

Section 1: Erosion and Weathering

- What is the difference between weathering and erosion?

The topography of the Earth is created by the interaction of processes which lift the landscape up and those which wear the landscape down. Weathering, erosion and mass wasting can wear down the landscape, and these processes are known collectively as 'denudation'.

The term 'weathering' refers to the breakdown of rocks, soils and minerals in their place of origin, or in-situ, whereas erosion commonly refers to the transport of this material to other regions where it can then be deposited. Weathering breaks down the material that make up rocks, through direct contact with heat, pressure, water, ice or chemicals, and when rocks are sufficiently weathered they can be transported or eroded by water, wind and ice.

Rivers form part of the water cycle and are able to erode material away, but also contribute to the rate at which rocks are weathered.

- **Suggested Film**
- Weathering

Extension Questions

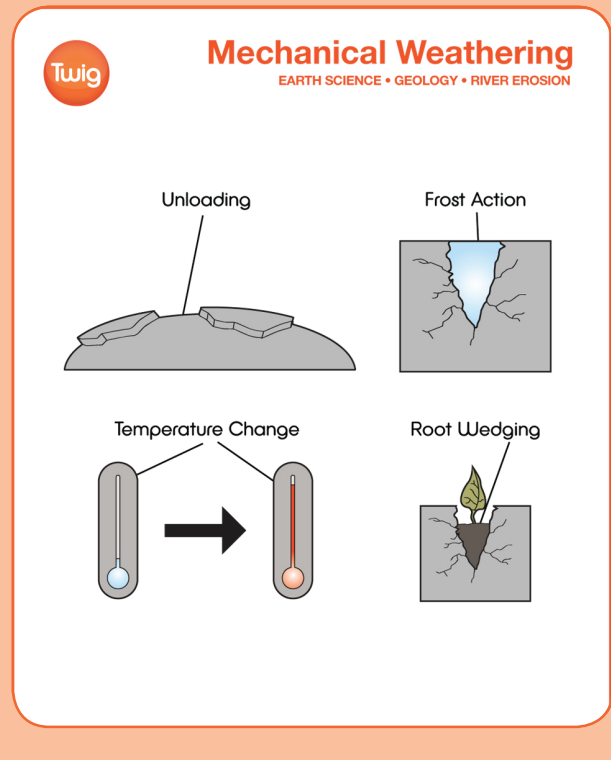
Q1. What is mass wasting?

Mass wasting, or mass movement, is the down slope movement of rock and sediment due to the force of gravity. Although gravity drives mass wasting processes, it can only cause movement where gravity is greater than the forces holding the surface material together, and so mass movements can be encouraged by changes in the factors which control erosion and weathering. The most important types of mass wasting are creep, debris flows and landslides, although processes such as rockslides, rock falls and subsidence can also be important. Creep is a slow process and achieves down slope movement of rock and soil via constant minor rearrangements of the material. Debris flows consist of a mixture of rock fragments, mud and water, and occur much more quickly than creep, commonly during periods of heavy rainfall. Landslides are slope failures which occur along a well-defined plane, and occur on a small scale nearly everywhere.

Q2. How does physical weathering operate?

Physical, or mechanical, weathering breaks down rock into small particles but involves no change in its chemical composition. Physical weathering occurs by two main processes: ice wedging and sheeting or unloading. Ice wedging occurs because water can get into fractures in the rock, and when the temperature drops the water freezes, expands and breaks apart the rock. This process produces loose, angular fragments and can also occur where salt crystals grow in rock cracks. Similarly, expansion and contraction of rocks caused by changes in temperature can produce these effects. Rocks deep within the Earth are confined under pressure, and when the overlying rocks are removed by erosion the pressure is released, allowing the rock to expand.

DIAGRAM 01:



• What are the main factors affecting erosion?

Climate, especially rainfall, is important in controlling erosion. Rainfall can affect erosion directly, but also indirectly through its effects on vegetation, as vegetation acts to bind together soils and resist erosion. This means that both the amount and the timing of rainfall are important.

The type of rock or soil is also important. Fine-grained materials can be eroded more easily than large fragments, while some soils have a greater cohesive strength than others, meaning that they are more difficult to transport.

The slope of the land is also important, because steeper slopes allow water to travel downhill faster and therefore transport more material. Steep slopes also tend to have less vegetation to protect the soil.

Extension Question

Q3. Why do rocks have different resistances to weathering?

The mineral composition of a rock can determine how resistant it is to weathering. For example, minerals such as quartz are very stable and are not easily altered, while minerals like feldspar are very quick to degrade, so quartz-rich rocks are much less susceptible to weathering than those rich in feldspars. When rocks are formed, the constituent minerals are created in equilibrium with their surroundings, so minerals formed deep within the Earth are forced to adjust rapidly when exposed to the atmosphere; they make these adjustments through weathering reactions. For this reason, igneous and metamorphic rocks are more susceptible to weathering than sedimentary rocks. Texture of the rock is also important, because rocks which are very porous allow more water in and expose a greater surface area to weathering processes. In addition, the same type of rock may be more susceptible to weathering in different types of climate.

• How do rivers erode?



In the upper course of a river, vertical erosion creates relatively narrow, steep-sided v-shaped valleys

Rivers form part of the global water cycle, and their main role is to drain the land and return water that has fallen on the ground to the sea. The source (start) of most rivers is found high up in hills and mountains, and river erosion occurs as water moves downstream from the source to the mouth of the river.

As water concentrates in the river channel, it gains energy and is able to erode and transport material. In the higher ground, the river tends to flow through narrow, steep sided v-shaped valleys, and flows turbulently.

Rivers erode the landscape by four different processes: attrition, abrasion, hydraulic action and corrosion.

Attrition – occurs when rocks and stones carried by the river, constantly collide with each other and break down into smaller, rounder pieces.

Abrasion – occurs when pieces of rock carried in the water, collide with the riverbed and riverbank and wear it away.

Hydraulic action – occurs when the force of the water hits the riverbank and causes air to become trapped and pressurised in cracks, weakening the rock and wearing it away.

Corrosion – occurs when slightly acidic rainwater flows over rocks, such as limestone, and slowly dissolves them.

• Suggested Films

- How Are Rivers Formed?
- Weathering
- How Did the Grand Canyon Form?
- Waterfalls and Gorges

Extension Question

Q4. What is regolith?

Regolith is the loose layer of material which covers the solid rock of the Earth. It is very variable in its composition, and is the product of weathering and decomposition of the underlying rock. Soil is the uppermost layer of regolith in many regions, and is composed of rock particles, new minerals formed by weathering, and decomposed organic matter. Regolith can also include materials such as alluvium, organic compounds and salts, and sand, mud and silt can be referred to as transported regolith. The thickness of the regolith depends partly on climate; regolith is thick where chemical weathering is intense (for example, in hot, humid regions) and thin in deserts.

• Suggested Activity

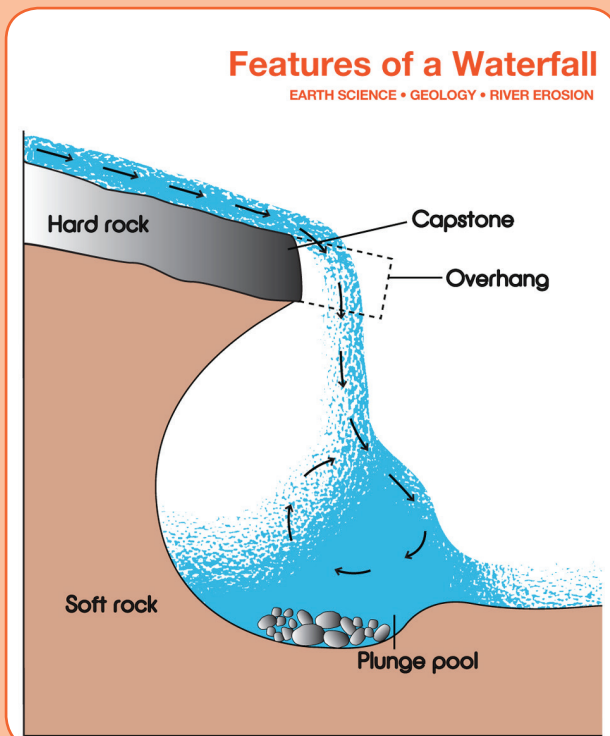
- Ask the students what evidence of weathering they can see on the school buildings. Suggest they look for steps that have been worn away, flaking brick surfaces, moss growing on north facing walls etc

Section 2: River Features

• How do waterfalls and gorges form?

Both waterfalls and gorges are landscape features associated with the upper course of a river. As water encounters rock of varying hardness, the riverbed will be eroded at different rates by the relative processes of erosion, and create rapids. A waterfall is formed when the river encounters a sudden change in rock hardness, usually where hard rock lies on top of softer rock. Softer rock is eroded at a faster rate than the harder rock, and this forms a 'step' over which the water begins to fall vertically. This serves to speed up the erosion at that point, further eroding the softer rock and undercutting the harder rock until an overhang forms. Eventually the overhang collapses and this process repeats. Over time, a steep-sided gorge will form as the waterfall retreats upstream.

DIAGRAM 02:



Extension Question

Q5. What is scree?

Scree is an accumulation of broken rock fragments resulting from weathering and erosion processes acting on a cliff face. It typically accumulates at the base of a cliff or steep slope, and the slope of the accumulated material is known as the angle of repose; this configuration is very unstable, since small changes in environmental conditions can cause fragments to move down slope. Scree is generally angular because it is often created by physical weathering processes which detach angular fragments from the landscape above. Scree deposits are often sorted or stratified, since the larger detached fragments can travel further down slope, while the smaller blocks are stopped and trapped upslope. Scree is therefore a direct product of weathering and is just one illustration of how the products of weathering can accumulate when erosion processes are unable to transport the material away.



Waterfalls form when a river erodes a softer layer of rock beneath a harder layer, creating an overhang

• Suggested Film

- Waterfalls and Gorges

• How do meanders and oxbow lakes form?

As the river moves onto flatter land, it generally has more water and energy than it did in the mountains, and it flows more smoothly and more quickly. The river tends to erode laterally (sideways), which widens the river, but differences in speed at different places cause the river to move from side to side. This erosion creates bends in the river, which are called 'meanders'. Water tends to flow more quickly around the outside of the bend, eroding it further, and the slower flow on the inside of the bend can lead to deposition.

Over time, this leads to a larger bend, which can eventually be separated from the main channel at periods of high flow. These cut-off meanders are called 'oxbow lakes'.

These features are part of the river's constant adjustments, as it tries to flow as efficiently as possible, transferring water downhill towards the sea.

• Suggested Film

- Meanders and Oxbow Lakes

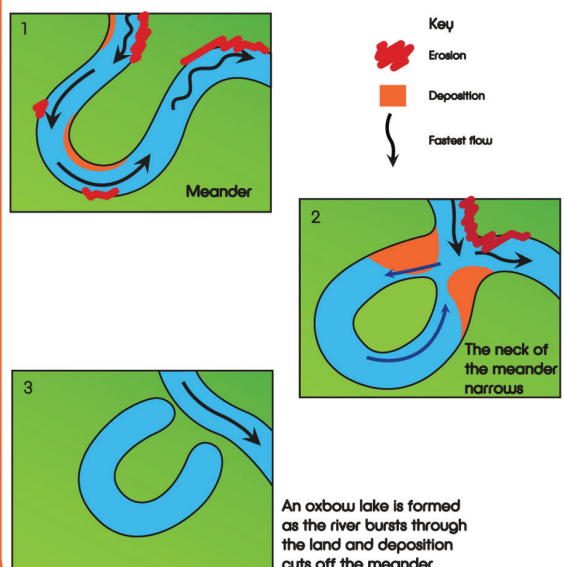


Over time, river erosion and deposition means the neck of the meander gets narrower. This may eventually cut the loop off to form an oxbow lake

DIAGRAM 03:

Twig Formation of an Oxbow Lake

EARTH SCIENCE • GEOLOGY • RIVER EROSION



• What are floodplains, levees and deltas?

Near the end of the river course, the volume of water will be at its greatest and the energy of the river is used to transport a large volume of sediment. This sediment is made up of rocks that have been ground down by abrasion while they have been in the river, or soil that has been washed in from the surrounding land.

Floodplains are the large flat areas on either side of the river channel, which form when the river overflows its banks and deposits its suspended load. The heaviest material is deposited first and can form raised areas near the channel; these are called 'levees'. Levees are sometimes strengthened to act as flood defences, such as those found along the Mississippi River in the USA.

The fine silt that makes up a lot of the river's load is not dropped until the water escapes the channel, or reaches the sea. At this point, the forward movement of the river is stopped, and all the remaining sediment is deposited in the shallow water in the delta. This may be shaped in various forms, although the classic delta is named after the Greek letter of the same name (Δ) and is usually triangular in form, such as that of the River Nile in Egypt.

• Suggested Film

- Depositional Features

• Suggested Activity

- Ask the students to research the ecology of river deltas and estuaries. Ask them to then write a 500-word report about the species native to these ecosystems.

Section 3: Rivers and People

• How do people use rivers?

As rivers are excellent sources of freshwater, settlements tend to be built close to them, particularly where there is a shallow point (a ford) or a permanent bridge structure. Historically, rivers were an important energy source for early settlements, they also offered a defensive advantage, particularly where the river may have cut through the land to leave an area within a meander that is higher than the surrounding area. Durham is one example of a city location like this.

Rivers around the world are used for drinking water, washing, transport, fishing and recreation. Building a dam across a river valley can provide hydroelectric power, and the floodplain provides fertile soils for growing crops.



Dams situated on rivers trap water and then release it under pressure, passing it through turbines which are connected to generators

• Suggested Films

- Populating the World: Physical Factors
- Water As a Resource
- Hydropower

• Suggested Activity

- Ask the students to look at a map and try to identify settlements whose development was shaped by a river. The particular words to look out for are bridge or ford. What other words on the map also relate to water?

• Why do people live on floodplains?

A floodplain is the flat area of land that lies immediately on either side of a river channel. Floodplains are created over time by the river's movement, which eventually erodes the higher ground. A line of higher ground, called a 'bluff', often marks the floodplain's edge. It is useful to live near the river to reduce the travelling distance to a freshwater source, but this increases the flood risk.

Another benefit of living on floodplains is that the soil is often very fertile, which is ideal for farming and growing crops. In an area such as the Pantanal in Brazil, farming is only possible in the floodplain, as dry regions surround it.

Flooding can be a problem for people who live near to rivers, so it is important to weigh up both the benefits and risks of living in such areas. Small floods are beneficial, as fertile alluvium is deposited on the floodplain, but large floods can cause extensive damage to homes and communication networks. Bangladesh is largely made up of a river floodplain, and as a result it is very low lying and prone to flooding. It also lacks rock resources that could be used for flood defences.



When a river breaks its banks it leaves behind layers of sediment, which build-up over time to create the flat floor of the floodplain

• Suggested Film

- Depositional Features

• How is our relationship with rivers changing?

Traditionally, rivers were important in settlement location as they provided a source of fresh water, transport links, and were often trading centres. The River Thames in London, for example, supplied the city's population with water and industry links for centuries. However, developments in technology and engineering have meant that rivers are no longer an influential factor in settlement location. Water systems ensure that clean water is piped to every home and business for domestic activities and industrial processes, and road and rail infrastructure takes precedence over waterways for transport. In rural settlements, agriculture has also benefitted from the supply of fresh water for irrigation and no longer needs to be located within the flood basin of rivers.

Today, rivers are more frequently used for leisure and tourism, and to provide a source of renewable energy. Hydroelectric power production involves the damming of large, fast-flowing rivers, such as the Columbia that stretches from the Canadian Rockies to Washington State, USA. The building of dams does however have a negative impact on river ecosystems and can lead to over-vegetation and destroy habitats.

In Less Economically Developed Countries (LEDCs), many people live and earn a living through farming within floodplains and deltas. Rivers in LEDCs often have multiple functions and are used for drinking water, washing, sewage disposal, fishing and transport, for example the River Ganges which runs through India and Bangladesh.

Rivers are also seen as a potential problem, as flooding can result in damaged homes, loss of belongings, loss of life and damage to the local economy. LEDCs are more greatly affected by river flooding due to the number of farming communities located on floodplains and the lack of resources available to respond to such events.

• Suggested Activity

- Ask the students to research and respond to the following questions: Where and what is your nearest river?

How do people use your local river?

• Quizzes

Weathering

Basic

• Rock is not worn away by which of the following?

- A – wind
- B – cloud
- C – water
- D – sand

• Which of the following is not a type of weathering?

- A – physical
- B – biological
- C – fiscal
- D – chemical

• Rainwater is naturally

- A – acidic
- B – slightly alkali
- C – neutral
- D – strongly alkali

Advanced

• Rainwater is naturally acidic because it has absorbed

- A – oxygen
- B – nitrogen dioxide
- C – hydrogen
- D – carbon dioxide

• The removal of rocky material is known as

- A – erosion
- B – mineralisation
- C – crystallisation
- D – eruption

• Breakdown of rocks into smaller pieces is known as

- A – swash
- B – mineralisation
- C – weathering
- D – petrification

• Which does not cause physical weathering?

- A – roots
- B – sponges
- C – driftwood
- D – sea urchins

• Answers

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