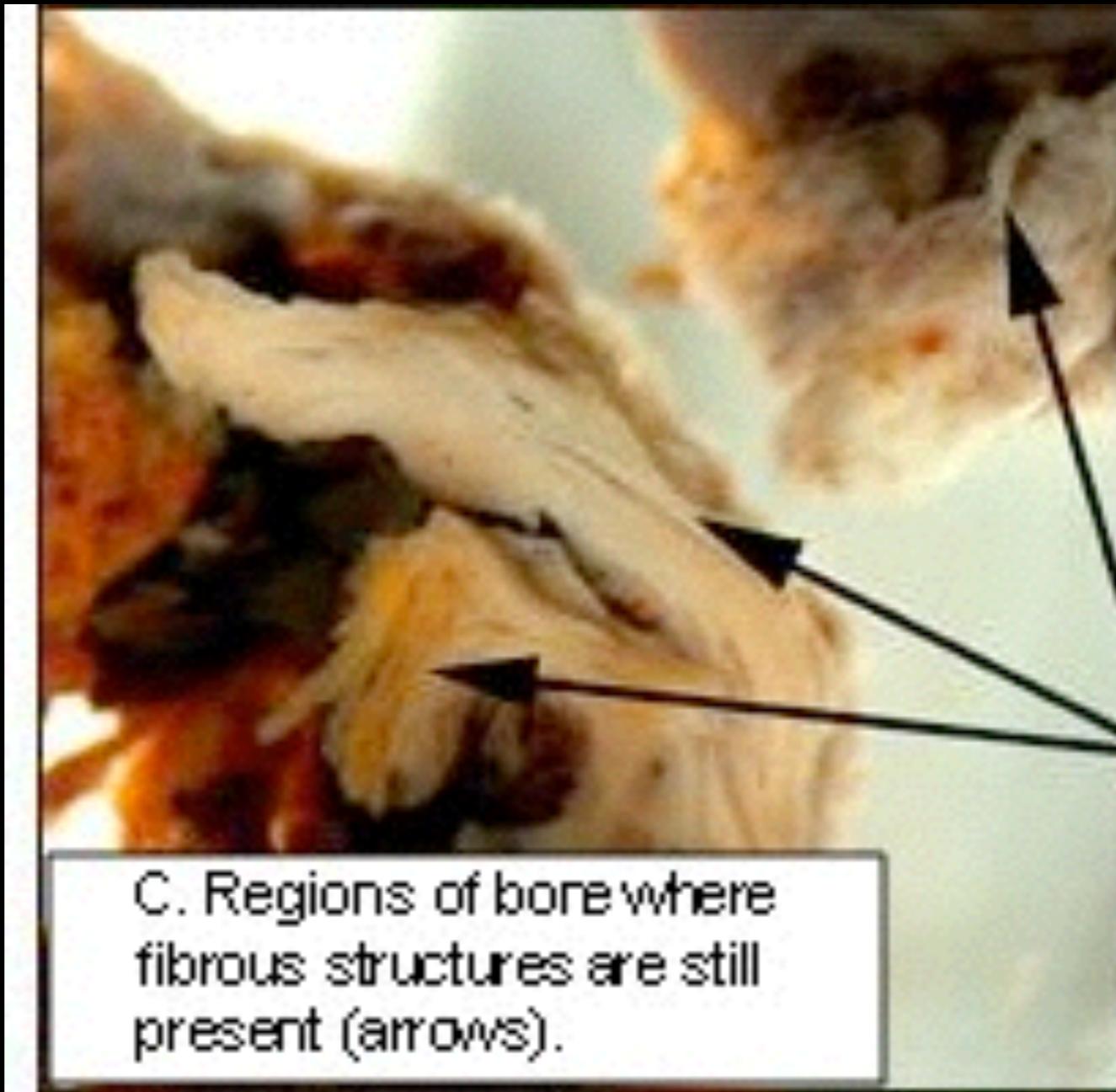
Soft Parts:
Impressions
Amber
Protein???



Hadrosaur skin



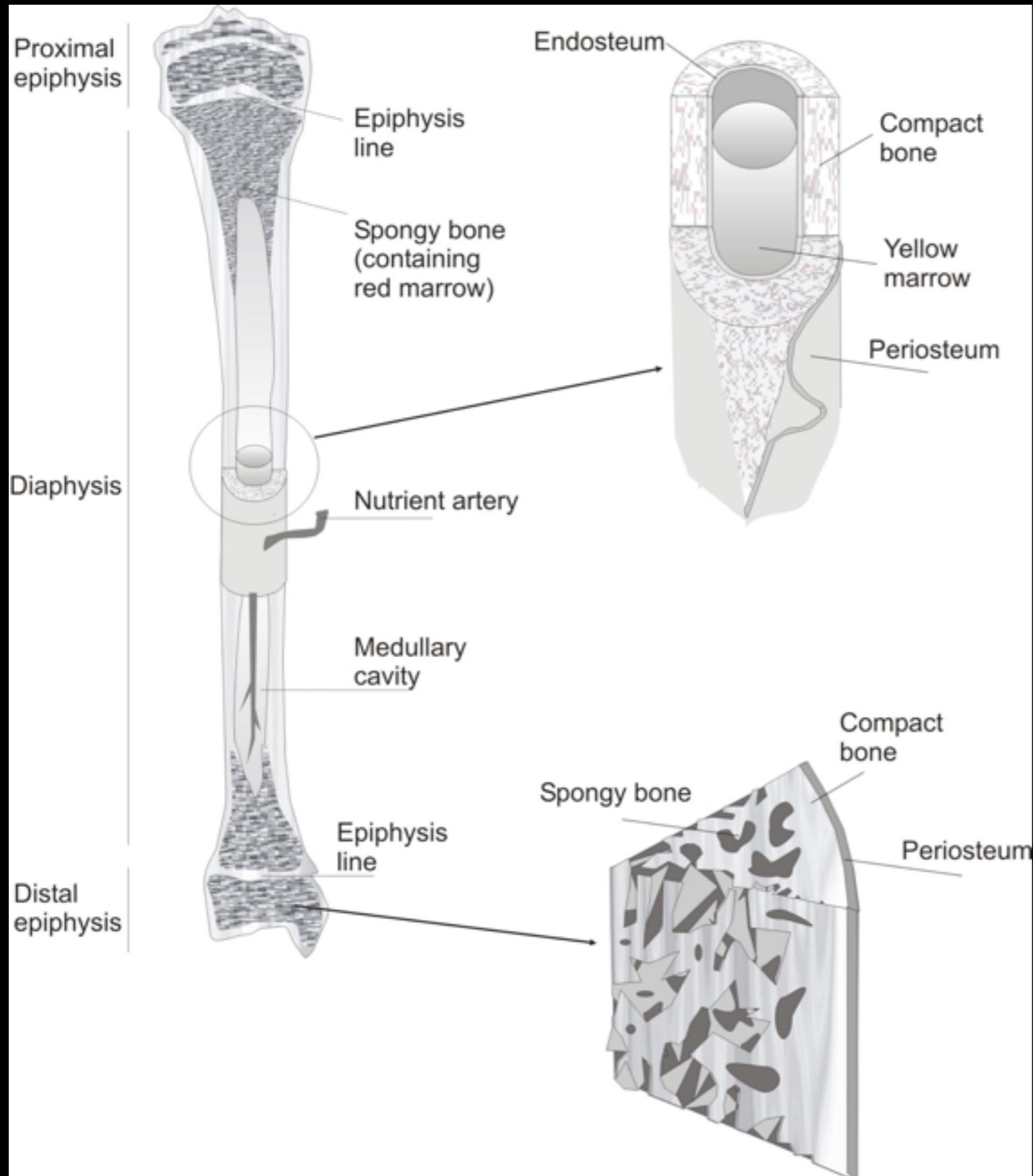
T. rex collagen?



68 Ma

Hard Parts: Living vs. Fossilized





Living Bone

Bone Matrix

- Organic
- Collagen**
- Nonorganic
- Hydroxyapatite

Structure of Bone

Diagram illustrating the structure of skeletal long bones comprising solid outer cortical (compact) bone and inner trabecular (spongy) bone in which the bone marrow is housed. Redrawn and adapted from Baron, 1996. Copyright BTR©

Fossil Bone

$\text{Ca}_{10}(\text{PO}_4)_6(\text{F}, \text{OH}, \text{Cl})_2$



Apatite Mineral Francolite
No longer biological- it's a rock.

Unaltered remains

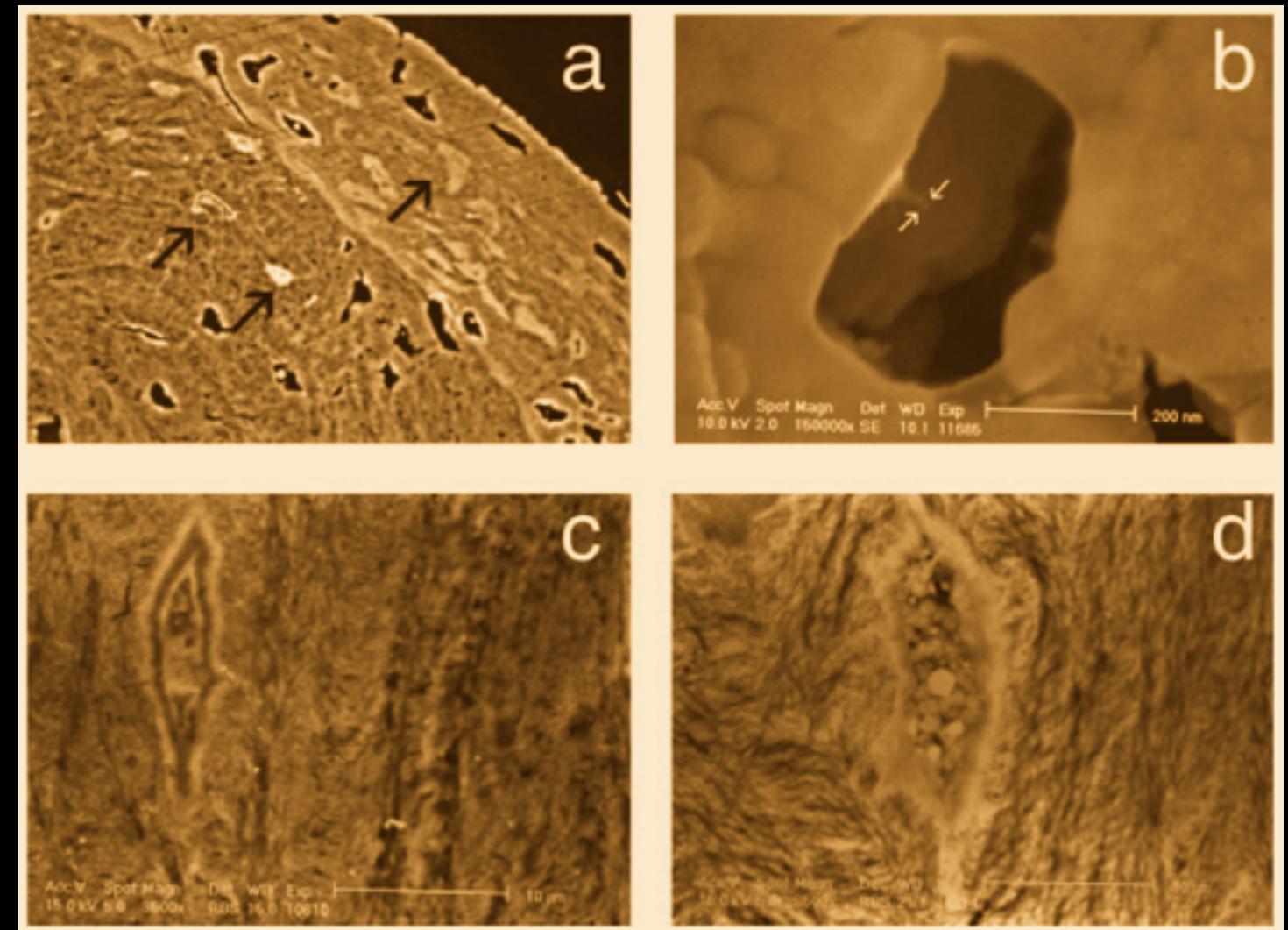


Bogs



- Acidic peat bogs, tar pits
- Pickling

Fossilization: A fine scale



Even osteocytes (bone cells) are preserved

Routes to Fossilization



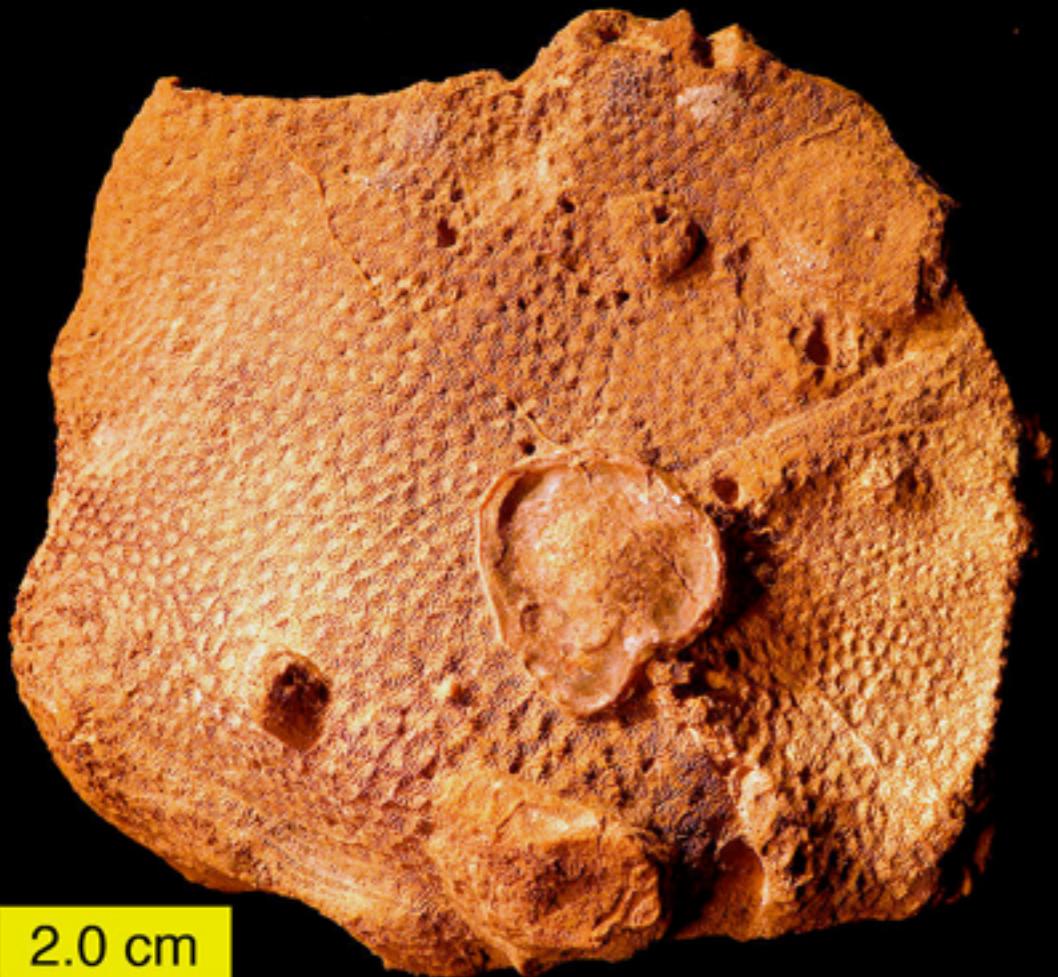
Permineralization

Trilobite

- Minerals become deposited within organic remains;
- Crystals form within cell walls
- This type of preservation conserves cell structure



Routes to Fossilization



2.0 cm

Fossil Coral: Jurassic
Mineralization and Recrystallization
(vs. Replacement)

- Shell, bone, tissue replaced with another mineral into a crystal

Routes to Fossilization



Structure is typically compressed

Pressure, heat force out gasses, liquids

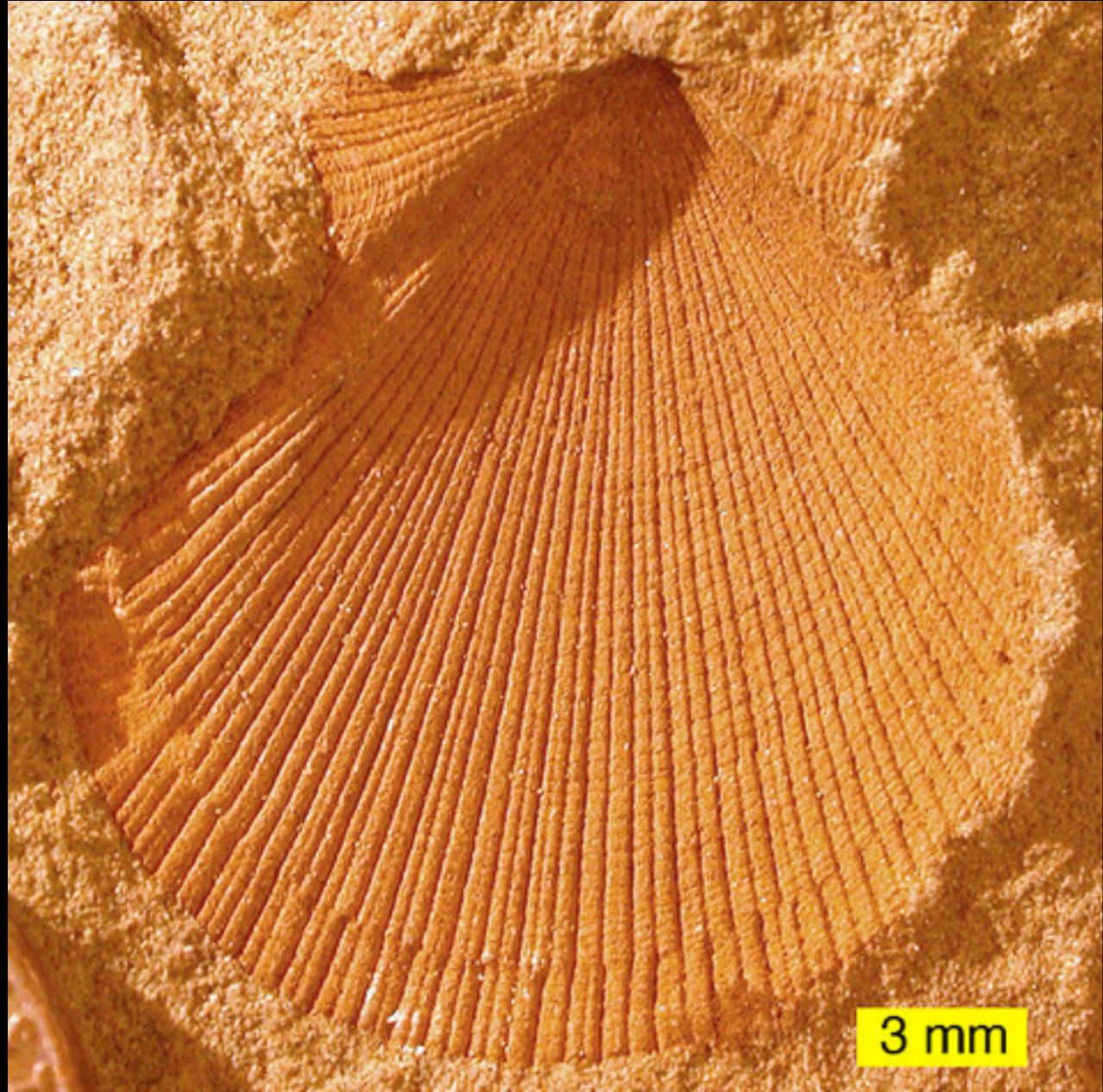
Leaves behind a carbon film

!! Soft parts !!

Carbonization



Routes to Fossilization

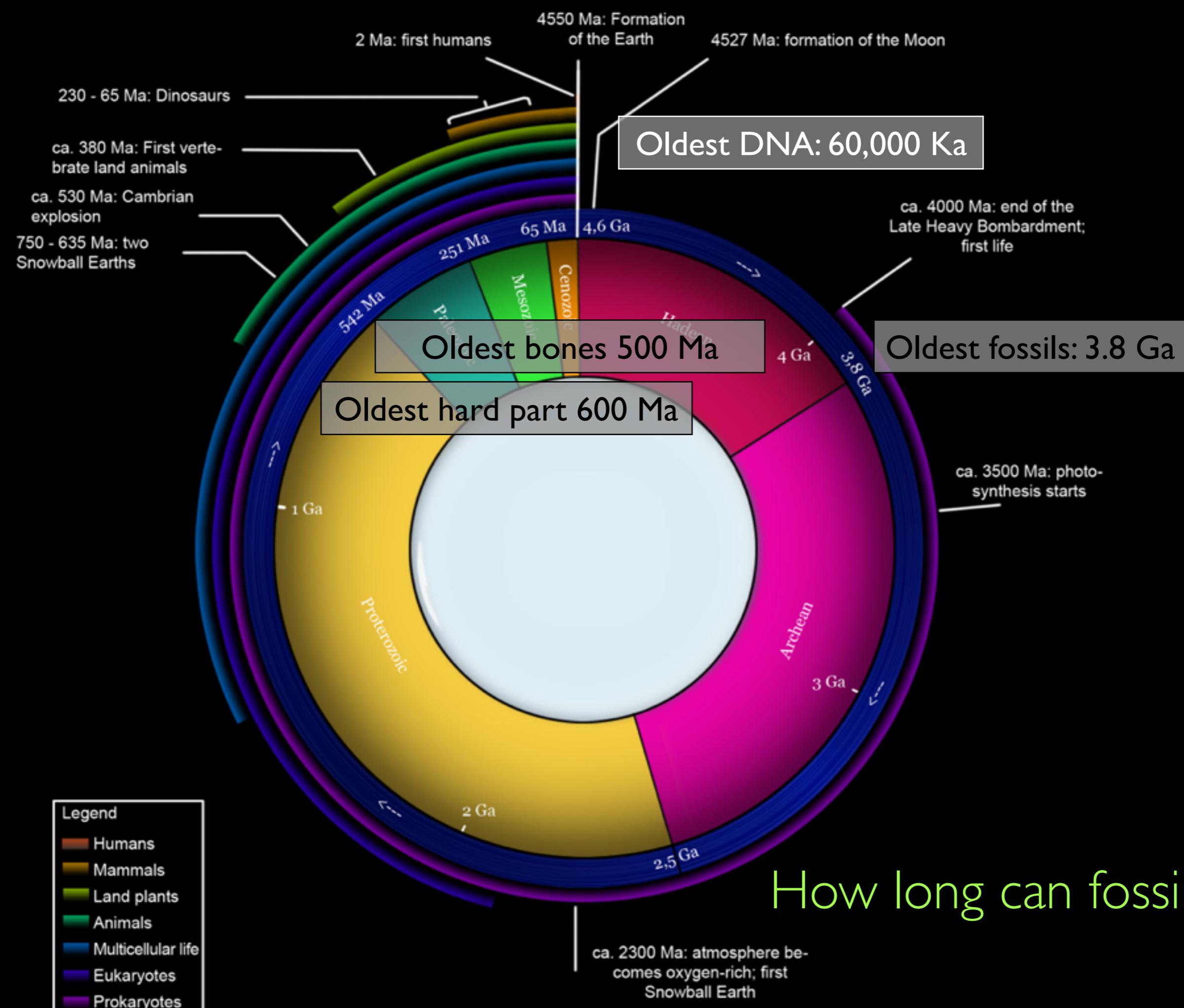


Molds, casts

- Molds
- Casts
- Little or no original material



T. rex brain cast



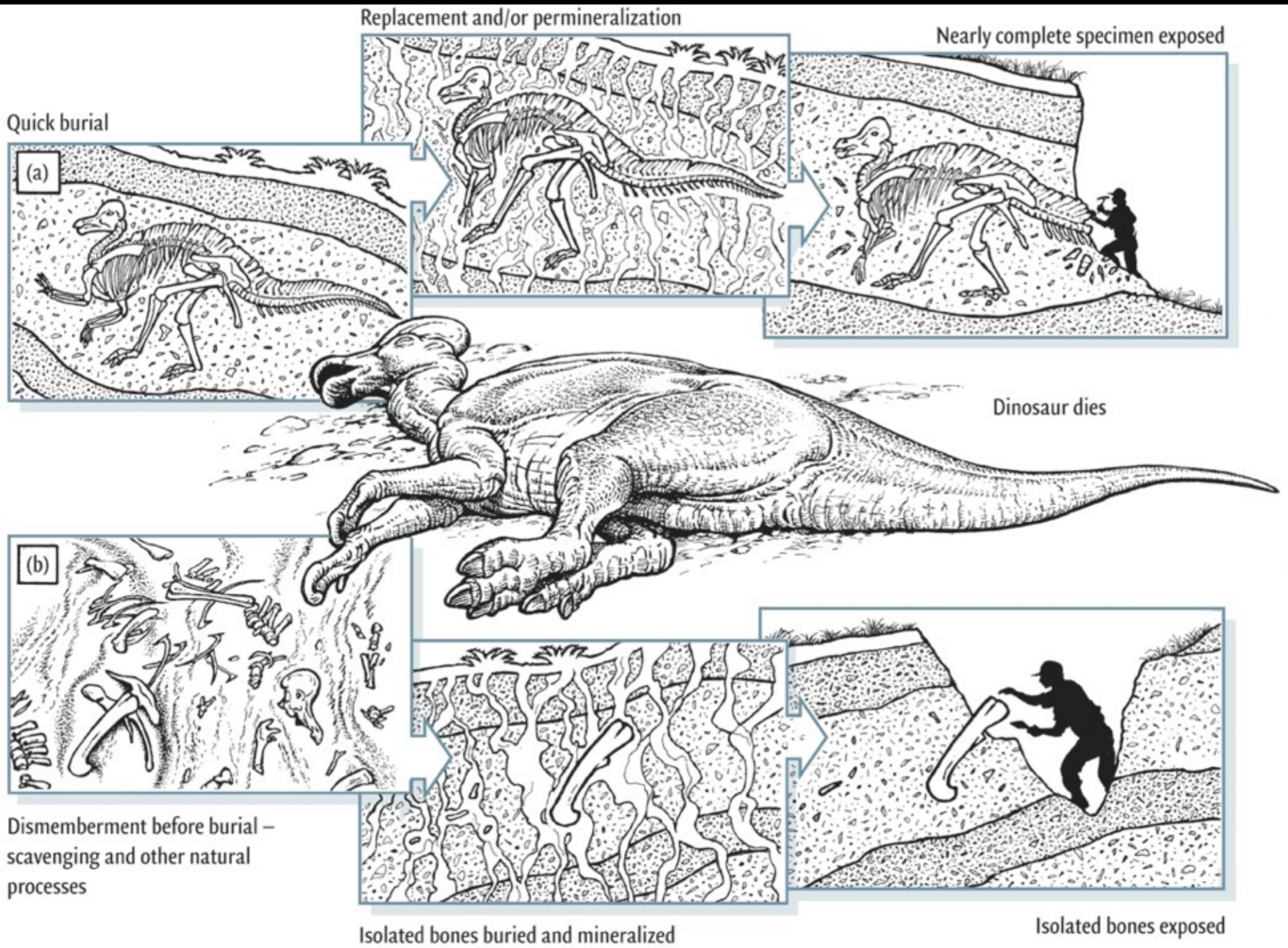
Depositional Environments

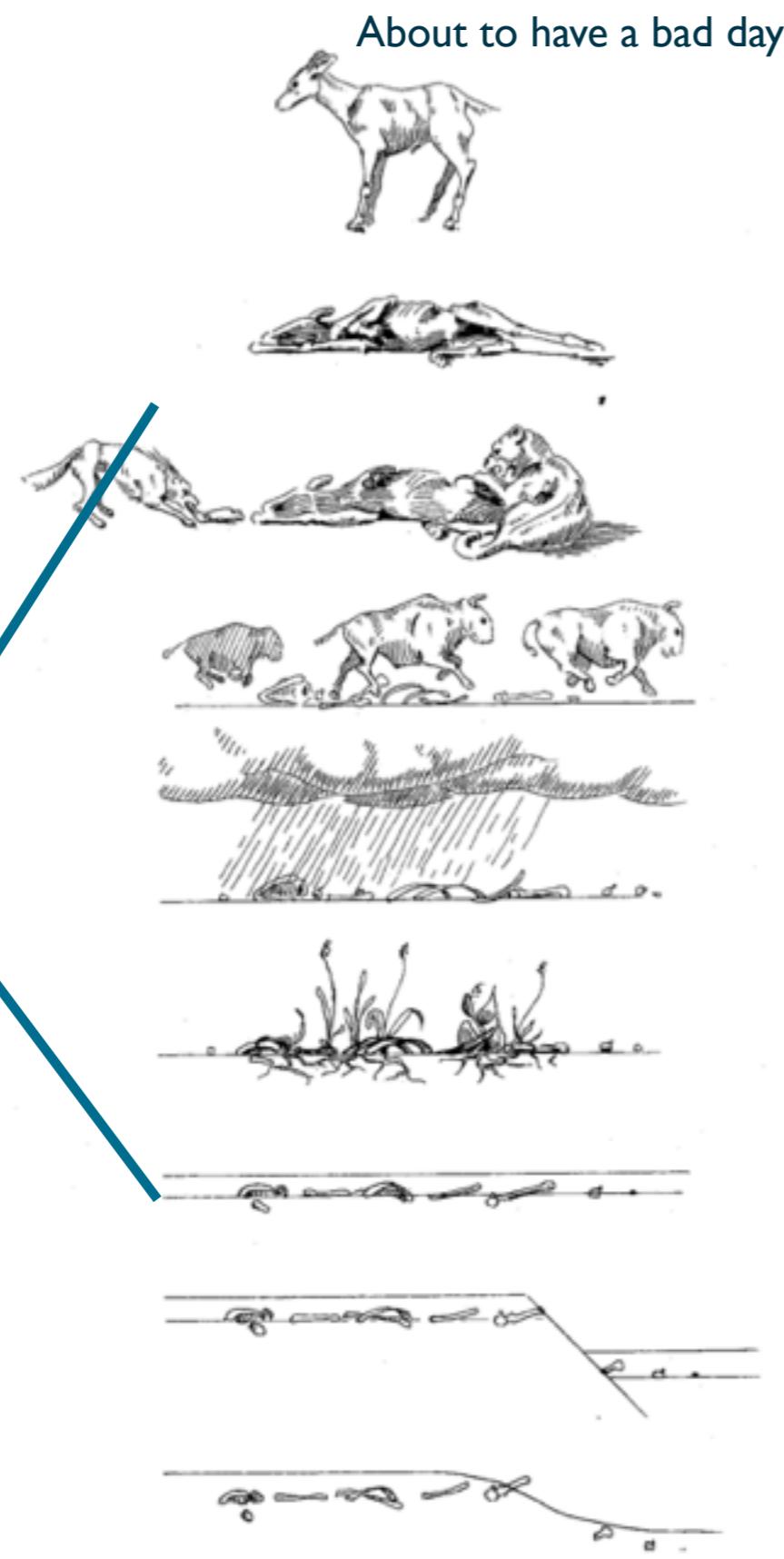
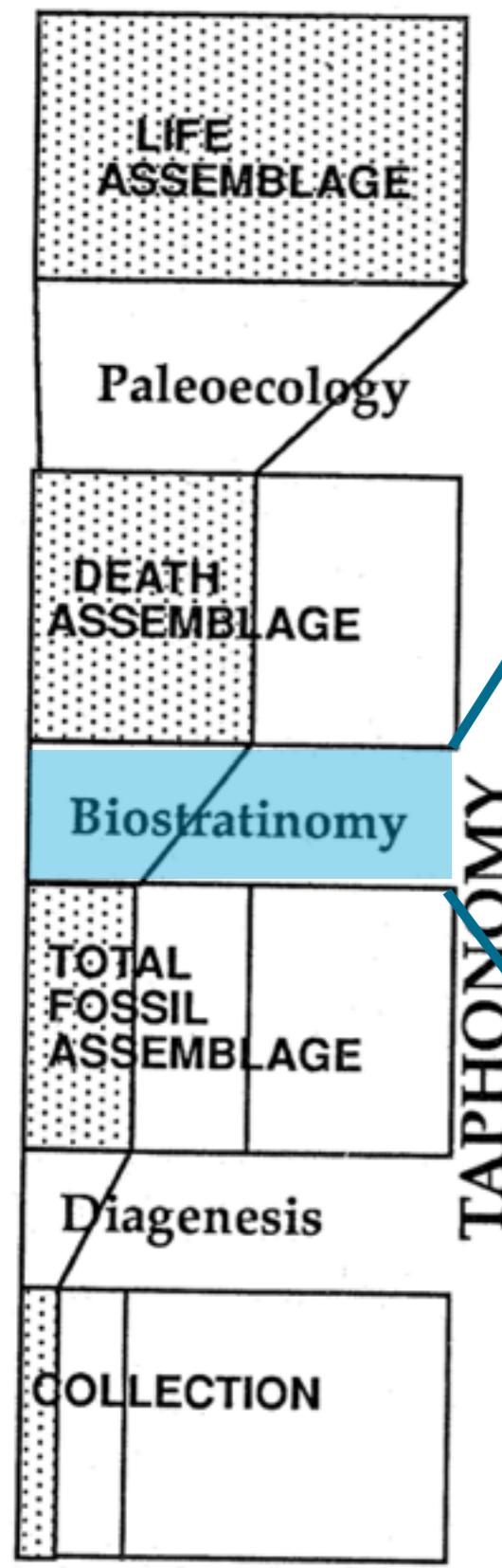


&
Taphonomy

Taphonomy: study of the transition from the biosphere to the lithosphere







Key: Rapid Burial!

Remains preserved at the death site (autochthonous)



Remains transported (allochthonous)



Fluvial (Rivers)





Deserts (rare)

Niger



Shallow Marine (rare)



All dinosaurs lived on land. Why do we care about coastal fossil sites, etc.?

