

Chapter 23 HOW WATER SHAPES THE LAND

23.3 Sedimentary Rocks

So far in this chapter, you have learned about weathering and erosion. You have also learned that one of the results of weathering is the formation of sediment and soil. What happens next? To answer this question, think back to Chapter 18, when you learned about the rock cycle. The processes of weathering and erosion are very important in the rock cycle because these processes lead to the formation of sedimentary rocks.

Sedimentary rocks

The rock cycle and a downhill journey The processes of weathering and erosion are important in the rock cycle. Weathering is the main recycling mechanism for rocks on Earth's surface. Sunlight, wind, water, ice, and changing temperature and pressure cause all rocks to form cracks, break into smaller pieces and might eventually become sediment. By the process of erosion, rock pieces move downhill due to the force of gravity and eventually reach a lake or sea. Larger pieces of rock break into smaller, smoother particles as they move along on their downhill journey.

Layers of sediment In time, the downhill movement results in the buildup of thick layers (or beds) of sediment in low places. Beds of sediment are compacted and cemented to form sedimentary rocks. Because igneous, metamorphic, and sedimentary rocks all weather and become sediment, the most common rock found on Earth's surface is sedimentary. Sedimentary rocks cover 75 percent of the land area in many places. Figure 23.22 illustrates the path that sediment takes to become a sedimentary rock.

Compaction and cementation As rock particles settle on top of previously deposited beds of sediment, water and air are squeezed out from between particles. **Compaction** is the pressing together of layers of sediment. Even though compacted sediment beds are hard and might be difficult to dig into, the particles are still separate grains and not yet sedimentary rock. **Cementation** is the process by which grains become "glued" together to form a sedimentary rock. Groundwater containing dissolved minerals seeps into the pore spaces between grains. Then, the dissolved minerals crystallize in these pore spaces.

VOCABULARY

compaction - the process by which sediment is pressed together as more and more layers, or beds, of sediment are deposited on top of one another.

cementation - the process by which sediment particles are "glued" together to make a sedimentary rock.

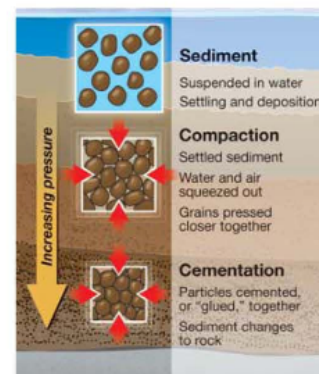


Figure 23.22: Compaction and cementation.

Types of sedimentary rock

- The size of particles** One way to classify sedimentary rocks is by particle size (Figure 23.23). Clay and silt particles form mudstone. Grains of clay are microscopic and cause mudstone to feel smooth. Silt is barely visible and feels gritty. Sand particles that you can see and feel form sandstone. Conglomerate, a lumpy rock, is made of rounded particles and rock pieces of varying size.
- Crystals in water** Some sedimentary rocks also form by precipitation of dissolved minerals from solution. Here, *precipitation* means that the dissolved minerals crystallize as solid particles as the water evaporates. This group of sedimentary rocks includes rock salt and rock gypsum.
- Sediment from animals and plants** The settling process that forms sedimentary rocks in water is ideal for forming rocks from once-living things. The hard parts of dead marine plants and animals sink to the ocean floor and form layers of shells, lime, and mud. Over millions of years, these layers eventually become sedimentary rock. Most limestone, a sedimentary rock, is formed this way. Peat and bituminous coal are sedimentary rocks made from ancient plant remains.
- Fossils in sedimentary rocks** Most fossils are found in sedimentary rocks. This is because many animals live near low areas (that hold water) where sediment accumulates, and the process of forming a sedimentary rock is good for preserving fossils. Fossil formation might begin when an organism's body is quickly covered in sediment from an event like a mudflow. Body parts that do not decay quickly, such as shells, bones, and teeth, are buried under sediment layers. After a long time, these harder body parts might be preserved or replaced by other minerals. Fossils are the remains, or traces (like footprints), of prehistoric organisms. Eventually, the sediment and fossils are compacted and cemented into sedimentary rock (Figure 23.24).
- The Moeraki Boulders formed in sedimentary rock** The Moeraki Boulders are concretions. Although geologists are not entirely sure what triggers the formation of a concretion, most think it is some form of organic material. Once begun, the process is the same. Mineral material, often calcite, replaces the original material. Since mudstone that once encased the boulders was softer than the mineral of the concretion, it eventually weathered away.

Rock Type	Particle Size (mm)	Sediment
mudstone	< 0.06	clay or silt
sandstone	0.06–2	sand
conglomerate	> 2	gravel

Figure 23.23: Types of sedimentary rocks.

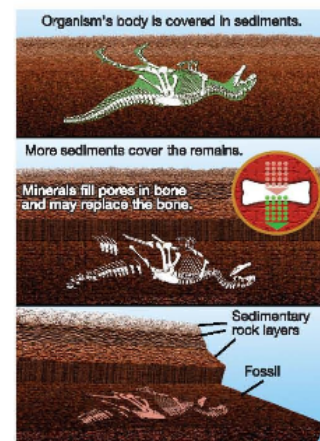


Figure 23.24: The process that forms sedimentary rocks also preserves fossils.

Chapter 23 HOW WATER SHAPES THE LAND

Interpreting layers of sediment

Direction of younging All rocks hold clues to the past. By studying rocks, you can learn something about the conditions under which they formed. What clues about the past do sedimentary rocks hold? One of these clues is the “up” direction. You learned that large particles settle before small particles, forming graded bedding. Figure 23.25 shows two graded beds. A layer of the finest particles is on the top of each bed. This layer of fine particles helps you know which direction is up. If you know the up direction, you know the **direction of younging**—this is the direction of younger layers of sediment. Graded bedding is preserved when sediment becomes sedimentary rock.

Cross bedding Compared to graded bedding, **cross bedding** is a more complicated sedimentary structure that tells stories about ancient conditions. Cross-bedding appears as a pattern of inclined graded beds. The pattern forms as dunes or ripples of sediment are moved in a flowing current of water or wind. The images below show cross-bedding patterns for an ancient stream channel. The angles of beds in cross bedding also provide clues for the direction of motion for ancient water or wind currents.

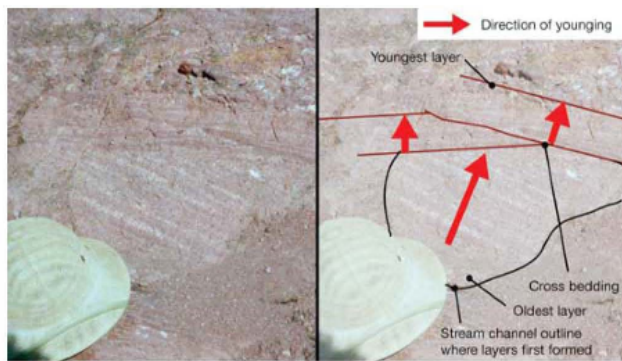


Photo courtesy of Jim Sammons, Sammons' INK

VOCABULARY

direction of younging - the order in which sediment is deposited—from larger to finer particles.

cross bedding - a pattern of inclined beds of sediment that often form as dunes or ripples of sediment are moved by wind and water.

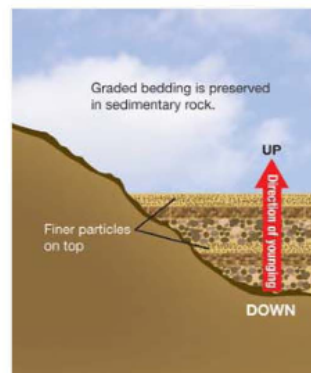


Figure 23.25: Direction of younging. This graphic shows two graded beds.

Section 23.3 Review

1. Explain how the processes of weathering and erosion are involved in forming a sedimentary rock.
2. In this section, you read that sedimentary rocks are the most common type of rock on Earth's surface. Why?
3. What is the difference between compaction and cementation?
4. Describe one way that sedimentary rocks are classified.
5. Why are fossils found in sedimentary rocks?
6. Mudstone, peat, and rock gypsum are all sedimentary rocks. Describe how each is formed.
7. Rock salt is a rock composed of the mineral halite (see Section 22.3). Where do rock salt and halite form? What are the uses for rock salt?
8. After reading about sedimentary rocks and how they are formed, Jane checked her email inbox. While doing that, she thought to herself: An email inbox is similar to a sedimentary rock.
 - a. Explain what Jane means by her statement.
 - b. Write a short paragraph that explains how an email inbox is both alike and different from a sedimentary rock.
9. How you can tell which layer in a sedimentary rock is the youngest?
10. Explain the terms *graded bedding* and *cross bedding*.
11. Review the rock cycle.
 - a. List the three groups of rocks and give an example of each.
 - b. Give a brief description of the processes involved in the formation of each group of rock.
 - c. Since the rock cycle is called a "cycle," one would think that the process of this cycle follows a certain sequence or order. Is that true? Explain your answer.

CHALLENGE

Cool Things in Sedimentary Rocks

Concretions: You have learned that the mysterious Moeraki Boulders formed in mudstone, a sedimentary rock. Similar concretions, such as the one below, form in other types of sedimentary rock. This one formed in sandstone.



Geodes: Geodes also form in sedimentary rocks. Here's a challenge: Find out what makes a geode different from a concretion. You might need to talk to a geologist to get your question answered.



Fossils: Sedimentary rocks are also a good place to look for fossils. Talk to a paleontologist (a scientist who studies fossils) to find out how scientists decide where to look for fossils. Do you think they search for areas that have sedimentary rocks?