Curriculum links

These notes accompanying the fossil samples box can be linked to support several curriculum areas for secondary age groups.

The key curriculum areas in England & Wales

Geography
- enquiry skills and knowledge and understanding of places, patterns and process and environmental change and sustainable development
- breadth of study to geomorphological process and environmental and resource issues.

Science
- enquiry and investigative skills
- materials and their properties, classifying, changing materials - physical, geological and chemical changes and useful products
- physical processes, energy resources and energy transfer.

The key curriculum areas in Scotland

Environmental studies:

– Society
- enquiry skills, knowledge and understanding of people and physical environment and interaction.

– Science
- investigating skills, knowledge and understanding of earth and space, materials from the earth and changing materials
- energy and forces - properties and uses of energy and forces and effects.

BPES has a range of other resources - for your free catalogue please contact us at:

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Alternatively, visit our website at **www.bp.com/bpes**

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ESTA may be contacted at:
ESTA c/o The Geological Society, Burlington House, London W1V 0JU.
Website: www.esta-uk.org

BP is a member of the U.K. Offshore Operators' Association (UKOOA). UKOOA supports the Earth Science Education Unit which exists to provide Earth Science INSET in secondary schools and teacher education institutions throughout the country. The workshops all involve practical and investigative work. Such INSET is free apart from the travel costs of your local ESEU facilitator. For further information please contact Bernadette Callan: eseu@keele.ac.uk, tel: 01782 584 437 website: **www.earthscienceeducation.com**

The website **www.jesei.org** is compiled by teachers of physics, biology and chemistry, with ESTA advice, and contains many ideas for practical and investigative work in Earth Science.

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secondary teacher's notes

fossil samples

Introduction

The fossils we find range from thousands of years old to many millions of years.

There is some disagreement as to what classifies as a 'fossil' but normally it needs to be at least ten thousand years old.

Earliest common fossils date from around 600 million years ago, but recent reports suggest bacteria may have existed for over 3 billion years. **(See Geological Ages chart on Page 7.)**

Fossils provide us with evidence of evolution, showing how species today have changed and evolved over millions of years.

Unfortunately not all former 'life' has been preserved as fossils – most has vanished without trace.

Our fossil record is incomplete; the majority of organisms were either eaten by other creatures, broken up by weather and waves, or decayed away before they had a chance to become fossilised.

But where they do survive, fossils are our only clues to life in the past. They are like photographs of a species at a particular time in history – a jigsaw telling us piece by piece more about the creatures, environments and conditions that existed millions of years ago.

The paper used for this booklet meets the strictest environmental standards set by the Nordic Swan Council and is fully recyclable. The pulp used to produce the paper is generated locally, fully sustainable and bleached without the use of elemental chlorine.

PALAEONTOLOGY

Palaeo means ancient.

Palaeontology means the study of ancient forms of life.

Palaeontologists are the scientists who study the remains of ancient life – the fossils and rocks they are found in.

Studying fossils is often complex:

- sometimes the fossil is hidden in the matrix – the rock that surrounds it
- sometimes the fossil may only be a fragment of the original organism
- sometimes the fossil may be the same colour as the matrix
- sometimes fossils are very fragile and need to be repaired or strengthened before being studied
- sometimes fossils are so tiny they can only be studied by microscope.

What is a fossil?

A fossil is any part of any living thing preserved within a rock after it has died. It can be just a footprint or a tooth or a single bone – right up to the whole skeleton of an animal, insect or plant (although this is rare!).

Most fossils are found in sedimentary rock (formed from layers of sediment – sand, silt, mud, etc.).

Just as pressing flowers in a flower press can preserve them for years, so layers of rock can preserve plants and animals as fossils.

Species

Scientists classify different types of living things into groups called **species**.

For example, people belong to the group called **homo sapiens**, but humans are grouped with monkeys and apes into larger groups called **primates**. Primates are part of a larger group called **mammals**, which include all animals that feed their young with milk.

To find out what species the fossils are, palaeontologists sort the specimens into groups based on similarities and differences.

Ways in which fossils are preserved

Fossils are actually preserved in several different ways.

- **The hard parts of animals**

  (This is the most common way)

  Things that are hard and don't decay easily can last a long time when they are buried – such as bones, teeth, shells, etc. The layers of sediment that cover them protect them from further damage.

  As they eventually decay, the chemicals are replaced by minerals and form a rock–like copy of the original item.

  As the sediment surrounding it turns to rock, the 'fossil' stays distinct within the new rock. This is **hard part fossilisation** or scientifically known as **permineralisation**.

- **The soft part of animals or plants**

  (This is more uncommon, as there are few occasions when decay happens so slowly)

  This is when the soft parts actually become "petrified", turning to "stone" as they decay away. The soft parts are replaced by minerals. This process is called **replacement** and examples of this are found with petrified wood, which looks like wood but it is made of rock.

- **The trace of an animal or plant**

  This is when no part of the original creature or plant actually remains – just the marks or trace they left behind. Footprints, burrows or tracks, or marks where root systems were, can all help geologists trace what was there originally.

- **The impression of the living thing**

  When the original living thing gets embedded in layers of sediment which then hardens, sometimes it gets dissolved out and leaves its impression in the sedimentary rock.

  When these are found they are called fossil moulds. If these impressions or moulds are then filled with new material, fossil casts are formed.

- **The soft part leaves only black carbon**

  Sometimes when the original organic material is under pressure and heated it disintegrates, leaving only black carbon. This is **carbonisation**.

- **Drying out**

  In hot desert areas, things are often completely preserved by drying out.

  For example, this was used by ancient Egyptians who used to preserve their dead by **mummification** (but it can also happen naturally).

- **Where no decay has happened**

  This is when the whole original animal or plant is preserved, surviving thousands of years. This can happen for several reasons, but all because nothing physical, chemical or biological is able to get to them to damage or change them.

  – **In frozen ground** – here it is too cold for decay micro-organisms to work and the whole creature is preserved by **freezing**. Examples of woolly mammoths have been discovered in this way.

  – **In amber** – here resin that ran out of ancient trees engulfs insects and these are completely preserved inside a clear yellow/orange stone or **amber**.

  – **In waterlogged bogs** – here the earth is too acidic for decay micro-organisms to work. The 'bog people' are bodies discovered deep in Irish peat bogs, squashed but preserved, showing folds of their skin and even hair, even though they are over 2,000 years old.

Conditions for and against fossilisation

There are a multitude of reasons why so many living organisms don't become fossilised after they die. However, these can be divided into three main areas – **physical, biological and chemical**.

Physical

Energy in varying degrees is involved in all earth's processes. Areas of low energy are the ones where most organisms are least likely to be damaged and so fossilisation is more probable. For example: sheltered, forested swampy places are **low energy areas**, whereas desert regions with strong, high gusting winds are **high energy areas**.

Caves and bays that are sheltered from the wind and where the tide gently flows and ebbs are **low energy areas,** whereas sea areas with high winds and waves pounding and crashing on the shore are obviously **high energy areas**.

Biological

Fossilisation is again most likely to occur in areas of **low biological activity**. In areas of **high biological activity**, as living things die, they are eaten in the food chain by other creatures or they decay, broken down by micro-organisms.

Where there is **low biological activity** there is no oxygen for any organism or decay micro-organisms to survive, so nothing can eat or decay the original plant, animal or organism.

Chemical

Here again it is in areas of **low chemical activity** that most fossils may form. **Chemically inert areas** are where there is no, or hardly any, oxygen present, so chemical reactions are less likely (such as below the surface of marshes or the deep ocean floor).

Chemically active areas, where there is much more oxygen (usually found where there is air or moving surface water as the moving water takes oxygen from the air), allow more chemical processes to occur.

How fossils are discovered

Over the years many fossils have been discovered through digs or excavations, during tunnelling for canals and pipelines, or in mining or quarrying, as well as during exploration for oil and gas. However, natural forces also reveal long-buried fossils. Two such geological forces are **uplifting** and **erosion**.

Uplifting

This occurs when two plates of land on the earth's surface crash into one another – one plate goes under as the other plate goes over. This is how many mountains were formed.

Erosion

This occurs when water or wind wears away rocks. The Grand Canyon in America is an example of this erosion – on a massive scale. The Colorado River (the water) together with wind over the years, carved through many layers of sedimentary rock. Many fossils were exposed and the different layers told stories of life on earth. As the deepest layers were deposited first, they of course tell the oldest stories.

Fossil fuels

This term is applied to fuels which were formed in the geological past, (unlike wood, which is being formed today at a rate that can be matched to the rate of exploitation). "Fossil" fuels are of organic origin, but the initial organisms are usually altered beyond recognition by the processes of heat and increased pressure which have led to the formation of a useable fuel. Thus, although coal may contain some recognisable plant fossils, it is not regarded as "a fossil". Crude oil is even less recognisable as being of organic origin, although fossils do occur within the associated rocks, e.g. microscopic spores and other remains.

GEOLOGICAL AGES

ERA	PERIOD	MILLION YRS AGO (Ma)	LIFE FORM
CENOZOIC	Quaternary	1.64	Humans appeared
	Neogene	23	
	Paleogene	65	Mammals flourish and first grasses
MESOZOIC	Cretaceous	142	Heyday of dinosaurs and flowering plants
	Jurassic	205	First birds
	Triassic	248	First mammals and dinosaurs
PALAEOZOIC	Permian	290	Reptiles increased
	Carboniferous	354	First reptiles
	Devonian	417	First amphibians
	Silurian	443	First land plants
	Ordovician	495	First fish
	Cambrian	545	First fossils with hard parts
PRECAMBRIAN	Proterozoic	300	Earliest living things
	Archaean	4600	

These words have interesting meanings:

Ceno means recent
Meso means middle
Palaeo means ancient
Zoic refers to animal life.

So put together they are self explanatory:

Cenozoic means recent animal life

Mesozoic means middle animal life

Palaeozoic means ancient animal life

Precambrian means before the Cambrian period i.e. before the first fossils with hard parts appeared.

Suggested starter questions

- What is a fossil? **1**
- How old can a fossil be? **1**
- What can fossils tell us? **1**
- Why is our fossil record incomplete? **1**
- What does palaeontologist mean? **2**
- Describe hard part fossilisation. **3**
- What does petrified mean? **3**
- Describe the replacement process of fossilisation. **3**
- What is a fossil mould? **4**
- How is a fossil mould different from a fossil cast? **4**
- What does carbonisation mean? **4**
- Who mastered mummification and what process did it include? **4**
- Describe how a whole woolly mammoth could be preserved. **4**
- How did resin preserve fossils? **4**
- What are the 'bog people'? **4**
- Give three main reasons why so many living plants, animals and organisms don't become fossilised. **5**
- Give an example for each of the following:
  – a low energy environment
  – a high energy environment
  – an environment of low biological activity
  – an environment of high biological activity
  – a chemically inert environment
  – a chemically active environment. **5**
- Name two natural forces that can expose fossils. **6**
- Describe how fossils may be discovered. **6**
- When do the first fossils date back to? **7**
- What does Palaeozoic mean? **7**

Glossary

Amber – a hard yellow to brown clear substance that is the fossilised resin of extinct trees.

Carbonisation – the process of converting into carbon.

Chemically active areas – when chemical reactions take place readily.

Chemically inert areas – when chemical reactions take place slowly.

Decay – become rotten/decomposed due to the action of bacteria and fungi.

Evolution – the gradual process by which life develops and changes.

Fossil – remains of animals/plants preserved in rock.

Freezing – to preserve by freezing the water content and maintaining at a temperature below zero degrees Celsius.

Geological – of the origin, structure and composition of the earth.

High energy areas – areas subject to winds and heavy waves, where fossils are unlikely to form.

Low energy areas – sheltered areas encouraging fossilisation.

Micro-organisms – tiny living things, only seen beneath a microscope.

Mummification – process of preserving by completely drying out.

Palaeontology – the study of ancient fossilised forms of life.

Permineralisation – the process of forming hard part fossils.

Petrified – turned into a stone-like substance.

Replacement – the process by which the soft parts of animals or plants petrify as they decay away and are replaced by minerals.

Trace – in fossils, when no part of the original animal or plant remains, just the marks they left behind.

Brachiopod

Fossil plant

Belemnite

Ammonite

Bivalve

Gastropod

Graptolite

Goniatite

Echinoid

Bivalve

Coral

Trilobite

Crinoid stem

Coral

Shark tooth