

Relative Age-dating -- Discovery of Important Stratigraphic Principles

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Abstract:

When piecing together the geologic history of the Earth, geologists rely on several key relative age-dating principles that allow us to determine the relative ages of rocks and the timing of significant geologic events. In a typical Historical Geology class or textbook, instructors/authors briefly discuss the important early researchers in the geological sciences, and then give the name of the stratigraphic principle, useful for relative age-dating of rocks and events, that these 17th and 18th century scientists are credited with discovering. After the instructor/author defines these principles, students are usually shown several examples so they can see how the principle can be applied.

But why not start with the examples and let students discover these principles for themselves?

Students are split into small groups which each work to discover a different relative age-dating principle. The groups are shown photos and given the following handout with drawings of rock outcrops illustrating the various principles. This handout includes worksheets for which they must answer a series of prompts that help lead them to the discovery of their relative age-dating principle. Groups must also invent a name for their principle, and select a spokesperson who will present the group's results to the rest of the class.

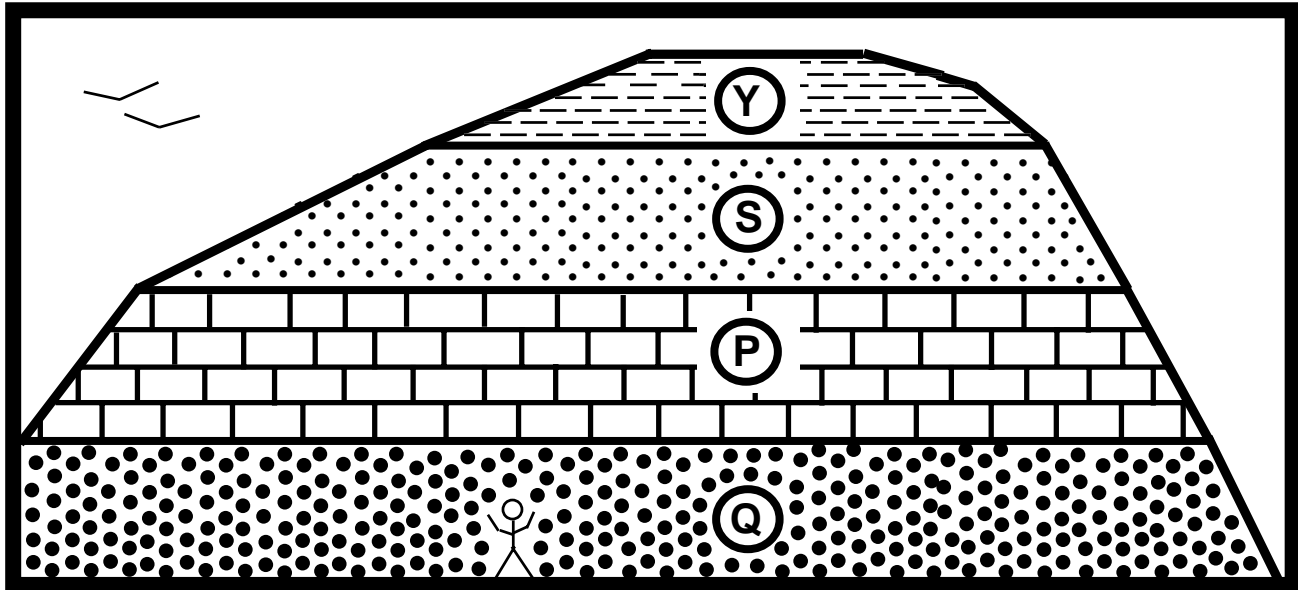
Note:

The "simple classroom demonstration by your instructor of the deposition of sediments" referred to in Example 1 and Example 2 utilizes a large graduated cylinder filled with water and sediment ranging in size from gravel to clay. I shake it up and then set it down quickly on the front table, so students can see how sediment will actually settle out of water in flat-lying layers--larger, heavier particles first--parallel to the Earth's surface and parallel to each other.

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EARTH HISTORY 1404

Example 1:



Four different rock units (layers of different rock types), labeled Y, S, P, and Q, are seen in a road cut, as shown schematically above:

- 1.) Are the rocks igneous, sedimentary, or metamorphic? (Which?)
- 2.) S and Q are the same kind of rock called _____
(Example: Granite, marble, limestone, etc.)
- 3.) Y is the rock type called _____
- 4.) P is the rock type called _____

(Think carefully about the simple classroom demonstration by your instructor of the deposition of sediments.)

- 5.) Which rock layer in Example 1 above is oldest? _____
- 6.) Which rock layer in Example 1 above is youngest? _____
- 7.) List all four of the rock units of Example 1 in chronologic sequence, with the oldest on the bottom. (Geologists always order rock units and events with the oldest on the bottom and the youngest on the top.)

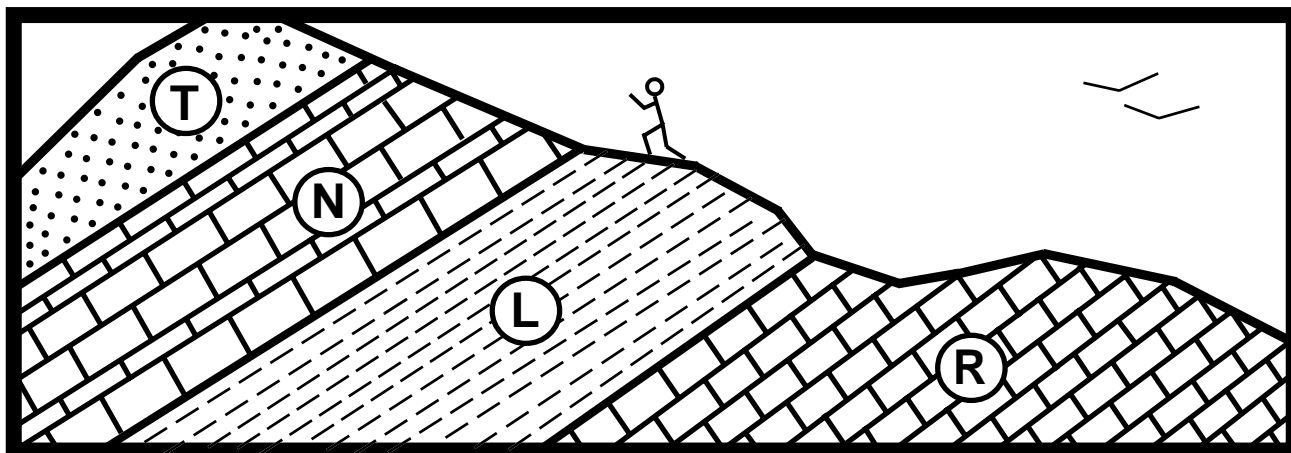
_____ Youngest

_____ Oldest

- 8.) This example illustrates one of the most fundamental and useful principles for relative age-dating of rocks.
Describe and *invent a name* for the general principle useful in relative age-dating that is represented here:

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Example 2:



Four different rock units (different rock types) are seen in a road cut and labeled T, N, L, R:

1.) Are the rocks igneous, sedimentary, or metamorphic?

2.) Give a more specific identification (name) for all of the layers:

T _____

N _____

L _____

R _____

(Example: Granite, marble, limestone, etc.)

(Think carefully about the simple classroom demonstration by your instructor of the deposition of sediments.)

3.) Do you think that when the layers in this example formed, they were already tilted?

If not, when would the tilting (or *deformation*, a type of geologic event) have occurred, relative to their formation?

4.) Which rock layer is oldest? _____

5.) Which rock layer is youngest? _____

6.) List all four of the rock units in chronologic sequence, with the oldest on the bottom. (Geologists always order rock units and events with the oldest on the bottom and the youngest on the top.) Include "*Deformation*" in its correct chronologic position, relative to the rock layers T, N, L, and R.

_____ Youngest

_____ Oldest

7.) Describe and *invent a name* for the general principle (or principles) useful in relative age-dating represented by this example:

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Example 3a:

The Grand Canyon is a spectacular example of the erosive power of rivers. The Canyon stretches for almost 100 miles in northern Arizona, and is one mile deep in some places. The walls of the Grand Canyon exhibit an exceptionally well-exposed sequence of sedimentary rocks. These are extremely useful when illustrating the remarkable geologic history of the Colorado Plateau, as well as various stratigraphic principles and geologic history in general.

Note in the cross section of the Grand Canyon, on the next page, that similar rocks (same age, thickness, and rock type) can be seen on both the North Rim and the South Rim, with a very large gap (many miles wide) in between.

1.) What used to be where the gap is now?

2.) What, in general, caused the gap to form?

Example 3b:

Now, consider another example, closer to home (a thought experiment):

You are driving in the Hill Country, heading NW along Interstate 10, just west of San Antonio. As you zoom along, you notice a very distinct sequence of sedimentary rocks on your right (East). You glance to the rocky roadcut on the left (West) side of the highway and quickly note the same distinctive sequence of rocks.

3.) What used to be where the large highway road cut (you are driving through) is now?

4.) What, in general, caused the gap (road cut) to form?

5.) Describe and *invent a name* for the general principle useful in relative age-dating represented by these two examples:

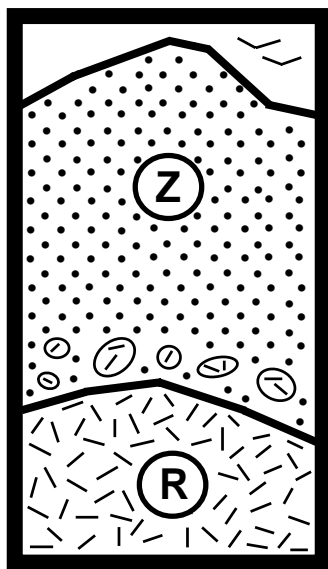
(Hint: What could you infer about the rocks on the North Rim of the Grand Canyon if you only knew details about the South Rim rocks, such as age, thickness, and rock type of the various layers?)

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**Grand Canyon Cross Section page
(Couldn't be included in this format--
can be found as pdf in "Supporting
Materials" file.)**

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Example 4a:



Two different rock units (of different rock types) are seen in a road cut:

- 1.) Describe what you see: _____

- 2.) What kind of rock is represented by Z? _____
 (Example: Granite, marble, limestone, etc.)

- 3.) What kind of rock is represented by R? _____

- 4.) What kind of rock are the small pieces? _____

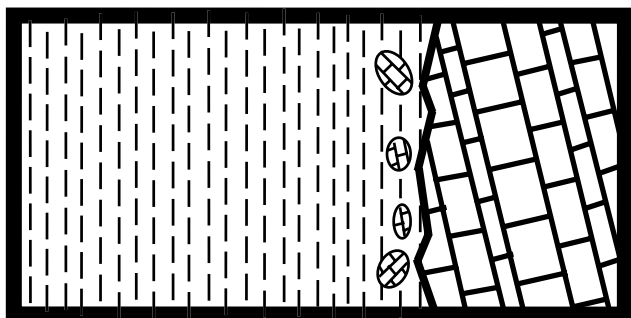
- 5.) What do you think is represented by the *uneven line of contact* between the two different rock types?

- 6.) Would your thoughts change if you examined this contact and were able to detect a thin layer of shale *exactly* at the contact, and realized it was probably an ancient soil layer?

Example 4b:

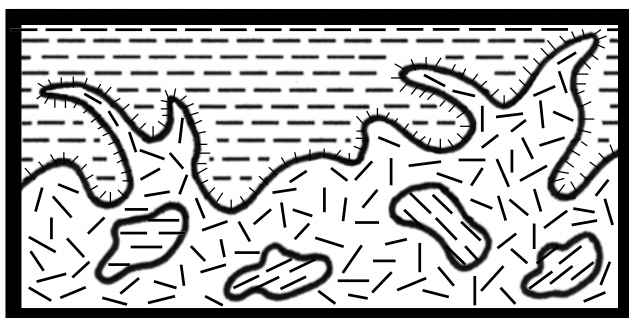
The two examples below show the same general rule for relative age relationships as illustrated by Example 4a above:

1.



Example 1. is very similar to the Example 4a above. The contact between the two different rock types exhibits an ancient, well-preserved soil layer.

2.

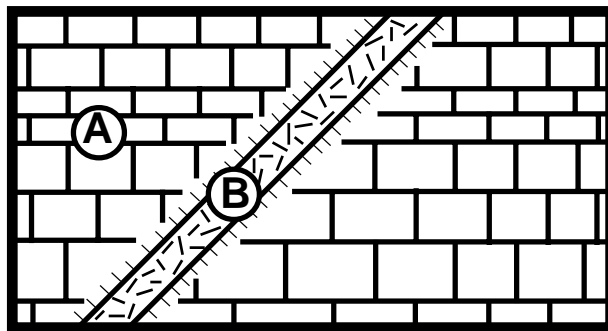


Example 2. shows an igneous intrusion that has intruded up and into overlying layers of shale.

- 7.) Describe and *invent a name* for the general principle useful in relative age-dating that is represented by these examples:
 (Hint: Consider, in particular, the relative age of the small pieces of rock that appear to be included within a different rock type in all of the examples.)

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Example 5a:



Two different rock units (of different rock type) are seen in a road cut:

- 1.) The rock unit labeled 'A' is a type of sedimentary rock called _____.
- 2.) The rock unit labeled 'B' is an igneous intrusion called a _____ (it cuts across overlying layers).
- 3.) Describe what you see:

- 4.) Which rock unit, A or B, is older? _____

- 5.) Why?

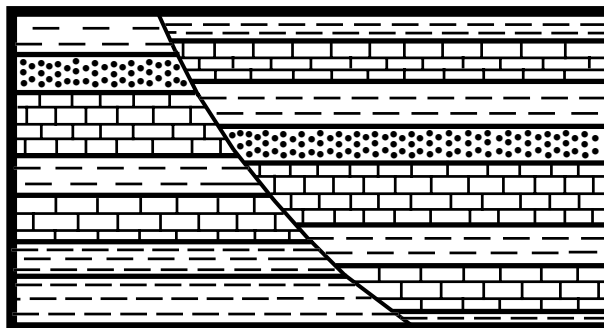
Example 5b:

In this next example, there are three kinds of sedimentary rocks:

- 6.) _____ . (rock type)
- 7.) _____ . (rock type)
- 8.) _____ . (rock type)

- 9.) What kind of geologic feature curves from the top of the diagram to the bottom?

- 10.) What are the relative ages of the rocks compared to this feature?



- 11.) Why?

- 12.) These two examples illustrate one of the most fundamental and useful principles for relative age-dating.

Describe and *invent a name* for the general principle that is represented by *both* Example 5a and 5b: