Activity 7.4 VIDEOS

As usual, there are some really helpful videos over at the YouTube channel. If you don't have time to watch all of them, at least watch the ones on the P and S waves (if you haven't already).

Activity 7.5 CANYON COLORING PAGE

This activity is designed to be used with a video that is posted on the YouTube playlist (also listed at www.ellenjmchenry.com/downloads/GrandCanyonDrawing.mp4). The video will tell you exactly what to do. However, if you don't have Internet access, here are some instructions to help you color and label it yourself. If you would like to see how the finished drawing is supposed to look, check the answer key. If the drawing looks too difficult, you can just do the parts that interest you. You could also use colors instead of those patterns.

The location of the diagram is the South Rim of the canyon, which is the most popular place for tourists to visit. It is important to remember that the canyon is hundreds of miles long. The layers change their depth, color, and mineral content in various places in the canyon. If you read information that is slightly different from what you read here, both pieces of information are probably correct, but for different locations. The canyon is very complicated!

You may notice that some of the layers have very sloped edges, while other have relatively straight (vertical) edges. The sloped layers are the ones that erode more easily. Harder layers are resistant to erosion are more like straight cliffs. The reddish color of some layers is mostly due to the presence of iron oxide (rust!) in the minerals.

1) Start by labeling the layers of the Cenozoic and Mesozoic. (Write these words between the dotted lines.) These top two layers are actually missing! These were removed before the canyon formed. (Geologists call this the Great Denudation. One very convincing idea is that a huge nearby lake spilled over and washed these layers off. Slow erosion can't explain the flat surface.) The top layer is the Cenozoic. The second layer is the Mesozoic. (The Mesozoic contains those "dinosaur layers.")

2) The next section is the Permian. There are 4 rock layers in the Permian.

3) The section below the Permian is the Pennsylvanian. (This does not mean the layer is in Pennsylvania!) There are 4 rock layers in the Pennsylvanian layer. (In other places, the Pennsylvanian contains coal, but here it does not.) The layers of the Pennsylvanian are also called the Supai Group. Often, the individual names (listed in number 8), are not used because they are hard to remember.

4) The layer below the Pennsylvanian is the Mississippian. In the canyon, the Redwall Limestone is Mississippian.

5) The Devonian layer is that little wedge-shaped piece.

6) The Silurian and Ordovician layers are missing. (Remember, we said that there are just a few places on earth where you can find all the layers.)

7) Below the wedge is the Cambrian layer. Below that (the side of that V-shaped notch at the bottom) is the Precambrian.

8) The V-shaped notch is the Inner Gorge. The tiny triangle at the bottom is the Colorado River.

9) Now we'll write the names of all the rock layers. That very tall column on the right side is for names and extra notes you might want to jot down. (Write small!) The very top box will just say that these layers are missing. The first actual layer of canyon rock is the famous Kaibab Limestone. Going on down from there the boxes should say: Toroweap Formation (you can abbreviate "Formation" as "Fm"), Coconino Sandstone (you can abbreviate "Sandstone" as "Ss"), Hermit Shale, Esplanade Sandstone, Wescogame Fm., Manakacha Fm., Watahomigi Fm., (don't worry about these hard names—you don't have to memorize them!), Redwall Limestone, Muav Limestone, Bright Angel Shale, and Tapeats Sandstone. That should bring you to that thick wavy line. (If you want to label that Devonian wedge on the left side of the Muav Limestone, it is called the Temple Butte Limestone.) All these names might sound strange and difficult to you, but to a geologist they are very familiar because these layers are studied so much.

10) The thick wavy line is called the Great Unconformity. This is a dividing line between the Cambrian and Precambrian areas. What went on here? It looks like the Precambrian layers got tipped and then cut off. Whenever there is a huge difference between two layers—something that looks abnormal or unexpected—it is called an "unconformity." There are smaller unconformities at the top and bottom of the Redwall Limestone.

11) If you want to know the names of the tipped layers, they are (from top to bottom): Sixty Mile Formation, Kwagunt Formation, Galeras Formation, Nankoweap Formation, Cardenas Lava, Shinumo Quartzite, Hakatai Shale, and the Bass Limestone. (If you'd rather not label these, that's fine. Or, you can just label the whole group as the "Grand Canyon Supergroup.")

12) Now we are ready to fill in the patterns and/or colors. (Leave that sectioned off strip blank. We will use that strip to write a few tiny notes, such as types of fossils.) We'll draw or color them in t If the patterns are too difficult, you can just decide to make each one a different color (with mudstone as gray). Just color over the patterns and use the colors as your key. Some of the layers are self explanatory, and have the words limestone, sandstone, and shale in their names. The ones you need more information about are listed below. (NOTE: The layers are actually much more complicated than this, and include thin stripes of mudstone, siltstone, shale, and conglomerate in almost all of the layers. The purity of the limestone varies greatly, also.)

a) The Toroweap Formation is often called the Toroweap Limestone, but it also contains dolomite, sandstone, mudstone, gypsum and shale. (Any model of the layers of the canyon is going to be overly simplified and not represent reality because the real layers are very complicated.) Since we have limited space, try this from top to bottom: one layer of limestone, some sandstone dots, a layer of shale, a blank space for gypsum, dolomite on the bottom. To indicate dolomite, just make your "bricks" look slanted.

b) The Coconino Sandstone is a "cross-bedded" sandstone. This means that there are layers going different ways, as shown in the pattern key. You can add little dots of sand, too, if you'd like.

c) In the Esplanade Sandstone there are a few layers of mudstone. Just add a few gray lines with a pencil. The Wescogame and Watahomigi Formations also have a few layers of mudstone.

d) The Redwall Limestone actually isn't solid limestone. It has a tiny bit of sandstone at the top, then a layer of mudstone, then limestone, then conglomerate, then a thin layer of limestone on the bottom. Can you fit all those into that space? Think small!

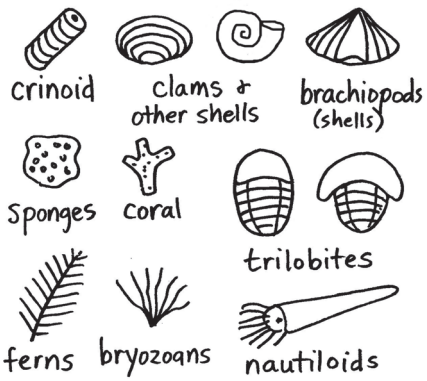
e) That rectangle in the Bright Angel Shale is a block of quartzite that is about the size of a bed or table. It's pretty small, so you might have to just color or label it, instead of trying to draw the pattern inside of it. (Unless you can fit one wavy line in the middle and some dots around it.) How did it get up there from that quartzite layer below (or somewhere else)? Perhaps this shows us that these layers were not solid rock when that block migrated upwards. You can see this block for yourself if you do an image search for "quartzite block in Grand Canyon." You can see how the layers of shale are folded around it.

f) Those tipped Precambrian layers are, from top to bottom: sandstone, shale, limestone, sandstone, basalt lava, sandstone, quartzite, shale, limestone.

g) The big areas at the bottom, around and under the tipped block, are schist. Schist is a metamorphic rock that used to be something else, in this case perhaps granite. Schist's layered look is because the original rock got squeezed, causing the atoms of SiO_2 to rearrange themselves into more compact layers. The things coming up from bottom, looking like igneous magma intrusions from below, are called the Zoroaster Granite. The schist's name is the Vishnu Schist. These names are not Native American, but are from Persia and India. (NOTE: If you look at other diagrams on the Internet, you will see that these granite intrusions are drawn in different ways. They might look very different on someone else's diagram. Remember, these are just diagrams, not photographs!)

h) Don't forget that tiny bit of Bright Angel Shale on the opposite side of the canyon. Our picture got cut off at that point so you can't see the Muav Limestone above it.

13) Now we can add fossils. You can draw simple shapes to represent the fossils, but you can also write notes in that strip on the right. You can draw the fossil symbols right on top of the patterns. (If you would like to know more about each type of fossil, use the Internet to search for information or pictures.)



a) The Kaibab Limestone has marine fossils: crinoids, clams, sponges, corals, bryozoans.

b) The Toroweap has fewer fossils, perhaps just a few brachiopods at the top.

c) The Coconino sandstone has only trace fossils, such as tracks of animals that look like they may have been reptiles or amphibians. (No bodies, just tracks.) The Coconino also has many ripple marks, made either by wind or water. (Add ripple marks.)

d) The Hermit Shale, and all 4 Supai layers (Esplanade, Wescogame, Manakacha, Watahomigi) have mostly just plant fossils, such as ferns, horsetails (which look like bamboo) and conifers (pines). There are some animal tracks in the Watahomigi.

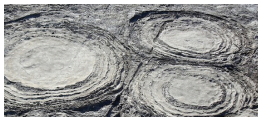
e) The Redwall has lots of marine fossils: crinoids, clams, brachiopods (similar to clams), nautiloids (which look like squids that got stuck in long ice cream cones), bryozoans, corals.

f) The Muav Limestone also has marine fossils, but trilobites also start to appear.

g) The Bright Angel Shale has marine life such as trilobites, brachiopods, and clams, but also has trace fossils of worm burrows.

h) The Tapeats Sandstone has trilobites, brachiopods, and trace fossils such as ripple marks and trilobite tracks.

i) The tipped layers of the Precambrian that are <u>above</u> the lava layer, contain **stromatolites**, which are fossilized remains of large mats of blue-green algae (cyanobacteria). You can make some little rings to represent them, (as shown in photograph).



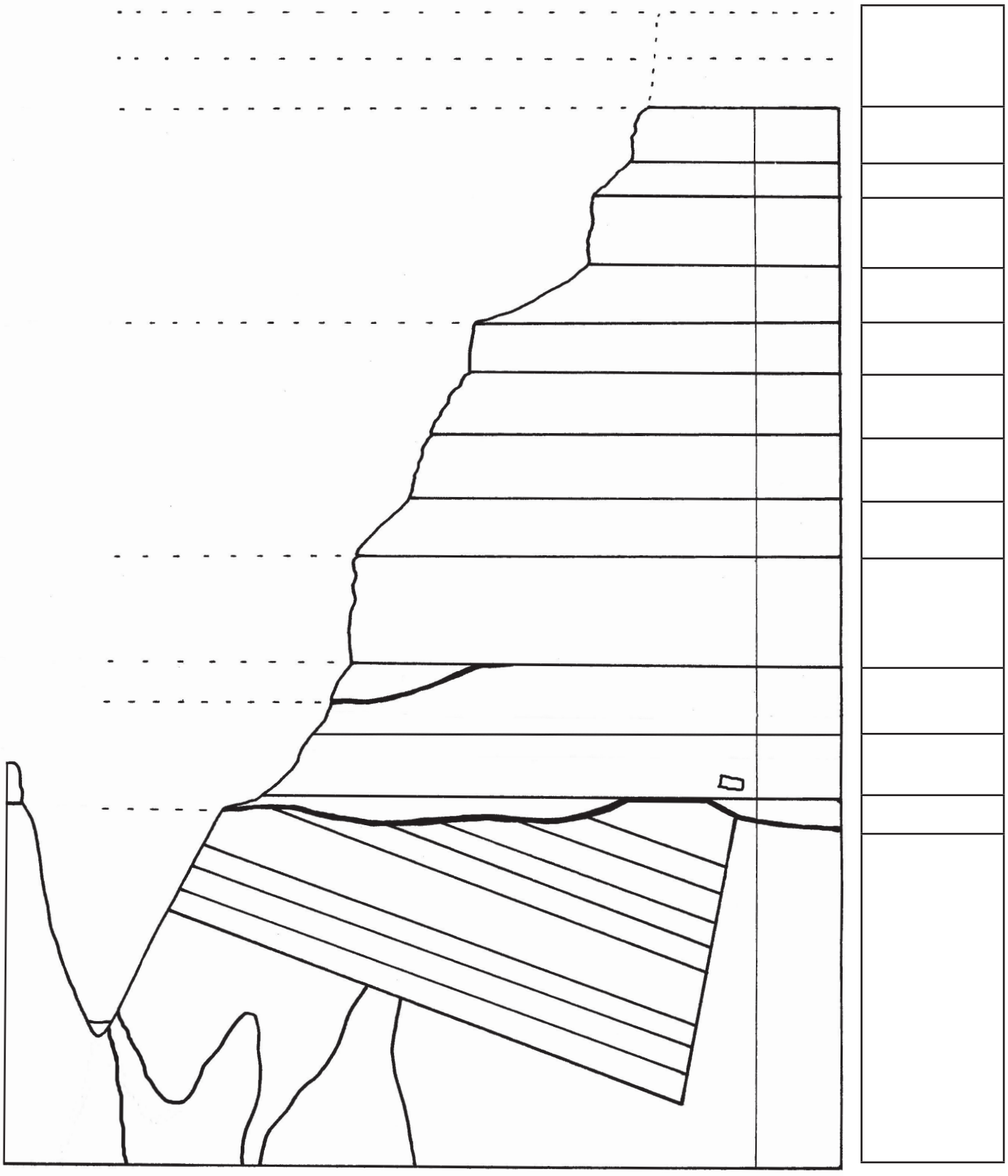
stromatolites

If you want to add some color to your drawing without covering up the patterns, you can just add a little color to the left edge, which is the surface you actually see at the canyon. Color suggestions:

Kaibab: light gray or tan; Toroweap: darker yellowish-gray; Coconino: white or cream; Hermit: rusty red; Supai group: red limestone, tan or yellow sandstone (lots of thin red strips in these 4 layers); Redwall: light red; Muav: grayish yellow-green; Bright Angel: rusty red; Tapeats: light tan; 60-mile: tan; Kwagunt: reddish purple; Galeros: greenish gray; Nankoweap: tan; Cardenas lava: dark gray; Dox: orange-tan; Shinumo quartzite: light reddish-purple (or use pink); Hakatai: red; Bass: gray.

ROCK LAYERS OF THE GRAND CANYON

This is the "South Rim" area. The top of the rim is about 7,000 feet (about 2,000 meters) above the bottom of the gorge.



limestone

shale

granite

mudstone

schist

sandstone

cross-bedded sandstone

basalt (cooled lava)

quartzite

conglomerate