Teaching the Dynamic Earth

Will my gravestone last?
An Earth science investigation

Contents

Relevance to National Curriculum at Key Stage 3 and Key Stage 4 ................................................. 2

Teachers’ notes
How to organise the investigation & its follow up ................................................................. 3
Teaching points of workshop activities (in C.A.S.E. terms) ........................................... 6

Pupils’ notes
Planning guidelines ................................................................................................................... 7
Writing up results .................................................................................................................... 8
Help sheet ............................................................................................................................... 10
Key to some rock types ......................................................................................................... 11
Prepared sheet for plotting data ............................................................................................. 12

With the support of:

UKOOA
Oil and Gas for Britain

UK Offshore Operators Association (UKOOA) is the representative organisation for the UK Offshore Oil and Gas Industry. Its 35 members are companies licensed by the Government to explore for and produce oil and gas in UK waters.

© The Earth Science Education Unit. Copyright is waived for original material contained in this booklet if it is required for use within the laboratory or classroom. Copyright material contained herein from other publishers rests with them.
Will my Gravestone Last?

An Earth science investigation in a nearby churchyard

Objectives: To use the wealth of opportunities presented by a graveyard for scientific investigation out of doors in an Earth science context.

The National Science Curriculum (2000) Perspective

The session is aimed at the following National Science Curriculum statements:

Key Stage 3, Sc3 - 2. Geological changes

"Pupils should be taught:

d) how forces generated by expansion, contraction and the freezing of water can lead to the physical weathering of rocks;

e) about the formation of rocks by processes that take place over different timescales, and that the mode of formation determines their texture and the minerals they contain;

f) how igneous rocks are formed by the cooling of magma, sedimentary rocks by processes including the deposition of rock fragments or organic material, or as a result of evaporation, and metamorphic rocks by the action of heat and pressure on existing rocks;

Key Stage 3, Sc3 - 3. Acids and bases

g) how acids in the environment can lead to corrosion of some metals and chemical weathering of rock [for example, limestone]"

Key Stage 3, Sc1 – Scientific enquiry

The field study offers scope for developing many of the investigative skills involved in planning, obtaining and presenting evidence, considering evidence and in evaluating it. Of particular relevance is:

2. Investigative skills

"Pupils should be taught to:

d) consider key factors that need to be taken into account when collecting evidence, and how evidence may be collected in contexts [for example, fieldwork, surveys] in which the variables cannot readily be controlled”.

Coverage of QCA Scheme of Work

Unit 8G Rocks and Weathering – Most of the ‘lessons’ in the QCA Schemes are applied to the outdoor situation in ‘Will my Gravestone Last?’. Aspects of Unit 9G Environmental Chemistry are also dealt with.
TEACHERS’ NOTES

Will my gravestone last?

Topic
A visit to a nearby churchyard or cemetery, which can be run as a pupil investigation. An alternative is to use a town centre, where there is a good range of building stones used for shop fronts. Sc1 skills can be practised, although it is probably unwise to use the visit for assessment purposes.

Prior knowledge
This is best undertaken after pupils have been introduced to the main groups of rocks (igneous, sedimentary, metamorphic) and have studied weathering.

In terms of Sc1 pupils are expected to use scientific knowledge and understanding to identify an appropriate approach… (AT1, level 6). In this context, this could include:

- Some materials occur naturally; others are manufactured.
- Materials formed at high pressures and/or high temperatures are less stable under ambient conditions.
- 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
Start by showing pictures of different types of gravestones and the ways in which they may become weathered. These may be taken locally, e.g. on slide film, 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. limestone or marble, it is usually thought of as an aspect of weathering.

Level
KS3 (11-14 year olds), but it works at any level from Primary to Pensioner!

Time
One preparation lesson. About an hour for the visit. One follow up lesson and a homework.

Equipment and safety notes
Carry out a written risk assessment before the visit and file it in the most apposite office. This includes the appropriate number of adults for the class, as decreed by your LEA. Take steps to ensure safety at road crossings and to avoid hypothermia or sunstroke among the pupils!

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
Will my gravestone last?

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.

Staff may carry a dropper bottle of dilute hydrochloric acid (0.5M), and a wash bottle. A hand lens and a set of Building Stones Postcards (Manchester Museum) are useful extras.

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 (e.g. slides) of fresh, unweathered gravestones and ask pupils to write down the rock type they like best.
- Show slides 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 slides 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 rain water and is removed in solution, leaving the lead letters standing out. This can be measured with a tyre depth gauge, and an estimate of the rate of weathering calculated).
- 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 haven’t thought of it.

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!

Follow-up lesson

Allow groups time to follow up their results, share statistical information to compile more significant class data and to draw graphs. Comment on their hypotheses and whether or not they have "proved" them.
Will my gravestone last?

Extension work

- 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.

References

The General Cemetery, Sharrow, Sheffield: a Geological Trail, by Peter Kennett, from ESTA.
The Building Stones of Sheffield: a Geological Walk in the City Centre, by Peter Kennett et al, from ESTA. There are many similar town trails, for other towns in the UK, available from Geo Supplies Ltd, Sheffield, S35 2XE, or from local outlets, e.g. museums and visitor centres.
<table>
<thead>
<tr>
<th>Activity</th>
<th>Pattern (construction)</th>
<th>Challenge (cognitive conflict)</th>
<th>Explanation of thinking (metacognition)</th>
<th>Relevance (bridging)</th>
<th>Practical teaching points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graveyard Visit</td>
<td>A wide range, depending on which ideas the pupils choose to investigate: eg.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Most popular rock types</td>
<td>How far back in time does ‘today’ go to?</td>
<td>Reasoning behind answers</td>
<td>Discussion of why they are most popular, eg. original appearance, appearance after weathering, cost, durability, rock types available from overseas.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Differences 50, etc. years ago</td>
<td>What time span should ‘50 years ago’ cover?</td>
<td>Reasoning behind answers</td>
<td>Discussion of historical differences, eg. availability of stone from overseas, transport costs, tastes 50 years ago, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Which rock types resist weathering best?</td>
<td>Which other variables need to be controlled and how (eg. age, aspect, whether or not under trees)?</td>
<td>Reasoning behind answers</td>
<td>The same discussions are relevant to stones chosen as facing and building stones today. Original choice of stone/building material greatly affects maintenance costs of buildings such as town halls, cathedrals and even schools and houses.</td>
<td>Some pupils will need to be guided on which variables to control and how to do it.</td>
<td></td>
</tr>
<tr>
<td>• Gravestone aspect</td>
<td>Which other variables need to be controlled and how?</td>
<td>Reasoning behind answers</td>
<td>Relevant to the aspect of their own house/flat/garden – and that of the school.</td>
<td>A compass is needed – particularly as some churches are not aligned east-west.</td>
<td></td>
</tr>
<tr>
<td>• Vertical vs horizontal stones</td>
<td>Which other variables need to be controlled and how?</td>
<td>Reasoning behind answers</td>
<td>Discussion of the effect of being near or in the soil – links to soil-forming and weathering processes.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| • Effect of lichens and mosses | Which other variables need to be controlled and how?                                      | Reasoning behind answers                                                                   | • Links to a range of biological weathering processes.  
• The requirements for life of living things. | Ensure that pupils know the difference between lichens and mosses – and are aware that lichens are living! |                          |
| • Effect of being under trees | Which other variables need to be controlled and how?                                      | Reasoning behind answers                                                                   | Discussions of the effects that trees can have in general, eg. soil/drips more acid, but trees reduce wind speeds and protect from weather. |                                                                                       |                          |
| Own ideas         | Control of variables                                                                     | Reasoning behind answers                                                                   | There will be features relevant to everyday life and the world in general. |                                                                                       |                          |
PUPILS’ NOTES

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.

When you go, 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 stone weathered more quickly than horizontal ones?
- 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 GOING 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 into your book: Heading: Gravestones in ................. Graveyard

<table>
<thead>
<tr>
<th>Type of stone</th>
<th>Sandstone</th>
<th>Marble</th>
<th>Granite</th>
<th>Gneiss</th>
<th>Mixed stones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of stones</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before 1850</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1851-1900</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1901-1950</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1951-present day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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, to add up on the blackboard.

3. Plot a bar graph of the class results, showing the different types of stone.
   a) Types of stone used e.g.

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 in your books.

5. Give these figures to your teacher to add up on the blackboard.

6. Plot graphs of the class results, showing types of stones for each date.
   b) Types of stone versus date of first burial, e.g.
7. Write down what you think the graphs show you about the choice of stones for graves in the churchyard. Why do you think the choice changed over the years? (Hint: Think about changing transport between the churchyard and the nearest quarry, port etc.)

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?
Will My Gravestone Last?

**Key to some rocks commonly used for ornamental purposes**

- Sedimentary rock
  - Igneous rock
  + Metamorphic rock

<table>
<thead>
<tr>
<th>Gravestone or Building Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does stone react vigorously when touched with acid dropper? (Check if this allowed)</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
</tbody>
</table>

- Can you see the crystals or grains which make up the stone? (With a lens, if needed.)
  - Yes
  - No

- Is the stone crystalline with crystals that interlock?
  - Yes
  - No

- coarse crystals (easily visible with naked eye)
  - medium to light coloured, speckled
    - randomly arranged crystals
      - GRANITE°
  - crystals arranged in bands
    - GNEISS +

- medium sized crystals (just visible with naked eye)
  - dark grey or green-grey
    - medium sized crystals (just visible with naked eye)
      - dark grey or green-grey
    - consists of rounded or angular sand grains cemented together
      - sand grains cemented together
        - SANDSTONE°
  - dark grey or green-grey
    - GABBRO°

- hard, dark grey, purple or greenish colour
  - SLATE +

- sugary texture: may be veined or mottled
  - MARBLE +

- non-sugary texture: may contain fossils
  - LIMESTONE°
### Survey sheet

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

| Surname of grave | Date of death of **first** occupant | Type of stone e.g.  
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>‘Granite’ (give colour)</td>
<td>Marble</td>
<td>Sandstone (coarse or fine)</td>
<td>Mixed stones (name types)</td>
<td>Extent to which stone is weathered e.g. crumbling stone, split slabs, rough surface in place of polished etc lead letters standing out</td>
<td>Aspect (North facing etc)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Will My Gravestone Last?**