Geology 101, Spring 2008 Name(s):

Lab 10: Sequence stratigraphy

In this lab, you are going to create a diagram simliar to the cross-section part of the Grand Canyon to Zion National Park diagram on the wall of the classroom. Such a **correlated cross-section** is a powerful tool in trying to understand the events of a larger area during a long period of time. In this lab, you will be looking at the northern Colorado Plateau area (see map) over the Mesozoic era.

On the attached sheet are the stratigraphic columns for Canyonlands and Capitol Reef National Parks and Colorado National Monument, as well as the explanation for the symbols used.

1. How many unconformities exist in *each* column? Note that it is *not* the same number, necessarily, for each column!

On the Capitol Reef National Park stratigraphic column, the named units can be divided into the following time periods: the **Triassic** is represented by the Cutler, Moenkopi and Chinle formations; the **Jurassic** is represented by the Wingate, Kayenta, Navajo, Carmel, Entrada, Curtis, Sumerville, Morrison and Cedar Mountain formations and the **Cretaceous** is represented by the Dakota and Mancos formations. From the accompanying handout, you know that the **Absaroka transgressive sequence** ended in the early Jurassic and the **Zuni transgressive sequence** began in the early Jurassic.

2. What evidence do you have of this change between sequences from the stratigraphic column? Does this change between sequences stand out particularly? In particular, what is the problem with the Absaroka sequence, especially during the Triassic? (This is a major problem with sequence stratigraphy: figuring out which unconformities are the important ones)

3. Note that the Mancos mudstone (shale) exists at the top of each of the three columns. Give **two** reasons why there is such a differing thickness of this unit between the three areas.

4. With a pair of scissors, cut out the three columns (don't cut off any of the fossil symbols) and arrange them on another sheet of paper such that the columns are oriented west to east in the proper arrangement (see the attached region map to get the order right). The spacing between the columns should be roughly proportional to the spacing of the areas on the map. Tape or paste them down to the paper, taking care not to get tape in between the columns (you're going to write in between). **Draw a mileage scale at the bottom**.

5. Correlate the different units by drawing **tie-lines** (lines representing the contacts between units) between the columns. For instance, draw a line from the contact of the Dakota/Mancos in Capitol Reef NP to the contact of the Dakota/Mancos in Canyonlands NP; then draw a line from the contact of the Dakota/Mancos in Canyonlands NP to the contact of the Dakota/Mancos in Colorado NM.

Continue to do this for as many of the units as you can. Note that due to the unconformities **not all tie lines will exist**. You will have to use the rock type, the fossils found and key beds to perform the correlations. You may wish to **color** certain layers so that you can trace them better across the region. Show **terminations** of beds as sideways V's; in other words, some layers will "pinch out" between two stratigraphic columns.

6. As you look at your completed correlated cross-section, in general, which direction was the **deeper** ocean? How do you know?

7. The Wingate, Navajo and Morrison formations are terrestrial sandstones, with cross-bedding literally ten meters tall. What is a possible **depositional environment** for them? What type of sandstone should they be to confirm your suspicions?

8. Notice there are a few more national parks in the area, like Grand Canyon NP. What prevents us from extending the sequence stratigraphic column to the North Rim of the Grand Canyon? Hint: Look at the "Cedar Breaks to North Rim of the Grand Canyon cross-section" poster.

9. From the "Cedar Breaks to North Rim of the Grand Canyon cross-section" poster, note that there seems to be quite a slope between Kanab, Utah (middle of the poster), and the North Rim of the Grand Canyon. Estimate the elevation of the **top** of the Kaibab Formation near Kanab, then estimate the elevation of the top of the Kaibab at the North Rim. Then calculate, using the horizontal scale given (and the fact that 1 mile = 5280 feet), what the **slope** of the top of the Kaibab actually is between those two points.

10. Given the slope you calculated in the previous question, what can you infer about the style of uplift (orogeny) in this area (a head-on collision or an elevator-like rise?)? Given that this area was part of the East Pacific Subduction Zone, what can you infer about the angle of subduction (this also explains the lack of volcanoes of that age in this area)?

11. What is the earliest time that this uplift could have occurred, and how do you know?

12. Why is there not as much **limestone** in the cross-section you constructed compared to the Paleozoic era record of the Grand Canyon (see the Grand Canyon cross-section on the poster)?

13. How could we go about getting some **numerical ages** to put on this cross-section? In other words, what are some appropriate datable materials found here?

14. Estimate the **thicknesses** (in feet) of the Absaroka and Zuni sequences in Capitol Reef National Park (use the scale provided on the cut-out sheet). How would you expect the thicknesses of the sequences in Zion National Park to compare (look at the map for relative geographic positioning)? Explain your reasoning.

15. Look at the poster with the Cedar Breaks to North Rim of the Grand Canyon cross-section. Estimate the **thicknesses** (in feet) of the Absaroka and Zuni sequences in Zion National Park (or nearby). Were you correct in your prediction in part a?