4.1 Tracing Evidence of Geologic Change Using Fossils

Kathy and Roberto went on a field trip to a canyon in the mountains. There they found some fossils embedded in the sedimentary rock layers. Below is a copy of a drawing they made of what they saw, and some of their comments. Think of what you know about sedimentary rocks, and answer the following questions related to their comments:

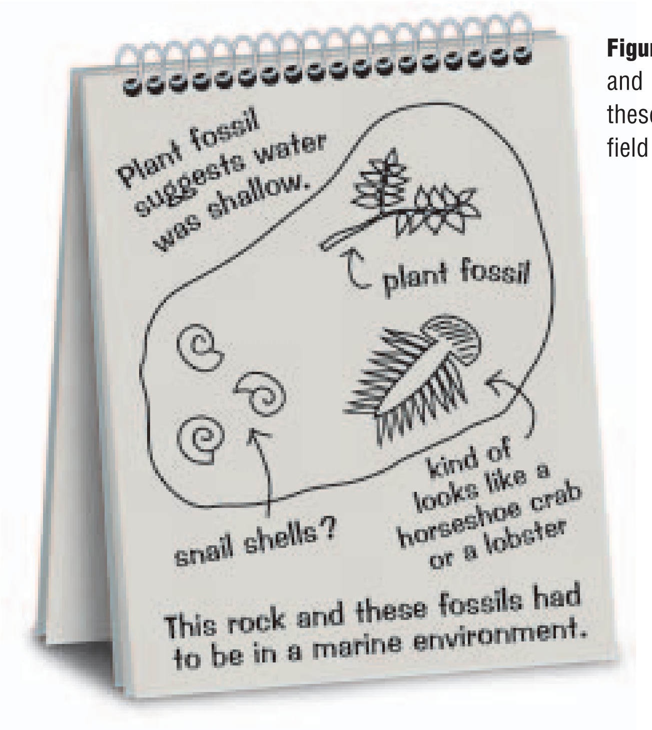


Figure 4.1 Kathy and Roberto made these notes on their field trip.

- How did Kathy and Roberto know that the fossils found in this sedimentary rock used to live in a marine environment?
- How did they know the water was shallow at the time the organism lived?
- What modern classification groups did Kathy and Roberto suggest were found on their sample?

Fossils

Fossils are traces of once-living things that are preserved in rocks. They form when animals or plants die and sink to the bottom of a body of water. There, they are buried by layers of sediments. This means fossils are the same age as the sedimentary rock in which they are found.

*info*BIT

Dug Out of the Ground

The word *fossil* is originally from Latin, meaning "dug out of the ground." Sedimentary rocks that are exposed at the surface are where the majority of fossils—usually marine animals—are found. Limestone, sandstone, and shale are the most common types of fossil rocks.

Figure 4.2 Trilobites lived on the bottoms of oceans 300–600 million years ago. No trilobites exist today. If you found a rock with a trilobite in it, what could you say about that rock?

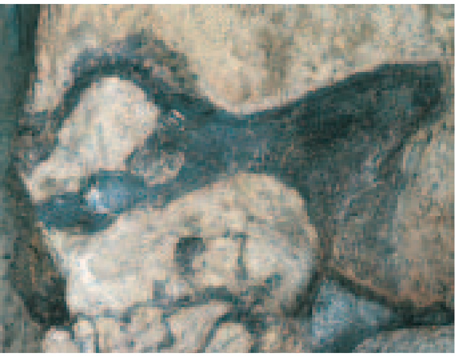
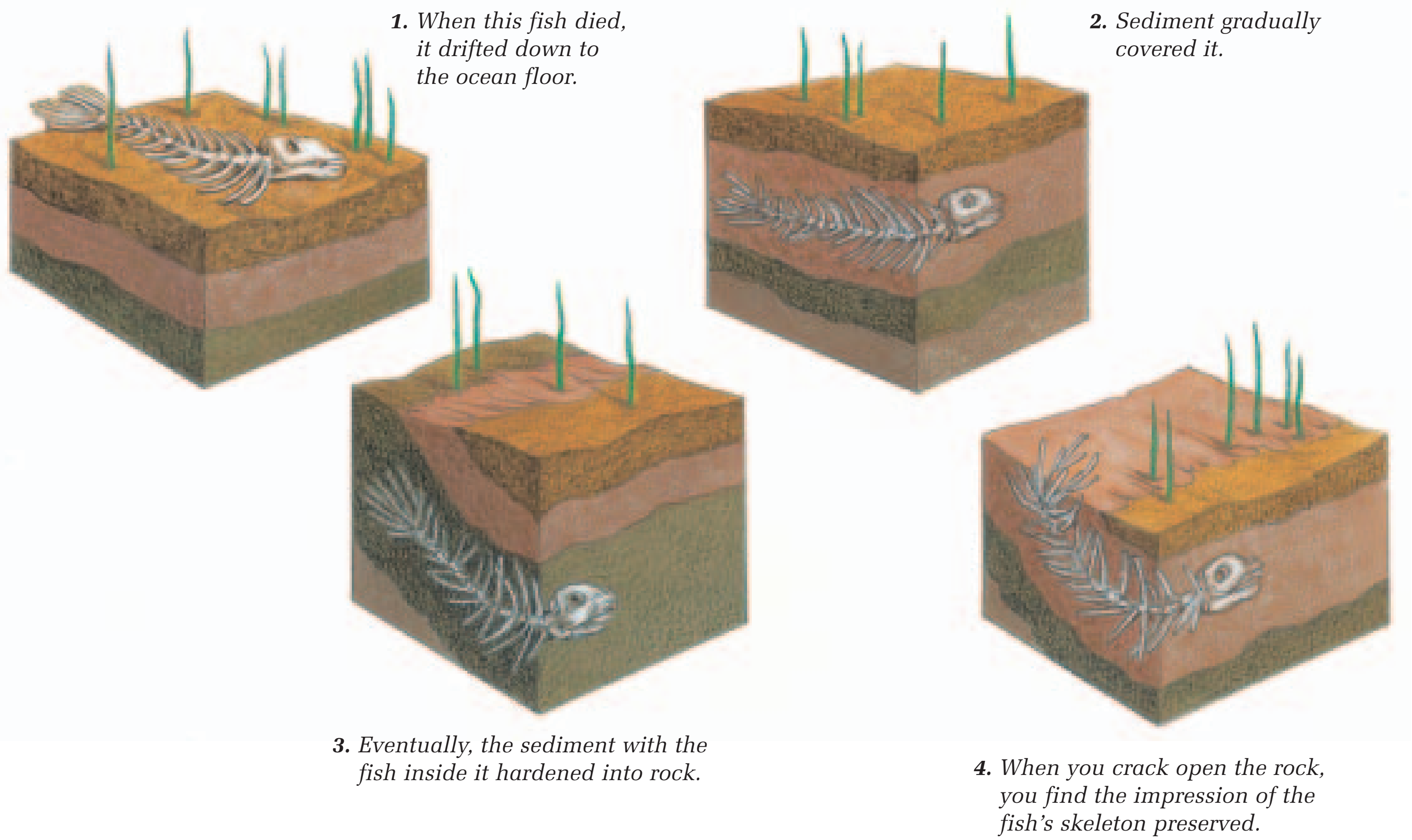


Figure 4.3 Sauropod vertebrae—the family of Sauropod dinosaurs were the largest animals to ever live on Earth. They include *Brachiosaurus* (24 m long) and *Apatosaurus*, or *Brontosaurus* as it was once called (21 m long).

Paleontologists [pāl lē on TOL e jists] are scientists who study early life forms by interpreting animal and plant fossils. It's a profession that takes a great deal of patience. Most fossils have to be carefully removed from the rock that surrounds them. Often, the fossils that are found are not complete, consisting of only parts of skeletons, shells, or other animal traces. Trying to make inferences based on these bits and pieces can be very challenging.

However, these inferences, together with a growing body of evidence, suggest that life on Earth has changed a great deal over the past millions of years. The fossils that we find in younger rocks are sometimes similar to animals and plants we see today. But older rocks often contain fossils of animals and plants that are extinct (no longer exist). Many of these fossils don't look like the plants and animals we see today. The trilobite in Figure 4.2 is a good example of an animal that once lived on the ocean floor, but became extinct about 300 million years ago.

Figure 4.4 Fossil formation



Becoming a Fossil

Not every living thing has the potential to become a fossil. In fact, the whole process of turning into a fossil is a rare experience. Furthermore, there is more than one way to become fossilized.

- Firstly, sediments quickly have to bury the original plant or animal remains. A quick burial usually means scavengers and other decomposers are not able to break the remains down further.
- Sometimes, a cavity is created as the original organic form decays. This cavity can then be filled by other sediments, which eventually harden into rock.
- In other cases, a fossil can be formed when the original organism is slowly replaced by mineral crystals.

Fossils may not just be the actual plant or animal. A *trace fossil* is a cavity or track left behind by an organism (for example, a footprint). Another type of fossil is a *cast*. Casts are the filled-in cavities left by the original organic bodies.

Trees and other plants can also become fossils. These are sometimes found in the form of petrified wood or remarkably preserved as in the photograph below.

Figure 4.5 Fifty million years ago, this was just another leaf on a tree.

Figure 4.6 A paleontologist carefully reveals an *Albertosaurus* skull that's 75 million years old.

Studying fossils is one of the ways geologists and paleontologists track changes in Earth's geologic history. But how do these fossils become preserved? Do all living things leave behind fossilized evidence of their existence? Fossilization is a process that can take thousands of years and only happens under certain conditions. Animals with hard parts (bones, shells, etc.) are the most common fossils. Fossils of earthworms and jellyfish have been found, but they are rare.

reSEARCH

Index Fossils

Paleontologists use particular fossils to identify certain time periods. These are known as **index fossils**. Using the Internet, your library, or other resources, try to identify index fossils that can be found in your area. For example, why is the trilobite in Figure 4.2 considered an index fossil?

Telling Time Geologically

The layers of sediment that have formed over millions of years are called **strata**. They provide important information about what happened in the past.

From studying the kind of rock and the grain size in a layer of strata, geologists can gather information about the environment in which it formed. For example, if it's limestone, this layer of rock was originally at the bottom of an ocean. If a layer of strata is very thick, it means that the environment remained stable for a long period. A new, different layer forms when something changes in the environment. For example, a rise in sea level would show up as a change in sediments along the former shoreline. The shoreline sediments would be replaced by the type of sediments that form in deeper water.

Figure 4.7 Mt. Rundle, Alberta—sometimes there is no change for many millions of years in the type of material that is deposited. While the bottom of this cliff was formed, the sedimentary deposits remained the same.

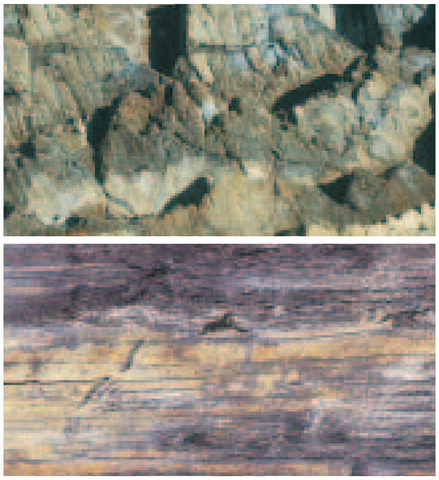


Figure 4.8 A changing rhythm of sedimentary deposits caused these different layers of shale to appear.

Check and Reflect

1. Suppose you went to a quarry and found some fossils in sedimentary rocks. Then you visited another quarry 5 km away and found exactly the same kinds of rocks, containing the same kinds of fossils. What could you say about the second set of rocks you found?
2. If there were fossils in sedimentary strata layers, and they were buried extremely deep (perhaps as much as 8 km beneath the surface), what would happen to the fossils? Would the clearness of their images change? Why or why not?

4.2 Methods Used to Interpret Fossils

The fossil record found in rocks shows a sequence, but not one based on size, habitat, or shape. Rather, the fossil record shows a sequence of *different life forms* appearing through time. For example, single-celled life forms appeared before multi-celled life forms, plants before animals, and invertebrates before vertebrates. Fossil records show that older rocks contain increasingly different organisms from those living today.

Have you ever looked at old pictures of your relatives who have passed away and wondered what they were like? Did they sound like you, do the same things, live in the same area? Piecing together the past life of someone is sometimes difficult because often there is no one around to answer those questions.

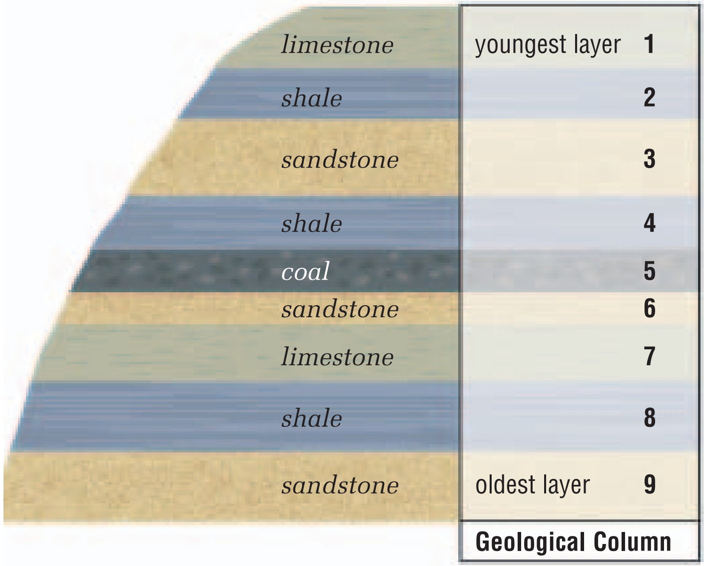
The ability to reconstruct fossils based on knowledge of current living things is an important part of understanding the history of life on Earth. The obvious challenge for paleontologists who study ancient life is that the animals and plants they are trying to study no longer exist. Fossils do provide important pieces of information. However, much of what science knows about them is based upon inferences or educated guesses.

Figure 4.9 Amber is fossilized tree sap that sometimes preserves trapped insects like this mosquito. Genetic material has been successfully extracted from insects encased in amber.

*info***BIT**

Geological Columns

Rock formations are deposited in layers from the oldest on the bottom to the youngest at the top. Paleontologists use these layers, or *geological columns*, to help determine the age of the fossils they find.



Fossils found in layer 7 will be older than those found in layers 1 to 6.

Studying Sedimentary Layers of Rock

In areas where the layers of sedimentary rock are deeply eroded, geologists can study the fossil record over a large portion of Earth's history. The Grand Canyon is one of these places. Down at the bottom of the canyon, where the oldest rock is found, there are no fossils. Then, just one layer higher, many fossils of trilobites appear (such as the one in Figure 4.2). As you travel up the canyon wall, other fossils can be found that are more similar to those that exist on Earth today.

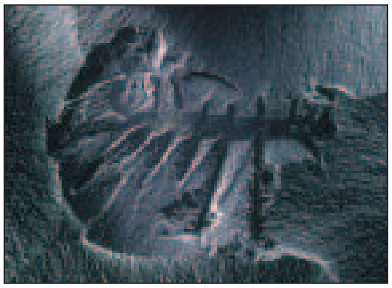
The Red Deer River in central Alberta, through Drumheller and Dinosaur Provincial Park, also has a vertical story to tell.

Give it a **TRY** — **Activity**

Fossils through Time

Below are a series of photographs of fossils from the era in Earth's history when life began to become extremely diverse in a short period of time. This was during the Cambrian period, about 515 million years ago.

Anomolocaris



Hallucigena

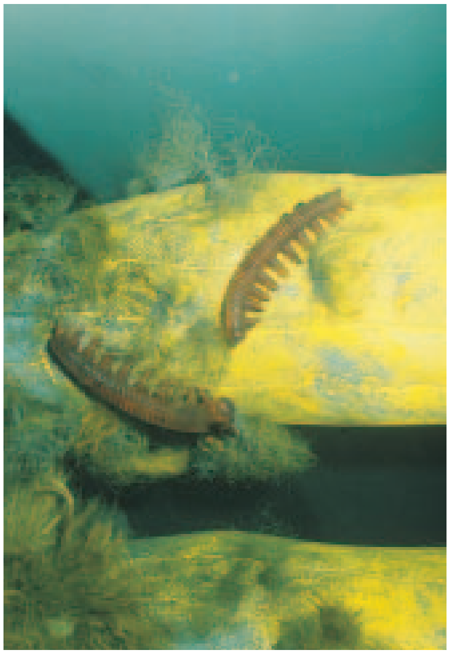
Opabina

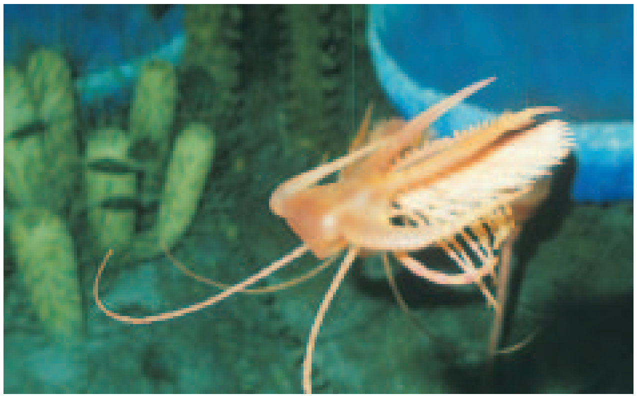
Figure 4.10 These fossils are some of the ancient creatures found in the world-famous Burgess Shale Fossil beds in Yoho National Park, British Columbia.

Choose one of the fossils in Figure 4.10, and, like a paleontologist, try to answer the following questions based on these photographs.

- What do you think are the characteristics of this animal?
- How did the animal move?
- Where did the animal live?
- How large do you think the animal was?
- What and how did this animal eat?
- Sketch a possible likeness of a relative for this creature.
- Suggest any possible related animals that might exist today. What new questions can you ask about your animal?

Fossil Beds





These are three-dimensional models of animals that once lived in The Burgess Shale Community (Ayshella, left, and Marella, right).

Figure 4.11 The *Burgess Shale Community* is a diorama that illustrates the type of community in which these animals may have lived. Western Canada has many other fossil locations that help explain the history of life on Earth. In fact, the Royal Tyrrell Museum of Paleontology in Drumheller, Alberta, is one of the best places in the world to meet the most famous of fossils—dinosaurs.

The Burgess Shale Fossil Beds have preserved the soft tissue of many species, allowing scientists to study these specimens in detail. Usually, scavengers, decomposers, and the passing of time ensure that only the most durable parts of an organism are preserved. Thanks to very fine sediments, a quick burial, and a lack of life-giving oxygen for bacteria, these shale fossils look much the same as they did half a billion years ago. So well preserved are the fossils in the shale, that scientists have been able to determine what final meal they had before they died!

Figure 4.12 Joseph Burr Tyrrell

The Royal Tyrrell Museum

The Royal Tyrrell Museum of Paleontology, located in the Badlands area of Alberta, opened on September 25, 1985. It was named after Joseph Burr Tyrrell, a geologist with the Geological Survey of Canada.

*info*BIT

Earth Giants

So you think *Tyrannosaurus rex* is the biggest dinosaur at 12 m? Or maybe you thought it was *Seismosaurus* at 30 m or *Supersaurus* at between 35 m and 40 m? (That's as tall as a 12-storey building.)

Well, you would be wrong. In January 2000, a dinosaur vertebra measuring 1.2 m was found in an Argentine village. That means this creature was probably close to 50 m in length, or nearly half the length of a football field! And who is to say what the next dinosaur fossil find will reveal?

Figure 4.13 Skeleton of *Tyrannosaurus rex*, more than 12 m long, on display in the Tyrrell Museum's "Dinosaur Hall"

Figure 4.14 A paleontologist unearths new dinosaur remains on one of the museum's many summer digs.

reSEARCH

Researching Ancient Life

Canada has many locations where there is ongoing research on a variety of ancient life. Using the Internet, your library, or other resources, find some of these projects and share what you find with the rest of the class.

In 1884, while studying coal deposits in the Badlands, he discovered a 70-million-year-old dinosaur skull, later named *Albertosaurus*. The find sparked international interest in the area, which turned out to be one of the richest sources of dinosaur bones in the world. The Alberta government recognized the area's importance and financed a major museum and research facility in the Badlands.

The Tyrrell Museum is one of the largest museums of paleontology in the world. It displays more than 200 dinosaur remains, the largest number under one roof anywhere. Most of the dinosaurs on display were found in Alberta. As well as dinosaur bones, the 11 200 m^2 facility contains computer terminals where visitors can design their own dinosaurs or play simulation games. Visitors can also watch from a special viewing area as technicians prepare and preserve fossils for study and display. One can even sign up to spend a day or a week working with paleontologists on a real dinosaur dig!

Check and Reflect

1. Scientists often try to determine if the fossilized animal they are examining is related to a group of animals living today. What things might they look for to help make this connection?
2. Do you think any fossilized animals are related to animals living today? If so, how could that be possible?
3. If you found a piece of petrified wood and bones in the same location, what could you say about the age of the two specimens?

4.3 Geologic Time

Figure 4.15 An artist's view of life during the age of dinosaurs (the Mesozoic Era)

Virtually everything that humans do today is affected by time. Classes, practices, meetings, departures, and arrivals are dependent on knowing what time it is. Everyone knows what a week, an hour, or a year feels like. But can you imagine a thousand years, a million years, a billion years? Perhaps that's why it's so hard to understand the history of life on Earth. How can anyone have a sense of what a half-billion years is like when 10 or 20 years seems like a long time?

Looking Back into Time

All that science knows about the ancient past, it has learned from rock and fossil records. Geologists have used this knowledge (some of which is not very exact) to organize Earth's history into geologic time intervals. These time periods are called **eras**. Geologists have based these eras on the sequence of rock strata, with the oldest

*info***BIT**

Geologic Periods
Some geologic periods are named after areas where rocks from that period are well exposed. For example, the time period Jurassic is named after Jura, a mountain range in France.

layer being on the bottom, and the youngest layer on the top. This sequence was established by identifying fossils and matching them with sedimentary rock layers from all over the world. There are four main divisions in these sequences. Each represents a major change in the global environment and is characterized by different life forms.

Scientists estimate that Earth is about 4.6 billion years old. The following illustration (see Figure 4.16) is an artist's representation of what the stages of Earth's evolution might have looked like.

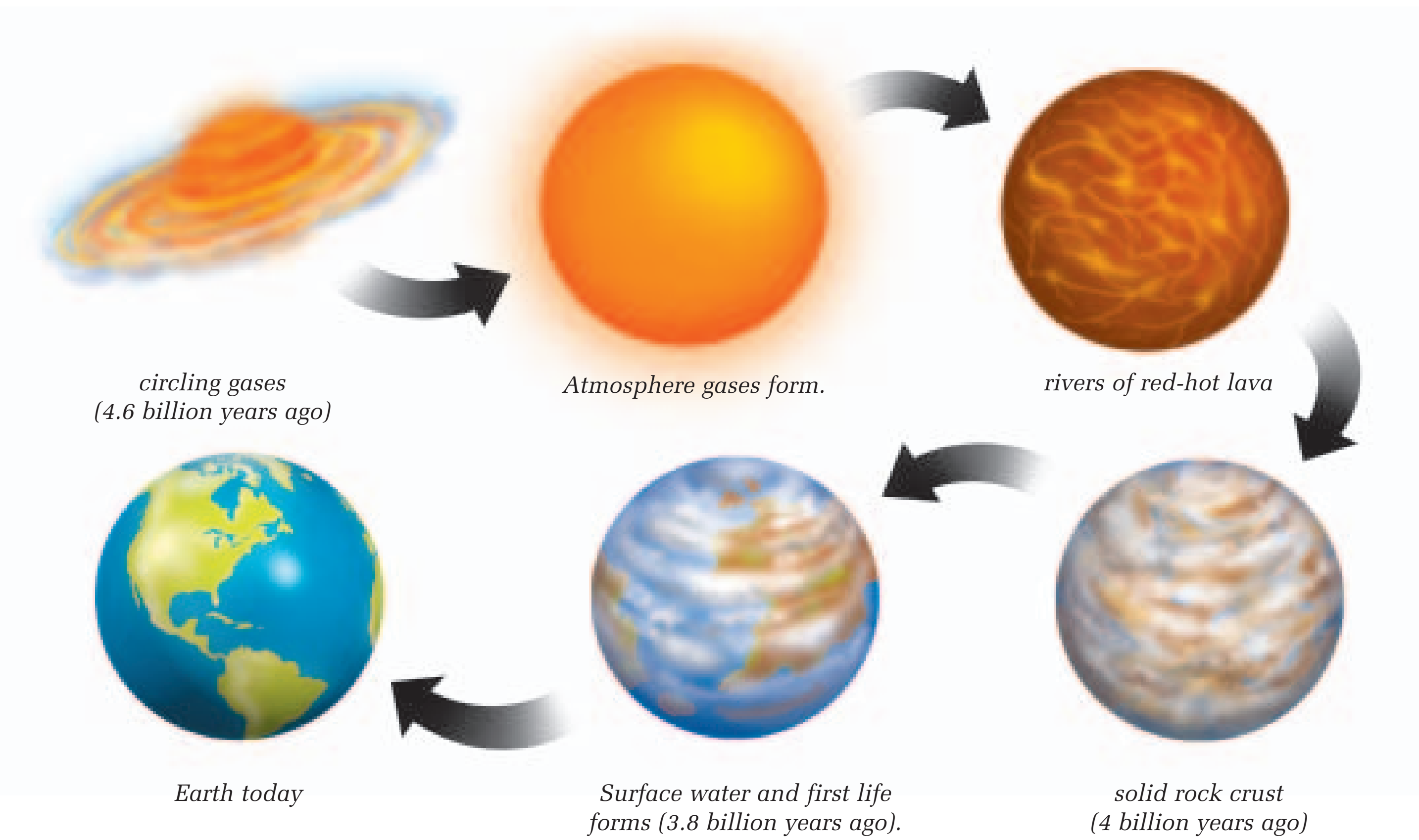
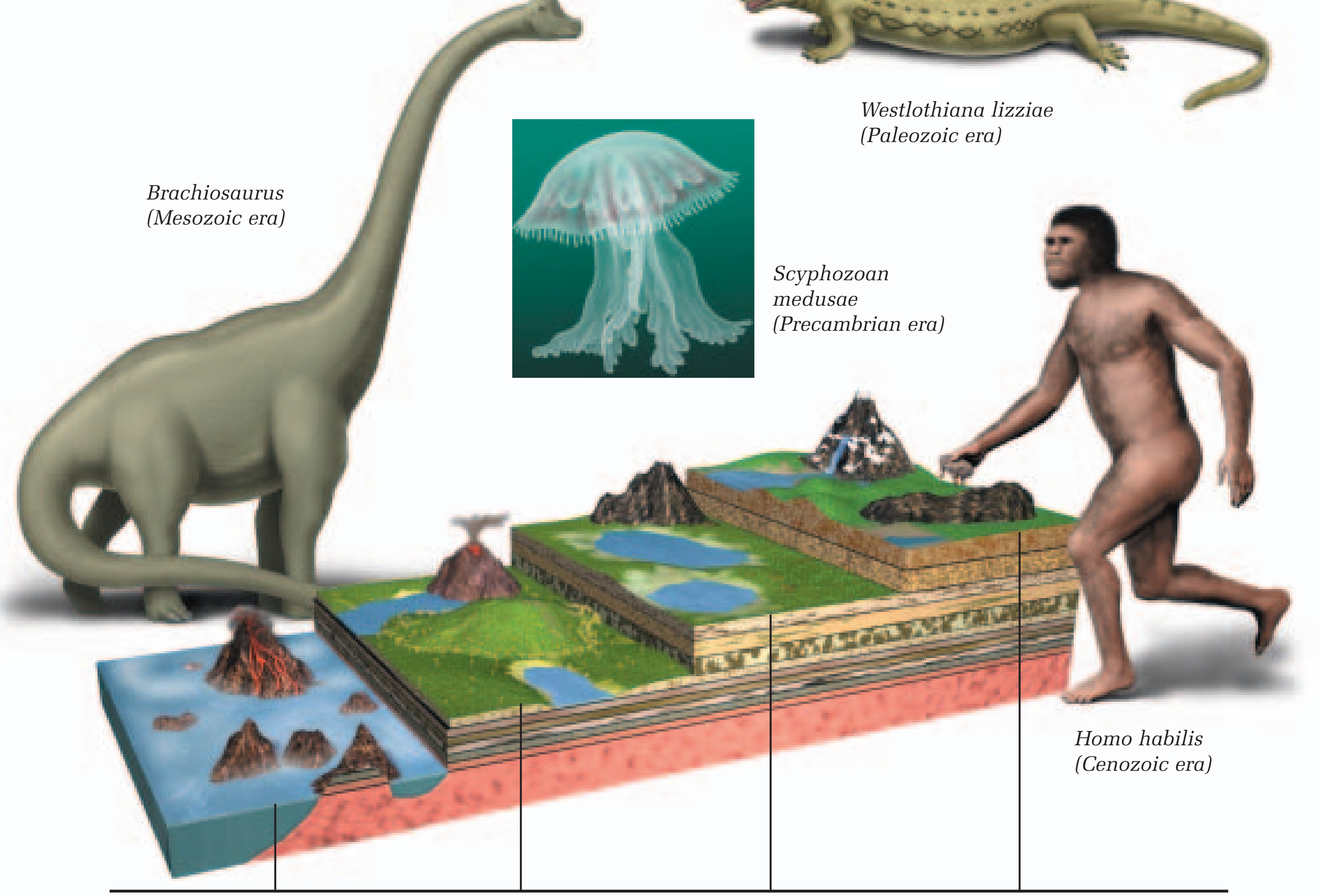


Figure 4.16 One representation of the evolution of Earth

Observations by scientists of bodies in outer space and geological evidence suggest that our planet was first a swirling cloud of gas that had once been part of a newly formed sun. In time, the outer layer began to cool. Massive eruptions of magma from below this outer layer spread sheets of lava over the surface.

Geologic Time Scale



Precambrian Era: 4600 to 600 millions of years ago

- formation of Earth
- first simple organisms (bacteria)
- first soft-bodied animals (no vertebrae)

Paleozoic Era: 600 to 225 millions of years ago

- first reptiles
- first large land animals (amphibians—frogs)
- first insects
- first large land plants
- first fish with jaws

Mesozoic Era: 225 to 65 millions of years ago

- dinosaurs rule and then become extinct
- first flowering plants
- first birds and mammals

Cenozoic Era: 65 millions of years ago to present day

- appearance of most modern species
- many more species of mammals
- first grasses
- first human-like species (about 2–3 millions of years ago)

Figure 4.17 The four eras of Earth's history

*re*SEARCH

Dating Rocks and Fossils

Use your library resources and the Internet to search some of the methods geologists and paleontologists use to date rock and fossil samples. For example:

- radioactive dating of certain elements, such as carbon and uranium
- examining the composition of dead organic material

Mammuthus primigenus (Cenozoic era)

Give it a **TRY** ACTIVITY

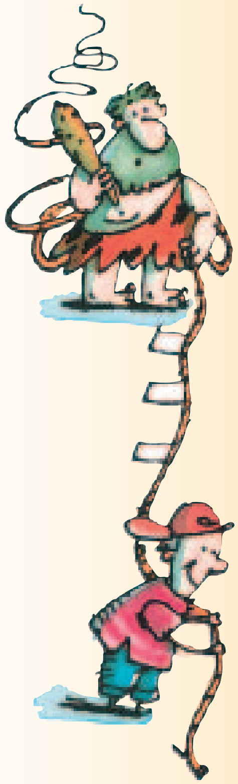
MEASURING TIME

Using a length of string, a long strip of tape, a length of wood, or any other piece of material, construct your own geologic time scale. (See Toolbox 5 for a review of measurement.)

- The beginning must read 4.6 billion years and extend to the present day.
- Use the chart below as a guide for your time line.
- When you have completed your time scale, bring it to a friend and explain your scale and some of the events that took place.

Significant Dates in Earth's History

Event	Years ago
Glaciers cover most of Canada and United States	11 000
Earliest human relative	3 000 000 (about)
Dinosaurs disappear	65 000 000
Evidence of first birds	150 000 000
Evidence of first mammals	190 000 000
First dinosaurs	225 000 000
First amphibians	350 000 000
First large land plants	430 000 000
Earliest fish	500 000 000
The Burgess Shale fossils and the Cambrian explosion	515 000 000
Multicelled organisms	700 000 000
First evidence of life	3 500 000 000
Earth formed	4 600 000 000



UNDERSTANDING FOSSIL EVIDENCE

Fossils are the only evidence scientists have of early life forms. Paleontologists use fossil evidence to help them develop theories about prehistoric life. Fossils are rare, however. And fossils of complete animals are very rare because the remains of animals usually disappear long before they can become fossilized.

Because fossils are rare, paleontologists cannot always make general statements about what life forms existed millions of years ago. For example, a few fossils, such as *Archaeopteryx* [ar kee OP ter iks], have impressions that look like feathers. But because so few of these fossils have been found, paleontologists cannot say that all similar creatures at that time had feathers. More evidence is needed.

Often when fossil remains are found, they are only broken fragments. Reconstructing these fragments (see Figure 4.18) into a full-size animal (Figure 4.19) takes skill and inferences based on a knowledge of modern animal anatomy. Creating a life-like illustration from these fossilized bones (Figure 4.20) requires careful study of the bones, a knowledge of anatomy, and imagination. Imagination is needed where we have no evidence; for example, for the colour of the skin.

Fossil Inferences

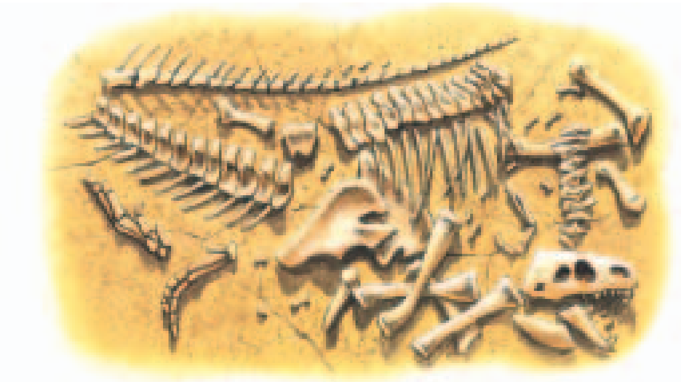


Figure 4.18 *Allosaurus skeleton before reconstruction*—Reconstructing fossil bones into a full-size skeleton is like trying to put a three-dimensional puzzle together without the picture on the box!

Figure 4.19 *Allosaurus skeleton after reconstruction*—Reconstructing a dinosaur skeleton requires a team of experts with a wide range of knowledge. Scientists compare the new bones they find to known dinosaur skeletons and to the skeletons of modern creatures.

Figure 4.20 *Completed Allosaurus*—After the skeleton has been reconstructed, the next step is to put the muscles on the bare bones. The arrangement of the different muscles is established by examining "scars" on the bones where the muscles were once attached. Next, the skin is added. Fossilized skin impressions that have been found suggest that dinosaur skin was scaly, similar to a reptile's skin.

TRY This at Home

ACTIVITY

MAKING A FOSSIL

Try making your own fossil mould and cast. You can use seashells or other small objects that have an interesting texture to make your fossil.

- Coat the outside of your seashell with petroleum jelly.
- Mix up about a cup of plaster of Paris and water in a small bowl so that it looks like thick cream. Add food colouring, mixing well.
- Slowly pour the plaster mixture into a plastic cup until it is about 3 cm from the top. Press the seashell, greased side down, into the wet plaster. Wash your hands after cleaning up. Leave overnight.
- Remove the shell the next day. The coloured plaster is the fossil mould. Coat the entire surface of the plaster mould with petroleum jelly.
- Mix up a new batch of plaster of Paris, but this time *don't* add food colouring. Pour the plaster onto the mould so that it fills the cup. Wash your hands.
- The next day, carefully separate the two plaster pieces. Examine the coloured *mould* and the white *cast*.
- What is the difference between the two pieces? Which one, the mould or the cast, looks more like your original seashell?

Figure 4.21 Pour the coloured plaster mixture so that it is about 3 cm from the top.

CHECK AND REFLECT

1. Why do geologists divide the history of Earth into eras?
2. What changes on Earth occurred between 515 000 000 years ago and 250 000 000 years ago?
3. During what era did dinosaurs become extinct? What other life forms lived during this era?
4. The fossil record indicates plants appeared before animals did. Do you think this could ever occur in reverse order? Explain your answer.

Assess Your Learning

1. What is a fossil and how is it different from a rock or mineral?
2. What kinds of information or data do paleontologists gather?
3. What information do the layers of sedimentary rock give scientists who study fossil records?
4. If fossils are found on the side of a mountain at 2500 m, and the same kind of fossil is found 30 km north at 1900 m, what could be said about the strata they are found in? Could they be the same? Would it be likely that more would be found along the same layer? Explain your answer.
5. What can the study of life forms on Earth today tell us about life forms of the past?
6. What are some of the types of fossils found in Alberta?
7. Why are inferences necessary when studying fossils?
8. What environmental influences could explain the appearance of some life forms and the disappearance of others?
9. What kind of life forms appeared in each of the four eras of Earth's history?
10. Why do you think it took about one billion years before the first life forms appeared on Earth?
11. Make a chart or another illustration that represents the four major periods in Figure 4.22.

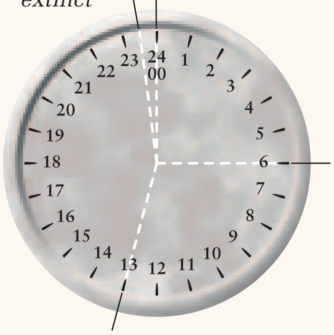
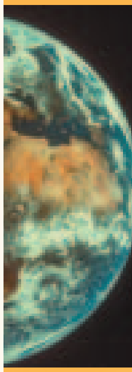


Figure 4.22 Comparing the evolution of life forms to a 24-h time clock



Focus On THE NATURE OF SCIENCE

So many of the discoveries and theories in science are the result of the work of a great many people. Scientists have been working co-operatively for over a hundred years to learn about and understand Earth's history.

1. Why do you think sharing knowledge is important in understanding fossil records?
2. Why is it important when working in a group for everyone to have a definite task to perform?

What Happened to the Dinosaurs?

The Issue

Dinosaurs ruled Earth for 150 million years, then suddenly became extinct about 65 million years ago. Many theories have been proposed:

- Small mammals ate the dinosaur's eggs.
- A deadly virus caused a dinosaur plague.
- Vicious meat-eaters ate all of the plant-eaters and then starved to death themselves.
- Hungry caterpillars devoured all of the dinosaur's plant-based food supply.
- Dinosaurs were hunted to extinction by aliens.

Some of these theories are obviously more believable than others. Over the years, a growing amount of evidence suggest two other theories. Evidence has led many scientists to believe that 65 million years ago, a giant meteor 10 km in diameter crashed into Earth. The impact created a crater over 100 km in diameter and ejected enormous amounts of dust and debris into the atmosphere. The cloud of dust encircled the entire Earth and blocked out sunlight for months or even years. Without sunlight, much of Earth's vegetation died off and the plant-eating dinosaurs starved to death. Without any prey to eat, the meat-eating dinosaurs soon followed.

Did the impact of a giant meteor destroy the dinosaurs?

Is this the end of the dinosaur story? Not according to other scientists. From the fossil evidence, they have developed the theory that dinosaurs did not disappear completely—they evolved into birds. The skeletons of birds have many similar features to small predatory dinosaurs known as *theropods*. A recent fossil find suggests that some theropods had feathers. However, one scientific study has suggested that this fossil is a fake. What is the real answer?

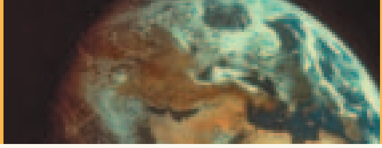
Go Further

Look into the following resources to help you form your own opinion about how dinosaurs became extinct:

- Look on the Web: Check out dinosaurs or paleontology on the Internet.
- Ask the Experts: Try to find an expert such as a paleontologist or an ornithologist (bird expert).
- Look It Up in Newspapers and Magazines: Look for articles about the extinction of dinosaurs or the origin of birds.
- Check out Scientific Studies: Look for scientific studies about dinosaurs, theropods, or Archaeopteryx.

In Your Opinion

- Which extinction theories seem most believable to you? Why?
- Could more than one extinction theory be correct? For example, if the meteor theory is true, does this mean the bird theory must be false?



Unit Summary: Planet Earth

Key Concepts	Section Summaries
1.0 • developing models • Earth models • earthquakes • volcanoes • tools and techniques for studying Earth • the effects of water, wind, and ice • glaciers	**1.0 Earth's surface undergoes gradual and sudden changes.** • Earth is viewed as a layered planet. The main layers are the crust, the mantle, and the core. Only the crust has been investigated because Earth's other layers are many hundreds of kilometres below its surface. • Earthquakes and volcanoes are examples of forces that take place within Earth's interior. These forces have the ability to suddenly and dramatically change Earth's surface. • Scientists use a variety of tools and techniques to investigate Earth's forces. • Wind, water, and ice are forces that slowly change Earth's features.
2.0 • rocks and minerals • classes of rocks: igneous, sedimentary, and metamorphic • geology tools and techniques • the rock cycle • describing and interpreting local rock formations	**2.0 The rock cycle describes how rocks form and change over time.** • Rocks are the hard structures that make up Earth's crust. They are composed of minerals, substances that give rocks their distinctive characteristics, such as hardness and colour. • There are three classes of rocks that make up Earth's crust: igneous, sedimentary, and metamorphic. • Rocks are always being broken down and transformed into different forms. This process is called the rock cycle. • All three classes of rocks can be found in Alberta although sedimentary rocks are the most common.
3.0 • continental drift • plate tectonics • mountain building	**3.0 Landforms provide evidence of change.** • The Theory of Plate Tectonics describes Earth's surface as being broken up into huge areas of rock called plates. • The continents and the ocean floors are carried on these plates. The plates are slowly moving on the partly melted mantle. • Mountains are formed as a result of plates colliding or rubbing together, pushing up part of the plate.
4.0 • tracing evidence of geologic change using fossils • methods used to interpret fossils • geologic time • understanding fossil evidence	**4.0 The fossil record provides evidence of Earth's changes over time.** • Fossils are traces or remains of past life preserved in stone. They have given scientists a picture of how life has evolved over the last three and a half billion years. • Scientists use a variety of methods and tools to interpret fossil evidence. However, since fossil remains are often incomplete, much of what is known is based on inferences. • Geologists have divided Earth's history into four periods, called eras. • Determining what animals looked like from fossil records is often based on inferences.

PROJECT

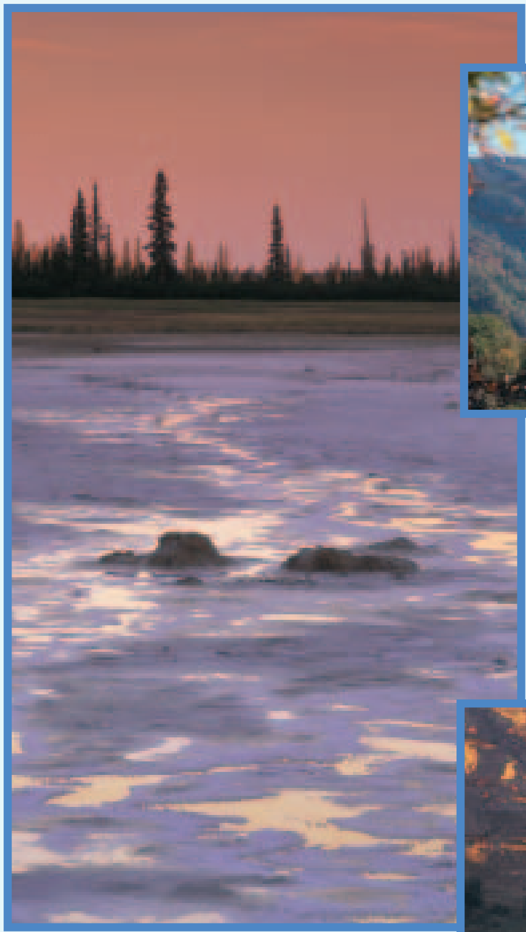
EARTH MODELS AND SIMULATIONS

Getting Started

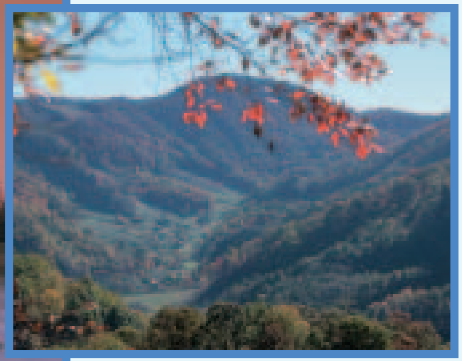
In this unit, you have explored the different processes that create features on Earth's surface. Forces inside Earth, such as the movements of tectonic plates or movements along faults, can create mountains. Forces on Earth's surface, such as ice and wind, can wear down and move mountains through weathering and erosion. For this project, you can use what you've learned about Earth's processes.

Think about the features that you would include in a display about the landscape in your area. To help your thinking, look at the pictures on this page, and see if you can answer the questions in the captions.

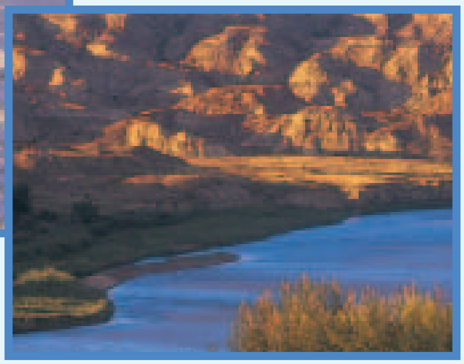
The features in these pictures are just examples of what you might see. Your area may be completely different. You may not have any mountains or deep valleys. Your major features may be large areas of flat fertile soil beside a large body of water. Or you may have large grassy areas between low rocky hills. Whatever the features in your area, you can use this project to apply the ideas about Earth that you developed in this unit.



Rock formations and deposits can tell us a great deal about a location's history. These salt flats are in Wood Buffalo National Park, Alberta. How would salt deposits end up far from the Pacific Ocean?



These mountains formed millions of years ago. When they first formed, they were tall and jagged. Now they are worn down and rounded. What processes do you think could have changed them?



The Red River runs through the Badlands of southern Alberta. What do you think happens to the soil when the river slows down or stops flowing?

Your Goal

Imagine that you are a designer who designs and builds models and simulations for science centres and other museums. Your community is building a new science centre. Your job is to provide a display that shows how the local features in your landscape began, and how they became the way they are today.

What You Need to Know

You and your classmates are partners in Time Travel Designs Inc., a company specializing in displays that show the origin and history of features on Earth's surface. For your assignment, as described, you can use any information you gathered as you worked through this unit. You will need to collect additional information about your local geology and geography from reference books, the Internet, and other resources.

Your company has found that the best way to develop these displays is for all the partners to work together to determine which features to model and simulate. Then you divide up the features among smaller teams. Each team is responsible for modelling or simulating one feature. When they are completed, all the features are combined in one large display.

> **CONTRACT**
>
> This document is a formal statement of an agreement between
>
> Discovery Science Centre
>
> and
>
> Time Travel Designs Inc. (herein called "the Contractor")
>
> To design and construct a display showing major features of the community and its local area.
>
> The Contractor will:
>
> - select the appropriate features to represent
> - research the information on the origin and history of the features
> - design and construct models and simulations to explain the features to the general public
>
> Discovery Science Centre agrees to provide the Contractor with the space for the display and the materials to construct it.

Steps to Success

1 With classmates, brainstorm answers and questions that will help your team develop a plan to build your model display.

2 Design your model or simulation. Give the design to your teacher for approval before you start building it. Include in your design:

a) a drawing of your model
b) a diagram showing how you will simulate the processes
c) a list of materials
d) a procedure for building your model
e) your schedule
f) safety considerations

3 Build your model or simulation according to the design and plan that your teacher approved.

4 Decide how you will explain your model or simulation to the rest of the class. You may want to have different team members explain different parts of the model or perform different parts of the simulation.

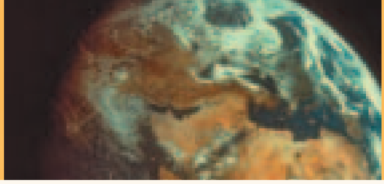
How Did It Go?

5 Write a report of the planning and building of your model. Share and compare it with the reports of other teams.

6 Explain your model or simulation to your class. As you watch other teams, write down:

a) what you liked best about their models or simulations
b) any ideas or materials that you could have used for your model or simulation

7 Combine your model or simulation with those of your classmates to create the display. Invite other classes to see your displays.



Unit Review: Planet Earth

Unit Vocabulary

1. Write a short story about Earth's crust using the following terms:

   Theory of Plate Tectonics
   deposition
   erosion
   sediments
   earthquake
   volcano
   landscape
   mineral
   rock cycle
   fossil
   Mesozoic Era

Check Your Knowledge

1.0

2. Describe the model scientists have developed that explains Earth's structure.
3. Describe the cause of an earthquake.
4. What is a volcano?
5. Describe some of the forces that slowly change Earth's surface.

2.0

6. What are the differences between rocks and minerals?
7. Briefly describe the three classes of rock found in Earth's crust.
8. What is meant by the rock cycle?

3.0

9. What evidence is there that the continents are drifting farther apart?
10. In a paragraph, explain the Theory of Plate Tectonics.
11. Describe the formation of the Rocky Mountains.

4.0

12. Why do scientists study fossils?
13. How is the age of a fossil determined?
14. During what geologic era did life on Earth first develop?

Connect Your Understanding

15. What do earthquakes and volcanoes have in common?
16. What model do geologists use to show how igneous, sedimentary, and metamorphic rocks are related?
17. Could all rocks become sedimentary rocks? Why or why not?
18. If Earth's plates are constantly moving, why aren't earthquakes occurring all of the time along every boundary?

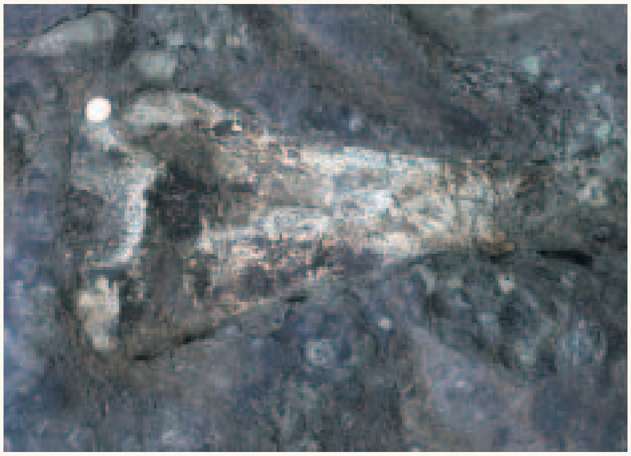
Practise Your Skills

19. Can geologists predict where new earthquakes, volcanoes, and mountain ranges will occur? Explain your answer.
20. Why is it probable that scientists will *never* have a complete understanding of how all life forms evolved on Earth?

21. A space probe lands on an unknown planet in another solar system. There are many volcanoes but only a few large bodies of water. Thick clouds of dust and water vapour cover the planet. Based on what is known about Earth, what inferences can you make about this planet? its composition? its rock formations? the presence of life forms?

22. You're looking at earthquakes in and around the eastern and western regions of northern India over the last 25 years. Major earthquakes of a Richter magnitude greater than 7 have caused tremendous damage. Why are they occurring, and what could your prediction be over the next 25 years?

23. The fossil skull's upper jaw (see below) has 14 teeth, and the lower jaw was missing. (A dime to the left of the skull gives an idea of the fossil's size.) What inferences can you make about what this creature looked like?



Self Assessment

Think back to the work you did in this unit:

24. Give an example where a number of people have contributed to the understanding of what Earth's structure is like.

25. Describe a subject area in the study of Earth where scientific evidence must be interpreted using inferences.

26. What is one idea, subject, or issue in this unit that you would like to explore in more detail?

Focus On The Nature of Science

27. Turn back to the Focus on the Nature of Science on page 351 of this unit. Use a creative way to demonstrate your understanding of one of the questions.

28. What experiments did you do that helped you understand some of the characteristics of our planet?

29. Describe a possible situation where using precise scientific language and a classification system would be important in identifying a newly discovered rock formation.

30. Describe the process involved in developing a theory or a model that best explains a natural phenomena.

31. Describe a situation where working in a group was important in completing a task or experiment.

32. Why do you think it is important that only qualified people be allowed to remove fossils from the ground?