8.9C: Erosional Features

Reflect

Have you ever looked at the land around you and wondered what processes shaped what you see? Perhaps you see mountains, valleys, rivers, or canyons. Do you know how long these geologic features have been there? How do you think they got there? What will they look like 10 years from now? How about 10,000 years from now? In thousands of years, do you think these features will still be there? Or will they have changed into something new?

What processes shaped this landscape?

Processes That Shape Earth's Crust

Earth's outer layer—its *crust*—is *dynamic*. This means it is constantly moving and changing. The geologic features you see around you may have been formed suddenly by forces from earthquakes or volcanic eruptions. However, most geologic features are shaped slowly over time by the natural processes of weathering, erosion, and deposition. These processes affect the land differently depending on the types of soil or rock found there. These processes can also be affected by other natural features such as vegetation, climate, and **topography**. The activity of humans and other animals can also change how weathering, erosion, and deposition affect Earth's crust.

topography: the steepness or flatness of Earth's surface

Weathering, Erosion, and Deposition

Many people mistakenly believe that weathering and erosion are the same. Though they typically occur at the same time, weathering and erosion are different processes. *Weathering* is the process by which rocks are broken down by mechanical (physical) or chemical means. The smaller bits of rock that result from weathering are called *sediments*.

This rock is being weathered, or broken down into sediments.

- *Mechanical weathering* changes the shape and size of a rock without changing the rock's chemical composition. The rock can be scraped, cracked, or broken, but the chemicals that compose it do not change.
- *Chemical weathering* breaks down rocks through chemical processes, such as dissolving or **oxidizing**. Chemical weathering changes a rock's chemical composition—in other words, a new kind of rock is formed. As a result of chemical weathering, a rock's state of matter (solid, liquid, gas) may also change; however, this would be physical, not chemical, change.

oxidize: to react chemically with oxygen

Erosion is the process by which rocks, sediments, or bits of soil are carried away. Agents of erosion include flowing water, ice, wind, and gravity. (An *agent* causes something to happen.) As sediments are moved, they can scrape against other rocks, causing mechanical weathering at the same time as erosion. Because weathering and erosion can occur at the same time, rocks that are carried long distances by erosion tend to be more weathered, making them smaller and more rounded. Rocks that are carried shorter distances, particularly through gravity, tend to be in larger, more angular pieces.

Eventually, sediments being carried by erosion stop moving and settle out in a new location. This process is called *deposition*. Sediments are generally deposited in horizontal layers. The older layers are on the bottom, and the newer layers are on the top.

Topography and Satellites

Topography refers to the steepness or flatness of the land. (This is also called *relief*.) Topography includes features such as mountains, hills, cliffs, valleys, and depressions. The processes of weathering, erosion, and deposition can change the topography of an area over time. For example, winds and gravity can lower the elevations of mountains by breaking them down and carrying away their rocks. Flowing rivers and moving glaciers can also cut canyons into the ground.

Scientists can track these changes in topography over time using satellite technology. *Satellites* are manmade instruments that are launched into space and that orbit Earth. Many satellites are equipped with powerful cameras. These cameras can photograph landforms and other features from space. This provides a large-scale view of the topography of an area, which allows scientists to study major features and patterns in ways that would otherwise be impossible. Because satellites orbit Earth, they can photograph the same area every time they pass over it. This allows scientists to study the changes in topography that weathering, erosion, and deposition can make over time.

What Do You Think?

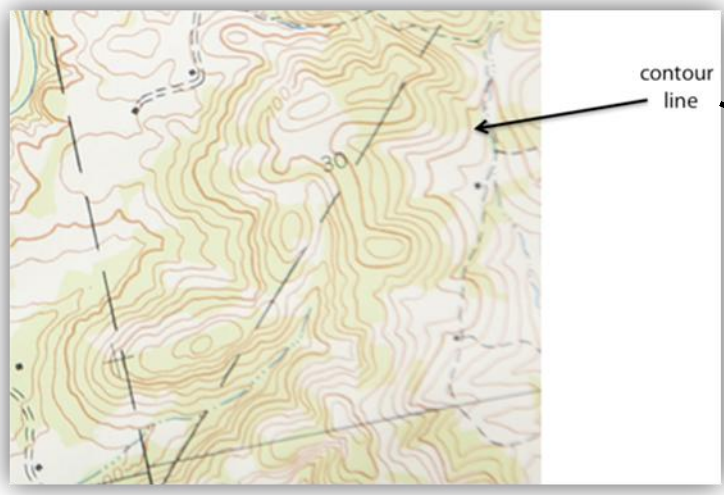
Both photographs on the next page were taken by a satellite. The photograph on the left shows China's Yellow River Delta in 1989. The photograph on the right shows the same region in 2009. How did the region change between 1989 and 2009? (HINT: Brown areas show land, and blue areas show water.) How might weathering, erosion, and deposition have caused these changes?

Topographic Maps

Scientists can also document the topography of an area by making *topographic maps*. Topographic maps may include a region's borders, roads, buildings, and other features; however, their primary purpose is to show how the **elevation** of the land changes. This is done using *contour lines*. Each contour line represents a different elevation above or below sea level. All the contour lines on a topographic map are drawn at regular intervals. In other words, each contour line on a particular map represents the same change in elevation in real life. This is called the *contour interval* of the map. The contour interval determines where the contour lines will be drawn on a particular map.

> **elevation:** distance above or below sea level

For example, a topographic map with a contour interval of 10 meters (10 m) would have a contour line representing every increase or decrease of 10 m in elevation. A single contour line would represent 10 m above sea level, another contour line would represent 20 m above sea level, and so on. (If the land falls below sea level, a contour line would represent 10 m below, or –10 m; another contour line would represent 20 m below, or –20 m; and so on.) Every point on the 10-m line would have an elevation of 10 m above sea level. Every point represented on the 20-m line would have an elevation of 20 m above sea level. Every point between those two lines would have an elevation between 10 and 20 m above sea level.



These topographic maps both have contour lines, but only the map on the right shows the contour interval: 20 m. Moving up from the 700-m line, the contour lines represent 720 m, 740 m, 760 m, 780 m, and 800 m above sea level. The highest point, labeled "A," is at least 820 m above sea level but less than 840 m. (If the land rose higher than 840 m above sea level, a new contour line would need to be drawn.) Notice how the contour lines are closer together around point A and farther apart away from point A. This indicates the land becomes steeper as it rises and flatter as it falls.

The patterns of contour lines on a topographic map reveal the shape of the land as viewed from above. (This is called a *bird's-eye view*.) Contour lines are generally curved to follow the natural flow of the landscape. Contour lines that are very close together represent very steep areas. This is because the elevation is changing drastically over a very short horizontal distance. Contour lines that are farther apart represent gently sloping areas. This is because the elevation is changing less over a horizontal distance.

The patterns formed by contour lines allow scientists to see the erosional features that shaped the topography of a landscape. Here are some other ways contour lines can show topography:

- When contour lines form *concentric circles*—that is, one circle completely surrounds another circle—they represent a hill or mountain. This is because the elevation is changing all the way around the mountain.
- Depressions, such as a cave or the top of a volcano, are represented by circular contour lines with small hash marks inside the circle.
- When contour lines cross a stream or a river, the contour lines are represented as V shapes. These V shapes point in the upstream direction of the stream or river. This is because rivers cut V-shaped valleys into Earth's crust. The contour lines point to the higher elevation from which the water is flowing.

- Unlike rivers, glaciers cut U-shaped valleys into Earth's crust. These valleys can also be seen in the patterns of contour lines on a topographic map.

Creating new topographic maps of an area can allow scientists to compare changes in the land over time. Scientists can also examine the topography of an area and predict how weathering and erosion will affect the land over time. For example, tall, steep structures that stick out from the land are more likely to be weathered and eroded by wind or flowing water. Shallow, gently sloping areas are better shielded from the wind and less likely to be weathered and eroded.

Look Out!

Contour lines get closer together as the land gets steeper. They can even appear to touch each other if an area has a vertical cliff. This is because the elevation is changing drastically with almost no change in the horizontal distance. However, contour lines can never cross over each other. For example, if a 10-m contour line crossed over a 20-m contour line, the point where the lines cross would have an elevation of both 10 m and 20 m. That is impossible! Contour lines also cannot simply end in the middle of a topographic map. They either connect in a loop or run off the borders of a map.

Career Corner: Surveyor

A *surveyor*, also known as a topographer, is a person who studies landscapes in order to create topographic maps. Surveyors are very important when planning excavations, new buildings, or other projects for which knowledge of topography is needed.

This surveyor is using a theodolite.

Surveyors use special instruments such as *theodolites* to gather data about a landscape. A theodolite can be used to measure both elevation and horizontal distance throughout an area. Modern theodolites are equipped with lasers that measure very precisely the distance to a particular point, as well as the elevation of that point. Surveyors also use compasses to determine the angle—north, south, east, or west—from one point to the next. Many theodolites have built-in compasses and will record all of these data at once. Surveyors can then use these data to create a topographic map.

What Do You Know?

Answer the following questions about this topographic map. All measurements are in feet.

Question	Answer
1. What kind of landform does this map show: an island, a mountain range, a valley, or a plateau? Explain your answer.	
2. What is the contour interval? (Remember: The unit for this map is feet.)	
3. What is the highest elevation shown on the map?	
4. What happens to the land between 600 feet above sea level and the lake?	

Connecting With Your Child: Creating Topographic Maps at Home

To help your child learn more about topographic maps, try making one together. First, gather the following items:

- A glass or plastic container
- A sheet of clear glass or plastic large enough to cover the container (optional)
- Plastic wrap
- Adhesive tape
- A permanent marker or dry-erase marker
- A pitcher full of water
- A metric ruler
- Several irregularly shaped objects that will fit inside and sit flush on the bottom of the container. The objects should be several centimeters tall, but should not stick out over the top of the container. These objects must not float in water.

Secure the ruler to the inside of the container with tape. The ruler should stand vertically and measure from the bottom of the container to the top. Place the objects on the bottom of the container. Cover the sheet of glass or plastic with the plastic wrap and stretch it tight, securing the wrap to the sheet with the tape. (This step is unnecessary if you don't mind your child writing on the glass or plastic with the marker.) Cover the container with the sheet of glass, leaving a gap on one side large enough to pour water into the container, but do not yet pour the water in. If you do not have a sheet of glass or plastic, you can instead stretch the plastic wrap tightly over the container and secure it with tape, still leaving the gap through which to pour water.

Pour water into the container until the water is level with the 1-cm mark on the ruler. (Discuss with your child that water naturally levels itself out when poured into a container, so the water level throughout the container should be even with the 1-cm mark of the ruler.) For the purposes of this project, the bottom of the container represents sea level; as you complete this activity, you will continue to increase the water level, drawing a new contour line with each increase. Instruct your child to trace onto the sheet or plastic wrap the outline of where the water touches the objects inside the container; your child should label this line "1 cm." You have just created a 1-cm contour line.

Once your child has completed the first contour line, pour more water into the container until the water is level with the 2-cm mark on the ruler. Again, instruct your child to trace onto the sheet or plastic wrap the outline of where the water touches the objects inside the container; your child should label this line "2 cm." You have just created a 2-cm contour line. Continue this process until the water completely covers the objects inside the container, or until the water gets too close to the top of the container. When your child has finished, examine the topographic map you have created and discuss how it represents the "topography" of the container.

Here are some questions to discuss with your child:

- What is the contour interval of the map you have just created? *(The answer to this question is 1 cm.)*
- Find a steep part of an object. What do you notice about the contour lines you drew over this part of the object? Are these lines close together or far apart?
- Find a gently sloping part of an object. What do you notice about the contour lines you drew over this part of the object? Are these lines close together or far apart?