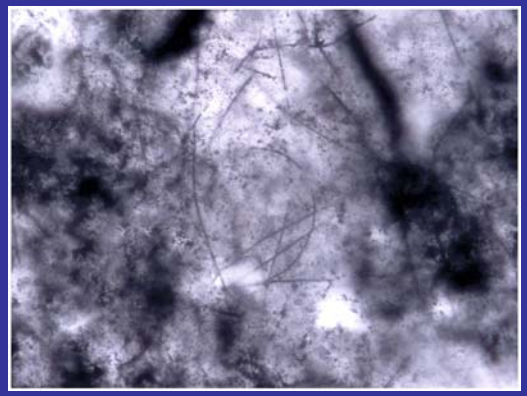
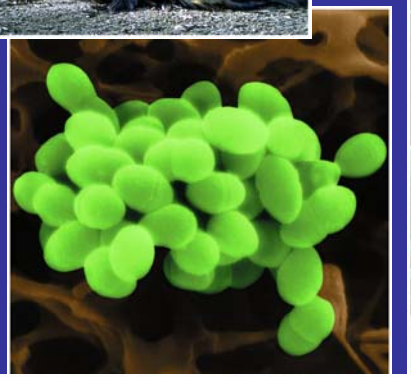












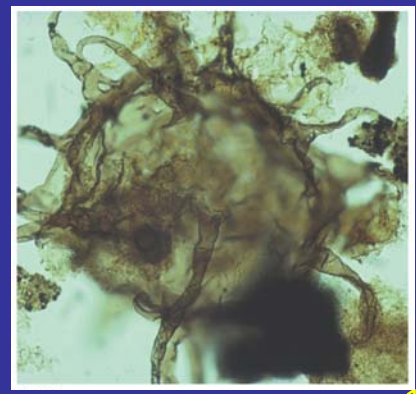


Similarities?

A) Breathing
B) Digestion
C) Cellular structure
D) Warm blooded
E) Living

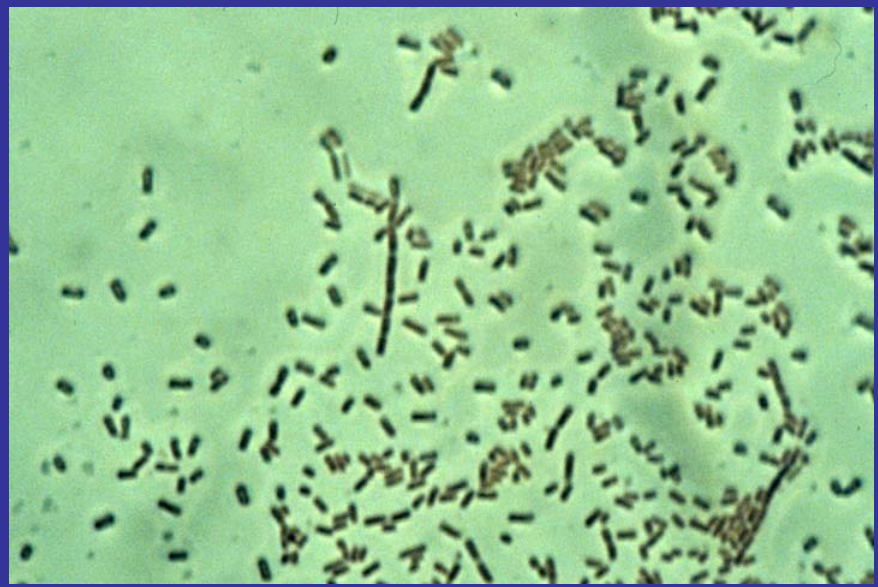






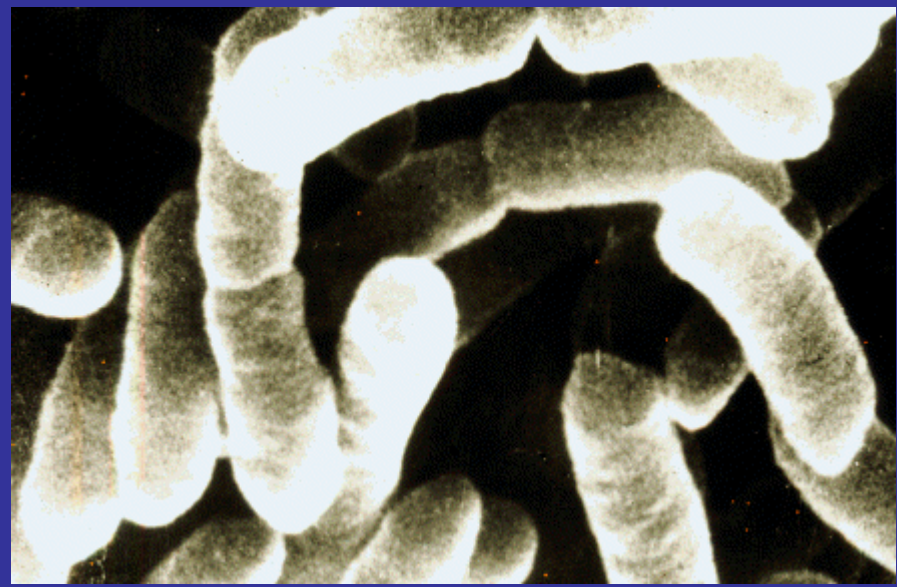
What defines

LIFE?



Bacteria

Self-replicating



Virus

Only under special circumstances









What defines

LIFE?

1) Self-replicating
2) Self-regulating
(Homeostasis)
(Metabolism)
3) Organization
4) Growth
5) Adaptation
6) Response to Stimuli



Why is Earth UNIQUE?

A) The right size

B) Right temperature

C) Water is liquid

D) Seasonality

E) Polar ice caps



Why is Earth UNIQUE?

A) The right size

B) Right temperature

C) Water is liquid

These traits allow Earth to host LIFE

James Ussher (1581–1656) Anglican Archbishop of Armagh and Primate of All Ireland

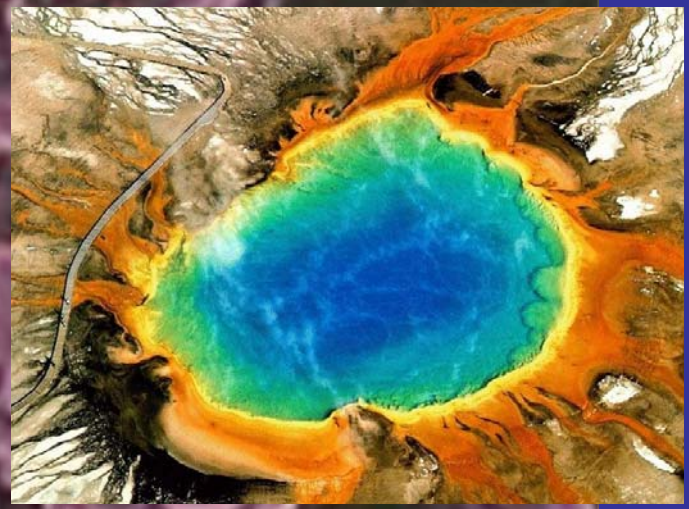


4004 BC - Creation
(at nightfall preceding 23 October)

2348 BC - The Great Flood
1921 BC - Yahweh's call to Abraham
1491 BC - The Exodus from Egypt
1012 BC - The founding of the Temple in Jerusalem
586 BC - The destruction of Jerusalem by Babylon and the beginning of the Babylonian Captivity
4 BC - The birth of Christ

Published 1650, therefore age of Earth assumed to be 5,654 yrs old.


Where did life originate?
How do we know?



Archaebacteria tolerate extreme environments:

<u>HIGH</u>

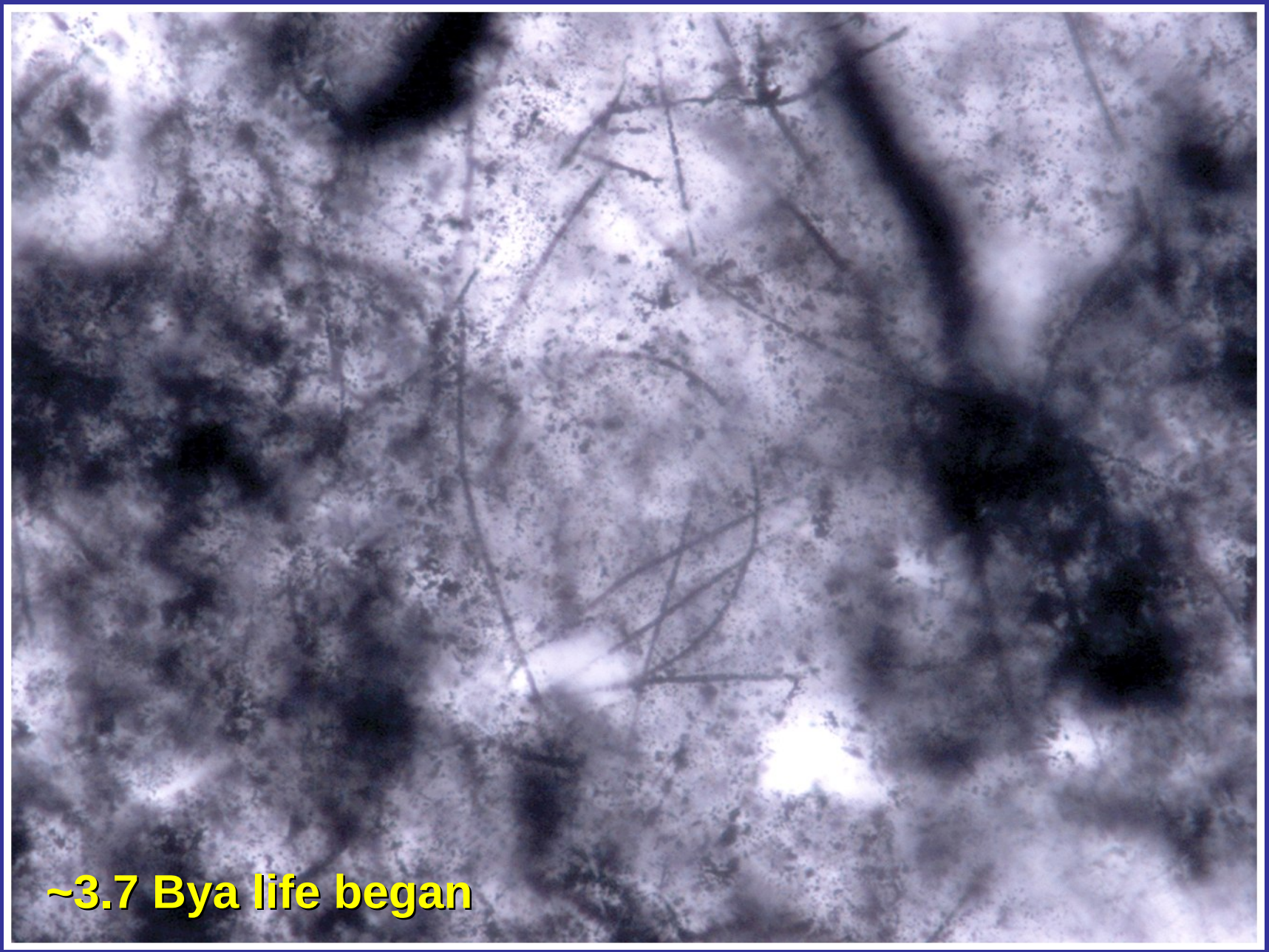
1) temperature

2) salinity

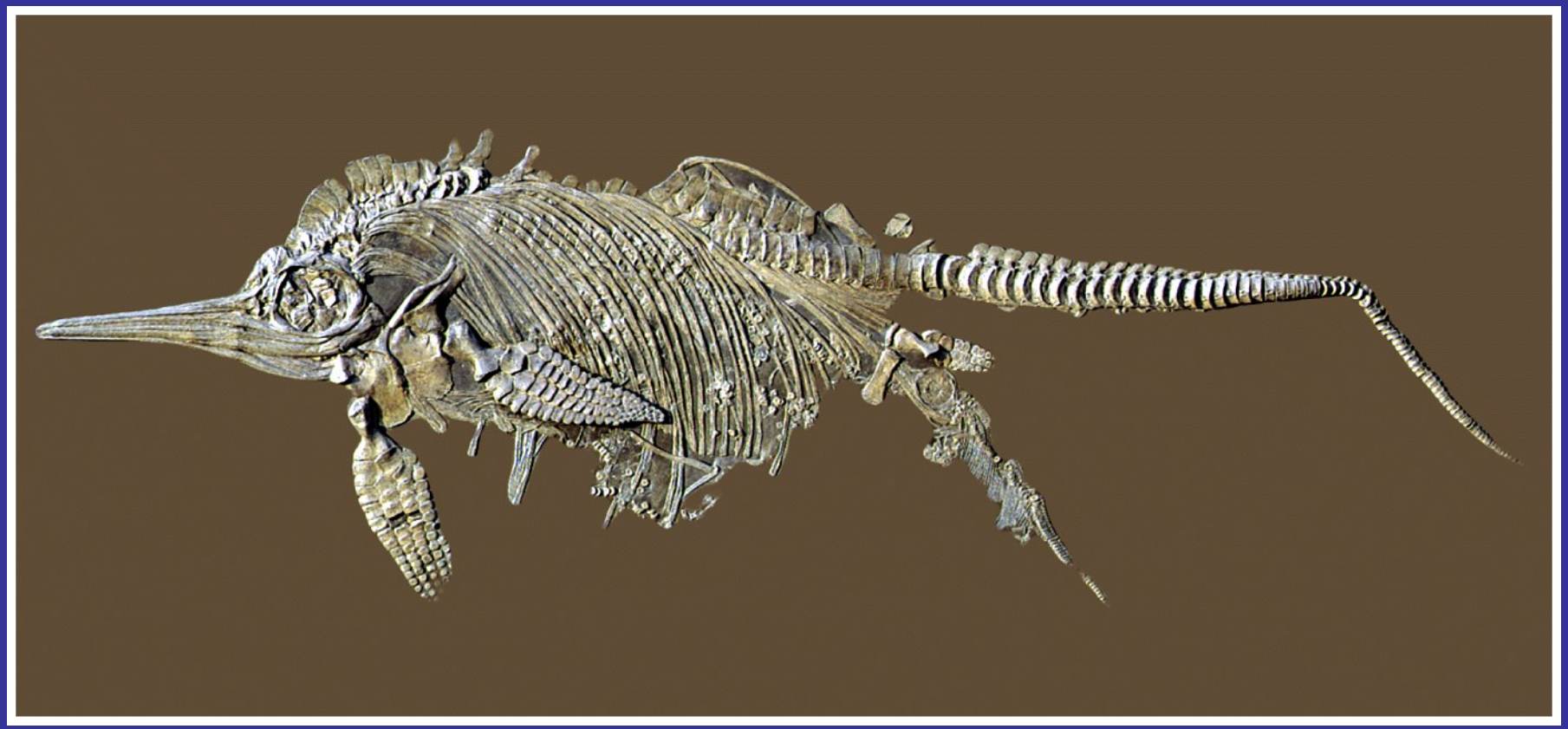
3) acidity



Oldest known fossil? Host rock 3.2 billion yrs old.



What two factors influence fossil preservation?

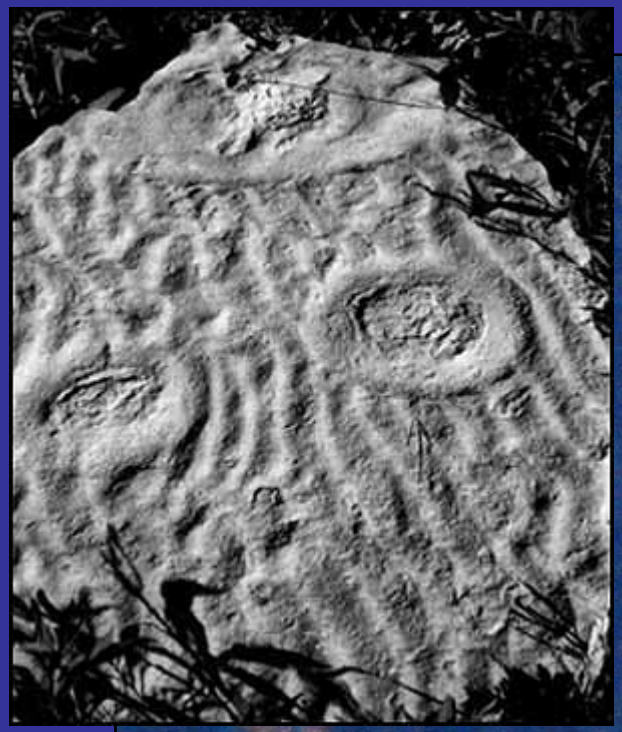


Icthyosaur (Jurassic 206-144 Mya)

What two factors influence fossil preservation?

1) Hard parts

2) Rapid burial



Cambrian (525 Mya)

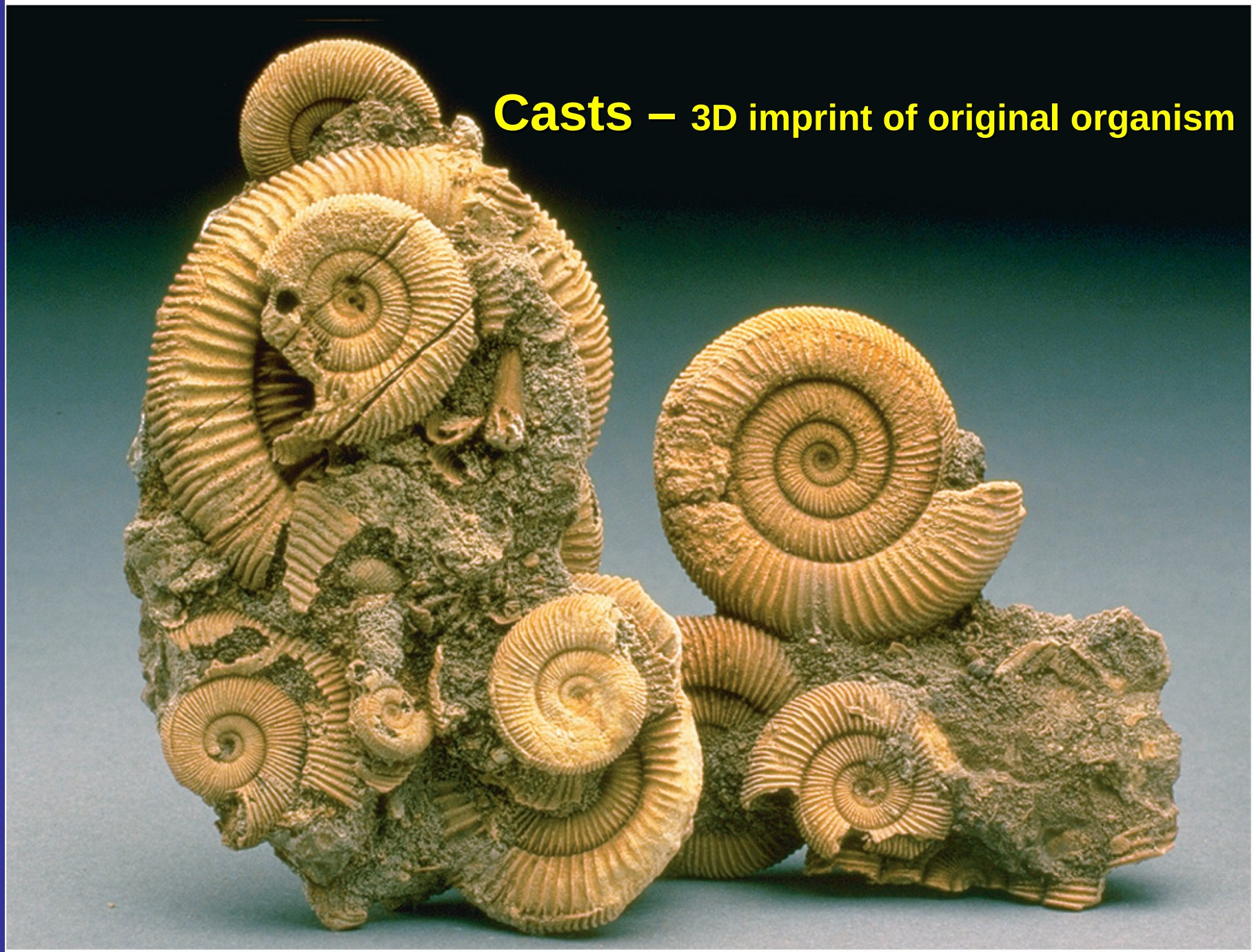


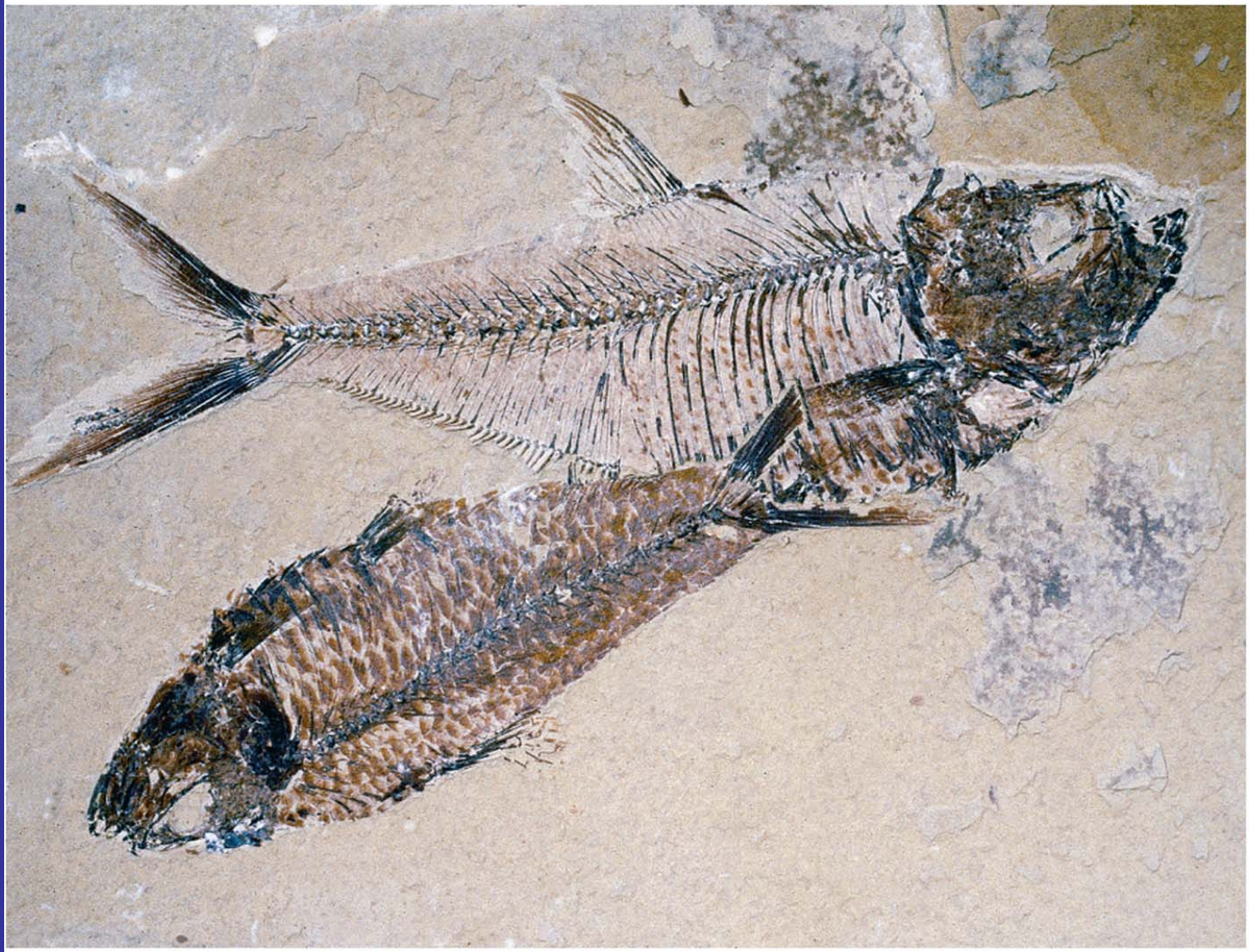
Eocene Mammal (54.8-33.7 Mya)

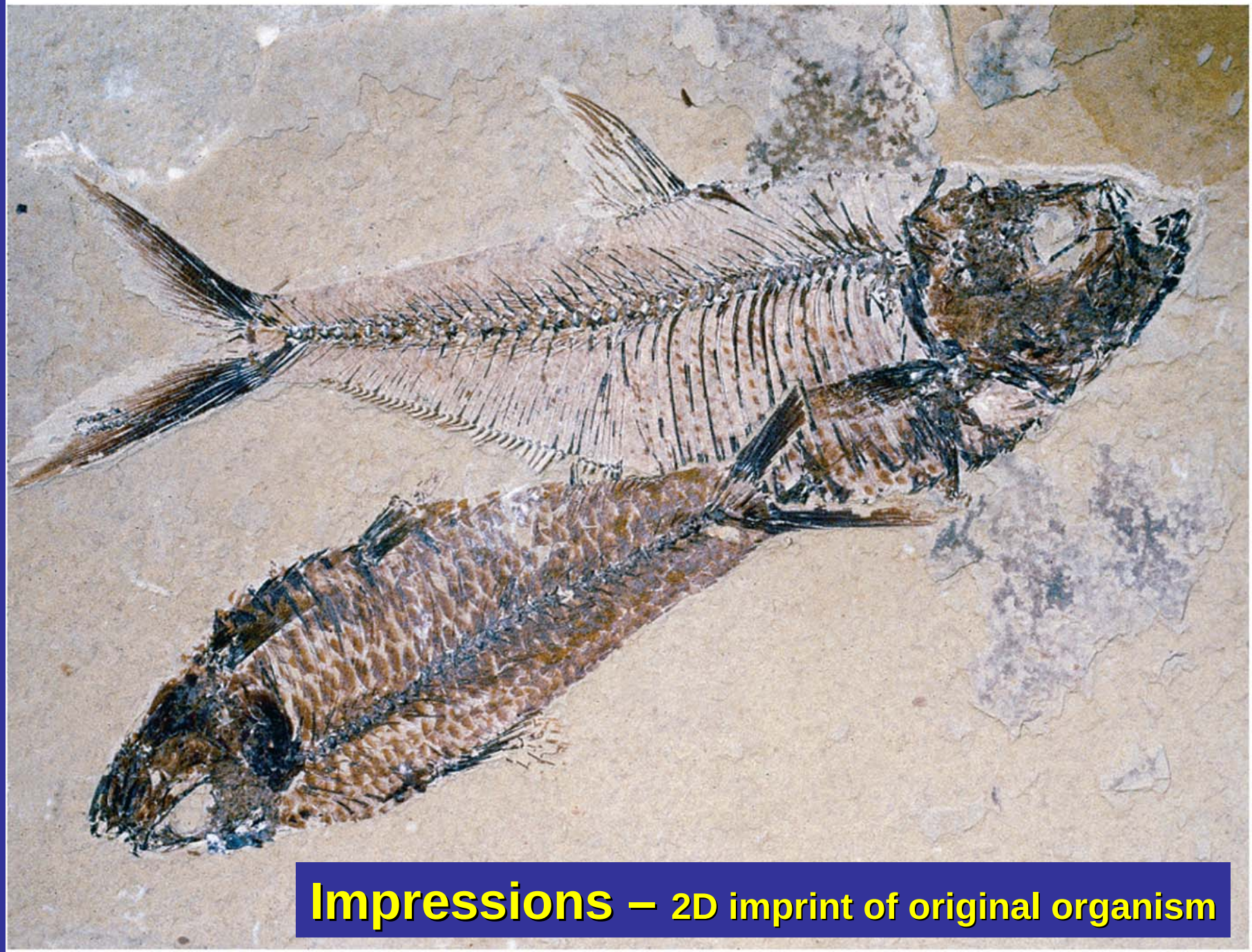



Petrified Wood – organic materials replaced with minerals




Casts – 3D imprint of original organism





Impressions – 2D imprint of original organism




Carbon films –
anoxic burial preserves carbon residue



What is this fossil?

A) Worm burrow

B) Dinosaur egg sack

C) Poop

D) Snakeskin

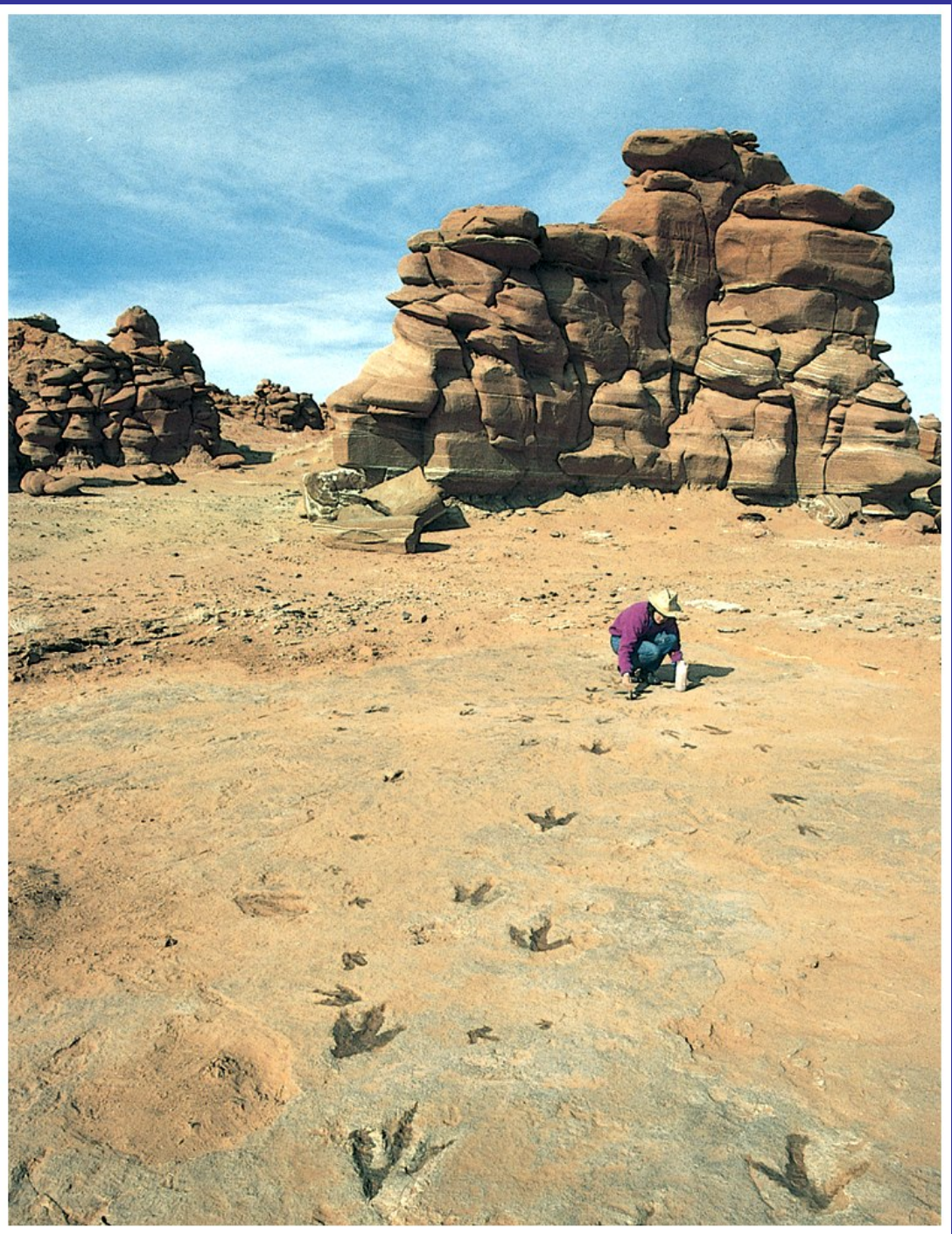
Coprolites (feces)

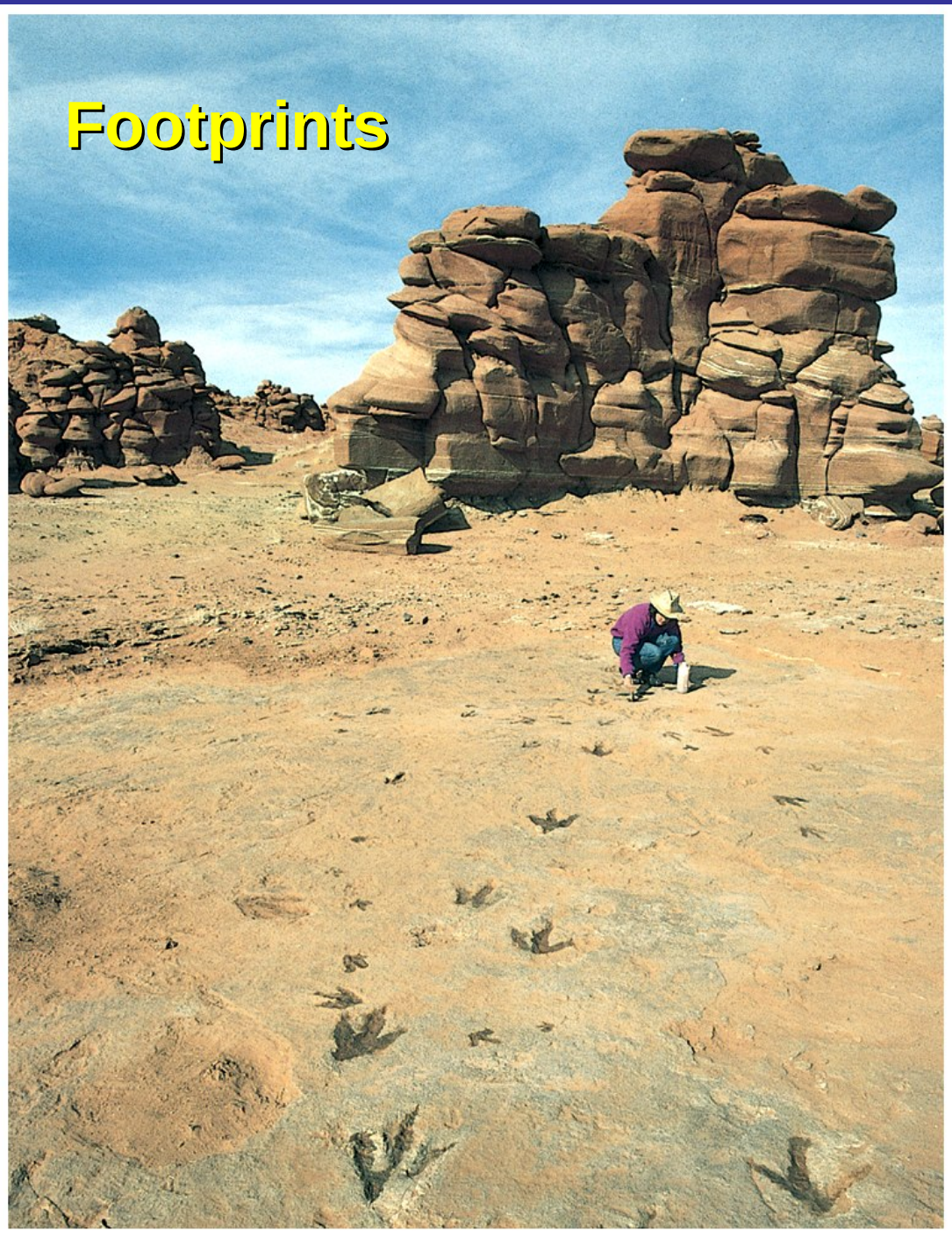







Amber – fossil tree resin




Footprints

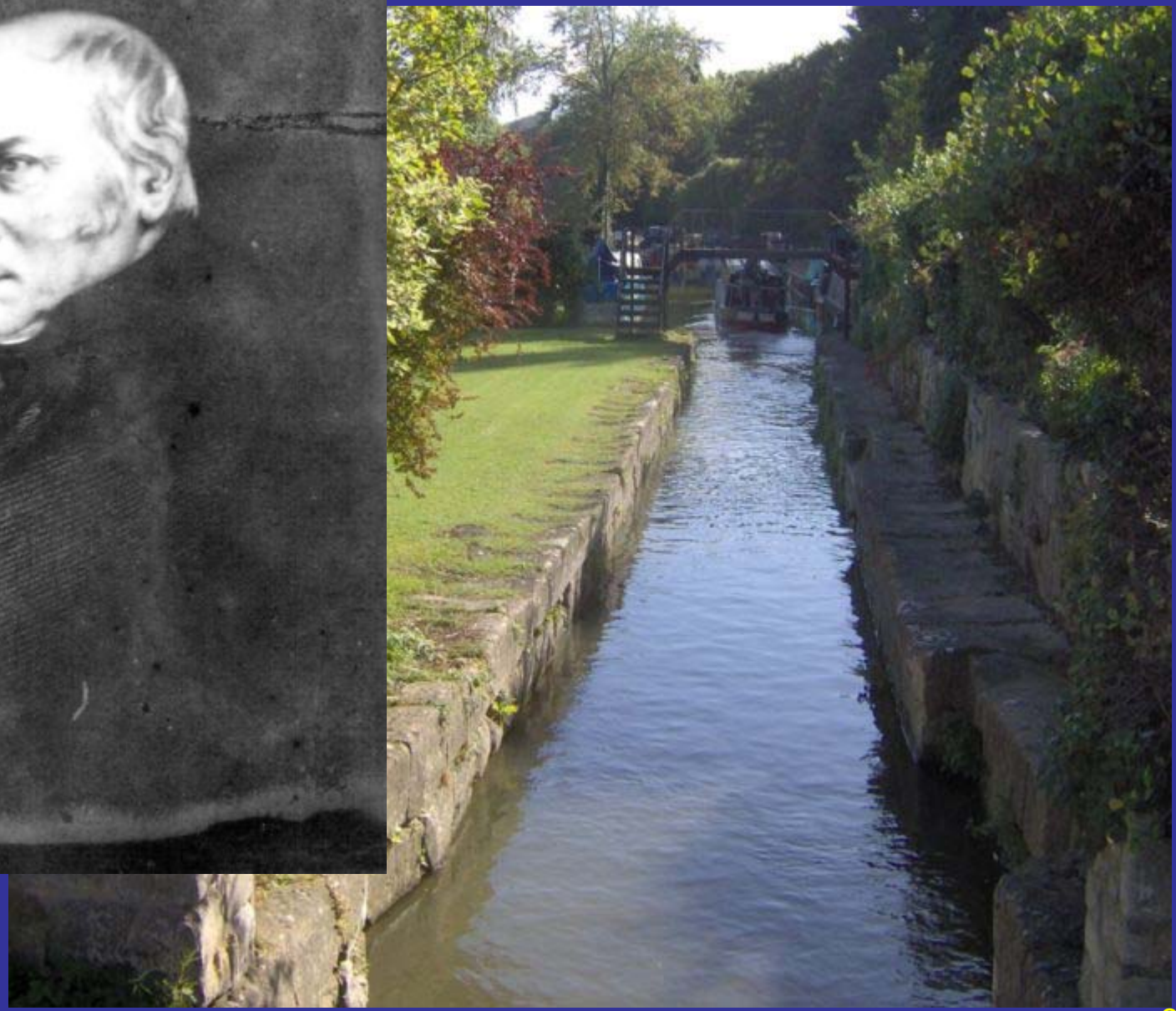


Burrows



William “Strata” Smith (1769-1839)





Stratigraphic correlation

A

B

C

D

E









Stratigraphic correlation

A

B

C

D

E



100Ka

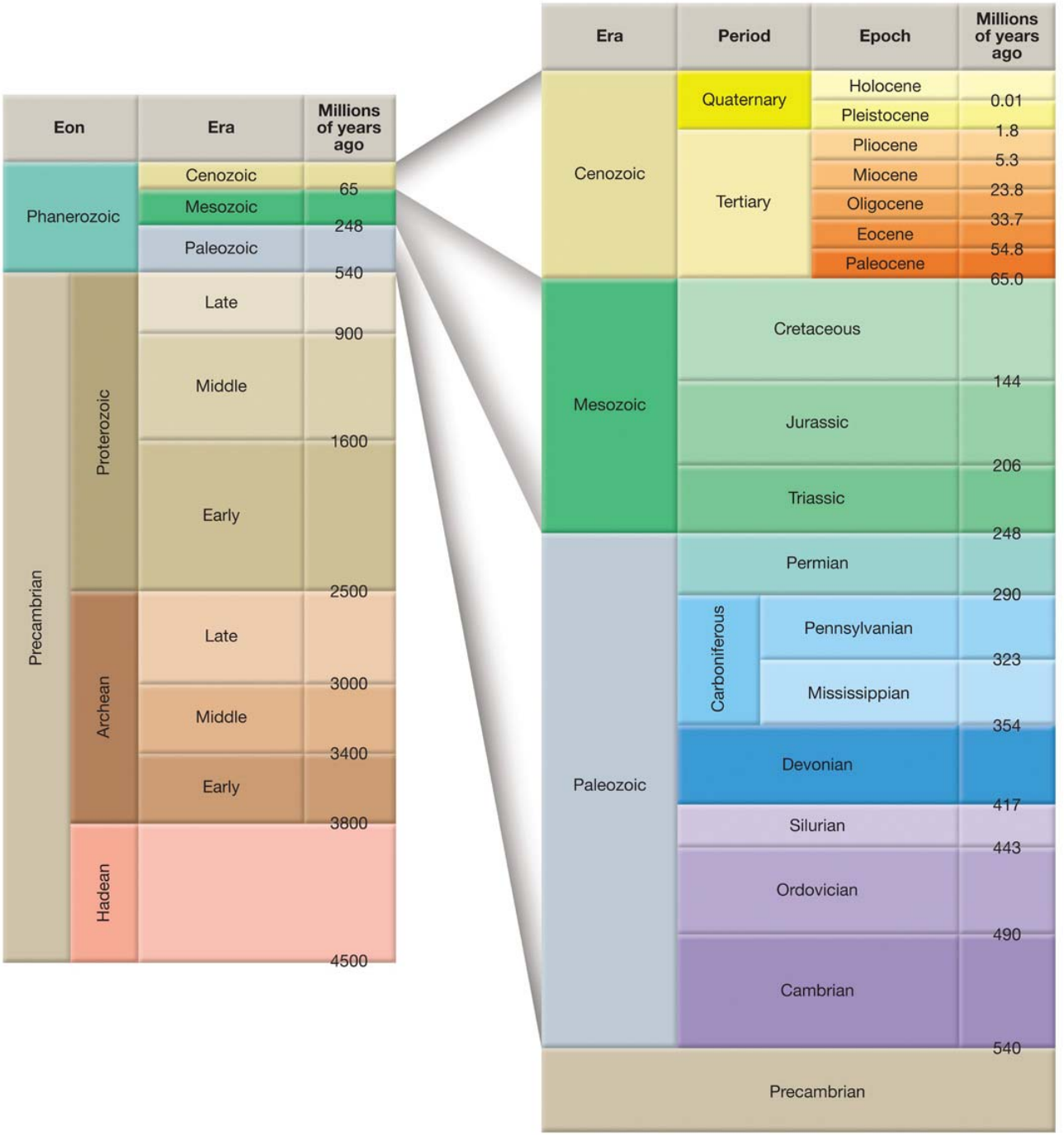


200Ka



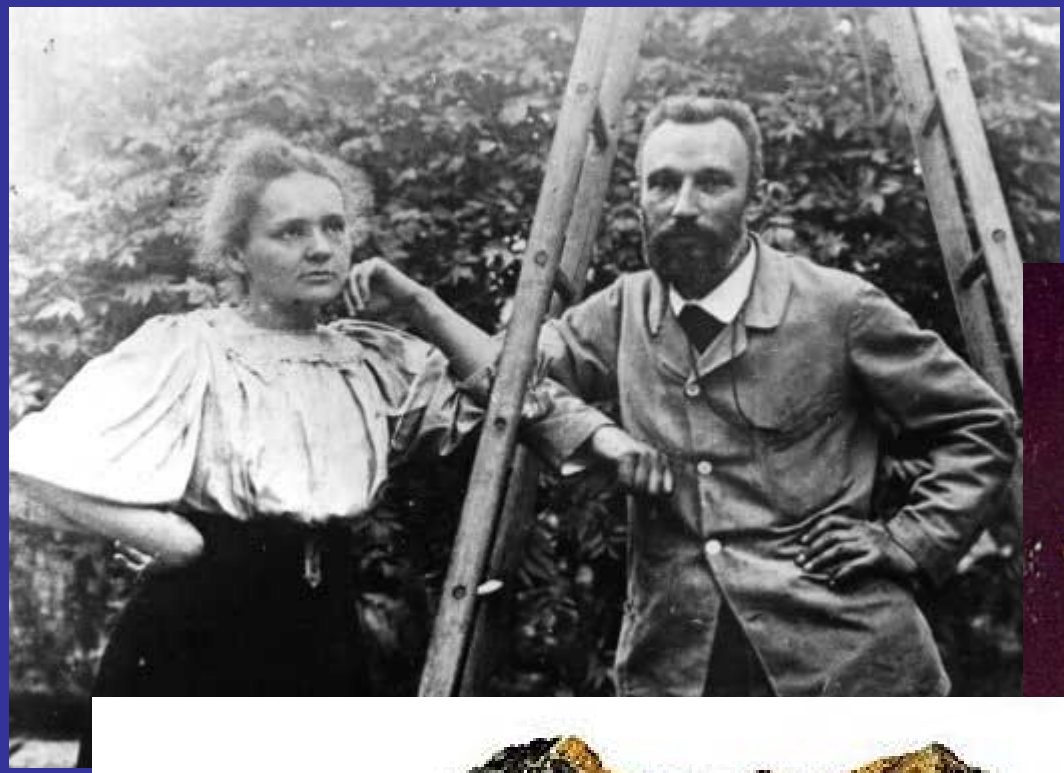


300Ka



Fossils define the:

"Geologic Timescale"



Radioactivity:

Henri Becquerel (1896)
Marie & Pierre Curie (1898)



chalcolite



pitchblende



Why do we care about radioactivity?

1) Radioactivity produces HEAT energy
(i.e. not all of Earth's heat has to have come from the Sun)

2) Radioactive decay happens on a measurable timescale – this gives us a calendar for Earth materials

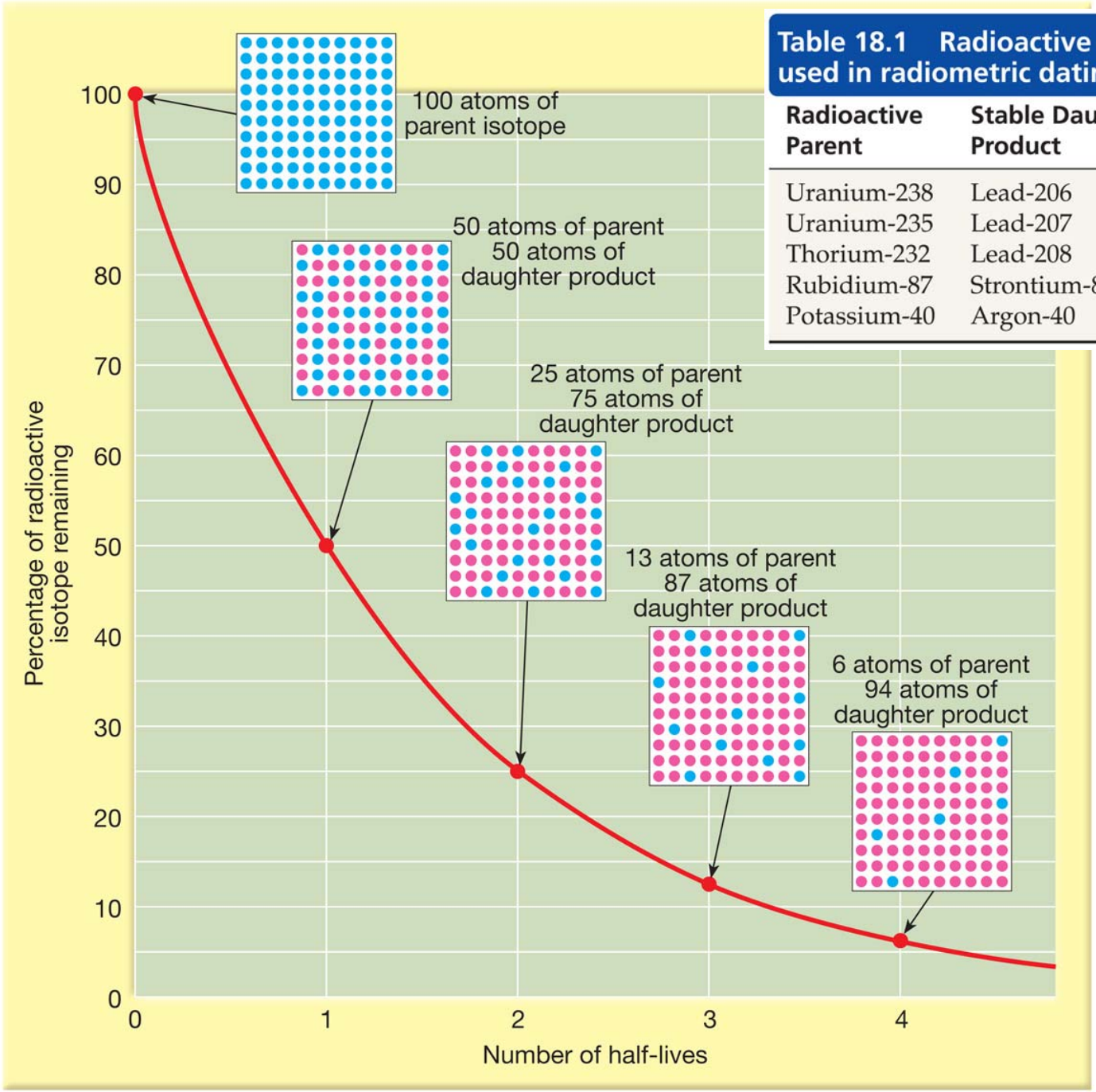


Table 18.1 Radioactive isotopes frequently used in radiometric dating.

Radioactive Parent	Stable Daughter Product	Currently Accepted Half-life Values
Uranium-238	Lead-206	4.5 billion years
Uranium-235	Lead-207	713 million years
Thorium-232	Lead-208	14.1 billion years
Rubidium-87	Strontium-87	47.0 billion years
Potassium-40	Argon-40	1.3 billion years

parent/ daughter ratio yields:

AGE

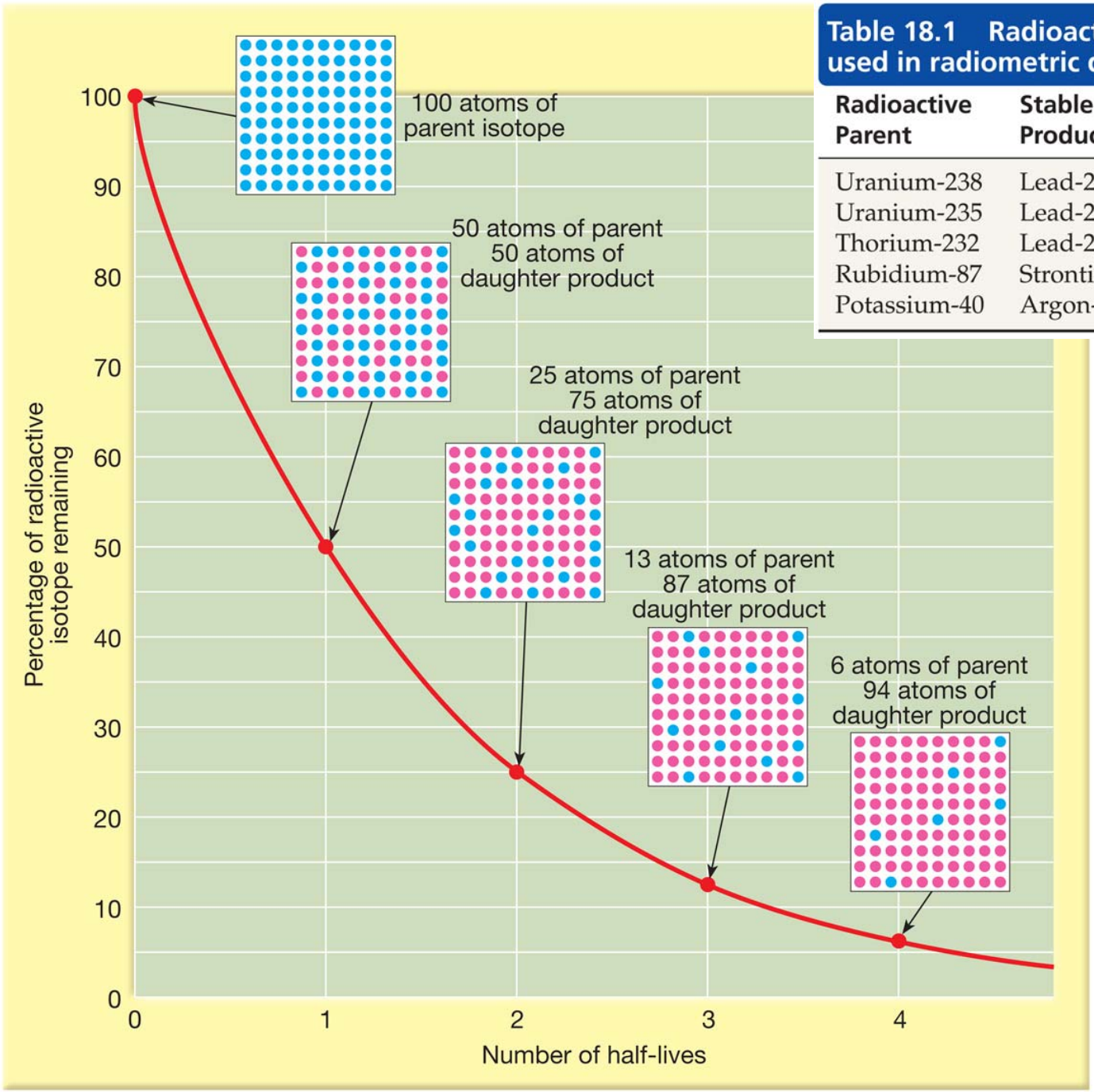


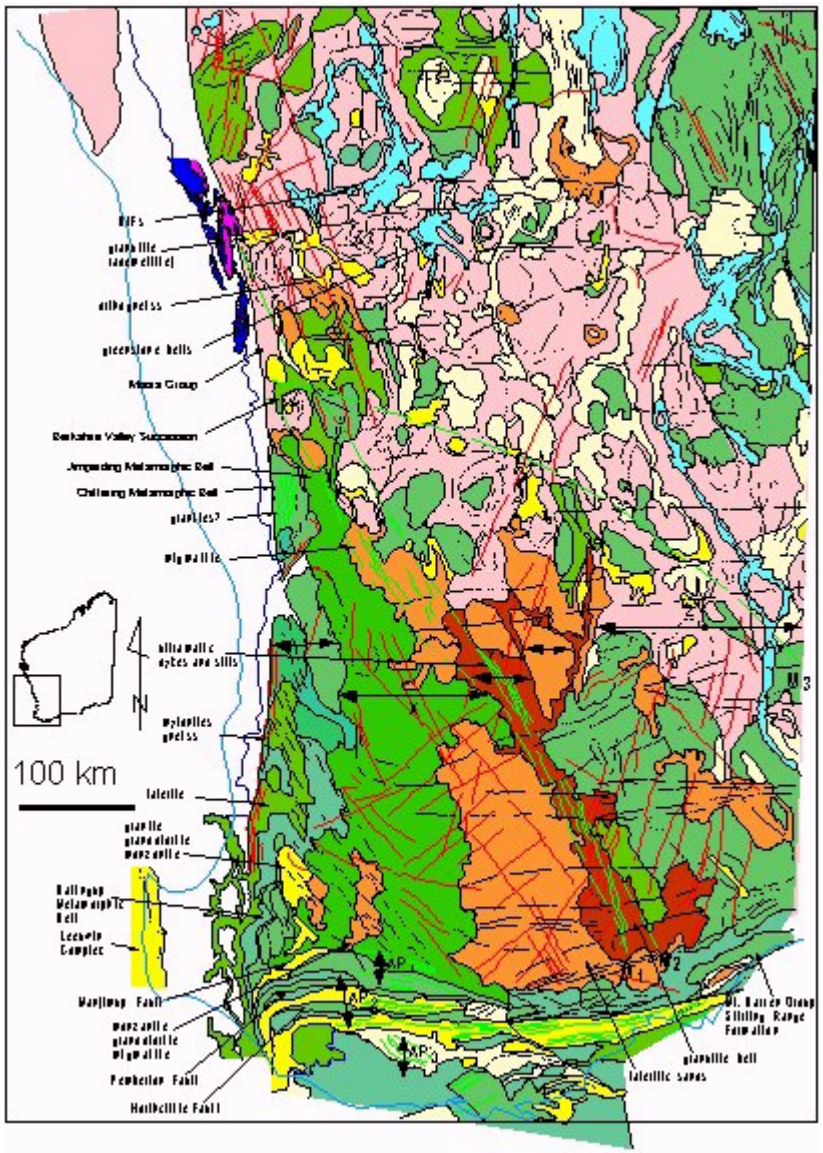
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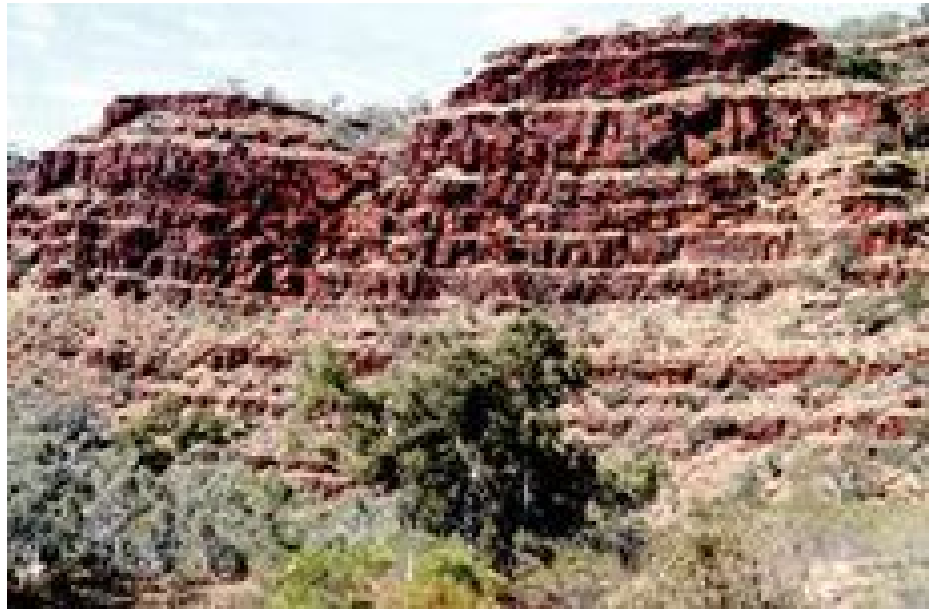
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Rubidium-87	Strontium-87	47.0 billion years
Potassium-40	Argon-40	1.3 billion years

Rock contains:
Potassium-40
P/D = 13/87

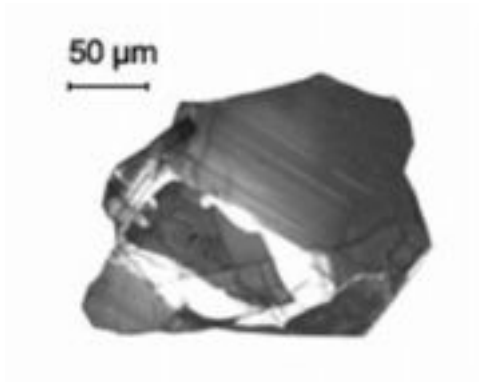
Age = ?

a) 1.3 Billion
b) 2.6 Billion
c) 3.9 Billion
d) 5.2 Billion
e) 6.5 Billion

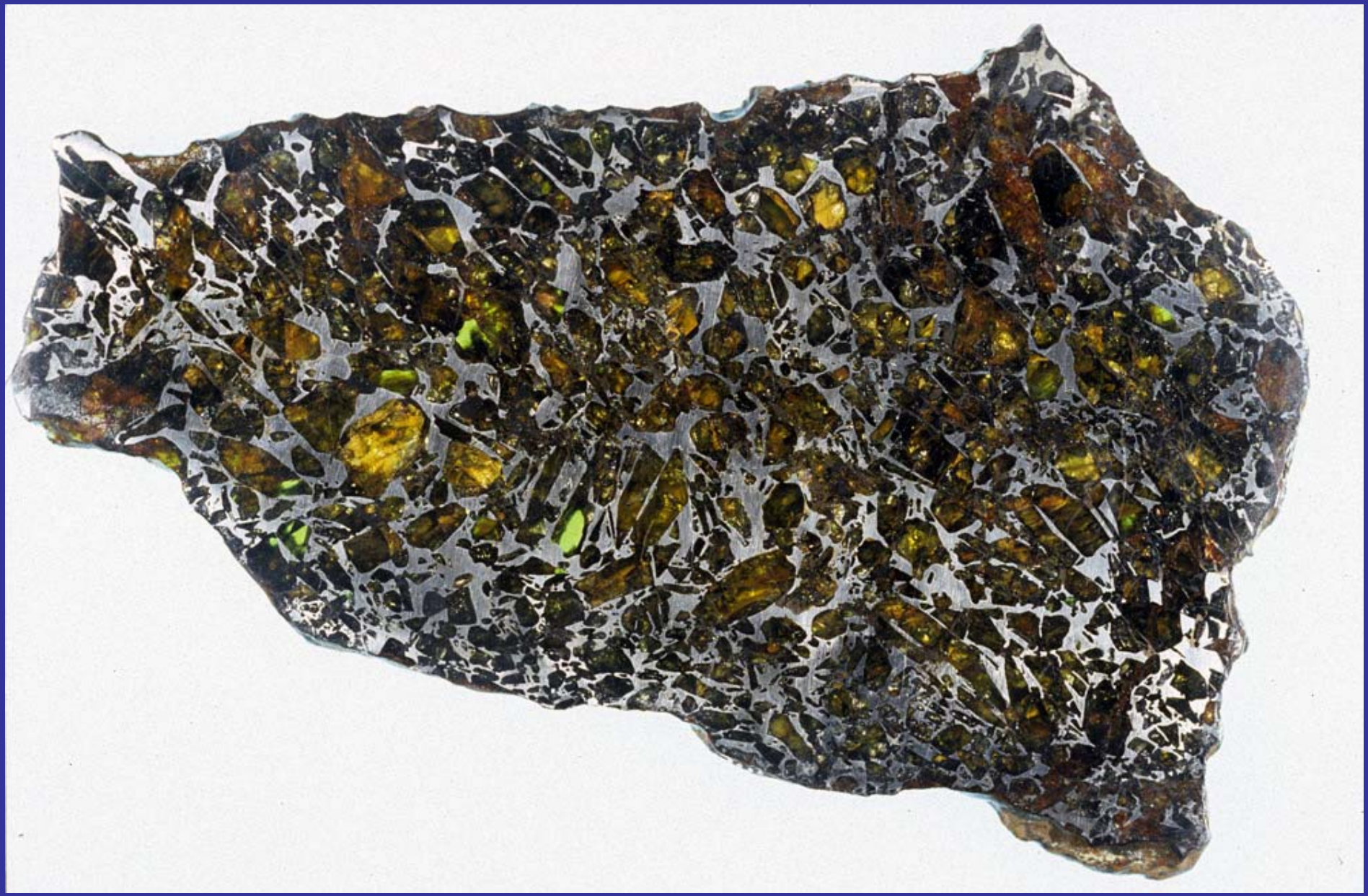




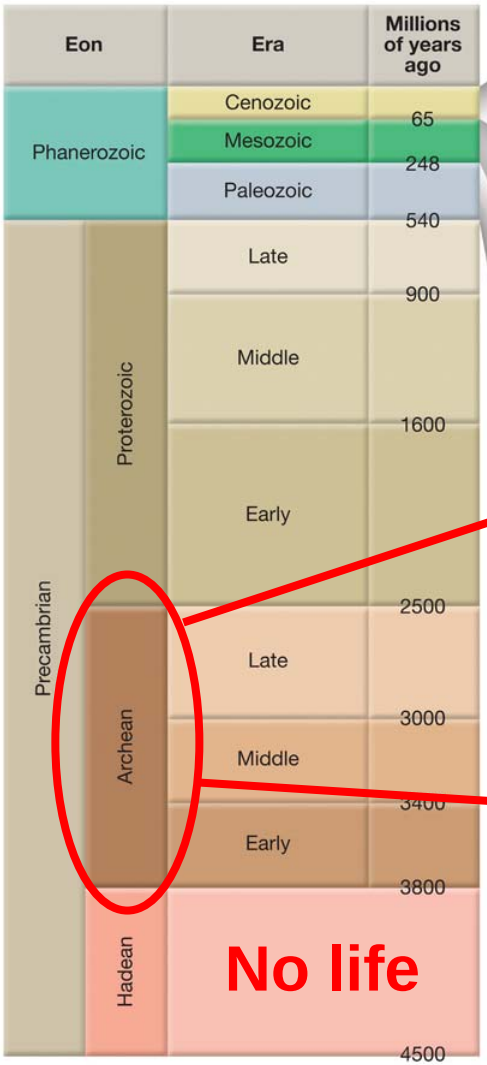
Oldest rock on Earth
4.404 Bya

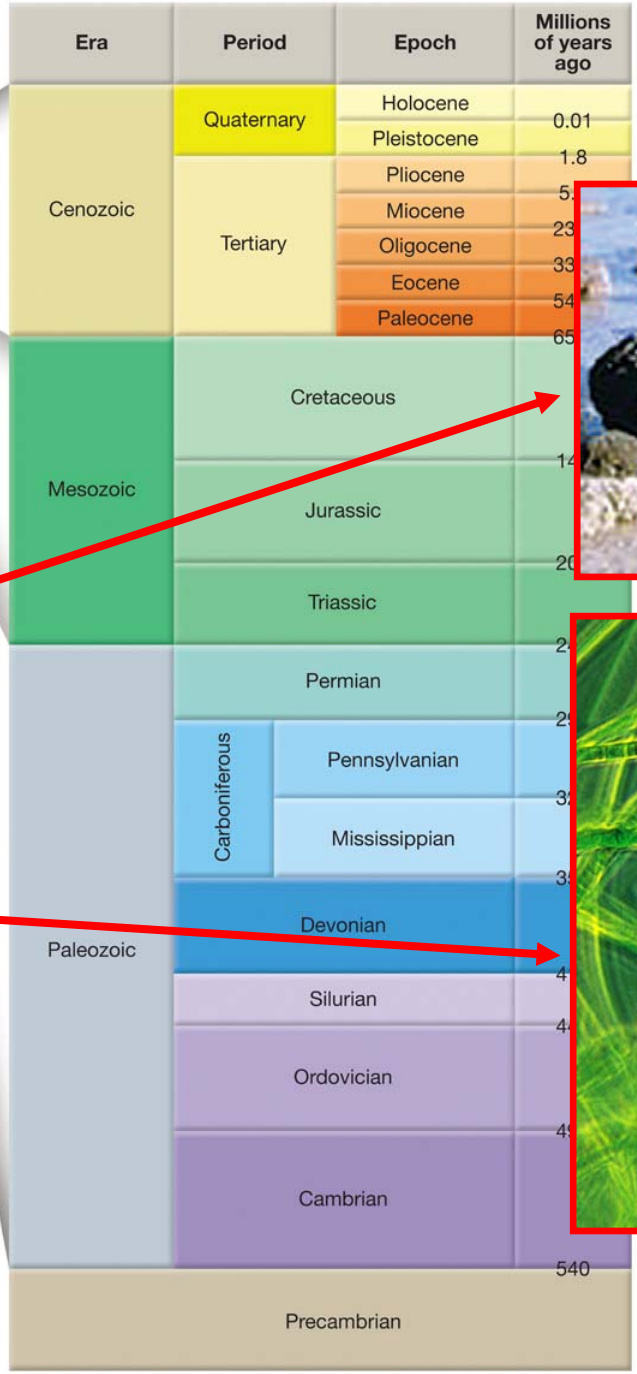


Jack Hills, Western Australia



Age of Earth from meteorites = 4.56 billion years





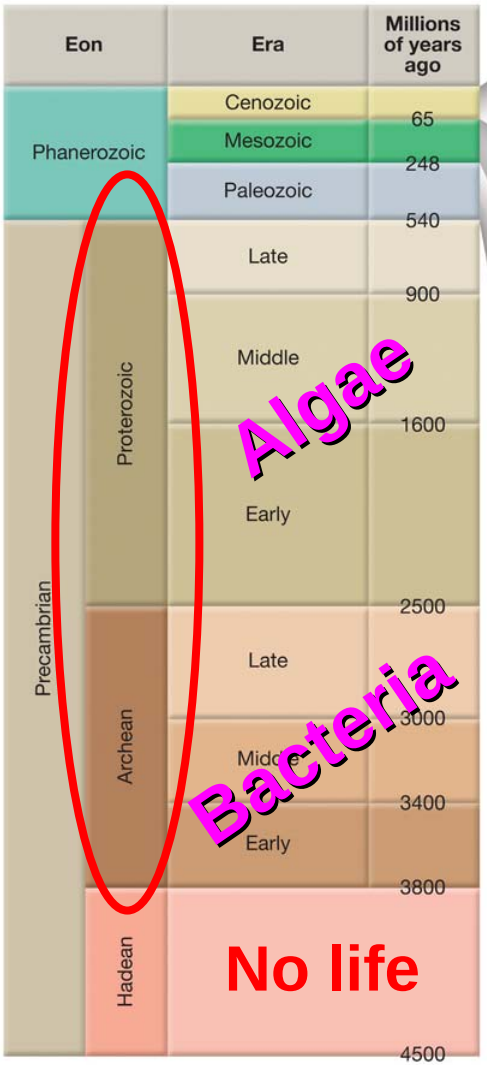
Hadean Eon
4.5-3.8 Bya

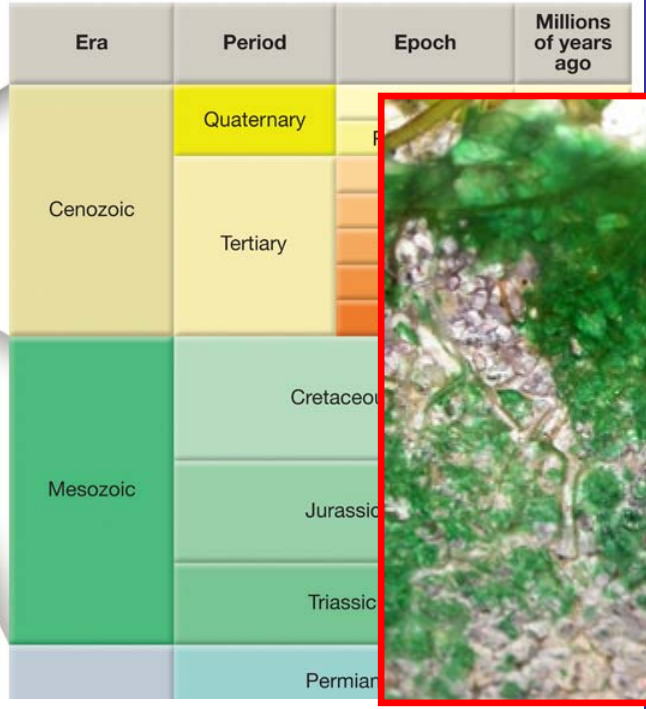
"Stromatolites"





Bacteria

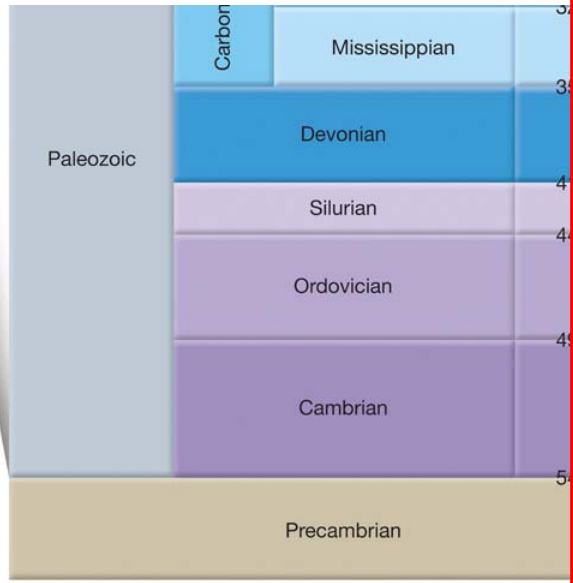


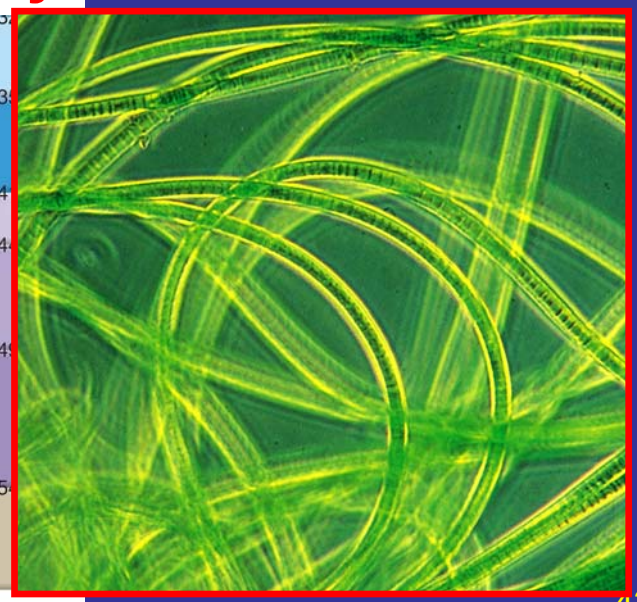


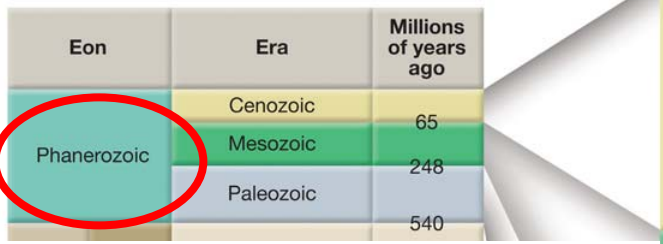


90% of Earth History

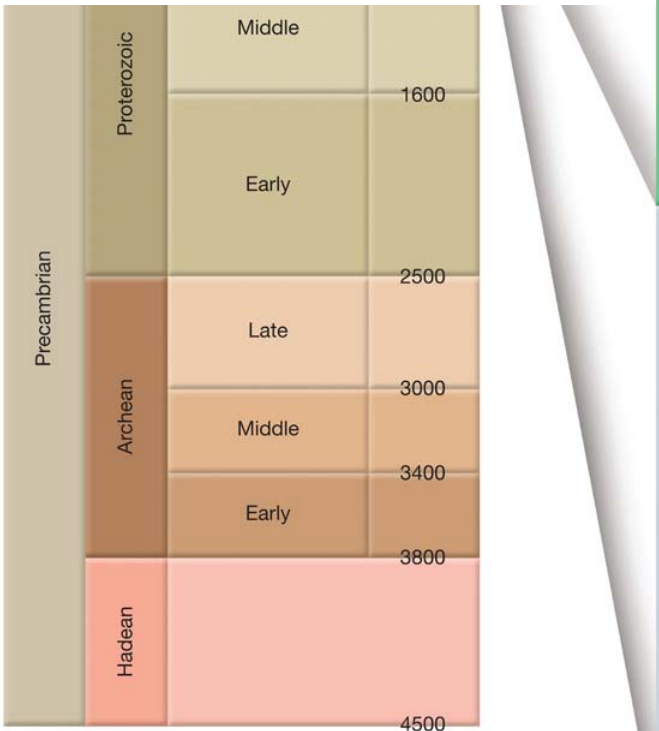
January 1 - November 18

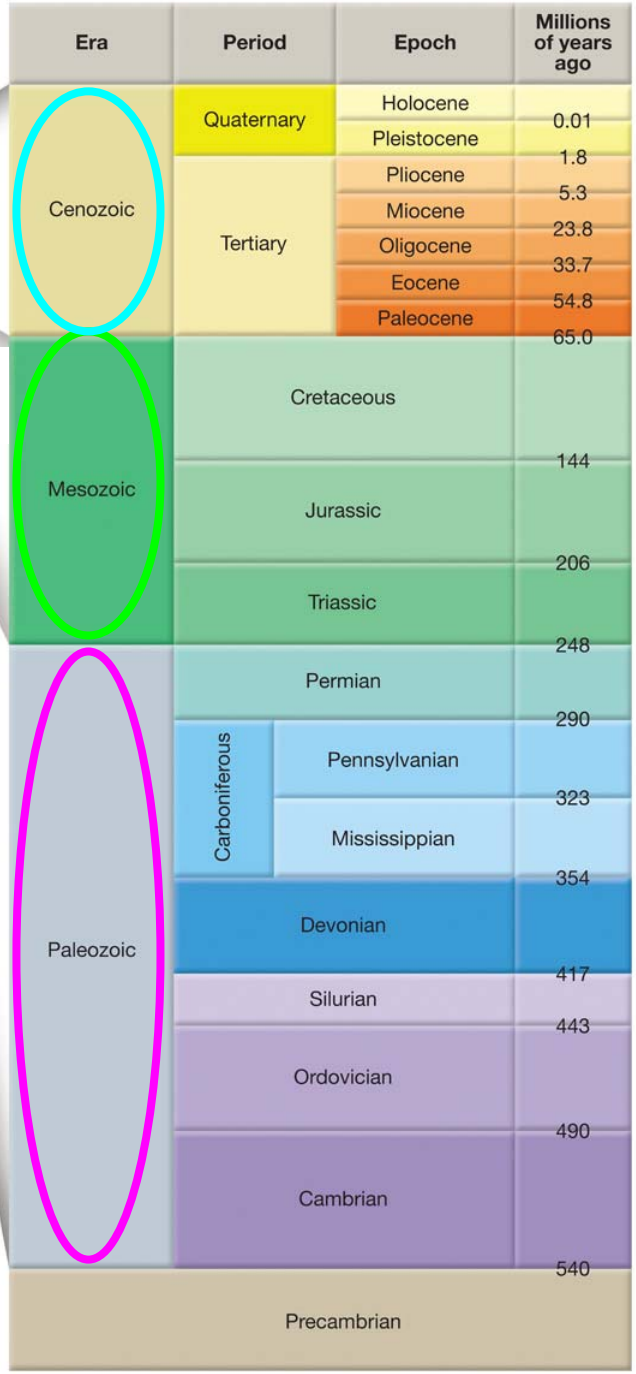






10% of Earth History





Phanerozoic

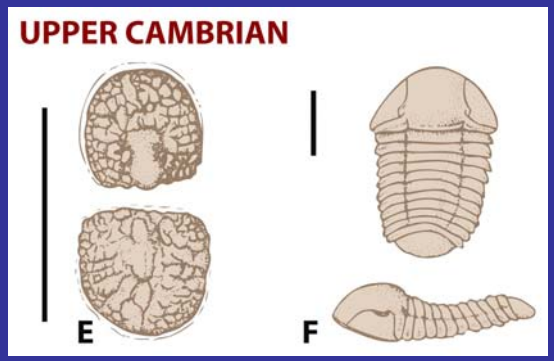
“Visible life”

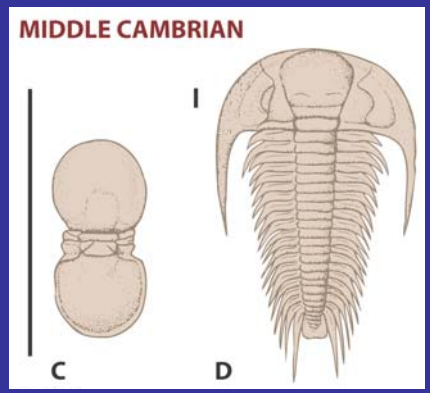
Recent life

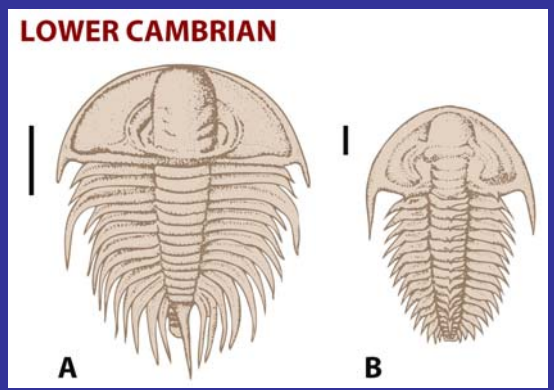
Middle life

Ancient life

Early Paleozoic (Ancient Life) – Trilobites: arthropods, 15k species



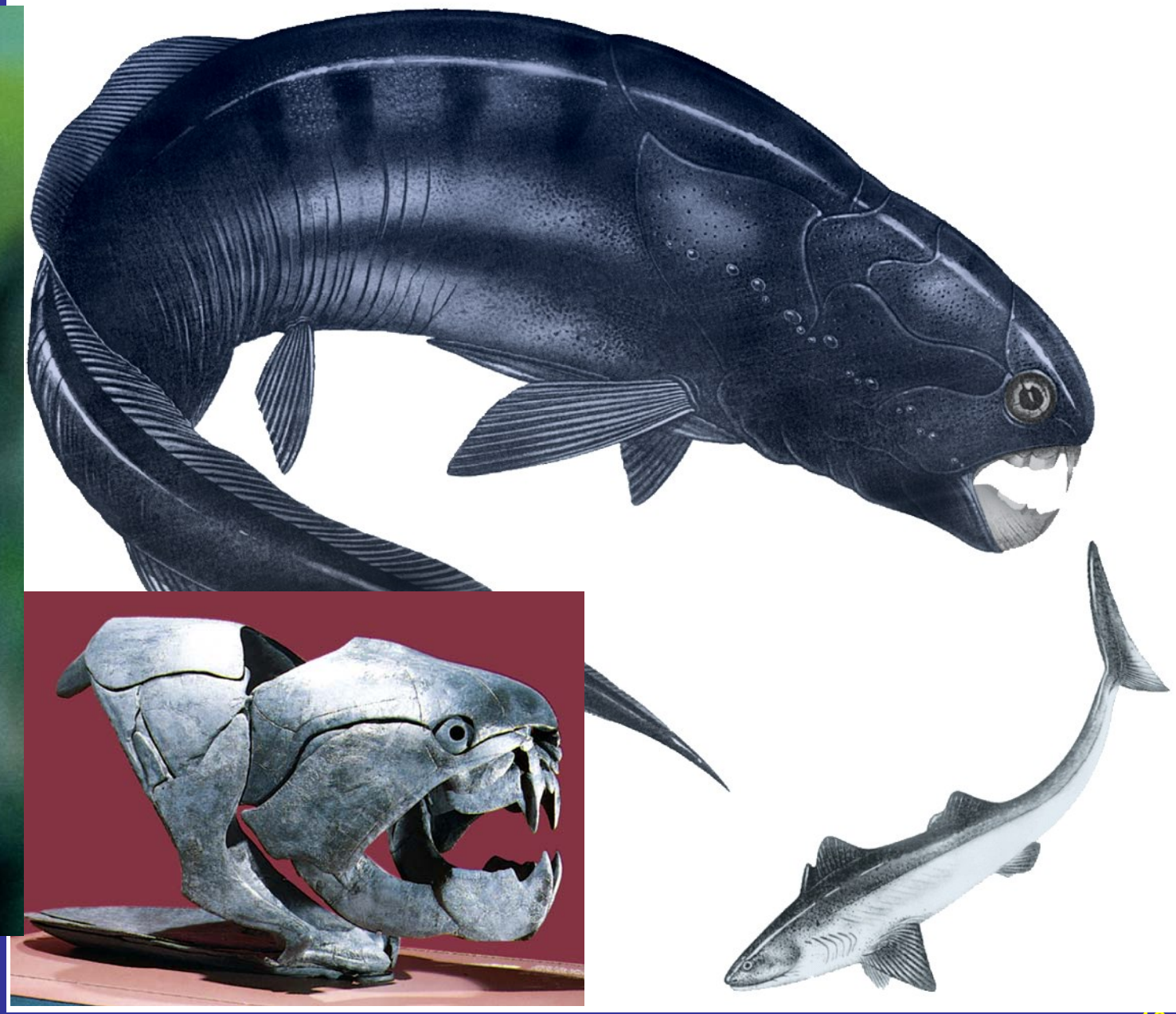




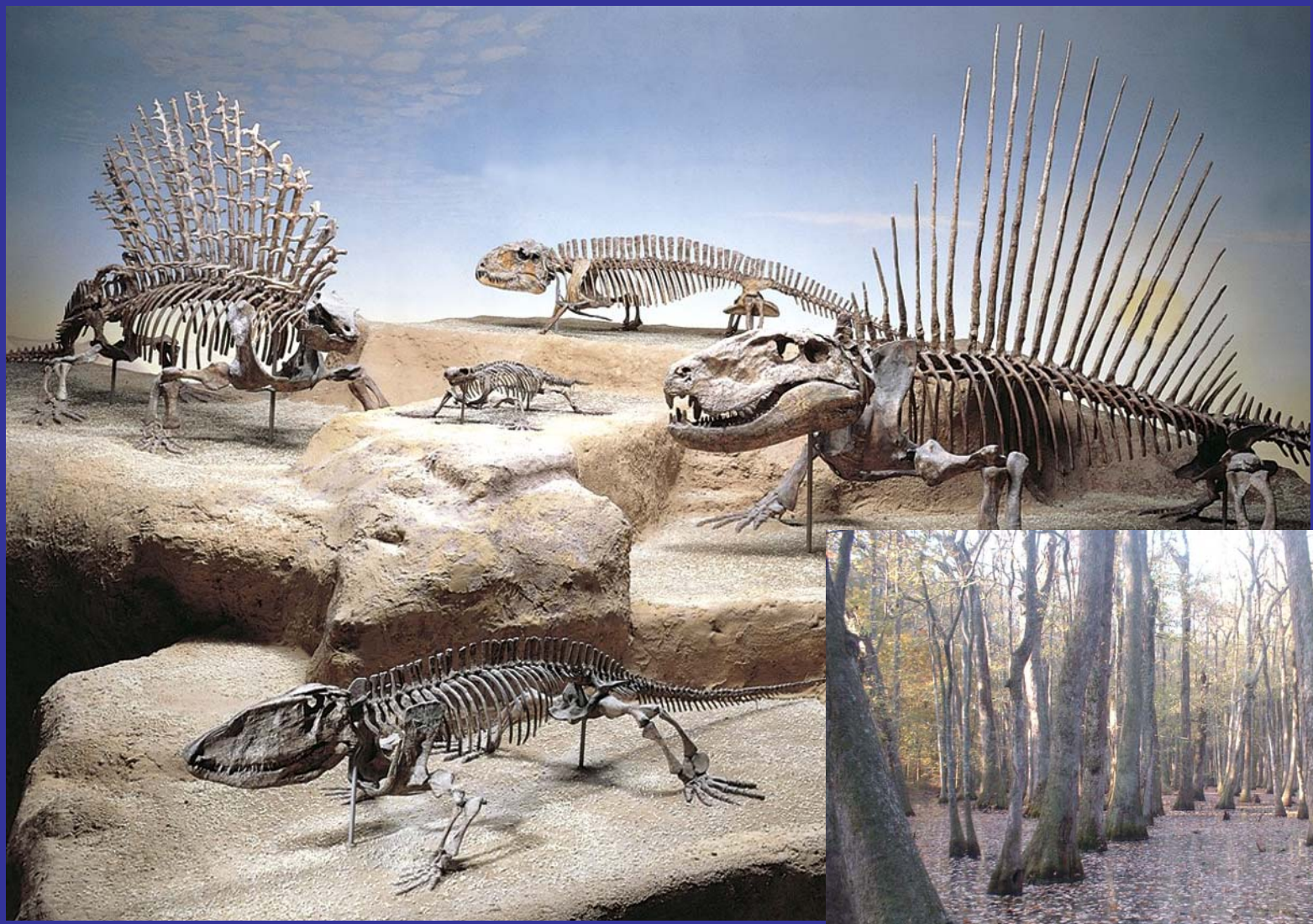


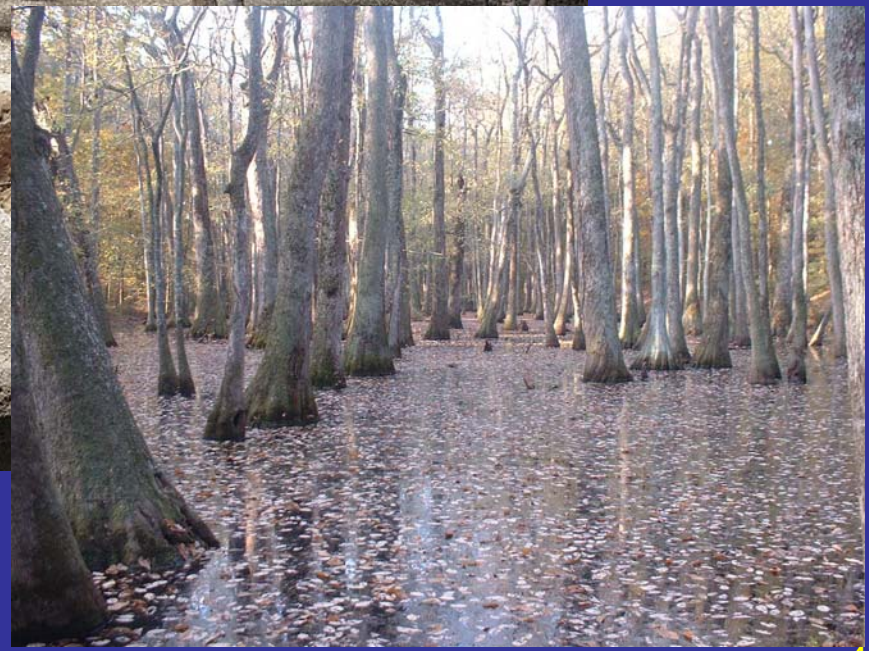
Middle Paleozoic (A.L.) – Jawed Fish: vertebrate predator; Seed Plants





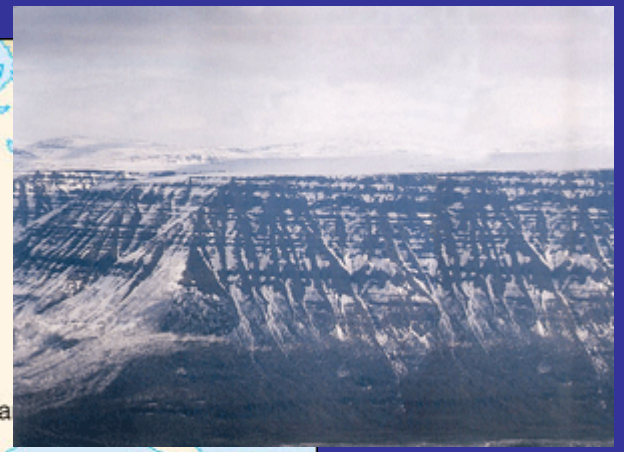
Late Paleozoic (A.L.) – Reptiles such as Dimetrodon, Coal Swamps





December 11





Permian Extinction

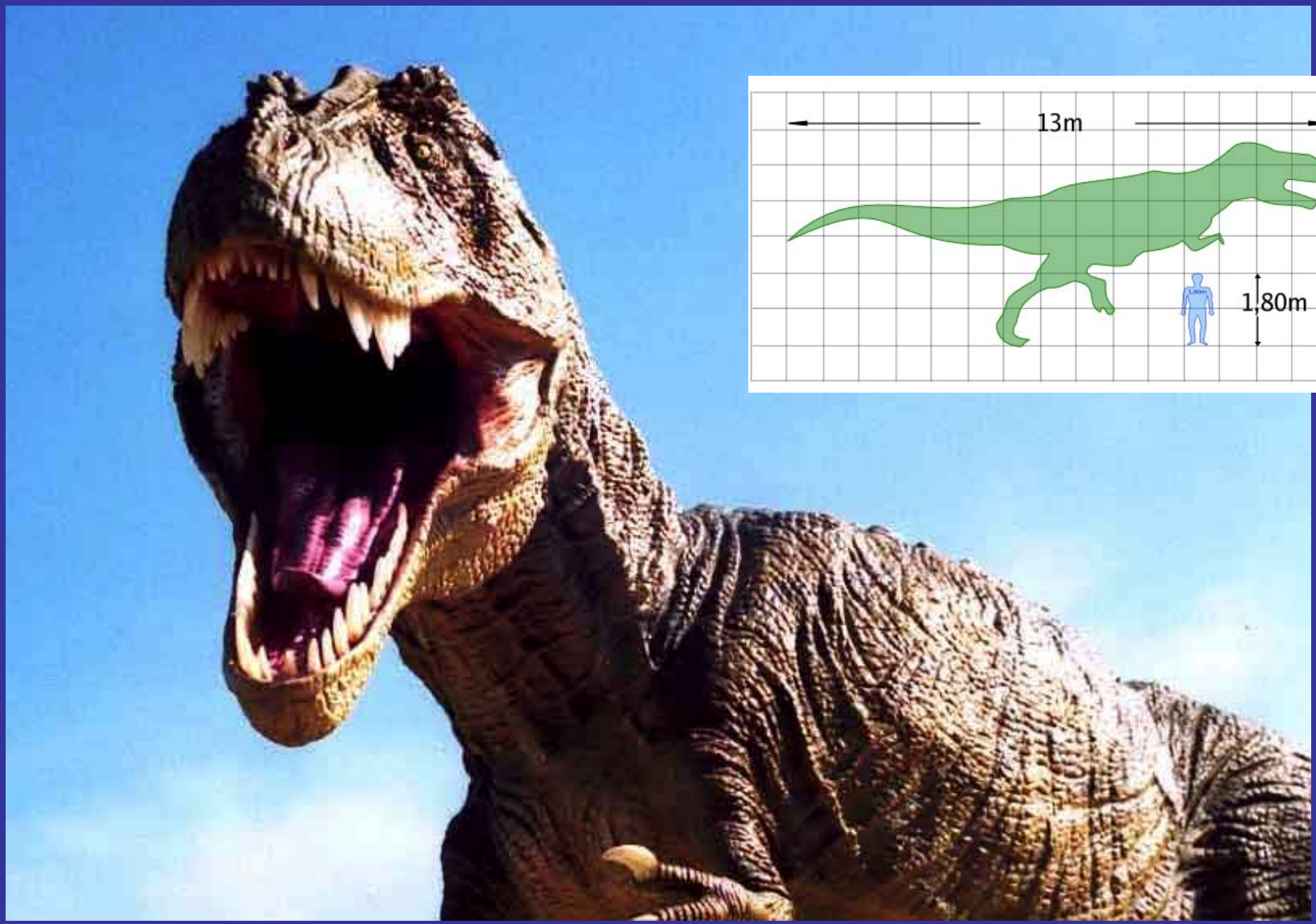
96% marine

70% terrestrial

Siberian Flood basalts: 251-250 Mya, 1-4 million km^3

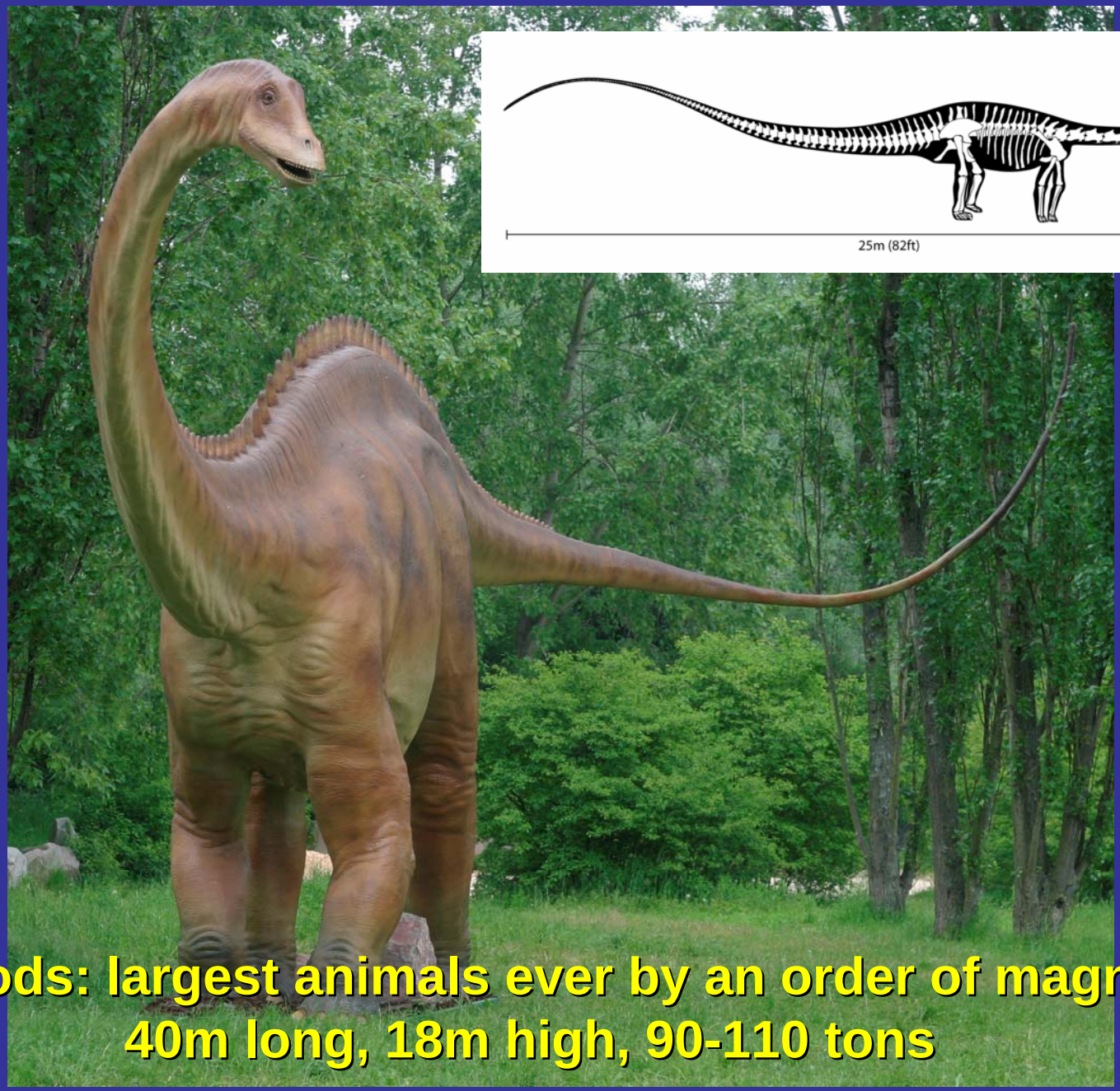


Early Mesozoic (Middle Life) – DINOSAURS!



T-rex: bipedal predator 13m long, 7.5 tons, hollow bones

Early Mesozoic (Middle Life) – DINOSAURS!



Sauropods: largest animals ever by an order of magnitude
40m long, 18m high, 90-110 tons

Early Mesozoic (Middle Life) – DINOSAURS!

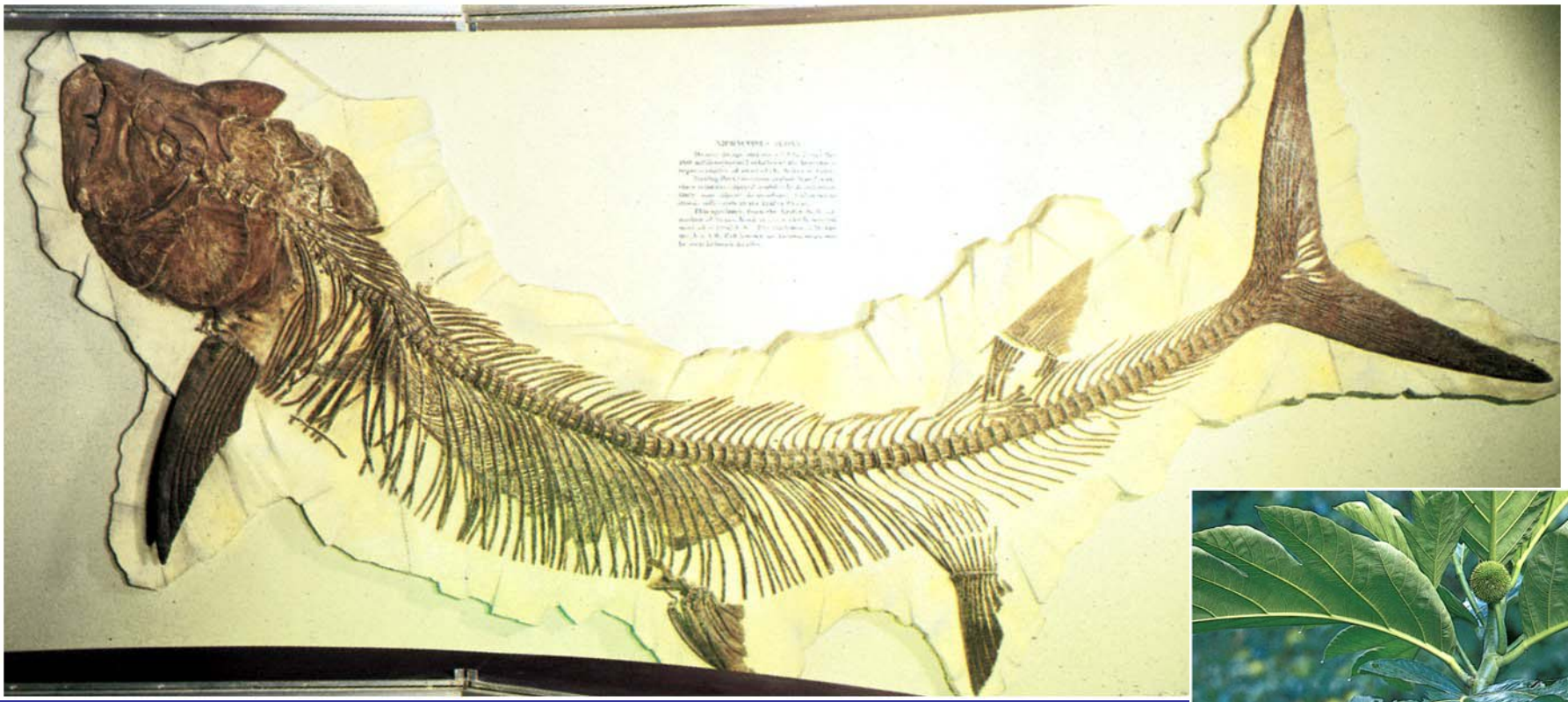




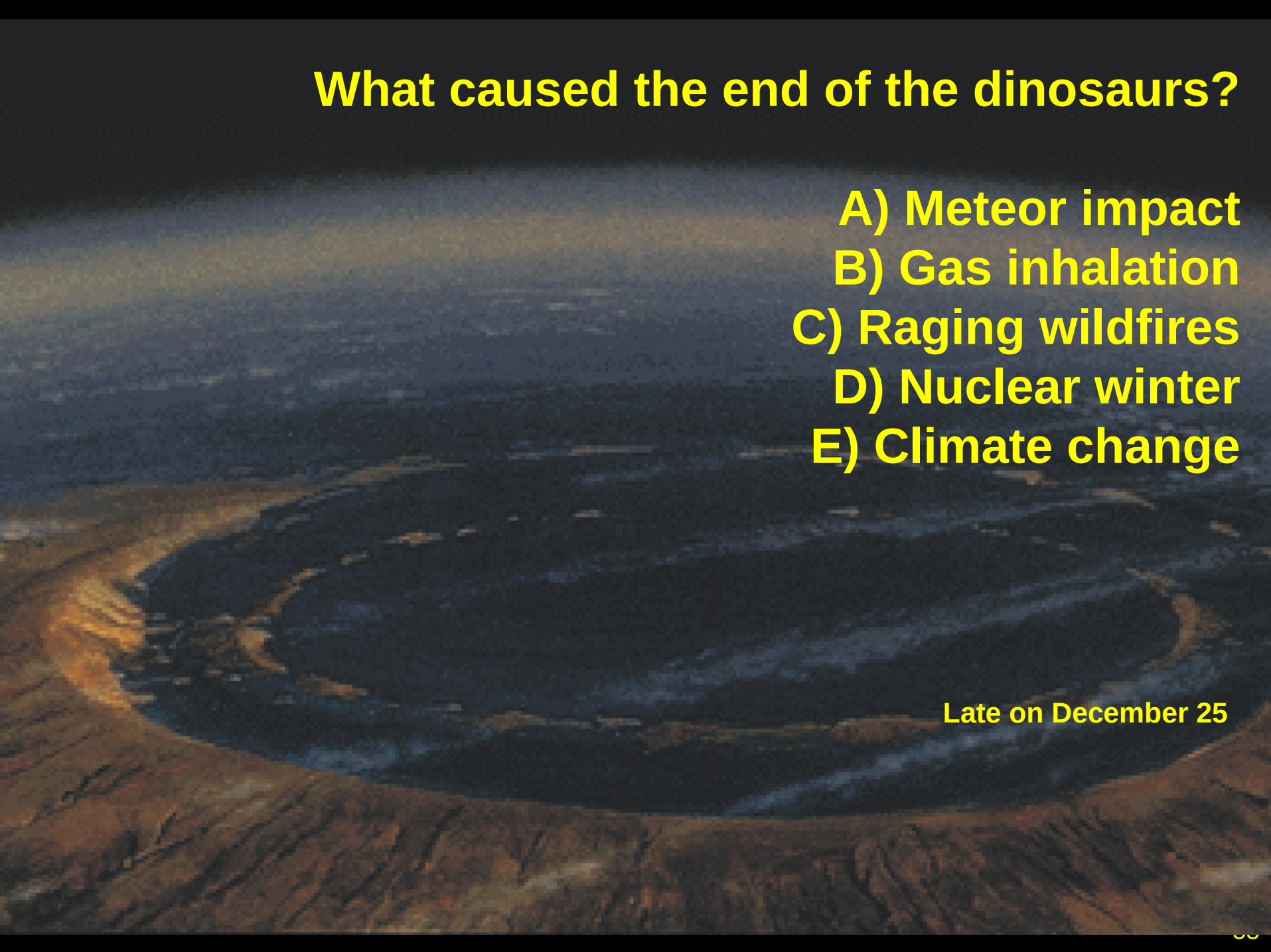


Median dinosaur weight 2 tons

Late Mesozoic (Middle Life) – Chalk (Cretaceous), modern fish







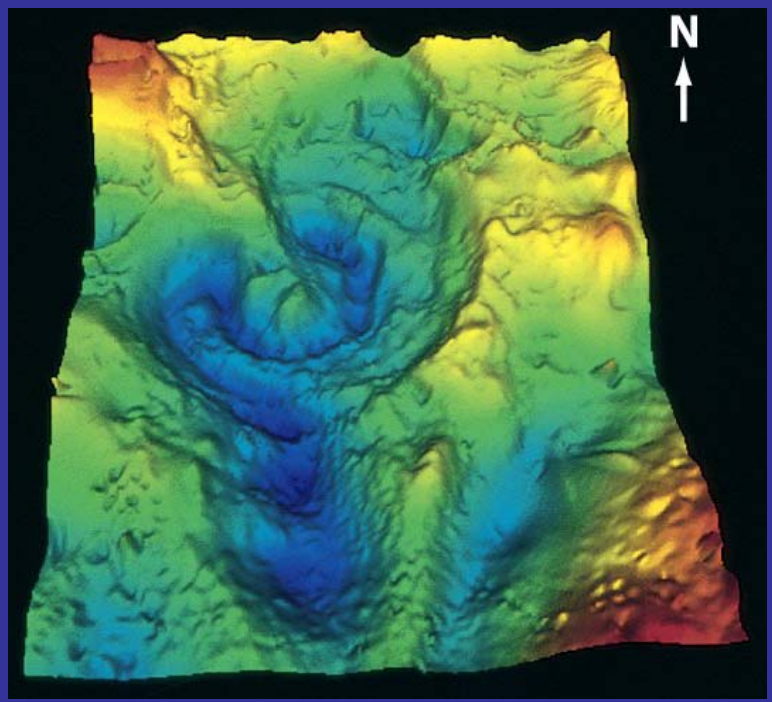
What caused the end of the dinosaurs?

A) Meteor impact
B) Gas inhalation
C) Raging wildfires
D) Nuclear winter
E) Climate change

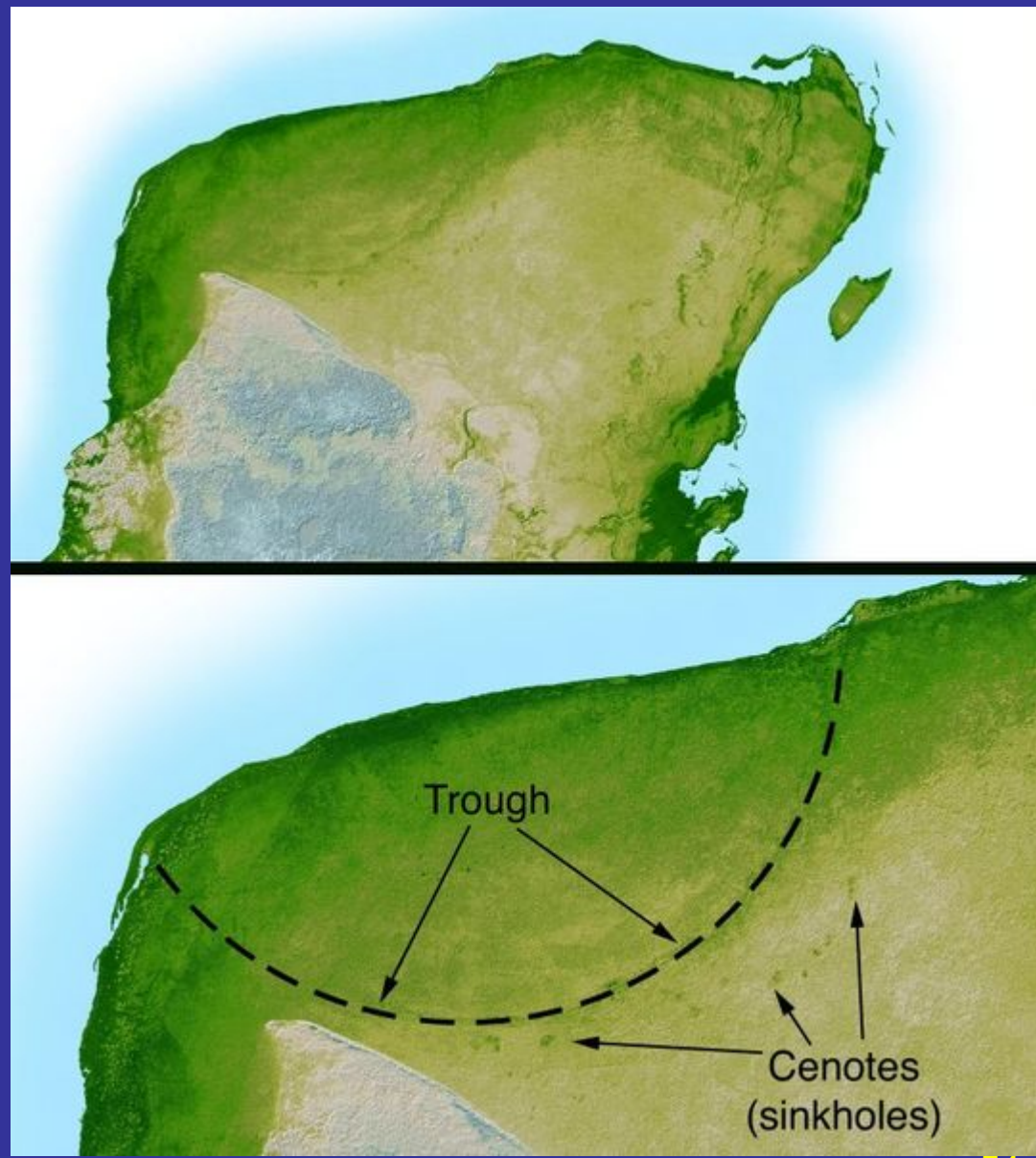
Late on December 25

Chicxulub Crater – >180km across





Andesite layer 1.3km down



10 km across ***(not to scale!)***



2 million times more powerful than largest nuclear explosion

K/T Boundary

65 Mya



spherules

10 km across ***(not to scale!)***



1) Mega-tsunami kilometers high

2) Nuclear winter from atmospheric debris



spherules

Early Cenozoic (Recent Life) – Radiation of mammals

What dinosaur do paraceratherium resemble?

A) T-rex
B) Velociraptor
C) Sauropod
D) Pterodactyl





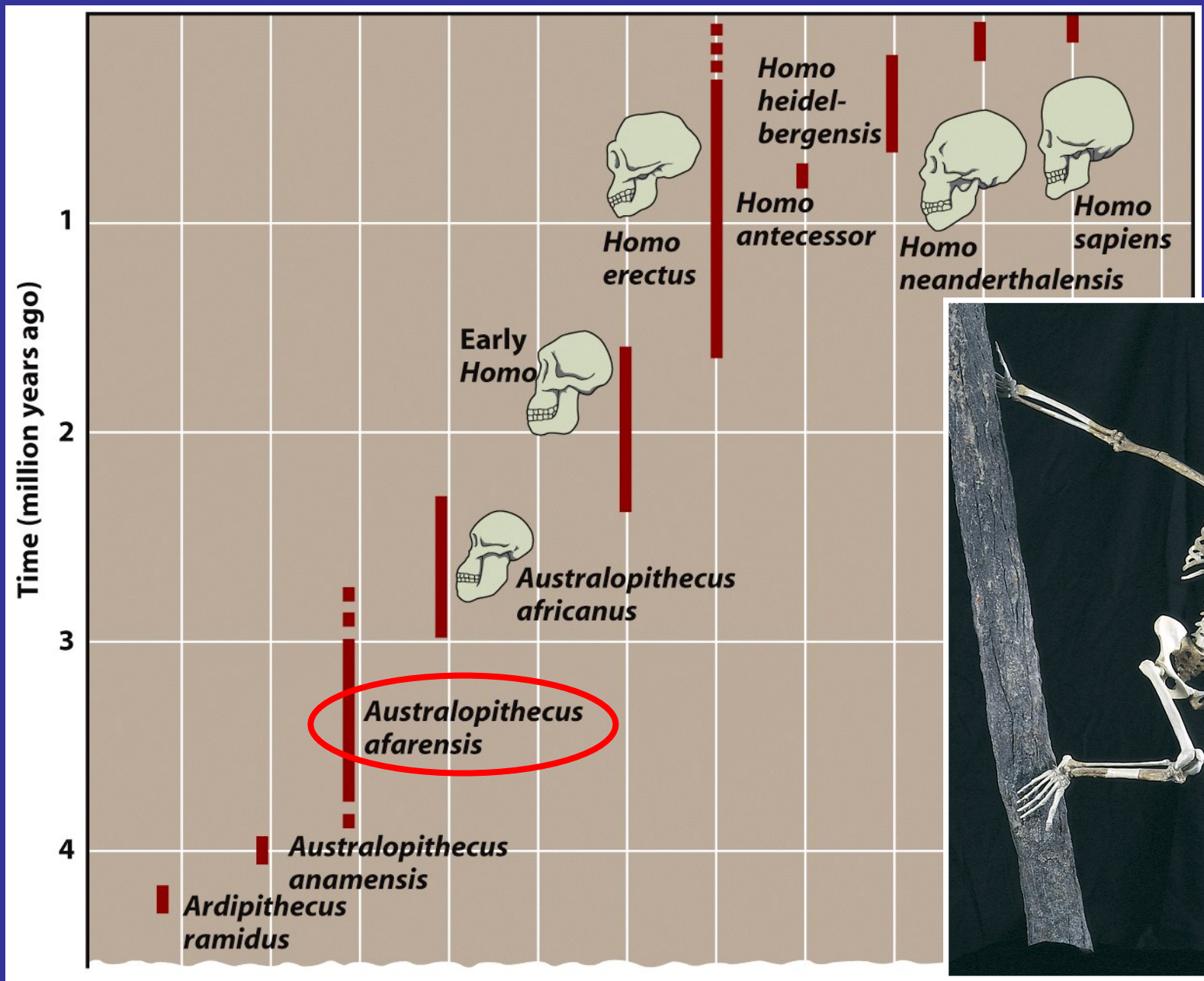


Late Cenozoic (Recent Life) – Diversification of mammals

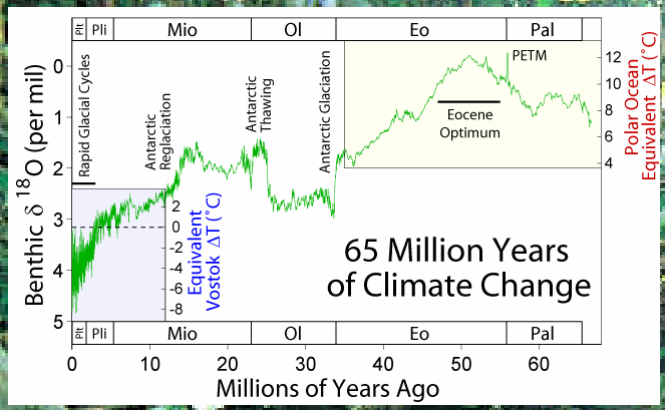


Grassland species thrive

Late (late) Cenozoic (Recent Life) – Human Evolution



Lucy



Transition from tropical to grassland environment



Cooling and drying worldwide



Where will humans thrive?



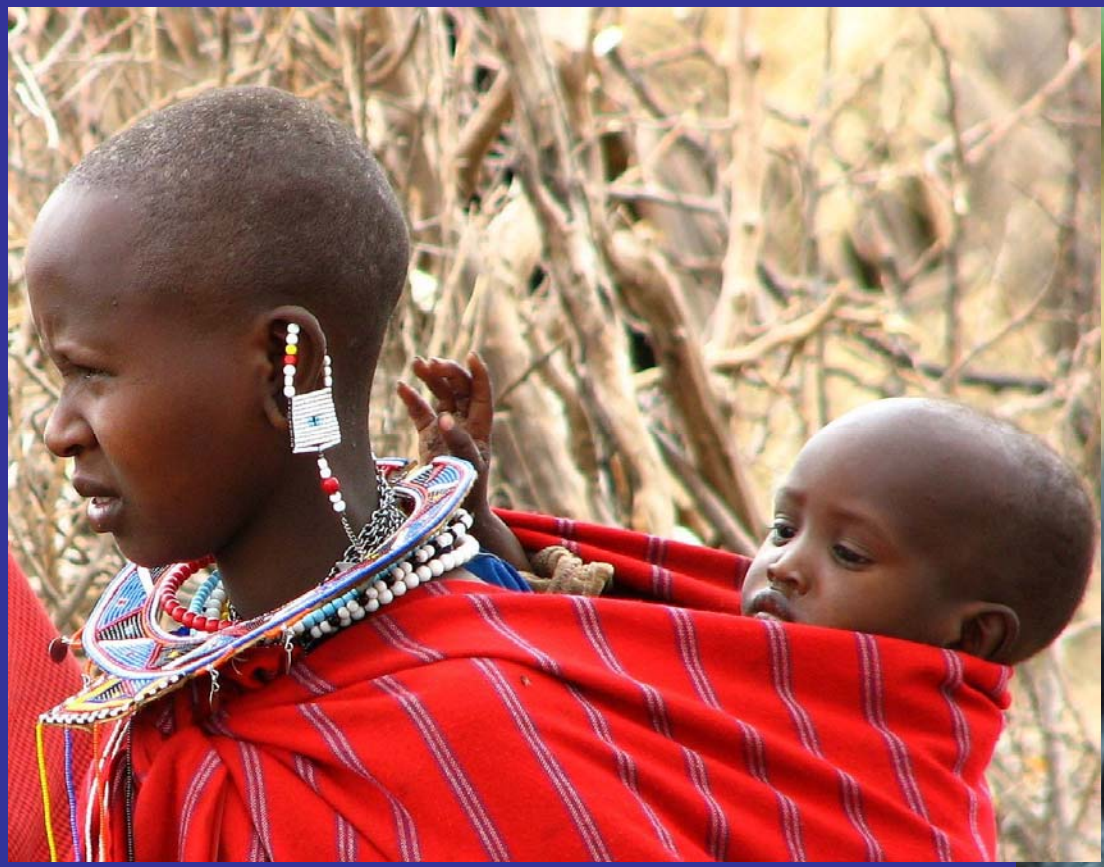


Where will chimps thrive?





Do we share a common ancestry?

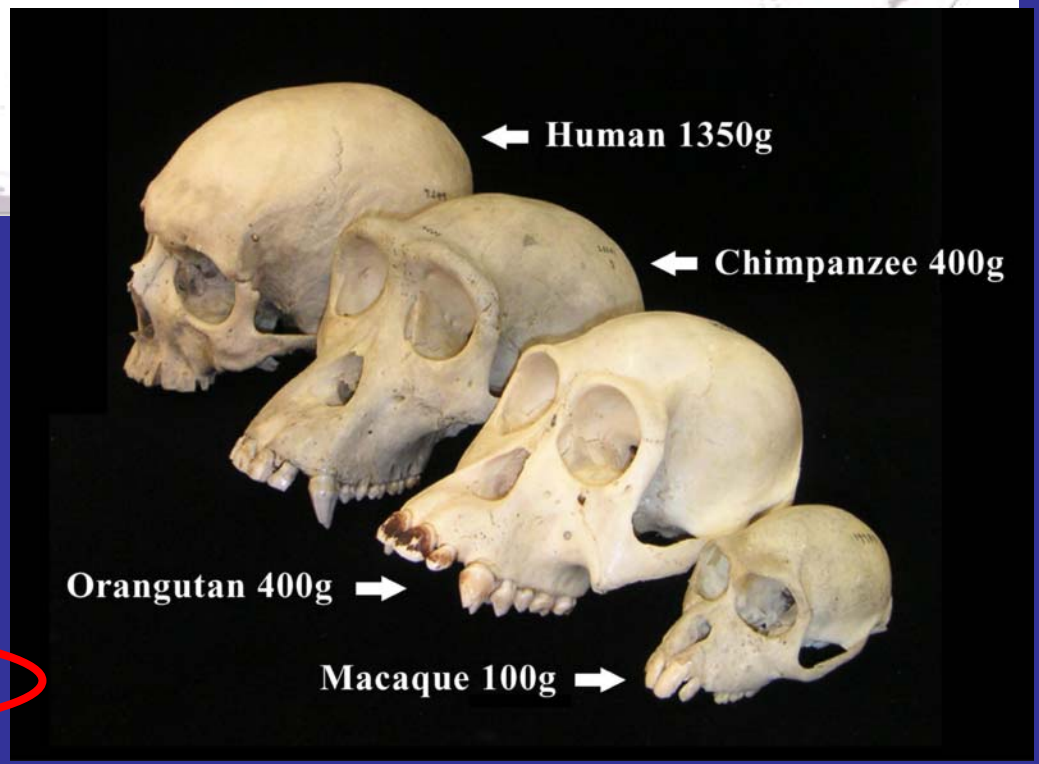




How do our young differ?

Origin of Humans



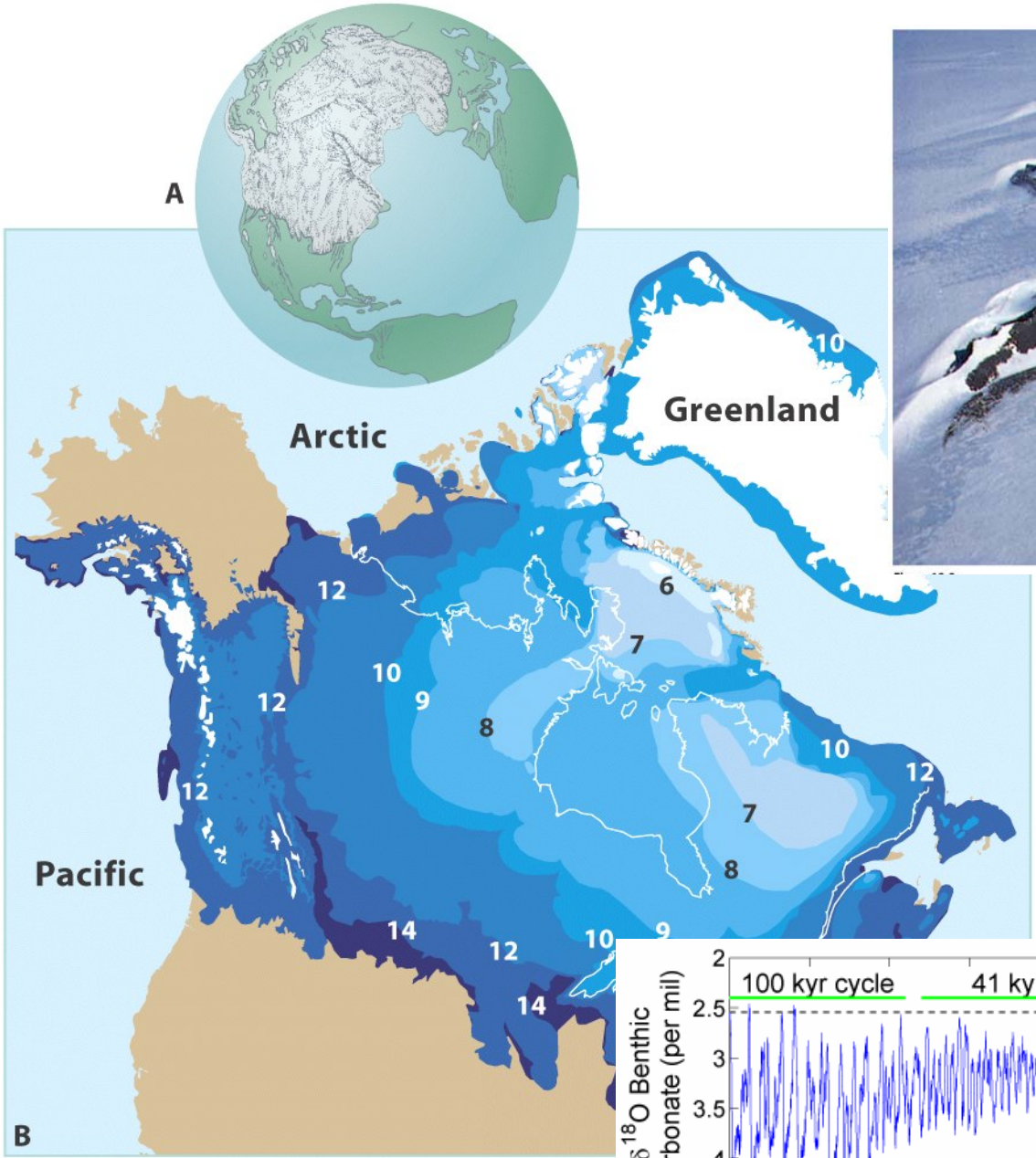


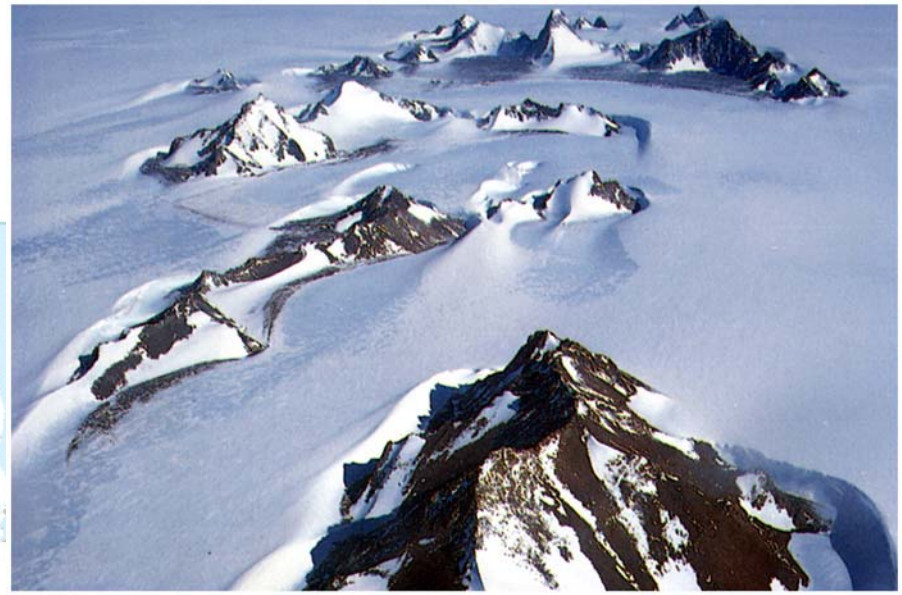
December 31, 11:42pm



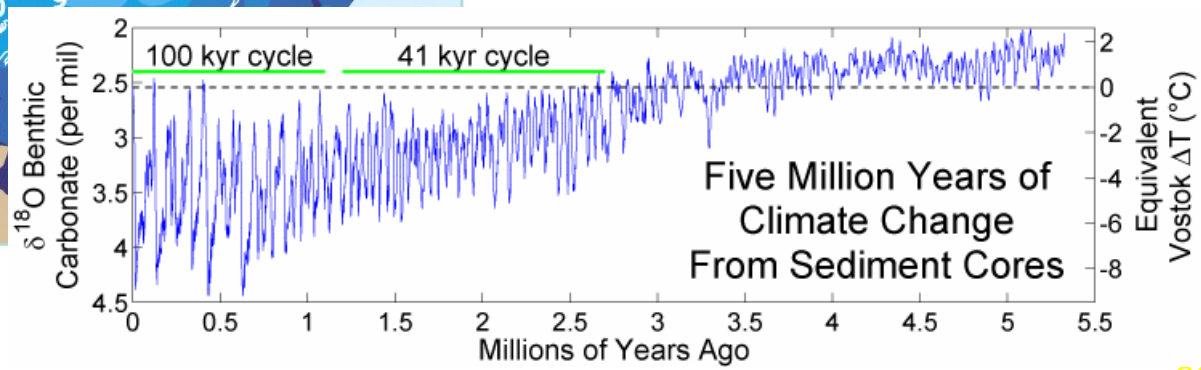
Forces driving human evolution:

1. **Migration**
2. **Mutation** (caused by something external)
3. **Genetic drift** (random genetic change)
4. **Natural selection** (survival of fittest)





Ice ages controlled human migration patterns

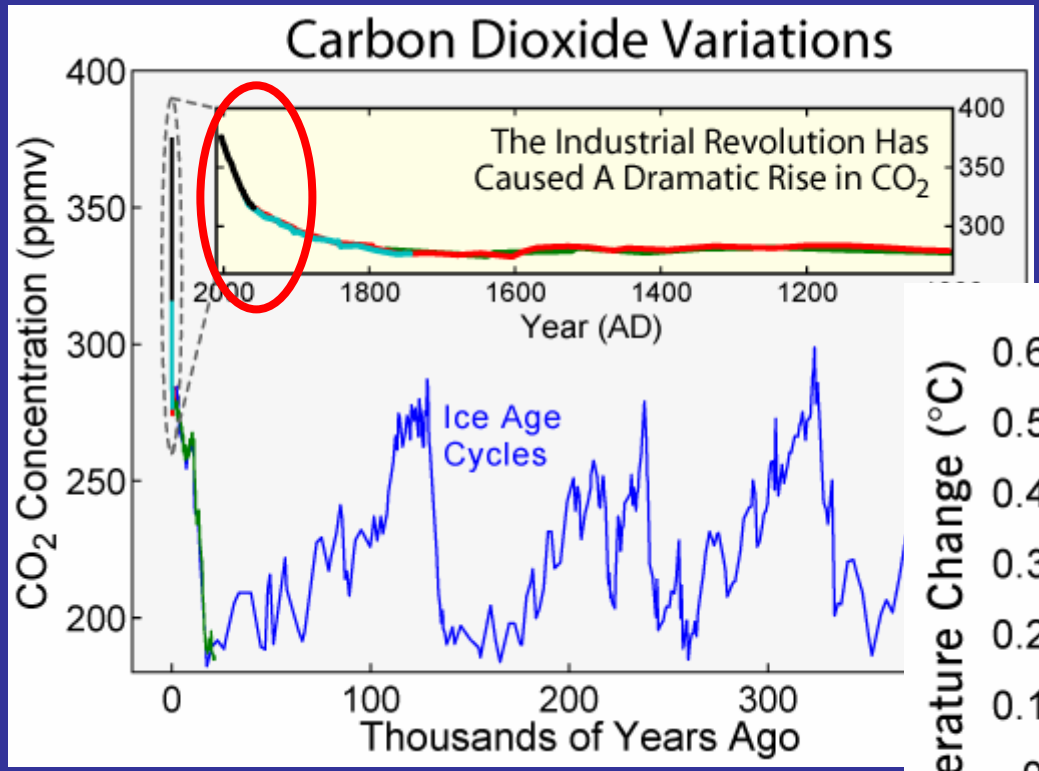




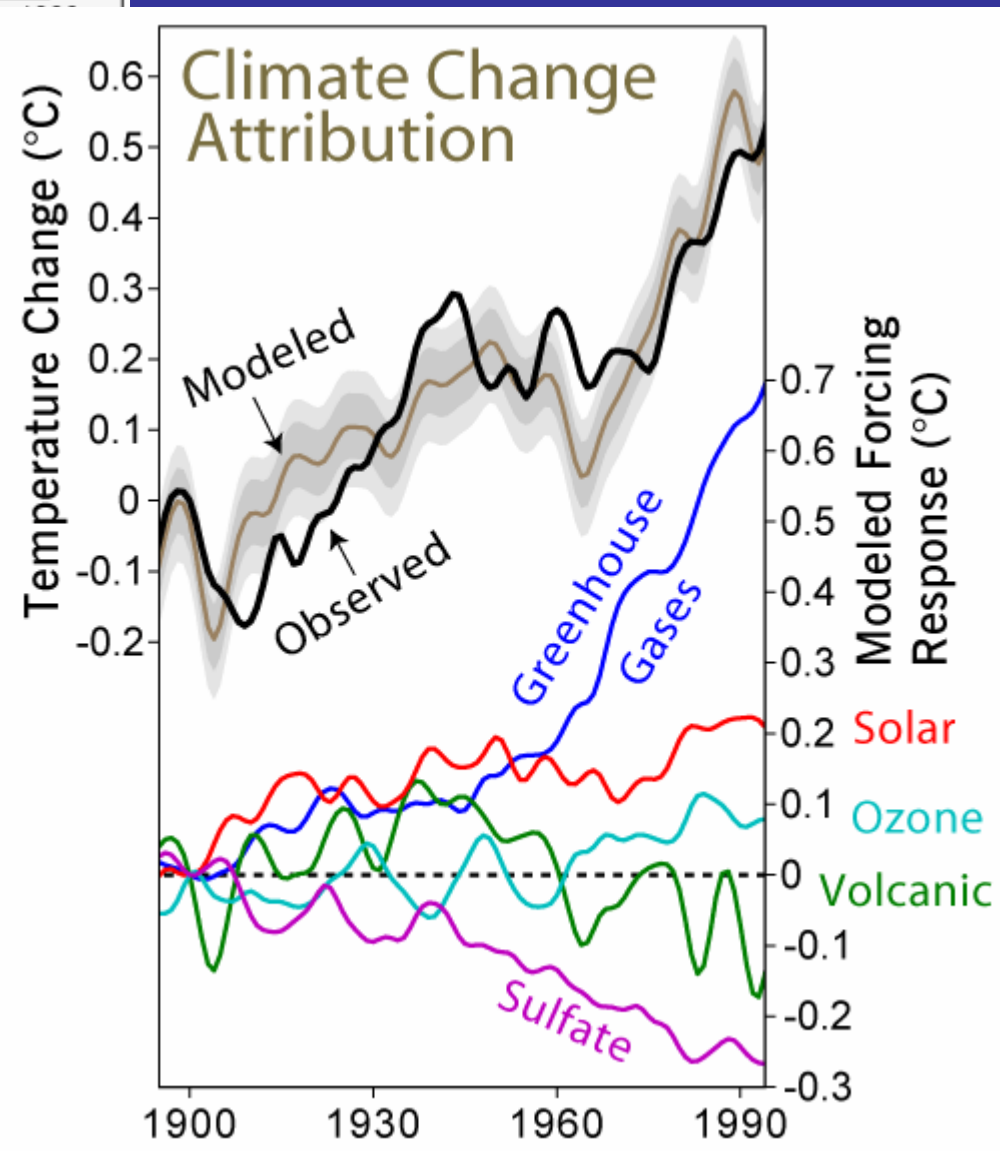




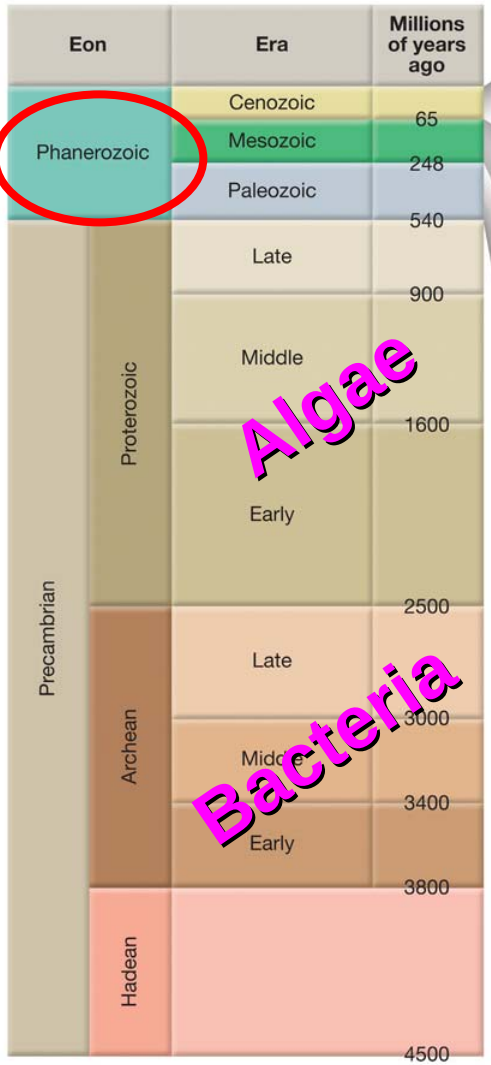
Where will evolution take us next ?



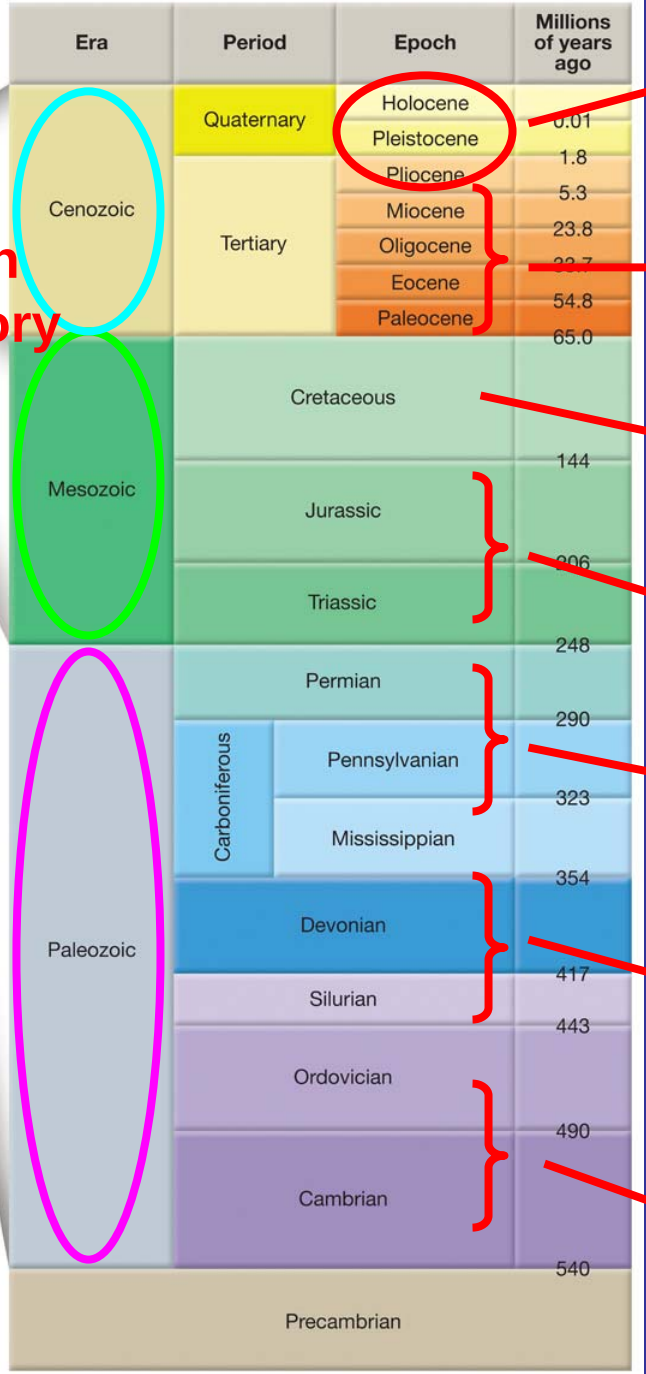
Burning of fossil fuels



CO_2 increases highly correlated with rising temperatures



10% Earth history



Humans
(<0.1% of Earth History)

Mammals

Modern fish

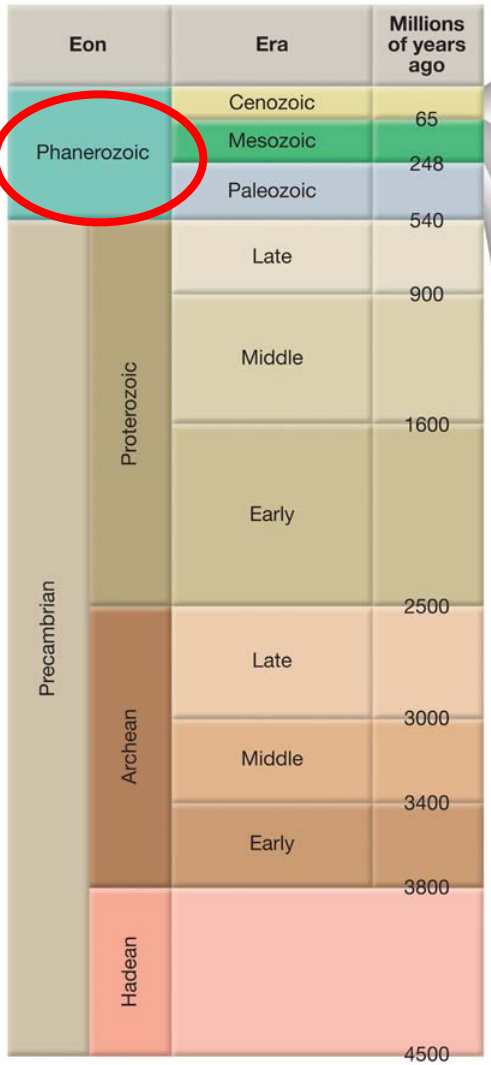
Dinosaurs

Reptiles

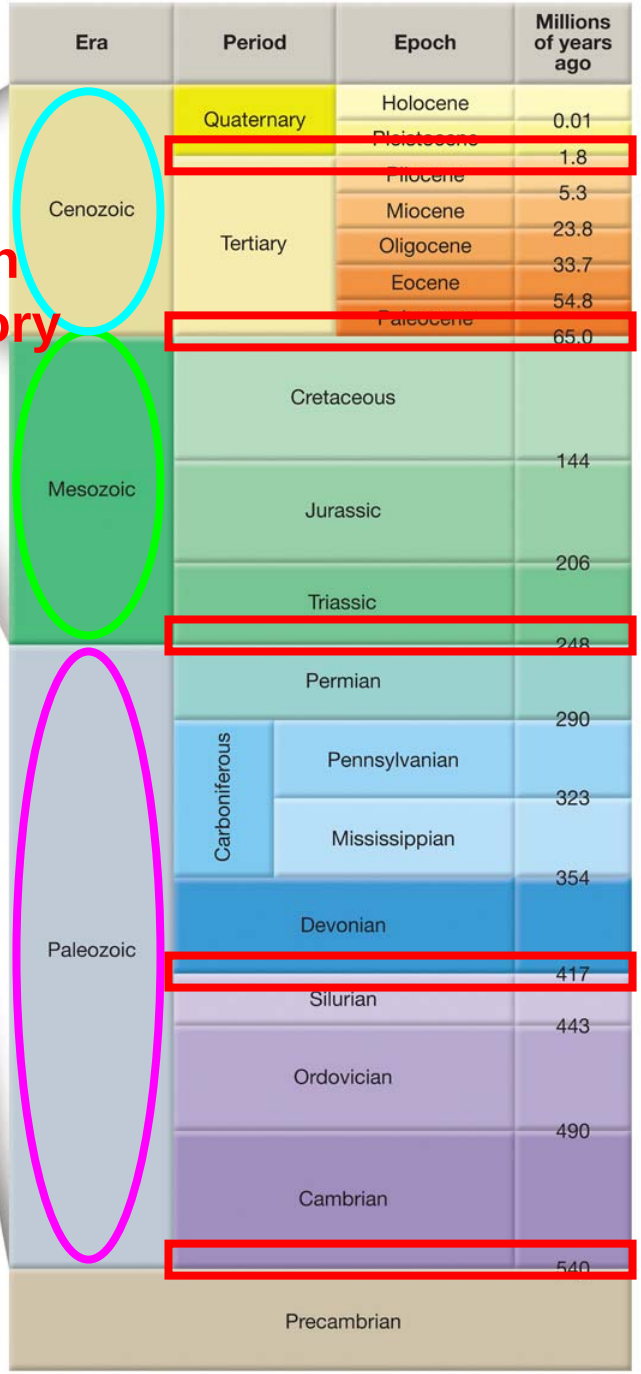
First jawed fish

Trilobites

"Life Assemblages"



10% Earth history



Extinctions define boundaries on geologic timescale:

1) Meteorite Impacts
2) Plate Reorganization
3) Volcanism
4) Astronomical Events
5) Etc…

Result:

Climate change