What Is the Sedimentary History of This Plateau?

A plateau in northern Arizona exposes a sequence of various kinds of sedimentary rocks. Some sedimentary units were deposited on land, and others were deposited by shallow seas. Using key observations about each rock unit, you will reconstruct the history of these sedimentary rocks.

Goals of This Exercise:
- Use photographs or samples to make observations about the sedimentary layers.
- Interpret a possible environment for each sedimentary layer.
- Use a stratigraphic section to infer how the environment changed through time as layers were deposited.

Observe the Sequence and Characteristics of Sedimentary Layers

Observe this photograph, which shows a sequence of layers, and try to identify boundaries between different sedimentary units. Next, compare your observations with the observations and interpretations next to the photograph and with the information on the next page. Record your observations and ideas on a sheet of paper, perhaps built around a simple sketch of the scene. Your instructor may also provide you with rock samples.

1. The highest rock unit exposed in this area forms an uppermost tan and brown cliff and steep slope. There are some color variations within the cliff, which probably reflect slightly different colors of the different layers. The colors and other aspects of the cliff are common in many sandstones. Although not visible here, the cliff-forming unit and nearby underlying layers contain beds of coal, some of which are large enough to mine nearby for the production of electricity.

2. Below the cliff are a series of gray and tan ledges. Between the ledges are slopes, which are mostly covered by loose pieces weathered and eroded off the ledges and overlying cliff. The alternating ledges and slopes are a clear expression of layers. The ledges are similar in appearance to those formed by sandstone, and the slopes probably contain easily eroded, fine-grained sedimentary rocks, like shale and siltstone.

3. Below the ledges is a gray slope, which nearby locally has badlands topography. The rock forming the gray slope has some faint layers, but all of the layers look similar. It looks fairly soft and nonresistant to erosion, as is common for fine-grained rocks like shale. The gray color of the rock implies that the unit was deposited in conditions that were not rich in oxygen.

4. The soft gray rocks directly overlie a tan and cream-colored cliff. The cliff-forming unit is resistant to erosion and weathers like many sandstones do. Elsewhere in the region, the sandstone is more tilted and forms a series of resistant ridges, or hogbacks.

5. The cliff overlies a series of soft, thinly layered rocks that are maroon, reddish brown, gray, and cream colored. The rocks are poorly exposed and composed of fine-grained, easily eroded sedimentary rocks. Most rocks that have this reddish color were deposited on land.
Interpret the Sedimentary History of the Sequence of Layers

The stratigraphic section below shows the relative thicknesses of the units. The oldest unit is on the bottom and the youngest is at the top. Photographs and brief descriptions of each rock unit accompany the stratigraphic section. Your instructor may provide you with samples of similar rocks. Follow the steps below to propose a plausible interpretation for the environment of deposition for each sedimentary unit and for how the environment changed from one rock unit to the next. Write your answers to the following questions on the worksheet, on a sheet of paper, or in an online form.

1. What is your interpretation of the environment for each of the four rock units? List two key attributes of each unit that support your interpretation.
2. What is the oldest environment represented by this rock sequence?
3. Does the change of environment from the base of the section up to the thick gray shale indicate an advance (transgression) or retreat (regression) of the sea? Explain the reasons for your answer.
4. Does the change from the thick gray shale to the overlying sandstone indicate a transgression or a regression? Explain the observations that support your answer.
5. Which of the following phrases summarizes the history of the entire sequence: (a) a transgression, (b) a regression, (c) a transgression followed by a regression, or (d) a regression followed by a transgression?
6. Compare this sedimentary sequence to the one exposed west of Denver (in the previous two-page spread). What name from the Denver area would you apply to the lower, yellowish-tan sandstone in this plateau?

Stratigraphic Section

This unit includes sandstone, mudstone, and layers of coal (shown in black). The upper part of the unit contains sandstone beds with small cross beds. The mudstone has mudcracks and plant fossils. The lowest part of the unit contains tan sandstone with broken marine shells. This photograph (▶) shows thin layers of black coal in this unit.

This shale is medium to dark gray because it has a high amount of organic matter. It contains fossils of clams and other marine organisms. Thin limestone beds are locally present in the middle of the unit but are not shown in the section. The shale and limestone contain abundant marine fossils. The photograph (▶) shows a close-up of the transition from the shale to the overlying sandstone.

This unit is mostly a yellowish-tan sandstone containing quartz sand with small pieces of marine shells. As shown in the photograph (▶), the very base of the unit is a thin conglomerate that overlies a scoured erosion surface. This lower part locally contains fossils of wood and leaves.

The lowest unit includes a conglomerate with moderately rounded pebbles and coarse sand containing scattered rounded pebbles and pieces of fossilized wood. The conglomerate is overlain by reddish, maroon, and gray shale and mudstone with plant fossils. This photograph (▶) shows a nearly circular dinosaur track where a large, plant-eating dinosaur with huge round feet stepped into and pressed down the then-soft sediment.