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Contact: geodiversity@btconnect.com

A). Recommended preparation prior to field work:
At an early stage, a preparatory visit is essential, not only to familiarise yourself with the Earth science aspects but also the wildlife potential of the area.

It is assumed that schools will have already undertaken class-based activities related to rocks and possibly soils. The following packs, published by ESTA, were written to support the QCA Guidance, Unit 3D Rocks & Soils. These, and the additional activities listed, will give teachers and pupils a useful vocabulary and introduce Earth science concepts in a practical way. Many can then be put into context by investigating the ancient world largely hidden in the rocks beneath our feet. "**Working with Rocks"** provides useful background on the rock cycle and explains the terms igneous, sedimentary and metamorphic rocks. In both packs porosity and permeability are clearly defined. The UK Geology Wall Map, published by the Ordnance Survey would be useful additional reference material. Teachers may wish to introduce soils as part of the field visit, collecting samples for later investigation.

'***Working with Rocks'*** includes the following activities:

1. Sequencing – Story of a marble gravestone[literacy]
2. Sorting rocks – using different criteria, incl texture, colour
3. Rock identification – using key terms as clues, introducing names of common rocks
4. Testing rocks – testing for porosity, permeability and "hardness". Making wells.
5. Weathering – how to weather your own rock by freeze/thaw
6. Use of rocks – devising a town trail & showing the use of building materials

'***Working with Soil'*** includes the following activities:
Science/Geography:
1. Looking at soil - see, feel, smell, content & properties.
2. Separating soils - by sieving dry
3. Separating soils - by settling in water
4. Porosity - water held in pore spaces
5. Permeability - rate of water draining through
6. Soil erosion - with or without vegetation cover?

There are also four Literacy and five Numeracy activities based on a storybook about a family of worms! Work on maps includes scale and compass points.

Additional activities: (Activities 1 to 5 are particularly appropriate for this visit.)

1. To model layering in sedimentary rocks by settling in water.
Collect samples of different coloured sand, silt, and a few broken shells. Mix each sample with water in separate beakers. Half fill a transparent tank or plastic jar with water. Ask the children to predict what will happen when material is tipped in. Carefully pour one beaker at a time into the larger container. Observe the settling of the sediment. Do not disturb. Pour in another beaker and observe. Repeat, using shells and the remaining samples. Note that clay in any of the samples will remain in suspension, make the water cloudy and take ages to settle. The sediment will be layered. Ask the children which is the oldest layer (the one on the bottom). Which is the youngest layer? (the one at the top).

A similar model could be the daily disposal of rubbish over a week. If collection is made early on Monday morning the rest of Monday's rubbish will go into the bin & reach the bottom. Tuesday's rubbish will be next, on top of Monday's, followed by Wednesday's ……..etc, with Sunday's rubbish on top - the last in the bin and youngest!

Geologists call this 'the law of superposition' and it helps them to work out the order of a sequence of events as shown by the rocks.

2. To model rounding of pebbles during transport.
Use a tin or plastic tub [with lid]. Weigh ten sugar cubes or chunks of confectionery pineapple. Record in table. Describe & record the shape – with corners and edges.
Place in tin or tub, with lid!

Ask children to predict what will happen when they are shaken. Shake for one minute [timed], carefully remove the "cubes" with tongs [why tongs?], weigh, record in table for later graph. Ask children to describe the shape and size and explain what is happening – corners and edges are being knocked off as a result of contact with other cubes and the sides of the container. Carefully look inside the container for powdered material [try not to blow or inhale!].
Repeat at one minute intervals. Record for later graph [block or line].

How long does it take to make them well-rounded [without corners or edges]?
You could weigh the amount of powder knocked off, but this is difficult [why?] Better to calculate the amount of powder knocked off by subtracting final weight from starting weight.
What would eventually happen if you continued? End up with just powder!
This is done dry. Problem of using soluble sugar etc in water! Is it a fair test?

Relate to erosion/abrasion of pebbles during transport – getting smaller and rounder, with fragments knocked off to form sand and mud. This happens especially in rivers, on the seashore [you can hear it], also in deserts to small pieces and less so in glaciers.
Harder pebbles of vein quartz and quartzite last longer than weaker rocks [see trail notes]. How could this be modelled? Use sugar cubes and pineapple chunks mixed together!!

3. To model river erosion, transport and deposition.
This is best used as an extension activity or for older children studying Rivers as part of the Geography curriculum.

Demonstration
A child's slide extension or guttering can be used as the channel for this activity. The channel will need to be gently sloped, supported by bricks/blocks of wood, draining into a large plastic container (wide bowl). The upper three quarters of the channel should be covered with a sand and gravel (pea-sized) mixture. Water will need to be supplied via a flexible tube clamped at the top of the channel. Turn water supply on and observe the river develop on the sand/gravel mixture. Many Earth science processes can be observed at work:

- Erosion - as the river cuts into its bed and banks.
- Transport - sand and finer sediments are moved along the river bed and in suspension.
- Deposition - sediments settle on the wide channel bed as sand bars and on the inside banks of meanders. Watch the sediment as it moves along the top of the sand bar. As it reaches the edge of the sand bar it avalanches down the front and sides at an angle. This sediment deposited at an angle produces 'cross-bedding'. It can be seen when cut through, as in the rocks at Park Hall

Variables can be introduced by altering the gradient and volume of water. These variables model changes in real rivers.

Large volumes of water, as a result of occasional flash floods in desert areas, can move vast amounts of sediment, including large boulders. As the flow of water loses energy the largest boulders and pebbles are deposited first, followed by smaller pebbles and gravel, then sand, silt and clay. Over hundreds of years such sediment can be transported hundreds of kilometres, becoming more rounded, smoother and smaller along the way.

4. Fossils
Fossil shells will be seen in the Portland limestone of the Monument and possibly in pebbles of limestone in the quarries. Children are interested in them and they are a significant part of interpreting Earth science.

> **"A fossil is the remains or trace of an animal or plant which lived in the distant past and is now found preserved in rocks."**

A body fossil is the altered remains of an animal or plant itself, eg shell, bone, leaf.
A trace fossil is the trace left behind by an animal, eg footprint, burrow".
Your local museum may have specimens to loan to schools. There are also many reference books available for children.
See also: **Teaching Primary Earth Science** Issues 1 – Fossils; and 22 – Putting Fossils into the National Curriculum.
Making plaster casts of fossils is one activity children enjoy.

5. To model geological time
There are several ways of demonstrating the immensity of geological time.
The Earth was formed about 4,600 million years ago. Use a paper roll or string to make a time line. At a scale of 1cm to 1 million years it will be 46 metres long. To fit your classroom, you may need to reduce the scale in the oldest part. The names and dates of the geological periods of the last 570 million years, with significant events, are illustrated in column form on the UK Geology Wall Map, published by the Ordnance Survey. The advantage of a column is that older are below younger!

Other comparisons involve using a 24 hour clock or a calendar year.
See also: **Teaching Primary Earth Science**, issue 43 – Geological Time.

6. Modelling igneous rocks
This can best be done as part of "Changing materials" – liquids to solids by cooling. Children are likely to have some first-hand knowledge from home, school, holidays, with additional input from TV , including news.

Examples include
- water to ice - see the crystals.
- Wax and fat can be melted.
- Chocolate, toffee & sugar-based sweets show solidification on cooling & may show crystallisation. Some are solidified froth or bubbles, like pumice!
- Industrial melting in furnaces and subsequent cooling – iron & steel making, glass making.

A model volcano can be made by utilising a mixture of baking powder, liquid detergent and red food colouring in the neck of a model volcano and adding vinegar. The eruption produces a red carbon dioxide froth, which trickles down the model!
In bakeries soft materials like cream and jam are injected into dough under pressure, as in doughnuts and profiteroles. Cream eggs are made in the same way.
Compare with magma!

Magma [molten rock] cooling slowly at depth beneath mountain chains produces rocks with larger crystals eg granite.
Magma cooling nearer the surface forms rock with small-medium crystals, eg dolerite,
Magma reaching the surface at volcanoes as flows of lava, often full of gas bubbles. It cools rapidly on land or under water as a glass or pumice [glass froth]. Such rapid cooling results in microscopic crystals

Useful illustrations include active volcanoes [Hawaii, Tenerife etc], ancient lava flows [Giant's Causeway etc], granite tors on Dartmoor etc. See also Working With Rocks.
Crystallisation from a watery solution by evaporation is rather different.

7. Modelling metamorphism – baking clay
The quartzite pebbles seen at Pinfold Quarry are metamorphic rocks.
Hot molten magma loses heat to the surrounding rocks as it cools and crystallises. This baking of rocks is known as metamorphism. When clay-rich rocks are baked they re-crystallise and harden. Limestone recrystallises to form marble during metamorphism.
If the school has a pottery kiln, this could be a useful time to link with Art.

A sample of clay can be tested before firing, and the children asked to predict the outcome of firing. Fired clay is shrunk, hard, has little water and is only slightly porous. If glazed in a second firing it is no longer porous. Link to the use of bricks and tiles in buildings.
In the BBC "Come Outside" series Auntie Mabel and Pip visit a brickworks.

8. Modelling the Pressure effects of Metamorphism.
The pressures suffered by rocks during metamorphism in plate collisions is immense. The minerals in the rocks accommodate the pressure by re-aligning themselves at right angles to the pressure. This is how muddy rocks become slate. To demonstrate this you need a flat surface, two pieces of wood, about 40 matchsticks [beheaded ones for safety] or short lengths of drinking straw.

Lay the pieces of wood about 10cm apart. Scatter the sticks/straws randomly. This represents the unsquashed clay minerals found in mudstone etc. ask the children to predict what will happen when the pieces of wood are pushed towards each oher.

Gently push the pieces of wood together and, observe how the bits behave. You should end up with the bits aligned in the same direction. This represents the mineral alignment found in slate and how they tend to split easily in one plane. Ask the children what will happen when the pressure is removed. (They stay in the same alignment, don't rebound, not elastic.)

With strawers you can go further and actually crush them. What would happen if you used a vice? With sandy rocks, the quartz grains tend to be rounded and hard. They do not compress much. Demonstrate this using hard balls.

For Teacher Reference
The following issues of **Teaching Primary Earth Science** provide useful background information for a visit to Barr Beacon.

1 - Fossils,	2 - Introducing Rocks,	3 - Soil,
5 - Using Rocks,	9 - Minerals,	10 - Out and About 1,
12 - Out and About 2,	20 - Out and About 3,	24 - Out and About 4,
25 - Out and About 5,	37 - Organising Field Trips.	

Samples of Pinfold Lane Triassic pebbles should be included in your collection.
See the follow-up suggestions below.

B). Barr Beacon & Pinfold Lane Quarry KS2 Follow-up

Suggested Follow-up work
Much material could go into a folder on Barr Beacon & Pinfold Quarry, being the first part of a wider study, adding later sections on soils, vegetation, wildlife, conservation, aggregate extraction and recreation.

1. Completion of all worksheets
Pupil Activity Sheet 1 – **Map Of Barr Beacon & Pinfold Quarry**
Pupil Activity Sheet 2 – **Investigating The Memorial (Building materials)**
Pupil Activity Sheet 3 – **The Old Quarry & Car park Entrance**
Pupil Activity Sheet 4* – **Field Sketch Of Pinfold Lane Quarry**
Pupil Activity Sheet 5* – **A Close Look At Triassic Sandstone**
Pupil Activity Sheet 6 – **Investigating A Fault / Pebble Hunt**
Pupil Activity Sheet 7 – **Investigating Pebbles**

*Summary Pupil Activity **Sheet 8** - **Sandstone and Pebbles at Pinfold Lane Quarry** may be used as a possible alternative to the questions of Sheets 5 and 6.]

2. Classroom display of all aspects of the field visit, including maps, diagrams and photographs. Samples of pebbles and sandstone collected should be displayed, showing a broken, fresh face, suitably labelled Samples of pebbles may be cut [by an adult with a DIY tile cutter] and varnished to bring out the detail, possibly showing layering within the sedimentary rocks, random crystal orientation in the igneous rocks and the cleavage in slate, a metamorphic rock. For range of examples see the Triassic pebble sheet and table in the Teaching Trail.

The display should include the UK Geology Wall Map. Barr Beacon & Pinfold Lane Quarries are in the lemon shading [Triassic] midway between Birmingham and Lichfield. Note the extent of Permian and Triassic rocks up to the Scottish border, containing pebbles eroded from SW England and S Wales. Rock samples children collect from locally or further afield could be added to the display, with labels and markers linking the sample to the location on the map.

3. Investigate a sandstone sample – crush to constituent grains. Put into plastic container half full of water. Shake vigorously for a minute. Allow to stand undisturbed. Sand settles quickly, followed by finer silt, leaving red clay in suspension - to settle over a day. Draw sketch & measure the thickness of sand, silt & clay. A similar activity is done with soil samples in Working with Soil.

4. Write the story of a pebble [quartzite or other], joined by mates from other mountains, rolling and bumping along in a river. Illustration might include panorama sketch of mountains & river; possibly as a cartoon strip to record the series of events as the pebbles become reduced in size. Original large blocks of rock becomes smaller, more rounded, as broken bits add to sand/clay particles all carried along**.** This could be used as a possible homework exercise.

5. Websearch for information on flash floods.

6. View the Park Hall KS3 CD animation of rivers forming cross-bedding and KS4 on faulting.

7. Investigate local water supply:
a - from boreholes and wells in porous Triassic rocks. (**Working with Rocks** has an activity on making wells.)
b - from surface reservoirs on non-porous rocks.

8. Very brief summary of geological events to be used in follow-up. This could be given as a list of statements for children to put in order as a sequencing exercise.

1. Erosion of local mountains by rivers in a desert environment.
2. Deposition of sands & angular fragments by flash flood rivers.
3. Erosion of distant mountains to SW by rivers in a desert environment.
4. Deposition of conglomerate [pebble beds] and sand by larger flash flood rivers.
5. Earth movements – uplift and tilting gently to east [c 10 deg], with fractures and faults.
6. Later weathering and erosion over millions of years to produce landscape with hills and valleys.
7. Man quarried the pebbles and sand for use as aggregate, concrete and mortar.
8. Weathering and soil formation allows Nature to reclaim the quarries for recreation.

9. Make a model of Pinfold Quarry – possibly in three parts.
a. as the original landscape, covered in trees.
b. during quarrying for sand and gravel, use plaster to cement sand to produce the landscape. Show a working quarry with men and machinery etc.
c. as it is today with trees, grass and paths. Use"vegetation" purchased from toy/model shops.

10. Research into quarrying and uses of sand and gravel aggregates - in the local area and further afield. Used sand with cement [made from limestone and clay-rich rocks] to make mortar. Gravels may be crushed to size to add to mortar to make concrete used in roads, buildings, paving slabs, kerbstones, roofing tiles etc. Easy to use, transport and pour! Also as lower layers in roads. There are not many hard rocks in the Midlands.
Make a collection of small pieces of concrete.

11. Research into the use of transport of aggregates
Road transport was used for the movement of aggregates from here, especially for major works, like road construction.

12. Research into uses of old quarries.
Find out about local examples of:
Landfill, restoration with water features for wildlife, recreation, etc

13. Research the history of the Monument and where the stones came from.
[Mark these on a map]

- Portland Limestone is Jurassic, from **Portland, Dorset**. – Also seen in town buildings.
- Hard grey sandstone is Triassic, from **Tixall, east of Stafford** – Also used in the steps of Dudley Town Hall.
- Red sandstone is likely Triassic, probably **local to Barr Beacon**.
- Dolerite/Basalt blocks in roadside wall, Carboniferous, probably local, from **Rowley Regis or Barrow Hill.**

Working with Soil
If this was not done prior to the visit, it would be appropriate for the Soil topic to follow the visit even if the school isn't following the QCA guidance, Unit 3D –Rocks and Soils. The notes on preparation for the visit give details of ESTA's Working with Soil pack. It is anticipated that soil samples will be collected during the visit from a selecton of localities.