Superposition

Imagine that you are walking to your favorite store and you happen to notice an interesting car go by. You’re not sure what kind it is, but you remember that you read an article about it. You decide to look it up. At home you have a stack of magazines from the past year, as seen in Figure 16.

You know that the article you’re thinking of came out in the January edition, so it must be near the bottom of the pile. As you dig downward, you find magazines from March, then February. January must be next. How did you know that the January issue of the magazine would be on the bottom? To find the older edition under newer ones, you applied the principle of superposition.

Oldest Rocks on the Bottom

According to the principle of superposition, in undisturbed layers of rock, the oldest rocks are on the bottom and the rocks become progressively younger toward the top. Why is this the case?

Figure 16  The pile of magazines illustrates the principle of superposition. According to this principle, the oldest rock layer (or magazine) is on the bottom.
**Rock Layers** Sediment accumulates in horizontal beds, forming layers of sedimentary rock. The first layer to form is on the bottom. The next layer forms on top of the previous one. Because of this, the oldest rocks are at the bottom. However, forces generated by mountain formation sometimes can turn layers over. When layers have been turned upside down, it’s necessary to use other clues in the rock layers to determine their original positions and relative ages.

**Relative Ages**

Now you want to look for another magazine. You’re not sure how old it is, but you know it arrived after the January issue. You can find it in the stack by using the principle of relative age.

The **relative age** of something is its age in comparison to the ages of other things. Geologists determine the relative ages of rocks and other structures by examining their places in a sequence. For example, if layers of sedimentary rock are offset by a fault, which is a break in Earth’s surface, you know that the layers had to be there before a fault could cut through them. The relative age of the rocks is older than the relative age of the fault. Relative age determination doesn’t tell you anything about the age of rock layers in actual years. You don’t know if a layer is 100 million or 10,000 years old. You only know that it’s younger than the layers below it and older than the fault cutting through it.

**Other Clues Help** Determination of relative age is easy if the rocks haven’t been faulted or turned upside down. For example, look at Figure 17. Which layer is the oldest? In cases where rock layers have been disturbed you might have to look for fossils and other clues to date the rocks. If you find a fossil in the top layer that’s older than a fossil in a lower layer, you can hypothesize that layers have been turned upside down by folding during mountain building.

**Figure 17** In a stack of undisturbed sedimentary rocks, the oldest rocks are at the bottom. This stack of rocks can be folded by forces within Earth. **Explain how you can tell if an older rock is above a younger one.**
Unconformities

A sequence of rock is a record of past events. But most rock sequences are incomplete—layers are missing. These gaps in rock sequences are called **unconformities** (un kun FOR muh teez). Unconformities develop when agents of erosion such as running water or glaciers remove rock layers by washing or scraping them away.

**How do unconformities form?**

**Angular Unconformities** Horizontal layers of sedimentary rock often are tilted and uplifted. Erosion and weathering then wear down these tilted rock layers. Eventually, younger sediment layers are deposited horizontally on top of the tilted and eroded layers. Geologists call such an unconformity an angular unconformity. **Figure 18** shows how angular unconformities develop.

**Disconformity** Suppose you’re looking at a stack of sedimentary rock layers. They look complete, but layers are missing. If you look closely, you might find an old surface of erosion. This records a time when the rocks were exposed and eroded. Later, younger rocks formed above the erosion surface when deposition of sediment began again. Even though all the layers are parallel, the rock record still has a gap. This type of unconformity is called a disconformity. A disconformity also forms when a period of time passes without any new deposition occurring to form new layers of rock.

**Nonconformity** Another type of unconformity, called a nonconformity, occurs when metamorphic or igneous rocks are uplifted and eroded. Sedimentary rocks are then deposited on top of this erosion surface. The surface between the two rock types is a nonconformity. Sometimes rock fragments from below are incorporated into sediments deposited above the nonconformity. All types of unconformities are shown in **Figure 19**.
An unconformity is a gap in the rock record caused by erosion or a pause in deposition. There are three major kinds of unconformities—nonconformity, angular unconformity, and disconformity.

A nonconformity, horizontal layers of sedimentary rock overlie older igneous or metamorphic rocks. A nonconformity in Big Bend National Park, Texas, is shown above.

An angular unconformity develops when new horizontal layers of sedimentary rock form on top of older sedimentary rock layers that have been folded by compression. An example of an angular unconformity at Siccar Point in southeastern Scotland is shown above.

A disconformity develops when horizontal rock layers are exposed and eroded, and new horizontal layers of rock are deposited on the eroded surface. The disconformity shown below is in the Grand Canyon.
Matching Up Rock Layers

Suppose you’re studying a layer of sandstone in Bryce Canyon in Utah. Later, when you visit Canyonlands National Park, Utah, you notice that a layer of sandstone there looks just like the sandstone in Bryce Canyon, 250 km away. Above the sandstone in the Canyonlands is a layer of limestone and then another sandstone layer. You return to Bryce Canyon and find the same sequence—sandstone, limestone, and sandstone. What do you infer? It’s likely that you’re looking at the same layers of rocks in two different locations. Figure 20 shows that these rocks are parts of huge deposits that covered this whole area of the western United States. Geologists often can match up, or correlate, layers of rocks over great distances.

Evidence Used for Correlation It’s not always easy to say that a rock layer exposed in one area is the same as a rock layer exposed in another area. Sometimes it’s possible to walk along the layer for kilometers and prove that it’s continuous. In other cases, such as at the Canyonlands area and Bryce Canyon as seen in Figure 21, the rock layers are exposed only where rivers have cut through overlying layers of rock and sediment. How can you show that the limestone sandwiched between the two layers of sandstone in Canyonlands is likely the same limestone as at Bryce Canyon? One way is to use fossil evidence. If the same types of fossils were found in the limestone layer in both places, it’s a good indication that the limestone at each location is the same age, and, therefore, one continuous deposit.
SECTION 3 Relative Ages of Rocks

SECTION REVIEW

Summary

Superposition
- Superposition states that in undisturbed rock, the oldest layers are on the bottom.

Relative Ages
- Rock layers can be ranked by relative age.

Unconformities
- Angular unconformities are new layers deposited over tilted and eroded rock layers.
- Disconformities are gaps in the rock record.
- Nonconformities divide uplifted igneous or metamorphic rock from new sedimentary rock.

Matching Up Rock Layers
- Rocks from different areas may be correlated if they are part of the same layer.

Self Check
1. Discuss how to find the oldest paper in a stack of papers.
2. Explain the concept of relative age. SC.D.1.3.5
3. Illustrate a disconformity. SC.D.1.3.1
4. Describe one way to correlate similar rock layers.
5. Think Critically Explain the relationship between the concept of relative age and the principle of superposition.

Applying Skills
6. Interpret data to determine the oldest rock bed. A sandstone contains a 400-million-year-old fossil. A shale has fossils that are over 500 million years old. A limestone, below the sandstone, contains fossils between 400 million and 500 million years old. Which rock bed is oldest? Explain. SC.D.1.3.3

Can layers of rock be correlated in other ways? Sometimes determining relative ages isn’t enough and other dating methods must be used. In Section 3, you’ll see how the numerical ages of rocks can be determined and how geologists have used this information to estimate the age of Earth.

Figure 21 Geologists have named the many rock layers, or formations (Fm), in Canyonlands and in Bryce Canyon, Utah. They also have correlated some formations between the two canyons. List the labeled layers present at both canyons.