1.0 Earth's surface undergoes gradual and sudden changes

1.1 A Model for Earth

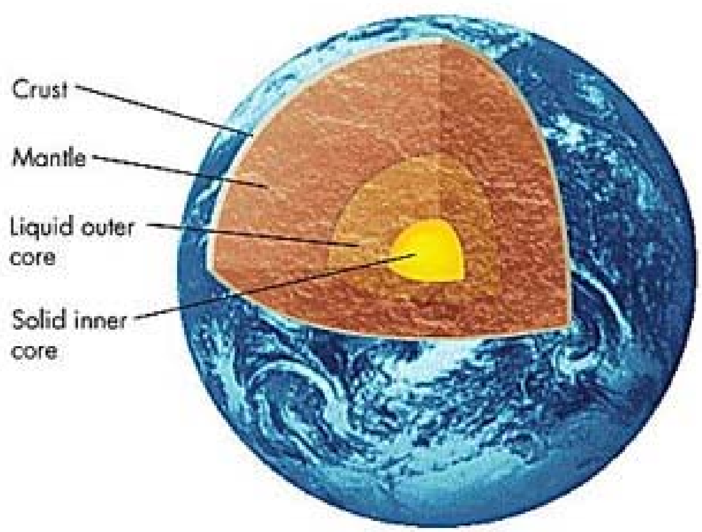
The story below the surface of the Earth is a mystery. The motion picture – **The Core** – tries to explain this mystery in a way that we can visualize it and understand it. Scientists make educated guesses based on data they collect from events that shape and reshape our planet every day. They try to understand this evidence so that they can explain how our planet began and what it is made of.

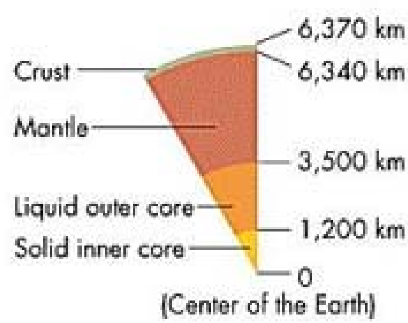
Developing A Model

A model is an idea of something that cannot be fully known or seen. It is a way of demonstrating an understanding based on evidence that is collected and interpreted, based on current knowledge. Models can take many forms: drawings, constructions, and comparisons to similar things.

What's Inside Earth

Geologists use a model to help them understand the inner structure of the Earth. This model is based on *indirect evidence*. The **crust** is the top layer of the Earth. Below it is the **mantle**, which is made of rock material (upper part is solid, lower part is partly melted. The upper mantle and crust are called the **lithosphere**. Below the mantle is the **core**. The **outer core** is made up of mainly liquid iron and nickel, while the **inner core** is solid.





The Crust

The crust is the layer of the Earth that we live on – the surface. It contains many minerals and fossil fuels, which help to supply much of our need for energy. It is also the thinnest part of the Earth. Because the inner part of the Earth is so hot, the crust radiates heat into the atmosphere. Despite the very thin film of soil and vegetation, the crust is primarily made of rock.

1.2 Sudden Earth Events

Few forces in nature are as devastating and Earth shattering as Earthquakes and Volcanoes. These are examples of sudden changes, that can transform a peaceful neighborhood into a shattered wasteland in a matter of minutes. **Kobe, Japan** – Earthquake killed 5000 people. **Mt. St. Helens** – Volcano killed 57 people and destroyed 560 square kilometers of land. Most recently, an undersea earthquake - in the Indian Ocean, caused the **Tsunami** which killed 150,000 or more people.

What Causes Earthquakes?

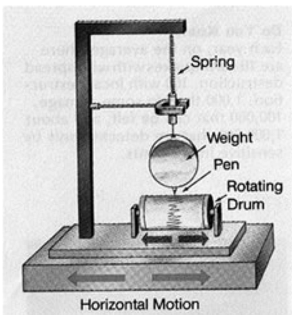
Earthquakes occur when tectonic plates break or move suddenly
Types of Rock Movement in Earthquakes
- where the plates meet, the rock is under great pressure, which can make it bend and stretch - when the pressure is too great, the rock breaks suddenly creating a **fault**
- there are three types of movement, of the tectonic plates, along a fault
- **Normal Faults**, (pulling action, which breaks rocks apart) - North Atlantic
- **Reverse Faults** (compression, where rocks are squeezed, causing them to bend and break) - Marianas Trench, near Japan
- **Strike-Slip** or **Transform Faults** (shear causes slipping, which makes the jagged edges break off) - Pacific Plate

The First Break

The **source** of an earthquake deep in the crust is called the **focus**, where the sudden breaking of the rock releases energy that spreads as waves through the Earth. These waves are called **seismic waves**.
The **p waves** (primary waves) and **s waves** (secondary waves) originate at the focus.
it is possible to determine the location of an earthquake by the interval between the p waves and the s waves (the farther apart they are, the further away the earthquake is
- the surface waves come from the **epicentre** (the location on the surface directly above the focus)

Measuring The Strength Of Earthquakes

Scientists called **seismologists** use a **seismograph** to record the intensity of an earthquake.



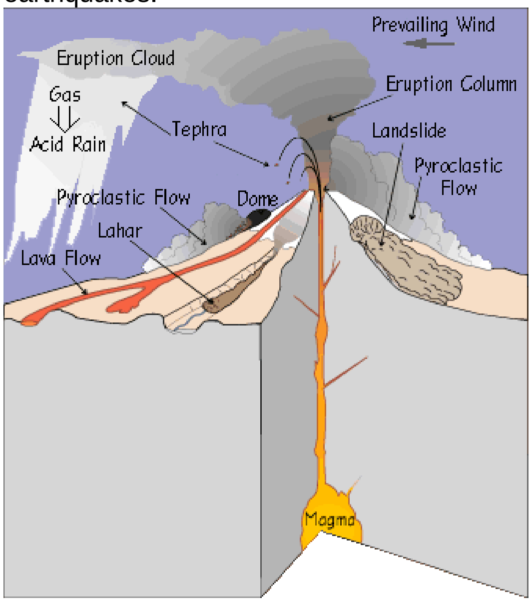
- the seismograph must be attached to **bedrock** (the solid rock that lies beneath the soil and looser rocks) to feel the vibrations on the plate
- a marking pen, inside the seismograph, records the vibrations on a rotating drum (modern seismographs are electronic)
- the measurement scale used is called the **Richter scale**

An Ancient Chinese Device to detect Earthquakes
Invented around 132 A.D., it consisted of a wine jar with eight dragon's head spouts which pointed in the compass rose directions.. A ceramic frog sat below each spout, which had a ball. With its open mouth, each frog was ready to catch any ball dislodged by an earthquake. The direction of the earthquake could be determined by which frogs caught balls.

http://volcano.und.nodak.edu/volcanoes.html* *(Volcano World)

Volcanoes

A **volcano** is an opening in the Earth's crust that releases lava, steam and ash when it **erupts** (becomes active). The openings are called **vents**. When volcanoes are not active, they are called **dormant**. Scientists are better equipped to predict volcano eruptions than they are at predicting earthquakes.



Famous Volcanoes

- the eruption of **Mt. Etna** in Italy this past summer shows that volcanoes cannot be predicted and don't always behave in ways scientists think they will behave. They can be rather spectacular (as the video link shows).
- the most active volcano on the Earth is **Kilauea** in Hawaii (**Loihi** is a new volcano forming beside the main island in Hawaii - creating a new island)
- **Krakatau**, in Indonesia (blast was heard 4800km away and tsunamis waves were 30 m high)
- **Mount St. Helens**, in Washington (sideways and vertical eruptions)
- **Mount Vesuvius**, in southern Italy (**City of Pompeii** was buried - it is due for another large eruption because it is sealed with a 'rock plug' that could blast 1.5 km upwards)
- **Mount Pinatubo**, in the Philippines (ash circled the globe and cooled temperatures around the world)
- Volcanoes on **Lo**, one of **Jupiter's moons** have been photographed using Vidicon - a type of TV camera mounted on the Voyager spacecraft, using an electron gun and photoconductor
- those on **Mars** and our **moon** have been extinct for millions of years, while those on **Venus** may still be erupting
- the largest volcano found in our universe is the extinct **Olympus Mons** on Mars

Current Volcano update: http://volcano.und.nodak.edu/vwdocs/current_volcs/current.html

- volcanoes that form a circle around the Pacific Ocean are called the **Ring of Fire** (derived from the circle of volcanoes that pour out red hot lava, fire and steam)

Tools and Techniques For Studying Earth

Volcanologists, Geologists and Seismologists take risks whenever they explore the world of Earthquakes and Volcanoes. Their efforts to learn more about these sudden Earth events may one day enable us to predict with more accuracy when they will occur.

Tools of the Trade

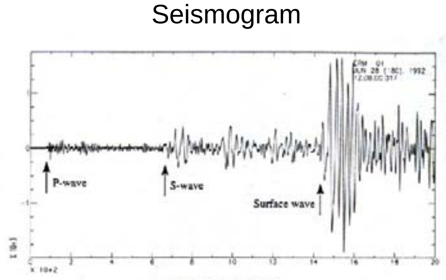
Silver Fire Suit

Reflects extreme temperatures

Surveyor's level

Detects changes in the slope of the ground

Seismogram



Determines the strength and location of an earthquake

1.3 Incremental Changes: Wind, Water and Ice

Weathering (3 types) breaks down and wears away rock, creating sediment. Erosion is the movement of rock and mineral grains from one place to another. Deposition is the process of placing the materials that are carried by water, wind and ice.

Mechanical Weathering
- the physical break-up or disintegration of rocks, caused by gravity, temperature change and frost wedging
- mechanical weathering 'wears away'
- sedimentation 'builds-up'

Chemical Weathering
- chemicals, present in the earth's surface or atmosphere, can be dissolved in water and react in the chemical decomposition of rocks and minerals (acid rain)

Biological Weathering
- living organisms (plants, animals, bacteria and fungi) can breakdown rock
- plant roots, acidic fluids produced by roots, bacteria, fungi and some insects and small animals can cause chemical reactions

The Effects of Moving Water

Water is one of the most powerful causes of erosion. Sudden or incremental changes occur due to the movement of water - rivers, rain, ocean waves. As rivers flow they carry a load of silt, sand, mud and gravel, called **sediment**.

When a river becomes mature it begins to meander (curving its bed from side to side). As it slows the sediment begins to fall to the bottom. **Sedimentation** is the process of sediments being deposited, usually at the bottom of oceans, lakes and rivers.

Landforms created by flowing water are called **fluvial landforms**.

The powerful forces of erosion caused by moving water wear away rock and soil and transport them to other locations.

Eroding Away

Agents of erosion include: glaciers, gravity, wind, and water. Changes can occur **gradually** (glaciers) or **suddenly** (flash floods, landslides, rock slides). **G**ravity causes landslides and rock slides – eg. Frank Slide (a **retaining wall** can often be used to hold back unstable material – but this is not always the best protection). **W**ind carries rock particles across the landscape, eroding the land by **abrasion** (planting vegetation, contour farming and reduced tillage can reduce the effects of wind erosion).

Glaciers – Rivers of Ice

Large rocks caught up in a glacier and then left behind when the glacier recedes are called **erratics**. Sediment that is push away, as the glacier moves forward, are called **moraines**. Scratches, made in the bedrock, by glaciers carrying rocks are called **striations**. As the glacier melts (or, retreats) it leaves behind sediment in the form of small hills, called **drumlins** and and snake-like hills called **eskers.**

2.0 The Rock Cycle describes how rocks form and change over time

2.1 What are Rocks and Minerals?

Minerals In Rocks

The building blocks of rocks are naturally occurring materials, called minerals. Rocks contain naturally occurring, non-living minerals. Most minerals are rare and can be elements (pure substances) or compounds (combinations of pure substances). Minerals are not only found in rocks, but they are also found in your body.
- Iron and pyrite help the blood carry oxygen
- Kidneys produce crystals, called kidney stones
- Calcium and dolomite help regulate water in body cells
- Diamonds are used in surgery, razor blades, computers, dentistry, oil drilling and a glass-cutter's wheel has diamonds embedded in it.

Some rocks are made up of only one mineral, like limestone, while other have many different minerals like granite. There are more than 3500 different minerals. Five minerals combine in different ways to form the majority of rocks.

They are:

Prospecting For Wealth

Identifying rocks, besides being a hobby, is also big business. Canada is one of the world's leading producers of gold, copper, nickel, zinc, lead, silver, iron ore, asbestos, potash, sand gravel, and clay.
There are also diamonds mined in Canada.

Using Properties To Identify Rocks

The properties that can be used to identify minerals are:

- **Lustre:** this refers to the 'shininess' of the mineral (how light is reflected off the surface)
- **Colour:** colour can vary even within the same mineral, like corundum (it can be white, blue or red), depending on what other elements are present.
- **Streak:** a streak is the color, of the powdered form, of the mineral. (it can be made by scratching a porcelain tile)
- **Cleavage and Fracture:** is the way a mineral breaks apart. If it breaks along smooth, flat surfaces or planes, it has cleavage. If it breaks with rough or jagged edges, it has fracture.
- **Transparency:** it can be **transparent** (see through), **translucent** (shadowy), **opaque** (non-see through).
- Type of mineral/s present (viewed through a microscope)

Moh's Hardness Scale

The hardness of a mineral is measured by how easily it can be scratched. A harder mineral will leave a scratch on a softer mineral.
- Friedrich Mohs developed a scale of hardness with **10 values** in 1812 (see Figure 2.5 p. 372)
- Diamond is the hardest and talc is the softest (check the table to find out how hard common objects, like your fingernail)

2.2 Three classes of Rocks: Igneous, Sedimentary, and Metamorphic

Types of Rock

Rocks are classified into 3 major groups

Igneous Rock

Magma is melted rock found below the Earth's crust. When it flows onto the Earth's surface it is called **lava.** Igneous rock forms when hot **magma** cools and solidifies.

There are two different types of Igneous rock:

Intrusive

(cooled and hardened magma below the Earth's surface)

Pegmatite

Extrusive

(rock that forms when lava - magma released during a volcanic eruption - cools on the surface)

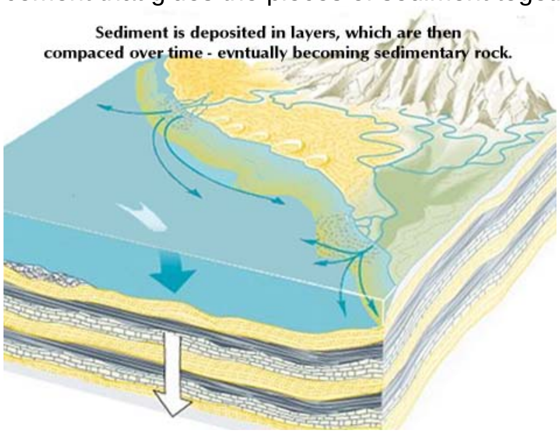
Basalt

Magma can contain crystals, their size depending on how quickly or slowly the rock cools (large crystals form when the rock cools slowly).

Sedimentary Rock

Sedimentary rock is formed from sediment (loose material - rock, minerals, plant and animal remains - that is layered and compacted together by the pressure of the material above it.

- stratification is the visible evidence of the layers
- cementation - some of the minerals that dissolve with the addition of water, makes a natural cement that glues the pieces of sediment together.



Types of sedimentary rock include:

-shale (formed from fine clay or mud)

-sandstone (sand, made of quartz)

-conglomerate (pebbles and small stones cemented together)

-limestone (organic sedimentary rock, containing fossils - plant and animal remains)

-organic sedimentary rock forms from living material that has been buried and is under pressure over thousands of years. (Coal is an example)

Metamorphic Rock

This type of rock has changed its form from what it was originally. It is formed below the Earth's surface by extreme pressure and heat

- the parent rock will become another type of rock depending on how much pressure and heat is used to change it. (example: shale → slate → schist)

Identifying Classes of Rock

Scientists classify rocks into categories which have shared characteristics.

Geology Tools and Techniques

Remote Sensing – satellite mapping of the Earth's surface

Geophysical prospecting – sensitive instruments like the magnetometer detect minerals hidden deep beneath the surface of the Earth.

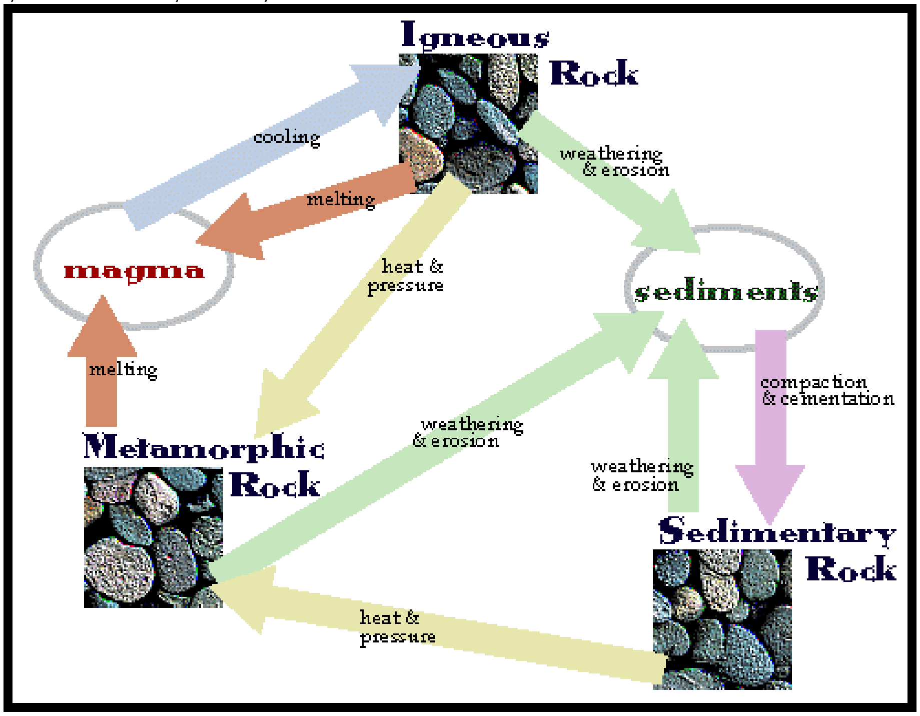
Geochemical prospecting – chemical analysis of core samples

Exploration – drilling with diamond-tipped drill bits

2.3 The Rock Cycle

http://www.cotf.edu/ete/modules/msese/earthsysflr/rock.html

Rocks are constantly changing. The Rock Cycle does not have a set order as they are weathered, consolidated, buried, melted and solidified.



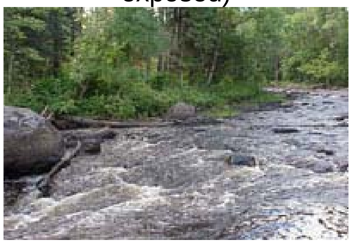
Investigating The Rock Cycle

Soil formation is determined by climate, type of rock present, amount of water, organic material, air spaces, living organisms in the soil. It takes nearly 1000 years for 5mm of soil to form.

The Alberta Story: Investigating The Changing Earth

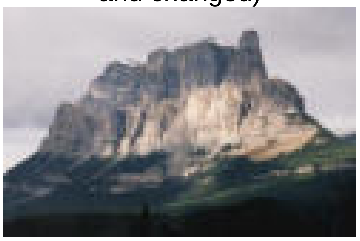
The rocks that make up Alberta were laid down in layers over hundreds of millions of years ago. The oldest layer, the **Precambrian Shield**, is at the bottom. This layer is made up of igneous and metamorphic rocks that were formed between 544 and 4500 million years ago. This layer of rock covers all of Alberta, but is only exposed in the upper northeastern part of the province. 87% of the Alberta landscape lies over the **Interior Plain**, which is sandwiched between the **Canadian Shield** and the **Rocky Mountains**. The Interior Plain has various layers of sedimentary rock that are between 544 million and 1.5 million years old.

Pelican Rapids
(where metamorphic rock is exposed)



Dinosaur Provincial Park
(where you can see sedimentary rock layers)

Rocky Mountains
(rocks that have been formed and changed)



3.0 Landforms provide evidence of change

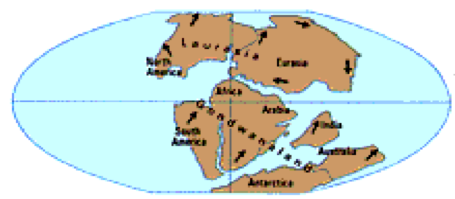
3.1 Continental Drift

Continents On The Move

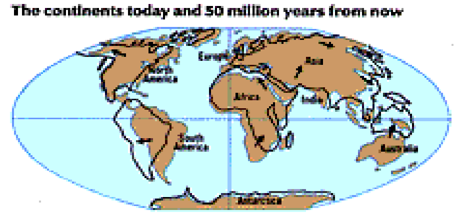
Alfred Wegener collected evidence to explain the various shapes of the continents and how they were all together at one time. Along with the fossils, climate similarities, and the interlocking shapes of the continents, Wegener concluded that the continents were joined together as one supercontinent – **PANGAEA**. His explanation is called the **Theory of Continental Drift.**

Pangaea: The supercontinent 200 million years ago

The land masses after 65 million years of drift



The continents today and 50 million years from now



Biological Evidence

- fossil evidence was found on different continents, like Mesosaurus, Kannemeyerid, Lystrosaurus and Glossopteris.

Evidence from Rocks

Mountain ranges were also compared:

- the Appalacian in North America and the range in Britain and Norway were made of the same kind and age of rock

- Trilobites in the Himalayas suggested that India was once part of Antarctica, which broke off and collided with Eurasia, putting the fossils of trilobites, from the bottom of the sea, high into the Himalayans.

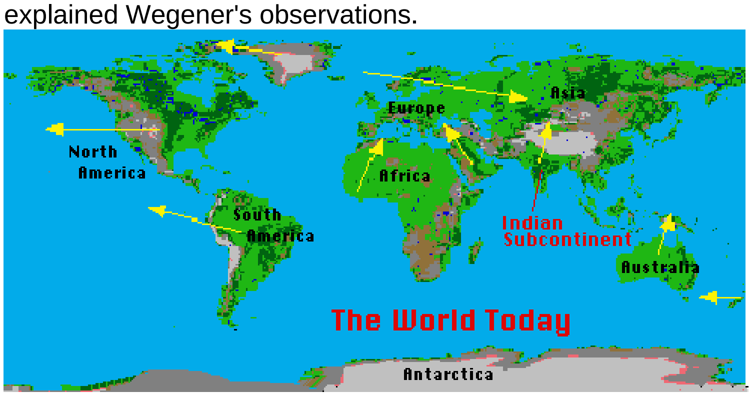
Geological Evidence of Climate

- coal provided more evidence, because in order for it to form, a rich tropical plant environment must have been present - coal is found in moderate to cold climates

- evidence of even greater climatic changes were found in places likely covered by glaciers (these places are now far too warm to support the presence of glaciers), this suggested that the continents may have once been part of the south pole.

Response to Wegener

After his findings were published, in a book called **The Origin of the Continents and Oceans**, Wegener's ideas were rejected. The scientific community did not agree with his assumptions and explanation that the moon might be responsible for the movement of the continents. After his death, advances in new technology and the work of a Canadian Scientist led to a new theory that explained Wegener's observations.



3.2 Plate Tectonics

Developing A New Theory

A unifying theory is one which explains several different natural events and landforms (volcanoes, earthquakes and mountains). Advances in New Technology helped explain Wegener's observations;

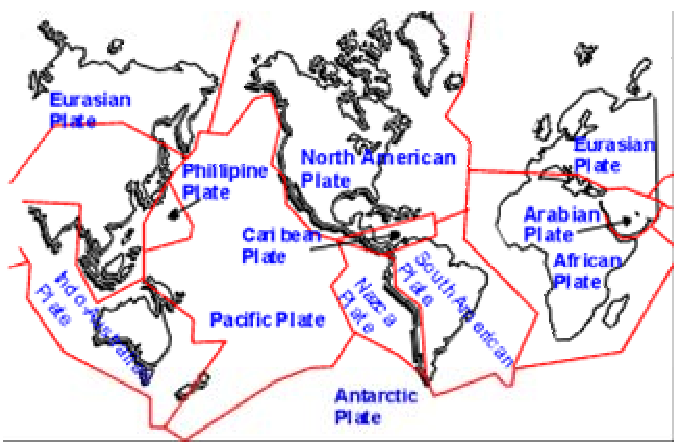
- *sonar* (sound wave technology) identified the **Mid-Atlantic Ridge.**
- Igneous rock contains **magnetite**, which lines itself with the Earth's magnetic field, as the rock hardens on the surface, the mineral particles maintain their alignment with the magnetic field, indicating that the reversal strips must have formed at a different time. M*agnetometers* (electronic instruments that detect the direction and strength of a magnetic field) the magnetic field in the Atlantic sometimes pointed south, instead of north (these were called reversal strips).
- *Submersibles* are small submarines that enable divers to go deeper, protecting them from the pressure of the water
- *satellites and lasers* are used to measure incremental change (change that happens slowly) in plate movements

Interpreting the Patterns

The pattern of magnetic reversal strips along the **Mid-Atlantic Ridge** meant the sea floor was spreading, leading to the **Theory of Sea Floor Spreading**. (as new rock forms, it takes on the magnetic polarity of the Earth at the time of formation). The ocean floor is moving deep into the trenches along the continental boundaries. Confirmation of the theory of sea floor spreading was provided by the ship, Glomar Challenger, which brought drill samples up from the ocean floor (younger rock was closer to the ridge and older rock was closer to the continents). Most earthquakes and volcanoes are concentrated in specific areas, and there are places where no earthquakes or volcanoes occur.

The Theory of Plate Tectonics

All the evidence collected indicates that the Earth's crust is broken up into plates, which are moving on the Earth's mantle. The new theory is called the **Theory of Plate Tectonics**. Plates pushing together are called *converging plates*, whereas plates pulling apart are called *diverging plates*.



J Tuzo Wilson (a Canadian Scientist) helped form this new theory, by suggesting the plates slide past each other. This type of movement is seen at a *transform boundary*.

To see Animations of Plate Tectonics – from the US Geological Survey, visit the link below, or type the address in your browser.

http://www2.nature.nps.gov/geology/usgsnps/animate/pltecan.html

Convection Currents

A convection current is the circular flow within a fluid that is caused by the rising of warmer particles and sinking of cooler particles. Scientists believe it is this action, within the mantle, which is causing the plates to move. The plates that collide, or converge have one plate above and the other below (these places are called *subduction zones*). Subduction zones occur where the convection currents, in the mantle, cool and sink.

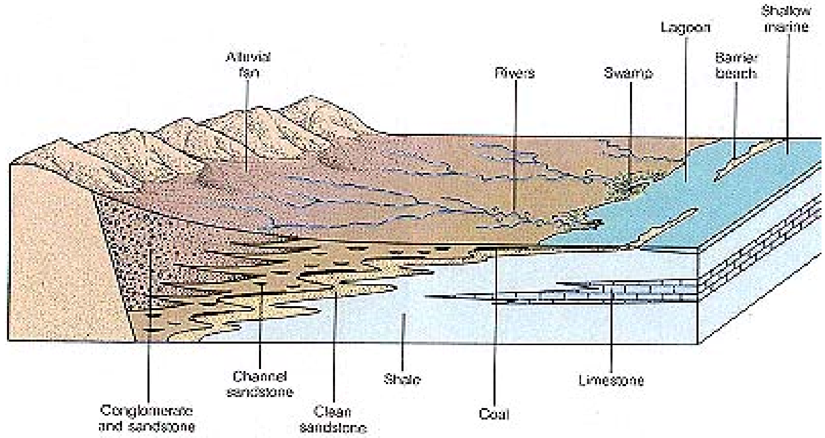
3.3 Mountain Building

What Is Mountain Building?

A mountain is part of the Earth's surface that is much higher than the land around it. A mountain range is a series of mountains (*Cordillera* is Spanish for mountain range).. The *Rocky Mountains* extend from the Yukon in the far North, between British Columbia and Alberta, through the western United States and into Mexico – making it one of the longest mountain ranges in the world. Mountain building takes many years. Most mountains are large areas that have uplifted due to the movement (converging, diverging or sliding) or heating of tectonic plates, where the build up of heat and pressure can cause folding and faulting.

Building The Mountains: An Alberta Story

%00 million years ago Alberta had a tropical climate, and it was bordered by a shallow sea (where British Columbia is now). The shallow sea was constantly being filled with sediments. The layers were 10-15kms thick.



After more than a billion years of sediment buildup the collision of two plates happened. The North American Plate and the Pacific Plate met. The Pacific Plate was forced down and the North American Plate rode above it. But the force and pressure of the collision cause the edge of the North American Plate to fold and break and some of the parts were pushed up and over each other, creating the Rocky Mountains. The Rocky Mountains are complex mountains.

The Structure and Development of Fold and Fault Mountains

Sedimentary rock under slow, gradual pressure can fold (bend like plastic because they are made soft by the heat) or break - and can be changed to metamorphic rock in the process. The upward, or top part of folded rock is called anticline, the bottom is called syncline. Rock that is too brittle to fold under heat and pressure, will break, called *thrust faulting*. When older rock ends up on top of younger rock as a result of thrust faulting, the result is the formation of fault block mountains. Movement of rock along a fault can be vertical or horizontal and can be traced by the location of the 'basement rock' on both sides of the fault.

Where Does The Folding Happen?

Heat and pressure soften and force rocks to fold and break. Mountains that are jagged at the top are 'young' mountains, while those that are more rounded (due to erosion and weathering) are 'old' mountains. The Himalayas are the youngest mountain range with the highest mountains (and still growing) mountains, such as Mount Everest. It rises about 1cm each year.

Mountains With Faults

Subduction of the Juan de Fuca plate (off the west coast of North America) has caused folding, faulting and uplifting, and magma has created volcanoes. The place wher the crack or break occurs is called the fault and is often below the surface of the Earth. Some faults are visible in layered rock that has been uplifted.

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

4.1 Tracing Evidence of Geological Change Using Fossils

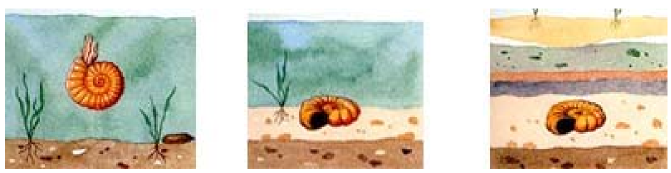
Fossils are preserved impressions in rock that tell us when, where, and how living organisms lived and behaved millions of years ago. The word fossil means '*dug out of the ground*'. The majority of fossils are found in exposed sedimentary rock. The most common types of fossil rocks are limestone, sandstone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





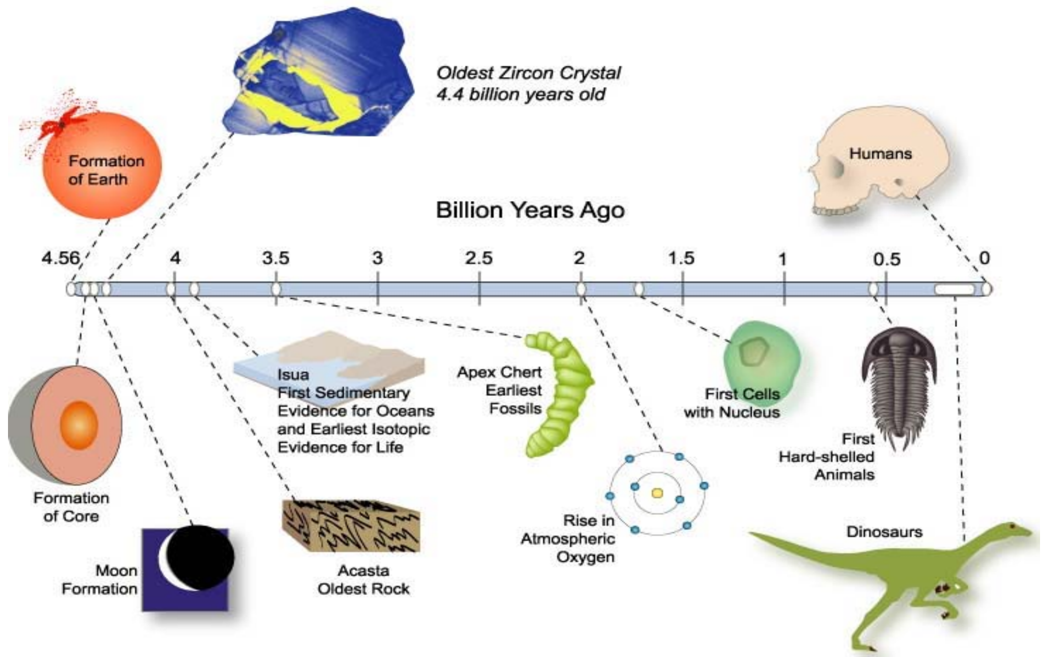
With dinosaurs outside, inside, and waiting to be discovered in the hills near Drumheller, Alberta, the Royal Tyrrell Museum of Paleontology is a world-renowned Mecca for lovers of big lizards

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.

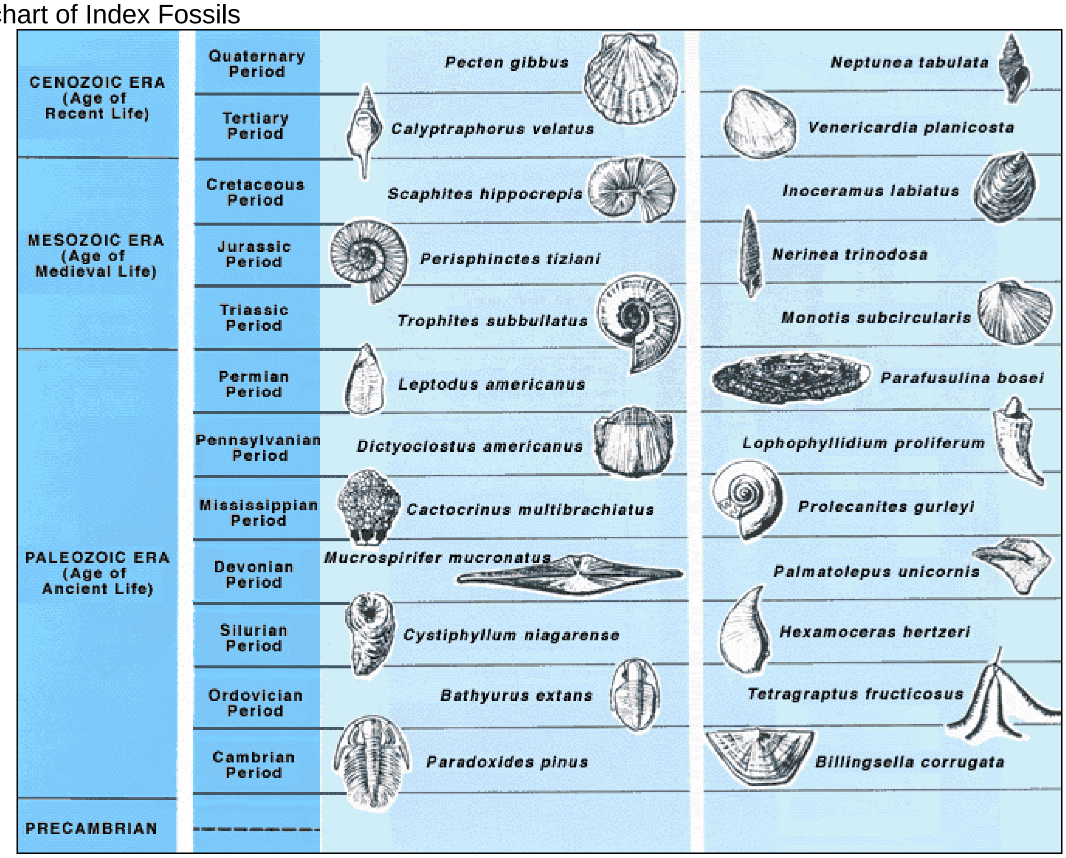
Find out more about the history of finding Dinosaur bones at:
http://www.arches.uga.edu/~rfreeman/GEOL3350_'4HistoryDinoSt.htm

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.

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			

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

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