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Contact: info@ukrigs.org.uk

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. Follow any guidance given by the church authorities at St Mark's, even if you are not visiting the churchyard. Check the graveyard to locate suitable headstones for the rock identity and weatherting exercises. Familiarise yourself with the Teaching Trail on-site. It is essential to have a copy of the leaflet: ***Barrow Hill, The Dudley Volcano***, available from Dudley Museum, local Tourist Information Centres and St Mark's Church, Pensnett.

There are toilets at St Mark's. Liase with the church authorites to arrange opening.
Remind the children of the need for respectful behaviour in the churchyard, especially towards people visiting graves.

It is assumed that, prior to this visit, 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:

1. To model layering in sedimentary rocks by settling in water – a demonstration.
Collect samples of different coloured sand, silt, and a few broken shells. Mix each sample with water in a beaker. 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).

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. Fossils
It is unlikely that fossils will be seen on the visit, but children are interested in them and they are a significant part of interpreting Earth science. The definition of a fossil is:

> **"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.

3. 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 the older are below the younger!

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

4. 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 and sugar-based sweets show solidification on cooling and may show crystallisation. Some are solidified froth or bubbles, like pumice!;
- Industrial melting in furnaces and subsequent cooling – iron amd 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!

Magma [molten rock] comes from 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.
Magma 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, e.g. dolerite, as at Barrow Hill.
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 slightly different from cystallising from magma.
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5. Modelling contact metamorphism – baking clay
Hot molten magma loses heat to the surrounding rocks as it cools and crystallises. This baking of rocks is known as contact metamorphism. When clay-rich rocks are baked they re-crystallise and harden. This has happened at Barrow Hill when the dolerite baked the Etruria Marl in Carboniferous times. Limestone re-crystallises 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. This could be linked to the use of bricks and tiles in buildings. In the BBC "Come Outside" series Auntie Mabel and Pip visit a brickworks.
Metamorphism with great pressure turns clay-rich rocks into hard, non-porous slate, which splits at right angles to the pressure.

For Teacher Reference
The following issues of Teaching Primary Earth Science provide useful background information for a visit to Barrow Hill:

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 commonly used rocks found in St Mark's Churchyard can be obtained from monumental masons. They will likely have cut and polished faces, but try to find pieces which show the freshly broken rock. Dolerite from Barrow Hill should be included in your collection. See follow-up suggestions below.

Barrow Hill KS2 Follow-up Work.

Suggested Follow-up work
Much material could go into a folder on Barrow Hill Nature Reserve, being the first part of a wider study, adding later sections on soils, vegetation, wildlife, conservation, recreation and quarrying.

1. Completion of all worksheets and Gravestone Survey [from Teaching Trail notes]

*Site 1a Activity Sheet 1 – Map and Church Study.
*Site 1b & 1c Activity sheet 2 - St Mark's Church.
*Site 1d Activity Sheet 4.- 1st. Churchyard Recording Sheet.
*Site 1d Activity Sheet 5.- 2nd. Churchyard Recording Sheet.
*Site 2 Activity Sheet 6 – What will make my gravestone last?
*Site 3 Activity Sheet 7 – Study Of St Mark's Church Gate
*Site 4 Activity Sheet 8 – Study Of The War Memorial
*Site 5 & 6 Activity Sheet 9 – Study Of The Vicarage Wall
*Site 7 Activity Sheet 10 – Poolside Soil and Vegetation
*Site 8a Activity Sheet 11 – Barrow Hill Quarries
*Site 9 Activity sheet 12 – Barrow Hill Summit Viewpoint.

See also **section 9** below for suggested follow up work from the churchyard survey.

2. Classroom display of all aspects of the field visit, including maps, diagrams and photographs. Samples of rock collected from a monumental mason could be displayed, showing a broken, fresh face, suitably labelled. Ask and make a note of where the individual rocks originate. Any sample 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 banding in some metamorphic rocks. Examples include sandstone, limestone, granite, gabbro, marble, slate and dolerite [include a sample collected from Barrow Hill].

The display could include the UK Geology Wall Map. Barrow Hill is in the blue shading [Carboniferous] midway between Birmingham and Kidderminster. 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. Make a model of the quarries. Use plaster to cement dark chippings. Paint corrugated cardboard to show the columnar jointing. Half of model could show a working quarry with men and small machinery etc, with the other half as landscaped today [with "vegetation" purchased from toy/model shops].

4. Research into quarrying and uses of dolerite - in the local area and further afield. Early use was to build rough walls, as the rock is strongly jointed, making it difficult to have large blocks which could be cut and dressed as a building stone. In the late 18th century the dolerite was crushed and used as road aggregate for turnpike roads being built locally. Barrow Hill is one of a few outcrops of dolerite in the Midlands, most of which have been quarried for road aggregates for many years. The rock is the hardest available in the area. It has a rough surface which makes it useful as a top dressing on the wearing surface of a road. It has also been used for cobblestones ["setts"] and kerbstones. These are still commonly seen in older parts of towns. They are valuable and can be re-used when areas are redeveloped. Some is mixed with cement to make concrete slabs for walls, garages etc.

There is one remaining dolerite quarry in the Midlands, at Rowley Regis, which gave rise to the local term for dolerite: Rowley "Rag", shortened from "ragstone", a rough and ragged stone, difficult to build with! Most of these old quarries have been used to tip waste materials, then covered in topsoil [a research topic in its own right]. Some, like Barrow Hill have been conserved as Nature Reserves – for their geology and wildlife value. Take photographs of any examples of these rocks being used and include in the classroom display. Collect a cobble! Many types of hard rock are used for cobbles.

5. The strangest use of dolerite?
In the early C19 when geologists were trying to understand how magma produced igneous rocks several experiments were carried out. "How do you prove that these hard crystalline rocks came from molten rock?" The answer chosen was "Heat up a sample to a melt and let it cool and crystallise back into a solid". The result looked a bit glassy, but quite similar to the original.

For a short time in the 1850s dolerite was used to produce artificial stone. Chance Bros, glassmakers, of Smethwick, allowed Henry Adcock to experiment with dolerite. Glassworks have crushers, furnaces and moulds which use silica [quartz] sand as the main ingredient for glass. Dolerite was crushed, heated to melting point in a coal-fired furnace and poured into moulds of various shapes. For just three years Chance Bros produced …

> ***"slabs for steps, window-heads and -sills, string [damp-proof] courses, mantel-pieces, doorways, columns and capitals, besides a number of objects suitable for internal decoration, slabs for tables and sideboards, door-plates and knobs etc"…***

… but production costs were too high!! (The quotation is from Victoria County History of Staffordshire [1967], Vol II - Industries. See chapter on Stone by D A Johnson, - Dolerite - pp203-205.)
Edgbaston Vestry Hall, now used by a stationery firm, has wonderful examples around the windows and doors. Unfortunately they have been painted white!

Figure 1. Fused dolerite mouldings, Edgbaston Vestry Hall.

6. Research into the extraction and use of other geological resources.
The view from Barrow Hill shows much evidence.
The Carboniferous rocks of the area contain vast amounts of coal, iron, clay and sandstone, as well as much dolerite. The older, Silurian, rocks contain limestone. These geological resources provided the raw materials and power for the Industrial Revolution. The industrial region of towns and villages, known as the Black Country, is based on the rocks of the South Staffordshire Coalfield.
Although much has changed in recent years, this rich geological heritage can still be seen wherever we go.

- **Coal** – fuel in furnaces, baked to make **town gas** and coke, coke used in blast furnaces. Investigate the history of coal mining, including the employment of youg children.
- **Ironstone, coke** and **limestone** used in blast furnaces to make **iron and steel**. These used in the metal-working industries producing a huge range of goods from railway track to machinery. Link this with history and the work of "Dud" Dudley and the Darby's of Coalbrookdale.
- **Limestone** was used to build Dudley Castle. A clear link with history.
- **Clay** – used to make **bricks & tiles** in coal-fired kilns. These were used in buildings, bridges, tunnels etc. "Staffordshire Blues", made from Etruria Marl are very strong. Silica-rich fireclays were used to make refractory bricks for furnace linings. Other clays were used for early pottery.
- **Sandstones** – used for gravestones, buildings and rough walls. Pure silica sands were used for glass-making and refractory bricks for furnace linings.
- **Dolerite** – as noted above, used extensively as road aggregate.

7. A visit to the Black Country Museum, Dudley
This would provide a clear link between the use of geological resources and the social history of the community.

8. A visit to the Dudley Museuem and Art Gallery
This has a fascinating display of local rocks and fossils, mining and quarrying. Runs workshops for school groups.

9. St Mark's Churchyard Gravestone Survey Results follow up work.
Use the combined results of each group to produce a table to show how the numbers of different groups of rock used in gravestones changed over time, based on the results of the survey**.**

	Sedimentary	Igneous	Metamorphic	Brick & ceramic	Two or more types
Before 1860					
1860 – 1910					
1911 – 1930					
1931 - 1951					
1951 – 1971					
1971 – 1991					
1991 to present day					
TOTALS					

These results could be used to make a graph.

Your results should help you to answer the following questions. See below for guidance on answers.
1. Which group of rocks is the most common overall? (IGNEOUS)
2. During which period were sedimentary rocks most common? (Likely to be before 1860)
3. Which rock type was this? (SANDSTONE)
4. During which period were igneous rocks most common? (Likely 1931 – 1950)
5. During which period were metamorphic rocks most common? .(Likely 1911 – 1930)
6. Which rock type was this? (MARBLE).
7. During which period were brick or ceramic used? (Likely 1931 – 1950)

- Relate the changes to costs of available stone and transport. Pre-1900, mostly local sandstones, though later use of rail transport for more exotic/beautiful igneous and metamorphic rocks from other parts of British Isles and abroad [e.g. marble from Italy]. Today, with cheap labour and sea transport, many beautiful headstones and surrounds come ready-cut and polished from China and India.
- Brick surrounds can be found, but are not common.
- Ceramic headstones and surrounds were in fashion for a short time, but the glaze becomes chipped, water gets in and freeze-thaw goes to work.
- Visit a monumental mason to get a catalogue as well as samples of stones.
- Perhaps arrange a class or group visit.

Working with Soil
If 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 selection of localities.

The soil samples from Poolside, the Quarry and the hillside itself will show large differences related to the rock type and length of time soil that forming processes have been at work.