Science Benchmark: 05 : 02

The Earth's surface is constantly changing. Some changes happen very slowly over long periods of time, such as weathering, erosion, and uplift. Other changes happen abruptly, such as landslides, volcanic eruptions, and earthquakes. All around us, we see the visible effects of building up and breaking down of Earth's surface.

Standard 02:

Students will understand that volcanoes, earthquakes, uplift, weathering, and erosion reshape Earth's surface.

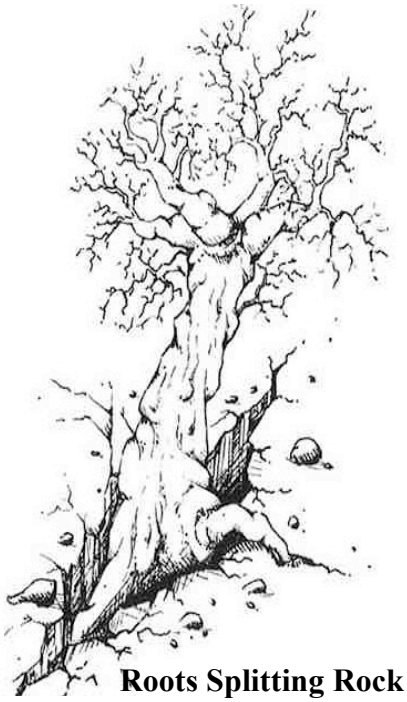
Shared Reading

It's All About Change

Imagine you are on the moon. The footprints of the astronaut who walked on its surface are still there. Craters formed by meteors still remain. The surfaces of the moon do not change as the surfaces of Earth change. The moon does not have the same forces at work as Earth does.

Earth's surface is constantly changing. Some of these changes like earthquakes, landslides and volcanoes happen quickly. Other changes such as weathering, erosion, and uplift happen slowly over long periods of time.

Weathering happens all around us. Water seeps into small cracks in rock. When the temperature falls below freezing, water expands as it becomes ice. Freezing and thawing make the cracks bigger until some of the rock breaks away. The roots grow larger, they split the rocks. Water can break rock into very small pieces. Rocks carried down a swiftly moving river are weathered as they bump against each other. Particles carried by wind also smooth and polish the rock as they strike its surface. Small pieces of rock produced by weathering become soil or sand.



Roots Splitting Rock

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weathering: the physical breaking up of the rocks on Earth's surface into smaller pieces of rock or sand.

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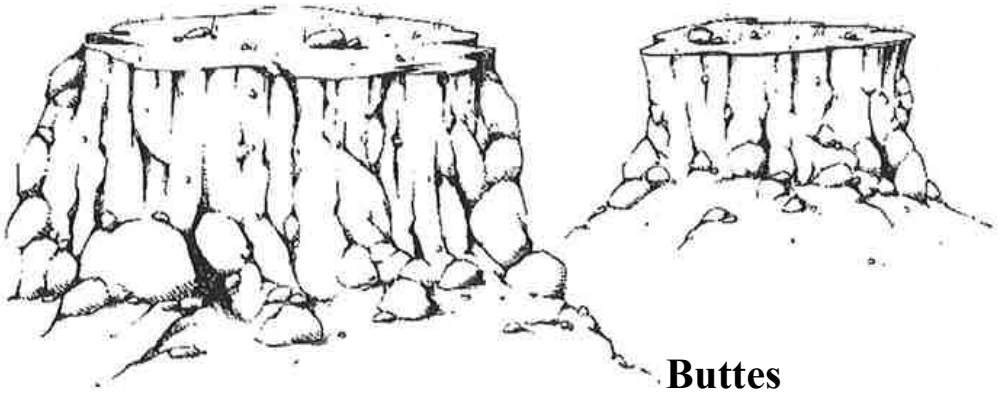
Erosion also contributes to our changing landscape. Glaciers, water, and wind with the force of gravity are some causes of erosion.

Glaciers form as a result of snow falling on the north side of mountains. The snow on the north side never completely melts each year because sunlight seldom shines on it. After thousands of years, the snow builds up and turns to ice. It becomes very heavy. Gravity pulls it slowly down the mountain. As it inches along the glacier *erodes* the surface beneath it. Boulders and rocks, carried in the ice, scrape the rock beneath the glacier carving valleys into mountainsides.

Arch

Water erosion moves the most rock on Earth's surface by the force of gravity. Rain carries the soil away as it washes over the land, leaving gullies, valleys, and canyons. The paths of some rivers have changed over the years as water erodes the banks. Rivers and streams have formed many natural wonders including arches and buttes. *Arches* are formed by a combination of erosional forces. Ice, rain, and wind continue to weather the arches found in Utah's Arches National Park. Running water can form a *butte*. Hard rock on the top of buttes protects the softer rock below from erosion.

Wind erosion moves soil in the air from place to place on Earth's surface. When there is soil in the sir, brevity pulls the soil out of the air and places it somewhere else. Many *geological* features, such as arches, valleys, canyons, and buttes, are continually changing due to the effects of weathering and erosion.



Buttes

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arches: curved rock formations, formed by a combination of erosional forces
butte: an isolated hill with steep, even sides, and a flat top
erode: to wear away by the action of water, wind, or glaciers
erosion: the process of moving weathered bits of rock from one place to another
geological: relating to the structure of Earth and the changes that have taken place over the years
glaciers: thick layers of ice

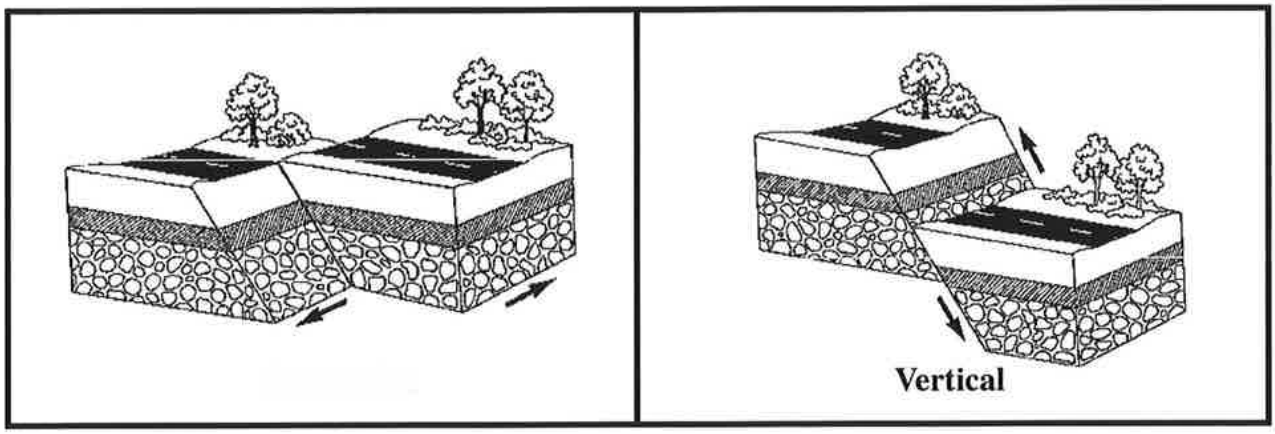
A *volcano* is an opening in Earth's crust. Hot rock deep in Earth expands and is forced out the opening. As the rock cools, it may form a mountain on Earth's surface, or it may flow and form a large flat layer of rock. Volcanoes are not all the same shape or size. Some volcanoes erupt often, some erupt rarely. Utah has had volcanoes erupt and flow in the past. Topaz Mountain is an extinct volcano. Volcanoes can erupt underwater, forming huge ranges of volcanic mountains on the ocean floor.

Volcano

Volcanoes are useful because they can enrich soil. The ash from volcanoes is rich in minerals, especially nitrogen. However, volcanoes can injure people and damage property. Scientists who study volcanoes try to predict when they will erupt. They use gas detectors and devices that measure the movement of Earth. If unusual gases are present and Earth is shaking, volcanic rock may be moving to Earth's surface.

Earthquakes also change Earth's surface. You know you are in an earthquake if the ground starts to shake. Tremendous forces under Earth's surface build up pressure, which is released along a *fault.* Imagine you are bending a popsicle stick. When the pressure is great enough, the stick snaps in two. The energy is released by the snap and waves travel through the stick to your hands. The fault, however, doesn't come apart like the stick. Portions of Earth's crust slide past each other, creating waves. Earthquakes can create landforms on the surface. Mountains, such as the Wasatch Mountains in northern Utah, form as the valley rocks slide down and the mountain rocks rise up during an earthquake. The picture below shows two directions a fault can clip.

Earthquake Faults



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earthquake: energy waves passing through Earth caused by a sudden shift of Earth's crust along a fault.
fault: a crack in Earth's crust that allows the crust to slip.
volcano: an opening in Earth's crust that allows hot, melted rock, ash, and gases to erupt outward

Can you see why the path of the road changes in the horizontal fault? An earthquake fault may leave a cliff over the fault line. The fault may slip deep underground and leave no trace on Earth's surface that an earthquake has occurred. Earthquakes occurring in the ocean can cause a tsunami, a large ocean wave.

There are frequent earthquakes all over the world. Many of them are too small to be felt by people. Instruments measure earthquakes and record their strength and location. Earthquakes are measured on a scale from 1-10. Any earthquake measuring a 6 or above is considered a very large earthquake. Scientists try to predict when earthquakes will occur because earthquakes cause loss of life and property damage every year.

Uplift occurs when part of Earth's surface rises above the surrounding land by great forces of heat and pressure deep within Earth. Uplift formed the Colorado Plateau, creating nearly all the spectacular variety of Canyon Country in Southern Utah.

Imagine you are in a raft floating down the Colorado River through the Grand Canyon. One of the first things you would probably notice is the steep canyon walls on both sides of the river. You may ask, why are the walls so steep? Why do you see different layers of rock exposed?

Millions of years ago, much of the western United States was covered by a shallow sea. The area of the Grand Canyon was once flat, marshy land under the sea. Scientists have determined that many seas have come and gone, leaving different layers of rock during various time periods. Some of the layers contain fossils of sea creatures exposed in the walls of the canyon. The pictures on the next page show when some of the layers were formed and what geologic events were happening at that time.

Uplift took place causing a high, flat plateau. As the land rose, water cut a channel down through the plateau creating a deep canyon. The oldest rocks at the base of the Grand Canyon are about two thousand million (two billion) years old. Each layer above the base was formed under different conditions. It has taken thousands of years for erosion to uncover the rocks of Grand Canyon. In our lifetime we wouldn't notice many changes because our life span is too short. However, thousands of years from now, the Grand Canyon will look different.

Rivers like the Colorado River carry enormous loads of sand and soil they pick up from erosional processes. In the spring, the Colorado River looks like chocolate milk from all the bits of rock it carries. When the water slows down, as in a reservoir or when it reaches the ocean, *deposition* occurs. Wind, glaciers, and running water all deposit weathered materials. Beaches, sandbars, deltas and sand dunes form when deposition occurs. Weathering, erosion, uplift and deposition all work to change Earth's surface. How would Earth appear without them?

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deposition: the dropping of sand and rock carried by wind or water as it slows down or from ice that melts

uplift: part of Earth's surface that rises above the surrounding land by great forces of heat and pressure deep within Earth.

Geologic Era	Time (In Million Years Ago)	Geologic Events	
Cenozoic	0 to 65 MYA	Thick glaciers in much of the world. Rocky Mountains, Alps, Andes, and Himalayas form. Glaciers cover North America	
Mesozoic	65 MYA to 248 MYA	Widespread volcanic activity Age of the dinosaurs American and Europe/African continents move apart.	
Paleozoic	248 MYA to 544 MYA	Age of Ocean life Appalachian Mountains begin to form. Warm, shallow seas cover much of North America Two ancient continents are found near the equator.	
Precambrian	544 MYA to 4,600 MYA	Earth's first ice age occurs. First sedimentary rocks form. Oceans form. Earth forms.	

Remember the footprints and craters on the moon? They remain unchanged. Without the forces of weathering, erosion, and uplift, the moon's surface is quiet and still. It would be similar on Earth. These forces make our planet an interesting place full of different landforms constantly transforming. Geological change makes Earth an exciting place to live!

Science Language that Students Need to Understand and Use

1. **arches:** curved rock formations, formed by a combination of erosional forces
2. **butte:** an isolated hill with steep, even sides, and a flat top
3. **deposition:** the dropping of sand and rock carried by wind or water as it slows down or from ice that melts
4. **earthquake:** energy waves passing through Earth caused by a sudden shift of Earth's crust along a fault.
5. **erode:** to wear away by the action of water, wind, or glaciers
6. **erosion:** the process of moving weathered bits of rock from one place to another
7. **fault:** a crack in Earth's crust that allows the crust to slip
8. **geological:** relating to the structure of Earth and the changes that have taken place over the years
9. **glaciers:** thick layers of ice
10. **uplift:** part of Earth's surface that rises above the surrounding land by great forces of heat and pressure deep within Earth
11. **volcano:** an opening in Earth's crust that allows hot, melted rock, ash, and gases to erupt outward
12. **weathering:** the physical breaking up of the rocks on Earth's surface into smaller pieces of rock or sand