

Geol 104 Geology of National Parks
List of Topics for Final Exam

Below is a list of topics we covered since the second exam. We cannot cover all these topics on the final exam; however, the new topics covered on the exam are listed here. Use the study guides from the previous exams to aid your review of material covered on those exams. Use this list as a guide during your review of new material. After studying for the exam, you should be able to say something meaningful and in depth about each topic here. Word of advice: By now you should know that I want you to understand the processes and events by which the parks were formed (and Earth in general). In general, be able to answer 'what is it?', 'how does it work or how did it form?', 'at what park do we see it?' – the 'it' being anything listed below.

I. Tectonic Events Discussed in Class:

A. Listing of the main NA Tectonic events (1-5, 7 & 8 are review from previous exams, 6, & 9-11 are new material. Events 1-3, & 6-11 build the NA Cordillera)

1. Yavapai collides with Nuna ~1.75 Ga
2. Grenville Orogeny 1.1 Ga: Rhodinia formed as Grenville collides with Nuna
3. Rhodinia rifts ~750-600 Ma
4. Taconic Orogeny ~490 Ma
5. Acadian Orogeny ~425 Ma
6. Antler Orogeny ~380 Ma
7. Alleghenian and Ouachita Orogenies ~320 ma
8. Rifting of Pangaea ~250 Ma
9. Sevier Orogeny 165-80 Ma
10. Laramide Orogeny 80-40 Ma
11. Basin and Range extension and San Andreas Faulting (25 Ma to present)

B. Tectonic Events of the Cordillera (Since the previous exams – i.e. events 1-3)

1. Antler Orogeny
 - a. >380 Ma Subduction of western boundary of Euro-American produces Antler Volcanic Arc
 - b. Reversal of subduction zone (~380 Ma) when Euro-American continent reaches the subduction zone. The Antler Arc is 'accreted' to Euro-American continent and the Klamath Volcanic Arc begins to build on Euro-America
 - i. The sediments eroded from these mountains make the rocks that are uplifted in the Ancestral Rocky Mountains
 - ii. This is the first of many events that add 'accreted' terrains to western North America
2. Alleghenian and Ouachita Orogenies ~320 ma
 - a. These are the final events that form Pangaea
 - b. They also uplift the Ancestral Rocky Mountains when South America and Africa collide with Euro-America
3. Sevier Orogeny (Jurassic to Cretaceous~165-80 Ma)
 - a. This is Andean-type subduction forming on the western boundary of North America after break-up of Pangaea
 - b. Forms the Sierra Nevada Orogenic Belt including the volcanic arc (parts preserved in Yosemite, Sequoia & Kings Canyon) and fold-thrust belt (preserved today in Glacier NP).

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- c. The Sevier Orogeny is not well preserved in central Rockies b/c it was 'diced-up' by later Basin and Range Extension.
- 4. Laramide Orogeny (80-40 Ma) = Change to shallow subduction
 - a. Results in migration of volcanic arc to the east
 - b. Uplifts the Cordillera (modern Rockies) by re-activating old, Precambrian faults originated during rifting of Rodinia.
 - Examples: Rocky Mountain NP, Colorado Plateau
 - c. Uplifts the entire Sevier Orogenic Belt forming the Coastal Ranges of CA, Great Valley of CA, eroding the Sierra Nevada Volcanic Arc and exposing the Sierra Nevada Batholith (now seen in parks of the Sierra Nevada).
- 5. Basin and Range Extension and San Andreas Faulting (25 Ma – present)
 - a. The shallowly subducting Farallon Plate breaks off and sinks into the mantle leaving the really tall and thick Cordillera unsupported and hot.
 - b. The Cordillera collapses under its own weight, spreading apart = Basin and Range Extension.
 - c. When westward moving North America overrides large oceanic transform boundary, the San Andreas Fault is created
 - d. Both San Andreas Faulting and Basin and Range Extension continue today
- 6. Cascade Range: Modern Subduction from northern CA through OR and WA

II. The Parks and what you see there:

A. Glacier National Park

- 1. The Lewis Thrust Fault = Sevier Orogeny Fold-Thrust Belt
- 2. Glacial Geology
 - a. U-Shaped Valleys
 - b. Glacial Budget = when glaciers advance vs. retreat

B. Rocky Mountain National Park

- 1. Cordilleran Basement (old rocks related to collision of Yavapai with Nuna)
- 2. Laramide uplift
- 3. Glacial Geology (as above) – also deposits from glaciers = moraines

C. Yellowstone – The first National Park

- 1. A mantle hot-spot volcanic system
 - a. Melting of a mantle plume (decompressive melting)
 - b. General magmatic-volcanic system
- 2. Volcanoes in general:
 - a. Where are they located on Earth?
 - b. Different types of volcanoes, their sizes, characteristics, and eruptions
 - c. Yellowstone produced by a Caldera Collapse
 - d. Geologic history of Yellowstone:
 - i. Laramide volcanic system of Absaroka Range
 - ii. Basin and Range extension raises the plateau and the Tetons
 - iii. Plume migrates to Yellowstone over past 16 Ma,
 - iv. Arriving ~2 Ma at Island Park Caldera (big eruption)
 - v. Shifts to Yellowstone Caldera ~1.2 Ma – huge eruption ~0.6 Ma

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3. Hydrothermal Activity: Geysers, Mud Pots and Paint Pots
 - a. Heat supplied to the hydrothermal system from the magma of Yellowstone volcanic system
 - b. Geyser plumbing system

- D. Death Valley
 1. Extreme topography and weather (why so hot?)
 2. Rain shadow desert
 3. Formation of Death Valley: Basin and Range extension and San Andreas Pull-Apart
 4. Geologic History of Death Valley –records an immense amount of time 1.75 through present

- E. Yosemite, Sequoia and Kings Canyon (the Sierra Nevada range)
 1. Formation of Sierra Nevada Mountains:
 - a. Antler Orogeny makes the basement/foundation
 - b. Sevier Orogeny creates the Sierra Nevada Volcanic Arc
 - c. Laramide Orogeny uplifts the Sierra Batholith to the surface
 - d. Basin and Range extension transports the Sierra Nevada westward
 - e. San Andreas faulting dices the Sierra Nevada a little
 2. Shaping the modern Sierra Nevada
 - a. Large dome structures from combination Spheroidal weathering, exfoliation/sheeting and joint controlled mass wasting
 - b. Glaciers carve the U-valleys we see at Yosemite, and Kings Canyon
 3. Sequoia Trees: Very old and Very Tall

- F. Cascade Range (Rainier, St Helens, Crater Lake)
 1. Tectonic Setting: Current/active subduction beneath North America
 - a. Cascade Volcanic Arc extends from northern CA to southern BC
 - b. Nearly all the volcanoes are either Dormant or Active
 2. Melting at Subduction Zones
 - a. Hydration or Flux Melting
 - b. How does it lead to Plinian/explosive eruptions?
 3. Cascade Volcanoes – risky in general because they erupt explosively and close to cities
 - b. Mt Rainier
 - i. Tallest cascade volcano
 - ii. Many glaciers flow from the middle of the mountain
 - iii. Lahars – the main risk from Rainier
 - c. Mt St Helens: The 1980 eruption – triggered by a landslide caused by magma bulge on flank
 - d. Crater Lake (fills the caldera of Mt Mazama)
 - i. About the Lake: deep and clear, very big
 - ii. Eruption of Mt Mazama