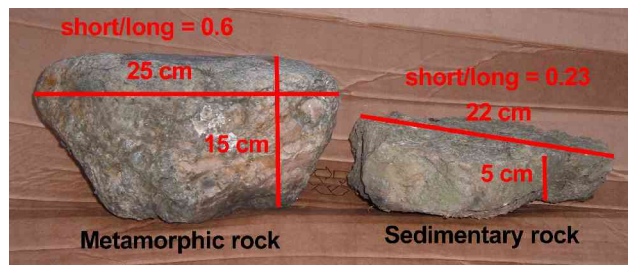
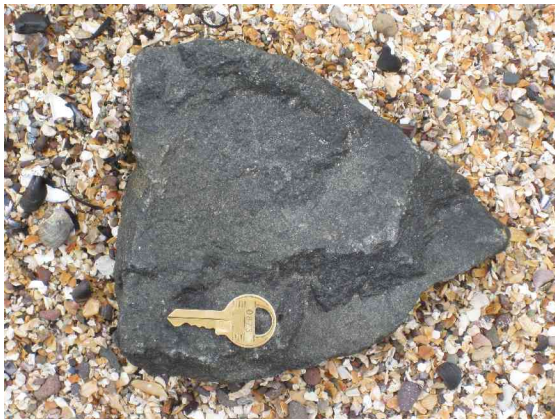


Earth Science Outdoors: Activities for all ages



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The Scottish Earth Science Education Forum (SESEF) is an association of educators and scientists established to promote understanding of planet Earth in Scottish schools and colleges.

An understanding of how planet Earth works should be an essential part of every young person's education and is necessary for the sustainability of Earth environments and resources.

Through development officers and forum members throughout Scotland we work with teachers, schools, colleges, public institutions, science centres, museums, industry and universities to address the challenges facing Earth Science education.

Membership of SESEF is free – visit www.scottishgeology.com/SESEF/ for further information.

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Introduction

Learning about the Earth is best done outdoors! Being outside - in the landscape and experiencing it directly - is the best place to appreciate the big picture of ceaseless change that is so important in understanding the Earth and our place on it.

This document, *Activities for all ages*, contains ideas for activities to help explore the Earth that could be carried out anywhere – many are suitable for indoors, or for school grounds. They might be used as an introductory activity before going further afield, or as a standalone investigation of an earth science topic.

These ideas are gathered from a variety of sources, which we have tried to acknowledge. However many of the activities are well known and it is difficult to identify the original source. If we have used an activity of yours without adequate acknowledgement, please let us know and we will correct this in future editions.

There are several collections of ideas on the internet, including:

Scottish Natural Heritage TeachingSpace www.snh.org.uk/teachingspace (What to do – Landscape)

Earth Learning Idea www.earthlearningidea.com practical teaching about the Earth with minimal equipment

Earth Science Education Unit www.earthscienceeducation.com

Earth Science On Site www.ukrigs.org.uk/html/esos.php has developed resources for geological sites in England.

The Earth Science Outdoors project develops and promotes educational resources to support outdoor activities for school and community groups, at specific sites of geological interest. We are writing Teachers' Guides that can be used to guide groups around the sites, and include suggested activities that could be carried out before, during and after a site visit. This document is intended to support outdoor science learning in Scotland and complement Teachers' Guides for specific sites, available from www.sesef.org.uk.

Suggested Activities

Exploring Geological Time

The vast span of time since the creation of the Earth is difficult to take in – for everyone, not just children! There are lots of ways of scaling geological time to try to make it a bit more understandable.

How old is the Earth? The current best estimate is 4,566 million years (that is 4,566,000,000 years or 4.566 billion years). This estimate may be revised in the future, but is thought to be accurate to within a few million years.

How do we know that? We use *radiometric dating* ... a technique that measures the level of radioactive particles. You may have heard of radiocarbon dating, which measures the level of radioactive carbon particles and is used to find the age of wood and plant material. Radiocarbon dating is good back to about 60,000 years ago, but to find the ages of rocks, we need longer-lasting radioactive material such as Uranium. And we need to find material that hasn't changed since it was created, which is tricky on an active planet like the Earth! The solution has been to measure the age of meteorites that formed at the same time as the Earth but have been drifting unaltered through space since they were formed, before falling to Earth in recent times.

There are many different ways of representing these time scales to allow people to appreciate not just the immensity of geological time, but the order of events (for example, most rocks in Scotland are older than the dinosaurs), and the relatively brief period in which humans have lived on Earth (modern humans appeared about 200,000 years ago).

One common analogy is that if you stand with your arm stretched out and imagine the Earth began at your shoulder and modern day is at the tip of your finger, then a single swipe with a nail file will remove the time that modern humans have existed (for a child's arm length of 46 cm, modern humans are represented by the last 0.02 mm of fingernail).

Time string: using a rope or string that is 46 metre long to represent Earth's history gives 1 m for every 100 million years, or 1 mm for 100,000 years. A 23 m rope might be more practical (able to be stretched around a classroom for example), with 50 cm representing 100 million years or 1 cm representing 2 million years.

Pace it out: Walking 460 m give good opportunities for cross-curricular linking to maths and maps (and health!), and allows stretching the distance allocated to modern humans to 2 cm.

Measuring geological time on a clock: people have often represented geological time by compressing it into one day (one second represents 53,000 years so modern humans appear in the last 4 seconds before midnight), or one year (where one second represents 146 years, and modern humans appear at 23 minutes before midnight on Hogmanay).

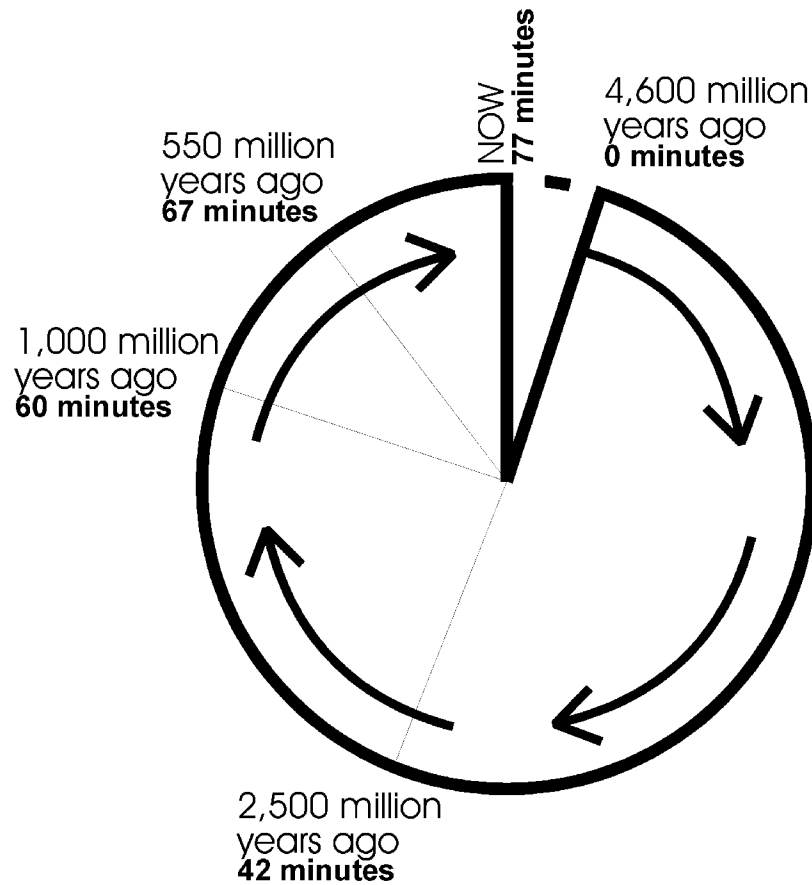
An alternative is to use a scale of one second to one million years, which allows Earth history to be compressed into 77 minutes (Figure 1). The Cambrian explosion of life 550 million years ago, and subsequent evolution of complex life forms fits in the final 10 minutes with 0.2 seconds for modern humans.

The passage of geological time can be illustrated with examples of typical lifeforms or with reference to the different conditions that Scotland has experienced through time (Table 1). These conditions reflect (1) the movement of the rocks we now call Scotland across the globe (Figure 2) and (2) changing tectonic settings and sea level so that at times Scotland has been a high mountain range and at other times the Scottish crust has been largely underwater.

Table 1: Examples of typical lifeforms and conditions in Scotland in the geological past

Time - million years ago	Typical lifeforms	Conditions in “Scotland”
3500	Cyanobacteria	No Scottish rocks are this old. The atmosphere was rich in nitrogen, carbon dioxide and methane, the sky was red. Single cell cyanobacteria formed, produced oxygen and altered their environment
2500	Stromatolites	Rocks of the Outer Hebrides and NW Highlands had begun to form, the remains of ancient continental crust that has been deformed by later events.
1000	Stromatolites	Continental setting, with erosion of high ground to the north providing sediment for the formation of the Torridonian sandstone.
650	First multi-celled animals	Scotland lay on the southern margin of the Laurentian continent, which was stretching (rifting). Sediment that will eventually form Highland rocks accumulated in shallow oceans.
500	Brachiopods, Trilobites	Iapetus Ocean to the south of Scotland at its maximum width.
400	Early fish	Closure of the Iapetus Ocean and collision of continents created the Caledonian mountains. Scotland is hot and fairly dry, with rapid erosion of bare mountain ranges and accumulation of the Old Red Sandstone.
330	Corals	Midland Valley of Scotland is a low-lying rift valley, close to the equator, and occasionally flooded by shallow seas.
280	Ammonites	Scotland incorporated in the Pangea super-continent, hot and dry.
100	Plesiosaurs & Dinosaurs	Most of Scotland submerged under tropical sea.
60	Early mammals	Chain of volcanoes along the western side of Scotland marks rifting of continental crust and eventually the formation of the North Atlantic.
1.5	Pleistocene Mammals	Frequent Ice Ages.

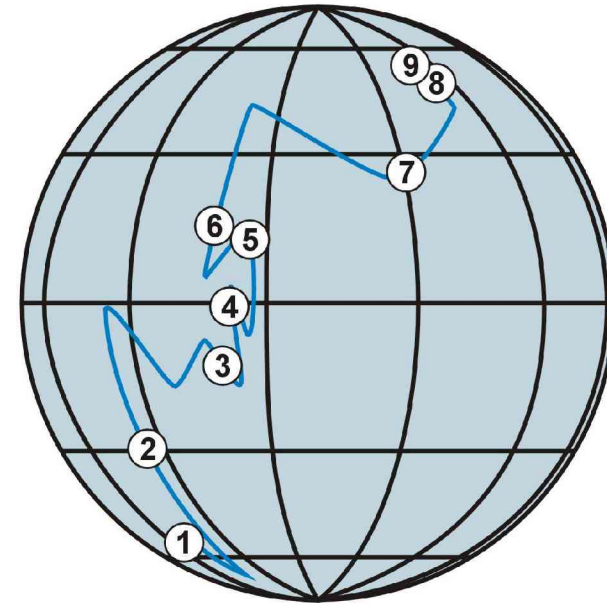
History of the Earth in 77 minutes



One second = 1 million years

Figure 1: Clock face representing the history of the Earth in 77 minutes.

Scotland's journey across planet Earth



- | | |
|----------------------|----------------------|
| 1. 600 million years | 6. 270 million years |
| 2. 525 million years | 7. 170 million years |
| 3. 430 million years | 8. 55 million years |
| 4. 365 million years | 9. Present day |
| 5. 300 million years | |

Figure 2: Position of "Scotland" on the Earth over the last 600 million years
(from SESEF/ESEU CPD workshop Scotland's Journey)

Exploring Rocks

The best place to discover local rocks is a pebbly beach. Encourage students to explore for themselves and discover examples of the rocks that lie beneath the local area. Inevitably the question on everyone's lips is "What's this one called?" The **Field Studies Council 'A Guide to Rocks' 2003 (£3.50)** www.field-studies-council.org will help with simple rock identification, or visit the Earth Science Education Unit's virtual rock kit online at www.earthscienceeducation.com.

Simple activities include:

- Making a rock collection. Each student collects as many different kinds of rock as they can find. What makes one rock a 'different kind' from another? How could you classify your rock collection? How do you describe rocks – what features can you see that make them unique? Is a brick / piece of clay pipe / piece of pottery a rock?
- What happens when you scratch a rock with a metal nail? (or a fingernail!). What can you see with a magnifying glass? Why are some rocks good for skimming?
- LETS ROCK (SNH TeachingSpace) Ask the children to pick a rock. Sit them in a large circle (using 'sticky elbows' so they are touching). Give them a short time to get to know their rock – looking and feeling, so that they get to know its distinctive features – eg angularity, shape, texture. Get them to blindfold themselves/partner. The rocks are passed round the circle until each person is sure they have got their rock and holds on to it. Take off the blindfolds – are they right? Ask the children to make rock families, and sort themselves into groups of similar rocks. These can be illustrated as a geological Venn diagram on the ground using chalk to group similar rocks.
- Matching pebbles – pupils make a collection of specimens representing the rocks of the local area, and write descriptions. They can then test their descriptions with other students (see Earth Science Outdoors - Crawton Teachers' Guide).
- The Earth Science On-Site project (<http://www.ukrigs.org.uk/html/esos.php>) suggests a suitable pre-visit preparation to raise pupils' awareness of the use of stone in the built environment. Set a homework exercise to list as many different uses of stone that they can see in suitable places. This might be on their way home from school, around school buildings, a local park, shopping centre or monument etc. Stress this is an exercise in observation, and a competition to see who can find the most examples. Some of the less obvious examples pupils might find are: clay (used to make bricks and tiles); silica sand (used to make glass); road metalling (stone gravel bonded with bituminous material to surface roads); limestone, and other minerals (used to make concrete and cement).

Exploring Landscapes

- Using distant observation can set the context at the start of a field visit. Students tend to focus on the details and find the bigger picture harder to see. Find a good observation point and spend a bit of time sitting and looking.
- FRAME IT (SNH TeachingSpace) Ask each child to find a place where they can hold up a cardboard frame to frame a view that is pleasing or interesting to them. Ask them to transcribe the key elements on to an A4 sheet, thinking about where the horizon is, and discuss/show how to represent distant and close up features, and annotate their pictures.
- ROCK DETECTIVES (SNH TeachingSpace) Encourage the children to work out where they are on a map as you go along your route, using landscape features to help them. Describe the geological feature you are looking for, for example a fault line or a raised beach, and see who can spot it first. Divide the class into two or three teams and award points to the first team to spot a particular feature. Older children could work in teams and be given a list of features they have to find, a map and a camera. Encourage the children to make sketches and write descriptions of the features they find.
- To help the process of exploring the landscape, you can provide outline sketches and get students to fill in the details. Provide vocabulary to help them annotate sketches.
- Many of the Earth Science Outdoors sites lend themselves to exploring the story of the changes that are recorded in the rocks and the landscape. This might be a simple story of one pebble: Where has it come from? What's going to happen next? Or each student could develop a "mind movie" - a story board in their heads showing stages in the formation of the rocks or the evolution of the landscape. This can be reported verbally or they can put it on paper, using a limited word count. The story can continue into the future.