Grand Canyon Geomorphology: What comes first ... last?

This is a preview of the published version of the quiz

Started: May 18 at 4:42pm

Quiz Instructions

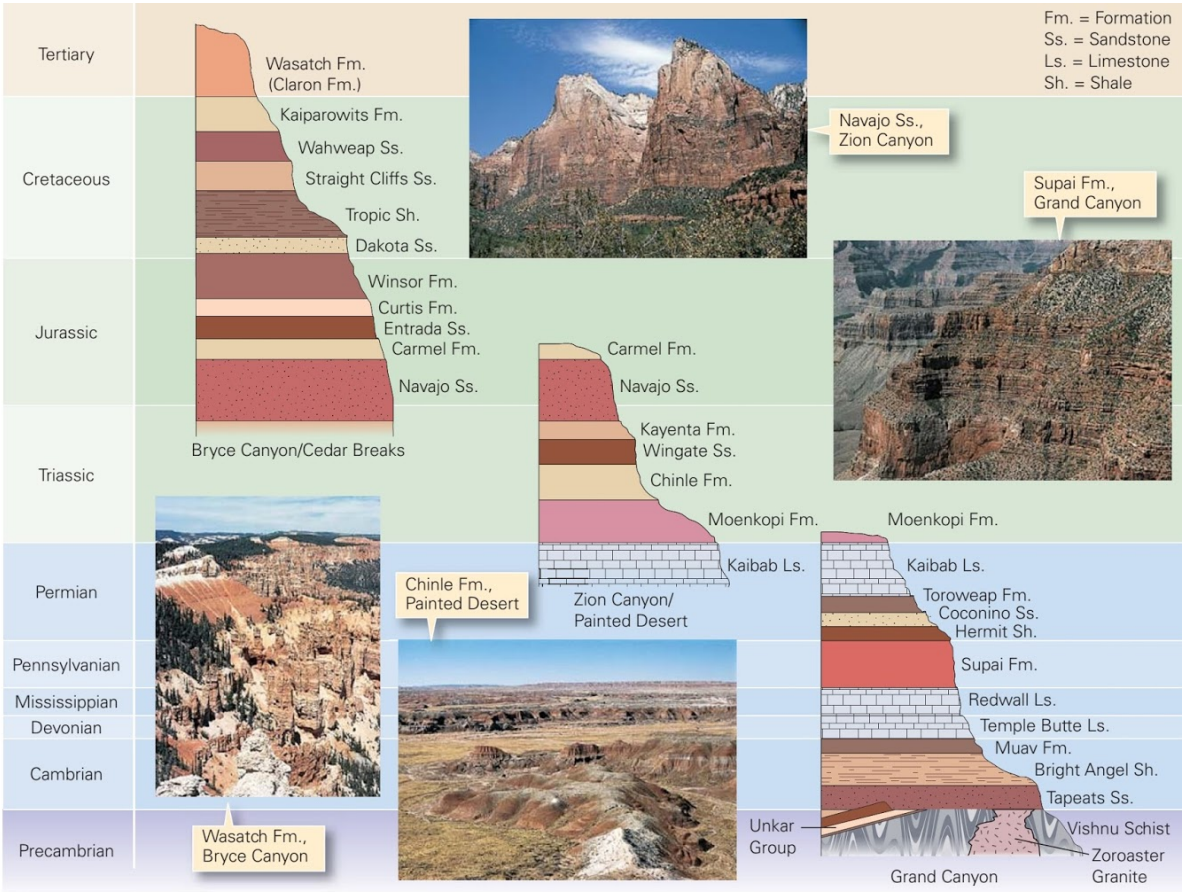
from **https://www.smbc-comics.com/comic/strata (https://www.smbc-comics.com/comic/strata)**

The events that shaped the geomorphology of the Grand Canyon can be ordered (called relative dating) from oldest to youngest. Sequencing what you are seeing is a great first step to sorting out the geomorphology of this landscape.

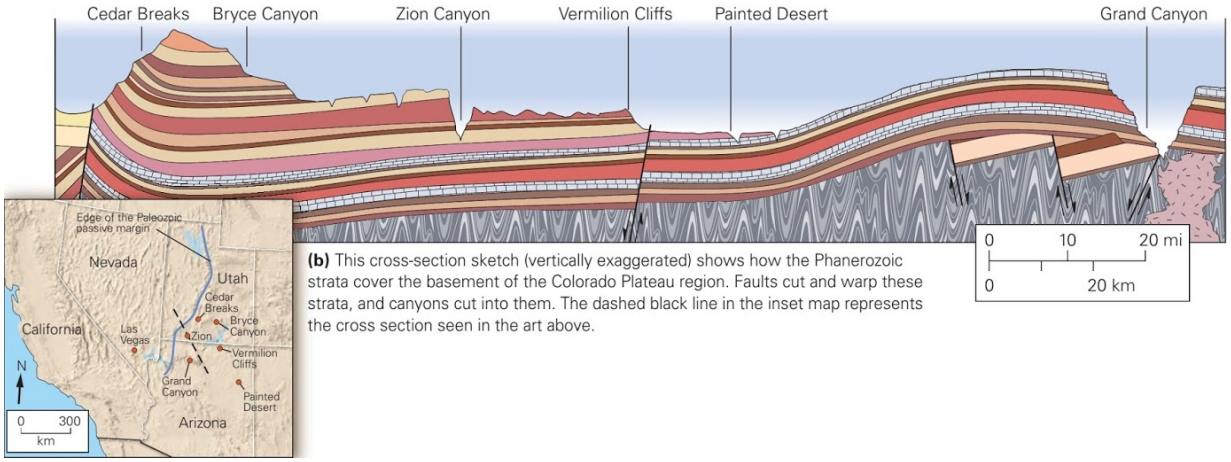
We need to stress to you that we are not trying to trick you with questions that look and seem easy. That is not our way. We want you to kick back and enjoy learning about the Grand Canyon. Tricking you is antithetical to this goal. So if something seems super obvious to you - great. That means you are a "natural" in thinking like a geomorphologist.

We assume that all of this material is pretty new to you, even though we hope you were exposed to this material in your physical geography lecture. But if not, the questions will reteach the basic concepts.

There are lots of sedimentary layers of Mesozoic age that used to be on top of this material. You can see these strata by visiting areas north of the Grand Canyon, such as Bryce and Zion National Parks, as illustrated below from **http://geologylearn.blogspot.com/2016/03/the-geologic-column.html (http://geologylearn.blogspot.com/2016/03/the-geologic-column.html)**



(a) Different intervals of geologic time are represented by the strata of different parks.



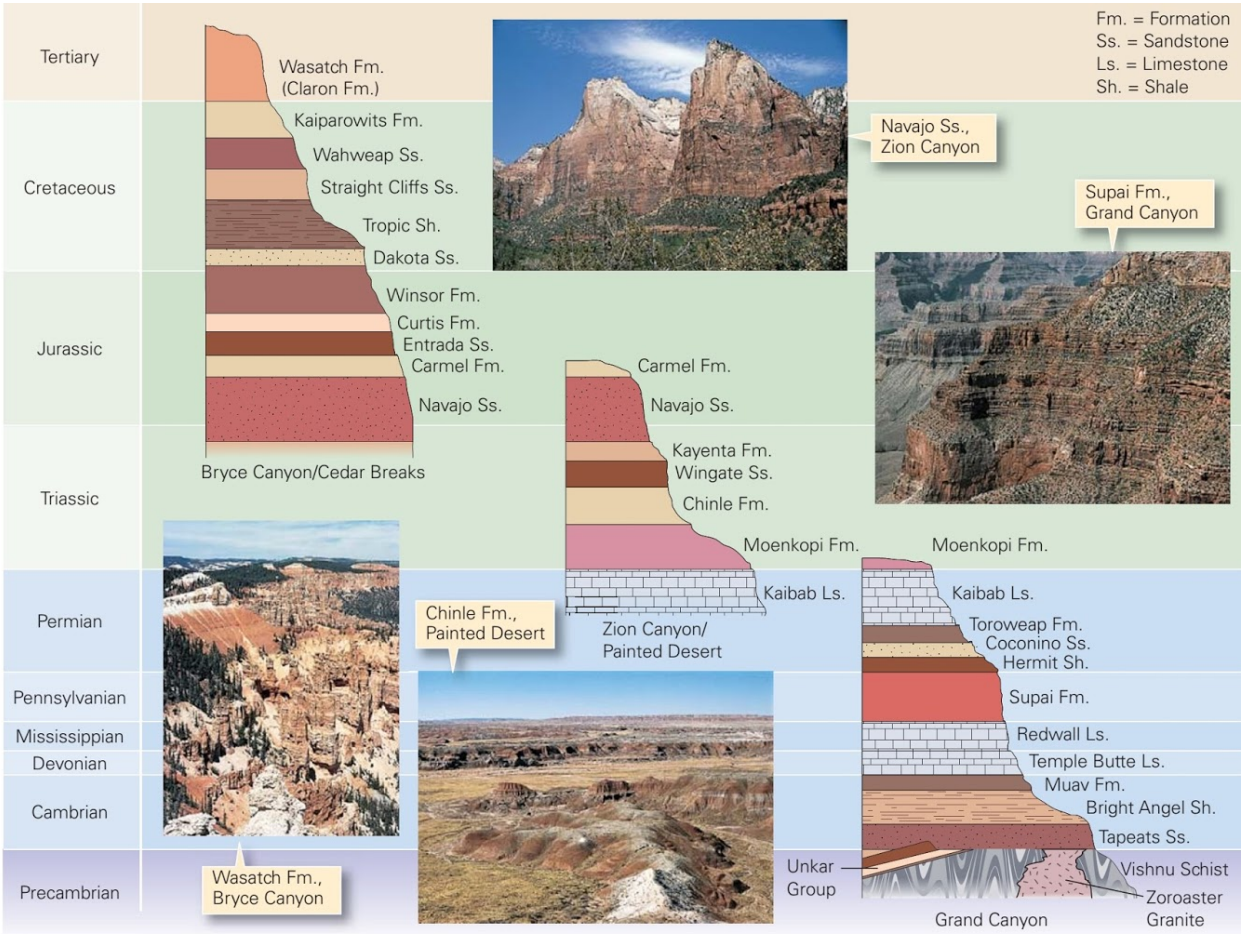
(b) This cross-section sketch (vertically exaggerated) shows how the Phanerozoic strata cover the basement of the Colorado Plateau region. Faults cut and warp these strata, and canyons cut into them. The dashed black line in the inset map represents the cross section seen in the art above.

Question 1

1 pts

This question focuses on an idealized geological cross-section in Grand Canyon region, that includes nearby Bryce and Zion National Parks, as illustrated below from **http://geologylearn.blogspot.com/2016/03/the-geologic-column.html (http://geologylearn.blogspot.com/2016/03/the-geologic-column.html) (http://geologylearn.blogspot.com/2016/03/the-geologic-column.html)**

The basic idea of a cross-section is to portray a vertical sequence of rocks. Geologists use a concept called "superimposition" where sedimentary rock layers (called strata) on the bottom are the oldest. Whatever goes on top has to be younger.



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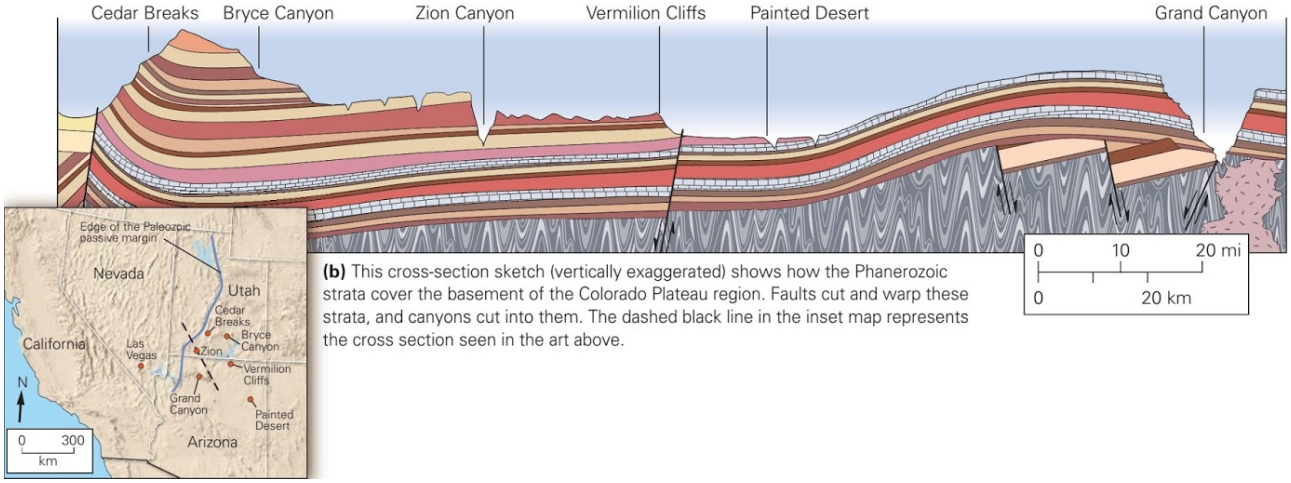

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The Grand Canyon's sedimentary strata (layers) starts with the Cambrian period and ends with the Kaibab Limestone in the Permian period -- all within the Paleozoic era. Way down deep in the Grand Canyon are rocks that are much older, forming in different eras in the Precambrian.

Zion National Park's strata is mostly Triassic in age, while Bryce National Park's strata include all periods in the Mesozoic (Dinosaur) era and even afterwards.

HINT: as you look at the diagram, think of the cartoon at the start of this lab. The process of superimposition is what drives thinking about the relative ages of rocks. Layers (strata) deposited at the bottom of a sequence must be older than the strata deposited on top. And, other sorts of rocks (e.g. those metamorphic and igneous rocks at the bottom of the Grand Canyon) that underlie the lowest strata must be older that that lowest strata layer.

QUESTION: Where would you go to see the oldest rocks in the region and then the youngest rocks in the region?

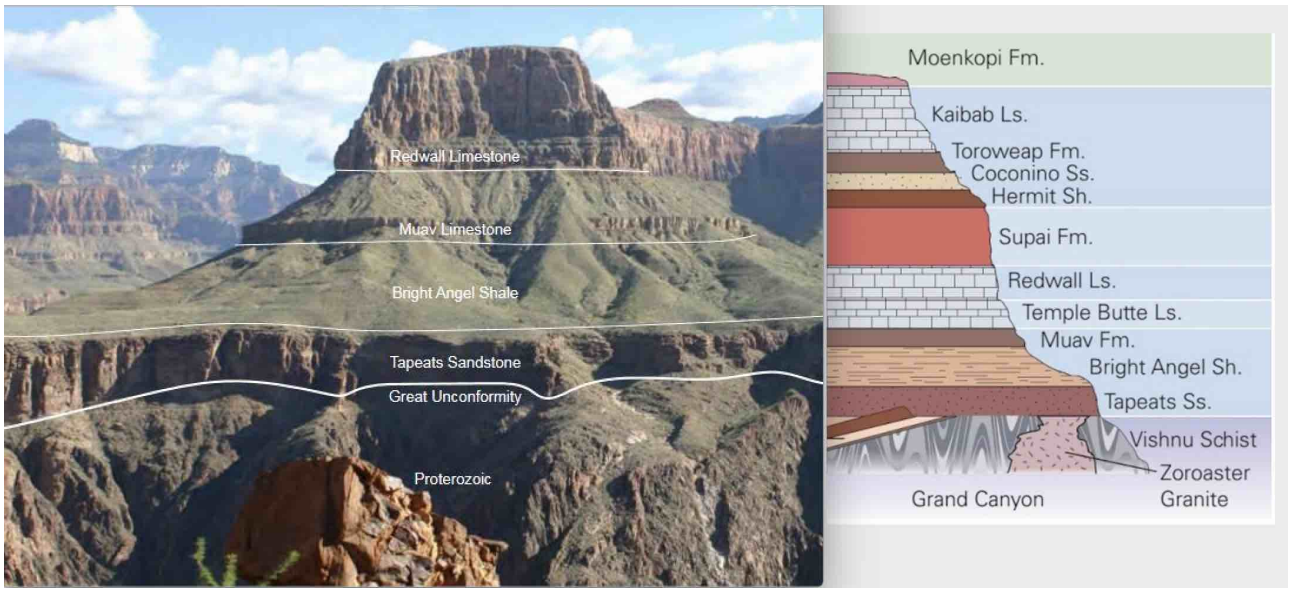
Please answer the question based on the diagram above. Think simplistically. If you are quite familiar with the geology in the region, you could be clever and answer that there are very young (1.2 million year old) lava flows down at the bottom of the Grand Canyon. But please don't think at a higher level than a 100-level basic science course.

- ◯ oldest: bottom of the Grand Canyon; youngest - Bryce National Park
- ◯ oldest: bottom of the Grand Canyon; youngest - Zion National Park
- ◯ oldest: bottom of the Grand Canyon; youngest - middle of the Grand Canyon
- ◯ youngest and oldest both are found in ryce National Park

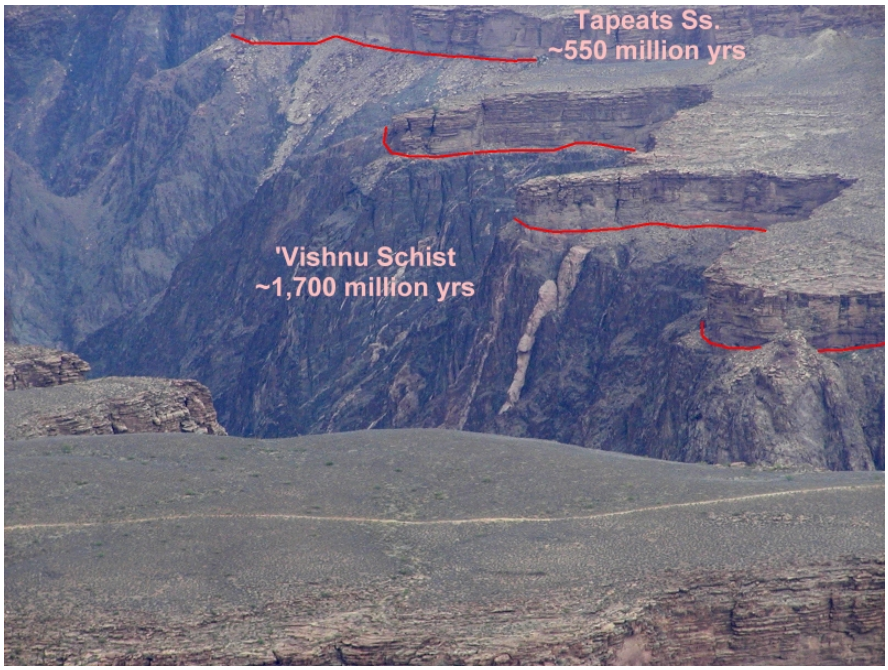
Question 2

1 pts

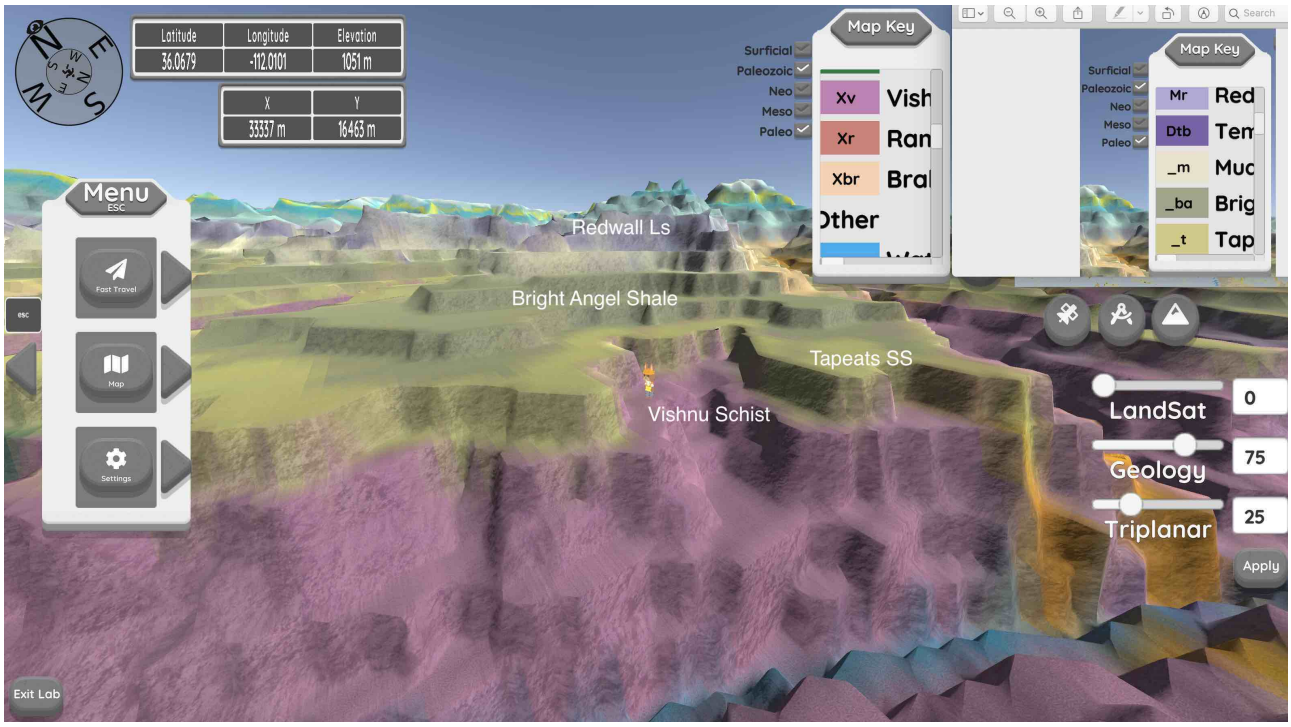
Geologists love a feature you can see in the Grand Canyon called an unconformity -- a concept that means no rocks were deposited during a period of time. Instead, erosion was going on instead. Perhaps the most famous unconformity in the world is "the Great Unconformity" -- seen in cross-section and in a photo. Its considered "great" because it is seen so beautifully in the Grand Canyon, because it represents a very long period of time, because its found globally, and because it separates rocks that have fossils from those with no fossils (too old or only bacteria fossils). The Vishnu Schist underneath is about 1.75 billion years old, and the Tepeats Sandstone is about 545 million years old. So that's over a billion years of no rock record, and geologists consider it a "must see in person" sort of thing.



This is another shot of the Tapeats SS (sandstone) resting on top of an erosion surface (Great Unconformity) and the Vishnu Schist:



Please Fast Travel to 36.0679 and -112.0101 in the geovisualization. The avatar should land on the Great Unconformity. The purple rock at the rabbit's feet is the Vishnu Schist. The Tapeats Sandstone and its yellowish-brown color is directly on top of the Vishnu. Then, the olive brown of the Bright Angel Shale is on top of the Tapeats.



THIS QUESTION HAS NO WRONG ANSWERS. All choices will be scored correctly. Really, this is a survey embedded into the lab. We want to know your opinion to this question

QUESTION: Does this location in the geovisualization do "justice" to the concept of the Great Unconformity?

- [ ] Yes. It does.
- [ ] Maybe. Maybe if you instructed us to walk the avatar along the Great Unconformity and look at this "contact" all along the inner gorge, it would have a better impact.
- [ ] Maybe. Maybe if you embedded a photo taken on the ground inside the game environment (which is being worked on right now), it

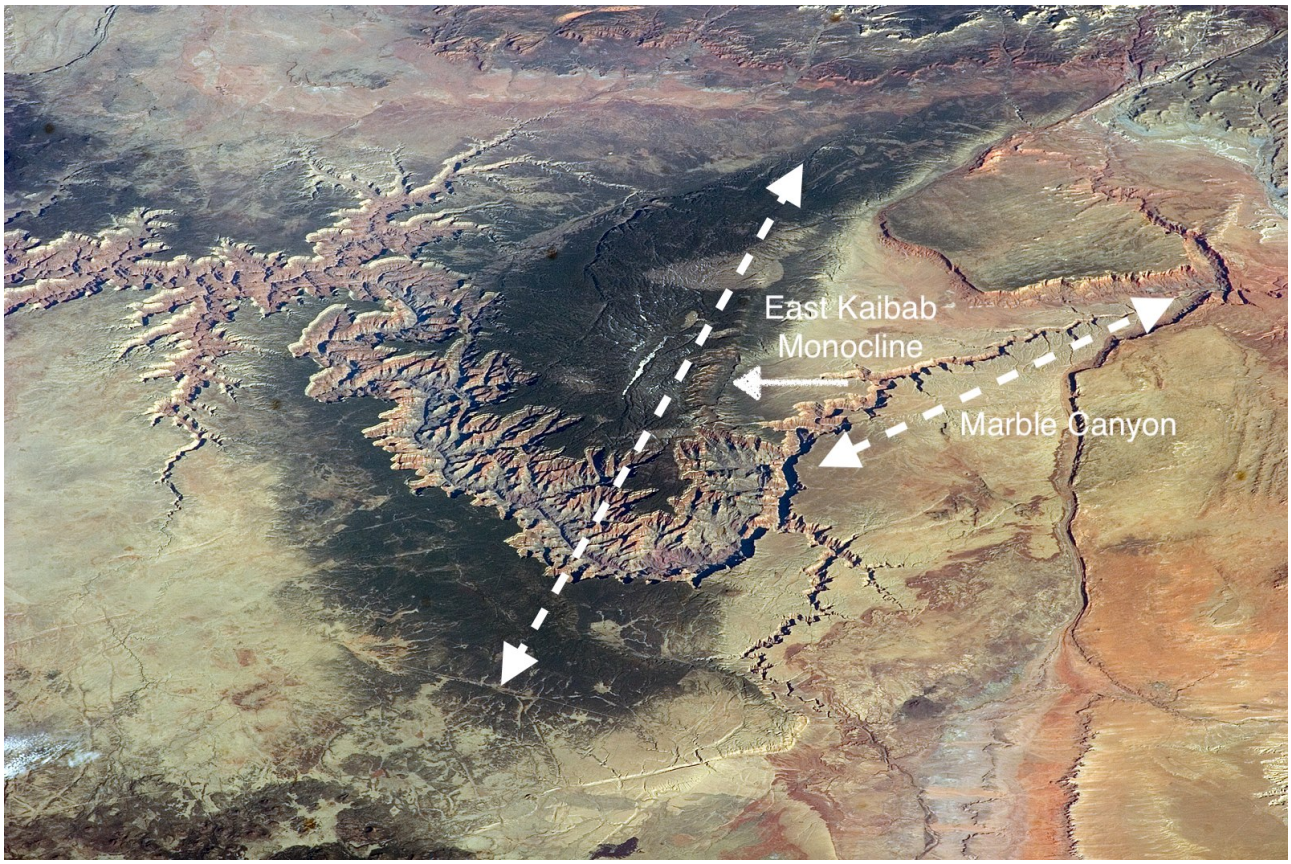
would have a better impact.

- [ ] No. The game environment just cannot handle this sort of a concept.
- [ ] I have a different view. And if you do have a different opinion, please feel free to contact your instructor and explain.

Question 3

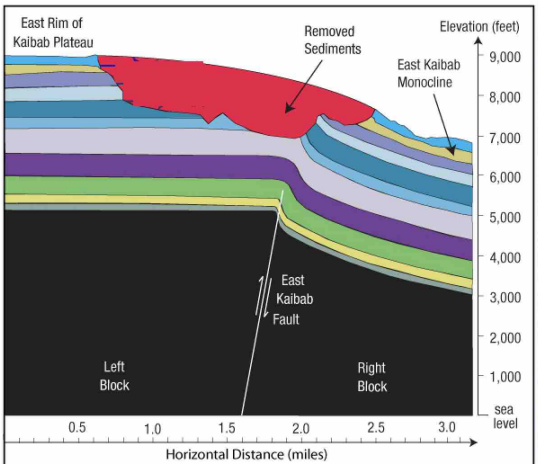
1 pts

The lecture physical geography class covers the topic of how compression of earth materials can lead to both faulting and folding of rock material. When the material consists of rocks like granite or metamorphic rocks, faults (or breaks) tend to be the response to compression. But sedimentary strata often undergo folding when pushed together. This is exactly what happened to the Grand Canyon. The image below was taken from the International Space Station, and there are two dashed double arrows. One is labeled Marble Canyon for your reference. The other is the upfolding of sediment called the Kaibab Upwarp. The solid arrow points to the focus area of this question called the East Kaibab Monocline.



In physical geography lecture, you learn that a monocline is a single bend in sedimentary rock. The rock is high on one side (East Rim of the Kaibab Plateau) and it folds down on the other side (Marble Canyon side). The East Kaibab monocline is one side of this giant upwarp (Kaibab Upwarp). It is underlain by a fault in metamorphic/granitic rocks. Its probable that faulting of these deep rocks caused the bend in the sedimentary rocks.

Notice in the cross-section and in the airplane photo that some of the sedimentary rocks have been eroded away right at the bend in the monocline.



INSTRUCTIONS: Using Fast Travel, go to 36.4492 and -112.0476. This spot is right above the deep fault, in the area of eroded sediments. Your instructions are to explore the erosion you are seeing. Pull the camera angle back way up high and spin it around. Zoom in and examine how the rocks are eroding via the development of river canyons. As you explore, think about the relative sequence of events that led to this "erosional window" into the center of the monocline.

QUESTION: Select the correct order from oldest to youngest among the following processes in play at the East Kaibab Monocline game site.

the folding of the sedimentary rock	deposition of the Kaibab limestone (blue color, top of the plateau)
the erosion of the different layers of Kaibab, Toroweap, Conconino, and then the Supai group fo sediments underneath the yellow Coconino sandstone and the purple Redwall Limestone	deposition of the Redwall Limestone

- ◯ The sedimentary Redwall Limestone was deposited first. Then, came the deposition of the Kaibab Limestone. Then the sedimentary rocks were folded. Lastly, the erosion of the sedimentary rocks occurred.
- ◯ The erosion of the sedimentary rocks occurred first.Then, came the deposition of the Kaibab Limestone. Then the sedimentary rocks were folded. Then, the sedimentary Redwall Limestone was deposited.
- ◯ The deposition of the Kaibab Limestone came first. Then, the sedimentary Redwall Limestone was deposited first. Then the sedimentary rocks were folded. Lastly, the erosion of the sedimentary rocks occurred.
- ◯ None of the answers make sense, and hence this is the best answer.

Question 4

1 pts

This question is pretty simple, we hope, if you look at things in the geovisualization environment. Fast Travel to 36.2001 (latitude) and -111.7540 (longitude). Your location is close to the edge of the game. The idea is that you have a nice

"cross-section" 3D view of a river incising (downcutting) through the Paleozoic rock sequence. Even though this is the Little Colorado River -- we think this perspective is the easiest way for you to answer this question.

QUESTION: As the river is starting to cut a canyon, what layer (sedimentary strata) does it first have to erode? What strata has been the last one to have been eroded?

Reminder of names: The light blue colored Kaibab Limestone strata is at the top. The tan-colored Tapeats Sandstone is at the bottom. The bright yellow is the Coconino Sandstone.

HINT #1: if you were going to saw through these rocks, which layer would you have to saw first?

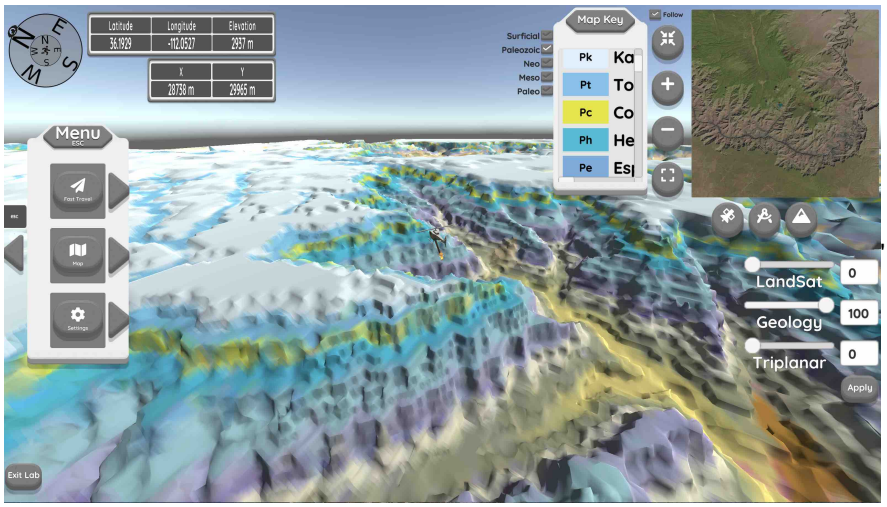
HINT #2: The sequence is the opposite of the age of the strata

- ◯ The river eroded the top (Kaibab Limestone) first and the bottom (Tapeats Sandstone last)
- ◯ The river eroded the Tapeats sandstone first and the Kaibab Limestone last
- ◯ The river eroded the Coconino Sandstone first, then Tapeats, and Kaibab
- ◯ I do not have sufficient information to answer this question.

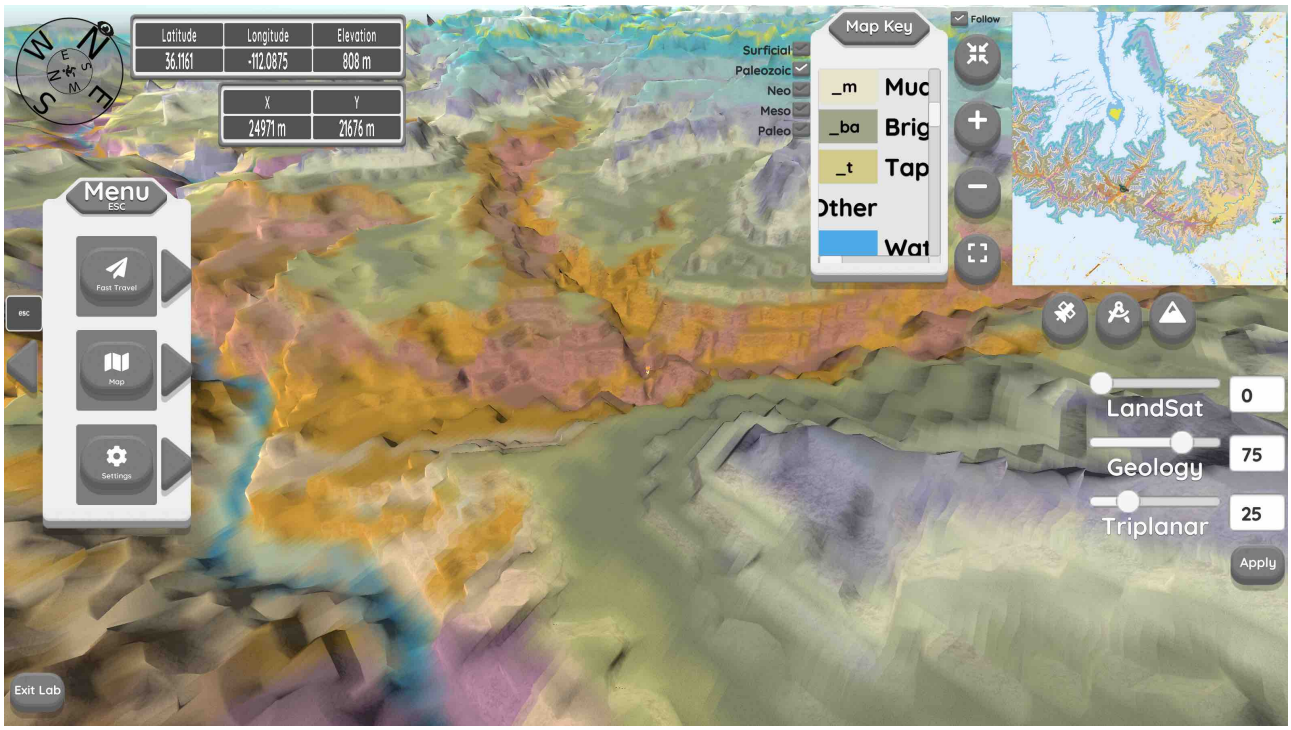
Question 5

1 pts

I hope you remember the helicopter tour in the geovisualization where you traveled along the Bright Angel Fault and up Bright Angel Creek to the North Rim. If not, this is a screenshot of a location on that tour with the camera angle pulled back.



It might help you to Fast Travel to 36.1161 and -112.0875 (below) and run the avatar up and down Bright Angel Creek -- thinking about the issue of this question.



ISSUE IN THE QUESTION: A tributary to a main river (like Bright Angel Creek is a tributary that flows into the Colorado River) does several geomorphic tasks as the main river incises (cuts down):

- The tributary also incises to "keep up" with the main river
- The tributary extends its length in the headward direction (up hill).
- The tributary transports the rocks that it eroding (both incising downward and extending headward).

QUESTION: What rock type is the headward end of Bright Angel Creek **currently** eroding? What rock type did the Bright Angel Creek **start to erode** as the Colorado River started incising into the Grand Canyon some 4.8 million years ago?

HINT: It is the same rock type. It has a light blue color, and it is the top of the Paleozoic strata in the Grand Canyon area.

- ◯ Kaibab Limestone
- ◯ Vishnu Schist
- ◯ Proterozoic granite
- ◯ Precambrian rocks

Question 6

1 pts

We have to fess up. Up until now, we have been telling you that the Kaibab Limestone was the top layer that had to be eroded away first when the Colorado River started flowing about 4.8 million years ago. That is probably not the case, actually.

There are strata that were on top of the Kaibab Limestone back then. They all eroded away over the last 4.8 million years. But it has just been simpler to ignore this issue until now.

There are a few places where these rocks have been preserved, underneath lava flows. The hard basalt rock of a lava flow erodes much slower than even the Kaibab Limestone. So a basalt lava flow can protect the rock underneath.

Please Fast Travel to one of these spots at 36.0553 (latitude) and -111.7730 (longitude). That green coloring is the selection by the U.S. Geological Survey to portray the Moenkopi Formation. The Moenkopi is composed mostly of weakly cemented siltstone, some compressed mud (shale) and some weakly cemented sandstone. It erodes quickly. So it took a basalt flow to cover it up.

QUESTION: What rock type is underneath the Moenkopi? And do you think the Moenkopi formation covered the entire Grand Canyon region before it was eroded?

- ◯ Kaibab Limestone. Yes, the Moenkopi Formation covered the entire Grand Canyon region before it was eroded.
- ◯ Don't put down this answer. But PLEASE STAY AT THIS LOCATION TO ANSWER THE NEXT QUESTION

Question 7

1 pts

Hopefully, your avatar is still at 36.0553 and -111.730. If so, please look at the tan material that is randomly draped all over this little hill. This tan material is one of the few geological mapping units that is in the "Surficial Deposits" category. This color designates the occurrence of one or more landslides. What's happening is that the Moenkopi formation is so weak, that the harder basalt on top is landsliding off the hill as the Moenkopi collapses into a landslide.

Now, Fast Travel to 36.2947 (latitude) and -111.8379 (longitude). Look up at the top of the cliff faces surrounding your avatar. Do you recognize this same color? Do you recognize that these landslide deposits are scattered about and not continuous?

QUESTION: HOW DO YOU KNOW THE LANDSLIDE DEPOSIT IS MORE RECENT THAN THE PALEOZOIC ROCK LAYERS IT COVERS?

Hint: The answer is given away in the very first question of this lab.

- ◯ Superimposition: the landslide deposits are superimposed over the Paleozoic strata
- ◯ Actually, the landslide deposits are older than the rocks they cover. Its the only way to explain things.
- ◯ There is not information to answer this question. Hence, this is the best answer.

Not saved Submit Quiz