Dear Participants,

Thank you for registering for my class on the Geology of the National Parks I. I am very excited about seeing all of you and sharing information about our national parks - America's Best Idea.

I am including some information that I think would best be shared ahead of time so that you better understand information in each of the classes. Included is a Tentative Syllabus, information about the National Park System, information about the formation of sedimentary, metamorphic, and igneous rocks, geologic time scale, map of the parks, and the notes for the first class. A lot of information, I know! If you have any questions about the material, please contact me or I can answer each during the first class.

I have chosen the national parks from those that I have visited that I think represent the best of our National Parks, with input from Ken Burns and National Geographic.

See you on February 6.

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Tentative Schedule

Date	Topic
February 6	Introduction to National Parks
	Continental/Alpine Glaciation
	Glacier
	Yosemite
	Cape Cod
February 13	**Volcanic Features and Activity**
	Mt Rainier
	Hawaii
	Yellowstone
February 20	**Weathering & erosion of flat-lying rocks**
	Grand Canyon
	Bryce
	Zion
February 27	Catch-up

National Park System

"There is nothing so American as our national parks.... The fundamental idea behind the parks... is that the country belongs to the people, that it is in process of making for the enrichment of the lives of all of us." - President Franklin D. Roosevelt

Our National Parks are a unique American Heritage

- Yellowstone – 1807:
  - John Colter sent description to national magazine. Their reply: "Sorry, we don't publish fiction."
- 1864: Yosemite:
  - legislation was passed to transfer the federally owned valley, as well as the nearby Mariposa Big Tree Grove, to the state
    - "be used and preserved for the benefit of mankind."
  - The act of Congress was signed by President Abraham Lincoln on June 30, which gave the state of California the lands,
    - "be held for public use, resort, and recreation... inalienable for all time."

- 1871 – Ferdinand Hayden
    - Expedition members suggested reserving Yellowstone for public use, rather than allowing it to fall under private control.
    - Reported to Congress with pictures and descriptions.
    - Yellowstone became first National Park in 1872 but without operating funds.
        - remained in the custody of the Department of Interior.
- 1890: Yosemite became a national park
- late 19th century
    - interest in preserving prehistoric Indian ruins and artifacts on public lands.
        - prehistoric cliff dwellings, pueblo ruins, and early missions found on public lands in the Southwest
        - Antiquities Act of 1906
        - authority for presidents to set aside "historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest" on lands owned or controlled by the United States as "national monuments."
        - President Theodore Roosevelt proclaimed 18 national monuments.
- 1913 - Yosemite lost battle for hydroelectric power and Hetch-Hetchy Valley was flooded.
- 1916 – Department of the Interior was responsible for 14 national parks and 21 national monuments but had no organization to manage them.
    - Stephen Mather visited Yosemite and was horrified at abuse of area. Wrote to Secretary of the Interior who wrote back, "If you think you can do a better job, come to Washington." He did, and President Wilson established National Park Service on August 25, 1916.
- 1920s - National Park System dealt mostly with natural areas west of the Mississippi.
    - West was home to America's most spectacular natural scenery, and most of the land there was federally owned and subject to park or monument reservation without purchase.
- 1926 - Congress authorized Shenandoah, Mammoth Cave, and Great Smoky Mountains.
    - historical parks in the East - battlefields, forts, and memorials
    - President Franklin D. Roosevelt ordered all military parks transferred to the Park Service, which received 15 national monuments, national capital parks, including the Lincoln Memorial and White House, and nearly 40 historical areas in the East.
- 1930s - Park Service became involved with areas intended for mass recreation
    - National Seashores, National Recreation Areas, and National Lakeshores.
- 1960' s - new types of parks joined the system
    - 1964 - Ozark National Scenic Riverways in Missouri
    - 1966 - National Historic Preservation Act of 1966
        - authorized the bureau to maintain a comprehensive National Register of Historic Places
    - 1968 - Wild and Scenic Rivers Act
    - 1968 – National Trails Systems Act
        - Appalachian National Scenic Trail.
    - 1968 - first national lakeshores
- 1980 - Alaska National Interest Lands Conservation Act
    - more than doubled the size of the national park system, by adding more than 47 million wilderness acres.
    - The Wrangell-St. Elias National Park comprises more than 8,300,000 acres
    - Wrangell-St. Elias National Preserve consists of nearly 4,900,000.
- The National Park Service System now includes more than 380 parks, covering more than 83 million acres, in nearly every state and U.S. possession. The Park Service supports the preservation of natural and historic places as well as promotes outdoor recreation outside the system through grant and technical assistance.
- Becoming a part of National Park system
    - National Park status requires act of Congress
    - National Monument – presidential proclamation – may be to quickly protect it and later will become a national park
    - National Recreation Areas – set aside specifically for purposes of recreation

SEDIMENTARY ROCKS

I. Origin of sediments
  A. Fragments of rocks and/or minerals
    1. originate from weathering of existing rocks and/or minerals
      a. mechanically (fragmented) and/or chemically (altered)
    2. Chemical precipitates – e.g. limestone or halite (salt) form when concentration in solution increases to point that material precipitates
    3. Organic materials – shells, plant material
II. Transportation
  A. Mode of transportation – wind, water, glaciers
  B. Rounding and Sorting – to greater degree the further from the source
III. Deposition
  A. sediments accumulate when:
    1. energy level of river/wind decreases
    2. chemical changes in water system
    3. animal/plant material dies and settles
IV. Diagenesis or lithification – from sediment/precipitates/organic material to rock
  A. What happens?
    1. Compaction – weight of overlying materials causes simple compaction of sediment; not very resistant to weathering
    2. cementation – grains held together by natural cement: iron oxide, silica dioxide, calcium carbonate; determines resistance to weathering & sometimes rock color
V. Beds or strata
  A. Develop during episodes of deposition – each layer represents an episode which can occur over a short or long period of time and which may change with the environmental; sand in a beach environment, clay (mud) in a tidal flat or near off shore environment, limestone in deep ocean or shallow warm ocean waters; salts in bays/lagoons/inland lakes with no outlet
VI. Sedimentary structures - reflect environment of deposition: mud cracks, ripple marks, thinning or thickening of beds
VII. Most common sedimentary rocks
  A. Clastic – formed from fragments: sand forms sandstone, clay forms shale
  B. Non-clastic – limestone (precipitate), salts
  C. Organic – coal, limestone (shells of marine animals)

METAMORPHIC ROCKS

I. Metamorphism: Definition
  A. Transformation of pre-existing rocks into texturally or mineralogically distinct new rock as a result of heat and/or pressure & chemically active fluids, but without complete melting.
II. Initiation of metamorphism
  A. Burial of rocks
    1. temperature: 200^{o} C – 800^{o} C
    2. depth: 2 - 20 km
    3. pressure: 7,000 -14,500 psi
III. Agents of metamorphism
  A. Heat: as temperature increases:
    1. change from solid to semi-liquid
    2. grains become more uniform in shape
    3. cracks and spaces filled in
    4. begins to flow
    5. chemical reactions become more vigorous
    6. new minerals form at different temperatures
  B. Pressure
    1. Confining, undirected pressure or directed pressure
      a. eliminates pore spaces
      b. induces rock flow

C. Chemical activity
1. water is forced out of structure of minerals containing water
2. minerals recrystallize/exchange ions (carried by water) - form new minerals – specifically some gems such as sapphires, rubies, garnets

IV. Types of metamorphism
A. Contact – change as a result of coming in contact with hot magma
B. Regional – over large area; mountain building and plate tectonics
C. Cataclastic - heat and pressure during movement along fault in an earthquake

V. Metamorphic minerals are geothermometers - indicate pressure/temperature during formation

VI. Metamorphic Rocks
A. Foliated – layers or bands – rocks with more than one mineral
1. slate - from shale or volcanic ash
2. schist - from shale-more intense metamorphism than slate
3. gneiss - from granite or intense metamorphism of shale
B. Nonfoliated - rocks with a single mineral
1. marble - limestone or dolomite
2. quartzite - quartz sandstone

IGNEOUS ROCKS

I. Origin of Magma
A. Depth: 20 – 200 km
B. Temperatures: ~600^{0}C - ~1600^{0}C
C. Composition
1.molten rock
a. elements: O, Si, Al, Fe, Mg, Ca, Na, K
2.gases – water vapor, chlorine, sulfur
3. basaltic magma - 40% – 50% silica - very fluid, flows to the surface
4. andesitic magma – 50% - 60% silica - more viscous, does not flow easily
5. granitic magma contains 60% - 70% silica - too viscous to make it to the surface
D. Melting of rocks
1. temperature: geothermal gradient
2. pressure increases with depth and raises melting point (need higher temperatures to melt than on surface)
3. water content lowers melting point
4. mineral content
a. most melt over range of temperatures because are mixture of minerals
E. Magma chambers
1. formed from rising magma which is hotter and less dense than surrounding rocks

II. Classification of igneous rocks
A. Chemical composition
B. Mineral composition
C. Texture
1. intrusive
a. intrusive igneous structures – magma cools underground
b. examples – batholith, sill, dike
2. extrusive
a. examples – magma cools near or at surface as lava – lava flows
3. special textures
a. ash
b. pumice
c. obsidian

GEOLOGIC TIME SCALE

Eon	Era	Period		Epoch	Date (Millions of years before present)
Phanerozoic	Cenozoic	Quaternary		Holocene	0.01
				Pleistocene	1.6
		Tertiary		Pliocene	
				Miocene	
				Oligocene	
				Eocene	
				Paleocene	
	Mesozoic	Cretaceous	End of Mesozoic 65.5 mya		
		Jurassic			
		Triassic			
	Paleozoic	Permian	End of Paleozoic 248 mya		
		Carboniferous	Pennsylvanian		
			Mississippian		
		Devonian			
		Silurian			
		Ordovician			
		Cambrian			
Precambrian (87% of geologic time)		End of Precambrian 543 mya Beginning of Precambrian 4,500 mya			

We might officially enter a new epoch in 2024, the Anthropocene. Scientists still debate whether the Anthropocene is different from the Holocene, and the term has not been formally adopted by the International Union of Geological Sciences (IUGS), the international organization that names and defines epochs. The primary question that the IUGS needs to answer before declaring the Anthropocene an epoch is if humans have changed the Earth system to the point that it is reflected in the rock strata.