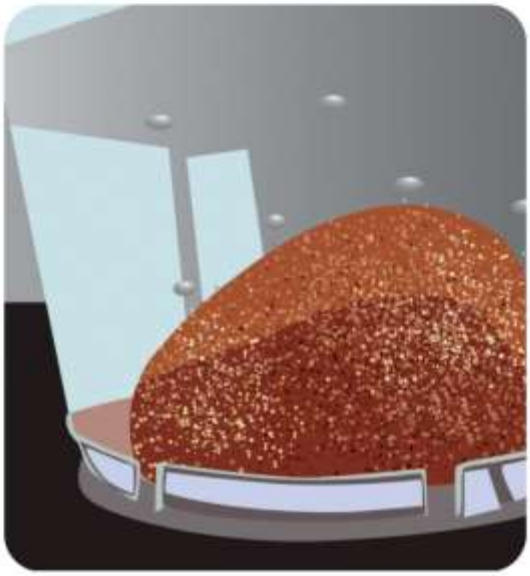
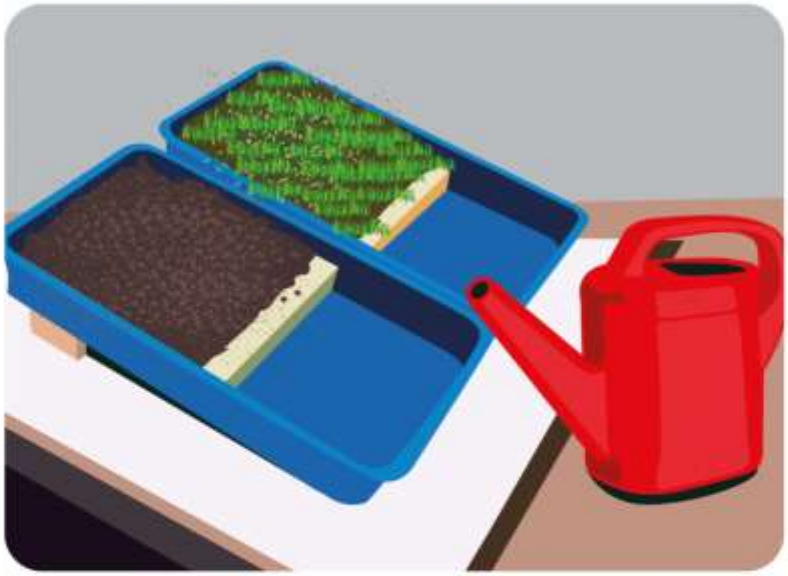
Teaching the Dynamic Earth

Exploring rock, soil, water, fossil

ESEU lower KS2 workshop material



Earth science for years 3/4



EARTH SCIENCE EDUCATION UNIT

With the support of:

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ESEU Primary Workshops

Exploring rock, soil, water, fossil
Earth science for lower KS2, Years 3/4

Contents

Summary

Try a series of ‘hands-on’ activities to describe, classify and identify rocks, investigate soils, explore the changing states of water, with their links to the water cycle, and find out what fossils can tell us. Have a go at the ‘Great soil race’, making your own rain, bringing a fossil to life and much more through a range of practical and investigative activities.

Earth Science Education Unit workshops

These workshops have been devised for teachers and trainee teachers. They are intended to provide participants with a range of activities that can be used in the classroom, whilst helping them to develop the skills for using the activities in an engaging and motivating way that will enthuse and educate their pupils, whilst developing their critical thinking skills. The workshops should also develop the background Earth science knowledge and understanding of the teachers involved.

The workshop format may be transposed directly into a classroom, but often this is not appropriate. Similarly, individual activities, and the worksheets on which these are based, may be transferable directly into a classroom situation, but will often require modification for the classes and situations in which they are used, during which suitable risk assessments are undertaken.

Workshop outcomes

The workshop and its activities provide the following outcomes:

- insights into how rocks can be; sorted, classified and identified most effectively;
- opportunities to investigate to investigate soils through a range of activities;
- an approach to understanding the different states of water and how these link to the water cycle;
- an introduction to fossils and what they can tell us about life in the past;
- practical activities that develop skills of investigation, discussion, argumentation and creativity;
- background information on some of the Earth-science processes active in the UK;
- exploration of the elements of science and geography that provide the underpinning to later Earth science study;
- guidance on how the elements of Earth science in the curriculum can be taught most effectively.

Starter: Found in the ground

Topic: This activity involves sorting out things that have been 'Found in the ground' according to criteria the participants choose for themselves. They then sort the things into rocks, minerals, fossils and other objects according to given criteria.

Activity:

A Sort them out

Ask pupils to 'sort out' the samples they have been given (as suggested in the resource list). You could add that the best way of doing this is to have about two or three categories with at least two things in each category and not to have a 'rag-bag' category of 'things that couldn't be fitted into the other groups'. Given this very open-ended request, they can respond in a number of ways. They may sort according to colour, size, shape, 'roughness', 'sparkly-ness/shininess', how heavy they feel, or a combination of these properties. Given that the question was open-ended, any method that works well (i.e. several categories, at least two things in each category and no 'rag bag') is a good response.

It may be useful to give pupils this information on a 'Pupil Success Criteria Card' (see later).

B Talking about the method

Explain that any method that works is fine. But that if we want to talk about the things 'Found in the ground' with others (across the room or across the world), we all need to use the same method of sorting them out. The method used by scientists for these 'Found in the ground' things is to first take out everything that is not rock, fossil or mineral, e.g. wood, bone, manufactured items. The objects that are left should now be divided into rocks, fossils and minerals

It may be useful to give pupils the definition cards (see later).

C Sort them out scientifically

Given these definitions, ask pupils to sort their objects 'Found in the ground' again, using the 'scientific' criteria.

Rocks, fossils and minerals (*Peter Kennett*)

Pupil learning outcomes Pupils can:

- sort out things 'Found in the ground' effectively, using their own criteria;
- understand effective and less-effective methods of 'sorting thing out';
- distinguish between a rock and a mineral;
- identify a fossil;

Curriculum references:

England	Scotland	Wales	Northern Ireland
Science: Lower KS2 **Years 3 and 4** **Working scientifically** • asking relevant questions and using different types of scientific enquiries to answer them • setting up simple practical enquiries • making systematic and careful observations • using results to draw simple conclusions, • using straightforward scientific evidence to answer questions or to support their findings **Year 3** **Rocks** • compare and group together different kinds of rocks on the basis of their appearance and simple physical properties Linked with work in geography, pupils should explore different kinds of rocks, including those in the local environment Pupils might work scientifically by: observing rocks, including those used in buildings and gravestones, and exploring how and why they might have changed over time; using a hand lens or microscope to help them to identify and classify rocks according to whether they have grains or crystals, and whether they have fossils in them **Geography** **KS3** **Human and physical geography** understand, through the use of detailed place-based exemplars at a variety of scales, the key processes in: • physical geography relating to: … rocks	**Sciences** **Early** **Biological systems** I can identify my senses and use them to explore the world around me. SCN 0-12a **Earth's materials** **Second** Having explored the substances that make up Earth's surface, I can compare some of their characteristics and uses. SCN 2-17a **Third** Through evaluation of a range of data, I can describe the formation, characteristics and uses of soils, minerals and basic types of rocks. SCN 3-17a **Social studies** **First** **People, place and environment** I can describe and recreate the characteristics of my local environment by exploring the features of the landscape. SOC 1-07a	**Science** **KS2** **The sustainable Earth** • a comparison of the features and properties of some natural and made materials • how some materials are formed or produced	**The world around us** **Foundation stage** **Strand 3: Place** **KS1** **Features of the immediate world and comparisons between places;** • about materials in the natural and built environment (G); (H); • about the properties of everyday materials and their uses (S&T); • the similarities and differences between buildings features and landscape in their locality and the wider world (G) **KS2** **Ways in which people, plants and animals depend on the features and materials in places and how** **they adapt to their environment;** • about the origins of materials (S&T)

Age range of pupils: 7 – 14 years

Time needed to complete activity: 15 minutes

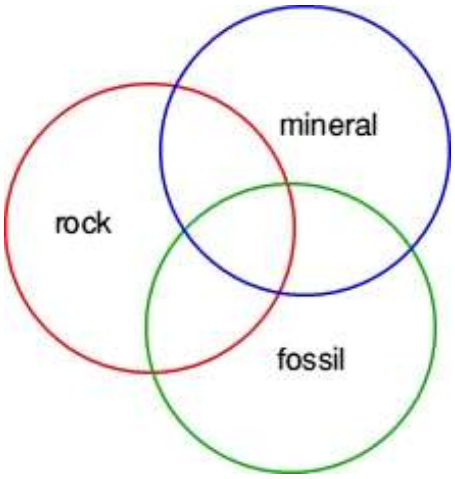
The story for teachers:
Pupils should be able to remove from the objects all specimens that are not rocks, minerals or fossils.
They will need to use the definition cards to divide their remaining specimens into rock, fossil and mineral:

- rock - natural and made of 'bits' called grains;
- fossil - any preserved sign of past life more than 10,000 years old;
- mineral - a naturally occurring chemical with the same properties all the way through.

More formal definitions:

- rocks are made of minerals, fragments of older rocks, or fossils. Most rocks contain a variety of minerals, but some, like limestone, can contain lots of grains of just one mineral;
- fossils include 'body fossils' such as a shell, the replaced shell, or the imprint of the body and 'trace fossils' (traces left by organisms) such as footprints or worm burrows;
- minerals, therefore, are natural inorganic elements or chemical compounds that have a definite atomic structure and therefore fixed physical properties (that can sometimes vary between known limits) including common minerals like quartz, calcite, haematite and halite.

Using the definition cards, pupils should be able to group rocks, minerals and fossils separately. However, some pupils will say that a rock containing a fossil is a rock and others will say it is a fossil. Both are correct. It is a good idea to set up a Venn diagram with three overlapping circles as shown overleaf. Specimens that fit in two categories can then be put inside two rings.



This activity fits any teaching scheme which involves grouping of objects and observational and descriptive skills.

A pattern develops as the objects are grouped scientifically and discussion about the groups involves metacognition. Cognitive conflict is caused when a specimen fits into two categories.

Lead in ideas:
Ask pupils the initial question – 'Why do we sort things out? – the answer is so that patterns in things can be investigated more effectively or so that we can develop systems for storing and finding things.
Once objects are grouped, or classified, they can be discussed with and understood by scientists everywhere.

Following up the activity:
Additional 'difficult' samples can be added, e.g. a broken brick, a piece of concrete, a piece of wood.

Source:
'Found in the Ground' a 'Science of the Earth' activity, published by the Earth Science Teachers' Association and written by Peter Kennett.

Preparation and set-up time:
Enough time to get out and organise the samples.

Resource list:
- samples of granite, permeable sandstone and other samples such as: shelly limestone, chalk, slate; specimens should be 2cm in diameter, or larger - see photo
- some fossils
- some minerals
- some objects, like, piece of brick, wood, large rusty nail
- 'Pupil success criteria' card (next page)
- Definition cards (next page)

Note: If pupil groups are doing this activity, it is useful for them to have enough sets so they can work in groups of three.

Risk assessment:

Potentially Hazardous Activity	Who/What may be Harmed?	Hazard Rating (A)	Likelihood (B)	Risk (AxB)	Further Action Required?
Found in the Ground	No significant hazard				No

Hazard Rating (A):
1 = Insignificant effect
2 = Minor Injury
3 = Major Injury
4 = Severe Injury
5 = Death

Likelihood of occurrence (B):
1 = Little or no likelihood
2 = Unlikely
3 = Occasional
4 = Probable
5 = Inevitable

Risk Priority (AxB):
12-25 = High risk – take immediate action
6-11 = Medium risk – take action as soon as possible
Less than 6 = Low risk – plan future actions where required

Pupil success criteria card (Found in the ground)

Sort them out

To do this in the best way, you will:

1) Group the samples into about two or three ‘categories’ with at least two things in each ‘category’;

2) Not have a group which is made of ‘things that couldn’t be fitted into the other groups’;

3) Make your choices based on the properties of the samples

Definition cards (Found in the ground)

Rock

natural and made of ‘bits’ called grains

Non-rock

may or may not be natural and are usually not formed of ‘bits’

Mineral

natural chemicals with the same properties all the way through

Fossil

any preserved sign of past life more than 10,000 years old

ESEU activity guide sheet:

Found in the ground

This activity involves sorting out things that have been 'Found in the ground' according to criteria the participants choose for themselves. They then sort the things into rocks, minerals, fossils and other objects according to given criteria.

A Sort them out

Ask pupils to 'sort out' the samples they have been given (as suggested in the resource list). You could add that the best way of doing this is to have about two or three categories with at least two things in each category and not to have a 'rag-bag' category of 'things that couldn't be fitted into the other groups'. Given this very open-ended request, they can respond in a number of ways. They may sort according to colour, size, shape, 'roughness', 'sparkly-ness/shininess', how heavy they feel, or a combination of these properties. Given that the question was open-ended, any method that works well (i.e. several categories, at least two things in each category and no 'rag bag') is a good response.

It may be useful to give pupils this information on a 'Pupil Success Criteria Card'

Rocks, fossils and minerals (*Peter Kennett*)

B Talking about the method

Explain that any method that works is fine. But that if we want to talk about the things 'Found in the ground' with others (across the room or across the world), we all need to use the same method of sorting them out. The method used by scientists for these 'Found in the ground' things is to first take out everything that is not rock, fossil or mineral, e.g. wood, bone, manufactured items.

The objects that are left should now be divided into rocks, fossils and minerals

It may be useful to give pupils the definition cards.

C Sort them out scientifically

Given these definitions, ask pupils to sort their objects 'Found in the ground' again, using the 'scientific' criteria.

Circus activity 1: A rocky look, touch and tell

Topic: This activity encourages rock identification based on rock appearance and texture.

Activity:

A What are the rocks like?

- You have been given two samples of rock. *Note. The two rocks provided are a sedimentary rock, e.g. sandstone, and an igneous rock, e.g. granite.*
- Pick up one sample and describe it to the rest of the group. Then do the same for the other.
  Possible answer(s): The words that often appear are: bits, colour, rough/smooth.
  Give the scientific word for 'bits' = grains.

B What are the 'grains' like?

- Now use a magnifier or hand lens to look at the grains in the rock.
- Pick up one sample and describe the grains to the rest of the group. Then do the same for the other.
  Possible answer(s): The words usually used are: shape, size, colour and shininess.

Looking closely at a rock with a magnifier (*Hazel Benson*)

C Rock scratch test

Use a piece of metal such as a spoon to try the 'rock scratch test' on the two rocks. How are the rocks different?
Possible answer(s): Grains will be scraped off the sandstone very much more easily than from the granite.

D Sorting out the rocks

- Rocks that are made of grains that are stuck together and can easily be scratched off are usually sedimentary rocks.
- Rocks that are made of interlocking grains that are very hard to scratch off are usually crystalline rocks (made of crystals).
  Possible answer(s): Sandstone, shelly limestone and chalk are sedimentary rocks, whilst granite, slate and marble are rocks formed of crystals (crystalline rocks).

Pupils use these definitions to sort all the rocks they have been given into two groups.
They can be given these definitions on cards, (see page 13).

Note: Further subdivision into igneous and metamorphic rocks is possible, as described in the 'Following up the activity' section on page 12.

Pupil learning outcomes

Pupils can:

- say that all rocks are made of bits or grains;
- observe that some of these grains are small and round and others are shiny and different shapes;

- say that some rocks are made up of lots of different coloured grains and in others, the grains are only one colour;
- say that some rocks are harder than others;
- show that some rocks have fossil shells in them;
- describe some rocks as sedimentary and others as made of crystals (crystalline).

Curriculum references:

England	Scotland	Wales	Northern Ireland
Science: Lower KS2 **Years 3 and 4** **Working scientifically** • asking relevant questions and using different types of scientific enquiries to answer them • setting up simple practical enquiries • making systematic and careful observations • using results to draw simple conclusions, • using straightforward scientific evidence to answer questions or to support their findings **Year 3** **Rocks** • compare and group together different kinds of rocks on the basis of their appearance and simple physical properties Linked with work in geography, pupils should explore different kinds of rocks, including those in the local environment Pupils might work scientifically by: observing rocks, including those used in buildings and gravestones, and exploring how and why they might have changed over time; using a hand lens or microscope to help them to identify and classify rocks according to whether they have grains or crystals, and whether they have fossils in them.	**Sciences** **Early** **Biological systems** I can identify my senses and use them to explore the world around me. SCN 0-12a **Second** **Earth's materials** Having explored the substances that make up Earth's surface, I can compare some of their characteristics and uses. SCN 2-17a **Social studies** **First** **People, place and environment** I can describe and recreate the characteristics of my local environment by exploring the features of the landscape. SOC 1-07a	**Science: KS2** **The sustainable Earth** • a comparison of the features and properties of some natural and made materials • how some materials are formed or produced	**The world around us** **Foundation stage** **Strand 3: Place** **KS1** **Features of the immediate world and comparisons between places;** • about materials in the natural and built environment (G); (H); • about the properties of everyday materials and their uses (S&T); • the similarities and differences between buildings features and landscape in their locality and the wider world (G) **KS2** **Ways in which people, plants and animals depend on the features and materials in places and how they adapt to their environment;** • about the origins of materials (S&T)

Age range of pupils: 7 – 18 years

Time needed to complete activity: 20 minutes

The story for teachers:
There is often confusion between minerals and rocks. Minerals are naturally formed chemical compounds (eg. quartz). Rocks are generally formed of a mixture of minerals (eg. granite), but sometimes rocks are made of only one mineral (eg. limestone made of the mineral calcite).

Granite is an igneous rock formed of minerals that crystallised with random arrangement as it cooled from a liquid. Slate is a metamorphic rock that was formed under great lateral pressure, so the minerals formed in layers, allowing the slate to be split into sheets. Marble is a metamorphic rock formed from limestone under heat and pressure, and so is a crystalline rock made of just one material. (This is the scientific definition of marble; the term 'marble' is also used as a trade name for a variety of polished rocks.)

The activity helps pupils identify rocks in their local buildings and surroundings; it is a useful fieldwork skill.

Pattern is involved in classifying the rock types. Cognitive conflict is caused when rocks do not seem to fit easily into one category, e.g. slate is apparently quite soft when scratched and is so fine-grained as to not appear crystalline. However, it is waterproof and splits easily into layers and is a metamorphic rock.

Lead in ideas:
- Ask pupils to bring in small samples of rocks they have found and discuss their similarities and differences.
- Try the 'Found in the ground' ESEU activity.
- Talk about the rocks the pupils have seen e.g. cliffs, quarries, road cuttings.
- Ask if they realise that rocks are hidden from view under the soil beneath their houses and school.

Following up the activity:
The crystalline rocks can be subdivided using these descriptions:

- crystalline rocks made of different minerals scattered through them are usually igneous rocks;
- crystalline rocks with minerals in layers or bands or made of just one mineral are usually metamorphic rocks.

Ask pupils to try to sort out the crystalline rocks using these definitions – which they could be given on cards (see next page).

Pupils could also try:

- 'Will my rock hold water' ESEU activity.
- If appropriate, take the pupils outside to try to identify some rocks e.g. shelly limestone, sandstone etc.
- Ask pupils to think about how rocks might have been made, e.g. a sandstone (made by the sand that might be found in a river, beach or dune being cemented together)
- Ask pupils how the underlying rocks might be related to hills/valleys or cliffs/beaches, eliciting that harder rocks are likely to make hills/cliffs, etc.
- Pupils could link the rocks to where they might be found in the local area or in the UK. Use a geological map for this, if available.

Source: Based on 'Spot that rock', an ESEU workshop, visit www.earthscienceeducation.com for further details.
Adapted from an original workshop by Duncan Hawley.

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Preparation and set-up time:
15 minutes maximum.

Resource list:

- samples of granite, permeable sandstone and other samples such as: shelly limestone, chalk, slate, marble; specimens should be 2cm in diameter, or larger
- magnifier
- metal teaspoon
- definition cards

Note: If pupil groups are doing this activity, it is useful for them to have enough sets so they can work in groups of three.

Risk assessment:

Potentially Hazardous Activity	Who/What may be Harmed?	Hazard Rating (A)	Likelihood (B)	Risk (AxB)	Further Action Required?
Rocky, Look, Touch and Tell	No significant hazard	-	-	-	No

Hazard Rating (A):
1 = Insignificant effect
2 = Minor Injury
3 = Major Injury
4 = Severe Injury
5 = Death

Likelihood of occurrence (B):
1 = Little or no likelihood
2 = Unlikely
3 = Occasional
4 = Probable
5 = Inevitable

Risk Priority (AxB):
12-25 = High risk – take immediate action
6-11 = Medium risk – take action as soon as possible
Less than 6 = Low risk – plan future actions where required

Definition cards (A rocky look, touch and tell: sorting out the rocks)

Sedimentary rocks

are usually made of grains that are stuck together and can often easily be scratched off

Crystalline rocks

are usually made of interlocking grains that are very hard to scratch off

Igneous rocks

are crystalline rocks made of different minerals scattered through them

Metamorphic rocks

are crystalline rocks with minerals in layers or bands or made of just one material

ESEU activity guide sheet:

A rocky look, touch and tell

This activity encourages rock identification based on rock appearance and texture.

A What are the rocks like?

- You have been given two samples of rock.
- Pick up one sample and describe it to the rest of the group. Then do the same for the other.

Give the scientific word for 'bits' = grains.

B What are the 'grains' like?

- Now use a magnifier or hand lens to look at the grains in the rock.
- Pick up one sample and describe the grains to the rest of the group. Then do the same for the other.

Looking closely at a rock with a magnifier (*Hazel Benson*)

C Rock scratch test

Use a piece of metal such as a spoon to try the 'rock scratch test' on the two rocks. How are the rocks different?

D Sorting out the rocks

- Rocks that are made of grains that are stuck together and can easily be scratched off are usually sedimentary rocks.
- Rocks that are made of interlocking grains that are very hard to scratch off are usually crystalline rocks (made of crystals).

Pupils use these definitions to sort all the rocks they have been given into two groups.

They can be given these definitions on cards.

Note: Further subdivision into igneous and metamorphic rocks is possible

Circus activity 2: Will my rock hold water?

Topic: This activity investigates the porosity/permeability of rocks.

Activity:

A Bubbling rocks

- Take one sample of a permeable sedimentary rock (eg sandstone) and one of an igneous rock (e.g. granite) both with clearly visible grains.
- Watch for bubbles as you put both of these into a container of water at the same time.
- Watch closely to see where the bubbles come from on each of the samples.
- Describe what you have seen.

(top view)

(side view)

Sandstone 'bubbling' in a plastic beaker (*Peter Kennett*)

(top view)

(side view)

Granite not 'bubbling' in a plastic beaker (*Peter Kennett*)

B Sorting the rocks

Put the rest of the rock samples into a container of water at the same time and watch for bubbles.

- What is the order of the rocks, from the most to the least 'bubbly'?
- Ask questions, e.g. How do we use a 'bubbly' (permeable) rock like sandstone?
- How do we use a non-'bubbly' (impermeable, waterproof) rock like slate?

Pupil learning outcomes

Pupils can:

- test to see whether a rock is permeable or not;
- test rock permeability and sort out rocks according to their permeability;
- know that some rocks can contain air or water and others cannot;
- apply their knowledge to real world situations.

Curriculum references:

England	Scotland	Wales	Northern Ireland
Science: Lower KS2 **Years 3 and 4** **Working scientifically** • asking relevant questions and using different types of scientific enquiries to answer them • setting up simple practical enquiries • making systematic and careful observations • using results to draw simple conclusions, • using straightforward scientific evidence to answer questions or to support their findings **Year 3** **Rocks** • compare and group together different kinds of rocks on the basis of their appearance and simple physical properties	**Sciences** **Second** **Earth's materials** Having explored the substances that make up Earth's surface, I can compare some of their characteristics and uses. SCN 2-17a **Social studies** **First** **People, place and environment** I can describe and recreate the characteristics of my local environment by exploring the features of the landscape. SOC 1-07a	**Science: KS2** **The sustainable Earth** • a comparison of the features and properties of some natural and made materials • how some materials are formed or produced	**The world around us** **Foundation stage** **Strand 3: Place** **KS1** **Features of the immediate world and comparisons between places;** • about materials in the natural and built environment (G); (H); • about the properties of everyday materials and their uses (S&T); • the similarities and differences between buildings features and landscape in their locality and the wider world (G) **KS2** **Ways in which people, plants and animals depend on the features and materials in places and how they adapt to their environment;** • about the origins of materials (S&T)

Age range of pupils: 7 - 18 years

Time needed to complete activity: 20 minutes

The story for teachers:
The bubbly rocks have spaces between the grains that can hold air and water and that air and water can flow through – so they are porous (they have spaces between the grains) and permeable (liquids and gases can flow through them). This activity shows which rocks are porous/permeable and which rocks don't allow air and water to flow through and so are impermeable.

The scientific definitions:
- **porosity** - percentage of pore space in a rock
- **permeability** - the rate of flow of a fluid through a rock

In the porous/permeable rocks, bubbles rise from the top. This is because the air 'hidden' in the pore spaces in the rock is less dense than the water and so rises through the connected pores. Atmospheric pressure on the surface of the water then pushes water into the spaces left behind – so water flows into the bottom of these rock samples as air rises from the top.

In the 'non-bubbly' (non-porous, impermeable) rocks, bubbles can sometimes be seen on the surface that come from trapped air in near surface cracks – but the bubbles do not grow or rise as they do in the 'bubbly' rocks with interconnected pore spaces.

The porosity/permeability of the rock samples is likely to be:
- porous/permeable - sandstone, chalk;
- impermeable – clay, slate, marble, granite.

This may vary according to the samples, e.g. some sandstones may have a mixture of grain sizes and may have poor permeability. Some sedimentary rocks that were once permeable but have become well cemented (natural cement has filled the pore spaces between the grains 'gluing' the rock together) may now be impermeable. Fine-grained sedimentary rocks, like clay, although having gaps between the grains (and so being porous), have gaps that are so small that water can't flow through, so they are impermeable.

Porous/permeable sandstone underground can store water (or oil and gas).
Impermeable slate can be used on roofs of buildings to keep the water out. Impermeable rocks can also be used as facing stones on buildings or gravestones, and nice-looking ones (eg. granite) are used for kitchen work surfaces.

The activity can be used in any teaching scheme about the different properties of rocks. Pupils can devise their own ways of making a porosity/permeability chart.

Cognitive conflict occurs when two different sandstones for example, behave differently when put into water. One may be much more 'bubbly' than the other. Applying their knowledge of porosity and permeability of rocks to the uses of rocks around them is a bridging skill.

Lead in ideas:
The 'Found in the ground' and 'Look, touch and tell' ESEU KS2 Years 3 and 4 activities – sorting, describing and grouping rocks according to their appearance and texture.

Following up the activity:
- Investigate the natural building materials around the school – are they permeable or impermeable?
- Where are rocks found locally? – are they permeable or impermeable?
- List several uses for each of the rock samples, e.g:
  1) sandstone – sand from sandstone is used in the building industry; sandstone is an underground reservoir rock because it is porous and permeable and so can hold water, oil or gas; tough sandstones are often good building stones;
  2) clay is impermeable and can be used to line reservoirs to stop the water leaking away; clay is also used in pottery and paper making;
  3) chalk is used in farming to make fields more fertile (it neutralises acid soils) and is used in cement-making. It is also a porous and permeable rock that can hold underground water supplies;
  4) slates are used on roofs to keep water out because slate is impermeable;
  5) marble and granite are both decorative stones used for buildings, sculpture.

Some of the more able may be able to time for how long a rock 'bubbling' continues. These results could then be recorded on a simple graph.

The rocks could be weighed when dry and then again after they have been immersed in water. Experimentation is necessary here, as some may need to be submerged overnight/weekend to make a significant difference. They also may need to be left on a window sill or radiator to dry out to ensure they are dry for next time.

Source: Earthlearningidea 'Modelling for rocks. What's hidden inside – and why?' devised by Chris King – http://www.earthlearningidea.com.

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Preparation and set-up time:
5 minutes.

Resource list:
- samples of granite, permeable sandstone and others such as: shelly limestone, chalk, slate, marble; samples should be 2cm in diameter, or larger
- plastic container/beaker of water to put the rocks in, preferably transparent

If pupil groups are doing this activity, it is useful for them to have enough sets so they can work in groups of three

Risk assessment:

Potentially Hazardous Activity	Who/What may be Harmed?	Hazard Rating (A)	Likelihood (B)	Risk (AxB)	Further Action Required?
Will my Rock hold Water?	No significant hazard	-	-	-	No

Hazard Rating (A):
1 = Insignificant effect
2 = Minor Injury
3 = Major Injury
4 = Severe Injury
5 = Death

Likelihood of occurrence (B):
1 = Little or no likelihood
2 = Unlikely
3 = Occasional
4 = Probable
5 = Inevitable

Risk Priority (AxB):
12-25 = High risk – take immediate action
6-11 = Medium risk – take action as soon as possible
Less than 6 = Low risk – plan future actions where required

ESEU activity guide sheet:

Will my rock hold water?

This activity investigates the porosity/permeability of rocks.

A Bubbling rocks

- Take one sample of a permeable sedimentary rock (eg sandstone) and one of an igneous rock (eg. granite) both with clearly visible grains.
- Watch for bubbles as you put both of these into a container of water at the same time.
- Watch closely to see where the bubbles come from on each of the samples.
- Describe what you have seen.

(top view)

(side view

Figure 3: Sandstone 'bubbling' in a plastic beaker (Peter Kennett)

(top view)

(side view)

Figure 4: Granite not 'bubbling' in a plastic beaker (Peter Kennett)

B Sorting the rocks

Put the rest of the rock samples into a container of water at the same time and watch for bubbles.

- What is the order of the rocks, from the most to the least 'bubbly'?
- Ask questions, e.g. How do we use a 'bubbly' (permeable) rock like sandstone?

- How do we use a non-'bubbly' (impermeable, waterproof) rock like slate?

Circus activity 3: The soil water shake test

Topic: This activity involves separating and sorting components of soil.

Activity:
Introduce this activity by asking your pupils:
- What is soil?
- What is it made of?

Then 'let's find out!'

Fill a plastic jar with soil to a depth of around 4cm. Pour water into the jar until it is full – put the lid on tightly. Shake the jar well. Leave it where you can watch it. A pre-prepared jar could be used.

While watching what is happening in the jar, ask the pupils:
- What do you think is happening?
- Where are the largest (coarse) particles?
- Why are they in this place?
- Where are the smallest (fine) particles?
- How many different layers can you see?
- Are the particles in each layer the same colour?
- Does your jar have more small particles than large ones?
- How long does it take for the water to clear?
- Is there anything floating on the water?
- If so, what do you think it is?
- What is the best way to record your findings?

Then ask the pupils to draw what they can see in a diagram.
They can add labels to their diagrams:
- small pebbles
- sand
- mud
- pieces of decaying plant

Ask the pupils:
To compare 'their' soil with the results from a different soil sample and then discuss their results. They could consider, 'What are the differences?', 'Why are there differences?', 'What has caused the differences?' Then ask the pupils where they think all these soil 'ingredients' originally came from.

Possible answer(s):
- The pebbles, sand and mud were either brought into the area by rivers or came from the rocks beneath.
- The pieces of plant came from plants growing in the soil that died and were buried.

Soil in a plastic beaker (*Peter Kennett*)

Pupil learning outcomes

Pupils can:

- say that soil is made of varying quantities of coarse and fine particles plus bits of vegetation;
- explain that these particles separate out when shaken in water;
- explain that the coarse particles settle quickly to the bottom of the jar and the fine particles settle more slowly and so are found at the top;
- explain that it takes quite a long time for some of the very fine particles to settle out of the water completely;
- explain that bits of vegetation will float on top of the water;
- explain that the water will not become completely clear because of material in solution
- draw a labelled diagram to show their results with measurements shown in cm or mm.

Curriculum references:

England	Scotland	Wales	Northern Ireland
Science: Lower KS2 **Years 3 and 4** **Working scientifically** • making systematic and careful observations and, where appropriate, taking accurate • measurements using standard units • recording findings using simple scientific language, drawings, labelled diagrams, • reporting on findings from enquiries, presentations of results and conclusions • using results to draw simple conclusions, make predictions for new values, suggest improvements • and raise further questions • identifying differences, similarities or changes related to simple scientific ideas and processes • using straightforward scientific evidence to answer questions or to support their findings. **Year 3** **Rocks** • recognise that soils are made from rocks and organic matter. Linked with work in geography, pupils should explore different kinds of soils, including those in the local environment Pupils could explore different soils and identify similarities and differences between them and investigate what happens when rocks are rubbed together or what changes occur when they are in water. They can raise and answer questions about the way	**Sciences: Materials** **Earth's materials** **Second** Having explored the substances that make up Earth's surface, I can compare some of their characteristics and uses. SCN 2-17a **Third** Through evaluation of a range of data, I can describe the formation, characteristics and uses of soils, minerals and basic types of rocks. SCN 3-17a **Social sciences: People, place and environment** **Early** I explore and discover the interesting features of my local environment to develop an awareness of the world around me. SOC 0-07a **First** I can describe and recreate the characteristics of my local environment by exploring the features of the landscape. SOC 1-07a **Second** I can describe the major characteristic features of Scotland's	**Science: KS2** **The sustainable Earth** • a comparison of the features and properties of some natural and made materials • how some materials are formed or produced **Geography: KS2** • study – living in Wales: their local area	**The world around us** **Foundation stage** **Strand 1: Interdependence** **KS2** **How living things rely on each other within the natural world;** • about the variety of living things and the conditions necessary for their growth and survival (S&T) **Strand 3: Place** **KS1** **Features of the immediate world and comparisons between places;** • about materials in the natural and built environment (G); (H); • about the properties of everyday materials and their uses (S&T); • the similarities and differences between buildings features and landscape in their locality and the wider world (G) **KS2** **Ways in which people, plants and animals depend on the features and materials in places and how they adapt to their environment;** • about the origins of materials

soils are formed **Geography: KS1** use basic geographical vocabulary to refer to: • key physical features, including: beach, cliff, coast, forest, hill, mountain, sea, ocean, river, soil, valley, vegetation, season and weather	landscape and explain how these were formed. SOC 2-07a **Third** Having investigated processes which form and shape landscapes, I can explain their impact on selected landscapes in Scotland, Europe and beyond. SOC 3-07a		(S&T); • how the use of materials relates to their properties (S&T)

Age range of pupils: 7 - 10 years

Time needed to complete activity: 10 minutes

The story for teachers:

- The largest particles are at the bottom of the jar because they are not suspended by the water and settle quickly.

- The smallest particles are at the top because they are held up in the water by suspension and settle slowly.
- You can usually see three layers – this will vary according to the types of soil used.
- Usually the colours of the different layers are slightly different – again, it will depend on the soils used.
- Most jars will have more small particles than large.
- The time for the water to clear can be accurately recorded; it sometimes takes hours or days for the very fine, suspended particles to settle out of the water.
- The water does not become completely clear. This is because some material has gone into solution
- Bits of vegetation could be floating on the surface of the water.

Differences in all these things should be spotted for different soils.

Note: The technique used here, of settling in a water column, is a more effective way of sorting and measuring the fine sediments often found in soils, than using sieves.

From watching a variety of soils settle out in water, pupils will realise that soils vary a great deal from those that are very sandy to those that contain mostly fine particles. Relating this to soils they see around them is a bridging skill.

Web links:
Earthlearningidea: http://www.earthlearningidea.com - 'Make your own soil', 'Soil doughnuts', 'Soil layers puzzle'.
Soil-net: http://www.soil-net.com
'Working with Soil' - activity pack and booklet (Waldorf the Worm ISBN 873266 16 2), ESTA Primary Committee, Earth Science Teachers' Association, 2003

Lead in ideas:
Explain that one of the ingredients in soil is broken-down rock. The activity could follow on from rock identification.

Following up the activity:
- Painting with different coloured soils.
- The 'Great soil race' and 'Save our soil' ESEU activities
- Ask pupils to devise a recipe for making soil. The ingredients they might suggest are:
  - sand
  - mud
  - clay
  - pebbles
  - bits of rock
  - organic material
  - decaying organic material
  - worms
  - 'bugs' of various types

You may need to tell them that two other key ingredients are water and air.

You might like to give them the opportunity to try their recipe (without the decaying organic material, bugs and worms!) and try out different quantities of ingredients.

Source :
Developed from the ESTA Primary activity 'Separating Soil by Settling in Water' by Tony Comerford, Julie Shenton, Clare Dawe, Ruth Oakes and Elizabeth Devon.

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Preparation and set-up time:
10 minutes.

Resource list:

- soil samples. You may want to hand-make or 'doctor' your local soil so that it contains a range of grain sizes and a variety of colours, e.g. some bits of gravel, some clay that will settle out, and some organic debris that will float (Health and Safety: natural soil samples should only be handled with plastic gloves)
- transparent plastic jars or bottles with lids (small jars are better for small hands; large sweet containers, pop bottles or fabric softener bottles are excellent for a teacher demonstration)
- rulers
- water
- diagrams of a jar (see overleaf)

Risk assessment:

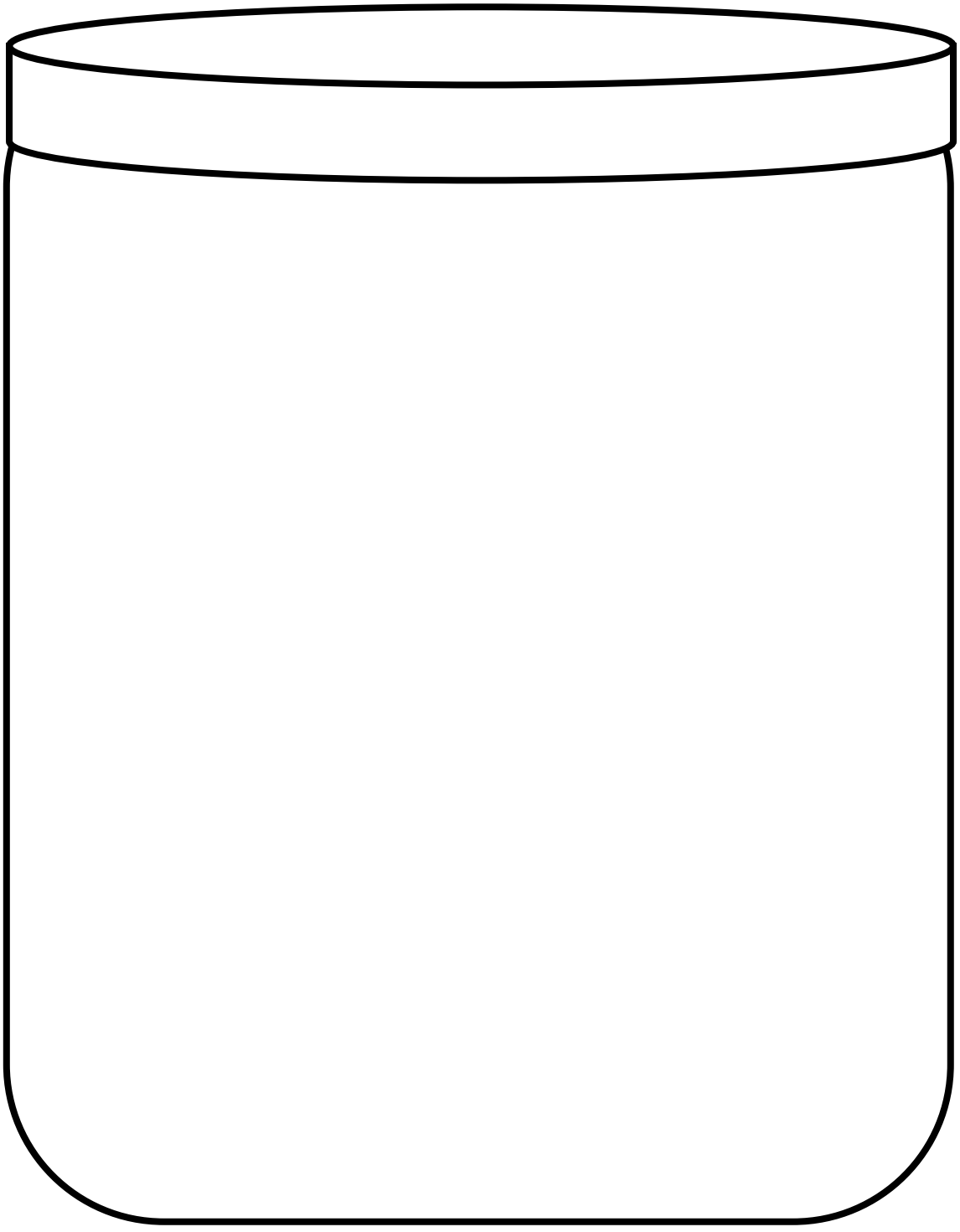
Potentially Hazardous Activity	Who/What may be Harmed?	Hazard Rating (A)	Likelihood (B)	Risk (AxB)	Further Action Required?
Soil Water Shake Test	Pupils and staff at risk from organisms in soil e.g. tetanus	3	2	6	Wear gloves if any cuts on hands. Otherwise, wash hands after activity

Hazard Rating (A):
1 = Insignificant effect
2 = Minor Injury
3 = Major Injury
4 = Severe Injury
5 = Death

Likelihood of occurrence (B):
1 = Little or no likelihood
2 = Unlikely
3 = Occasional
4 = Probable
5 = Inevitable

Risk Priority (AxB):
12-25 = High risk – take immediate action
6-11 = Medium risk – take action as soon as possible
Less than 6 = Low risk – plan future actions where required

The soil water shake test – diagram of a jar



ESEU activity guide sheet:

The soil water shake test

This activity involves separating and sorting components of soil.

Introduce this activity by asking your pupils:
- What is soil?
- What is it made of?

Then 'let's find out!'

Fill a plastic jar with soil to a depth of around 4cm. Pour water into the jar until it is full – put the lid on tightly. Shake the jar well. Leave it where you can watch it. A pre-prepared jar could be used.

While watching what is happening in the jar, ask the pupils:
- What do you think is happening?
- Where are the largest (coarse) particles?
- Why are they in this place?
- Where are the smallest (fine) particles?
- How many different layers can you see?
- Are the particles in each layer the same colour?
- Does your jar have more small particles than large ones?
- How long does it take for the water to clear?
- Is there anything floating on the water?
- If so, what do you think it is?
- What is the best way to record your findings?

Then ask the pupils to draw what they can see in a diagram.
They can add labels to their diagrams:
- small pebbles
- sand
- mud
- pieces of decaying plant

Soil in a plastic beaker (*Peter Kennett*)

Ask the pupils:
To compare 'their' soil with the results from a different soil sample and then discuss their results. They could consider, 'What are the differences?', 'Why are there differences?', 'What has caused the differences?' Then ask the pupils where they think all these soil 'ingredients' originally came from.

Possible answer(s):

- the pebbles, sand and mud were either brought into the area by rivers or came from the rocks beneath;
- the pieces of plant came from plants growing in the soil that died and were buried.

Circus activity 4: Make your own soil

Topic: Investigating the type and origin of the ingredients of soil

Activity:
Mix together some gravel, sand, powdered clay, dry compost (to represent humus*) and decayed, crumbled, dry leaves (to represent litter*). Mix enough for small groups of children to have one small bowlful each.

The ingredients for 'Make your own soil' (*Elizabeth Devon*)

Ask the pupils to:
- use magnifiers to identify all the ingredients of the mixture. Ask one child in each group to record the results
- use rulers to measure each of the ingredients
  - gravel should be more than 2 mm (long axis)
  - sand (1 - 2mm)
  - clay less than 1mm
  - compost - variable
  - dry leaves - variable
- add a tablespoon of water to their mixture and stir it up
- suggest what their mixture might be
  A. hopefully, they will say 'soil'
- suggest what is missing from their soil mixture
  A. answers should include small creatures, worms, bacteria, fungi etc.
- suggest what could make two soils different
  A. soils would be different depending on the quantities of the ingredients above and on the type of litter and the type of rock grains.

Introduce correct terminology:
- litter is the name used for dead plant material
- humus is decomposed litter and animal remains; decomposition occurs from the action of bacteria, fungi and small animals.

The pupils now know that the organic ingredients of their soil are litter, humus and living things.
Now ask the pupils to suggest where the gravel, sand and powdered clay might come from.
A. They all come from broken down (weathered) rock which is beneath the soil.

Finale:
Put all the ingredients for making the soil on to the table in front of you. Invite the pupils to contribute as you make soil in front of them. Any debate about 'how much to use' leads on to further discussions about the make-up of different soils.

Pupil learning outcomes: Pupils can:
- use magnifiers to look carefully and identify the ingredients of their mixtures;
- use rulers to measure small and very small grains;
- record their results;
- realise that all soils are made up of similar ingredients;
- appreciate that those ingredients may vary in quantity and type.

Curriculum references:

England	Scotland	Wales	Northern Ireland
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Age range of pupils: 5 - 10 years

Time needed to complete activity: 20 minutes

The story for teachers:
Soil is a mixture of rock grains and decayed plant matter (litter). Bacteria and fungi are essential to decompose this litter. The most productive soils usually have 45% mineral particles, 25% air, 25% water, 5% humus. Humus is decayed litter and animal debris decomposed by bacteria, small creatures and worms. Soils vary with different types of underlying rock and different vegetation types.

- Rock weathers by physical and chemical processes and the broken pieces form the inorganic component of soils.
- Litter, (decayed plant matter) and humus, (decomposed litter and animal remains) comprise the organic components of soils.

- Soils can be acid, alkaline or neutral, as measured on a pH scale. Acid soils give pH readings of less than pH 6, alkaline soils of more than pH 7 and neutral soils have a reading of pH 6 - 7.
- Sandstone weathers to give a sandy soil which usually results in an acid pH and so is suitable for acid-loving plants, such as heathers.
- Limestone weathers to give a lime-rich soil which has an alkaline pH, encouraging alkaline-loving plants such as brassicas (cabbage family).
- Bacteria and fungi are essential in the decomposition of plant and animal matter.
- Worms are important in mixing litter, humus and rock particles and in aerating soils, thus allowing water to percolate into the soil.

By looking carefully at a variety of soils, pupils will realise that there is a pattern in their composition. Discussion within the group involves metacognition. Relating their own mixture of ingredients to real soils involves bridging skills.

Lead in ideas: Lead a discussion about what is soil. Many young children think it is mud and have very little idea what it is made of.

Following up the activity:
- If litmus paper is available, pupils could mix a dessert spoonful of soil with a little distilled water. A piece of litmus paper dipped into the mixture will indicate whether the soil is acid, neutral or alkaline.
- The ingredients in the soils around the school or from a garden could be investigated
- They could try some of these ESEU and Earthlearningidea activities (http://www.earthlearningidea.com)
  - Soil doughnuts
  - Soil layers puzzle
  - Permeability of soils - 'The great soil race'
  - Why does soil get washed away?
  - Darwin's 'big soil idea'
- Try other activities in the '*Working with Soil'* - activity pack and booklet (Waldorf the Worm ISBN 873266 16 2), ESTA Primary Committee, Earth Science Teachers' Association, 2003.

Note: Pupils should wear disposable plastic gloves if these are available, or take care to wash their hands carefully after handling soils.

Source: Elizabeth Devon, ESEU and ELI Team

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Preparation and set-up time: 10 minutes

Resource list:
- gravel, sand, powdered clay, humus, decayed, crumbled, dry leaves - all in separate containers
- magnifiers
- paper and pencils
- rulers
- jug of water
- tablespoons
- if available, disposable plastic gloves for any work with real soils

Risk assessment:

Potentially Hazardous Activity	Who/What may be Harmed?	Hazard Rating (A)	Likelihood (B)	Risk (AxB)	Further Action Required?
Make your own soil	Pupils and staff at risk from organisms in soil e.g. tetanus	3	2	6	Wear gloves if any cuts on hands. Otherwise, wash hands after activity

Hazard Rating (A):
1 = Insignificant effect
2 = Minor Injury
3 = Major Injury
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Likelihood of occurrence (B):
1 = Little or no likelihood
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Risk Priority (AxB):
12-25 = High risk – take immediate action
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5 = Death 5 = Inevitable

ESEU activity guide sheet:

Make your own soil

Investigating the type and origin of the ingredients of soil

Mix together some gravel, sand, powdered clay, dry compost (to represent humus*) and decayed, crumbled, dry leaves (to represent litter*). Mix enough for small groups of children to have one small bowlful each.

Ask the pupils to:

- use magnifiers to identify all the ingredients of the mixture. Ask one child in each group to record the results
- use rulers to measure each of the ingredients
  - gravel should be more than 2 mm (long axis)
  - sand (1 - 2mm)
  - clay less than 1mm
  - compost - variable
  - dry leaves - variable

The ingredients for 'Make your own soil' (*Elizabeth Devon*)

- add a tablespoon of water to their mixture and stir it up
- suggest what their mixture might be
- suggest what is missing from their soil mixture
- suggest what could make two soils different

Introduce correct terminology:

- litter is the name used for dead plant material
- humus is decomposed litter and animal remains; decomposition occurs from the action of bacteria, fungi and small animals.

The pupils now know that the organic ingredients of their soil are litter, humus and living things.

Now ask the pupils to suggest where the gravel, sand and powdered clay might come from.

Finale

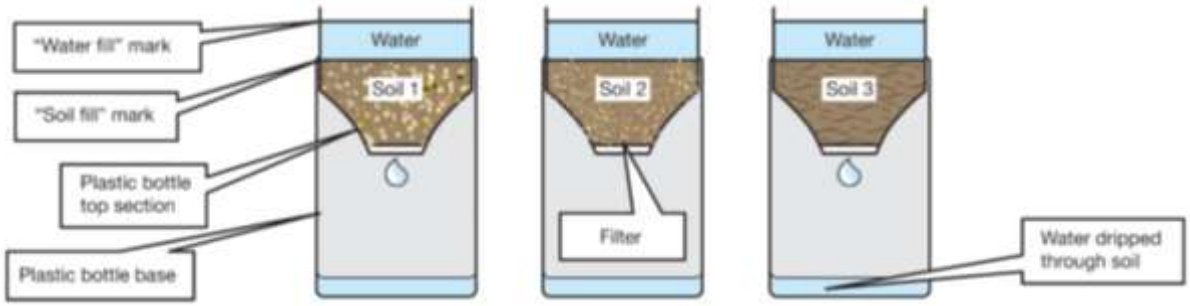
Put all the ingredients for making the soil on to the table in front of you. Invite the pupils to contribute as you make soil in front of them. Any debate about 'how much to use' leads on to further discussions about the make-up of different soils.

Circus activity 5: The great soil race

Topic: Comparing the permeability of different soils – and thinking what this means.

Activity:
Show the pupils the different soils you have available and ask them which one they think will let water through most quickly. You could ask them to plan a fair test first, by asking them: 'What will we keep the same?', 'What will we change?', 'What will we measure?'. Then test their ideas as follows:

- each group should collect the apparatus and a soil sample (Health and Safety: natural soil samples should only be handled with plastic gloves). They should line the funnel with the cloth filter and fill the funnel to the soil-fill mark;
- then, to highlight the 'race' potential of this investigation, they should line the apparatus up in a row, with a water pourer behind each. When you say 'start' the pourer should fill the funnel up to the water-fill mark and everybody should watch what happens. When all the water has drained into and through the soils (or you get tired of waiting) ask the pupils to examine the results, and work out which is the fastest draining soil (the 'winner') and what is the rank order of the others.



Simple equipment for testing soil permeability (*ESEU*)

The great soil race (*Peter Kennett*)

After the activity, by putting the beakers in order, the pupils can produce a visual bar graph of the amount of water that drained through – which is an appropriate 'graph' of soil permeability.

Ask the pupils, in the light of their findings:
- which soils would get muddy on top after heavy rain?
- which soils would dry out quickly – so that plants in them might need to be watered often?
- which soils would store water for plants well?
- in a rainstorm, would you prefer to be walking over a well-drained soil or a poorly-drained soil?
- in a drought, would you prefer your garden soil to be well-drained or poorly-drained?
- if you had a poorly-drained soil in your garden, what could you do to help it to drain better?
- are soils in your school and local area generally well-drained or poorly-drained?

Pupil learning outcomes
Pupils can:
- carry out a fair test of soil permeability;
- describe the results and give an explanation of them;

- link the results to questions about soil-draining, including the local soils.

Curriculum references:

England	Scotland	Wales	Northern Ireland
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Age range of pupils: 7 - 11 years

Time needed to complete activity: 20 minutes

The story for teachers:

The results will depend on the different types of soils used. Sandy soils drain quickly, whilst clay soils drain much more slowly. Loam soils, formed of mixed organic material and sand, drain at different rates, depending on the mix.

Soil through which water flows through quickly is called a well-drained soil – it is very permeable; however, soil where water flows through slowly is poorly-drained (fairly impermeable). Sandy soils are usually well-drained whilst clay soils are usually poorly-drained.

Use local soils if you can – but you may want to compare them with a soil collected on your holidays!

Possible answers to the questions posed:

- which soils would get muddy on top after heavy rain?
  A. the least permeable will hold water well, but will easily become waterlogged with mud and puddles on the surface.
- which soils would dry out quickly – so that plants in them might need to be watered often?
  A. the most permeable soil will tend to dry out quickly,
- would store water for plants well?

A. the soil whose permeability is somewhere between the two extremes above

- In a rain storm, would you prefer to be walking over a well-drained soil or a poorly-drained soil?
  A. a poorly-drained soil will quickly become very muddy, so a well-drained soil is best.
- In a drought, would you prefer your garden soil to be well-drained or poorly-drained?
  A. poorly-drained, as it would retain more water.
- If you had a poorly-drained soil in your garden, what could you do to help it to drain better?
  A. you could add sand (or organic material) or make holes in it to help it to drain.
- Are soils in your school and local area generally well drained or poorly drained?
  A. *if after heavy rain, there are usually puddles on the soil, it is poorly-drained, and vice versa.*

This activity can be carried out as an experiment by the pupils and so fits well into a teaching scheme for science. Pupils can also test their own local soils, making predictions about the outcome based on their observations

Relating the results of the permeability of different soils to different local soil types is a bridging activity

Lead in ideas:
Try the ESEU 'Soil water shake test' activity.

Ideas for following up the activity:
Follow up with the 'Save our soil' ESEU activity.

Ask how the test could be made more fair. Possible answers include:

- all the soils should be fully saturated beforehand, so that the test is not affected by how much water remains stored in the soil;
- a very permeable filter should be used so that the measure of permeability of very permeable soils is not affected by the permeability of the filter paper;

If you ask pupils to work out recipes for their own soils (as suggested for the ESEU 'Soil water shake test' activity') – and then to make them, you could then ask them to test the different recipes for permeability, as above.

Source:
A development from the ESTA Primary Pack, '*Working with Soil'* – 'Look at how much water is kept in soil' developed by members of the ESTA Primary Committee.

Preparation and set-up time:
Once the bottles have been cut to make 'funnels and beakers', the remainder takes just a few minutes to set up.

Resource list
For each group:

- soil samples (Health and Safety: natural soil samples should only be handled with plastic gloves) (a minimum of three different soil samples)
- three plastic jugs to pour water
- a container of water
- three empty lemonade bottles cut in half so that the lower parts become 'beakers', meanwhile, the upper parts, when inverted, become 'funnels'
- cloth filter (e.g. muslin)

Risk assessment:

Potentially Hazardous Activity	Who/What may be Harmed?	Hazard Rating (A)	Likelihood (B)	Risk (AxB)	Further Action Required?
Great Soil Race	Pupils and staff at risk from organisms in soil e.g. tetanus	3	2	6	Wear gloves if any cuts on hands. Otherwise, wash hands after activity.

Hazard Rating (A):
1 = Insignificant effect
2 = Minor Injury
3 = Major Injury
4 = Severe Injury

Likelihood of occurrence (B):
1 = Little or no likelihood
2 = Unlikely
3 = Occasional
4 = Probable

Risk Priority (AxB):
12-25 = High risk – take immediate action
6-11 = Medium risk – take action as soon as possible
Less than 6 = Low risk – plan future actions where required

5 = Death 5 = Inevitable

ESEU activity guide sheet:

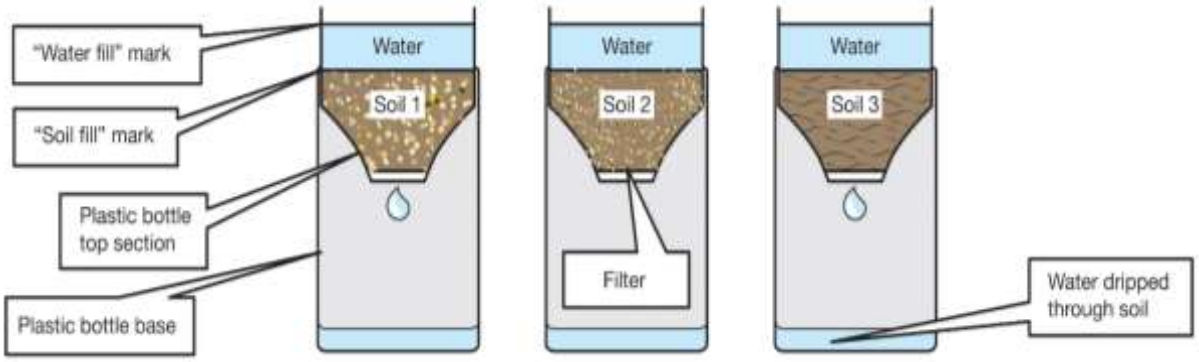
The Great Soil Race

Comparing the permeability of different soils – and thinking what this means.

Show the pupils the different soils you have available and ask them which one they think will let water through most quickly. You could ask them to plan a fair test first, by asking them: 'What will we keep the same?', 'What will we change?', 'What will we measure?'. Then test their ideas as follows:

- each group should collect the apparatus and a soil sample (Health and Safety: natural soil samples should only be handled with plastic gloves). They should line the funnel with the cloth filter and fill the funnel to the soil-fill mark;

- then, to highlight the 'race' potential of this investigation, they should line the apparatus up in a row, with a water pourer behind each. When you say 'start' the pourer should fill the funnel up to the water-fill mark and everybody should watch what happens. When all the water has drained into and through the soils (or you get tired of waiting) ask the pupils to examine the results, and work out which is the fastest draining soil (the 'winner') and what is the rank order of the others.



Simple equipment for testing soil permeability (*ESEU*)

The great soil race (*Peter Kennett*)

After the activity, by putting the beakers in order, the pupils can produce a visual bar graph of the amount of water that drained through – which is an appropriate 'graph' of soil permeability.

Ask the pupils, in the light of their findings:

- which soils would get muddy on top after heavy rain?
- which soils would dry out quickly – so that plants in them might need to be watered often?
- which soils would store water for plants well?
- in a rainstorm, would you prefer to be walking over a well-drained soil or a poorly-drained soil?
- in a drought, would you prefer your garden soil to be well-drained or poorly-drained?
- if you had a poorly-drained soil in your garden, what could you do to help it to drain better?
- are soils in your school and local area generally well-drained or poorly-drained?

Circus activity 6: Changing state - transforming water

Topic: Investigating and discussing the change in state of water from solid to liquid to gas and *vice versa.*

Activity:
A: 'Disappearing' ice
Check that ice cubes are not so cold that they stick to your hand, then give one to each pupil

As they hold the ice cube clasped in their hands, discuss these questions:
How does the ice cube feel? Why?
Where is the water coming from? How?
Where will the ice cube go?
How could you make another ice cube from the water?

This gives pupils opportunities to explore ideas about the change of state from ice to water (and back again), whilst developing their language and discussion ideas.

'Disappearing ice' *(Peter Kennett)*

B: 'Disappearing' water
Show the pupils two plastic beakers, one empty, and the other containing half a centimetre of water. Explain that the empty one had just as much water in it as the other one, when it was left on the shelf by the window over the weekend. On Monday morning, it was empty.

'Disappearing water' *(Peter Kennett)*

Ask the pupils to:
- think of as many things as they can, that might have happened to the water over the weekend;
- note down their ideas;
- then write numbers beside their ideas from the most likely (No. 1) to the least likely;
- think about how to describe how the most likely ideas might have worked.

Pupils can let their imagination run riot in thinking of different things that might have happened to the water, but then need to concentrate on reality, in deciding which is the most likely. This will probably be that the water evaporated into the air, and can no longer be seen.

C: 'Reappearing' water

Take a cold dry bottle of liquid from the fridge (milk or a soft drink). Leave it in the air until drops of water appear on the outside and discuss these questions:

- Where does the water come from?
- Does this happen outdoors naturally?

'Reappearing water' *(Peter Kennett)*

This leads into a discussion about the invisible water in the air becoming visible liquid water on the outside of the bottle when the air cools down. This happens when dew (or frost – as ice) forms on the grass on cool mornings or when rain drops grow in clouds in the atmosphere as they become cooler.

Pupil learning outcomes: Pupils can:

- describe what happens to ice as it melts to form liquid water;
- describe what happens to liquid water as it evaporates to form water vapour;
- describe how liquid water collects on cold surfaces as the water vapour in the atmosphere condenses;
- explain some of these processes.

Curriculum references:

England	Scotland	Wales	Northern Ireland
Science: KS1 Years 1 and 2 **Working scientifically** • asking simple questions and recognising that they can be answered in different ways • observing closely, using simple equipment • performing simple tests • using their observations and ideas to suggest answers to questions • gathering and recording data to help in answering questions Pupils in years 1 and 2 should explore the world around them and raise their own questions. They should experience different types of scientific enquiries, including practical activities, and begin to recognise ways in which they might answer scientific questions. With help, they should record and communicate their findings in a range of ways and begin to use simple scientific language **Year 1** **Everyday materials** • identify and name a variety of everyday materials, including wood, plastic, glass, metal, **water,** and rock • describe the simple physical properties of a variety of everyday materials **Lower KS2 Years 3 and 4** **Working scientifically** • asking relevant questions and using different types of scientific enquiries to answer them • making systematic and careful observations • recording findings using simple scientific language. • reporting on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions • using results to draw simple conclusions, make predictions for new values, suggest improvements	**Sciences:** **Early/First** **Planet Earth** **Processes of the planet** Learners explore the changing states of matter By investigating how water can change from one form to another, I can relate my findings to everyday experiences. SCN 0-05a / SCN 1-05a **Second** I can apply my knowledge of how water changes state to help me understand the processes involved in the water cycle in nature over time. SCN 2-05a	**Science: KS2** **The sustainable Earth** • a comparison of the features and properties of some natural and made materials	**The world around us** **KS2** **Strand3: Place** **Change over time in places:** • how changes in state can be brought about (S&T); • that some changes can be controlled (G, S&T)

• and raise further questions • identifying differences, similarities or changes related to simple scientific ideas and processes • using straightforward scientific evidence to answer questions or to support their findings **Year 4** **States of matter** • compare and group materials together, according to whether they are solids, liquids or gases • observe that some materials change state when they are heated or cooled. • identify the part played by evaporation and condensation in the water cycle and associate the rate of evaporation with temperature. Pupils should explore a variety of everyday materials and develop simple descriptions of the states of matter (solids hold their shape; liquids form a pool not a pile; gases escape from an unsealed container). Pupils should observe water as a solid, a liquid and a gas and should note the changes to water when it is heated or cooled They might observe and record evaporation over a period of time, for example a puddle in the playground or washing on a line, and investigate the effect of temperature on washing drying or snowmen melting **Geography: KS2** **Human and physical geography** describe and understand key aspects of: • physical geography, including: climate zones, biomes and vegetation belts, rivers, mountains, volcanoes and earthquakes, and the water cycle			

Age range of pupils: 5 – 8 years

Time needed to complete activity: 10 minutes

The story for teachers:
- Solid water (ice) becomes liquid through melting.
- Liquid water becomes the invisible gas, water vapour through evaporation.
- Water vapour becomes liquid through condensation.
- Liquid water becomes solid through freezing.

A series of three activities for pupils to encounter and discuss the changing states of water, from ice to water to water vapour and back again – giving opportunities to develop a range of observation and description skills.

Note that water vapour is an invisible gas; when we breathe out on a cold morning, we can see our breath because the gas condenses to tiny water droplets that can be seen. These droplets can also be seen coming out of the spout of a boiling kettle, and in clouds, mist and fog.

The activity can be used in any science or geography lessons when changing state and/or the water cycle is under discussion.

Thinking about how the processes link to the real world and the 'What state am I in myself?' follow up, both involve bridging learning to new situations. Meanwhile, discussions involving disagreements involve cognitive conflict.

Lead in ideas: Ask the pupils if they know where rain comes from. Why does it fall from the sky? Why do puddles disappear? How does washing dry on a line?

Following up the activity:
- Ask, 'What state am I in, myself?' to reinforce learning about the states of matter and their transformations. Pupils should realise that whilst they are mostly solid, they contain several litres of liquid (blood and other fluids) and also gas in the lungs (and in the bowel!). They may also realise that transformations happen in their bodies, for example that the gas in the lungs becomes dissolved in blood, thus becoming part of the liquid, whilst the blood takes materials to form new solid cells. Meanwhile the gut breaks down food into liquids and gases. A variety of other solid/ liquid/ gas changes occur in the body too.
- Discuss how wet washing hung on a line outside, dries – and the factors that might affect how quickly it dries.

- Devise classroom tests for testing the variables affecting drying washing, e.g. one 'control' cloth lying on the bench and others: a) on the radiator, b) hanging near the window, c) hanging near the door, d) hanging near a fan, etc.
- Put "water cycle song" into a search engine like Google™ to find several songs at different learning levels. By just inserting "water cycle", you will find a range of other water-related activities.
- See the other Earthlearningidea 'watery' activities at:
  http://www.earthlearningidea.com/home/Teaching_strategies.html

Source: Devised during an Earth Science Education Unit workshop in Scotland, based on ideas by Roger Mitchell.

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Preparation, set-up: 5 minutes provided ice is available and a bottle of liquid has been put in the refrigerator, (and the teacher is prepared to cheat with the two plastic beakers)!

Resource list:

A: 'Disappearing' ice

- a container of ice cubes
- a cloth to mop up with

B: 'Disappearing' water

- two transparent plastic beakers, or similar, one containing about 0.5 cm depth of water

C: 'Reappearing' water

- a bottle of liquid from the fridge (milk or a soft drink), that has been dried off before using

Risk assessment:

Potentially Hazardous Activity	Who/What may be Harmed?	Hazard Rating (A)	Likelihood (B)	Risk (AxB)	Further Action Required?
Changing state - transforming water	No significant hazard	-	-	-	No

Hazard Rating (A):
1 = Insignificant effect
2 = Minor Injury
3 = Major Injury
4 = Severe Injury
5 = Death

Likelihood of occurrence (B):
1 = Little or no likelihood
2 = Unlikely
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5 = Inevitable

Risk Priority (AxB):
12-25 = High risk – take immediate action
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Less than 6 = Low risk – plan future actions where required

ESEU activity guide sheet:

Changing state - transforming water

Investigating and discussing the change in state of water from solid to liquid to gas and *vice versa.*

A: 'Disappearing' ice

Check that ice cubes are not so cold that they stick to your hand, then give one to each pupil

As they hold the ice cube clasped in their hands, discuss these questions:

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B: 'Disappearing' water

Show the pupils two plastic beakers, one empty, and the other containing half a centimetre of water. Explain that the empty one had just as much water in it as the other one, when it was left on the shelf by the window over the weekend. On Monday morning, it was empty.

Ask the pupils to:

- think of as many things as they can, that might have happened to the water over the weekend;
- note down their ideas;
- then write numbers beside their ideas from the most likely (No. 1) to the least likely;
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Pupils can let their imagination run riot in thinking of different things that might have happened to the water, but then need to concentrate on reality, in deciding which is the most likely. This will probably be that the water evaporated into the air, and can no longer be seen.

C: 'Reappearing' water

Take a cold dry bottle of liquid from the fridge (milk or a soft drink). Leave it in the air until drops of water appear on the outside and discuss these questions:

- Where does the water come from?
- Does this happen outdoors naturally?

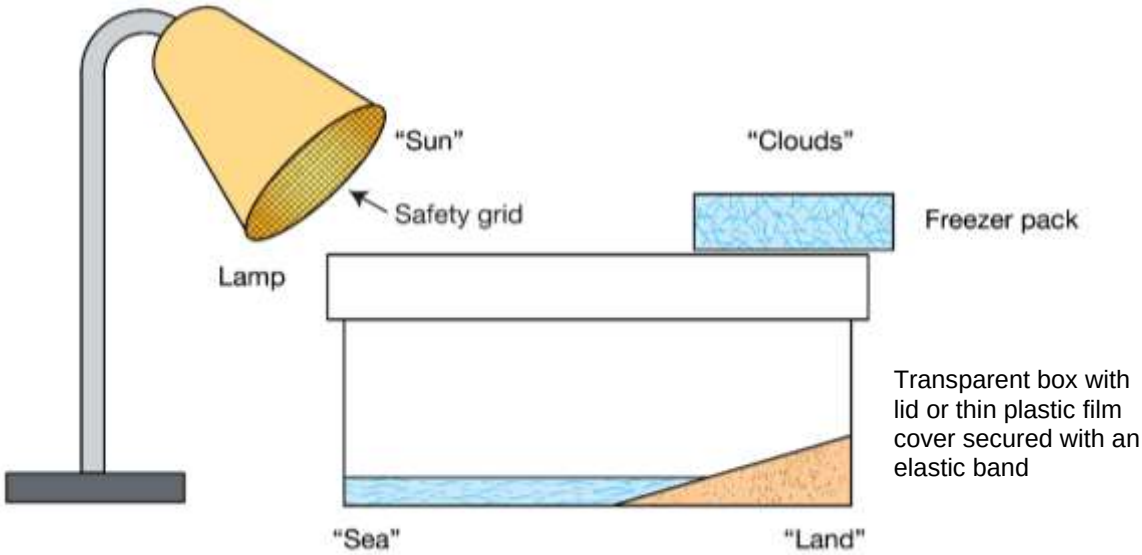
All photos: Peter Kennett.

This leads into a discussion about the invisible water in the air becoming visible liquid water on the outside of the bottle when the air cools down. This happens when dew (or frost – as ice) forms on the grass on cool mornings or when rain drops grow in clouds in the atmosphere as they become cooler.

Circus activity 7: Make your own rain

Topic:
The activity demonstrates the stages of the water cycle in a mini-world.

Activity:
Set up the activity as shown in the diagram below: ***Be wary of the hot lamp/bulb – see note in the 'Resources' section.***



A mini-water cycle *(ESEU)*

- Pupils work in groups to design and make a mini-world model in a plastic container with a lid or thin plastic film cover secured with an elastic band - including the 'sea',' land', and the 'sun'.
- The lamp is then switched on (show that this produces heat as well as light).
- After a few minutes the freezer block is placed on top of the container above the 'land'. The freezer block concentrates the condensation into one place and simulates a cloud, as well as hastening the process.
- The results can be related to a diagram of the water cycle.

Make your own rain (*Peter Kennett*)

Pupil learning outcomes
Pupils can:
- explain that heating the water causes evaporation, i.e. the water changes state to water vapour;
- explain that the air with water vapour cools as it rises. When saturation point is reached, condensation occurs, i.e. water vapour changes state to liquid;

- say that the water droplets are tiny (clouds) and need to join together before they will fall as rain droplets;
- describe how the rain falls into the 'sea' and the cycle starts again with evaporation of 'sea' water;
- visualise how the water cycle works on the planet.

Curriculum references:

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Age range of pupils: 7 – 11 years

Time needed to complete the activity:

- 20 minutes minimum.
- 5 minutes set-up time, leave for 15 minutes, then review.
- Can be set up and left for 24 hours plus and observed at different intervals.

The story for teachers:

- The Sun warms the Earth - represented by the lamp in the activity.
- Water evaporates from water surfaces, from the 'sea' in the model. The warmer the water the greater the evaporation rate.
- The warm, wet air rises and cools (near the freezer block) and condenses into water droplets or clouds (on the plastic lid under freezer block).
- Air contains evaporated water as molecules of invisible water vapour; the more water vapour, the greater the humidity.
- When humid air is cooled, water condenses to form water droplets.
- As condensation continues, water droplets can grow until they become heavy enough to fall i.e. water drips from lid on to the land. *Note: if the 'clouds' were above the 'sea', it would 'rain' on the 'sea' instead.*
- The main elements of the water cycle are evaporation, movement of air carrying water vapour, condensation to form precipitation (rain, snow, etc.) and, following precipitation on land, flow of water over or through the soil/rocks.

This activity about the water cycle can be used in any science or geography teaching scheme.

The linking of the model to reality is a bridging skill. Responding to the questions involves elements of construction, cognitive conflict and metacognition

Lead in ideas:

- Changes of state must have been taught before this activity is undertaken. Pupils should understand liquid, solid, vapour, evaporation and condensation, e.g. by trying the ESEU/Earthlearningidea activities 'Changing state - transforming water' or 'Water cycle world'.
- Introduce photos/pictures of the water cycle in action. Pick out the key characteristics, i.e. sea, land and clouds. What are clouds? Why are they there? How are they made?

Following up the activity:

- Draw the water cycle and add key words.
- Leave the mini-world for one or two weeks and make a diary of observations/draw pictures. (Don't use the freezer block if the project is set-up long term).
- The variables could be altered, e.g. fresh or salt water, ratio of land to water, light on/off for periods.
- Predictions could be made about what might happen.
- Clay or Plasticine™ could be used for the land mass and predictions made about where rivers might form.
- If the sea is made of salty water, you could demonstrate that the cycle of evaporation and condensation affects only water, not salt, so that the 'rain' is fresh.

Source:
Adapted and refined by Sarah Lewis.

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Preparation and set-up time:
See 'Time needed to complete the activity' above.

Resource list:

- **lamp - the bulb has to be a filament-type of 60-100W (low energy bulbs will not work) Ideally it should be a 60W reflector bulb which keeps the lamp body cool. The safety grid will get almost as hot as the bulb and is easily touched. It's best to have a well-recessed reflector bulb!**
- transparent plastic box; a box suitable for the freezer is ideal

EITHER

- lid for the transparent box

OR

- thin transparent plastic film (e.g. Cling Film™) to cover box
- large elastic band to secure plastic film

- sand for the 'land'
- water
- frozen freezer block
- water cycle diagram from the internet

Risk assessment:

Potentially Hazardous Activity	Who/What may be Harmed?	Hazard Rating (A)	Likelihood (B)	Risk (AxB)	Further Action Required?
Make your own Rain	Teacher/pupil Risk of burnt fingers from hot lamp	2	2	4	Ensure that nobody touches the hot lamp

Hazard Rating (A):
1 = Insignificant effect
2 = Minor Injury
3 = Major Injury
4 = Severe Injury
5 = Death

Likelihood of occurrence (B):
1 = Little or no likelihood
2 = Unlikely
3 = Occasional
4 = Probable
5 = Inevitable

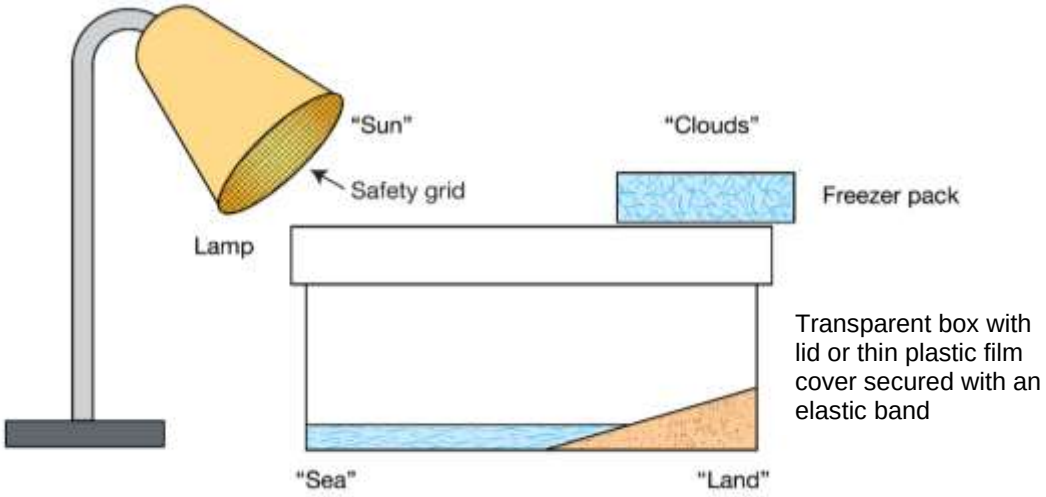
Risk Priority (AxB):
12-25 = High risk – take immediate action
6-11 = Medium risk – take action as soon as possible
Less than 6 = Low risk – plan future actions where required

ESEU activity guide sheet:

Make your own rain

The activity demonstrates the stages of the water cycle in a mini-world.

- Set up the activity as shown in the diagram below:
  Be wary of the hot lamp/bulb



A mini-water cycle *(ESEU)*

- Pupils work in groups to design and make a mini-world model in a plastic container with a lid - including the 'sea',' land', and the 'sun'.
- The lamp is then switched on (show that this produces heat as well as light).
- After a few minutes the freezer block is placed on top of the container above the 'land'. The freezer block concentrates the condensation into one place and simulates a cloud, as well as hastening the process.
- The results can be related to a diagram of the water cycle.

Make your own rain (*Peter Kennett*)

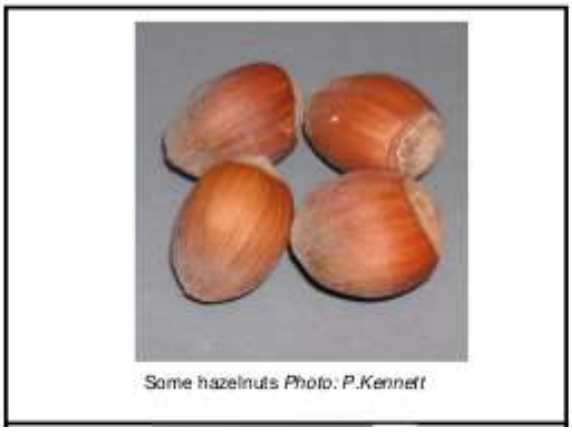
Circus activity 8: Fossil or not?

Topic: A discussion about what is a fossil and what is not; this is a practical activity with pictures (see later) and/or specimens to help you to discuss what is a fossil and what is not.

Activity:
Give the pupils these definitions:
A fossil: is any preserved sign of past life, more than 10,000 years old;
A body fossil: is the remains of the body of an animal or plant, or the imprint or cast of it;
A trace fossil: indicates that an animal or plant was there, but is not a body fossil; it includes footprints, burrows, signs of roots, tooth marks, etc.

Ask the pupils:
- Now you know what fossils are, can you put the pictures and/or specimens into three groups and label them: (1) Body fossil (2) Trace fossil (3) Not a fossil.

(You may like to give the pupils pre-prepared labels.)



Example pictures of 'Fossil or not?'

- Which of the following are fossils?
  - 4000 year-old footprints like ours;
  - a squirrel killed on the road;
  - 3500 million year-old cell filaments;
  - a petrified tree stump;
  - the trail of a trilobite in 530 million year-old rocks;
  - 'tree-like', dendritic mineral growths;
  - a beach pebble with holes bored by marine organisms;
  - a human shape preserved in volcanic ash at Pompeii;
  - a piece of dinosaur skin?

Pupil learning outcomes: Pupils can:
- distinguish between what is and what is not a fossil;
- discuss the criteria for making that decision.

Curriculum references:

England	Scotland	Wales	Northern Ireland
Science: KS1 Years 1 and 2 **Working scientifically** • asking simple questions and recognising that they can be answered in different ways • observing closely, using simple equipment • performing simple tests • identifying and classifying • using their observations and ideas to suggest answers to questions **Year 1** **Everyday materials** • identify and name a variety of everyday materials, including wood, plastic, glass, metal, water, and rock	**Science: Biodiversity and independence** **First** I can distinguish between living and non-living things. I can sort living things into groups and explain my decisions. SCN 1-01a	**Knowledge and understanding of the world** **Foundation phase** **Development of skills** The following skills are essential to this Area of Learning and can also be developed across the curriculum.	**The world around us** **Foundation stage** **Strand 1: interdependence** How living things rely on each other within the natural world; • about the variety of living things

Year 2 **Living things and their habitats** • explore and compare the differences between things that are living, dead, and things that have never been alive **Lower KS2 Years 3 and 4** **Working scientifically** • asking relevant questions and using different types of scientific enquiries to answer them • making systematic and careful observations • gathering, recording, classifying and presenting data in a variety of ways to help in answering questions • recording findings using simple scientific language, drawings, labelled diagrams, • reporting on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions • using results to draw simple conclusions, make predictions for new values, suggest • improvements and raise further questions • identifying differences, similarities or changes related to simple scientific ideas and processes • using straightforward scientific evidence to answer questions or to support their findings **Year 3** **Rocks** • describe in simple terms how fossils are formed when things that have lived are trapped within rock **Upper KS2 Years 5 and 6** **Year 6** **Evolution and inheritance** • recognise that living things have changed over time and that fossils provide information about living things that inhabited the Earth millions of years ago	**Second** I can identify and classify examples of living things, past and present, to help me appreciate their diversity. I can relate physical and behavioural characteristics to their survival or extinction. SCN 2-01a	• Observing • Comparing • Classifying • Listening • Making decisions • Reflecting • Describing • Sorting and grouping • Asking/ answering questions • Recording • Communicating	As pupils progress through the Foundation Stage they should be enabled to: • show curiosity about the living things, places, objects and materials in the environment; • identify similarities and differences between living things, places, objects and materials;

Age range of pupils: 5 - 16 years

Time needed to complete activity: 20 minutes

The story for teachers:
The fossil record is evidence for evolution. In order to study it, we need to understand what a fossil actually is. Pupils may think that only the bones and teeth of animals can be fossilised, and that fossils have to be preserved in rock.

- What is a fossil? A fossil is any preserved evidence of life, usually regarded as more than 10,000 years old (the start of the Holocene Epoch – although some palaeontologists disagree about this age-related definition). Fossils consisting of the organisms themselves, or of isolated body parts, are known as body fossils. Fossils which preserve evidence of behaviour (such as footprints, burrows and droppings) but not body parts, are known as trace fossils. Some rocks that contain fossils are unconsolidated, such as some clays and sands. The fossil record is evidence for evolution.

  The pictures show the following:-
  - fossil bone (body fossil)
  - hazelnuts (not a fossil – not old enough)
  - fossilised wood (body fossil)
  - fossil shell (body fossil)
  - desiccation cracks (not a fossil – evidence of a dry environment but not evidence of life)
  - fossil tooth (body fossil)
  - dinosaur footprint (trace fossil)
  - insects in amber (body fossil).

- Which of the following are fossils?

○ 4000 year-old footprints like ours as found in mud north of Liverpool, UK	not old enough to be a trace fossil
○ a squirrel killed on the road	not a fossil, not old enough
○ 3500 million year old cell filaments	body fossil
○ a petrified tree stump	body fossil
○ the trail of a trilobite in 530 million year-old rocks	trace fossil

○ ‘tree-like’, dendritic mineral growths	not a fossil – not produced by life
○ a beach pebble with holes bored by marine organisms	probably not a fossil, unless the boring took place more than 10,000 years ago, in which case the boring is a trace fossil
○ a human shape preserved in volcanic ash at Pompeii	not old enough to be a fossil – Vesuvius erupted, burying Pompeii, in AD79
○ a piece of dinosaur skin	body fossil

By organising objects into groups pupils are establishing a pattern. Recognising that some objects are not fossils, even though they appear to be, involves cognitive conflict. Discussion about the activity is metacognition. The ability to say something about the environment of the animal or plant when it was alive is bridging.

This activity fits well into teaching schemes with lessons about the development of life on Earth and with sorting objects into groups.

Lead in ideas: With some specimens and photographs discuss the pupils' knowledge about fossils and the fossilisation process.

Following up the activity:
Consider what would be the best way for you to leave a sign of your life for the future? For it to be classified as a fossil, it would have to last for more than 10,000 years!
See Earthlearningidea ‘Dead and buried - how could I become fossilised?’

Source: Earth Science Education Unit, Keele University - www.earthscienceeducation.com
2005 Dead and Buried? Teaching KS4 Biology.

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Preparation and set-up time: 10 minutes

Resource list:
Pictures of the following (supplied - you may wish to replace some with your own specimens)
- fossil bone
- hazelnuts (if you provide these, be sure they are shelled – due to possible nut allergies)
- fossilised wood
- fossil shell
- desiccation cracks
- fossil tooth
- dinosaur footprint
- insects in amber

Include more specimens or pictures of your own, such as:
- egg-shaped pebble (not a fossil – not organic)
- modern tooth (not a fossil – not old enough)
- coprolite (fossil droppings; trace fossil)
- fossil leaf (body fossil)
- fossil burrows (trace fossil).
- three sheets of paper, or card, labelled ‘body fossil’, ‘trace fossil’ and ‘not a fossil’ on which to group the pictures or specimens, (optional – given overleaf)
- definition cards with the following definitions, (optional – given on page 49)

Risk assessment:

Potentially Hazardous Activity	Who/What may be Harmed?	Hazard Rating (A)	Likelihood (B)	Risk (AxB)	Further Action Required?
Fossil or not	No significant hazard	-	-	-	No

Hazard Rating (A):
1 = Insignificant effect
2 = Minor Injury
3 = Major Injury
4 = Severe Injury
5 = Death

Likelihood of occurrence (B):
1 = Little or no likelihood
2 = Unlikely
3 = Occasional
4 = Probable
5 = Inevitable

Risk Priority (AxB):
12-25 = High risk – take immediate action
6-11 = Medium risk – take action as soon as possible
Less than 6 = Low risk – plan future actions where required

Fossil bone - Ichthyosaur vertebra *Photo: P.Kennett*

Some hazelnuts *Photo: P.Kennett*

Fossil wood *Photo: P.Kennett*

Fossil shell *Photo: P.Kennett*

Desiccation cracks *Photo: P.Kennett*

Fossil shark tooth *Photo: P.Kennett*

Cast of fossil footprint of hind foot of *Iguanodon*
Photo: P. Murphy, Leeds University

Insects in amber *Photo: E. Devon*

Sorting sheets (Fossil or not?)

A body fossil:

A trace fossil:

Not a fossil

Definition Cards (Fossil or not?)

A fossil:

is any preserved sign of past life more than 10,000 years old

A trace fossil:

indicates that an animal or plant was there, but is not a body fossil; it includes footprints, burrows, signs of roots, tooth marks, etc.

A body fossil:

is the remains of the body of an animal or plant, or the imprint or cast of it

ESEU activity guide sheet:

Fossil or not?

A discussion about what is a fossil and what is not; this is a practical activity with pictures (see later) and/or specimens to help you to discuss what is a fossil and what is not.

Give the pupils these definitions:

- A fossil: is any preserved sign of past life, more than 10,000 years old;
- A body fossil: is the remains of the body of an animal or plant, or the imprint or cast of it
- A trace fossil: indicates that an animal or plant was there, but is not a body fossil; it includes footprints, burrows, signs of roots, tooth marks, etc.

Ask the pupils:

Now you know what fossils are, can you put the pictures and/or specimens into three groups and label them: (1) Body fossil (2) Trace fossil (3) Not a fossil.
(You may like to give the pupils pre-prepared labels.)

Example pictures of 'Fossil or not?

Then consider, which of the following are fossils?

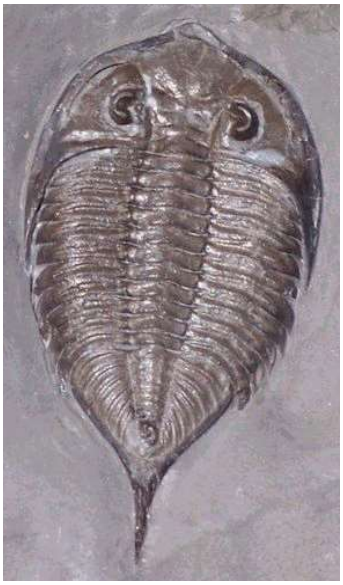
- 4000 year-old footprints like ours;
- a squirrel killed on the road;
- 3500 million year-old cell filaments;
- a petrified tree stump;
- the trail of a trilobite in 530 million year-old rocks;
- 'tree-like', dendritic mineral growths;
- a beach pebble with holes bored by marine organisms;
- a human shape preserved in volcanic ash at Pompeii;
- a piece of dinosaur skin?

Plenary: What was it like to be there? – bringing a fossil to life

Topic: Using a series of questions to bring fossils (real specimens, plaster casts, photos or drawings) to life in the ancient environments in which they lived and died.

Activity:
Try to bring fossils to life in the imaginations of your pupils by asking a series of key questions. Encourage them to use the evidence from the fossils themselves to answer the questions, rather than by guessing. Ask them to suggest what other evidence might help them to give even better answers. The '**What was it like to be there?**' questions are as follows:

When it was alive:
- What sort of place was this animal living in?
- What did it breathe?
- What did it eat?
- Was it a hunter? – or hunted? – or both?
- What could it have seen?
- What could it have sensed?
- How did it die? – can we tell?
- What happened after it died?



A fossil trilobite of the species *Dalmanites limulurus*, 7 cm long. From Silurian age (443 – 416 million year old) mudstone strata of New York state (USA). (*Taken by DanielCD. Permission is granted to copy, distribute and/or modify this document under the terms of the GNU Free Documentation License.*)

Possible answers, for the trilobite shown in the photograph, are:
- What sort of place was this animal living in*? A. The flat shape suggests that it crawled around on the sea bed or swam near the sea floor.*
- What did it breathe? *A. It took oxygen from the water around, it 'breathed' from sea water.*
- What did it eat? *A. Smaller sea bed creepy crawlies or bits of dead animals*.
- Was it a hunter? – or hunted? – or both? *A. Depending on the age of the rock, both – it hunted little things, but was hunted in later geological periods by bigger things, like large nautiloids (squids). Its "armoured" exterior was for protection from these bigger things*.
- What could it have seen? *A. It had eyes, so it could have looked around and seen the sea bed with plants and other sea bed animals and, depending on the age of the rock, maybe fish in the water above.*
- What could it have sensed? *A. It could sense light with its eyes and vibrations in the water with its body.*
- How did it die? – can we tell? *A. This near perfect specimen might have been suddenly buried by muddy sediment and died.*
- What happened after it died? *A. The soft parts rotted and disappeared and the surrounding sediment hardened into rock.*

The questions should help pupils to understand that the fossil was once a living, breathing, animal before it died and became preserved in the rock.

Pupil learning outcomes: Pupils can:
- describe an animal fossil as the ancient remains of a living, breathing entity preserved in rock;
- interpret evidence from the fossil itself and the surrounding sediment to suggest the lifestyle and environment of the original animal.

Curriculum references:

England	Scotland	Wales	Northern Ireland
Science: KS1 Years 1 and 2 **Working scientifically** • asking simple questions and recognising that they can be answered in different ways • observing closely, using simple equipment • performing simple tests • identifying and classifying • using their observations and ideas to suggest answers to questions	**Science: Biodiversity and independence** **First** I can distinguish between living and non-living	**Knowledge and understanding of the world** **Foundation phase** **Development of skills** The following skills	**The world around us** **Foundation stage** **Strand 1: interdependence** **KS2** How living things rely on each other

Year 2 **Living things and their habitats** • explore and compare the differences between things that are living, dead, and things that have never been alive **Lower KS2 Years 3 and 4** **Working scientifically** • asking relevant questions and using different types of scientific enquiries to answer them • making systematic and careful observations • gathering, recording, classifying and presenting data in a variety of ways to help in answering questions • recording findings using simple scientific language, drawings, labelled diagrams, • reporting on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions • using results to draw simple conclusions, make predictions for new values, suggest • improvements and raise further questions • identifying differences, similarities or changes related to simple scientific ideas and processes • using straightforward scientific evidence to answer questions or to support their findings **Year 3** **Rocks** • describe in simple terms how fossils are formed when things that have lived are trapped within rock **Upper KS2 Years 5 and 6** **Year 6** **Evolution and inheritance** • recognise that living things have changed over time and that fossils provide information about living things that inhabited the Earth millions of years ago • identify how animals and plants are adapted to suit their environment in different ways and that adaptation may lead to evolution	things. I can sort living things into groups and explain my decisions. SCN 1-01a **Second** I can identify and classify examples of living things, past and present, to help me appreciate their diversity. I can relate physical and behavioural characteristics to their survival or extinction. SCN 2-01a	are essential to this Area of Learning and can also be developed across the curriculum. • Observing • Comparing • Classifying • Listening • Making decisions • Reflecting • Describing • Sorting and grouping • Asking/ answering questions • Recording • Communicating	within the natural world; • about the variety of living things and the conditions necessary for their growth and survival (S&T) As pupils progress through the Foundation Stage they should be enabled to: • show curiosity about the living things, places, objects and materials in the environment; • identify similarities and differences between living things, places, objects and materials

Age range of pupils: 5 - 10 years

Time needed to complete activity: 10 minutes for each fossil

The story for teachers:
The **'What was it like to be there?'** questions can be used to bring other fossils to life, such as those shown in the photographs.

Possible answers, for the *Gorgosaurus* skeleton in the photograph, are:
- *What sort of place was this animal living in?* It had feet, so must have lived on land and there must have been other animals around for it to eat – and they must have eaten plants.
- *What did it breathe?* It lived on land, breathing the oxygen in the air as we do.
- *What did it eat?* Its sharp teeth show it was a meat-eater.

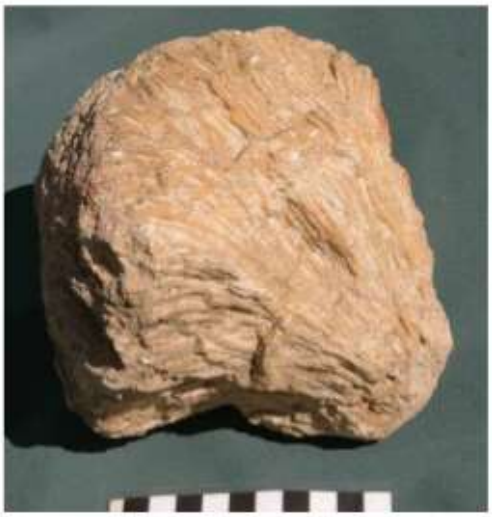
Albertosaurus skeleton in its burial position. Skeleton about 4m across.

(From the American Geological Institute, Earth science World Image Bank

http://www.earthscienceworld.org/images/index.html.
Photo ID: hpdzvh, copyright Abi Howe, AGI.)

- *Was it a hunter? – or hunted? – or both?* The teeth are those of a hunter.
- *What could it have seen?* It could have seen its prey – especially plant-eating dinosaurs, and the plants that they lived on.
- *What could it have sensed?* It would have all the senses that we do.
- *How did it die? – can we tell?* This well-preserved skeleton must have died suddenly and been buried by muddy sediment. The tightening of the neck muscles after death caused its head to bend backwards.
- *What happened after it died?* The soft parts rotted and disappeared and the surrounding sediment hardened into rock, preserving the bones.

What was it like to be there? – when this coral was fossilised in limestone.



Colonial fossil coral *Cladophyllia* from Jurassic (200 - 145 million year old) rocks in Wiltshire, UK, Photo: Elizabeth Devon. Specimen about 15 cm across.

Possible answers, for the coral, are:

- *What sort of place was this animal living in?* Colonial corals today live in shallow warm sea reefs – this one probably did too. ('Colonial' - lots of tiny soft jelly-like coral polyps living together in a colony.)
- *What did it breathe?* It took oxygen from the water around, it 'breathed' from sea water.
- *What did it eat?* Modern coral polyps have soft parts with tentacles to catch small organisms in the sea water. The fossil probably did too.
- *Was it a hunter? – or hunted? – or both?* It caught tiny live animals, so it was a "hunter" even though it was fixed in position.
- *What could it have seen?* It had no eyes.
- *What could it have sensed?* It could sense vibrations and 'smells' in the water.
- *How did it die? – can we tell?* This specimen might have been broken off a reef in a storm and buried with other coral debris – you can see the broken base.
- *What happened after it died?* The soft polyps rotted and disappeared and the surrounding sediment hardened into rock.

The evidence on how fossils lived and died comes from:

- the principle of Uniformitarianism that the 'present is the key to the past' – we use our understanding of the lifestyles of organisms today to interpret how similar organisms lived in the past;
- the evidence preserved in the fossil, such as presence of eyes, limbs, etc. and the unusual preservation of soft parts;
- the traces left by the organism – tracks, trails, burrows, etc. can be very revealing;
- the sediments, with their sedimentary structures, in which the organisms were buried.

Pupils have to use their creativity and imagination to bring the animals and their environments to life, whilst 'bridging' between life today and in the past.

Lead in ideas: With some specimens and photographs discuss the pupils' knowledge about fossils and the fossilisation process.

Following up the activity:
Many other fossil examples can be dealt with in this way, including plant fossils. (Many examples of fossil photographs can be found on the internet, by searching images using an internet search engine like Google).

Consider what would be the best way for you to leave a sign of your life for the future? For it to be classified as a fossil, it would have to last for more than 10,000 years!

See the ESEU/ Earthlearningidea fossil-related activities (http://www.earthlearningidea.com)

- Curious creatures
- How could I become fossilised?
- Mary Anning: Mother of Palaeontology
- Running the fossilisation film backwards
- Trace fossils - burrows or borings
- Trail making
- Who ate the ammonite?
- Dinosaurs
- Dig up the dinosaur
- Dinosaur death - did it die or was it killed?
- Dinosaur in the yard
- How to weigh a dinosaur
- Meeting of the dinosaurs - 100 million years ago

Source: Chris King, Earthlearningidea

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Preparation and set-up time: 10 minutes

Resource list:
Fossils, as real specimens, plaster casts, photos or drawings, and a vivid imagination.

Risk assessment:

Potentially Hazardous Activity	Who/What may be Harmed?	Hazard Rating (A)	Likelihood (B)	Risk (AxB)	Further Action Required?
What was it like to be there? - bringing a fossil to life	No significant hazard	-	-	-	No

Hazard Rating (A):
1 = Insignificant effect
2 = Minor Injury
3 = Major Injury
4 = Severe Injury
5 = Death

Likelihood of occurrence (B):
1 = Little or no likelihood
2 = Unlikely
3 = Occasional
4 = Probable
5 = Inevitable

Risk Priority (AxB):
12-25 = High risk – take immediate action
6-11 = Medium risk – take action as soon as possible
Less than 6 = Low risk – plan future actions where required

ESEU activity guide sheet:

What was it like to be there? – bringing a fossil to life

Using a series of questions to bring fossils (real specimens, plaster casts, photos or drawings) to life in the ancient environments in which they lived and died.

Try to bring fossils to life in the imaginations of your pupils by asking a series of key questions. Encourage them to use the evidence from the fossils themselves to answer the questions, rather than by guessing. Ask them to suggest what other evidence might help them to give even better answers. The '**What was it like to be there?**' questions are as follows.

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- What could it have sensed?
- How did it die? – can we tell?
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Possible answers, for the trilobite shown in the photograph, are:

- What sort of place was this animal living in*?*
  A. The flat shape suggests that it crawled around on the sea bed or swam near the sea floor.

- What did it breathe?
  A. It took oxygen from the water around, it 'breathed' from sea water.

- What did it eat?
  A. Smaller sea bed creepy crawlies or bits of dead animals.

- Was it a hunter? – or hunted? – or both?
  A. Depending on the age of the rock, both – it hunted little things, but was hunted in later geological periods by bigger things, like large nautiloids (squids). Its "armoured" exterior was for protection from these bigger things.

- What could it have seen?
  A. It had eyes, so it could have looked around and seen the sea bed with plants and other sea bed animals and, depending on the age of the rock, maybe fish in the water above.

- What could it have sensed?
  A. It could sense light with its eyes and vibrations in the water with its body.

- How did it die? – can we tell?
  A. This near perfect specimen might have been suddenly buried by muddy sediment and died.

- What happened after it died?
  A. The soft parts rotted and disappeared and the surrounding sediment hardened into rock.

The questions should help pupils to understand that the fossil was once a living, breathing, animal before it died and became preserved in the rock.

Optional activity: Save our soil

Topic: This activity investigates the effect of vegetation cover in protecting soil from erosion in heavy rainfall.

Activity:

- Ask the pupils if they know anyone whose soil has washed away in the rain or know somewhere else where soil has been eroded (erosion: the removal of solid material by flowing water or other surface processes). You might find video-clips or photographs of this on the internet.
- Ask the pupils if they can suggest what can be done to reduce this loss of valuable soil?
- Set up two identical trays, resting on props so that they slope at the same amount, (see photo). Half-fill each tray with the same type of soil, retaining it from slipping down with a piece of wood if necessary.

Save our soil (*Peter Kennett*)

- Cover the soil in one tray with a thin piece of turf, but leave the soil in the other tray exposed. (Alternatively, the investigation could be started a few weeks in advance by sowing a quick-growing crop in the vegetated tray).
- Ask pupils in which tray they expect the soil to be washed away more quickly.
- Sprinkle water on to the soil in each tray, using a watering can.
- In which tray does more muddy water build up in the space at the bottom?
- Is this what the pupils expected?
- Ask the pupils what they think should be done to protect soil from erosion. We can't just put a piece of turf on top to protect it!
- Discuss with pupils what might happen to the material eroded from the soil.

Pupil learning outcomes

Pupils can:

- describe what happens when soil is exposed to rainfall under varying conditions;
- explain why soil needs to be conserved;
- describe what happens to soil after it has been eroded.

Curriculum references:

England	Scotland	Wales	Northern Ireland
Science: Lower KS2 **Years 3 and 4** **Working scientifically** • making systematic and careful observations and, where appropriate, taking accurate • measurements using standard units • recording findings using simple scientific language, drawings, labelled diagrams, • reporting on findings from enquiries, presentations of results and conclusions • using results to draw simple conclusions, make predictions for new values, suggest improvements	**Sciences: Materials** **Earth's materials** **Second** Having explored the substances that make up Earth's surface, I can compare some of their characteristics and uses. SCN 2-17a **Third** Through evaluation of a range of data, I can describe the formation, characteristics and uses of soils, minerals and basic types of rocks. SCN 3-17a	**Science: KS2** **The sustainable Earth** • a comparison of the features and properties of some natural and made materials • how some materials are formed or produced	**The world around us** **Foundation stage** **Strand 1: Interdependence** **KS2** **How living things rely on each other within the natural world;** • about the variety of living things and the conditions necessary for their growth and survival (S&T)

• and raise further questions • identifying differences, similarities or changes related to simple scientific ideas and processes • using straightforward scientific evidence to answer questions or to support their findings. **Year 3** **Rocks** • recognise that soils are made from rocks and organic matter. Linked with work in geography, pupils should explore different kinds of soils, including those in the local environment Pupils could explore different soils and identify similarities and differences between them and investigate what happens when rocks are rubbed together or what changes occur when they are in water. They can raise and answer questions about the way soils are formed **Geography: KS1** use basic geographical vocabulary to refer to: • key physical features, including: beach, cliff, coast, forest, hill, mountain, sea, ocean, river, soil, valley, vegetation, season and weather	**Social sciences: People, place and environment** **Early** I explore and discover the interesting features of my local environment to develop an awareness of the world around me. SOC 0-07a **First** I can describe and recreate the characteristics of my local environment by exploring the features of the landscape. SOC 1-07a **Second** I can describe the major characteristic features of Scotland's landscape and explain how these were formed. SOC 2-07a **Third** Having investigated processes which form and shape landscapes, I can explain their impact on selected landscapes in Scotland, Europe and beyond. SOC 3-07a	**Geography: KS2** • study – living in Wales: their local area	**Strand 3: Place** **KS1** **Features of the immediate world and comparisons between places;** • about materials in the natural and built environment (G); (H); • about the properties of everyday materials and their uses (S&T); • the similarities and differences between buildings features and landscape in their locality and the wider world (G) **KS2** **Ways in which people, plants and animals depend on the features and materials in places and how they adapt to their environment;** • about the origins of materials (S&T); • how the use of materials relates to their properties (S&T)

Age range of pupils: 7 - 11 years

Time needed to complete activity: 20 minutes

The story for teachers:
The soil with no protective vegetation cover will wash away more quickly. Once eroded, soil may silt up drainage channels or reach rivers, lakes and the sea, where it is deposited.
This activity can generate much discussion. Perhaps the grass represents tropical rain forest? If the trees are removed, soil will be washed away together with precious nutrients. In the UK, farmers with sloping fields usually plant a winter crop so that the soil is not exposed to erosion while it has nothing growing in it.

This activity can be used in teaching schemes in both science and geography.

Relating what happens in the two trays to the real world is a bridging skill.

Lead in ideas:
Soil erosion is a normal part of the natural rock cycle, but it can become a major problem in many rural areas where people depend on the land for their livelihood. This activity provides the opportunity to investigate some of the factors involved in limiting soil erosion.

Following up the activity:
- Investigate the resistance to erosion of a range of different soil types.
- Investigate the effects of different crops in resisting soil erosion, by planting different 'crops' in soil and investigating their effects (using 'fair testing' approaches), or by using the internet
- Investigate other ways of reducing soil erosion, e.g. by ploughing along the contour and not up and down the slope. 'Up and down' furrows produce channels that increase soil erosion whilst ploughing horizontally along a slope, while much more difficult to do, produces furrows that retain the water and so reduce erosion.
- Invite a local farmer or gardener who has suffered loss of soil from the land in to speak to the pupils.
- Find out if any local river or reservoir has been silted up as a result of soil erosion within its catchment.
- Look out for good farming practice which could reduce soil erosion in their own district.
- Consider some consequences of soil erosion – e.g. not only is valuable top soil lost from the fields but eroded soil frequently finds its way into rivers, where it can cause silting up, which often contributes to flooding.

- Use other ESEU/Earthlearningidea soil-related activities (http://www.earthlearningidea.com) such as: 'Make your own soil', 'Soil doughnuts', 'Soil layers puzzle'.
- Try the 'Working with Soil' - activity pack and booklet (Waldorf the Worm ISBN 873266 16 2), ESTA Primary Committee, Earth Science Teachers' Association, 2003

Note: please be careful when pouring water away so that the soil does not get accidentally poured down your drains!

Source:
Earth Science Teachers' Association, (1993) *Teaching Primary Earth Science, No: 3, Soil,* forming part of *Teaching Earth Sciences,* Vol.18.
Adapted for Earthlearningidea www.earthlearningidea.com by Peter Kennett.

Preparation and set-up time:
10 minutes.

Resource list:
- 2 shallow trays approximately 30cm x 15 cm, e.g. Gratnell™ trays
- 2 pieces of wood to fit the width of the trays
- soil to half-fill each tray

OR
- 2 short lengths of guttering, with end pieces to fit inside one 30cm x 15 cm, e.g. Gratnell™ tray
- soil to fill each gutter

AND
- a thin piece of turf (or quick-growing seeds) to fit over the soil in one tray/gutter
- 2 props, e.g. blocks of wood
- water
- watering can, or old tin or plastic bottle with holes punched in the base

Risk assessment:

Potentially Hazardous Activity	Who/What may be Harmed?	Hazard Rating (A)	Likelihood (B)	Risk (AxB)	Further Action Required?
Save our soil	Pupils and staff at risk from organisms in soil e.g. tetanus	3	2	6	Wear gloves if any cuts on hands. Otherwise, wash hands after activity

Hazard Rating (A):
1 = Insignificant effect
2 = Minor Injury
3 = Major Injury
4 = Severe Injury
5 = Death

Likelihood of occurrence (B):
1 = Little or no likelihood
2 = Unlikely
3 = Occasional
4 = Probable
5 = Inevitable

Risk Priority (AxB):
12-25 = High risk – take immediate action
6-11 = Medium risk – take action as soon as possible
Less than 6 = Low risk – plan future actions where required

ESEU activity guide sheet:

Save our soil

This activity investigates the effect of vegetation cover in protecting soil from erosion in heavy rainfall.

- Ask the pupils if they know anyone whose soil has washed away in the rain or know somewhere else where soil has been eroded (erosion: the removal of solid material by flowing water or other surface processes). You might find video-clips or photographs of this on the internet.
- Ask the pupils if they can suggest what can be done to reduce this loss of valuable soil?
- Set up two identical trays, resting on props so that they slope at the same amount, (see photo). Half-fill each tray with the same type of soil, retaining it from slipping down with a piece of wood if necessary.
- Cover the soil in one tray with a thin piece of turf, but leave the soil in the other tray exposed. (Alternatively, the investigation could be started a few weeks in advance by sowing a quick-growing crop in the vegetated tray).
- Ask pupils in which tray they expect the soil to be washed away more quickly.

Save our soil (*Peter Kennett*)

- Sprinkle water on to the soil in each tray, using a watering can.
- In which tray does more muddy water build up in the space at the bottom?
- Is this what the pupils expected?
- Ask the pupils what they think should be done to protect soil from erosion. We can't just put a piece of turf on top to protect it!
- Discuss with pupils what might happen to the material eroded from the soil.

Optional activity: Soil doughnuts

Topic: sorting out types of soils

Activity:
Lay out some different soil types ranging from sandy to heavy clay. Show the pupils a copy of the table.

Ask the pupils to:-

- if possible, wear the plastic gloves provided. (If these are not available, hands must be washed carefully after handling soil);
- take a plastic cupful of one of the soil types;
- the soil should be damp, not wet - add a little water if necessary, (help may be needed with this);
- squeeze the soil and knead it like bread dough;
- try to make the shapes shown on the table in order from 1 to 7;
- identify their soil type by looking at the table. If they can make a ball but not a sausage, then their soil is a sandy loam. If they can make a horseshoe but not a tyre, their soil is a clay loam;
- suggest which soil will let rain go through most easily and which one will hardly let any rain through;
- decide which soil it would be best to have in a garden;
- suggest why the type of soil in a garden, or on a farm, is important.

	Shape	Soil type	Picture
1	cone	sandy	
2	ball	sandy loam	
3	sausage	silt loam	
4	worm	loam	
5	horseshoe	clay loam	
6	tyre	light clay	
7	inner tube	heavy clay	

Soils table from an unknown source

Sandy soil (forms cone but not ball) | Silt loam (forms sausage but not worm) | Light clay (forms horseshoe and tyre but not inner tube)

Three different soil types (*Elizabeth Devon*)

Pupil learning outcomes: Pupils can:

- identify types of soil;
- decide which soil lets water through easily and which does not;
- suggest a suitable garden soil;
- realise that the type of soil is important for good crops to be produced.

Curriculum references:

England	Scotland	Wales	Northern Ireland
Science: Lower KS2 **Years 3 and 4** **Working scientifically** • making systematic and careful observations and, where appropriate, taking accurate • measurements using standard units • recording findings using simple scientific language, drawings, labelled diagrams, • reporting on findings from enquiries, presentations of results and conclusions • using results to draw simple conclusions, make predictions for new values, suggest improvements • and raise further questions • identifying differences, similarities or changes related to simple scientific ideas and processes • using straightforward scientific evidence to answer questions or to support their findings. **Year 3** **Rocks** • recognise that soils are made from rocks and organic matter. Linked with work in geography, pupils should explore different kinds of soils, including those in the local environment Pupils could explore different soils and identify similarities and differences between them and investigate what happens when rocks are rubbed together or what changes occur when they are in water. They can raise and answer questions about the way soils are formed **Geography: KS1** use basic geographical vocabulary to refer to: • key physical features, including: beach, cliff, coast, forest, hill, mountain, sea, ocean, river, soil, valley, vegetation, season and weather	**Sciences: Materials** **Earth's materials** **Second** Having explored the substances that make up Earth's surface, I can compare some of their characteristics and uses. SCN 2-17a **Third** Through evaluation of a range of data, I can describe the formation, characteristics and uses of soils, minerals and basic types of rocks. SCN 3-17a **Social sciences: People, place and environment** **Early** I explore and discover the interesting features of my local environment to develop an awareness of the world around me. SOC 0-07a **First** I can describe and recreate the characteristics of my local environment by exploring the features of the landscape. SOC 1-07a **Second** I can describe the major characteristic features of Scotland's landscape and explain how these were formed. SOC 2-07a **Third** Having investigated processes which form and shape landscapes, I can explain their impact on selected landscapes in Scotland, Europe and beyond. SOC 3-07a	**Science: KS2** **The sustainable Earth** • a comparison of the features and properties of some natural and made materials • how some materials are formed or produced **Geography: KS2** • study – living in Wales: their local area	**The world around us** **Foundation stage** **Strand 1: Interdependence** **KS2** **How living things rely on each other within the natural world;** • about the variety of living things and the conditions necessary for their growth and survival (S&T) **Strand 3: Place** **KS1** **Features of the immediate world and comparisons between places;** • about materials in the natural and built environment (G); (H); • about the properties of everyday materials and their uses (S&T); • the similarities and differences between buildings features and landscape in their locality and the wider world (G) **KS2** **Ways in which people, plants and animals depend on the features and materials in places and how they adapt to their environment;** • about the origins of materials (S&T); • how the use of materials relates to their properties (S&T)

Age range of pupils: 5 - 10 years

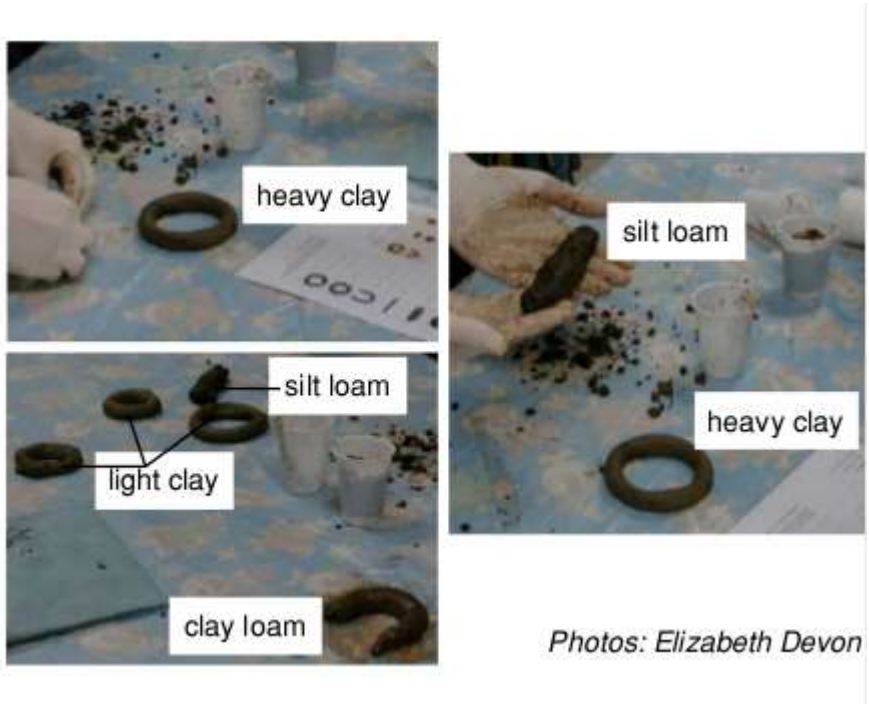
Time needed to complete activity: 20 minutes

The story for teachers:
Sandy soils allow water through easily and clay soils do not. Gardeners usually prefer loam soils.
For a farmer or gardener, it is important to know the soil type so that it can be managed properly and crop production increased.

- Loam is a mixture of 40% sand (usually quartz grains), 40% silt (usually quartz and feldspar grains, smaller than sand) and 20% clay (very small particles of clay minerals).
- Loam soils contain more nutrients and humus (decayed material) than sandy soils.
- Loams are easier for gardeners and farmers to dig and plough than clay soils.
- Loams are easy to work over a range of moisture conditions; they retain more moisture than sandy soils and allow better drainage than clay soils.
- The soils of most successful farming areas around the world are loams.

Pupils can see a pattern as they try to make various shapes. Many children think all soils are the same and finding that there is a lot of variety causes cognitive conflict. Discussion of soil types is metacognition and applying the soil types to the farming world involves bridging.

This activity can be used in any lesson about the environment, rocks and landscape, agriculture, gardening or investigations out of doors.



Lead in ideas: Lead a discussion about what is soil. Many young children think it is mud and have very little idea what it is made of. The ESEU activity 'Make your own soil' is a good lead-in for this activity.

Following up the activity:
Ask pupils to find out how soils develop and why it is important to understand and conserve soils.
They could try some of the other soil-related ESEU/Earthlearningidea (http://www.earthlearningidea.com) activities below:

- Soil layers puzzle
- Darwin's 'big soil idea'

Try the activities in: 'Working with Soil' - activity pack and booklet (Waldorf the Worm ISBN 873266 16 2), ESTA Primary Committee, Earth Science Teachers' Association, 2003.

Source: Elizabeth Devon, ESEU and ELI Team

……

Preparation and set-up time: 10 minutes

Resource list:

- a range of soil types from very sandy to heavy clay
- disposable plastic gloves (if available)
- hand washing facilities
- plastic cups
- jug of water

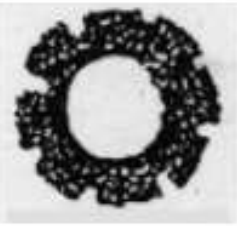
Risk assessment:

Potentially Hazardous Activity	Who/What may be Harmed?	Hazard Rating (A)	Likelihood (B)	Risk (AxB)	Further Action Required?
Soil Doughnuts	Pupils and staff at risk from organisms in soil e.g. tetanus	3	2	6	Wear gloves if any cuts on hands. Otherwise, wash hands after activity

Hazard Rating (A):
1 = Insignificant effect
2 = Minor Injury
3 = Major Injury
4 = Severe Injury
5 = Death

Likelihood of occurrence (B):
1 = Little or no likelihood
2 = Unlikely
3 = Occasional
4 = Probable
5 = Inevitable

Risk Priority (AxB):
12-25 = High risk – take immediate action
6-11 = Medium risk – take action as soon as possible
Less than 6 = Low risk – plan future actions where required

	Shape	Soil type	Picture
1	cone	sandy	
2	ball	sandy loam	
3	sausage	silt loam	
4	worm	loam	
5	horseshoe	clay loam	
6	tyre	light clay	
7	inner tube	heavy clay	

Soils table from an unknown source

ESEU activity guide sheet:

Soil doughnuts

Topic: sorting out types of soils

Activity:

Lay out some different soil types ranging from sandy to heavy clay. Show the pupils a copy of the table.

Ask the pupils to:-

- if possible, wear the plastic gloves provided. (If these are not available, hands must be washed carefully after handling soil);
- take a plastic cupful of one of the soil types;
- the soil should be damp, not wet - add a little water if necessary, (help may be needed with this);
- squeeze the soil and knead it like bread dough;
- try to make the shapes shown on the table in order from 1 to 7;
- identify their soil type by looking at the table. If they can make a ball but not a sausage, then their soil is a sandy loam. If they can make a horseshoe but not a tyre, their soil is a clay loam;
- suggest which soil will let rain go through most easily and which one will hardly let any rain through;
- decide which soil it would be best to have in a garden;
- suggest why the type of soil in a garden, or on a farm, is important.

Sandy soil (forms cone but not ball)	Silt loam (forms sausage but not worm)	Light clay (forms horseshoe and tyre but not inner tube)

Three different soil types (*Elizabeth Devon*)

Optional activity: Will my gravestone last?

Topic:
A visit to a nearby churchyard or cemetery, run as a pupil investigation. An alternative is to use a town centre, where there can often be a good range of building stones used for shop fronts. Scientific investigational skills can be practised, although it is probably unwise to use the visit for assessment purposes. ***Carry out a preliminary visit to ensure there is a suitable variety of gravestone rock types and to undertake a risk assessment.***

Activity:
Note: Use lead in ideas first (see "lead in ideas" following).
The visit

- Gather the group together inside the graveyard and check that they can recognise the main rock types used for nearby graves.
- Allocate small groups to work as they have planned, probably advising them to survey as many graves as they can in the time, along a particular avenue of graves. Ensure that they record the date of death (the stone is usually set up a year or so after the death of the first named occupant). Give them the time and place for regrouping at the end.
- Tour the small groups, with colleagues doing likewise, checking on progress and discreetly applying one drop of acid to the back of any grave which pupils think might be a limestone or marble.
- Allow time at the end to pull the visit together and to visit any particularly significant site with the class, e.g. the oldest tombs in the graveyard etc.
- Count heads and ensure that they all return safely to school!

Pupil learning outcomes: Pupils can:

- recognise a range of rock types under field conditions;
- set up hypotheses about rates of weathering and test them under field conditions;
- make careful observations and record them systematically;
- appreciate that it is not always possible to find the answers to hypotheses, especially under field conditions;
- learn how to work responsibly and as a member of a small team out of doors;
- appreciate how to approach respectfully a site of great significance to bereaved people;
- appreciate how people's choice of gravestones has changed over time and depending upon transportation facilities.

Curriculum references:

England	Scotland	Wales	Northern Ireland
Science: Lower KS2 **Years 3 and 4** **Working scientifically** • asking relevant questions and using different types of scientific enquiries to answer them • setting up simple practical enquiries • making systematic and careful observations • using results to draw simple conclusions, • using straightforward scientific evidence to answer questions or to support their findings **Year 3** **Rocks** • compare and group together different kinds of rocks on the basis of their appearance and simple physical properties Linked with work in geography, pupils should explore different kinds of rocks, including those in the local environment Pupils might work scientifically by: observing rocks, including those used in buildings and gravestones, and exploring how and why they might have changed over time; using a hand lens or microscope to help them to identify and classify rocks according to whether they have grains or crystals, and whether they have fossils in them.	**Sciences** **Early** **Biological systems** I can identify my senses and use them to explore the world around me. SCN 0-12a **First** **Properties and uses of substances** Through exploring properties and sources of materials, I can choose appropriate materials to solve practical challenges. SCN 1-15a	**Science: KS2** **The sustainable Earth** • a comparison of the features and properties of some natural and made materials • how some materials are formed or produced •	**The world around us** **Foundation stage** **Strand 3: Place** **KS1** **Features of the immediate world and comparisons between places;** • about materials in the natural and built environment (G); (H); • about the properties of everyday materials and their uses (S&T); • the similarities and differences between buildings features and landscape in their locality and the wider world (G)

Science: Upper KS2 **Working scientifically** • recording data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graph **KS3** **Working scientifically**: • ask questions and develop a line of enquiry based on observations of the real world, alongside prior knowledge and experience. • make predictions using scientific knowledge and understanding • select, plan and carry out the most appropriate types of scientific enquiries to test predictions, including identifying independent, dependent and control variables, where appropriate. • use appropriate techniques, apparatus, and materials during fieldwork and laboratory work, paying attention to health and safety. • make and record observations and measurements using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements. • apply sampling techniques. **KS3 Chemistry**: • the rock cycle and the formation of igneous, sedimentary and metamorphic rocks. **Geography:** **Geographical skills and fieldwork** **KS1** • use simple fieldwork and observational skills to study the geography of their school and its grounds and the key human and physical features of its surrounding environment. **KS2** • use fieldwork to observe, measure, record and present the human and physical features in the local area using a range of methods, including sketch maps, plans and graphs, and digital technologies. **KS3** use fieldwork in contrasting locations to collect, analyse and draw conclusions from geographical data, using multiple sources of increasingly complex information.	**Second** **Earth's materials** Having explored the substances that make up Earth's surface, I can compare some of their characteristics and uses. SCN 2-17a **Social studies** **First** **People, place and environment** I can describe and recreate the characteristics of my local environment by exploring the features of the landscape. SOC 1-07a I can consider ways of looking after my school or community and can encourage others to care for their environment. SOC 1-08a	**Geography: KS2** **Pupils develop their geographical skills, knowledge and understanding through learning about places, environments and issues.** **carry out** • fieldwork to observe and investigate real places and processes	**KS2** **Ways in which people, plants and animals depend on the features and materials in places and how they adapt to their environment;** about the origins of materials (S&T)

Age range of pupils: 8 – 16 years

Time needed to complete activity: One preparation lesson. About an hour for the visit. One follow up lesson and a homework.

The story for teachers
Prior knowledge:
This graveyard visit is best undertaken after pupils have been introduced to the main groups of rocks (igneous, sedimentary, metamorphic) and have studied weathering.

In terms of "working scientifically", many of the requirements may be met very admirably in the graveyard investigation
In this context, this could include:

- Some materials occur naturally; others are manufactured.
- Materials formed at high pressures and/or high temperatures (such as metamorphic rocks) are less stable under the normal ambient conditions of the Earth's surface.
- In the UK, the sun traverses the southern sky, so north-facing surfaces are always in shade.
- Some materials dissolve in water or react with acids and are removed in solution.
- Rainwater is naturally acidic and industrial pollutants make it even more acid.
- Water expands powerfully on freezing.
- Tree roots exert forces as they grow.
- Gravity makes things fall.
- Rusting occurs in a damp atmosphere.
- Speed = distance/time (in calculating rates of weathering).
- Geological time scales are immensely long.

Starting points/misconceptions to avoid
A useful 'starter' is to show pictures of different types of gravestones and the ways in which they may become weathered. These may be taken locally and projected to the class.

Pupils may be confused by the differences between weathering and erosion. **Weathering** is the break down of rock *in situ*, caused by atmospheric and biological agencies. **Erosion** is the removal of the rock debris by gravity or by moving agents such as water, ice or wind. (*Erodere* = to gnaw). Where rock material is removed **in solution**, e.g. from limestone or marble by acid rain, it is usually considered to be an aspect of weathering.

Safety and courtesy notes
- Carry out a written risk assessment before the visit and file it in the most apposite office. This includes the appropriate number of supervisory adults for the class, as decreed by your LEA or school/ institution. Take steps to ensure safety at road crossings and to avoid hypothermia or sunstroke among the pupils!
- Obtain parental permission to take pupils out of school; this is critical, since most classes will contain a pupil with a relative who has died recently, and it is important to be alerted to this issue.
- Pupils should be primed regarding appropriate behaviour in a place where grieving people may also be present.
- Check for sensitivities among ethnic minority groupings, although in practice, most faiths are amenable to such surveys, so long as graves are treated with respect and not walked over.
- Check first with the authorities responsible for the churchyard/cemetery, who will not usually worry about an occasional drop of acid being added on an obscure part of a gravestone, to see if contains a carbonate mineral (calcite in marble or in limestone). Acid is often used to clean gravestones anyway!

Your local monumental mason will usually provide much helpful information, as well as off-cuts of the stones currently in use.

Lead in ideas
Preparation lesson in the lab or classroom:
- Introduce the theme with samples of fresh ornamental stones, appropriate to your locality and remind pupils of the groupings into sedimentary, igneous and metamorphic rocks.
- Show pictures of fresh, unweathered gravestones and ask pupils to write down the rock type they like best.
- Show pictures (or PowerPoint presentation) giving a general view of the graveyard and exhibit a map of it. Ask pupils to choose a site for their gravestone, e.g. in open ground, under trees, on a slope etc.
- Show pictures of weathered gravestones and revise the main processes of weathering which have affected them. Ask pupils to write down their final choice for a stone type and location, now that they know more about the ways in which rocks react to weathering. They are allowed to change their minds! (Note: On a marble tomb, the lettering is usually cut into the stone; then sheet lead is hammered in and smoothed off flush with the stone surface. Over time, the marble reacts with acidic rainwater and is removed in solution, leaving the lead letters standing out. The amount they stand out can be measured with a tyre depth gauge, and an estimate of the rate of weathering calculated, based on the date of the first burial recorded on the gravestone).
- Working in small groups of about three, or alone, pupils then plan a visit, to carry out a small group investigation in the graveyard, to find out which type of stone lasts the longest and where the best site for it would be.
- Encourage pupils to set up hypotheses in advance, which they can test on location (see pupil sheet).
- Have some sheets prepared onto which pupils can record their data, to guide those who are slow to suggest ideas.

Following up the activity:
Allow groups time to follow up their results, share statistical information to compile the significant class data and to draw graphs. Comment on their hypotheses and whether or not they have "proved" them.

Extension ideas:
- Pupils could be asked to draw up a simple guide to the graveyard, so that their parents could follow their route and understand what had been discovered.
- Pupils could map the distribution of the main types of stone seen during their survey.
- Pupils could draw up a simple key to the identification of stones used in monuments.

Source:
Earth Science Teachers' Association (ESTA) (1990) *Science of the Earth: 'Will my gravestone last?'* by Peter Kennett, Sheffield: GeoSupplies.

Preparation and set-up:
Carry out a pre-visit and write a risk assessment beforehand.

Resource list
Staff may carry**:**
- set of building stone cards – see (http://www.earthlearningidea.com/PDF/134_Building_stones.pdf)
- white vinegar or lemon juice (to test for the calcium carbonate in limestone and marble)
- tyre depth gauge (optional)
- wash bottle with tap water
- hand lenses
- a magnetic compass

For follow up lesson:
- PowerPoint presentation
- computer and data projector
- it would be useful to use pictures of gravestones in various states of decay, and flash cards with unfamiliar names etc. e.g. "gneiss" (optional)

Risk assessment:

Potentially Hazardous Activity	Who/What may be Harmed?	Hazard Rating (A)	Likelihood (B)	Risk (AxB)	Further Action Required?
Will my gravestone last?	Acid for testing for calcium carbonate (white vinegar or lemon juice) may get into eyes or an open cut	2	2	4	No

Hazard Rating (A):
1 = Insignificant effect
2 = Minor Injury
3 = Major Injury
4 = Severe Injury
5 = Death

Likelihood of occurrence (B):
1 = Little or no likelihood
2 = Unlikely
3 = Occasional
4 = Probable
5 = Inevitable

Risk Priority (AxB):
12-25 = High risk – take immediate action
6-11 = Medium risk – take action as soon as possible
Less than 6 = Low risk – plan future actions where required

Carry out a written risk assessment before the visit in accordance with the rules of your local authority or school/institution for outdoor visits and file it in the most suitable office. This includes the appropriate number of supervisory adults for the class, as stated by your LEA/school. Take steps to make sure that pupils and staff are safe at road crossings and to avoid hypothermia or sunstroke among the pupils! If you choose to take a dropper bottle of acid with you, then make sure that you include this in your risk assessment and take water with you as well. Pupils should be warned to keep clear of any slabs that are leaning: also that flat slabs can become very slippery when wet. Dog mess may be a problem in some graveyards.

Pupil Sheet

Planning Guidelines
You have seen a map of the churchyard and pictures of some of the gravestones. Now **read this sheet and then plan an investigation** which you can do when you visit the churchyard.

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When you go to the churchyard, you will be working in groups of about three people, but this planning part is for you to do **on your own**.

Here are some ideas which you could **choose** from to investigate:

- Which rock types are the most popular today?
- Was this the same 50, 100, 150 years ago?
- Which rock types resist weathering best?
- Does it make any difference which way a gravestone faces?
- Are vertical stones weathered more quickly than horizontal ones?
- On which gravestone rock types do lichens and mosses grow best?
- Do lichens and mosses speed up the weathering of gravestones?
- Are graves beneath trees weathered more quickly than those in the open?
- OR, you can investigate your own ideas.

Hints:
a) You will need to identify the main rock types - granite, sandstone, marble and gneiss. How can you do this without damaging them? (You may ask a member of staff to add one drop of acid to each gravestone, if it helps you).
b) How can you find out how long each gravestone has been there?
c) How can you collect enough information to draw valid conclusions?
d) How can you keep tidy records?
e) How can you show which part of the graveyard you were working in?
f) Will you need to compare one part of the graveyard with another?
g) How can you look for the effects of **one** variable at a time?

WRITE DOWN IN DETAIL WHAT YOU ARE PLANNING TO DO

Some 'do's and don'ts':
DO *bring warm clothing and a coat - it usually rains!*
DO *respect the feelings of any other visitors.*
DO NOT *clamber about on the graves any more than you can help.*
DO NOT *make a lot of noise.*
DO NOT *wander out of earshot.*

The Graveyard Visit - writing up your results

You can write up some of your findings on your own, but other things will need to be done as a class - we shall start with these:

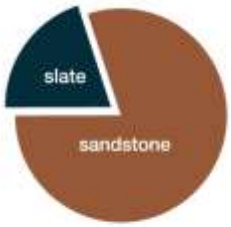
1. Copy this table:

Gravestones in ……..... Graveyard					
Type of stone	**Sandstone**	**Marble**	**Granite**	**Gneiss**	**Mixed stones**
Total number of stones					
Before 1850					
1851-1900					
1901-1950					
1951-present day					

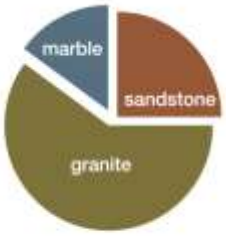
Look at your results sheets and add up how many graves there are of each stone. Show them in your table, along the line headed 'total number of stones'.

2. When you have finished (1), give your figures to your teacher so that they can be added to the rest of the class information on the board.
3. Plot a bar graph of the **class** results, showing the different types of stone, like the example shown below.
   a) Types of stone used

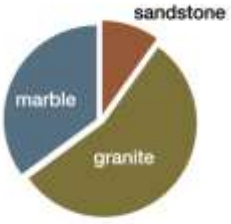
4. Now look at your own figures again. Count how many stones there are, of each type, between these dates: Before 1850; 1851-1900; 1901-1950; 1951-present day. Show the figures on the table.
5. Give these figures to your teacher to add up on the board.
6. Plot graphs of the **class** results, showing types of stones for each date.



Up to 1840

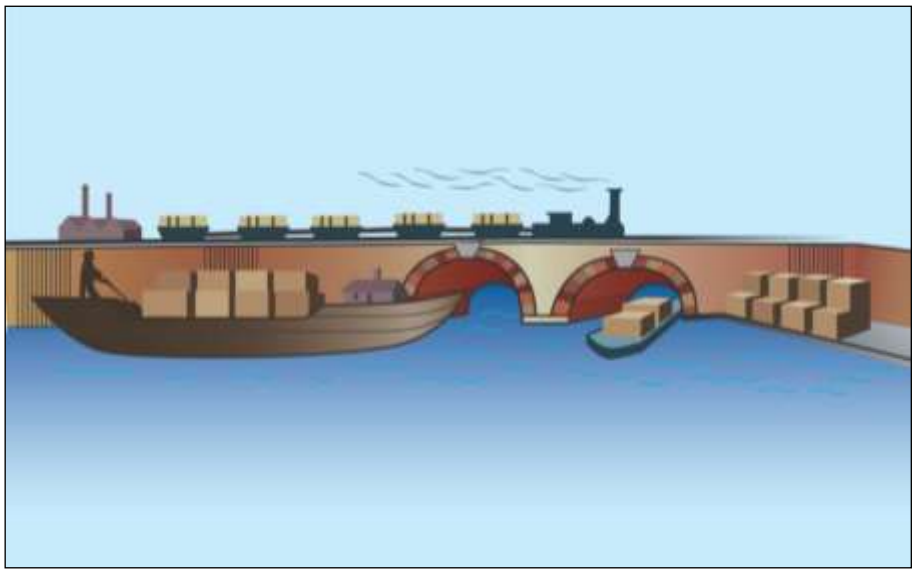


1841-1900



1901 to present day

7. Write down what you think the graphs show you about the stones chosen by people for graves in the churchyard. Why do you think their choice changed over the years? (Hint: Think about changing transport between the churchyard and the nearest quarry, port etc.)



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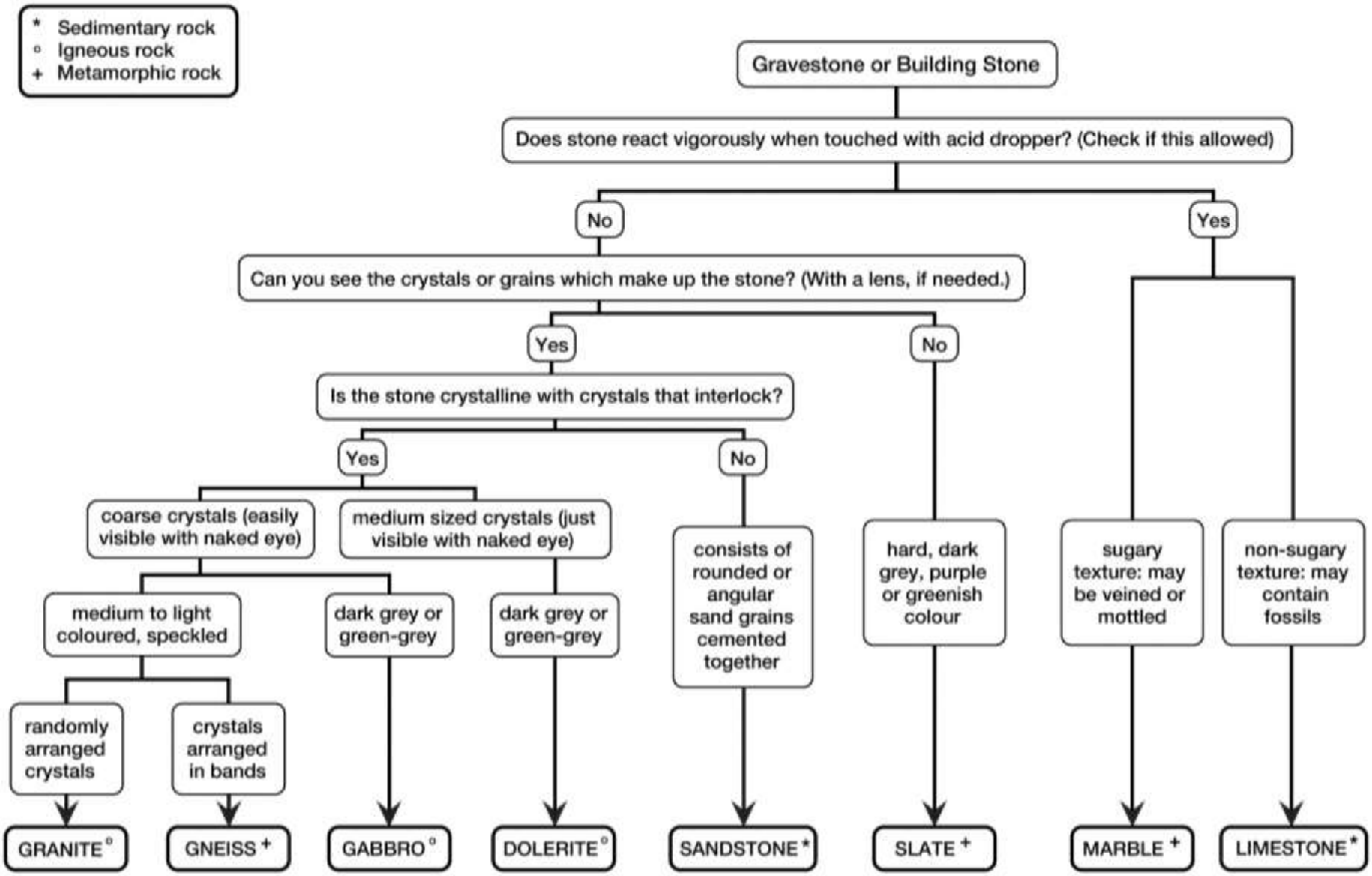
8. Draw a **simplified** copy of the map of the churchyard. On your copy, show the graves which you studied, and any others which you looked at briefly.
9. Write down any answer you found to questions, such as:
   - Which kind of stone is covered most by lichens?
   - Which kind of stone has weathered the most?
   - What methods of weathering did you find had happened (probably).
   - Were the gravestones under the trees more weathered than those in the open? Explain your answer.
   - Were the east-facing sides of the gravestones more weathered than the west-facing ones? Explain your answer.
10. Name any things which you would like to check, if you could go again.
11. Finally, which type of stone would you choose for your own gravestone, and whereabouts in the churchyard would you have it put? Why?

……

Help Sheet

1. You should plan to survey the graves in rows, showing your results on the printed sheet.
2. On marble tombs, the lead letters were level with the marble surface when it was fresh. Marble weathers by **solution**, so you can tell how much has dissolved by measuring how much the lead letters stand out from the surface.
3. The date on the tomb will tell you how long it has been there.
4. Try to look at tombs in the open, as well as under trees - does weathering take place faster or more slowly under trees?
5. Find examples where tree roots have broken stone slabs apart.
6. Look for cracks where frost has cracked the slabs.
7. Do lichens and mosses cause any weathering?
8. Do they grow more thickly on north-facing surfaces?
9. Are slabs which are lying flat more weathered than ones which stand up straight?

Key to some commonly used rocks for ornamental purpose



Survey sheet

Survey of part of ..... graveyard **Surveyor: .....** **Date: .....**

Surname of grave	Date of death of **first** occupant	Type of stone e.g. 'Granite' (give colour) Marble Sandstone (coarse or fine) Mixed stones (name types)	Extent to which stone is weathered e.g. crumbling stone, split slabs, rough surface in place of polished etc lead letters standing out	Aspect (North facing etc)	Is it under trees?	Vegetation growth on stone and its effects e.g. lichens, grass, brambles etc

Resource list

Resource list: Starter: Found in the ground	Supplied By: Facilitator	Supplied By: Institution
One set for every group of three pupils/participants:		
• samples of granite, permeable sandstone and other samples such as: shelly limestone, chalk, slate; specimens should be 2cm in diameter, or larger - see photo	✓	
• some fossils	✓	
• some minerals	✓	
• some objects, like, piece of brick, wood, large rusty nail	✓	
• 'Pupil success criteria' card	✓	
• Definition cards (rock, non-rock, mineral, fossil)	✓	

Resource list: Circus activity 1: A rocky look, touch and tell	Supplied By: Facilitator	Supplied By: Institution
One set:		
• samples of granite, permeable sandstone and other samples such as: shelly limestone, chalk, slate; specimens should be 2cm in diameter, or larger	✓	
• magnifier	✓	
• metal teaspoon	✓	
• definition cards	✓	

Resource list: Circus activity 2: Will my rock hold water?	Supplied By: Facilitator	Supplied By: Institution
One set:		
• samples of granite, permeable sandstone and others such as: shelly limestone, chalk, slate, marble; samples should be 2cm in diameter, or larger	✓	
• plastic container/beaker of water to put the rocks in, preferably transparent	✓	

Resource list: Circus activity 3: The soil water shake test	Supplied By: Facilitator	Supplied By: Institution
One set:		
• soil samples. You may want to hand-make or 'doctor' your local soil so that it contains a range of grain sizes and a variety of colours, e.g. some bits of gravel, some clay that will settle out, and some organic debris that will float (Health and Safety: natural soil samples should only be handled with plastic gloves)	✓	
• transparent plastic jars or bottles with lids (small jars are better for small hands; large sweet containers, pop bottles or fabric softener bottles are excellent for a teacher demonstration)	✓	
• rulers		✓
• water		✓
• diagrams of a jar	✓	

Resource list: Circus activity 4: The great soil race	Supplied By: Facilitator	Supplied By: Institution
One set:		
• soil samples (Health and Safety: natural soil samples should only be handled with plastic gloves) (a minimum of two different soil samples)	✓	
• three plastic jugs to pour water	✓	
• a container of water		✓
• three empty lemonade bottles cut in half so that the lower parts become 'beakers', meanwhile, the upper parts, when inverted, become 'funnels'	✓	
• cloth filter (e.g. muslin)	✓	
• sample of the local soil – a drinking mug-full (Health and Safety: natural soil samples should only be handled with plastic gloves)		✓

Resource list: Circus activity 5: Make your own soil	Supplied By: Facilitator	Supplied By: Institution
One set:		
• gravel, sand, powdered clay, humus, decayed, crumbled, dry leaves - all in separate containers	✓	
• magnifier	✓	
• paper and pencil		✓
• ruler		✓
• jug of water	✓	
• tablespoon	✓	
• if available, disposable plastic gloves for any work with real soils	✓	

Resource list: Circus activity 6: Changing state – transforming water	Supplied By: Facilitator	Supplied By: Institution
One set:		
A: 'Disappearing' ice		
• a container of ice cubes		✓
• a cloth to mop up with	✓	
B: 'Disappearing' water		
• two transparent plastic beakers, or similar, one containing about 0.5 cm depth of water	✓	
C: 'Reappearing' water		
• a bottle of liquid from the fridge (milk or a soft drink), that has been dried off before using		✓

Resource list: Circus activity 7: Make your own rain	Supplied By: Facilitator	Supplied By: Institution
One set:		
• lamp - the bulb has to be a filament-type of 60-100W (low energy bulbs will not work) Ideally it should be a 60W reflector bulb which keeps the lamp body cool. The safety grid will get almost as hot as the bulb and is easily touched. It's best to have a well-recessed reflector bulb!		✓
• transparent plastic box; a box suitable for the freezer is ideal	✓	
EITHER		
• lid for the transparent box	either ✓	
OR		
• thin transparent plastic film (e.g. Cling Film™) to cover box	or ✓	
• large elastic band to secure plastic film	or ✓	
• sand for the 'land'	✓	
• water		✓
• frozen freezer block		✓
• water cycle diagram from the internet	✓	

Resource list: Circus activity 8: Fossil or not?		Supplied By: Facilitator	Supplied By: Institution
One set:			
Pictures of the following • fossil bone • hazelnuts • fossilised wood • fossil shell	• desiccation cracks • fossil tooth • dinosaur footprint • insects in amber	✓	
• (optional) more specimens or pictures of fossils or non-fossils			✓

• Sorting sheets (body fossil, trace fossil, not a fossil)	✓	
• Definition cards (a fossil, a body fossil, a trace fossil)	✓	

	Supplied By	
Resource list: Plenary: What was it like to be there? - fossil	**Facilitator**	**Institution**
One:		
Fossils, as real specimens, plaster casts, photos or drawings	✓	

	Supplied By	
Resource list: Optional activity: Save our soil	**Facilitator**	**Institution**
One set:		
• 2 shallow trays approximately 30cm x 15 cm, e.g. Gratnell™ trays	✓	
• 2 pieces of wood to fit the width of the trays	✓	
• soil to half-fill each tray	✓	
OR		
• 2 short lengths of guttering, with end pieces to fit inside one 30cm x 15 cm, e.g. Gratnell™ tray	alternative	
• soil to fill each gutter	alternative	
AND		
• a thin piece of turf (or quick-growing seeds) to fit over the soil in one tray/gutter	✓	
• 2 props, e.g. blocks of wood	✓	
• Water		✓
• watering can, or old tin or plastic bottle with holes punched in the base	✓	

	Supplied By	
Resource list: Optional activity: Soil doughnuts	**Facilitator**	**Institution**
One set:		
• a range of soil types from very sandy to heavy clay	✓	
• disposable plastic gloves (if available)	✓	
• hand washing facilities		✓
• plastic cups	✓	
• jug of water	✓	
• sample of the local soil – a drinking mug-full (Health and Safety: natural soil samples should only be handled with plastic gloves)		✓

	Supplied By	
Resource list: Optional activity: Will my gravestone last?	**Facilitator**	**Institution**
Staff may carry**:**		
• set of building stone cards – see (http://www.earthlearningidea.com/PDF/134_Building_stones.pdf)	✓	
• white vinegar or lemon juice (to test for the calcium carbonate in limestone and marble)	✓	
• wash bottle with tap water	✓	
• hand lenses	✓	
• a magnetic compass	✓	
For follow up lesson:		
• PowerPoint presentation	✓	
• computer and data projector		✓

