

# Geologic Evaluation of North America

## With a Focus on the US National Parks with Nicole Myers

*Week 4: Life & the Last Supercontinent*

<https://www.appreciatingearth.com/olli>

Video link: [https://www.youtube.com/watch?v=xaj\\_J\\_3YJMc](https://www.youtube.com/watch?v=xaj_J_3YJMc)



*Reminder!*  
*Join me next Saturday for the*

## Community Planting Day in the SSU Native Plant Garden

- Join us on Saturday, February 28<sup>th</sup> 10am-2pm
- More info at <https://cei.sonoma.edu/calendar-events>

# National Park Service

*“conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.” [National Park Service Organic Act of 1916]*

- **National Park Field Stations:** environmental protection through conservation research & application
  - **Channel Islands Field Station**

*The Virtual Field:*

<https://thevirtualfield.org/video/santa-rosa-island-torrey-pines/> &

*Video Link*

<https://www.youtube.com/watch?v=bFJDZOgfySQ>



# Recap

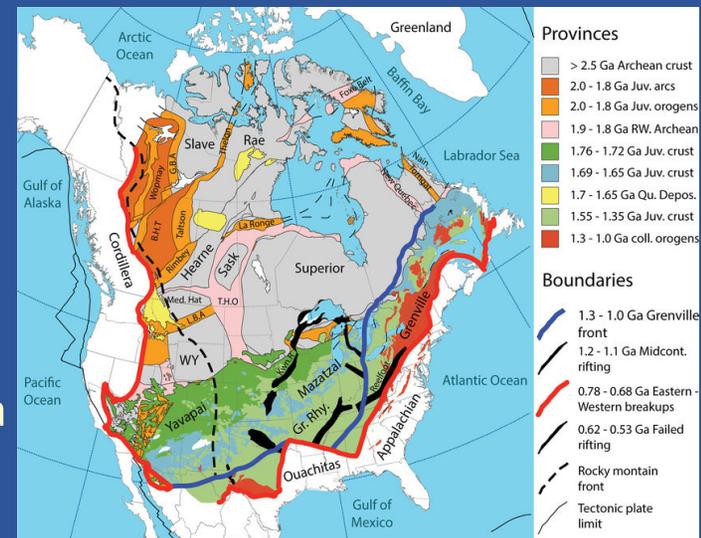
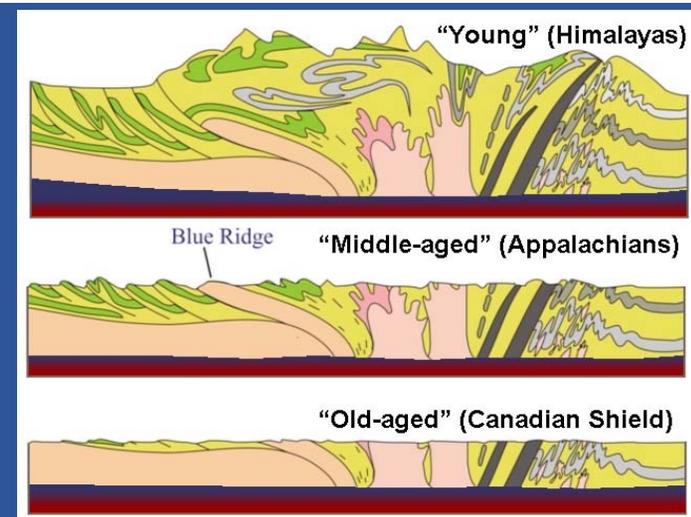
***National Parks provide very high conservation protection & research opportunities***

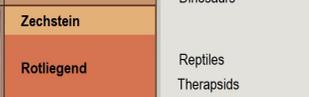
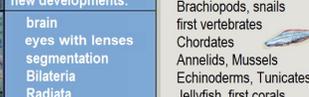
## Precambrian craton

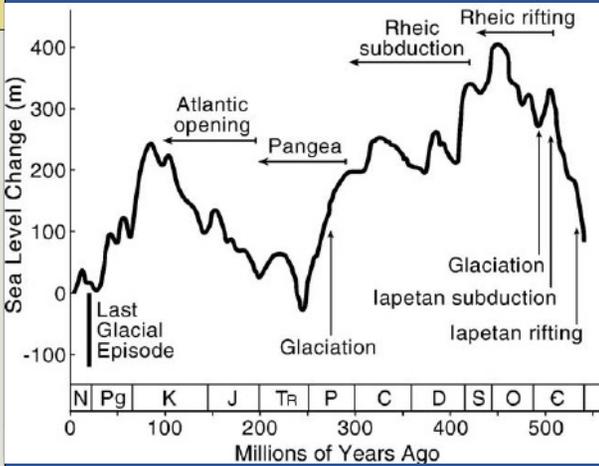
- 2800-2500Ma Kenorland Supercontinent
- 2400-2200Ma Snowball Earth
- 1650-1630Ma Penokean Orogeny
- 2000-1400Ma Trans-Hudson Orogeny/Columbia “SC”
- 1800-1600Ma Yavapai , Mazatzal, Mojave Orogenies
- 1300 - 700Ma Grenvillian Orogenies = Rodinia “SC”
- 720 - 635Ma Final Snowball Earth
- 541 - 530Ma Cambrian Explosion

Only ~25% of National Parks have Precambrian rock outcrops:

Voyageurs, Pipestone, Grand Teton, Yellowstone, Wind Cave, Glacier, Black Canyon of the Gunnison, Rocky Mountains, Joshua Tree, Grand Canyon, Death Valley, Saguaro, Isle Royale, Great Smoky Mountains, Shenandoah, Great Basin



Global temperatures		Phanerozoic: times of origin of plants and animals		
CENOZOIC	Quaternary		Holocene Pleistocene with alternating periods of glaciation and warm periods	<i>Homo sapiens</i>
	Neogene		Pliocene Miocene Oligocene Eocene Paleocene	Early humans <i>Sahelanthropus</i> Apes Monkeys Primates
	Paleogene		Late Cretaceous Early Cretaceous	Mammals Angiosperms
MESOZOIC	Cretaceous		Late Jurassic (Malm) Middle (Dogger) Early (Lias)	bird <i>Archaeopteryx</i> earliest Mammals (i. e. <i>Hadrocodium wui</i> )
	Jurassic		Keuper Muschelkalk Buntsandstein	Pterosaurs Fish dinosaurs Dinosaurs
	Triassic		Zechstein Rotliegend	Reptiles Therapsids Sauropsids Synapsids first Amniotes Giant dragonflies
PALEOZOIC	Permian		Pennsylvanian Vegetation that became coal Mississippian	first terrestrial vertebrates <i>Ichthyostega</i>
	Carboniferous		early land plants in riparian zones	first bony fish (Osteichthyes) Placodermi
	Devonian		all life forms are still aquatic new developments: brain eyes with lenses segmentation Bilateria Radiata	Cephalopods Arthropods e.g. Trilobites Brachiopods, snails first vertebrates Chordates Annelids, Mussels Echinoderms, Tunicates Jellyfish, first corals
PRECAMBRIAN	Siurian			
	Ordovician			
PRECAMBRIAN	Cambrian			
				



# Paleozoic Accretion

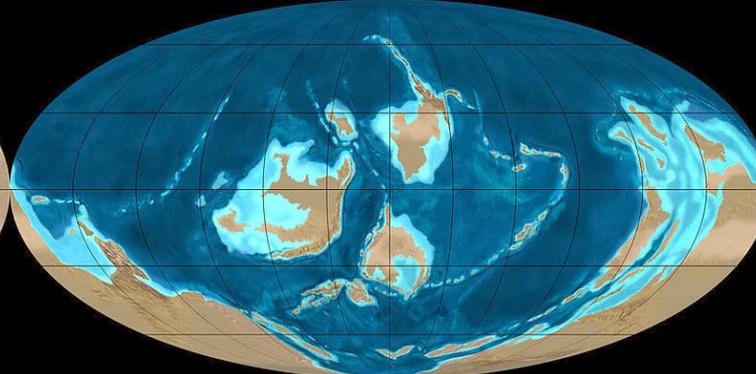
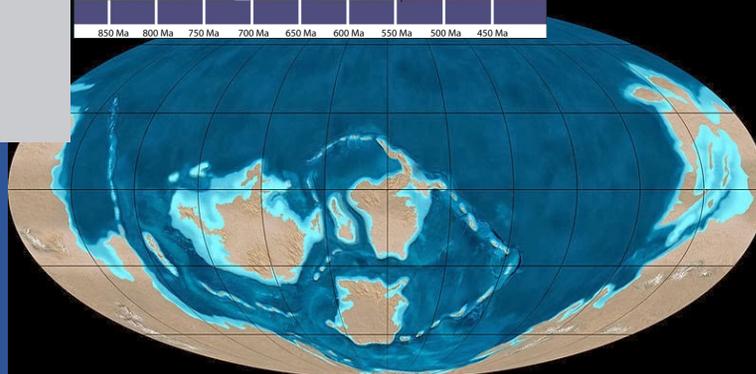
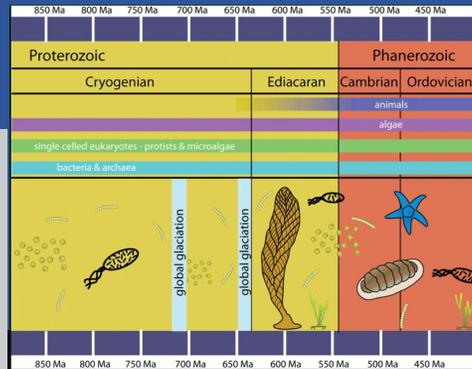
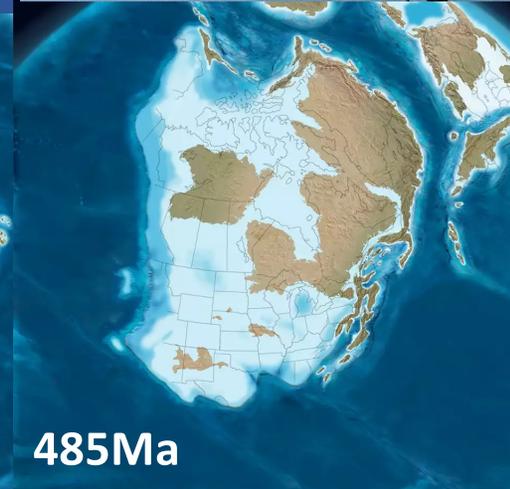
## Orogenies: Appalachian (Taconic, Acadian & Alleghenian) + Antler & Sonoma

Video link:  
[https://www.youtube.com/watch?v=g\\_iEWvtKcuQ](https://www.youtube.com/watch?v=g_iEWvtKcuQ)

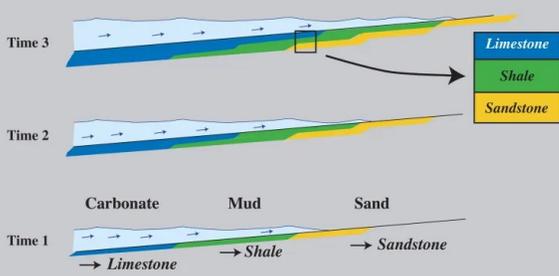
# Cambrian-Ordovician Shallow Seas

## 541-443Ma Drowned Tropical North America

- Evolution of animals, fungi, plants
- Global warming
- Sea level: transgression → ice age regression
- Oxygenated seas & biodiversification
- Taconic Orogeny
- 85% extinction



### Marine Transgression



# Cambrian-Ordovician Alaska

## Submerged & Fragmented

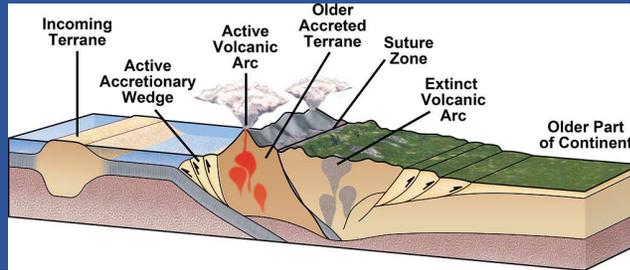
Equatorial: submerged passive margin  
 continental shelf, continental slope, & deep  
 basins + distant offshore volcanic arcs &  
 microcontinent(s)

### Shallow continental shelf

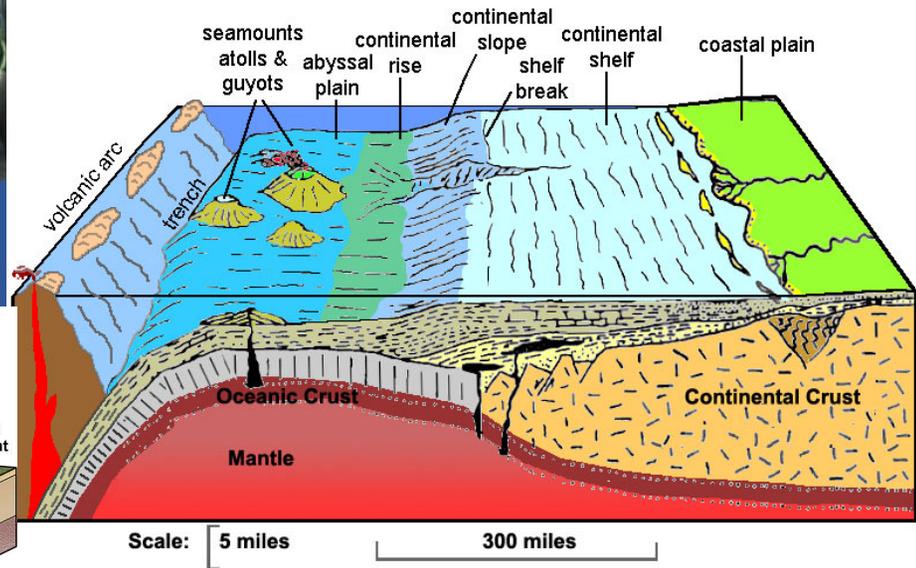
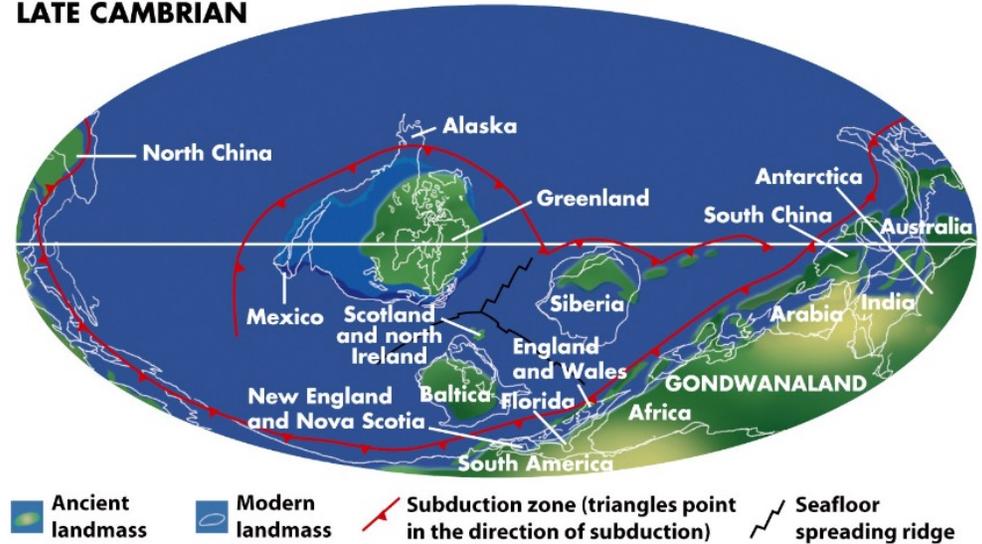
- Denali
- Gates of the Arctic
- Kobuk Valley

Continental shelf → deep marine  
 along a distant microcontinent

- Wrangell-St. Elias



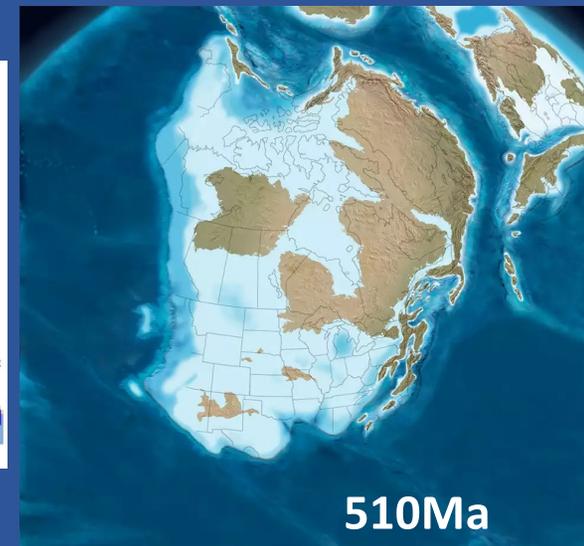
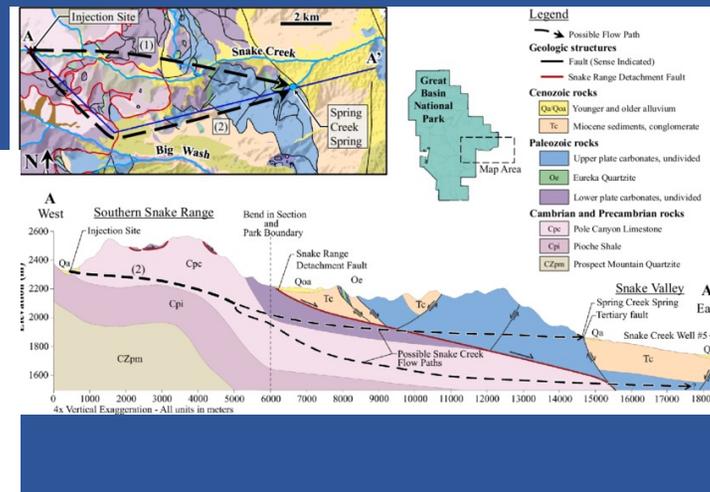
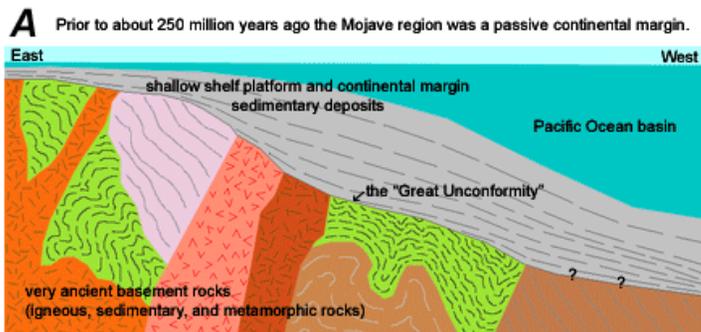
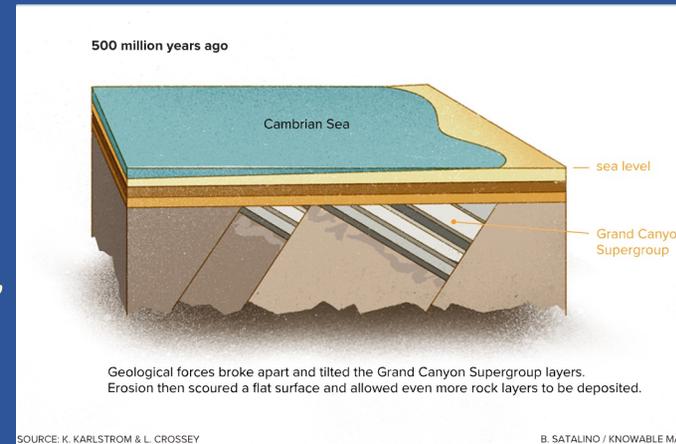
### LATE CAMBRIAN



# Panthalassa Coast Cambrian-Ordovician Rocks

Equatorial: submerged passive margin continental shelf, continental slope & deep basin

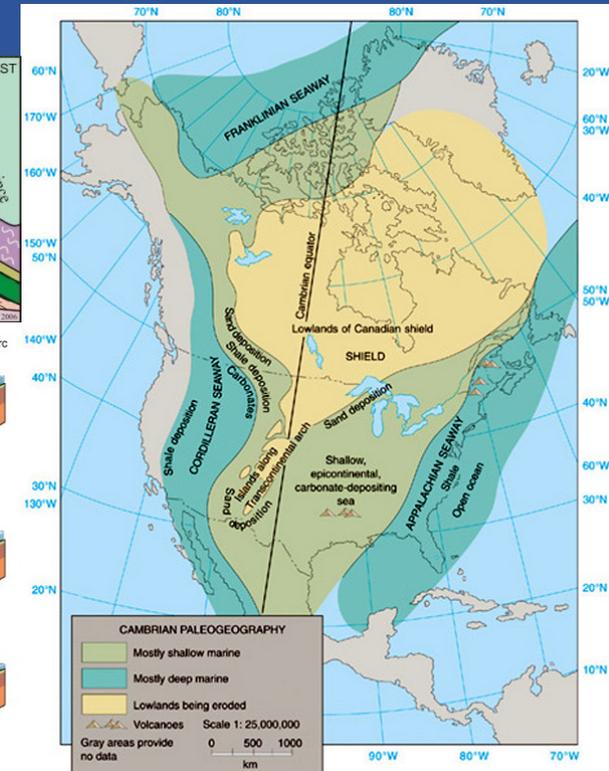
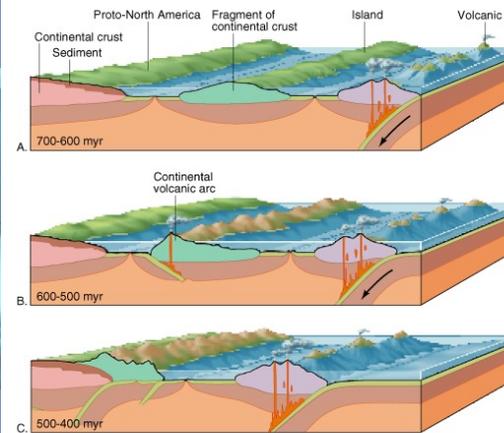
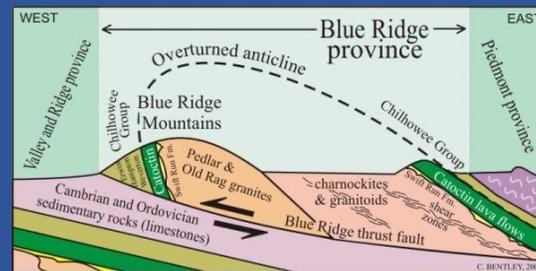
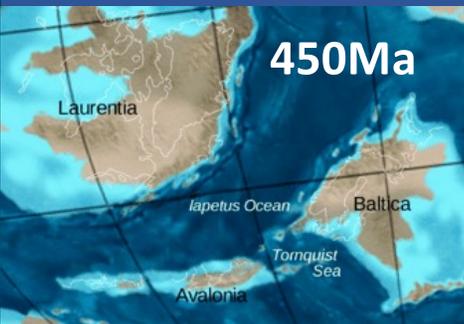
- Wyoming/Montana/Idaho: Yellowstone, Grand Teton, Glacier
- California: Sequoia, Kings Canyon, Yosemite, Death Valley, Joshua Tree
- Nevada: Great Basin
- Arizona: Grand Canyon (Cambrian limestone & shale → Ordovician unconformity)



# Iapetus Coast Cambrian-Ordovician Rocks

- Cambrian passive margin → Ordovician active margin with offshore volcanic arcs
- Equatorial: coastline to submerged continental shelf, slope & deep basin
- Virginia: Shenandoah
- West Virginia: New River Gorge
- Tennessee: Great Smoky Mountains
- Arkansas: Hot Springs

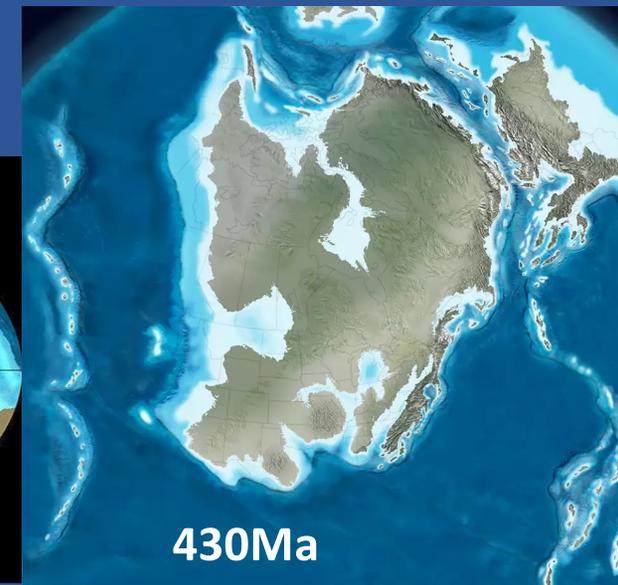
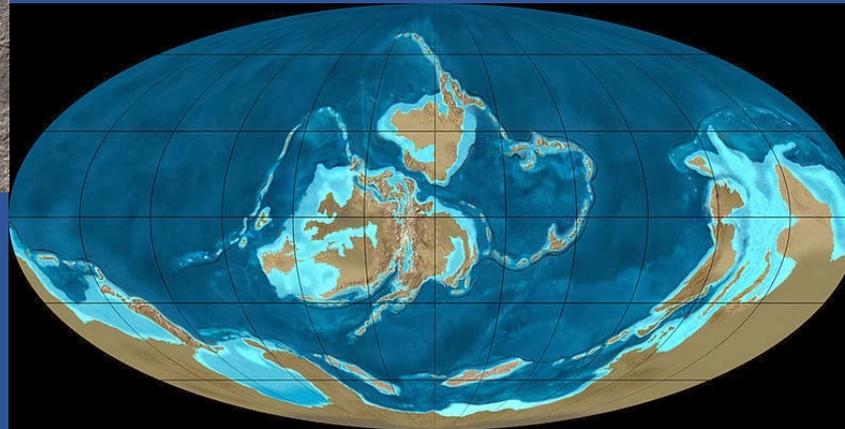
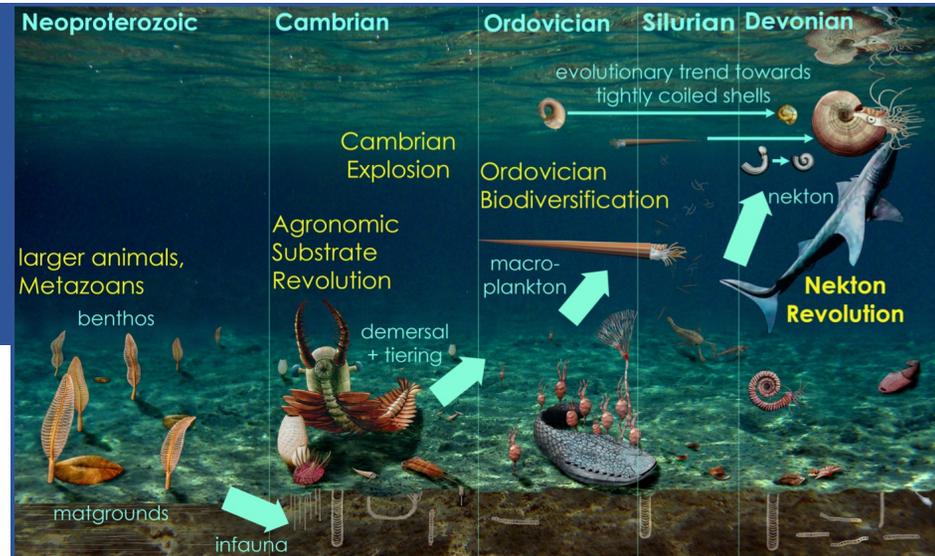
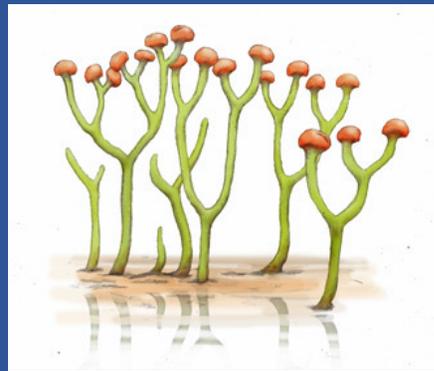
- Maine: Acadia = offshore Avalon Microcontinent island-arc
- Florida: Everglades, Biscayne, Dry Tortugas = African Gondwana granite basement



# Silurian Active Margins

## 443-419Ma Equatorial North America

- First coral reefs
- Oldest terrestrial fungi
- First cartilaginous fish
- First vascular plants
- Oldest insect (milliped)
- Sea level drop



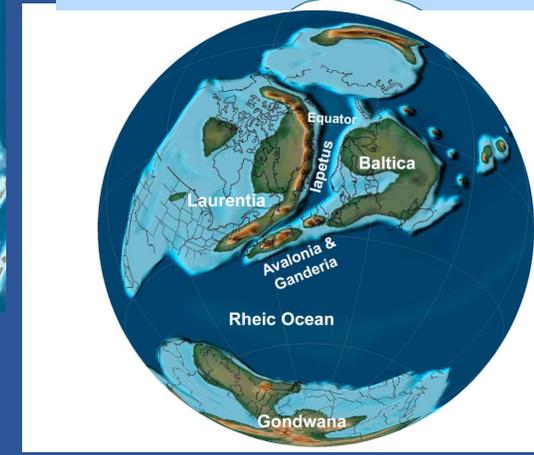
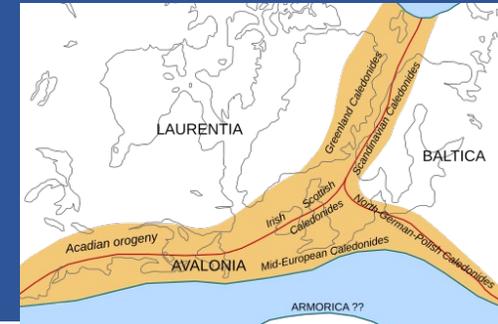
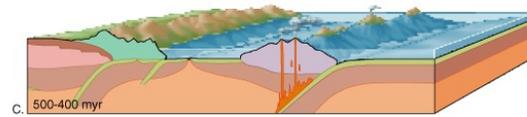
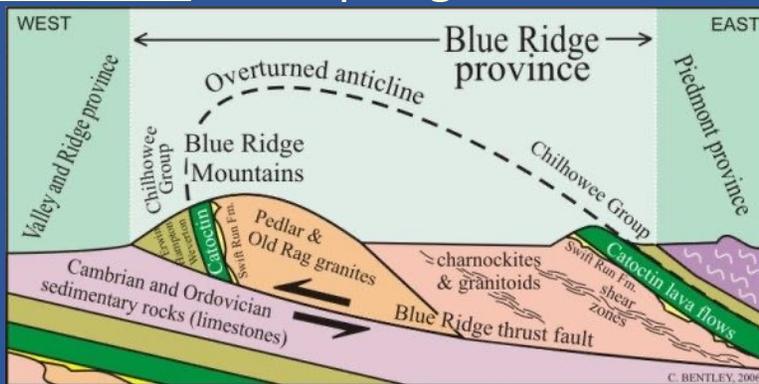
# Iapetus Coast Silurian Rocks

- **Active margin: volcanic island arcs & nearing microcontinents**

**Equatorial: submerged continental shelf, continental slope & deep basin with far offshore volcanic arcs**

- Virginia: Shenandoah
- West Virginia: New River Gorge
- South Carolina: Congaree
- Tennessee: Great Smoky Mountains
- Arkansas: Hot Springs

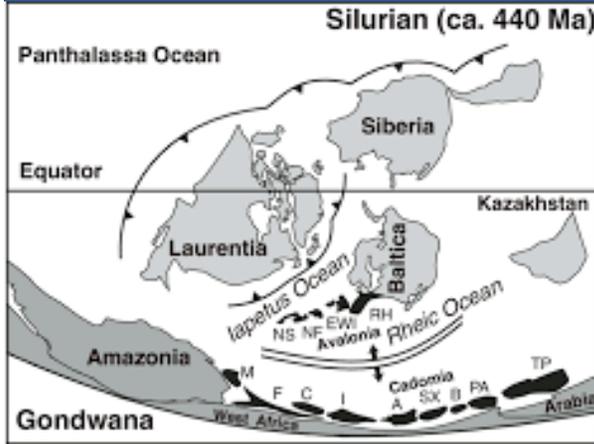
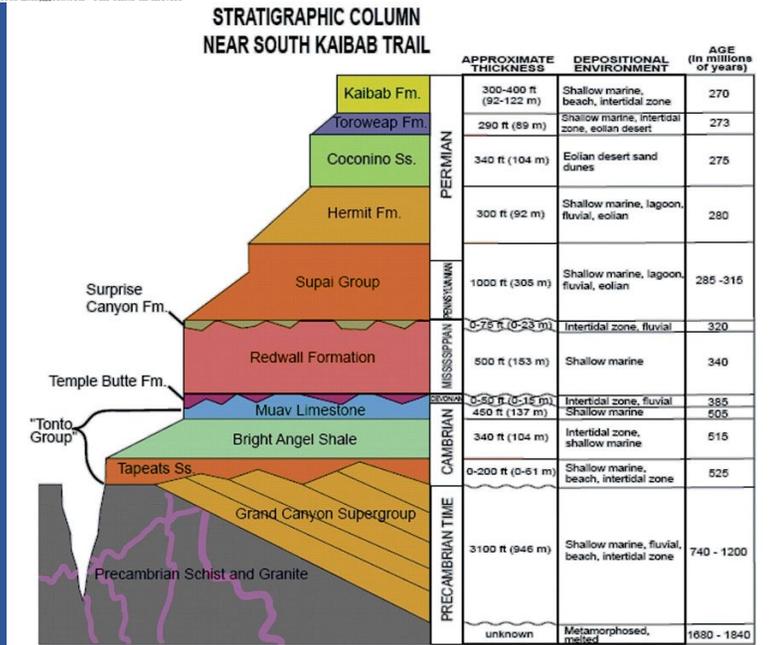
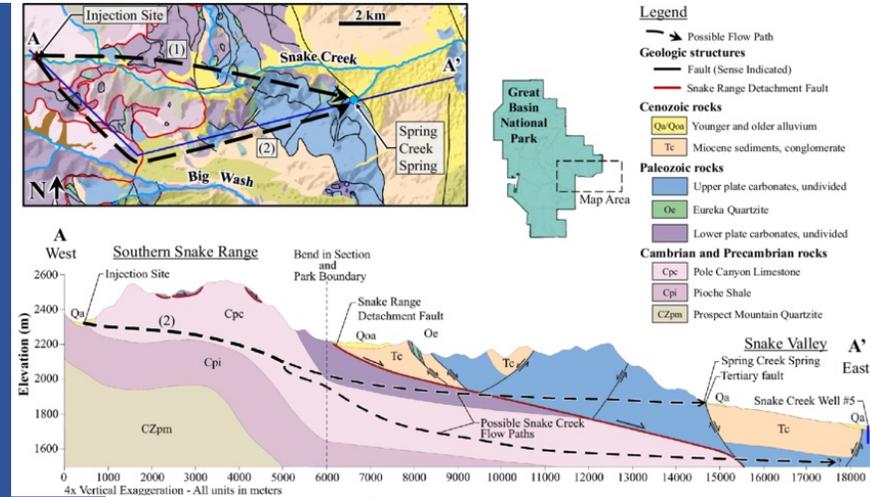
- Maine: Acadia = subduction zone of Acadian Orogeny & accretion of Avalonia
- Florida: Everglades, Biscayne, Dry Tortugas = African Gondwana cover sediments



# Panthalassa Coast Silurian Rocks

Equatorial: submerged passive margin continental shelf, continental slope & deep basin

- California: Pinnacles, Sequoia & Kings Canyon, Yosemite, Death Valley, Joshua Tree
- Nevada: Great Basin
- Colorado Plateau: *unconformity (erosion)*



# Alaskan Silurian Tropical Islands

- **Active margin: volcanic island arcs & offshore microcontinents**

Equatorial: submerged continental shelf, continental slope, & deep basins

## Deep Marine

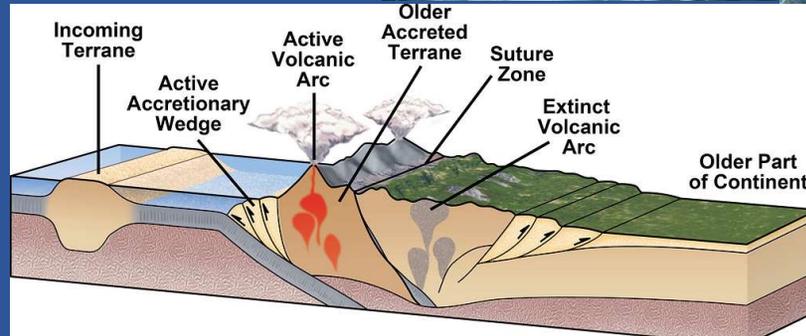
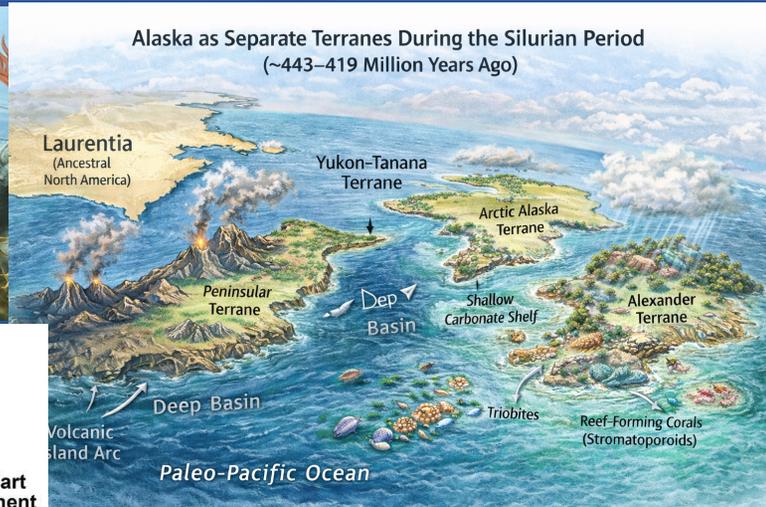
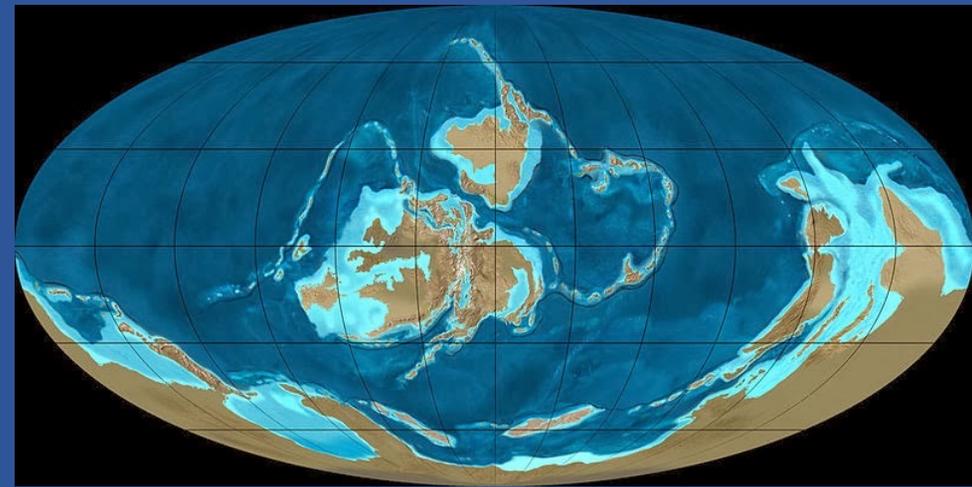
- Denali

## Volcanic Island Arc + Shallow Marine

- Wrangell-St. Elias
- Katmai & Lake Clark

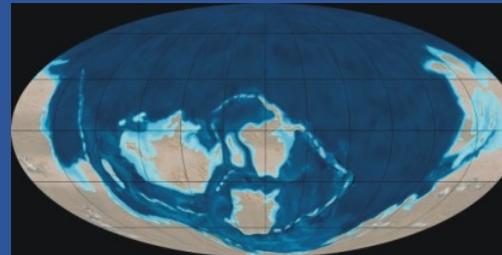
## Shallow Marine

- Gates of the Arctic
- Kobuk Valley
- Glacier Bay

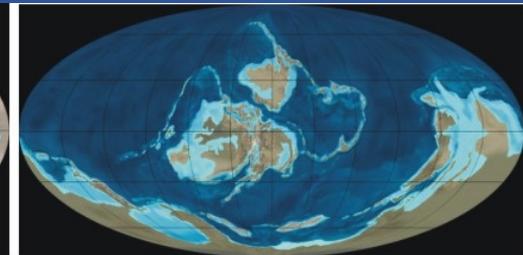


Global temperatures		Phanerozoic: times of origin of plants and animals	
CENOZOIC	Quaternary		Holocene Pleistocene with alternating periods of glaciation and warm periods <i>Homo sapiens</i>
	Neogene		Pliocene Miocene Oligocene Eocene Paleocene Early humans <i>Sahelanthropus</i> Apes Monkeys Primates
	Paleogene		Mammals
MESOZOIC	Cretaceous		Late Cretaceous Early Cretaceous Angiosperms
	Jurassic		Late Jurassic (Malm) Middle (Dogger) Early (Lias) bird <i>Archaeopteryx</i> earliest Mammals (i. e. <i>Hadrocodium wui</i> )
	Triassic		Keuper Muschelkalk Buntsandstein Pterosaurs Fish dinosaurs Dinosaurs
	Permian		Zechstein Rotliegend Reptiles Therapsids Sauropsids Synapsids first Amniotes Giant dragonflies
	Carboniferous		Pennsylvanian Vegetation that became coal Mississippian
PALAEOZOIC	Devonian		Cycads Lycophytes Ferns Horsetails (Equisetidae) first terrestrial vertebrates <i>Ichthyostega</i>
	Silurian		early land plants in riparian zones Placodermi
	Ordovician		all life forms are still aquatic Cephalopods
Cambrian			new developments: brain eyes with lenses segmentation Bilateria Radiata Arthropods e.g. Trilobites Brachiopods, snails first vertebrates Chordates Annelids, Mussels Echinoderms, Tunicates Jellyfish, first corals
	Precambrian		Ediacara fauna

# 10 Minute Break!



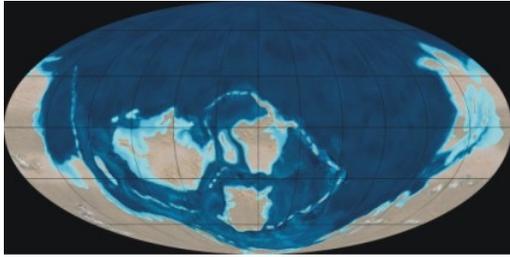
500 mya



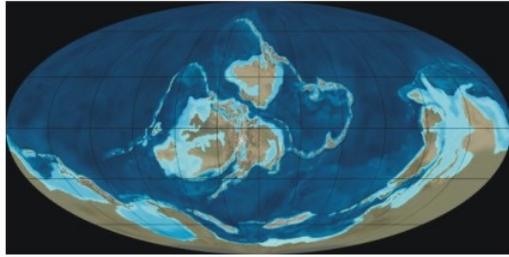
430 mya

Video link:

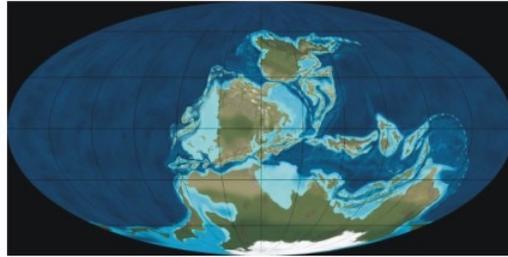
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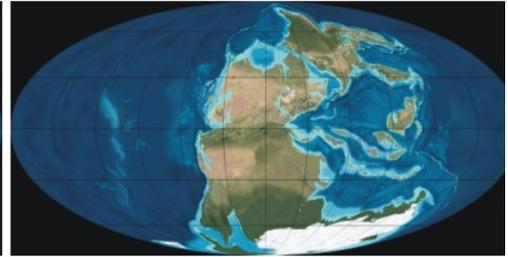
500 mya



430 mya



340 mya



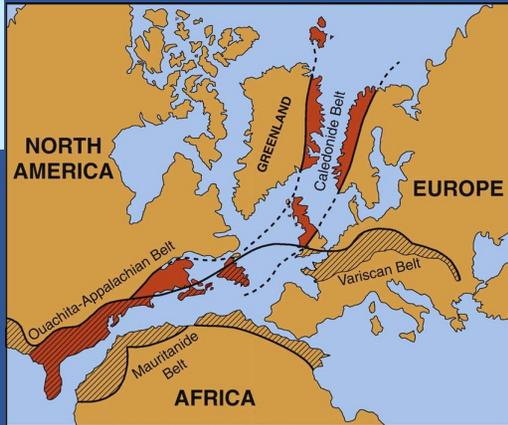
260 mya



## Assembly of Pangaea Supercontinent

480-260Ma East coast active margin

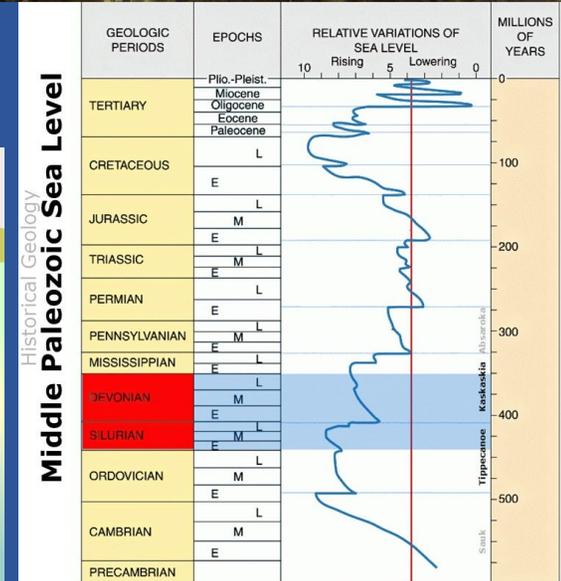
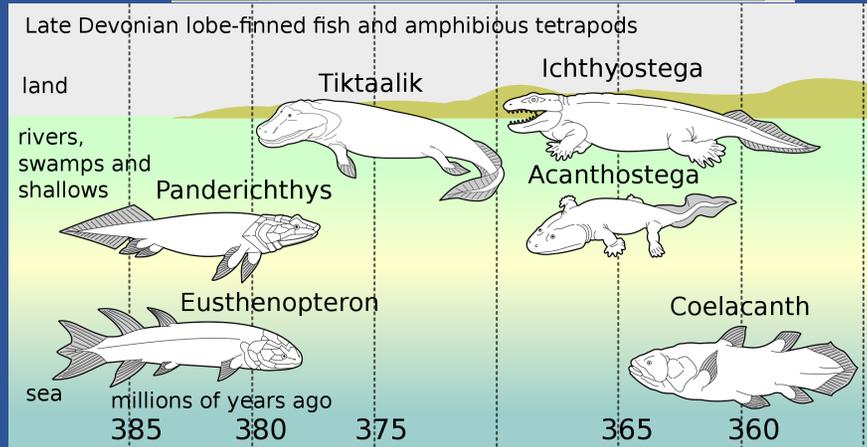
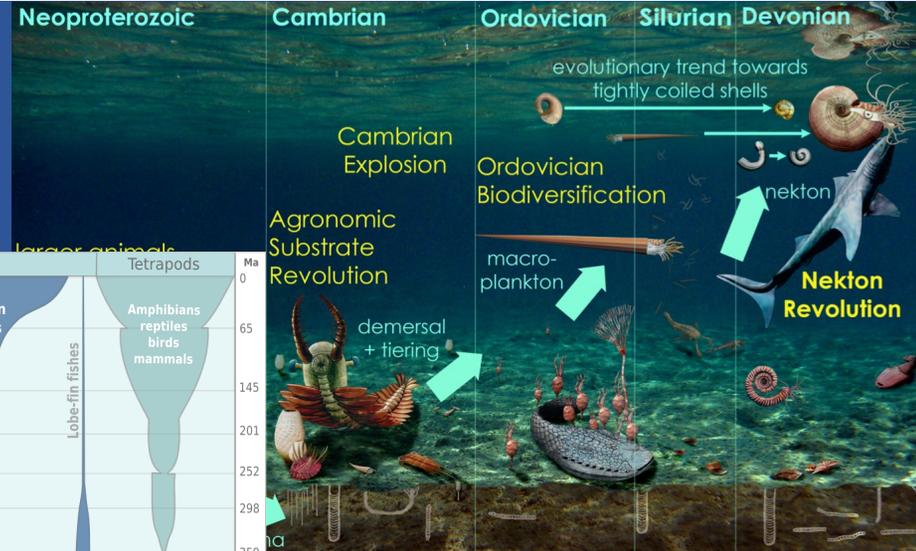
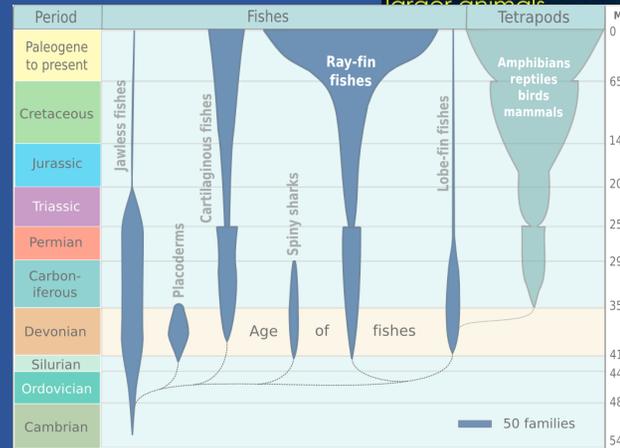
- Taconic Orogenies: volcanic arcs
- Acadian Orogeny: Avalonia microcontinent
- Alleghanian Orogenies: Europe, Africa, NA, SA



# Devonian Active Margins

## 419-359Ma Equatorial North America

- First tetrapod track & amphibian fossils
- Oldest trees/forests (lignin)
- Terrestrial insects
- Land-water transition
- Lobe-finned fish
- LIP & 75+% extinction



# Alaskan Devonian Tropical Islands

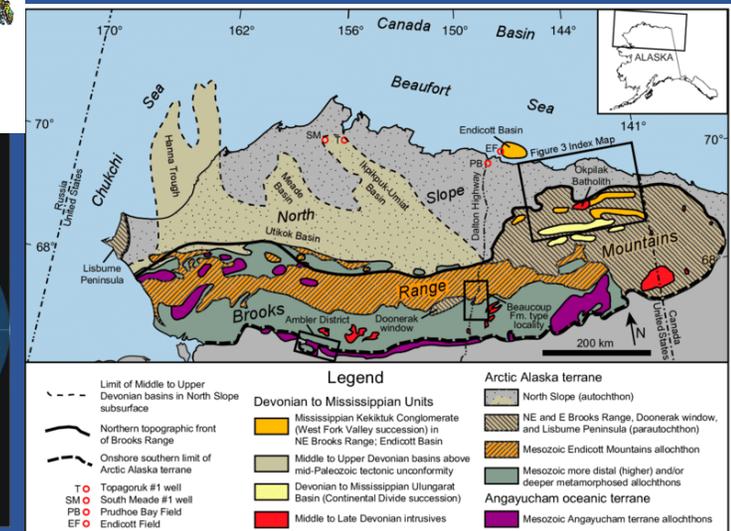
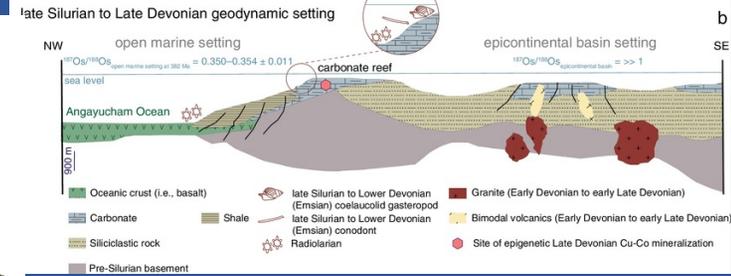
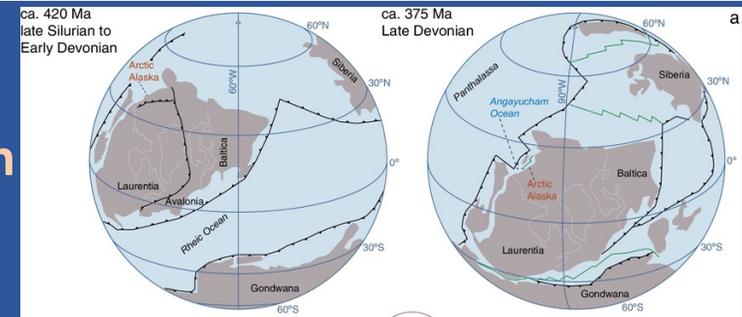
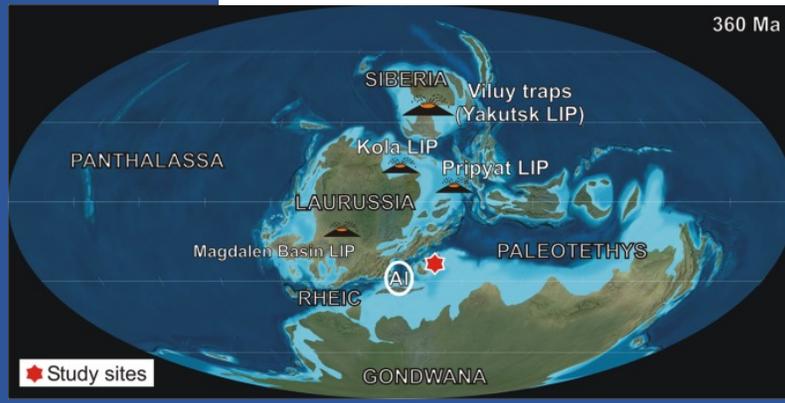
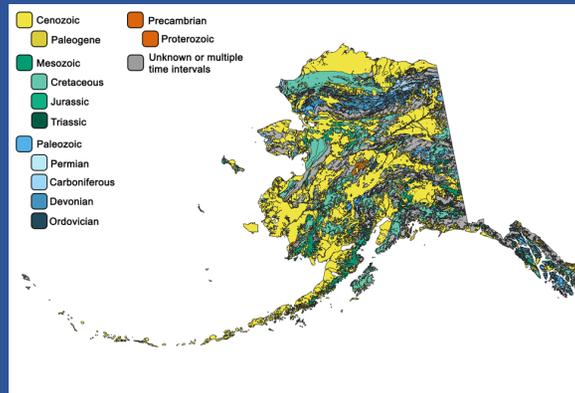
- 380-320Ma Ellesmerian/Innuitian Orogeny: accretion of distant offshore volcanic arcs
- Equatorial: submerged continental shelf & deep basins

## Volcanic Island Arc & Marine Basin

- Denali
- Katmai
- Lake Clark

## Volcanic Island Arc & Shallow Marine

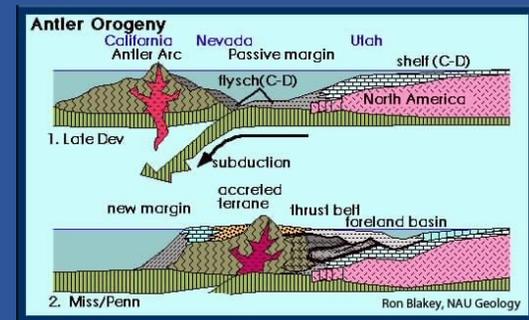
- Glacier Bay
- Wrangell-St. Elias
- Continental Shelf
- Gates of the Arctic
- Kobuk Valley



# Panthalassa Coast Devonian Rocks

- **375-320Ma Antler Orogeny: accretion of distant offshore volcanic arcs**

**Equatorial: submerged continental shelf & subduction trench**

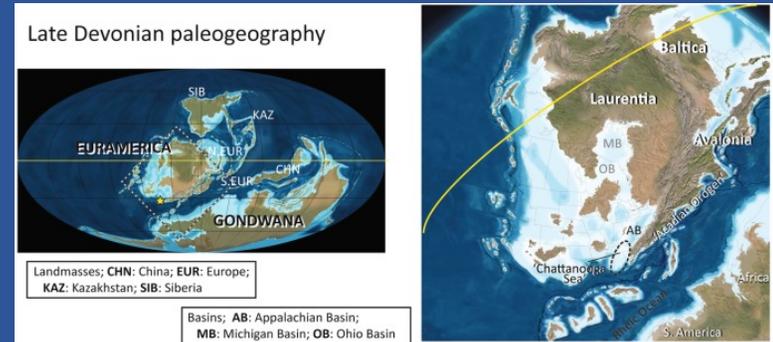
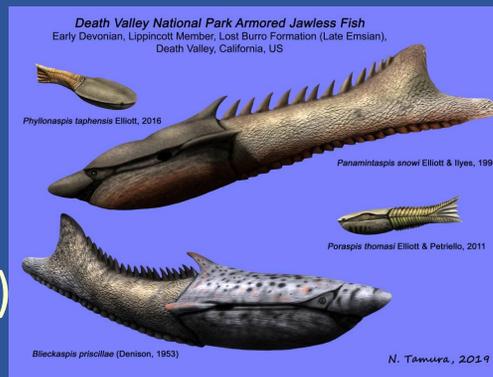


## Volcanic Island Arc, Deep & Shallow Marine Basins

- California: Channel Islands, Sequoia & Kings Canyon, Yosemite
- Washington: North Cascades

## Continental Carbonate Shelf

- California: Death Valley (fish!)
- Nevada: Great Basin
- MT/WY/ID: Yellowstone, Grand Teton



## Nearshore Continental Shelf (nearby rivers)

- Arizona: Grand Canyon (fish!)

Video link:  
[https://www.youtube.com/watch?v=xaj\\_J\\_3YJMc](https://www.youtube.com/watch?v=xaj_J_3YJMc)

# Rheic Coast Devonian Rocks

- **410-360Ma Acadian Orogeny: accretion of Avalonia microcontinent**

## Tropical: shallow continental shelf

- Indiana: Indiana Dunes
- Kentucky: Mammoth Cave
- **Regression to Coastal Delta**
- Ohio: Cuyahoga Valley
- West Virginia: New River Gorge
- Virginia: Shenandoah

- Maine: Acadia = Avalon Microcontinent island-arc accretes on to North America
- Florida: African Gondwana approaching

