

# GY 112L Earth History

## Lab 2

### Vertical Successions and Sequences of Events

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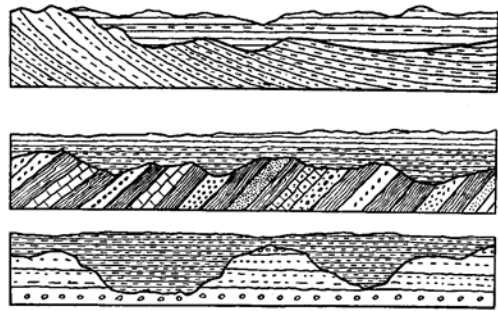
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The recipes that are included in some sections are intended to prove that you can eat anything as long as you serve it with plenty of ketchup. Neither Haywick, nor the Connors are responsible for any food poisoning that might occur if you actually try them.

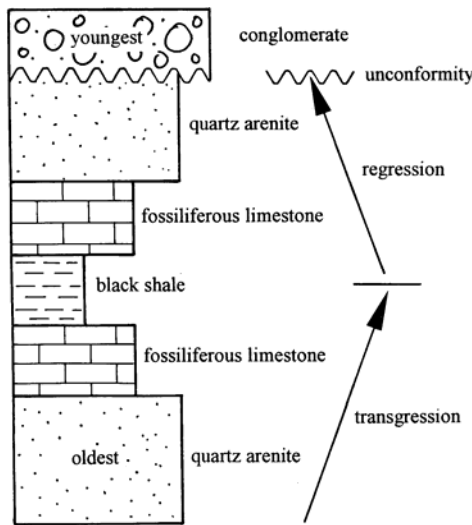
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# Lab Two

## Vertical Successions and Sequence of Events

**Background:** Sedimentary rocks are deposited within specific **depositional environments** in an orderly and predictable fashion: one layer at a time. In fact, one of the most important principles of sedimentary geology is the **Law of Superposition** which states *that in any sedimentary succession that has not been overturned, the oldest sedimentary units (or **strata**) are on the bottom.* This is an obvious principle, but one which has important predictive connotations. For example, consider the simple (and totally fictitious) vertical profile observed by a geologist in a cliff outcrop pictured below:



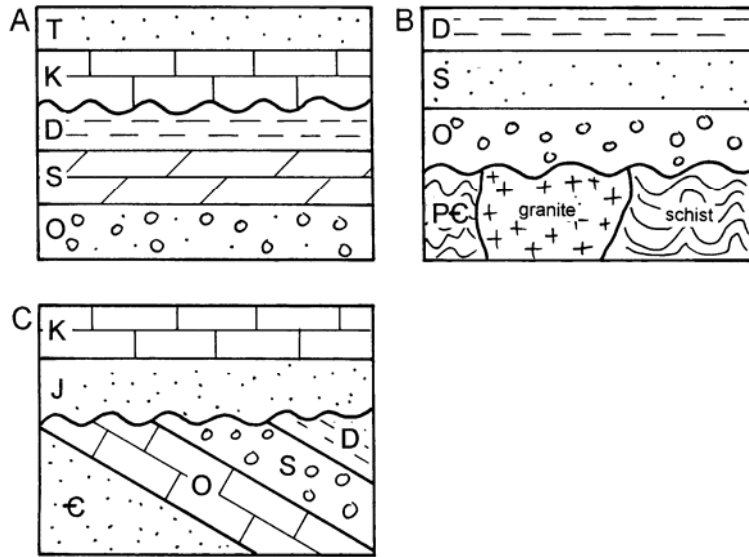
**Figure 2-1:** A schematic vertical section of a sequence of sedimentary rocks that were deposited during a transgression and a regression. See the text for additional information.

The quartz arenite on the bottom of the succession is clearly the oldest strata in the cliff section. It is **overlain** by a fossiliferous limestone and that is in turn overlain by a black shale. Above this, the whole sequence is repeated in reverse (shale-limestone-sandstone). Each of these sedimentary rocks was deposited within a specific

<sup>1</sup>The Figure shows some cartoons of unconformities. From Le Conte, J., 1905. Elements of Geology. D. Appleton & Co. New York, 667p.

environment. Quartz arenites are mature sandstones that are commonly deposited in beach environments. Fossiliferous limestones are marine (typically shelf-depth; <200m). Black shales are usually deposited in deeper water (> 200 m). Since we know that the quartz arenite is the oldest strata in the sequence it follows that there must have been a change in depositional environment at the location where these rocks were deposited *over time*. In other words, we went from a beach environment to a shallow marine environment to a deep marine environment. Overall, this was progressive deepening. Geologists refer to this trend as a **transgression** or a **relative sea level rise**. The term relative is applied because it is generally not easy to establish whether it was sea level that actually rose (e.g., glacial ice melted) or simply a local tectonic process (e.g., local **subsidence**). The three rock layers above the transgressive sequence (shale-limestone-sandstone) record just the opposite trend (progressive shallowing). This is called a **regression** or a **relative sea level fall**. It should be noted that most sedimentary sequences, especially those that involve millions of years of deposition, contain evidence of many transgressions and regressions. In fact, sedimentary geologists spend considerable amounts of time trying to unravel the historical record of sea level change (**eustasy**☀) on the Earth. The reason is that sea level position determines what depositional environments are created, the sediment that is deposited and the kinds of resources that are produced (e.g., economic minerals, petroleum, natural gas, coal).

At this point we should also introduce an important new concept that you will need for this lab and for the remainder of GY112; **unconformities**. In the sedimentary section on the previous page, the upper part of the sequence is regressive in nature. If the regression was drastic (e.g., a major sea level fall), the quartz arenite that was being deposited on a beach might be overlain by a more terrigenous type of sedimentary rock like lithic sandstone or conglomerate (e.g., river deposits). As you should all know, rivers are channelized streams of water. At the base of the channel, significant amounts of erosion normally take place. Any sediment that lies below the river (e.g., quartz arenite) would be partially removed. The contact between the conglomerate and the quartz arenite would be **scoured**. If a significant period of time had passed between deposition of the quartz arenite and deposition of the conglomerate (>100,000 years), the contact is said to be **unconformable**. The official definition of an unconformity is as follow: *a substantial break or gap in the geological record where a rock unit is overlain by another rock unit that is not next in the stratigraphic succession*. Unconformities are very common and very important in the **rock record**, and we'll be looking at them further in the lab exercises next week. The main thing to remember about them is that they record *periods of time*.



**Figure 2-2:** Schematic cartoons illustrating the three most common types of unconformities

- A) disconformities
- B) nonconformity
- C) angular unconformity

They may be a simple surface (i.e., the contact between two rock units), but that surface may represent a period of many millions of years. In fact, there are unconformities which bring early Pre-Cambrian rocks in contact with Quaternary rocks. In this case, the unconformity represents a period of *billions* of years. For today's lab, you will need to know about the basic types of unconformities. There are three of them:

- 1) **Disconformities:** these are unconformities that are *parallel* to the rock units that underlie and overlie them (e.g., Figure 2-2a). They are generally the most difficult of the unconformities to identify because they are layer parallel.
- 2) **Nonconformities:** These are unconformities that occur between igneous or metamorphic (crystalline basement) rocks and overlying sedimentary rock units (Figure 2-2b). The most common basement rocks are continental rocks like granite.
- 3) **Angular unconformities:** These are unconformities between inclined or folded strata and overlying sedimentary rock units (Figure 2-2c). They are usually the easiest to identify.

In this lab, some of the questions that you will be asked to answer will deal with recognition of unconformities and/or basic geological structures like **folds** and **faults**. If you previously taken GY 111\111L, you might also want to try and identify the specific of structure (e.g., anticline), but this is not required for GY 112L. If you are interested in structural geology, refer to the table on the next page or ask your lab instructor.

Unconformities	Folds*	Faults*
Angular Unconformity	Anticline	Dip slip (Normal and Reverse)
Disconformity	Syncline	Strike slip (Left and Right Lateral)
Nonconformity	Monocline	Oblique slip

\*The terms in these columns are not necessary for GY 112L labs.

The other important part of this lab is establishing the sequence of events responsible for geological situations. For this, you as a geologist must think like a detective and try to reconstruct past events that led to the current condition. Geologists do not have the benefit of consulting witnesses and therefore must rely upon the rock record to tell the history of any particular suite of rocks. By now, you should have been introduced in lectures to some basic geologic principles that are applied when discerning a sequence of events. You will want to remember the following:

- Law of Superposition
- Law of Original Horizontality
- Law of Original Lateral Continuity
- Principle of Cross-Cutting Relationships
- Principle of Inclusions

Here are some quick and dirty definitions of these laws/principles:

**1) The principle of superposition** (one more time!) states that *in any sedimentary succession that has not been overturned, the oldest strata occur on the bottom,*

**2) The principle of original horizontality** states that *sedimentary layers are originally deposited as horizontal sheets,*

**3) The principle of original lateral continuity** states that *sedimentary layers are originally deposited as laterally continuous sheets that naturally terminate against basin margins or barriers or which grade into other sedimentary layers,*

**4) The principle of cross-cutting relationships** states that *in a succession where rocks are cut by specific events (e.g., a fault cutting across a sandstone), the rock that is cut is older than the event that did the cutting, and*

**5) The principle of inclusions** states that *inclusions within an igneous rock are older than the igneous rock that contains them.*

To determine the sequence of events, you will need to establish the order in which various geological processes occurred. Some of these processes include deposition of sedimentary rock units, erosion (determined on the basis of unconformities), deformation (tilting, folding, faulting, metamorphism), intrusion of igneous rocks etc.

Most GY 112L students find that the sequence of events exercises are an enjoyable activity, quite possibly the best in the introductory geology labs. Some students have also claimed that these exercises are the most fun that they have *ever* experienced. These students have no lives. However, even if you do have a life, you should find these exercises somewhat rewarding. And there is absolutely no math involved in anything this week! But next week.... well that's another story.

Notes

