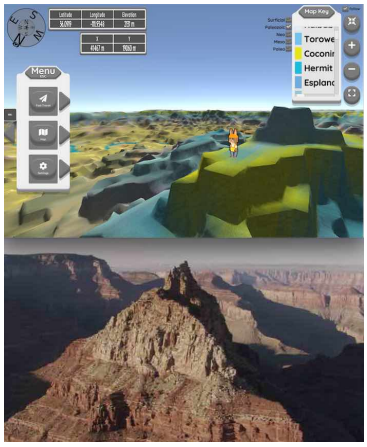
Grand Canyon Geomorphology: Cliffs and their Retreat

ⓘ This is a preview of the published version of the quiz

Started: May 18 at 4:42pm

Quiz Instructions

The cliffs and ramps around the confluence of the Colorado & Little Colorado Rivers.



Grand Canyon Temple cliffs and ramps.

Please start by watching this 28 second video filmed by a National Park Service helicopter flight. You are seeing a stunning close-up view of the Kaibab Formation making up the cliff face. This Kaibab cliff is a limestone. The underlying rock is called the Torroweap formation made up of a mixture of sandstone, shale (compressed mud) and salt (gypsum) that is making a ramp under the Kaibab cliff.

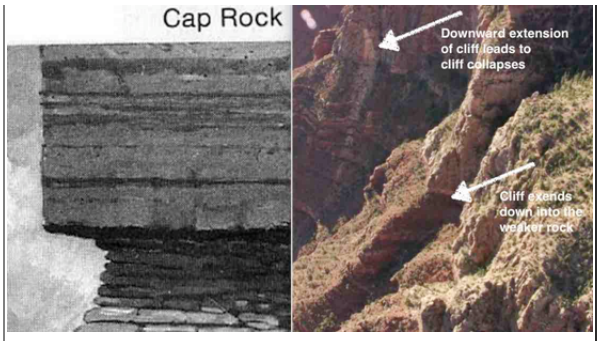
Grand Canyon: Aerial View Close to the Rim

The Kaibab Formation is the youngest (top) of the Paleozoic strata. It ranges between 90 and 120m thick, and it forms cliff faces because the limestone in this semi-arid environment is resistant to erosion.

The underlying Toroweap Formation is between 60 and 90 meters thick The weaker nature of the Toroweap means that it erodes more easily that the Kaibab.

What happens is that water streaming off the Kaibab cliff erodes the Toroweap and extends the cliff down into the weaker rock. Eventually, this weak rock just cannot take the weight of the overlying cliff and a big chunk of rock face suddenly collapses (Toroweap and Kaibab together) -- eroding back the Grand Canyon. This occasional cliff face retreat is the way that, and the whole Grand Canyon widens by eroding away from the Colorado River by landsliding.

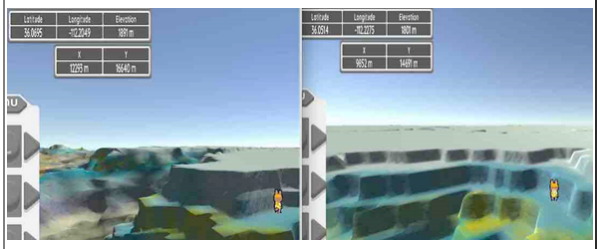
The idea of making and maintaining a cliff in the Grand Canyon, then, is just like everywhere else: a strong layer of rock (called a caprock) suddenly collapses in landslide when a weaker layer of rock underneath can no longer support the weight of the overlying cliff.



Step 1 to prepare for the questions: simply investigate the Kaibab cliff and the underlying Toroweap, in the game, by fast traveling to the location of the helicopter flight:

36.0695 - 112.2049

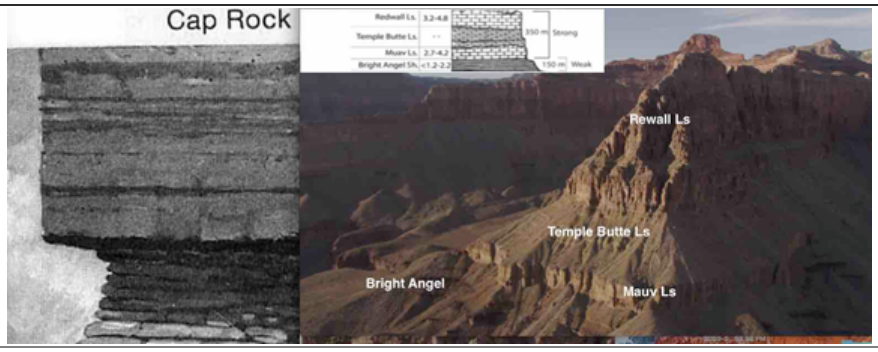
This spot puts the avatar on Toroweap formation – between the cliff-forming Kaibab and Coconino formations. Directly above the avatar is the cliff face of the Kaibab Formation (light blue) and below is the massive sandstone of the Coconino Sandstone (yellow-gold).



Just walk the avatar around the Kaibab cliff face that makes the rim of the Grand Canyon in this area. Observe.

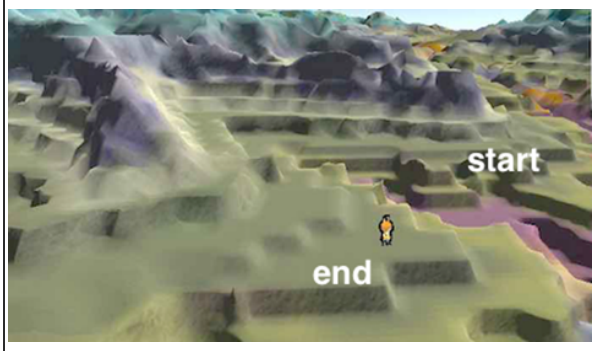
STEP 2 TO PREPARE FOR THE QUESTIONS: start by watching this 41 second video of a National Park Service helicopter flight video of limestone cliff faces (the big cliff is the Redwall Limestone). Examine what is underneath the vertical cliff faces. Just look at the scene from the flatter slopes at the bottom up to the cliff.

Grand Canyon: Aerial View of Redwall Limestone Abutment



The Redwall and the Mauv limestones make up the cliffs, because they form “cap rocks” that protect the weaker rock underneath. The Temple Butte Limestone can also make cliff faces.

The Bright Angel Shale at the bottom of the limestones is nothing more than compressed mud. Its much weaker, and these cliffs exist because the shale erodes the base of the cliffs, and they collapse. This erosion of the base and collapse is one way the Grand Canyon widens.

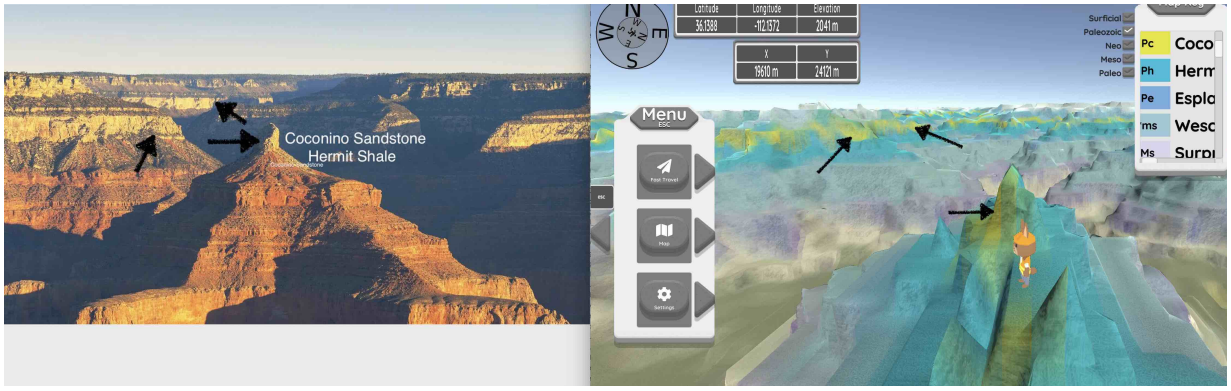


Step 3. Fast Travel to this area of the Grand Canyon in the game at 36.1082 - 112.2143 & have your avatar walk around the area to **36.1152 -112.2233**.

The color of the various rock types, including the Bright Angel Shale (that the avatar is standing on in a screenshot to the left) was established by the U.S. Geological Survey (this map is draped over the topography in the game environment).

Step 4. So far, you have been exposed to limestones that form cliffs inside the Grand Canyon.

In this step 4, just use the Fast Travel Menu to jump to the top of Isis Temple. The yellow color in the U.S. Geological Survey mapping is the Coconino Sandstone. The blueish color underneath is the Hermit Shale. In the corresponding helicopter view to the left - the black arrows point to the same spots as the black arrows in the game screenshot. Now that you have been oriented to what the Coconino Sandstone (sand glued by a strong silica cement) and Hermit Shale (compressed mud) look like -- your task is to spin the camera around and look to see other cliff face and ramp combinations of these two formations inside the Grand Canyon.



Step 5 to prepare for the questions: A 19th century scientist and artist, Clarence Dutton, produced the famous artwork below of the Grand Canyon from Point Sublime showing the canyon's stair-stepped topography of cliffs and ramps. Dutton is famous for highlighting what he saw in the geomorphology -- exaggerating what he wanted you to see.

In the geovisualization -- you can visit Point Sublime very quickly (instead of taking a very long road to reach the spot). Just Fast Travel to: **36.1987** and **-112.2502**. Pull the game camera back so you are looking well above the avatar and have the game camera look due south.

You will see the light blue of the Kaibab Formation making up the plateau surrounding the Grand Canyon (that the avatar is standing on). You will also recognize the yellow of the Coconino Formation making a cliff. And the purple color (selected by the U.S. Geological Survey, no the game maker!!) is the limestone cliffs (mostly the Redwall Limestone).

Now focus underneath the purple limestone cliffs. You should now recognize from Step 3 the formation that is underneath the limestone. Its the Bright Angel Shale. Look at the landform -- the basic appearance of the landscape -- where you find the Bright Angel Shale. How would you describe that landform.

Now you are ready to answer some questions about cliffs in the Grand Canyon.

1. A caprock composed of a _____ layer of rock and the underlying _____ layer of rock art the two key ingredients necessary to develop a cliff and maintain it over time by ongoing cliff collapse (and cliff retreat).

2. The _____ and the _____ are two examples of caprocks forming cliffs in the Grand Canyon.

3. The _____ and the _____ are two examples of a layer of rock erodes away underneath a caprock and forms ramps inside the Grand Canyon.

4. In the geovisualization view from Point Sublime, you are instructed to look south and describe the landform associated with the Bright Angel Shale. What is the best description for that landform in the view from Point Sublime? Select the best answer.

Question 1

1 pts

A caprock composed of a _____ layer of rock and the underlying _____ layer of rock art the two key ingredients necessary to develop a cliff and maintain it over time by ongoing cliff collapse (and cliff retreat). Select the best answers to fill in the blanks.

- ◯ hard (difficult to erode); soft (erodes faster)
- ◯ soft (erodes faster); hard (difficult to erode)
- ◯ shale; sandstone
- ◯ shale; limestone

Question 2

1 pts

The _____ and the _____ are two examples of caprocks forming cliffs in the Grand Canyon.

- ◯ Kaibab Limestone; Coconino Sandstone
- ◯ Bright Angel Shale; Toroweap Formation
- ◯ Kaibab Limestone; Hermit Shale
- ◯ Kaibab Limestone; Bright Angel Shape Shale

Question 3

1 pts

The _____ and the _____ are two examples of a layer of rock erodes away underneath a caprock and forms ramps inside the Grand Canyon.

- ◯ Bright Angel Shale; Hermit Shale

- Toroweap Formation; Coconino Formation
- Supai Group; Redwall Limestone
- Granite; Gneiss

Question 4

1 pts

In the geovisualization view from Point Sublime, you are instructed to look south and describe the landform associated with the Bright Angel Shale. What is the best description for that landform in the view from Point Sublime? Select the best answer.

- a platform inside the Grand Canyon
- a topography of conical hills inside the Grand Canyon
- a mixture of cliffs and risers inside the Grand Canyon
- a stair-stepped topography inside the Grand Canyon

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