

Unit 1 Weathering

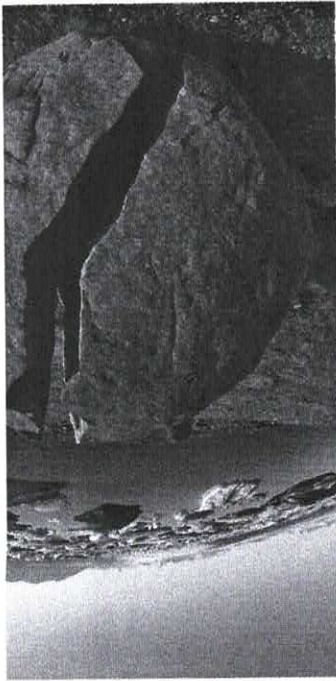
Concept of weathering

Weathering is a continual process that breaks down solid rock into smaller parts until fine particles, such as sand, are formed. Weathering happens on site. There is no removal of rock material in the process. The tiniest granules that are formed by the breakdown of the rock contain the same mineral and chemical composition as the massive solid rock from which they come. We recognise three different types of weathering processes.

Types of weathering

Type	Description
Physical	Temperature extremes and pressure within the rock
Chemical	Chemical change and breakdown of rock material in the presence of water
Biological	Break-up of rock by the action of plants and animals

The weathering that happens is often a combination of two or more of the types shown above. For example, plants may grow between rocks and in the cracks formed by split rocks, and help to break down the rock physically by forcing the rock apart. The plant and its roots may give off chemicals which react with the rock and change the minerals within the rock, speeding up the weathering process. This is a combination of biological and chemical weathering.



Granite rock is made up of quartz and feldspar minerals. When the surface of granite is exposed, weathering breaks up the rock into these separate mineral parts. Splitting of rock along a crack, caused by extreme temperature

Activity 1.1

What is weathering?

Where in the world would the rate of weathering be greatest?

Suggest why the rate of weathering for rock covered by soil and vegetation is slow.

What factors contribute to weathering in a desert area?

Did you know?

In tropical areas the hot and wet conditions help chemical weathering of rocks to a recorded depth of 60 m.

Factors that accelerate the weathering process	
Factor	Explanation
Rock size	A small particle weathers more quickly than a large particle.
Mineral composition	Rocks are made up of minerals that have different levels of resistance to break up.
Cracks and joints	Cracks are weak points in a rock that plants and animals, or water, can enter.
Exposure	Rocks need exposure to the elements of weather.
Temperature differences	Expansion and contraction of the rock occurs, creating physical stress.
Freezing and thawing	Ice expands. When it melts, it contracts.
Steepness of exposed slope	Rock is exposed to the elements of climate.
Moisture and wet conditions	Chemical weathering needs water and heat.
Vegetation	Roots widen cracks in rocks; chemicals are released that speed up weathering.
Human activity	Pollution, gases, deforestation, farming and animals can expose rock surfaces and speed up the weathering process.

Speed at which weathering occurs is affected by a number of factors.

Unit 1 Weathering

Word bank

A B C

Frost shattering physical breaking of pieces of rocks by repeated freezing and thawing of water and spaces in the rocks
scree weathered material that collects at the base of a slope
weathering the breaking down of rocks and soil by the action of weather

1. Concept of weathering

All things on the surface of the earth are affected by the action of the weather. Weathering describes all the processes that break down rocks, soil, and other objects on the earth's surface. Weathering happens in one place. We can see the effects of weathering on constructed features such as buildings.

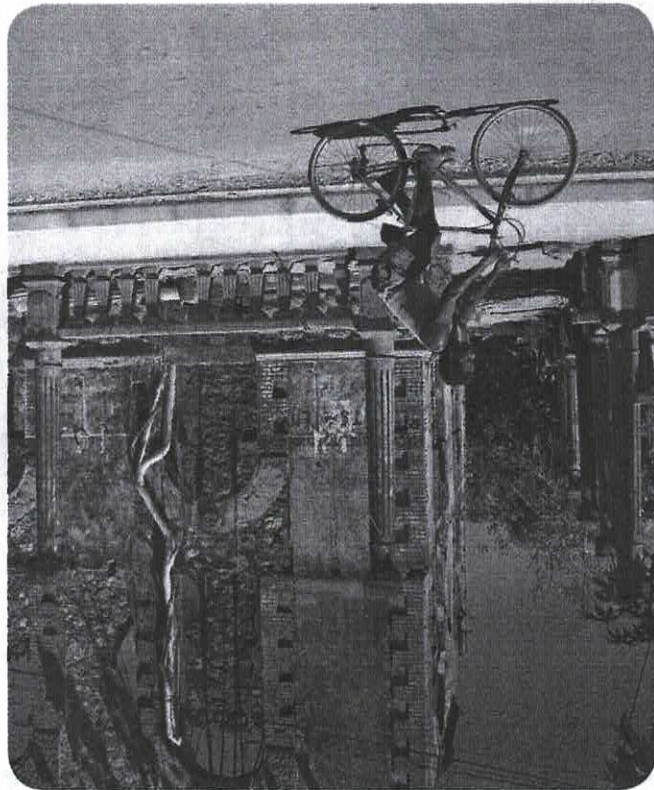
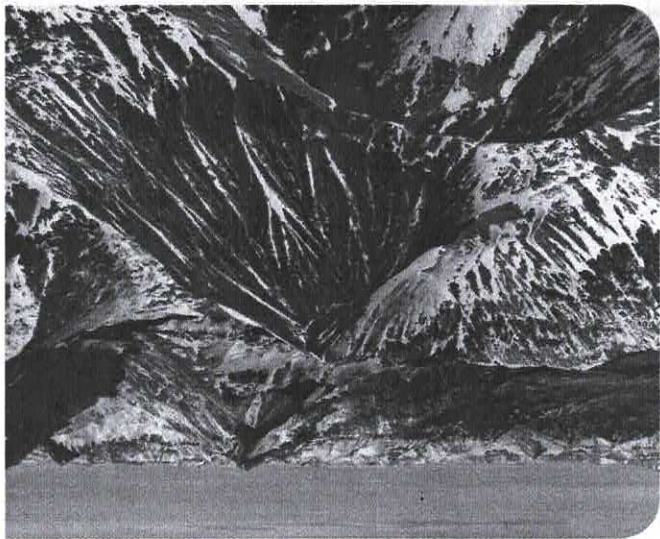
Some of the ways weathering affects buildings:

- Sun causes the paint to peel.
- Rain makes metal objects rust.
- Hot and cold temperatures weaken surfaces.
- Plants break up the bricks.

Weathering has affected these buildings.

Weathering of rocks and soil is very slow compared to a human lifetime. You are unlikely to notice many changes caused by weathering to rocks in your lifetime. The rocks in the photograph on this page are being slowly weathered by the action of rain, frost and ice.

Temperature and water are the main causes of weathering.



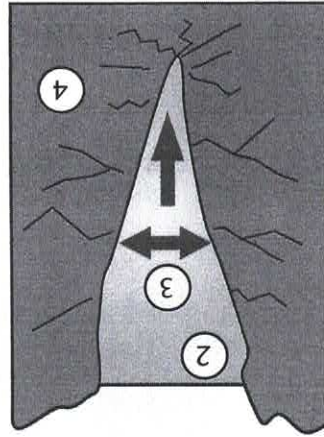
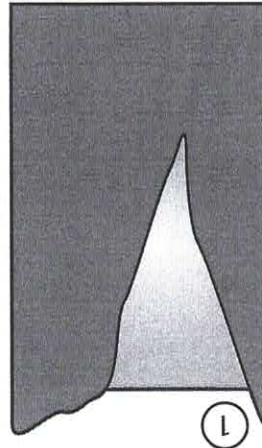
Physical weathering

Physical weathering happens when a physical force breaks rocks into small pieces. Small physical weathering removes grains of rock one grain at a time. Large scale physical weathering causes large pieces of rock to break away from mountains and crash down the mountains. Temperature and water are the main causes of physical weathering. Cold, wet conditions increase physical weathering. The most common kind of physical weathering is frost shattering.

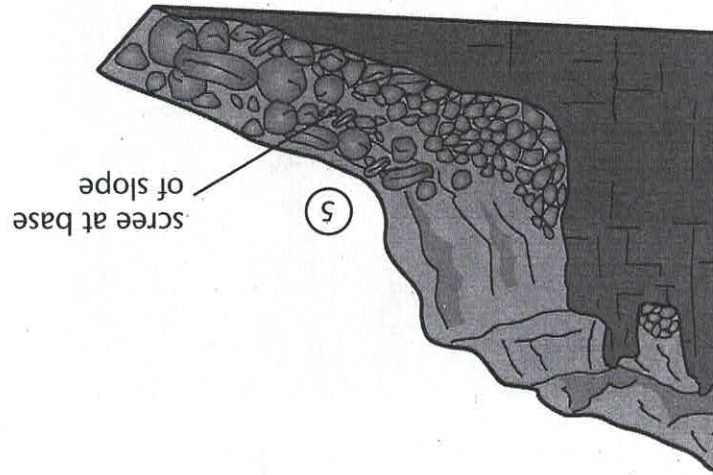
Frost shattering

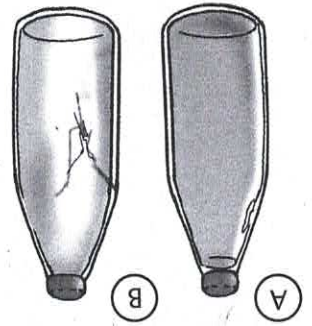
Frost shattering is caused by the constant freezing and thawing of water in cracks in rocks. Frost shattering occurs mostly in mountain areas where temperatures often drop below freezing. It takes up about 10% more space than water. The expanded ice puts pressure on the cracks in the rock, causing them to expand and contract. This repeated expanding and contracting of water and ice weakens the rock, causing small pieces to shatter and fall off. Small rock pieces collect at the bottom of a slope as piles of loose rock called scree.

Frost shattering occurs in mountainous areas which experience freezing and thawing of water in cracks in the rocks. These diagrams illustrate this process.

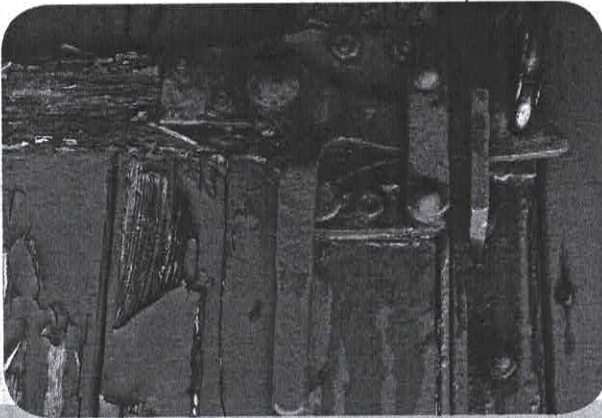


1. Water collects in cracks in rocks.
2. Water at the top of the cracks freezes first to form a 'cap' of ice.
3. Ice has to expand sideways.
4. Pressure from ice weakens the rock.
5. Rock pieces eventually fall off.





A. Glass bottle full of water
 B. Water in glass bottle freezes to become ice
 A bottle of water before and after being in a freezer for eight hours



Paint peeling off a surface is a kind of exfoliation

Work with a partner. Examine the drawings of the two bottles of water on this page.

- a) What has happened to the water in bottle B?
 b) What causes water to expand?
 c) Why did the water not expand upwards?
 d) What would happen to the bottle if the ice was allowed to thaw (melt)?
- Use the example of the bottle to describe the process of frost shattering. Compare the bottle to part of a rock.
- Examine the diagram on page 55. Explain why the ice in a crack in a rock does not expand upwards.
- Look at the photograph on this page showing paint peeling off a piece of wood. Explain how it demonstrates the physical weathering process of exfoliation. Use the words 'temperature' and 'layers' in your answer.

Classroom activity 3.1

Exfoliation is common in hot dry climates with big temperature ranges between day and night.



- Extreme daytime heating causes the outer rock layers to heat up and expand away from the cooler internal parts of the rock. At night, when the temperature drops quickly, the outer layers of rock cool and contract. The constant expanding and contracting weakens the outer layers of the rock. Eventually the outer layers flake off.
- Exfoliation is also a kind of physical weathering caused by big day and night temperature changes such as those in desert and semi-desert areas. 'Exfoliation' means shedding or casting off in layers. This is what happens to rocks affected by this type of weathering:

Exfoliation

carbonation a chemical weathering process that affects limestone rocks
composition what something is made up of
oxidation weathering that happens when oxygen from the air dissolves in water and combines with chemicals in rocks to form oxides
oxides chemicals formed when minerals such as iron mix with oxygen in the air

Word bank

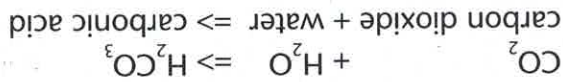
A B C

Chemical weathering

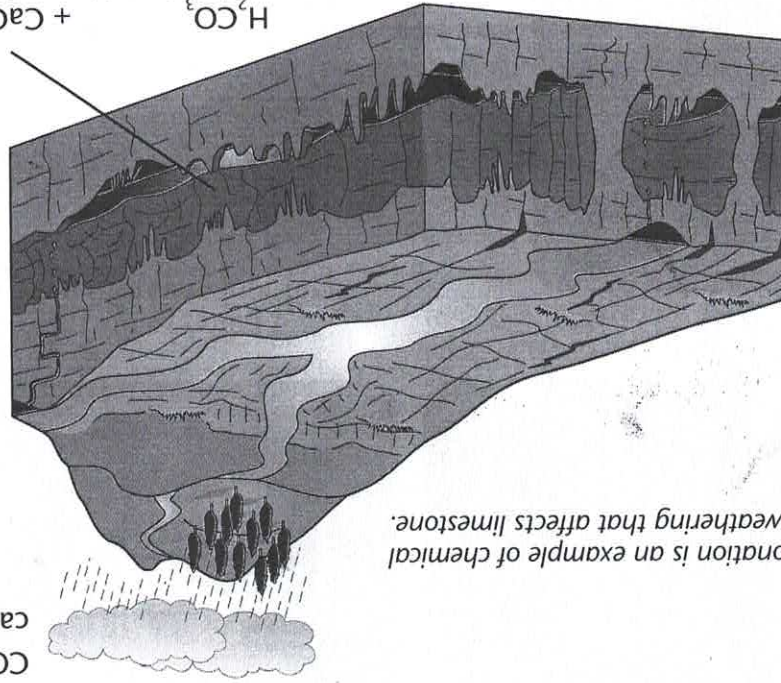
are made up of different minerals. Different minerals have their own chemical composition. Chemical weathering changes the chemical composition of the rocks. This weakens rocks, causing them to break up and wear away. Examples of chemical weathering are carbonation and oxidation.

Carbonation – an example of chemical weathering

As rain passes through the atmosphere it mixes with chemicals to make weak acids. For example, rain combines with carbon dioxide to make carbonic acid. Carbonic acid attacks a mineral called calcium carbonate. Calcium carbonate is the main mineral in certain kinds of limestone rock. Carbonic acid changes calcium carbonate into a mineral called calcium bicarbonate. Calcium bicarbonate is soluble. This means it is washed away in water, causing weathering in the process. This process is called carbonation. Carbonation can produce very interesting cave features.



- Water seeps through cracks and joints in the rock.
- Carbonation dissolves rocks, forming caves and underground rivers.

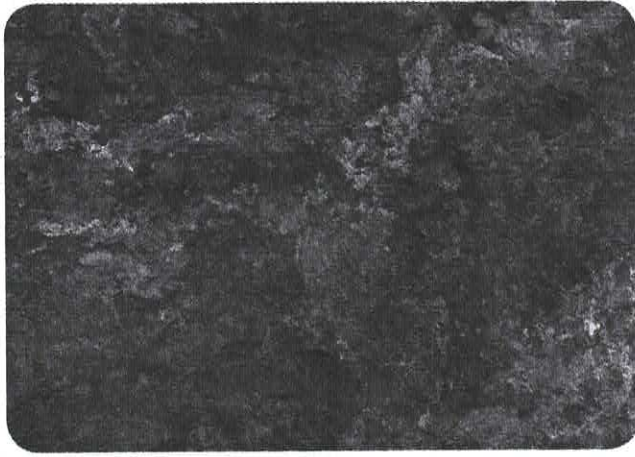


Carbonation is an example of chemical weathering that affects limestone.

Oxidation

Oxidation is another kind of chemical weathering. It occurs when oxygen from the air dissolves in water and combines with iron in the rocks to form iron oxides. If the rock contains a lot of iron, then oxidation causes a brown material called iron oxide to form on the rock. Oxidation weakens rocks and causes them to crumble.

Oxidation is a chemical process that weakens rocks.



Homework activity

- You will need a piece of chalk, some vinegar and a small bowl to do this experiment.
1. Leave a piece of chalk in a small bowl of vinegar for 30 minutes. Chalk contains calcium carbonate. Vinegar is a weak acid. Observe what happens to the chalk.
 2. Consider how this experiment illustrates the chemical weathering process of carbonation. Write a paragraph to explain how carbonation causes rocks such as chalk and limestone to wear away. Include the words 'calcium carbonate', 'carbonic acid', 'minerals', 'soluble' and 'caves' in your answer.
 3. Look around your school grounds or local area for an example of biological weathering.
 - a) Draw a picture of your example.
 - b) Explain the biological weathering processes that your example illustrates.



Lichens and plants make weak acids that cause minerals in rocks to break down.

Decaying remains of dead plants in soil may form organic acids which, when dissolved in water, cause chemical weathering. Animals burrowing into the soil can also weaken rocks or expose rocks and soil to physical and chemical weathering.

Plants and animals may release chemicals that cause chemical weathering. For example, tiny plants called lichens grow on rocks. Lichens produce a dilute, acidic solution that causes some minerals in rocks to break down. The tiny roots of lichens also physically break small grains off rocks. An experiment in the United States noted that weathering on rocks covered with lichens was three to four times greater than weathering on bare rocks.



Biological weathering is weathering caused by the action of plants and animals. You may have seen weeds growing in cracks in roads and concrete. As these roots grow they break up the soil and can cause rocks and pavements to split and break up as well.



Roots of plants and trees can break rocks and concrete.

4. Biological weathering

biological to do with living organisms
decaying rotting; breaking down after dying
dilute weak solution; not strong or concentrated
lichens tiny plant organisms which exist together in a way that benefits each other



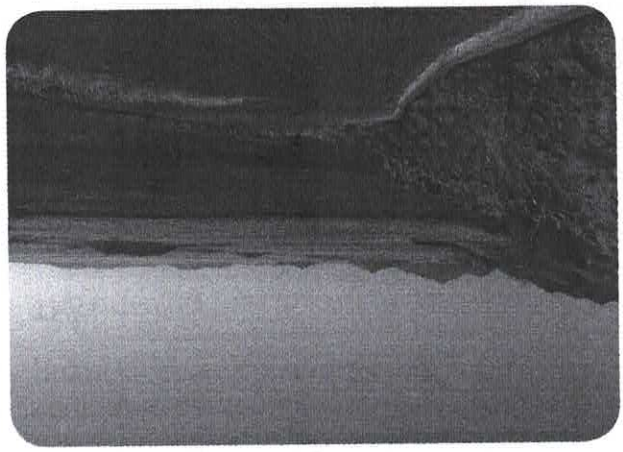
Word bank

The impact of human activities on weathering

of the following human activities can increase chemical and biological weathering: building settlements, taking farms, digging mines, building roads and railways.

Impact of human activities on physical weathering

Physical weathering involves the action of forces that break rocks and soil into smaller particles. For example, mine shafts and tunnels are dug through rocks, causing them to break and collapse. Road building involves moving thousands of tons of soil and rock. A new road exposes rocks and soil to physical weathering processes such as frost shattering and exfoliation.

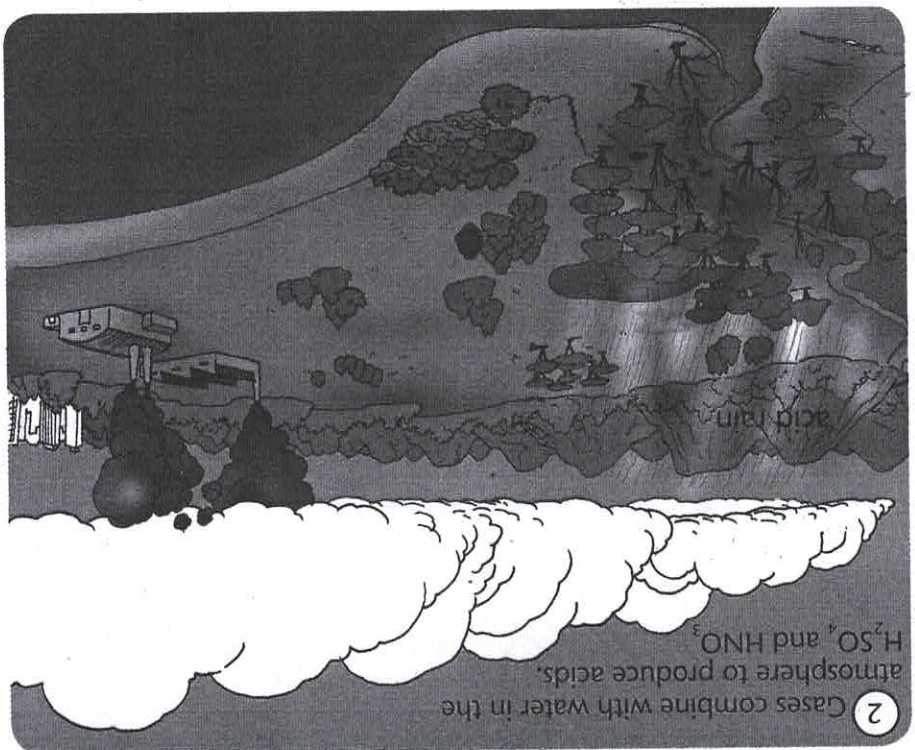


Rocks and soil are exposed to weathering during road building.

Impact of human activities on chemical weathering

Chemical weathering occurs when chemical reactions break down rocks. One major cause is acid rain. Acid rain is formed when pollutants like sulphur dioxide and nitrogen dioxide are released into the air. These gases combine with water in the atmosphere to produce acids like sulphuric acid (H_2SO_4) and nitric acid (HNO_3). When it rains, these acids fall to the ground and react with rocks, causing them to dissolve. This process is called chemical weathering. Acid rain can damage buildings, statues, and plants. It also increases the acidity of lakes and rivers, which can harm fish and other aquatic life. Constructed features like stone buildings and statues are also affected by the effects of acid rain.

1 Industries and cities produce sulphur dioxide (SO_2) and nitrogen oxide (NO_2).



Acid rain is caused by chemicals released into the atmosphere from human activities.

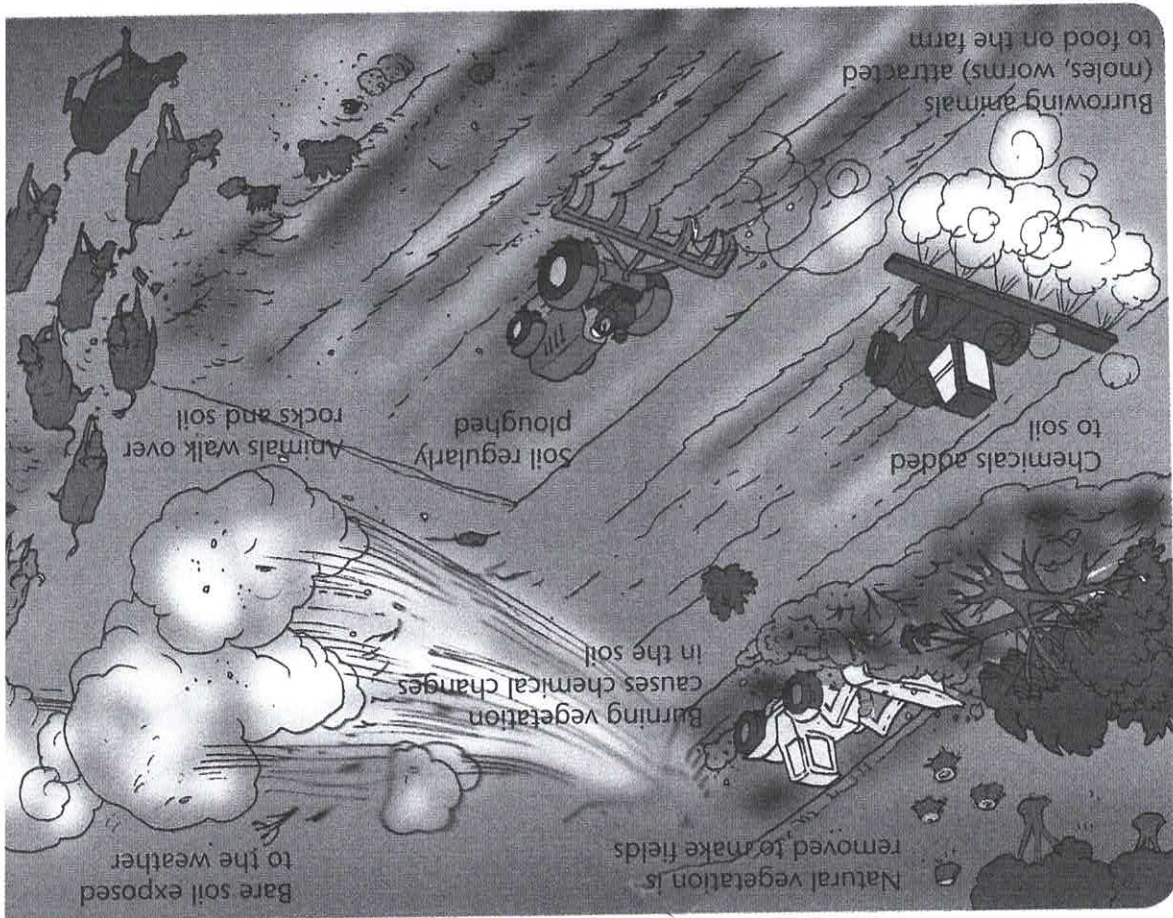
acid rain
plants,
lakes and
chemical
weathering.

Classroom activity 3.2

Work on your own and answer these questions.

1. Give three examples of ways in which human activities speed up weathering.
2. Make your own diagram with arrows to show how the following words and phrases are connected to each other in the process of acid rain: 'sulphur dioxide', 'acid rain', 'burning fossil fuels', 'weak sulphuric acid', 'damage to the environment'.
3. a) Identify three biological weathering processes in the diagram of the farm above.
b) Describe some of the effects of these examples on the land.
4. a) Identify two other kinds of weathering in the diagram.
b) Explain how these examples could affect the environment.

How farming causes increased biological weathering as well as other kinds of weathering



Impact of human activities on biological weathering

Many human activities can increase biological weathering. For example, making a vegetable garden exposes rocks and soil to attack from all three kinds of weathering: physical, chemical and biological.

The drawing that follows shows how farming speeds up different kinds of weathering.