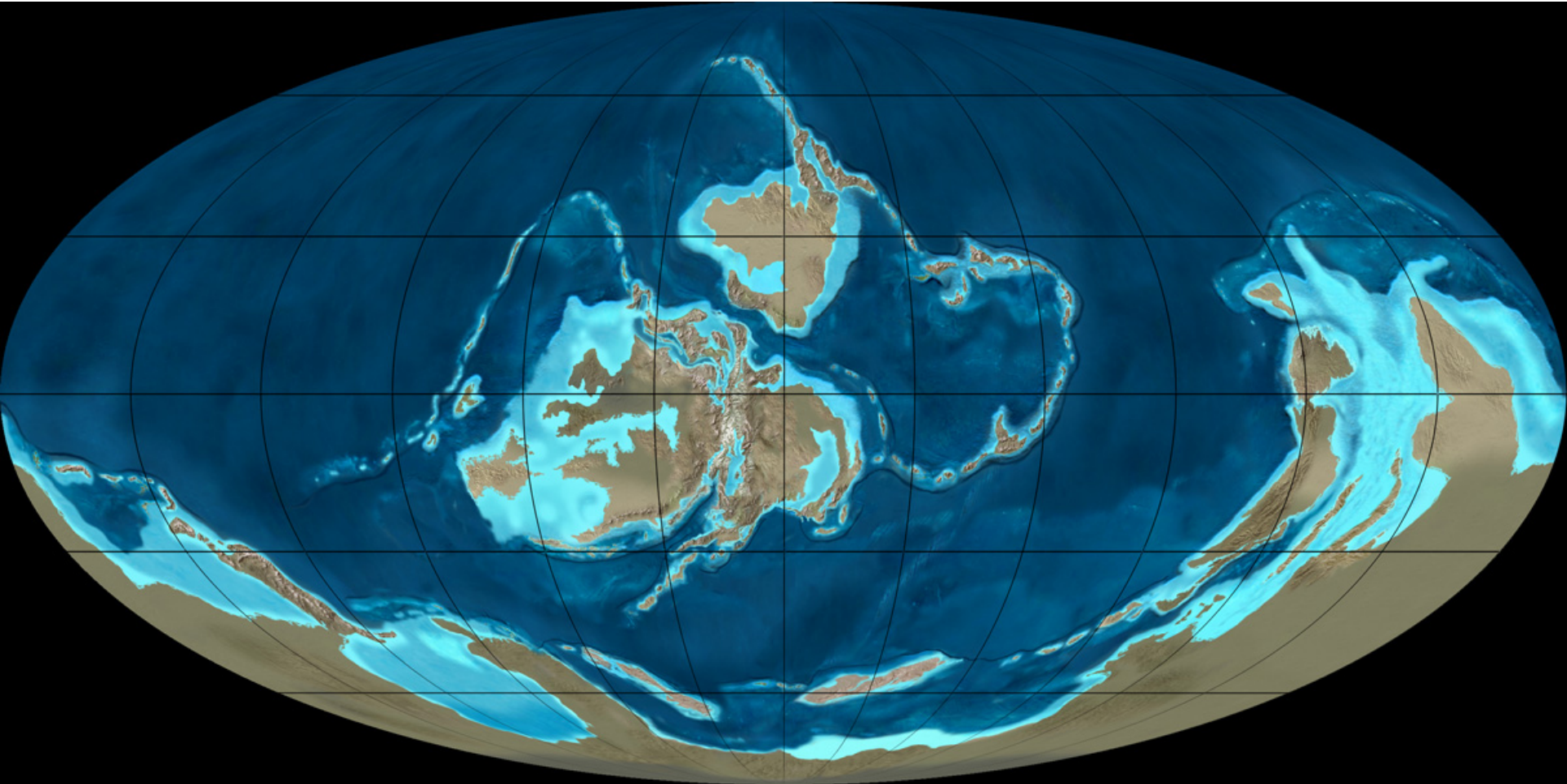


Earth's Tectonic History



In class exercise!

- Create groups of 5-6 (10 groups all together)
- Pick up your slice of geological history
- Work within your groups to research this time – develop a summary of what life on Earth was like during this period
- **Use these slides to review the major time periods in Earth's history**

In your summary:

Describe the distribution of landmasses and water bodies

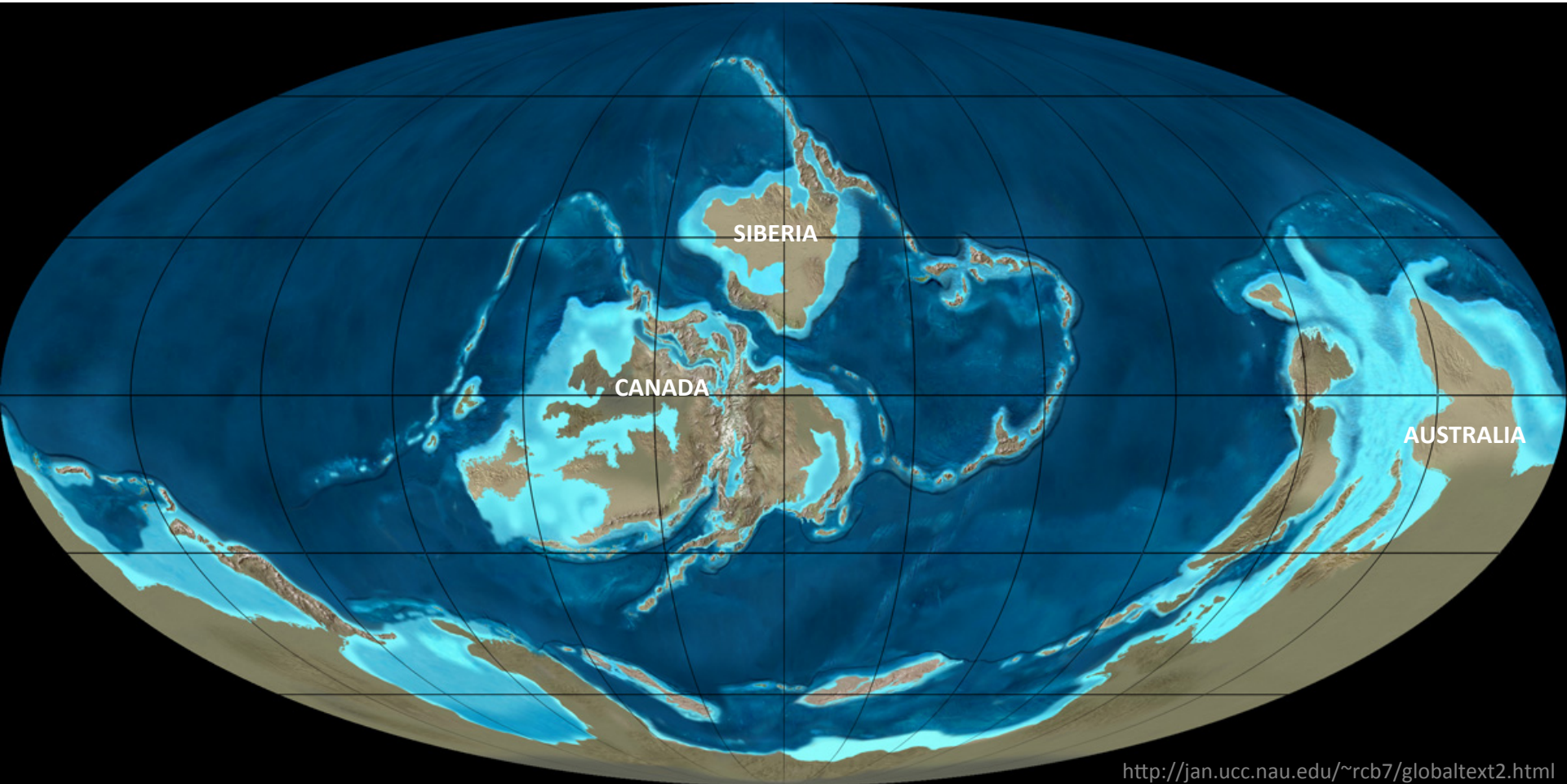
Where are the continents positioned across latitude? How did this influence global climates?

How much connectivity was there across global terrestrial and marine realms, and between which regions? Which areas were the most isolated?

What were the dominant life forms on the planet? Describe Earth's biodiversity during this time (major extinctions, proliferation of new groups)

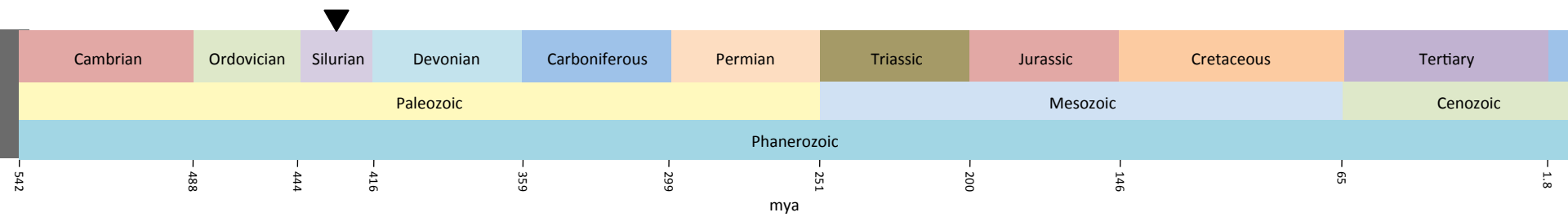
Use Google to put together some representative images in a powerpoint slide that captures your time period

Earth's Tectonic History



<http://jan.ucc.nau.edu/~rcb7/globaltext2.html>

430 mya (Silurian – first jawed fishes)



Silurian

Distribution of land-masses & water-bodies

Land-masses - more in southern hemisphere

Siberia & Canada at equator

Other land-masses were in south

Lots of island chains, but not many mountains

Water-bodies

Found in both hemispheres

Sea levels were 180 m higher than today

Lots of shallow seas (most of present day

North America was submerged)

Landform connectivity

Land-masses

Siberia & Canada colliding at equator

All other continents were connected in southern hemisphere

Water-bodies

Shallow seas - high connectivity in marine life - high sunlight - rapid diversification bc of this

Higher connectivity in marine life

How did this influence climates?

- CO2 levels were 10x higher
- The “great oxygen event” occurred - O2 content in atmosphere increased
 - Higher O2 content than present
- Mean temperature was 3°C higher
- Sea levels were 180 m higher

Dominant life-forms

Period began with a major extinction event; many minor ones occurred during it

Aquatic

Jawless fish (agnathans) are dominant

Earliest “jawed fish” (placoderms)

First bony fish appeared

Extensive coral reefs (shallow water) - tabulate & horn corals still exist today

Terrestrial

Earlier terrestrial life - sarcopterygii moved onto land

Vascular plants (first *true* plants) began colonizing earth

Team

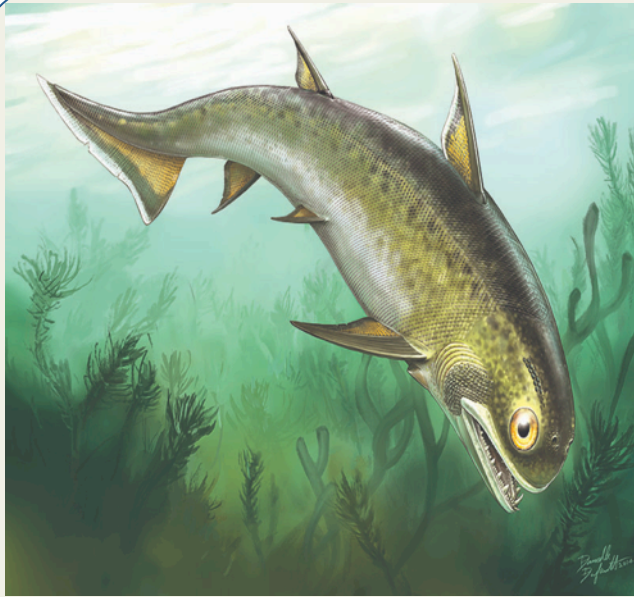
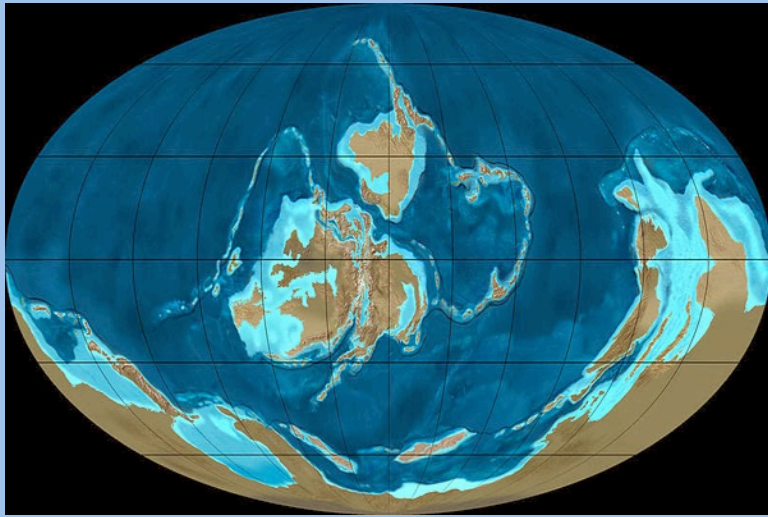
Avneet
Chhina

Hunter
Doerksen

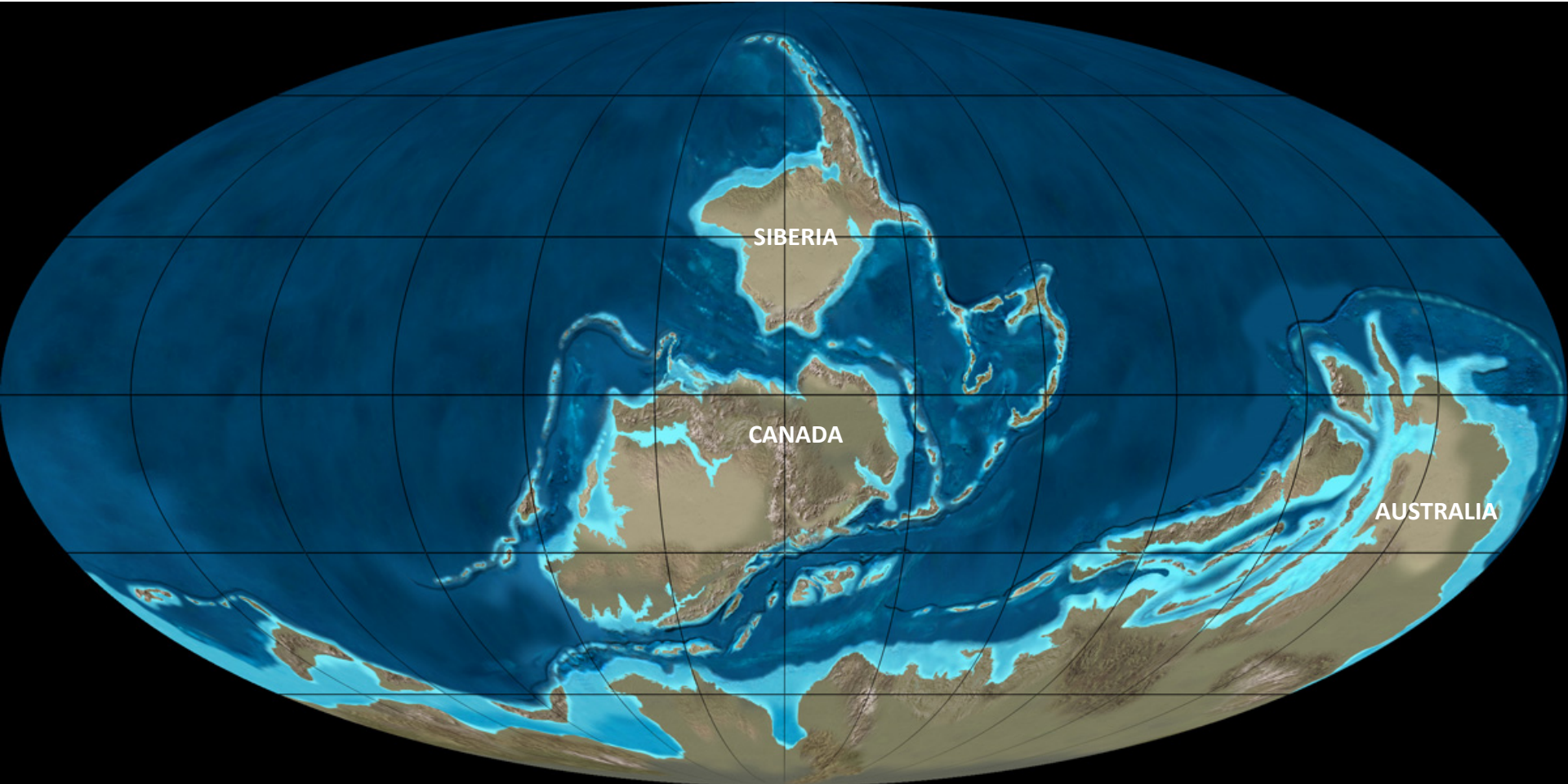
Halley
Nasu

Reva
Shenwai

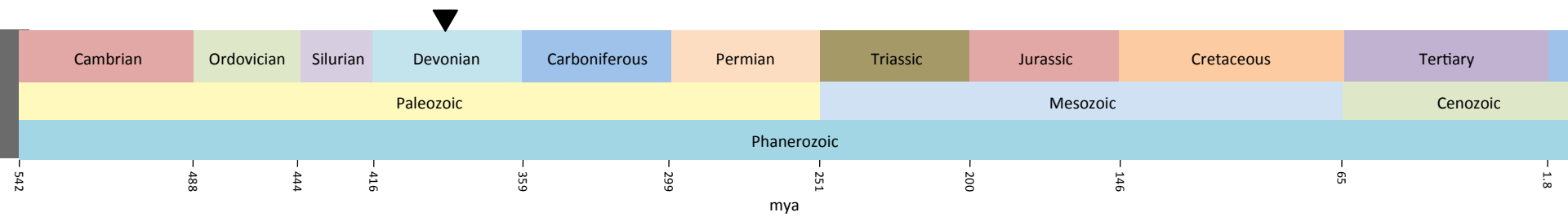
Silurian



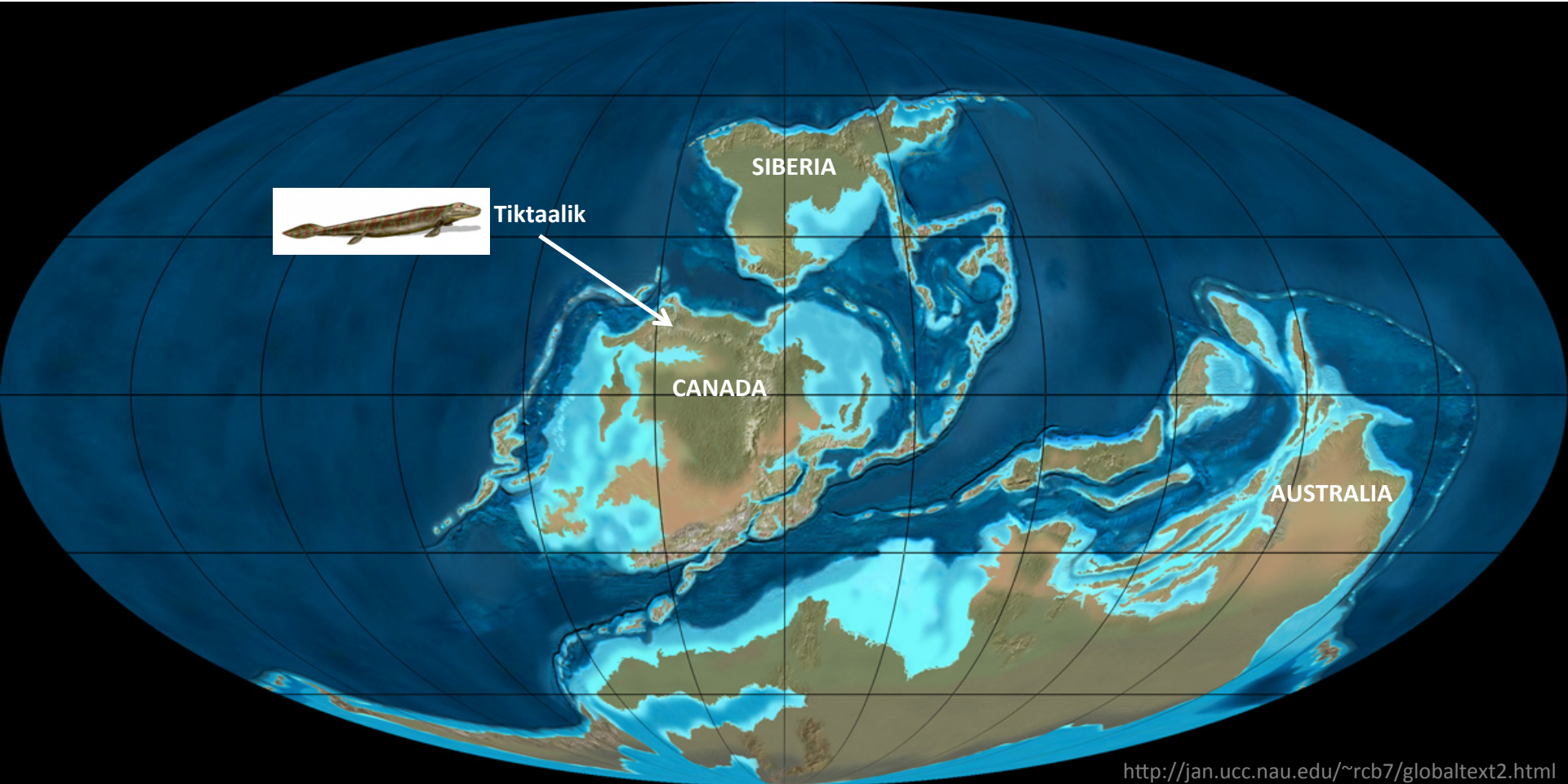
Earth's Tectonic History



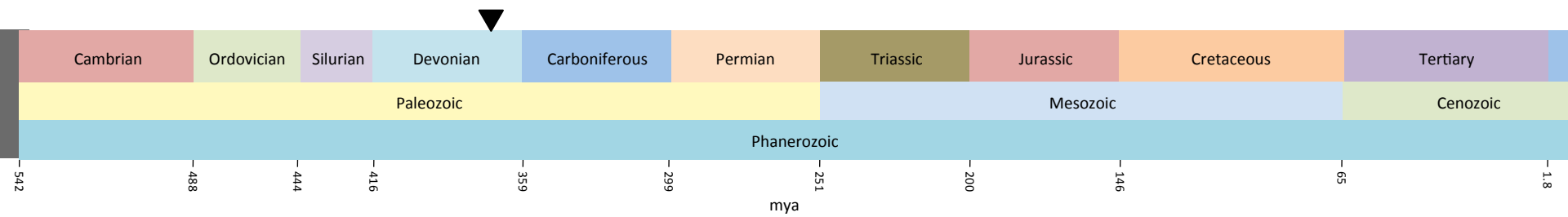
400 mya (Early Devonian – first vascular land plants, first insects)



Earth's Tectonic History



370 mya (Late Devonian – first land vertebrates, first forests)





DEVONIAN PERIOD

Jazz Amber, Michael Kolasa, Shaina Calara and Urim Lim

GEOLOGICAL TIME SCALE



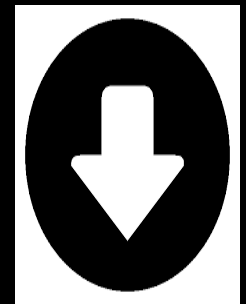
Eons

Eras

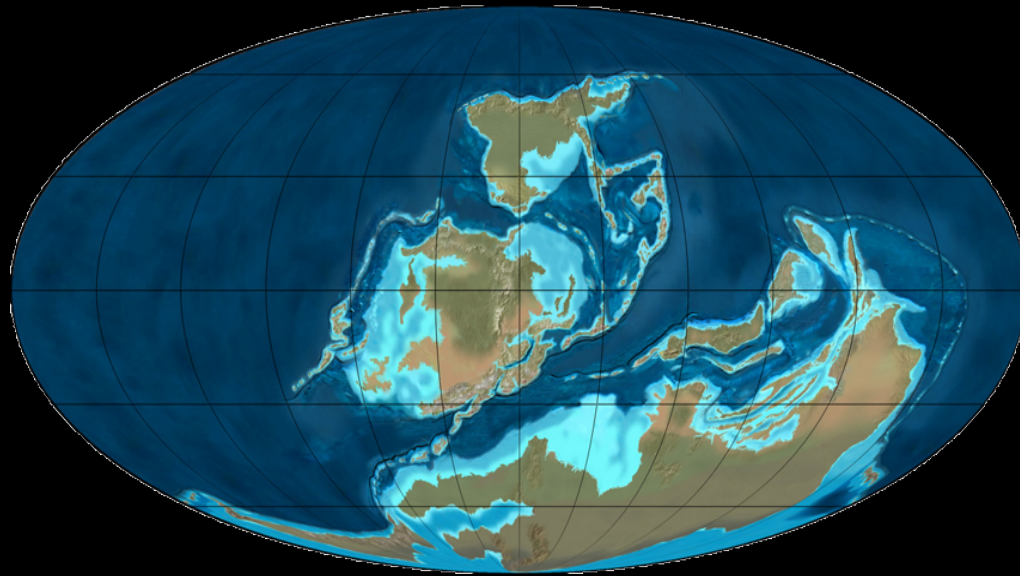
Periods

Epochs

Age

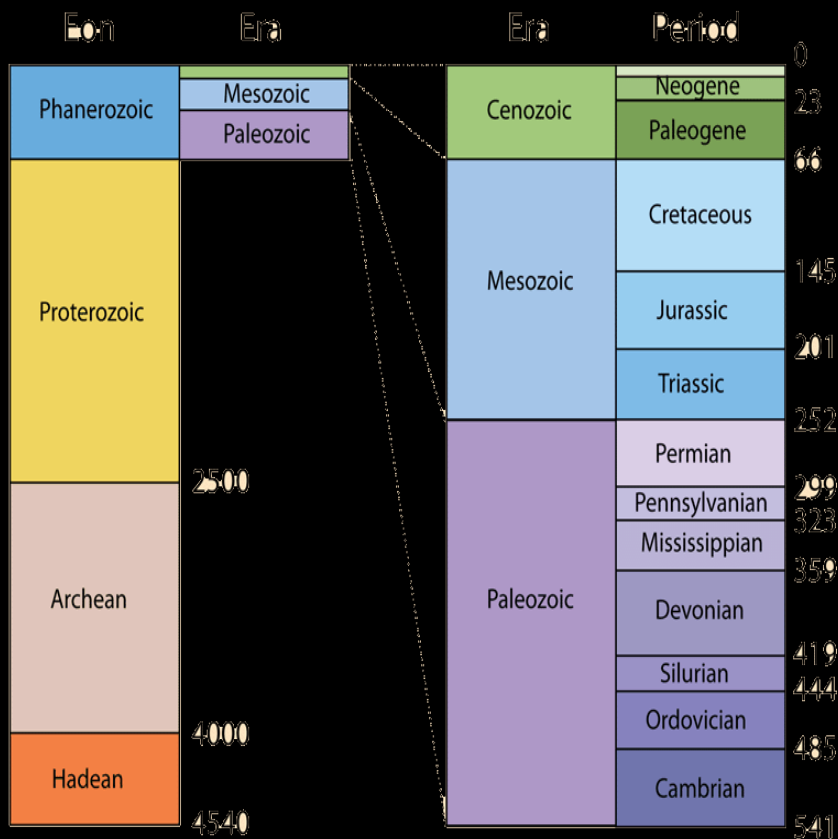


4TH OUT OF FOUR EONS: PHANEROZOIC



First three eons form a supereon called the Precambrian

1ST OUT OF THREE ERAS: LATE PALEOZOIC



Geologic time and the geologic column

4TH OF 6 PERIODS: DEVONIAN

Describe the distribution of landmasses and water bodies

- In the Devonian Period, North America, Greenland, and Europe were a single landmass in the Northern Hemisphere called:
 - **Laurussia**
- In the Southern Hemisphere, South America, Africa, India, and Antarctica were a single landmass called:
 - **Gondwana**
- Approximately 85% of the globe was covered by ocean.



4TH OF 6 PERIODS: DEVONIAN

Where are the continents positioned across latitude? How did this influence global climates?

- Mostly centered around the equator
 - Compressed in latitude, relative to today
- Therefore, saw more warmer climate



4TH OF 6 PERIODS: DEVONIAN

Where are the continents positioned across latitude? How did this influence global climates?

- Continent Laurussia (i.e. Euramerica) was created by merging Laurentia and Baltica in the early Devonian
 - Increasing the connectivity
- Later there was the beginning of Laurussia and Gondwana began to meet starting the early stages of forming:
 - Pangea
- Siberia (i.e. North) was the most isolated at this time



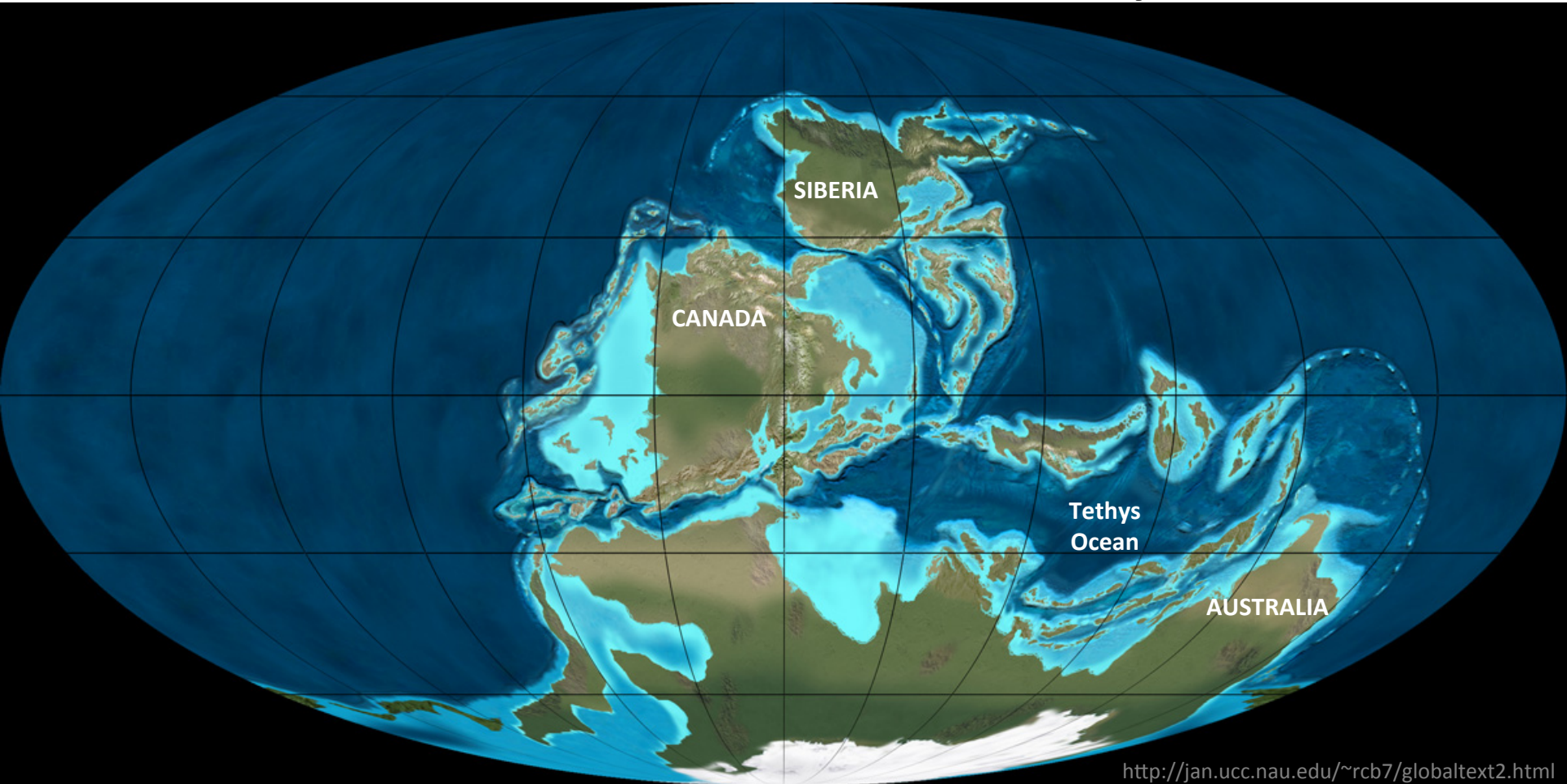
4TH OF 6 PERIODS: DEVONIAN

What were the dominant life forms on the planet? Describe Earth's biodiversity during this time (i.e. major extinctions, proliferation of new groups)

- The Devonian's end saw the second of the five major extinction events in Earth's history
- Two marine mammals existed:
 - Ray-Finned Fish
 - Ancestor of most modern fish
 - Lobe-Finned Fish
 - Died off during the extinction
- Plants:
 - Major reefs formed
 - Horsetails and Ferns formed Earth's first forests

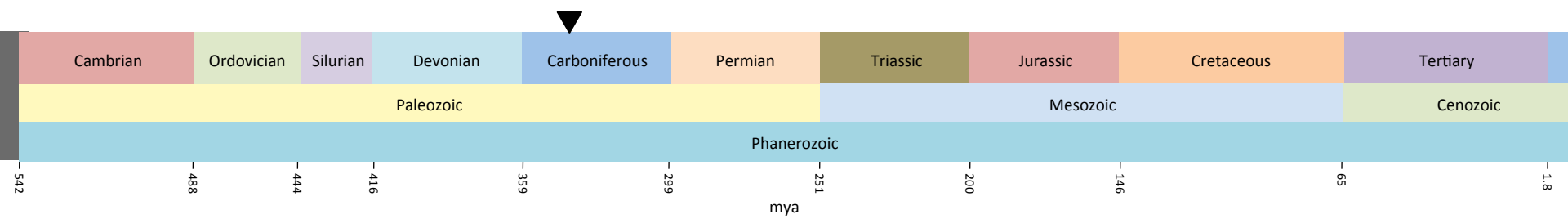


Earth's Tectonic History

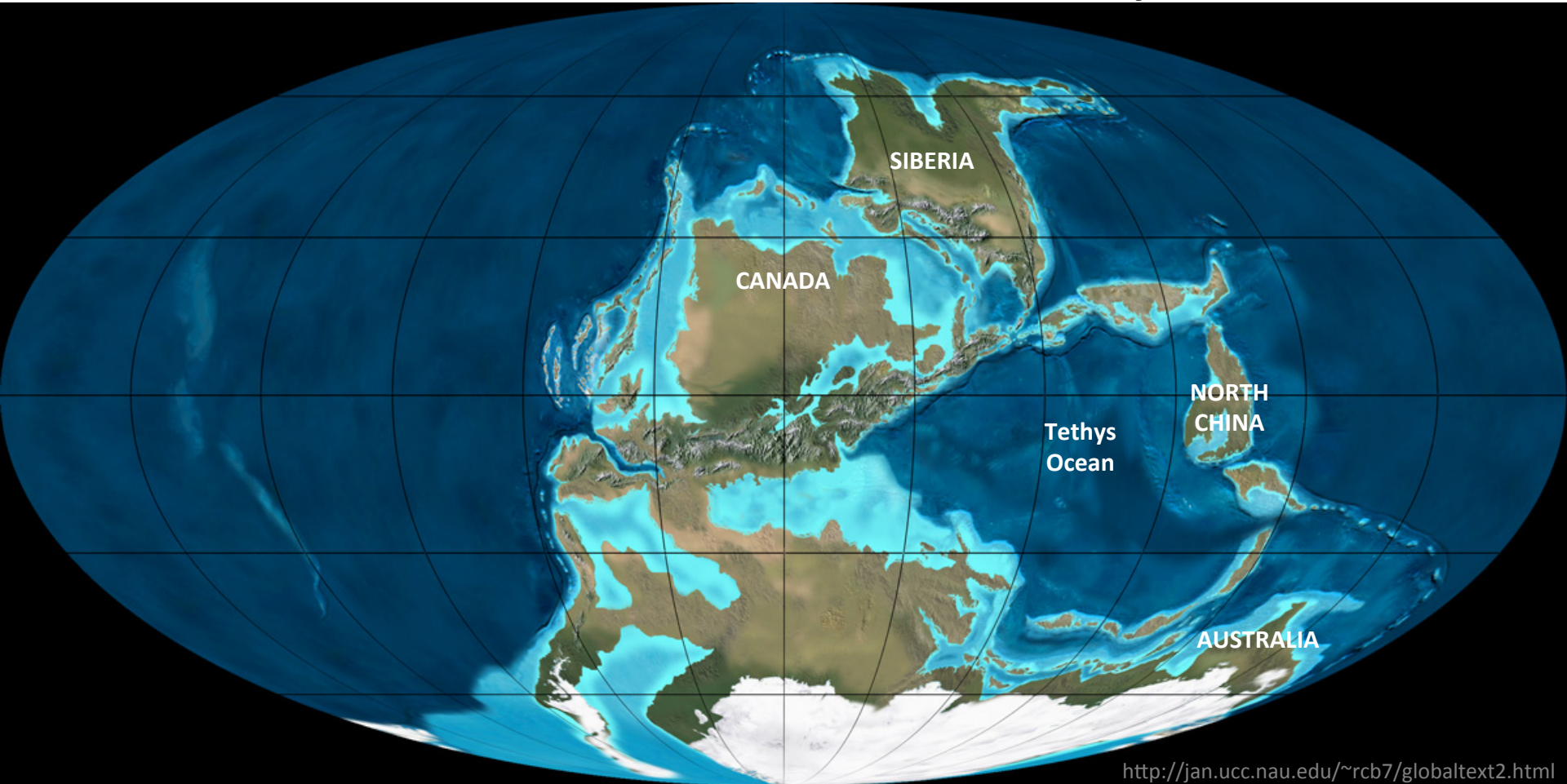


<http://jan.ucc.nau.edu/~rcb7/globaltext2.html>

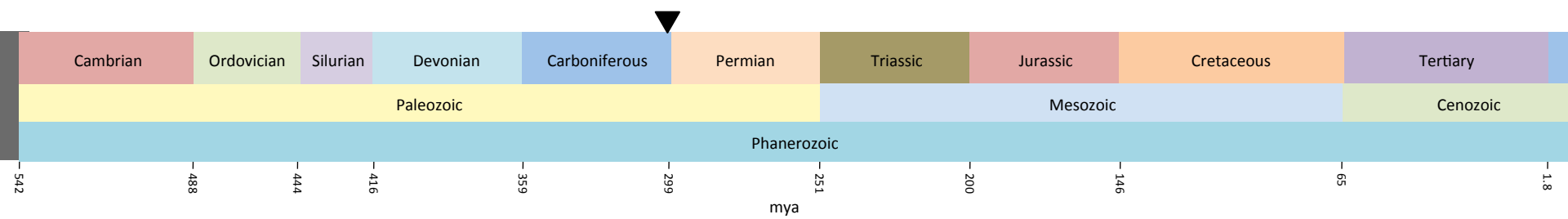
340 mya (Early Carboniferous - “The Coal Age”)



Earth's Tectonic History



300 mya (Late Carboniferous – first reptiles)

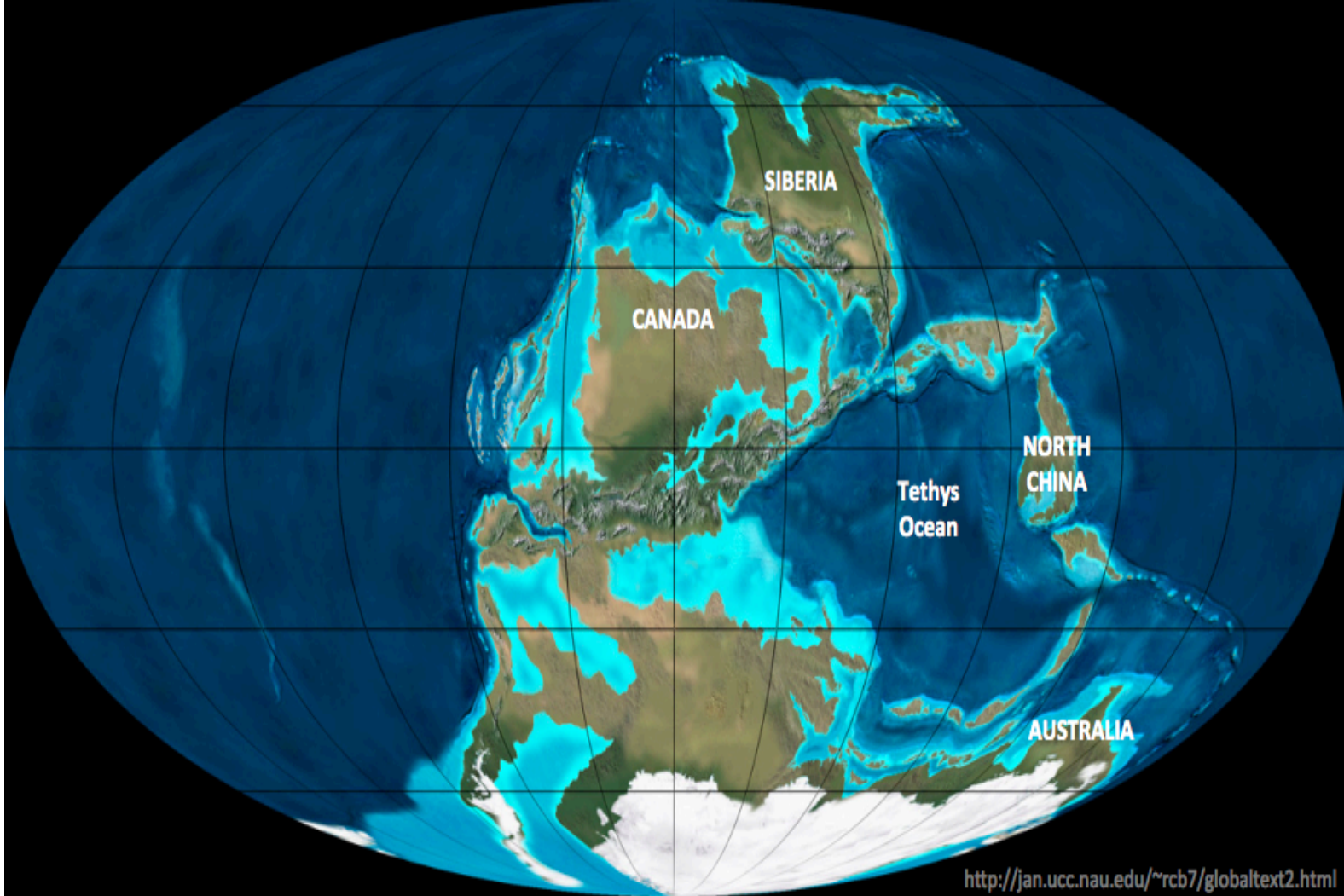


Late Carboniferous Period

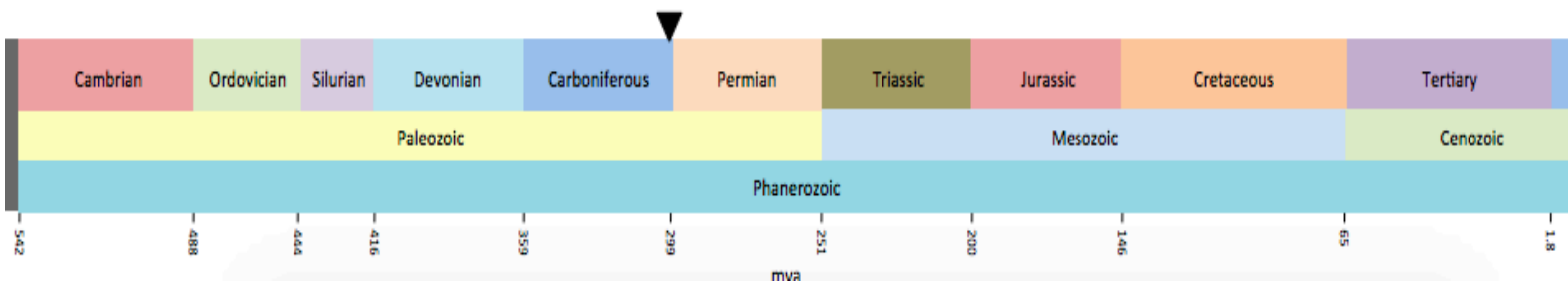
(299 - 359 mya)

Sammi Conard
Jennifer Thi
Theresa Cashore
Gopal Sharma
Carol Dung





300 mya (Late Carboniferous – first reptiles)



Position of Continents Across Latitude, and Global Climates

- Land masses spread out across latitudes, with coverage from 90 S to about 75N
- The largest land mass is at the bottom of the Southern Hemisphere, lower latitudes especially covered mostly in ice
- From Australia to what was South America/ Asia
- Shifting from warmer, wetter to cooler, dryer climate due to shift of landmass
- The interior of the large landmasses was likely very dry, as its huge size prevented water from coming too far in easily. As the continents continue to come together, this effect will increase.
- Atmospheric oxygen levels peaked around 35 percent, compared to 21 percent today.
- Forests of seedless vascular plants in tropical swamps provided organic material that became coal beds up to 11-12 meters thick

How much connectivity was there across global terrestrial and marine realms, and between which regions? Which areas were the most isolated?

→ ***Terrestrial realms:***

- Southern hemisphere more connected and continuous than the northern hemisphere
- Still some degree of connectivity in the northern hemisphere, but more smaller islands and less of a presence of major land bridges
- East of the Tethys ocean is very isolated from other areas (eg. North China)
- Leading to the formation of Pangea, Gondwana and Euramerica moving towards each other, resulting in the uplift of Mountains (eg. Appalachian Mts)

How much connectivity was there across global terrestrial and marine realms, and between which regions? Which areas were the most isolated?

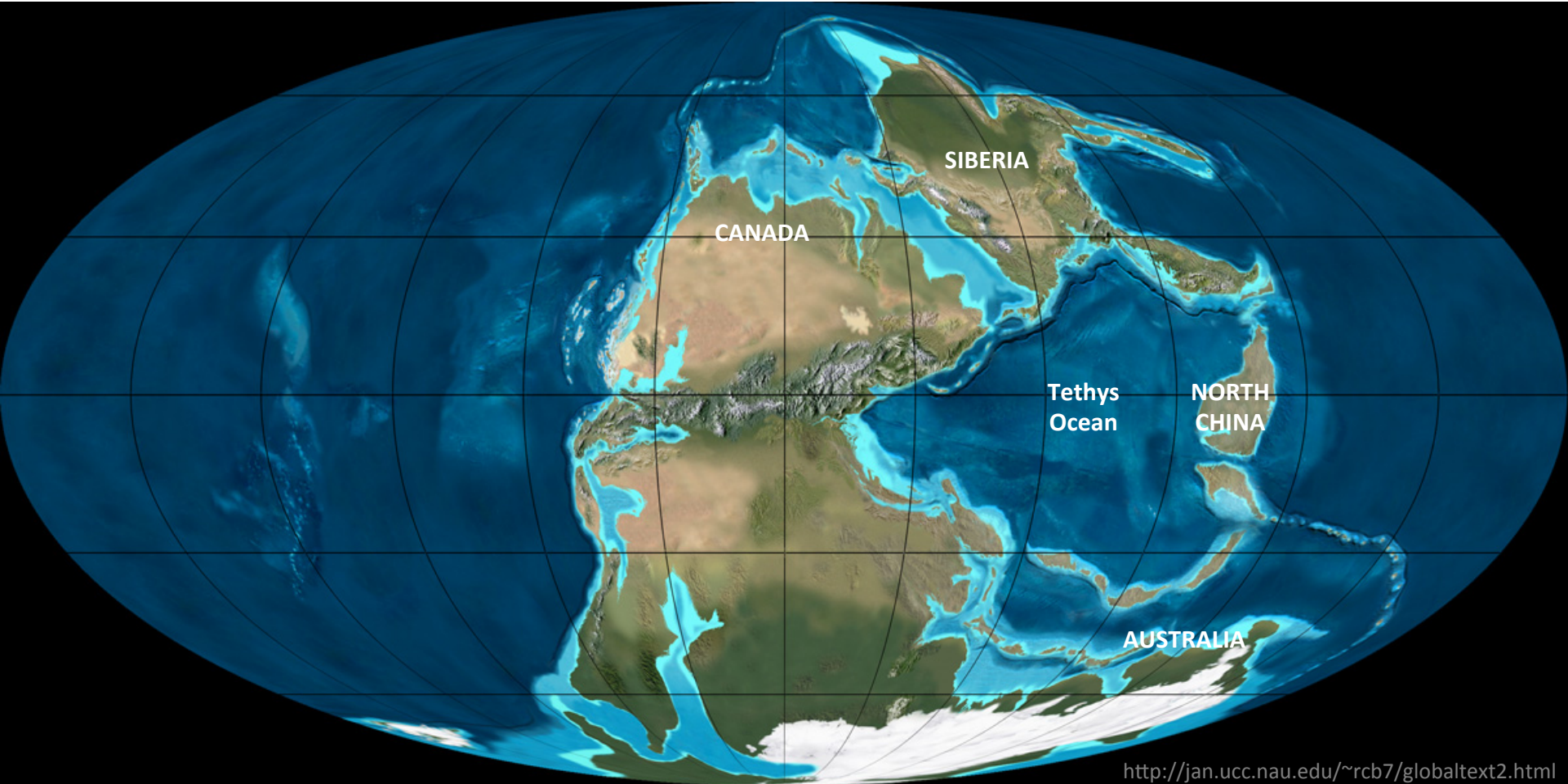
→ ***Marine realms***

- Relatively isolated: major ocean (Tethys) and many small bays, seas surrounding coasts of land masses
- Large ice sheet in southern pole locked up a lot of water → decreased sea levels gave rise to more exposed land, less marine connectivity
- Polar ice cap: isolation through freezing of available water for marine habitats
- Just south of equator → lots of isolated bay areas south of Canadian land mass

What were the dominant life forms on the planet? Describe Earth's biodiversity during this time (major extinctions, proliferation of new groups).

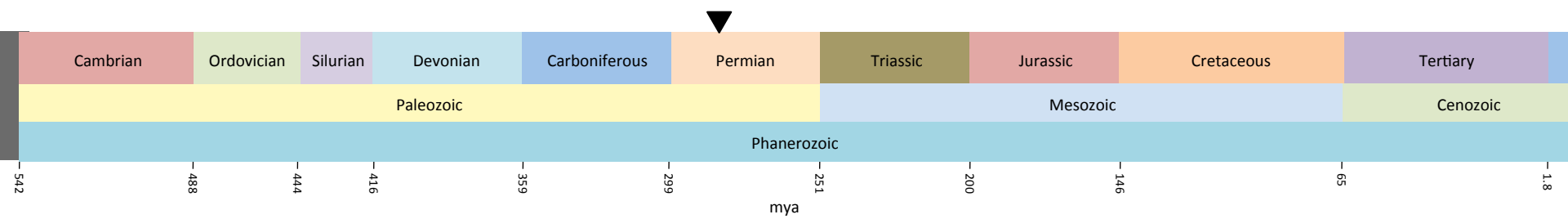
- Large vascular plants (size ranged from small to 100 ft) were abundant
- Plants resemble those that proliferated in tropical to mildly temperate biomes/ areas
- Marine life such as Bryozoans, Brachiopods and foraminifers dominated the sea floor
- Corals, crinoids, arthropods also existed during this time
- Many species of fish and sharks developed during the late Carboniferous
- Larger animals due to more oxygen in the atmosphere from mass proliferation of plant life
- Reptiles developed leathery skin as they moved further into land

Earth's Tectonic History

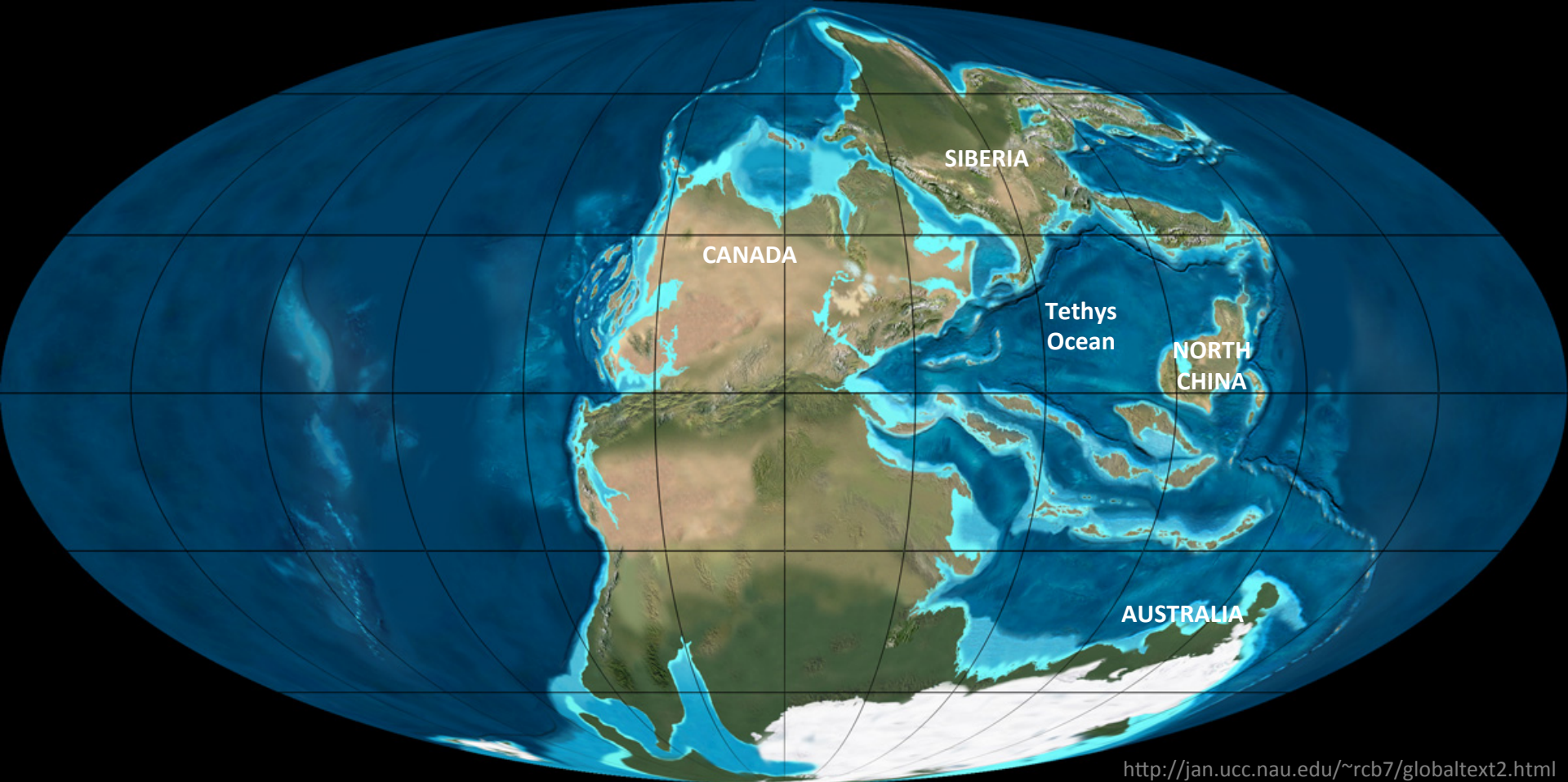


<http://jan.ucc.nau.edu/~rcb7/globaltext2.html>

280 mya (Early Permian – first mammal-like reptiles)

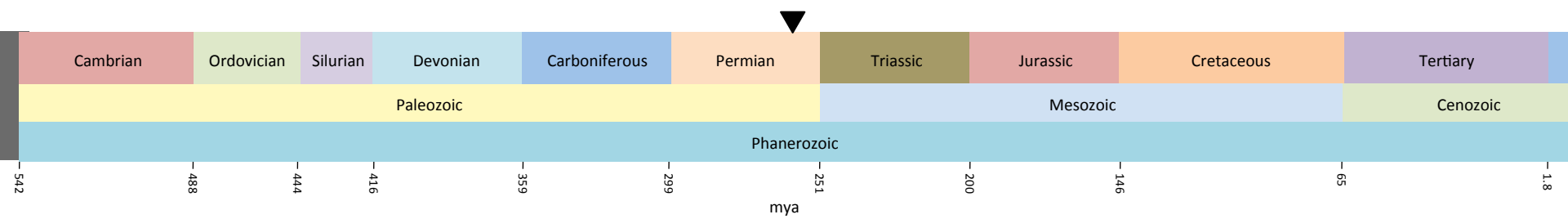


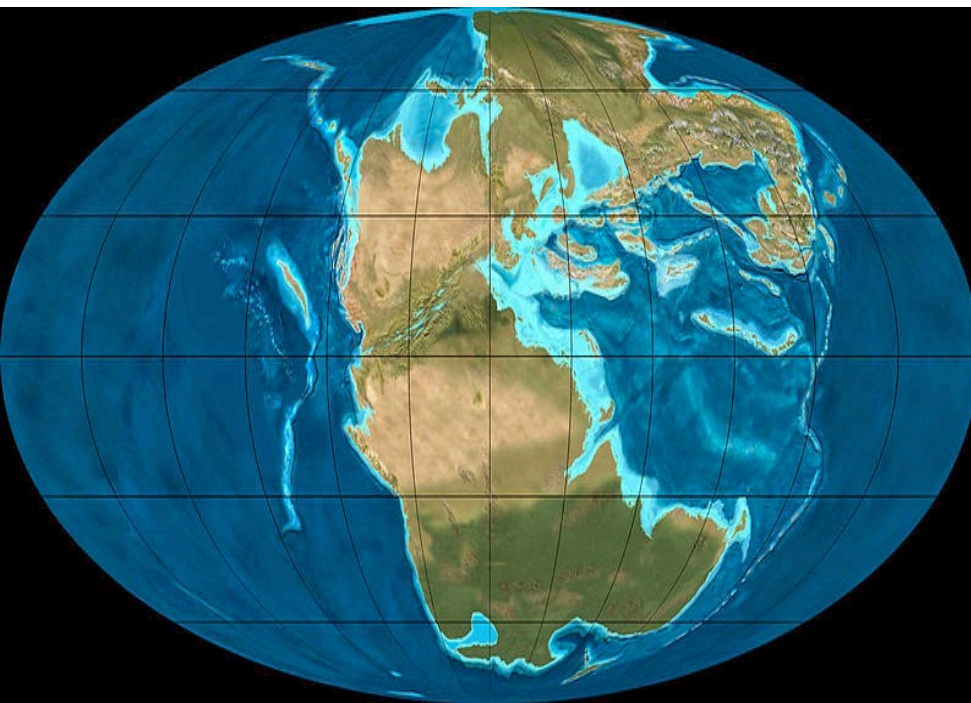
Earth's Tectonic History



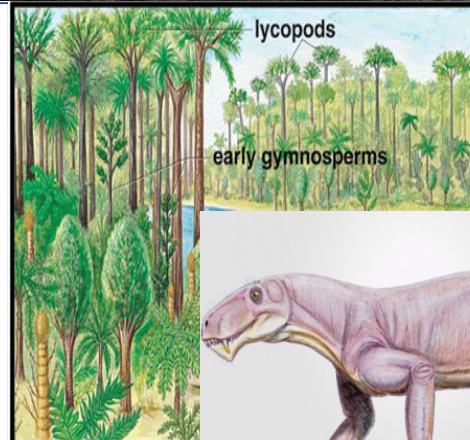
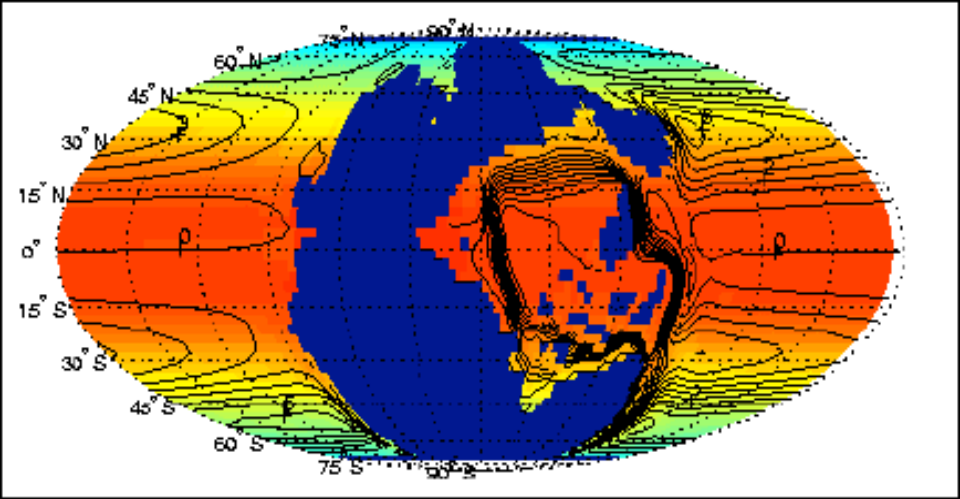
<http://jan.ucc.nau.edu/~rcb7/globaltext2.html>

260 mya (Late Permian – mass extinctions of marine invertebrates and terrestrial vertebrates and insects)





Permian



Permian

Landmass & Water Distribution

- Most of the land masses are still connected in a C-shaped supercontinent, aligned along similar longitude
- There was an ocean called Tethys Ocean
- Most of the bodies of water were spread across the other half of the globe that lacked land masses. The waters bordering the continent tended to be shallow, and leftover water were stored in ice caps and glaciers.

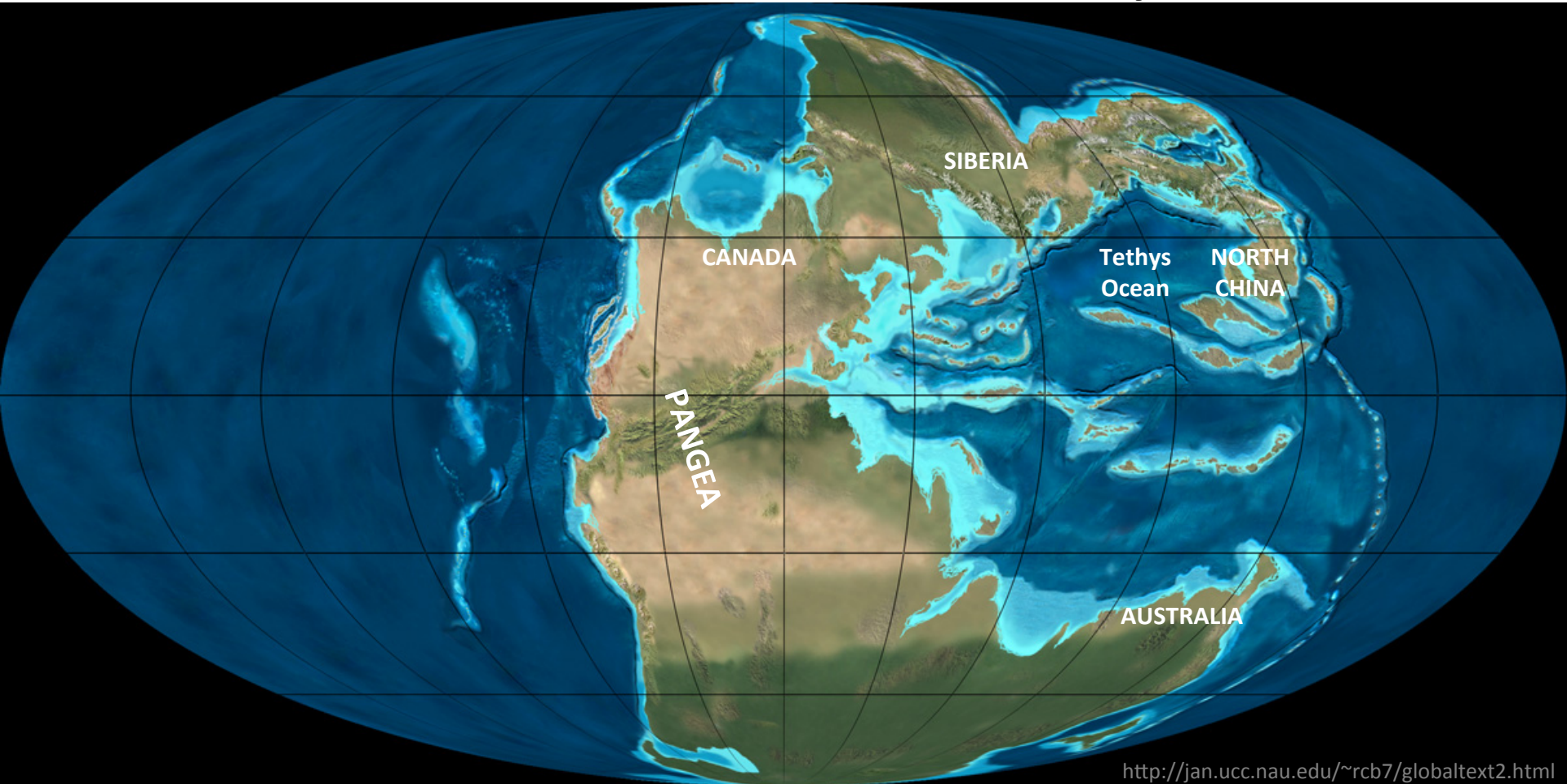
Climate

- The southern regions were cold and arid, and a majority of the region remained frozen under ice caps
- The northern regions experienced intense heat and extensive seasonal fluctuations alternating from a dry to a wet season
- Deserts became widespread in various tropical and subtropical areas during this time
- Middle Permian climates generally were warmer and moist. Climates of the Late Permian (Lopingian) Epoch were typically hot and locally very dry.

Dominant Life Forms:

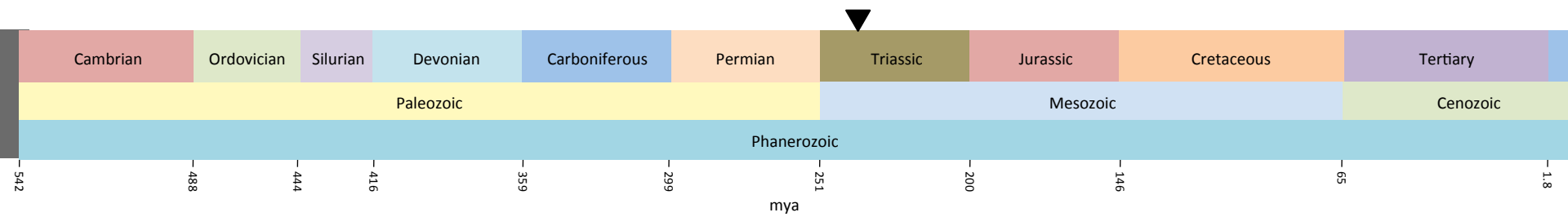
- Plants: large carboniferous swamp forests began to dry out, early gymnosperms began to proliferate
- Land Animals: Synapsids were the dominant group in the early Permian (pictured is the Dimetrodon); Therapsids (“mammal-like reptiles”) were the dominant group in the late Permian
- Marine Life: not much is known about the Panthalassic Ocean; ammonites (pictured), brachiopods, sharks, rays, and true bony fish were prominent
- Insects: Arthropods were prominent

Earth's Tectonic History

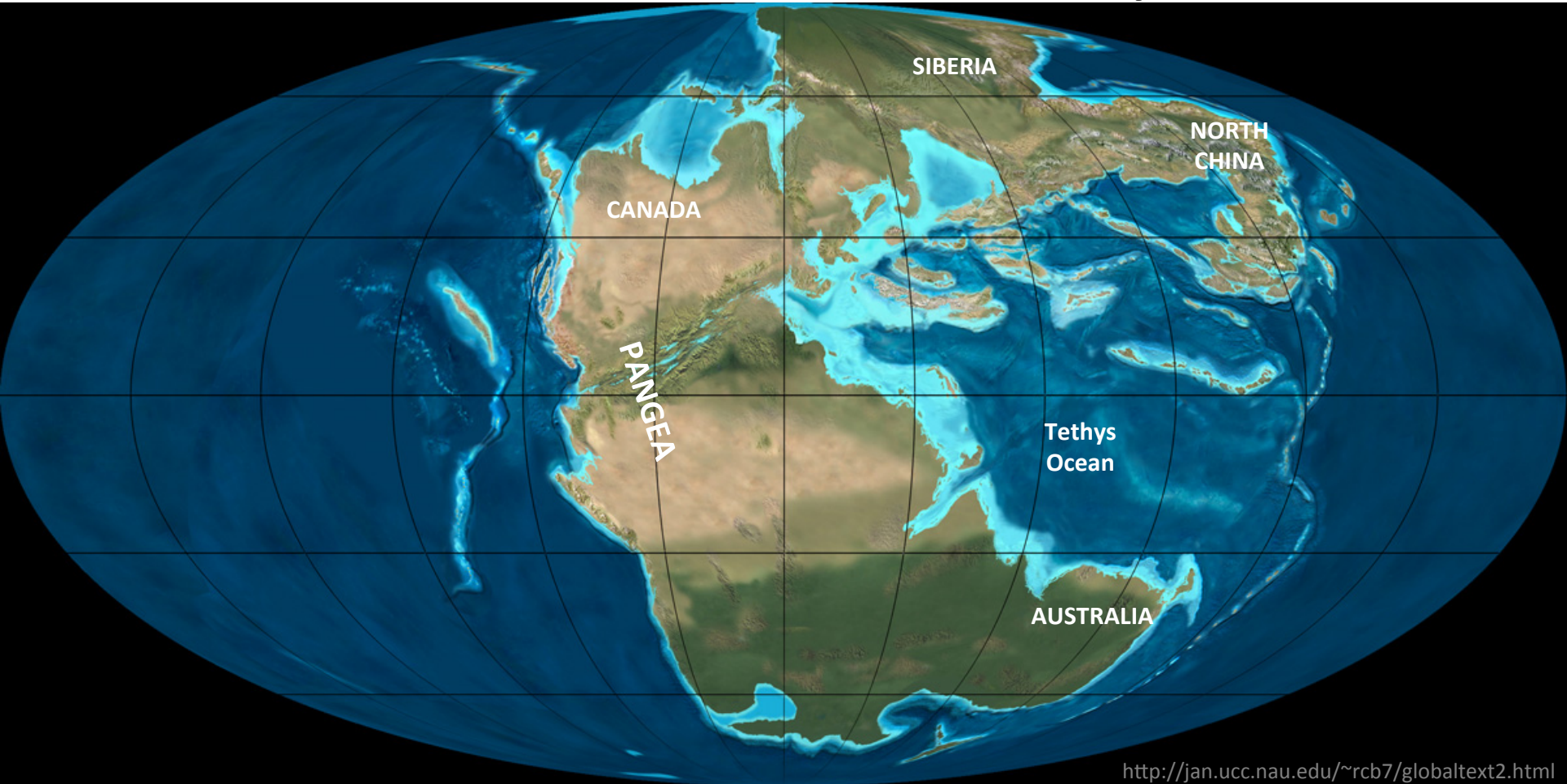


<http://jan.ucc.nau.edu/~rcb7/globaltext2.html>

240 mya (Early Triassic – first dinosaurs, first mammals)

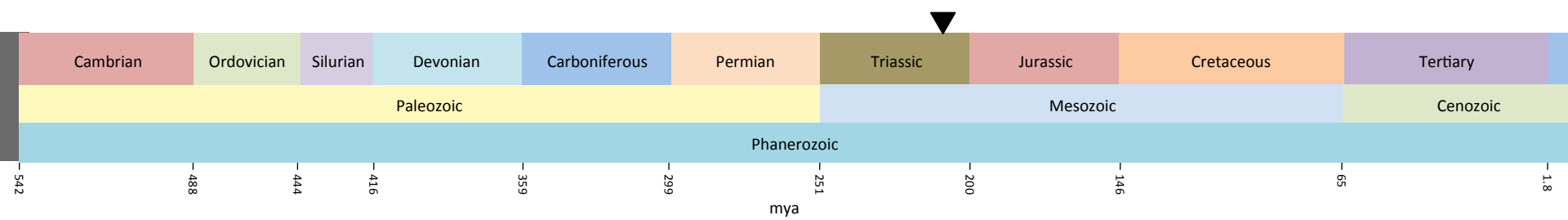


Earth's Tectonic History

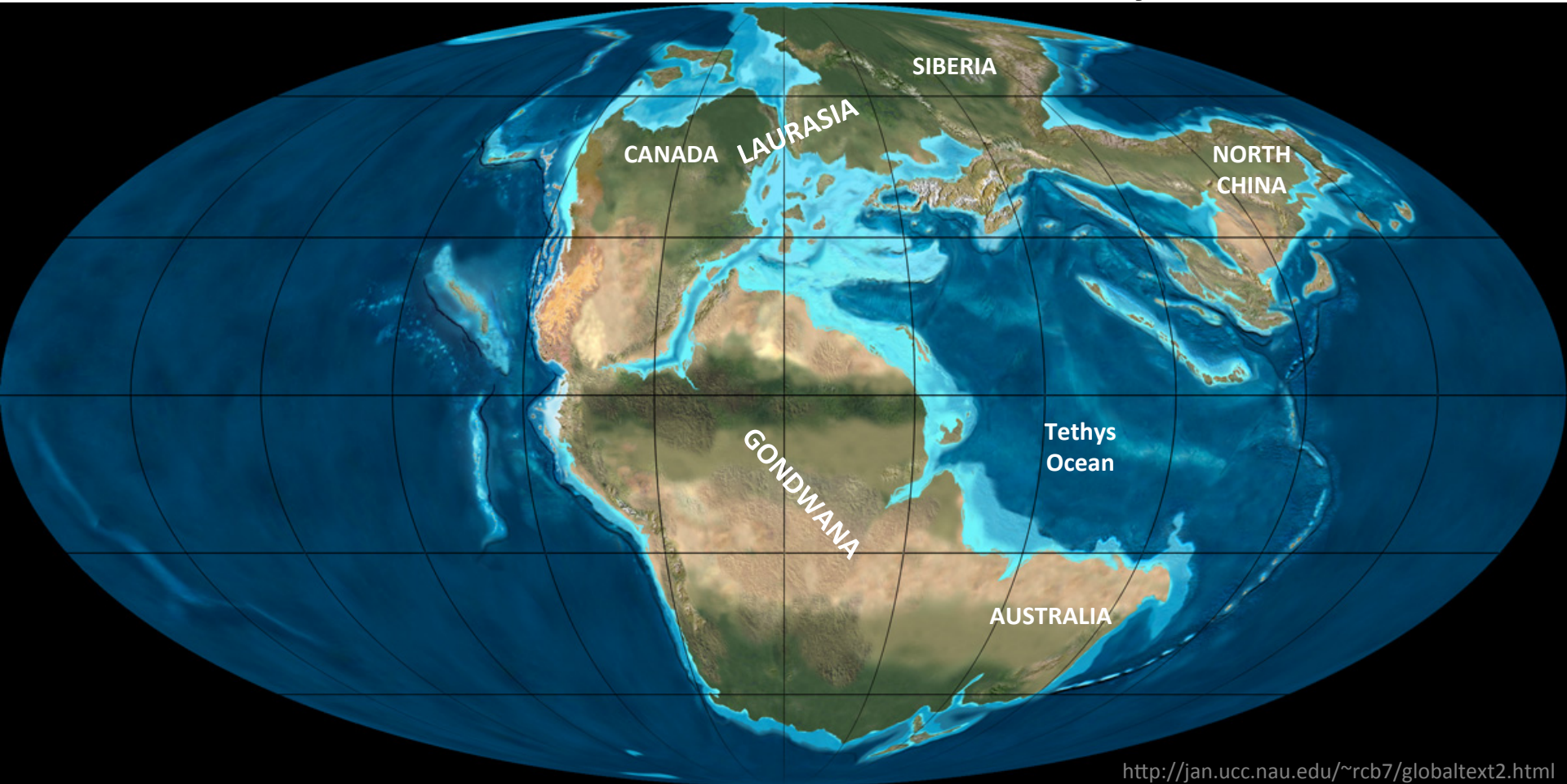


<http://jan.ucc.nau.edu/~rcb7/globaltext2.html>

220 mya (Late Triassic – first flying vertebrates)

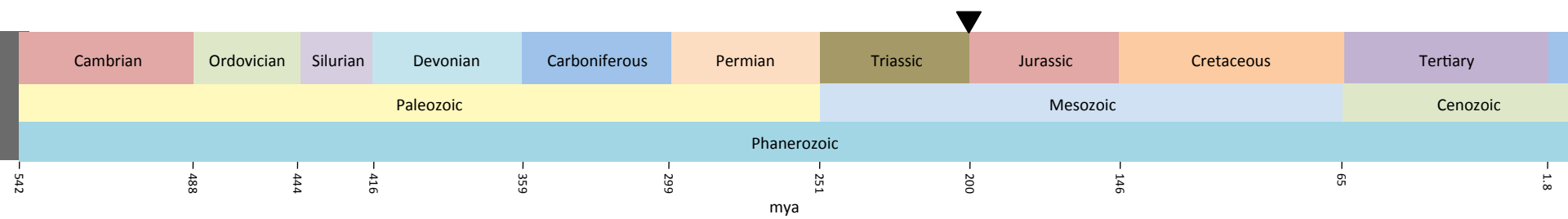


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<http://jan.ucc.nau.edu/~rcb7/globaltext2.html>

200 mya (Early Jurassic – Gondwanan and Laurasian supercontinents)



Early Jurassic Period

(Gondwanan and Laurasian supercontinents)

- 200 MYA ago
- Land masses are still heavily connected between a surrounding major water body
- A few of the Northern continents are positioned to the North, whereas the major continental mass was positioned in lower latitudes. The global climate in this time period around the tropics was expected to approximate tropical like climates and the polar regions due to the absence of ice caps at this point would experience a temperature-like climate
- The continents were still mostly connected as Pangea was just beginning to break apart. The ocean was highly connected as well as one large ocean called the Panthalassic ocean surrounding the giant land mass.. Islands and land masses breaking off the edges of the supercontinent were the most isolated, which were located to the east of Canada and south of Laurasia

Early Jurassic Period (Gondwanan and Laurasian supercontinents)

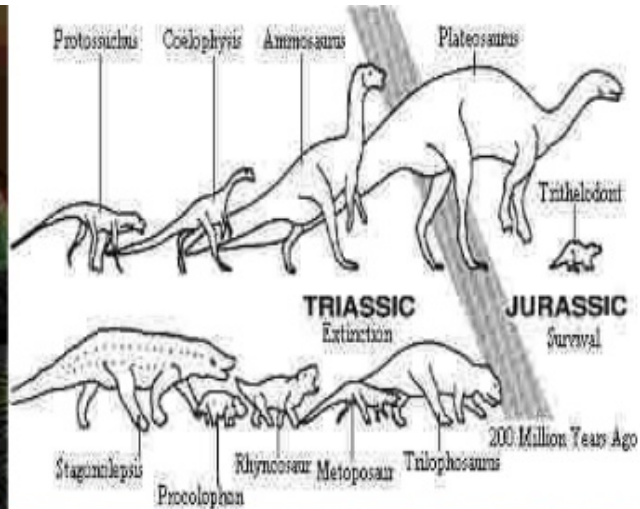
During this period, the major extinction event was the Triassic-Jurassic extinction event which occurred approximately 200 MYA. Due to this event, 42% of all terrestrial tetrapod's went extinct which allowed for ecological niches to open and allowed dinosaurs to become the dominant life form and proliferate during the Jurassic period.

Early Jurassic Period (Gondwanan and Laurasian supercontinents)



This image represents the essence of the Triassic-Jurassic period where dinosaurs were the dominant life forms and there were extant oceans and a massive land mass starting to disconnect from one another

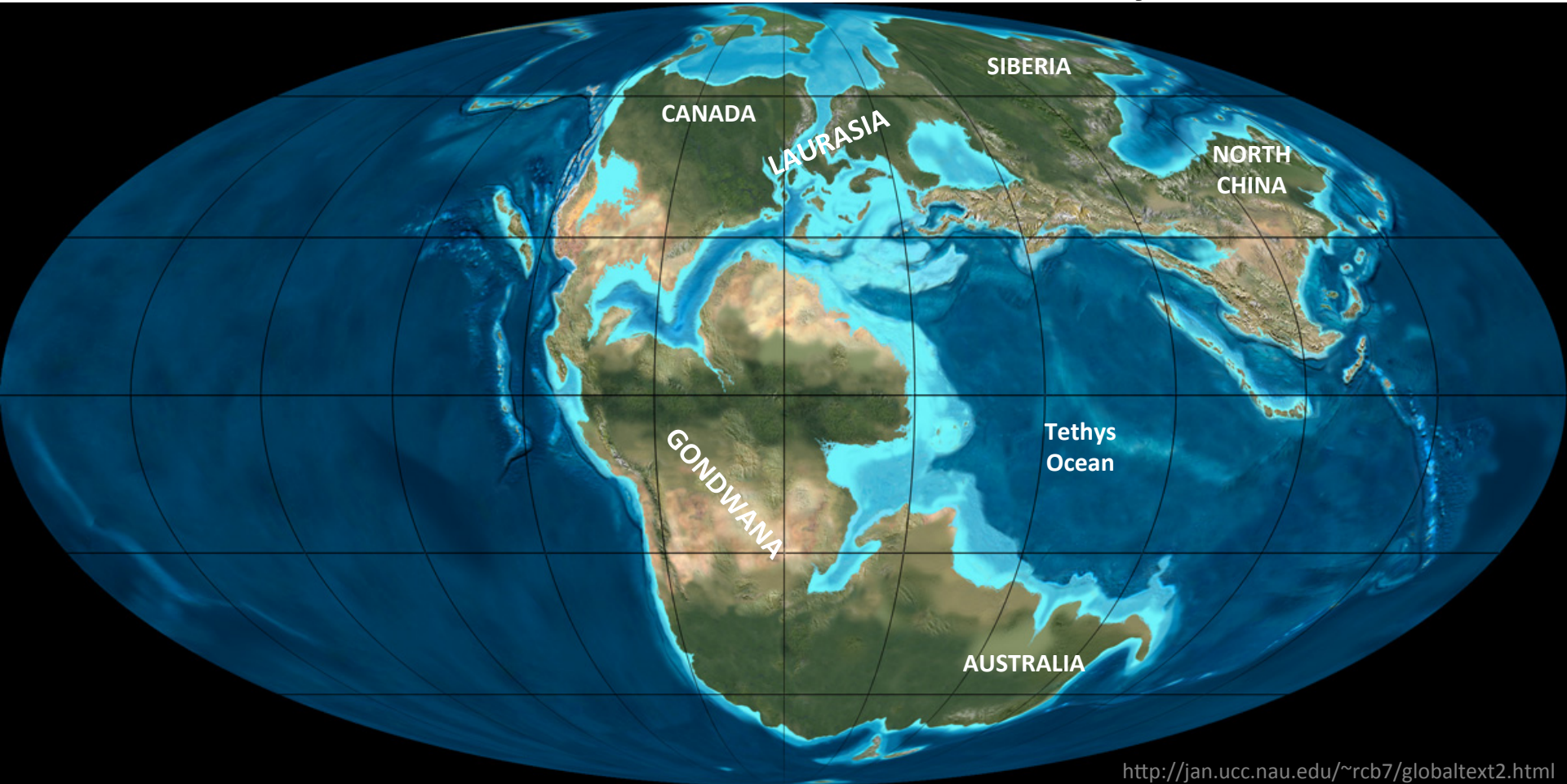
Early Jurassic Period (Gondwanan and Laurasian supercontinents)



This image depicts the major extinction event that occurred during this time around 200 MYA, effectively removing 42% of all terrestrial tetrapod's, however some dinosaurs survived to dominate during the Jurassic period

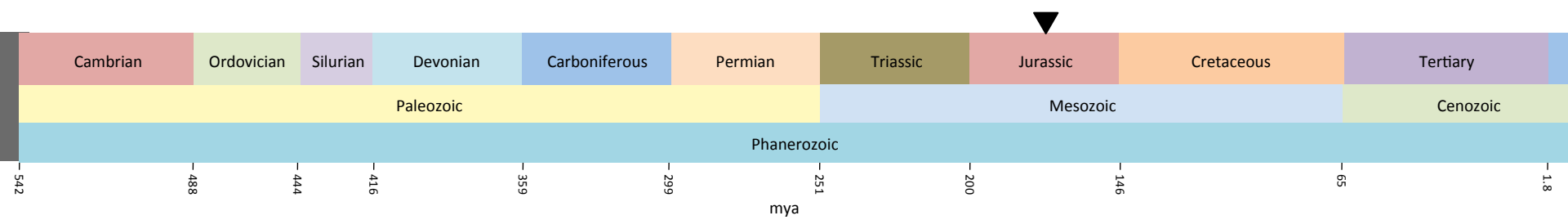


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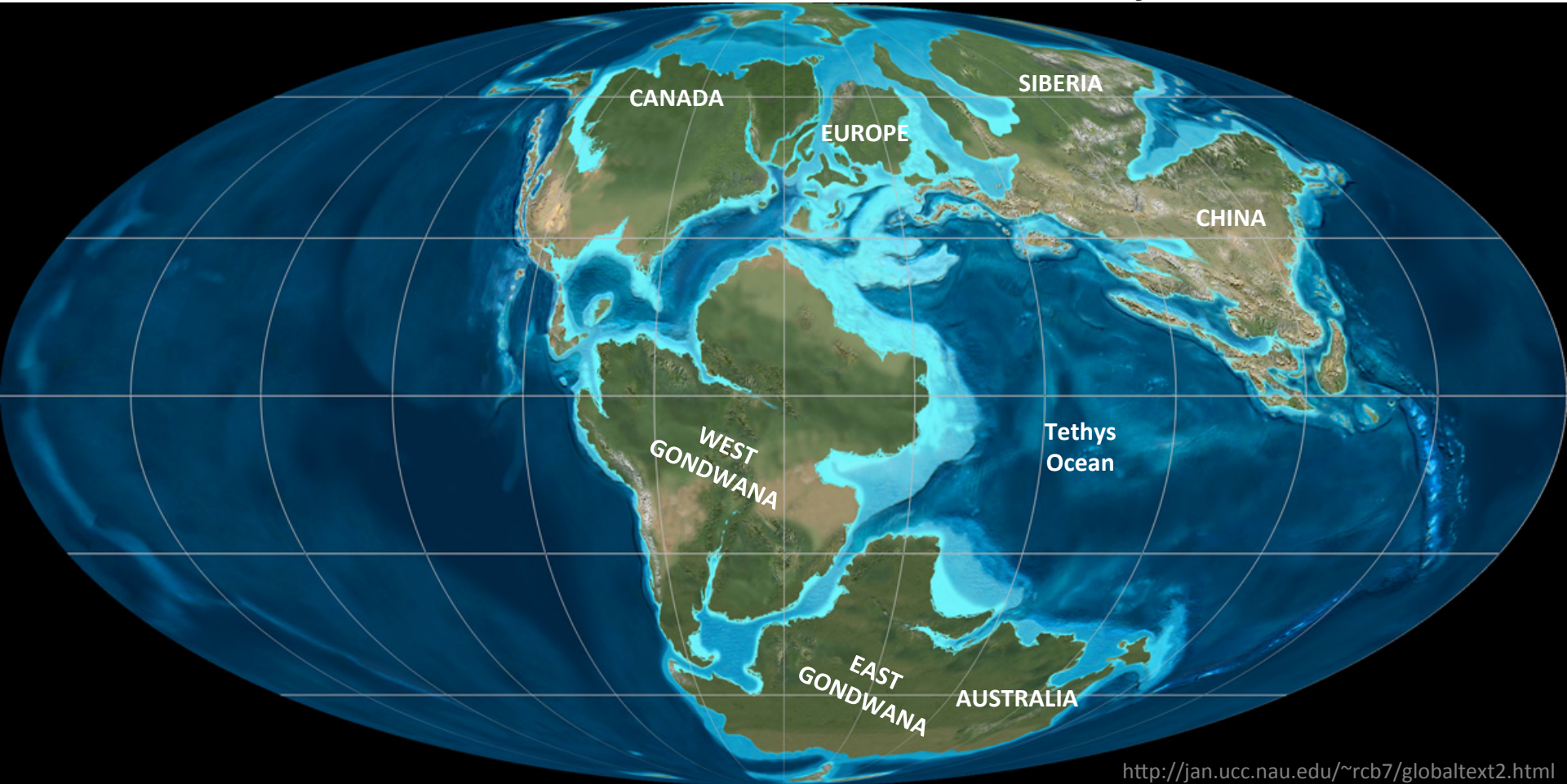


<http://jan.ucc.nau.edu/~rcb7/globaltext2.html>

170 mya (Middle Jurassic)

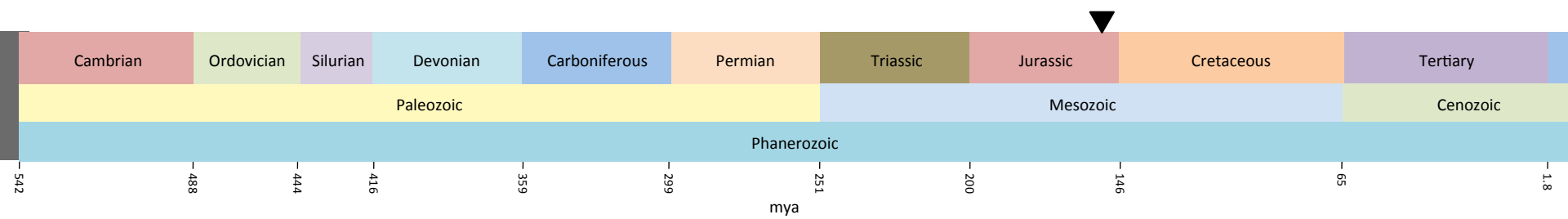


Earth's Tectonic History



<http://jan.ucc.nau.edu/~rcb7/globaltext2.html>

150 mya (Late Jurassic – first flowering plants, first birds)



Late Jurassic Period

- Divergence of Continents: Specifically the split of Gondwana



Late Jurassic Period

Warm Climates throughout all latitudes



Late Jurassic Period

No Polar Ice = High Sea Levels



Jurassic Seas

Lots of coral reefs, sharks, first sting rays, crocodiles, plesiosaurs and fish



Late Jurassic Period

Conifer Plants and Ferns Dominant Plant Life



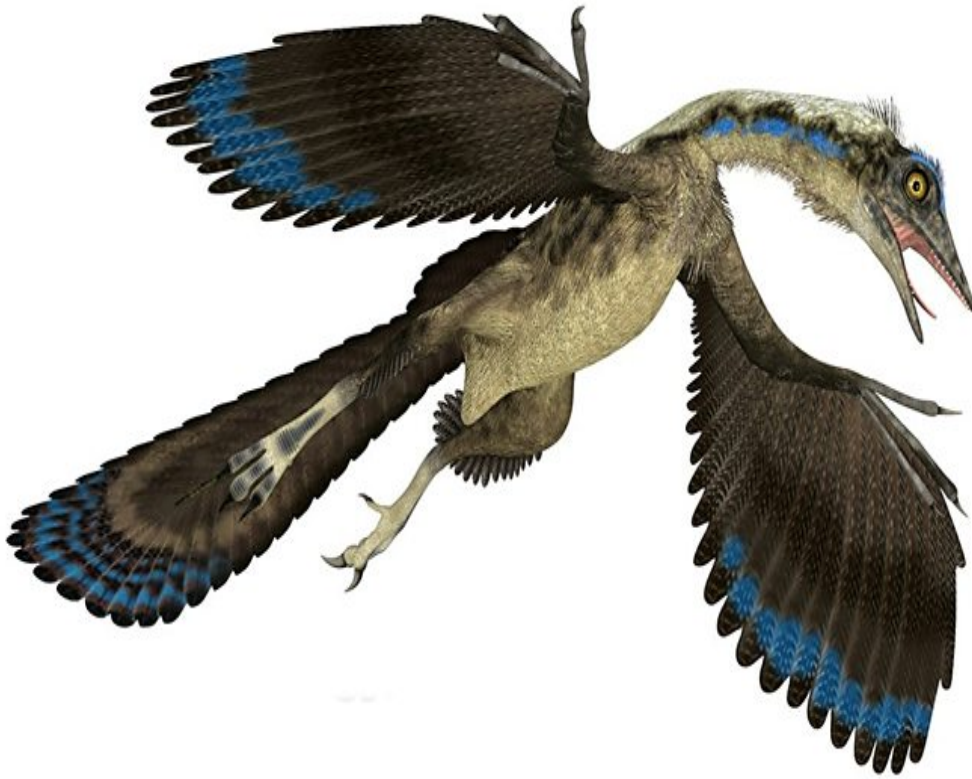
Late Jurassic Period

First Appearance of Flowering Plants (Angiosperms)



Late Jurassic Period

First Appearance of Birds (Archaeopteryx)



Late Jurassic Period

Reptiles were the Dominant Life Form

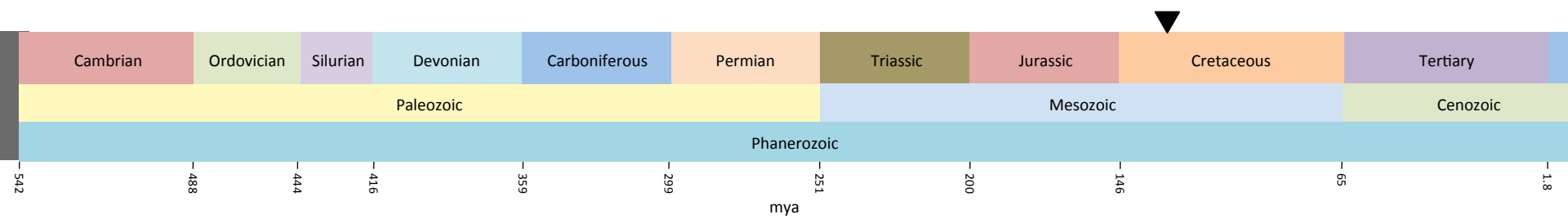


Earth's Tectonic History

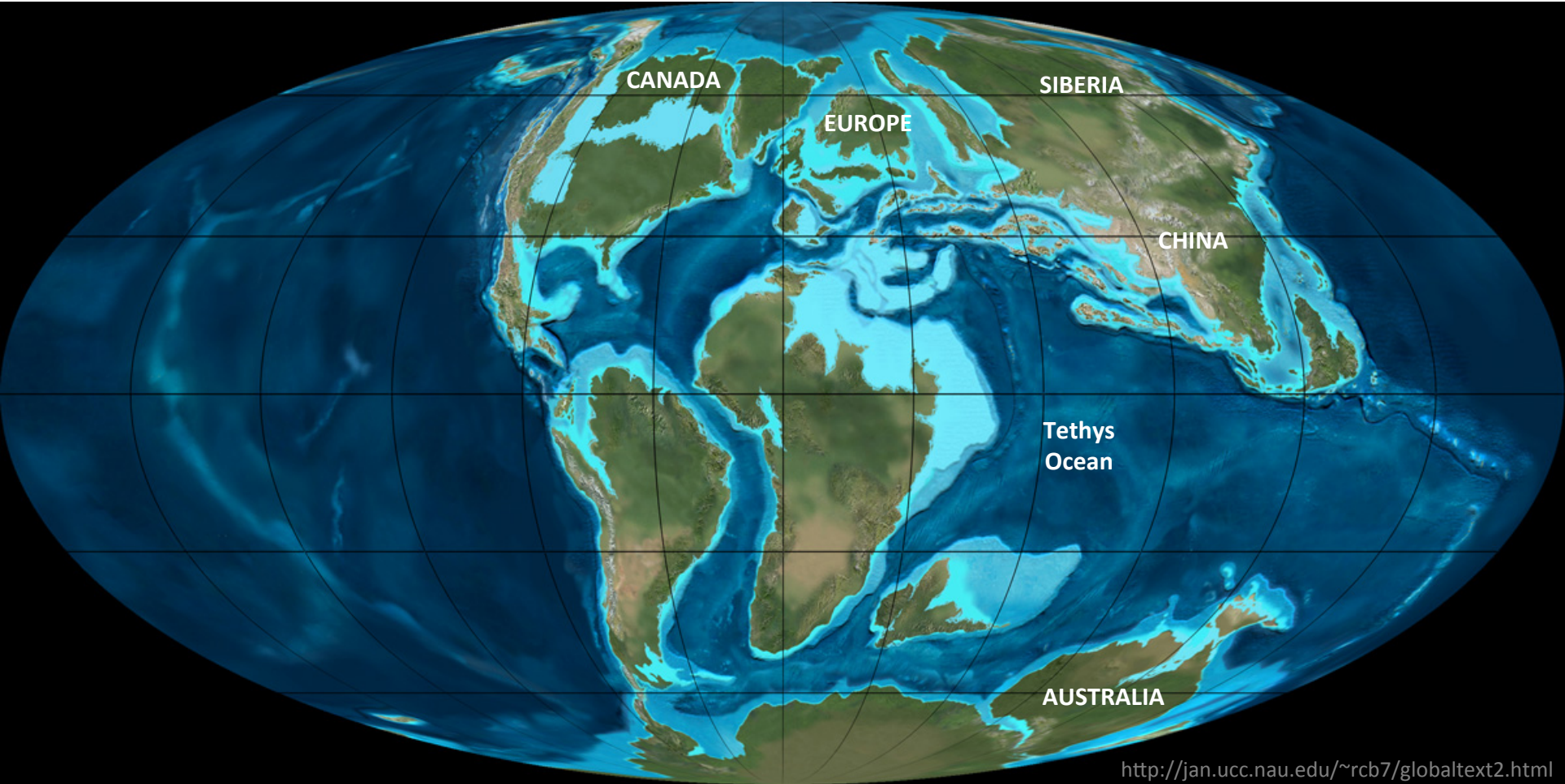


<http://jan.ucc.nau.edu/~rcb7/globaltext2.html>

120 mya (Early Cretaceous – “Age of the Dinosaurs”)

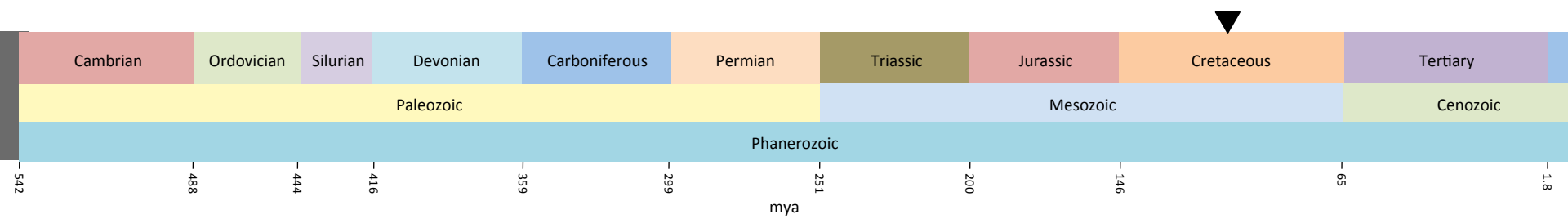


Earth's Tectonic History

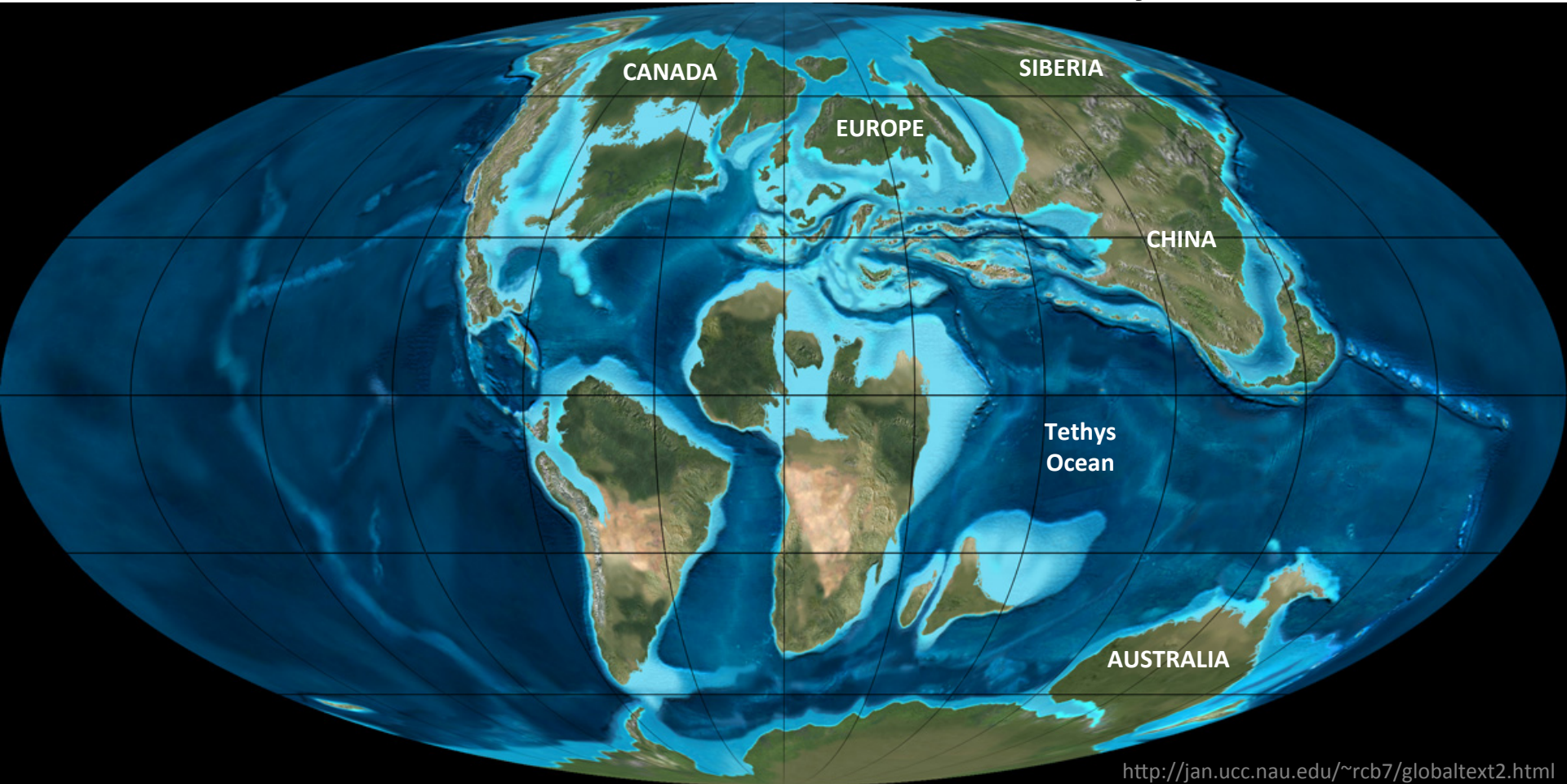


<http://jan.ucc.nau.edu/~rcb7/globaltext2.html>

105 mya (Middle Cretaceous – adaptive radiation of flowering plants and pollinating insects)

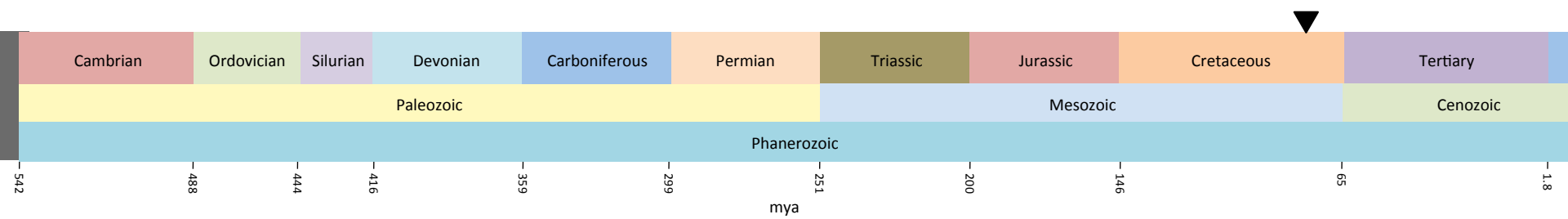


Earth's Tectonic History

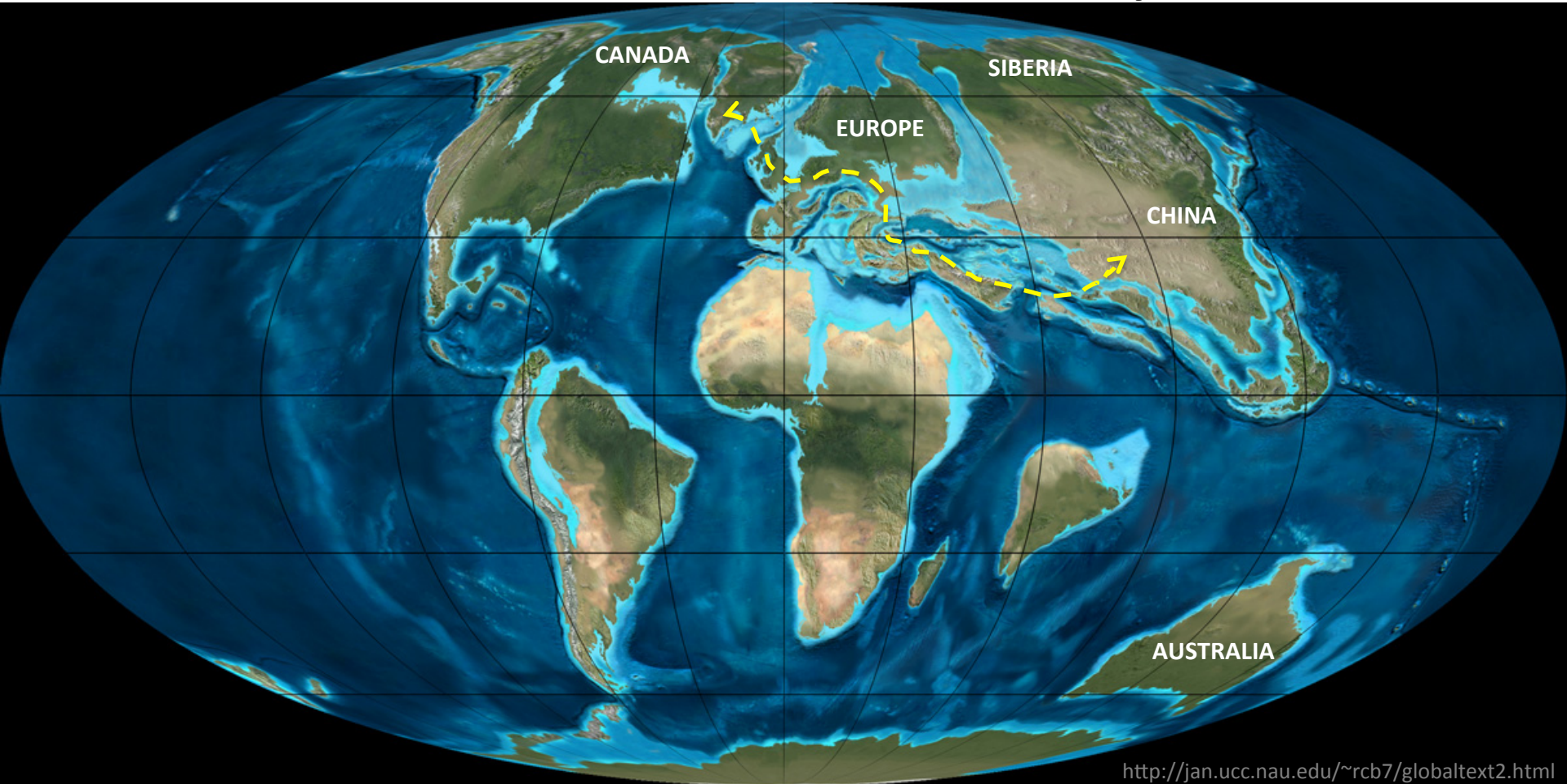


<http://jan.ucc.nau.edu/~rcb7/globaltext2.html>

90 mya (Late Cretaceous)

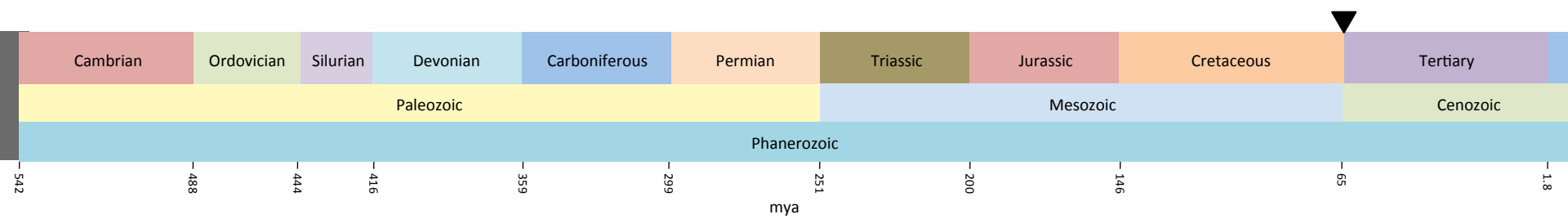


Earth's Tectonic History



<http://jan.ucc.nau.edu/~rcb7/globaltext2.html>

65 mya (K-T – mass extinction)





65 mya- KT mass extinction

Yun Li, Chelsea Ma, Andac Gunay, Nicholas Najy





Overview

Distribution

Continent position

Global connectivity

Dominant life forms





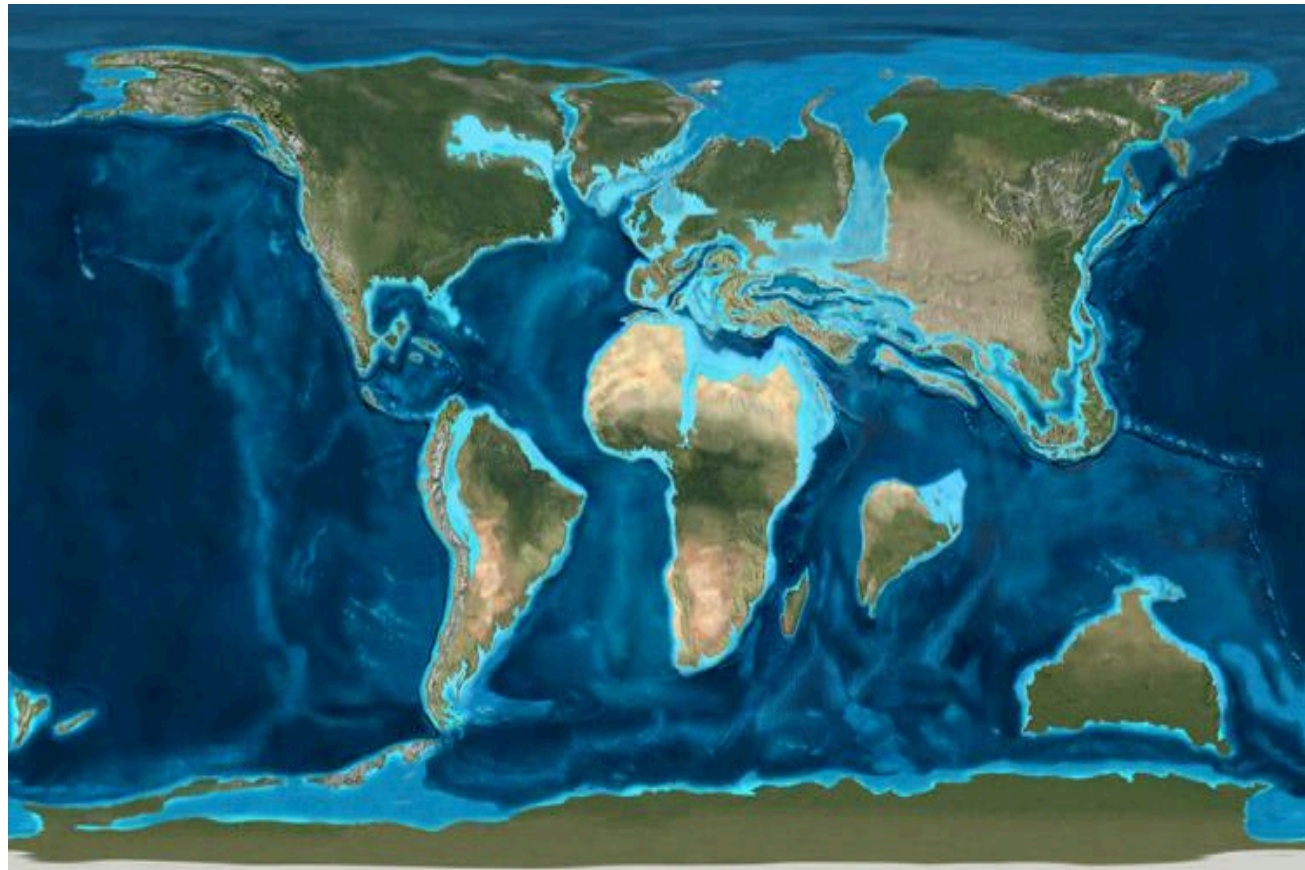
Distribution

Land started to separate from each other and colliding with others

Polar regions were free of continental ice sheets, their land instead covered by forest

Continents were separated by water

- India was adrift in the Indian Ocean
- Australia was still connected to Antarctica



Continent Position

- Similar to present day positions
 - North America = 30-60°N
 - South America = 0-60°S
 - Antarctica = 90°S
 - Asia = 0-60°N
 - Europe = ~60°N
 - Africa = 30°N-30°S
 - Australia = 30-60°S
- Hypothesized asteroid impact released significant amount of greenhouse gases
- Global warming of 2-5 °C for several years after the impact

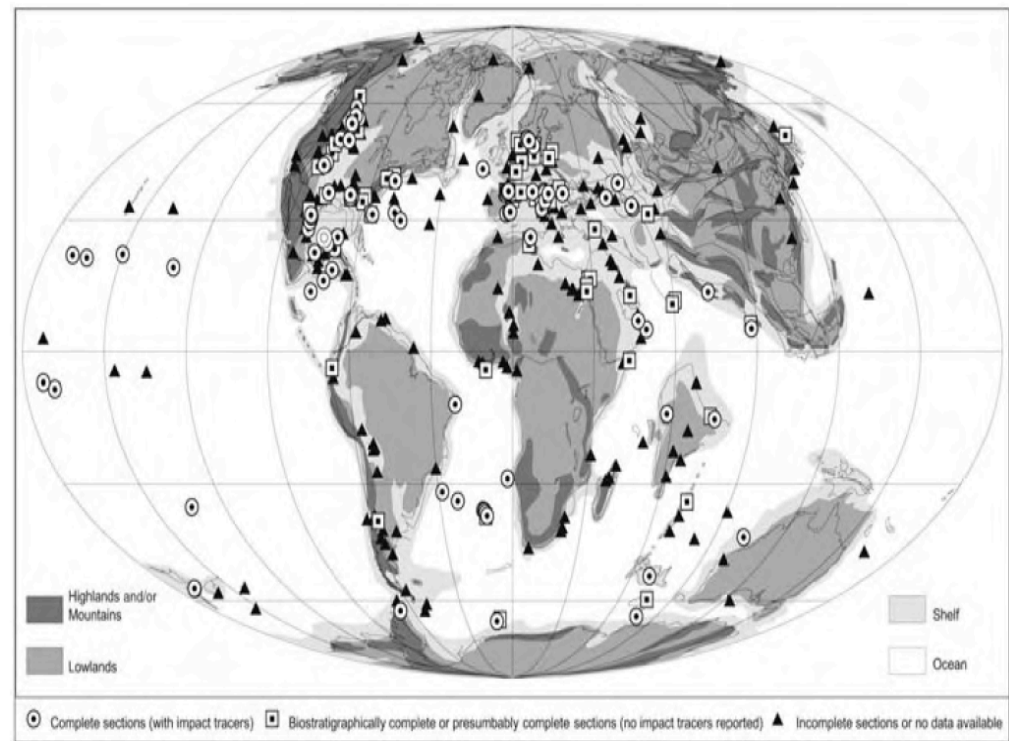
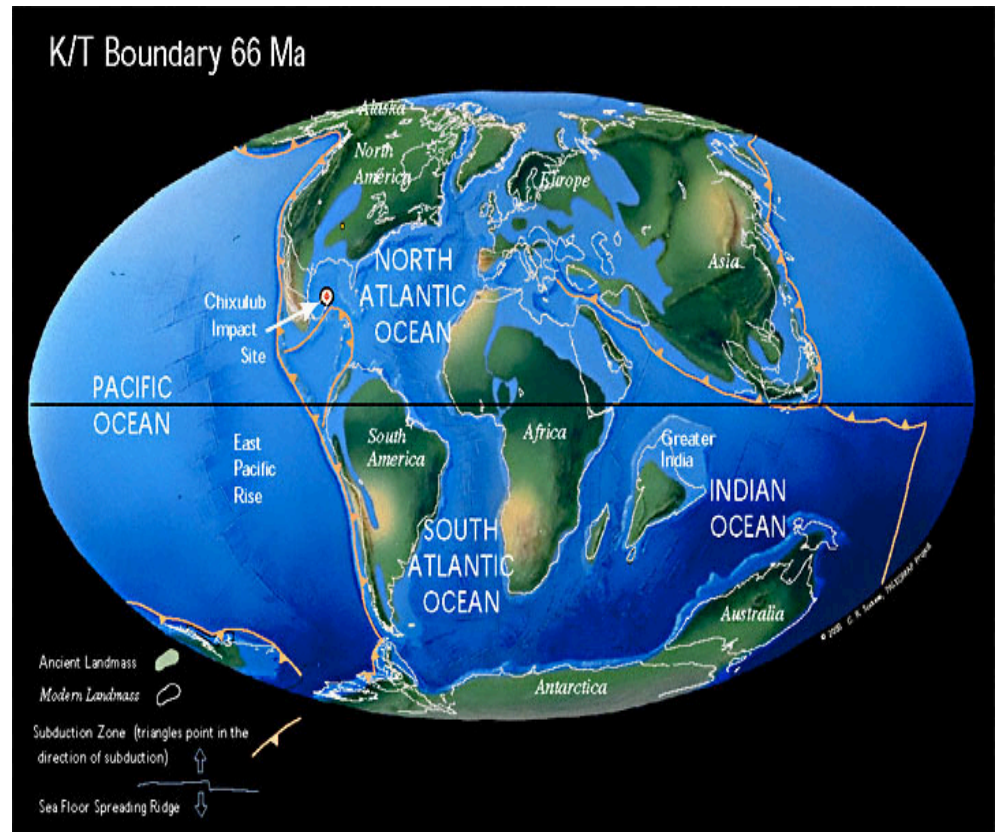


Figure 1. Completeness of Cretaceous-Tertiary (K-T) sections: 101 K-T sites that have recorded ejecta debris are globally distributed, clearly supporting worldwide deposition of Chicxulub ejecta. Paleogeographic reconstruction (J. Golonka, 1997, personal commun.) presented here is based on modified version of Late Cretaceous map of Scotese and Golonka (1992.)

Global Connectivity

Land masses were less connected compared to today, with Europe and Asia being fragmented and mostly underwater and North America and South America being further apart. Europe had split into several subcontinents/islands. The Indian subcontinent had not merged with Asia yet, and Australia and Antarctica had not separated. There was no ice sheet over Antarctica, so it formed one continuous potentially habitable landmass.





Dominant Life Forms

Major life forms on the planet

Dinosaurs

Giant marine reptiles

Flying reptiles

Angiosperms

Marine invertebrates





Dominant Life Forms

Major extinctions

- Non-avian dinosaurs
- Large mammals
- Extinction of many photosynthesizing plants because of volcanic ashes and other particles blocking sunlight and reducing solar energy
- Extinction of pure herbivores and carnivores
- Only omnivores, insectivores, and carrion eaters survived. Insects, worms, and snails survived since they fed on detritus.
- Extinction of many aquatic species that relied on photosynthesizing plankton, including coccolithophorids and mollusks (ammonites, rudists, freshwater snails, mussels). Aquatic animals that fed on these such as mosasaurs and other large marine reptiles died. Crocodile ancestors survived since they would feed on detritus and could survive long periods with no food.
- Deep sea creatures survived better, especially with all the falling detritus.
- Large extinction of plants

Dominant Life Forms

New proliferations

- Small mammals leading to the mammal takeover
- Proliferation of saprotrophic organisms (such as fungi) with all the dead plants. Only lasted a few years though.
- Proliferation of ferns.
- Flower polyploidy greatly helped them adapt.

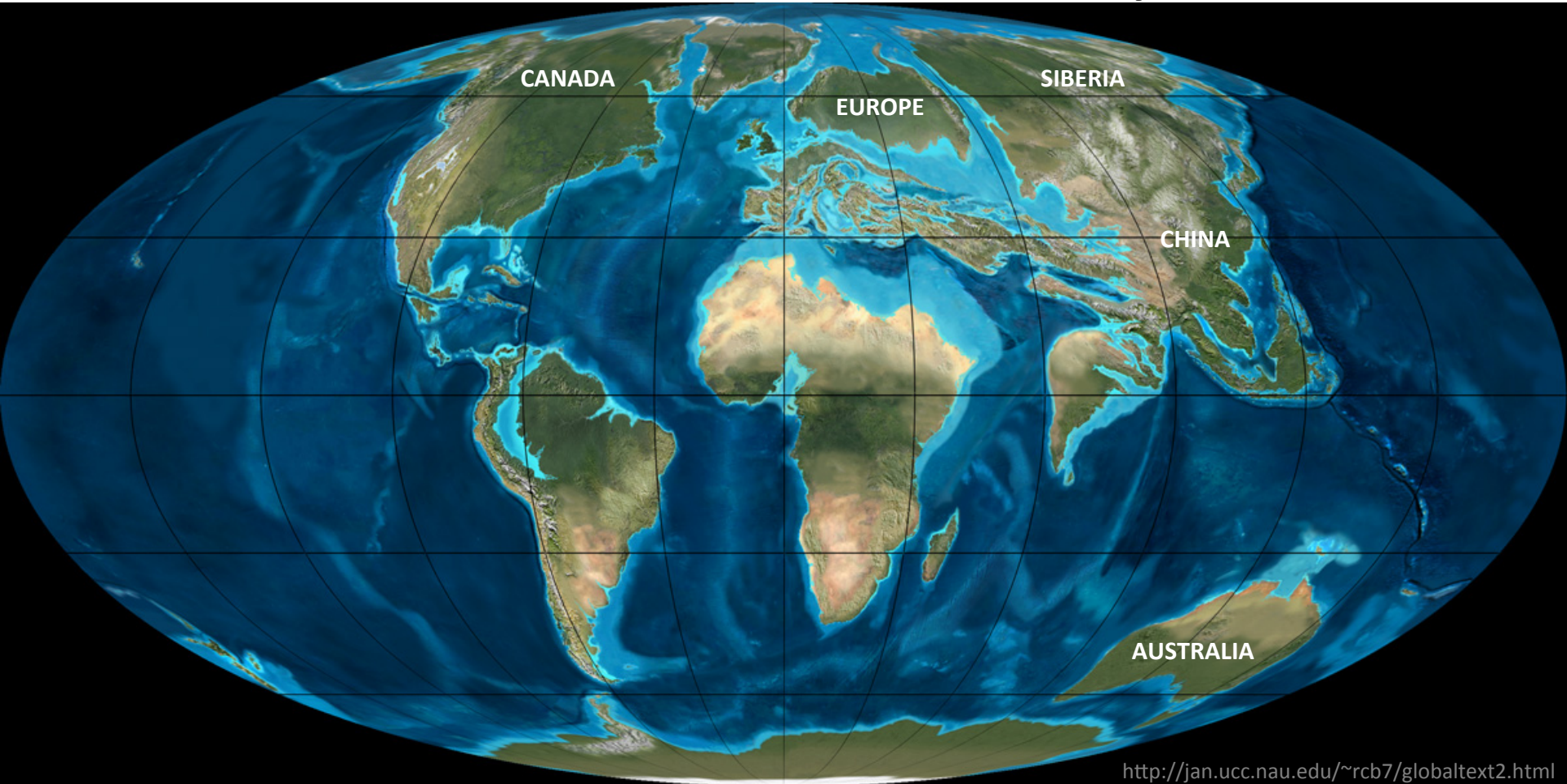




Thank you.

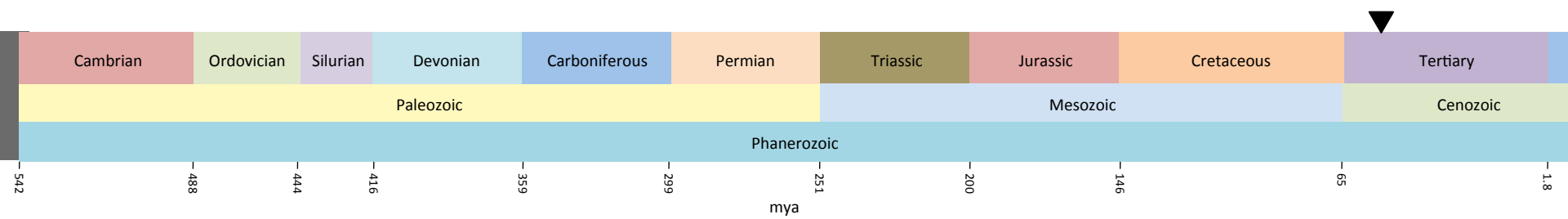


Earth's Tectonic History

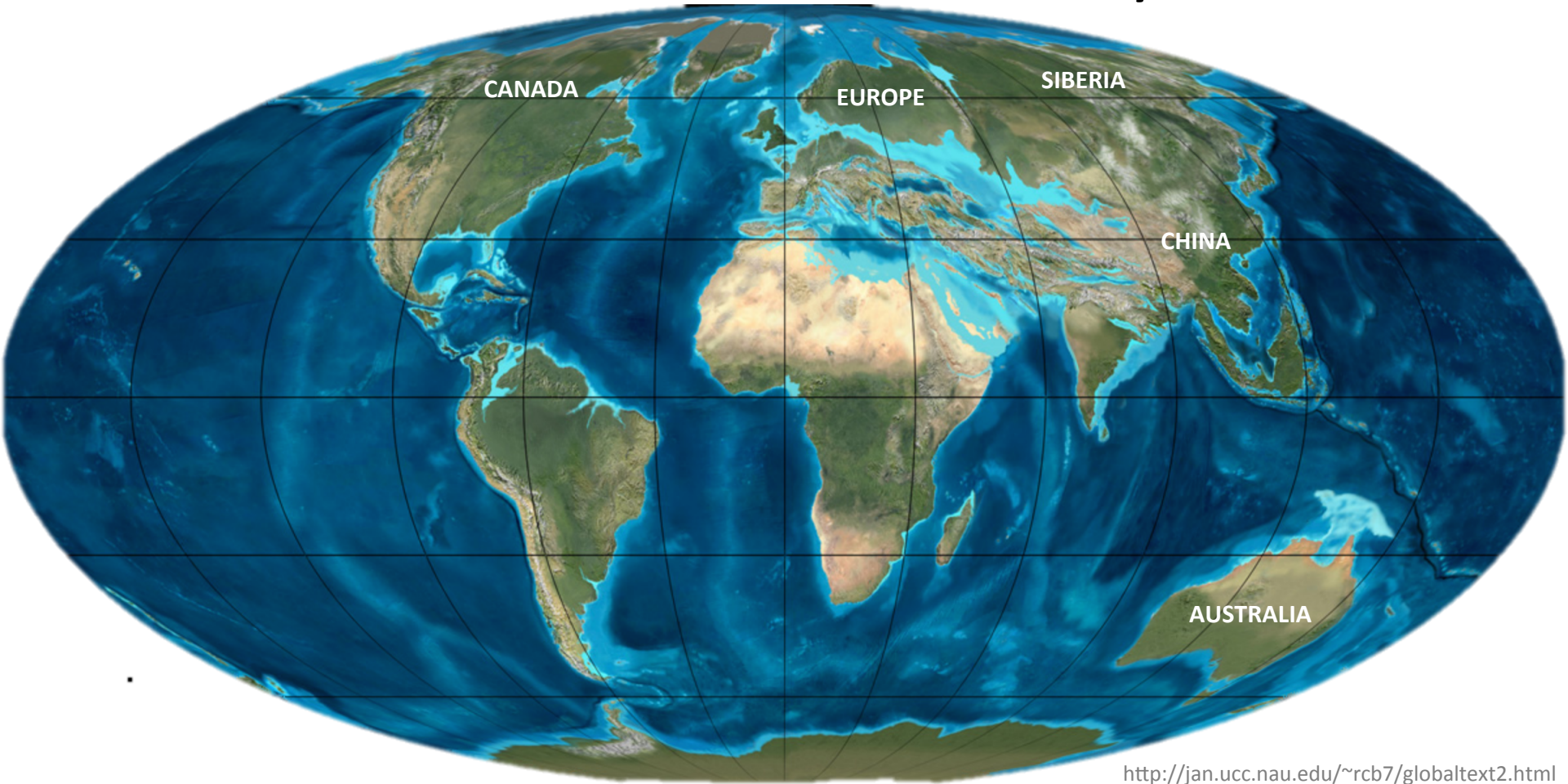


<http://jan.ucc.nau.edu/~rcb7/globaltext2.html>

50 mya (Eocene – adaptive radiation of mammals)

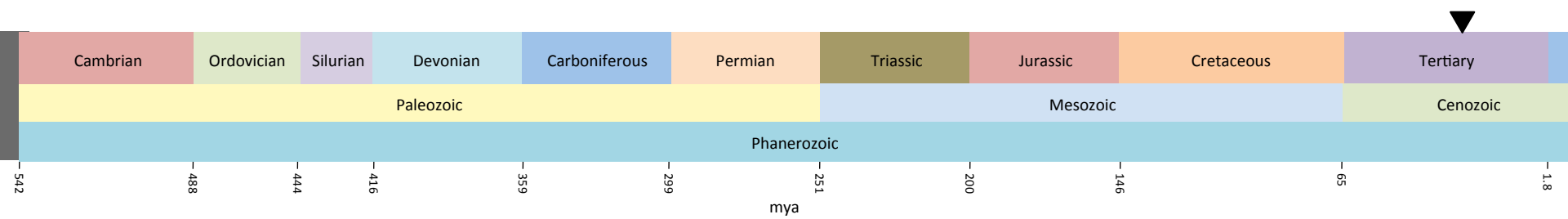


Earth's Tectonic History

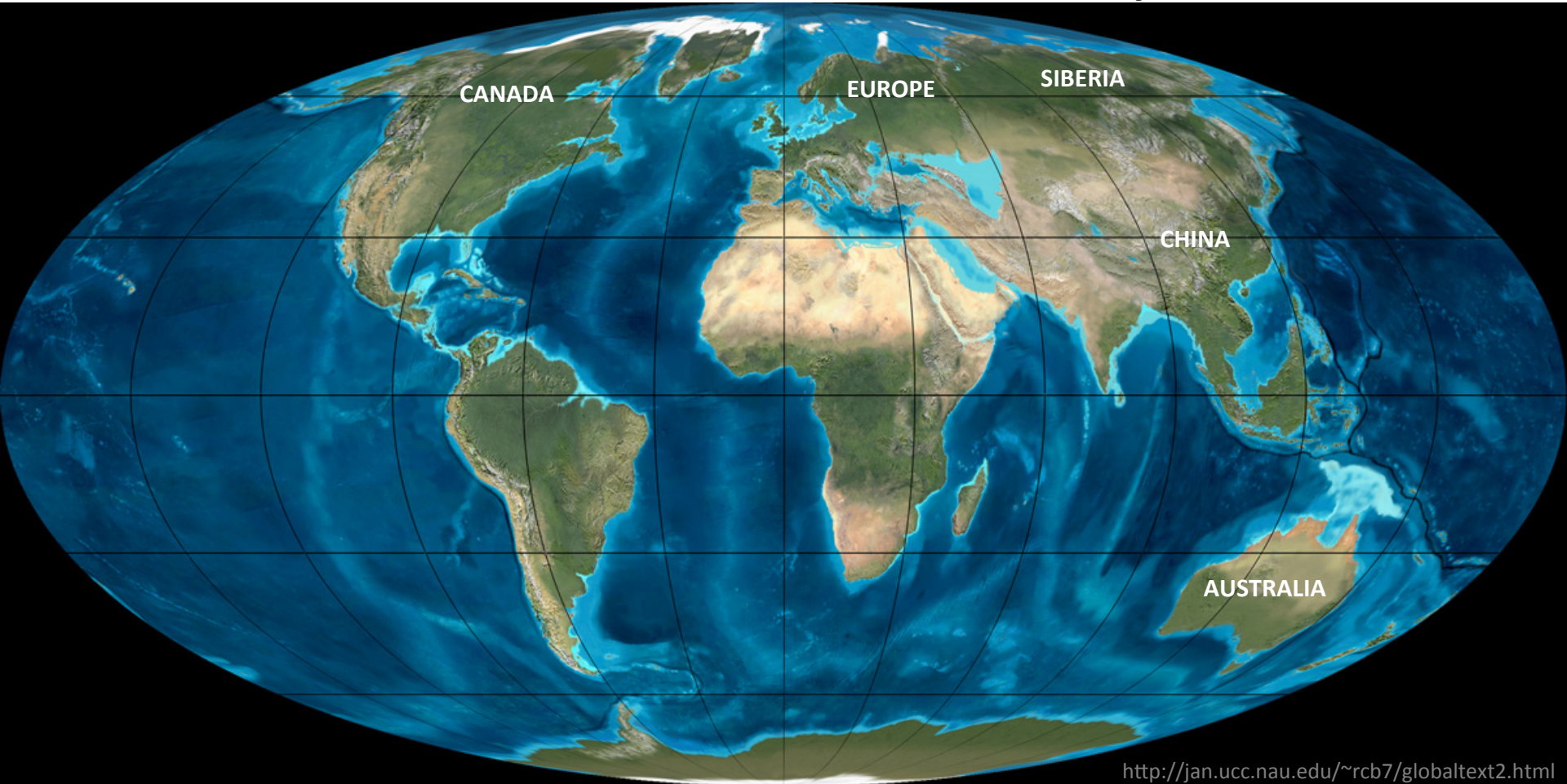


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35 mya (Oligocene – major coral reef development)

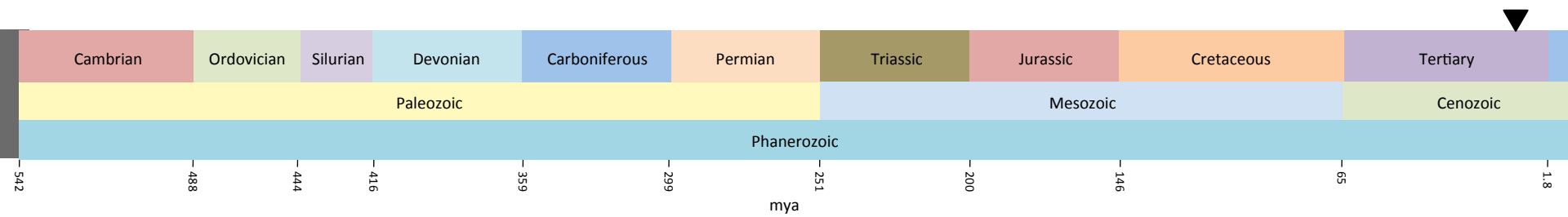


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20 mya (Miocene – global expansion of major C₄ grasslands)





Earth's Tectonic History: Late Tertiary

Louisa Hsu
Nikita Payne
Jenelle Warner
Victoria Wu



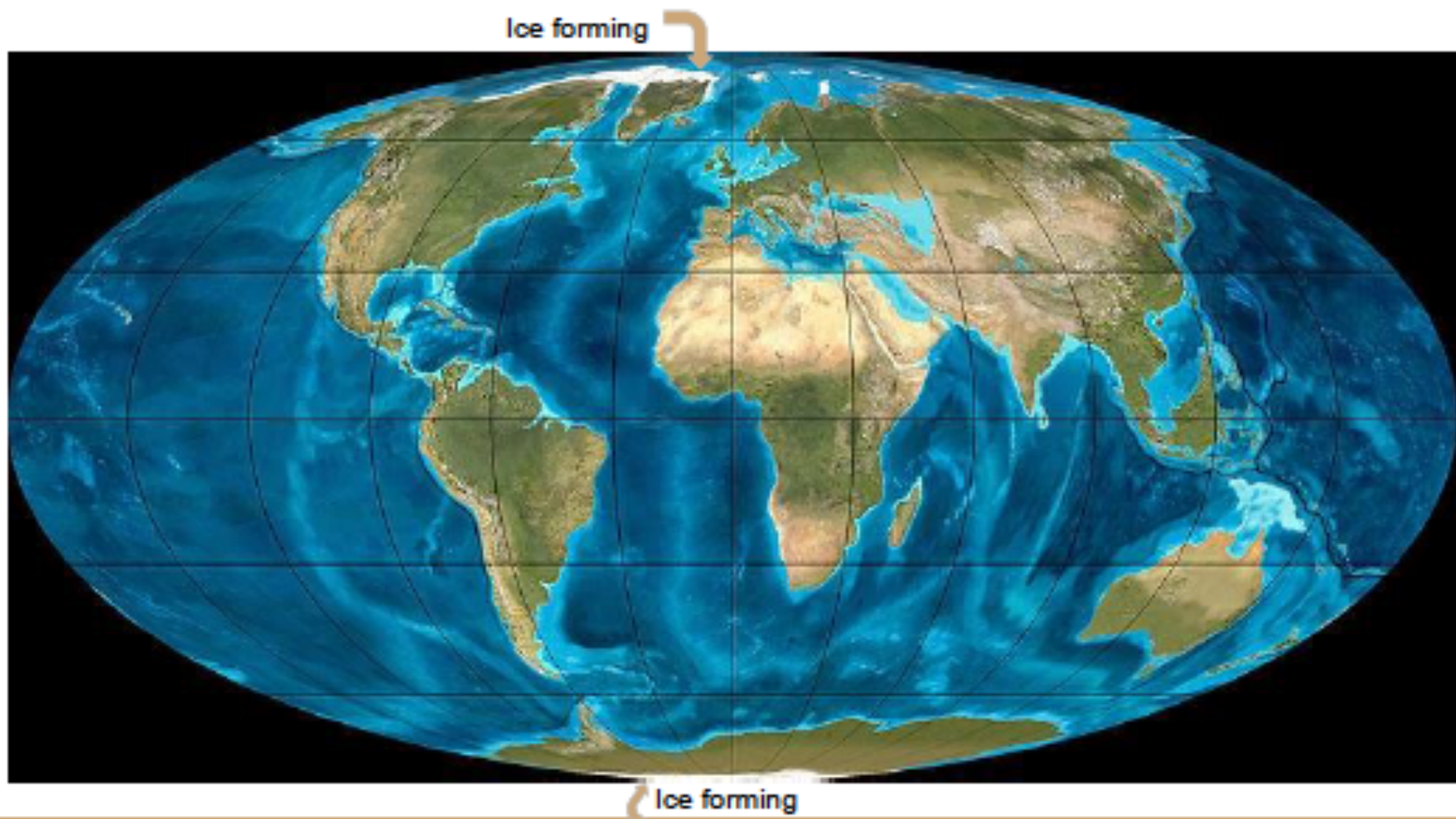
Late Tertiary

Middle Eocene 50.2 million years ago



■ Mountains ■ Land ■ Shallow seas ■ Deep ocean basins ▶ Subduction zone (triangle point in the direction of subduction)

Late Tertiary



Late Tertiary

Distribution of landmass and water bodies

Landmass with wide latitudinal range

More landmass in the Northern Hemisphere. Similar to present-day distribution

Greater marine connectivity: waterway between North and South America, easier access between the Mediterranean and the Arabian Sea

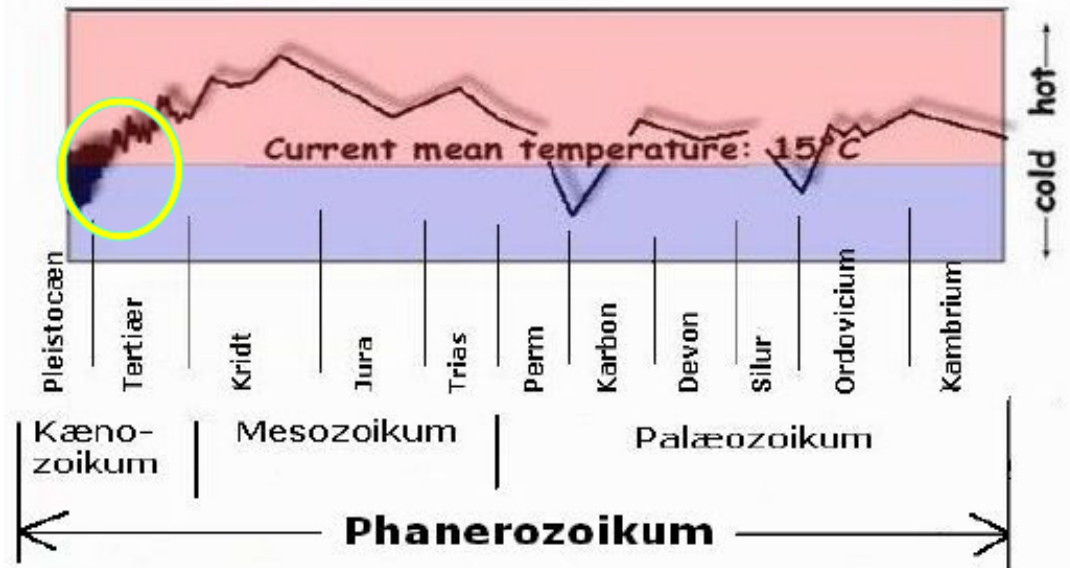


Late Tertiary

Flightless bird



Ancestor of modern mammal



Continent positions across latitude and influence on global climate

Continents are relatively evenly distributed across all the latitudes

Northern parts of Europe, Siberia and Canada and Southernmost part of Antarctica had some ice formation but not as extensively as seen today

Tropics remained very warm, North and South Africa had extensive deserts

Rain forests were predominantly directly around the equator within both hemispheres

Climate of the early Tertiary period was very warm/moist compared to today's climate, by middle of the Tertiary it started to cool, leading to glaciation in the Pleistocene

Much of the earth was tropical or subtropical

Connectivity across terrestrial and marine realms

Overall, there was a large amount of connectivity between the European and Asian continents (Siberia and China)

North and South America are not yet connected -The land bridge has not yet formed

Australia and Antarctica are the most isolated during this time period

There was a moderate amount of connectivity between the continents with only a few outliers (mainly Australia, Antarctica, New Zealand, and South America (but it is very close to forming the land bridge with North America))

Saudi Arabia is connected to Africa with a big body of water separating it from Asia

Dominant life forms and biodiversity

Radiation of angiosperms on land

Number of birds increased significantly, notably, there was the emergence of large flightless birds that were more than 2m high

Rates of speciation of mammals accelerated

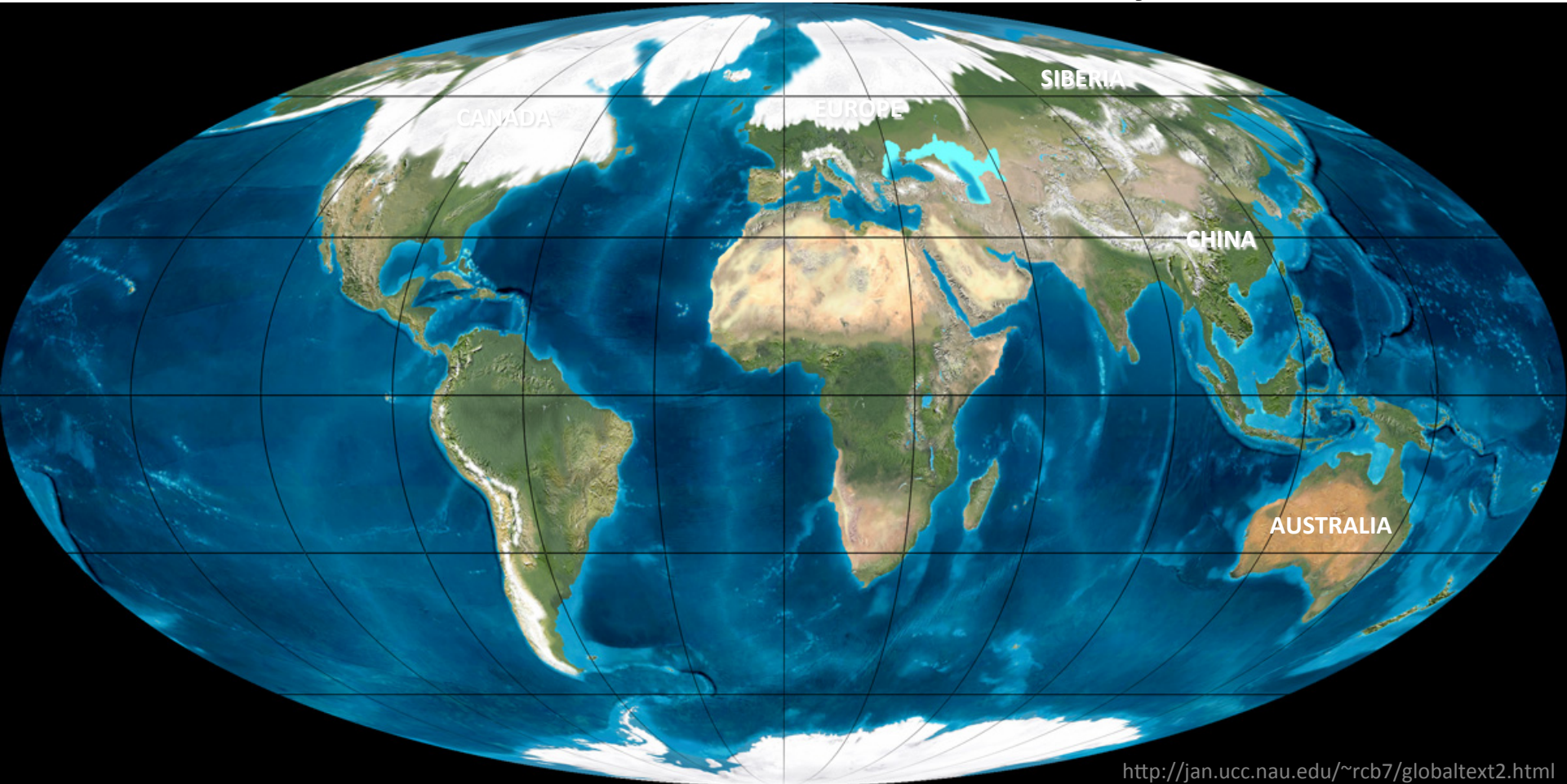
Faunal turnover replaced many archaic groups with modern groups such as perissodactyls (primitive horses, rhinoceroses, and tapirs), artiodactyls (camels and deer), rodents, rabbits, bats, primates, etc.

Radiation of crabs, bony fish, snails, clams, and other invertebrates

Cetaceans appear and accelerate in evolution due to increase in oceanic productivity

Emergence of swimming birds and penguins

Earth's Tectonic History



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0.05 mya (Pleistocene - glaciations)

