



**O**ur Earth has existed for billions of years and will exist for billions more. Much of Earth's current landscape, such as mountains and canyons, was formed only millions of years ago (or less). Although the forces and processes associated with plate tectonics have helped create many **landforms**, or landscape features, almost all of today's landscape has been shaped by the action of water, gravity, and heat. Water, gravity, and heat are primarily responsible for **erosion** and **deposition**, natural processes that change the earth's surface by moving rock and soil particles from one area to another. Typically, landscape features start out small and continue to grow larger as more time passes and more material is removed or added.



What causes the different landforms found on Earth's surface?

## READING

Because water is most commonly found as a liquid on Earth's surface, evidence of landscape changes caused by liquid water are all around us. Almost every valley, from the smallest gully to the Grand Canyon, was formed when flowing water removed rock particles and lowered the level of the Earth's surface. Believe it or not, erosion can help create hills and mountains. Many hills and mountains are simply what is remaining after the water has carried away all the material that used to be surrounding them.

### *Chemical Erosion and Deposition*

Groundwater, water below Earth's surface, also erodes rocks, especially a rock called **limestone**. Calcium carbonate, the main mineral in limestone, is easily broken down by and dissolved in water that is slightly acidic. A lot of groundwater is weakly acidic because it contains carbonic acid produced by organic materials. When acidic underground water comes in contact with limestone, the calcium carbonate **dissolves**, creating holes and weakening the rock.

Given enough time, usually tens of thousands of years, and enough water, underground channels, caves, sink holes, and a rough and bumpy ground surface can form. These features are called **karst topography**, named after the Kras plateau, a region with these features located in eastern Italy and western Slovenia. Because about 10% of the earth's land and about 15% of the United States consists of limestone, karst topography is fairly common. The area around Mitchell, Indiana is a good example of how groundwater can shape the land surface and create the classic features of karst topography.

Sinkholes can be less than a meter wide and deep to over 100 meters (300 feet) and have "swallowed" cars and buildings. Sinkholes that collapse through the roof of an underground cave often form the entrance to a cavern. The world's longest cavern, the Mammoth Caves of Kentucky is over 350 miles (560 km) long. Inside karst caves, you can find structures such as stalagmites and stalactites that are created by the deposition of limestone when water drops containing dissolved calcium carbonate evaporate. Stalactites, which hang down from the ceilings of caves, can form when water drops on the ceiling of caves evaporate. When the water drops fall to the cave's floor and then evaporate, columns called stalagmites can form.

### ***Ice-Related Erosion and Deposition***

Solid ice can also create powerful erosional forces. On a small scale, when water that is inside small cracks in rocks freezes, it expands and makes the crack bigger. Eventually this process can break down rocks into smaller pieces. On a large scale, ice masses, such as glaciers and ice sheets, can cover hundreds of square kilometers and can remove huge amounts of rock from one area and deposit it in another area. Most of this erosion and deposition occurs because the ice is constantly moving. Imagine a moving ice mass as a giant bulldozer, scraping and pushing rocks from one place to another. The awesome force ice can carve deep valleys, such as California's Yosemite Valley, and can completely alter the surface of large areas. Much of the landscape of the northern US was created as ice sheets advanced then retreated during several different ice ages.

Common features created by ice include scoured valleys, glacial lakes, kettle holes and kettle lakes, till, pot holes, glacial erratics, and moraines. Scoured valleys are valleys that show signs of ice action such as steep sides, rounded bottoms, and glacial striations (**scrape**

marks). Glacial lakes form when water from melting ice fills up depressions formed by the scouring action of moving ice. Till refers to any mixture of sediment, clay, gravel, and rocks deposited by a glacier. Kettle holes are well defined “circular” depressions that form when a large ice chunk is trapped within glacially deposited sediment. Sometimes the melting ice chunk fills up the hole and forms a kettle lake. Pinhook Bog in Indiana is an example of a kettle lake that has evolved into a bog. Glacial erratics are large boulders that were carried by ice and deposited in a different location, sometimes very far from where they were picked up. A moraine is a linear “hill” that can be formed by sediment deposited most commonly along the sides and front of the ice “bulldozer.”

## **ANALYSIS**

1. Describe three different ways water can create landforms.
2. Why do you think gravity is considered a major force in the creation of landforms?
3. Why do you think heat is considered a major force in the creation of landforms?