Unit 8G Rocks and weathering

About the unit

In this unit pupils:
- learn about rock texture as one of the key characteristics of different rock types
- model rock texture
- learn about the processes of weathering, erosion, transportation and sedimentation
- relate processes, *eg evaporation and dissolving*, involved in rock formation to processes observed in other contexts
- consider processes operating on different timescales

In scientific enquiry pupils:
- consider how evidence from sedimentary layers and from fossils has led to changes in ideas about the development of the Earth
- frame questions to be investigated
- make qualitative observations, including using time-lapse photography to record gradual changes, evaluating methods used
- present data in an appropriate way
- use scientific knowledge and understanding to explain observations
- investigate a question about sedimentation

This unit is expected to take approximately 7.5 hours.

Where the unit fits in

This unit builds on unit 3D 'Rocks and soils' in the key stage 2 scheme of work.

The two units about Earth science draw on work about pH in unit 7E 'Acids and alkalis', work on evaporation in unit 7H 'Solutions', work on mixtures in unit 8F 'Compounds and mixtures' and work on changes of state in unit 8I 'Heating and cooling'.

This unit relates to unit 2 'The restless earth – earthquakes and volcanoes', unit 7 'Rivers – a fieldwork approach' and unit 8 'Coastal environments' in the geography scheme of work.

The unit provides a foundation for work on the rock cycle in unit 8H 'The rock cycle'. Ideas about weathering are revisited in unit 9G 'Environmental chemistry'. Together with unit 8H 'The rock cycle', this unit lays the foundation for work in key stage 4 on rock formation and deformation and on processes involving tectonic plates.

Expectations

At the end of this unit

in terms of scientific enquiry

most pupils will: describe evidence for a sequence of geological events; suggest a question to be investigated about the movement of sediment and, with help, identify an appropriate approach; use ICT to make and record observations and explain these using scientific knowledge and understanding

some pupils will not have made so much progress and will: describe changes in rocks or rock fragments over time; with help, identify a question about movement of sediment to be investigated and use ICT to make and record observations related to the question

some pupils will have progressed further and will: use evidence from several sources to describe a sequence of geological events

in terms of materials and their properties

most pupils will: describe rock specimens in terms of texture and relate this to properties such as porosity; describe the physical and chemical processes by which rocks are weathered and transported and relate these to features of the environment; describe and explain the processes by which layers of sediments are produced

some pupils will not have made so much progress and will: describe rock specimens and recognise that different rocks have different textures; describe some effects of weathering and recognise sedimentary layers

some pupils will have progressed further and will: relate processes of chemical weathering to the reactions of particular grains with acids; relate sedimentary layers to the processes by which they were produced

Prior learning

It is helpful if pupils:

- know that there are rocks under the surface of the Earth and that soils come from rocks
- can name some examples and uses of rocks
- know that solids, liquids and gases are made of particles and about differences between the way particles are arranged in solids and liquids
- have experience of determining the pH of a solution and relating this to acidity or alkalinity
- know that dissolved solids are left behind when water evaporates

Health and safety

Risk assessments are required for any hazardous activity. In this unit pupils:

- plan and carry out an investigation into sedimentation

Model risk assessments used by most employers for normal science activities can be found in the publications listed in the *Teacher's guide*. Teachers need to follow these as indicated in the guidance notes for the activities, and consider what modifications are needed for individual classroom situations.

Language for learning

Through the activities in this unit pupils will be able to understand, use and spell correctly:

- words and phrases for physical processes associated with rock formation, *eg chemical weathering, abrasion, sedimentation*
- words and phrases for timescales over which change occurs, *eg millions of years, millennia*
- names for specific rocks, *eg granite, limestone, sandstone*
- words and phrases relating to geological features, *eg sedimentary layers, porosity*
- words and phrases relating to scientific enquiry, *eg time-lapse photography, sequence of events*

Resources

Resources include:

- a collection of rocks, either one available commercially or one compiled by the department, *eg conglomerate, sandstone, limestone, chalk, mudstone, shale, slate, marble, quartz, granite, gabbro, basalt, pumice, obsidian*, some of which are typical of their type and some of which have unusual features
- access to pictures, CD-ROMs, internet sites showing geological landscapes and events, *eg volcanic eruptions, both explosive and lava,* and simulations of geological events which occur over many millennia
- examples of fossils or fossilised materials
- materials for modelling rivers
- digital camera for recording changes over a period of time
- secondary sources illustrating the work of Mary Anning

Out-of-school learning

Pupils could:

- read books about the Earth and its history and newspaper articles about weather conditions (floods and high winds) or volcanic eruptions
- watch television programmes or videos about the Earth, which will help them understand how rocks are formed
- visit science museums to see displays about the Earth and its rocks as well as simulations which will help them to imagine the effects of earthquakes and the forces involved
- visit other museums and art galleries to see how rocks are used
- read science fiction texts about earlier geological ages
- visit the seashore to observe shingle, sand, river estuaries and cliffs, or hills to observe peat and rock formations, *eg limestone pavements*

1	Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
What are rocks made of?				
	• that rocks are usually made up of a mixture of mineral grains • that two main textures can be recognised • how to use experimental evidence and models to explain the texture of different rocks	• Show pupils samples of rocks and ask them to sort them into groups. Ask them to explain the basis for their groups, prompting if necessary by asking questions, *eg What makes the rock shiny? What can you see in the rock? Is the rock all the same colour?* Ask pupils to record key responses. Discuss with them the words/observations that occurred most frequently. • Provide pupils with samples of granite and sandstone and ask them to explore their textures, *eg by close observation using a magnifier and by immersion in water*. Ask pupils to explain why one rock produces bubbles in water and the other does not. Investigate the absorption of water by weighing samples before and after immersion to illustrate porosity. Model interlocking and non-interlocking textures, *eg using a three-dimensional block puzzle and marbles,* and relate observations to interlocking and non-interlocking textures. Ask pupils to record and explain their findings using annotated drawings and diagrams. Establish the idea that rocks are almost always mixtures of materials.	• describe rocks as containing different grains which fit together • explain that some grain shapes are interlocking and some are not, *eg some grains fit together and others do not; when the grains don't fit there are spaces and the water goes into these* • relate evidence about porosity to the way in which grains fit together	• Rocks need to be chosen so that pupils will see easily that they are a mixture of different grains. The word most commonly used in their explanations/descriptions may be 'bits'. • Some pupils may not realise that the term 'rock' as used by geologists includes unconsolidated material, such as sand, clay and peat, as well as harder materials. • Differences between mixtures and chemical compounds are considered in unit 8F 'Compounds and mixtures'. • It may be helpful to illustrate porosity using sponges of different kinds.
How does rain cause rocks to weather?				
	• that rocks at the Earth's surface disintegrate through exposure to water in the environment, which causes chemical reactions • how to record results over a period of time • to use knowledge and understanding of the composition of igneous rocks to explain results of changes over time	• Take pupils to observe rock materials out of doors, *eg in a cemetery or on a high street*, or show them pictures, video clips of rocks/building materials in the locality of the school. • Ask pupils to compare older surfaces with new or chipped surfaces to record evidence of discoloration and/or crumbling. Ask them to speculate about possible causes. Note the effects of weathering under trees or adjacent to soil and ask pupils to suggest reasons for this. • Remind pupils about earlier work on acids and alkalis and show that samples of rainwater are slightly acidic. • Ask pupils to compare fresh granite with weathered granite to observe any changes to minerals. Simulate wet, oxygen-rich, acidic conditions using dilute hydrochloric acid and hydrogen peroxide in a 50:50 mixture. Place a sample of granite in the solution and capture the changes daily for up to two weeks using a digital camera to create a time-lapse sequence. Ask pupils to examine, describe and explain the changes using a computer-generated slide show. Discuss with them why this is an effective way of recording results.	• describe changes in rocks and building materials over time • identify acidic rain as a cause of chemical weathering • describe and evaluate the use of time-lapse photography to record gradual changes • describe changes in granite exposed to acid and relate these to changes in particular grains that are dissolved by acids	• Weathering of rocks and the formation of sedimentary rocks are considered before the formation of igneous rocks, as these processes are likely to be more familiar to pupils. • The formation of acid rain is covered in more detail in unit 9G 'Environmental chemistry'. • A set of photographs of weathered materials in other environments may be useful. See suitable internet sites, *eg www.geo.duke.edu/sched/geopages/geo41/wea.htm www.geo.duke.edu/sched/geopages/geo41/wea2.htm http://athena.wednet.edu/curric/land/landform* • Extension: present pupils with a map showing rainfall and temperature and ask them to suggest regions where extensive weathering might occur. ⚠ **Safety** – use acid solutions in concentrations less than 0.4 mol dm^{-3} as these are low hazard

Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
How do changes in temperature cause rocks to weather?			
• that rocks are broken down by forces that result from stresses generated when water in cracks and fissures expands on freezing • that rocks at the Earth's surface are broken down by forces that result from stresses generated when rocks expand and contract on heating and cooling	• Show pupils pictures or a video clip as a stimulus and ask them to suggest why mountaineers climbing in high mountains, *eg the Alps or Himalayas*, start early in the morning and try to complete their climbing on mountain faces before midday. • Demonstrate the magnitude of the forces arising from expansion or contraction of a solid, *eg by repeatedly heating a corner of a chip of granite to red heat then quenching it in cold water or by using a breaking-bar experiment*. Establish with pupils that these forces are large enough to cause pieces of rock to break off and are most significant where there are large temperature ranges. • Present pupils with a rock sample containing cracks and soak in water. Explain that this is to be used to model what happens when water freezes and thaws. Ask them to suggest how this might be done and how to record the results. Use a digital camera to create a time-lapse sequence showing the number of freeze–thaw cycles on the rock sample and ask pupils to examine the changes, particularly the width of cracks and the shape and size of fragments, using a computer-generated slide show. Discuss how the angular fragments are formed. Ask pupils to re-evaluate their suggestions about mountaineers and explain why rockfalls can be a major hazard to climbing.	• explain how water absorbed by rocks expands on freezing and fragments the rock • describe how changes in temperature can result in rock fragmentation • describe conditions when fragmentation is likely to occur • explain that the forces arising from expansion and contraction are great enough to break off pieces of rock • relate expansion and contraction to the particle model of matter	• If pupils do not know that water expands when it freezes, a demonstration using a plastic bottle filled with water frozen in a freezer would be helpful. • Extension: ask pupils to use a hand lens to look at a sample of highly porous rock that has been soaked in a saturated salt solution, *eg sodium sulfate solution,* and then dried, and to note the presence of crystals occupying the pore spaces. Discuss how the salt can be leached in solution from the rock and then crystallised on nearing the surface of the rock. • Extension: use a digital camera to create a time-lapse sequence showing a number of saturation–drying cycles on the rock sample. Ask pupils to examine the changes using a computer-generated slide show and to record the size and shape of the fragments that are formed. Ask pupils to explain how the growth of salt crystals breaks down the rock. ⚠ **Safety** – eye protection should be worn when heating granite
Checking progress			
• to relate a landscape to a process of weathering	• Show pupils photographs of natural scree slopes, *eg Wast Water in the Lake District*, and ask them to suggest how rock ended up as fragments in a pile at the bottom of the cliff and what the scree slope tells us about past conditions. Ask pupils what characteristics would lead to rocks being weathered easily.	• identify conditions under which rocks fragment • explain the formation of the scree slope in terms of these conditions	• Pupils would not be expected to recall terms such as 'scree slope'. • Extension: to test their ideas, pupils could investigate rock resistance by shaking several small specimens of different rock types in a plastic container and recording changes of size after different time intervals.

3	Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
What happens to weathered pieces of rock?				
	• that rock fragments become sediment grains which can be transported by water currents and deposited when the energy is dissipated • to make predictions about where sediment is deposited	• Review work on weathering and fragmentation of rocks. Find out pupils' ideas about how rock fragments are transported and changed by asking them to sequence a set of statements/drawings and to explain their sequence. Help pupils to investigate water flow in a channel and its overflow by using square guttering that channels water into a large trough. Use a dye, *eg ink,* to track what happens to the current along the gutter and in the trough. Discuss the spreading out of the dye and ask pupils to describe and record where water is moving quickly, and where it is moving slowly, and to use the results to predict where large and small fragments will be deposited.	• state that rock fragments can be transported by flowing water • use the results of their investigation to predict where different sizes of sediment might be moved or deposited in a river flowing into a lake or sea	• Pupils' understanding of how different grains behave can be reinforced by adding a cupful of mixed-sized grains of sediment to a jar of water and swirling it around. Ask pupils to observe which grains roll, which bounce and which 'fly', *eg in suspension*. ⚠ **Safety** – take care that floors do not become wet and slippery
	• how to frame a question that can be investigated • to decide whether evidence supports predictions • that larger grains are not taken as far, as it requires more energy to move them • that sediment grains of similar size are deposited together	• Ask pupils to suggest how water flow might affect the movement of different-sized grains of sediment and to plan how to investigate a specific question using gravel, sand and muddy soil. As part of their investigation, ask pupils to observe and record the distribution of sediment grain size along the gutter and to explain the relationship with volume and speed of water flowing. Bring together the outcomes of all investigations, asking pupils to describe what they did, what problems they encountered and how they overcame them.	• suggest a question that can be investigated, *eg Is sand carried as far as gravel? Does the distance sand travels depend on the width of the channel?* • relate the outcomes of their investigation to the grain size and/or volume and speed of water • conclude that grains of similar size are deposited together	⚠ **Safety** – teachers will need to check pupils' plans for health and safety before practical work begins
	• that as transportation times and distances increase, sediment grains become more rounded and are also sorted into similar sizes • to present data in an appropriate form	• Show pupils that the change in sediment shape and size during transportation can be simulated by shaking plaster cubes in a cylindrical container. Ask them to investigate what happens over several cycles of tumbling in terms of, *eg number, average, mass or shape of fragments after each cycle*. Ask pupils to show the results as line graphs or appropriate drawings, and to explain what has caused the changes and what happens to the 'lost' mass. Bring together the class results with the pupils, and help them to make generalisations about fragmentation.	• identify changes in fragments as time and distance of transportation increase, *eg become smaller, smoother, rounder* • display their results, *eg line graph for average mass of fragments, drawings for shape of fragments*	

Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
Checking progress			
• about fragmentation and transportation	• Show pupils photographs, video clips of rivers full after a storm and in normal state and ask them a series of questions, *eg* – *Why does the river appear dirty?* – *Where has the dirt come from?* – *What happens when the water level drops?* – *Why does the river become clearer?* • Help pupils to generate key points about transportation and formation of sediment grains from their responses and the responses of others.	• identify the source of 'dirt' in rivers in flood • make generalisations about transport and formation of sediment grains, *eg larger grains don't get carried so far*	
Why do sediments form layers?			
• that sedimentary layers are the result of distinct episodes of sedimentation over a variety of timescales • to suggest explanations for observations they make	• Show pupils photographs or video clips of cliffs with sedimentary strata and ask them to suggest, *eg in drawings or annotated diagrams*, how the layers were formed. • Ask pupils to investigate how quickly sediment settles using grains of different sizes, *eg clay, sand, gravel*, in a jar of water. • Ask pupils to observe if the layers have sharp boundaries or grade into each other and to relate this to the conditions under which the layers were formed. Ask pupils to speculate about what controls the thickness of layers and to explain their ideas to others.	• describe how sediments settle to form layers • identify in drawing or annotation that different layers were formed at different times • relate observations about sedimentary layers to factors, *eg particle size*	• Sharp boundaries are formed when there is a time interval between the deposition of the layers.
• that sedimentary layers can be formed by the evaporation of waters containing dissolved salts • that the remains of dead organisms and their shelly material can accumulate to form sediments • to use evidence in rock layers to suggest a sequence of events over time • about the use of fossils as evidence	• Ask pupils whether water in rivers, lakes, seas has solids dissolved in it. Remind them of earlier work on different types of water. Ask them to explain the origin of the salts. Use a flow diagram to explain how salts become concentrated in seas or lakes. Ask pupils to suggest what would happen if the seawater evaporated and how to test their ideas. Modify the flow diagram to discuss how seas and lakes can dry up. • Explore with pupils how a sequence of sediments can be built up by covering the residue from evaporated seawater with a layer of clay and shells to represent the remains of dead organisms, adding more seawater and allowing it to evaporate. Extend to the formation of oil, *eg by using video clips*. • Give pupils a simplified diagram showing different strata and ask them to tell the story of how the layers were formed and why fossils are often found in sedimentary layers. • Extend by asking pupils to use secondary sources to find out about Mary Anning and the fossil specimens she collected.	• describe how dissolved solids are left behind when water evaporates • describe a possible sequence of events leading to a pattern of sedimentary strata • justify their sequence using the evidence from the layers	• Pupils are likely to have investigated different types of water at key stage 2 to find out whether they contain dissolved solids. • The use of fossil fuels is included in unit 7I 'Energy resources'. • Extension: pupils could be asked to find out about how evidence in rock strata, *eg fossils, coal layers*, has been used to develop other ideas about changes in the Earth over time, *eg continental drift, climate changes*. • Teachers will be aware of the need to be sensitive to different religious beliefs. ⚠ **Safety** – care is needed if the seawater is evaporated by heating. Eye protection should be worn

Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
Reviewing work			
• to relate key ideas about geological changes to each other	• Provide pupils with a series of photographs/diagrams/drawings and brief descriptions, *eg a muddy river estuary – grains of mud and sand deposited at the edges of rivers; a pile of rocks at the bottom of a scree – water that gets into cracks and expands as it freezes*, and ask them to match them. Where pupils have matched images and descriptions in different ways, ask them to justify their choices to each other.	• match a description of a geological process to an illustration of it • relate the processes involved in weathering, transport and sedimentation	

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