4.0 The fossil record provides evidence of Earth's changes over time.

4.1 Tracing Evidence of Geological Change Using Fossils

Fossils are preserved impressions in rock that tell us when, where, and how living organisms lived and behaved millions of years ago. The word fossil means '*dug out of the ground*'. The majority of fossils are found in exposed sedimentary rock. The most common types of fossil rocks are limestone, sandstone and shale.

Fossils

Paleontologists are scientists who study early life forms by interpreting plant and animal fossils. After carefully removing the fossils from the rock they are studied and interpreted. Most fossils are fragments or parts of skeletons, shells or other animal traces. The inferences made suggest that life on Earth has changed a great deal over the past million of years. Fossils found in younger rocks are much like the organisms living today. Older rocks contain fossils of organisms that are extinct (no longer existing).

The trilobite, that lived on the ocean floor over 300 million years ago, is an example of an extinct organism, that we have only seen as a fossil.

An animal dies and falls to the seafloor. It gets covered by sediment. The body dissolves, leaving a **mould**, which is then filled with more sediment and hardens into rock, making a **cast** of the original animal.



Becoming A Fossil

Remains of dead *plants and animals* that have been protected from scavengers can become fossilized in a number of ways:

- **petrified** (rock-like) fossils preserve the bones of dead animals by using silica
- an outline or **impression** from the carbon residue on rock surfaces can provide **a carbonaceous film**
- **original remains** may be preserved in tar, amber or peat bogs
- **trace fossils** are evidence of animal activity, like worm holes, footprints, and burrows

Dinosaur Provincial Park is a world UNESCO Heritage site, where over 36 species of *Dinosaur* have be found;
- *Albertosaurus*, found in Dinosaur Provincial Park is a relative of Tyrannosaurus Rex.
- *Oviraptor* (when a clutch of eggs were found with a fossil of this dinosaur, it was thought it was a scavenger, but further evidence indicates it was likely an overprotective parent)
- *Bambiraptor*, a dinosaur, found by a 14 year old boy in Glacier National Park, may help to provide the link between birds and dinosaurs

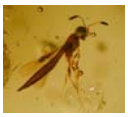
Nearby, **Burgess Shale** in B.C. is also renowned because of the rich deposits of fossilized marine animal soft-body parts, such as;
- *Trilobites*, which date back before the dinosaurs roamed the Earth
- *Ammonites* are common fossils found in Alberta

Telling Time Geologically

Layers of sediment formed over millions of years are called **strata**. By studying strata, paleontologists and geologists interpret the strata formations to learn about the environment of long ago. If a sediment layer is thick, the climate was stable. When a new layer appears in the strata, a change occurred. Paleontologists use particular fossils to identify certain time periods. These are known as **index fossils**.

4.2 Methods Used to Interpret Fossils

The fossil record in rocks indicates a sequence of different life forms appearing at different times. Single celled life forms appeared before multi-celled life forms, plants before animals, and invertebrates before vertebrates. Older rocks show more diversity than there is today.
The ability to reconstruct fossils based on knowledge of current living things is an important part of understanding the history of our planet. With only fragments and pieces, scientists must try to fill in the missing gaps - through inferences and educated guesses.


Insect preserved in a piece of **amber** (fossilized tree sap). Remember Jurassic Park!

Studying Sedimentary Layers Of Rock

The principle of **superposition** states that in undisturbed layers of rock, the oldest layers are always on the bottom and the youngest layers are always on the top. Knowing this, geologists can study layers in places where many layers are exposed, like the Grand Canyon and Dinosaur Provincial Park. Geologists use a technique called **relative dating**, to find the order in which events occurred. The relative age of the rock is determined by its position within the strata. Fossils found in a layer can help to identify the age of the rock.

Fossil Beds

The *Burgess Shale Community* is a diorama that illustrates the type of community that lived there, and *Dinosaur Provincial Park* is a great place to see the community of dinosaurs.

The Royal Tyrell Museum

The Royal Tyrell Museum of Paleontology, is located in Dinosaur Provincial Park, in the Badlands of Drumheller, Alberta.
It was named after Joseph Burr Tyrell, a geologist with the Geological Survey of Canada. Back in 1884 Joseph Burr Tyrrell discovered the skull of Albertosaurus near Drumheller, Alberta. His find sparked international interest among paleontologists, and the area has attracted dinosaur hunters ever since.





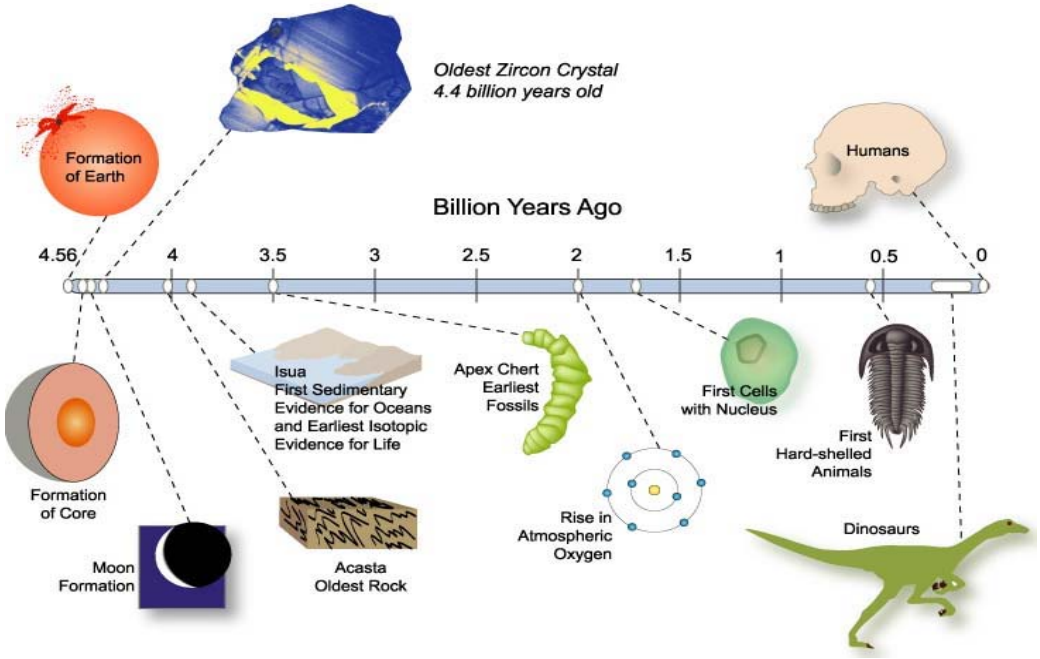
With dinosaurs outside, inside, and waiting to be discovered in the hills near Drumheller, Alberta, the Royal Tyrrell Museum of Paleontology is a world-renowned Mecca for lovers of big lizards

The Tyrrell Museum of Paleontology opened in 1985 to instant acclaim, and in 1990, Queen Elizabeth granted it "Royal" status. The museum has 35 complete dinosaur skeletons on display, and more than 200 dinosaur remains, the largest such collection in the world.

Find out more about the history of finding Dinosaur bones at:
http://www.arches.uga.edu/~rfreeman/GEOL3350_'4HistoryDinoSt.htm

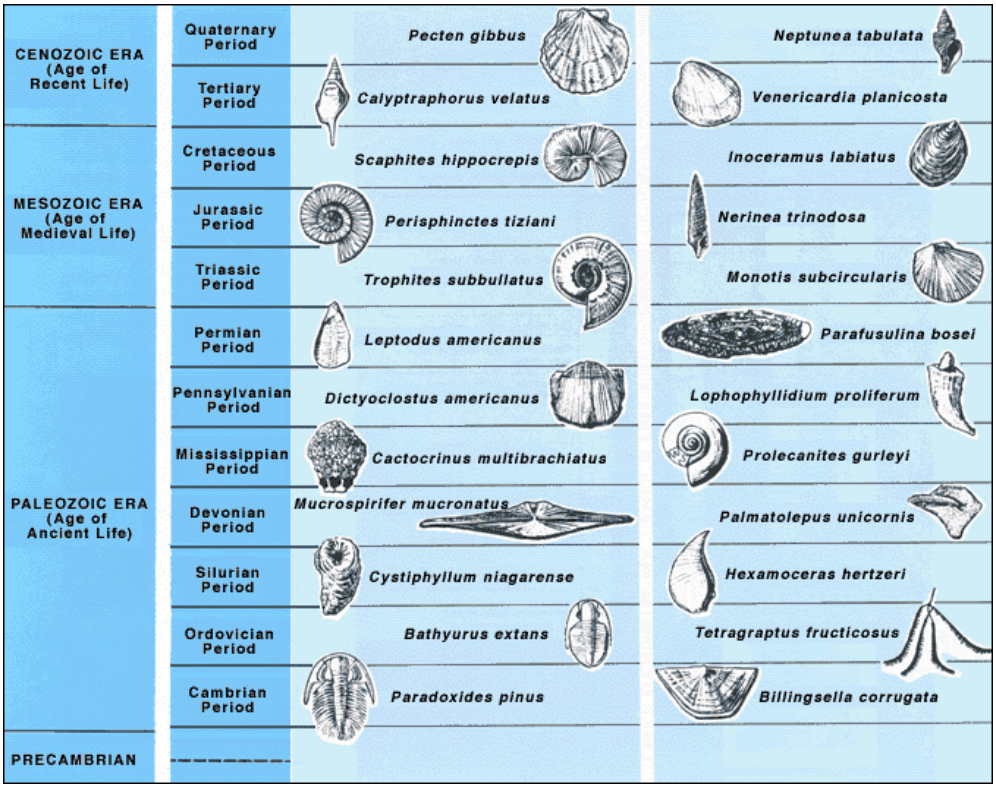
4.3 Geological Time

Looking Back Into Time



All that science knows about the ancient past, it has gathered from the fossil records. Fossils found in a particular layer can help to identify the age of the rock. If the fossil was on the Earth for a short time and widespread then it is called an **index fossil**.

A chart of Index Fossils



Explore other fossils at this website: http://fossils.valdosta.edu/home_time.html

Geologic Time Scale

Geologists use this knowledge to organize the Earth's history into geologic time intervals. These intervals are called **eras**, and are based on the principle of superposition. The geological time scale is a division of Earth's history into smaller units based on the appearances of different life forms.

The largest divisions are called eons, which are divided into eras and then further divided into periods.

Check out ***Figure 4.17*** in your Science In Action 7 Textbook. Page 421

EON	ERA	PERIOD	MILLIONS OF YEARS AGO
Phanerozoic	Cenozoic	Quaternary	1.6
		Tertiary	66
	Mesozoic	Cretaceous	138
		Jurassic	205
		Triassic	240
	Paleozoic	Permian	290
		Pennsylvanian	330
		Mississippian	360
		Devonian	410
		Silurian	435
		Ordovician	500
		Cambrian	570
Proterozoic	Late Proterozoic Middle Proterozoic Early Proterozoic		2500
Archean	Late Archean Middle Archean Early Archean		3800?
Pre-Archean			

Relative age of rock is determined by its position within the strata. To determine the age of rock geologists use a technique called **relative dating.** Over billions of years, some elements will change into other elements - uranium is such an element - in 4.5 billion years, half of the uranium will change into lead (which will not change). The uranium is called the parent element. This time period is called the half-life of uranium. By measuring the amounts of change in a sample, scientist can calculate the absolute age of the rock. This is called **Radiometric Dating.** http://pubs.usgs.gov/gip/geotime/radiometric.html Scientists also use a process called **radiocarbon dating** (which uses carbon-14, a rare form of carbon, as its parent material) http://www.cs.colorado.edu/~lindsay/creation/carbon.html

Understanding Fossil Evidence

Fossils are the only evidence scientists have of early life forms. Paleontolgists use these fossils to develop theories and models of what they think prehistoric life looked like and what interactions took place. Because fossils are rare, assumptions are made based on the fragments of information they are able to gather.

Reconstructing the fragments into a full-size animal or plant takes skill and inferences based on knowledge of modern plant and animal anatomy. Creating a life-like replica requires careful study of the evidence and a little imagination.

Skull fragment

Allosaurus Cast

Life-like Replica