Geol 104 Geology of National Parks
Lecture 15: The Appalachians; Smokey Mountains and Acadia

I. Physiography of Appalachian Mountains

A. Introduction

1. These mountains extend from NE Canada to Georgia
2. They are the remains of a deeply eroded, ancient mountain chain once larger than the Himalayans

B. Parts of the Appalachians (From E to W):

1. Coastal Plain (not strictly part of Appalachian)
   a. this is the exposed continental shelf
   b. Covered with young (< Cretaceous) sediment
2. Fall Line – Piedmont
   a. Fall line = topographic rise separating Coastal Plain from Piedmont
      - Abrupt change in rock types results in waterfalls on rivers (differential weathering)
   b. Piedmont = metamorphic rocks
      i. Once the core of a huge mountain chain
      ii. Now extensively eroded to nearly flat or rolling hills
3. Blue Ridge – Runs from VA through NC, SC and GA.
   a. High ridge of metamorphic rocks formed beneath huge mountains
   b. Represent the eastern margin of Laurentia prior to formation of Pangaea
   c. Made of old 1.1 Ga rocks formed during assembly of Rodina (Luna + other continents)
   d. All rocks to the East of Blue Ridge are 'exotic or accreted terrains' = sutured to continent at convergent margins
4. Valley and Ridge Province
   a. Large folds and differential weathering produce this topography
      i. Ridges = resistant rock – weathers slowly and remains high
      ii. Valleys = less resistant rocks – weather rapidly and forms valleys
   b. Folds and faults repeat the section resulting in region of ridges and valleys.
5. Appalachian Front and Appalachian Plateau
   a. Front = westernmost folded rocks, pass abruptly onto plateau
   b. Plateau = flat-lying strata, deeply incised by rivers
6. Great Plains = flat lands underlain by flat-lying strata

II. Tectonic History of Appalachian Mts. (**Slides of Pangaea)**

- You will notice much of this is repeated from our history of North America lecture earlier this semester.

A. Grenville Orogeny ~1.1 Ga

1. This orogeny sutures Laurentia to the supercontinent Rodinia
   - Formed a huge Himalayan-style mountain range
2. The metamorphic rocks preserved from this event form
   a. The core of the Blue Ridge
   b. The basement of the entire Appalachian province

B. Rifting of Rodinia ~600 Ma

1. Rift valley formed (similar to east African Rift) – filled with sediment and volcanics
2. Rifting continued and
   a. The Iapetus Ocean formed (this ocean precedes Atlantic),
   b. New continent = Laurentia
      i. East coast of Laurentia is a passive margin, very similar to east coast of NA today
      ii. This coastline becomes covered with sediment including limestones, sandstone and shales.

C. Taconic Orogeny (~490 Ma Ordovician)

1. Beginning of Appalachian Mountain Building
2. Baltica Approaches Laurentia (from what is now NE Canada)
   a. Volcanic Island Arc collides is sutured to Laurentia
      - The resulting mountains eroded away before the next event
   b. Metamorphic and igneous rocks produced by this collision are preserved in parts of New England

D. Acadian Orogeny (~425 Ma Silurian to Mid-devonian)

1. Euroamerica forms by
   a. Baltica colliding with Laurentia (in what is now Canada and Greenland)
   b. Avalonia (micro continent) collides with Laurentia near what is now Eastern NA, (Maine down through NC and SC).
2. More igneous and metamorphic rocks created and exotic terrains accreted

E. Alleghanian Orogeny (~320 Ma Pennsylvanian into Permian)

1. Euroamerica collides with Gondwana – forming Pangaea

a. really big, HUGE, collision results in large scale deformation and igneous activity

b. Forms the fold and thrust belt (Valley and Ridge) and Appalachian Mountains

2. These mountains then erode away

F. Pangaea Rifts apart (Begins in Triassic ~250 Ma)

1. Rift basins form and fill with sediment and volcanics

a. This uplifted the east coast (like East African Rift is uplifted)

b. **This high topography, sculpted now by erosion, is the modern Appalachian Mountains.**

2. Atlantic Ocean opens in Jurassic ~180 Ma

- this forms North America

III. Great Smoky National Park

A. Geography:

1. Located on the TN – NC boarder
2. Highest Mountains East of Black Hills SD
3. 'Smoky' from water vapor and oils from the trees (evaporation – transpiration)
4. 'Rolling' hill topography

a. From stream erosion of faulted and folded stratigraphy

b. This topography has not been Glaciated

B. Geology:

1. The park exposes the rocks of Blue Ridge and the Valley and Ridge Provinces

a. Blue Ridge = ~1.1 Ga Greenville metamorphic rocks (schists and gneisses)

b. Valley and Ridge:

i. Pre-Cambrian rift sediments

ii. Cambrian marine sedimentary rocks (Chilhowee group)

iii. Marine limestones of Knox group (Ordovician)

2. Structures in the Valley and Ridge

a. Thrust faults from Alleghanian Orogeny fault and fold the sedimentary rocks.

b. Erosion of the softer rocks produces the valleys

IV. Acadia National Park

A. Geography

1. Location: Coastal Islands of Maine

2. Landscape is sculpted by glacial erosion

B. Geology

1. Accreted terrain of Avalon microcontinent

Oridovician (~470 Ma) and Silurian (~430 Ma) metamorphic rocks

2. Igneous rocks from Acadian Orogeny (Devonian ~400 Ma).

V. Glaciers and Ice Ages

A. Cause of Ice Ages - Current Ice Age began ~2 m.y. ago (Pleistocene)

1. Plate Tectonics

a. Place continents at poles – 300,000 m.y.

b. Disrupt ocean circulation with continents

c. Ice-house effect (Himalayan uplift) – enhanced weathering consumes CO2

2. Milankovitch Cycles (orbital variations)

a. Cycles in 'perturbations' of Earth's orbit & axis

i. Eccentricity of Earth's orbit cycles over 100,000 yr

ii. Obliquity of Earth attitude (change in axis angle) – 41,000 yrs

iii. Precession (wobble) of Earth's axis – 26,000 years

b. When these perturbations coincide, Ice ages occur

B. Types of Glaciers

1. Valley Glaciers – $2.1E^5$ km^3 of water = volume of all lakes

a. Form in high elevation (above snow line)

b. Flow down slope though valleys

c. 100s m thick

2. Continental Glaciers/Ice Sheets - Cover & bury land on a regional scale
   a. > 70% of Earth's fresh water – melt and sea level would raise 60 to 70 meters
   b. Form in polar regions today (limited solar radiation)
      - Antarctica and Greenland
   c. ~3-5 km thick

C. How Glaciers Move
1. Plastic flow **-** Flow occurs by creeping along grain boundaries or deforming crystals
2. Basal Slip
   a. Under high pressure, ice melts
   b. Glacier flows over ground surface lubricated by melt water
3. Movement of glacier is combination of (a) & (b)

D. How glaciers erode, & transport,
1. Plucking
   a. Caused by basal melt water infiltrating bedrock
   b. This water freezes & expands, wedging bedrock blocks free
   c. These blocks are entrained in the ice – also mass wasting onto glacier
2. Abrasion
   a. Ice and plucked rocks grind bedrock
   b. Produce fine rock powder = Rock Flour (Loess)
   c. Glacial Striations