Mesozoic Earth History I

Pop Quiz

Please take out a piece of paper and a writing utensil and put everything else away

Q1. The first Mesozoic orogeny in the Cordilleran region was the: A. Sevier; B. Laramide; C. Sonoma; D. Antler; E. Nevadan

Q2. Triassic rifting between which two continental land masses initiated the break-up of Pangaea? A. India and Australia; B. Antarctica and India; C. South America and Africa; D. North America and Eurasia; E. Laurasia and Gondwana

THE TRIASSIC

The Triassic is named after a three-member sedimentary sequence found in Germany: the Bunter, Muschelkalk, and Keuper formations.

The Bunter and Keuper are redbeds, hematite-stained sediments deposited in playa lakes, deltas, and mudflats under semiarid warm to hot conditions

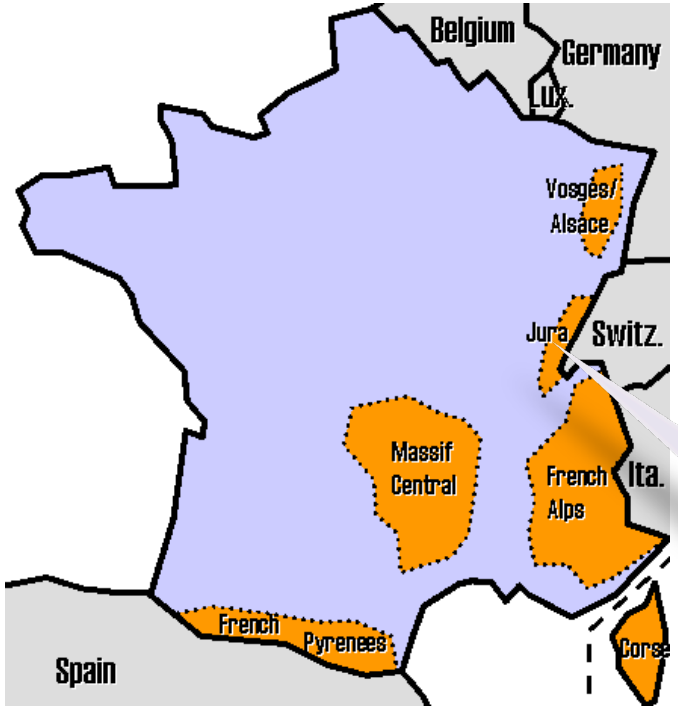
http://www.mindat.org/photo-219751.html

http://www.palaeo-online.de/images/trias/muschelkalk.jpg

The Muschelkalk is a marine limestone deposited after the Bunter during a marine transgression. The Keuper redbeds were deposited during the subsequent regression.

THE JURASSIC

The period is named after the Jura Mountains, located between France and Switzerland, where rocks of Jurassic age were first studied



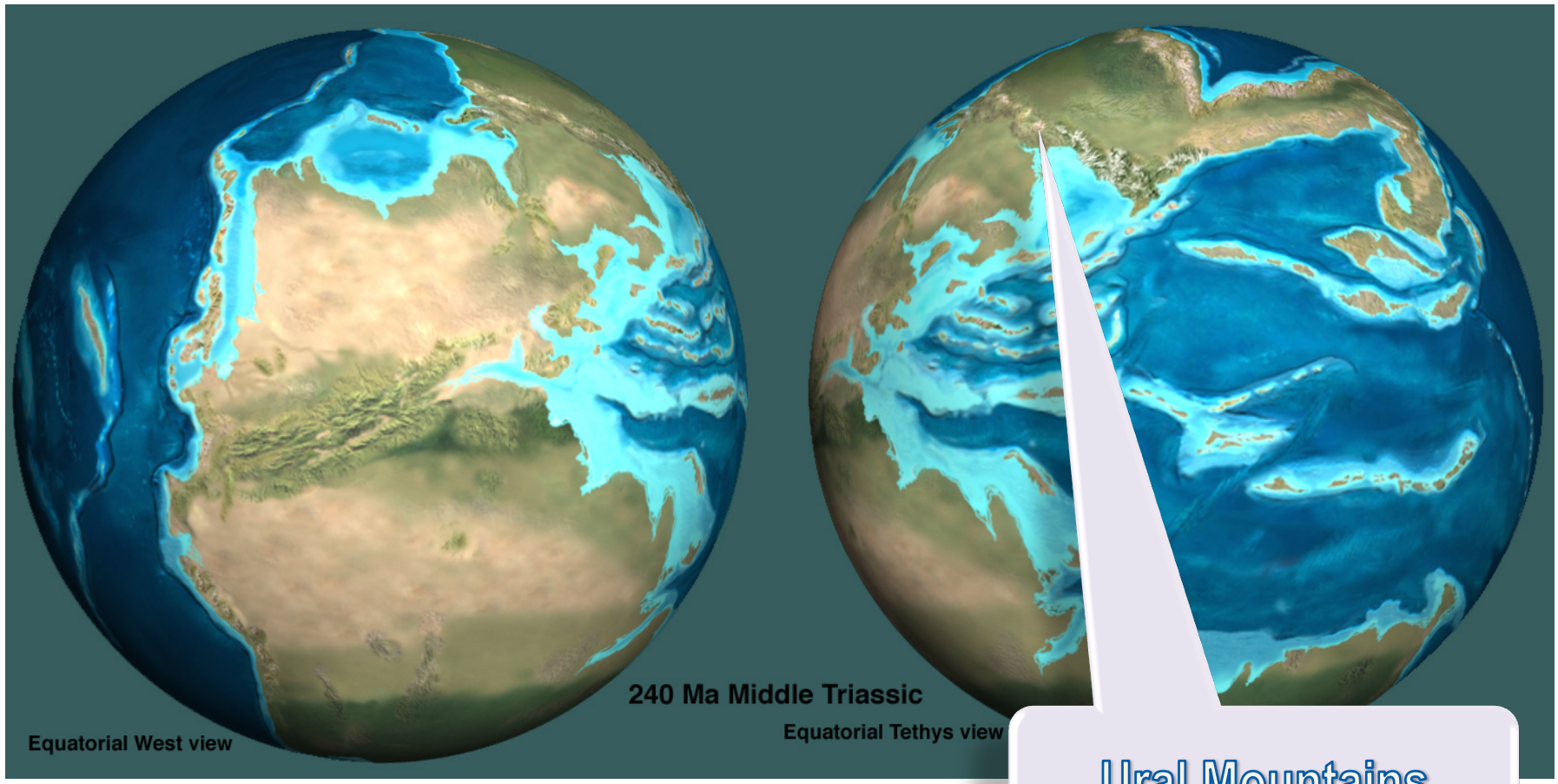
http://www.skimap.info/europe/france/

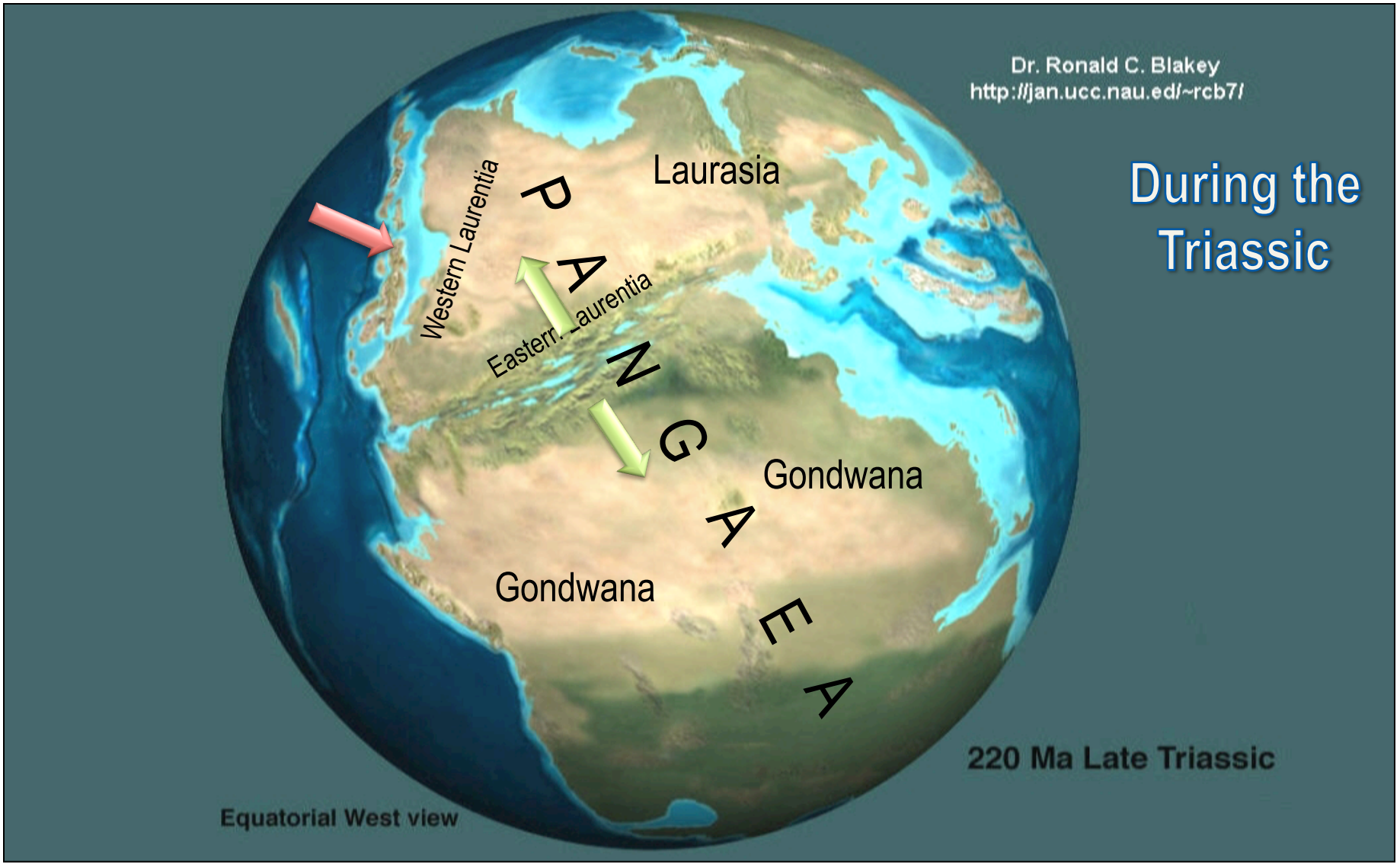
Jura Mountains

The Cretaceous Period

The Cretaceous is named for its extensive chalk deposits of this time (Cretaceous = “abounding in chalk”)

The last part of Pangaea assembled during the early Triassic, when Siberia collided with the part of Pangaea that would become most of Europe, causing the Ural Orogeny.

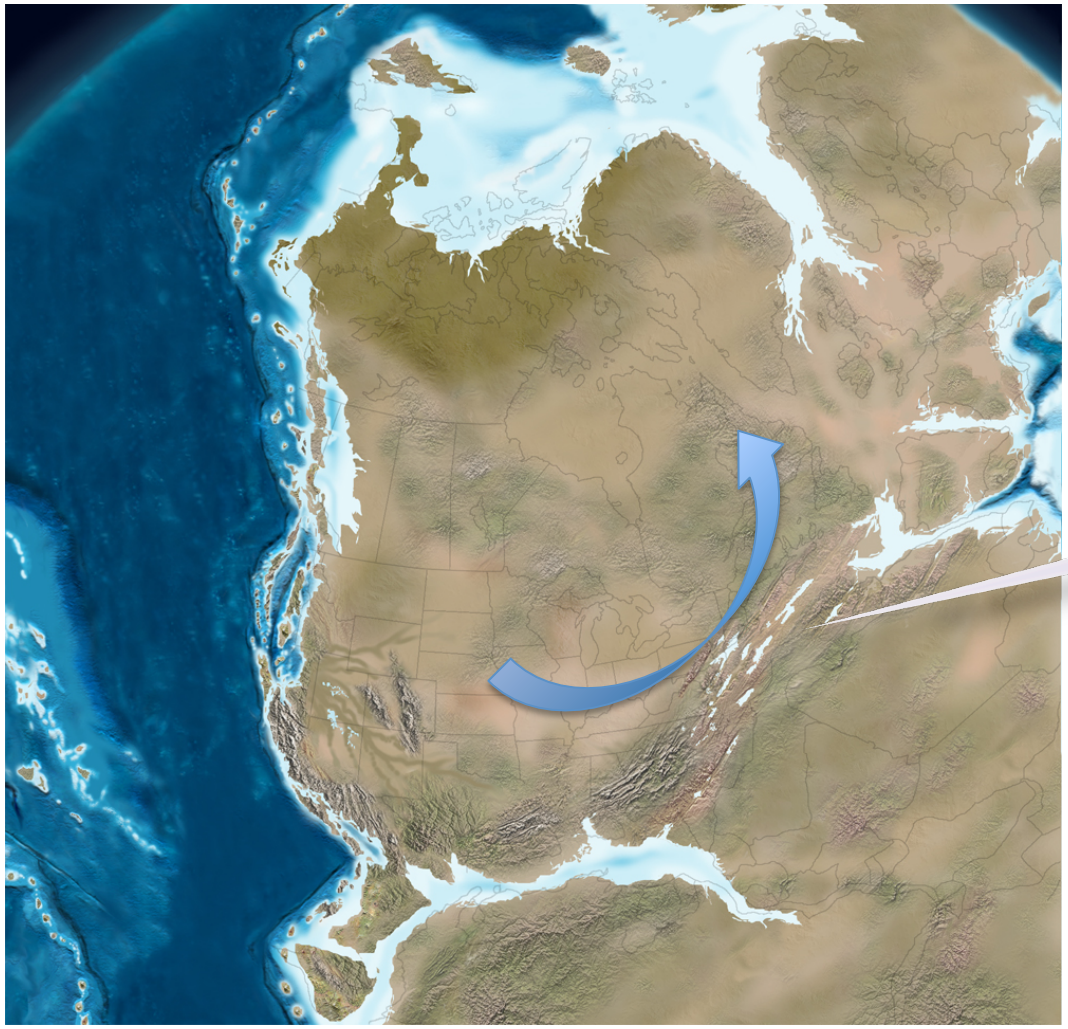




Triassic rift basins formed along eastern Laurentia

The Klamath arc completes accreted to western Laurentia

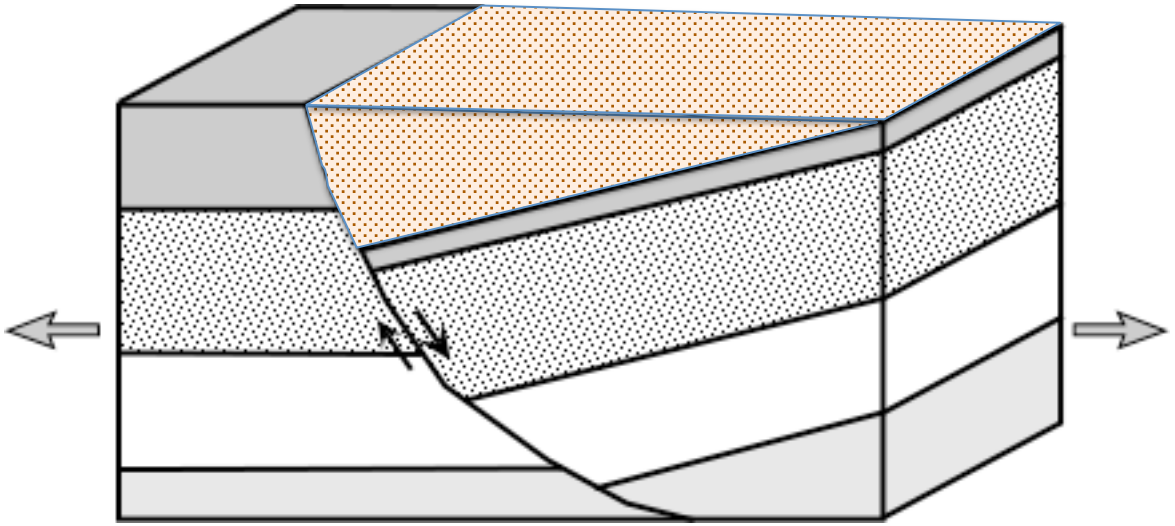
TRIASSIC TECTONIC EVOLUTION OF EASTERN NORTH AMERICA



Eastern North American tectonism was influenced by rifting of Pangaea and opening of the Atlantic, which led to the formation of NE-trending Triassic rift basins and of NW- and N-trending Jurassic diabase (gabbro) dikes.

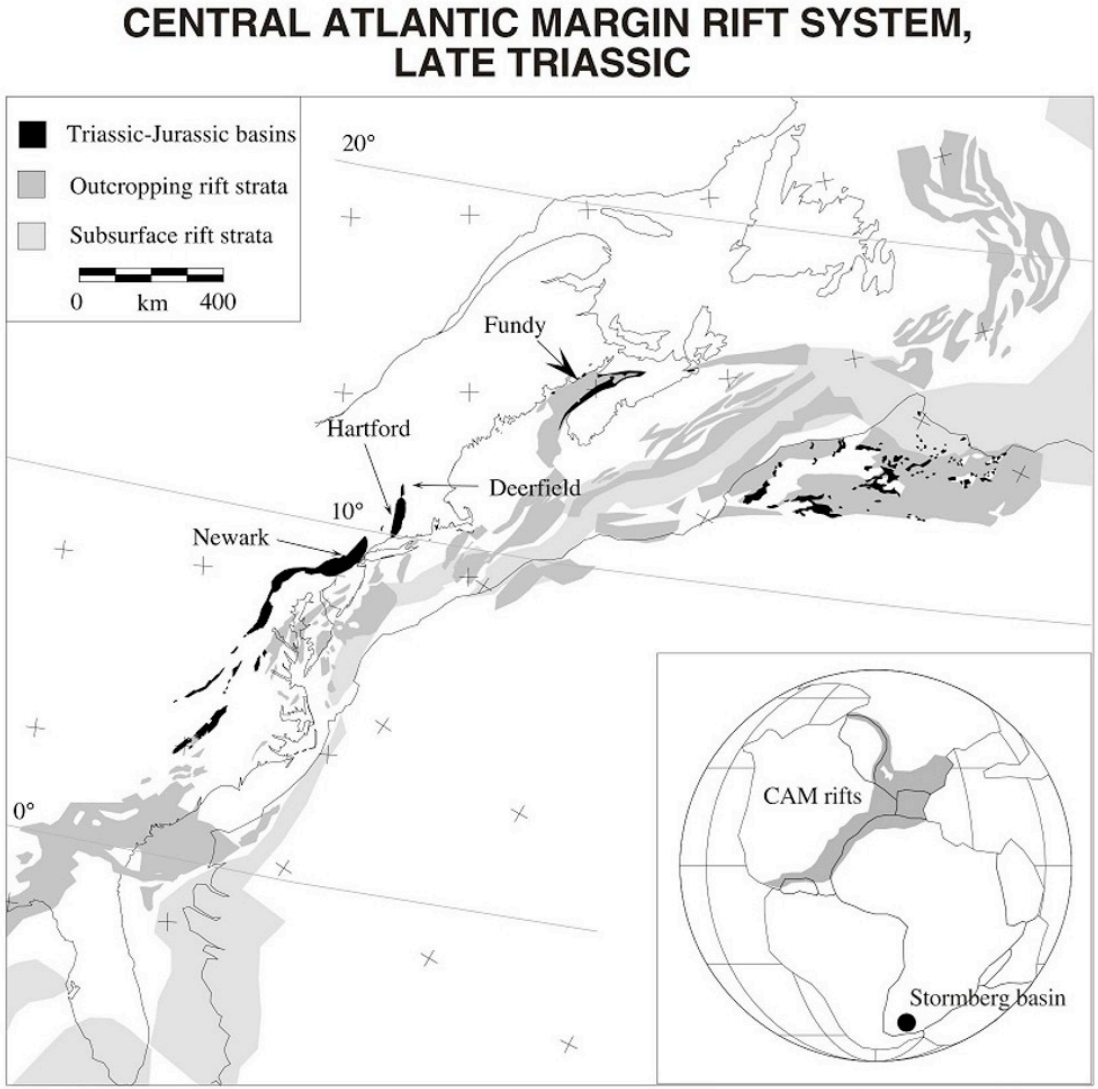
TRIASSIC TECTONISM IN EASTERN NORTH AMERICA

Numerous rift basins formed during the Triassic along the suture between Laurentia and Gondwana. The Triassic rift basins are parallel to the Appalachians and the modern coastline. Each rift basin is a half graben bounded on one side by a normal fault. They are filled with very thick packages of mostly clastic sedimentary rocks.



http://www.tulane.edu/~sanelson/eens1110/deform.htm

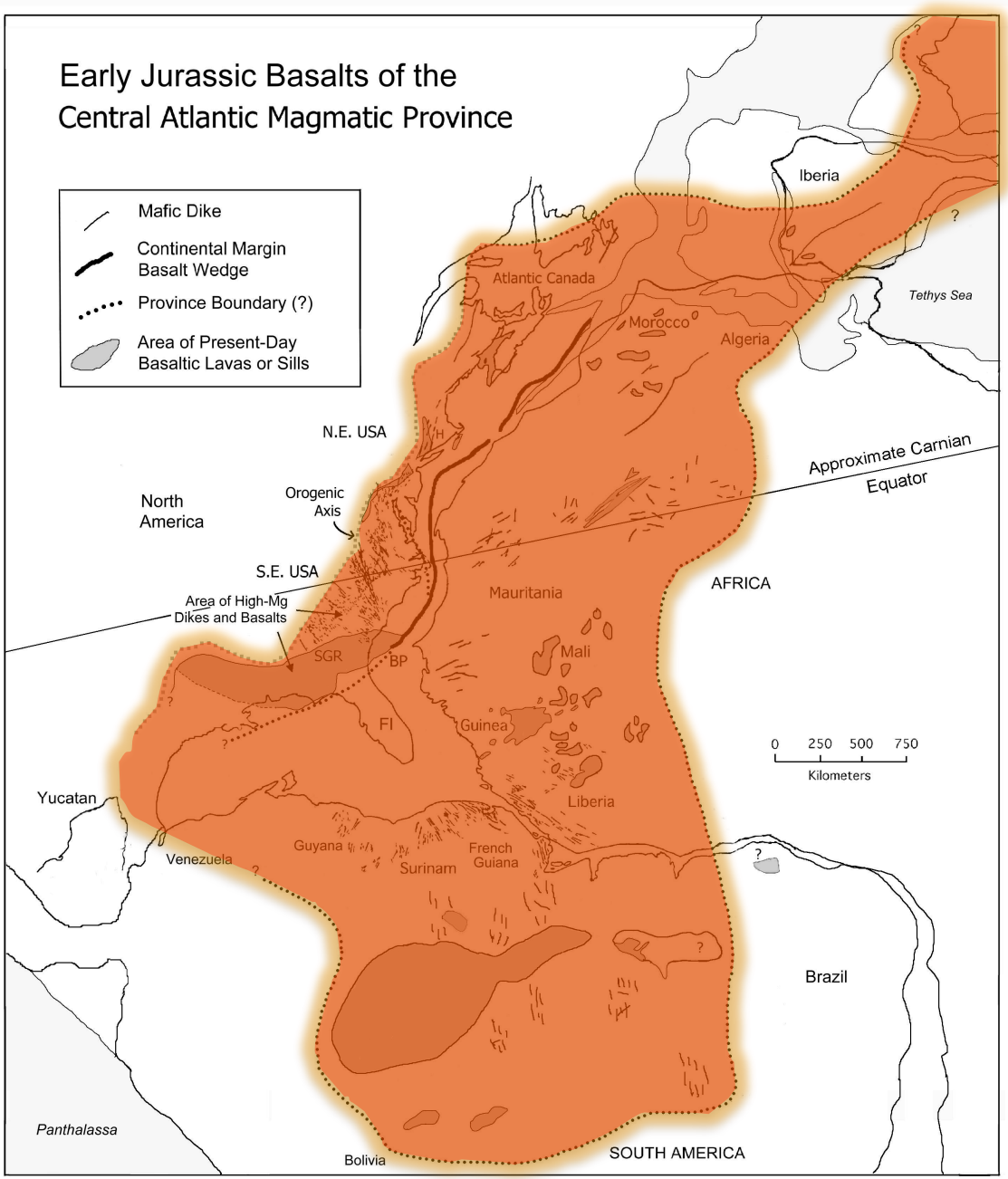
TRIASSIC TECTONISM IN EASTERN NORTH AMERICA



Pre-drift configuration of eastern North America and north Africa, showing locations of rift-related strata. Inset: reconstruction of Pangea showing location of CAM rift system and Stormberg basin (Lesotho). (After Olsen *et al.* 2000.)

Most of the rifts are now buried beneath sedimentary rocks deposited after the Jurassic along the passive margin setting of the Atlantic Coastal Plain (ACP).

The exposed basins contain a remarkably rich suite of fossils of plants and animals that lived in this area during the Triassic and Jurassic, including dinosaurs, early mammals, very early relatives of flowering plants, and other organisms.



http://www.auburn.edu/academic/science_math/res_area/geology/camp/

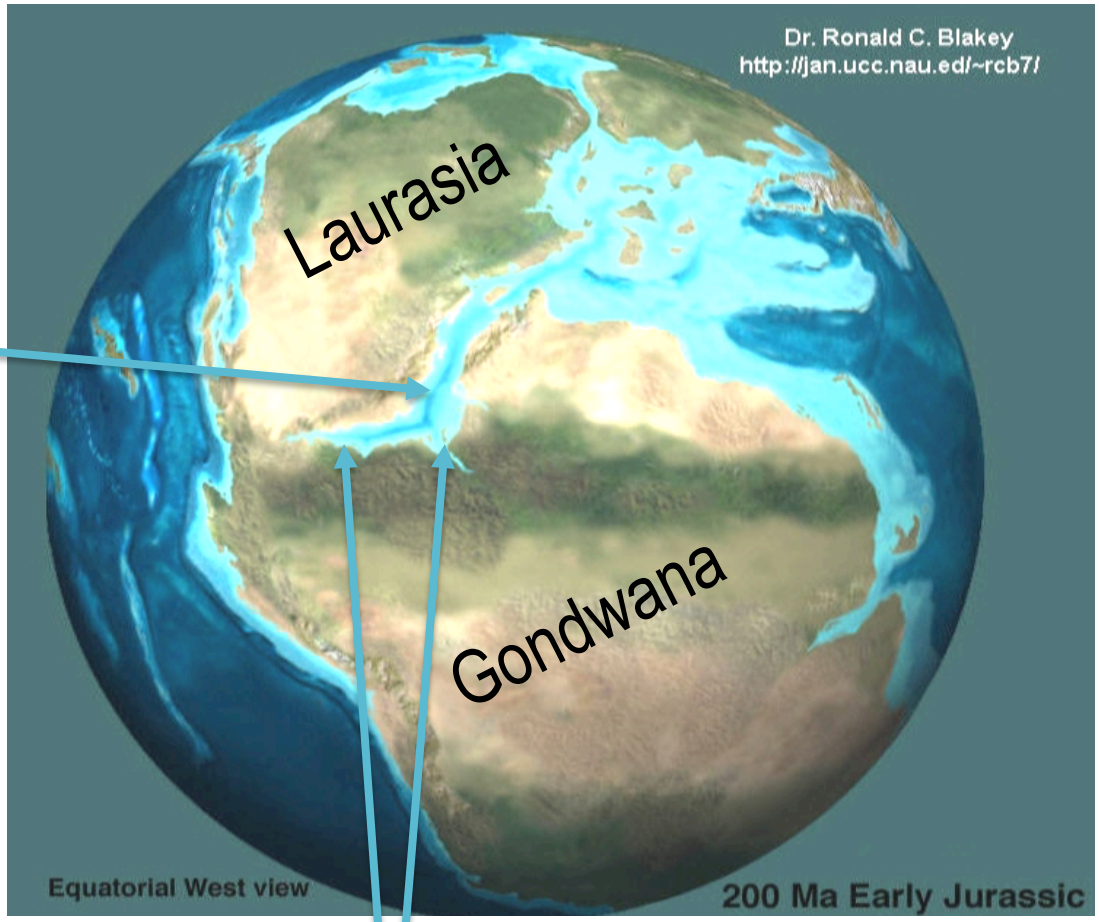
CAMP

The North American rifts are part of a much more extensive Large Igneous Province (LIP) called the Central Atlantic Magmatic Province (CAMP).

Environmental upset caused by the enormous output of volcanic gases from these basaltic lavas may have been responsible for the end-Triassic mass extinction event.

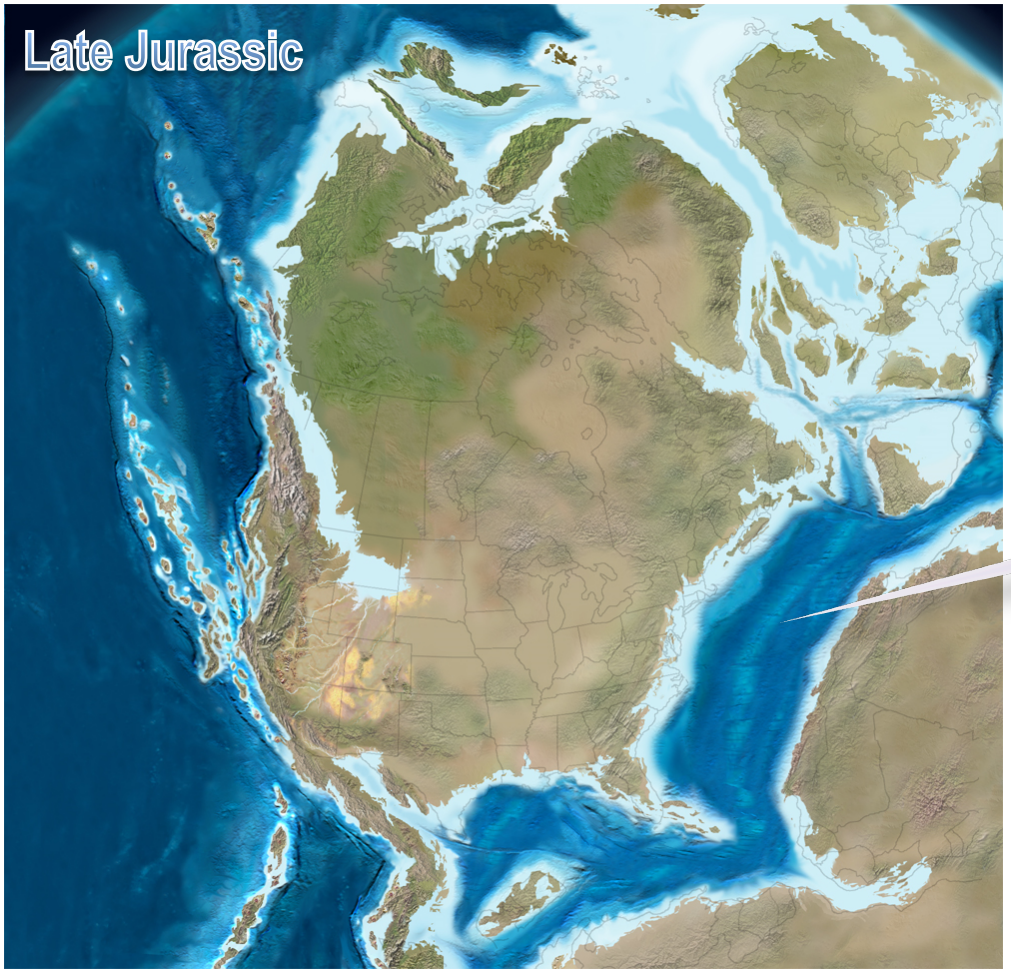
DURING THE EARLY JURASSIC

The northern Mid-Atlantic ridge formed between Gondwana and Laurasia



South America began rifting from Gondwana and Laurasia

JURASSIC TECTONIC EVOLUTION OF EASTERN NORTH AMERICA

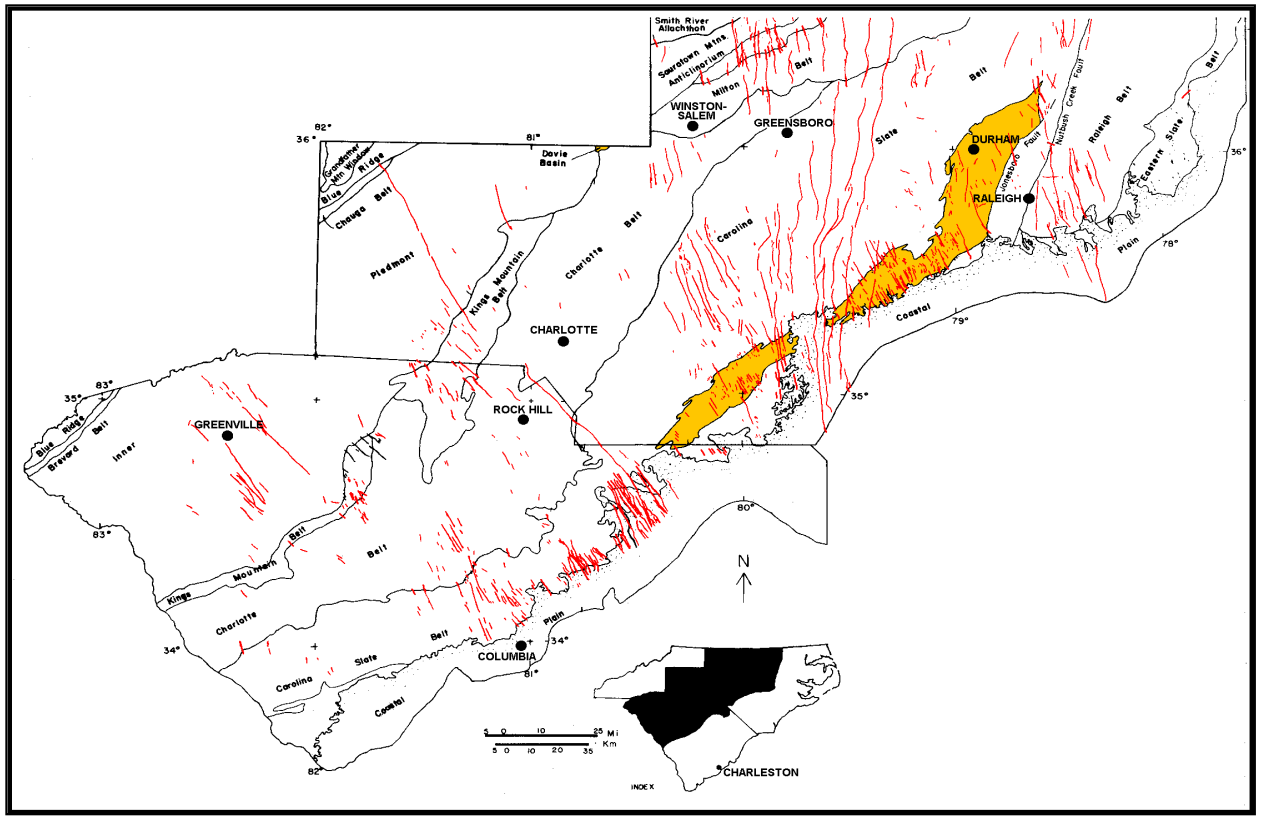


Mid-Ocean Ridge in young Atlantic Ocean

Late Jurassic rifting between Gondwana and Laurasia and opening of the Middle Atlantic Ocean basin led to the development of a passive continental margin along the rifted margin.

JURASSIC TECTONISM IN EASTERN NORTH AMERICA

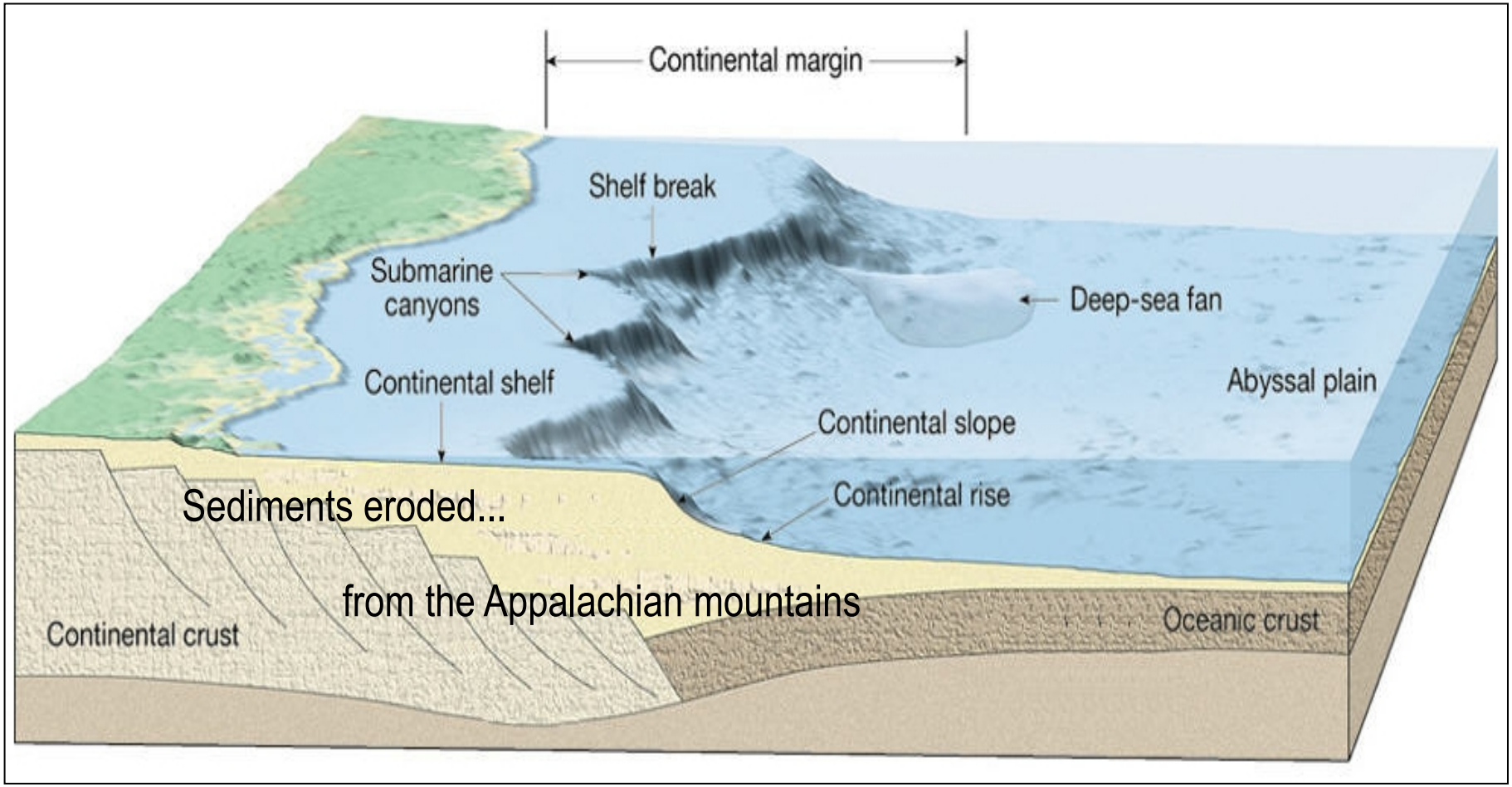
In the Early Jurassic, just before the opening of the Atlantic Ocean basin, long northwest to north-trending cracks opened in eastern North America and magma intruded into the cracks to form the Jurassic diabase (gabbro) dikes.



Jurassic Diabase Dikes (red lines) in the Carolinas

EASTERN NORTH AMERICA IN THE JURASSIC

As the Mid-Atlantic continued to widen, a wide passive continental margin began developing along the eastern margin of North America



LATE JURASSIC

By the end of the Jurassic, Pangaea had rifted into a large northern continent and a large southern continent. The continents were still close together, separated by shallow seas.

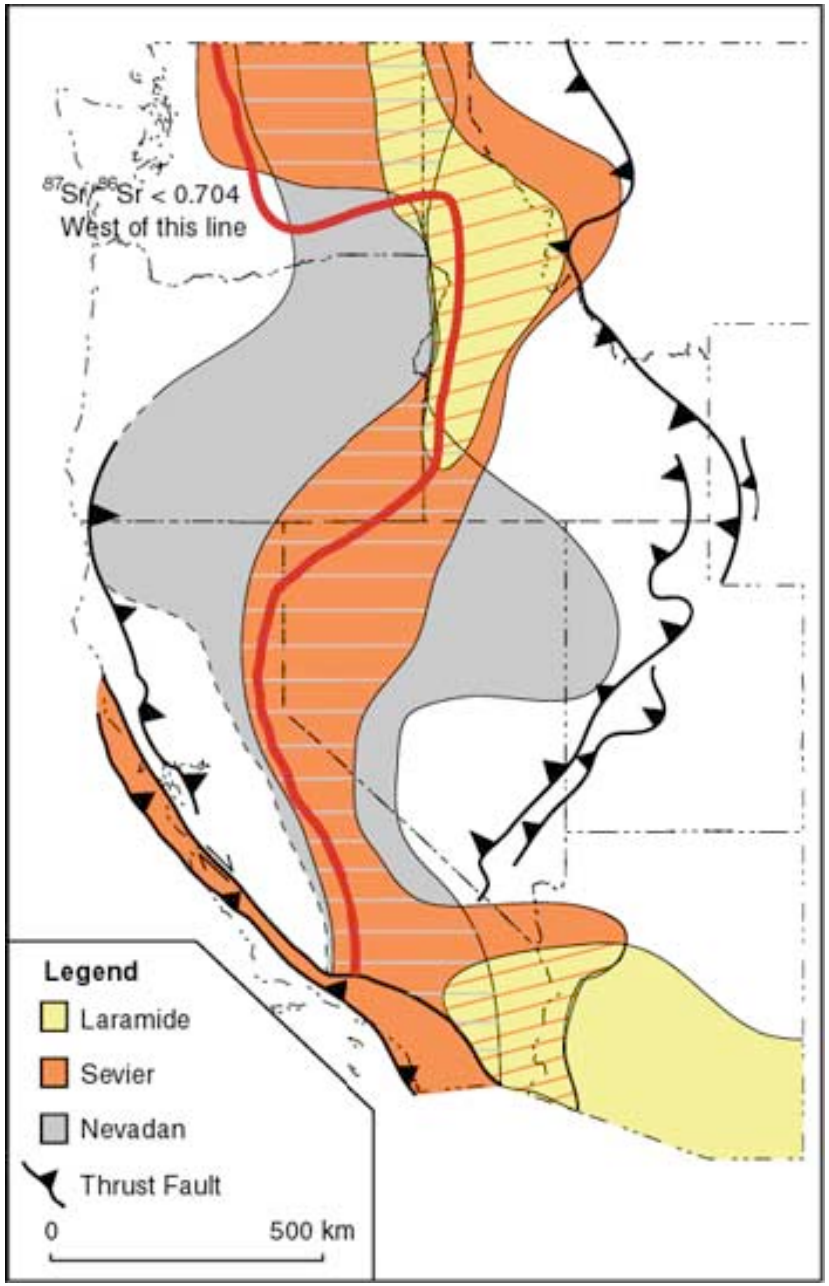
Cretaceous Tectonic Evolution of Eastern North America

Rifting

The middle section of the Atlantic Ocean continued to widen. Laurasia rifted apart, opening the northern Atlantic and separating Europe and North America.

Sea level rose ~ 350 ft during the Zuni transgression. The Atlantic Ocean advance as far inland as Columbia, Raleigh, Richmond and Philadelphia.

Deposition on the entire Atlantic and Gulf coastal plains started during this transgression. It also flooded western North America, forming the Cretaceous Interior Seaway



Mesozoic Tectonic Evolution of Western North America

Formation of the mountainous regions of western North America ramped up during the Mesozoic with four major orogenies (the Sonoma, Nevadan, Sevier and Laramide Orgenies), plus the accretion of many volcanic arcs and microcontinents to the western margin.

Subduction of primarily oceanic crust continued throughout the Mesozoic as North America consumed the Farallon and other plates. All of this tectonic activity caused volcanic activity and significant structural deformation.

http://www.nature.nps.gov/geology/parks/whis/geol_history.cfm

More of Ron Blakley's Marvelous Maps

Mesozoic Tectonic Evolution of Western North America

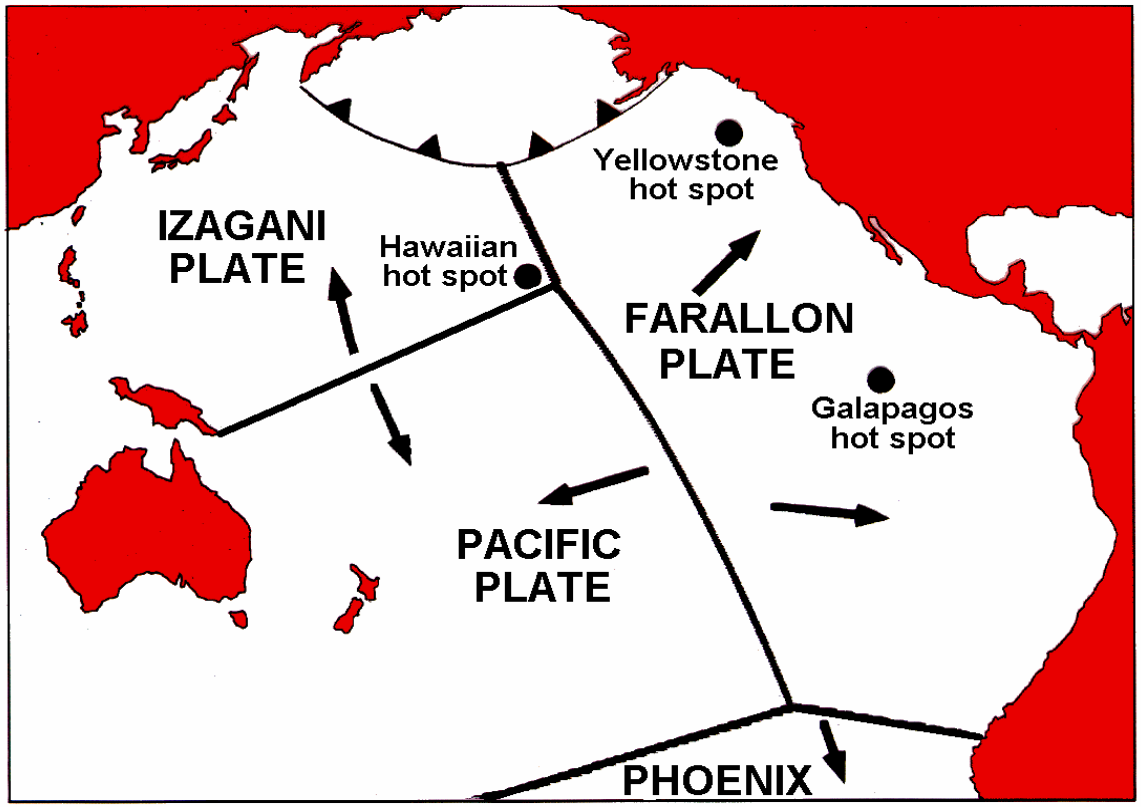
Global climate change combined with local climate change caused by mountain building to cause considerable climate variability in western North America.

Late Cretaceous (Campanian)

Blakey, R. C., 2008, Pennsylvanian-Jurassic sedimentary basins of the Colorado Plateau and Southern Rocky Mountains in, Miall, A. D. (ed), Sedimentary Basins of United States and Canada: Elsevier, Amsterdam p. 245-296.

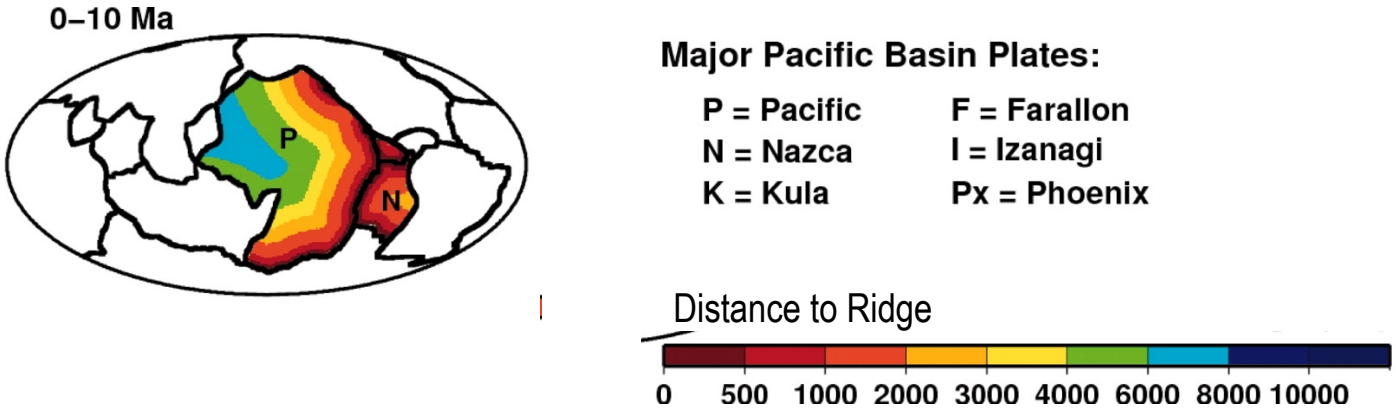
http://cpgeosystems.com/ColoPlatPalgeog.html

Subduction of the Farallon Plate



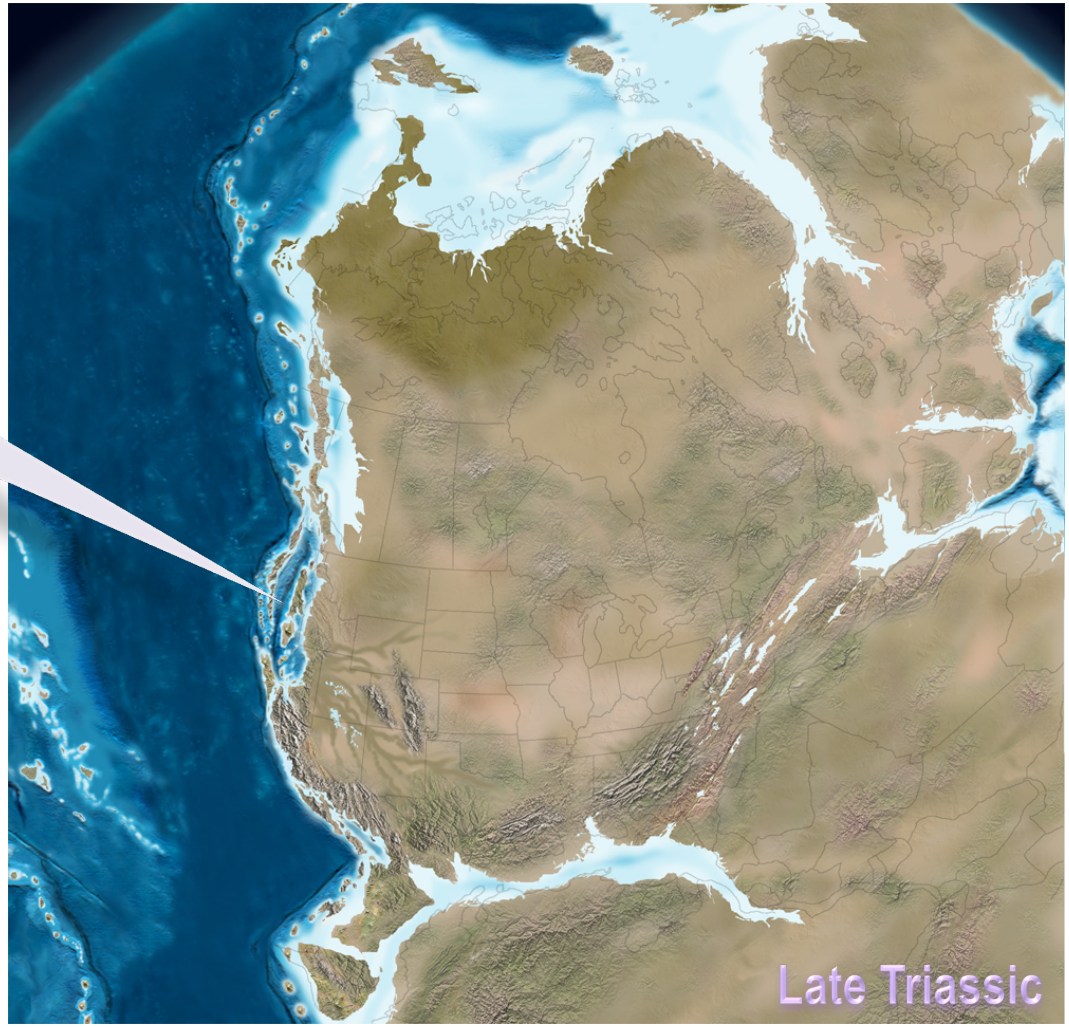
The Farallon plate subducted under western Laurentia from the Early Paleozoic to the Mid-Tertiary. Subduction of the Farallon plate caused mountain building in the western Cordillera. The Juan de Fuca and Cocos plates are remnants of the Farallon plate.

Cenozoic and Mesozoic evolution of the Pacific basin as characterized by seafloor distance to the nearest mid-ocean ridge.



Loyd S J et al. PNAS 2007;104:14266-14271

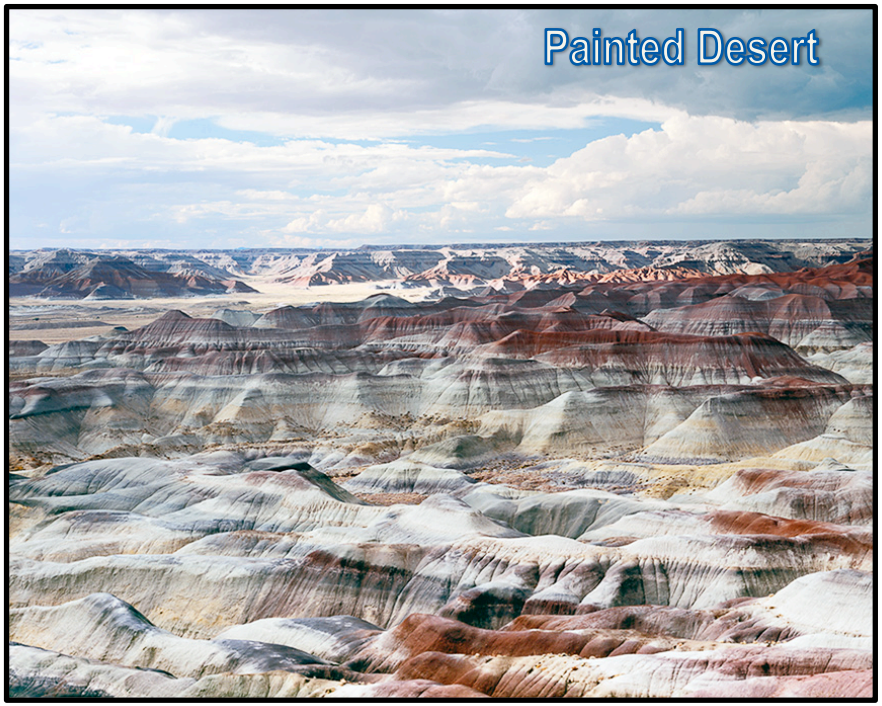
TRIASSIC TECTONIC EVOLUTION OF WESTERN NORTH AMERICA



Western North American tectonism was influenced by the final accretion of the Klamath arc during the Sonoma orogeny.

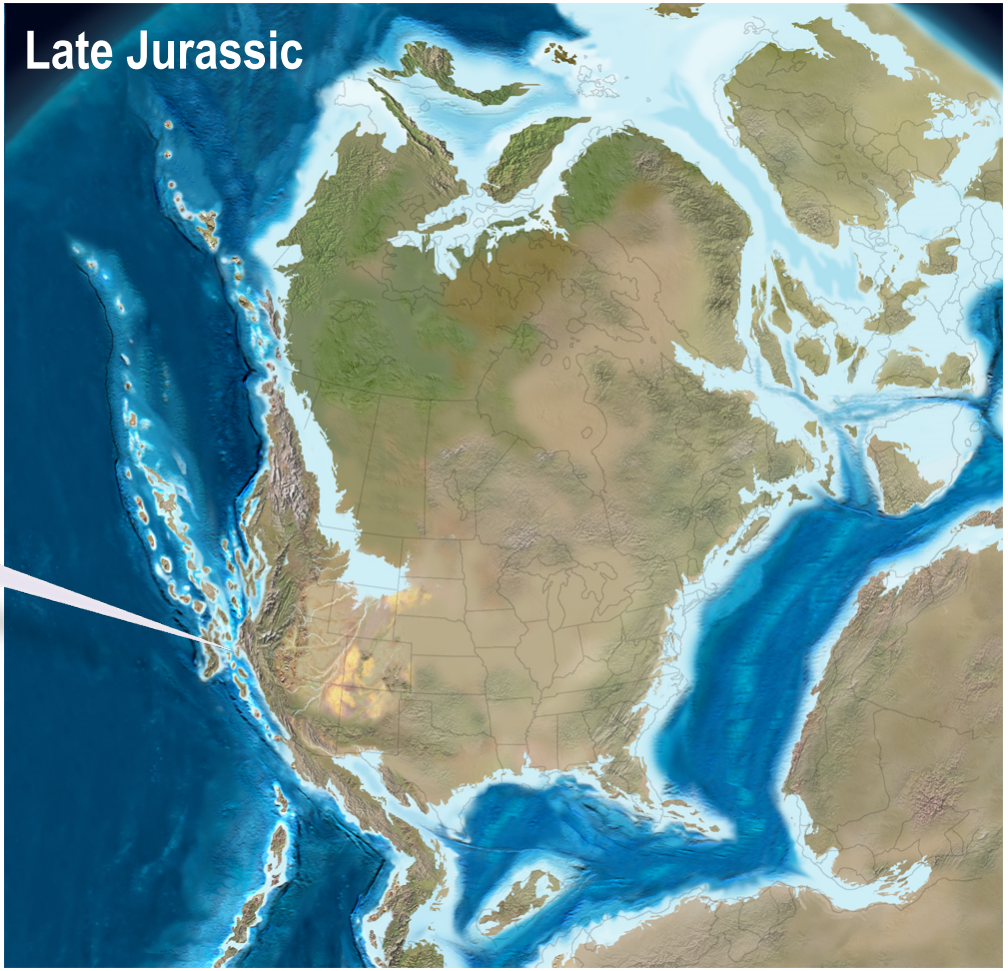
THE TRIASSIC CHINLE FORMATION

The Sonoma Orogeny led to the deposition of sedimentary redbeds and volcanic igneous rocks in Utah, Nevada, Arizona, Colorado and New Mexico. The Chinle Formation includes the famous Petrified Forest (remnants of alpine trees that silicified while stewing in a hot volcanic ash soup) and Painted Desert (fantastically multicolored clastic sedimentary rocks).

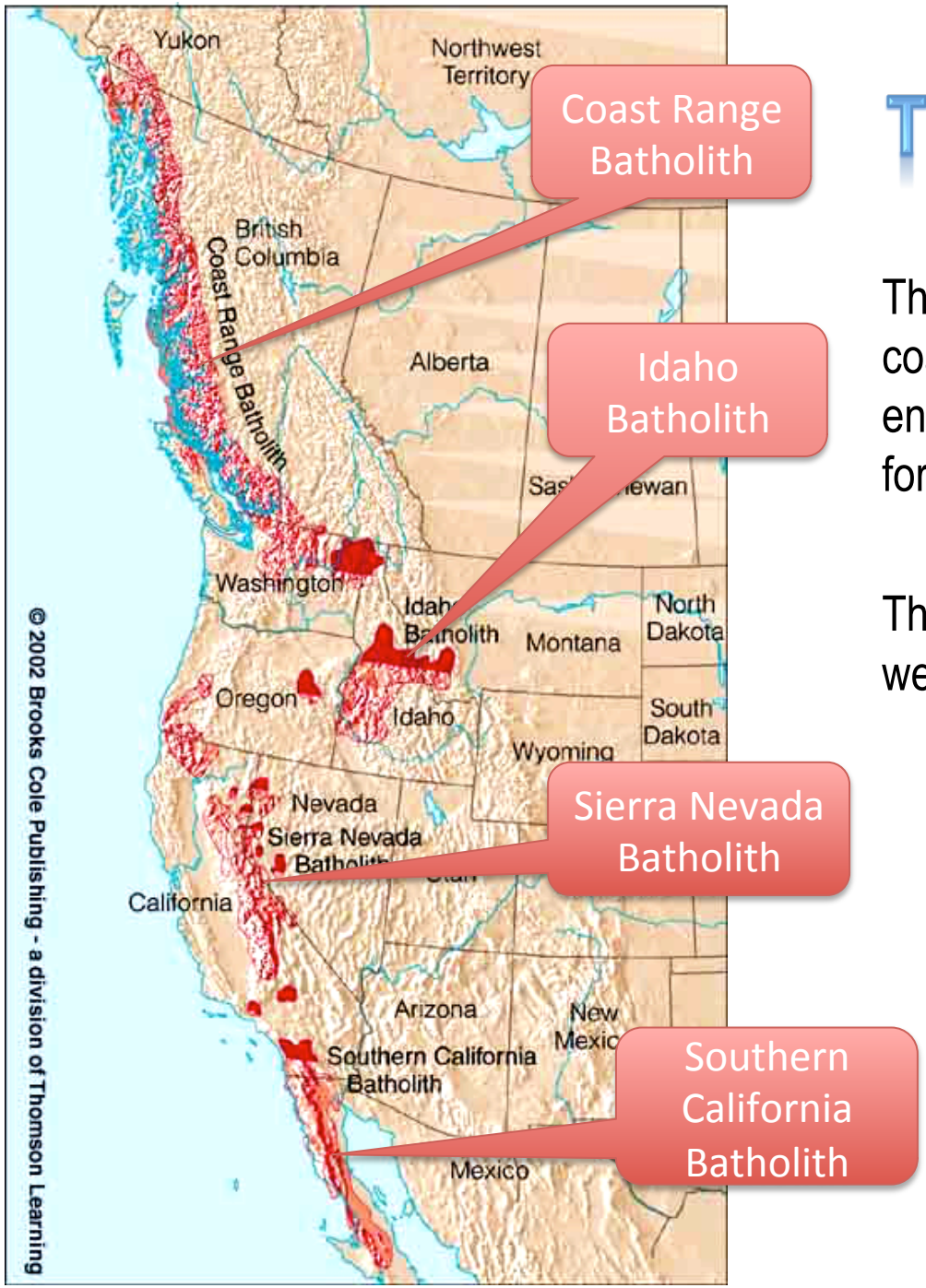


JURASSIC TECTONIC EVOLUTION OF WESTERN NORTH AMERICA

Nevadan Orogeny



The collision of several arcs during the late Jurassic and early Cretaceous caused the Nevadan orogeny, forming the heart of the Sierra Nevada mountains.

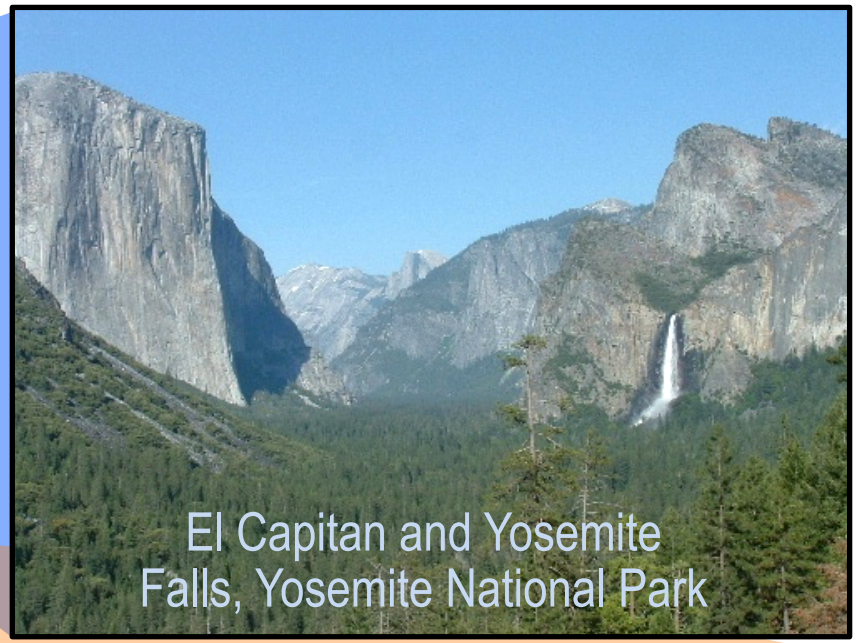


THE NEVADAN OROGENY

The Nevadan occurred closest to the west coast and involved intrusion of and enormous volume of magma that cooled to form four huge batholiths.

These batholiths form the backbone of the western Cordilleran.

The Sierra Nevada Batholith

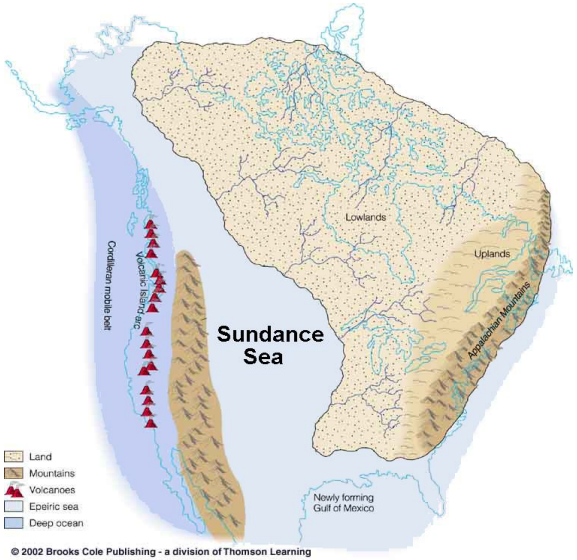


El Capitan and Yosemite Falls, Yosemite National Park

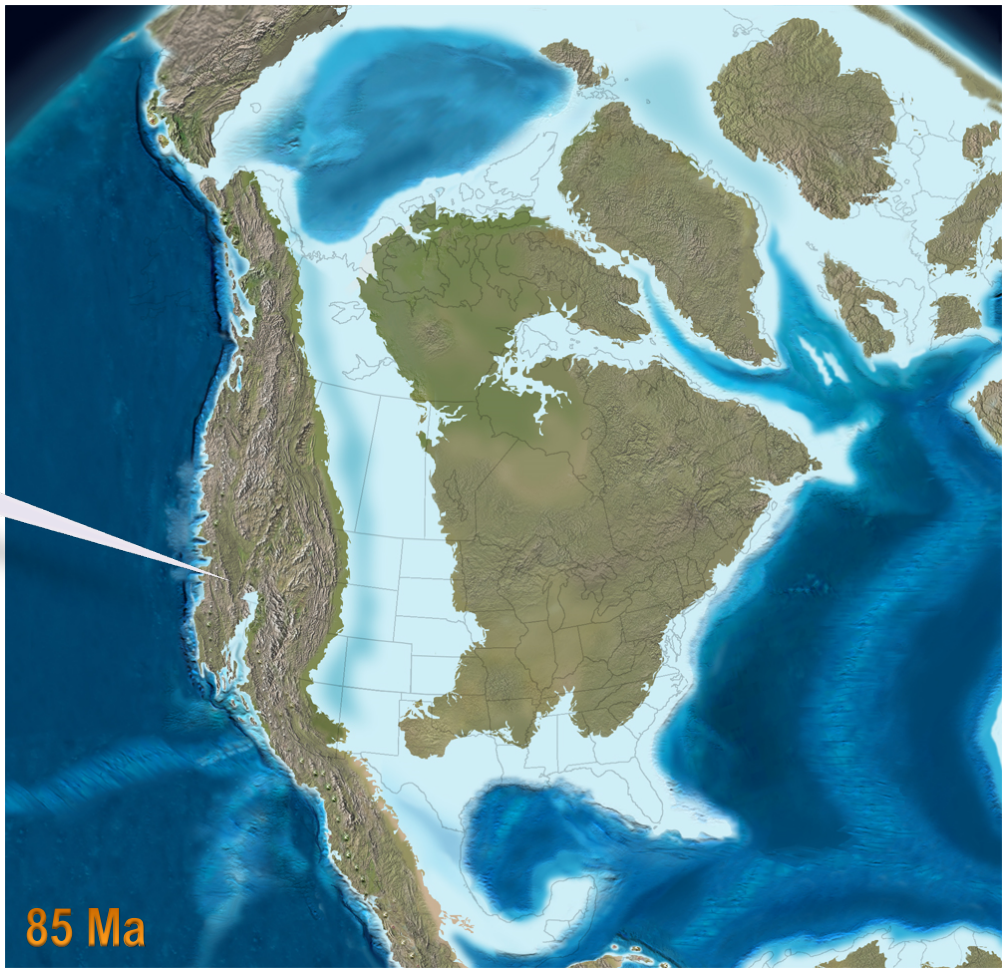
Owens Valley

JURASSIC EVOLUTION OF WESTERN NORTH AMERICA

Sediments eroded from the Nevadan mountains formed the Morrison Formation, a complex mixture of marine and non-marine sedimentary rocks. It is famous for its dinosaur fossils.



Cretaceous Tectonic Evolution of Western North America

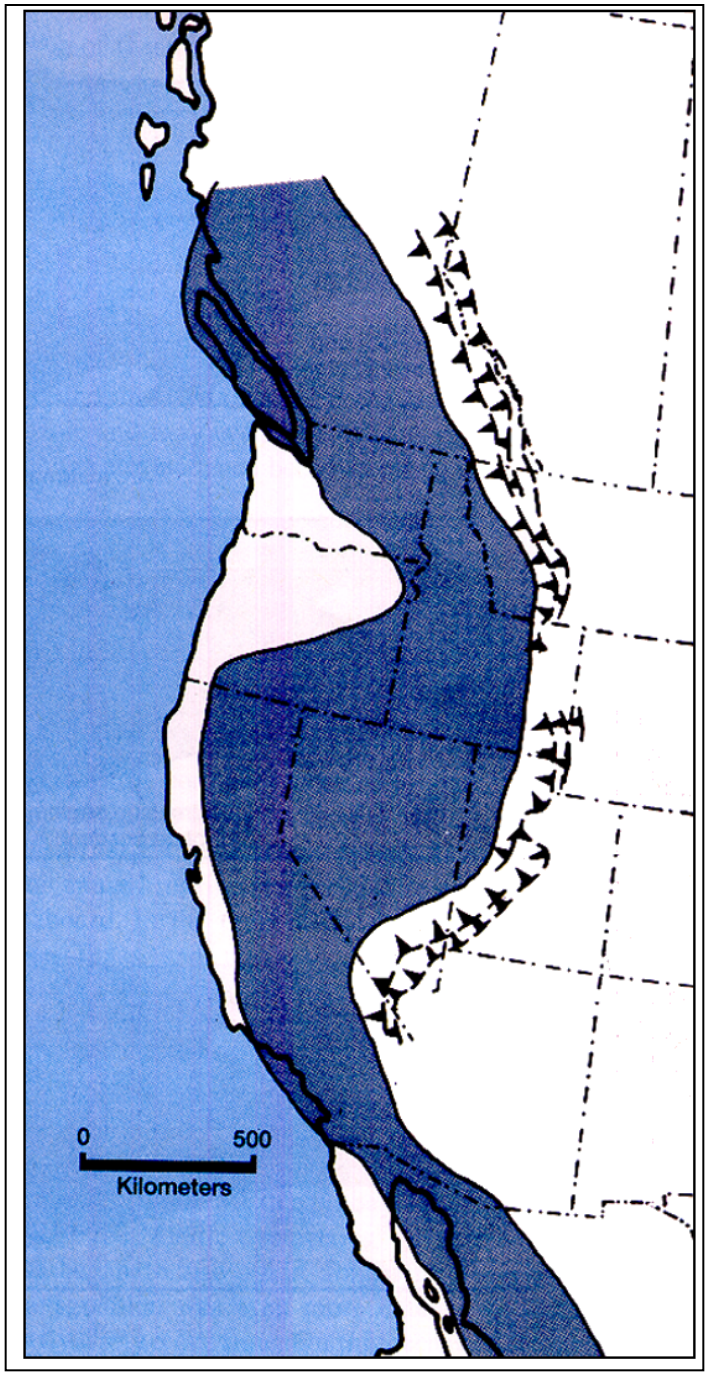


The Sevier Orogeny followed the Nevada Orogeny as two oceanic plates subducted beneath the western margin of the North American Plate.

The Sevier Orogeny

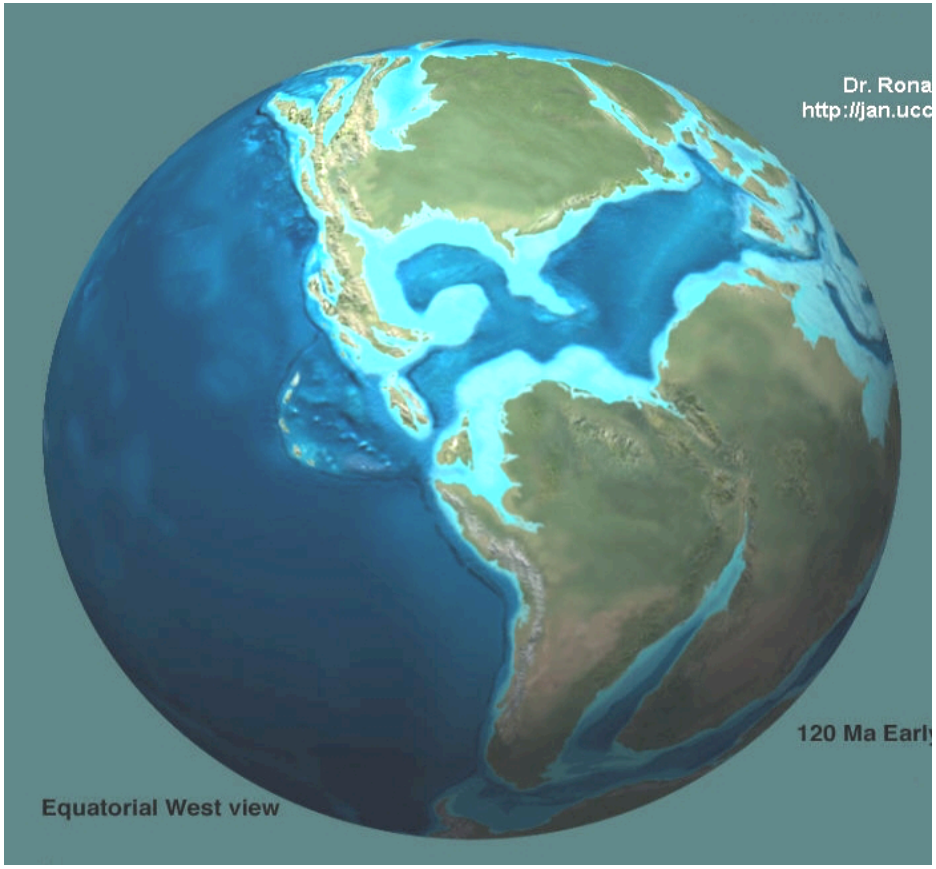
The Sevier orogeny occurred east of the Nevadan orogen during the Cretaceous

The Sevier orogeny involved “thin-skin” thrusting of Late Proterozoic and Paleozoic sedimentary sequences toward the east over Mesozoic sedimentary sequences.

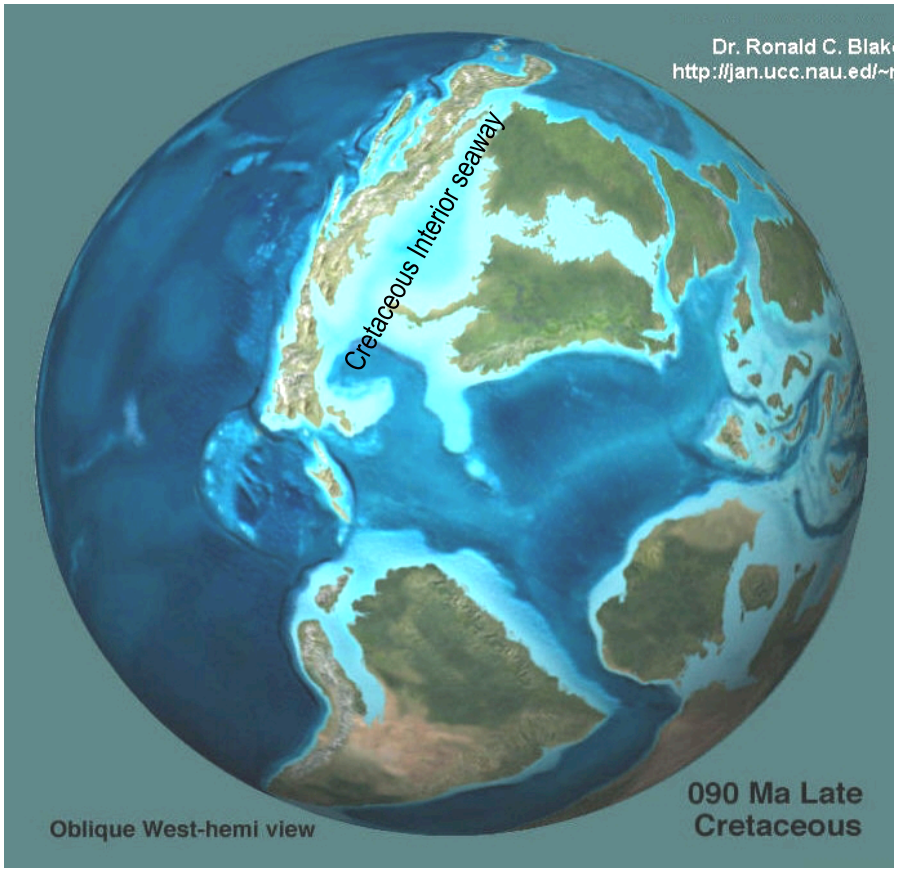


The Zuni Transgression

Early Cretaceous



Late Cretaceous



Cretaceous Tectonic Evolution of Eastern North America

Laramide Orogeny

The Laramide Orogeny followed the Sevier Orogeny. The angle of subduction was shallower, allowing mountain building far inland from the western margin. The orogeny continued into the Tertiary and formed the Rocky Mountains.

The Rocky Mountains

The Rockies are the most recently formed mountains in the eastern region of the Cordillera.