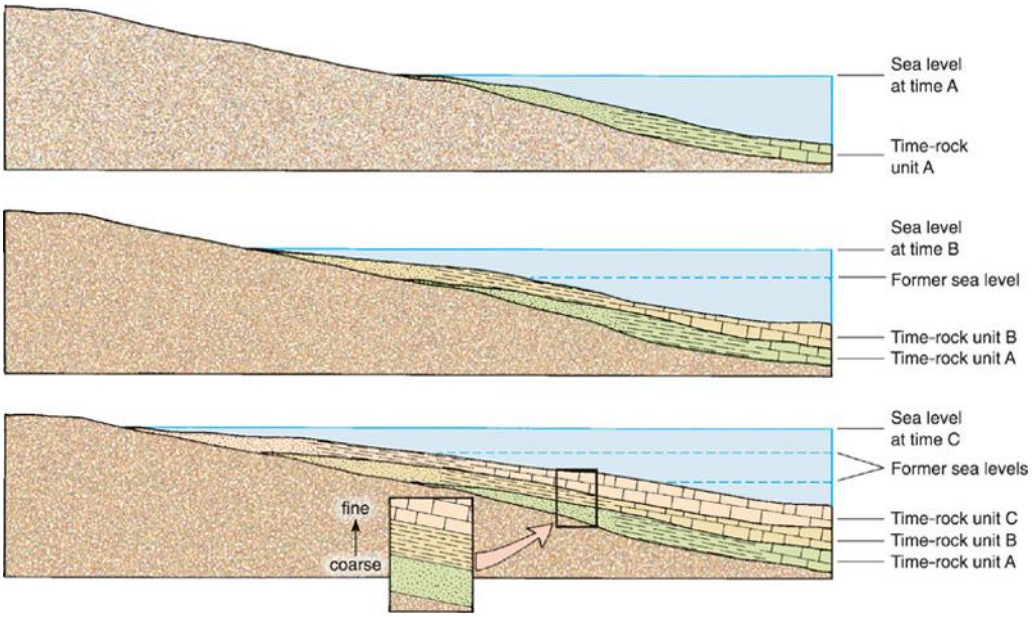
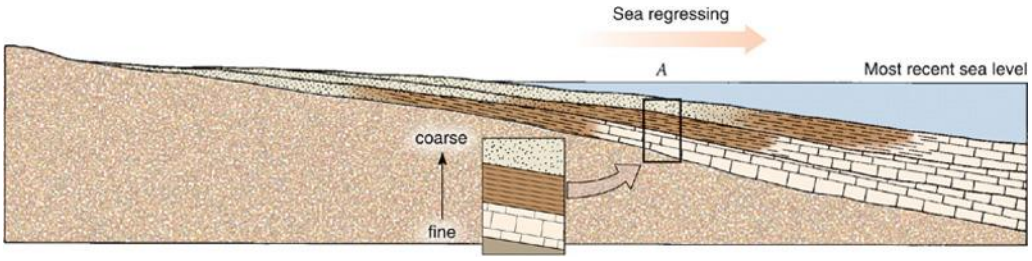
Transgression and Regressions





Bryce Canyon National Park

I. Introduction
   A. John Wesley Powell – 1870's
   B. Paiute Indians - many of their names retained: Paunsaugunt "home of the beaver
   C. Mormons, Ebenezer and Mary Bryce, settled here but left because of lack of water
      1. "It's a hell of a place to lose a cow!"
   D. National Forest in 1905
   E. National Monument in 1923 – Temple of the Gods N.M.
   F. Utah National Park – 1924
   G. Bryce Canyon NP in 1928
II. Geographic setting
   A. rim elevation is 8,000' – 9,100'
   B. not really a canyon: horseshoe shaped basin 12 miles wide and 3 miles long, 800' deep
III. Geologic Processes
   A. Joint control
      1. primary direction of fracture – direction of fins
      2. secondary cross-cutting fractures – forms pinnacles
   B. physical weathering - ~ 200 freeze-thaw cycles/year with differential erosion
   C. chemical weathering
      1. decomposition by solution
      2. oxidation and staining
         a. white is absence of iron minerals
         b. pink or purple – manganese dioxide
         c. red and yellow – iron minerals (run over white - stucco coating
   D. Topography
      1. 3 plateaus
         a. Paunsaugunt – Sevier Fault: Pink Cliffs
         b. Markagunt – west
         c. Aquarius – 2000' higher – no tree line
IV. Cenozoic 40 – 60 mya – Claron Formation
   A. streams, lakes, shallow seas
      1. limy ooze precipitated to form limestone – pink limestone forms much of scenery
      2. shallow seas & mud formed shales
      3. shoreline formed sandstone cemented by iron oxide
      4. gravels formed rock cap
   B. Laramide Orogeny – deformation gentler in Colorado Plateau – not mt. building
      1. Faulting – Sevier, Paunsaugunt
         a. Uplifted 4,000' – 6,000' and tilted to west ~ 1,700'
         b. Tensional – pulled apart as well as uplifted
         c. Movement still going on
   C. Erosion
      1. Water runoff dominates at Sunset Point - pinnacles
      2. Frost wedging dominates at Rainbow Point – 1000' higher and forms cliffs
      3. Forms hoodoos (variable thickness) and pinnacles or spires (uniform thickness)
         a. 6' to 100' high

Mesa Verde National Park

I. Introduction
   A. Dwellings of Anasazi– "Ancient Ones" now called Ancestral Pueblo people
      1. occupied for 700 years, 600 AD – 1300 AD – drought or overuse of surface depleting the soil may have driven them out
      2. 600 dwellings and 4,000 archaeological sites
      3. descendants are Hopi, Zuni, and other Pueblo people (total of 24 associated tribes)
   B. William Jackson, photographer for Hayden expedition, was first person to photographed cliff dwellings and make a report
   C. Virginia McClurg – New York journalist campaigned to get the area preserved
   D. Wetherill and Mason happened upon Cliff Palace and Spruce House while looking for cattle
   E. 1906 - National Park to preserve works of man, the first national park to do so
   F. 1978 – World Heritage Cultural Site
   G. First to have museum, interpretive services, and campfire programs

II. Geologic History
   A. Upper Cretaceous 100 – 75 MYA
      1. Mancos Shale – deep water; fine particles, organic material, and fossils: oysters, clams, snails, shark teeth, ammonites
      2. Mesaverde Group
         a. Point Lookout Sandstone – shoreline of sea: marine, crossbedded
         b. Menefee Formation – backshore and lagoon: shale, siltstone, sandstone
         c. Cliff House Sandstone – shifting shoreline, 400' thick, canyon cliffs
            i. Shale zones in Cliff House determine location of alcoves in which dwellings were constructed
               a.) Springs and seeps: sandstone is permeable and shale is not = differential erosion
         d. 1500' of shale & sandstone – eroded away
   B. Laramide Orogeny – Colorado Plateau–65 MYA
      1. gentle slope (7 ^{0}) to the south forming a cuesta – necessary for formation of alcoves
      2. streams downcut parallel canyons rapidly
         a. exposed Menefee and Cliff House in canyons

III. Main Dwellings
   A. Cliff Palace – largest; 150 rooms, 23 kivas, 100 - 120 people
      1. thought to have special significance as social/ administrative site with high ceremonial usage
   B. Spruce Tree House – third largest & best preserved; 130 rooms & 8 kivas; 60 – 80 people
   C. Balcony House – 40 rooms; enter by 32' ladder

Zion National Park

Mukuntweap National Monument 1909
National Park in 1919
Portions added in 1937 and 1956

I. Introduction
   A. earliest inhabitants were Anasazi Indians
   B. 1847 – Mormons settled gave it its name which means "resting place"
      1. raised cotton and sheep but not very successful
   C. 1860's John Wesley Powell – first scientific expedition
II. Geologic history – part of Grand Staircase
   A. Triassic
      1. Environment changes from shallow sea to coastline to rivers and lakes
      2. Moenave Sandstone – 300' – grey-white sandstone with some fossil fish; lower cliffs at base of canyon
      3. Kayenta Fm – 200' – limestone, sandstone, siltstone, shale with minor amounts of limestone and conglomerate
         a. Flood plain and stream deposits
         b. Canyon opens up when come to this layer
   B. Jurassic – climate change to desert
      1. Navajo Sandstone – 2200' – 98% quartz with $CaCO_3$ and Fe_2O_3 cements
      2. Shallow warm seas transgress from west
      3. Temple Cap Sandstone – beach deposit
      4. Carmel Limestone – 300': shallow warm seas; youngest rock in park
   C. Tertiary – 13 mya
      1. Block faulting NNE – SSW normal faults
         a. Raised Markagunt Plateau and Zion 9000'
         b. Bounded by Hurricane and Sevier Faults
      2. 1.3 mya Virgin River began its downcutting
         a. descends from 10,000' at Pink Cliffs to 4,000' in Zion Canyon
         b. precipitation and snows of Pleistocene provided water for downcutting
         c. gradient 40' – 8-'/mile
III. Geologic features
   A. Hanging valleys – 1,100' – 1,300'
      1. Lack of adjustment of tributaries
   B. Rectangular patterns of streams
      1. Vertical joints at right angles
   C. Arches
      1. Springs and seepage
      2. Differential weathering
         a. Cement holding sand dissolves in areas of greatest moisture and sand grains fall away
         b. If joint parallels cliff face, slab will eventually separate from main cliff
      3. Tunnels bored into Navajo SS showed joints only within 30' of surface
         a. become further apart with distance from cliff face
         b. joints rarely extend laterally without interruption
            i. stop or split into multiple joints
         c. may have been caused by gradual release of pressure during canyon cutting
            i. reason it is not further into canyon walls
   D. Cold travertine at springs – solution of calcite cement
   E. Checkerboard Mesa – crossbedding and vertical fractures
   F. Staining
      1. MnO_2 – black or purple
      2. Na_2HCO_3 and $CaCO_3$ - white

Grand Canyon National Park
National Monument in 1908
National Park in 1919
portions added in 1932, 1969, 1975
World Heritage site – 1979

I. Introduction
   A. Geologic Setting
      1. Colorado Plateau
      2. Numerous faults cutting across the Canyon
      3. Canyon itself
   B. Geographic
      1. averages 1 mile deep, 4-8 miles wide (avalanches and landslides widen the canyon, 280 miles long, deepens 2200' from NE – SW
      2. great range in elevations and climate
      3. variations between N & S rims

II. Geologic History
   A. Precambrian to 2 bya
      1. Sediments metamorphosed to form **Vishnu Schist** during mountain building – Mazatzal Mountains
      2. Igneous intrusions formed **Zoroaster Granite**
      3. Formation of minerals: garnets, tourmaline, etc.
   B. 1.7 bya
      1. erosion of mountains formed an unconformity
   C. 1.25 bya
      1. seas transgressed
      2. lava flows
      3. limestone, conglomerate, shale, and sandstone were deposited to form the Unkar Group or **Grand Canyon Series**
   D. 0.5 bya
      1. block faulting and tilting formed Grand Canyon Mountains
   E. 0.25 bya
      1. erosion in some cases all the way down to the Vishnu
         a. Great Unconformity
   F. Paleozoic
      1. Cambrian – transgression of seas
         a. rivers flowing from the west into sea
         b. Beach and coastal sand dunes: **Tapeats Sandstone**
         c. as seas transgress further, the shoreline shifts eastward and Canyon area is shallow sea – **Bright Angel Shale**
         d. transgression – deeper seas **Muav Limestone**
      2. Devonian - regression of seas – shallow intertidal marine sea
         a. **Temple Butte Limestone** – scattered remnants that fill eroded channels and depressions
      3. Mississippian – transgression of seas – wide, warm, shallow, clear
         a. Redwall Limestone
         b. Surprise Canyon Formation
      4. Pennsylvanian – regression of seas forms flood plain
         a. **Supai Formation**: sandstone and siltstone
      5. Permian – swamps and lagoons into deserts
         a. Hermit Shale
         b. Coconino Sandstone

c. Transgression of seas: Coconino sands smoothed by advancing seas
d. Toroweap Formation
i. Formed during 3 transgressions interspersed with 2 regressions – marine, tidal flat, dunes
e. Advancing seas formed **Kaibab Limestone**
i. Youngest rock unit found in Grand Canyon NP

III. Colorado River
A. Evolving system – 5 mya
B. Evidence for both conflicting theories: flowed from the north to SE or to the SW and or from south to NW
C. Uplift, downcutting, rejuvenation
1. Uplift of Colorado Plateau provided driving force for canyon carving
a. Last major uplift occurred 250,000 ya
2. Temples are erosional remnants from tributaries
3. Hanging valleys
a. Deer Creek
b. Elves Chasm
4. Entrenched meanders

IV. Volcanic activity – 1.2 mya western part of canyon
A. Powell was first to report lava cascades
B. Long periods of time and multiple episodes
C. In Toroweap area - > 100 cones on N rim and <12 on S rim
D. Lava flows concentrated along fault areas
E. Toroweap and Vulcan's Throne area – sequence
F. filled tributary valleys – some with 47 different flows up to level of rim
G. lava dams formed each time
1. river gravels at high elevations
2. lake silts and lake beds
3. Colorado River now ~ ½ mile south of where it was originally

Prior to the Glen Canyon Dam in 1963, the Colorado River could carry 500,000 tons of sediment/day. During times of flooding, it was closer to 27 million tons.