

Geol 104 Geology of National Parks
Lecture 08 Grand Canyon Geography and Colorado Plateau

I. Geography of the Grand Canyon

A. Located on the Colorado Plateau

1. Part of the NA Cordillera
 - Large Plateau (composed of many smaller ones) west of Rocky Mountains
3. Formation of the Rocks and the canyon itself are intimately related to the history of the Colorado Plateau and the Colorado River that flows through the canyon
4. J.W. Powell
 - a. First non-native to explore the canyon
 - b. Rafted down the river
 - i. lost only three of his nine men – they abandoned the party to ‘escape’ the canyon and were killed by hostile Mormons (or Native Americans).
 - ii. Correctly assumed that a river transporting so much sediment would have eroded its channel and would not have big waterfalls (certain death!).
4. Colorado River Flow
 - a. Regulated since 1966 by Glen Canyon Dam (Lake Powell)
 - b. This cut of sediment supply to the river, devastating it’s ecosystem
 - i. No spring floods to clean river bottom and ‘pulse’ cold water
 - ii. Loss of beaches and bars along river – loss of habitat
 - c. Below the canyon, Hoover Dam (Lake Mead) has regulated the river since 1935
 - i. two football fields thick at the base
 - ii. Enough concrete to build 4-lane highway from Seattle to Miami, or a sidewalk around Earth’s equator.

B. The Canyon is roughly oriented East-West

1. 227 river miles run through the Canyon
2. > 1 mile deep (~1.6 km)
3. 9-18 miles across (14-29 km)
4. The rocks span ~1.75 Ga of Earth history – Precambrian through Permian

Geol 104 Geology of National Parks
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C. North vs. South Rim

1. North Rim

- a. From east to west, the North Rim is on the Kaibab Plateau, Kanab Plateau and Shivwits Plateau
- b. Elevation ~8900 feet (about 1200 feet higher than South Rim)
- c. Ecologic zone is similar to Northern US/Canada
 - Aspen, fir and blue spruce trees

2. South Rim

- a. On the Coconino Plateau
- b. Elevation ~6900 feet)
- c. Ecologic zone typical of upper Sonoran desert – juniper and pinon pine
 - evolution on the south rim diverges from that of the north rim due to widening of the canyon and elevation differences (e.g. Kaibb squirrel on North rim and Abert squirrel on South. Both evolutionarily related to a common ancestor.)
- d. The canyon floor and the Coconino Plateau dip to the south
 - i. drainage from the south rim does not feed the canyon – erosion is less on this side
 - ii. Result: the river flows closer to the south side of the canyon

II. Tectonics of the Colorado Plateau

A. Early Cenezoic (Tertiary ~60 Ma)

1. Kula oceanic plate subduction
 - a. off the (current) west coast of NA
 - b. at that time, continental margin was East of Nevada
2. Very shallow subduction in NA (volcanism shuts off in CA/NV)
 - a. caused uplift of Rocky Mountain foreland (LARAMIDE Orogeny) in UT, CO, WY
 - b. this uplifted the Co Plateau too

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Lecture 08 Grand Canyon Geography and Colorado Plateau

B. End of Paleocene ~55 Ma, Kula slab founders into Asthenosphere

1. Upwelling Asthenosphere
 - a. wide-spread volcanism in CA, NV
 - b. Thermal uplift of Western NA
2. Miocene (~20 Ma): Warm weak, elevated crust collapses
 - a. results in Basin and Range and Rio Grande Rift (boundaries of CO Plateau)
 - b. CO Plateau remains relatively un-extended, but thermally elevated

III. Formation of the Grand Canyon

Note: This is still an active area of research. What follows is the currently accepted model.

A. Prior to uplift

1. Ancestral CO River flowed southwest across an immense plain.
2. Uplift of Co Plateau region diverts Ancestral CO River southeast to Gulf of Mexico.
 - now the Little Colorado River

B. Post uplift

1. Western, cut-off portion of Ancestral CO River (now Hualapai Drainage)
 - a. Drains the uplifted plateau
 - b. Begins headward erosion into CO Plateau
2. Stream Piracy:
 - a. Eventually, the Hualapai cuts across the CO Plateau
 - b. Captures the Little Colorado and diverts flow to SW toward Gulf of California
 - c. Enhanced flow down the newly formed Colorado River caused rapid down-cutting of the channel – forming the Grand Canyon.
3. Most of this happened in past 7-10 Ma – VERY YOUNG

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C. Erosion of the Grand Canyon – When land is uplifted, rivers cut down into the crust!

1. Channel down-cutting:

- a. Sediment in the river scours the channel (NOT the water)
- b. Most efficient during flood – high flow, velocity and sediment load

2. Valley widening

- a. Mass wasting of valley walls widen the valley
- b. CO Plateau is arid
 - i. little water to cause wasting/erosion
 - ii. Wasting of the walls is controlled by joints (natural fractures) in the rocks

3. Jointing:

- a. Fractures caused by expansion of the rocks when the plateau was uplifted and unloaded
- b. Spacing of the Joints is dictated by thickness of the layers of rock
 - i. Some layers are thick and thus widely spaced joints – they don't waste away easily
 - ii. Thin layers have closely spaced joints – they do waste away easily
- c. Result: the 'stair-stepped' appearance of the walls of the Grand Canyon
- d. The blocks that break free of the walls tumble down into the river = sediment that scours the channel.