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In-school learning in preparation for field visit to the Ercall Quarries

Part 1
Revision of KS3 knowledge and understanding of geological processes should form the basis of the preparatory lesson(s) in school within the two week prior to the field visit.

KS3 geological processes **Time: 80 minutes**
In broad terms KS3 'geological processes' is the study of the 'Rock Cycle'.

Learning objectives for KS3
1. be able to describe and explain ways in which rocks are weathered
2. be able to observe and describe the key features of a rock specimen, including colour, texture and mineral content
3. be able to classify specimens of common rock types, using observed features, as igneous, sedimentary or metamorphic, and name such common rock types
4. be able to describe and explain how sedimentary rocks may be formed by processes including the erosion, transport and deposition of rock fragments
5. be able to make reasonable suggestions as to how a common sedimentary rock type they have described was formed, and how long the process took.

1. Weathering (10 minutes)
A brief question and answer session using photographs of rocks that have suffered weathering. Suggested images:
- boulder(s) showing onion-skin weathering
- boulder(s) split in half – e.g. Devil's Marbles
- jagged, broken rocks on mountain ridges, preferably with patches of snow still visible.

An internet search yields many possible images for classroom use. Internet images may provide useful background discussion about the weathering mechanisms involved Examples:

http://www.geos.ed.ac.uk/undergraduate/field/holyrood/spheroids
http://academic.brooklyn.cuny.edu/geology/leveson/core/topics/weathering/picturegallery/display/newjerseygarretmt1.html
http://www.au.au.com/cameras/images/devilsmarbles.jpg
http://www.thewalkzone.co.uk/Lake_District/walk36/180203h.jpg

Tasks in small groups: show the pupils the photographs and give them one minute to come up with suggested causes of the weathering depicted in each image. There is probably no single 'correct' answer in any of these situations because weathering is rarely one process operating on its own. Weathering is usually caused by a combination of physical and chemical weathering processes. It is the pupils' suggestions and subsequent discussion generated that are important.

2. The rock cycle (35 minutes)
A simplified pictorial version of the rock cycle should be used in the session and this diagram can be downloaded from:

http://www.washington.edu/uwired/outreach/teched/projects/web/rockteam/WebSite/rockcycle.htm.htm

Animations under the heading "The formation of fundamental rock types" are useful resources and these are available at:

http://earthsci.org/rockmin/rockmin.html

Activity 1: provide a set of six common rock types (sandstone, shale, conglomerate, granite, dolerite/basalt with crystals just visible, slate or schist or gneiss). Tasks in small groups:
- agree key features of each specimen (colour, texture, etc), and how the grains are held together (which help them to identify whether they are sedimentary, or igneous or metamorphic).
- provide a set of name labels; groups have to decide quickly which label belongs to each specimen, and be able to justify (for able groups, provide more name labels than specimens!)
- plenary agreement on correct labelling and why the name label is appropriate.

Activity 2: teacher shows quick demonstrations of:
(1) sedimentation jar filled with water then 3 charges of different sediment (the last one being muddy to show slow fall of sediment)
(2) a volcano in a laboratory. This demonstration of a volcano uses wax and sand. Details are available from:

http://www.earthscienceeducation.com/workshops/rock_cycle/index.htm

(3) effects of pressure on rocks. This simulation of the distortion of fossils by metamorphism uses modelling clay and cockleshells. Details are available from:

http://www.earthscienceeducation.com/workshops/rockcycle/metamorphism.htm

Task for small groups using the rock cycle diagram:

- decide what part of the rock cycle each demonstration is modelling

Activity 3: How did sediment become hard rock? This can be modelled for sandstone, as shown on the JESEI website at:

http://www.chemsoc.org/networks/learnnet/jesei/sedimen/index.htm

3. Sedimentary processes (35 minutes)
Activity 4: pupils place cubes of sugar in a closed container and shake for 30 seconds and then observe changes to the shape and size of the cubes. Repeat activity at 30 second intervals, weighing & measuring the cubes at each stage. Tasks in small groups:

- decide what is the cause of the changes they have observed
- decide what part of the rock cycle is modelled in the experiment
- agree what will affect the degree of rounding and size reduction of rock fragments in the rock cycle.

Activity 5: provide three piles of sediment (one of gravel, one of soil and one of sand) and watering cans for pupils to use to pour water over the sediments to see how far the water spreads the sediment. Tasks for pupils work in small groups:

- agree what needs to be done to ensure the test will be a fair test
- pour 2 litres of water slowly over each pile of sediment
- observe what happens and measure how far the water spreads each pile
- agree which type of material was spread further
- predict what would happen if they poured 4 litres of water over each pile of sediment.

Activity 6: teacher shows demonstrations of river erosion, transport and deposition using a child's slide extension or a very long tray covered with a sand and gravel (pea-sized) mixture.
Tasks for pupils in small groups:

- decide how the different types of sediment are moved along the river bed in this model
- agree where erosion takes place and what evidence shows that erosion has occurred here
- agree where deposition occurs and why deposition occurred at this place
- decide what different results they could expect to see if (a) the slope of the tray is increased and (b) a greater volume of water is poured into the tray.

Details of **Activities 5 and 6** (and of related practical activities) are available at:

http://www.kented.org.uk/ngfl/subjects/geography/rivers/Teacher%20Plans/whatiserosionanddeposition.htm

Activity 7: teacher shows a demonstration of the formation of ripple marks using a fish tank (approximately 100cms long, 50cms deep and 50cms wide) and two wooden cylinders 3cm diameter and slightly longer than the width of the tank
Put clean, well sorted sand of fine to medium grain size into the tank, sufficient to line the floor of the tank to a depth of several cm. Place the tank on the wooden rollers, and fill the tank with water to a depth of 15-20cm. Gently and rhythmically rock the tank back-and-forth in an oscillatory motion until ripples form on the sediment surface. (This does not take long, but there is the potential for disaster if the tank is rocked too vigorously!).

Activity 7 is particularly relevant for The Ercall visit, since ripple marks will be seen and used in a simplified attempt to interpret ancient environments of sediment deposition. For more details on ripples, see the **ERC4 E.S. briefing** document.

Part 2

In addition to the briefing on the organisation for an off-site visit, the necessary Physics studied at KS3 of the response of materials to deforming forces needs to be revised and slightly extended. This should form the basis of part of the preparatory lesson in school within a week prior to the field visit.

The response of materials to bending forces *Time: about 15 minutes*

In KS3, pupils are likely to have investigated the behaviour of springs and rubber bands when they are stretched. Under lower stresses, both show a linear relationship (known as **Hooke's Law)** between force (load) and extension. This is called elastic deformation. However as the stress increases, the behaviour of the two materials begins to differ; neither obeys Hooke's Law any more, but the spring becomes permanently deformed, while the elastic band becomes much more difficult to stretch further, and eventually snaps.

It is unlikely that pupils will have investigated behaviour of materials under bending forces. For the purpose of this preparatory lesson, a few quick qualitative demonstrations should be enough to achieve the following **learning objectives**:

- know that under low bending forces, a strip of material will exhibit ***elastic deformation***
- know that under higher bending forces, a strip of material will exhibit ***plastic deformation***, becoming permanently bent
- know that under very high bending forces, a strip of material may snap, suffering *brittle* ***fracture.***
- know that some materials deform in these ways more readily than others

For quick demonstrations the teacher will need to 'sacrifice' e.g. a few (old) wooden rulers (or wooden skewers), a few (old) plastic rulers (or similar plastic strips which do eventually show brittle fracture) and a few metal (steel) rulers (or similar metal strips which can be bent by hand). If strips of a variety of metals in strip form such as copper, zinc, aluminium, are available for comparative purposes, so much the better. A steel wire coat hanger could be used to show brittle fracture after 'working' in the plastic stage.

Finally leave the class with the (unanswered) questions:

- is it possible to deform rocks in these ways?
- what would you look for "in the field" as pieces of evidence to show rocks had undergone
  a) plastic deformation &
  b) fracture?
- what could be the cause(s) of different types of deformation in rocks?

Follow up Homework:
An explanation and correct sequence for the following homework exercise can be found in document **ERC13 teachers' notes, page 1.**
In the Index, the file **"ERCALL05.exe"** is an animated sequence which teachers might like to show pupils after the completion of the homework exercise.

KS4 Pupil Follow – Up Homework sheet: The Ercall Quarries

Here is a list of events that have happened at The Ercall Quarries. Some of them are quite recent and some happened a very long time ago. Your task is to put them into the correct order in a list with the oldest at the **bottom** and the youngest at the **top**. Earth Scientists do this to remind them that the oldest beds of evidence are always underneath, and the youngest on top.

It may help to cut out the statements so that you can move them about. You may find that looking at the worksheets that you used when you were in the quarries will help you.

A. The overlying rocks are eroded until the pink granophyre is exposed at the earth's surface.
B. The quarries are sold to Shropshire Wildlife Trust as a nature reserve.
C The pebbles and sand are cemented into hard sedimentary rocks.
D. Pebbles and sand, weathered from older rocks, are deposited in beds on top of the Granophyre
E. Resistant rocks are dug out of the ground for use as road stone.
F Magma is intruded into older rocks and crystalises into a pink igneous rock called granophyre.
G. Uplift, tilting, faulting and erosion of the conglomerate and sandstones occurs.

When you have done that use the list to tell the story of what happened at The Ercall. You could do this in writing, as a poster, in verse or you even could record a spoken commentary or make a 2 minute video.