8 Weathering

In this chapter you will answer...

- What is the difference between weathering and erosion?
- When does freeze-thaw weathering happen?
- Which rocks are weathered by carbonation?
- Where does exfoliation occur?
- Why is chemical weathering faster in the tropics?

KEY WORD

Weathering is the disintegration and decomposition of rocks in situ. Changing temperature, rainfall and rock type have an important influence on the type of weathering occurring

8.1 Weathering

Weathering breaks rocks into smaller pieces. It is the effect of rainfall and temperature on rocks. Weathering occurs **in situ**. This means the rocks stay in the same place and are not moved. This is different from **erosion**. Erosion is when rocks are moved around or hit by something moving so that they break into smaller pieces.

KEY WORDS

In situ staying in the same place

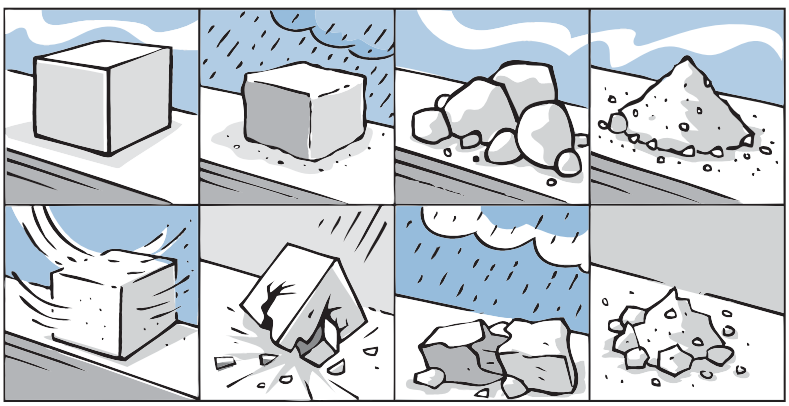
Disintegration breaking into smaller pieces

Decomposition changing the chemicals which make up a rock

8.2 Types of weathering

Rocks can be weathered in three ways:

- **Physical (or mechanical) weathering** causes rocks to **disintegrate**. This means the rocks fall apart into smaller pieces.
- **Chemical weathering** causes rocks to **decompose**. This means the minerals that make up the rock are changed by a chemical reaction.
- **Biological weathering** is when plants cause rocks to break up.



8.1 Weathering in situ compared to erosion by moving agents

Exercise

1 **Using the information above, copy and complete the following table in your notebook.**

Noun	Verb
disintegration	
	to compose
decomposition	
integration	
	to erode
exfoliation	
	to fluctuate

Exercise

2 **Copy and complete the following sentences using words from the box below.**

a As the water freezes it _____ and this makes the _____ wider.

b This freezing and _____ makes the cracks in the rock wider and the rock becomes _____.

c When temperatures _____ above and below 0°C then _____-thaw weathering may occur.

d The ice _____ the crack even more.

e When the _____ drops below 0°C _____ in cracks in the rock will freeze.

f Eventually the _____ falls apart.

g During the next _____ the water in the crack _____ when the temperature _____ below 0°C.

h When the temperature rises again the ice _____ and water fills the cracks.

fluctuate	temperature	melts	water	thawing
widens	freeze	expands	drops	rock
crack	weaker	freezes	night	

3 **Put the sentences above in the correct order to describe the process of freeze-thaw weathering. (Hint: start with c and finish with f)**

8.3 Physical weathering

Physical weathering causes rocks to **disintegrate in situ**. This means the rocks break up. They form smaller pieces of rock with sharp edges. Physical weathering happens when there are changes in temperature over a short period of time. The temperature needs to be **fluctuating**. Two types of physical weathering are **freeze-thaw weathering** and **exfoliation**.

8.4 Freeze-thaw weathering

Freezing is when water becomes ice. This happens at a temperature of 0°C. Water expands when it becomes ice, taking up more space. **Thawing** is when ice turns to water. This happens when the temperature rises above 0°C. **Freeze-thaw weathering** occurs when the temperature keeps fluctuating above and below 0°C. When the temperature drops below 0°C water in a crack in a rock will freeze. The ice thaws during the day when the temperatures rise. The water freezes when the temperature drops again at night and the ice widens the crack even more. This is freeze-thaw weathering.

8.5 Exfoliation

Exfoliation is when pieces of the outer layer of rock breaks away. Exfoliation happens in places where there is a very big difference in temperature between the night and day. This is most common in deserts. During the day in deserts the temperature may rise to over 40°C. At night the temperature may drop to below 5°C. During the day the heat causes the outer layers of the rocks to expand. At night the cold temperature causes the outer layers of the rocks to get smaller and they contract. This makes it weaker until it breaks up.

8.6 Chemical weathering

The **composition** of a rock is the chemicals or minerals that it is made from. Chemical weathering causes rocks to **decompose**. This means the composition of the rocks is changed, because chemical reactions have occurred. Chemical weathering usually needs water from rainfall, and warm temperatures. **Carbonation** and **oxidation** are types of chemical weathering.

8.7 Carbonation

Carbonation is the chemical weathering of **chalk** and **limestone** rocks by rainfall.

Chalk and limestone are made of **calcium carbonate**. When rain falls on chalk and limestone a chemical reaction occurs.

The air contains gases such as **water vapour** and **carbon dioxide**. Water vapour reacts with carbon dioxide to form **carbonic acid**. All rainfall contains carbonic acid. This reacts with the calcium carbonate. The mineral changes and becomes **soluble** in water. This means the rock **dissolves** in rainwater and is washed away. Carbonation is when chalk and limestone are dissolved in rainwater.

KEY WORD

Chemical reaction the response of one chemical to the addition of another chemical

8.8 Oxidation

Oxidation is a chemical reaction between some minerals in rocks and the **oxygen** in the air. Oxidation changes iron minerals in rocks from a light grey colour to a brown-red colour. This is called **rusting**. The change in colour shows the change in the composition of the rock. This chemical reaction causes the rock to break up.

Exercise

4 Cause and effect. Match the starter sentences with their endings. Copy the completed sentences into your notebook.

a Chalk and limestone dissolve in rainwater.....	..... because water expands when it freezes.
b Oxidation turns iron minerals a brown-red colour.....	..... because there is a big difference between night and daytime temperatures.
c The cracks in rocks get wider.....	..... because chemical weathering has occurred.
d Exfoliation occurs in deserts.....	..... because rainwater contains a weak carbonic acid.
e The mineral composition of rocks may change.....	..... because the minerals react with oxygen in the air.

8.9 Biological weathering

Biological weathering is when plants cause rocks to break up. The **roots** of plants cause rocks to disintegrate. Plant roots grow down through soil and rocks to find water and minerals. The roots can grow through cracks in rocks to find **groundwater**. As the roots grow the cracks are made wider and eventually the rock breaks up. Dead plants can cause chemical weathering. The plants produce acids when they rot. These acids may cause a chemical reaction in the rocks.

8.10 Climate and rate of weathering

Climate is the average rainfall and temperature of a place over a long period of time.

The **rate** of weathering is the speed of weathering. Heat causes chemical reactions to occur faster. Most chemical weathering needs

KEY WORDS

Climate the average rainfall and temperature of a place over a long period of time

Mineral composition the different minerals (chemicals) which make up a rock

Sedimentary rock rocks formed by layers of sediment under water

Igneous rock rock formed by magma or lava cooling

rainfall. Chemical weathering occurs fastest where it is warm and there is a lot of rainfall. This means chemical weathering will occur quickly in warm, wet places such as rainforests in the **tropics**. In cool, wet places chemical weathering will occur slowly, for instance in Britain and New Zealand.

Physical weathering occurs fastest in places where temperatures rapidly fluctuate over a

short time. Rainfall is not always necessary. Freeze-thaw weathering occurs most rapidly where temperatures fluctuate just above and below 0°C over a short time. Rainwater is needed. Exfoliation happens most rapidly where there are large changes in temperature between night and day. It does not need rainfall.

Exercise

5 Are the following statements true or false? Copy the correct statements into your notebook.

a Chemical weathering occurs fastest where temperatures rapidly fluctuate.
b Chemical weathering occurs fastest in warm, wet places.
c Chemical weathering does not happen where it is cold and wet.
d Tropical areas such as the rainforest will experience the most chemical weathering.
e Limited physical weathering occurs in tropical areas where there is little change in temperature.
f Physical weathering occurs quickly in deserts.
g Rainfall is needed for weathering to occur.

8.11 Rock type and mineral composition

Certain rock types are made up of different minerals. This is the **mineral composition** of the rock. Certain rock types are more affected by certain types of weathering. Limestone is composed of calcium carbonate. This means that it can be weathered by carbonation. However granite is not affected by carbonation as it does not contain calcium carbonate. Rocks containing iron minerals will be weathered by oxidation.

8.12 Rock type and lines of weakness

Lines of weakness are cracks in rocks which are attacked by weathering. Water and air can enter these cracks and break down the rock by physical or chemical weathering. A rock with lots of lines of weakness will be more easily weathered. Chalk and limestone are **sedimentary** rocks. They are formed in layers. Each layer is separated by a **bedding plane**. These are horizontal lines of weakness in the rock. There are also vertical lines of weakness called **joints**. Rain water flows through limestone through the joints and bedding planes. The rock is weathered by carbonation. Limestone **caves** are formed by carbonation. **Granite** is an **igneous** rock. It is formed when **magma** slowly cools as it rises towards the surface of the earth. As it cools horizontal bedding planes and vertical joints form. These are lines of weakness in the rock. Granite is weathered to form **tors**.

Language

Verbs in formal and informal English

In English there is often more than one way to express the action of a verb. **Phrasal verbs** are used frequently in informal (everyday) conversations, while one word verbs tend to be used in formal or technical language.

Informal = the match was **put off** until the following Saturday because the pitch was flooded.

Formal = The match was **postponed…. (prefix post-** = **after)**

[Hint: the one word verbs often have prefixes that make their meaning more precise so it is helpful to know the meanings of the prefixes.]

Prefixes: com- = bringing or putting together
de- = undoes the action of the stem verb
dis- = moving away (opposite meaning to the stem verb)
ex- = moving out of/away

Exercise

6 **Copy the table below into your notebook and match the phrasal verb with the correct verb in the following table.**

Phrasal verb	One word verb
To work together	To destabilise
To break up	To exfoliate
To change the make up	To dissolve
To make up	To combine
To make unstable	To expand
To lose a layer	To decompose
To absorb into liquid	To disintegrate
To spread out	To compose

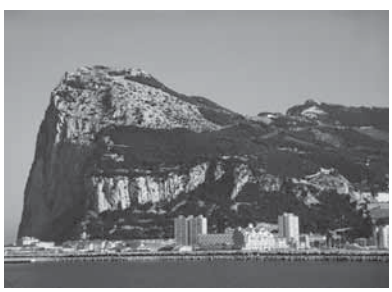
Exercise

7 **Copy the sentences below into your notebook and put the appropriate verbs from the table above into the correct form.**

a Freeze-thaw weathering _____ the cracks as water becomes ice.
b The calcium carbonate in limestone is _____ by the carbonic acid in rainwater.
c When a plant dies it _____ producing chemical reactions in the surrounding rock.
d Granite rocks _____ in climates which fluctuate rapidly above and below 0°C.
e Physical, chemical and biological weathering often _____ to weaken sedimentary rock.
f Sedimentary rock is _____ of layers of sediment, while igneous rock is _____ of cooled magma from the earth's mantle.
g Rocks _____when they have been weakened through physical weathering.

Exercise

8 **Look at the following photos and match them to the descriptions below.**



a Enchanted Rock in Texas is a granite dome. Cracks in the granite have allowed rainwater to enter and weaken the rock. Vegetation has also contributed to the weathering. The outer layer of granite has been separated from the lower layers.

Fluctuating temperatures have caused the joints in the surface layer to widen. In places the top layer of rock has broken away and disintegrated along the vertical joint lines.

b The Rock of Gibraltar towers over the western end of the Mediterranean. It is composed of limestone. To the west and south there are more gentle slopes but to the north and east the rock face rises sheer to 426m above sea level. Rainfall has seeped down through the joints and bedding planes in the limestone. Weathering has formed over 100 caves in the rock. In the caves stalactites and stalagmites have formed.

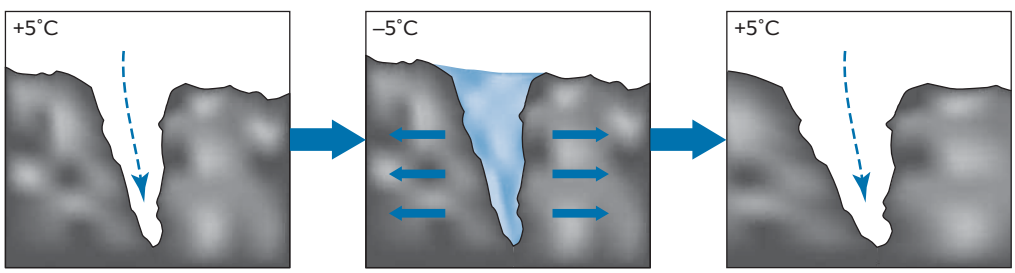
c Uluru is a massive mound in the desert of Central Australia. It is formed of sandstone. It is 8km round and rises 348m above sea level. The rock has been weathered so iron minerals in the sandstone cause the rock to appear red. The high daytime temperatures can reach over 40°C and contrast with the low temperatures at night which can drop to below 0°C. This rapid change accelerates physical weathering.

9 **Copy and complete the table below using the previous information.**

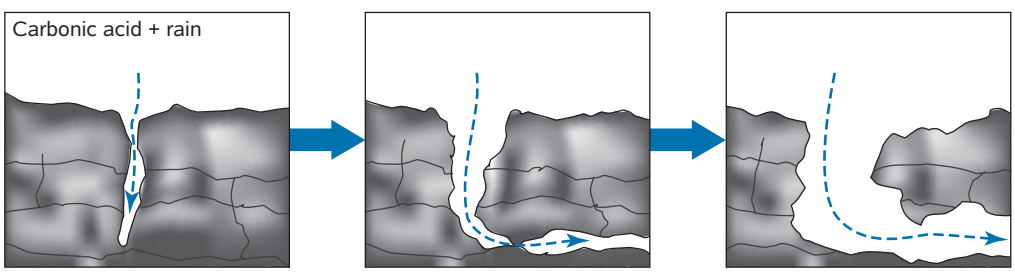
Location	Rock type	Appearance	Weathering processes?
	Granite	Sheets of rock breaking up on the surface	
	Sandstone	Red isolated mound	
	Limestone	Sheer rock faces; caves	

Exercise

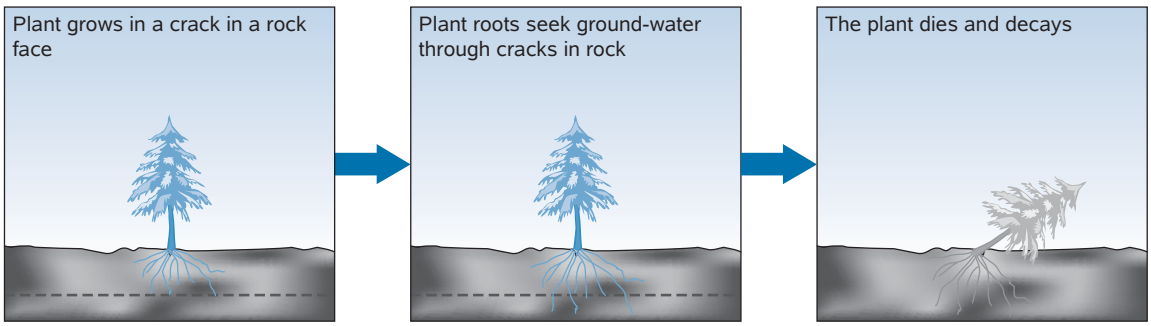
10 **Which of the flow diagrams below illustrates physical weathering, chemical weathering and biological weathering?**



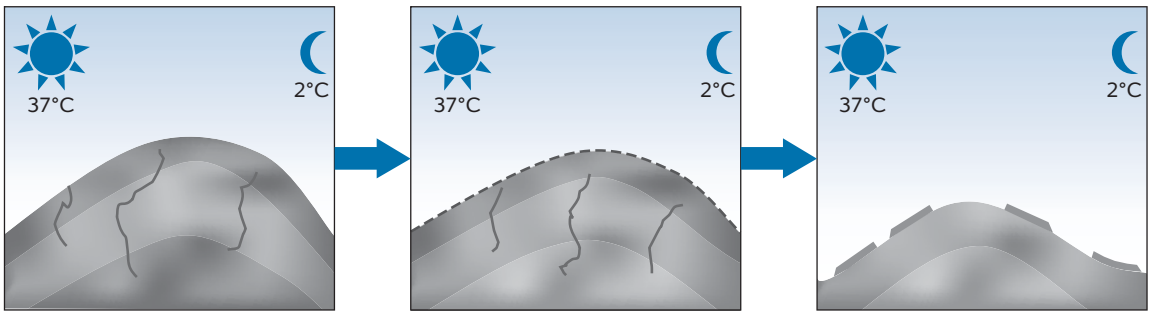
8.2 Weathering process A



8.3 Weathering process B



8.4 Weathering process C



8.5 Weathering process D

11 **Study figure 8.2 and answer the questions below in your notebook.**

a Where is the rainwater going?
b What happens when temperatures fall below 0°C?
c Why has the crack widened?
d What effect will this have on the rock?
e Which process does this flow chart illustrate?

12 **Study figure 8.3 and answer the questions below in your notebook.**

a What kind of weathering is this?
b How does this kind of weathering affect the rock?
c Which climates speed up this kind of weathering?

13 **Study figure 8.4 and answer the questions below in your notebook.**

a What happens to the crack as the roots get bigger?
b What kind of weathering is this?
c When the plant dies the roots decay and chemicals are produced. What kind of weathering does this process cause?

14 **Study figure 8.5 and answer the questions below in your notebook.**

a Are the changes in temperature gradual or rapid?
b In which regions do these fluctuating temperatures often occur?
c Where are the points of weakness in the rock?
d What is this weathering process called?
e Which types of rock are affected by this process?

Exercise

15 **Fill in the missing words in the following sentences and copy into your notebook.**

a Carbonic acid is present in _____.
b Carbonation causes limestone to _____ and be washed away.
c Caves form in _____ by carbonation.
d Freeze-thaw is a type of _____ weathering.
e When the top layer of rock becomes detached from lower layers it is called _____.
f _____ lines of weakness in rocks are called bedding planes.
g Joints are the _____ cracks in rocks.
h The reaction of oxygen with minerals in rocks causes _____.
i Granite is an _____ rock which is not weathered by carbonation.
j Plant roots grow down through cracks in rocks to find _____. _____, thus widening the cracks and causing biological weathering.
k _____ dead plants produce acids which cause chemical weathering.

Exercise

16 **Choose the correct options form the statements below. Copy the correct sentences in your notebook.**

a Weathering is different from erosion because it occurs *now and again/between moving objects/in situ*.
b Freeze-thaw weathering needs *fluctuating/constant/low* temperatures.
c Exfoliation is a process similar to peeling a *banana/an onion/an orange*.
d Plants cause *only biological/only physical/both biological and chemical* weathering.
e Physical weathering affects *only sedimentary/sedimentary and igneous/only igneous* rock types.
f Oxidation is a chemical weathering process which makes rocks appear *red/black/white*.

Talking points

Explain the role of a) rainfall and b) temperature fluctuation in the weathering process.

Why is granite a more popular surface for kitchen work surfaces than limestone?

How do plants contribute to the weathering process?

Extension

Internet search: Find out about...

Weathering
Desert rock formations
Exfoliation

Think about the questions from the start of the chapter. Can you answer these now?

- What is the difference between weathering and erosion?
- When does freeze-thaw weathering happen?
- Which rocks are weathered by carbonation?
- Where does exfoliation occur?
- Why is chemical weathering faster in the tropics?