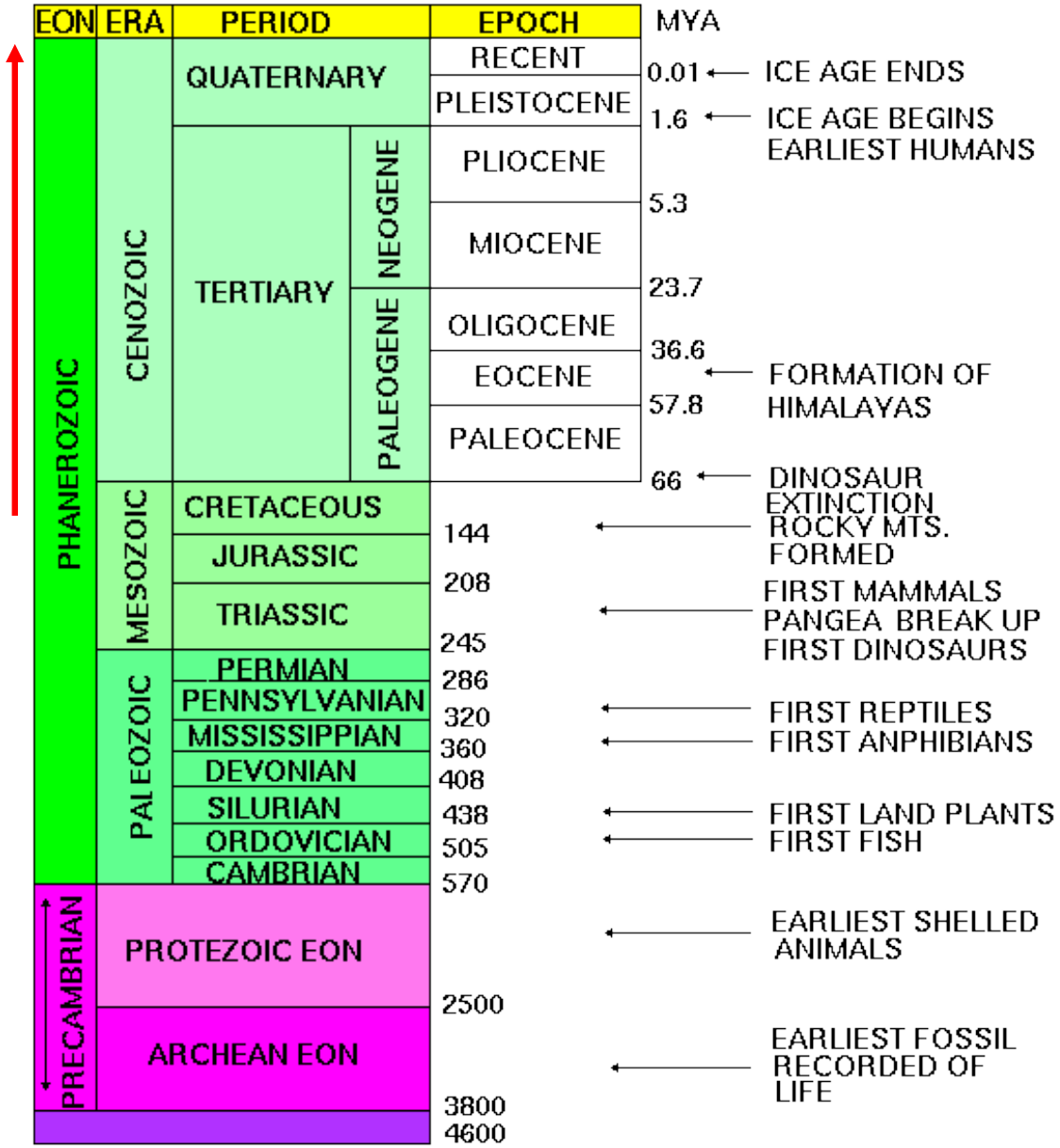
# Evolution of North American Vegetation and Flora

# North American Flora - the Fossil Record

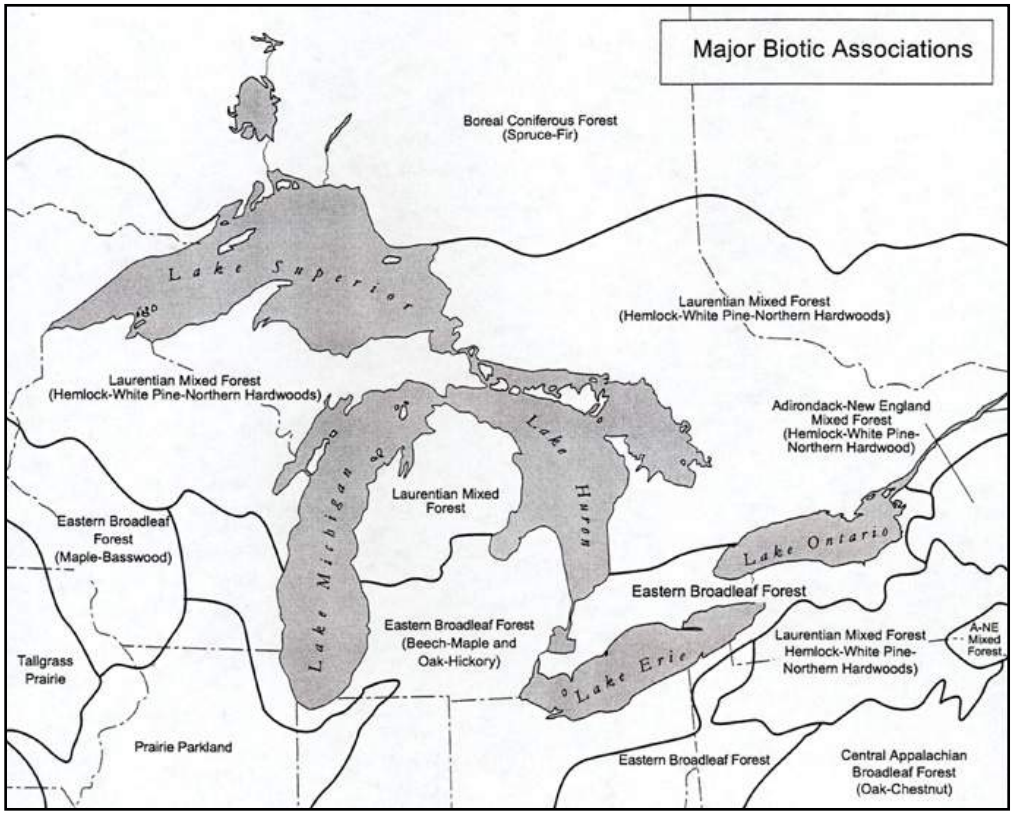



The study of the North American flora, vegetation, and fauna - its history and assembly - begins in the late Cretaceous with the major events staged later in the Tertiary of the Cenozoic

# North American Flora - the Fossil Record


**Pleistocene**

The final shaping of North American (and Great Lakes) flora and vegetation occurs during the Recent Epoch (Holocene) following the glaciation of the Pleistocene



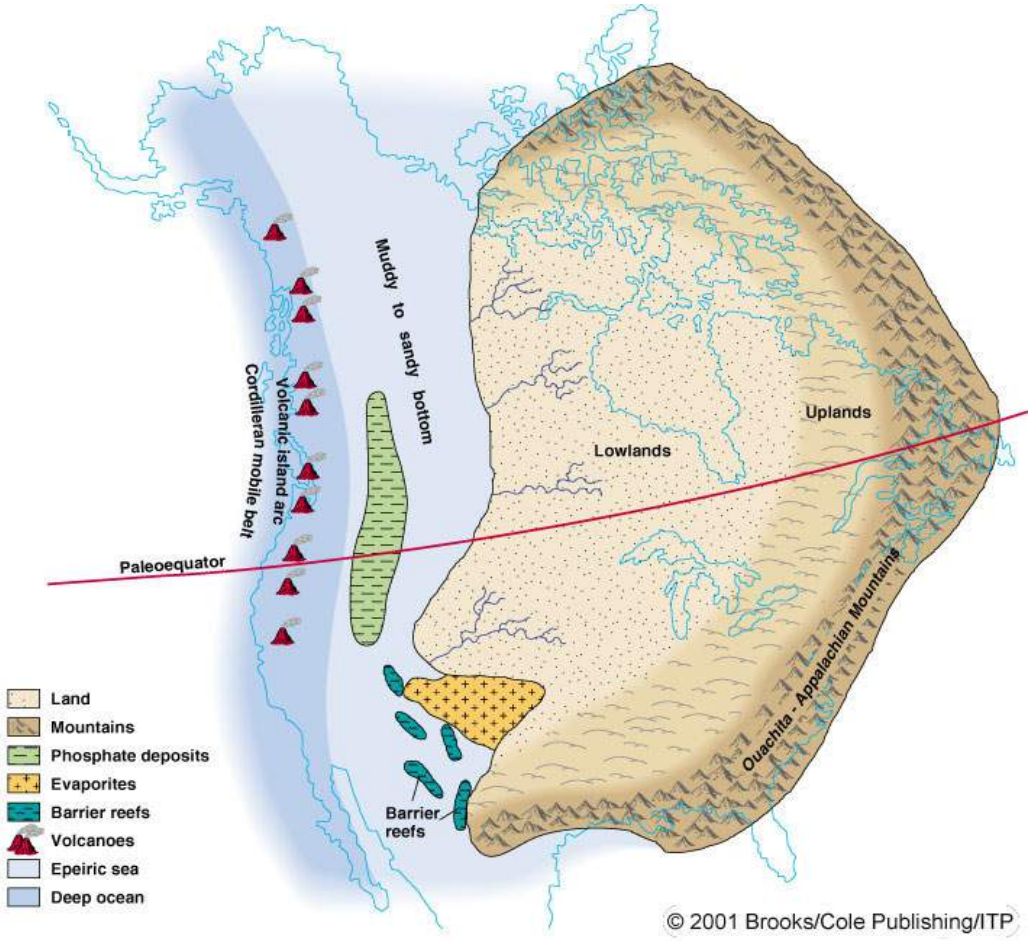

**Holocene**

# North American Flora - the Fossil Record

To understand North American biogeography, follow it through the end of Paleozoic and Mesozoic

## Permian North America
## 260 mya

- N. America near equator
- Appalachian Mountains well developed

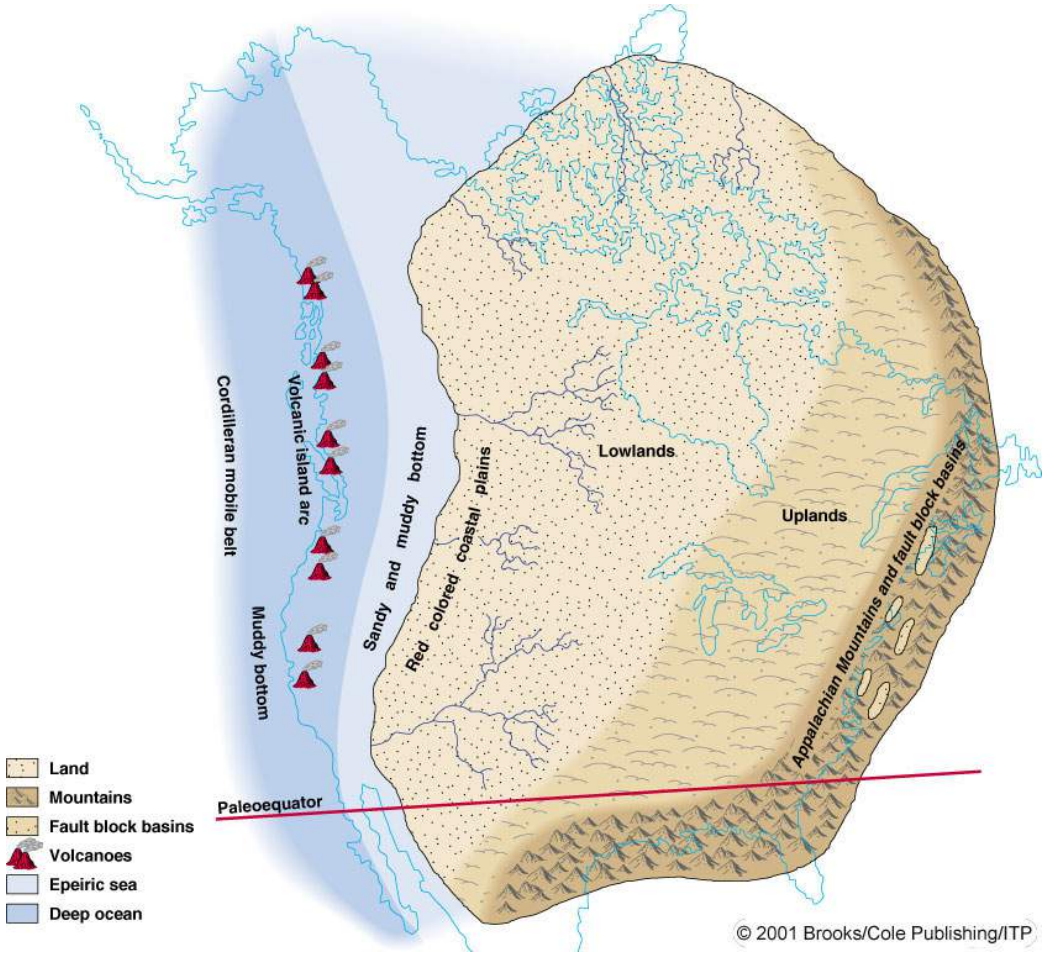


# North American Flora - the Fossil Record

To understand North American biogeography, follow it through the end of Paleozoic and Mesozoic

## Triassic North America
## 230 mya

- N. America moves north
- Extensive volcanic activity in oceanic western N. America

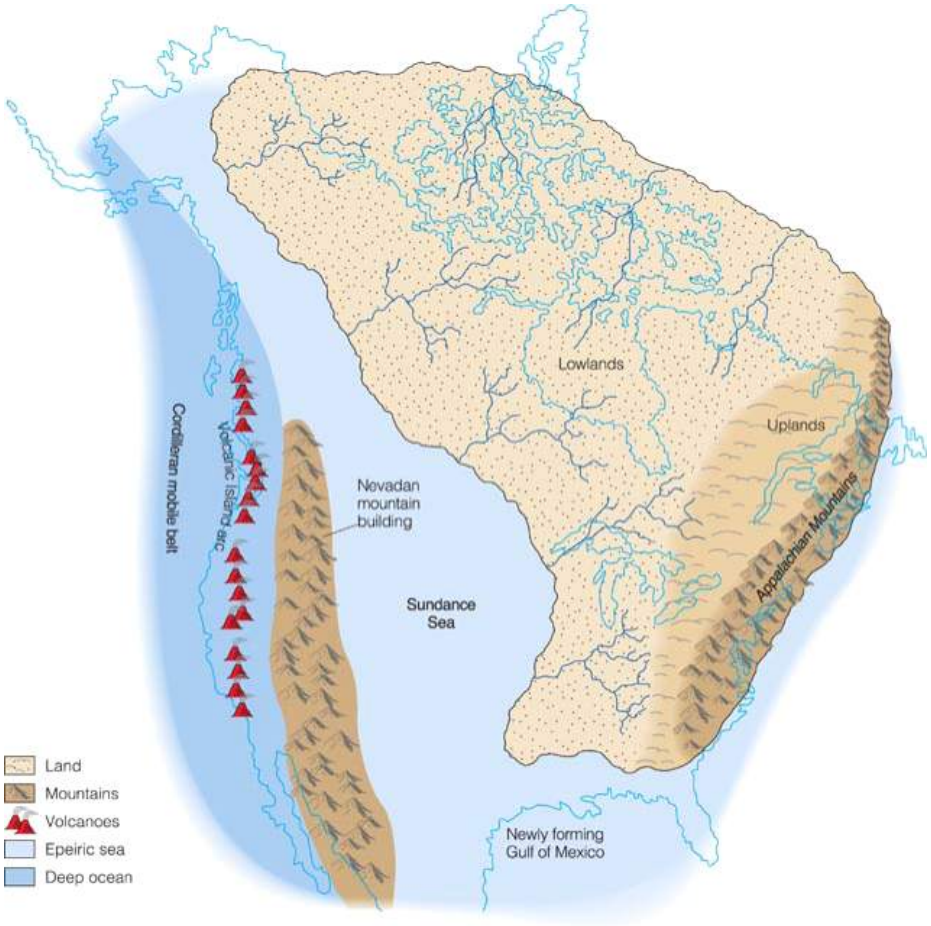


# North American Flora - the Fossil Record

To understand North American biogeography, follow it through the end of Paleozoic and Mesozoic

## Jurassic North America
## 170 mya

- N. America moves north
- Appalachians eroding
- Western mountain building begins
- Interior sea forms

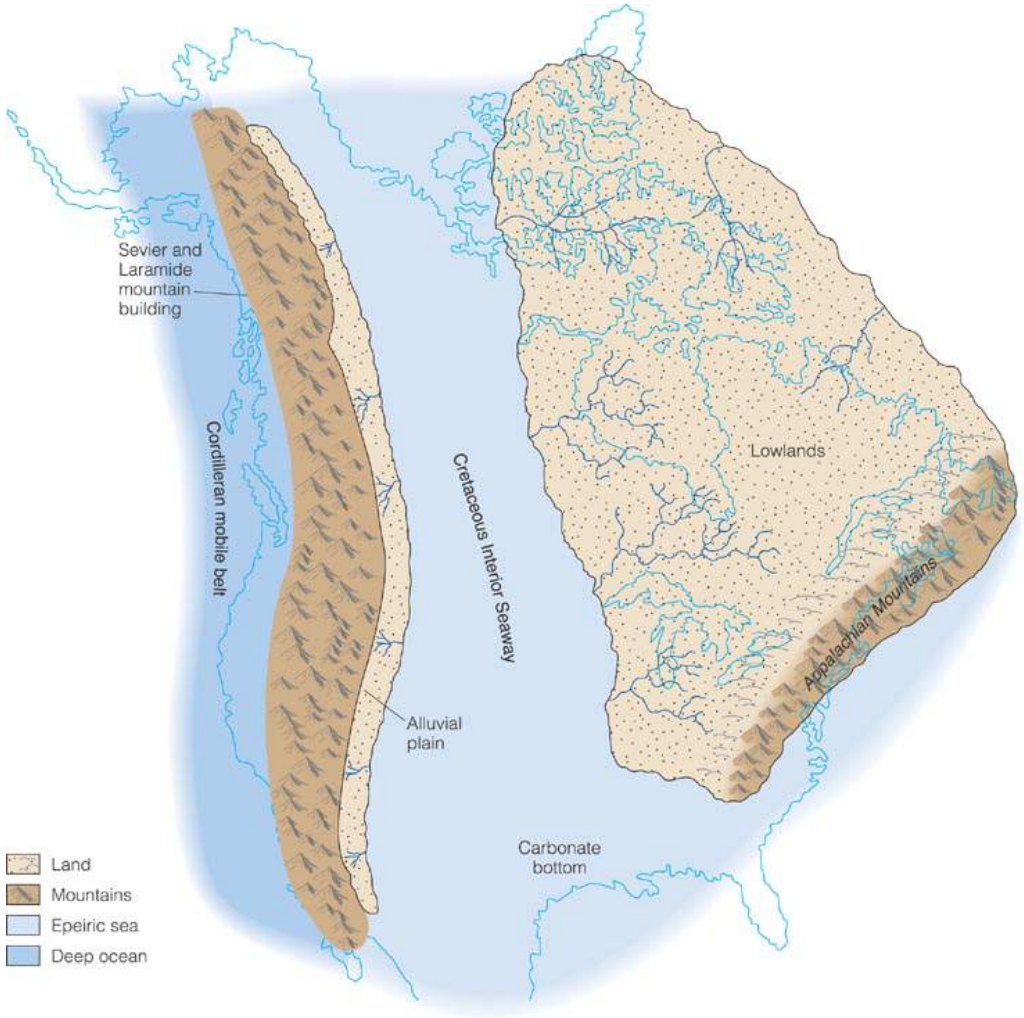


# North American Flora - the Fossil Record

To understand North American biogeography, follow it through the end of Paleozoic and Mesozoic

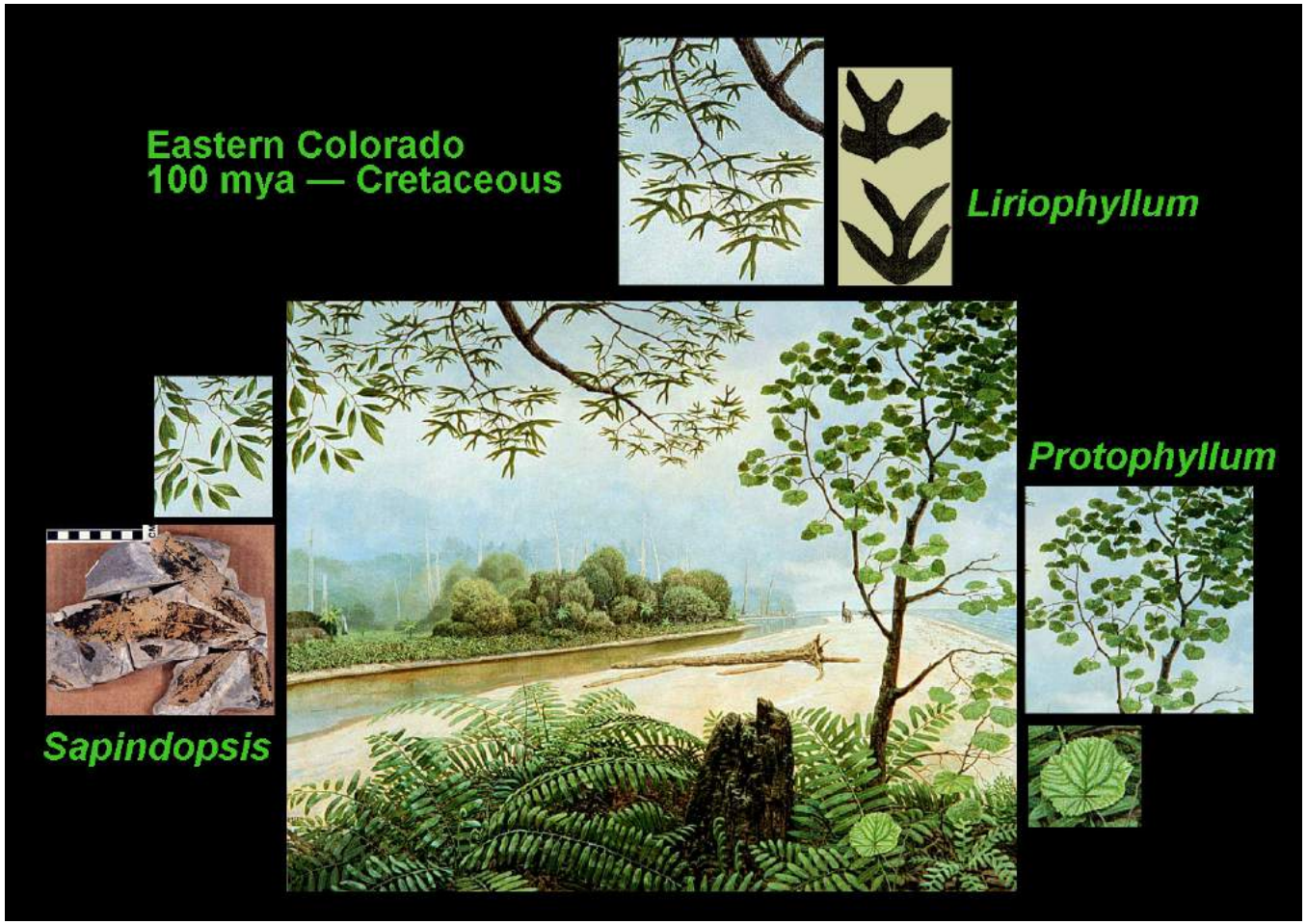
Cretaceous North America
100 mya

- Interior Seaway from Gulf of Mexico to Arctic Circle



# North American Flora - the Late Cretaceous

The end of the Cretaceous and beginning of the Tertiary (100-50 mya) saw the warmest temperatures since the PreCambrian

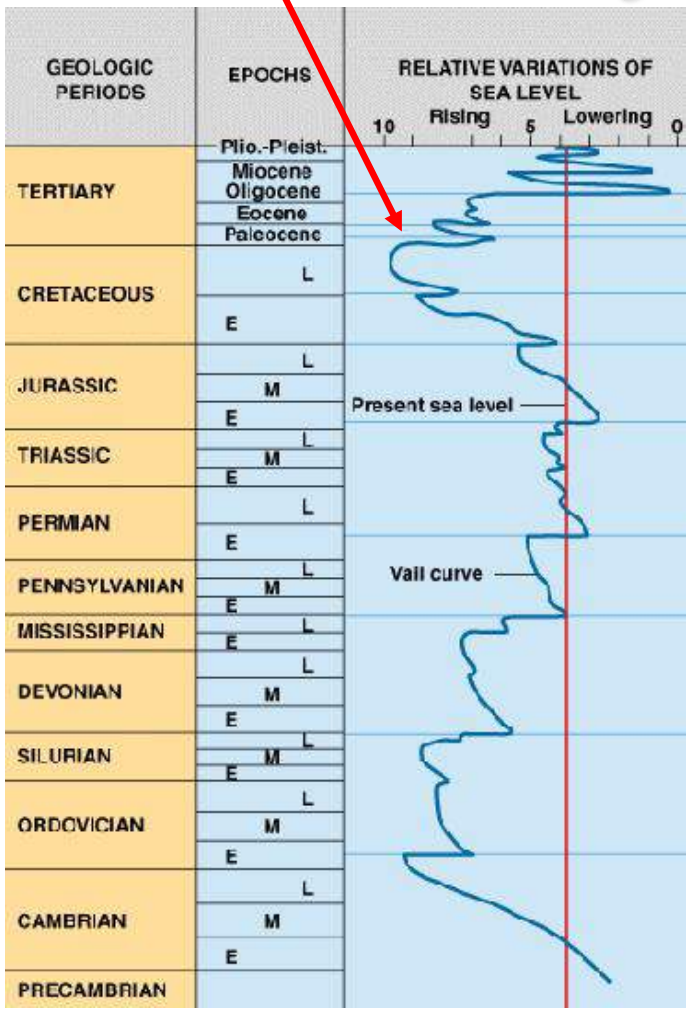


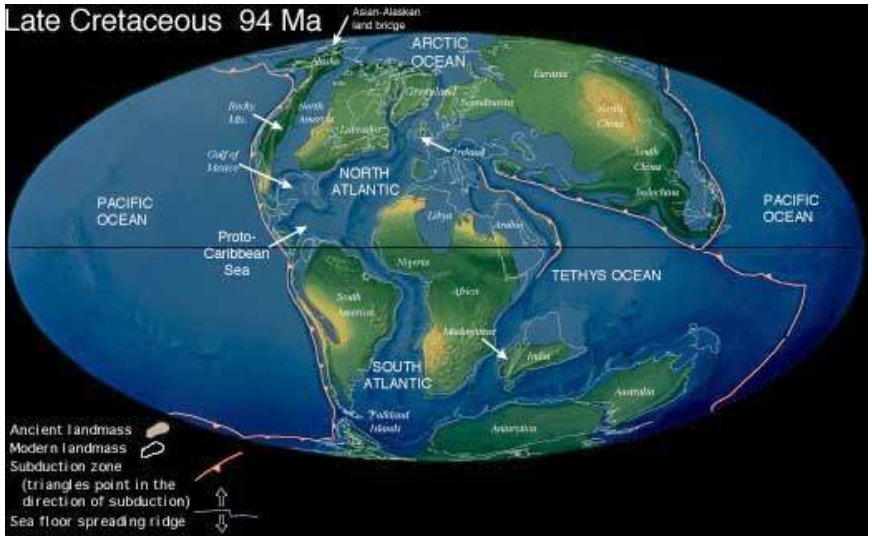

Effect was widespread over latitudes

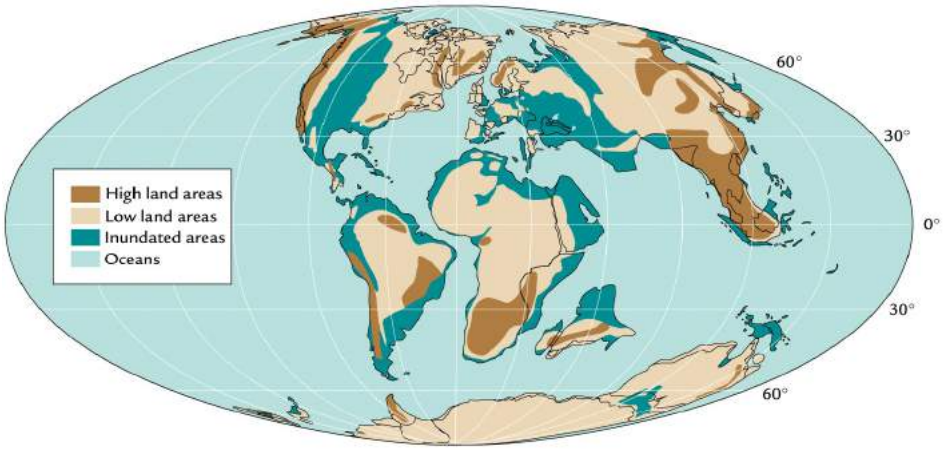
Cosmopolitan floras existed despite Pangaea breakup

# North American Flora - the Late Cretaceous

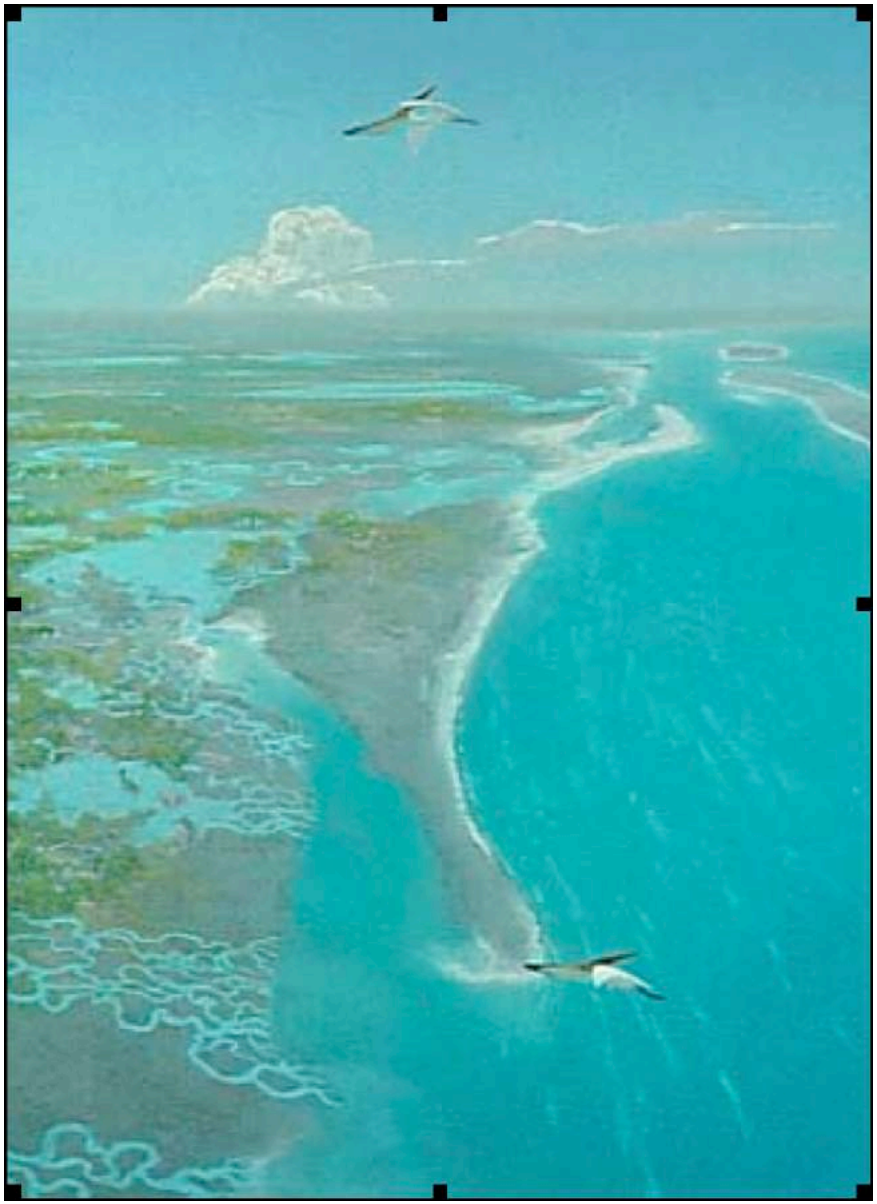
Contributing to this moderation of climate were the large epicontinental seas that existed in North America and Eurasia in the Late Cretaceous due to high sea levels



# North American Flora - the Late Cretaceous

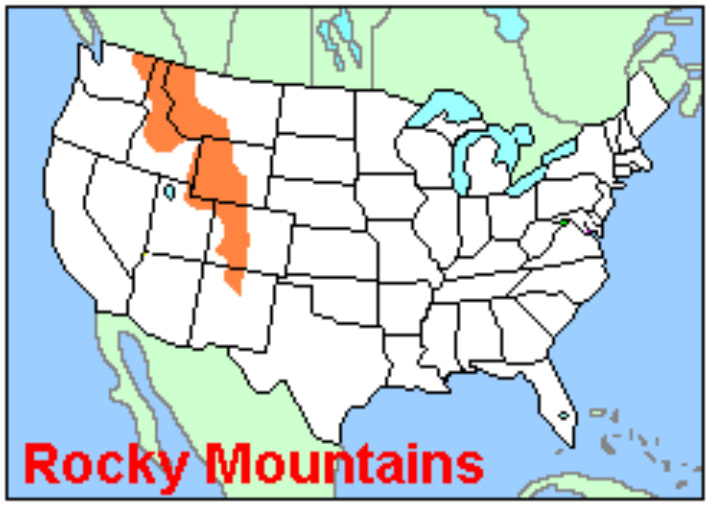


- water bodies absorb more heat than land and release it more slowly
- these inland seaways lowered the intensity of seasonality - "lake effect" - as did the Tethys Sea during the Mesozoic
- more temperate / subtropical to higher latitudes

An aerial view of the eastern coast line of western North America and the Interior Cretaceous Seaway, some 75 million years ago

# North American Flora - the Late Cretaceous

Also contributing to the warm and wet climate of much of North America was that low relief existed in much of North America




The **Rockies** form a mountain barrier that stretches from Canada through central New Mexico but were only of moderate relief in the Late Cretaceous

Uplift of the present Rockies occurs **70-40 mya**

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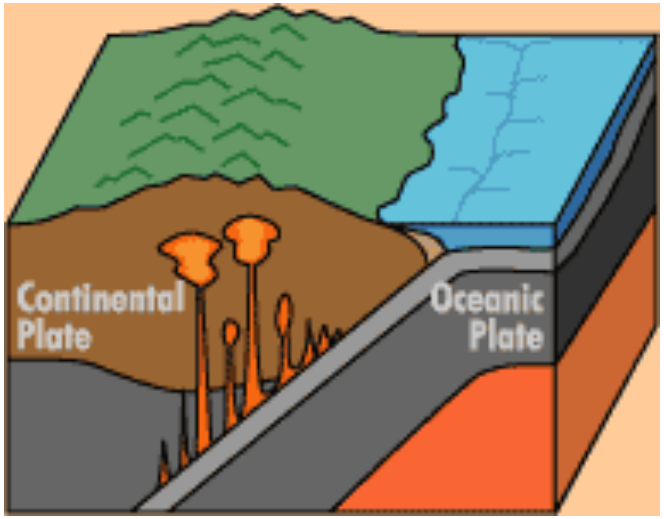



**Sierra Nevada 65 mya**

**Sierra Nevada** were only a series of low foothills in the Late Cretaceous

Uplift and tilting of the Sierra Nevada range begins **25 mya**

# North American Flora - the Late Cretaceous

Also contributing to the warm and wet climate of much of North America was that low relief existed in much of North America

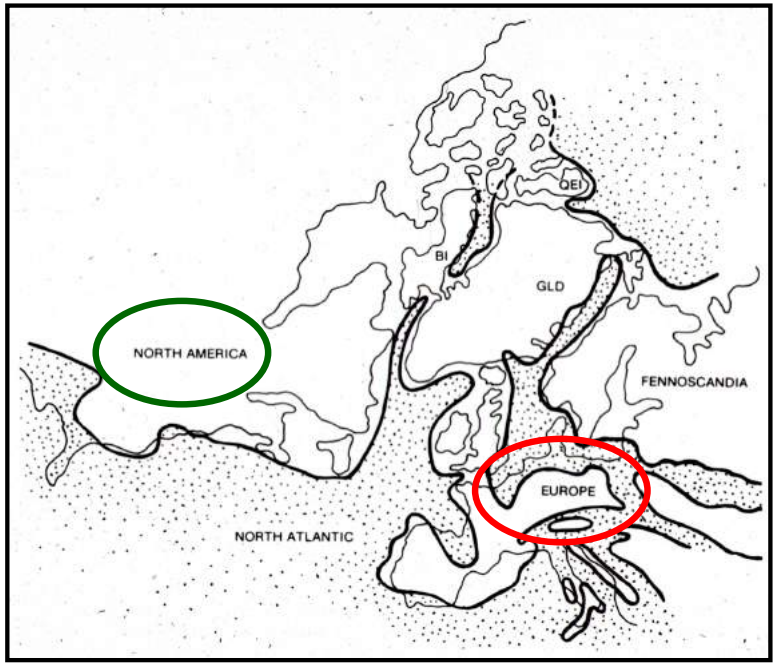

**Shade relief of the Cascades**

**High Cascades** would not appear until the Plicoene around **10 mya**

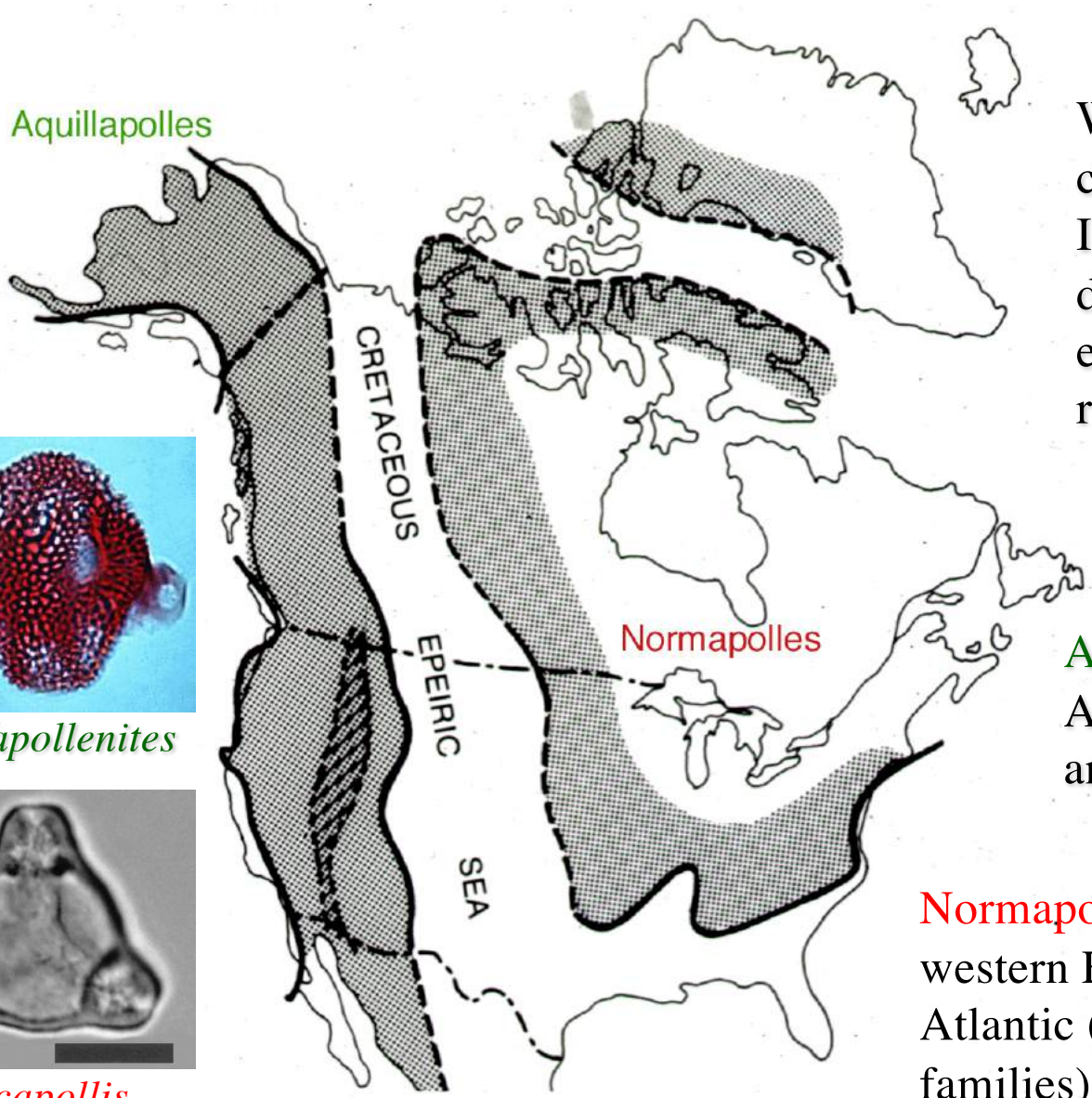
# North American Flora - the Late Cretaceous


Floristic exchange was widely possible between Eastern Asia and Western North America via Beringia

Floristic exchange was also widely possible between Eastern North America and Western Eurasia via the North Atlantic Land Bridge



# North American Flora - the Late Cretaceous






*Aquilapollenites*



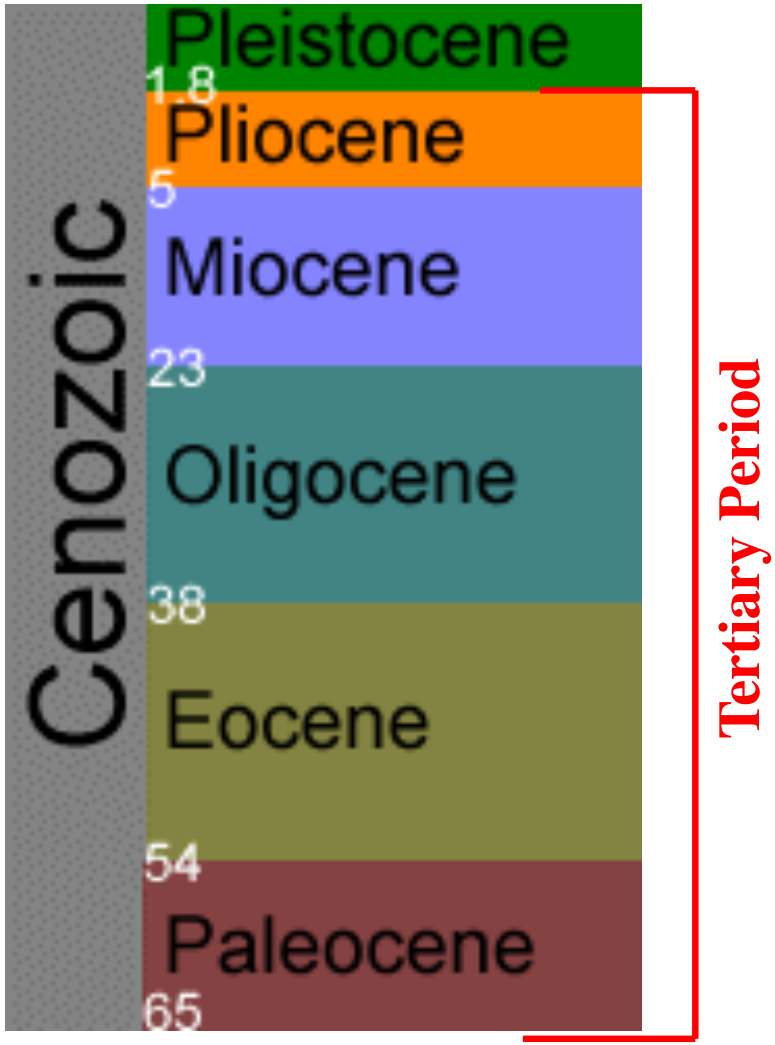
*Plicapollis*

With the North American continent subdivided by the Interior Cretaceous Seaway, two distinct floristic regions are evident in the pollen fossil record (**palynofloras**)

Aquillapolles: western N. Am. - Asia via Beringia (sandalwood and mistletoe families)

Normapolles: eastern N. Am. - western Eurasia via North Atlantic (walnut and sycamore families)

# North American Flora - the Tertiary




Paleocene of the Tertiary 65-66 mya

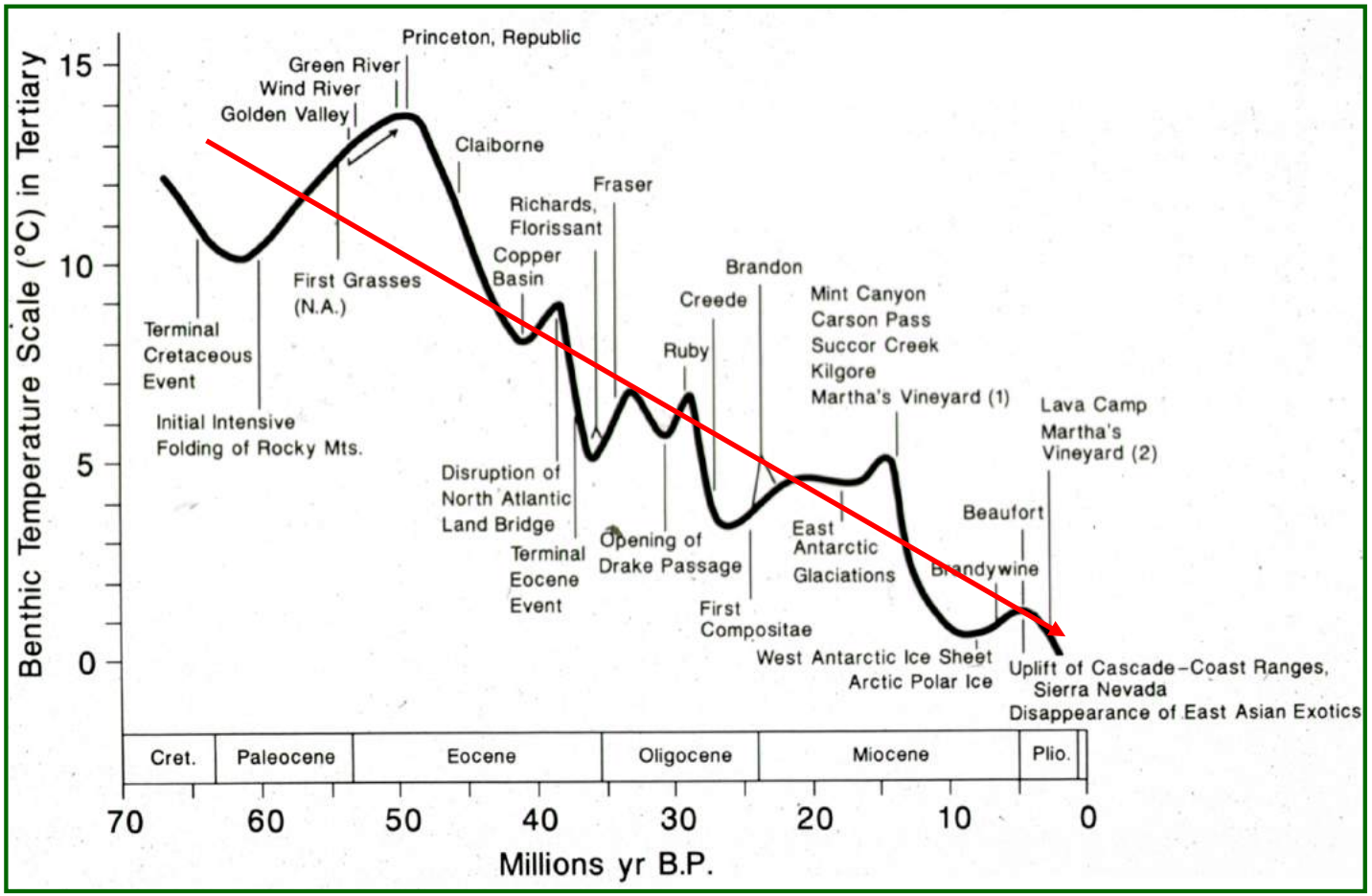
- warm temperatures, inland seas, and low relief
- tropical, subtropical, and temperate climates from southern United States to the Arctic

Paleothermometers indicate:

- temperature gradient
  - 0.3° C / 1° latitude (Paleocene)
  - 1.0° C / 1° latitude (today)
- 30° N it was 5-10° C warmer
- 80° N it was 30° C warmer

# North American Flora - the Late Cretaceous

The end of the Cretaceous and beginning of the Tertiary (100-50 mya) saw the warmest temperatures since the PreCambrian

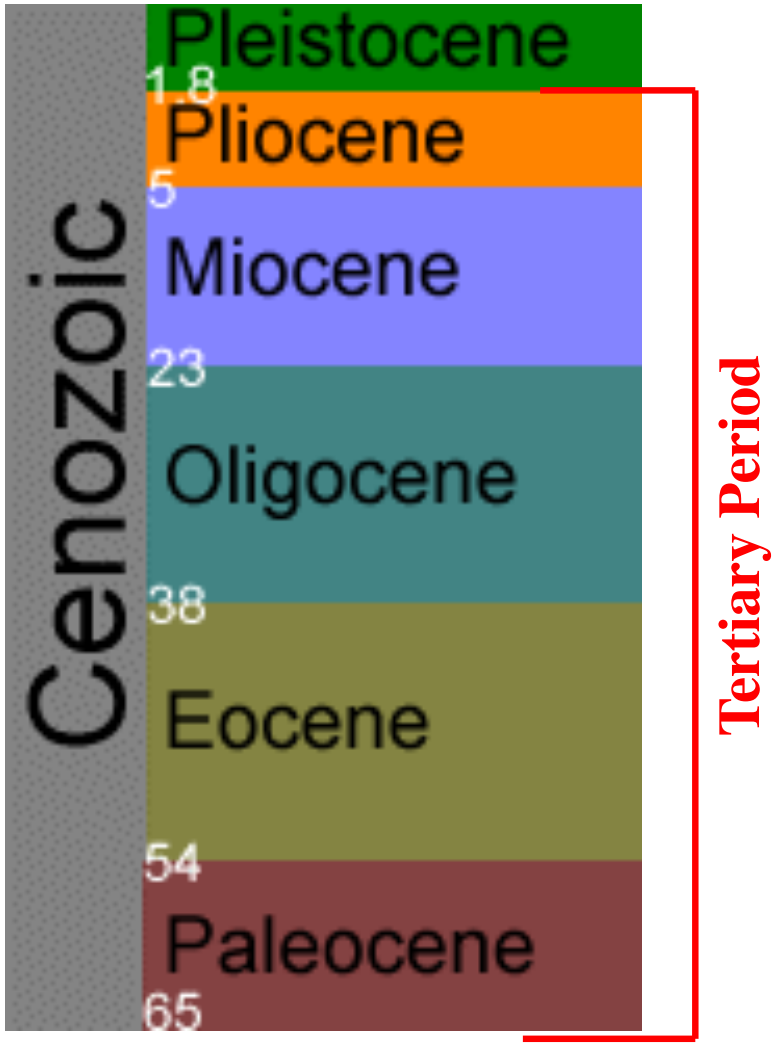



Effect was widespread over latitudes

Cosmopolitan floras existed despite Pangaea breakup

Worldwide cooling then commenced during the Tertiary and culminated in the Pleistocene glaciations

# North American Flora - the Tertiary




## Major points about the Tertiary - 1st half

1. subtropical (or temperate evergreen) forests up to 50° N latitude through Eocene

Wyoming
Eocene 45 mya

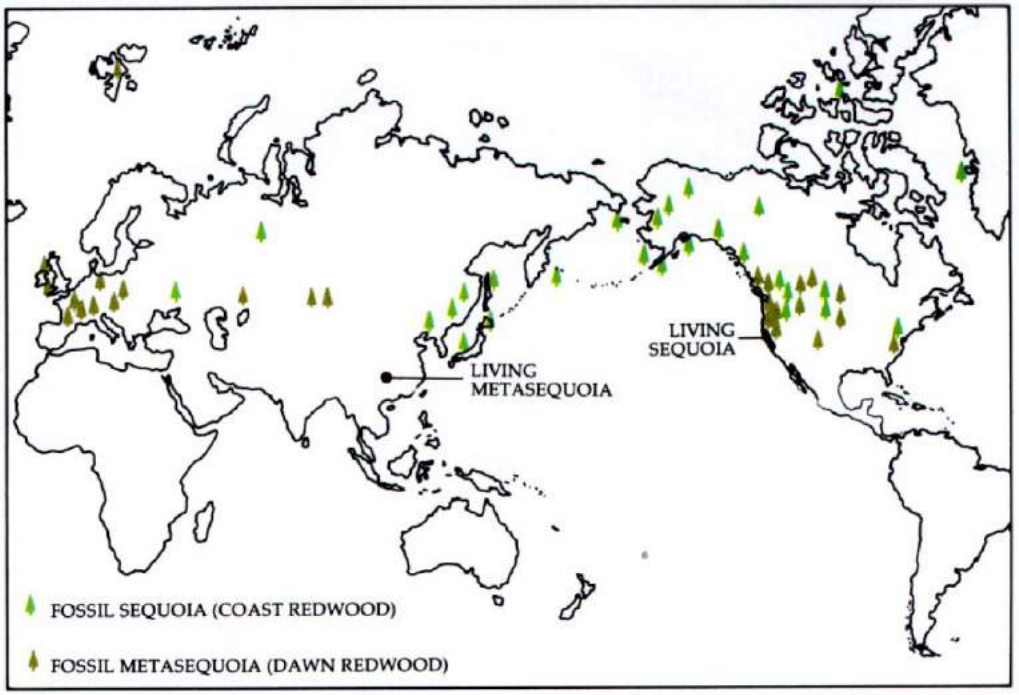
# North American Flora - the Tertiary

Redwood forest in CA

## Major points about the Tertiary - 1st half

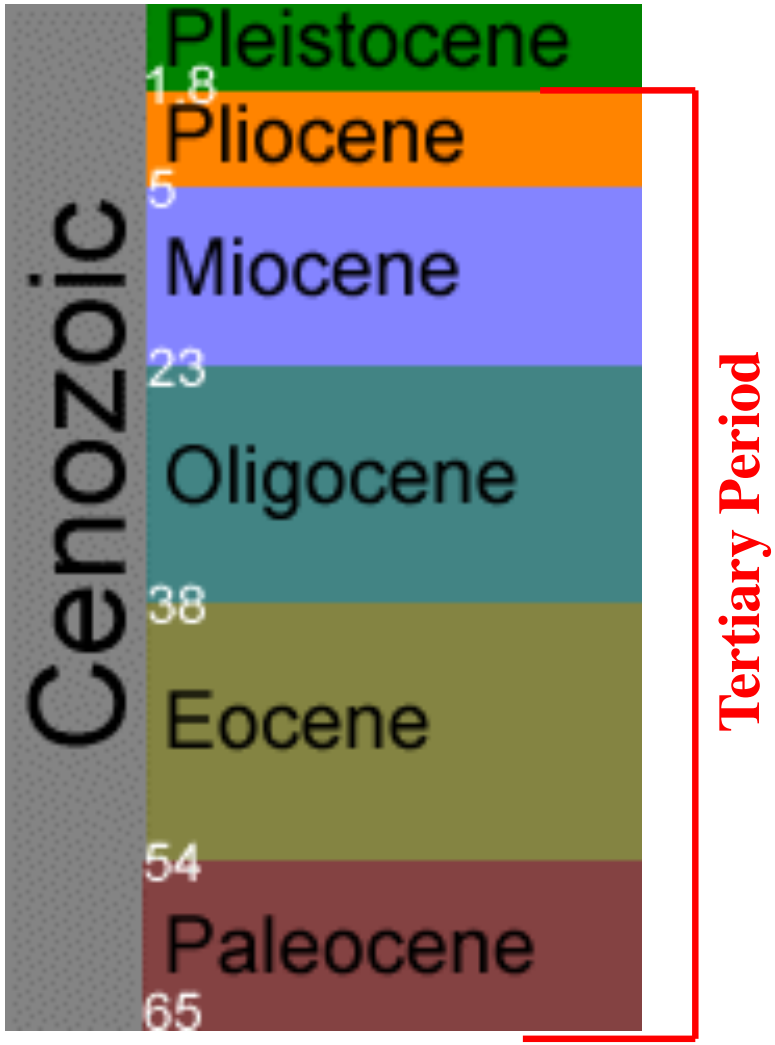
2. Araucariaceae type conifers go extinct in North America, but redwoods and dawn redwoods become dominant conifers

*Metasequoia glyptostroboides*




Distribution of Redwoods

# North American Flora - the Tertiary




## Major points about the Tertiary - 1st half

3. Grasses evolve and appear at the Paleocene/Eocene border (54 mya)

*Sorghastrum nutans* - Indian grass

# North American Flora - the Tertiary

## Major points about the Tertiary - 1st half

4. Major radiation of deciduous forest families [Arcto-Tertiary Flora]

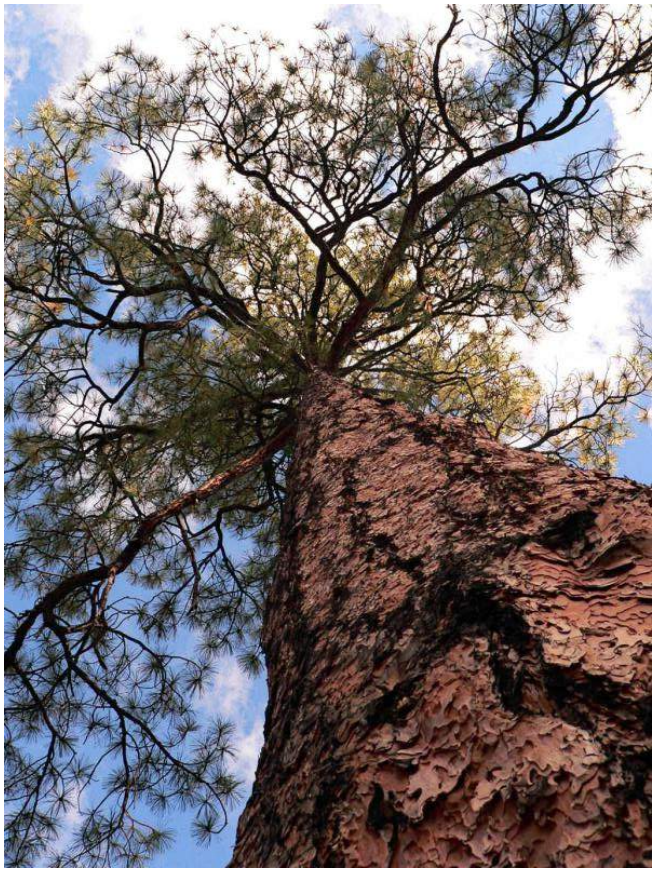

Fagaceae - beeches

but also rose, walnut, and maple families

# North American Flora - the Tertiary

## Major points about the Tertiary - 1st half

5. Montane regions become dominant in western North America; pine family diversifies



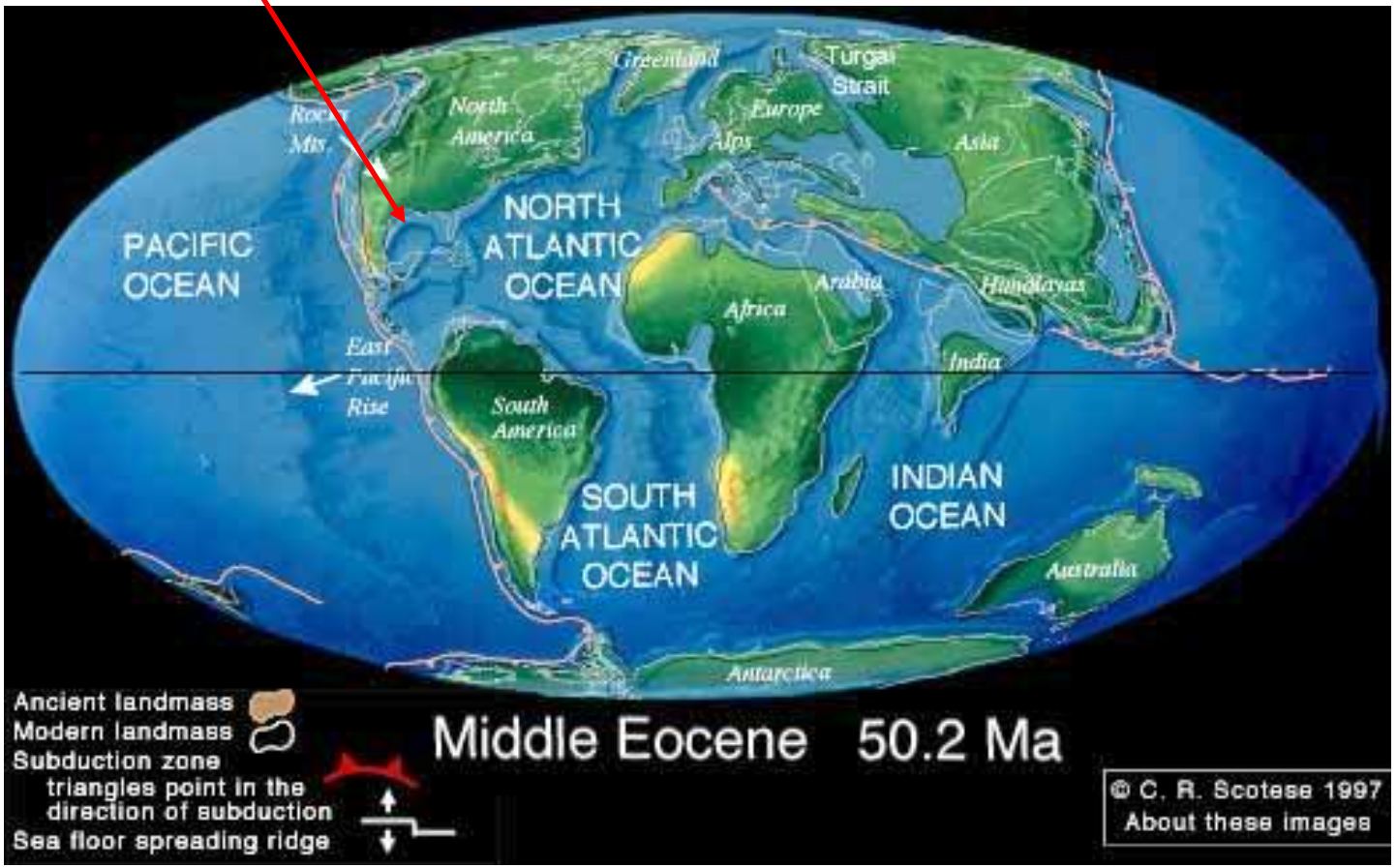
Ponderosa pine

Canadian Rockies

# North American Flora - the Tertiary

## Major points about the Tertiary - 1st half

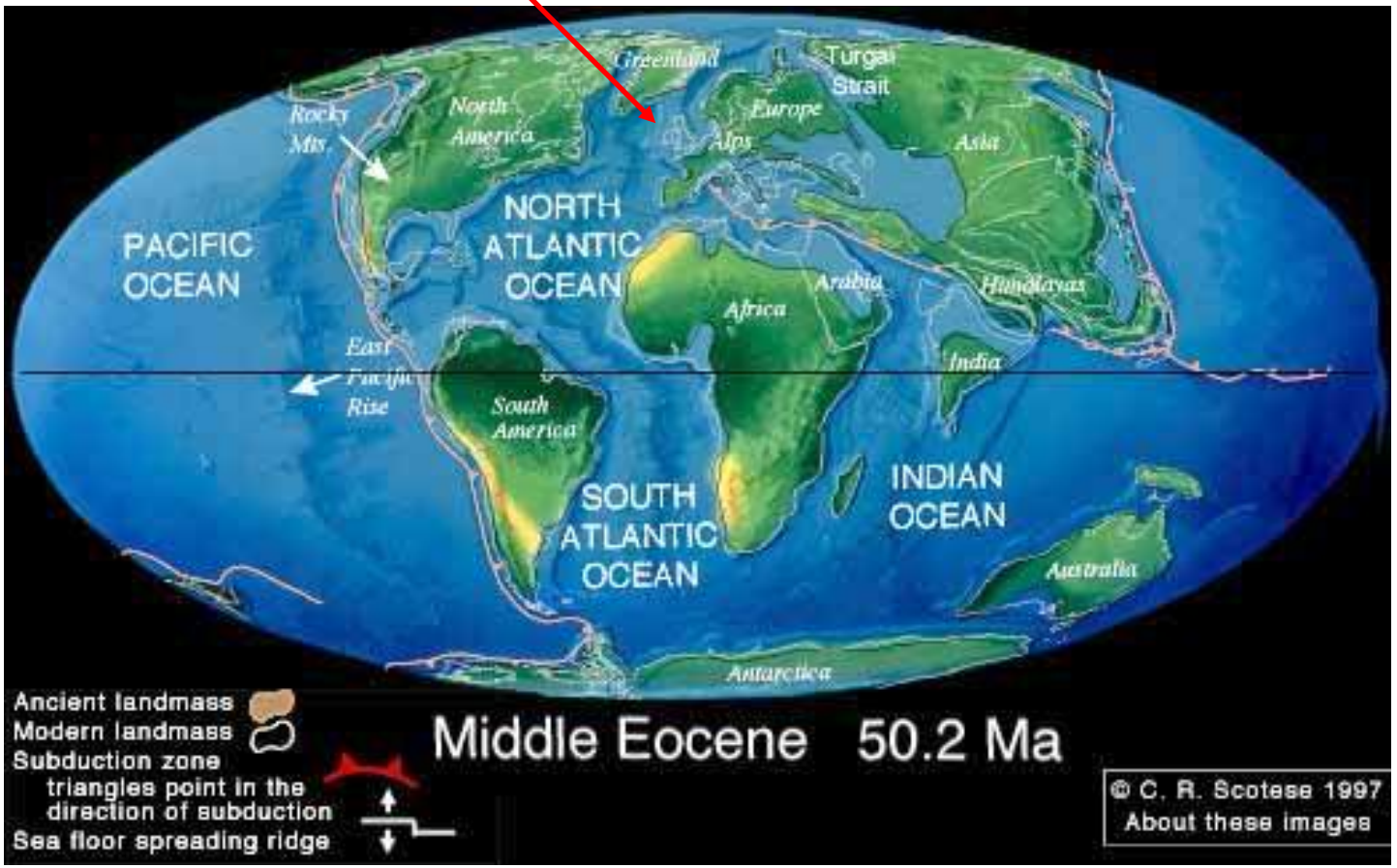
6. Epicontinental sea in North America retreats to Gulf of Mexico; interior dries out



# North American Flora - the Tertiary

## Major points about the Tertiary - 1st half

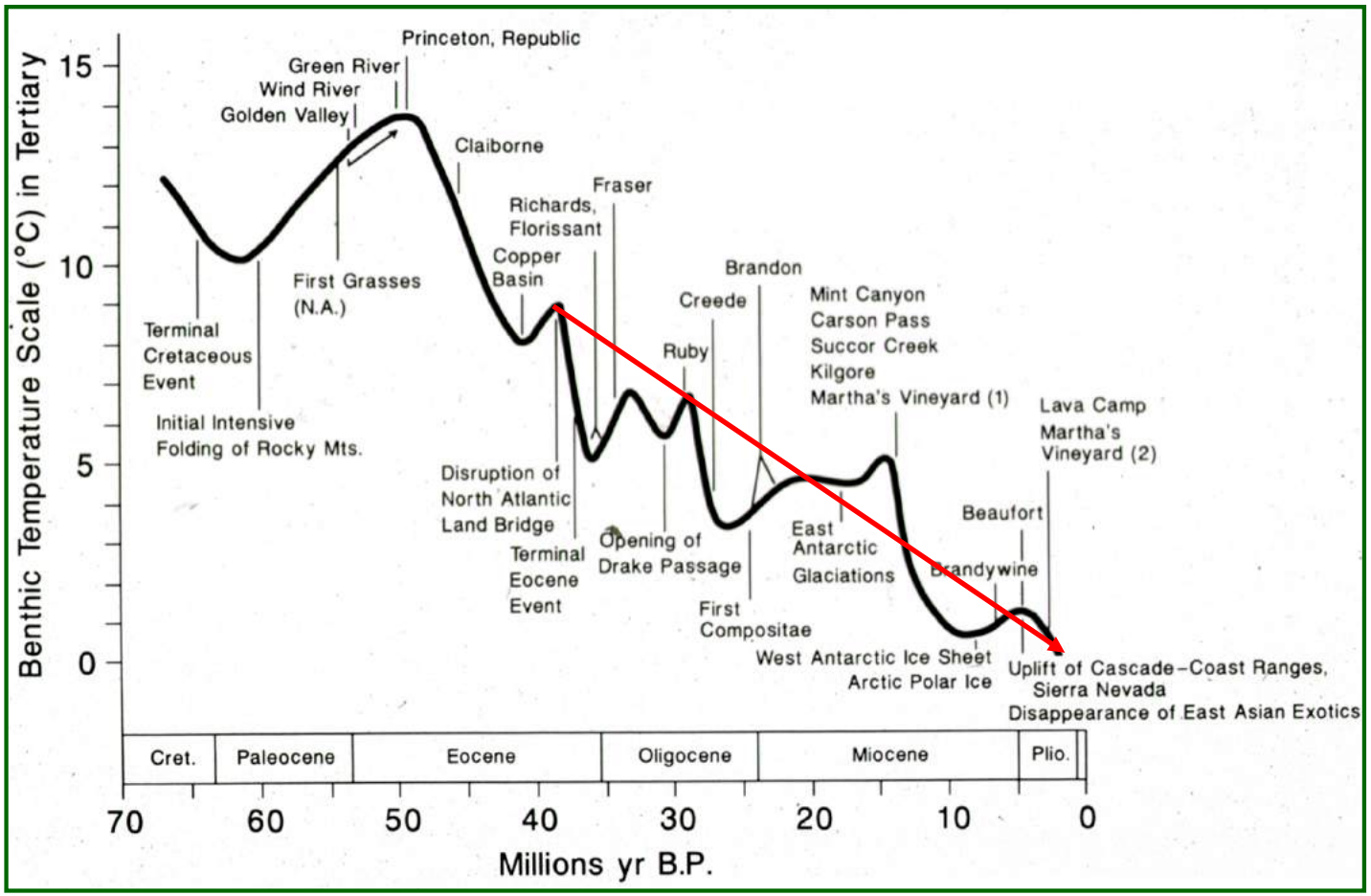
7. Euramerica separated by North Atlantic widening by 55 mya



# North American Flora - the Tertiary

## Major points about the Tertiary - 2nd half

1. Significant cooling worldwide from late Eocene - Oligocene - Miocene



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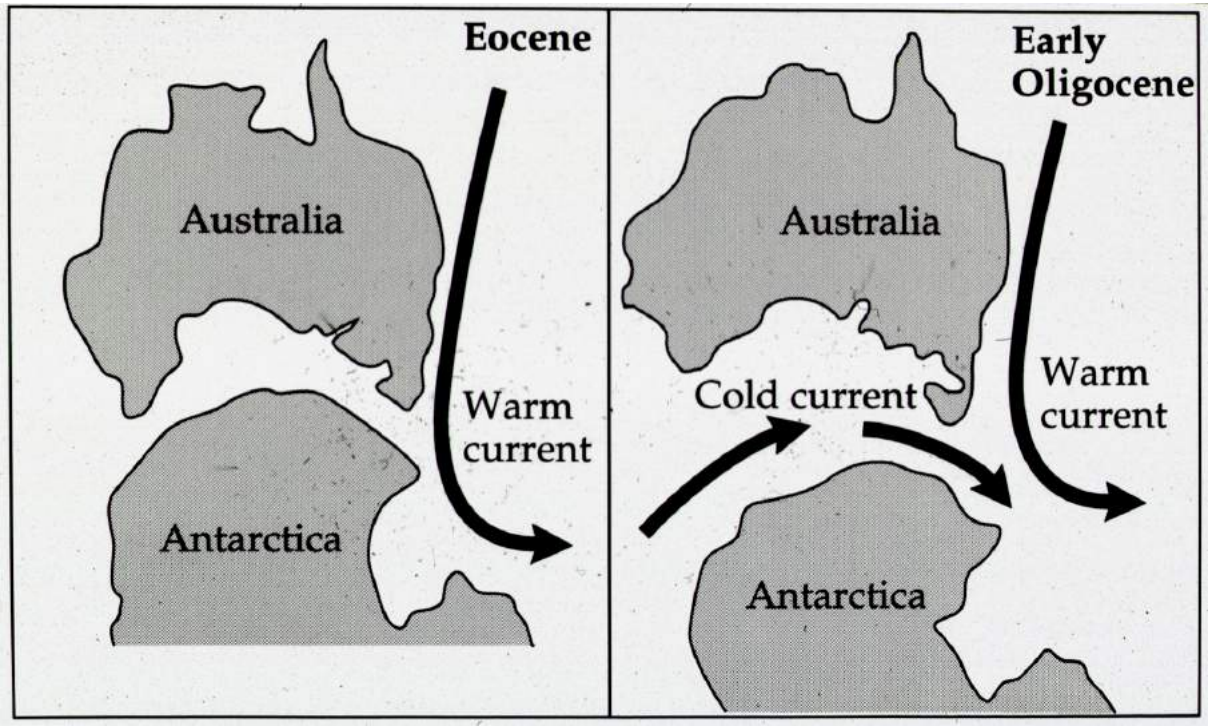


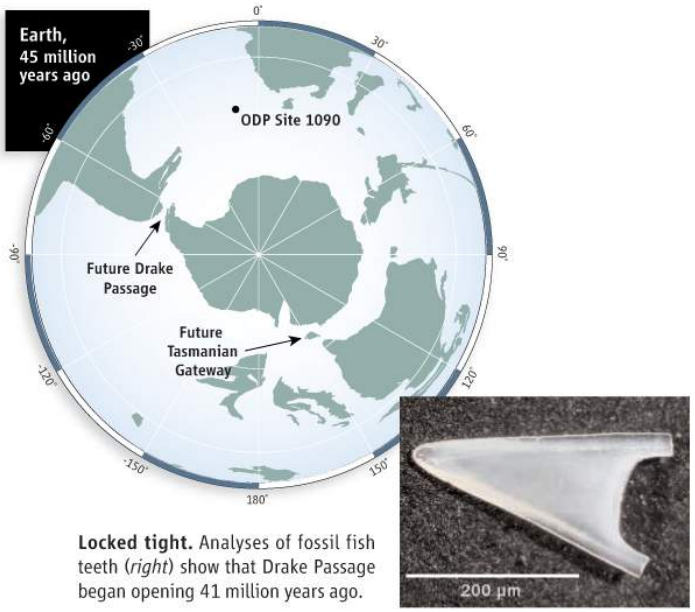


**Locked tight.** Analyses of fossil fish teeth (*right*) show that Drake Passage began opening 41 million years ago.

Gondwanan events affects Northern Hemisphere heat budget via ocean currents

- Tasman Passage
- Drake Passage

# North American Flora - the Tertiary

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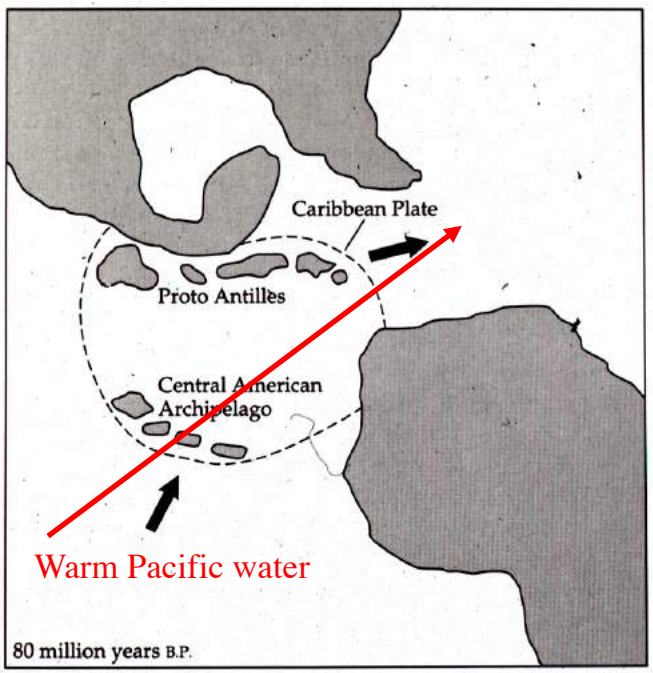
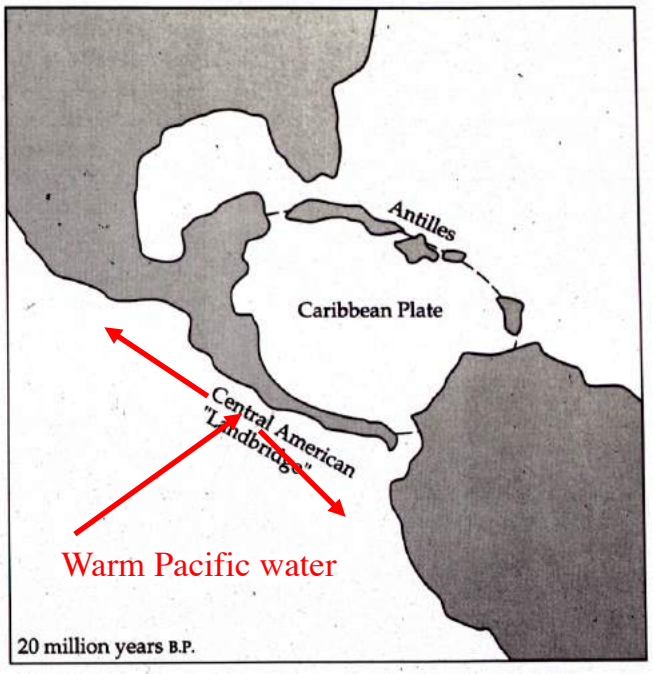


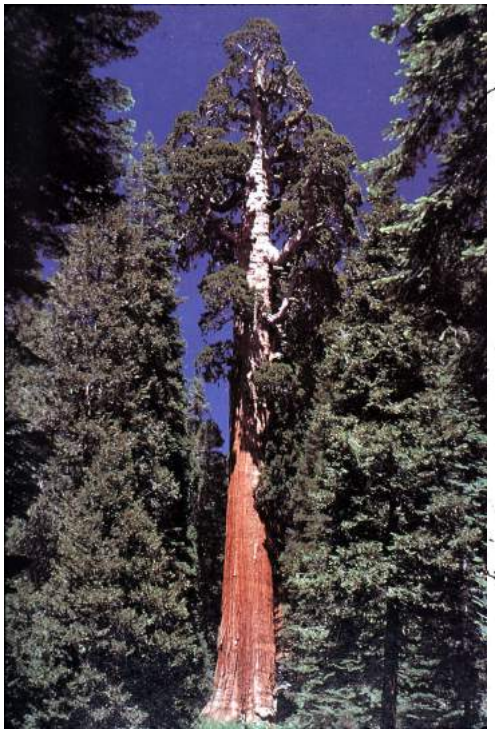



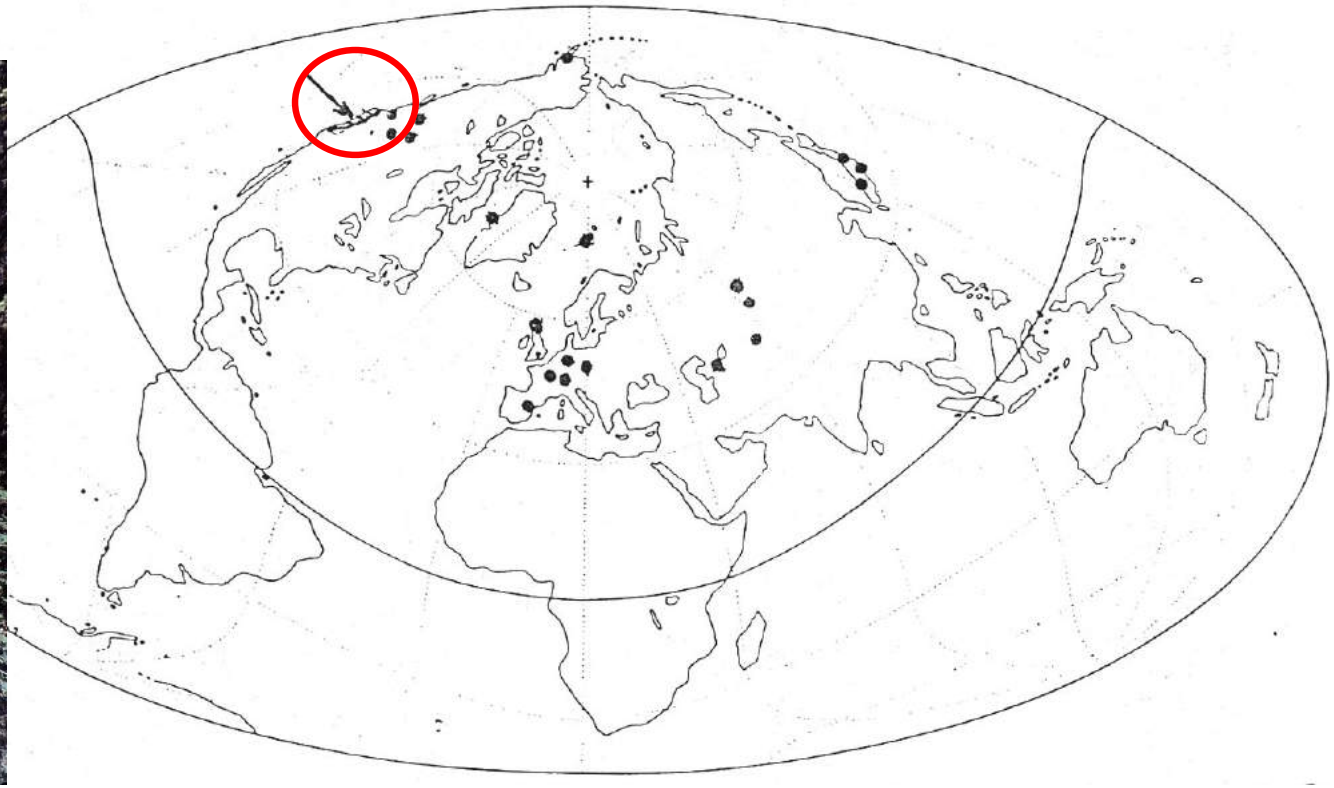

Central American closure affects Northern Hemisphere heat budget via ocean currents

# North American Flora - the Tertiary

## Major points about the Tertiary - 2nd half

2. Cooling and drying of central North America forces the fragmentation and decline of the Arcto-Tertiary flora





*Sequoia*, now confined to coastal California and adjacent Oregon, had a Holarctic Tertiary distribution as indicated by some of its fossil sites ( ● ).

# North American Flora - the Tertiary

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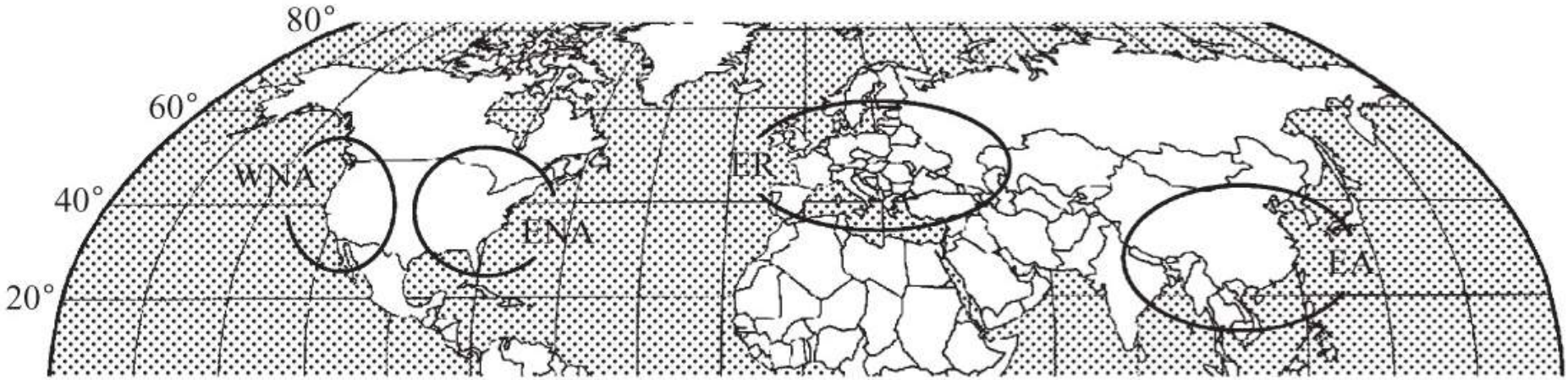


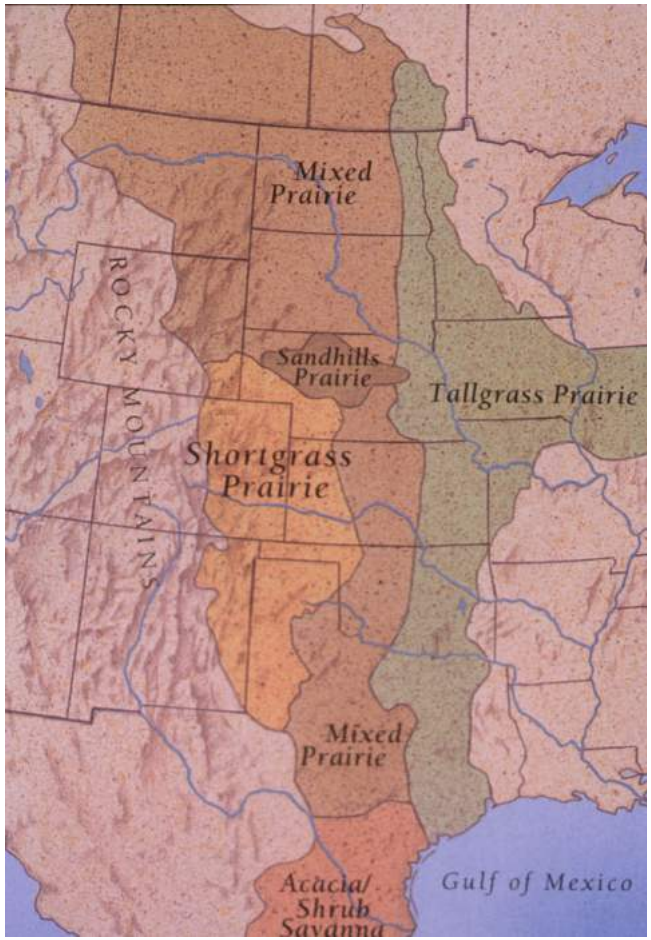

and the beginning of the four areas of forest endemism

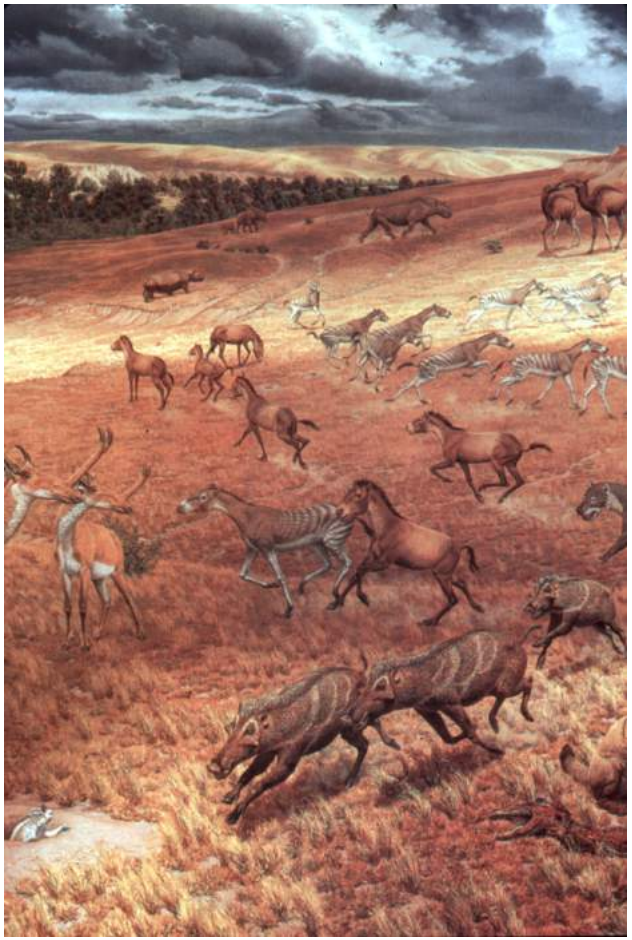
# North American Flora - the Tertiary

## Major points about the Tertiary - 2nd half

3. Rocky Mountain uplift finished by the Miocene (10 mya) and beginning for Sierra Nevada (25 mya) provided significant barriers to moisture

Rainshadow caused plains and prairie formation and the diversification of ungulates



**Missouri, Pliocene 5-10 mya**