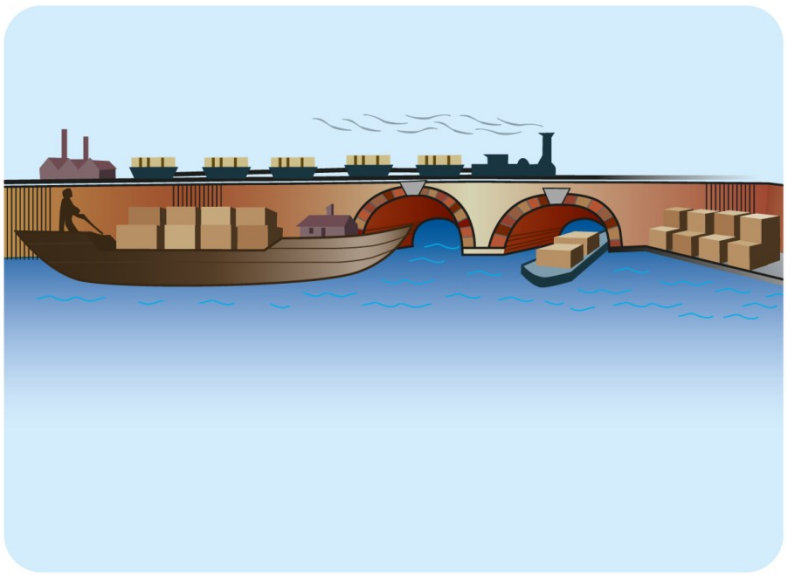
Teaching the Dynamic Earth

# Will my gravestone last?: an Earth science investigation

## Earth science out of doors

ESEU KS3 science/geography workshop material



Earth science for KS3

EARTH SCIENCE EDUCATION UNIT

**With the support of:**

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# ESEU Secondary Workshops
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# Will My Gravestone Last?
# An Earth science investigation in a local churchyard
# Earth science for KS3 science/geography

**This Pack provides the background to the organisation of a group visit to a local churchyard or cemetery. It includes pupil sheets, which may be used to guide a class on site in a churchyard, including a plotting sheet for recording of observations. Suggestions are provided for follow-up work at school.**

## Contents



**Summary**

This is the basis of a 'field visit' to a local graveyard to use the wealth of opportunities available for scientific investigation, out of doors, in an Earth science context. The case study videos were filmed in Ecclesall Churchyard, Sheffield, UK. The video scripts outline the content of each video, which, taken together provide a full example of how a churchyard may be used for Earth science investigations.

**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.

## Curriculum references:

| England | Scotland | Wales | Northern Ireland |
|---|---|---|---|
| **Science: Lower KS2**<br>**Years 3 and 4**<br>**Working scientifically**<br>• asking relevant questions and using different types of scientific enquiries to answer them<br>• setting up simple practical enquiries<br>• making systematic and careful observations<br>• using results to draw simple conclusions,<br>• using straightforward scientific evidence to answer questions or to support their findings<br><br>**Year 3**<br>**Rocks**<br>• compare and group together different kinds of rocks on the basis of their appearance and simple physical properties<br>Linked with work in geography, pupils should explore different kinds of rocks, including those in the local environment<br>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.<br><br>**Science: Upper KS2**<br>**Working scientifically**<br>• recording data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graph<br><br>**KS3**<br>**Working scientifically**:<br>• ask questions and develop a line of enquiry based on observations of the real world, alongside prior knowledge and experience.<br>• make predictions using scientific knowledge and understanding<br>• select, plan and carry out the most appropriate types of scientific enquiries to test predictions, including identifying independent, dependent and control variables, where appropriate.<br>• use appropriate techniques, apparatus, and materials during fieldwork and laboratory work, paying attention to health and safety.<br>• make and record observations and measurements using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements.<br>• apply sampling techniques.<br><br>KS3 Chemistry:<br>• the rock cycle and the formation of igneous, sedimentary and metamorphic rocks.<br><br>**Geography:**<br>**Geographical skills and fieldwork**<br>**KS1**<br>• 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.<br><br>**KS2**<br>• 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.<br><br>**KS3**<br>• use fieldwork in contrasting locations to collect, analyse and draw conclusions from geographical data, using multiple sources of increasingly complex information.<br><br>**Human and physical geography**<br>**KS3**<br>understand, through the use of detailed place-based exemplars at a variety of scales, the key processes in:<br>• physical geography relating to: … rocks | **Sciences**<br>**Early**<br>**Biological systems**<br>I can identify my senses and use them to explore the world around me.<br>SCN 0-12a<br><br>**First**<br>**Properties and uses of substances**<br>Through exploring properties and sources of materials, I can choose appropriate materials to solve practical challenges.<br>SCN 1-15a<br><br>**Second**<br>**Earth's materials**<br>Having explored the substances that make up Earth's surface, I can compare some of their characteristics and uses.<br>SCN 2-17a<br><br>**Social studies**<br>**First**<br>**People, place and environment**<br>I can describe and recreate the characteristics of my local environment by exploring the features of the landscape.<br>SOC 1-07a<br><br>I can consider ways of looking after my school or community and can encourage others to care for their environment.<br>SOC 1-08a | **Science: KS2**<br>**The sustainable Earth**<br>• a comparison of the features and properties of some natural and made materials<br>• how some materials are formed or produced<br><br>**Geography: KS2**<br>**Pupils develop their geographical skills, knowledge and understanding through learning about places, environments and issues**<br>• fieldwork to observe and investigate real places and processes | **The world around us**<br>**Foundation stage**<br>**Strand 3: Place**<br>**KS1**<br>**Features of the immediate world and comparisons between places;**<br>• about materials in the natural and built environment (G); (H);<br>• about the properties of everyday materials and their uses (S&T);<br>• the similarities and differences between buildings features and landscape in their locality and the wider world (G)<br><br>**KS2**<br>**Ways in which people, plants and animals depend on the features and materials in places and how they adapt to their environment;**<br>• about the origins of materials (S&T) |

# Will My Gravestone Last?

**Topic addressed:**
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.

**Level:**
7-14 year olds, but the approach works at all levels.

**Activity time:**
One preparation lesson. About an hour for the visit. One follow up lesson and a homework.

**Resource list:**
**Staff** may carry:
- dilute (0.5M) hydrochloric acid or white vinegar (to test for the calcium carbonate in limestone and marble)
- wash bottle with tap water
- First Aid kit

Useful extras:
- hand lens (for pupils too, if supplies permit)
- tyre depth gauge
- magnetic compass
- set of building stones photographs (See Earthlearningidea activities below)

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”.

**Pupils** will need**:**
- clipboards.
- survey sheets
- key to rock types
- pencils

**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 dilute acid being added to 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.

**Leading into the activity:**

**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.

**Activity:**
**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!

**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.
See the following Earthlearningidea activities for further guidance and for sheets of photographs (at natural scale) of rocks used for gravestones and buildings.

http://www.earthlearningidea.com/PDF/135_Gravestones.pdf
https://www.earthlearningidea.com/PDF/134_Building_stones.pdf
https://www.earthlearningidea.com/PDF/140_Building_stones_sed.pdf
https://www.earthlearningidea.com/PDF/143_Building_stones_met.pdf

# 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:

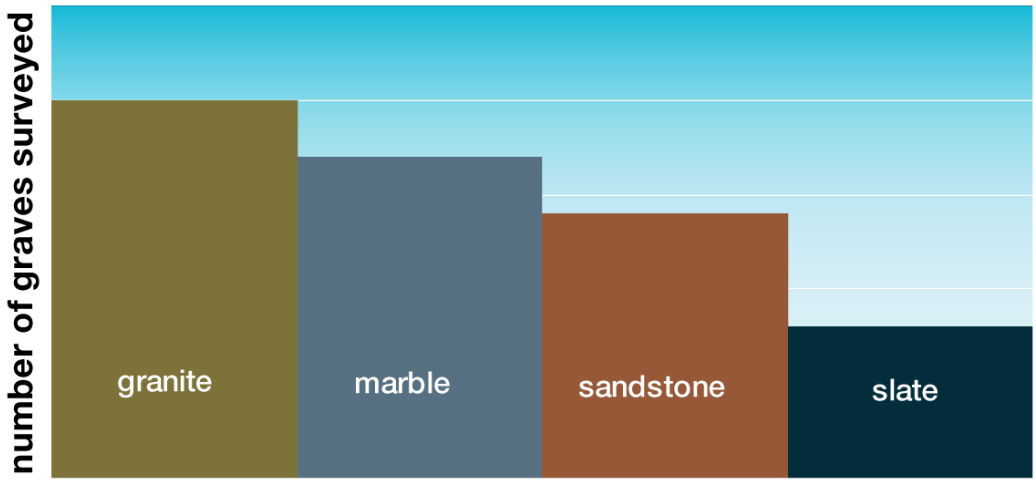
| **Gravestones in ……..... Graveyard** | | | | | |
|---|---|---|---|---|---|
| **Type of stone** | **Sandstone** | **Marble** | **Granite** | **Gneiss** | **Mixed stones** |
| Total number of stones | | | | | |
| Before 1850 | | | | | |
| 1851-1900 | | | | | |
| 1901-1950 | | | | | |
| 1951-present day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

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

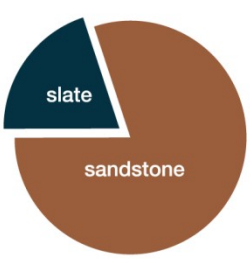



4. Now look at your own figures again. Count how many stones there are, of each type, between these dates: Before 1850; 1851-1900; 1901-1950; 1951-present day. Show the figures on the table.

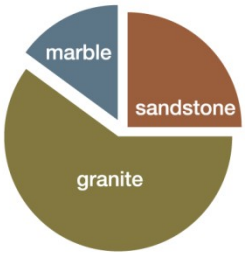
5. Give these figures to your teacher to add up on the board.

6. Plot graphs of the **class** results, showing types of stones for each date.

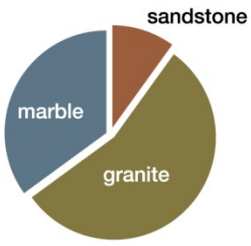
   b) Types of stone versus date of first burial, e.g.




Up to 1840

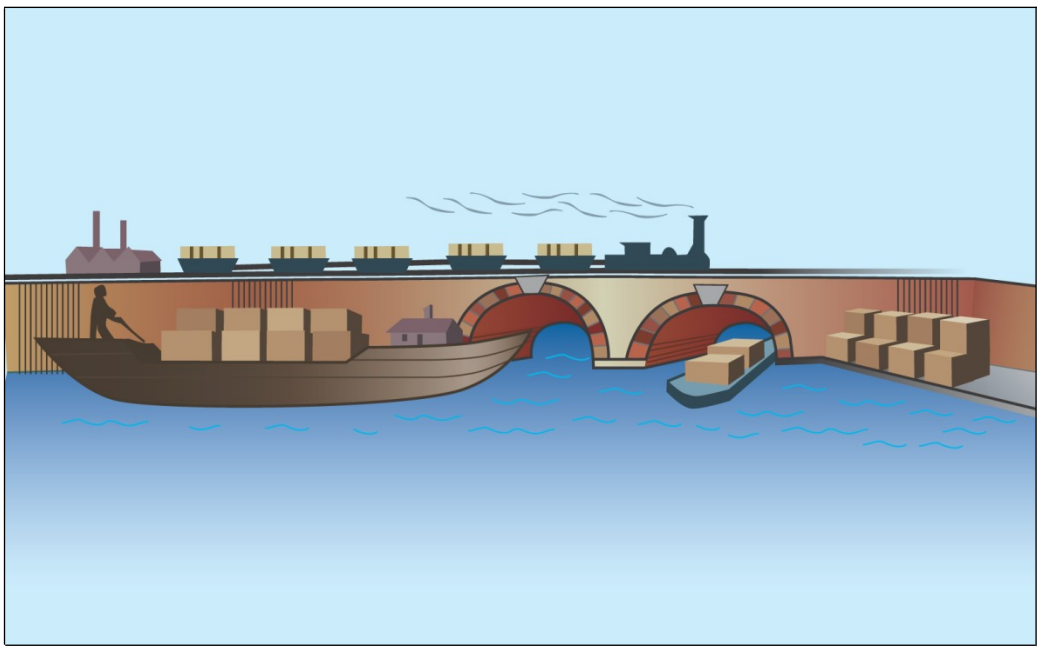



1841-1900




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.

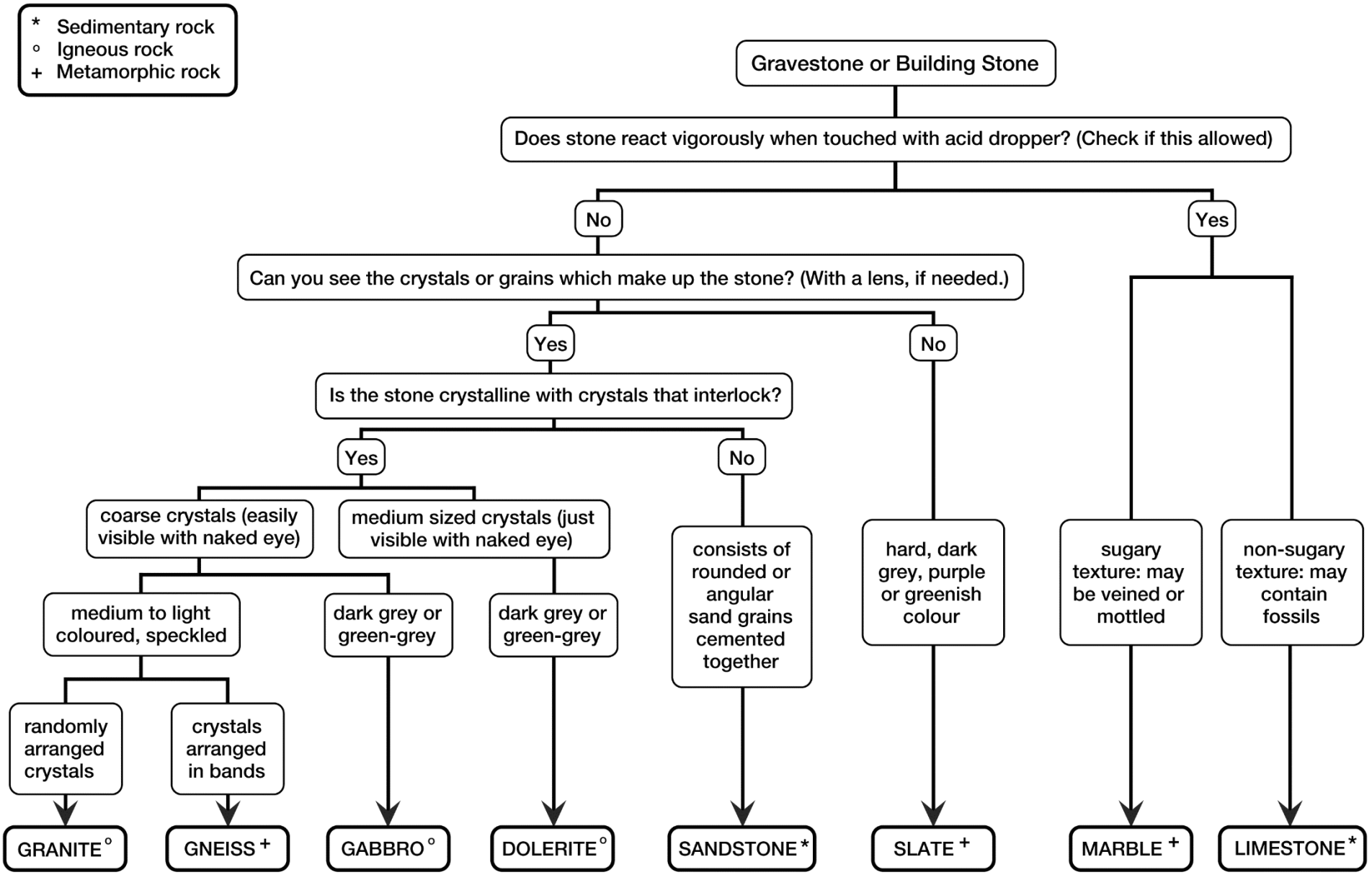
6. Look for cracks where frost has cracked the slabs.

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 rocks commonly used for ornamental purposes



# 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 |
|---|---|---|---|---|---|---|
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## Teaching Points

There are a wide range of teaching points, depending on which ideas the pupils choose to investigate. Here are some examples:

| Activity | Pattern (construction) | Challenge (cognitive conflict) | Explanation of thinking (metacognition) | Relevance (bridging) | Practical teaching points |
|---|---|---|---|---|---|
| Graveyard Visit | • Most popular rock types | How far back in time does 'today' go to? | Reasoning behind answers | Discussion of why they are most popular, e.g. original appearance, appearance after weathering, cost, durability, rock types available from overseas. | |
| | • Differences 50, etc. years ago | What time span should '50 years ago' cover? | Reasoning behind answers | Discussion of historical differences, e.g. availability of stone from overseas, transport costs, tastes 50 years ago, etc. | |
| | • Which rock types resist weathering best? | Which other variables need to be controlled and how (e.g. age, aspect, whether or not under trees)? | Reasoning behind answers | The same discussions are relevant to stones chosen as facing and building stones today.<br>Original choice of stone/building material greatly affects maintenance costs of buildings such as town halls, cathedrals and even schools and houses. | Some pupils will need to be guided on which variables to control and how to do it. |
| | • Gravestone aspect | Which other variables need to be controlled and how? | Reasoning behind answers | Relevant to the aspect of their own house/flat/garden – and that of the school. | A magnetic compass is needed – particularly as some churches are not aligned east-west. |
| | • Vertical vs horizontal stones | Which other variables need to be controlled and how? | Reasoning behind answers | Discussion of the effect of being near or in the soil – links to soil-forming and weathering processes. | |

## Teaching Points continued...

| Activity | Pattern (construction) | Challenge (cognitive conflict) | Explanation of thinking (metacognition) | Relevance (bridging) | Practical teaching points |
|---|---|---|---|---|---|
| Graveyard Visit | • 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.<br>• 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, e.g. 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. | |

# Risk Assessment

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.

| 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-0.5M hydrochloric acid - 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