9th Grade

Spring Theme: Pre field trip Surface Processes

Class Description

Students will explore the different rock layers inUpper Monument Canyon. The focus will be on how water, air, gravity and biological activity causes changes in the Earth's surface. Students will be asked to make sketches and interpret what is happing along the canyon.

Standards Addressed

Science 3.6 The interaction of Earth's surface with water, air, gravity and biological activity causes physical and chemical changes

Enduring Understandings/Essential Questions

How do various changes impact Earth's landforms due to water, air, gravity and biological activities?

Vocabulary Addressed

Erosion
Deposition
Schist
Gneiss
Sandstone
Composition
Weathering
Climate
Windgate
Entrada
Kayenta

Theme, etc.

Theme:

Learning about how the CNM was formed over time through earth surface movement, weathering, erosion, and history of the layers of the rock formation and how they were formed

Objectives:

-Students will be able to explain how Schist, Gneiss, Chile Sandstone, Wingate Sandstone, Kayenta Sandstone, Entrada Sandstone, and Morrison Sandstone were formed.
-Students will be able to describe the different types of environments that lead up to the formations of the layers within the CNM.
-Explain the different forms of erosion and/or weathering.
-Students will be able to explain the timeline of the formations of the different rock layers

Major Concepts:

-Compare and contrast weathering and erosion.
-What are the types of erosion have the largest effect on the layers of the CNM.
- How were the different types of rocks, found in the CNM, formed?
-What is the timeline for the formation of each of the layers?

Sample Class Outline

9th Grade

Spring Theme: Surface Processes

Class Description

Students will explore the different rock layers inUpper Monument Canyon. The focus will be on how water, air, gravity and biological activity causes changes in the Earth's surface. Students will be asked to make sketches and interpret what is happing along the canyon.

Duration: 3 hours – 3 miles round trip

Standards Addressed

Science 3.6 The interaction of Earth's surface with water, air, gravity and biological activity causes physical and chemical changes

Enduring Understandings/Essential Questions

How do various changes impact Earth's landforms due to water, air, gravity and biological activities?

Vocabulary Addressed

Erosion
Deposition
Schist
Gneiss
Sandstone
Composition
Weathering
Climate
Windgate
Entrada
Kayenta

Theme, etc.

Theme:

Understanding how the Colorado National Monument was formed from the factors of air, water, gravity and biological activity and to understand that it is continuing today.

Objectives:

-Students will be able to name the different types of rocks located at the CNM.
-Students will be able to describe how each of the types of rock layers formed.
-Explain how the erosion has affected the formation of the CNM
-Students will be able to explain how erosion is occurring today and sight examples of air, water, gravity and biological activities and provide examples.

Major Concepts:

-Compare and contrast weathering and erosion.
-What are the types of erosion have the largest effect on the layers of Monument Canyon along the Independence Trail?
- What are the rock layers and how were they formed?

Sample Class Outline

Introduction:

We will be hiking down Monument Canyon 6 miles, general welcome/arrowhead talk… Have students discuss what they know about the Colorado National Monument. The history, John Otto; How it formed, the uplift, the erosion etc.; Students should be writing the information in their journals. Give an overview of what will be seen on the hike, what needs to be the focus, identifying the different rock layers, and understanding of how old the rock is.

Stop 1 (in Cottonwoods at mouth of Monument Canyon):
Theme: The theme of the hike is to identify all of the different methods of weathering and erosion that has the Colorado National Monument, air, water, wind and gravity. The importance of John Otto
Props: John Otto; Rock layers of the Monument handout
Tips: Have them look at their handout. Explain that we will be walking through

Transition: At our next stop we'll be looking at the sandstone that makes up the cliff walls, on the way think about how sandstone is formed.

Stop 2 (at Wingate sandstone slabs):
Theme: How sandstone forms, Wingate SS depositional environment
Props: SS rock cycle diagram, Sand dunes photo, grallator track/coelophysis photo, grallator track
Tips: What do we need to make SS? How do you think it forms? Touch the sandstone, can you feel tiny layers of sand in it? What do you think this area was like when it was forming? Good…it was a giant desert, with huge sand dunes (show photo)…We find the tracks of lizards and even larger dinosaurs like Coelophysis (See-lo-fi-sis)- (show picture and grallator track)

Transition: We'll have a nice shady rest spot coming up and we'll eat a snack there, on the way think about what you've learned about fossils and the different types of fossils.

Stop 3 (at large shady boulder around the first bend):
Theme: What are fossils? Types of fossils
Props: Allosaurus finger, Plant Fossils, petrified wood, grallator track (real fossils/models)
Tips: Ask students what a fossil is? Go through different types of fossils:
1. Body fossil *– an actual part of a plant or animal that gets preserved (explain how Allosaurus' finger would have been preserved as a fossil)*
2. Trace Fossil *- signs of an animal/dinosaur that are preserved, ask for examples of animal signs (tracks, poop/scat, burrows, etc.) Show grallator track and explain how it would have been preserved*

Transition: Alright, at our next stop we are going to look at a different rock layer, the rocks that make up the dark red hills below the cliffs (point to Chinle across the canyon). Think about what this area was like when that rock was forming.

Stop 4 (at shade tree in the Chinle formation):
Theme: Chinle depositional environment
Props: chinle swamp illustration/ phytosaur drawing, petrified wood
Tips: pick up a piece of the red rock around you, try to break it, does it feel weak? What do you think it's made out of..right, mud! Where would you find a lot of mud? What about in a swamp? (show photo) This rock is made from layers and layers of mud at the bottom of a swamp. What types of animals

would you expect to live in a swamp? Alligators, crocodiles, right, (show photo of phytosaur) show them how large his jaws would have been (spread arms)

Transition: We are getting close to Independence and the trail is much easier for the rest of the hike. We have one last layer of rock to talk about, and it's the layer that has tons of fossils in it, and is actually why this area is famous for fossils. It is also the youngest layer of rock in the park, so on the

Stop 5 (at the last corner after the tunnel in the rock):
Theme: Morrison Formation
Props: Morrison environment photo, allosaurus photo, brachiosaurus photo
Tips: Where do you think the youngest rocks are located?...Good, at the top of the canyons, point out the Morrison Formation on top of the cliffs explain that it is the reason this area is famous for fossils, describe environment (show photo) Tell them there were big plant eating dinosaurs like Brachiosaurus and big meat eating dinosaurs like Allosaurus, we don't find a lot of body fossils from these dinosaurs in the Monument because we don't do a lot of digging, but we have found trace fossils like footprints.
Transition: Does everyone understand now how we can use the rock types and the fossils we find to learn about past environments? It's kind of like the rocks here all tell us a story, pretty neat huh? Ok…We have a little farther to go, but when we get to the base of Independence it's lunch time!

After Lunch Activities/Lesson (at the base of Independence

Lay out all the fossil pictures and props on the ground away from Declaration rock. You will be doing 3 activities, the easiest way is to start all together for story time, have students climb up on the rock, then have them look at fossil props afterwards. If it's a particularly large group, you may want to split into 2 groups and have them do the Declaration Rock Climbing & Looking at fossils separately so it's easier to manage.

John Otto Story Time
Theme: John Otto History
Props: variety of John Otto pictures; Wedding, Climbing/SAR on 4th of July, Leading Tours, etc. all of the
Tips: Have students in a large group in an area where you can see Otto's route up Independence (if you look at the west-facing side of the Monolith, Otto's route follows the diagonal crack up to the large V-shaped gap near the top of the monolith). Tell a few stories about John Otto & his patriotism, climbing Independence story & wedding story are good ones, show photos.

Transition: *John Otto did another funny thing to show how much he loved America…he carved last sentence of Declaration of Independence into the big boulder next to you. In a minute, we will be climbing up on the rock to look at the carving (if you want to). These are the words you are looking for….*
And for the support of this declaration with a firm reliance on the protection of divine providence, we mutually pledge to each other our lives, our fortunes and our sacred honor.
John Hancock

Checking out carving on Declaration Rock
Tips: Have students get in a single file line behind the rock steps on the east side of the boulder. Position a few chaperones near the steps to offer their knees for students to use to climb up onto the rock. Have at least one chaperone on the left (looker's left) side of the rock to help students jump down off the rock. Ranger should climb up before any students. Then have 5-6 students get up at a time to check out the carving, do not let them step or sit on it (so we can help preserve it). May need to explain that this is historic since it's over 100 years old and was made by the park's first ranger, but we shouldn't carve into

rocks today, can have students find some graffiti on the rock. Have students climb down off the rock to the right (looking down the rock) Then have next group come up until all students who want to climb up have done so. After Declaration Rock have the students go look at the fossils and props from the hike.

9th Grade

Spring Theme: Post field trip Surface Processes

Class Description

Students will explore the different rock layers inUpper Monument Canyon. The focus will be on how water, air, gravity and biological activity causes changes in the Earth's surface. Students will be asked to make sketches and interpret what is happing along the canyon.

Standards Addressed

Science 3.6 The interaction of Earth's surface with water, air, gravity and biological activity causes physical and chemical changes

Enduring Understandings/Essential Questions

How do various changes impact Earth's landforms due to water, air, gravity and biological activities?

Vocabulary Addressed

Erosion
Deposition
Schist
Gneiss
Sandstone
Composition
Weathering
Climate
Windgate
Entrada
Kayenta

Theme, etc.

Theme:

Students will participate in creating a model of the CNM using the same types of rock types found in the monument. They will model how the Uplift happened and how wind, water, chemical processes and biological activity.

Students will write a report on all that was learned on the CNM field trip with detailed descriptions on the formation, the rock types and how they were formed and an explanation on how weathering is continuing to erode the CNM.

Objectives:

-Students will be able to explain how Schist, Gneiss, Chile Sandstone, Wingate Sandstone, Kayenta Sandstone, Entrada Sandstone, and Morrison Sandstone were formed.
-Students will be able to describe the different types of environments that lead up to the formations of the layers within the CNM.
-Explain the different forms of erosion and/or weathering.
-Students will be able to explain the timeline of the formations of the different rock layers

Major Concepts:

-Compare and contrast weathering and erosion.
-What are the types of erosion have the largest effect on the layers of the CNM.
- How were the different types of rocks, found in the CNM, formed?
-What is the timeline for the formation of each of the layers?

Sample Class Outline


Weathering Heights
COLORADO
NATIONAL MONUMENT
UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

The Difference between a National Monument and a National Park

- The difference between a National Park and a National Monument is that a National Monument is declared by a President and a National Park takes an act of Congress.
- President Taft declared the Colorado National Monument on May 24, 1911.
- Currently the CNM is pursuing National Park status, but we all know how long an act of Congress can take.
- As of July 17, 2014 the bill was dropped.

History of the Monument

- John Otto moved to Grand Junction in 1906. He was a self-proclaimed trail builder and with a pick and shovel he carved out the trails that made the CNM accessible to the public.
- In 1907 Otto stated….

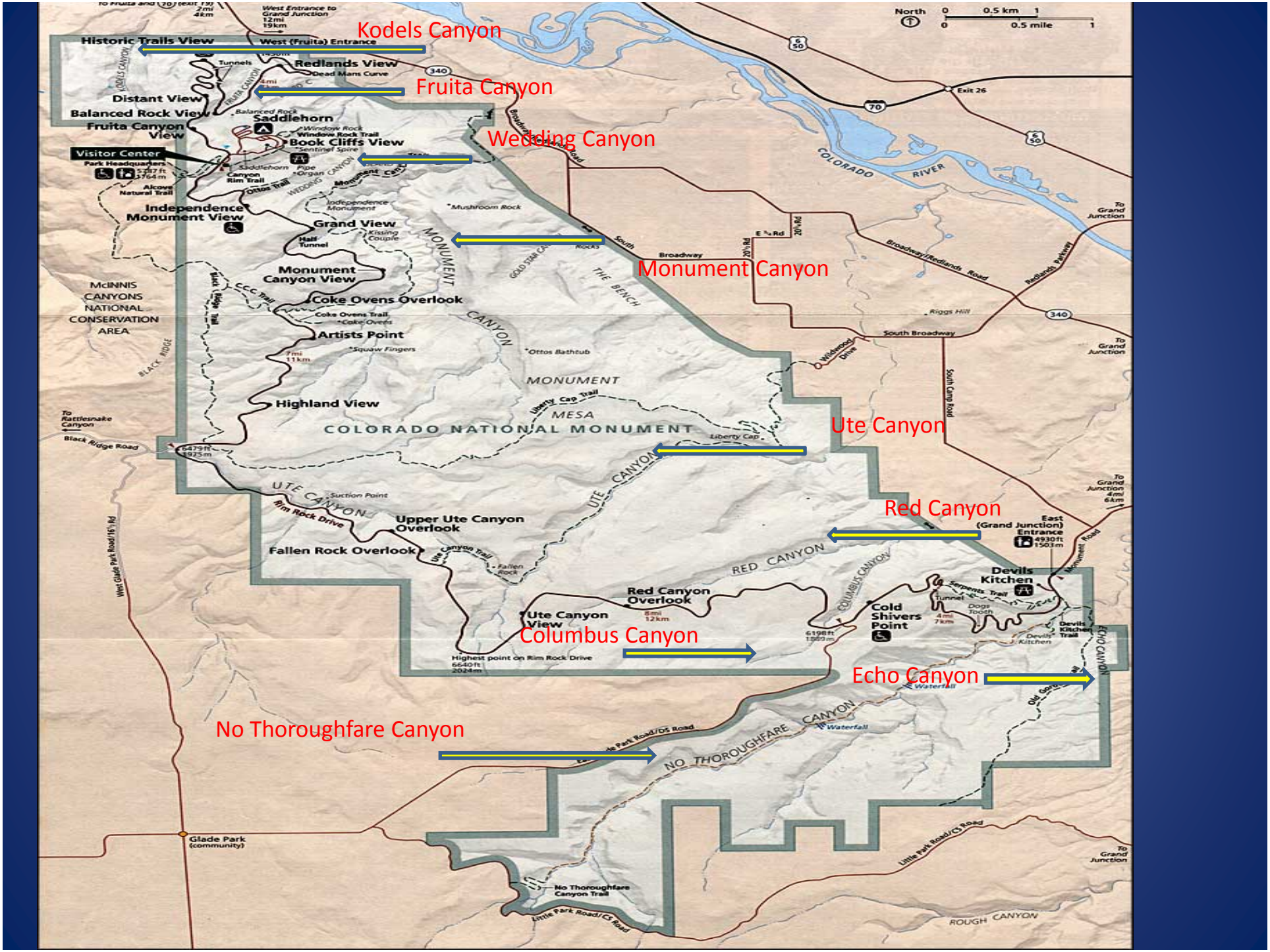
"I came here last year and found these canyons, and they feel like the heart of the world to me. I'm going to stay and build trails and promote this place, because it should be a national park.“

John Otto

- On May 24, 1911 President Taft declared the Colorado National Monument thanks to Otto's relentless pursuit.
- John Otto was the first custodian of the Monument and was paid $1.00 a month.

Canyons of the Colorado National Park

- There are 9 Canyons that make up the CNM. Starting from East to West they are;
  - Echo Canyon
  - No Thoroughfare Canyon
  - Columbus Canyon
  - Red Canyon
  - Ute Canyon
  - Monument Canyon
  - Wedding Canyon
  - Lizard Canyon
  - Kodels Canyon


Kodels Canyon
Fruita Canyon
Wedding Canyon
Monument Canyon
Ute Canyon
Red Canyon
Columbus Canyon
Echo Canyon
No Thoroughfare Canyon
Historic Trails View
West (Fruita) Entrance
Redlands View
Distant View
Balanced Rock View
Fruita Canyon View
Saddlehorn
Visitor Center
Book Cliffs View
Independence Monument View
Grand View
Monument Canyon View
Coke Ovens Overlook
Artists Point
Highland View
McINNIS CANYONS NATIONAL CONSERVATION AREA
COLORADO NATIONAL MONUMENT
MESA
MONUMENT CANYON
UTE CANYON
RED CANYON
COLUMBUS CANYON
NO THOROUGHFARE CANYON
ROUGH CANYON
Upper Ute Canyon Overlook
Fallen Rock Overlook
Red Canyon Overlook
Ute Canyon View
Highest point on Rim Rock Drive
Cold Shivers Point
Devils Kitchen
East (Grand Junction) Entrance
Exit 26
COLORADO RIVER
Broadway/Redlands Road
South Broadway
Glade Park (community)
No Thoroughfare Canyon Trail

The Great Uprising

- The reason that the Colorado National Monument sits approximately 2000 feet above the valley floor is due the Redlands Fault




Field Trip Through the Layers of the
Colorado National Monument

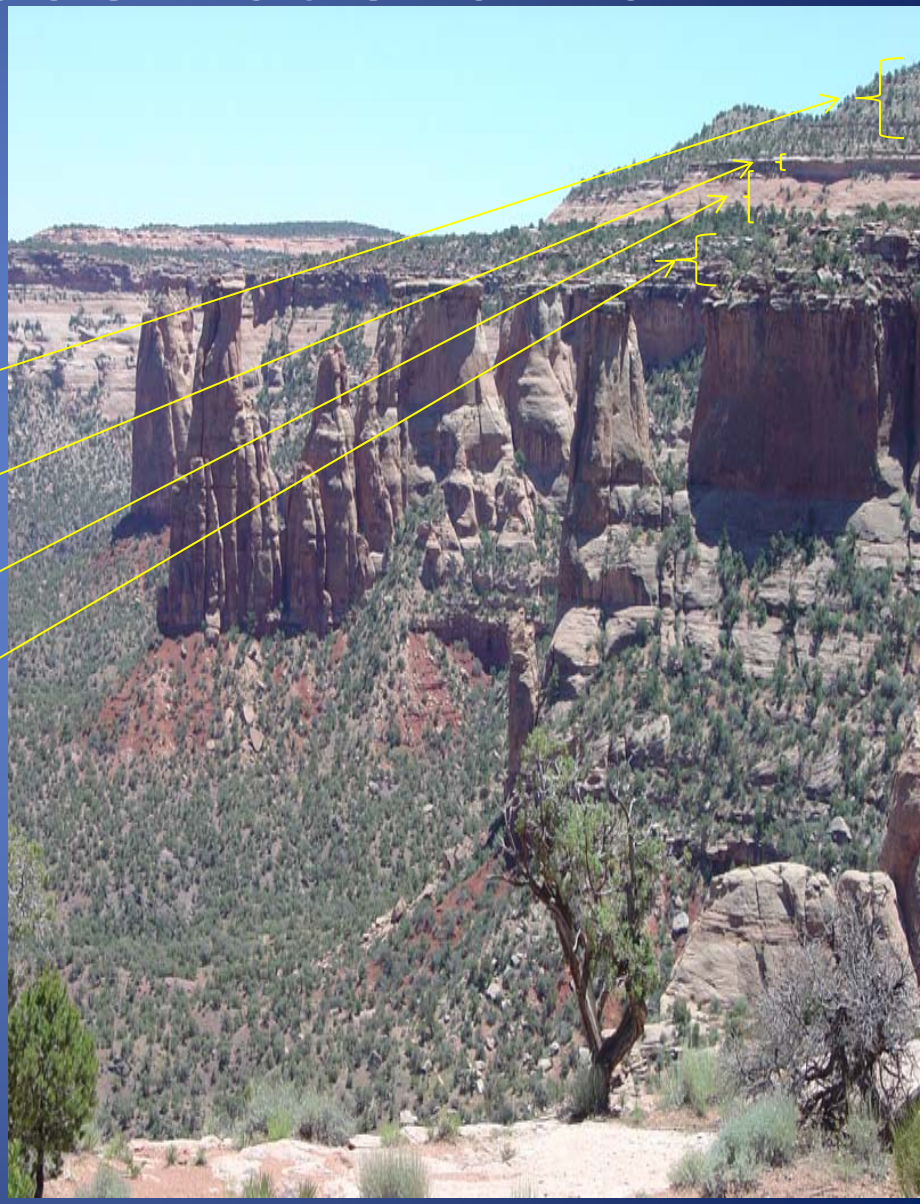
Layers of the Colorado National Park

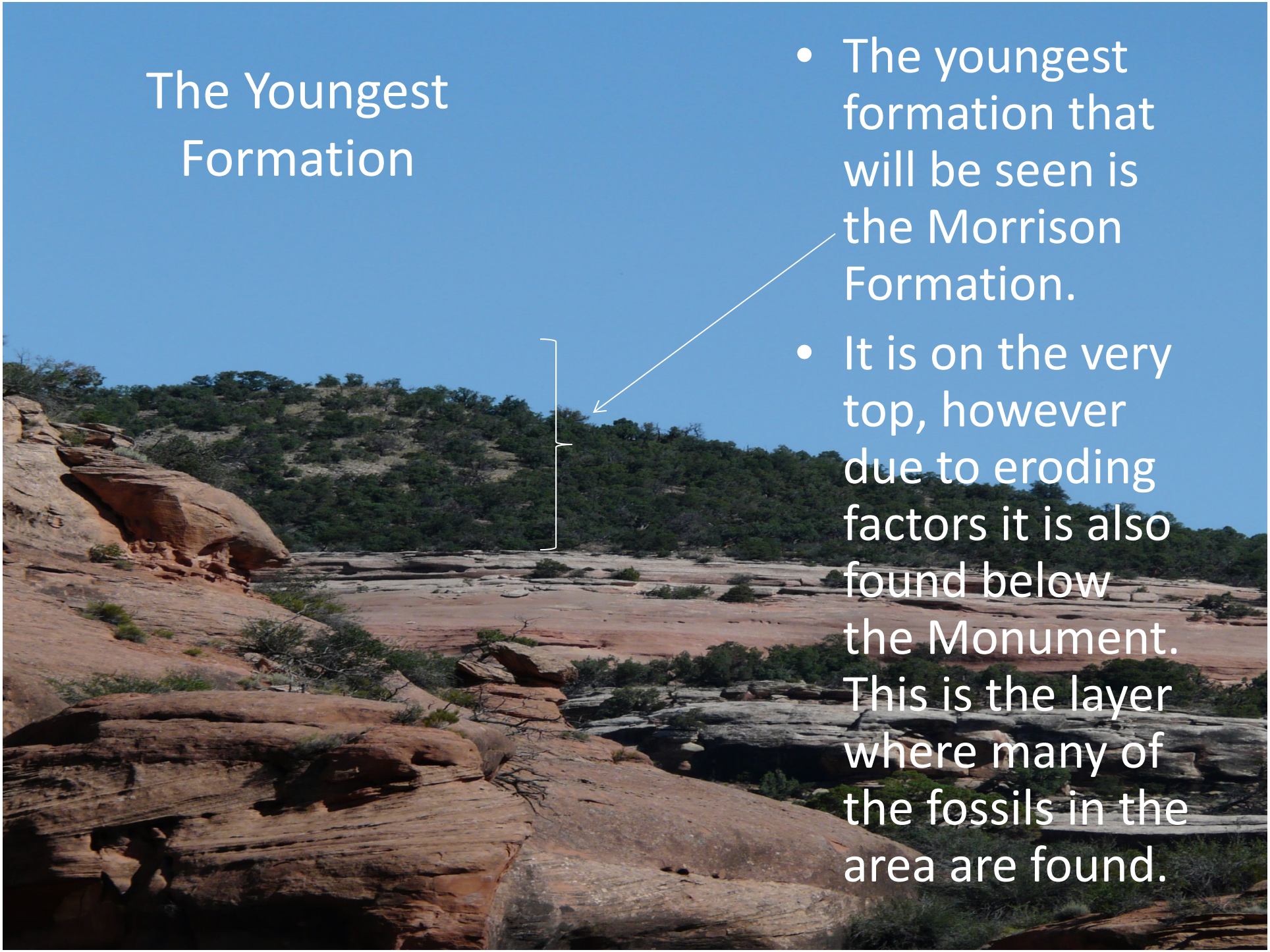
Morrison Formation- 150 MYA

Wanakah Formation – 160 MYA

Entrada Formation – 165 MYA

Kayenta Formation




The Youngest Formation
• The youngest formation that will be seen is the Morrison Formation.
• It is on the very top, however due to eroding factors it is also found below the Monument. This is the layer where many of the fossils in the area are found.

The Morrison Formation

- The Morrison Formation is between 148 -150 million years old and this is the baby of the family.
- The sediments in the Morrison Formation include multi-colored mudstones, sandstones, and conglomerates, as well as minor amounts of marls (lime -rich mud or mudstone), limestone, and claystones.
- Home of the Dinosaur Fossils.

Morrison Formation

- Some sediments in the lowest portion of the Morrison Formation are marine in origin, but the majority of the sediments were deposited along rivers, streams, lakes, mudflats, swamps, and alluvial (formed by sediment deposited by flowing water) plains that covered the western interior of North America during the Late Jurassic.

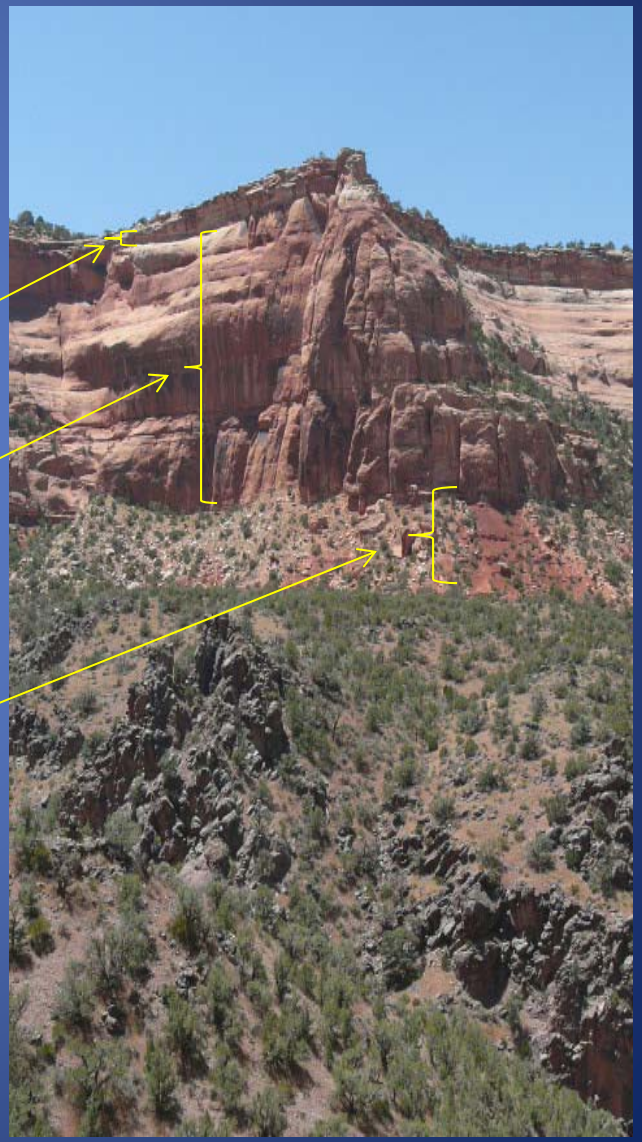
Introducing Entrada

- The layer immediately below the Morrison Formation is the Entrada Layer.
- Entrada Formation is 165 million years old and formed from ancient sand dunes.
- Originally covered about 99,000 square miles and is present throughout most of the Colorado Plateau.
- Consists of an earthy sandstone and siltstone.

Entrada Sandstone

- Siltstone-is a sedimentary rock which has a grain size in the silt range, finer than sandstone and coarser than claystones
- Sandstone is composed of quarts and/or feldspar because these are the most common minerals in the Earth's crust.
- Why is it red? *A function of varying amounts of iron (mineral hematite - Fe2O3)that imparts red color.*

Layers of the Colorado National Monument



Kayenta Formation – 190 MYA

Wingate Formation – 200 MYA

Chinle Formation – 210 MYA

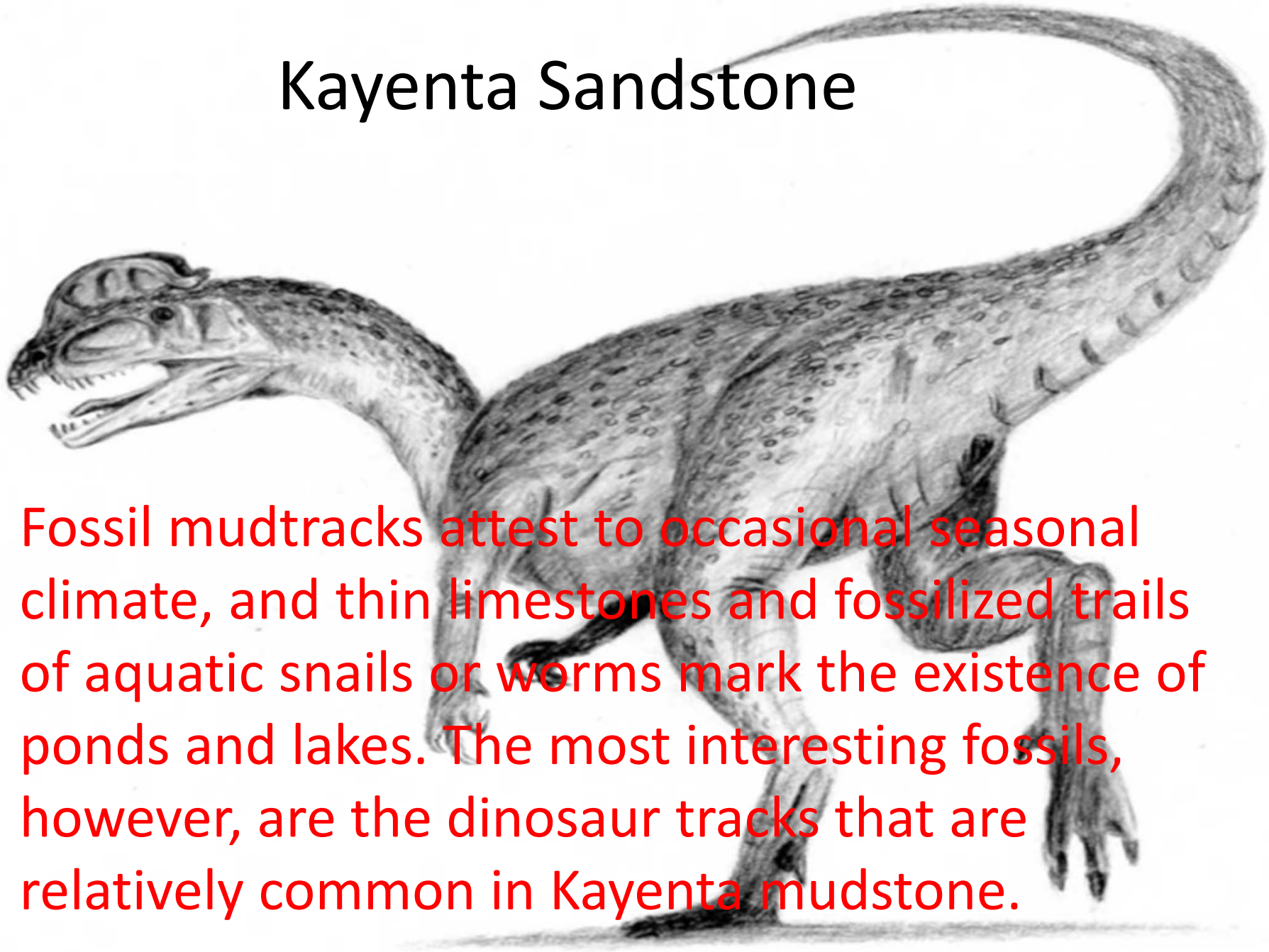
The Field Trip

- On the Field Trip to the Colorado National Monument, we will be hiking down through the layers of the rock. Our starting point is in the Kayenta formation. Monument Road is built on top of the Kayenta.
- It is estimated at 190 million years old

Kayenta Sandstone

- The Kayenta is made up of beds of sandstone, shale, and limestone, all lenticular(shaped like a lens), uneven at their tops, and discontinuous within short distances.
- Composed of relatively coarse, well-rounded quartz grains cemented by lime and iron.
- Part of climatic belt with rainy summers and dry winters at the southern edge of a great desert.

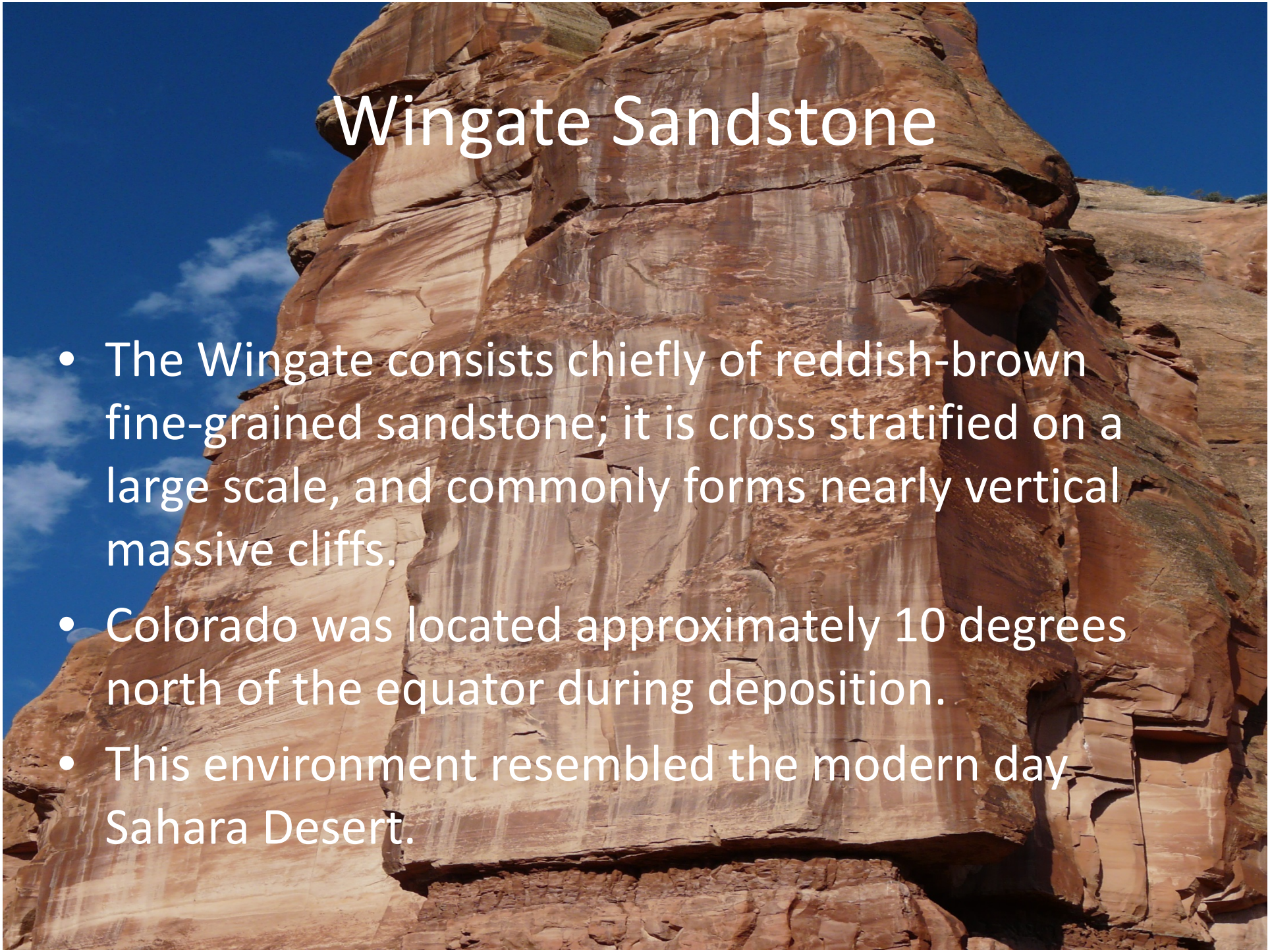
Kayenta Sandstone



- Fossil mudtracks attest to occasional seasonal climate, and thin limestones and fossilized trails of aquatic snails or worms mark the existence of ponds and lakes. The most interesting fossils, however, are the dinosaur tracks that are relatively common in Kayenta mudstone.

Wingate Sandstone

- After leaving the Kayenta we immediatley enter the Wingate Formation.
- It is estimated at 200 million years old



Wingate Sandstone

- The Wingate consists chiefly of reddish-brown fine-grained sandstone; it is cross stratified on a large scale, and commonly forms nearly vertical massive cliffs.
- Colorado was located approximately 10 degrees north of the equator during deposition.
- This environment resembled the modern day Sahara Desert.

Chinle Sandstone

- After leaving the Wingate Formation we will enter the Chinle Formation.

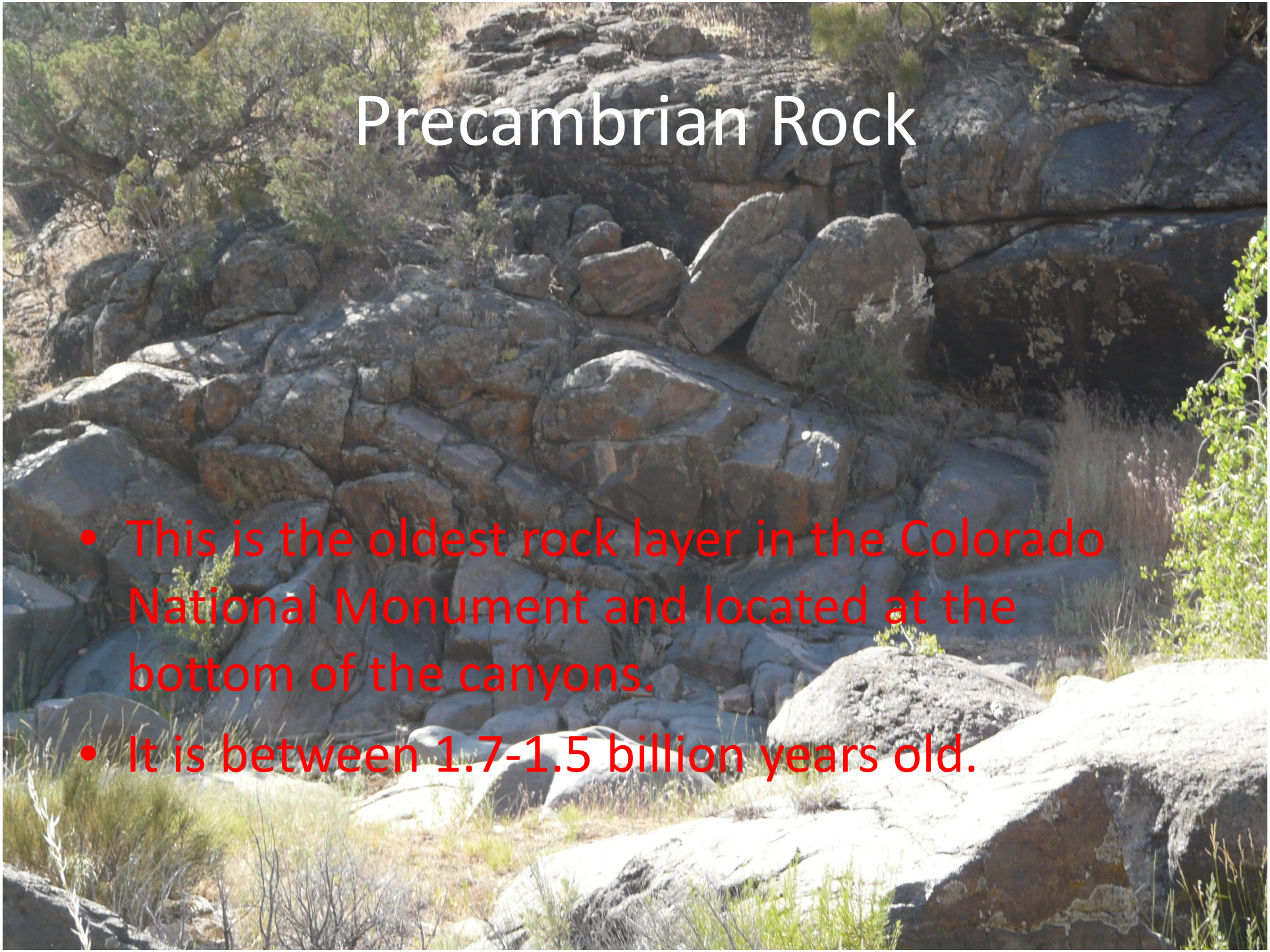
Chinle is the oldest Sandstone in the Colorado National Monument at 210 million years old.

The Chinle is composed of red mudstone, shale, conglomerate and thin limestones.

Chinle Sandstone

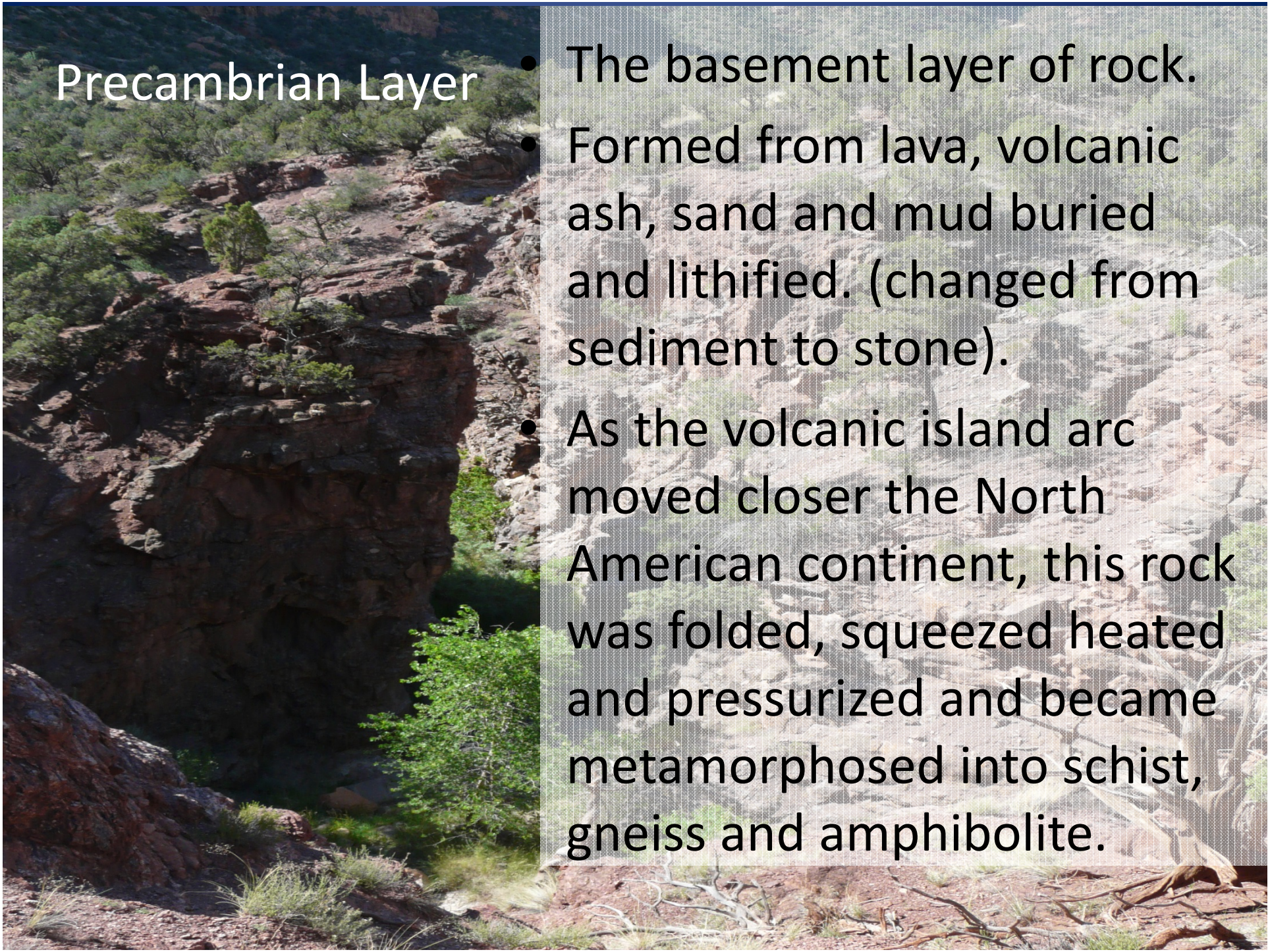
The Chinle Formation was deposited during the Late Triassic when the supercontinent Pangea had landmass on both sides of the equator.

The environment was dominated by wet environments such as stream systems, lakes, wetlands, and deltaic distributary channels. Eventually the climate shifted and dryer environments prevailed such as seasonal stream systems and floodplains.



Precambrian Rock

- This is the oldest rock layer in the Colorado National Monument and located at the bottom of the canyons.
- It is between 1.7-1.5 billion years old.

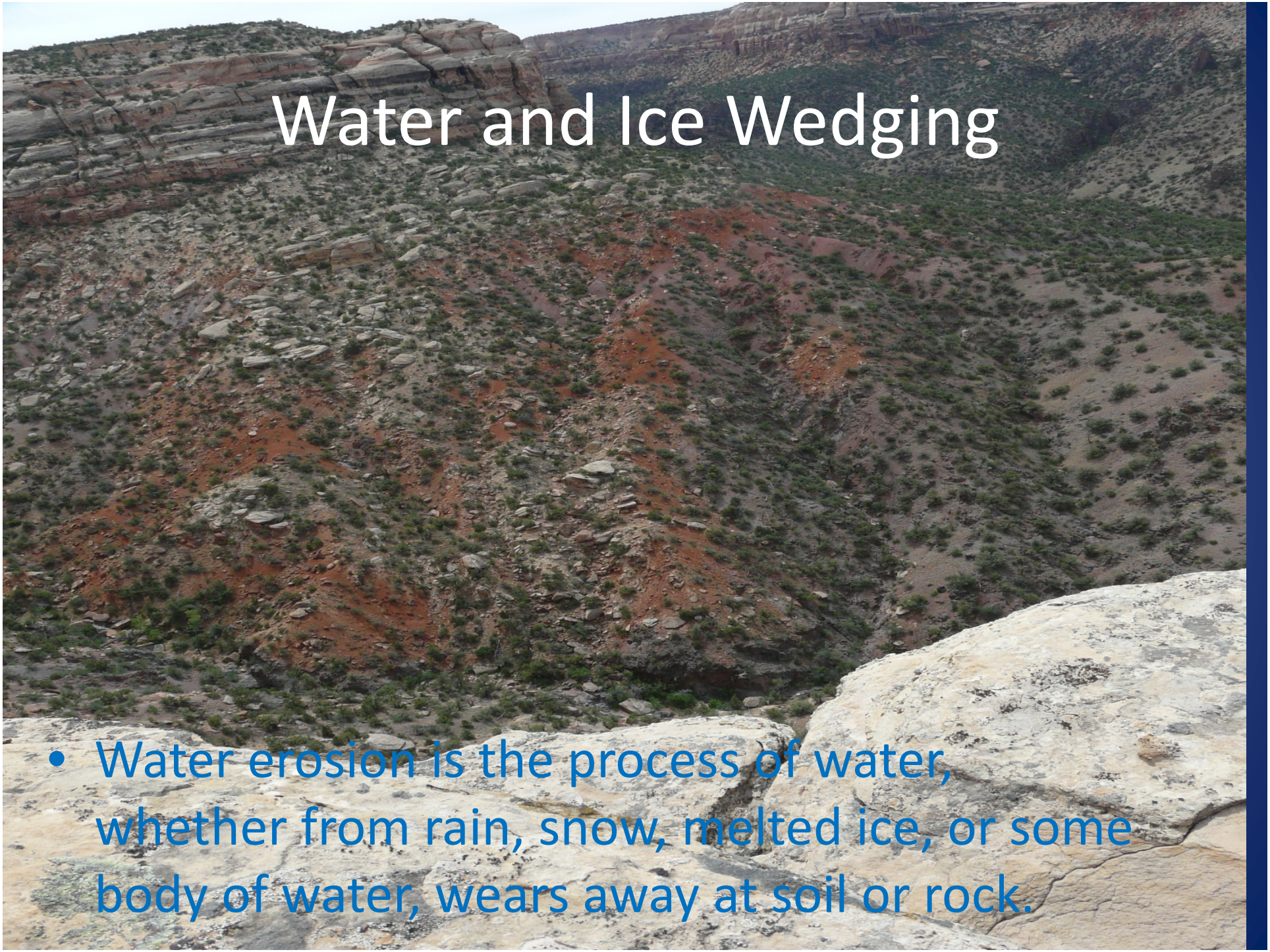


Precambrian Layer

- The basement layer of rock.
- Formed from lava, volcanic ash, sand and mud buried and lithified. (changed from sediment to stone).
- As the volcanic island arc moved closer the North American continent, this rock was folded, squeezed heated and pressurized and became metamorphosed into schist, gneiss and amphibolite.

Weathering Heights

- Erosion is the cause of the beautiful canyons located in Colorado National Monument.



Water and Ice Wedging

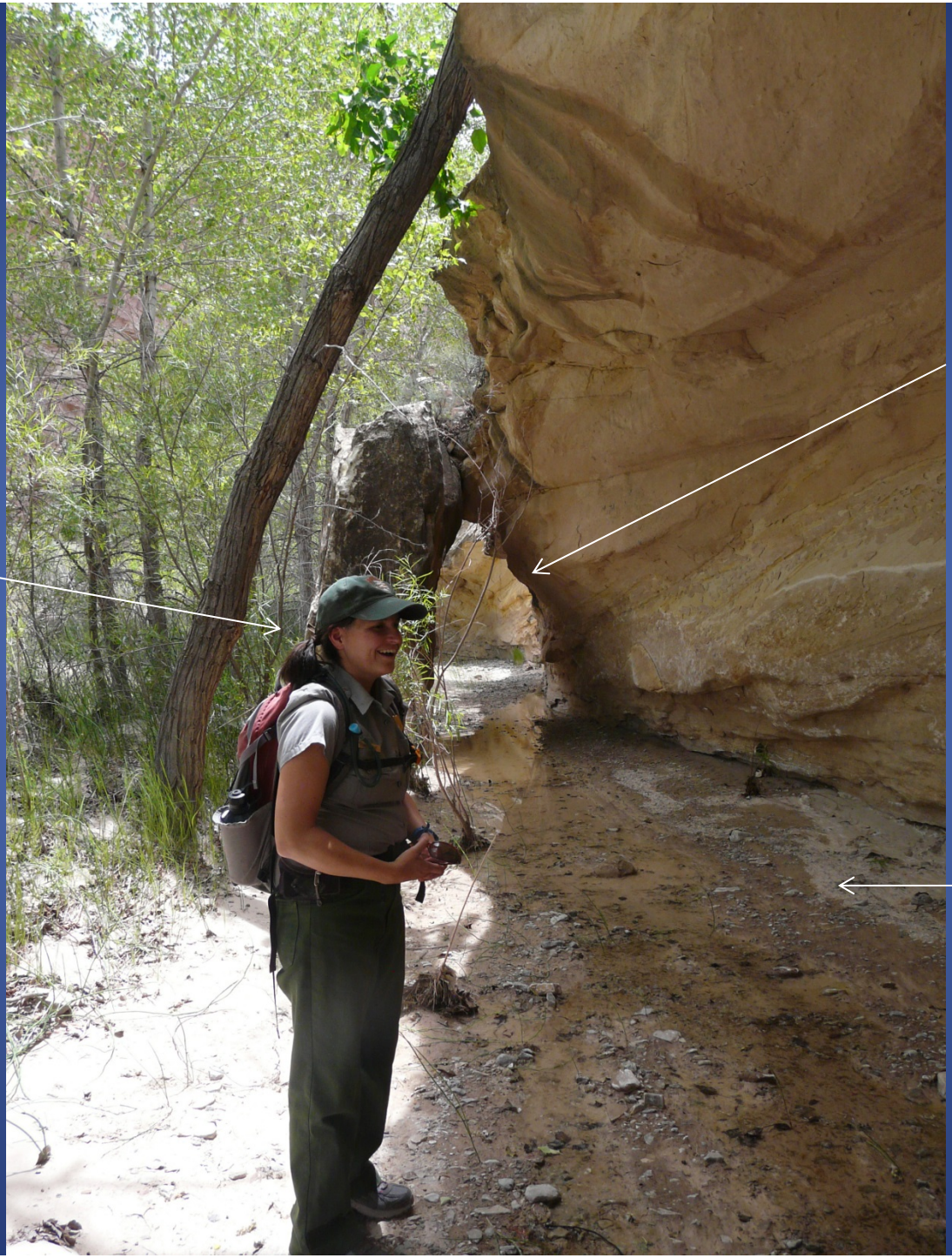
- Water erosion is the process of water, whether from rain, snow, melted ice, or some body of water, wears away at soil or rock.

Ice Wedging

- At the Colorado National Monument the process of ice wedging occurs along the many cracks and crevices of the sandstone.
- Water penetrates the sandstone and freezes, expands and causes bigger cracks

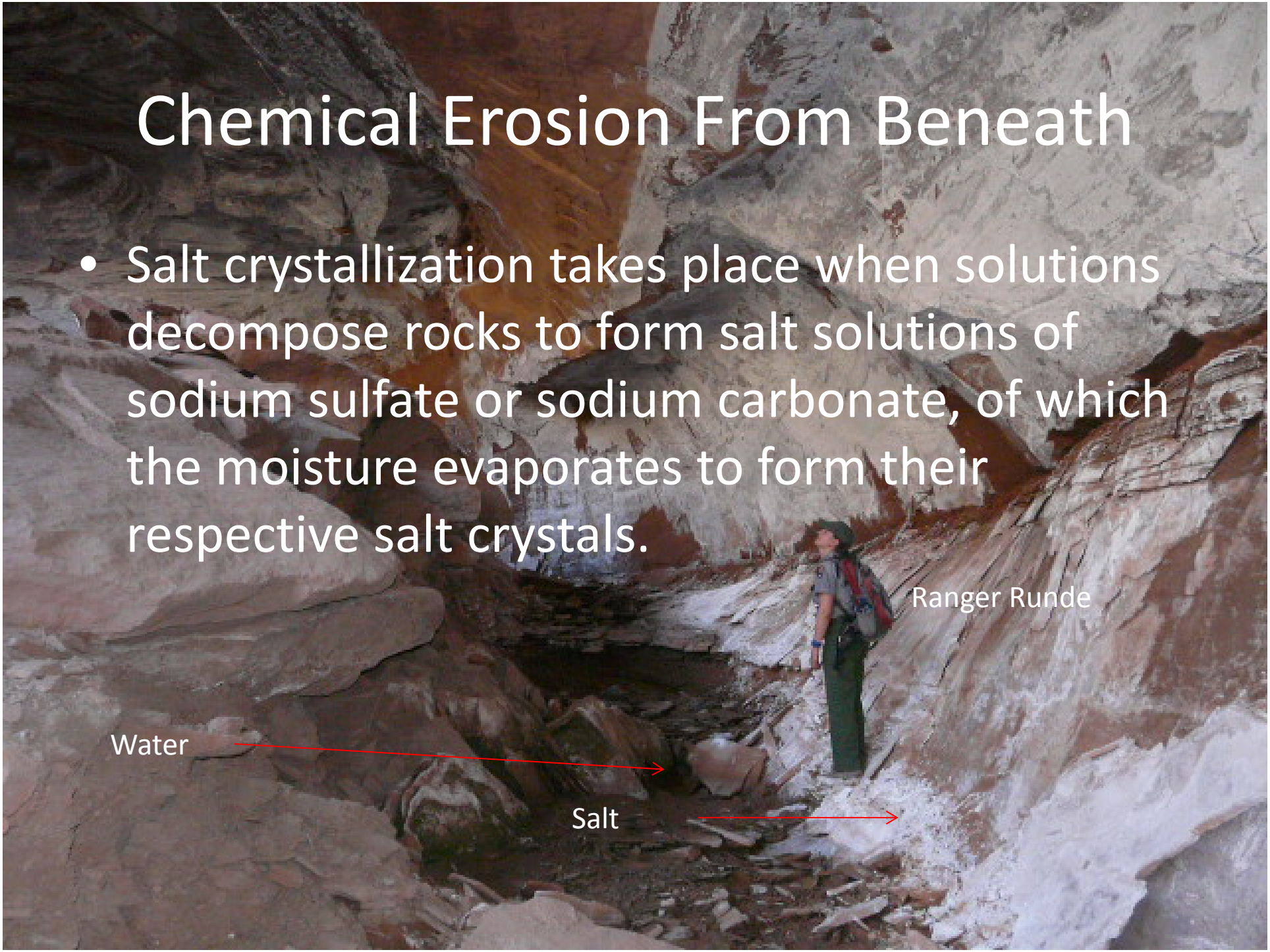
Erosion from Beneath

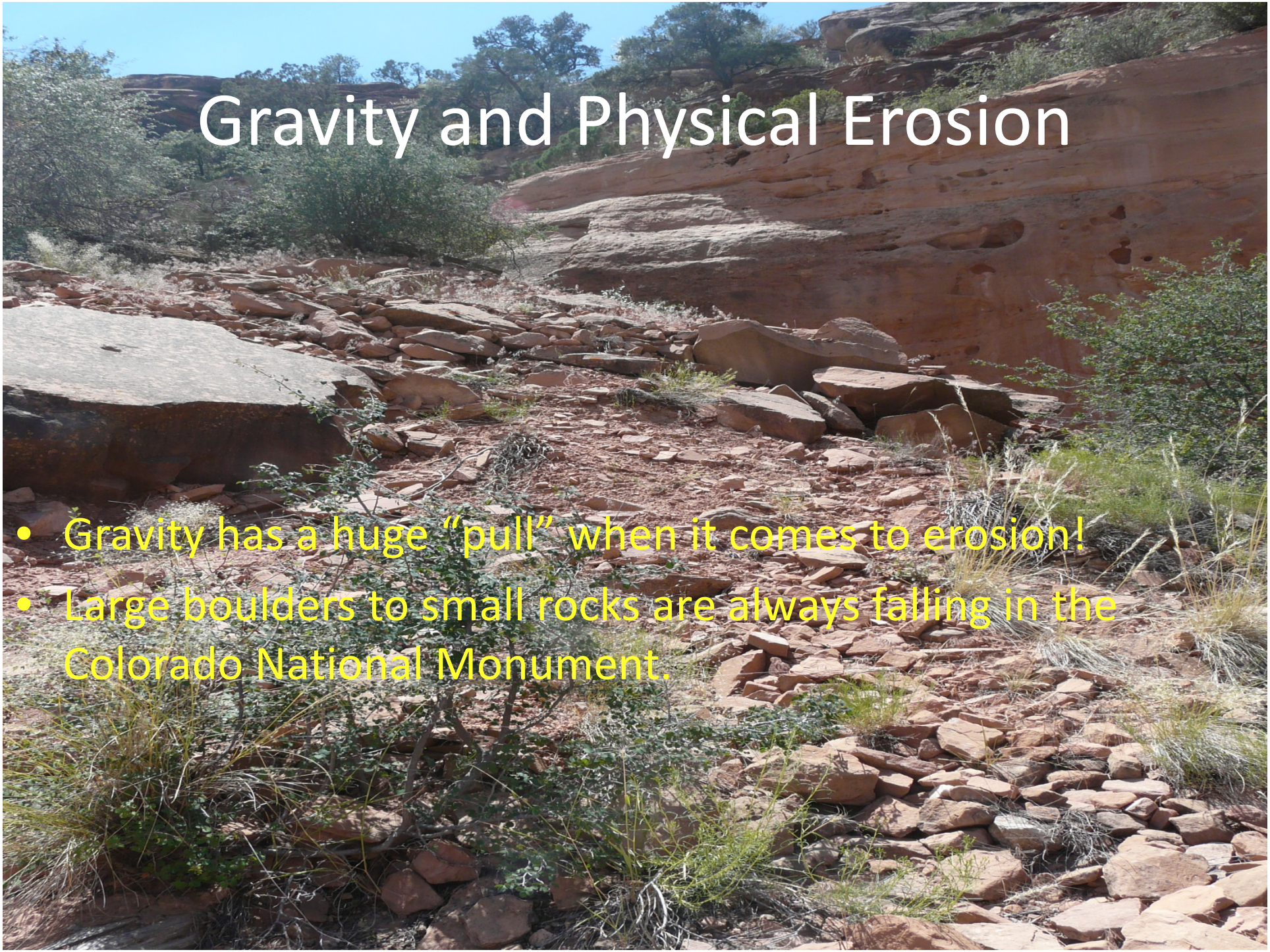
- Because the Chinle Sandstone is less porous and the Wingate Sandstone more porous, springs and seeps can be found between these layers.
- The water found in these areas date back to the Jurassic Period!


Ranger Runde
Arch formed by spring
Spring water

Chemical Erosion From Beneath

- Salt crystallization takes place when solutions decompose rocks to form salt solutions of sodium sulfate or sodium carbonate, of which the moisture evaporates to form their respective salt crystals.





Gravity and Physical Erosion

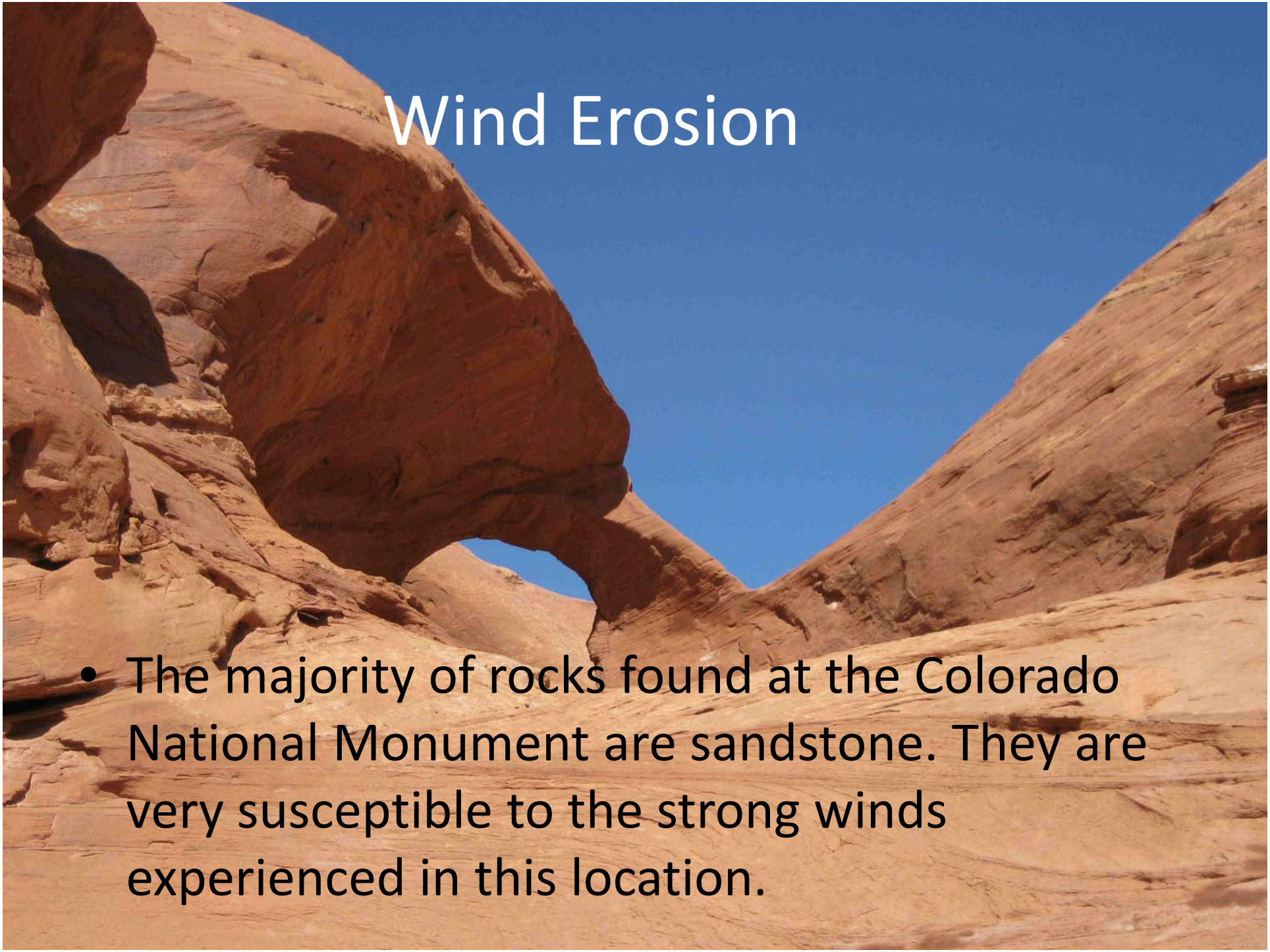
- Gravity has a huge "pull" when it comes to erosion!
- Large boulders to small rocks are always falling in the Colorado National Monument.

Biological Erosion

- Plants and roots loosen rocks

Additional Biological Erosion

- Animals in the Colorado National Monument can also contribute to erosion through the dislodging of rocks.



Wind Erosion

- The majority of rocks found at the Colorado National Monument are sandstone. They are very susceptible to the strong winds experienced in this location.

The Formation of the Colorado National Monument

- https://www.youtube.com/watch?v=uOjlUjXHcD4&feature=player_detailpage

Bibliography

- William Newman; Distribution of Elements in Sedimentary Rocks of the Colorado Plateau.
- University of Colorado Boulder
- National Park Service US Department of the Interior (http://www.nps.gov/colm/index.htm)
- Foos, A. (n.d.). Geology of Colorado National Monument. *Geology of Colorado Nationl Monument*. Retrieved June 17, 2013, from http://www2.nature.nps.gov/geology/education
- Maura McDougal TRT 2014