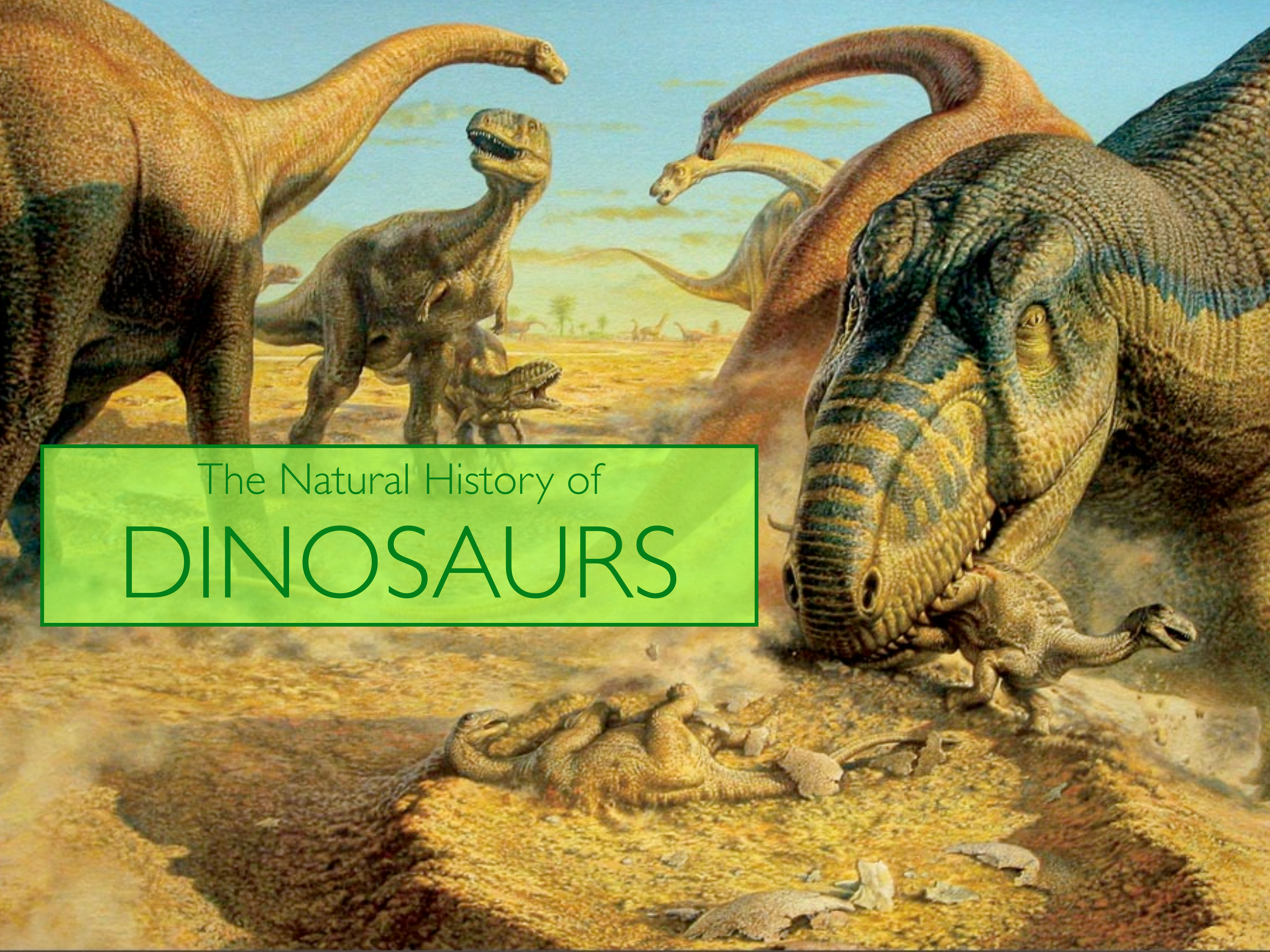
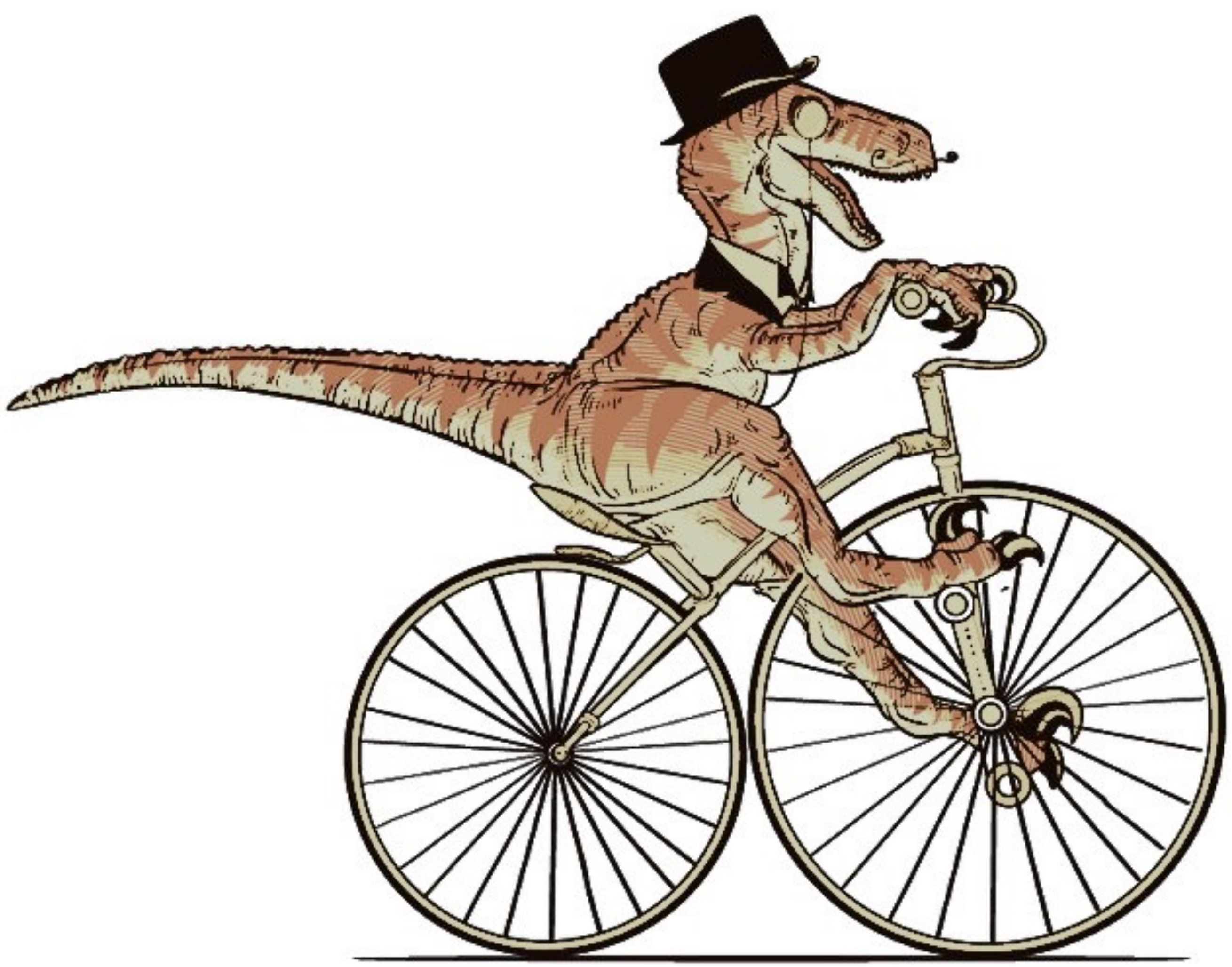

The Natural History of
DINOSAURS

Two websites:

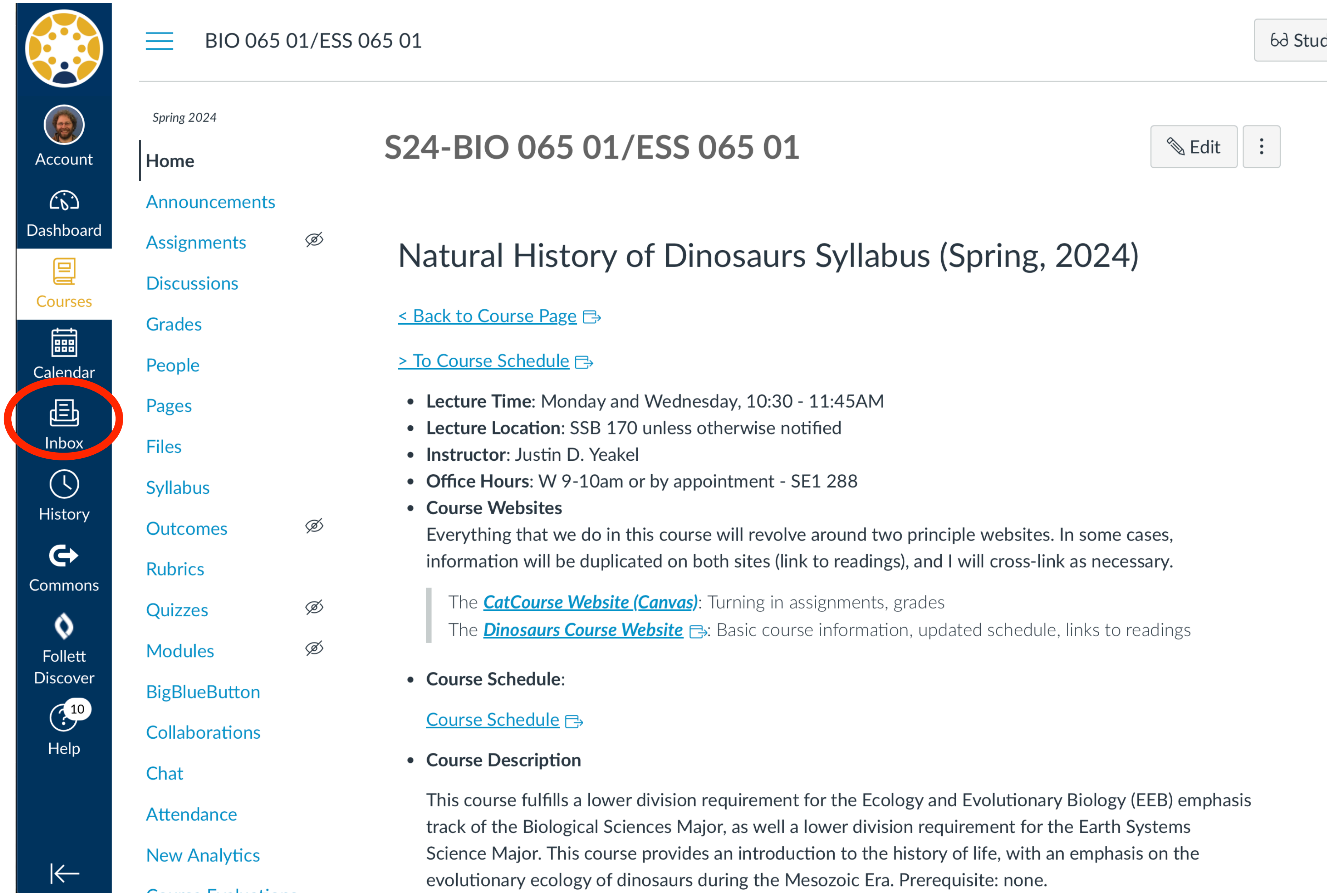
1) The main course website

http://jdyeakel.github.io/teaching/dinos/

2) Catcourses (Canvas)



How to contact



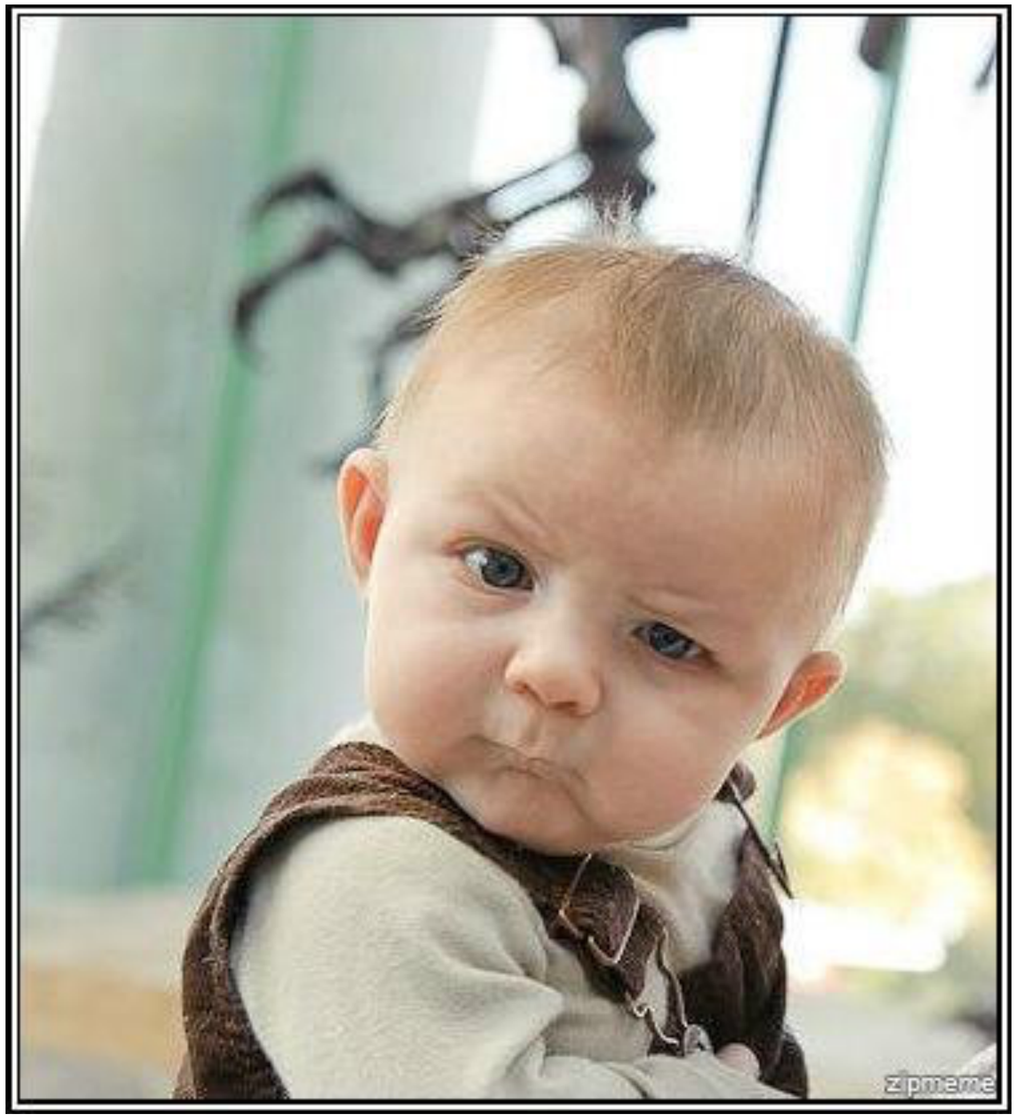
Homework assignments and exams will be submitted on Catcourses unless otherwise stated

Class time and location:
MW 10:30-11:45am
SSB 170

Important information:
Office hours: W 9-10am SEI 288

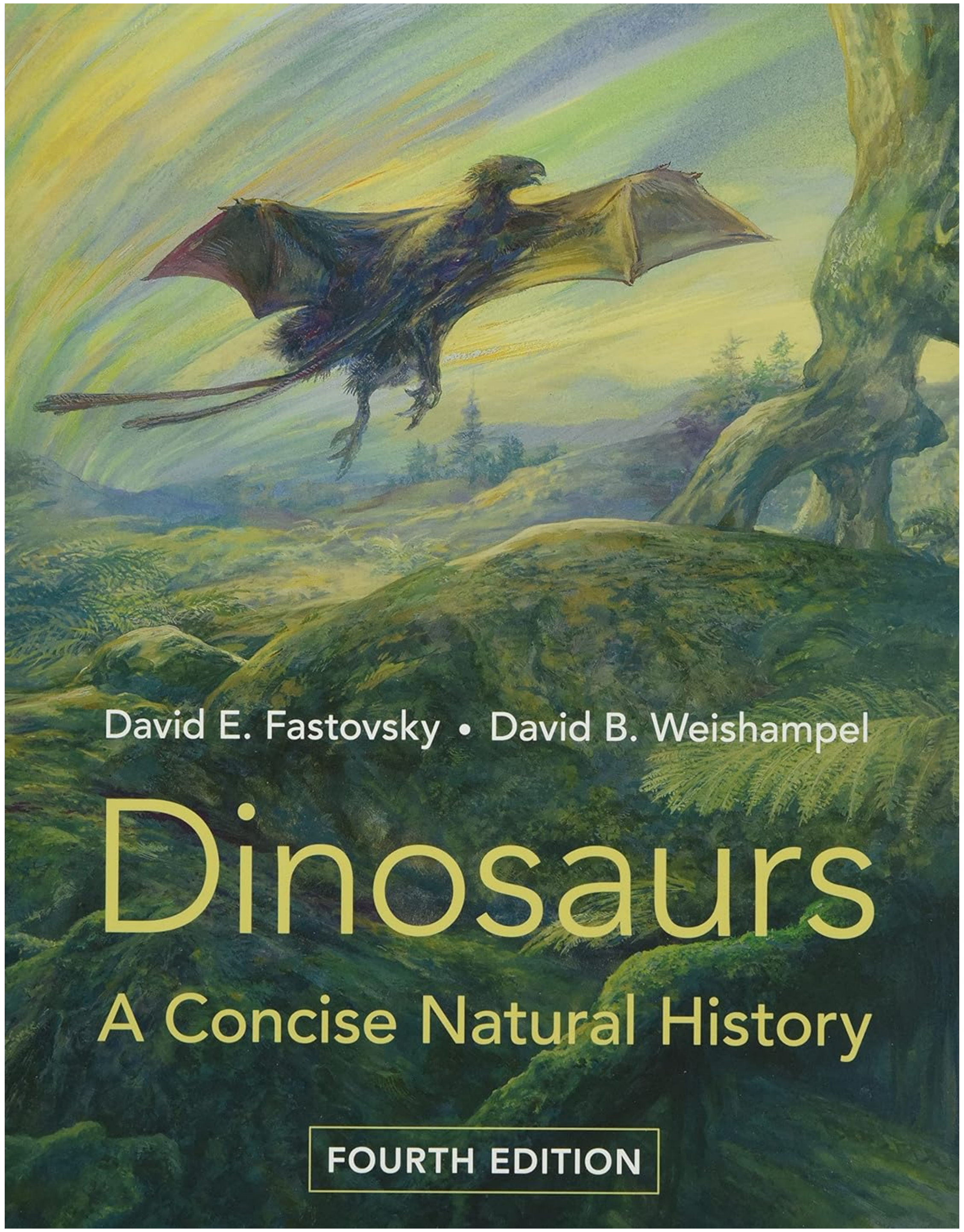
Important Dates
Class add/drop deadline: 2/5

Who are you and why are you here?
Catcourses - participation credit (due tonight at midnight)



Name
Major
Year
What you want from Dinosaurs

The Textbook



Reading for this week:
Fastovsky & Weishampel
Pgs 2-43 (through Chapter 2)

- **Required Textbook**: Fastovsky & Weishampel. Dinosaurs: A Concise Natural History, 4th edition.
- Note: earlier editions (1st, 2nd, 3rd) of this textbook may be used but however the student will be responsible for differences!
- This course is part of the UC Merced Inclusive Access program. You will have immediate access to your digital course materials on the first day of class through CatCourses. The materials that are provided are at a discounted fee, you will see the material charge on your student account in the Mybill section.
    - Please do not PRE-Pay for any content or access. If you are prompted to pay for access, try using another web browser such as Chrome or Firefox.
    - If you wish to opt-out of Inclusive Access, you must do so by 02/06/24.

Lecture Schedule

Week	Month/Day	Lecture No.	Lecture Topic	Description	Required Readings
1	**1/17**	**W-L1**	Introduction	Paleontology and fossils	Fast. Ch. 1,2
2	**1/22**	**M-L2**	Evolution 1	Natural selection	Fast. Chp. 3
	1/24	**W-L3**	Evolution 2	Cladistics	
3	**1/29**	**M-L4**	Early life	Cambrian through Devonian	Fast. Chp. 4
	1/31	**W-L5**	Early life	Devonian through Permian	
4	**2/5**	**M-L6**	Dinosaurs	Basal dinosaurs	Fast. Chp. 5
	2/7	**W-L7**	Thyreophorans 1	Stegosaurs	Fast. Chp. 10
5	**2/12**	**M-L8**	Thyreophorans 2	Ankylos	Fast. Chp. 10
	2/14	**W**	***Exam I***	In class	

What is a dinosaur???

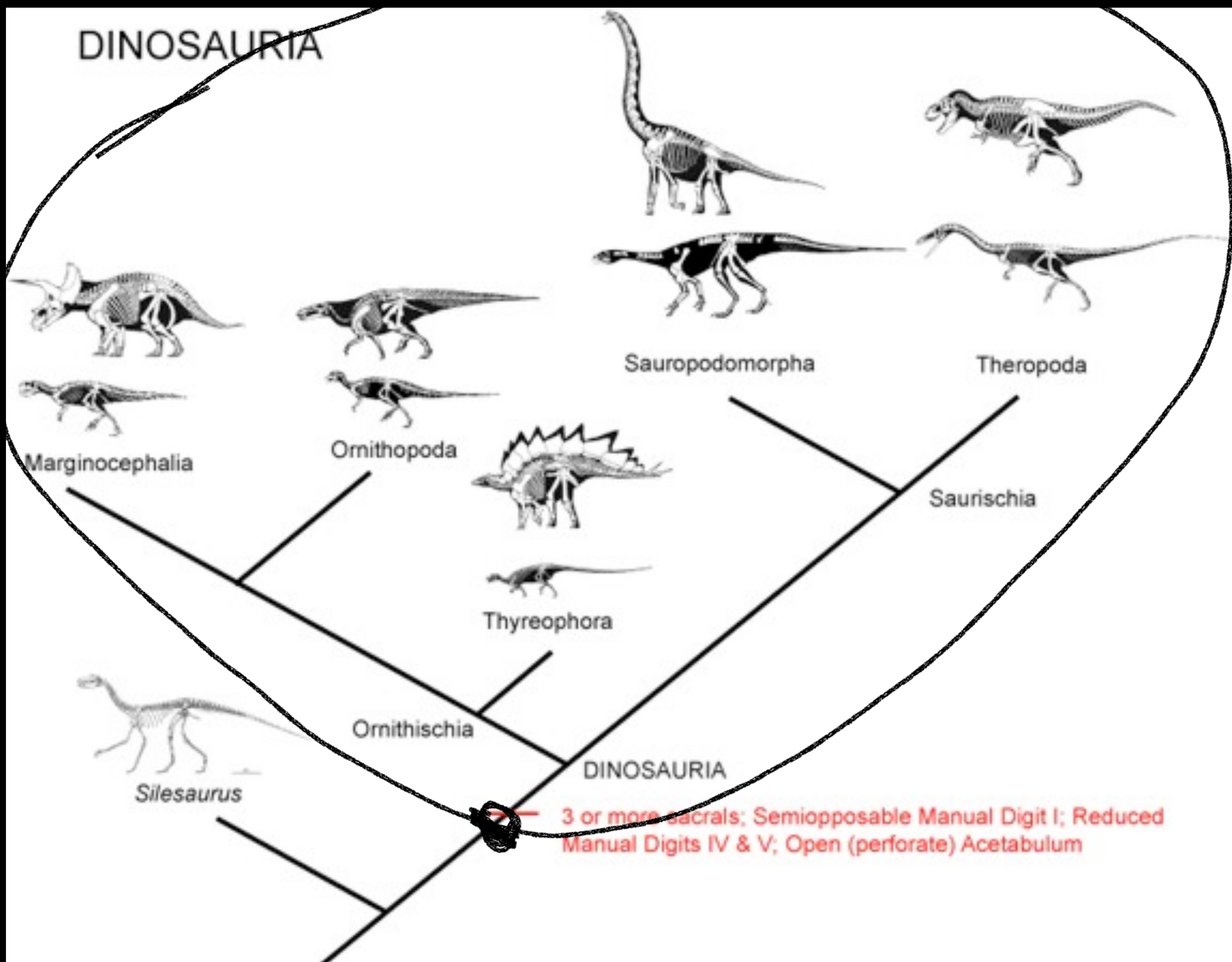
Scales: Space

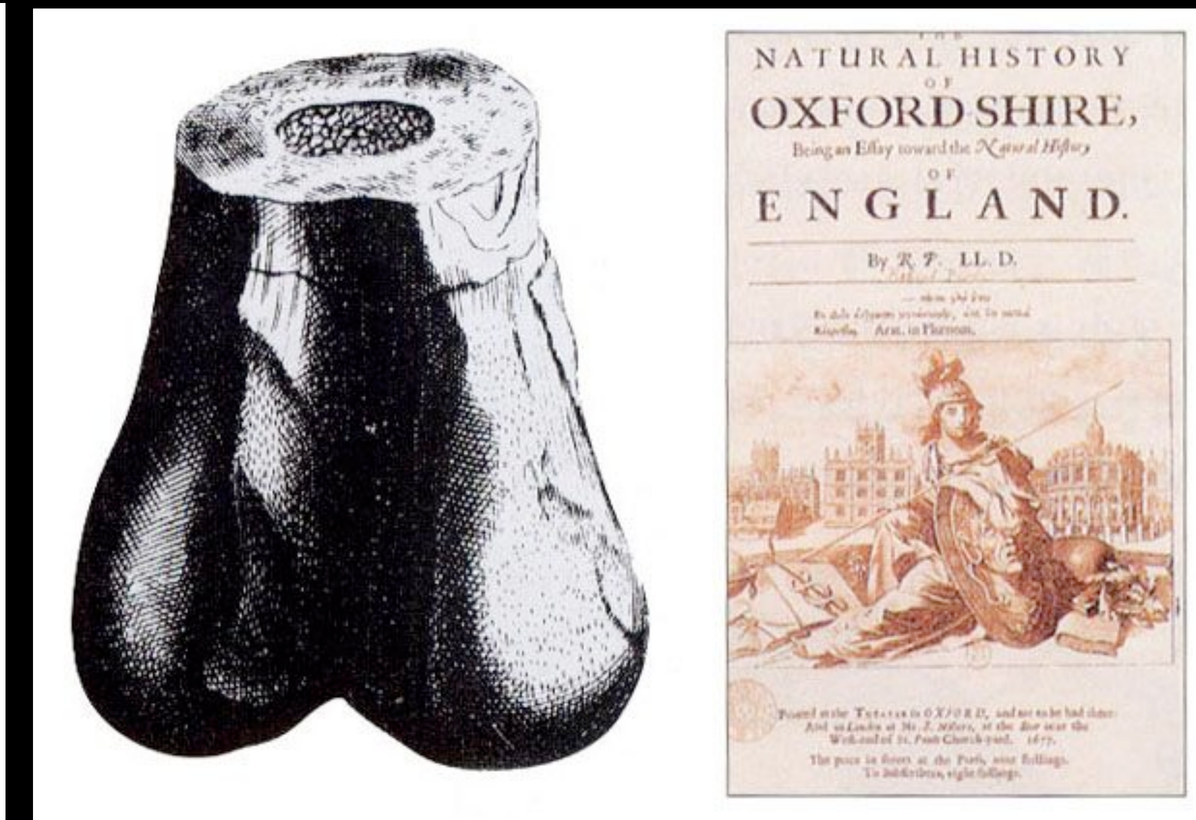
Scales: Time

Where do Dinos fit in?

Fossilization and Taphonomy

Dr. Robert Plot





Scrotum humanum

The distal femur of Megalosaurus

Dinosauria:
A monophyletic clade

Go to www.menti.com

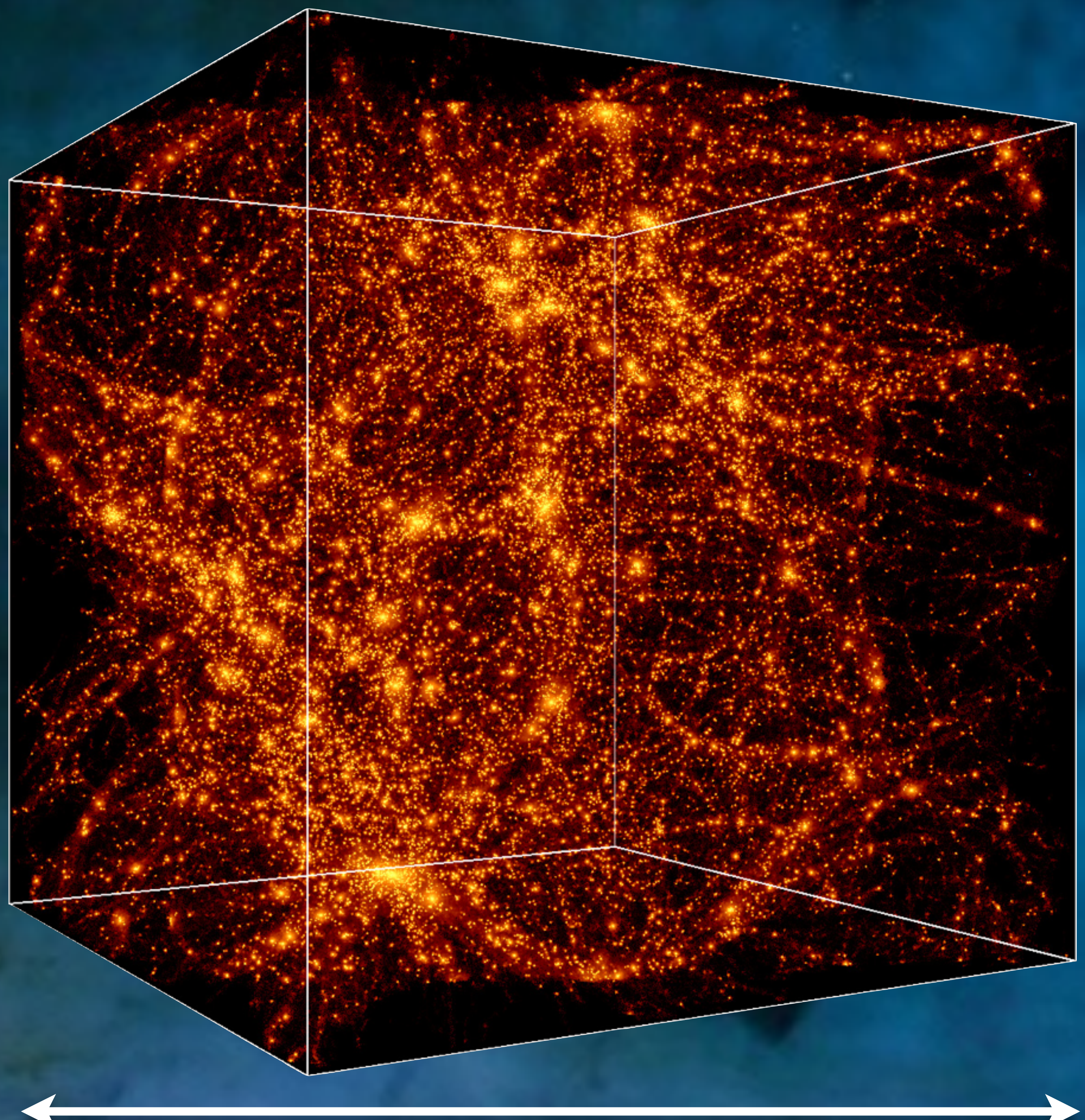
Orders of Magnitude

$$10^{10} = 10000000000$$
$$= 10*10*10*10*10*10*10*10*10*10$$

$$10^{-10} = 0.0000000001$$
$$= .10*.10*.10*.10*.10*.10*.10*.10*.10*.10$$

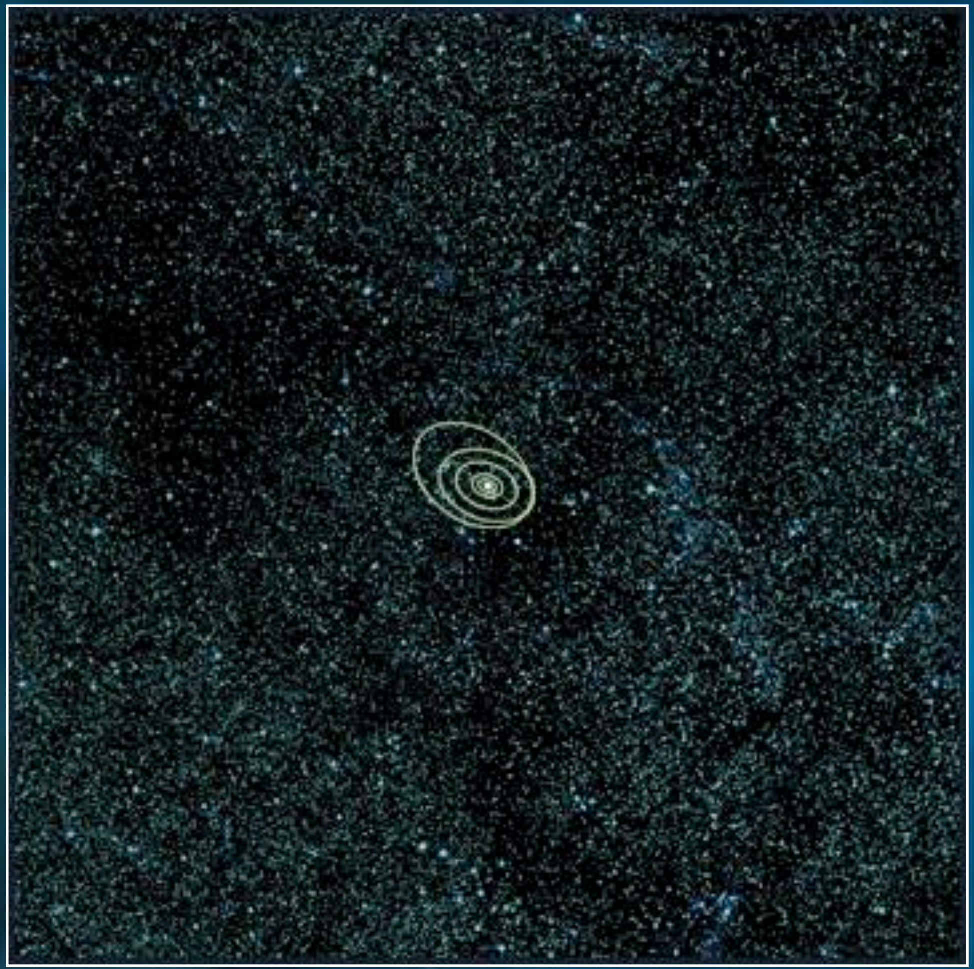
Spatial Scales

Orders of Magnitude



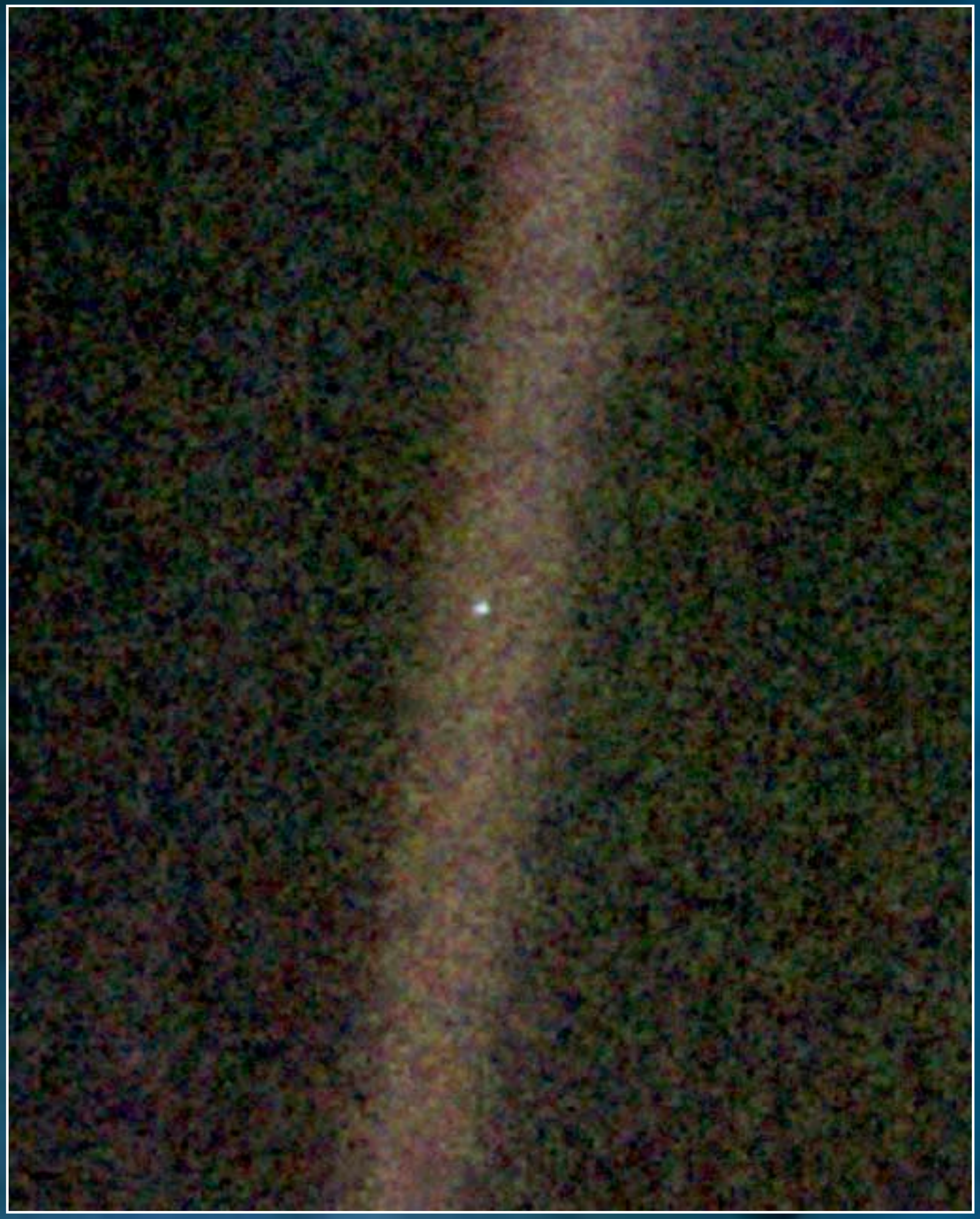
10^{26}

Orders of Magnitude



10^{15}

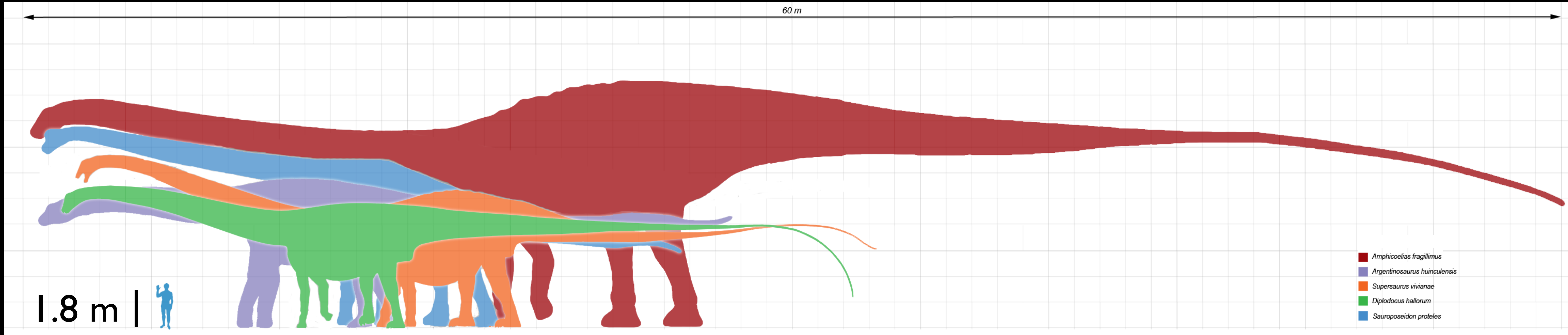
Orders of Magnitude



10^{10}

Orders of Magnitude

10^6


60 m
1.8 m
Amphicoelias fragillimus
Argentinosaurus huinculensis
Supersaurus vivianae
Diplodocus hallorum
Sauroposeidon proteles

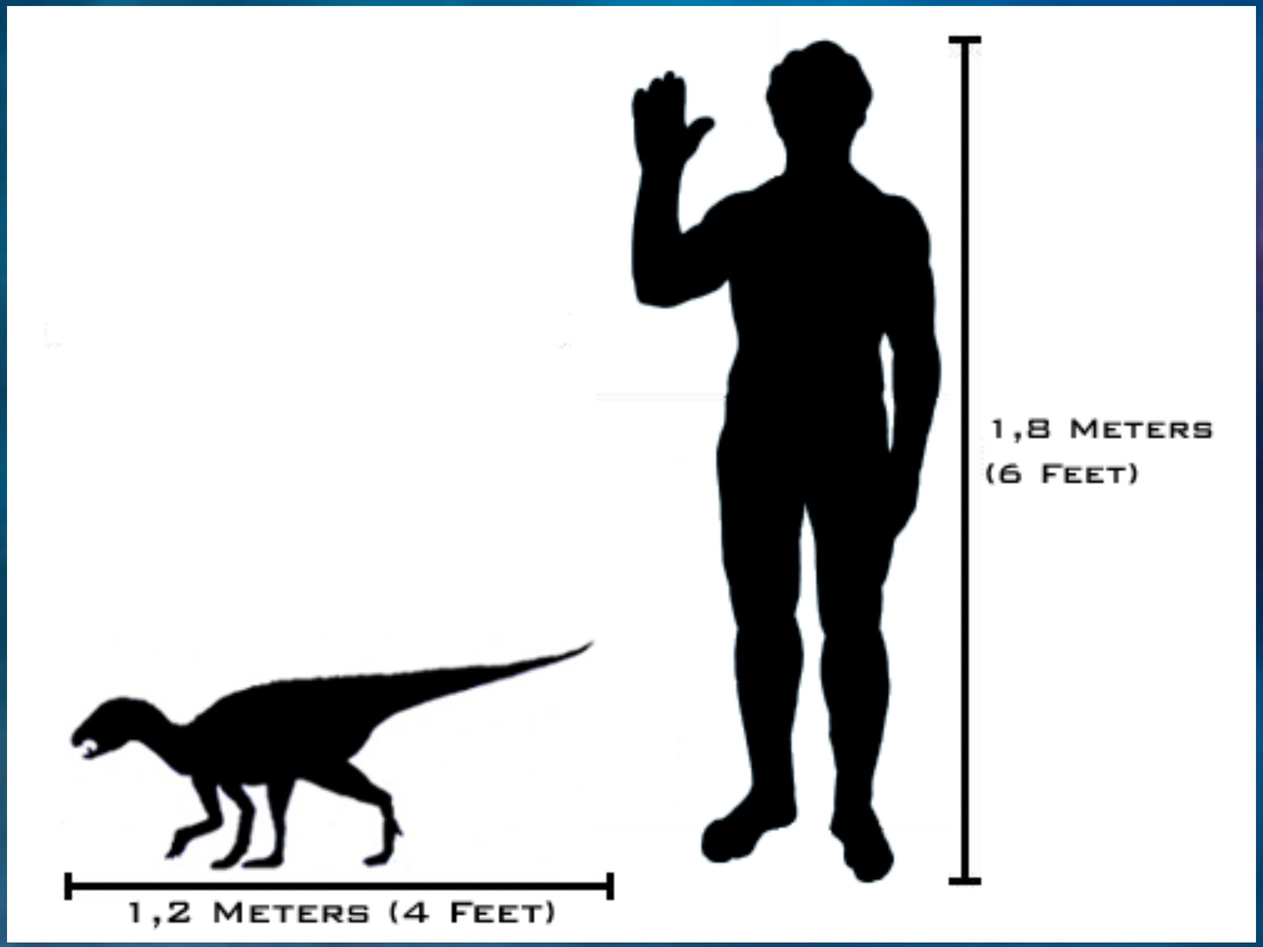
60 m


Amphicoelias fragillimus
Argentinosaurus huinculensis
Supersaurus vivianae
Diplodocus hallorum
Sauroposeidon proteles

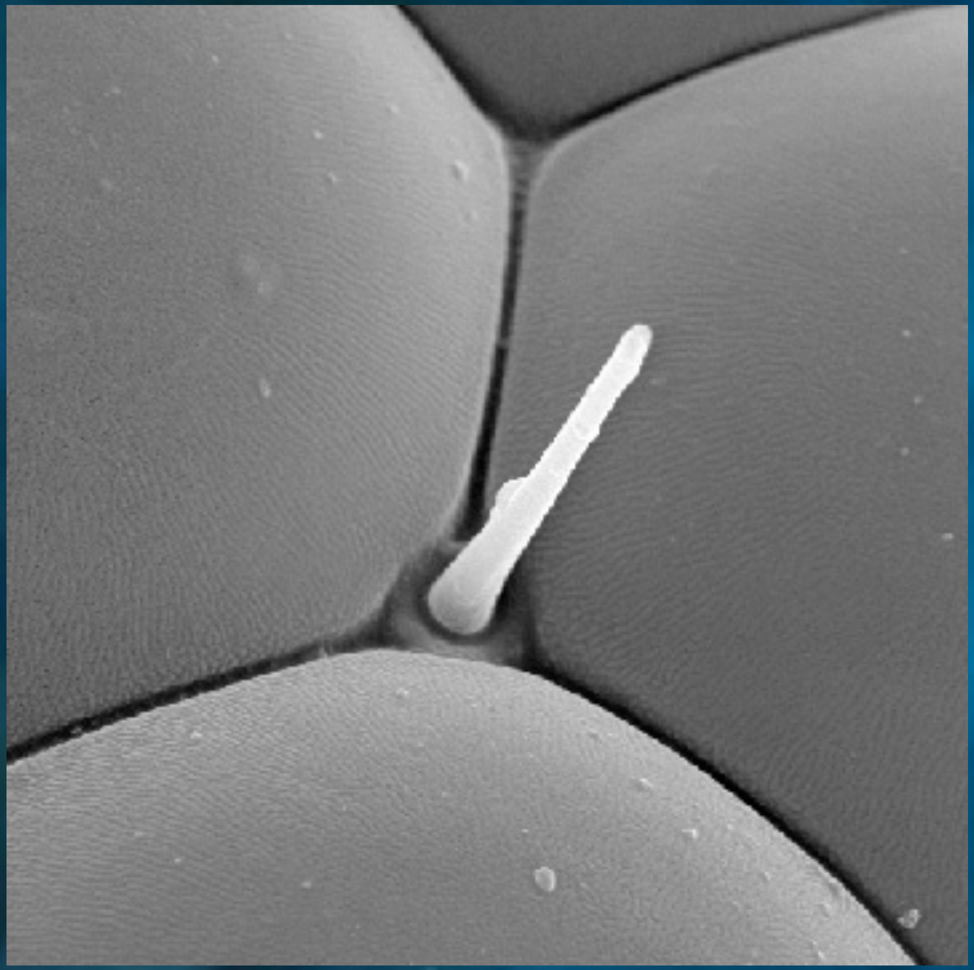

THE TITANOS

Orders of Magnitude

10^0



Orders of Magnitude



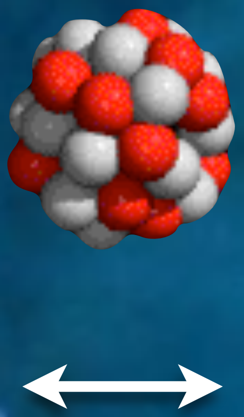
10^{-5}

Orders of Magnitude

10^{-10}

Orders of Magnitude

10^{-15}



Orders of Magnitude

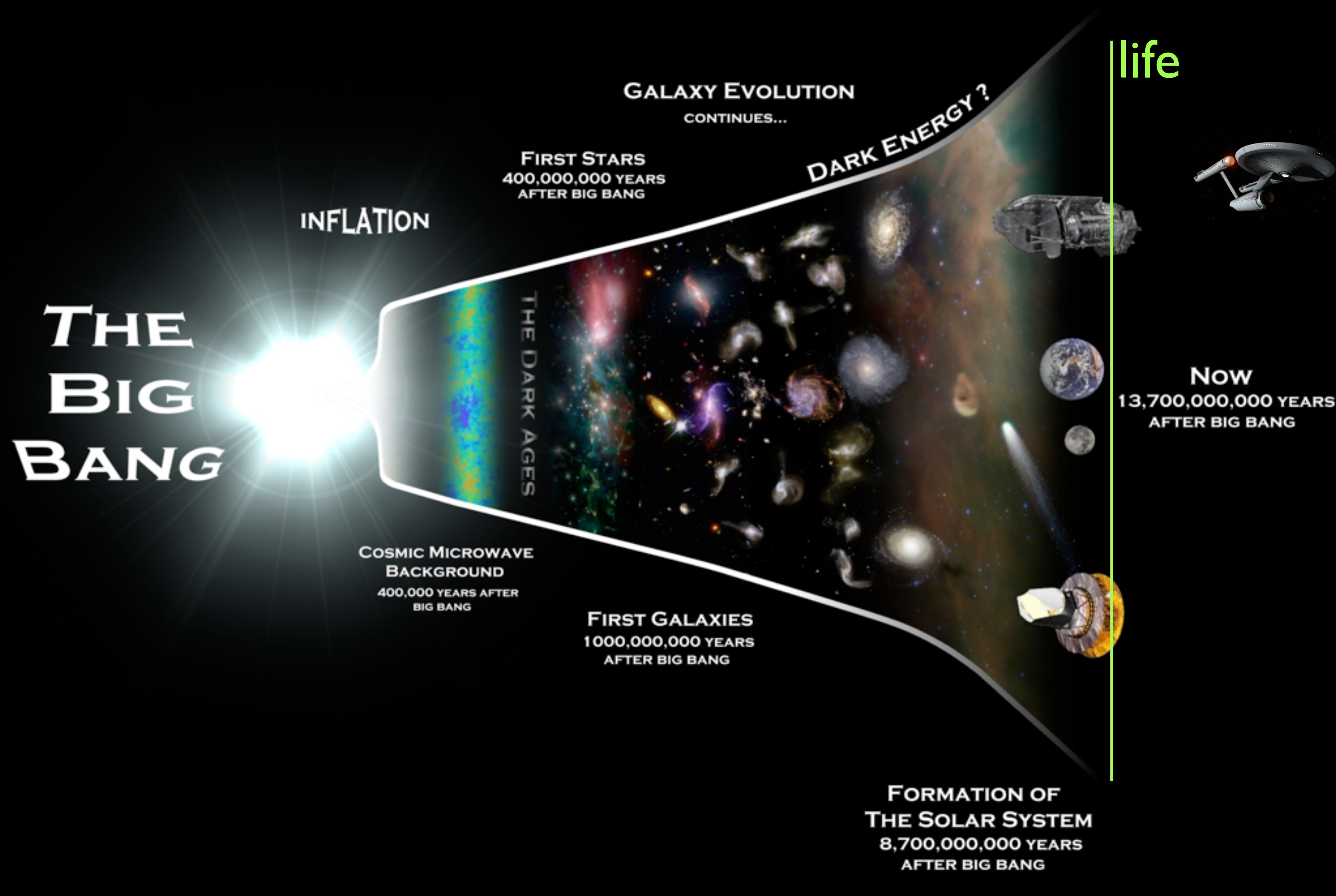
10^{-34}

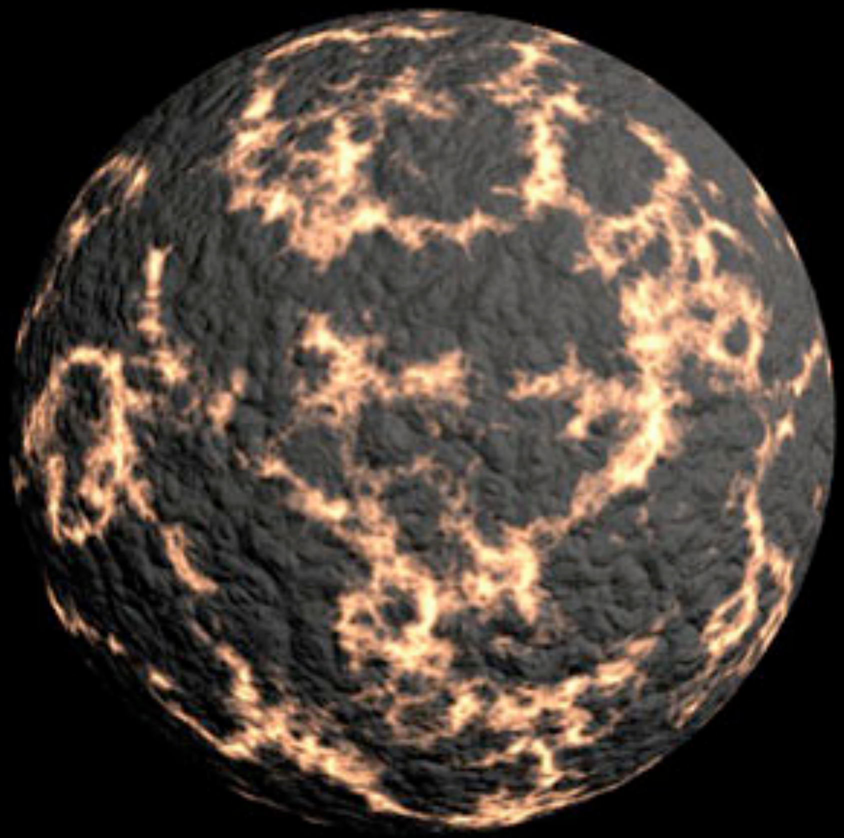
Plank's Constant

$h = 6.63 \times 10^{-34}$

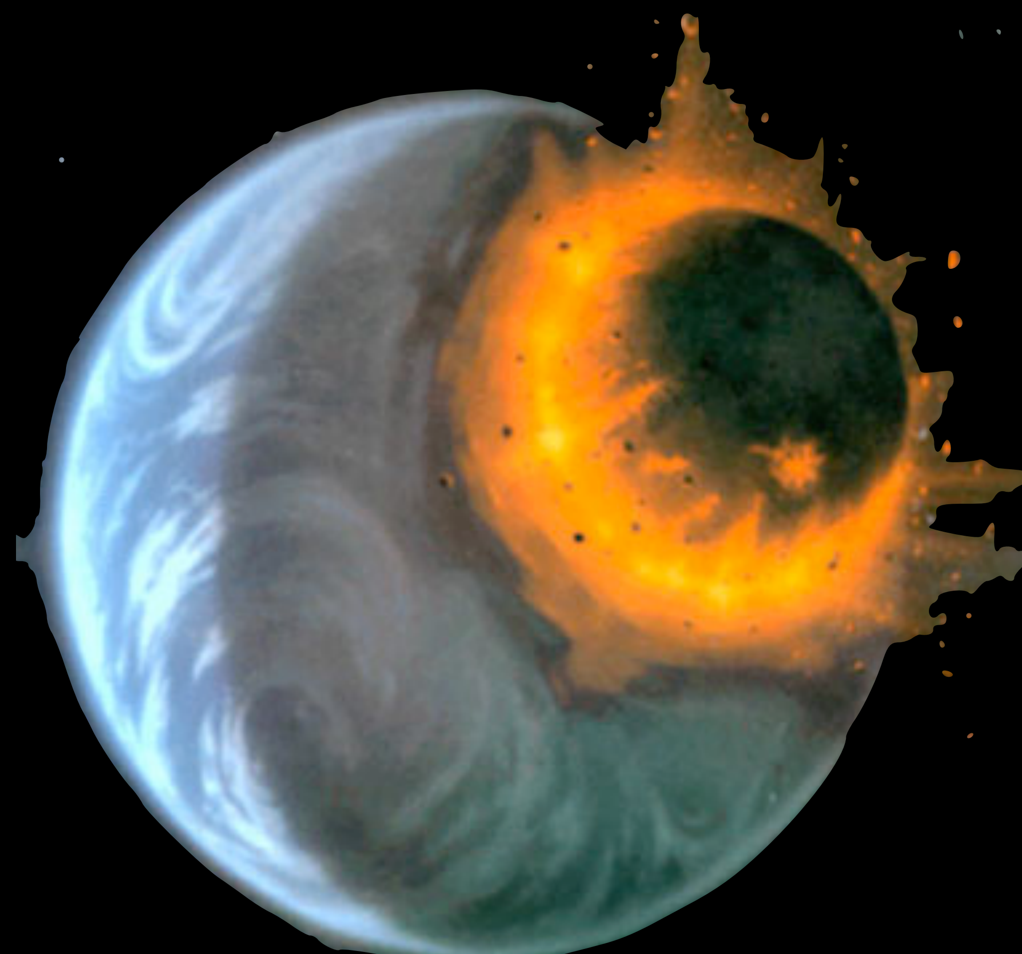
Temporal Scales

13.3-13.9 Ga
0


life
The Big Bang
Inflation
Cosmic Microwave Background
400,000 years after Big Bang
The Dark Ages
First Stars
400,000,000 years after Big Bang
First Galaxies
1000,000,000 years after Big Bang
Galaxy Evolution
continues...
Dark Energy ?
Formation of The Solar System
8,700,000,000 years after Big Bang
Now
13,700,000,000 years after Big Bang



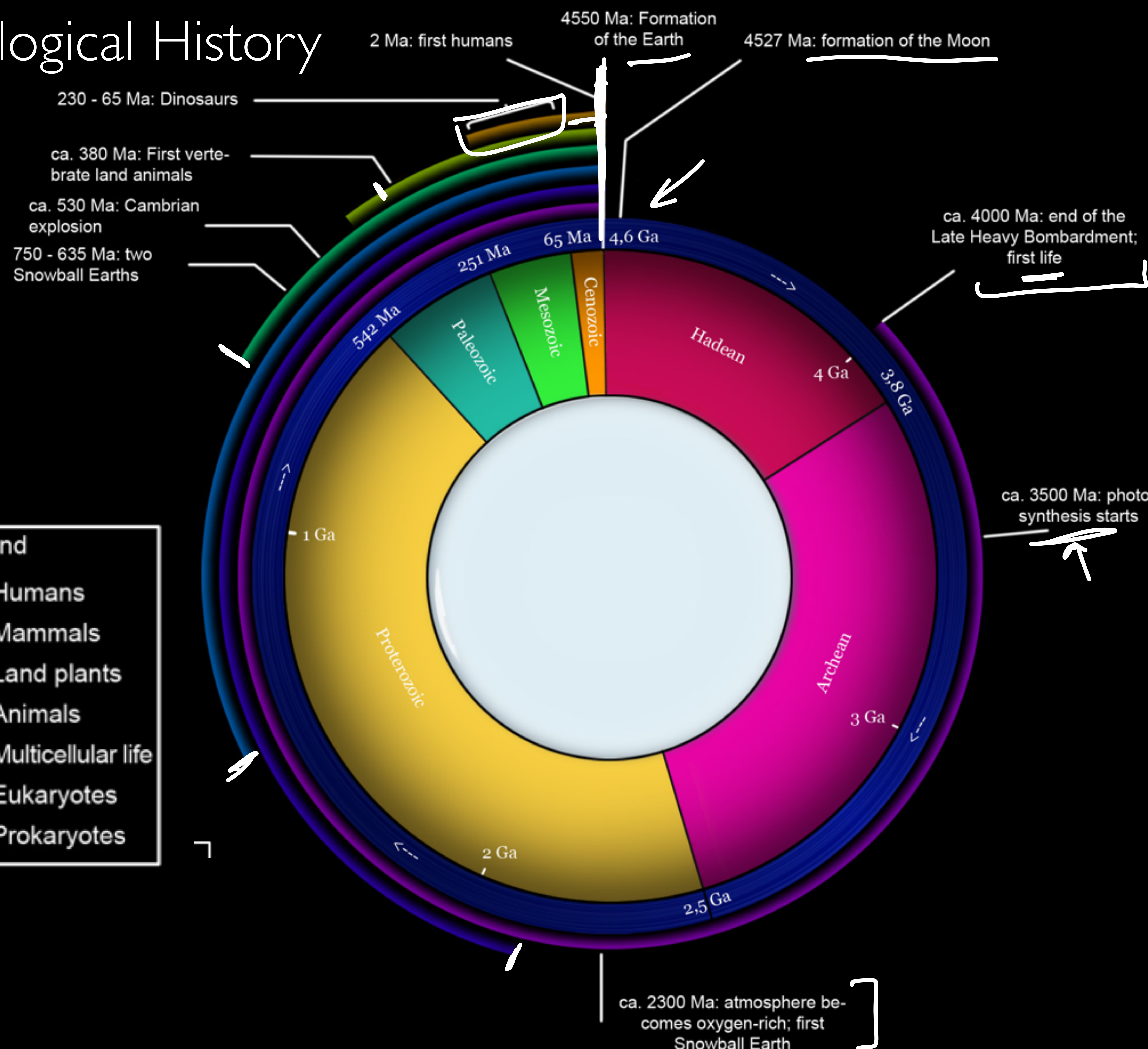
4.56 gyr

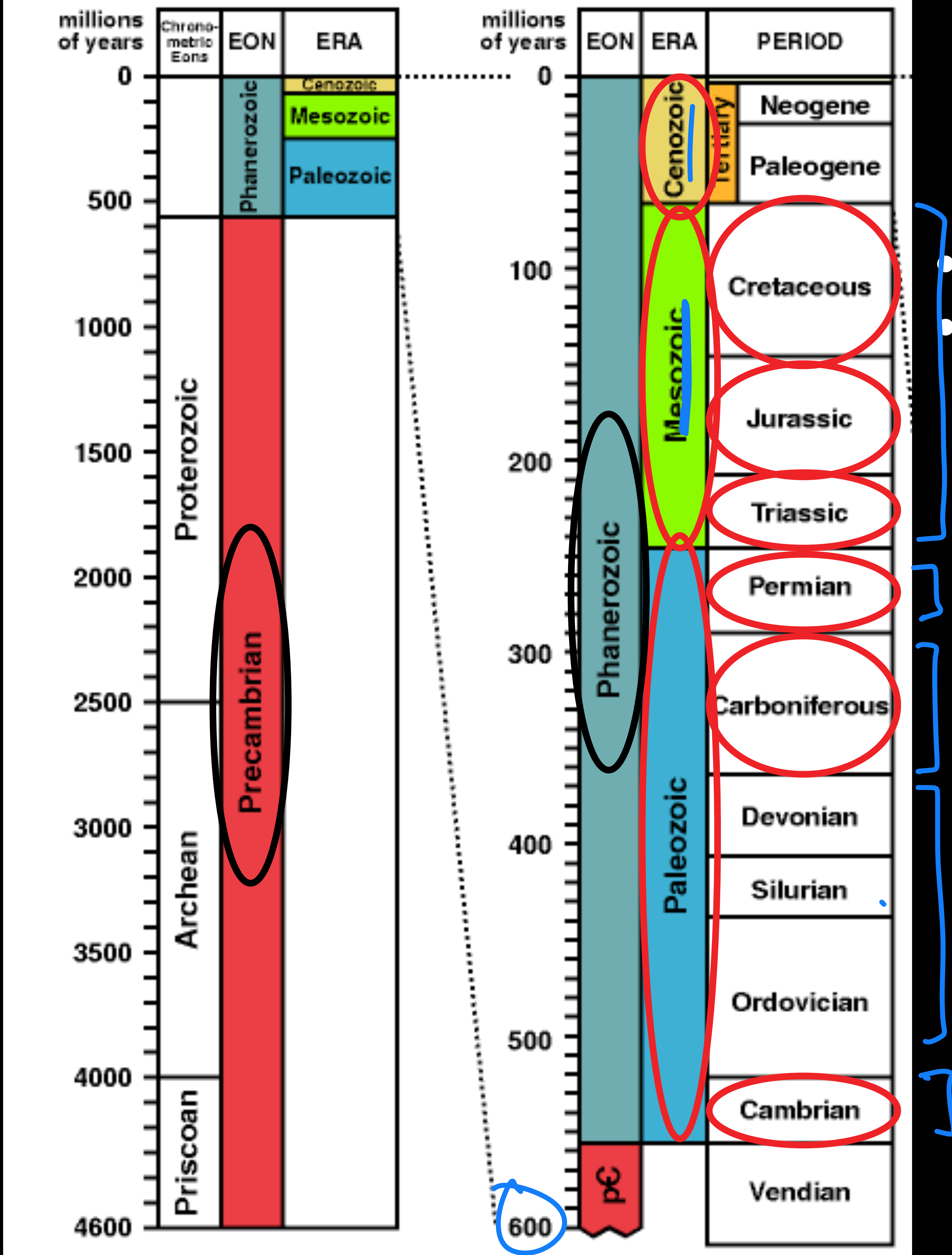


4.527 gyr

> 4.527 gyr

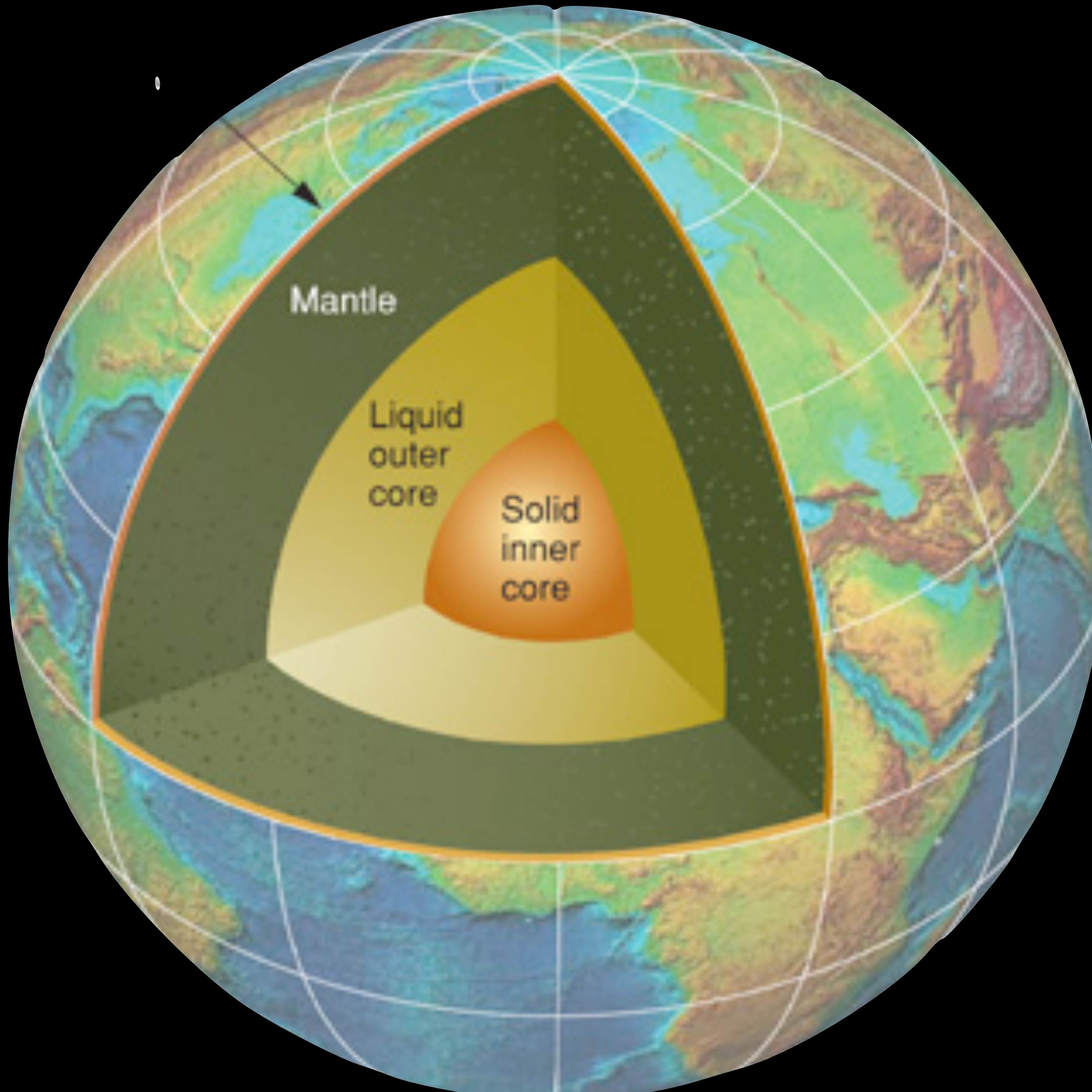
Geological History



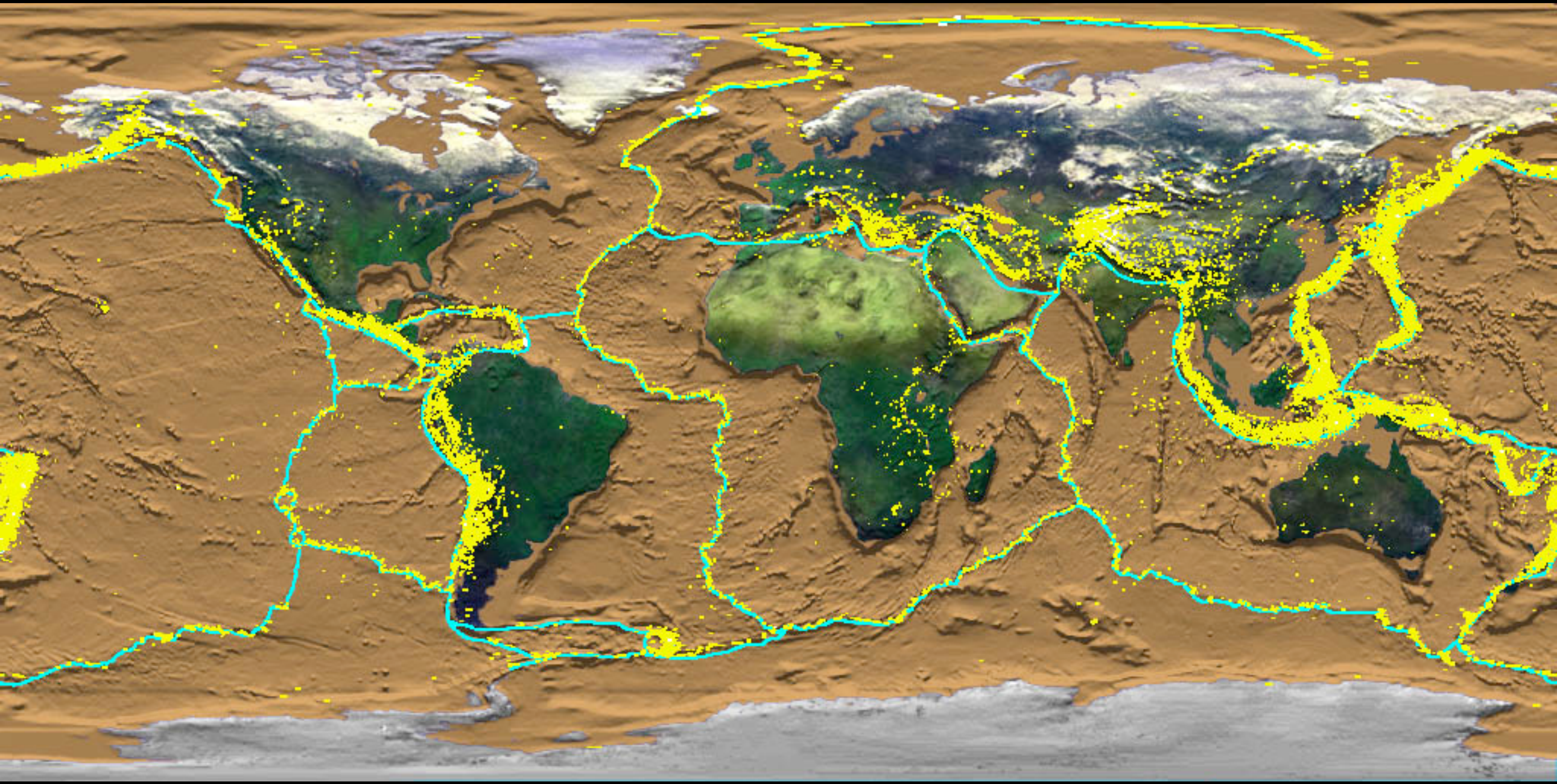


Be Familiar
Know

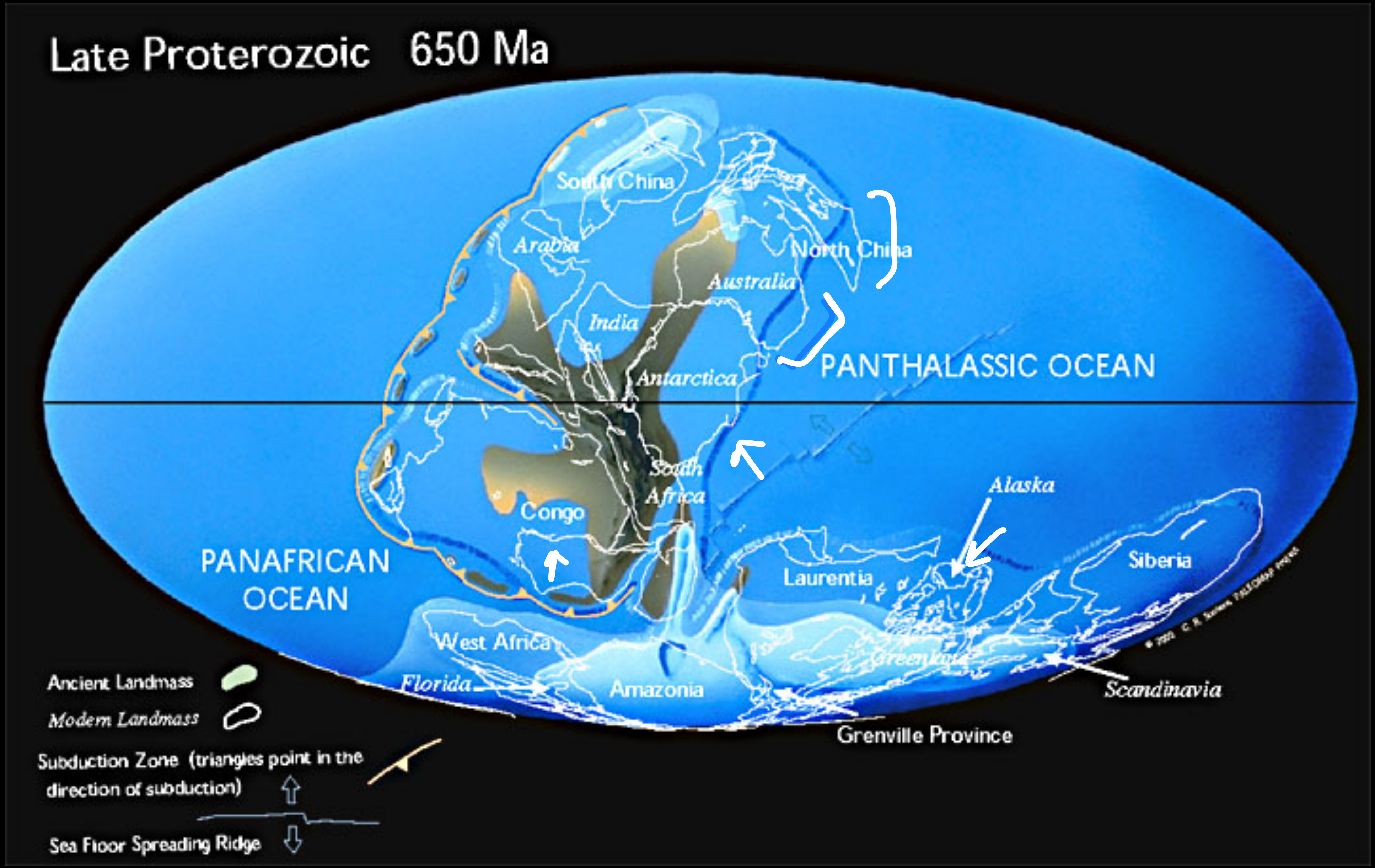
- Precambrian Eon
- Phanerozoic Eon
  - Paleozoic
    - Cambrian (542:488 Ma)
    - Carboniferous (360:299 Ma)
    - Permian (299:251 Ma)
  - Mesozoic
    - Triassic (251:200 Ma)
    - Jurassic (200:146 Ma)
    - Cretaceous (146:65.5)
  - Cenozoic (65.5:now)

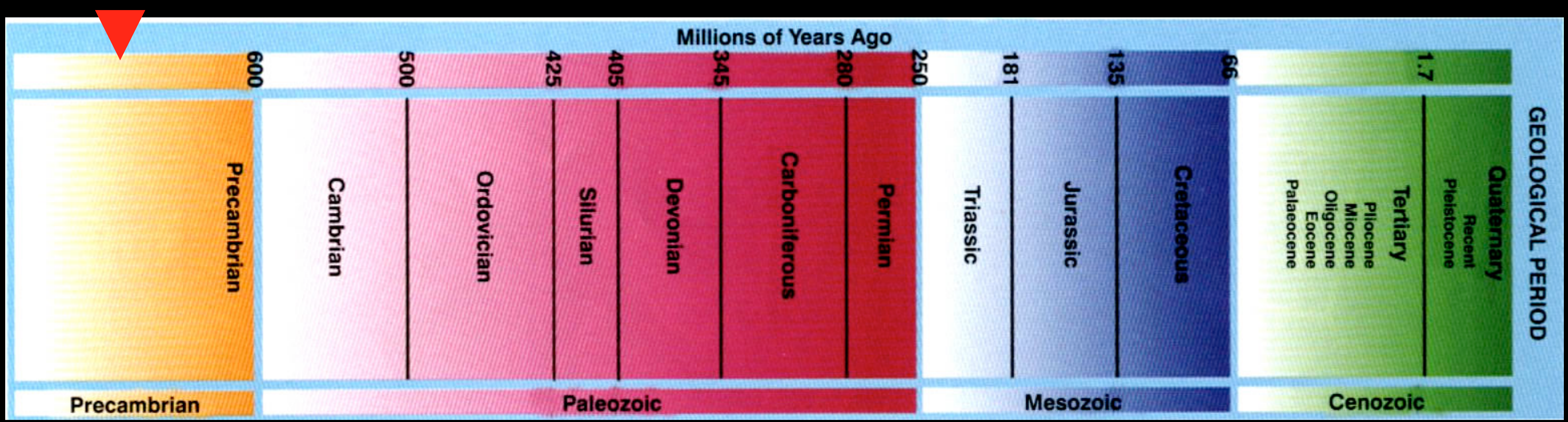

Mantle
Liquid outer core
Solid inner core

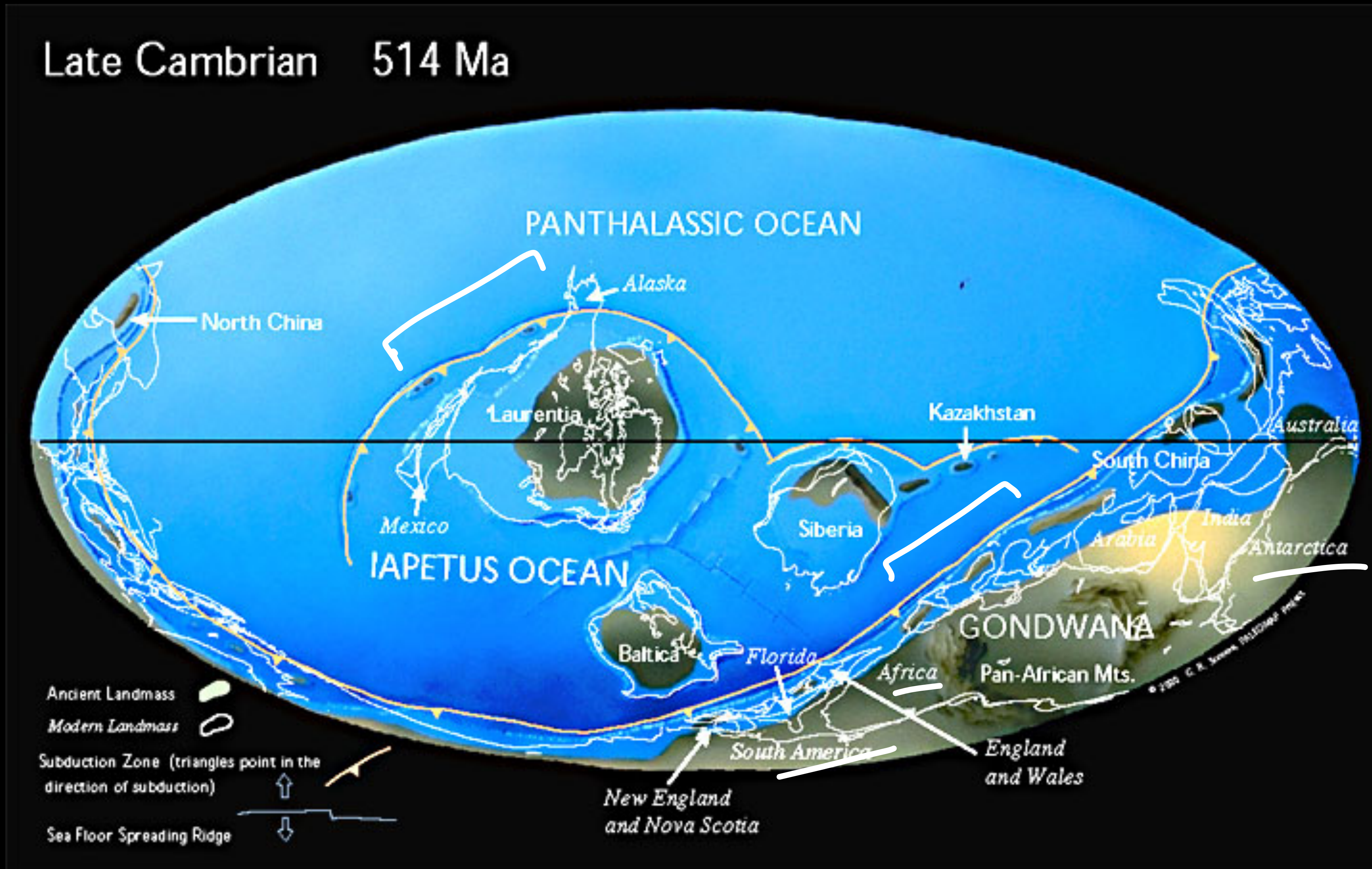
Continental Plates

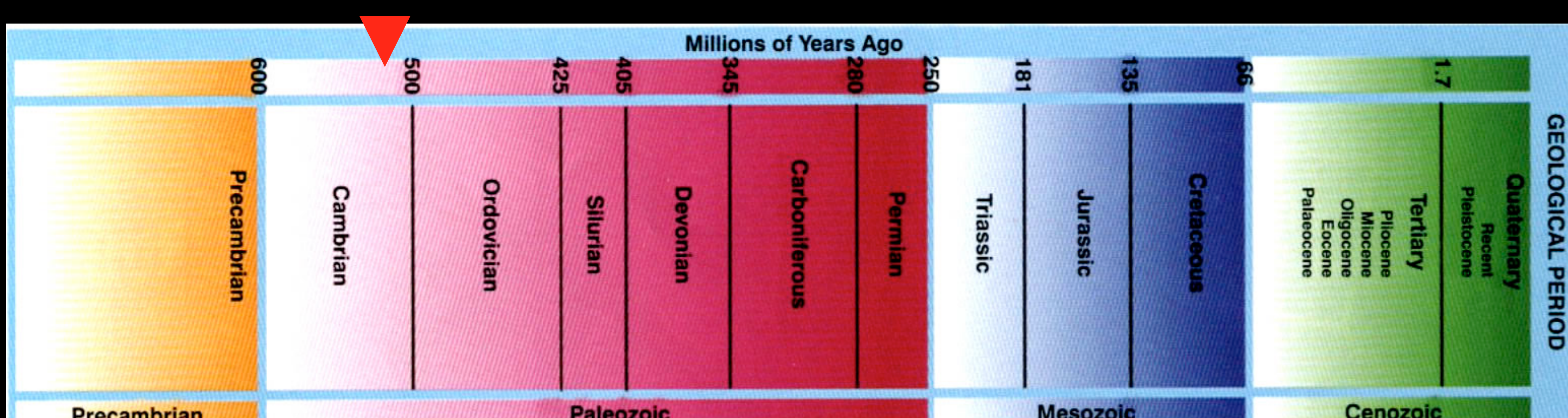


• = earthquakes


Late Proterozoic 650 Ma
South China
Arabia
North China
Australia
India
Antarctica
PANTHALASSIC OCEAN
South Africa
Congo
Alaska
Siberia
PANAFRICAN OCEAN
Laurentia
West Africa
Greenland
Florida
Amazonia
Scandinavia
Grenville Province
Ancient Landmass
Modern Landmass
Subduction Zone (triangles point in the direction of subduction)
Sea Floor Spreading Ridge


Millions of Years Ago
600
500
425
405
345
280
250
181
135
66
1.7
Precambrian
Cambrian
Ordovician
Silurian
Devonian
Carboniferous
Permian
Triassic
Jurassic
Cretaceous
Tertiary
Palaeocene
Eocene
Oligocene
Miocene
Pliocene
Quaternary
Pleistocene
Recent
GEOLOGICAL PERIOD
Precambrian
Paleozoic
Mesozoic
Cenozoic


Late Cambrian 514 Ma
PANTHALASSIC OCEAN
Alaska
North China
Laurentia
Kazakhstan
Australia
South China
Mexico
Siberia
India
Arabia
Antarctica
IAPETUS OCEAN
GONDWANA
Baltica
Florida
Africa
Pan-African Mts.
South America
England and Wales
New England and Nova Scotia
Ancient Landmass
Modern Landmass
Subduction Zone (triangles point in the direction of subduction)
Sea Floor Spreading Ridge


Millions of Years Ago
600
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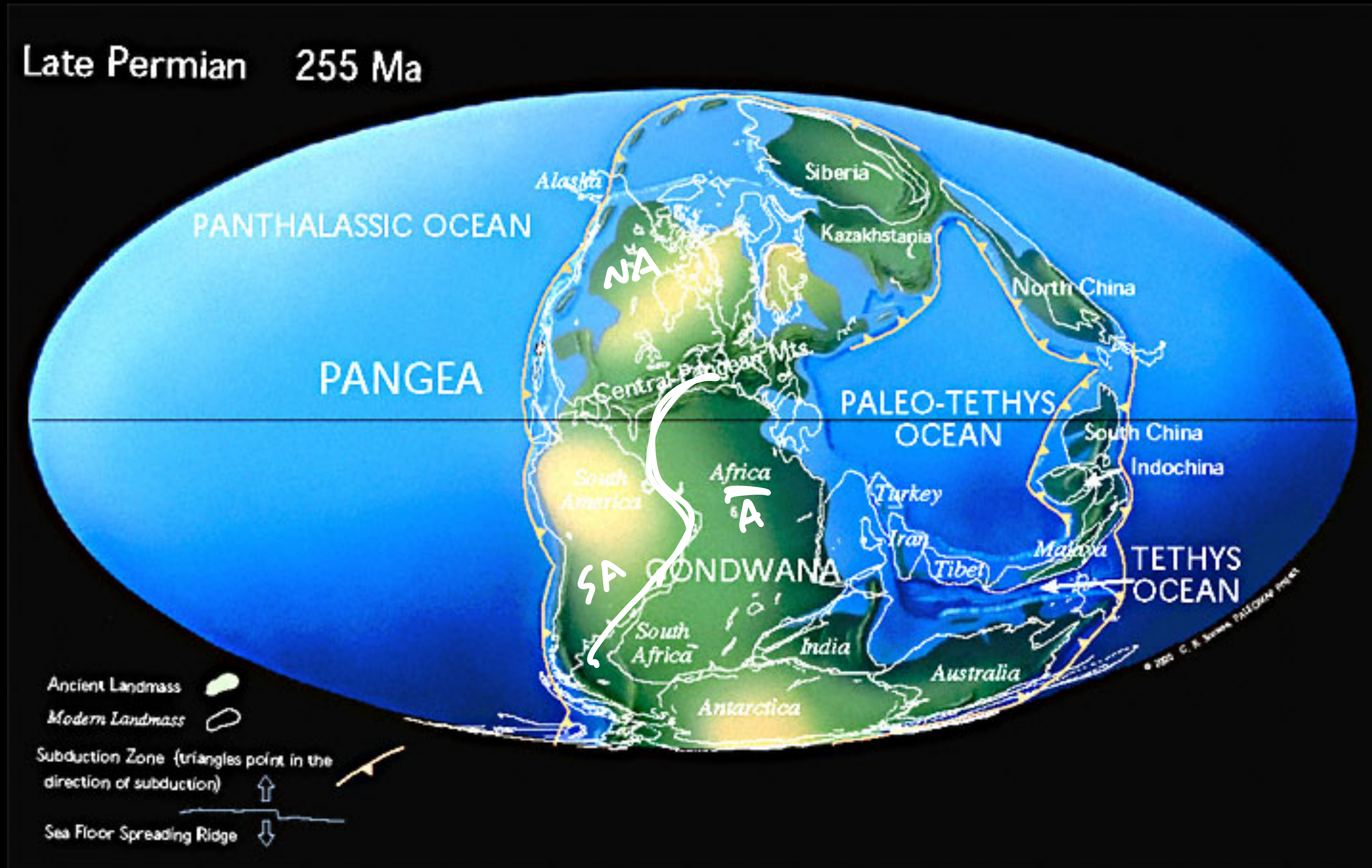
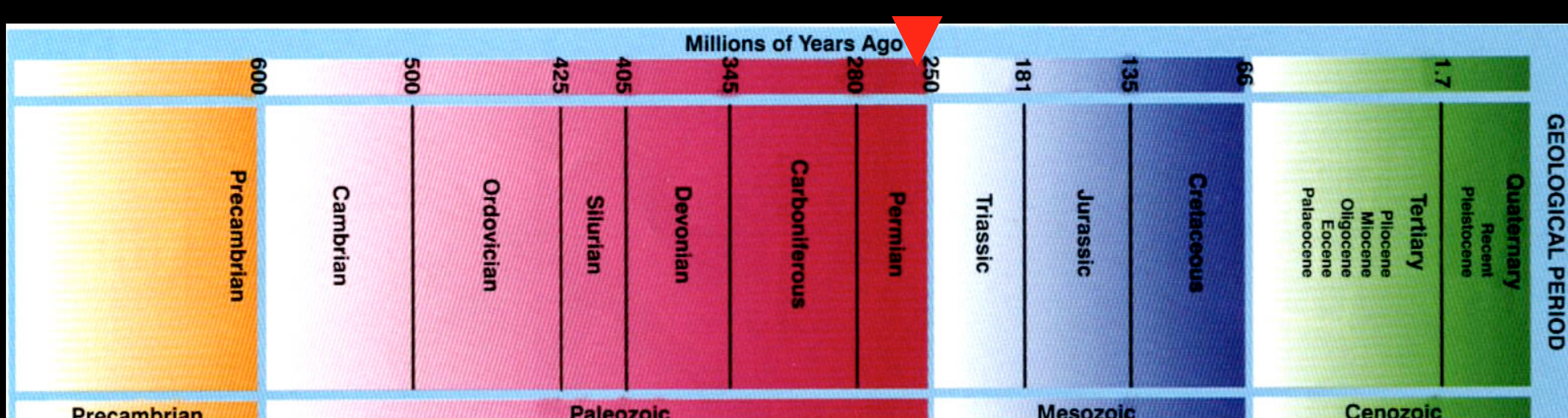
425
405
345
280
250
181
135
66
1.7
Precambrian
Cambrian
Ordovician
Silurian
Devonian
Carboniferous
Permian
Triassic
Jurassic
Cretaceous
Tertiary
Palaeocene
Eocene
Oligocene
Miocene
Pliocene
Quaternary
Pleistocene
Recent
GEOLOGICAL PERIOD
Precambrian
Paleozoic
Mesozoic
Cenozoic


Late Permian 255 Ma
PANTHALASSIC OCEAN
PANGEA
Alaska
Siberia
Kazakhstania
North China
Central Pangean Mts.
PALEO-TETHYS OCEAN
South China
Indochina
NA
South America
Africa
A
SA
GONDWANA
Turkey
Iran
Tibet
Malaya
TETHYS OCEAN
South Africa
India
Australia
Antarctica
Ancient Landmass
Modern Landmass
Subduction Zone (triangles point in the direction of subduction)
Sea Floor Spreading Ridge


Millions of Years Ago
600
500
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405
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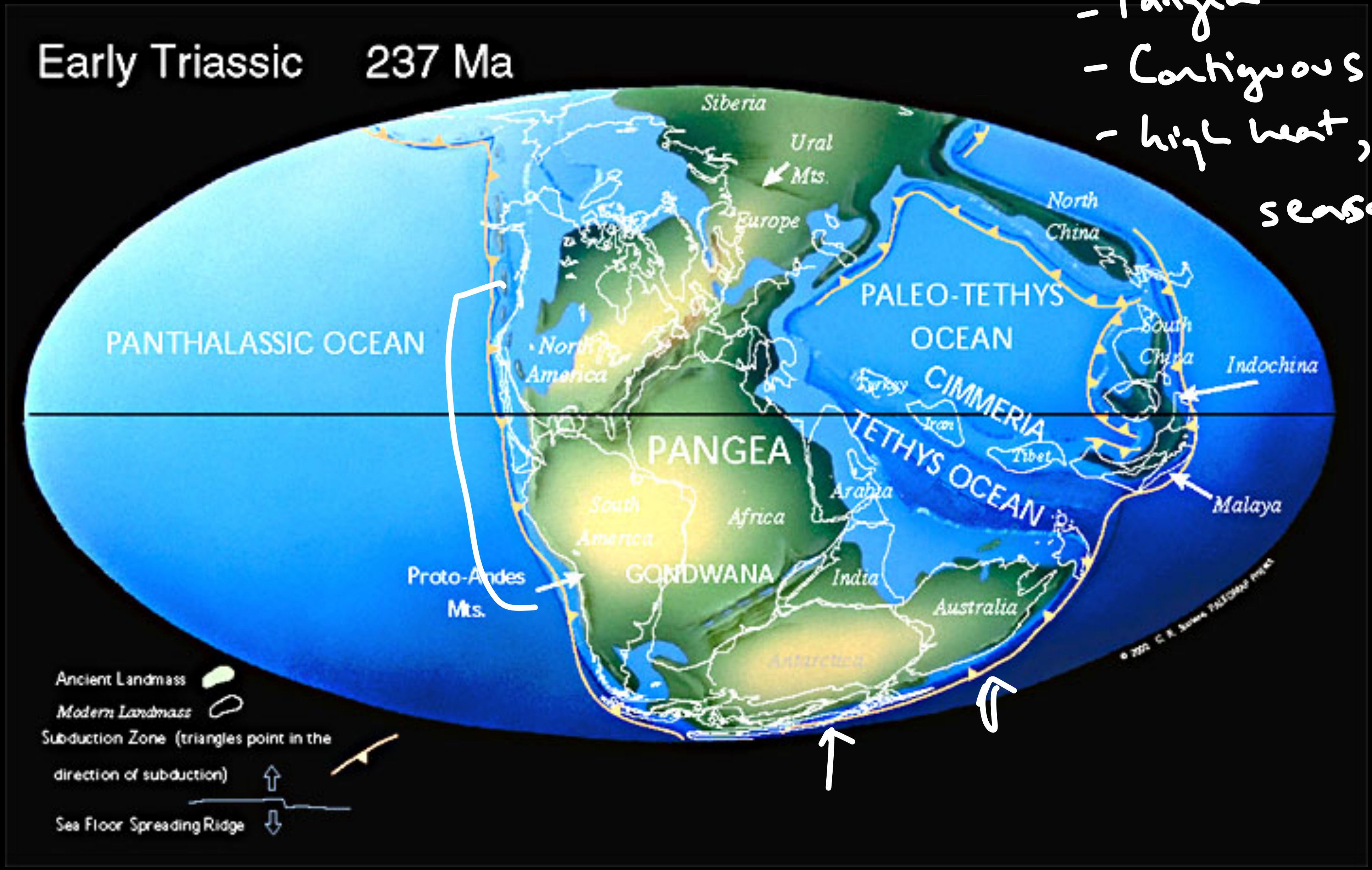
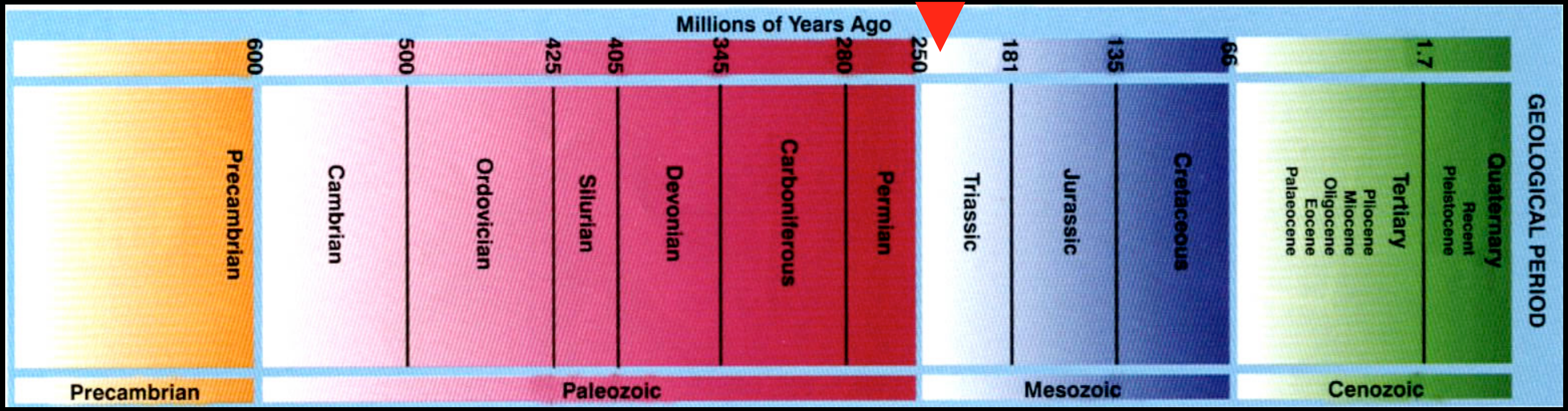
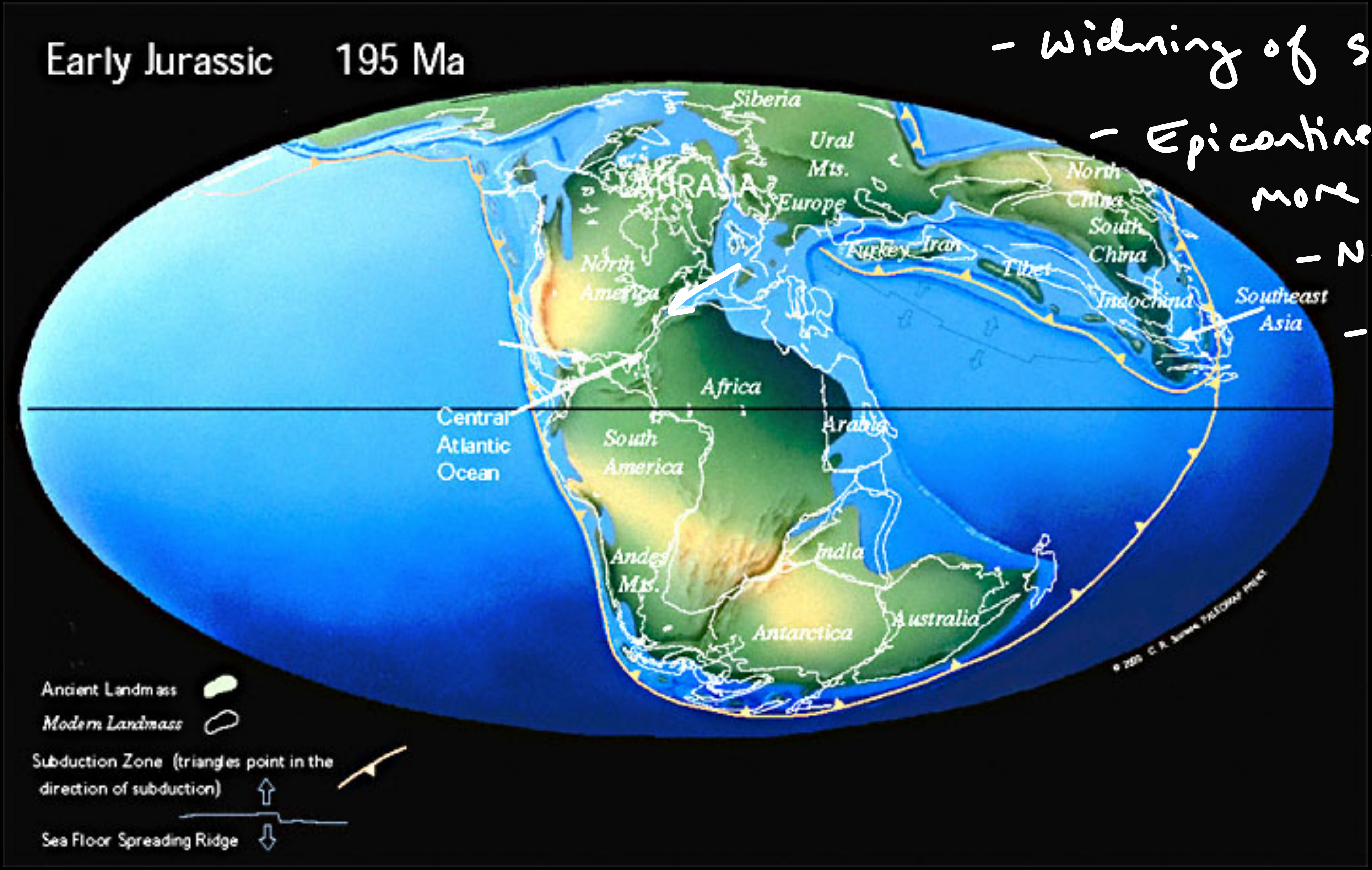
280
250
181
135
66
1.7
Precambrian
Cambrian
Ordovician
Silurian
Devonian
Carboniferous
Permian
Triassic
Jurassic
Cretaceous
Tertiary
Palaeocene
Eocene
Oligocene
Miocene
Pliocene
Quaternary
Pleistocene
Recent
GEOLOGICAL PERIOD
Precambrian
Paleozoic
Mesozoic
Cenozoic

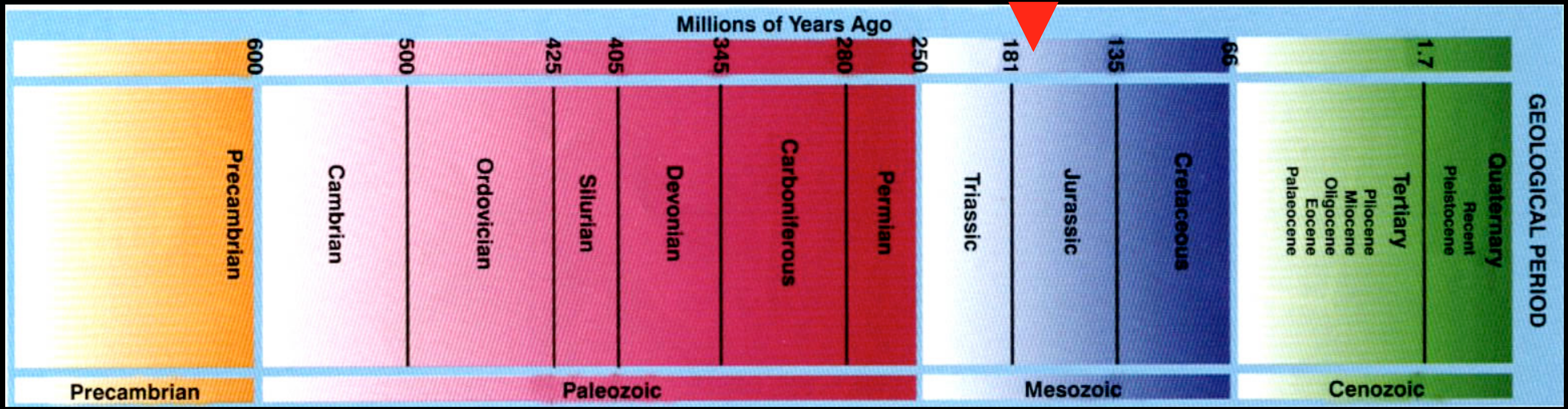
- Pangea
- Contiguous
- high heat, dry, seasonality



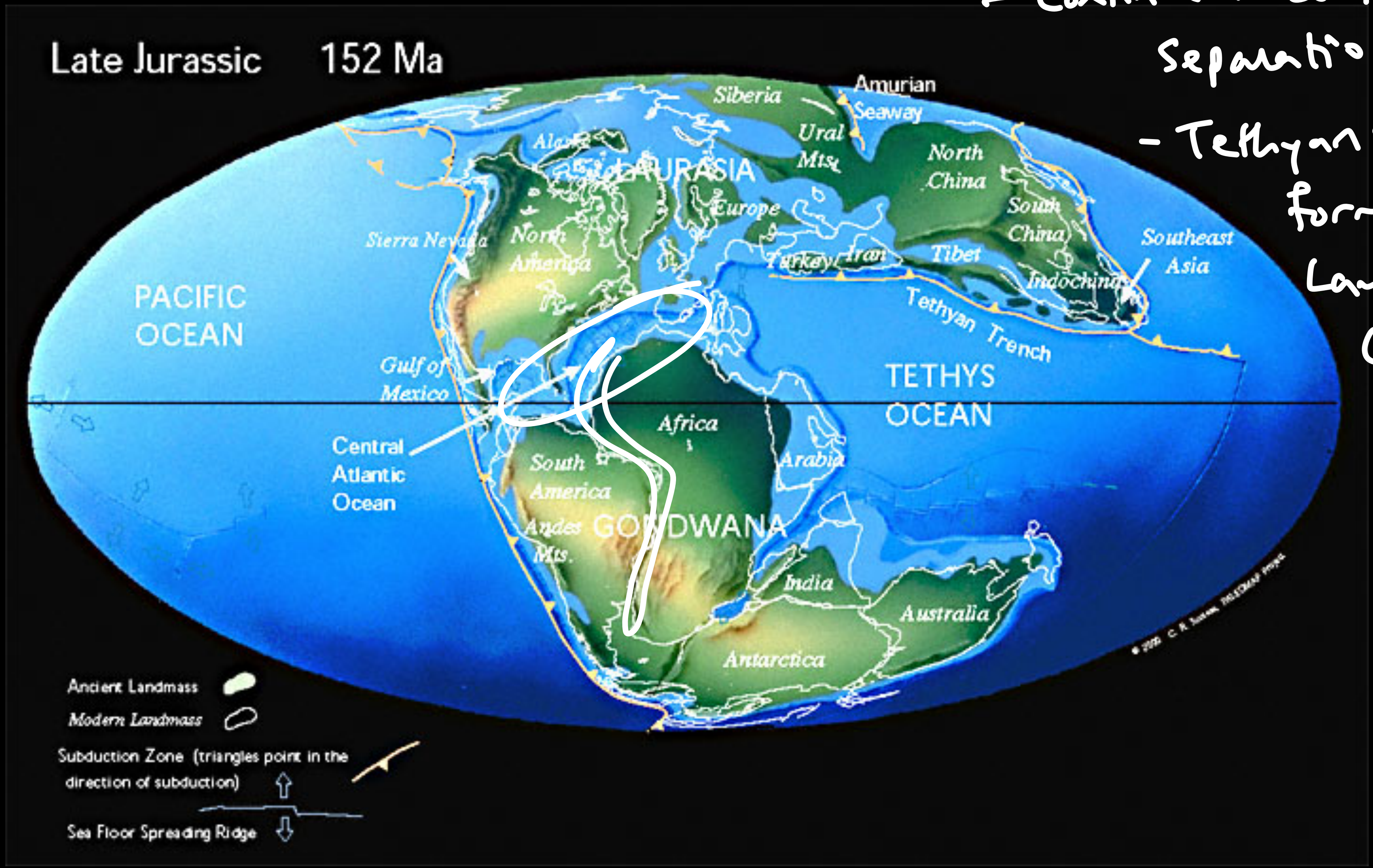


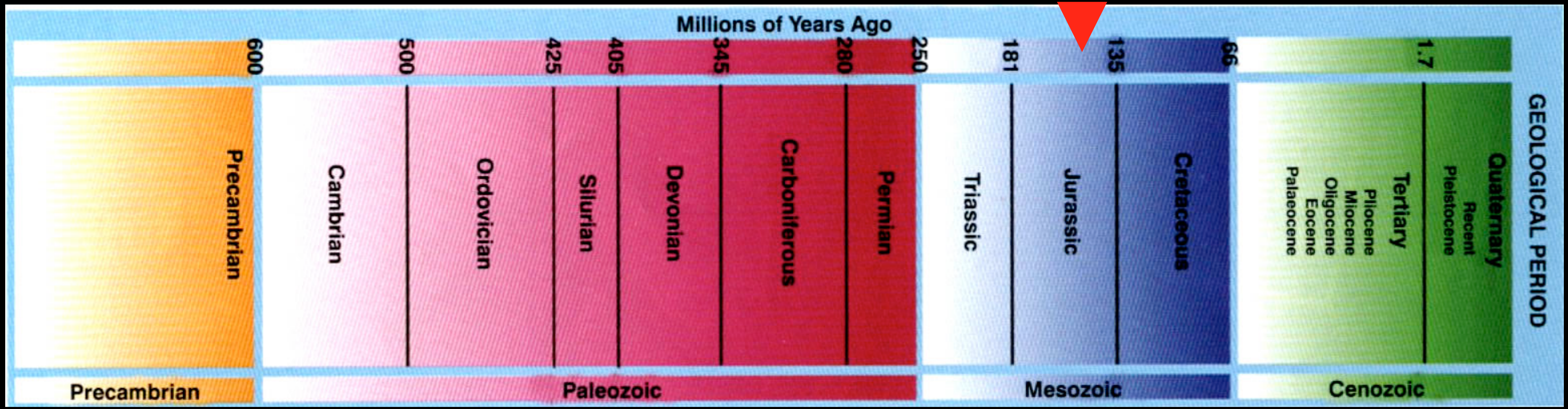


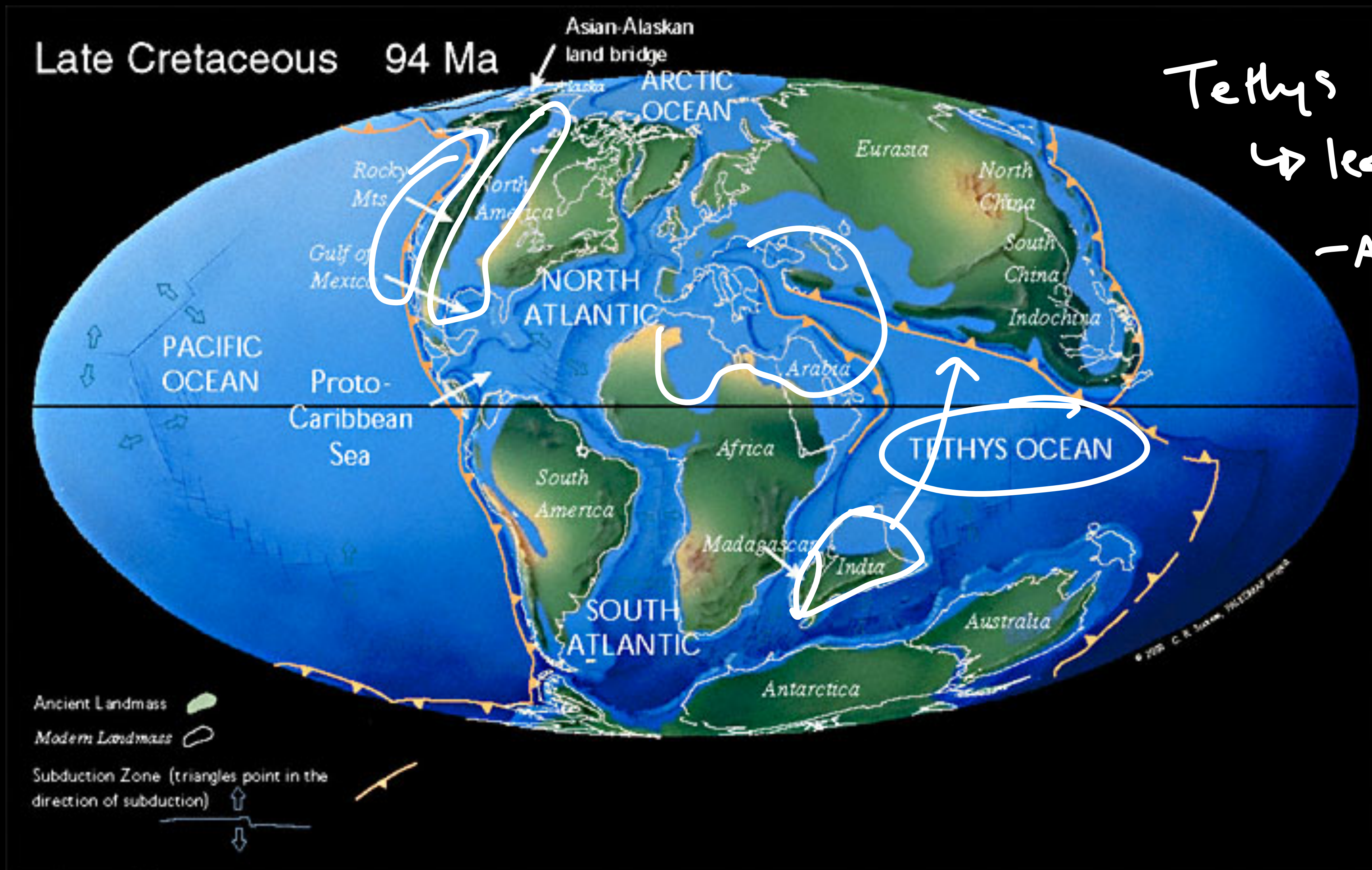
- Breakup of Pangea
- widening of seaways
- Epicontinental seas more common
- No ice caps
- Sea levels higher



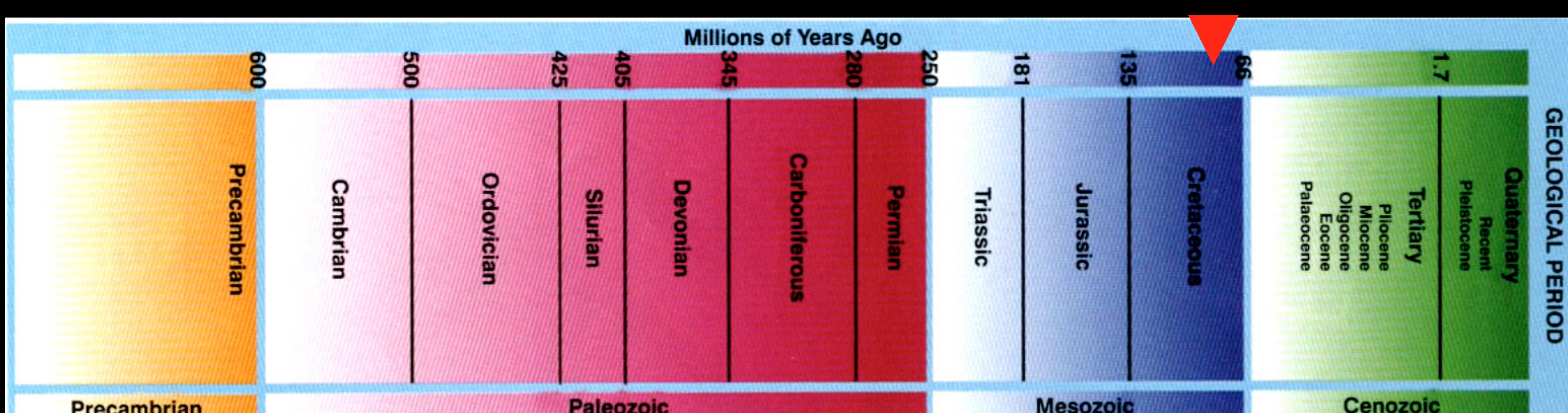
- Continued continental separation
- Tethyan seaway forms btw Laurasia & Gondwana

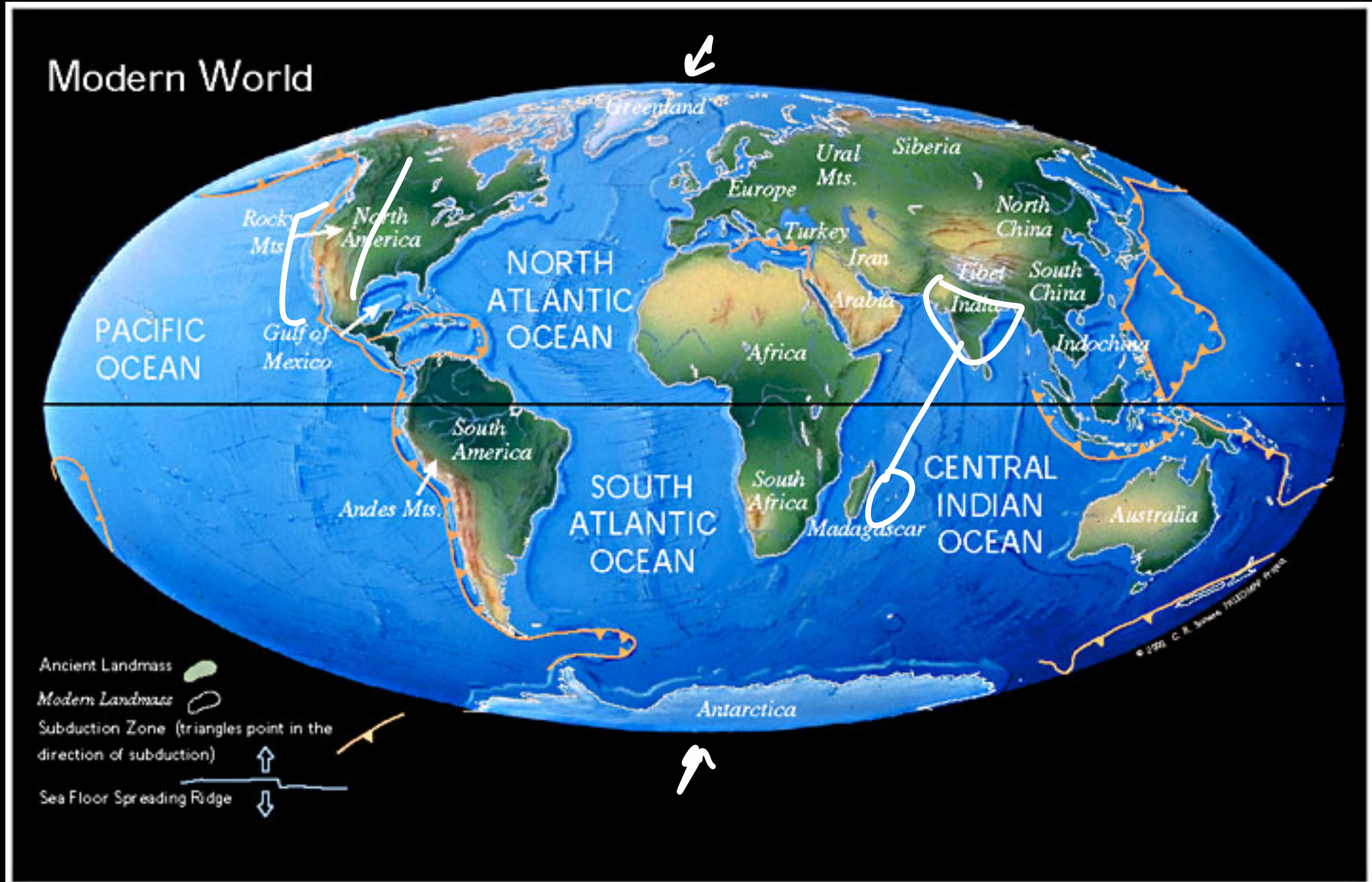






Tethys Ocean
→ less seasonality
- Africa / S. America
split




Modern World
Greenland
Ural Mts.
Siberia
Europe
North China
Rocky Mts.
North America
Turkey
Iran
Tibet
South China
India
Arabia
NORTH ATLANTIC OCEAN
PACIFIC OCEAN
Gulf of Mexico
Africa
Indochina
South America
Andes Mts.
SOUTH ATLANTIC OCEAN
South Africa
Madagascar
CENTRAL INDIAN OCEAN
Australia
Antarctica
Ancient Landmass
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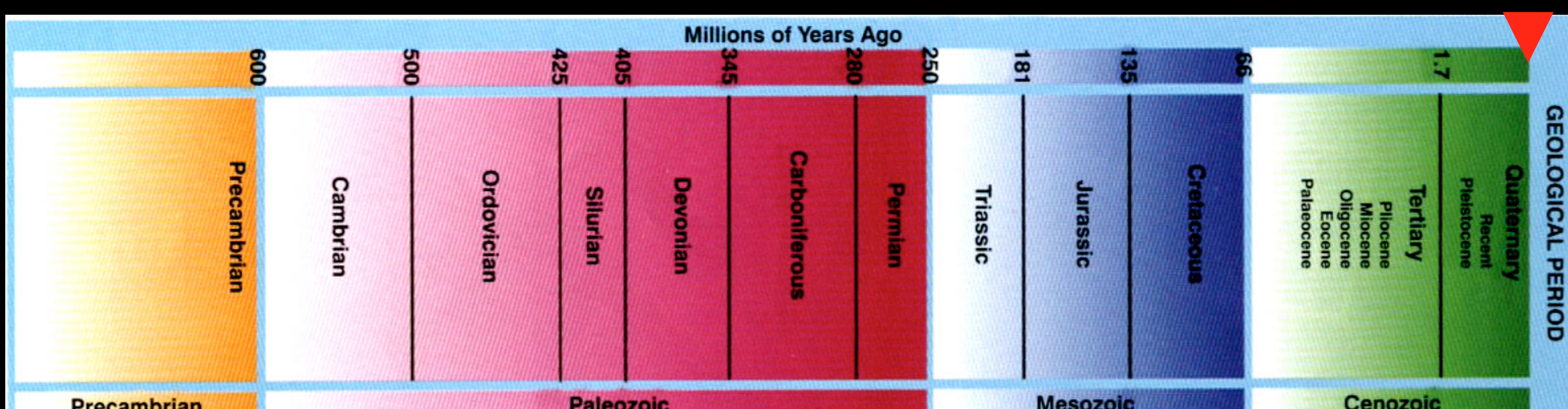
Millions of Years Ago
600
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Precambrian
Cambrian
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Cretaceous
Tertiary
Palaeocene
Eocene
Oligocene
Miocene
Pliocene
Quaternary
Pleistocene
Recent
GEOLOGICAL PERIOD
Precambrian
Paleozoic
Mesozoic
Cenozoic

Consequences

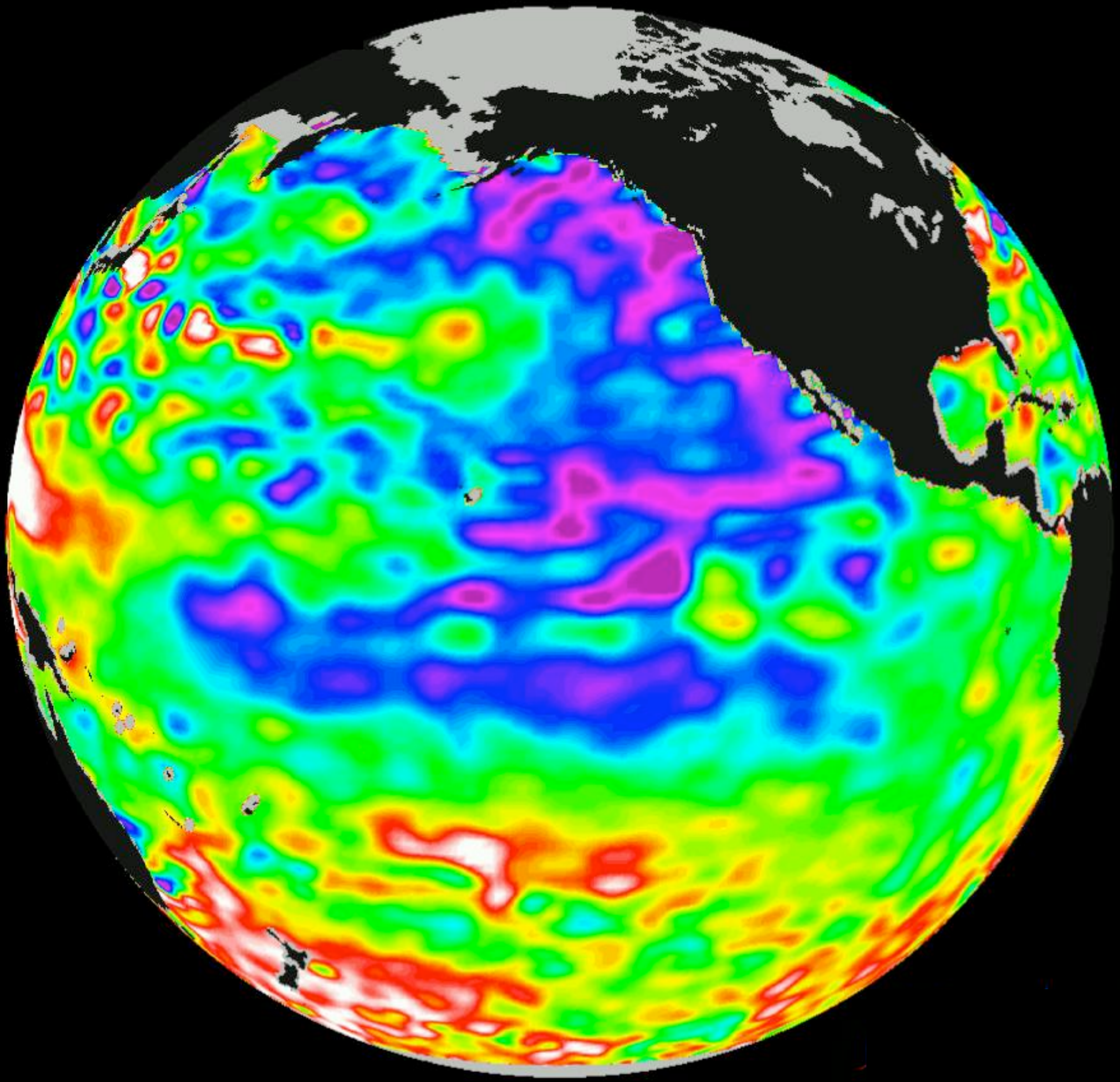
1) Pangea : More rapid warming/cooling — more intense than today

* ~~Moden~~ Modern continents tempered by oceans between them. Pangea didn't have this

2) Heat is distributed more equally through fluids than solids ~ oceans are slower to warm/cool than continents

Effects of large seas increase as Pangea breaks up. [lowers the magnitude/rapidity of temperature fluctuations]

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

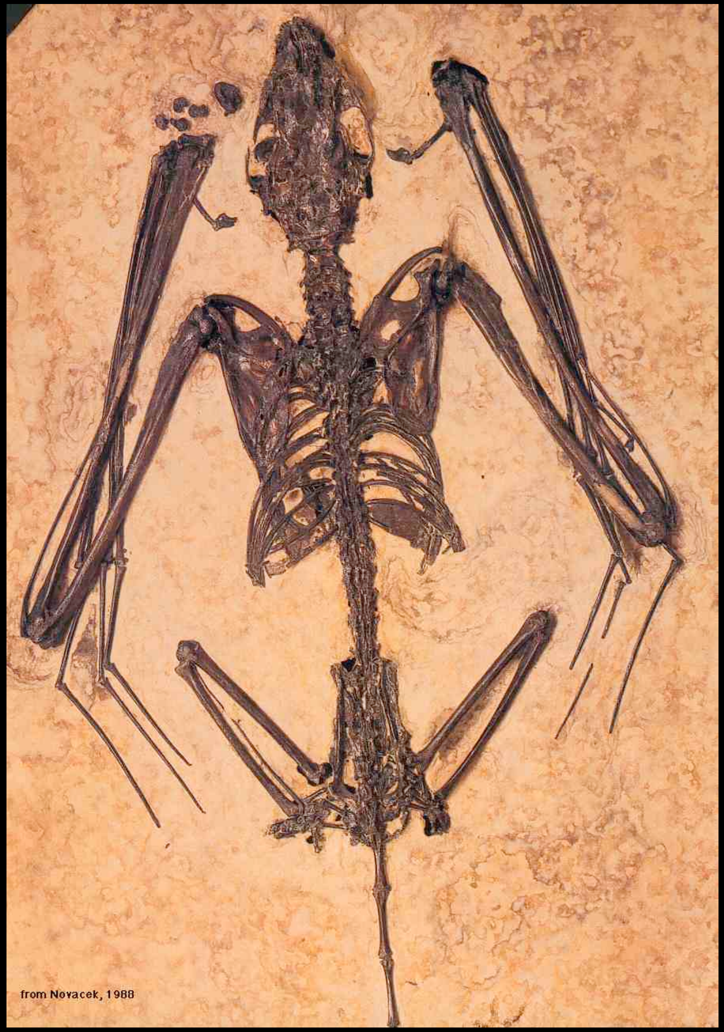
There is a lot that we don't know about dinosaurs…

Science is dynamic

Fossils and Preservation:

Fossils

From greek *Fossilis* = 'Dug Up'



Many meanings... types of fossils

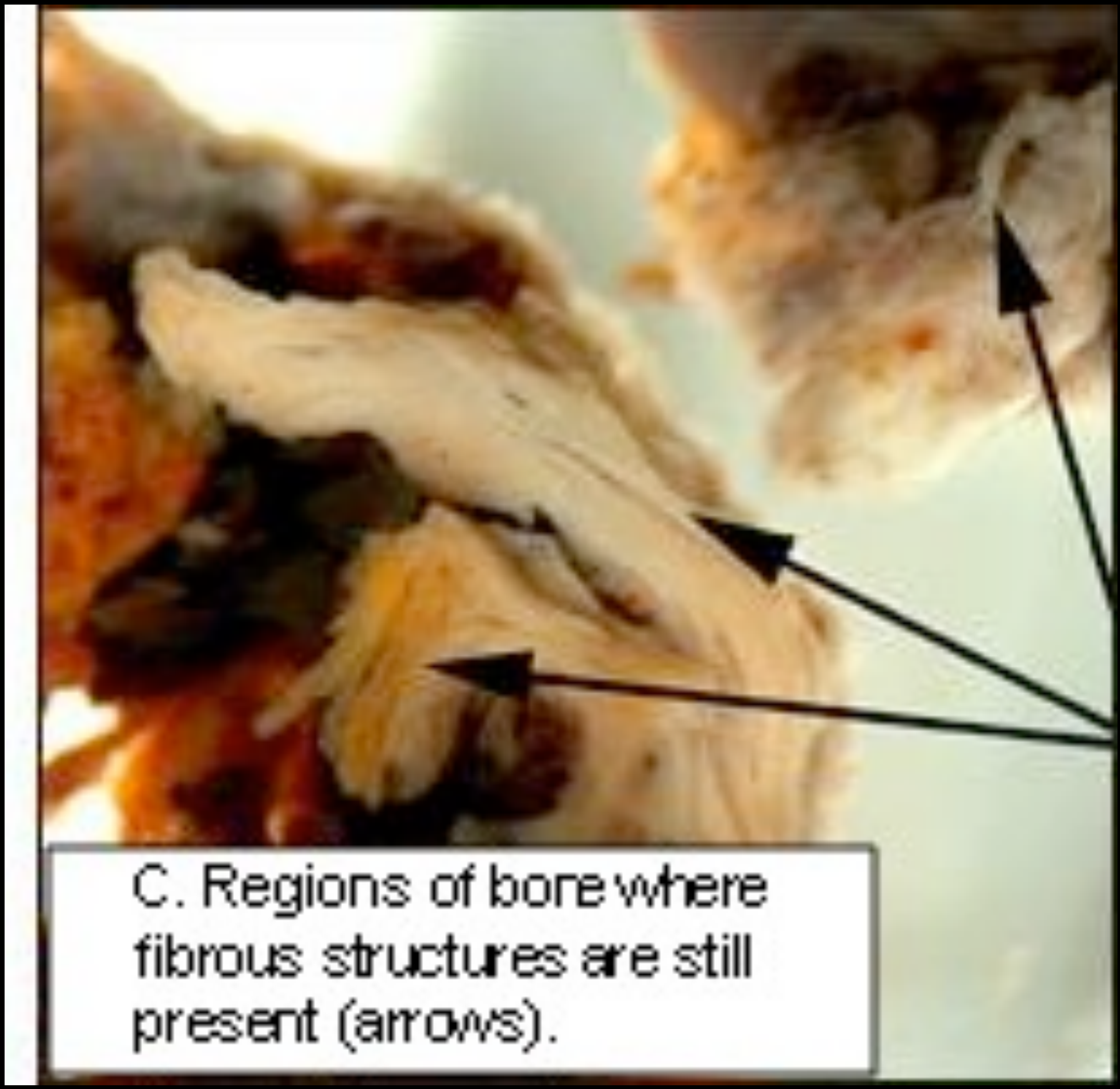
Trace Fossils

- Poo (Coprolites)
- Gastroliths
- Trackways

Soft Parts:
- Impressions
- Amber
- Protein???

Hadrosaur skin

T. rex collagen?



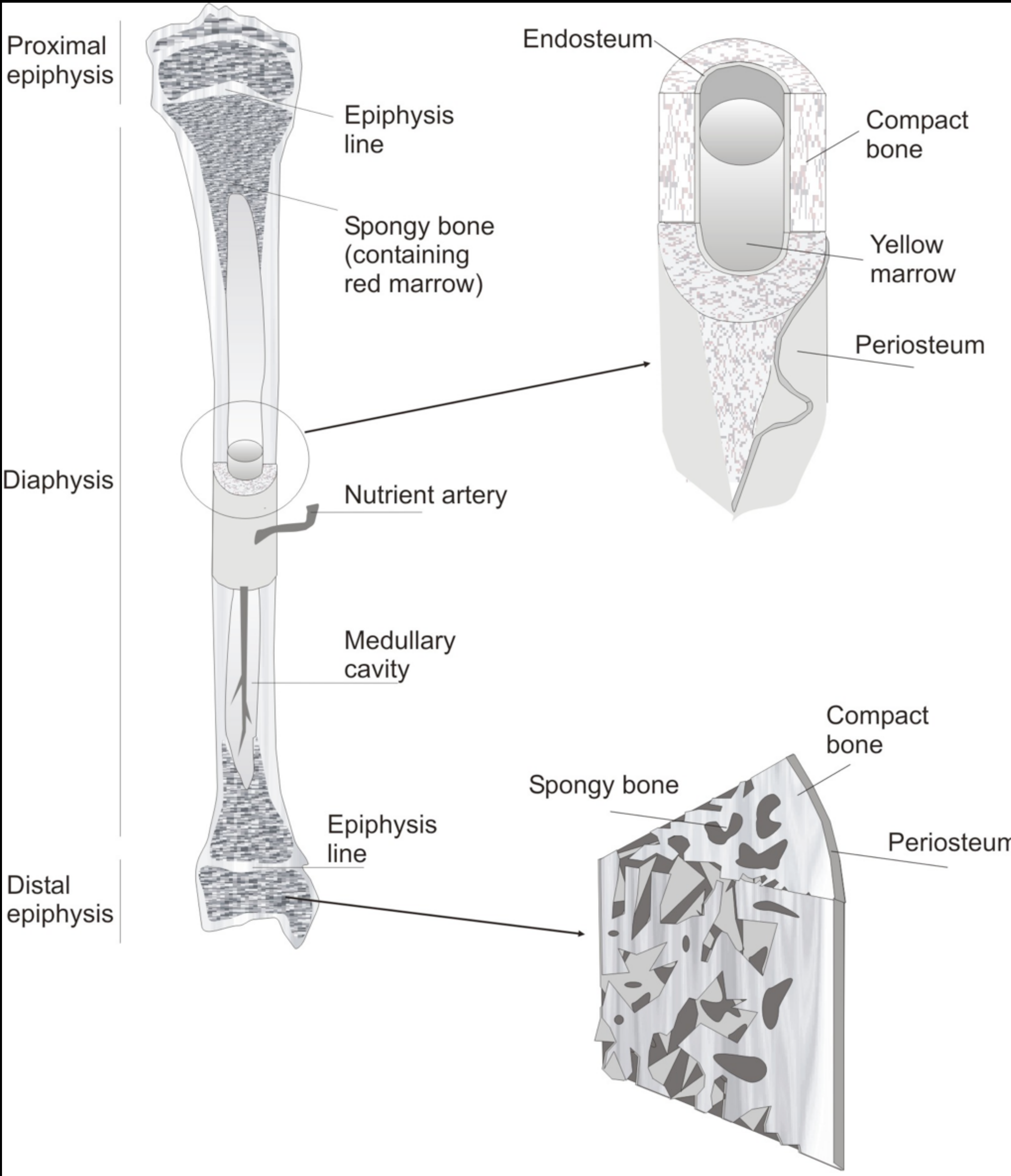
68 Ma

Hard Parts: Living vs. Fossilized

Tooth

Egg

Bone



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©

Living Bone

Bone Matrix

- Organic
  - **Collagen** protein
- Nonorganic
  - Hydroxyapatite

Fossil Bone

$Ca_{10}(PO_4)_6(F, OH, Cl)_2$

Apatite Mineral Francolite

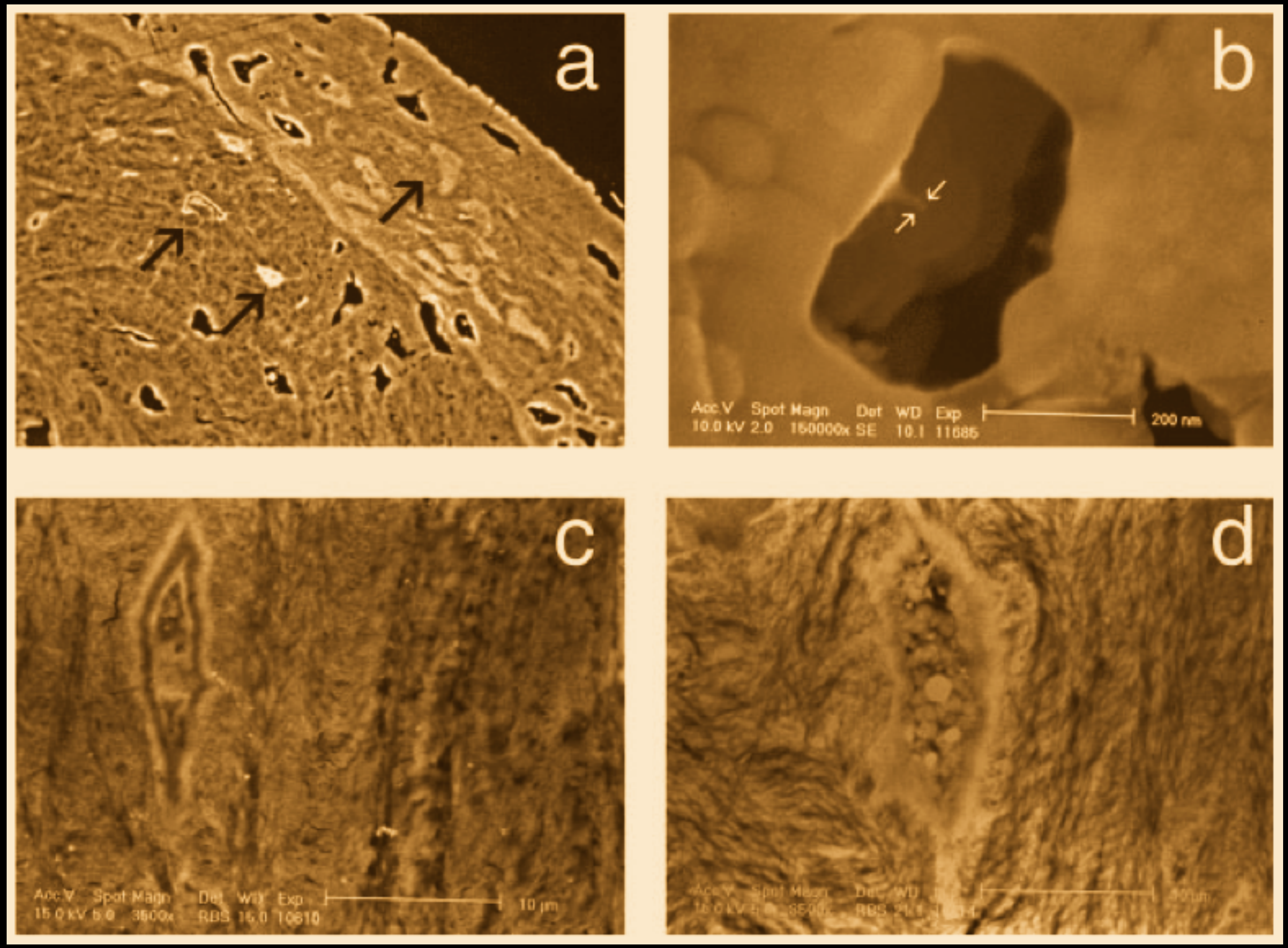
No longer biological- it's a rock.

Unaltered remains

Bogs

- Acidic peat bogs, tar pits
- Pickling

Fossilization: A fine scale process



Even osteocytes (bone cells) are preserved

Routes to Fossilization

Permineralization

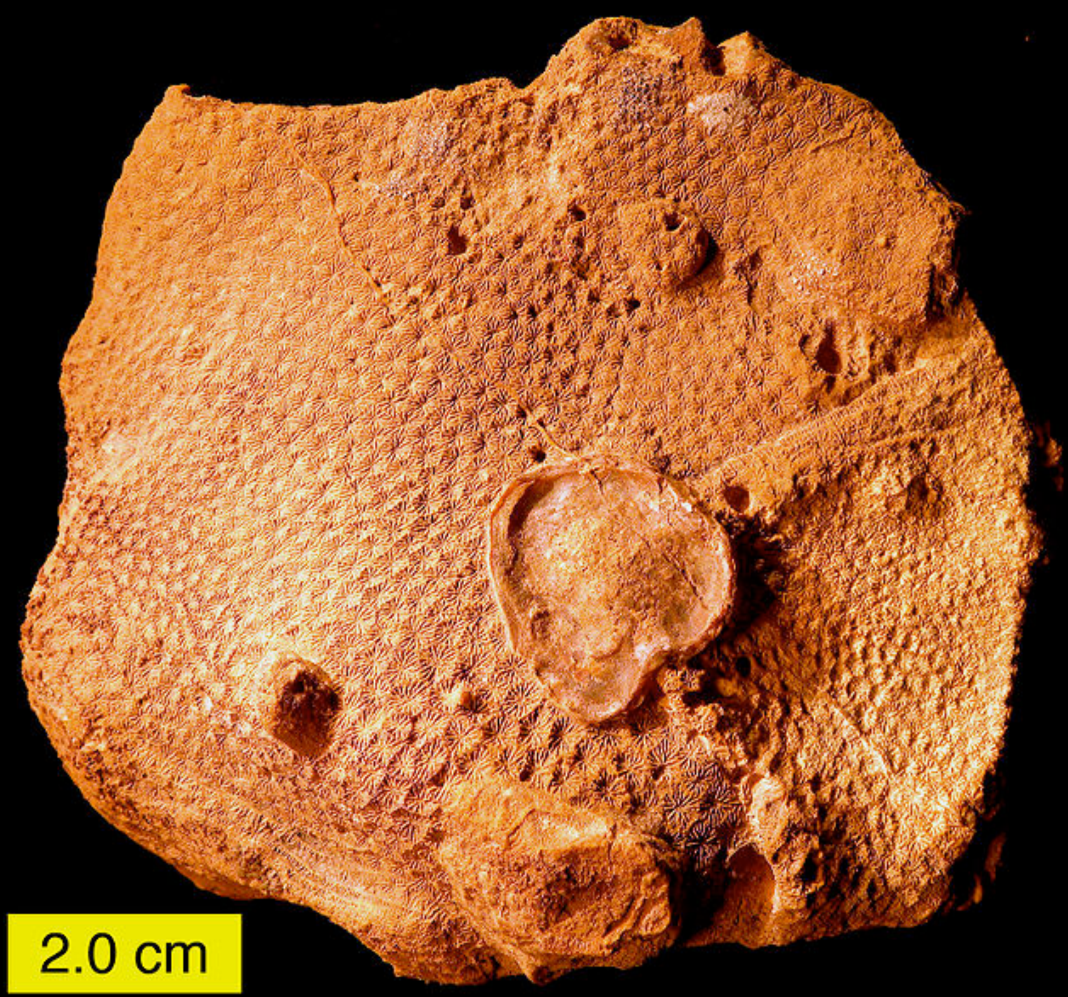
Trilobite

•Open spaces in organic material is filled up with minerals

•Crystals form within cell walls

•This type of preservation conserves cell structure

Routes to Fossilization



Fossil Coral: Jurassic

Mineralization and Recrystalization

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

Routes to Fossilization

Structure is typically compressed

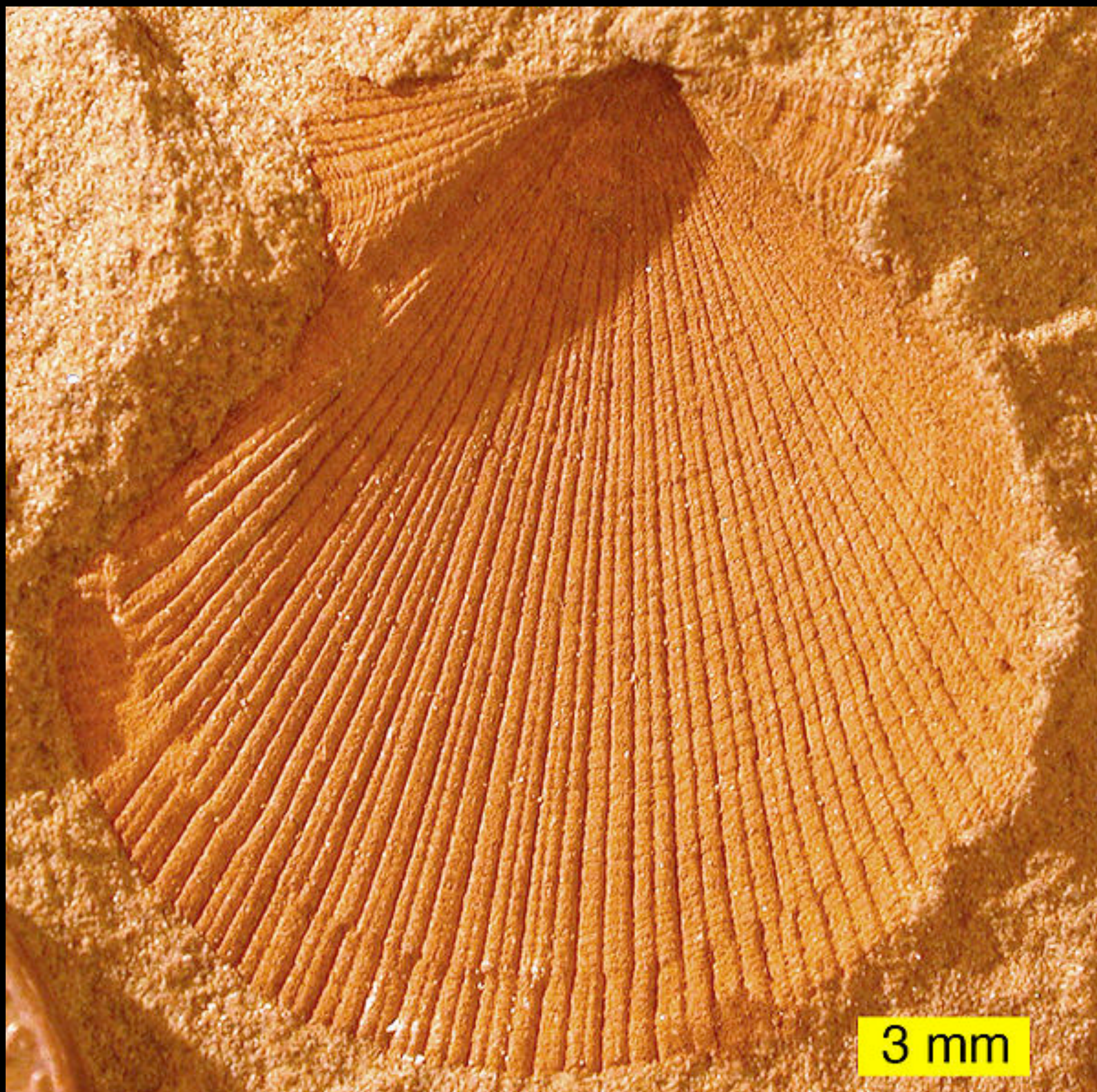
Pressure, heat force out gasses, liquids

Leaves behind a carbon film

!! Soft parts !!

Carbonization

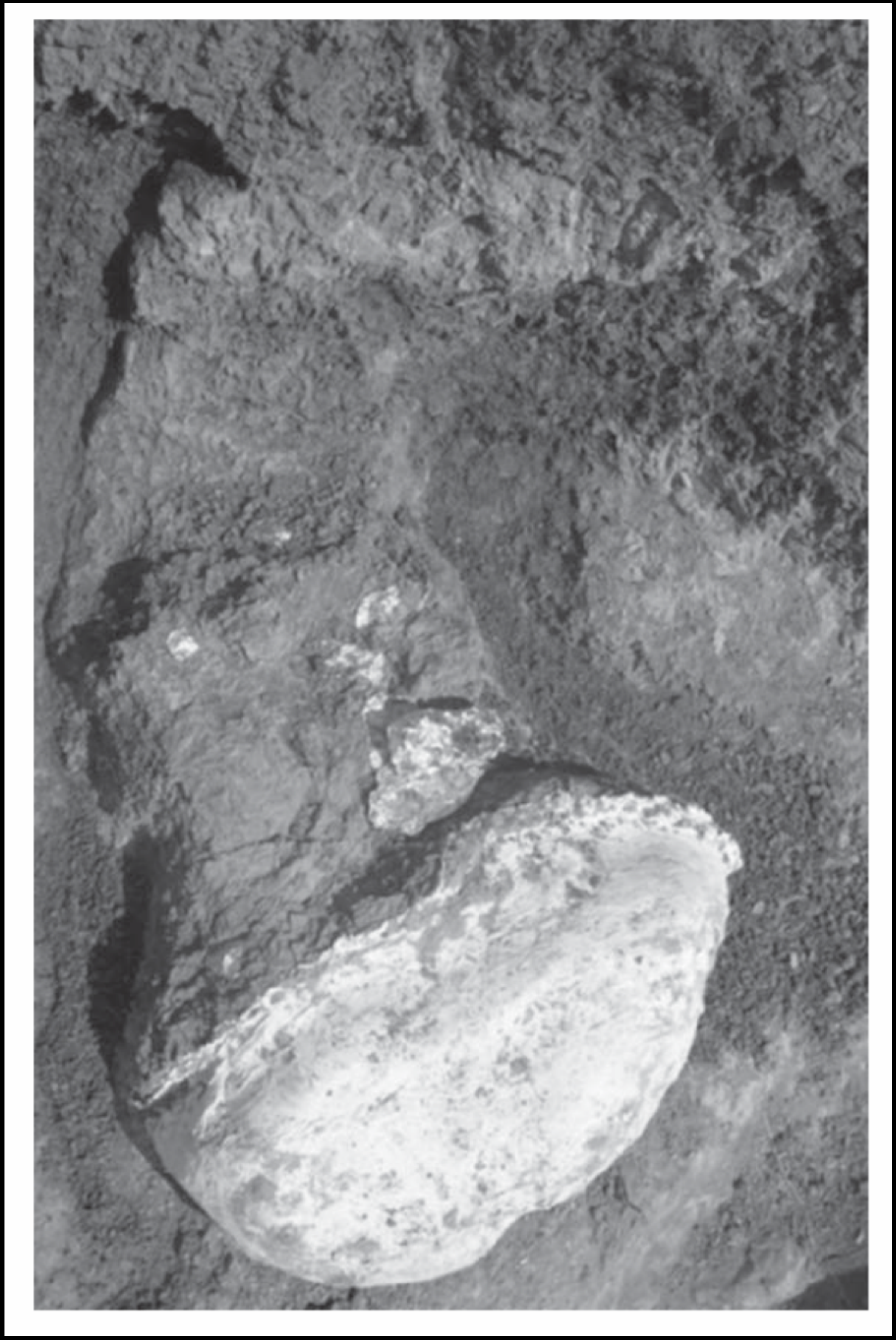
Routes to Fossilization



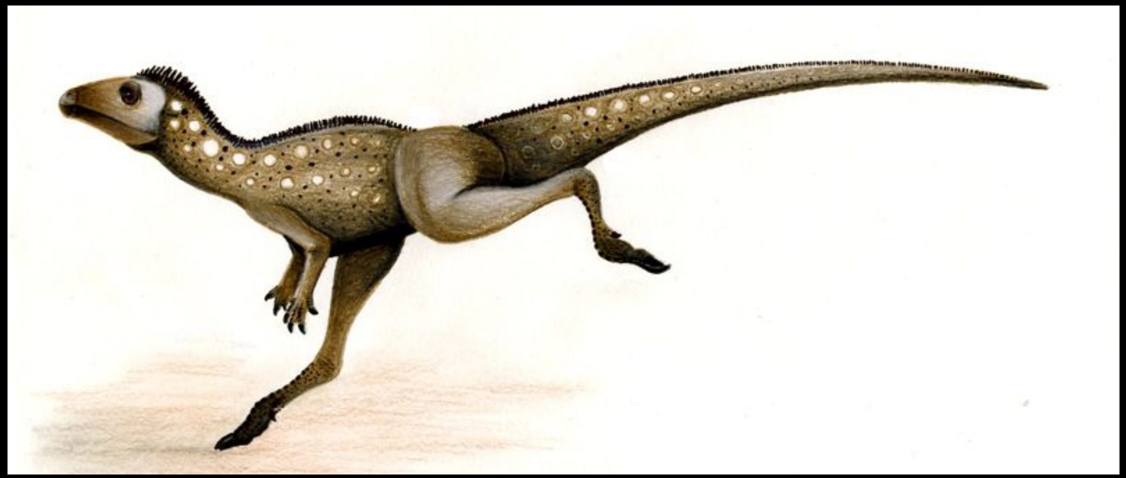
Molds, casts

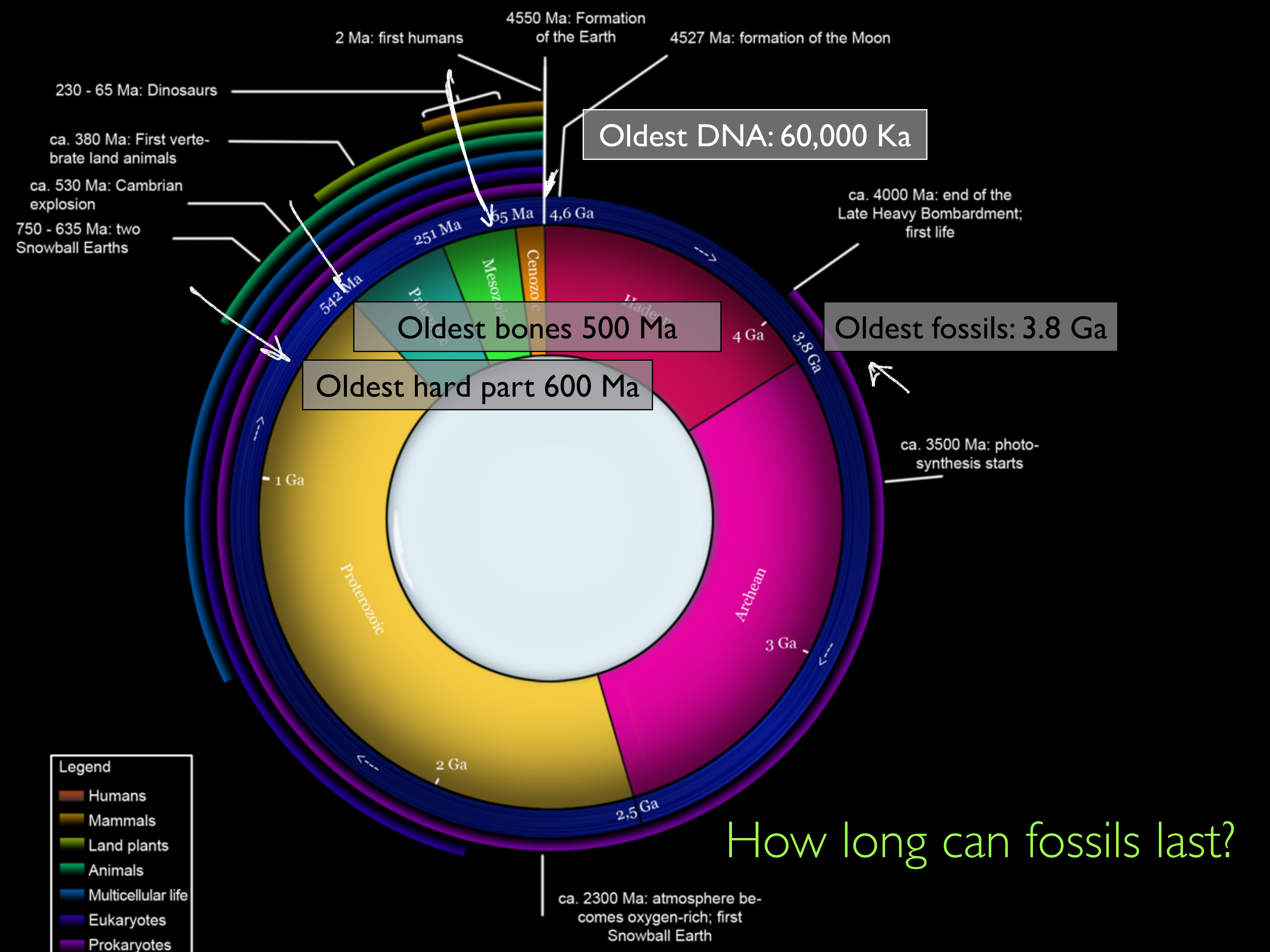
- Molds
- Casts
- Little or no original material

T. rex brain cast



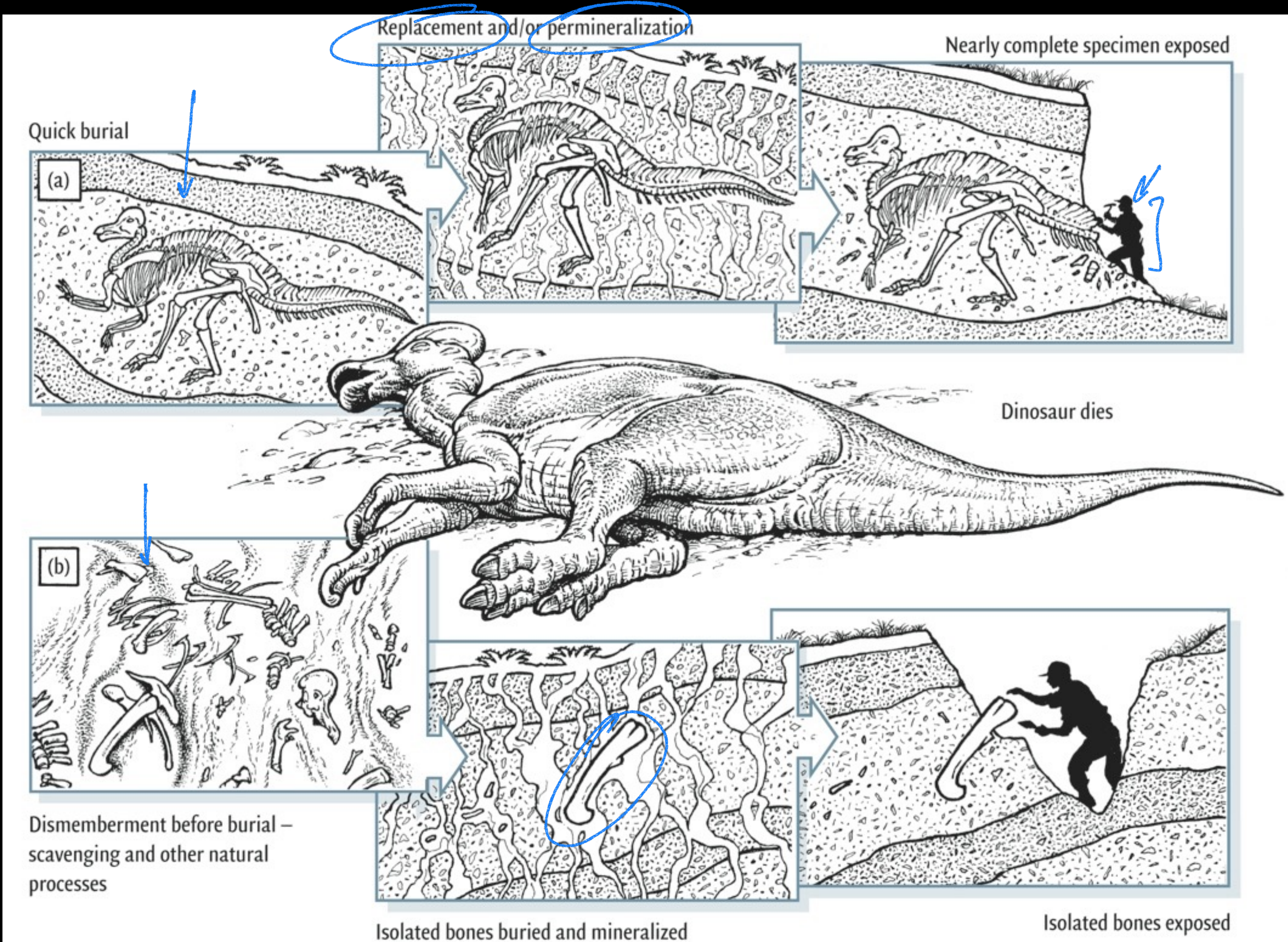
Oryctodromeus

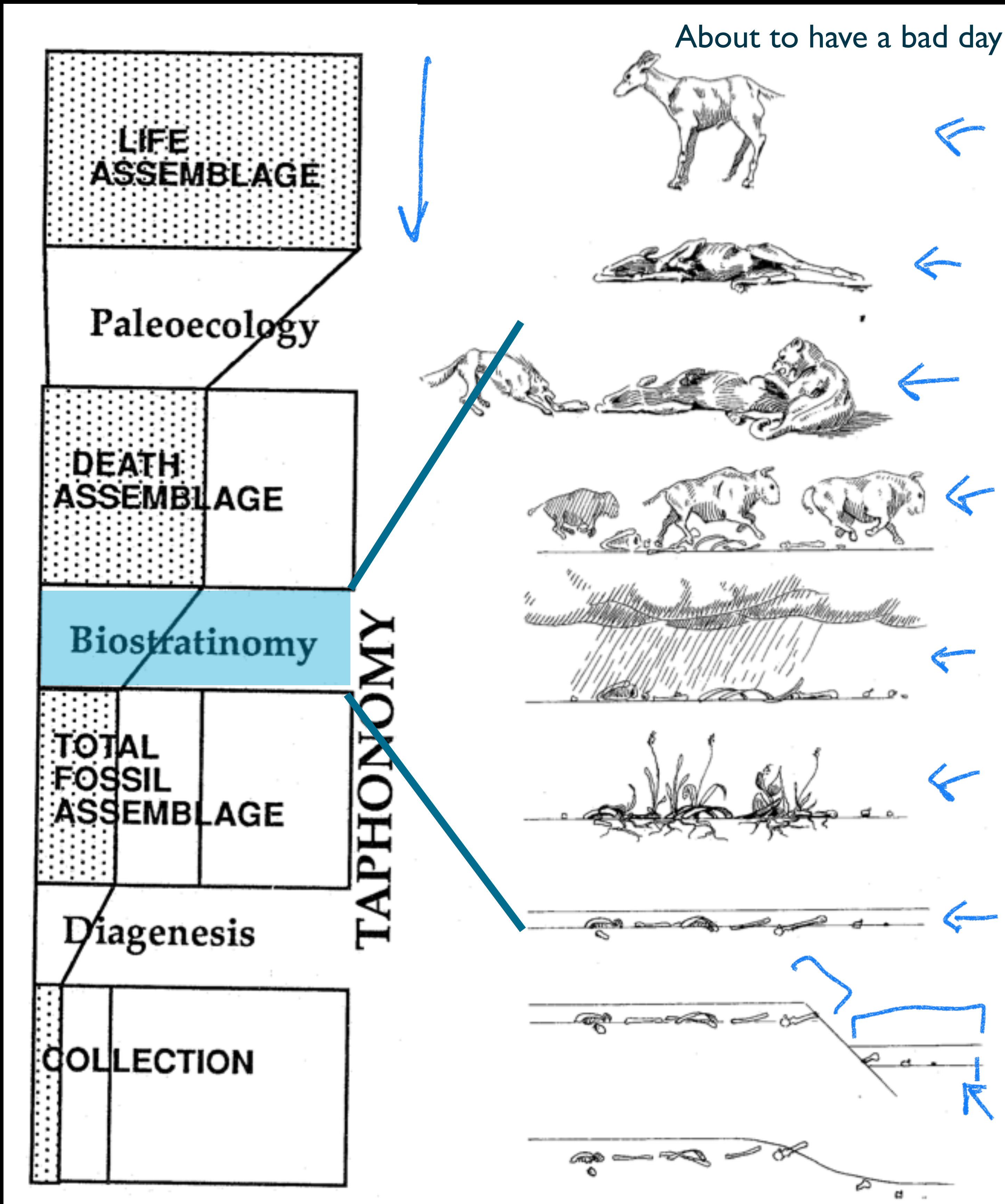




How long can fossils last?

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


Replacement and/or permineralization
Nearly complete specimen exposed
Quick burial
(a)
Dinosaur dies
(b)
Dismemberment before burial – scavenging and other natural processes
Isolated bones buried and mineralized
Isolated bones exposed



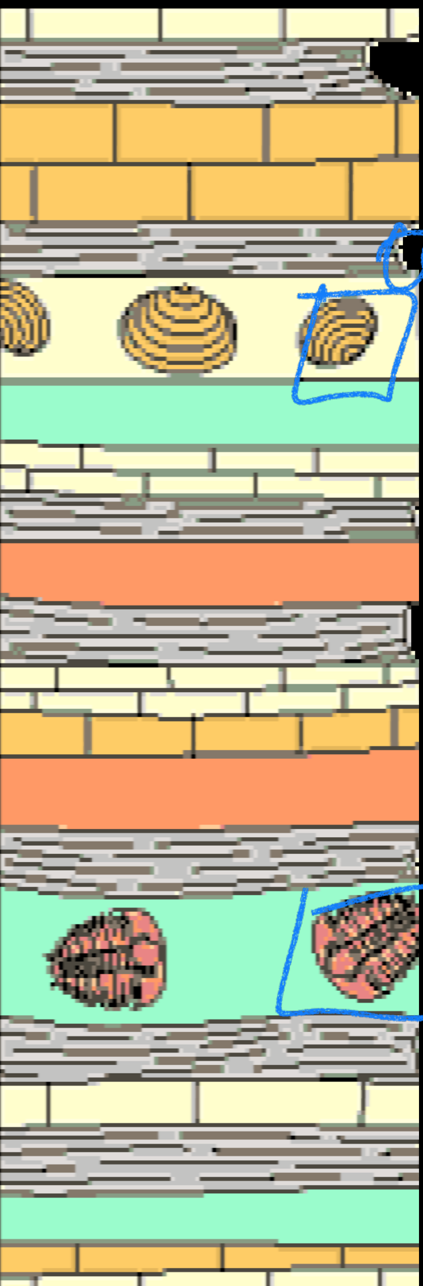
Key: Rapid Burial!

Placing fossils in TIME

Relative vs. Absolute Dating

YOUNGER

Sediments



495 Ma

510 Ma

520 Ma

545 Ma

Absolute dates
Volcanic Ash

Relative ages

Issues:

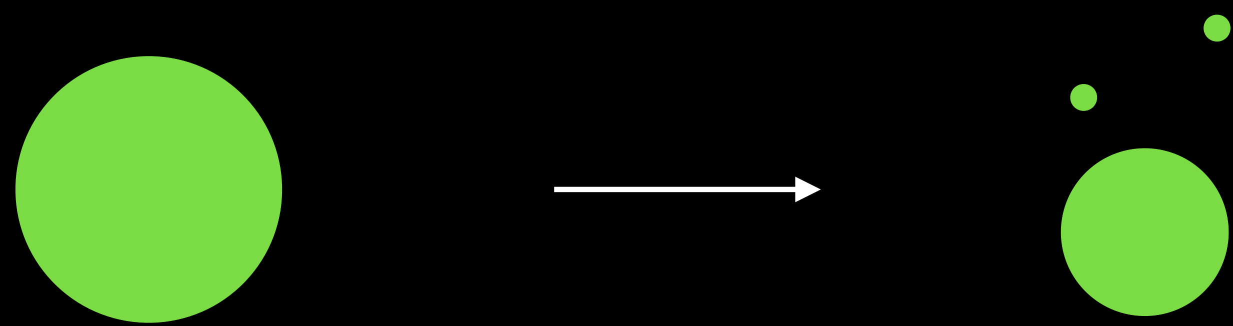
·Last appearance

·Lazarus Taxa

Principle of superposition

OLDER

Radiometric Dating
via radioactive (UNSTABLE) isotopes



If we know:
- -Original amt of parent isotope
- -How much of the parent isotope is left
- -Rate of decay of that isotope

Then we can estimate:
Amount of elapsed time

Absolute dating!

- Material must be chemically inert
- Must have radioactive isotopes
- Must be 'right type' of radioactive isotopes

Radioactive Isotope: ^{14}C

$$^{14}_{6}C \xrightarrow{\text{Rate}} {}^{14}_{7}N + \text{heat} + e^- \; \bar{\nu}_e$$

electrons

electron antineutrinos

6 protons

8 neutrons

Decay process

Isotopes have ~~at~~ the same # of ~~pro~~ protons, different numbers of neutrons

Carbon: half life (50% is broken down)

5730 years

$^{40}K - ^{40}Ar$: 1280 MY

$^{235}U - ^{207}Pb$: 707 MY

Biostratigraphy

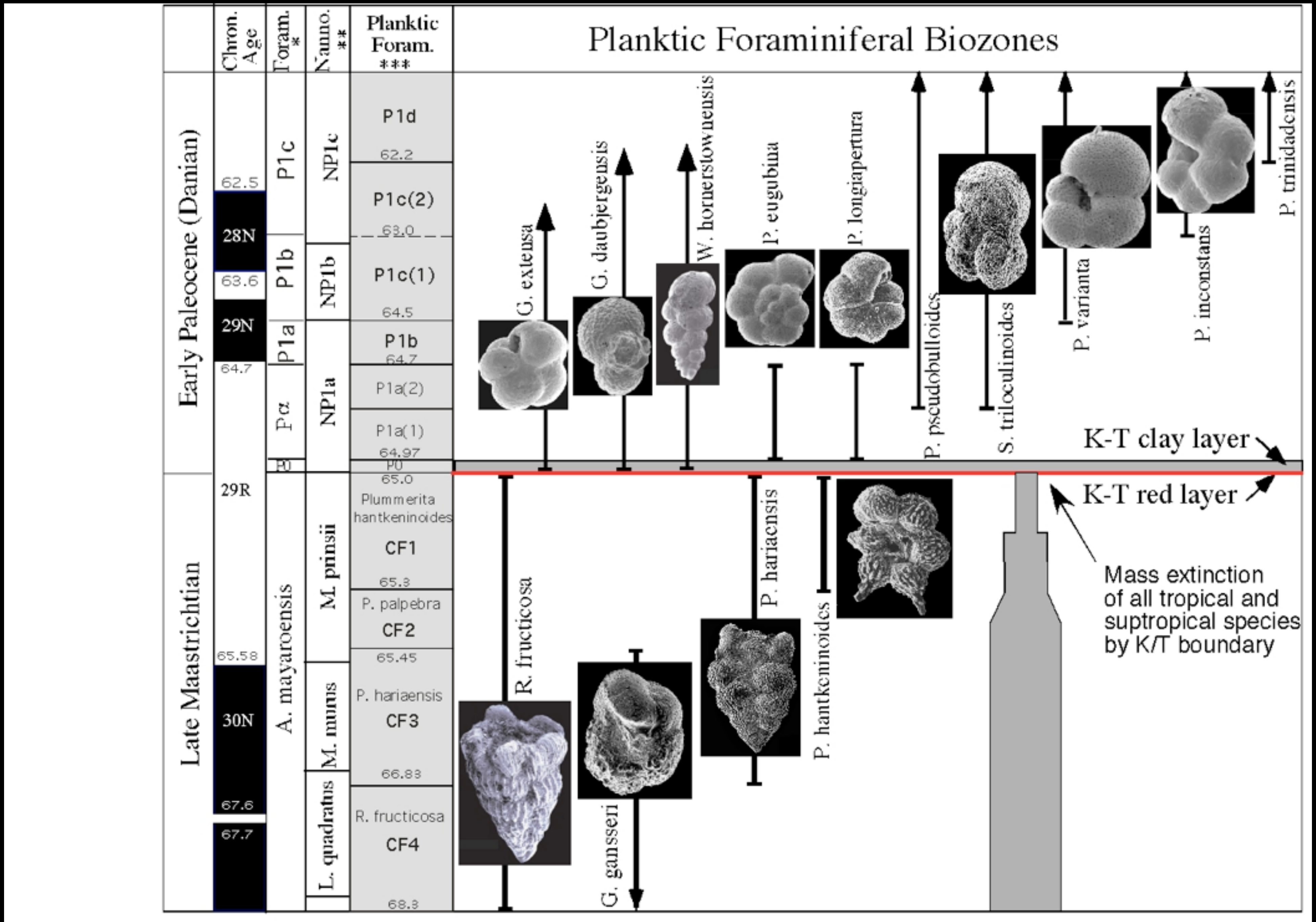


Figure 2

Relative Dating