Fossil Record

World of Earth Science

Fossil record

The fossil record is the record of life on Earth (/earth-and-environment/geology-and-oceanography/geology-and-oceanography/earth) as it is preserved in **rock** as **fossils** . The fossil record provides evidence of when and how life began on the planet, what types of organisms existed and how long they persisted, how they lived, died, and evolved, and what the **climate** was and how it changed. The fossil record also has allowed scientists to correlate rocks on a worldwide basis and to determine the relative ages of rock formations.

Fossils record life by preserving remains of organisms. A fossil is a rare thing. Most organisms decay and disappear quickly after dying. Of the tiny minority of organisms that do become preserved as fossils, an even smaller fraction survives the geologic cycle to become exposed and visible. As a result the fossil record is incomplete; there is no record of most organisms that probably lived and died.

The interpretation of the fossil record requires describing fossils, classifying them to place them in a biological context, and determining their age to give them chronological context. Fossil classification follows the same system of taxonomy as modern biology. Fossil organisms are placed in a genus, species, etc. Owing to the

incompleteness of the fossil record, the classification of fossil organisms includes only about 250,000 species, a small number when compared to the over 2 million species of modern organisms that have been identified.

The most direct information the fossil record provides is of an organism's physical structure and what it may have looked like, thereby enabling it to be classified. Other information such as its environment, its diet, and its life cycle is deduced from its physical attributes, from other fossils found in association, and from the types of rocks containing the fossils. Trace fossils, or fossilized marks left as a result of the activities of creatures such as trails, footprints, and burrows also provide important information.

Of critical importance to the fossil record is the age of fossils. Many theories about how Earth and life on it evolved would not be possible without knowing the time sequence of the fossil record. The age of fossils is determined by two methods: relative dating and absolute dating. Relative dating involves comparing one rock formation with another and deciding the relative ages of the two formations. For example, when one formation is found above another, the lower formation and the fossils it contains must have been deposited prior to the overlying formation and so must be older. This rule, known as the principle of **superposition** , holds as long as the rocks have not been overturned by faulting or folding. In determining an absolute age, radiometric age dating is used. This method measures the abundance of a radioactive element in a fossil or an associated rock. An absolute age is then reverse-calculated based on the rate of decay, or **half-life** of the element.

Often, certain fossils are found in a limited vertical sequence of rock and are assumed to represent a limited time period. These fossils, known as index fossils, are useful for determining relative ages and for correlating rock formations on a

worldwide basis. Early workers used index fossils and rock **correlation** to develop the geologic scale. Originally, the geologic scale was relative, based largely on the fossil record. Subsequently, absolute ages have been applied to the geologic scale.

By synthesizing the fossil record, classifying fossils, aging them, and placing them in the context of the geologic scale, scientists have revealed the sequence of life on Earth. In many cases, the scale shows how some organisms evolved systematically over time, each subsequent version of an organism displaying modifications over the earlier. In other cases, there are large gaps in the fossil record and the developmental process for some organisms is not as clear. Often, the **evolution** of organisms leads to a dead end. The fossil record shows that throughout **geologic time** , life often evolved slowly, punctuated by explosions of life when a large number new organisms appeared. For example, the beginning of the **Cambrian Period** of the geologic scale contains a phenomenal number of new organisms. It also shows that, periodically, mass extinctions occurred, such as at the end of the **Cretaceous Period** , when a majority of species came to an end over a relatively short amount of time.

The fossil record begins with 3.5 to 3.0 billion-year-old rocks from **Australia (/places/australia-and-oceania/australian-and-new-zealand-political-geography/australia)** and South **Africa** , which preserve the remains of blue-green algae. These fossils resemble the modern stromatolites that grow in oceanic tidal areas. The fossil record shows a steady increase in the complexity of marine organisms over the next three billion years. Eventually, about 435 million years ago, terrestrial organisms appeared. The subsequent rise and fall of different creatures, from insects to fish, dinosaurs to mammals, has all been deduced from the fossil record.

In addition to outlining the history of life on Earth, the fossil record provides clues to climatic and tectonic evolution of the planet. Plant fossils and microscopic fossils such as pollen are particularly useful for the evidence they provide about the climate of the earth (/earth-and-environment/geology-and-oceanography/geology-and-oceanography/earth). For example, the Carboniferous period must have been very warm and moist because of the presence of abundant fossils of ferns and other tropical plants from that time. Also, the lack of fossilized remains of **oxygen** breathing organisms and the dominance of photosynthetic algae fossils from the very early Earth suggest that the primordial atmosphere was devoid of oxygen. The concept of **plate tectonics** was greatly aided by the observation that fossils now found widely spaced across the globe must have actually lived on the same original landmass that subsequently split apart.

See also Evolution, evidence of; Fossils and fossilization; Uniformitarianism