Geol 104 Geology of National Parks
Lecture 16: Rocky Mountain National Park

I. Introduction

A. We will look at two parks in the eastern North American Cordillera: Rocky Mountain NP and Glacier NP

B. Each park shows a portion of the history of the North American Cordillera

1. Laramide orogeny in Rocky Mountain NP

2. Sevier orogeny in Glacier NP

C. How we will proceed…

1. Survey the Precambrian and Paleozoic history of the Cordillera

- Some of this will be review, some new material

2. Investigate the Mesozoic – Cenozoic history of the Cordillera

a. Some of this will be review, some new material

b. Look at the two parks for illustrations of this history

3. The Cenozoic-recent history of the Cordillera will follow when we discuss the Western North American Cordillera

II. Precambrian and Paleozoic History of the Eastern North American Cordillera

A. Assembly of Rodinia ~1.75 Ga

1. Sediments metamorphosed in mountains produced by collision of Nuna and Yavapai

2. Igneous intrusions related to this orogenic event

- Recall similar rocks in Grand Canyon = Vishnu Schist and Zoroaster Granite

B. Rifting of Rodinia: ~8-700 Ma

1. Passive Margin (like eastern US today) forms on Western Laurentia

- Normal faults from rifting – these faults are re-activated during Laramide Orogeny

2. Sediments from the continent into the basins and ocean floor

- Recall this event formed the basins that the Grand Canyon Super Group filled.

C. Change to Subduction Zone during Paleozoic

1. Antler Orogeny (Mid-Devonian ~380 Ma):

a. Subduction of Laurentian oceanic slab produces Antler Arc

b. Laurentia approaches Antler Arc

2. Subduction reverses

a. Antler Arc is sutured to Laurentia

- Configuration is much like southwest Pacific off coast of Australia

b. This causes Klamath arc to form, Thrusting of sediments to form a highland that erodes to fill a foreland basin

- This foreland basin (and the sediments) become the rocks that are uplifted in the Ancestral Rockies

D. Pangaea forms and uplifts Ancestral Rockies

1. Allegany & Ouachita orogenies (Pennsylvanian into Permian ~ 290 Ma)

a. Recall this is the final event of the Appalachian Mountain building

b. Uplifts the Ancestral Rockies by reactivation of Precambrian normal faults

2. Erosion of the Ancestral Rockies to a swampy flatland

a. This existed through Mesozoic (Triassic and Jurassic ~240 to 150 Ma) – Dinosaurs, amphibians and reptiles roamed the area. (Recall that Pangaea rifts during this time forming North America and other modern continents)

b. Cretaceous (~100 Ma) sea then floods the area depositing shales

E. Uplift of the North American Cordillera (and Modern Rockies)

1. Sevier Orogeny (Jurassic to Cretaceous~165-80 Ma) (**Draw)**

a. Subduction of Farallon plate beneath Western North America

i. Forms the Sierra Nevada Arc (and the Sierra Nevada batholith that is now exposed in Yosemite)

ii. Coastal Range of Ca, Fore-Arc Basin = Great Valley of CA

iii. Sevier Fold and Trust Belt (these are the ROCKY MOUNTAINS)

- Precambrian strata (from rifting of Rodinia), faulted on top of Mesozoic strata

b. Sevier fold and thrust belt

i. West Central US: diced-up by basin and range extension,

ii. Well preserved in Northern Rockies (Glacier National Park and into Canada)

2. Laramide Orogeny (Cretaceous to Cenozoic ~80 to 40 Ma) – Recall this uplifted the Colorado Plateau

a. Young Farallon/Kula oceanic slab subducts shallowly

b. This causes

i. Eastward migration of volcanic arc (to Sierra to Colorado Arc)

ii. Re-activation (again) of Precambrian normal faults (from rifting of Rodinia)

- These are 'reverse' faults now
- Pops-up the basement and overlying strata

c. Laramide uplift lifts up the central rocky mountains including: Rocky Mountain National Park, CO; Laramie Range WY, Bighorn Mountains WY, Black Hills, SD; Uinta Range, UT

III. Look at pictures of the two parks to see what there is to see. Notice in the pictures of Glacier National Park (1) Lewis-Clark Thrust – this is Sevier orogeny, (2) the glacial features.

IV. Return to Glaciers: Erosional and Depositional features

A. Recall how glaciers move

1. Plastic flow

2. Basal Slip

3. Flow of glacier is combination of (a) & (b)

a. Frictional Drag along the base and walls causes differential velocity

b. 'Rolls' sediment to edges

4. Advance of glaciers
   a. Rates of flow - as slow as m/year and up to m/day (surges)
   b. Glacial Budget
      i. Zone of accumulation (above snow line)= where ice accumulates
      ii. Zone of Wastage = where glacier melts and calves (below snow line)

C. Recall How glaciers erode, & transport,
1. Plucking
2. Abrasion
3. Some Erosional Features
   a. U-shaped valleys: glaciers widen and deepen V-shaped river valleys
   b. Hanging valleys & truncated spurs
   c. Arête: Ridge between two valley glacier/glacial valleys
   d. Cirque: 'Bowl' shaped feature caused by 'head ward' erosion
   e. Horn: Peak created by 3 or more Cirques meeting
   f. Roches Moutonnées (sheep rock)

D. Glacial deposits
1. Sediments
   a. Accumulated w/in glacier by abrasive & ice plucking action
   b. Deposited at terminus and sides of glacier from melt water
2. Glacial deposits bury underlying bedrock/topography leaving gently rolling topography.
3. Some Depositional features
   a. Moraines = deposits of till from glacier
      i. Lateral Moraines - Material falls from Arête onto glacier
      ii. Medial Moraines - Formed as lateral moraines of two valley glaciers coalesce
      iii. End Moraine: Terminal Moraine & Recessional Moraine
      iv. Ground moraine - Deposited as glacier retreats (sed cont. delivered to toe)
   b. Outwash plain
      i. Melt water pours from glacier
      ii. Substantial suspended & bed load
      iii. Braided stream (velocity slow– transport capacity decreases)
   c. Loess = rock flour blown by wind (aeolian transport)