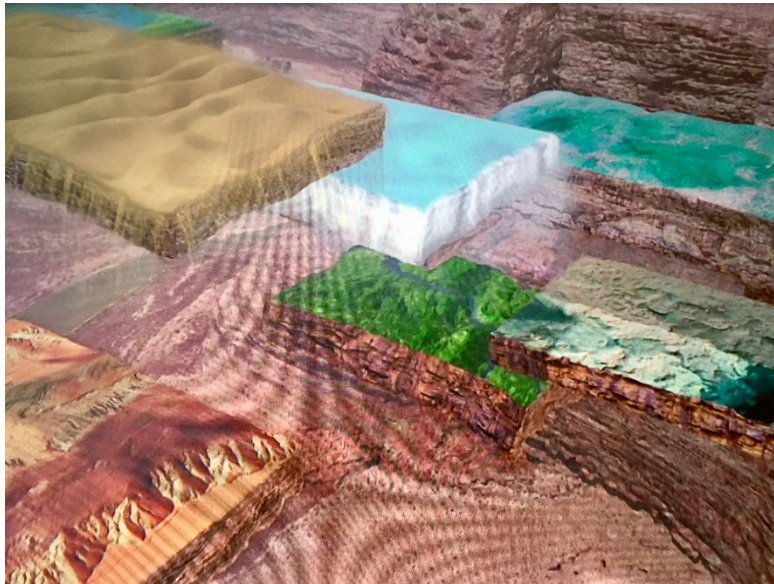


## F3.2 Relative Dating LTF Activity: Using Cross-Sections to Order Time

### **BACKGROUND INFORMATION**

**Stratigraphy**, a branch of geology, studies rock layers and layering (stratification). It is primarily used in the study of sedimentary and layered volcanic rocks. Using stratigraphy, geologists can calculate the relative age of specific layers of rocks and then compare rocks from different areas of the world to calculate placement of rock formations in time.



The Grand Canyon offers a perfect example of this. Millions of years of rocks are layered to form the walls of the Grand Canyon. The Colorado River eroded these layers exposing them to reveal the progression of time as you walk from the bottom to the top of the canyon. The oldest rocks are on the bottom and the youngest rocks are on the top, and you can see from the preserved organisms how life has changed over time.

## Principles

In this activity you will be given layers of rock and asked to compare and conclude the sequence of events that occurred when the rock was formed. The following principles and definitions will help you solve the problems:

- **Principle of Original Horizontality:** Sedimentary rocks are originally deposited as horizontal layers. Strata that are not horizontal must have been disturbed at some point in the past by movements of Earth's crust.
- **Principle of Superposition:** In an undisturbed sedimentary sequence, or a sequence of interbedded sediments and extrusive igneous rocks, the oldest beds are at the base and the youngest beds at the top.
- **Principle of Cross-Cutting Relationships:** Geologic structures (e.g. faults and folds), intrusive rock bodies, and erosional surfaces are younger than the beds and structures which they cut or affect.
- **Principle of Faunal Succession:** Fossil organisms succeed one another in a definite and recognizable order. Fossil content can determine the relative ages of rocks.
- **Unconformities:** Unconformities are intervals of time during which deposition ceased, erosion removed previously formed rock, and then deposition resumed. There are three types of unconformities.
  - **Disconformity:** Erosional or non-depositional surface between older and younger beds that are effectively parallel to one another. This represents a gap in time.
  - **Angular unconformity:** An erosional surface on previously folded or tilted strata over which younger rocks have been deposited.
  - **Nonconformity:** The contact between igneous or metamorphic rocks and sedimentary rocks.

## MATERIALS

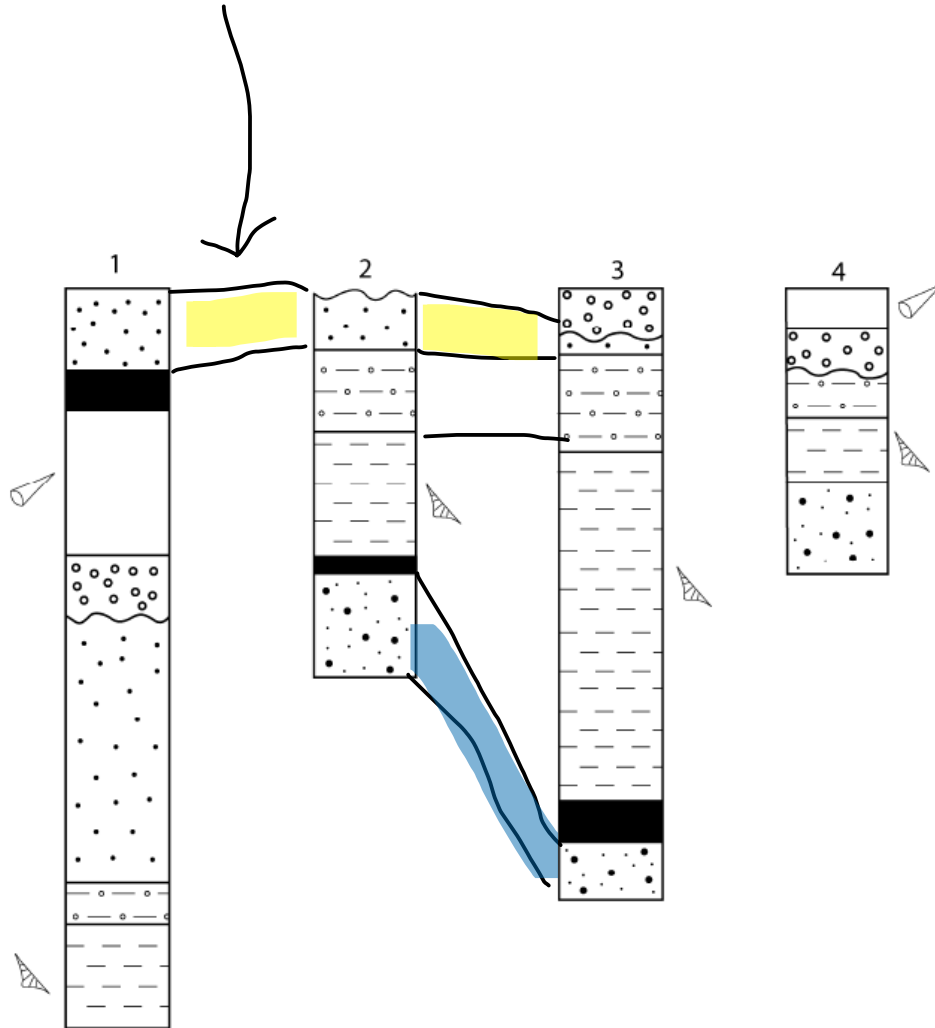
- Handouts
- Colored pencils
- Pencil
- Ruler

**ANALYSIS**

**PART I**

Directions:

- Correlate<sup>1</sup> the geologic layers in the stratigraphic<sup>2</sup> columns in *Figure 1*. Use fossil and lithologic<sup>3</sup> (rock type) clues to determine the connections between the strata<sup>4</sup>:
  - Color code the layers and fossils before drawing the solid lines connecting the layers.
  - Draw solid lines between layers of the same time period.



*Figure 1*

<sup>1</sup> have a mutual relationship or connection, in which one thing affects or depends on another; each of two or more related or complementary things.

<sup>2</sup> the branch of geology concerned with the order and relative position of strata and their relationship to the geological time scale; the analysis of the order and position of layers of archaeological remains; the structure of a particular set of strata.

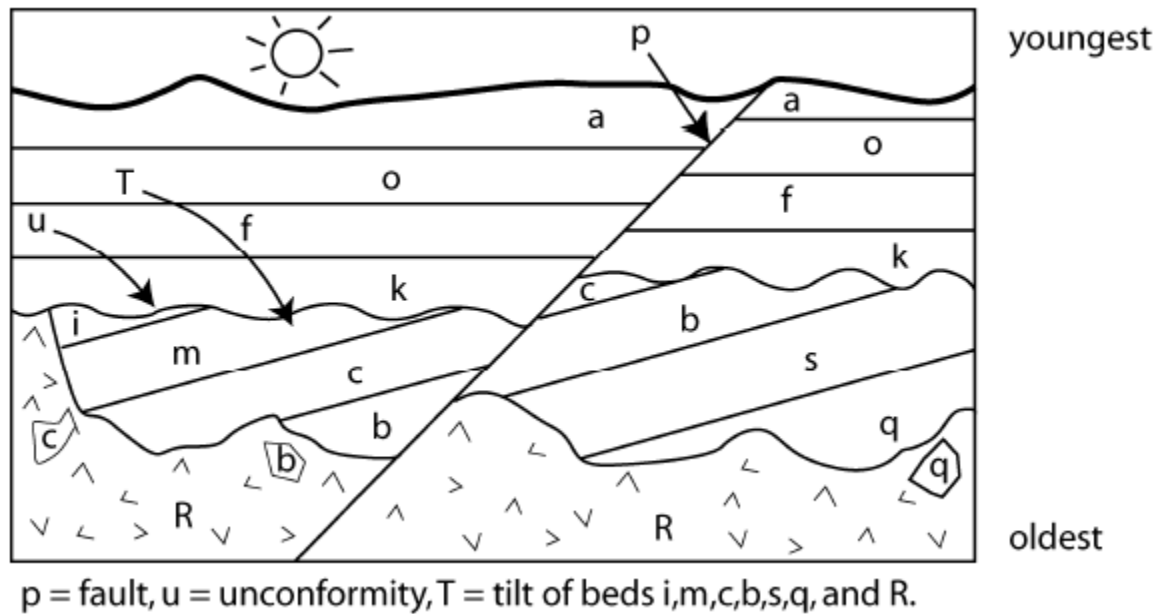
<sup>3</sup> the study of the general physical characteristics of rocks; the general physical characteristics of a rock or the rocks in a particular area.

<sup>4</sup> a layer or a series of layers of rock in the ground.

**PART II**

Directions:

- Based on stratigraphic principle, find the relative age of the various beds and/or structures labeled in *Figure 2*:
  - Pay close attention to when the events: *Intrusion*<sup>5</sup> (R), *Fault*<sup>6</sup> (P), *Tilt*<sup>7</sup> (T) and *Unconformity*<sup>8</sup> (U) occurred. They are included in #1-14.
  - Color code the lettered layers before putting the layers in order #1-14 (oldest to youngest).
  - Order the layers and events with the oldest as number 1.



*Figure 2*

- |                 |           |           |
|-----------------|-----------|-----------|
| 1. _____ Oldest | 6. _____  | 11. _____ |
| 2. _____        | 7. _____  | 12. _____ |
| 3. _____        | 8. _____  | 13. _____ |
| 4. _____        | 9. _____  | 14. _____ |
| 5. _____        | 10. _____ |           |

<sup>5</sup> Intrusive rocks are a type of igneous rock. Igneous rocks are rocks that form from cooled magma. Intrusive rocks are igneous rocks that form from crystallized magma beneath the earth's surface.

<sup>6</sup> a fracture, or break, in the Earth's crust; Faulting occurs when shear stress on a rock overcomes the forces which hold it together.

<sup>7</sup> To cause to slope, as by raising one end; incline; occurs when the earth's surface layers begin to tilt or slant irregularly. Typically, faults cause movement in the earth's surface.

<sup>8</sup> a buried erosional or non-depositional surface separating two rock masses or strata of different ages, indicating that sediment deposition was not continuous. In general, the older layer was exposed to erosion for an interval of time before deposition of the younger, but the term is used to describe any break in the sedimentary geologic record. The rocks above an unconformity are younger than the rocks beneath (unless the sequence has been overturned). An unconformity represents time during which no sediments were preserved in a region.

**PART III**

Directions:

- These cross-sections in *Figure 3* came from four different locations in New York State. Reconstruct the order of deposition for the entire region. Assume that the oldest rocks are on the bottom and the youngest are on the top. Each rock type is used only once and there are eight strata total:
  - Color code the key and the layers in columns A-D. Connect the layers with lines.
  - Put the layers in order in the blank column with the oldest on the bottom.
  - Include the rock name and color of each layer in the blank column.

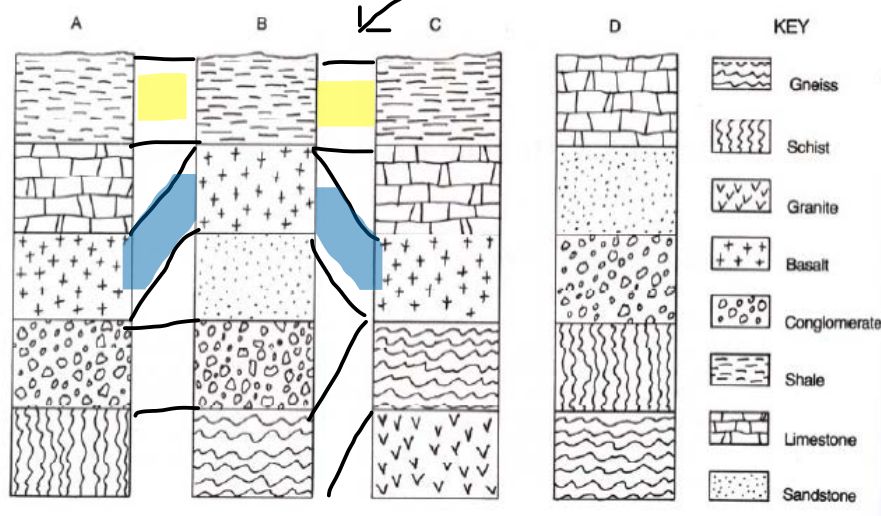


Figure 3

<b>Youngest</b>	
<b>Oldest</b>	

## CONCLUSION QUESTIONS

**Look at the different types of unconformities in the BACKGROUND INFORMATION or in the textbook to reasonably answer the questions below. Write in complete sentences with proper grammar.**

1. On a field trip, you observe layers of rock that have: *sandstone at the bottom, shale in the middle, and limestone on top*. A short distance away you find the same rock types, but: *the limestone is on the bottom, shale in the middle, and sandstone on the top*. The fossils found in the rocks indicate that the sandstone should be the oldest layer.
  - a. Provide a reasonable explanation for the presence of the sandstone as the top layer in various locations. How could the layers be flipped?

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2. While observing a large sequence of marine<sup>9</sup> sandstone you notice that the fossils in the upper part of the sandstone are a million years younger than in the lower part of the outcrop.
  - a. What type of unconformity probably exists within the sandstone? Explain.

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- b. What process(es) could have caused a missing layer in sedimentary rock? Explain.

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3. The bottom of the Grand Canyon contains very old metamorphic rock, Vishnu schist, which is more than 1.5 billion years old. The layer directly above the Vishnu schist is limestone, a sedimentary rock, that is only about 1 billion years old.
  - a. What type of unconformity probably exists within the sandstone?

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- b. What process(es) could have caused a missing layer of sedimentary rock above metamorphic rock? Explain.

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<sup>9</sup> of, found in, or produced by the sea.