Issue 81. 2013:1

FOSSILS

A 20th Anniversary Celebratory Re-Issue

Registered Charity No. 1005331

Introduction

This issue is an updated version of the very first PEST issued in the Spring of 1993 which has been out of print for some time. It seemed fitting in this 20th Anniversary Year to revisit some of the earliest issues to revise them and make them more relevant for today's primary classes as well as allowing the incorporation of some recent changes to the curriculum.

What are fossils?

Fossils are the remains or traces of organisms (plants or animals) which lived many thousands of years ago. The actual remains of plants or animals are known as body fossils, whereas any burrows, footprints or other marks and impressions left behind in the sediment by such organisms are called trace fossils.

Do all plants and animals become fossilised?

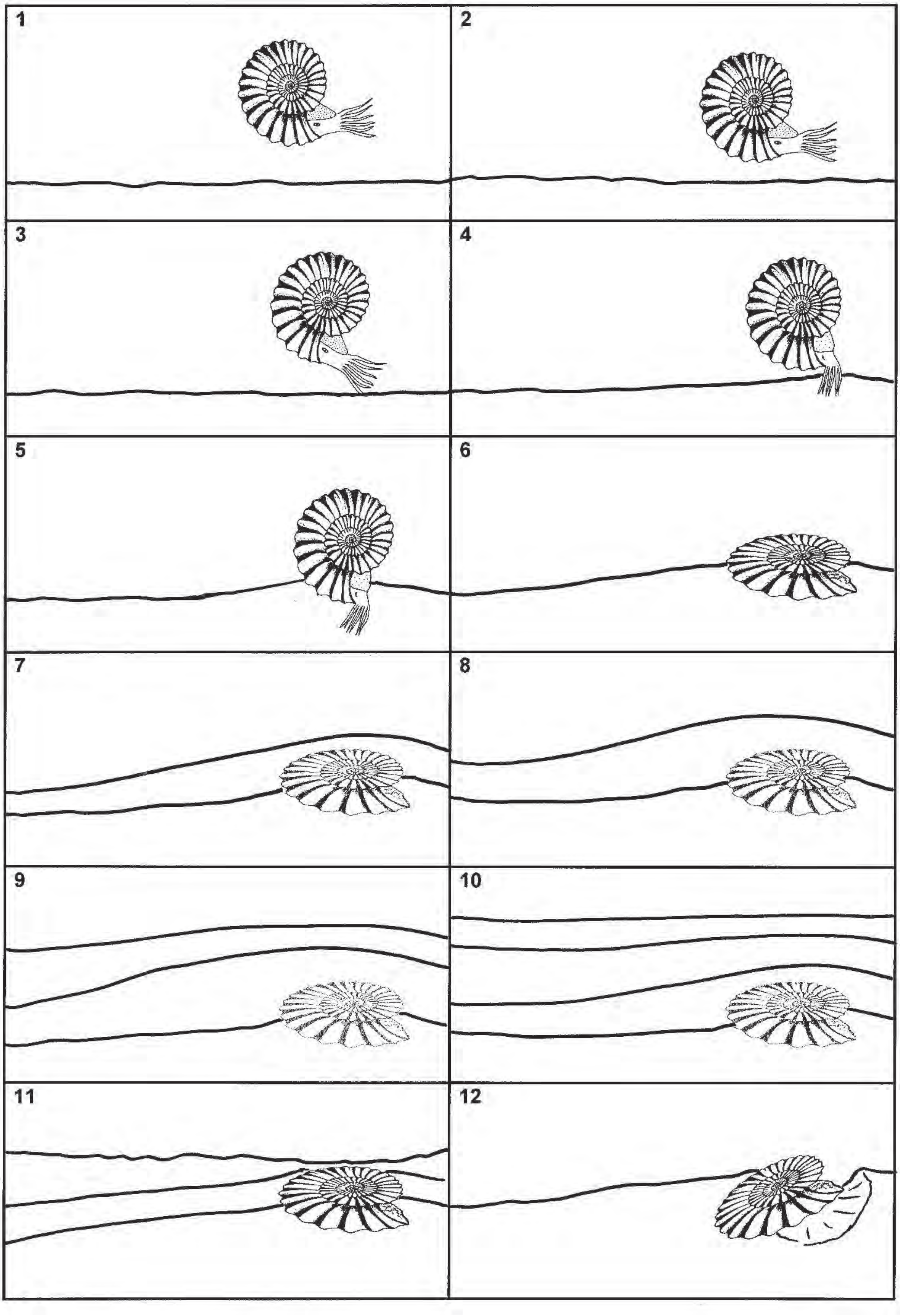
Only a very small percentage of dead animals or plants will become fossils because the majority of them will be eaten by scavengers or broken down by decaying processes (e.g. plant material in a compost heap) and recycled within the environment. Likewise most traces, such as tracks, feeding traces and burrows will be removed by wind, water, other animal disturbance or plant roots, before they can be preserved. Organisms can only be fossilised if they are buried, so sediment needs to be accumulating in the environment in which an organism dies.

How do remains become fossilised?

Fossilisation can only occur if the dead organism or trace is covered, encased or buried quickly, usually by sediment (often sand or mud). This is most likely to happen in lakes or the sea. Any soft body parts quickly rot away, leaving hard parts behind. These may be preserved in several ways:

- The original shell material may be *replaced*, molecule by molecule, by minerals which seep through the sediment during burial. With this process many internal structures are preserved and the resulting fossil is stronger, harder and heavier than the original shell.
- Sometimes buried shells may be dissolved away by weak acid solutions passing through the sediment, leaving behind a *hollow mould* where the shell had been. Later the mould may be filled by other minerals, making a *cast* of the outside of the original shell.
- Plants are often preserved in rocks as a thin *film of carbon.* Great thicknesses of preserved plant material form seams of coal, hence the term 'fossil' fuel.
- Some hollow plant stems may be preserved by mud seeping in as they are buried. Others become petrified after burial by minerals being deposited in the plants' cells.
- Only very rarely are the original plants and bodies of animals preserved with little alteration. Shark's teeth remain unaltered; insects may be preserved in amber (fossil tree resin); mammoths have been found in ice and peat bogs and other mammals have been found in tar pits. More usually remains are crushed and flattened by the pressure of the overlying layers of sediment.

Flip Book: Colour the ammonite, seawater and the different sedimentary layers. Cut out the individual pictures and staple together down the left edge to create a flip-book with page 1 at the top. It shows the rapid burial of an ammonite and its re-appearance after erosion of rock layers.



What can fossils tell us?

Fossils can help us in several ways such as:

Dating Rocks

Sedimentary rocks are deposited in layers by wind, water or gravity. As the layers of sediment accumulated over time, it can be seen that any rock layer is younger than the ones below it and older than those above (Figure 1) or that the first sediment to be deposited is the lowest and therefore oldest. This observation is the basis of the *Law of Superimposition* and tells us the ages of layers (or beds) of rock relative to each other. When specific fossils are found only in certain rock beds, these can be used to date the rocks more accurately (see ammonite example in Evolution section).

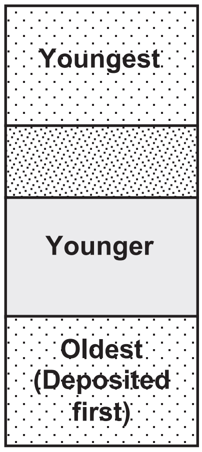


Figure 1 The relative ages of sedimentary rock beds.

Evolution

Fossils provide evidence that organisms have not stayed the same but have changed gradually and developed over time. Changes can include body size, shape and changes in how limbs or organs are used. Such changes (or adaptations) help organisms to overcome environmental difficulties or stresses, such as the shape of birds' beaks being adapted to the type of prey they catch and food they eat. For example eagles have strong, short, hooked beaks which are ideal for tearing flesh, whereas curlews have long, thin and gently curving beaks which are ideal for probing deep into the mud for worms and other grubs otherwise hidden from view.

Over geological time, some organisms have evolved rapidly and can provide scientists with very good 'fossil clocks' to help date rocks more precisely. Ammonites changed their shape and the patterns of their spirals (whorls) very quickly and their evolution can be traced through the rocks and fossil records for over 385 million years so are excellent fossils for rock dating purposes. Other long-lived animals, such as the horseshoe crab which first appeared about 450 million years ago, have not changed very much in all that time so they are very poor 'fossil clocks'. [Evolution will be covered in more detail in a future PEST.]

Extinctions

Fossils show us that many different forms of life have existed in the past but some of these have since died out (become extinct). Scientists can often trace an organism's emergence, evolution and extinction through fossils found in successive rocks. Extinction occurs when there are too few of a species to breed successfully, when their food supply is reduced too much and too fast and/or when their habitat is destroyed (e.g. deforestation). If any of these environmental stresses occur too quickly for the organisms to relocate or adapt they will eventually become extinct. Excessive predation, especially by introduced (alien) species, can put irreversible strain on some populations. Hunting by humans can also cause species to go into extinction. The dodo is a notable example and over-fishing is currently putting a number of fish species in danger of extinction, e.g. tuna.

Environmental changes, such as climate change (rapid global warming or cooling) and rising or falling sea-level, can be too extreme and happen over too short a period for some organisms to survive because they can not adapt quickly enough, making extinction inevitable. These major events are recorded in the rocks which show significant declines in many different fossilised species at a similar time. Such events are known as *mass extinctions* and notable examples of species wiped out in such events include trilobites, ammonites and dinosaurs.

Past Environments

Throughout the Earth's history, climate has controlled plant and animal distributions. The distribution of present day animals and plants can help scientists to work out past climates by investigating the geographical locations of ancient fossilised versions. Some tiny plankton species (microscopic shells) are very useful as they change the chemical composition of their shells, and sometimes the direction of their coil, according to the temperature of the seawater. This allows past sea temperatures and climates to be interpreted. Ancient plant spores and pollen from cold climates (tundra) have been found over a wide area and provide important information about Ice Ages. The sizes and shapes of leaves can also be good indicators of past climates by comparing modern examples of tropical, temperate and tundra species with their fossilised counterparts.

- Tropical (close to the Equator and hot all year) rainforest trees and plants typically have large, often waxy leaves.
- Temperate (between the Tropics and Polar Regions with warm, moist summers and mild cold winters) forest trees and plants are typically broad leaved and deciduous or needle-leaved and evergreen.
- Tundra (Polar Regions and cold all year) plants typically have small leaves, grow close to the ground and often close together for protection against the cold.

Tracing the movement of continents

The study of *plate tectonics* is the scientific theory that explains the slow and very gradual movement of sections of the Earth's crust. One of the first indications that a mechanism for this *continental drift* (as it was first known) came from fossils which were discovered to be very similar to each other, despite now being found on different continents and separated by vast oceans. These fossils helped geologist to support the theory of plate tectonics and trace which continents had been connected at some time in the geological past by comparing and linking the areas containing similar fossils.

There is very strong evidence, supported by the fossil record, that the continents were once clumped together in a supercontinent known as Pangaea. When rifting occurred and the continents began to separate, plant and animal populations were also split up. The following are well known examples of fossils of the same species being found on different continents and across distant geographical areas that were once connected:

- Fossil remains of a 3m long Triassic reptile called *Cynognathus* are found in mid South America (present day Brazil) and west-central Africa (regions of Angola and The Congo).
- Fossils of the reptile *Lystrosaurus* occur across central India, eastern Antarctica, Madagascar and western-central Africa (approximately present day Tanzania – Zambia)
- Some species of graptolites (large, extinct plankton) were widespread in the oceans during the Devonian period. Fossils of some species of graptolites can be found on the edges of ancient oceans such the Iapetus Ocean. At first their distribution and fossil locations appear quite random if shown on a present day map, but when plotted on a map of the reconstructed ancient continental locations they actually fit together very well.

The Primary Team will be at the following Conferences:-

Geographical Association Conference: Derby. Friday 5th April 2013. The Team will present three workshops: Sweet Physical Geography; Rivers and Coasts; Rocks and Soils.

ESTA Conference: Plymouth; Saturday September 28th 2013; with a full day of primary INSET activities.

This issue was revised and updated by Tracy Atkinson (from the original by John Reynolds, Sue Pryor and Frank Spode). It was edited by Geoff Selby-Sly (NSC) and Stewart Taylor. All ESTA Primary Team members.

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