

Geologic Time

A short history of the Earth

Dr Alissa Flatley

ACNA4007 – Physical Landscape and the Geosphere



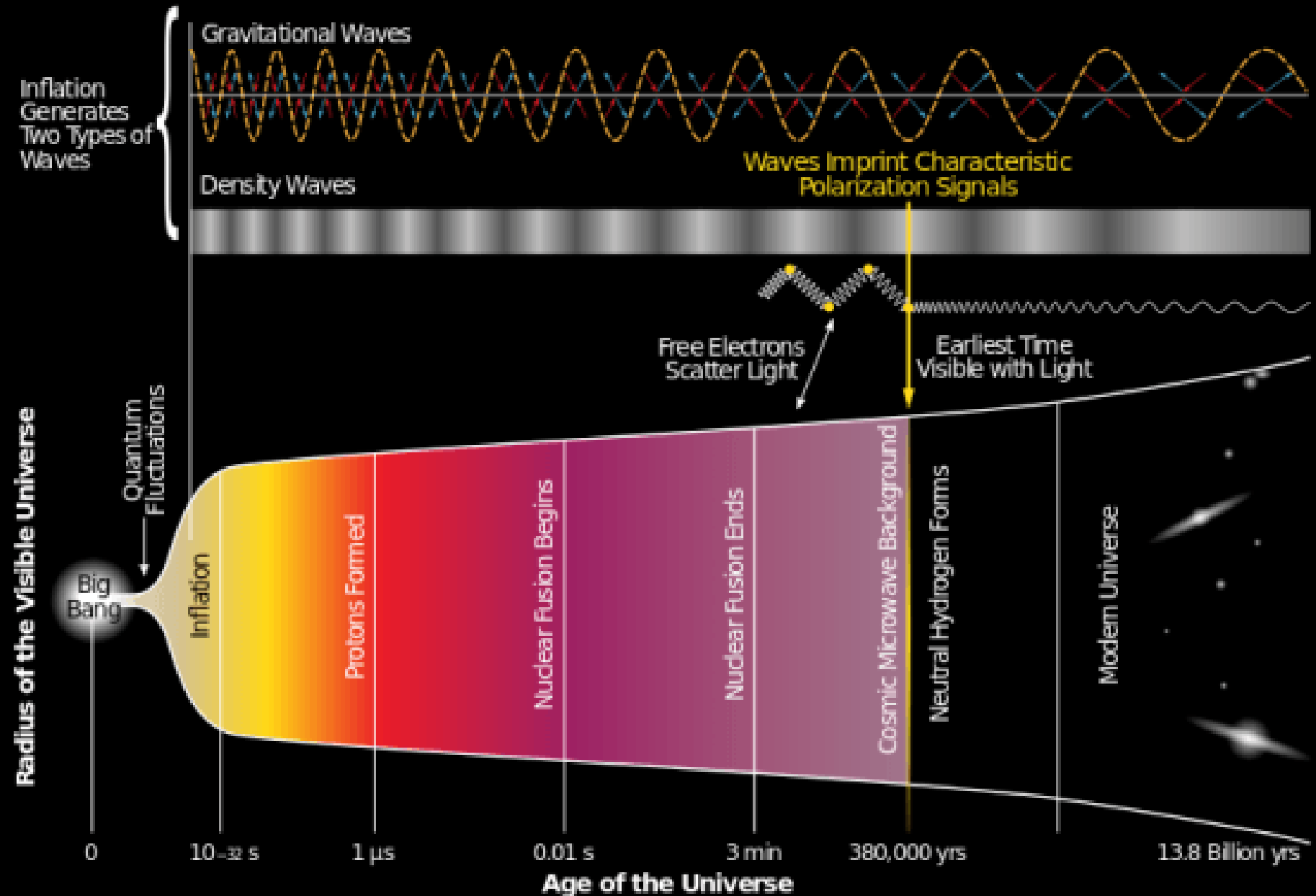
Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

History of the Universe



- Big Bang
- **Geologic timescale**
- Geologic history
- The rock record

History of the Universe



History of the Universe

1

Boiling "soup" with electrons, quarks and other elementary particles. Space cools off rapidly. Quarks form protons and neutrons.

2

Universe - superhot fog. Heated protons and electrons hinder the emission of light. Light elements created like deuterium, lithium, helium.

3

Protons, electrons, neutrons combine and form atoms. Primarily hydrogen and helium atoms

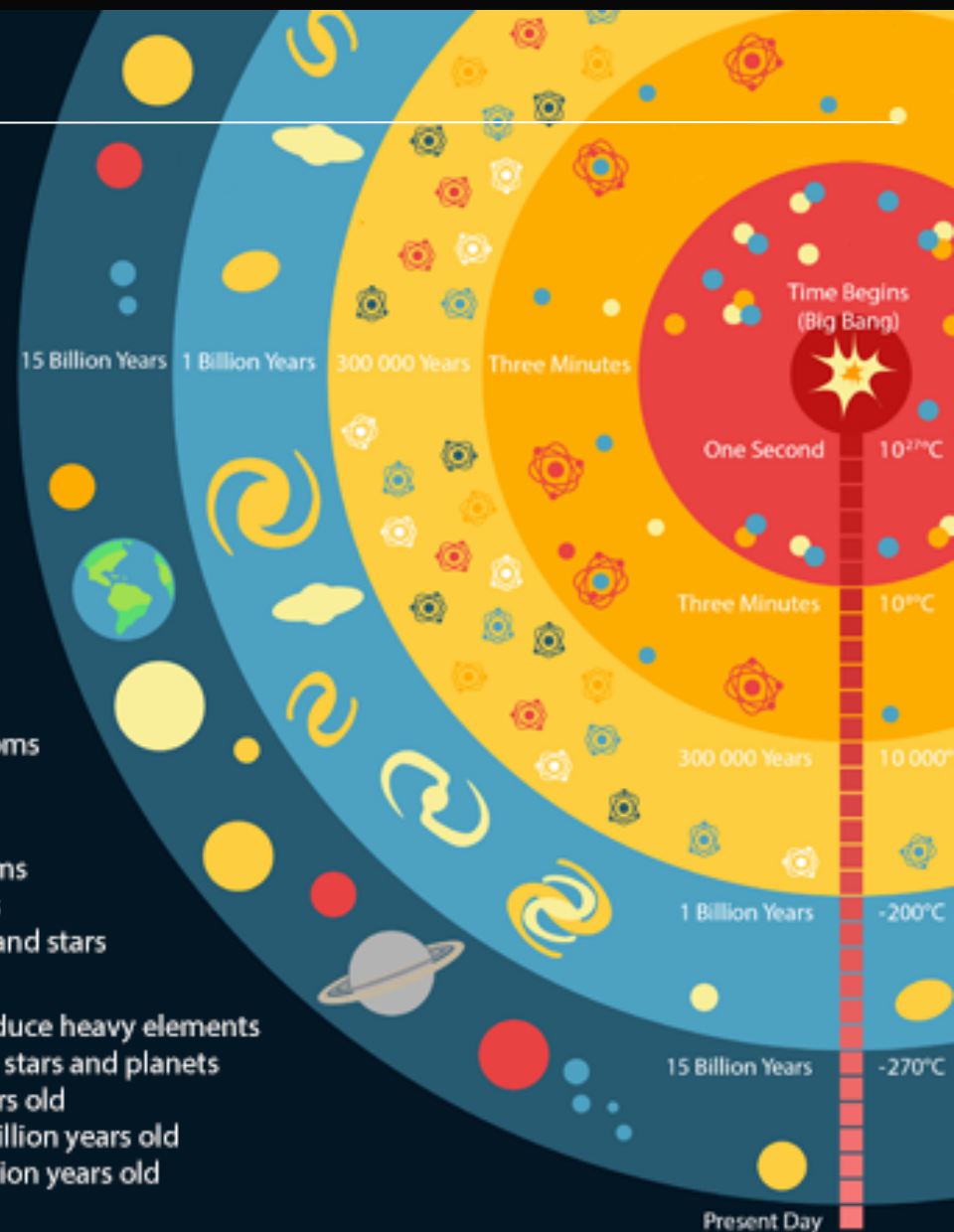
4

Galaxy formation era. Hydrogen and helium atoms begin to form giant clouds that will become galaxies and stars

5

First dying stars produce heavy elements which turn into new stars and planets
Sun ~ 4.6 billion years old
Solar System ~ 4.5 billion years old
Milky Way ~ 13.2 billion years old

BIG BANG THEORY PHASES



5 minutes...



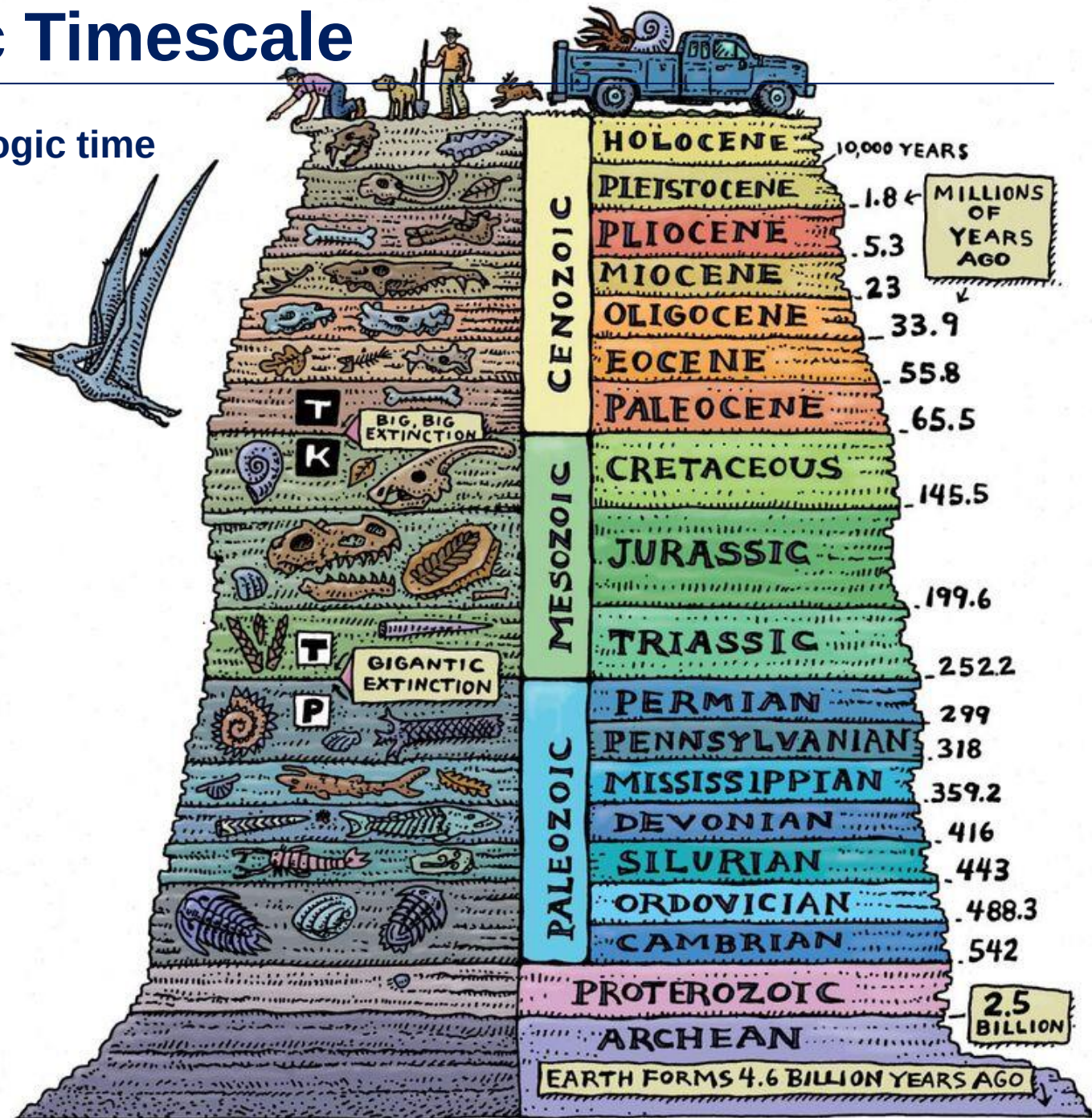
The Geologic Timescale

- A calendar of geologic time

EON	ERA	PERIOD	MILLIONS OF YEARS AGO	KEY EVENTS	
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Proterozoic		Also known as Precambrian	3500	← Earliest life	
Archean					
Hadean					

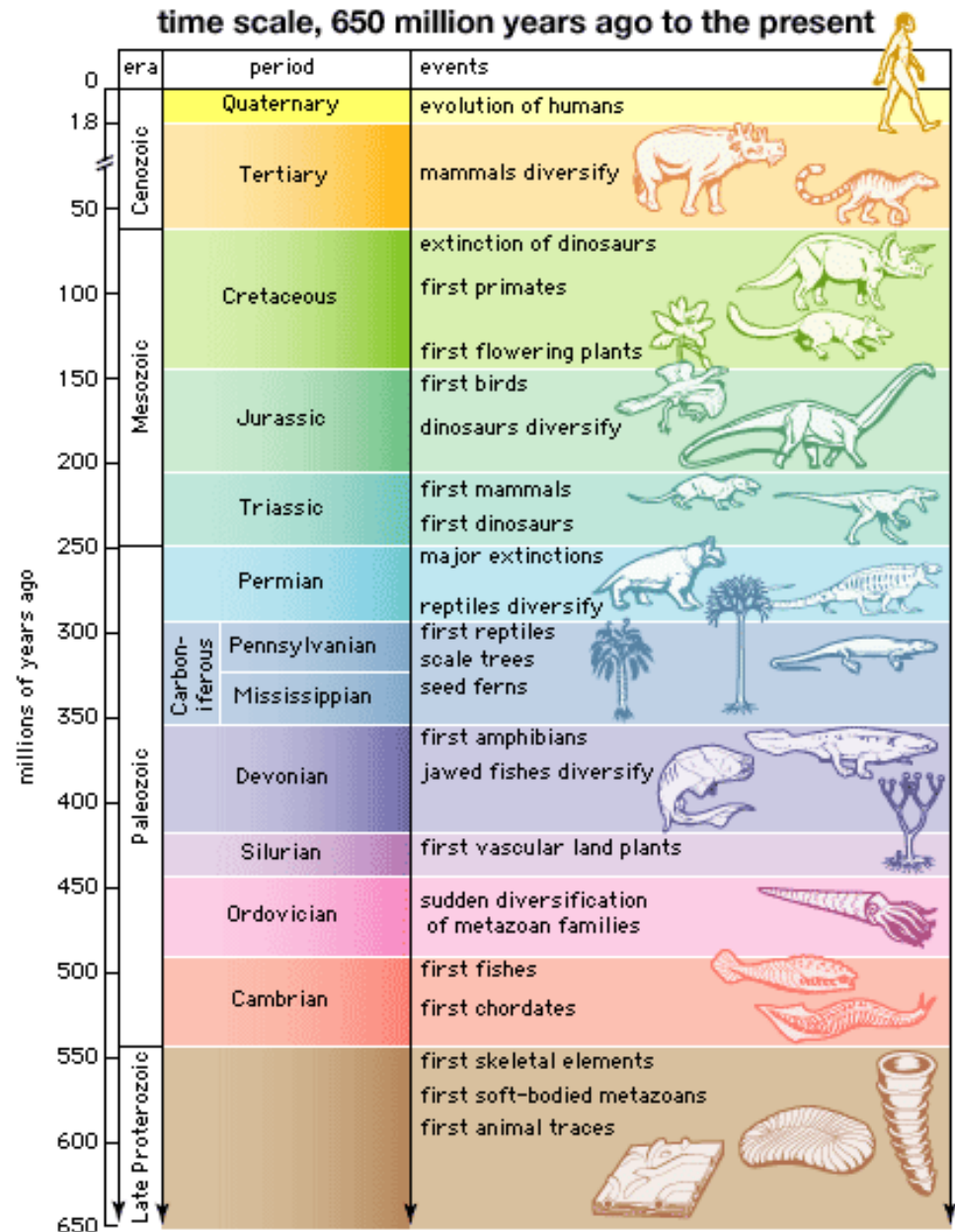
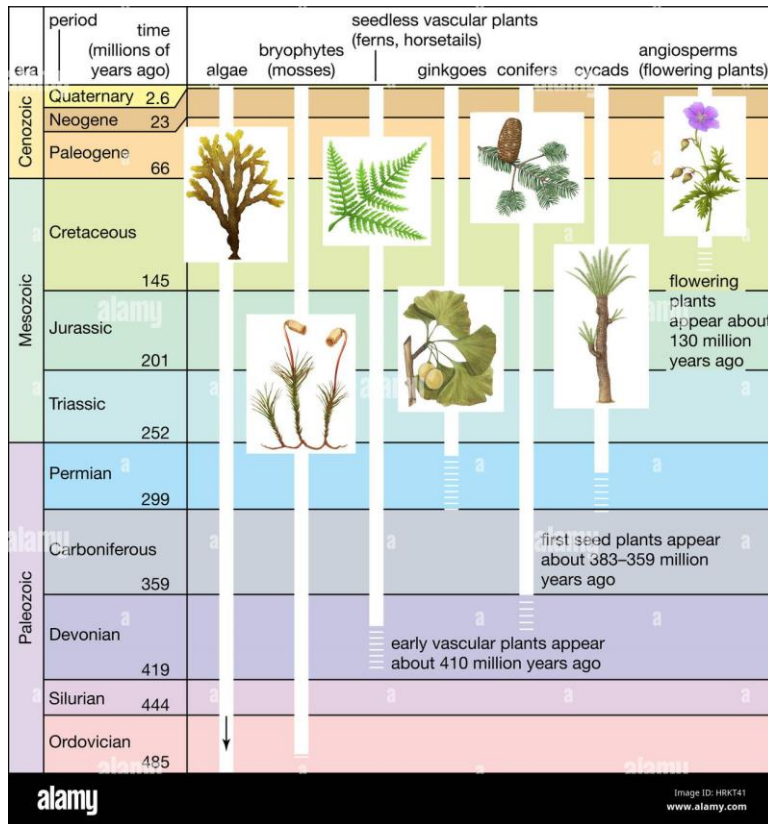
The Geologic Timescale

- A calendar of geologic time

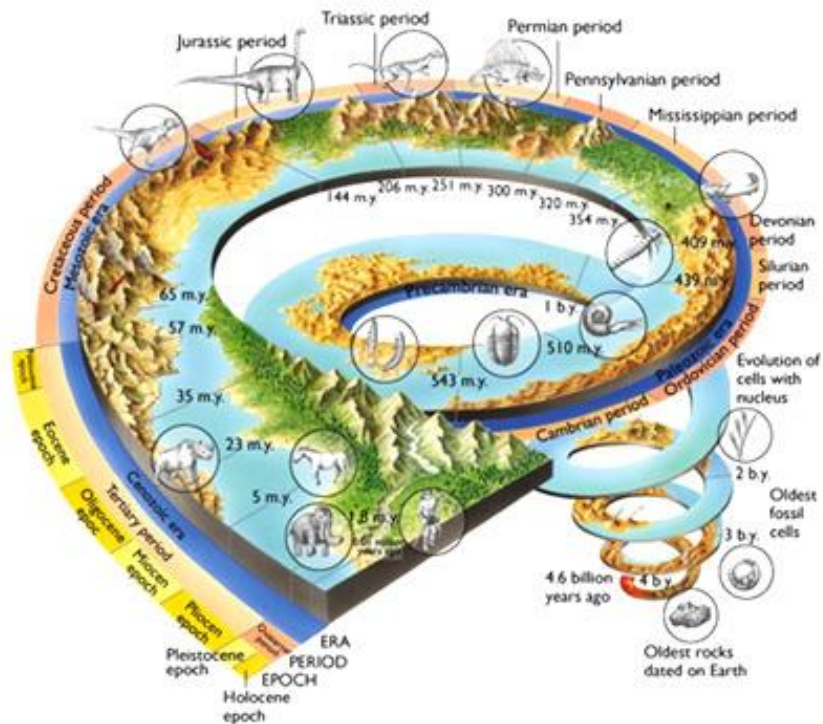


The Geologic Timescale

- A calendar of geologic time



The Geologic Timescale



Spiral Poster16Meg (usgs.gov)

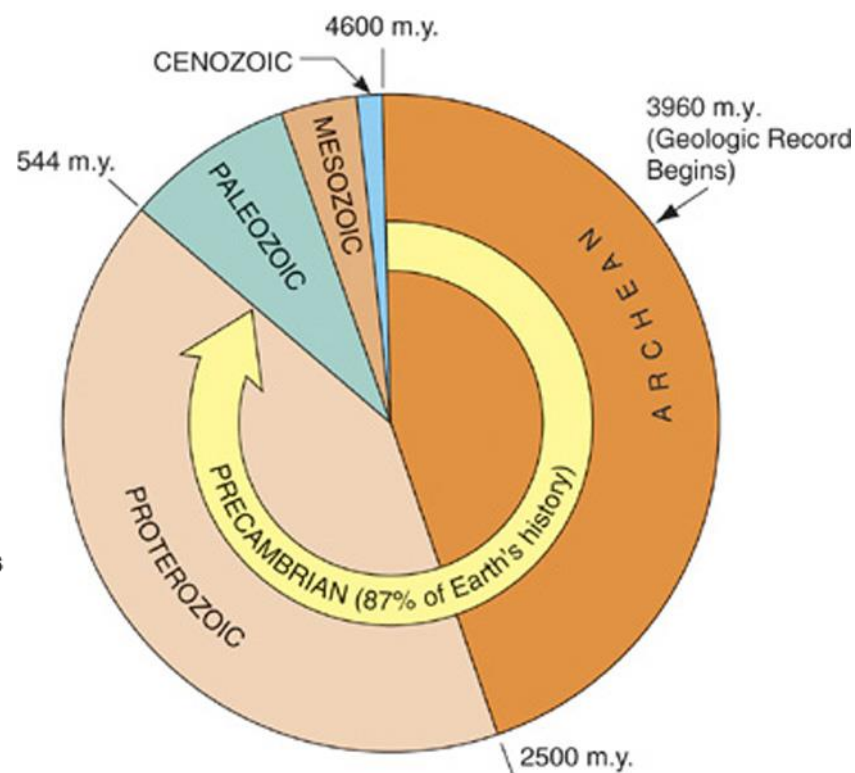
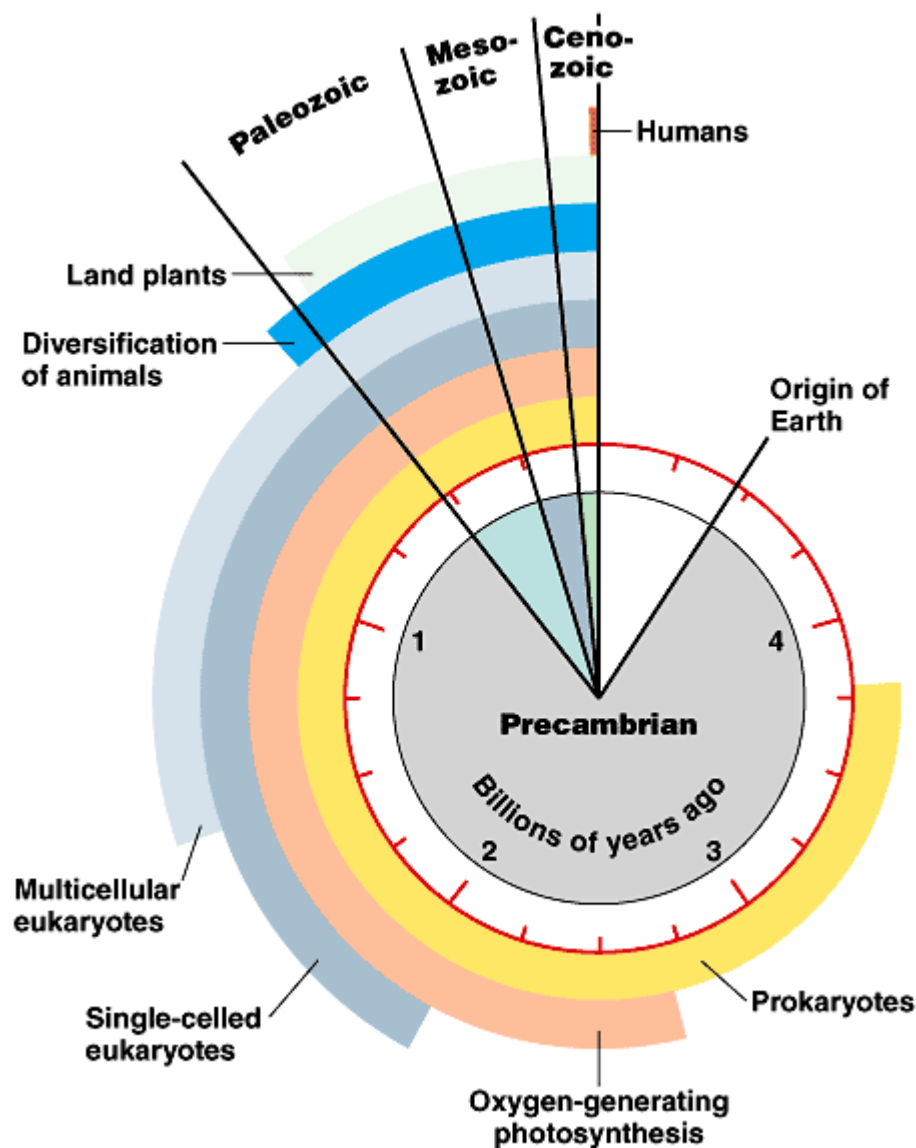
The Geologic Time Spiral—A Path to the Past



U.S. Department of the Interior
U.S. Geological Survey

Spiral designed by Joseph DeGroot, William Mendenhall, and John Sloss. Digital conversion by Web Services. Printed copies of this and other USGS products are available for sale at store.usgs.gov.
Catalog Number Publication 58

The Geologic Timescale



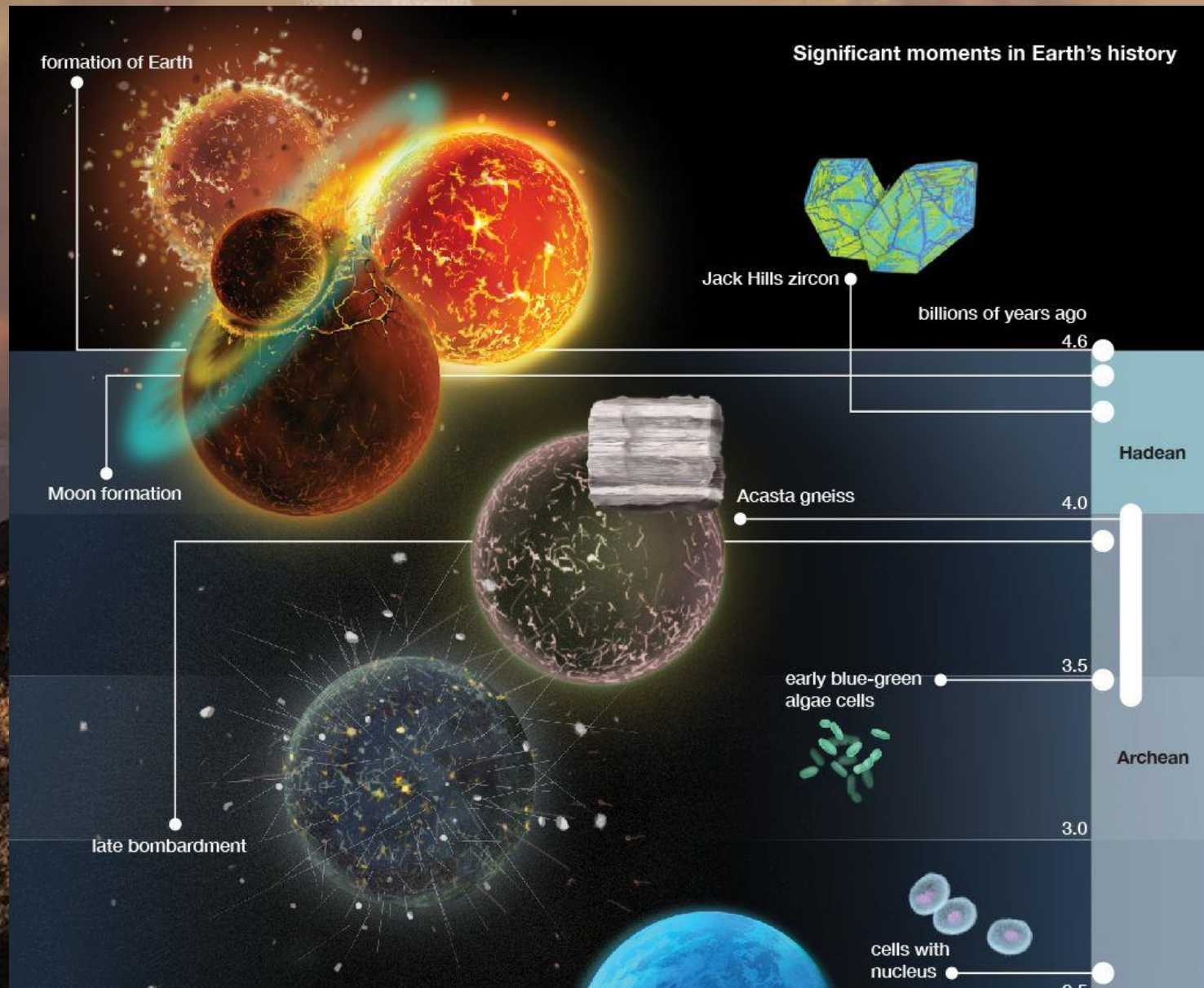
Hadean (4.5 to 4.0 Ga.)

1. Initial Formation of the Earth
2. Impact of Mars-sized planet - Formation of Moon

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Archean						
Hadean						
		Precambrian				

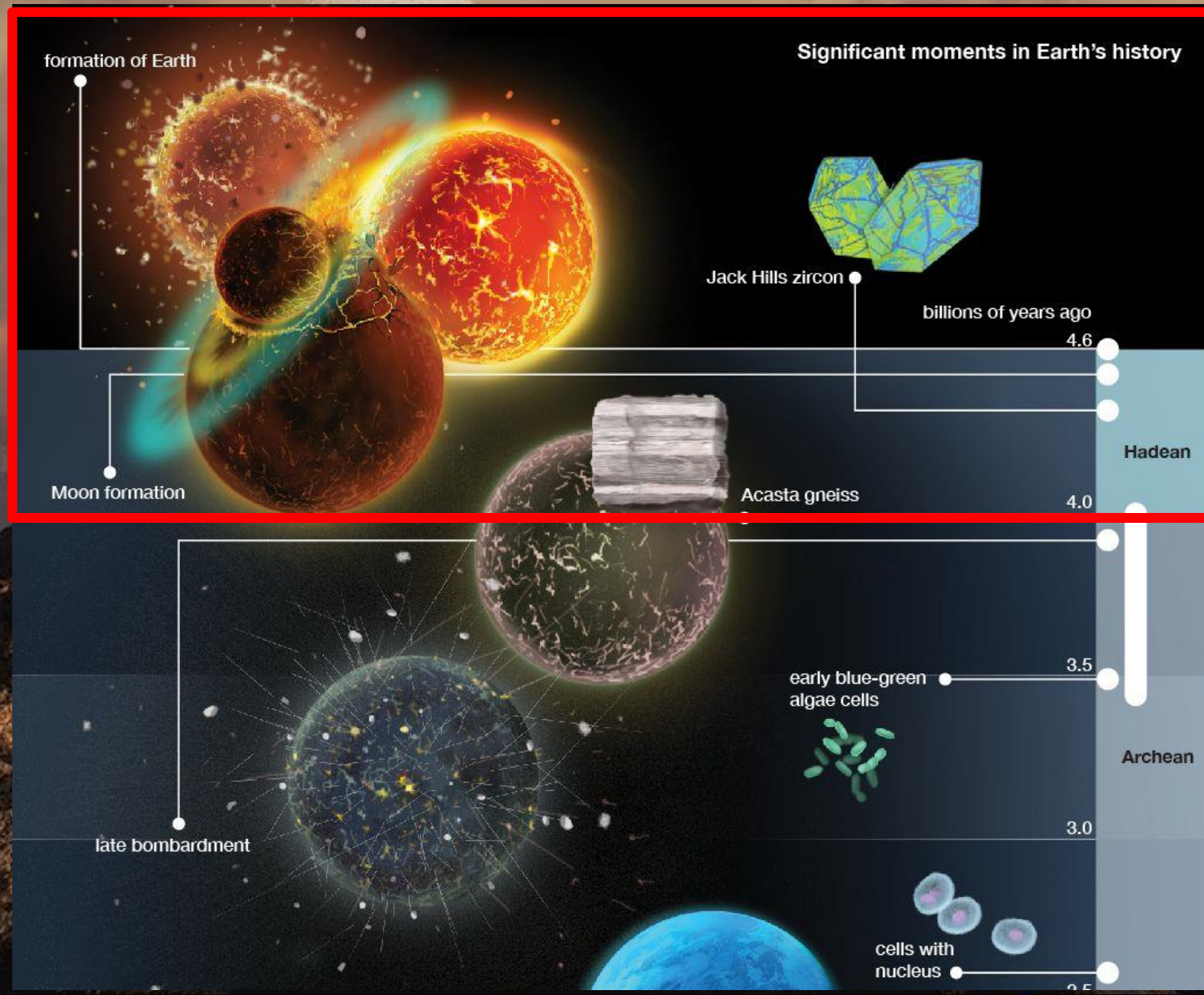
Era of Asteriod Bombardment (4.1 to 4.5 Ga)

The evidence?



Era of Asteriod Bombardment (4.1 to 4.5 Ga)

The evidence?



Era of Asteriodal Bombardment (4.1 to 4.5 Ga)

The evidence?



[Impact Cratering on the Hadean Earth \(usra.edu\)](http://usra.edu)

Era of Asteriodal Bombardment (4.1 to 4.5 Ga)

The evidence?

Hadean Earth

ca. 4 billion years ago

Hadean Bombardment

[Widespread mixing and burial of Earth's
Hadean](#) crust by asteroid impacts | Nature

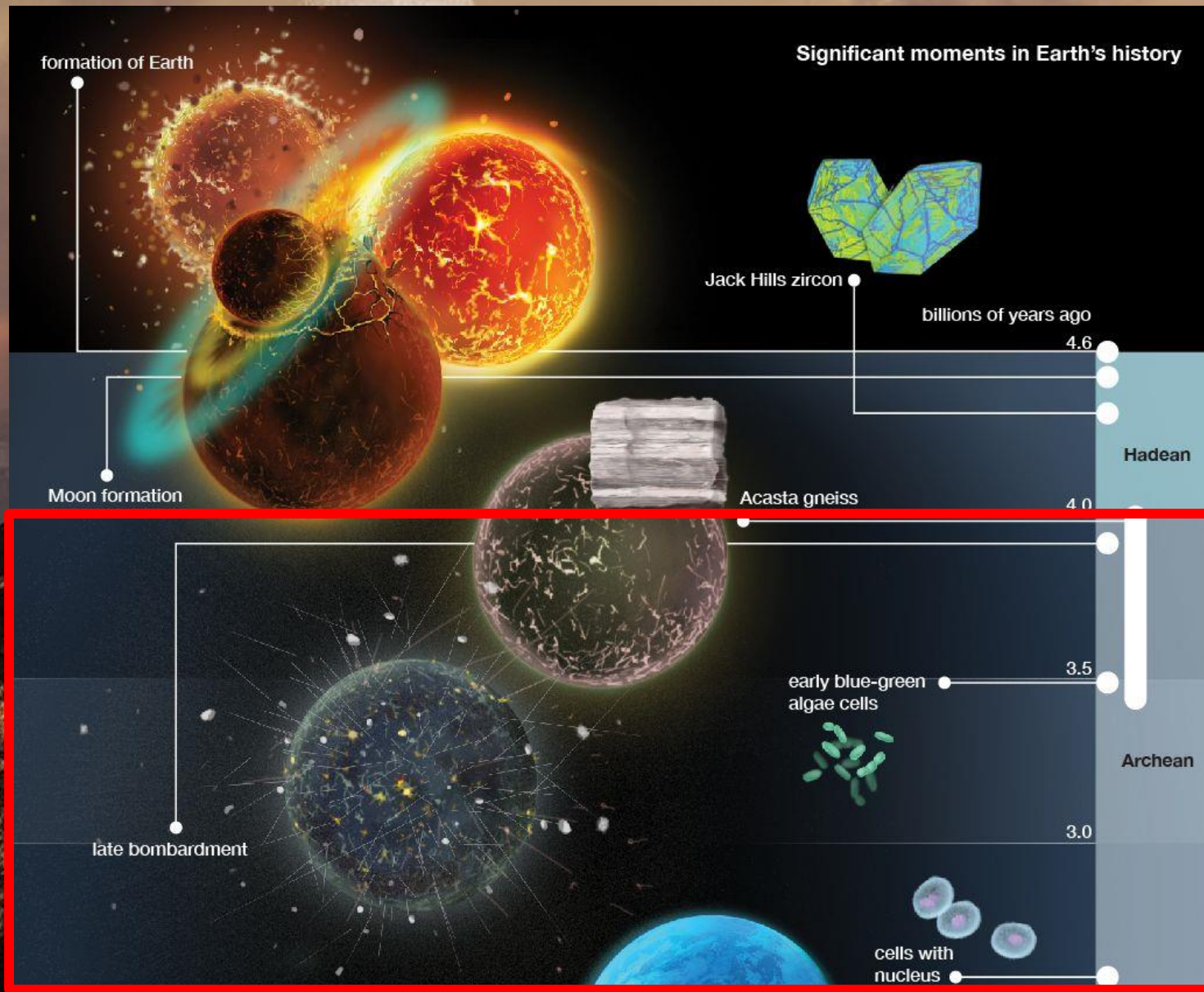
Bombardment of the Earth during
the Hadean and Eoarchean eras

(ca. 3.5 - 4.5 billions of years ago)

© Simone Marchi, 2014

Era of Asteriodal Bombardment (4.1 to 4.5 Ga)

The evidence?



Archaen (2.5 to 4.0 Ga.)

1. Formation of First Stable Crust
2. The Archean Atmosphere
3. The Origins of Life

- Oldest Fossil – 3.7 Ga.

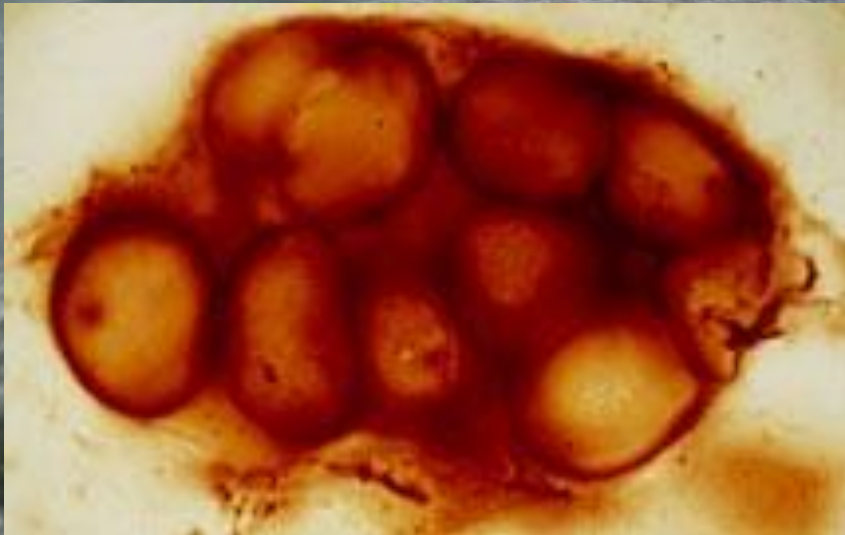
What was the
Archean world like?

EON	ERA	PERIOD	MILLIONS OF YEARS AGO	KEY EVENTS
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Primitive Unicellular Organisms

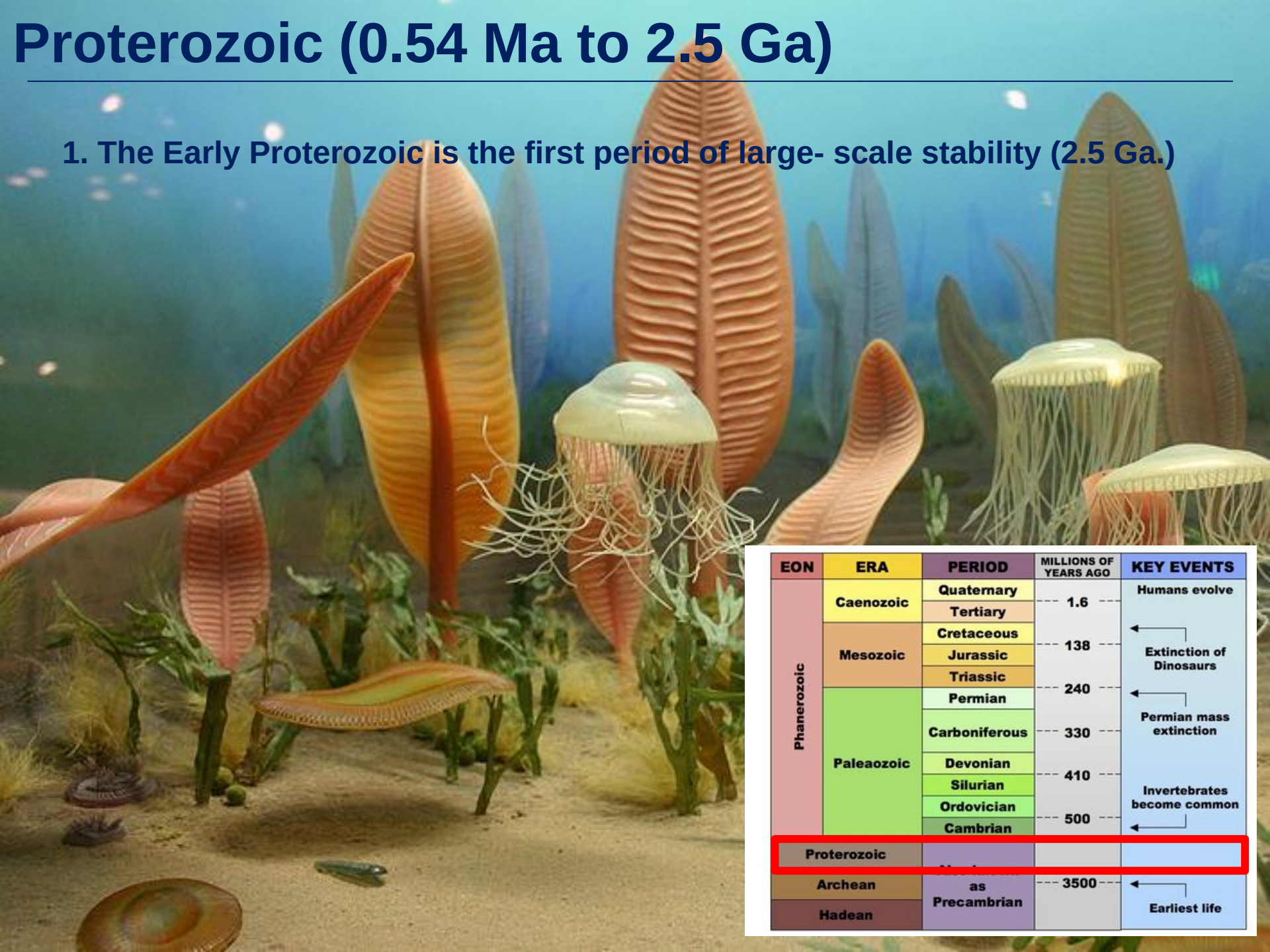


Stromatolite



Proterozoic (0.54 Ma to 2.5 Ga)

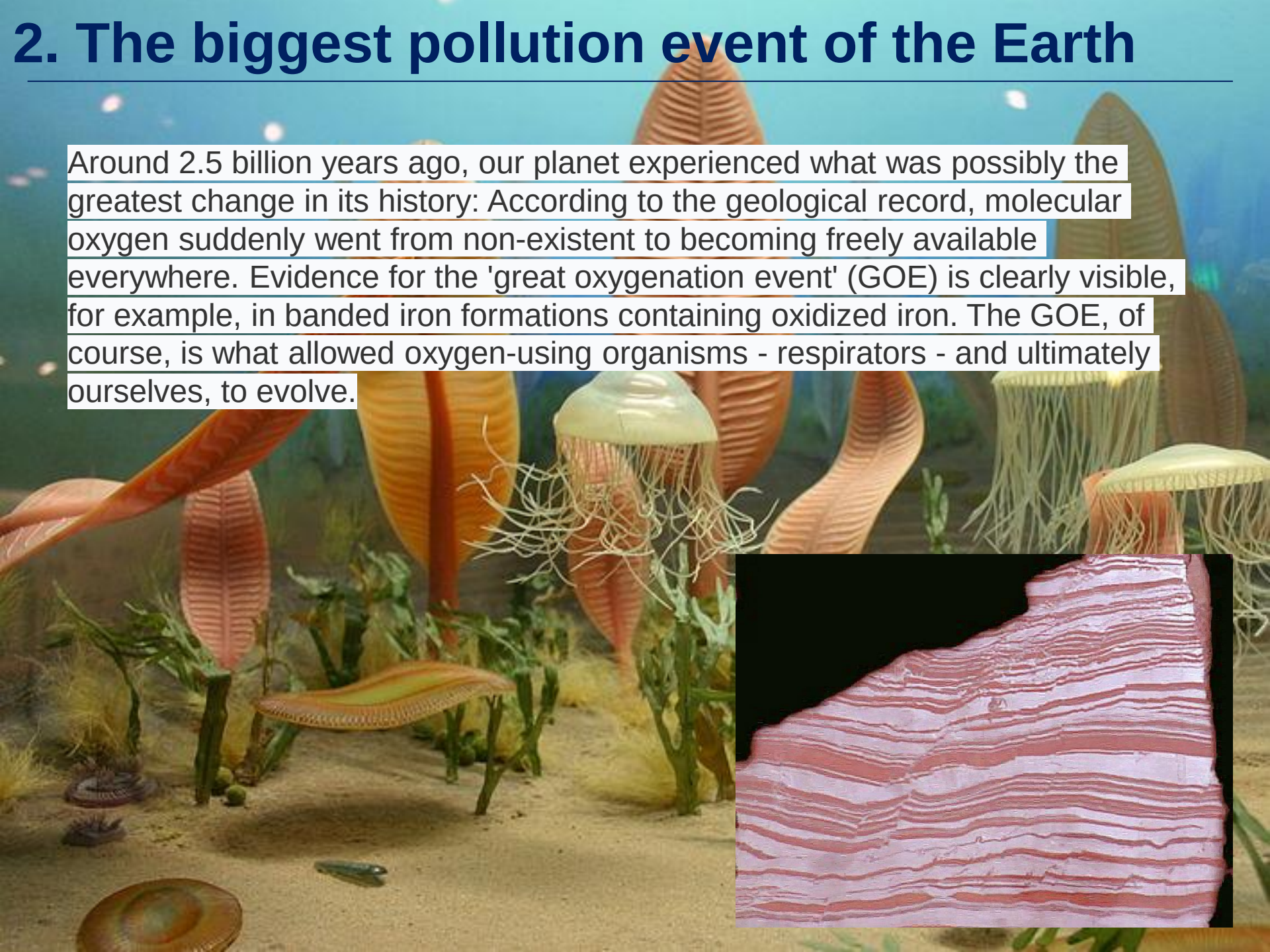
1. The Early Proterozoic is the first period of large- scale stability (2.5 Ga.)



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Cambrian				
Proterozoic				
Archean	as Precambrian		3500	← Earliest life
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2. The biggest pollution event of the Earth

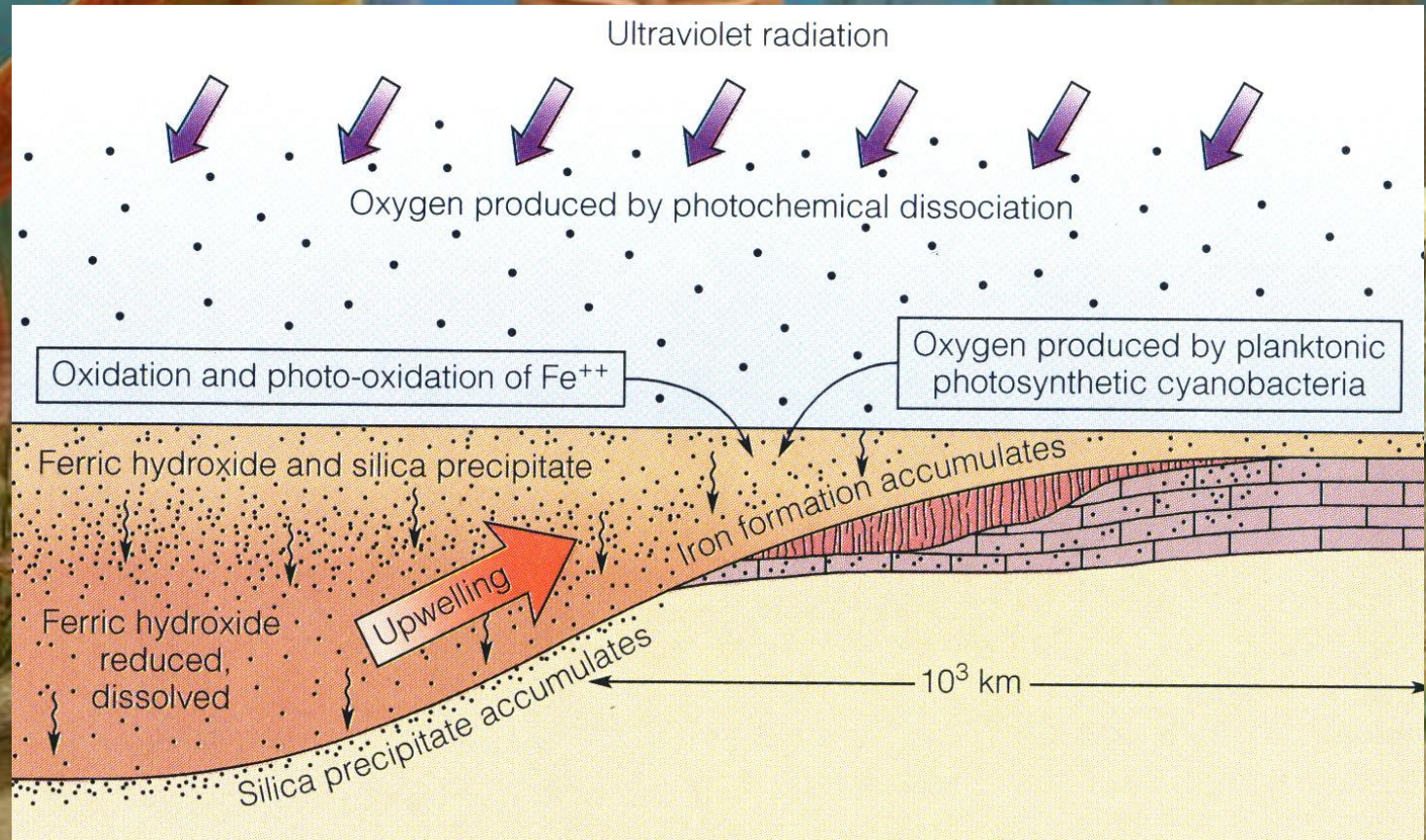
Around 2.5 billion years ago, our planet experienced what was possibly the greatest change in its history: According to the geological record, molecular oxygen suddenly went from non-existent to becoming freely available everywhere. Evidence for the 'great oxygenation event' (GOE) is clearly visible, for example, in banded iron formations containing oxidized iron. The GOE, of course, is what allowed oxygen-using organisms - respirators - and ultimately ourselves, to evolve.



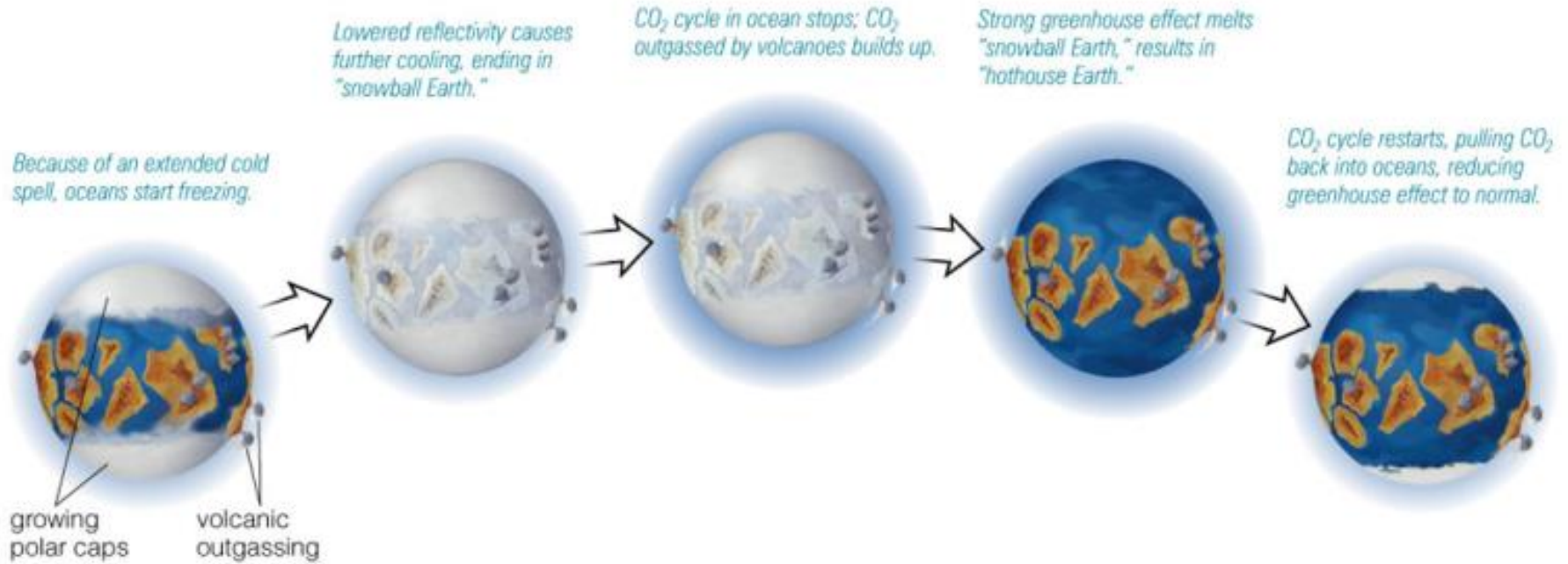
3. Presence of Oxygen

The presence of oxygen supported the development of more complex organisms (1.2 Ga.)

Eukaryotes versus prokaryotes



4. Snowball Earth (600 to 700 Ma)



- Strange Climatic Conditions
- The Entire Earth Froze-up

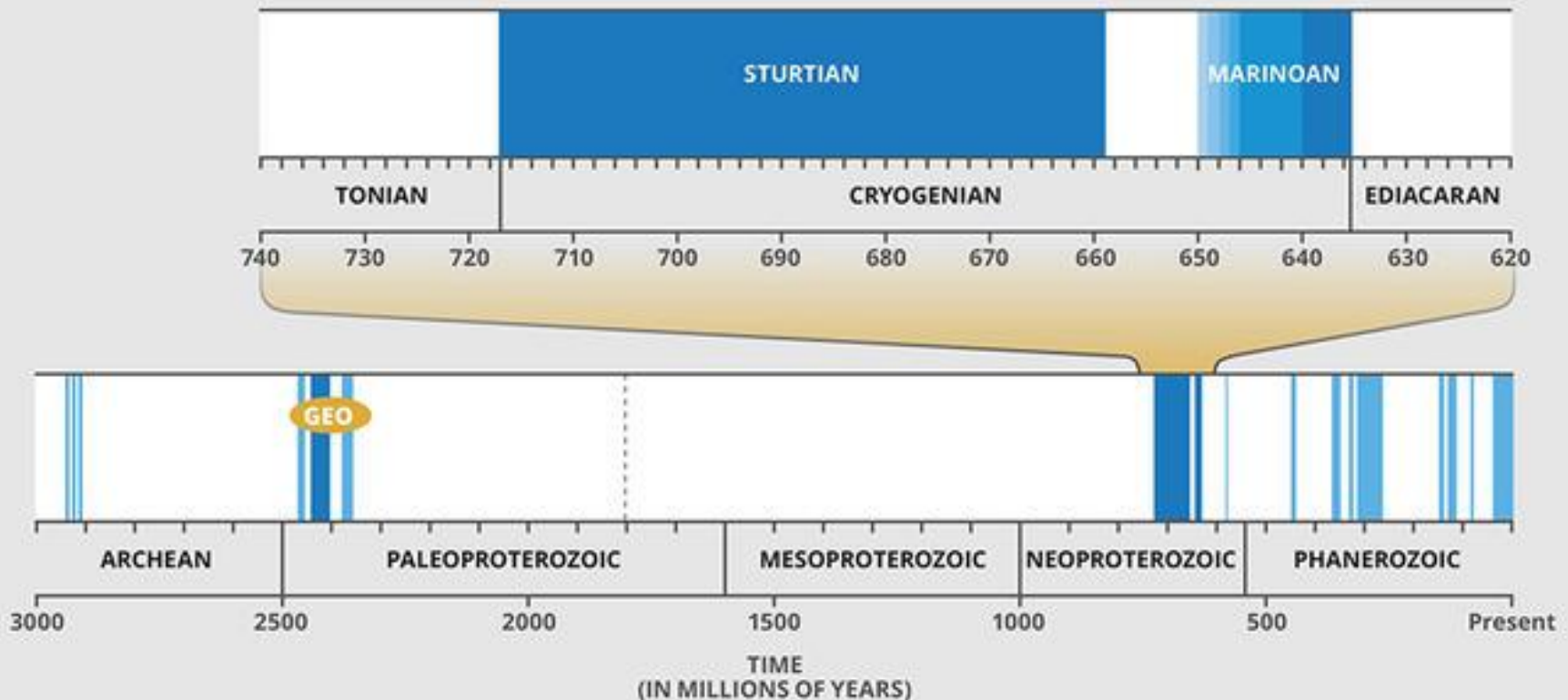
4. Snowball Earth (600 to 700 Ma)

Earth's glaciations over the past 3 billion years



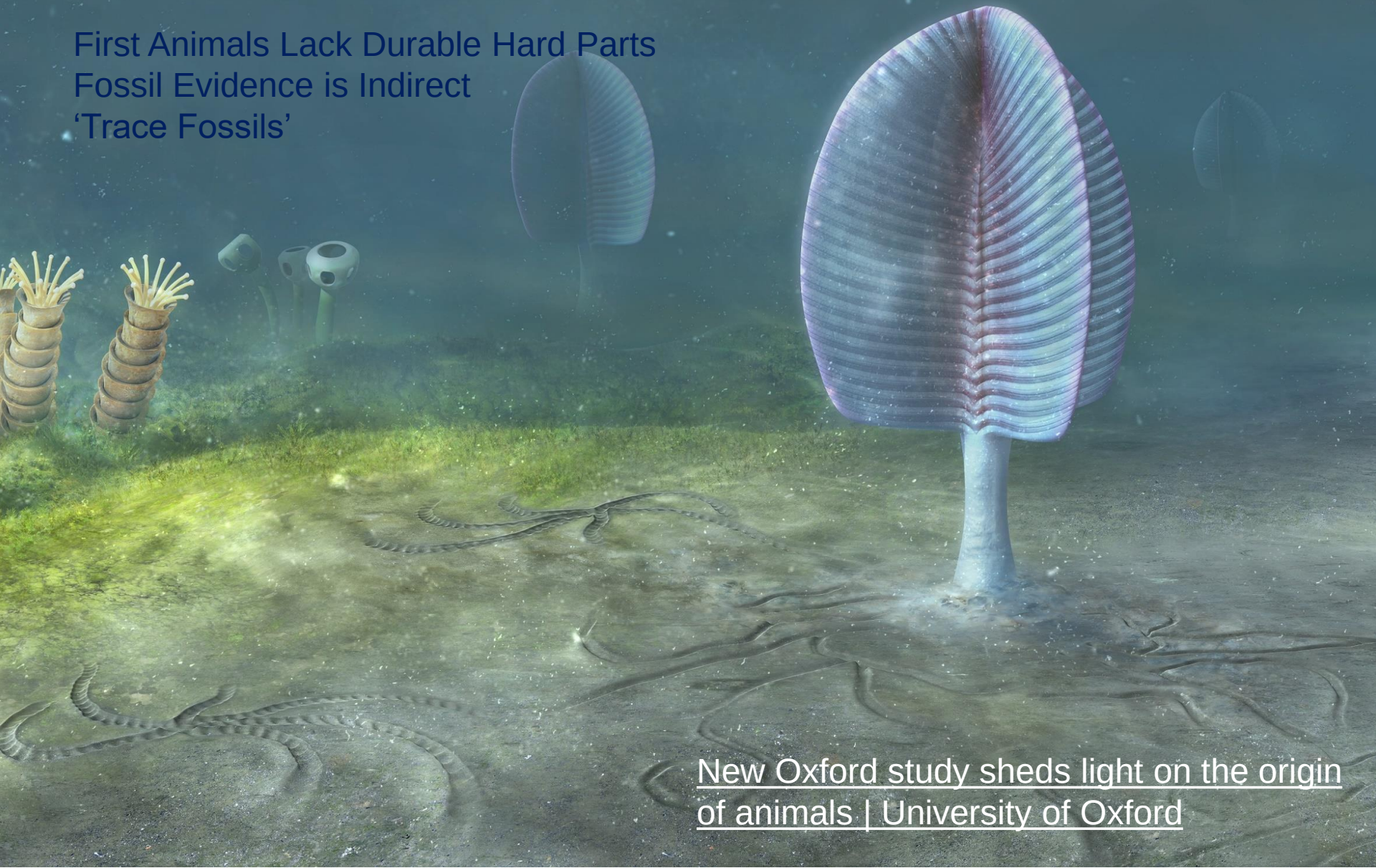
In paleoclimatology, an ice age is a period in which there are one or more permanent ice sheets. For instance, even though we have been living for 10,000 years in a period of relative warming, for the past 2.6 million years the planet has been going through an ice age characterized by the permanent presence of two polar ice sheets. However, as can be seen from the timeline, the presence of permanent ice (periods shown in light blue), even when confined to the poles,

was rather an exception in Earth's history. As for Snowball Earth episodes (in dark blue), characterized by ice sheets extending to equatorial regions, only three have been discovered by researchers: the first occurred 2.4 billion years ago, just after the Great Oxygenation Event (GOE), and the other two more than a billion and a half years later, just before the emergence of the first animals.



The origin of Animals (600 Ma)

First Animals Lack Durable Hard Parts
Fossil Evidence is Indirect
'Trace Fossils'



New Oxford study sheds light on the origin
of animals | University of Oxford

Paleozoic (250 to 540 Ma)

Early Paleozoic (420 to 540 Ma.)
Origin of Animals with Skeletal Hard Parts



EON	ERA	PERIOD	MILLIONS OF YEARS AGO	KEY EVENTS
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Proterozoic		Also known as Precambrian	3500	Earliest life
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Early Paleozoic

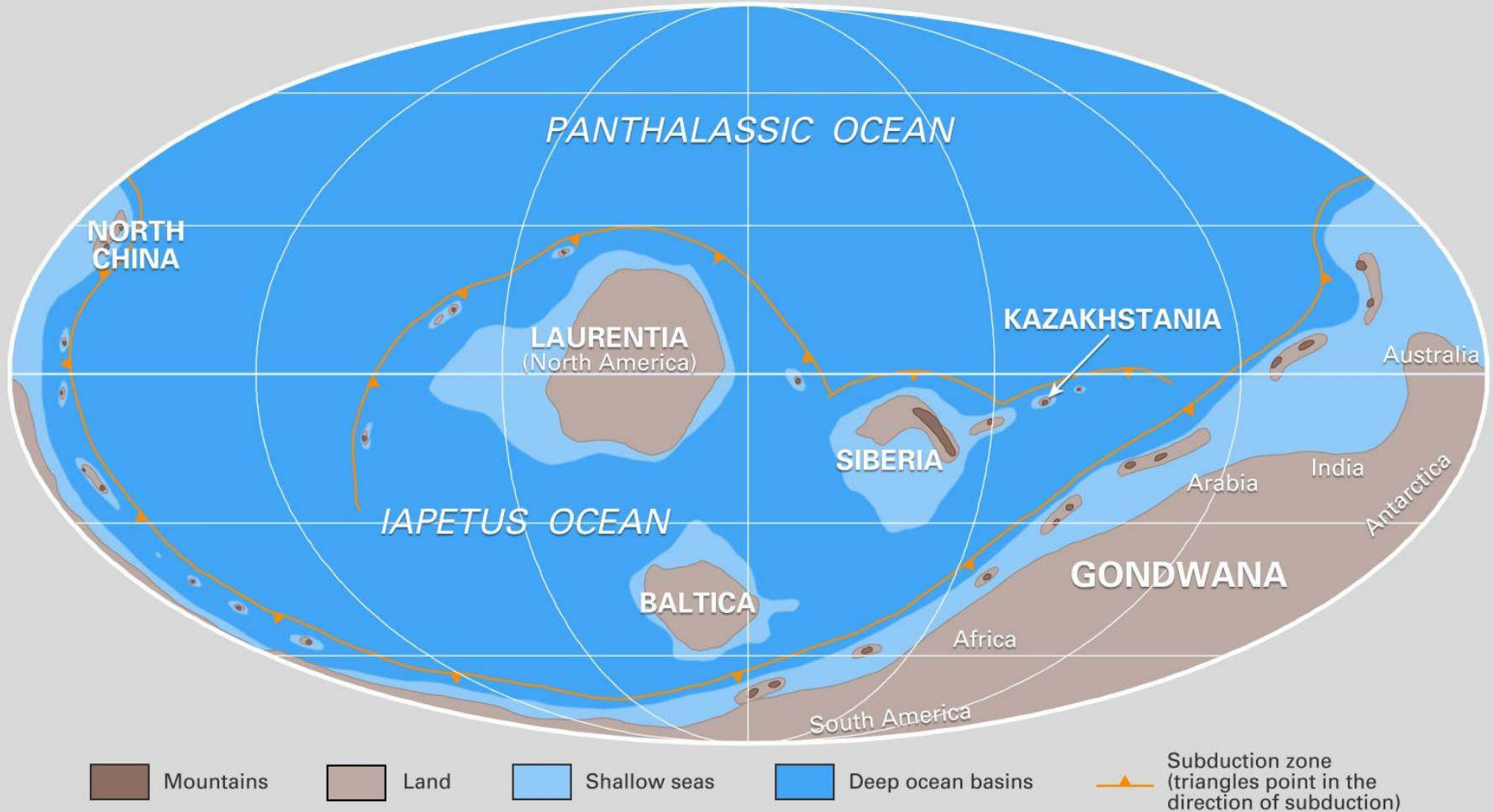


A rich diversity of sea life existed

Q: What is missing in this photo?

Shifting Continents

Late Cambrian 514 million years ago



SOURCE: © 2001 C.R. Scotese, PALEOMAP Project

© Encyclopædia Britannica, Inc.

The continents are not fixed. They move - But, very slowly

Late Paleozoic (250 to 420 Ma.)

Origin of Terrestrial Life

Toward the end of the Paleozoic large forests consisting of fern trees were established

-These swampy forests ultimately generated most of the world's coal



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Late Paleozoic



During the Late Paleozoic land animals evolved

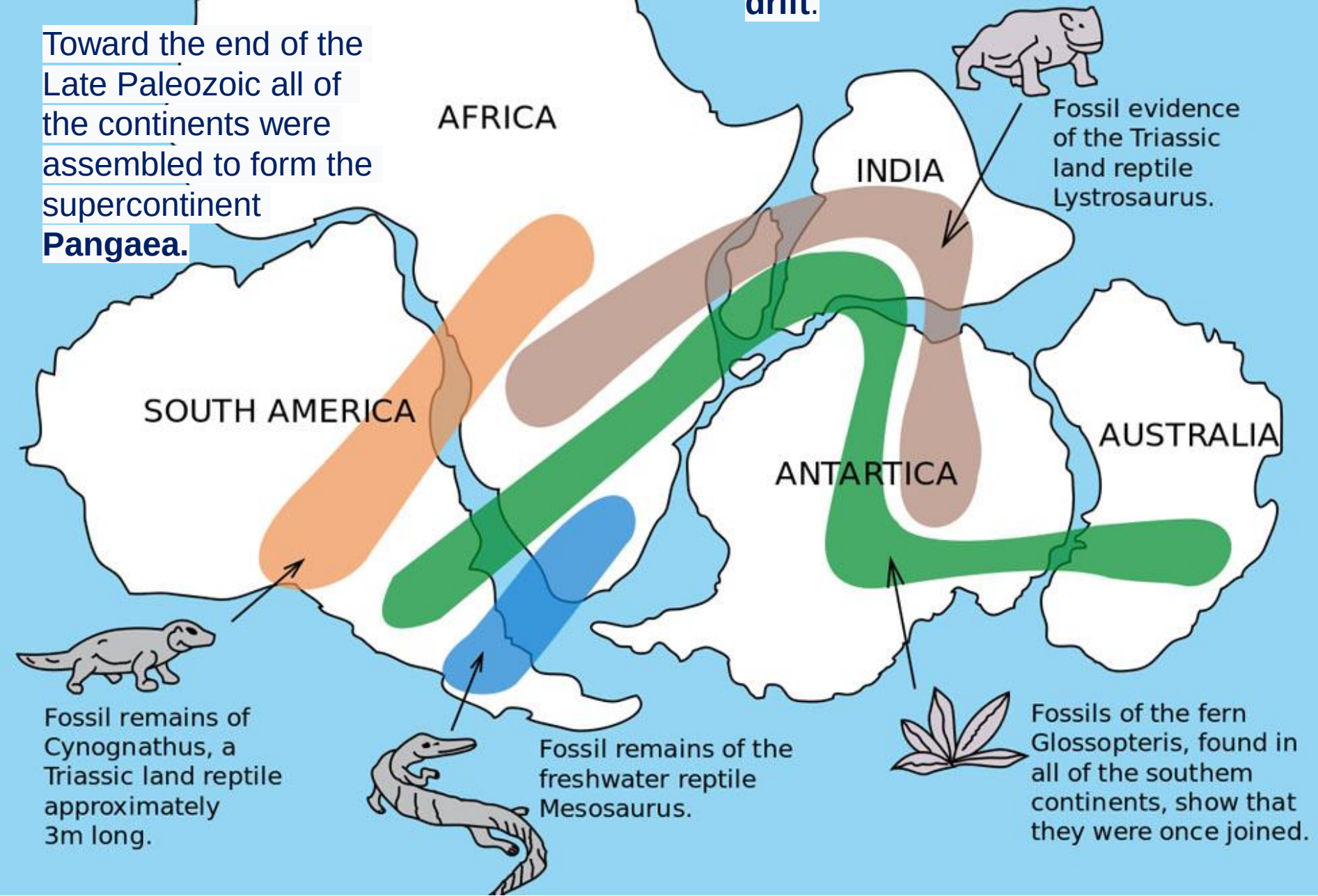
- Insects
- Amphibians
- Reptiles

Paleozoic | U.S. Geological Survey
([usgs.gov](https://www.usgs.gov))

Pangaea Supercontinent

Gradual movement of continents over geologic time is called **continental drift**.

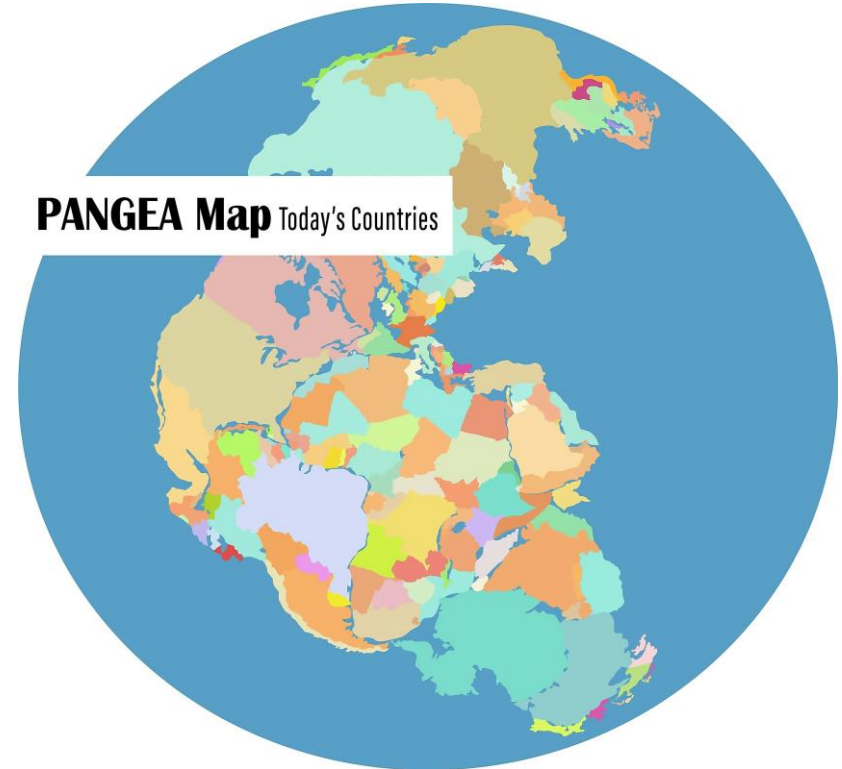
Toward the end of the Late Paleozoic all of the continents were assembled to form the supercontinent **Pangaea**.



Pangaea Supercontinent



Alfred Wegener in Greenland



Read these:

[Alfred Wegener: Building a Case for Continental Drift - University of Illinois at Urbana-Champaign](#)

[Continental Drift versus Plate Tectonics \(nationalgeographic.org\)](#)



5 minutes...



Permian Extinction

The Great Permian Extinction: When
all life on Earth | Earth Archives

Permian extinction, facts and
information (nationalgeographic.com)



A quarter of a billion years ago, long before dinosaurs or mammals evolved, the predator *Dinogorgon*, whose skull is shown here, hunted floodplains in the heart of today's South Africa. In less than a million years *Dinogorgon* vanished in the greatest mass extinction ever, a... [Read More](#)

PHOTOGRAPH BY JONATHAN BLAIR

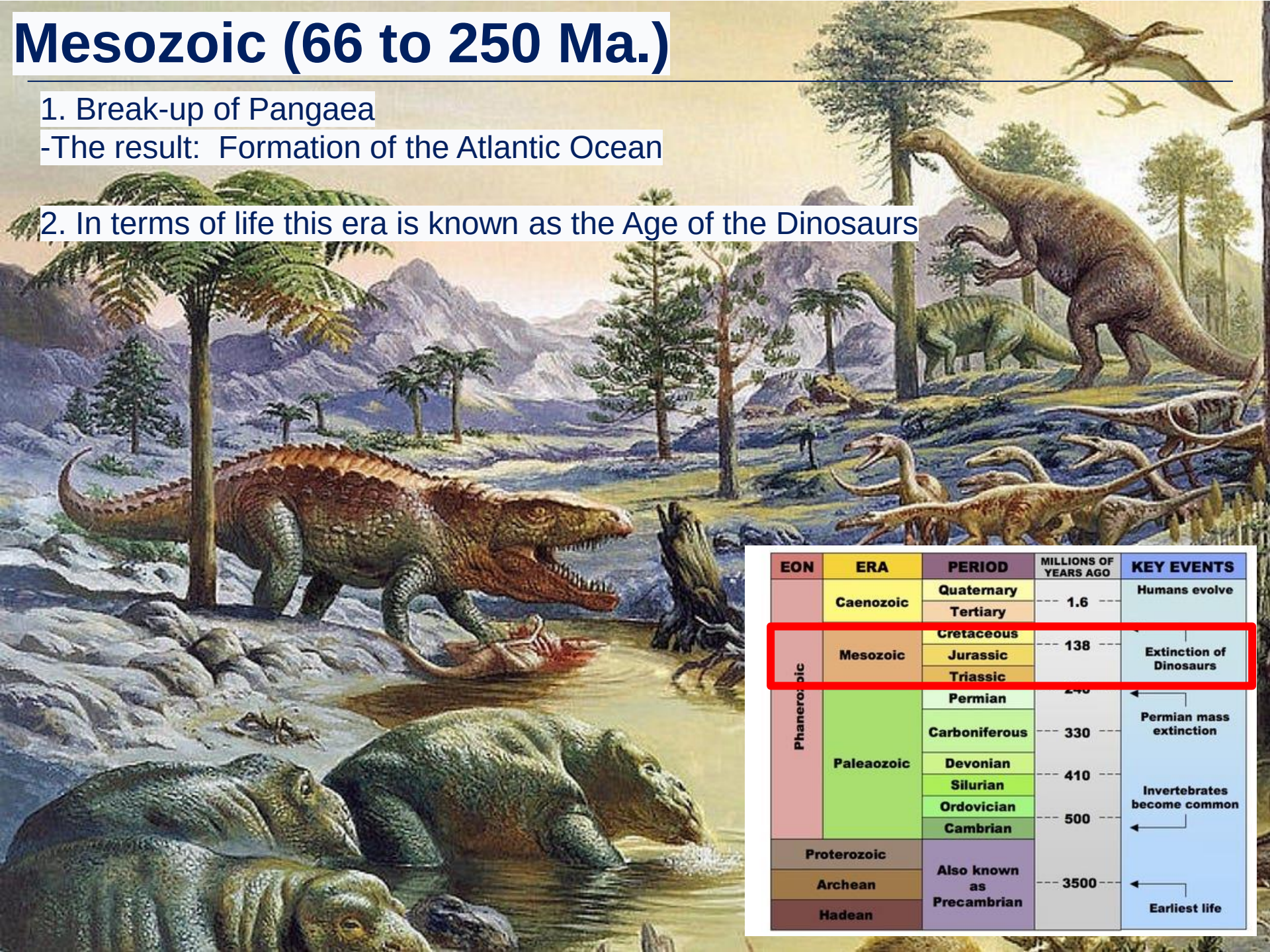
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Mesozoic (66 to 250 Ma.)

1. Break-up of Pangaea

-The result: Formation of the Atlantic Ocean

2. In terms of life this era is known as the Age of the Dinosaurs



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What happened at the end of the Mesozoic?



What caused the extinction of the dinosaurs?

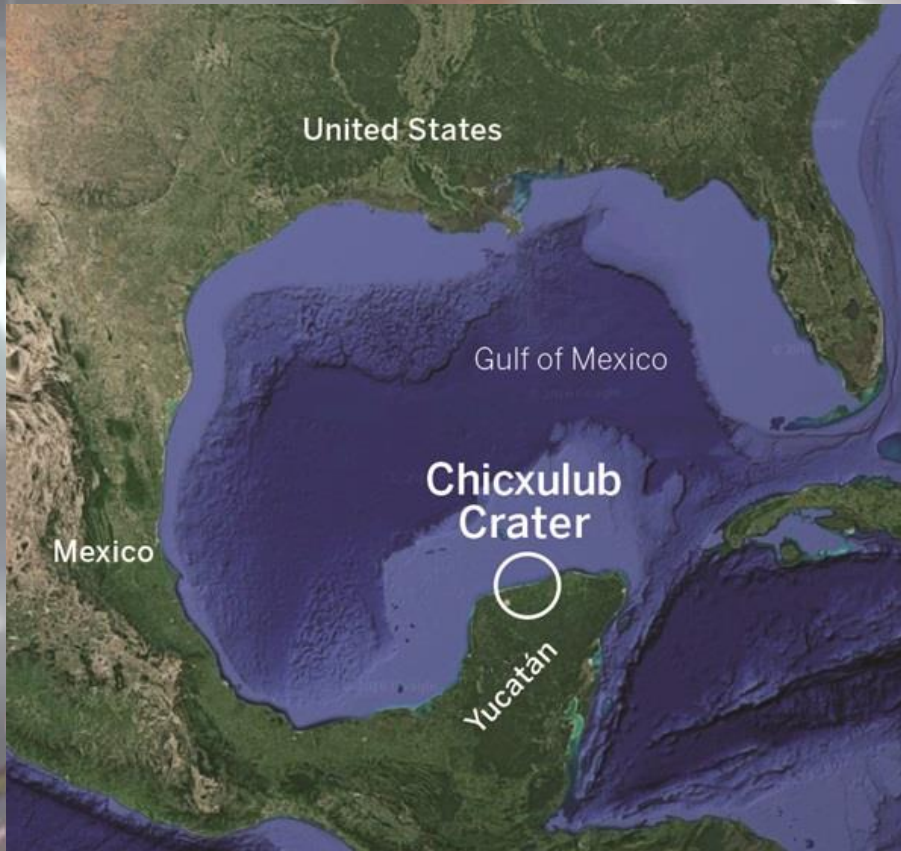
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Phanerozoic	Caenozoic	Quaternary	1.6	Humans evolve
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The big one?

The big one?
An impact of a Comet or Asteroid



Asteroid Impact



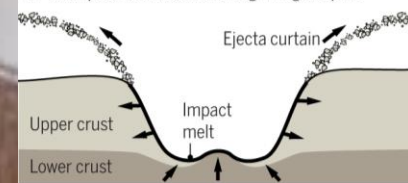
Probing ground zero

Since April, scientists have been drilling into Chicxulub crater, where an asteroid impact 66 million years ago led to one of Earth's biggest mass extinctions. Researchers are now sampling rocks from a buried peak ring, Earth's only preserved example.

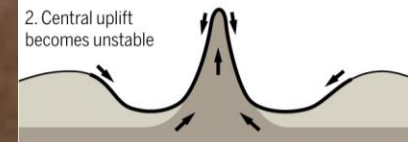
Making the mounds

Impact shocks could make rocks behave like fluids, piling deep crustal rocks on top of rocks of shallower origin.

1. Postimpact excavation and beginning of uplift



2. Central uplift becomes unstable

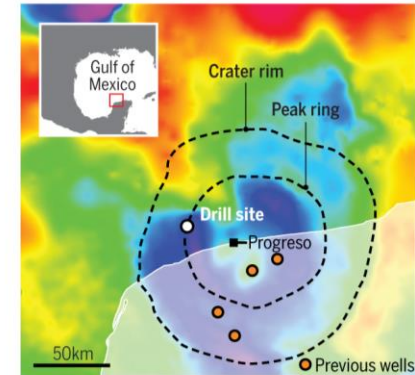


3. Uplift collapses to form peak ring



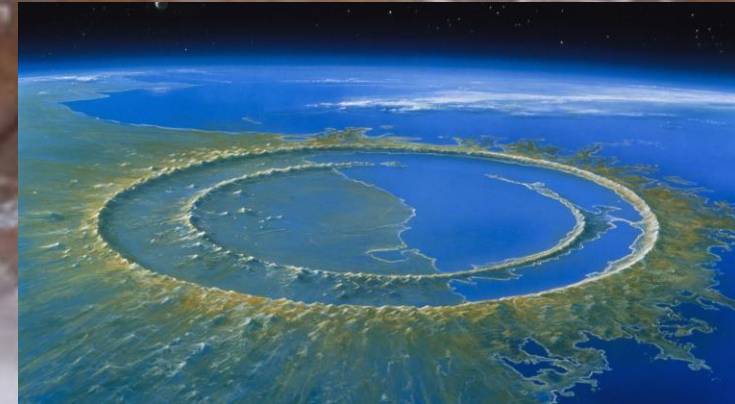
Buried treasure

Offshore from Progreso, Mexico, scientists will drill into the crater's peak ring, partially seen by geophysical remote sensing. Onshore wells have been drilled into the crater before, but few were cored and none reached the peak ring.



[Updated: Drilling of dinosaur-killing impact crater explains buried circular hills | Science | AAAS](#)

Where did this asteroid impact?



Cenozoic (0 to 66 Ma)



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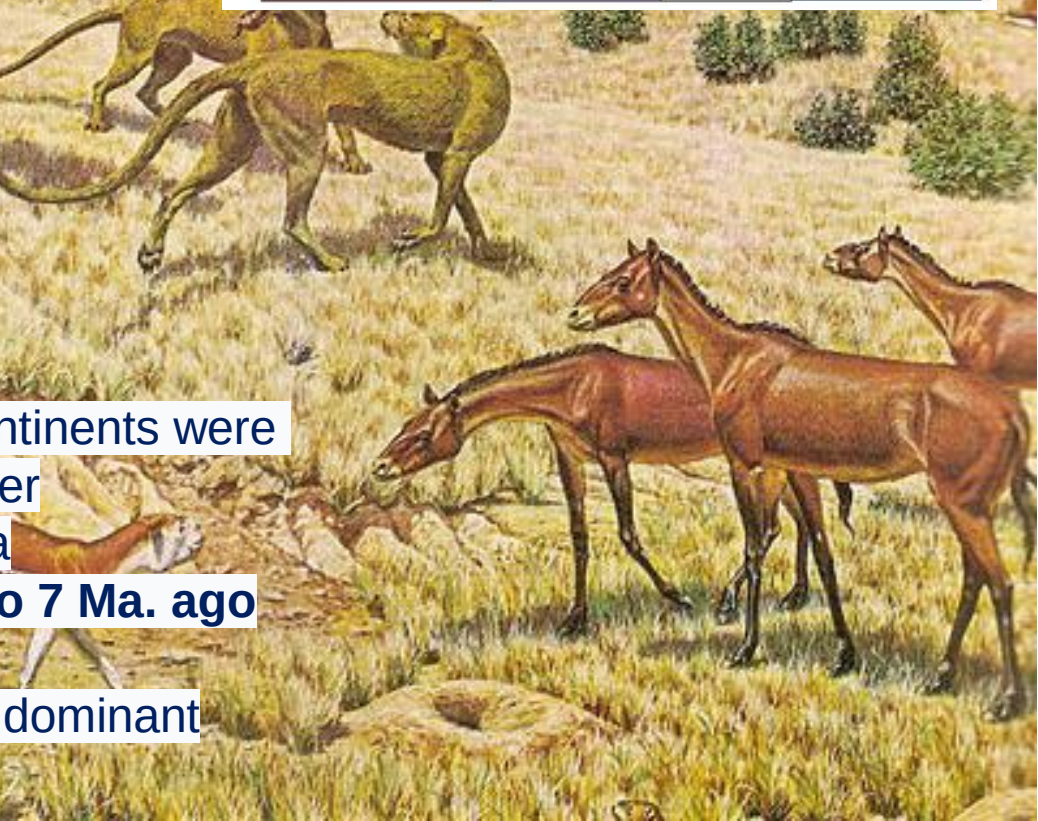
1. Global Cenozoic Plate Tectonics

The Mesozoic was a period in which continents were in general moving away from one another
Exception: collision of India with Eurasia

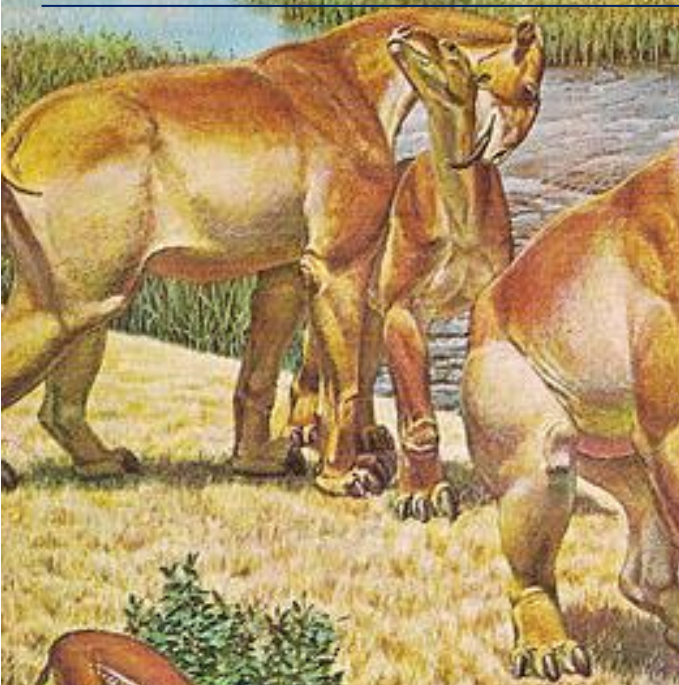
2. The Mediterranean Basin about 6 to 7 Ma. ago

3. Cenozoic Life

Mammals and flowering plants become dominant



Cenozoic (0 to 66 Ma)



The Quaternary “Ice Age” (0 to 2 Ma)

- Climate variability is the norm, Glacial versus interglacial periods. We will discuss this in future lectures!

The Quaternary glacial periods has it roots in the development of ice sheets at South Pole over 30 m.y.

When looking at earth’s history as a whole ice sheets are rare even at the poles except during the last 30 m.y.



[Climate change and humans caused Ice Age extinctions – Molecular Ecology, Evolution, and Phylogenetics Laboratory \(sydney.edu.au\)](http://www.sydney.edu.au)

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Activities

Click on [Ancient Earth globe \(dinosaurpictures.org\)](http://dinosaurpictures.org). This is an ancient geology viewer.

Jump to key geologic events we have discussed to explore how the earth looked at this time. Can you find Wales at each of these points?

Complete the Theory of Continental Drift H5P activity in the Moodle tile.

