

Background information

Year 4, unit 3: Shaping the Earth's surface

Rock information

There are three different types of rock found on Earth. These are:

- sedimentary rocks
- igneous rocks
- metamorphic rocks.

Each type of rock forms in a different way but all rocks are made of minerals. A mineral is a natural, solid material. Most minerals have a crystalline structure. Crystals usually have a regular shape and smooth, flat sides called faces.

Sedimentary rocks

Sedimentary rocks are made of layers of material such as mud, clay and sand that have been compressed together over time. Examples of sedimentary rocks are sandstone, mudstone and limestone. Limestone is also made from the remnants of coral reefs.

Sedimentary rocks are formed when rivers dump tonnes of sand, mud and tiny pebbles into the Earth's oceans. As microscopic sea creatures die, their tiny skeletons and shells fall to the ocean floor. The action of the waves sorts all these sediments into horizontal layers or beds. The largest, heaviest materials fall through water more quickly, so they form the bottom layers. Layers of lighter materials form on top of them and over time, these materials build up. The weight of the sediments at the top presses down on the lower layers. The sediments become glued together by some of the minerals from the rocks. All that pressure squeezes out the water and cements the sediments together to form rock.

Igneous rocks

Igneous rocks form when magma from the Earth's mantle or lower crust cools. Examples of igneous rock include basalt, pumice and obsidian.

Igneous rocks such as granite contain large crystals. This is because granite is formed when pools of molten magma become trapped within the crust and cool slowly. Igneous rocks are also formed when magma that has moved above the ground to become lava cools more quickly on the surface. This results in rocks such as basalt that have smaller crystals.

Metamorphic rocks

Metamorphic rocks form when heat or pressure changes the minerals within igneous rock, sedimentary rock or other metamorphic rock. Examples of metamorphic rock include marble, slate and phyllite.

The changes that form metamorphic rock often happen when the Earth's tectonic plates collide. The extreme pressure and temperature conditions that create

metamorphic rocks cause the minerals to change. Most metamorphic rocks are made when sedimentary rocks are heated, folded and squeezed during mountain building.

Other metamorphic rocks form when streams of hot magma spurt up into the crust and bake the surrounding rock. Meanwhile the magma itself eventually cools and forms igneous rock.

For more information, pictures and interesting facts visit '[News and information about Geology](#)', Geology.com website <http://geology.com/> (2013)

Soil information

Soil is a natural substance that consists of layers or horizons of minerals and other matter that is found on the surface of the Earth.

Soil is made of three main components. These are:

- minerals from rocks
- organic matter from the remains of plants and animals
- living organisms that reside in the soil.

Soil consists of particles of broken rock that have been altered by physical and chemical processes including weathering and erosion. Soil can form from rocks nearby or from far away. It is also made up of air and water. Other factors such as climate, vegetation, surrounding landscape, time and human activity all influence how soils are formed and what soils are in certain areas.

Soil is considered to have three main parts – sand, clay and silt. These give it its texture.

Soil is made of layers or horizons. These are:

- ground level – contains plants and animals
- topsoil – this organic layer contains humus and decomposed plant and animal matter
- subsoil – contains minerals and generally low amounts of organic matter
- weathered parent material – can be very deep and is all rock particles. This layer can contain layers of rock particles that have been washed in or moved from different areas
- bedrock – parent material made of solid rock that will generally only come to the surface due to erosion or earthquake, for example.

Weathering information

Weathering is the breakdown and the wearing away of rocks. There are two types of weathering – physical or mechanical weathering and chemical weathering or weathering by naturally produced chemicals.

- **Physical weathering** occurs when rocks break down because they are exposed to physical forces such as wind and the expansion and contraction of rocks due to changes of temperature.

- **Chemical weathering** is when rocks break down because their composition changes due to exposure to water and air. For year 4 the term being used is weathering caused by naturally produced chemicals.

Erosion in contrast is the washing away or removal of these weathered fragments of rock.

Physical weathering (mechanical weathering)

- **Wind** action removes rock grain by grain. High-speed wind scours rock smooth and swirls the grains around and around, creating cavities.
- **Running water** in streams and rivers wears rocks into smaller and smoother particles.
- **Extremes and changes in temperature** cause rocks to crack and split as they expand and contract. Excessive heating by the sun and rapid cooling overnight also create cracks. Small fragments of rock then fall off and are carried away by other forces such as rain or wind.

Water can also enter porous rocks and freeze causing the rock to break apart.

Exfoliation can occur as sheets or slabs of the cracked rock slip off and become further eroded.

- **Waves** crashing on the shore forces air and water into rocks, creating spaces and cracks. As the waves move, small fragments of rock fall away and are washed away. Waves also undercut cliffs causing large chunks of rock to fall.
- **Plants** can force their roots into cracks of rocks and, as the roots grow they cause the rocks to break apart. Some lichens and moss grow on the surface of rocks, eventually eating into the rocks and causing them to split and break away. Plants also produce chemicals that can mix with rainwater to eat away rock surfaces.
- **Animals** can also trample and crush rock. This, over a long time, wears them away.

(Plant action or animal weathering is also known as biological weathering.)

Chemical weathering (weathering by naturally produced chemicals)

- **Acid weathering** is when rainwater mixes with gases such as carbon dioxide in the air as it falls. In this case, the resulting carbonic acid dissolves rock such as limestone and sandstone.
- **Oxidation** occurs, in its most common form, when iron particles in rock combine with water and oxygen to form a coloured layer of oxidised mineral. Oxidation is similar to rusting and makes rocks softer. Rocks are then easier to wear away by mechanical means.

Erosion information

Erosion is the washing away or removal of weathered fragments of rock.

There are three common types of erosion. These are:

- water erosion
- wave erosion
- ice erosion.

Water erosion

This is where the material is moved away by water.

- **Sheet erosion** occurs when the top plain of the soil is moved. This occurs with the saturation of the soil and results in water and soil run-off.
- **Splash erosion** occurs when the force of rain droplet impact displaces soil particles.
- **Rill erosion** usually displays as many shallow channels. Water creates and flows down a slope. This is most often seen in cultivated fields.
- **Gully erosion** are carved by, and followed by water as it moves down a slope. Technically, gullies are as deep as they are wide.
- **Stream erosion.** This includes:
 - **lateral erosion** where part of the bank is being washed away
 - **vertical erosion** (also called scour) where the bed of the stream is being washed away
 - **headward erosion** is where a waterway extends its beginning location further up the slope
 - **mass movement** (better known as a landslide or avalanche) occurs when the saturated surface of the slope weighs too much to stay attached to the ground underneath.

Wave erosion

This is where materials are moved away by the action of waves.

- **Coastal erosion** is often due to wave erosion but can also be due to currents, tides or drainage. It occurs where the land meets the sea or ocean.
- **Rock erosion** occurs where waves crash into rock.
- **Sand erosion** occurs on the beach.

Ice erosion

This is when materials are moved away by ice, usually in the form of a glacier.

- **Plucking** occurs when water solidifies around protrusions and cracks in rock and expands during freezing, widening cracks and breaking rock.
- **Abrading** occurs when ice and broken bits of rock slide as the ice scrapes away at the rock bed of the glacier.

Lesson 3: Erosion investigation

Erosion investigations can be carried out to look at the effects of water on sand. These simulate how water affects sedimentary rock landforms. Students can investigate what happens to a sandcastle when they pour differing amounts of water onto it.

These activities can be easily conducted in sandpits within playgrounds to minimise sand and water spillage.

Suggested resources (per group)

- sand
- tray for sand – tidy trays are a good option for ease of cleaning
- sand mould – beach bucket or a disposable cup
- small shovels or spades
- watering can or measuring jugs or cups
- water
- ruler and tape measure
- digital camera

Suggested instructions

1. Nominate an area for students to carry out the activity and give each group of three students a bucket, spade, ruler and tape measure.
2. Each group is to make three sandcastles – one per student.
3. Each sandcastle should be the same size – width and height.
4. Each student should measure their sandcastle using the ruler and tape measure.
5. Students predict what will happen when they pour the instructed amount of water over the sandcastle.
6. Ensure students have recorded their prediction before moving on.
7. Students should measure each sandcastle as before, following each pouring session.
8. Students record their findings for each sandcastle.
9. Students can draw or photograph the different states of their models.

Lesson 4: Human impact on erosion

There are a variety of ways that human activity can lead to and exacerbate rates of erosion. These include:

- recreational activities such as:
 - walking and cycling through areas without paths
 - driving 4WD vehicles through forest and beach areas

- playing games and sports in parklands
- riding trail, dirt and quad bikes.
- building and construction of:
 - housing developments
 - high-rise buildings
 - bridges
 - roads and freeways.
- beach development such as the building of:
 - breakwaters
 - sea walls
 - groins
 - dams, docks and jetties.
- farming and agriculture
- deforestation (land clearing)
- mining
- fire regimes – controlled burn-off of bushland areas
- sea floor dredging.

Ways to reduce or stop erosion

There are many methods that can be used to help reduce or stop erosion of landforms. These methods range from simple actions to more complex.

Strategies to address small-scale erosion

Preventing erosion in the early stages could entail:

- building paths through affected areas to direct foot traffic away from eroding areas
- blocking pedestrian traffic to vegetated areas or areas under revegetation
- trimming large trees to enable more sunlight onto shady areas with limited grass cover. This will encourage grass growth.

Reinforcing the eroding area could entail:

- planting indigenous plants with absorbent root structures to decrease water pooling and to stabilise soil
- planting vegetation such as trees, shrubs and other plants near eroded areas to collect water and stabilise soil
- placing large rocks or boulders near eroded banks or gardens to prevent soil being washed away

- constructing run-off barriers such as brick walls or garden edges to prevent soil and water run-off
- terracing gardens to prevent water and soil run-off
- applying mulch to large areas of garden to help retain water.

Strategies to address large-scale erosion

Protecting areas could entail:

- creating windbreaks, such as barriers built out of trees or bushes, planted along the windward exposure of the land. This helps to prevent wind erosion by stopping wind from blowing across the land
- growing cover crops on farming land when areas are not being used for producing crops. This helps to prevent wind and rill erosion of exposed soils
- using terrace farming that follow along the lay of the land to prevent soil and water run-off
- building trenches that follow contours of the land and run at right angles to the flow of water. This helps protect land from erosion and directs large scale water run-off to certain areas
- building dams that restrict or slow water flow – these can be small or large scale.

Beach nourishment could entail:

- dredging sand from an unaffected area and moving it to stabilise an eroded area.

Rivers and streams revitalisation could entail:

- decreasing the speed of watercraft in affected areas to prevent further erosion of riverbanks from high volume waves
- decreasing the amount of watercraft in affected areas to prevent erosion from waves.

Lesson 5: Human impact on Uluru and Kata Tjuta

Uluru and Kata Tjuta hold significant cultural and spiritual meaning for the Anangu people, the local Indigenous people, and it is important that students are aware of this significance.

Generations of Anangu have actively managed this ancient land using traditional practices and knowledge passed down through Tjukurpa – the foundation of all Anangu knowledge. This land continues to hold powerful cultural connections today.

The Australian Government, Department of Sustainability, Environment, Water, Population and Communities has a large amount of information on its website regarding the Uluru and Kata Tjuta regions. Pages include information on the cultural and historical aspects of the area along with information about the nature and science.

There are small video clips, maps and guides all giving an insight into the significance of the area to the local Anangu culture.

'[Nganana Tatintja Wiya – we never climb](#)', Department of Sustainability, Environment, Water, Population and Communities website, <http://www.environment.gov.au/parks/uluru/explore/do-not-climb.html> (2012)

'[Uluru-Kata Tjuta National Park Note – Please don't climb](#)', Department of Sustainability, Environment, Water, Population and Communities website, <http://www.environment.gov.au/parks/publications/uluru/pn-please-dont-climb.html> (2012)

Interested in finding out more information on Uluru? Try these resources

'[Uluru-Kata Tjuta National Park note – geology](#)', Department of Sustainability, Environment, Water, Population and Communities website, <http://www.environment.gov.au/parks/publications/uluru/pn-geology.html> (2012). Information on how Uluru was formed from a geologist's perspective.

'[Uluru](#)', Wikipedia, <http://en.wikipedia.org/wiki/Uluru> (2012). Information on the history and geology of Uluru.

'[Uluru uproar](#)', *Behind the News*. Australian Broadcasting Corporation, <http://www.abc.net.au/btn/story/s2627617.htm> (21 September 2009). This story from *Behind the News* is great for examining both the environmental and cultural impact of human activity on and around Uluru.

'[Uluru, Mutitjulu, Northern Territory](#)', Google maps, Google, <http://maps.google.com.au/maps?q=Uluru,+Mutitjulu,+Northern+Territory&hl=en&ll=-25.345267,131.037884&spn=0.05073,0.10952&sll=-25.335448,135.745076&sspn=52.4378,78.837891&vpsrc=6&t=h&z=14> (2012). Great bird's-eye view of Uluru. Zoom in to look at all the elements of the rock.