

# What's Up?

## A Relative Age Dating Activity

By Christine McLelland

**Topic:** Relative age dating of geologic cross sections

**Grade Level:** 7-14

**Content Standard:** National Earth and Space Science Standard

**Content Objective:** This exercise will introduce your students to the concept of relative age dating, and allow them to practice their new skills by determining the age sequence of geologic events in a cross section. They will learn the geologic principles that help geologists in their study of the Earth's crust.

**Time Required:** One class period if an introduction to relative time has already been completed.

**Materials Needed:** Student pages, which contain cross sections.

**Directions for Activity:** Begin with an introduction to geologic time based on the teacher text. Making overheads of some of the diagrams will be helpful. Go through each principle with the appropriate diagram. The newspaper example in the text is helpful for students to understand, in the most simplified way, how sedimentary rocks are deposited on top of one another. Once you review the principles and hints, do the first few cross sections together and check for understanding. It may be fun to then do a mini-contest where you give a small reward to the first person to finish correctly one of the cross sections. Or have students come up and complete the cross sections with the class on the overheads. Make sure to leave a few cross sections for students to do *on their own* to make sure that each student is correctly understanding how the process works.

### Evaluation:

Answers to activity:

Part 1:

1. Principle of superposition; principle of original horizontality; principle of faunal succession; principle of inclusions
2. No, igneous can be used (principle of cross cutting relations) and metamorphic can also be used (metamorphic contact zones)
3. Faults are younger than the rocks they cut.
4. a. Yes, if the faults contained fossils, particularly index fossils.
4. b. Yes, this figure contains igneous rocks and it may be possible to find an absolute age by using radiometric dating.
5. Cross cutting relationships, contact metamorphic zones, inclusions.

Part 2:

Figure 1: Oldest to youngest: C, E, D, A B

Figure 2: Oldest to youngest: E, B, C, D, A

Figure 3: Oldest to youngest: C, A, B

Figure 4: Oldest to youngest: G, C, A, F, B, H, D, I, E

Geologic History: Sedimentary rocks G, C, A, F were deposited in that order, then they were faulted (B), then rocks H, D and I were deposited, and then the whole sequence was faulted.

Figure 5: Oldest to youngest: D, H, A, C, G, F, I, B, E

Geologic history of the area: original rocks were metamorphosed (D), the sediments H and A were deposited on top of them, the sequence was lithified and folded, then an igneous rock (C) intruded into them, and then they were all faulted (G). Sandstone F, limestone I, and siltstone B were then deposited, the whole sequence was tilted, and finally limestone E was deposited.

Figure 6: Oldest to youngest: O, H, B, L, J, A, F, M, D, G, N, E, I, C, K

Geologic History: Original bedrock was metamorphosed, then igneous rock H intruded into the area (there was some contact metamorphism) then rocks B, L and J were deposited in that order, and then they were folded into a syncline. Next, igneous dike A intruded into the rocks, then they were all faulted by F. Sandstone M and conglomerate D were deposited, the whole sequence was tilted, rocks G, N and E were deposited, the sequence was intruded by an igneous dike (I), sandstone C was deposited, and finally conglomerate K was deposited, probably in a stream bed.

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## A Relative Age Dating Activity

By Christine McLelland

Name: \_\_\_\_\_

**Purpose:** In this activity you will learn to determine the sequence of geologic events from cross-sections of strata (rocks) in a given area. It is a bit of a mind-puzzler, so have fun!

**Background:** Before absolute dating of rocks was developed in the 20<sup>th</sup> century, geologists had to rely on relative age dating, which places geologic events in their order of occurrence. The method begins with the careful drawing and description of strata (the geologic cross section or profile). Relative age dating assumes that the lower layers in any particular cross section are older than the upper layers in that cross section (“the law of superposition”) and that an object cannot be older than the materials of which it is composed. Igneous rocks are dated according to whether they caused metamorphism in the surrounding rock (proof that they intruded into the preexisting rock), whether they cross cut preexisting rocks, or whether sediments were deposited on them after they were formed. The profile from one location is then compared with profiles from surrounding sites to determine the geologic history of a larger area. If fossils are present in the rocks, they may also be used to correlate rock layers across large distances and, now that absolute time has been established, to determine the age of the rocks.

**How?** In this process, you will study the rocks and events in a geologic cross section and put them in the correct order from oldest to youngest. In order to do your best on this activity, you must understand a few of the basic principles that are applicable to relative age relationships between rocks:

**Principle of superposition:** in a sequence of undeformed sedimentary rocks, the oldest beds are on the bottom and the youngest are on the top.

**Principle of original horizontality:** sedimentary layers are horizontal, or nearly so, when originally deposited. Strata that are not horizontal have been deformed by movements of the Earth’s crust.

**Principle of faunal succession:** groups of fossil plants and animals occur in the geologic record in a definite and determinable order. A period of geologic time can be recognized by its respective fossils.

**Principle of crosscutting relations:** geologic features, such as faults, and igneous intrusions are younger than the rocks they cut.

**Principle of inclusion:** a rock body that contains inclusions of preexisting rocks is younger than the rocks from which the inclusions came from.

The easiest way to do relative age dating is to work from oldest to youngest. Try to find the oldest rock (usually located near the bottom) in the diagram below and work your way up. Your first example is the diagram below. Review the **principle of original horizontality** and the **principle of superposition** and you will see that the only possible answer to this puzzle is that layer A is the oldest and layer D is the youngest.

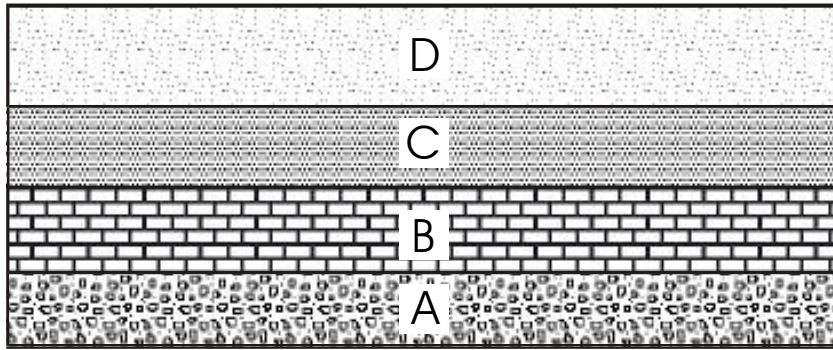


Figure A. Cross sections showing a simple example of undisturbed sedimentary rocks. A is the oldest, D is the youngest.

Here are some additional hints that will help you with your diagrams:

Sedimentary rocks:

- If rocks are folded, the folding is younger than the youngest rock affected.
- If they are folded into a syncline (a U-shaped fold) the youngest rocks are in the core of the fold (see figure B). The opposite is true for an anticline (a big dome-shaped fold). Sedimentary rocks that contain fragments of another rock are younger than the rocks that the fragments came from.

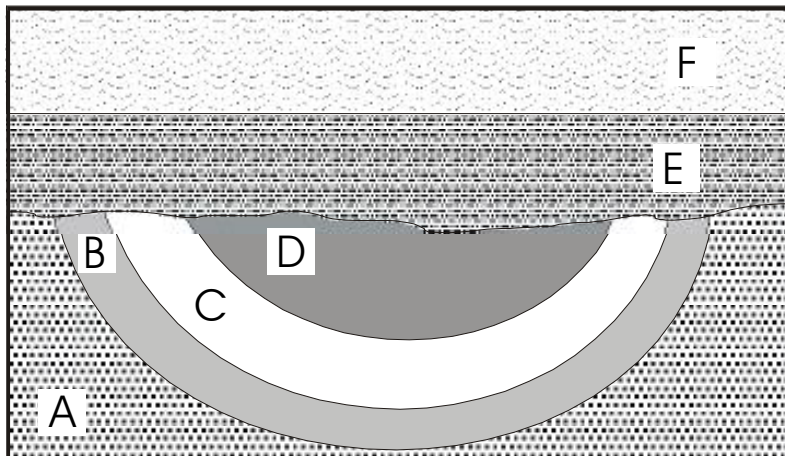


Figure B. Oldest rocks: A, followed by B, C and D. All four sedimentary layers were folded into a syncline. Layers E and F were then deposited at a later time and are the youngest.

Igneous rocks are formed by the solidification of a liquid magma; they therefore can intrude into preexisting rocks or be poured out onto the surface of the earth:

- If an igneous body crosscuts another rock, the igneous rock is younger than that rock (see Activity figures 1 & 3).
- If a body of granite contains unmelted inclusions of another rock, the granite is the younger rock.
- Remember! Granites can intrude into other rocks, even though they may be on the bottom of your geologic diagram. Look carefully for the granitic pattern (see below) and for irregular contacts between the granite and the country (preexisting) rock (see Activity figure 2). The granite may also metamorphose the country rocks:

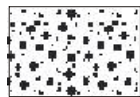
- Intrusive rocks produce contact metamorphism (shown as a starred pattern within the country rock pattern, see Activity figures 2 & 3) along their contacts with the older rocks they intrude into.
- Lava flows may cause contact-metamorphism with the older rocks they lie upon.

Metamorphic rocks are preexisting rocks that have been metamorphosed (changed into different rocks) by large amounts of heat and pressure in a region. These rocks have usually been deformed by large, mountain forming events, and therefore if they are in contact with layered or unmetamorphosed rocks, they are usually the oldest rocks in the sequence (considering that if those rocks had been in place when the metamorphism occurred, they also would be metamorphosed!). Always look for the metamorphic pattern (see below) to determine if there is a metamorphic rock in your sequence.

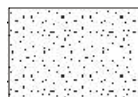
- Metamorphic rocks are older than sedimentary rocks deposited above them or with igneous rocks that may intrude them.

Now, familiarize yourself with the rock patterns:

### Key to Rock Symbols Sedimentary Rocks



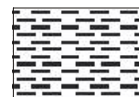
Conglomerate



Sandstone



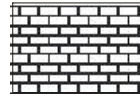
Siltstone



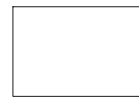
Shale



Shale



Limestone



Limestone

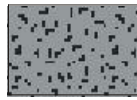
### Igneous Rocks



Granite

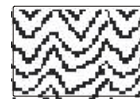


Granite

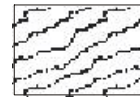


Basalt

### Metamorphic Rocks



Gneiss



Schist

### Special Features:



Contact that is an unconformity (layers on either side of it are of differing ages)



Fault



Zone of contact metamorphism

### Directions:

**Part 1:** Answer the following questions based on your reading.

1. Which of the principles apply to sedimentary rocks?

2. Are only sedimentary rocks used for relative age determinations? Explain:
  
3. Explain the relative age relationship of faults to the rocks they cut:
  
4. Look at the diagrams in Part 2.
  - a. In figure 1 below, could it be possible to determine an absolute age of these rocks? If yes, explain in detail how you may be able to do this:
  
  - b. In figure 3 below, could it be possible to determine an absolute age of these rocks? If yes, explain in detail how you may be able to do this:
  
5. How do you determine the relative ages of igneous rocks? (List the ways)

**Part 2:** For each of the following cross sections, determine the relative age sequence of the rocks. Place the answers in the spaces on the right. Remember, always start by looking for the oldest rock first and working your way from oldest to youngest. Don't forget to consider all intrusions and faults! The diagrams go from simplest to hardest to let you progressively improve your skills.

Figure 1:

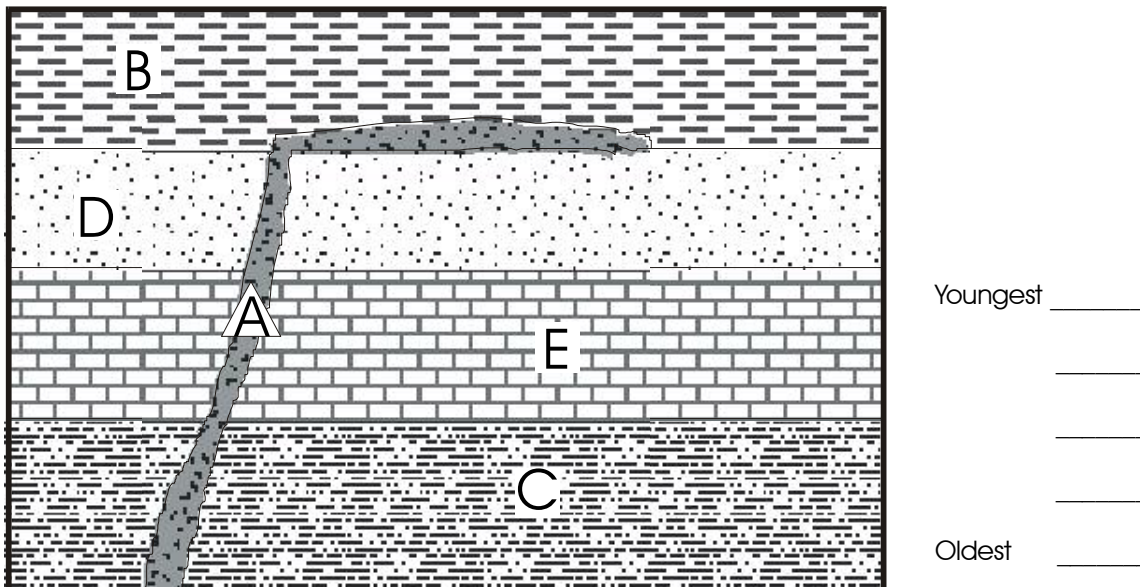


Figure 2:

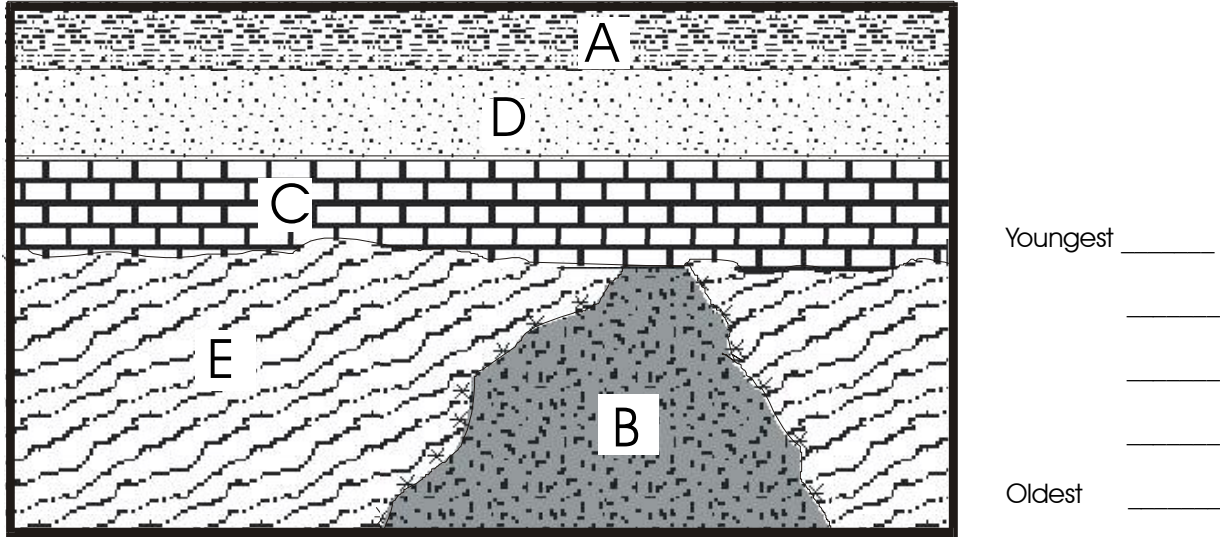


Figure 3:

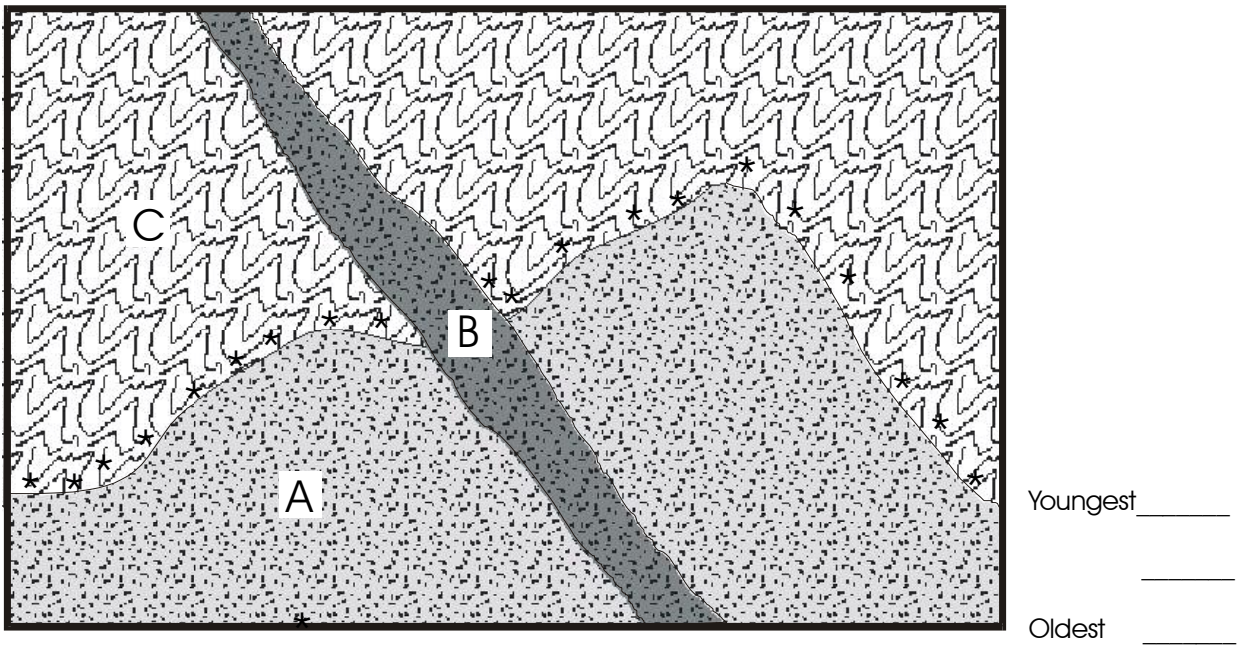
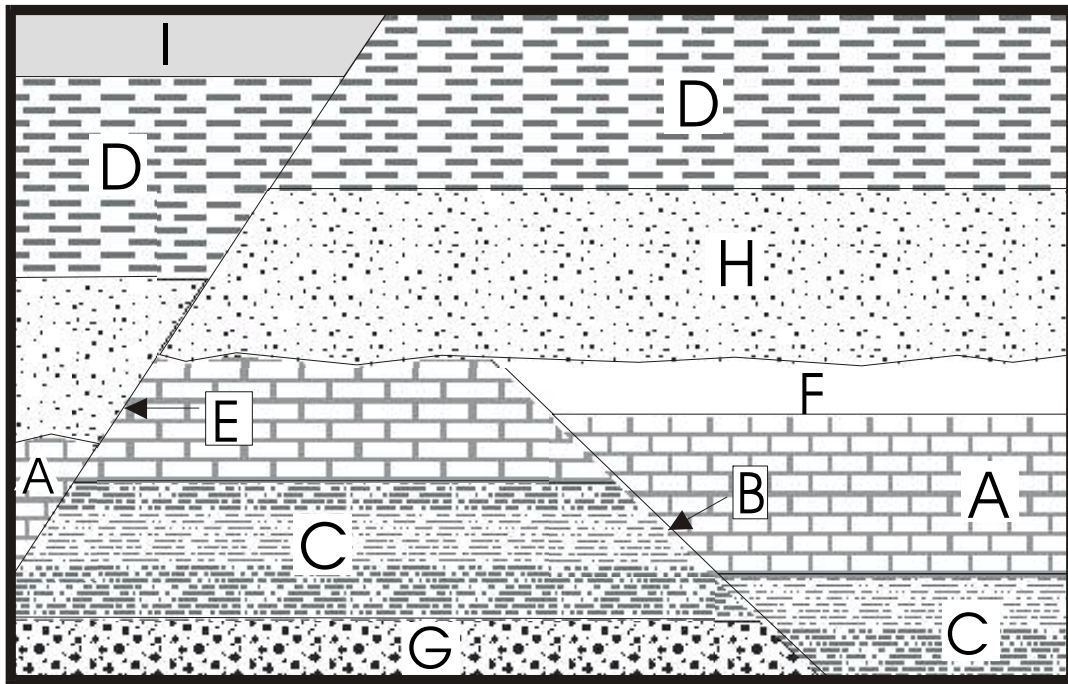


Figure 4:



Youngest \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

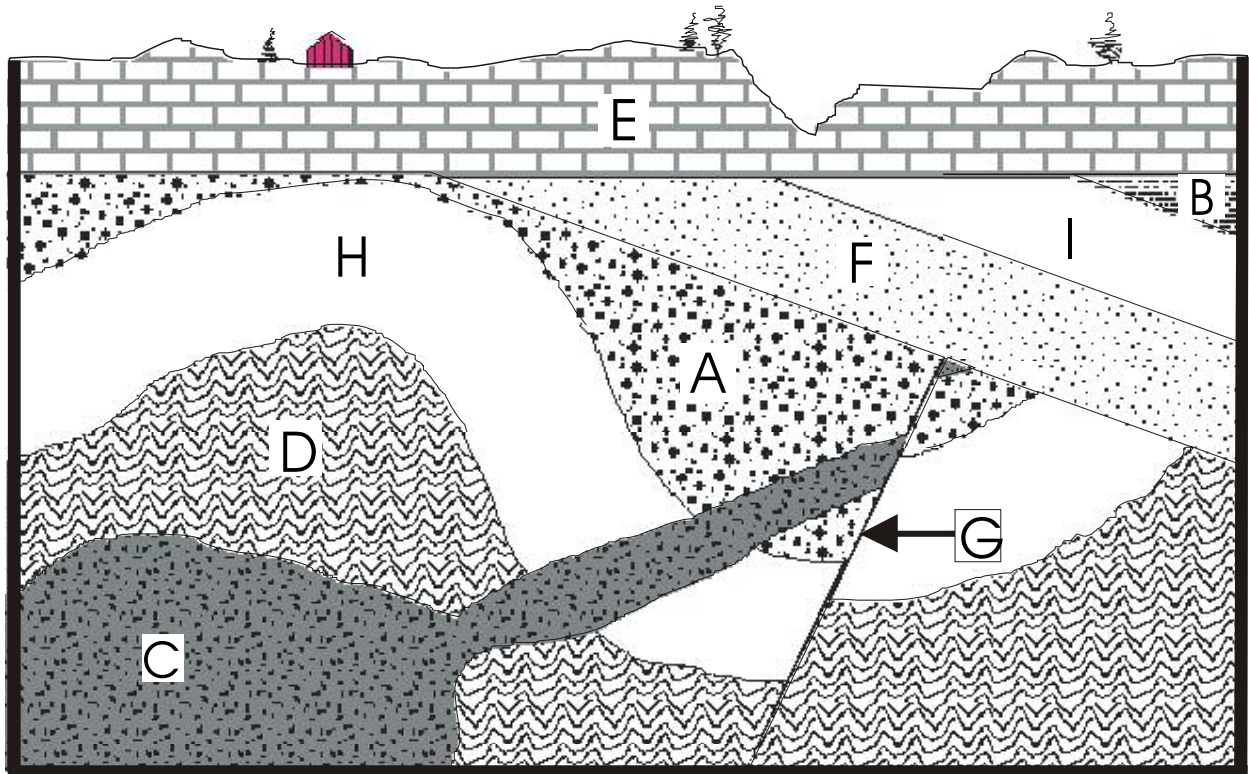
\_\_\_\_\_

Oldest \_\_\_\_\_

Try to write the geologic history of this area:



Figure 5:



Youngest \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Oldest \_\_\_\_\_

Try to write the geologic history of this area:

Figure 6:

