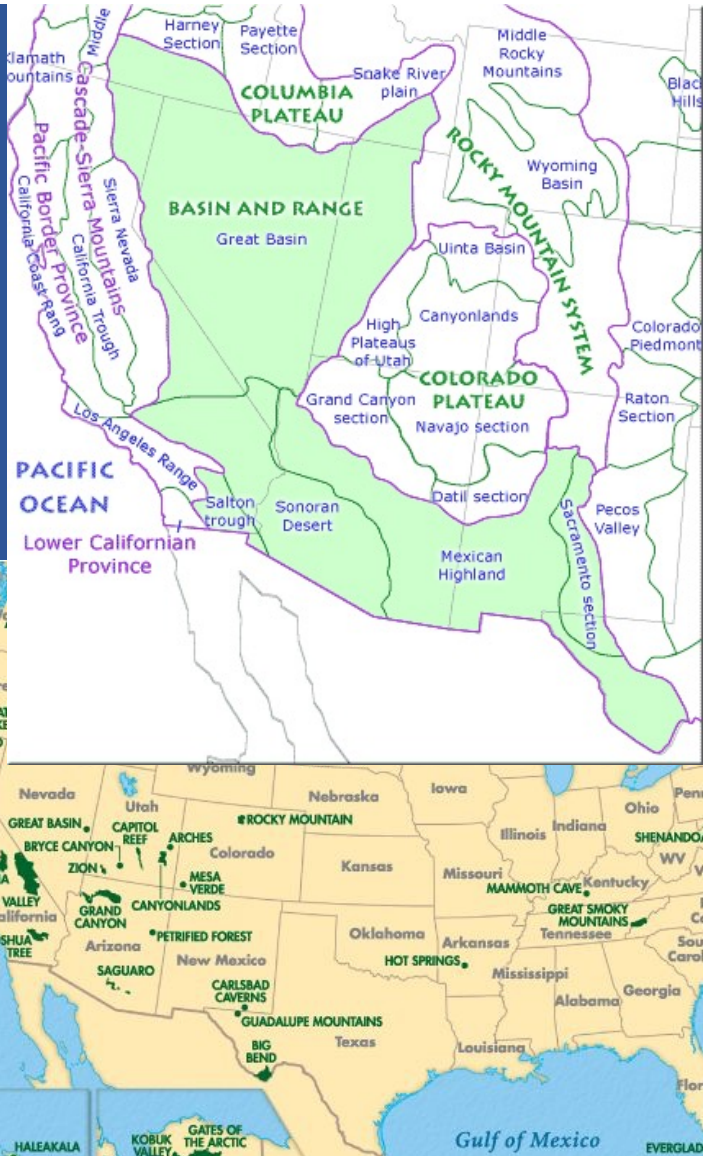
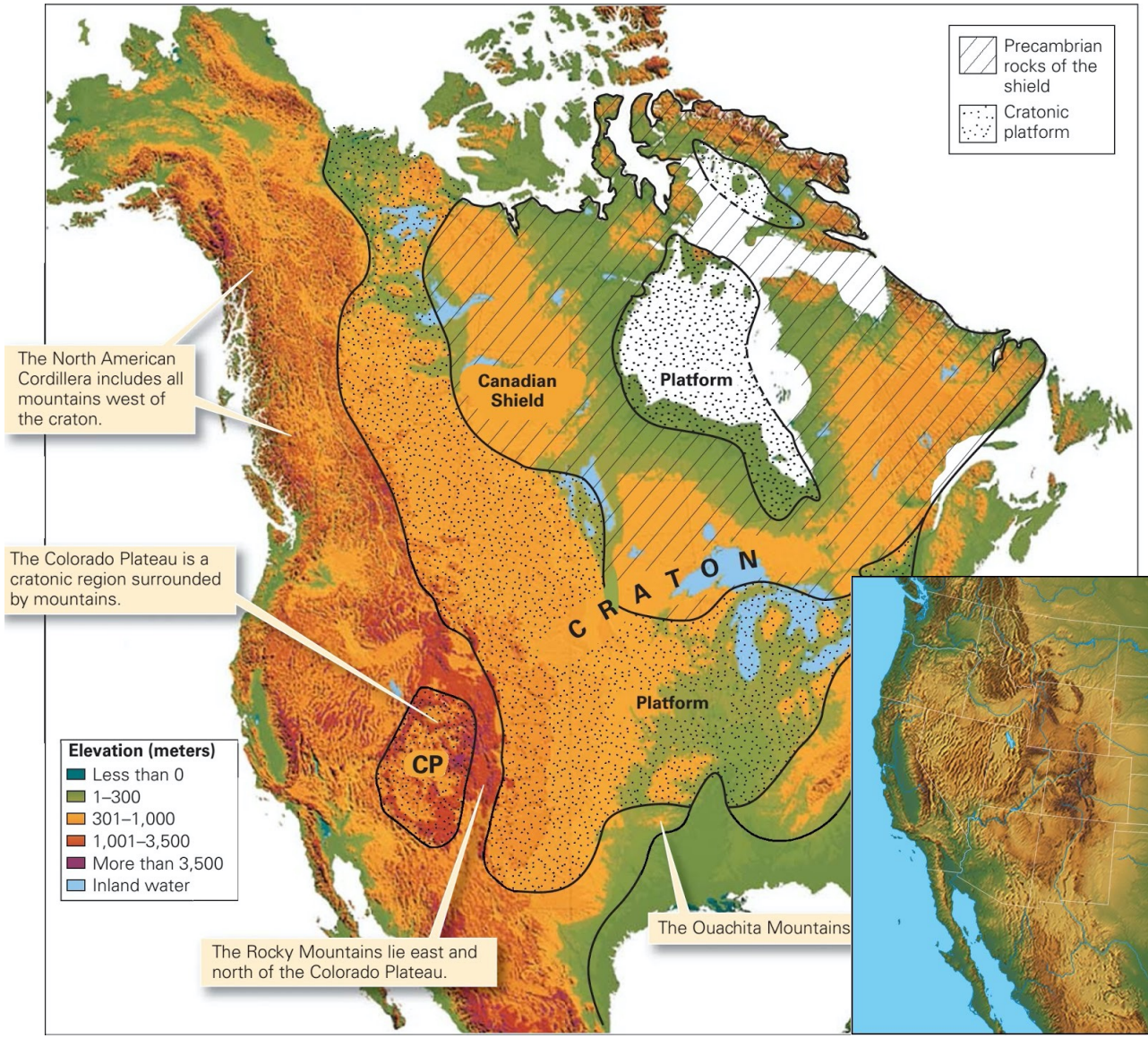
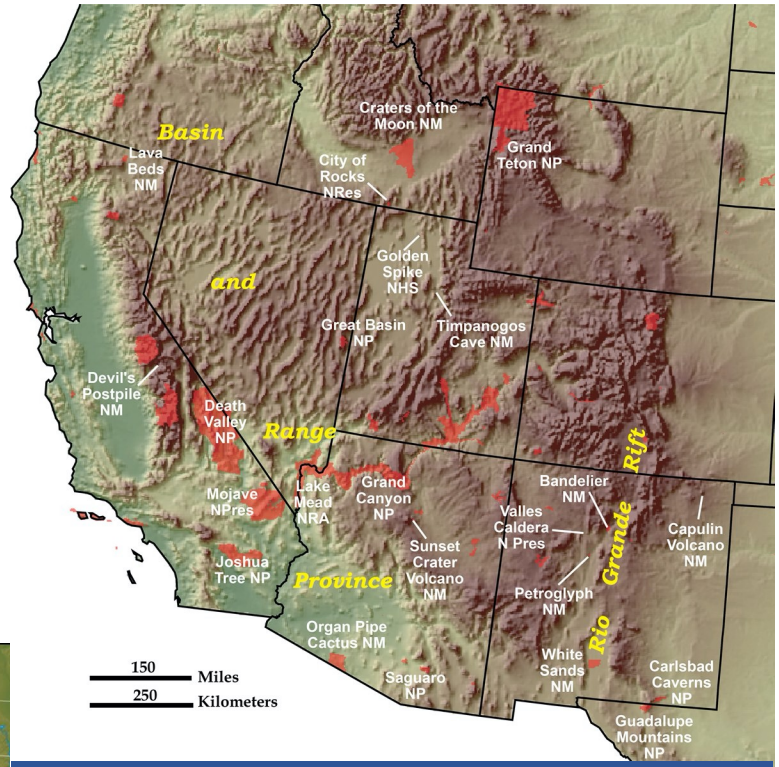
Geology of the National Parks

Evolution of North America
with Nicole Myers
Week 5: The Basin & Range

Video link: https://www.youtube.com/watch?v=xaj_J_3YJMc



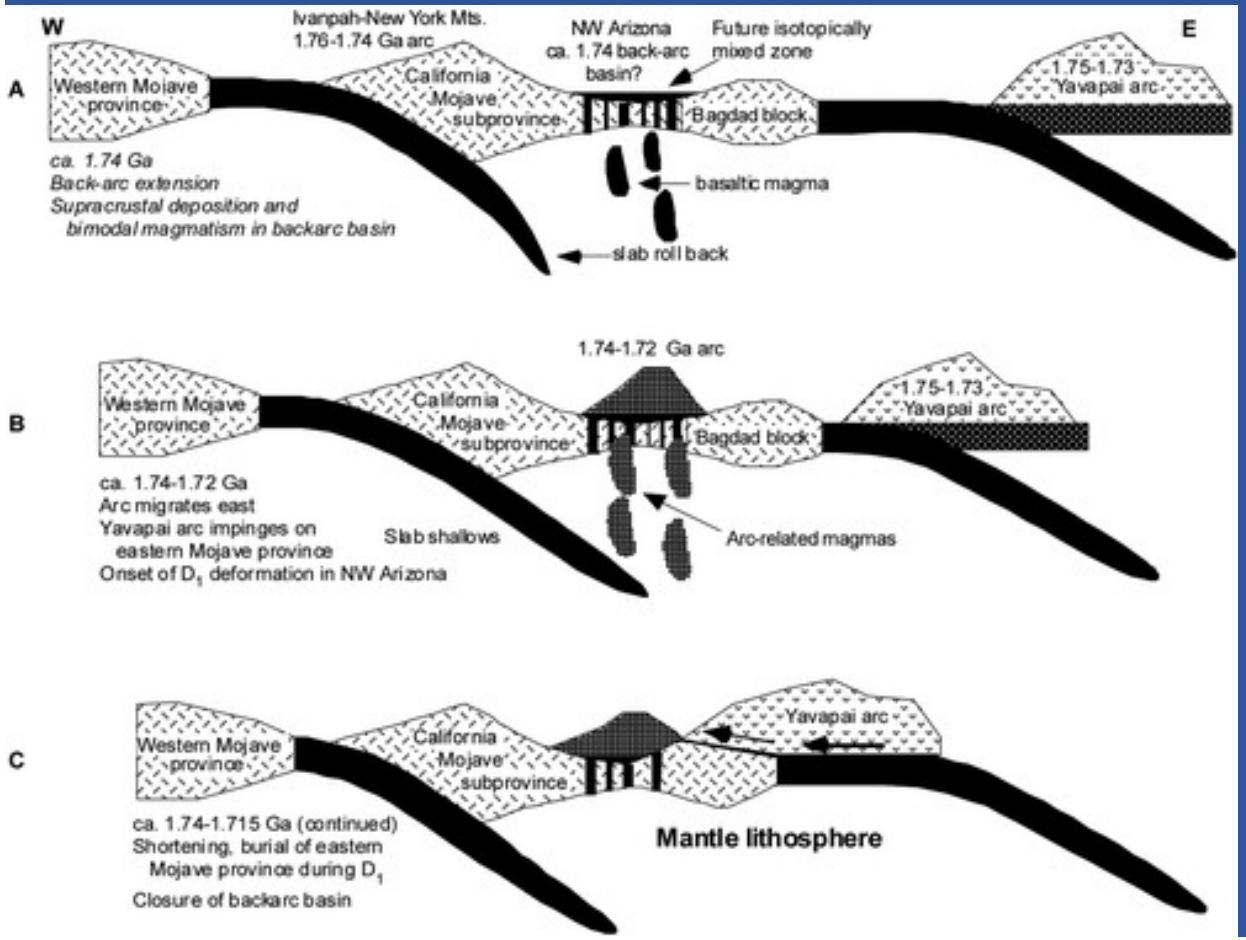


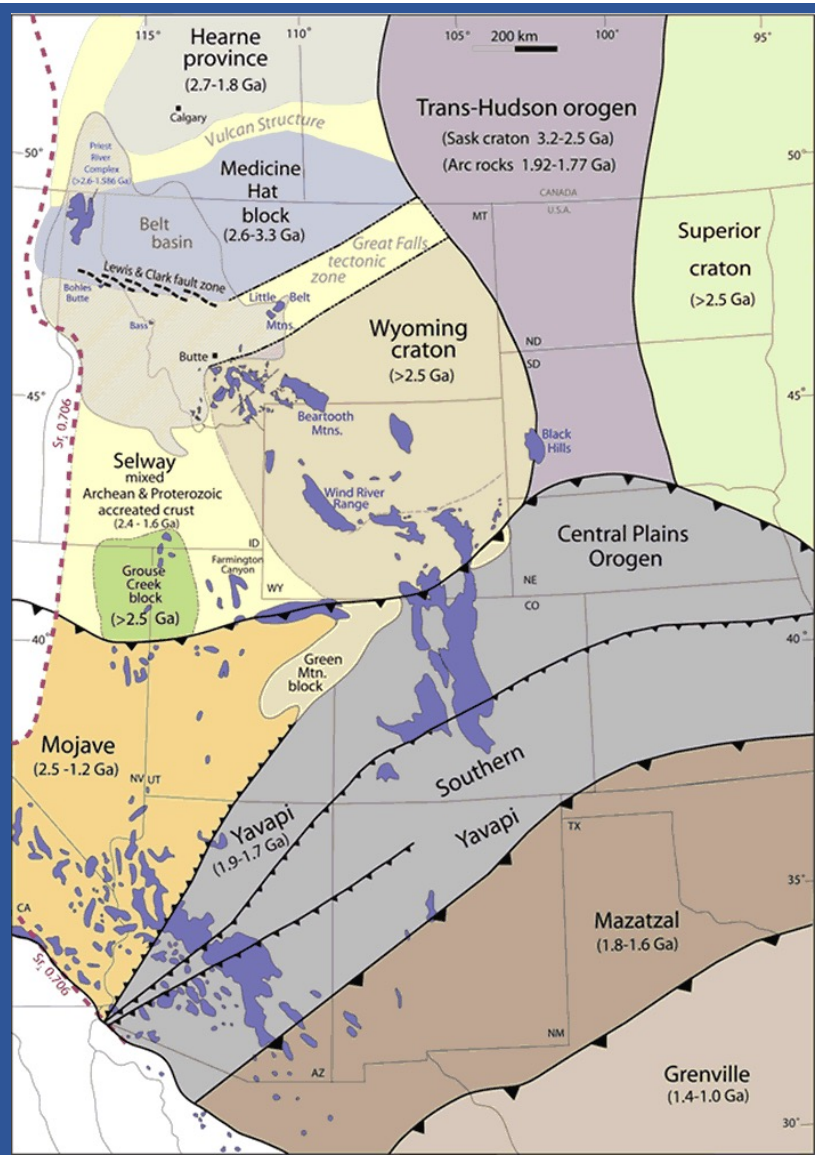


N. America Convergent Boundaries

- Mojave-Yavapai-Mazatzal Orogenies 1.8-1.6Ga
- Ouachita Orogeny ~318-271Ma
- Cordillera Orogenies 375-40Ma

Basin & Range = highly deformed Precambrian rocks sutured at old subduction zones



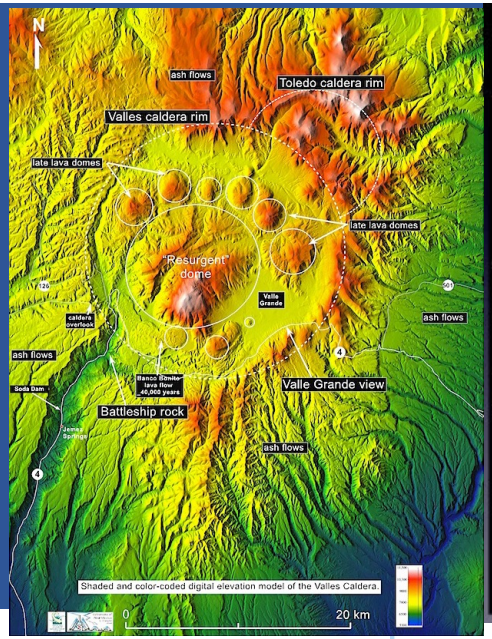


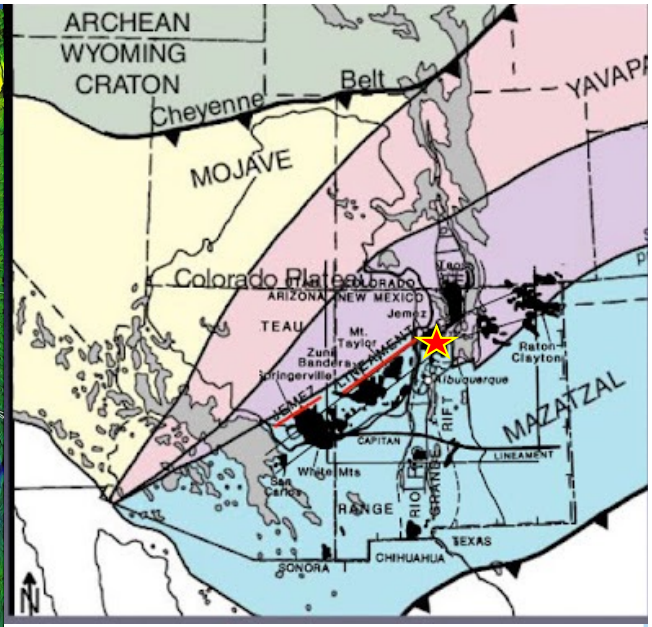
Jemez Lineament

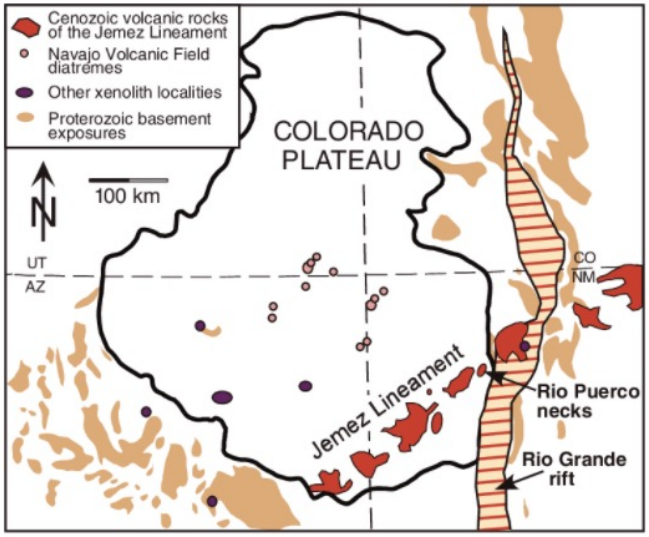
- 14-0.4Ma Lineament: volcanism along zone of weakness = Yavapai Orogeny subduction scar

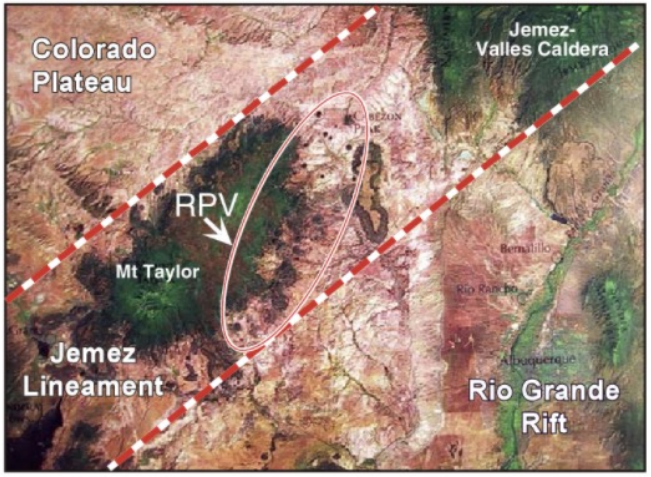
Valles Caldera National Preserve, NM

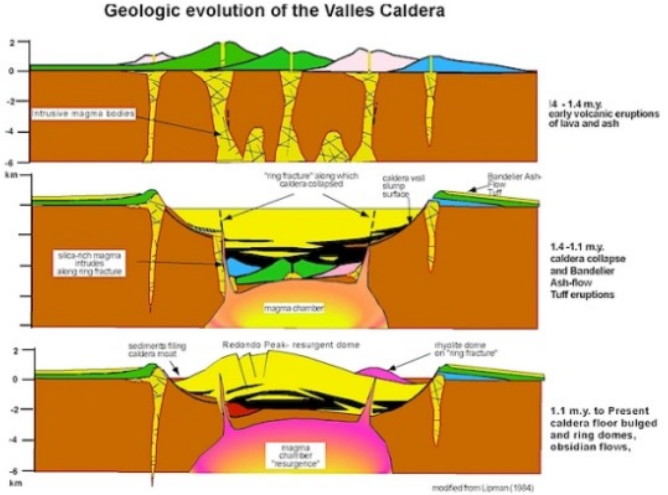
- 1.2Ma Valles Caldera: one of worlds largest young calderas 13.7 miles wide







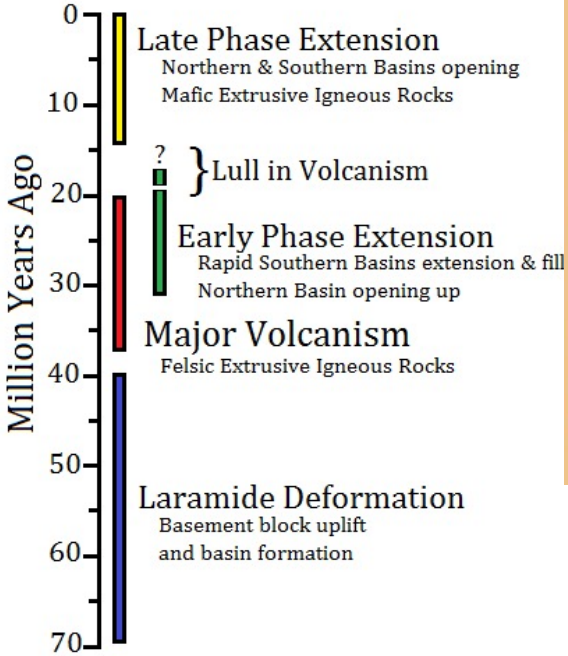


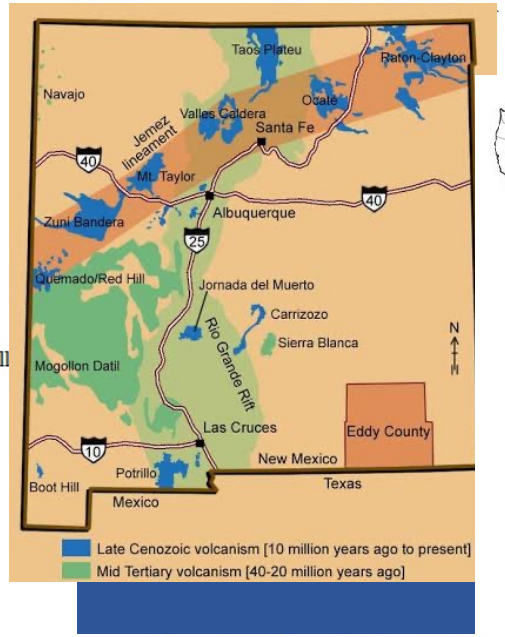


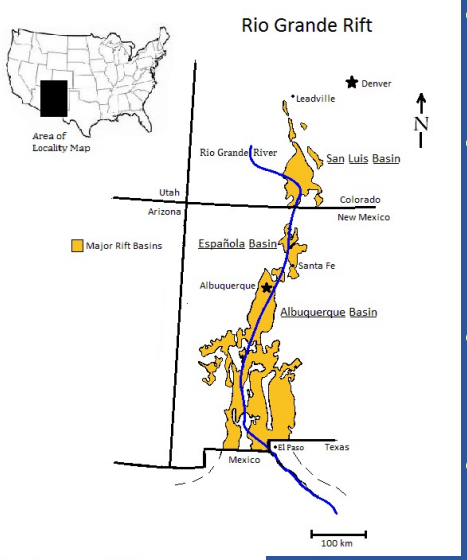
Rio Grande Rift NM & CO

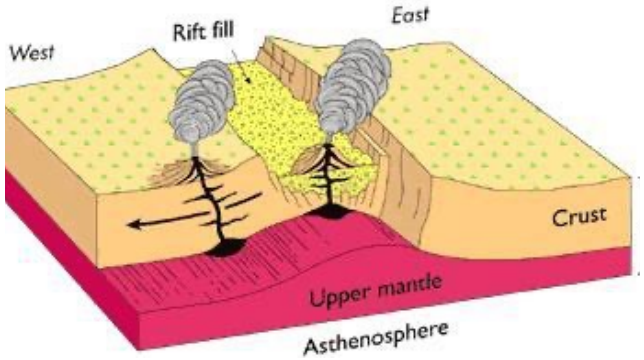
- Rifting : S. ~36Ma, N. ~26Ma, peak 17-10Ma
- Colorado Plateau "Microplate": 1.0-1.5° clockwise rotation?
- Basin Deposition: <15,000ft
- Eruptions: Valley of Fires NM 5,400ybp (youngest)

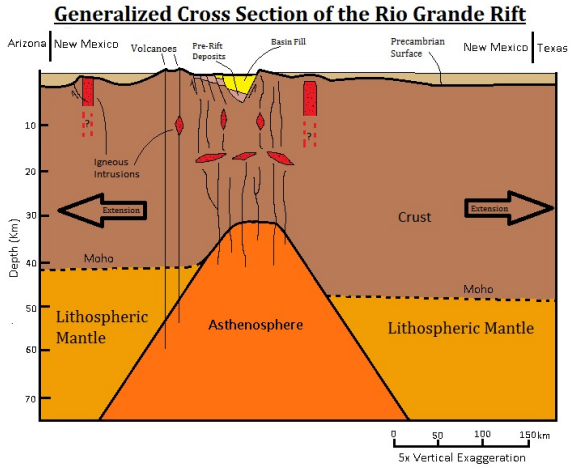
Generalized Timeline of Rio Grande Rift Formation

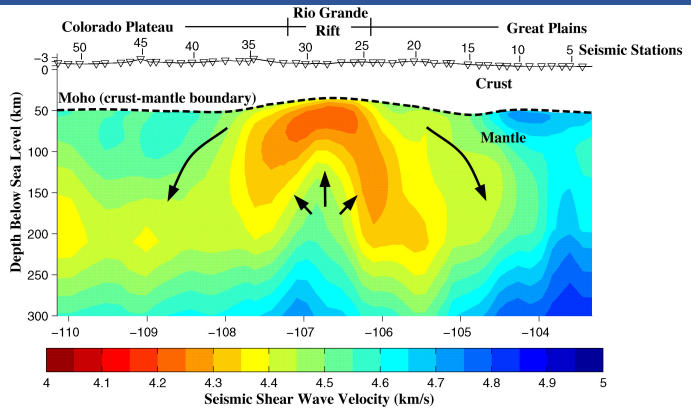








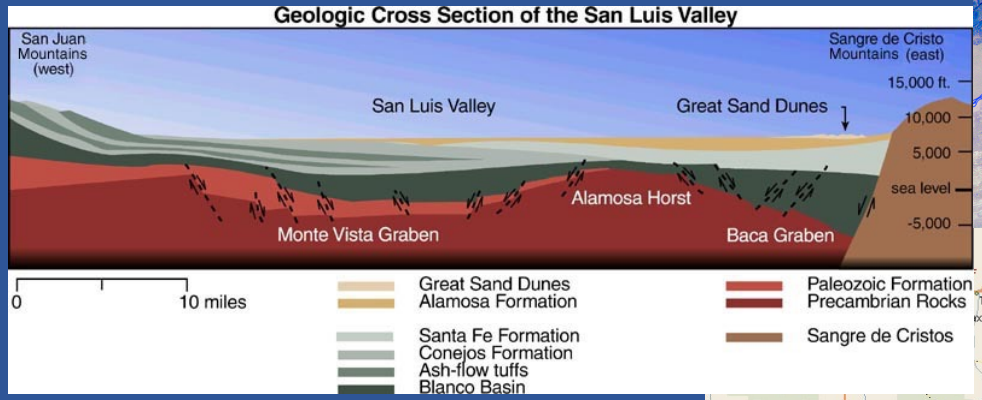


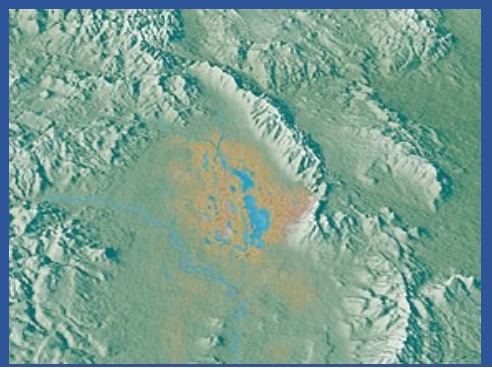


Great Sand Dunes National Park, CO Est. 3/17/1932

- San Juan Volcanic Field: 40-30Ma
- Sangre de Cristo Mountains: ~20-10Ma normal fault
- Lake Alamosa: ~440ka evaporated & wind blew sand
- Avalanches: singing sands

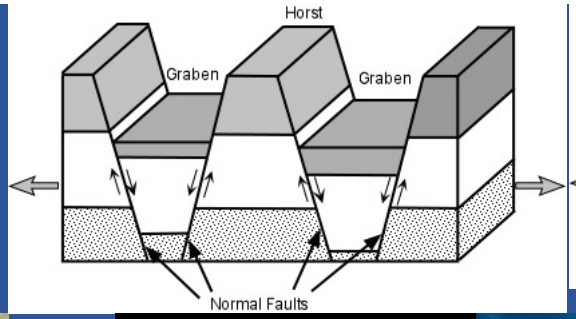
Video links:
https://www.nps.gov/grsa/learn/nature/sanddunes.htm

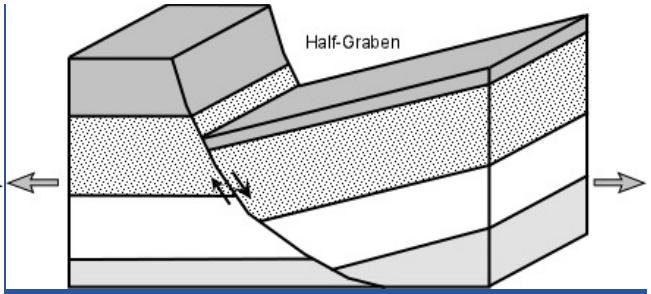


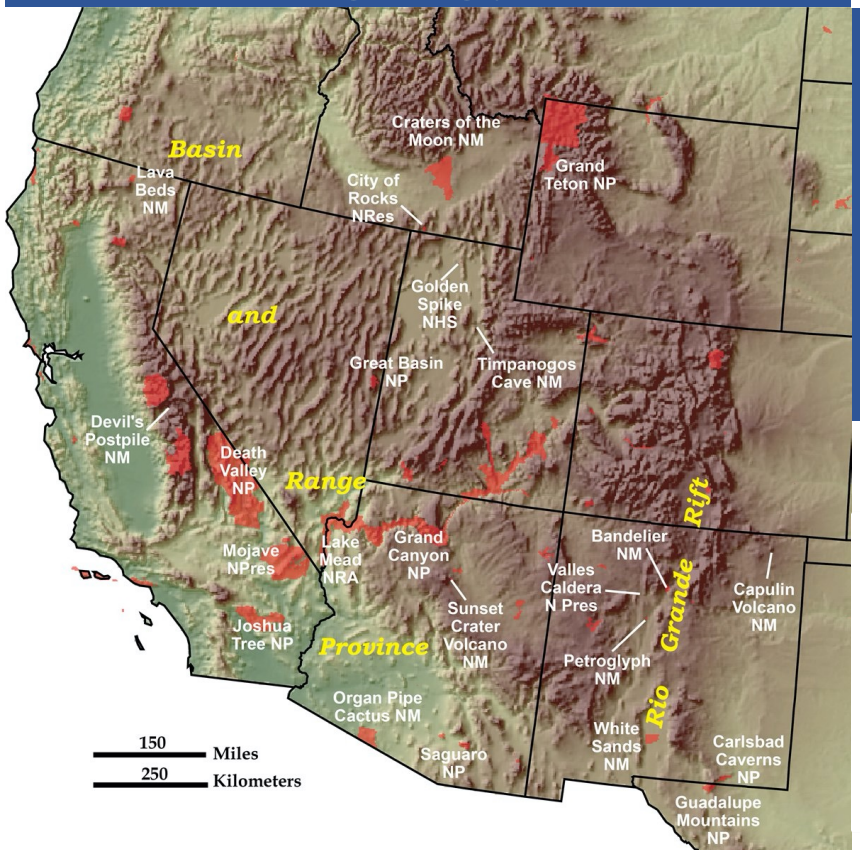


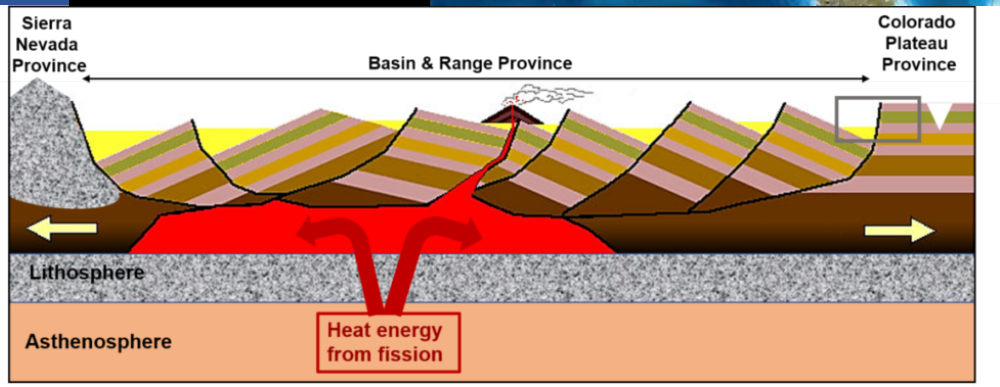
Extensional Faulting

- Normal Faults (high-angle)
- Detachment Faults (low angle)
- Décollement (gliding plane)



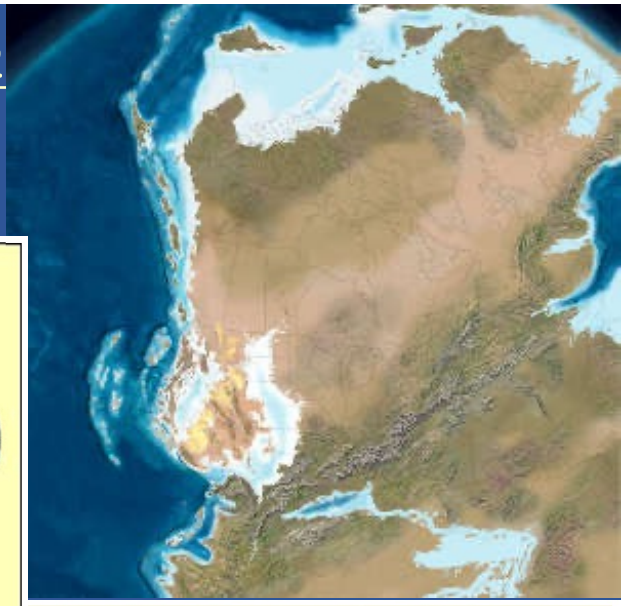


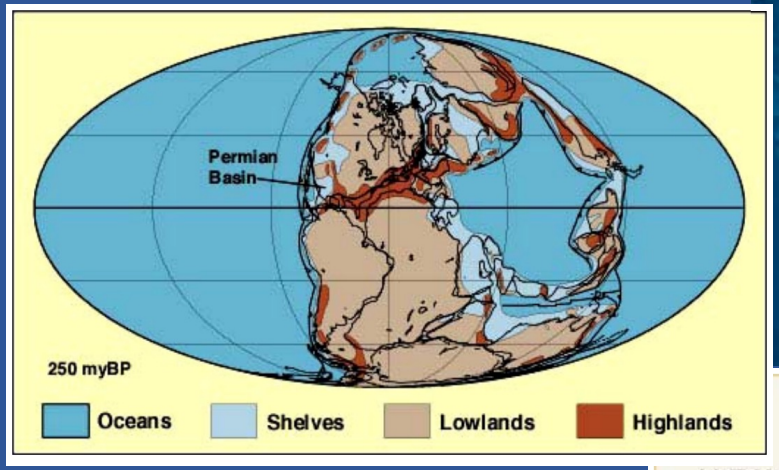


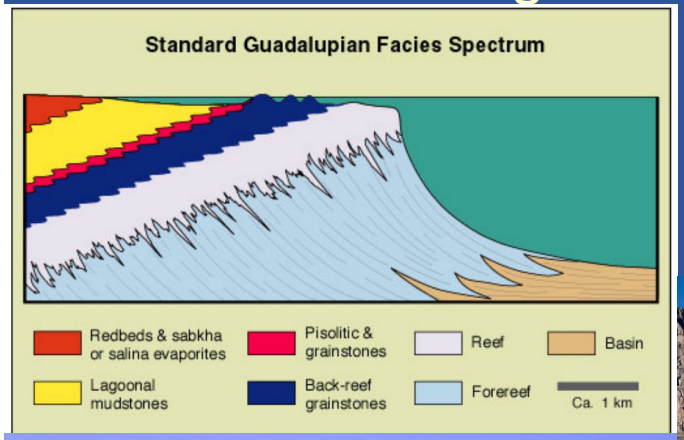


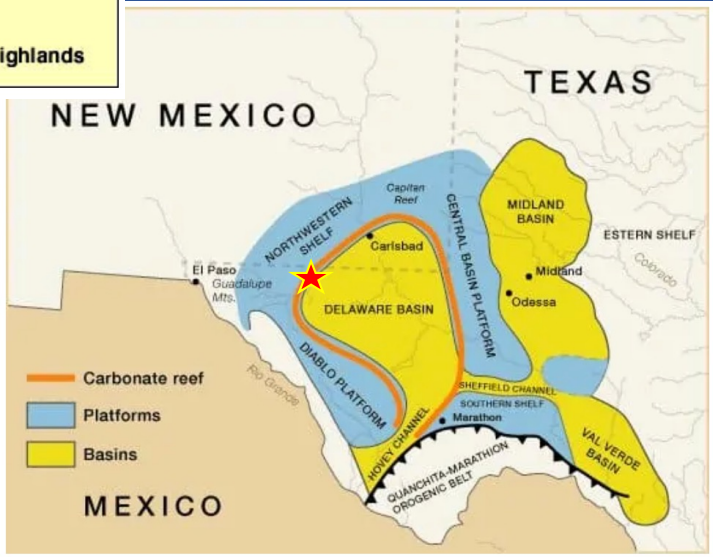
Guadalupe Mountains National Park, TX Est. 9/30/1972

- 300-250Ma Permian Sea & Delaware Basin
- 280-225Ma deposition of limestone interbedded with dark shale
- The Capitan Reef
- 26Ma normal faulting



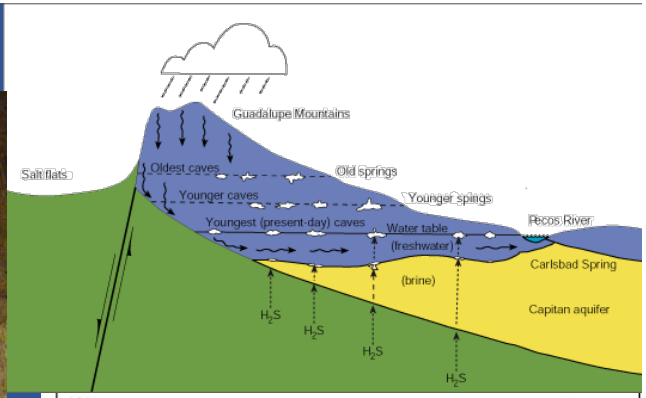


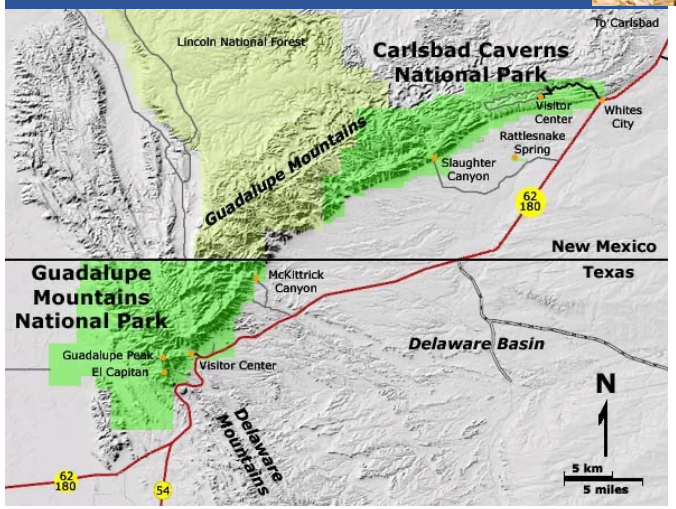


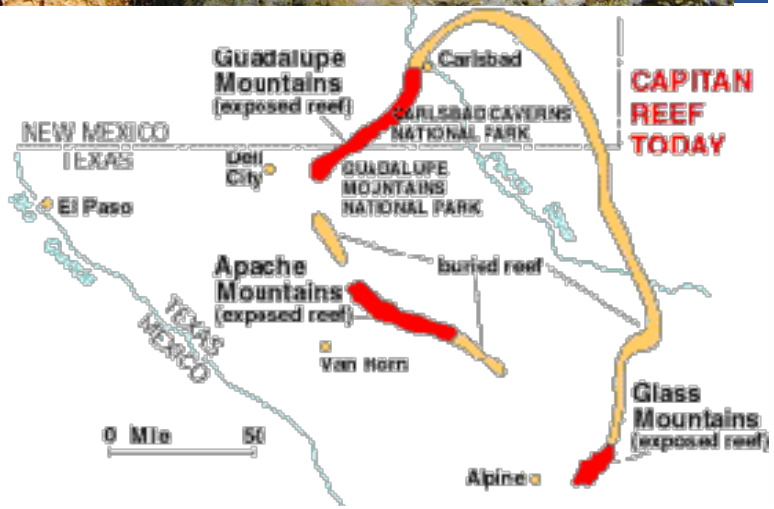


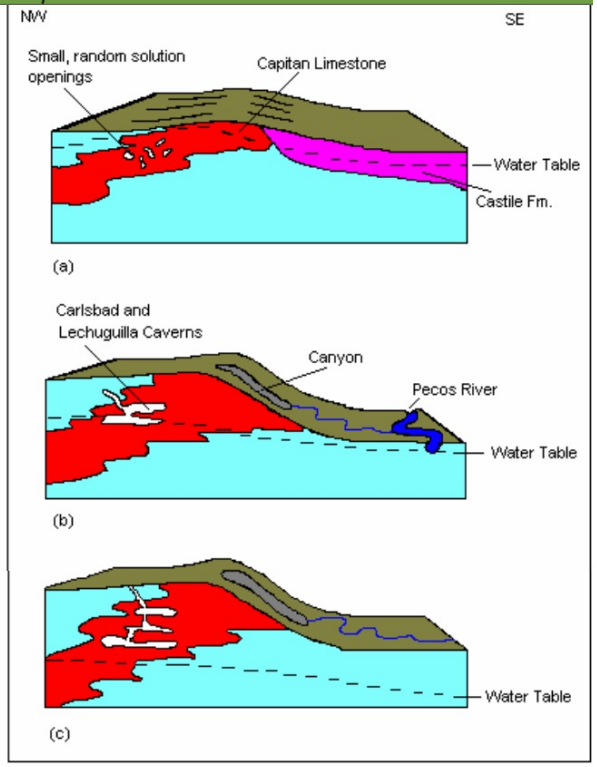
Carlsbad Caverns National Park, New Mexico

- Guadalupe Mountains
- 300-250Ma Permian Sea Capitan Limestone
- 0.6-0.5Ma cave drains & travertine precipitation began
- Est. 5/14/1930





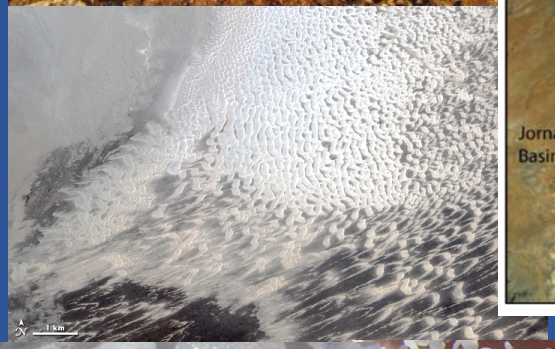


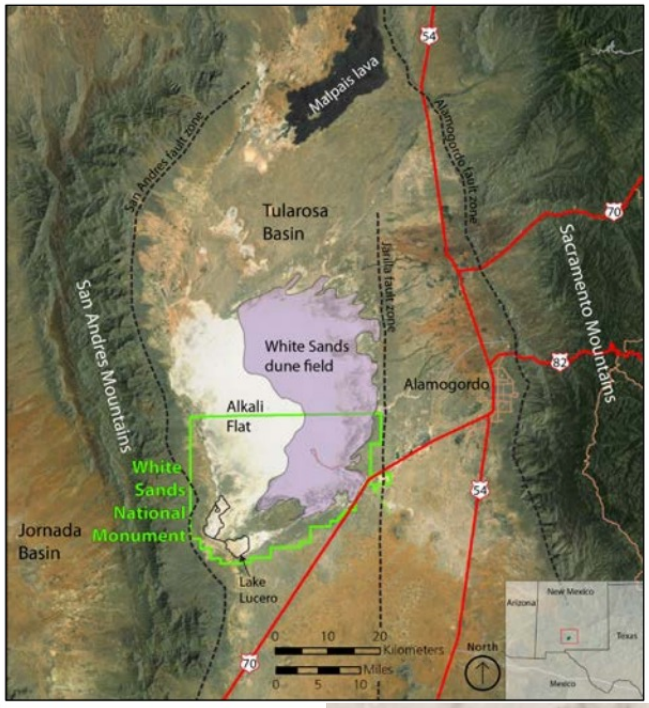


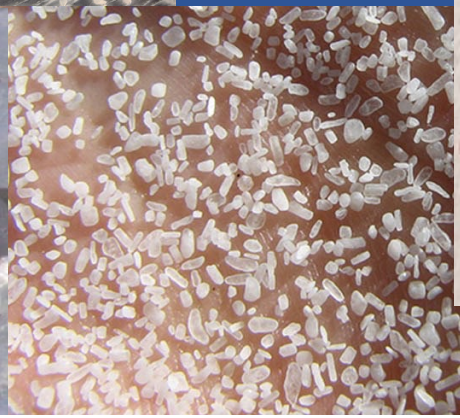
White Sands National Monument, NM Est. 1/18/1933

98% pure gypsum sand

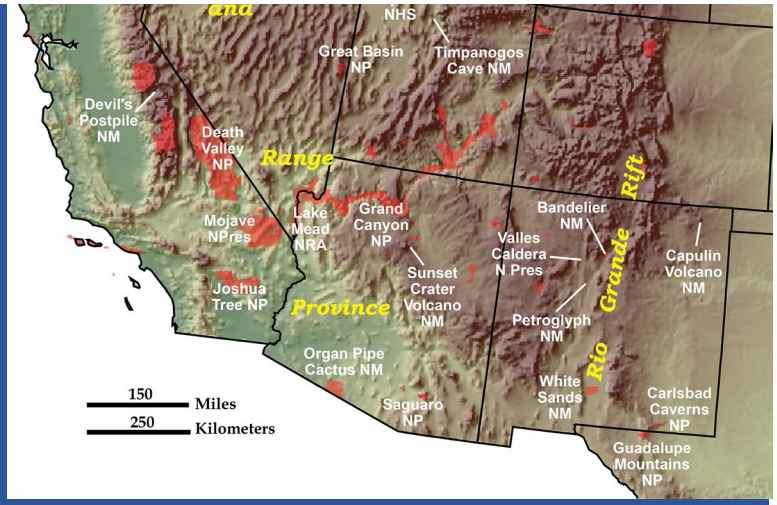
- Permian Sea: evaporation & deposition of gypsum
- 30Ma normal faulting
- 2-3Ma Lake Otero: lake formed by sediment dam during Pleistocene
- Holocene Epoch: Lake Otero → alkali flat eroded by strong SW winds
- ~10-14yr cycle: selenite crystals form

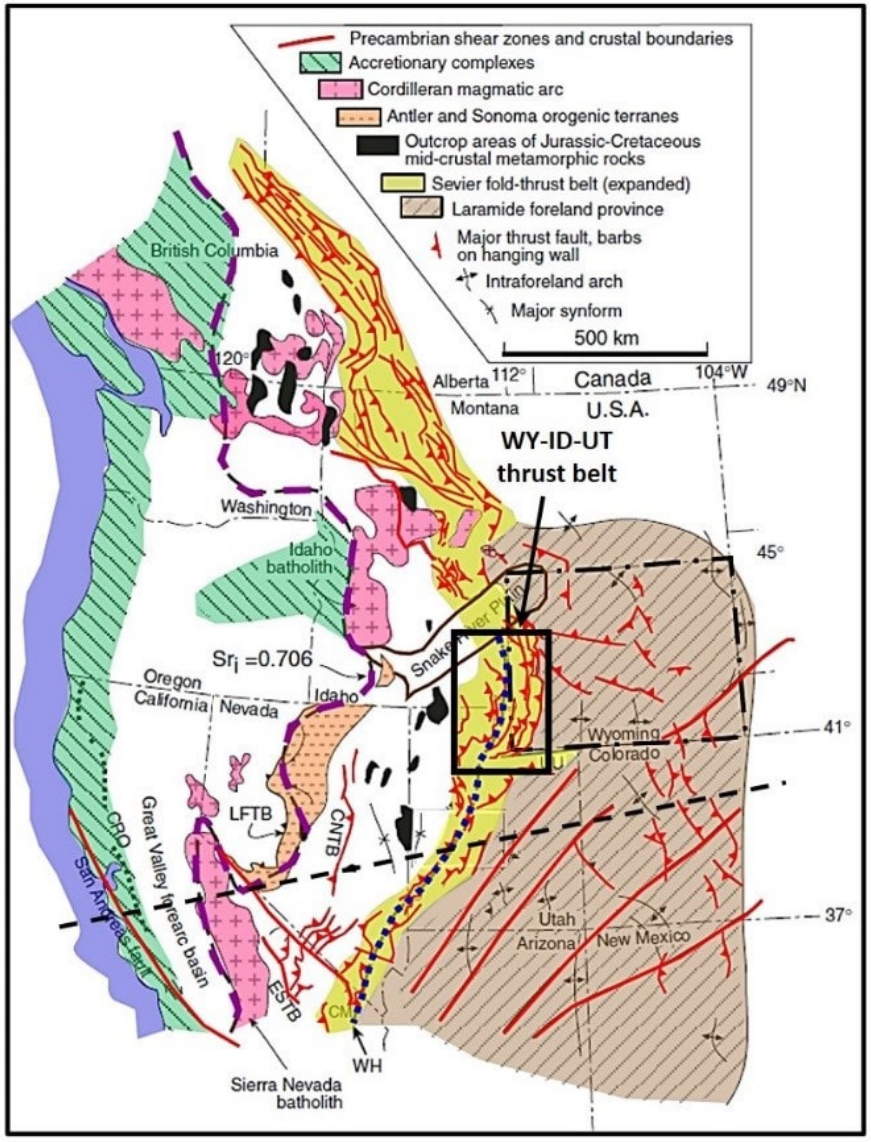






10 Minute Break!





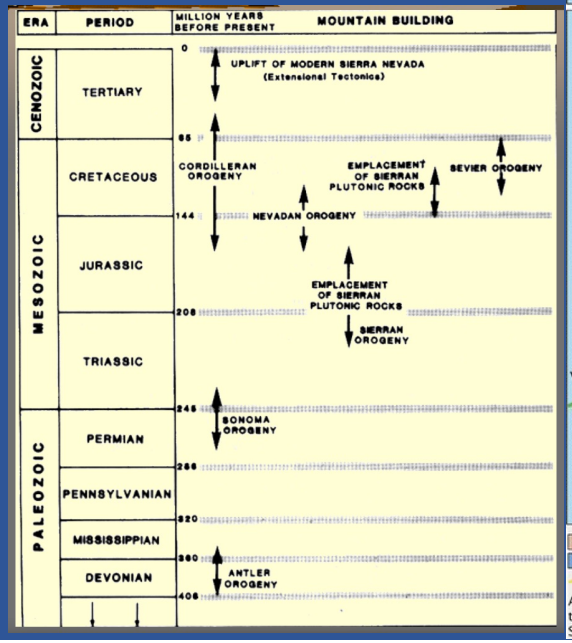
Video link: https://www.youtube.com/watch?v=xaj_J_3YJMc

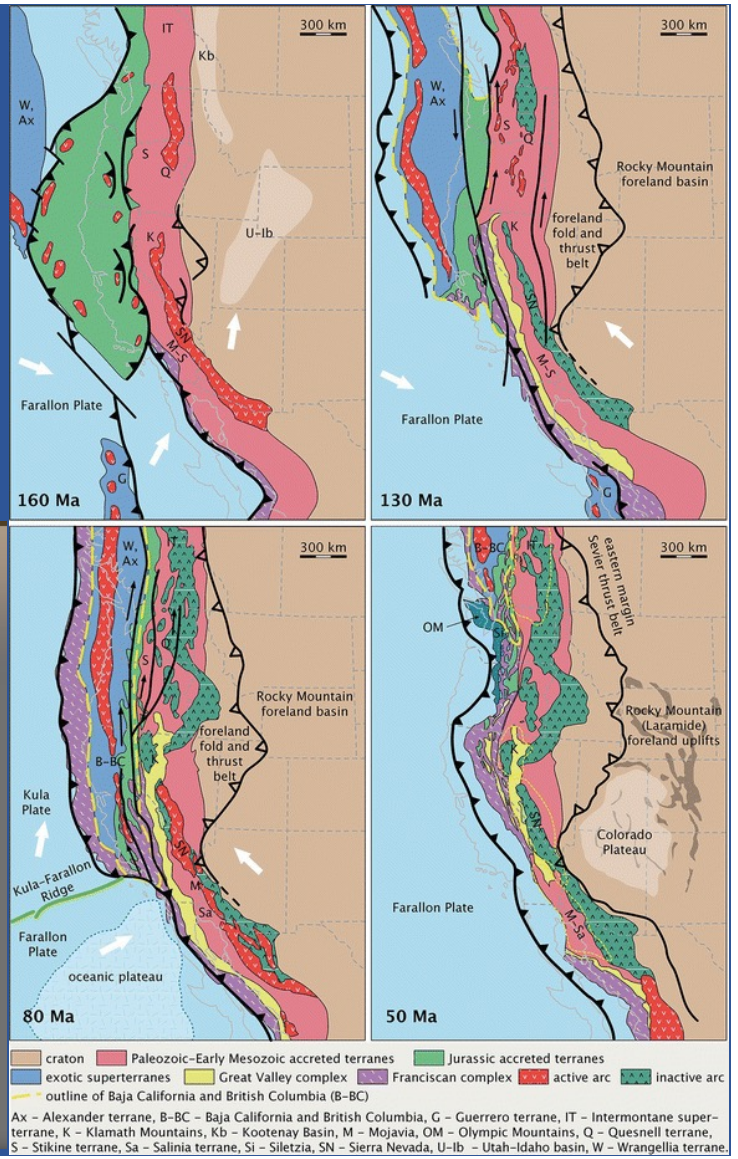
West Coast Accretion

Foreign terranes, deformation, volcanism, & uplift:

- Antler Orogeny 375-300Ma: island arc accretion
- Sonoma Orogeny 280-200Ma: island arcs
- Nevadan Orogeny 180-140Ma: E of Sonoma Orogeny deform., intrusion of Sierra Nevadan granite
- Sevier Orogeny 120-50Ma: E of Nevadan Orogeny deform.
- Laramide Orogeny 80-40Ma: near horizontal subduction?

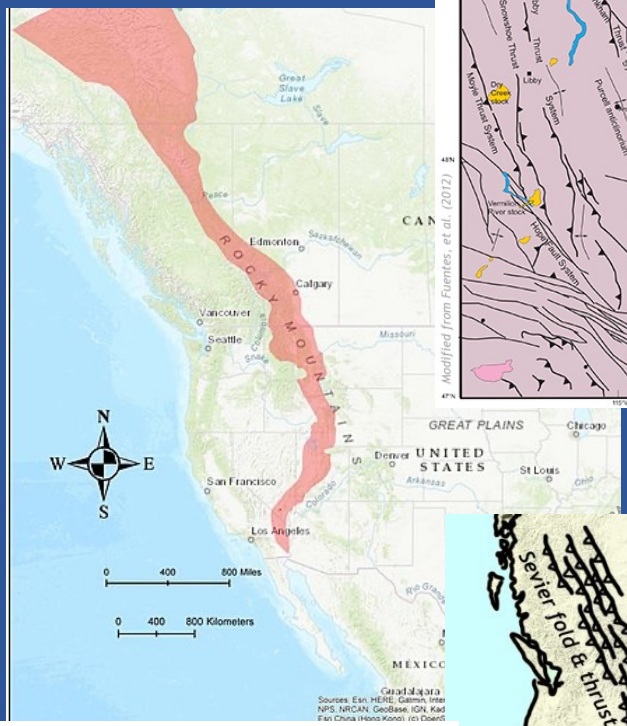
Video link:
https://www.youtube.com/watch?v=xaj_J_3YJMc

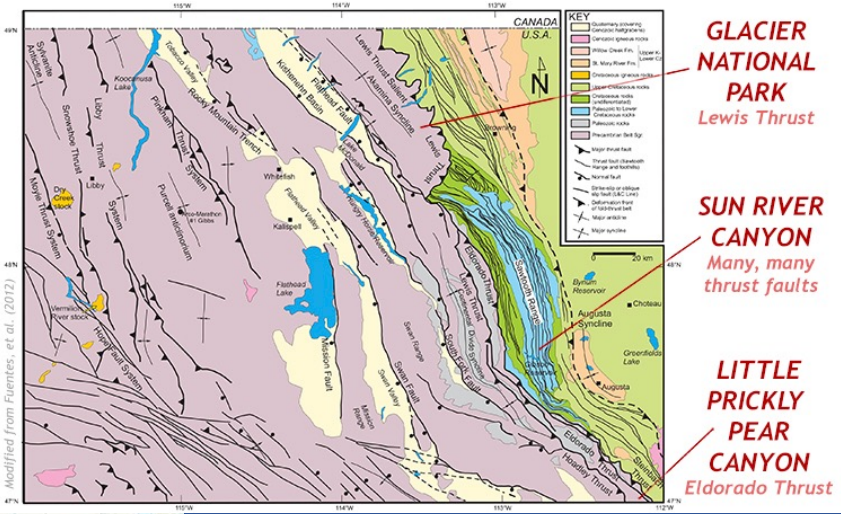


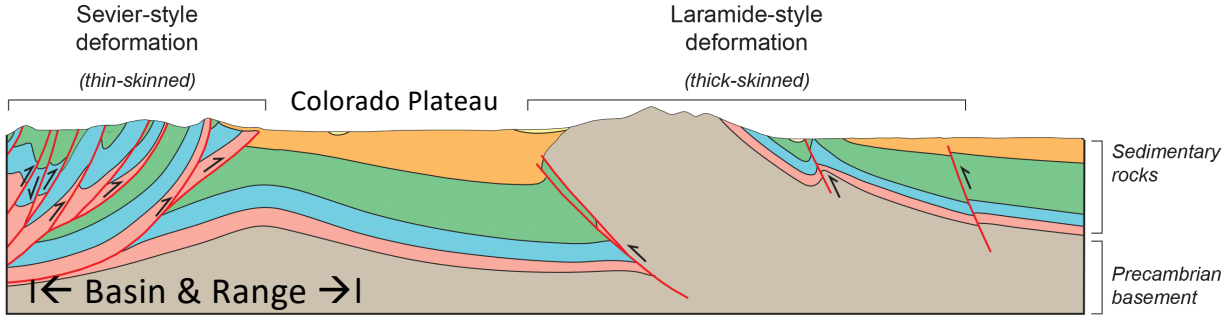


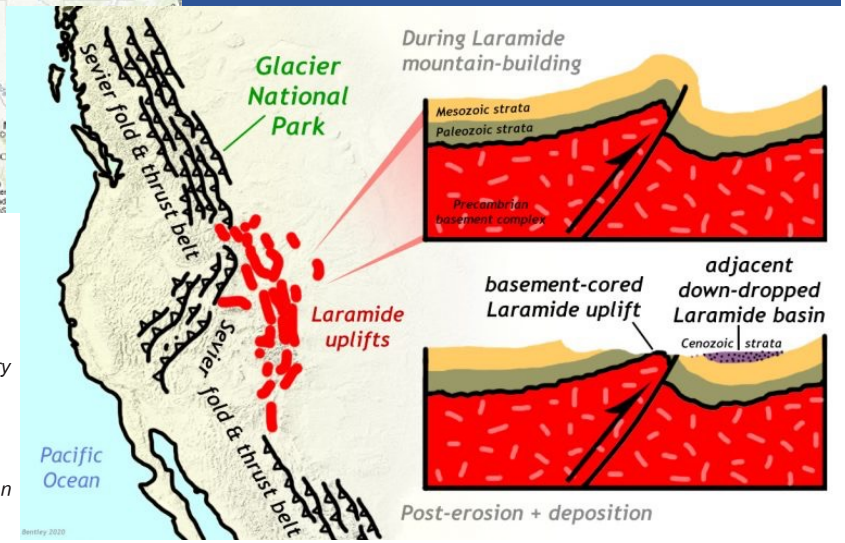
Sevier Orogeny

- 120-50Ma older West migrating to younger East
- 90-70Ma peak metamorphism & shortening up to 60 miles
- 20,000ft mtns due to collapsed when compression ceased
- Sierra Nevada volcanism migrated eastward: 170-150Ma & 100-85Ma
- Late K: transition to Laramide & volcanism East → Colorado



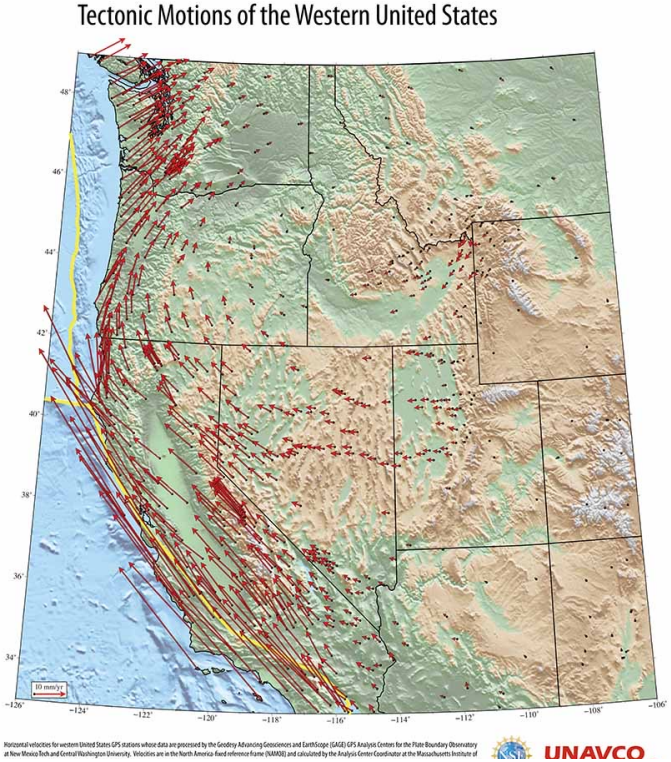


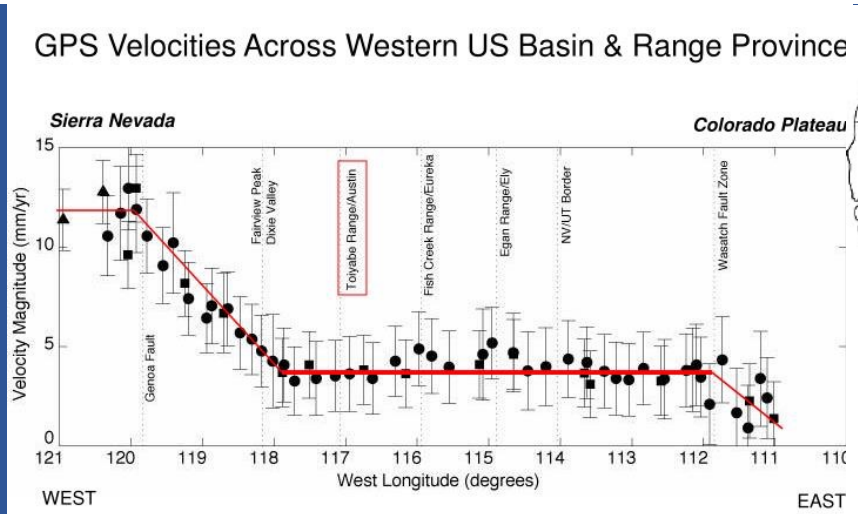


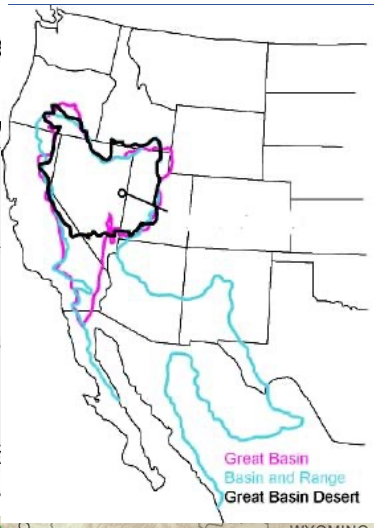


Extensional Basin

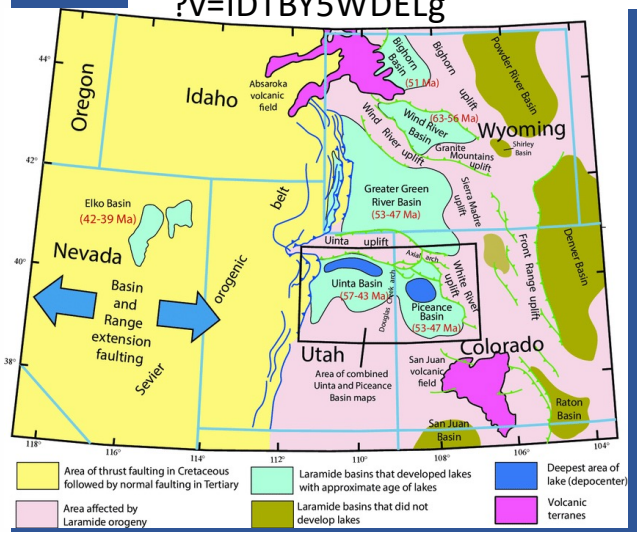
- Isostacy
- Subduction of East Pacific Rise = Formation of San Andreas Transform Boundary







Video link:
https://www.youtube.com/watch?v=IDTBY5WDELg



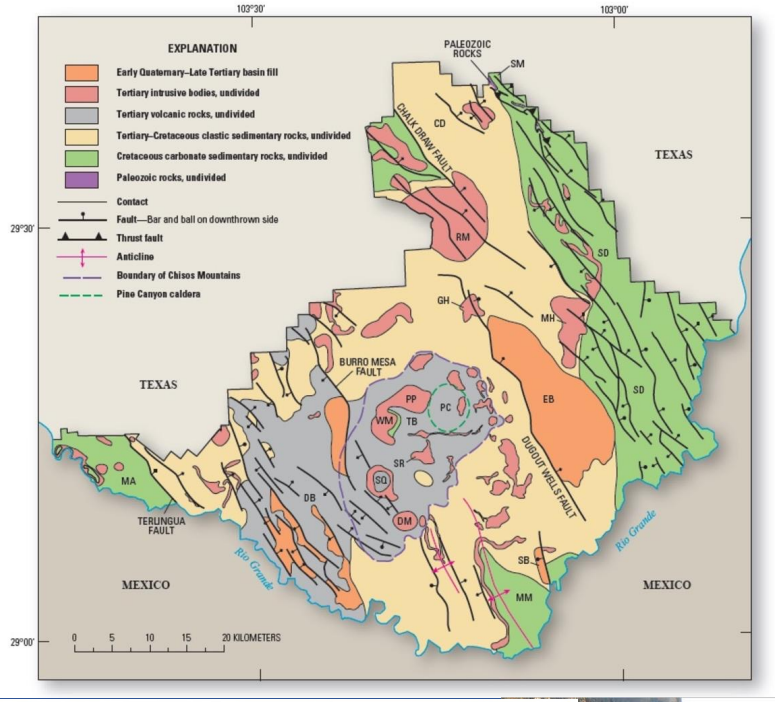
Big Bend NP, TX

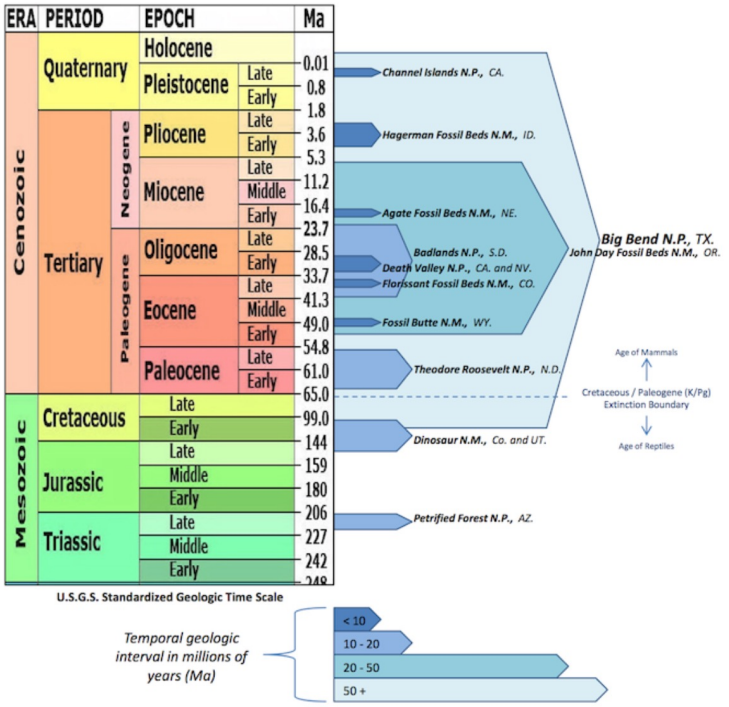
- Paleozoic: marine (exposed in Persimmon Gap)
- Cretaceous: marine → terrestrial

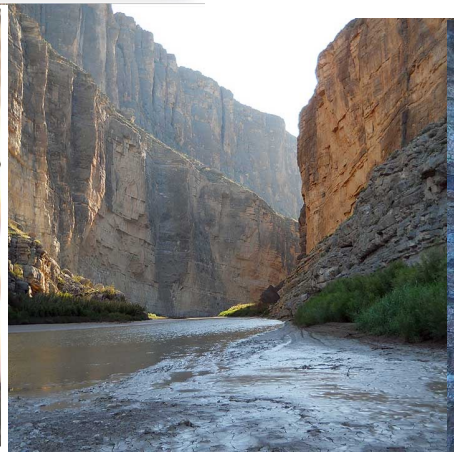
- Fossils: Mesozoic & Cenozoic 50+Ma
- Cenozoic: volcanism 42-2Ma & faulting

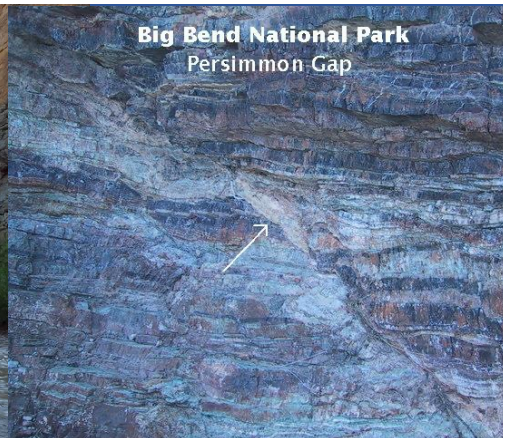
Rio Grande River = ~3Ma transverse downcutting

- Pleistocene: wetter & more erosive river
- Est. 6/12/1944



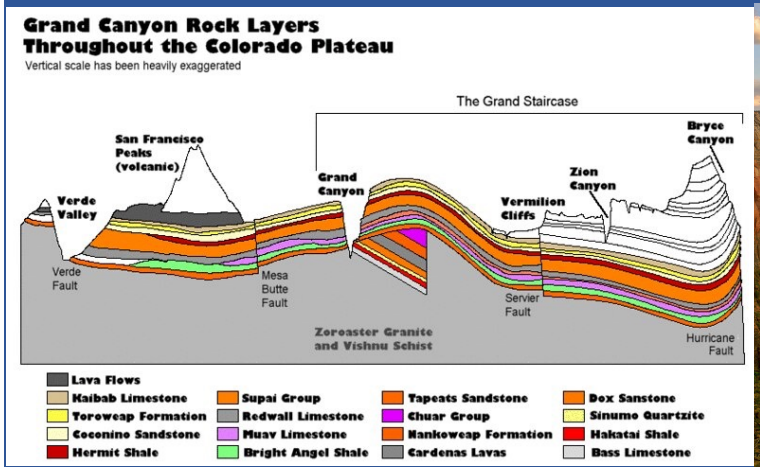


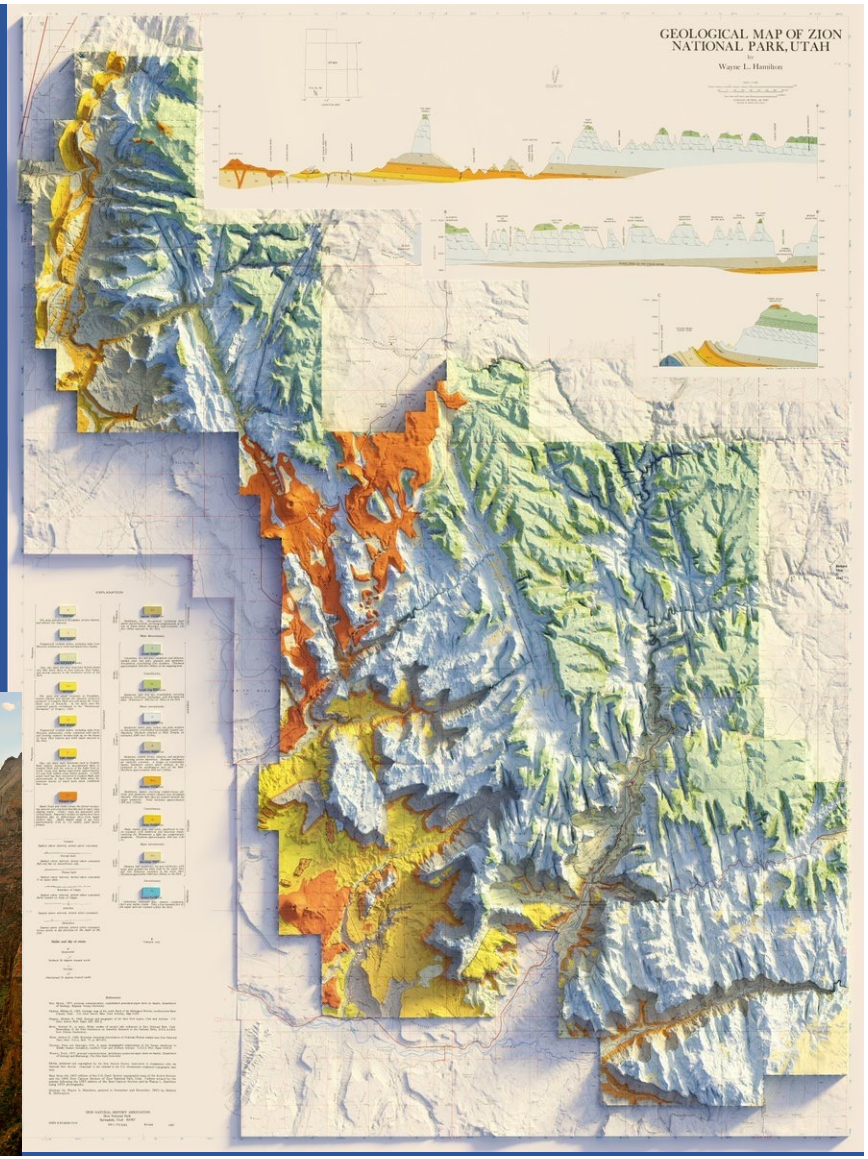




Zion National Park, UT Est. 10/23/1972

- 270-110Ma marine → terrestrial deposition
- 120-40Ma Sevier & Laramide uplift & erosion
- 30Ma San Andreas forms
- 20-25Ma normal faults
- 13Ma Virgin River erosion
- 6Ma Colorado Plateau uplift
- 3.5Ma Santa Clara volcanic field erupts
- 1.1-0.12Ma eruptions dam Virgin River





Zion National Park

Saguaro National Park

Reconstruction of Western North America approximately 10 million years ago.

Paleogeographic map courtesy of Ron Blakey, Colorado

Image links:
https://www.nps.gov/zion/learn/nature/rock-layers.htm &
https://www.nps.gov/zion/learn/nature/upload/Geology07.pdf

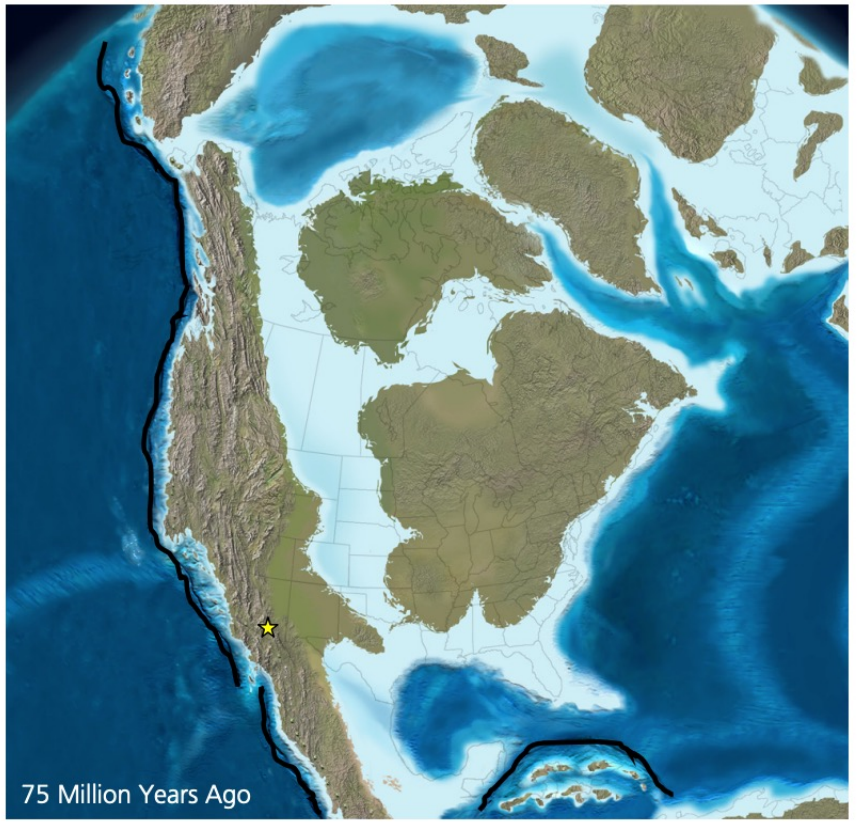
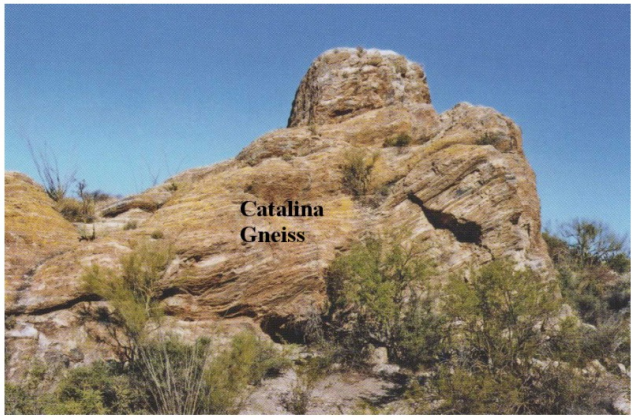
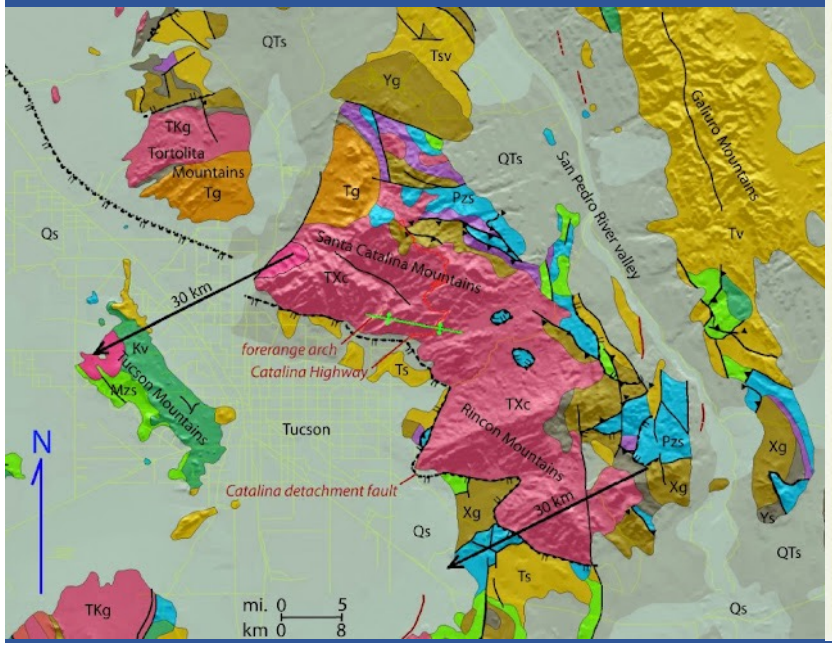


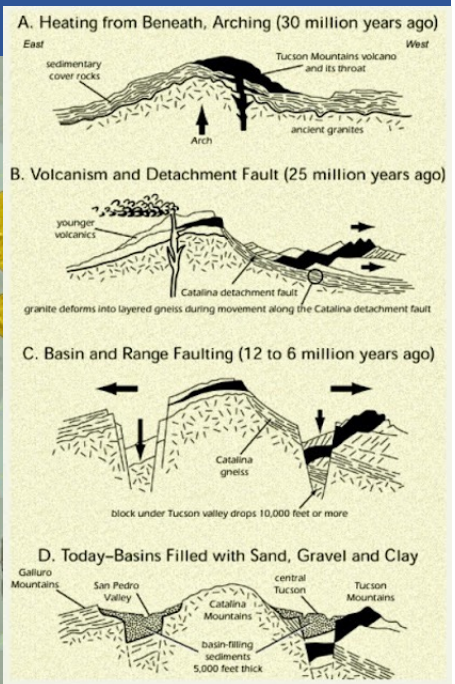
Figure 22. Late Cretaceous paleogeographic map of North America. Approximately 75 million years ago, the Western Interior Seaway slowly retreated to the northeast, leaving vast alluvial plains to mark its past locations. Along the western continental margin, the Sevier Orogeny was at its climax. Regional metamorphism affected western Arizona and eastern California. Paleozoic and Mesozoic sandstone, mudstone, and limestone were metamorphosed to quartzite, schist, and marble. The yellow star marks the approximate location of today's Saguaro National Park. Thick, black lines identify subduction zones. Brown color is land surface. Relative depths of marine water are divided into shallow (light blue) and deep (dark blue). Modified from the Late Cretaceous paleogeographic map of Dr. Ron Blakey, Northern Arizona University, http://jan.ucc.nau.edu/rcb7/namK75.jpg (accessed February 10, 2010).

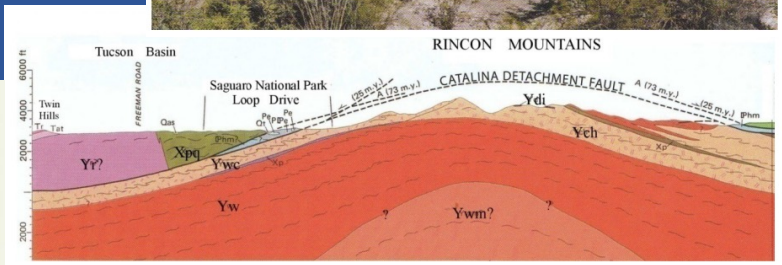
Saguaro National Park, AZ Est. 10/31/1994

- 1.7Ga metamorphic core complex (East)
- 600-275Ma marine
- 80-50Ma Laramide Orogeny: Tucson Mtn caldera eruption
- 30Ma Santa Catalina Detachment Fault
- 30-15Ma Intrusion & lava flows

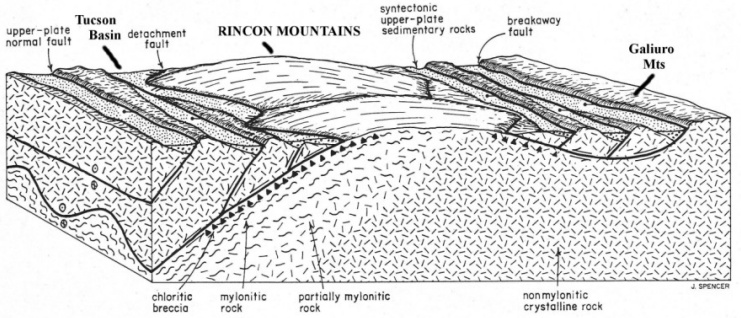








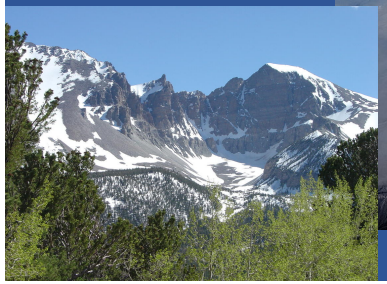
A) Cross section view

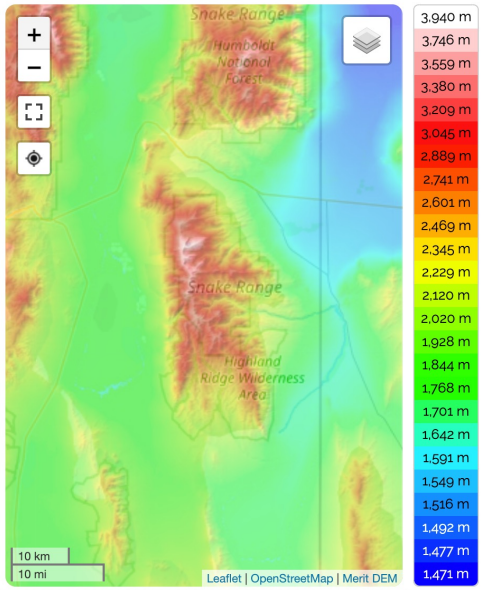


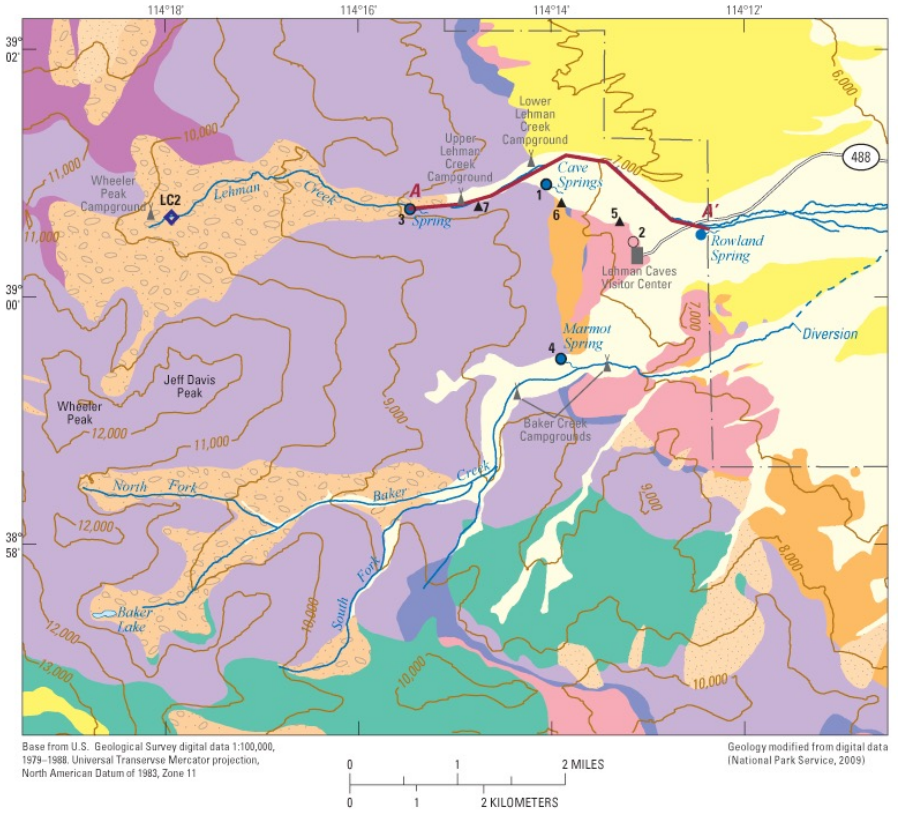
B) Block diagram

Great Basin NP, NV Est. 10/27/1986

- Cambrian marine: Lehman Caves limestone, gypsum, aragonite
- Cretaceous intrusions
- Decollement + normal faulting + volcanism
- Caves began forming 2-5Ma + glacial moraines
- Wheeler Peak glacier + 7 active rock glaciers
- Sevier Lake playa lake







Death Valley NP, CA Est. 10/8/1994

- Turtlebacks: 1.7-1.4Ga basement
- Unconformity: Rodinia divergence + Snowball Earth diamictite
- Paleozoic: marine to near-shore
- Mesozoic: Nevadan Orogeny (Sierra Nevada) thrust faulting & plutons
- Extension: >14Ma faulting
- Volcanism: Ubehebe Crater maar
- Lake Manly: evaporites, alluvial fan, delta