Geoscape Ottawa-Gatineau

Grade 7 Lesson Plans to accompany the Geoscape Ottawa-Gatineau poster and website

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Theme Two: Deep Time: Ancient Rocks

List of Expectations		
Grade	Strand and Topic	Expectations
7	Science: Earth and Space Systems The Earth's Crust	• demonstrate an understanding of how changes in the earth's crust result from external processes • analyze, through observation, evidence of geological change (e.g., fossils, strata); • describe, using simulations or models, the origin and history of natural features of the local landscape • describe, using models, the processes involved in faulting of the earth's surface
7	Geography: Patterns in Physical Geography	• identify and describe world climate patterns; • demonstrate an understanding that climate patterns result from the interaction of several factors: latitude, altitude, global wind systems, air masses, proximity to large bodies of water, ocean currents

Overview

The Geoscape "Deep Time" theme involves lessons that will introduce students to the concept of geological time. The geological time scale will be presented, emphazing the magnitude of time and the classification of eon, era and system. The importance of fossil assemblages will be reviewed as the students are introduced to the nature of fossils and to the importance, for geological dating, of the evolution of lifeforms through time . Students will also learn about continental drift and how this relates to the development of the present day Ottawa-Gatineau Geoscape.

At the end of these lessons, students will be able to:

- explain the great length of geological time and the brief time of human existence
- identify the rock-building time periods preserved in the Ottawa area and explain why there are time gaps in the ages of Ottawa rocks.
- recognize that continents drift with time
- identify local fossils
- discover evidence of changing climate throughout our geological history.

Suggested Lessons	**Brief Description**
Students Take Notes	Deep Time: Ancient Rocks
Key Word Game	Word Match game
Lesson 1	What's the oldest thing you know? Study the Geological Time Scale and get an appreciation for the magnitude of geological time compared to the human lifespan. Review the geological age of the rock formations in the Ottawa-Gatineau Area.
Lesson 2	Roll up timeline Make a timeline of important geological events in the Ottawa-Gatineau area
Lesson 3	Drawing and Identifying Ottawa Fossils Draw four different fossils of the Ottawa area and identify other students' drawings.

Funding for this project came from Natural Resources Canada and the government of Ontario

Lesson 4	Inside the Earth
Lesson 5	As the Continents drift: This lab activity demonstrates how convention currents from the Earth's interior cause the drifting of the continents.
Lesson 6	Ottawa Valley Drops Notes from overhead and worksheet on the Ottawa-Gatineau Graben system
List of related web sites and resources	Maps of the continents in various geological periods as they are drifting. • Urban Geology of the National Capital Area http://gsc.nrcan.gc.ca/urbgeo/natcap/his_introduction_e.php • http://www.scotese.com/earth.htm Fossil websites: • Geological Survey of Canada – fossils http://gsc.nrcan.gc.ca/paleochron/index_e.php • http://www.palaeos.com/ • Kentucky Geological Survey http://www.uky.edu/KGS/fossils/ • Royal Ontario Museum http://www.rom.on.ca/ • http://www.virtualmuseum.ca/Exhibitions/TraceFossil/intro-eng.html

Students take notes:

Deep Time: Ancient Rocks

Earth was formed 4.6 billion years ago.

Scientists have divided this huge interval of time into parts called era and eon and they developed a "geological time scale".

During most of the Precambrian era (4.6 billion to 544 million years ago) not much is known other than

- Earth's crust developed
- Early life evolved

The rugged terrain of the Gatineau Hills and the West end of Ottawa (Carp and Kanata) is made up of very old Precambrian rocks. These hills were once as high as the Himalayas but have been eroded (worn down) through the years.

During part of the Paleozoic era (510 – 440 million years ago), the Ottawa-Gatineau area was near the equator and a warm tropical sea covered the region. We know this because the flat lying rocks of the Ottawa valley contain many fossils of tropical marine life.

The continents that make up part of the Earth's crust move continuously and so, through time, the Ottawa-Gatineau area moved northward and collided with other continents.

Long periods of time are not represented in the Ottawa rocks. These were periods were rocks were being eroded in this region.

In the Mesozoic era (175 million years ago), two major breaks, called fault zones, in the rocks created a rift valley called "Ottawa-Bonnechere Graben". This area is still active and earthquakes can occur anytime.

During the Quaternary (beginning 1.7 million years ago) huge ice sheets called "glaciers" covered Canada, including the Ottawa-Gatineau area. They eroded bedrock and deposited "loose" sediments.

The weight of the ice depressed the crust underneath. As the glaciers finally melted away, seawater flooded the region. This was the "Champlain Sea". This sea eventually retreated about 10 000 years ago.

Key word game: **Match the word with it's definition** **name:**

Deep Time:

1. Cenozoic ____
2. Cephalopods ____
3. Corals ____
4. Crinoids ____
5. Era ____
6. Fault ____
7. Fossils ____
8. Granite ____
9. Ice Age ____
10. Interlude ____
11. Magma ____
12. Marble ____
13. Mesozoic ____
14. Metamorphose ____
15. Paleozoic ____
16. Precambrian ____
17. Quartzite ____
18. Quaternary ____
19. Radiometric Age ____
20. Trilobites ____

a) 1.64 million years ago to present time.

b) a coarse-grained igneous rock made up of quartz, feldspar and often mica.

c) the earliest age in the history of the Earth which began 4.6 billion years ago and ended 570 million years ago.

d) a hot, mobile, "liquid" rock found beneath the earth's crust.

e) a metamorphic rock, composed of calcite and dolomite that has been recrystallized under high pressure and heat.

f) early (Paleozoic) fossil of an extinct marine animal with a body divided into three lobes.

g) The most recent era in geologic time. From 65 million years ago to the present.

h) the age of a fossil or rock in years, determined by radioactive decay of natural radioactive elements.

i) the remains or traces of a plant or animal that have been preserved by natural causes and hardened into rock.

j) fossil of marine invertebrate that has either a straight or spirally coiled shell divided into many internal chambers.

k) a long break (fracture) across layers of rock, along which there has been displacement of one side relative to the other; caused by the moving of the Earth's crust.

l) to change by process of metamorphism.

m) a hard metamorphic rock which is granular and primarily consists of quartz; metamorphosed from sandstone.

n) a definite period of time, represented by a distinct event, that is different from what happened before and after.

o) approximately 570 to 245 million years ago.

p) an era from about 245 to 65 million years ago.

q) a period in the Earth's history when much of its surface was covered by glaciers.

r) a major division of geological time (Paleozoic, Mesozoic and Cenozoic).

s) marine organisms the first appeared in the Cambrian period and is still in existence in present time.

t) Marine Invertebrates that form the calcified skeletons of organisms that live in salt waters along coasts.

Key word game solutions

<u>Deep Time</u>

1.	Cenozoic	**g**
2.	Cephalopods	**j**
3.	Corals	**t**
4.	Crinoids	**s**
5.	Era	**r**
6.	Fault	**k**
7.	Fossils	**i**
8.	Granite	**b**
9.	Ice Age	**q**
10.	Interlude	**n**
11.	Magma	**d**
12.	Marble	**e**
13.	Mesozoic	**p**
14.	Metamorphose	**l**
15.	Paleozoic	**o**
16.	Precambrian	**c**
17.	Quartzite	**m**
18.	Quaternary	**a**
19.	Radiometric Age	**h**
20.	Trilobites	**f**

2.1 Lesson 1: What's the oldest thing?

Brief Description
This lesson consists of a class discussion of geological time followed by two worksheets where students can label a geological time scale with the names of the eon, era and section as well as labelling a diagram of the ages of the rock formations in the Ottawa-Gatineau area.

Suggested Materials
Overheads (Attached)
Two worksheets

Duration 40 minutes

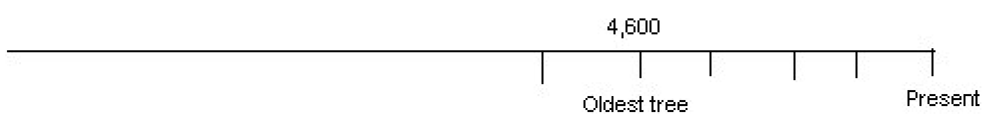
Preparation
As homework the day before the lesson, you may wish to have the students research the questions in Part One.

Lesson Instructions

Part One: Discussion

1. Start by asking the class the following questions and making a list on the board of the "ages" in years.
   - Who is the oldest student in the class?
   - Who is the oldest person in the school?
   - Who is the oldest person in your family?
   - How old was the oldest person that ever lived? (122 years: Jeanne-Louise Calment, who died in a nursing home in France in 1997.)
   - What is the oldest tree in the world? (4,600 years: the Methuselah tree) (http://yahooligans.yahoo.com/content/ask_earl/20030910.html)
   - What is the oldest manmade structure in the world? (500,000-year-old house in Japan) (http://www.trussel.com/prehist/news181.htm)

2. At this point, you can start a horizontal time line on the board. On one end of the line, indicate "present". Then indicate all the ages so far accumulated asking the students what increments should be used. Don't worry too much about scale at this point.



3. Continue to ask the following questions about ages.
   - How old is Ottawa?
     Political answers (http://www.capcan.ca/bins/index.asp)
     (http://www.occdsb.on.ca/~sel/cyberpal/timeline.htm)
     - Before 1600's Ottawa area inhabited by Algonquins
     - In 1759, the Ottawa area came under British rule with the end on New France.
     - In 1832, construction of the Rideau Canal. Ottawa was then called Bytown.
     - In 1855, Bytown was incorporated and became Ottawa.
     - The city was named Canada's Capital in 1857.

     Refer to timeline on the board and sketch in these dates.

   - How old are the rocks in the Ottawa area? (http://sts.gsc.nrcan.gc.ca/urban/his_introduction.asp)
     The rock formations in the Ottawa area were formed millions of years ago.

4. Refer to the timeline on the board and see how one million years ago can be shown. Most likely there will not be room on the board. This will give students an idea of the order of magnitude of geological time.

Part Two: Geological time scale and the Ottawa-Gatineau rock formations

1. Hand out Worksheet 1: Geological Time Scale.
2. Use Overhead 1: Geological Time Scale.
3. Have the students fill in the missing information using the overhead as a reference.
4. Hand out Worksheet 2: Age of Ottawa’s rock formations.
5. Use Overhead 2: Ottawa-Gatineau’s geological time scale. Explain the difference in the two columns emphasizing the “missing” time periods. Discuss why these would be missing. (Erosion - wearing away of rocks from many time periods. The sediments have been carried elsewhere and no records of these missing periods exist in the Ottawa-Gatineau area.)
6. Have students fill in the missing information on Worksheet no. 2 using the overhead as a reference.

Overhead 1: **Geological Time Scale**

Eon	Era	Age (in millions of years)	System	Characteristics
Present Day		**0**		
Phanerozoic	**Cenozoic** ***(Recent Life)***	**1.7**	**Quaternary: Holocene and Pleistocene**	**Advent of Humans The Ice Age**
		65	**Tertiary**	
	Mesozoic ***(Middle Life)***	**140**	**Cretaceous**	**The Age of the Great Reptiles (Dinosaurs)**
		208	**Jurassic**	
		250	**Triassic**	
	Paleozoic ***(Ancient Life)***	**290**	**Permian**	
		360	**Carboniferous**	**"The Coal Age"**
		410	**Devonian**	
		438	**Silurian**	
		510	**Ordovician**	
		544	**Cambrian**	
Precambrian (90% of all geologic time)		**2,500**	**Proterozoic**	
		4,500	**Archean**	**- Life arose on Earth about 3.5 billion years ago - the beginning of the earth, about 4.5 billion years ago**

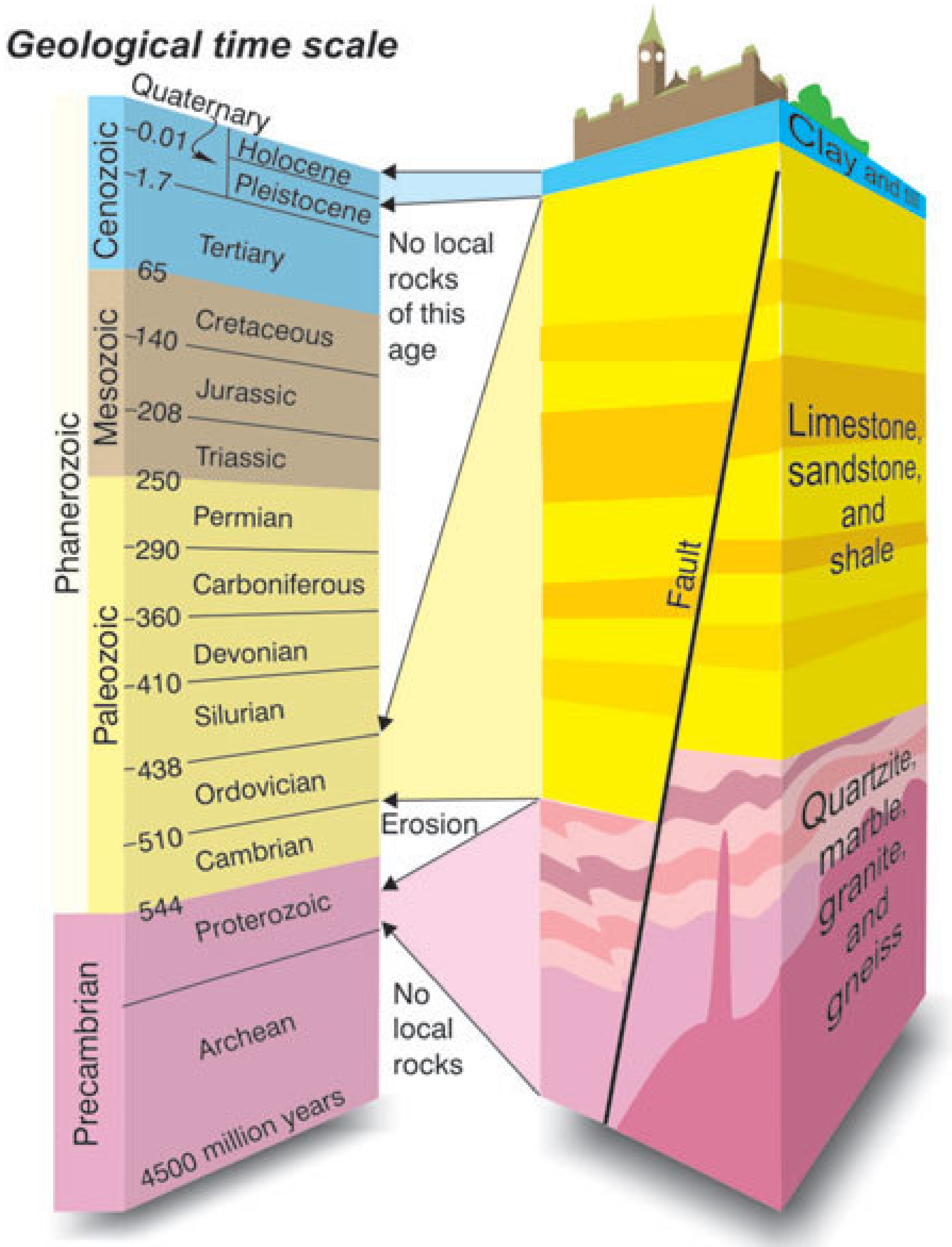
http://vulcan.wr.usgs.gov/Glossary/geo_time_scale.html
http://www.es-designs.com/geol105/timescale/

Worksheet 1: **Geological Time Scale**

Using the information on the teacher's overhead, fill in the missing information

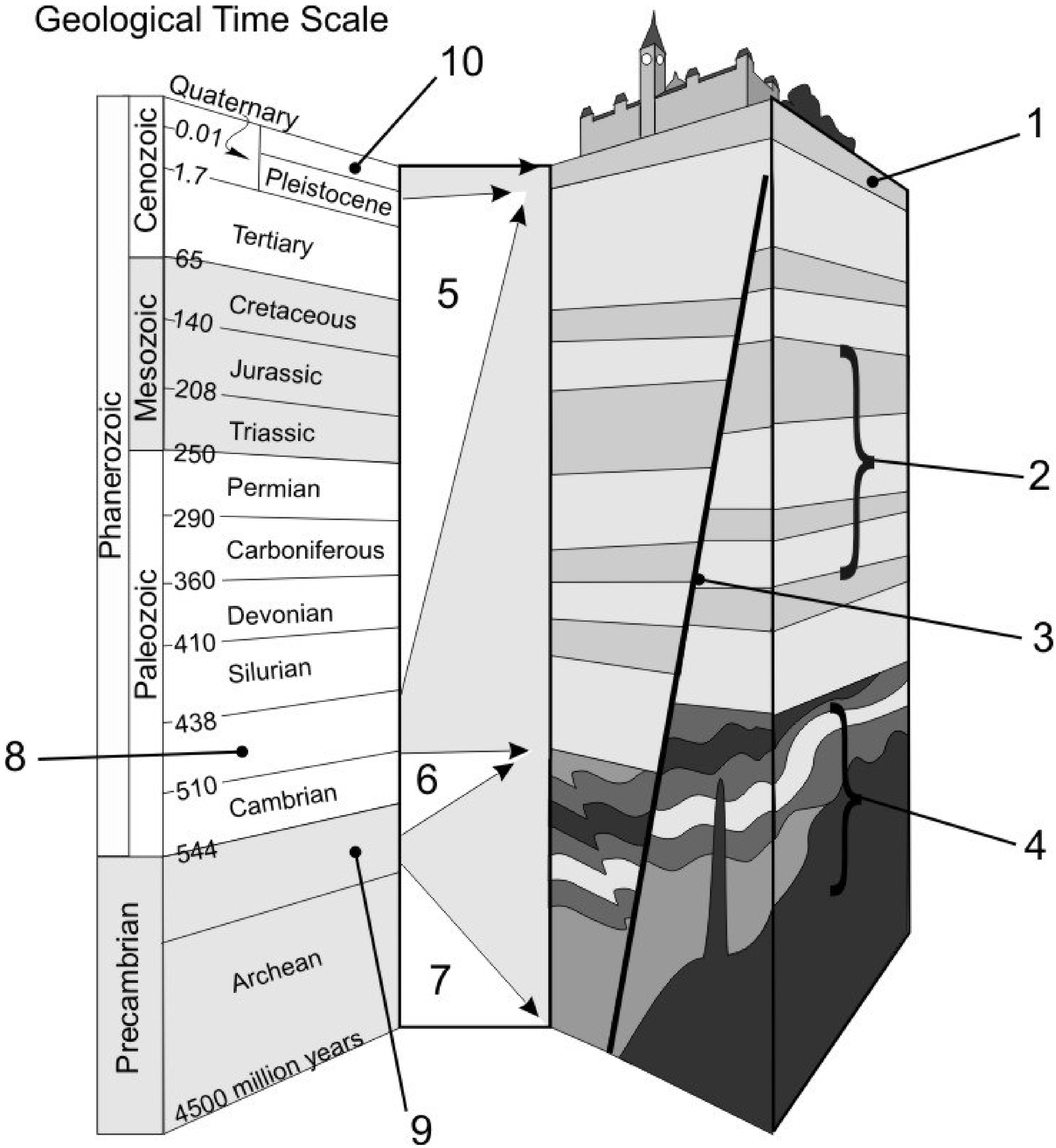
Eon	Era	Age (in millions of years)	System	Characteristics
Present Day		**0**		
Phanerozoic			**Quaternary: Holocene and Pleistocene**	**Advent of Humans The Ice Age**
		65	**Tertiary**	
		140		**The Age of the Great Reptiles (Dinosaurs)**
			Jurassic	
		250		
			Permian	
		360	**Carboniferous**	**"The Coal Age"**
		410		
		510	**Ordovician**	
		544	**Cambrian**	
Precambrian (90% of all geologic time)		**2,500**		
				- Life arose on Earth about 3.5 billion years ago - the beginning of the earth, about 4.5 billion years ago

Overhead 2: Ottawa-Gatineau's geological time scale



Worksheet 2: **Ottawa-Gatineau's geological time scale**

Using the information on the teacher's overhead, fill in the missing information



2.2 Lesson 2: Roll Up Timeline

Brief Description
It's very difficult for students to understand the enormous numbers we must use when we talk about the age of the Earth and geological age. This lesson consists of an activity where the students make a roll-up time line of the history of the Ottawa-Gatineau area. This allows them to construct a model to help visualize those millions of years required for the Ottawa-Gatineau rock formations to form.

Suggested Materials
- Overhead 2 from Lesson 1 of this theme
- Access to Internet or Geoscape Poster
- 5 sheets of construction paper (per student or group), each a different colour
- Scissors
- Glue stick or white craft glue
- Markers

Duration 40 minutes

Preparation
It is recommended that Lesson 1 of this theme be completed prior to this lesson.
Students may need to review the place value of large numbers, particularly the difference between thousand, million and billion.

Lesson Instructions

1. If Lesson One in this theme was not completed, use Overhead 2: Ottawa-Gatineau's geological time scale and explain the geological ages present in the Ottawa-Gatineau area.

2. Handout materials to students.

3. Have them follow the instructions on the Student Hand-out: Roll Up Time

   Sample list of times:
   1.6 billion years: granites and gneisses of Precambrian Shield
   1.2 billion years: Continental crunch begins
   1.0 billion years: Granite intrusions
   510 – 440 million years: warm tropical sea (area near equator)
   175 million years: Bonnechere fault zone formed
   20,000 years (0.02 million): Last ice age

Student Hand-out: Roll Up Timeline of Ottawa-Gatineau

Lab: Roll up timeline of Ottawa-Gatineau

Problem: How would you describe a timeline of the geological history of the Ottawa area?

Hypothesis:

Materials:

- 5 sheets of construction paper (per student or group), each a different colour
- scissors, glue stick or white craft glue, markers

Procedure

1. Fold each sheet of construction paper in half lengthwise.
2. Press on the fold to make a crease.
3. Cut each sheet along the crease and glue each sheet together end to end. This will form a double sheet of the same colour.
4. There should be five double sheets altogether, each sheet representing 1 billion years. (1,000 million years)
5. Glue all 5 sheets end to end to form a very long strip with 5 different colours.
6. Start marking from the left end of the strip. Halfway across the first colour (where the sheets have been glued together), write “4.5 billion years”.
7. Continue to mark on the strip, each of the following: 4.0, 3.5, 3.0, …., 1 billion years.
8. The final colour (to the right of the strip) represents 1 billion years ago. This colour can be divided into 100, 200, 300, …, 900 million years.
9. Indicate “Birth of Planet Earth” at about 4.6 billion years. (Slightly to the left of the 4.5 billion year mark)
10. Indicate “Oldest preserved rocks” at 3.9 billion years.
11. Indicate “Oldest fossil ever found” at 3.5 billion years.
12. Read the information on the “Deep Time” Web page: http://geoscape.nrcan.gc.ca/ottawa/time_e.php and make a list of geological periods important to the Ottawa-Gatineau area (in the observation chart below) and mark these on the strip in the appropriate places.
13. Label each time period and draw a small diagram.
14. After completing the concluding questions, you can roll up your timeline and hand it in.

Observations

List of important geological periods	
Geological Event	**How many years ago** ***(in billions or millions of years)***

Concluding Questions

1. How would you describe the Ottawa-Gatineau timeline you have made?
2. Are the geological events evenly distributed or are there many blank areas? Explain.
3. Between which times do we know the most? Why?
4. If you had to include events that have occurred in the Ottawa area in terms of human history (Bytown, Rideau Canal, etc.) what modifications would you have to make to your timeline?

2.3 Lesson 3: Drawing and Identifying Ottawa Fossils

Brief Description
The shales and limestones (sedimentary rocks) of the Ottawa area contain thousands of fossils. These fossils represent the lifeforms that once lived in the ancient seas that existed in this area. In this lesson students will learn about fossils that are commonly found in Ottawa and why they are important in helping to date the rock formations. Students will be able to draw fossils of the Ottawa-Gatineau area and identify them according to their classmates' drawings.

Suggested Materials
Blank white paper
Sharp pencils
Overheads: Fossils of the Ottawa area
Many small boxes with closing lids

Duration 2 x 40 minute periods

Background information
The Ottawa Limestone rocks are rich in marine fossils. Four important fossils that can be found are trilobites, cephalopods, crinoids and stromatolites. These fossils are essential tools for reconstructing what life was like many millions of years ago in the Ottawa area.

Lesson Instructions

Part one:
1. Have students copy the notes on the overhead and have them draw a picture of each fossil on separate sheets.
2. Have students write: "Fossil created by: " with their own names but not the name of the fossil they drew.
3. Have students hand in their four sheets.

Part two:
1. Shuffle the sheets and distribute randomly four sheets, face down, to each of the students.
2. Have students write: "Fossil identified by: " and the name of the fossil they think is drawn on the sheet.

Part three:
1. Have the students return the sheet to the student that drew the fossil.
2. Students get one mark each if fossil has been identified correctly.

Part four:
An additional fossil match worksheet is provided, if extra time is available.

Overhead 1: **Fossils of the Ottawa area**

Trilobites

Trilobites were marine creatures that moved just above the sea floor. Trilobite means 3 lobes and the creature is divided lengthwise into 3 lobes: a centre lobe and 2 side lobes.

Trilobites were hard-shelled creatures that used to shed their hard skin in order to grow. This covering is the most common part that we find in their fossils.

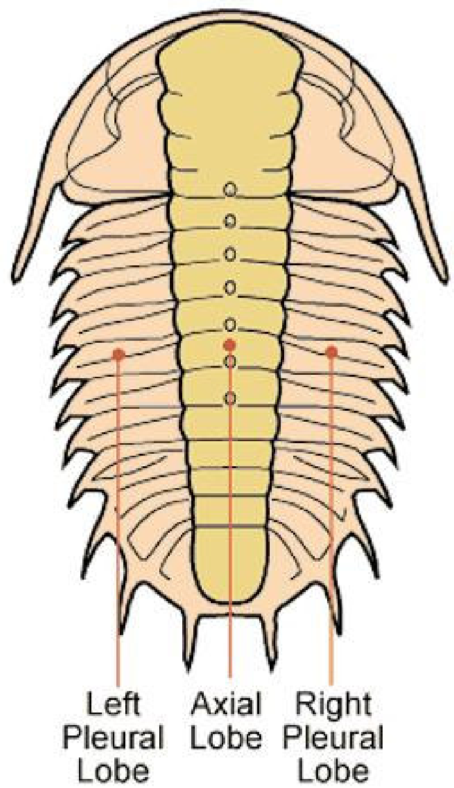
These are very important fossils because they are now extinct and they only lived in the Paleozoic Era (between 545 million and 250 million years ago).

When we find a trilobite fossil, we have a good idea how old the rock is.

Photo of Fossil

T. spinosus, Billings Fm., Ottawa, Ontario.
photo courtesy K. Brett
http://www.geocities.com/trilobitologist/Dec2001.html

sketch of fossil



http://www.trilobites.info

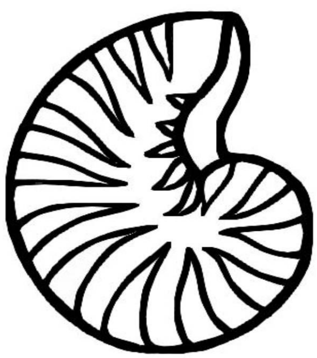
Overhead 2: **Fossils of the Ottawa area**

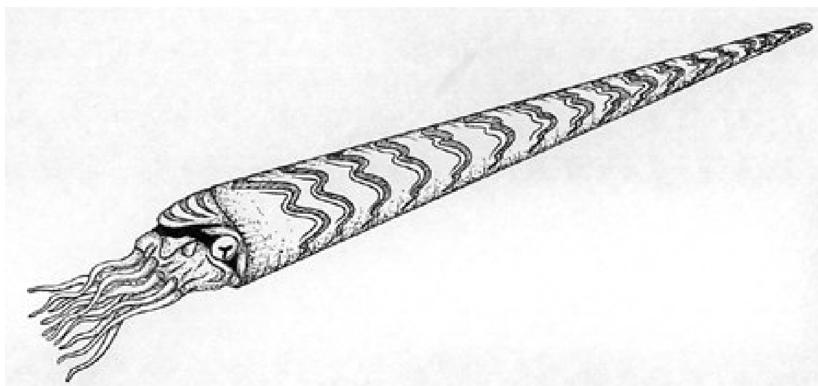
Cephalopods,

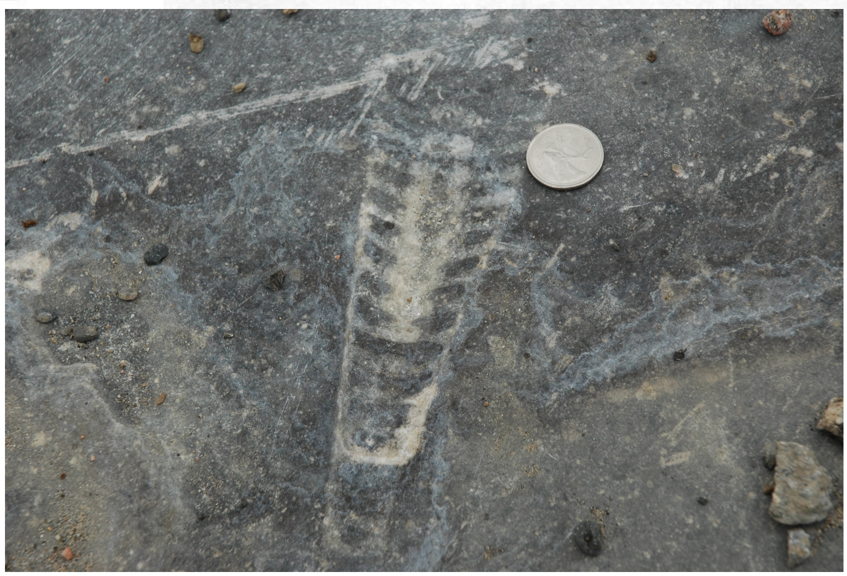
Cephalopods are ancient mollusks that were dominant large predators in the Tropical seas that existed in the Ottawa Area.

There were two main groups of fossil cephalopods: nautiloids and Ammonoids. Only nautiloids are found locally, and most have straight shells (orthocone). They lived in the Ottawa area from the Cambrian period through to the Ordovician.

Now there are two main groups of living cephalopods: The Nautilus group (the only shelled cephalopod) and the Coleoidea group (squid, cuttlefishes and octopus).







http://palaeo.gly.bris.ac.uk/palaeofiles/lagerstatten/soom/Fauna.html
http://www.manandmollusc.net/kid_zone/1nautilus_cp.html
http://www.manandmollusc.net/beginners_intro/cephalopoda.html

Funding for this project came from Natural Resources Canada and Ontario Ministry of Economic Development and Trade

Overhead 3: **Fossils of the Ottawa Area**

Stromatolites

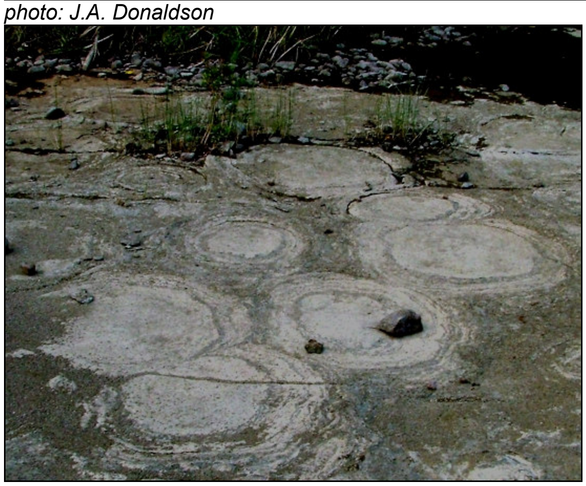
Stromatolites represent the most primitive life forms and are neither plants nor animals. They are formed by the action of algae that trap sediments and form layers that eventually harden.

These organisms thrived in the warm ancient seas of the Ottawa area about 450 million years ago.

There are many Stromatolite fossils in the Ottawa limestone rocks. Although most of the tops have been eroded, their relative position, alignment and grouping demonstrate growth pattern, as well the direction of the movement of tides and currents and depth of the Paleozoic sea.

Stromatolite fossils in Ottawa
Stromatolites living today
(Champlain Bridge)
in Australia

photo: J.A. Donaldson



Coalescing stromatolites **Concentric Circles**

Overhead 4: **Fossils of the Ottawa Area**

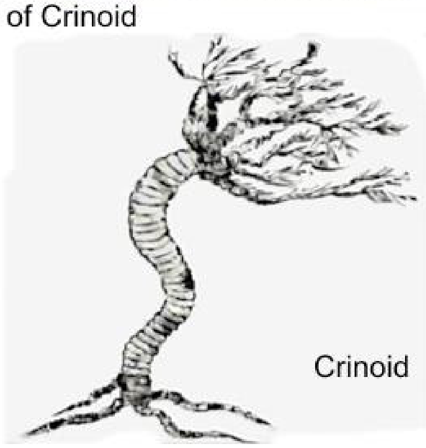
Crinoids

Crinoids are a group of marine organisms that include starfish and sea urchins. Most forms consist of stalks composed of a series of stacked columns with a head-like structure and feathered arms.

Crinoids lived attached to the seafloor by a holdfast, with its arms extended up into the water. Scales, called ossicles, cover the surface exposed to the water.

In many cases, the crinoid has broken off at the base of the stalk. The most common crinoid fossil will be a single, or few, scales clumped together. A whole crinoid is much rarer.

pieces of Crinoid



http://www.cartage.org.lb/en/themes/Sciences/Paleontology/Paleozoology/EarlyPaleozoic/EarlyPaleozoic.htm
http://www.geocities.com/earthhistory/ff.htm

Overhead 5: **Fossils of the Ottawa Area**

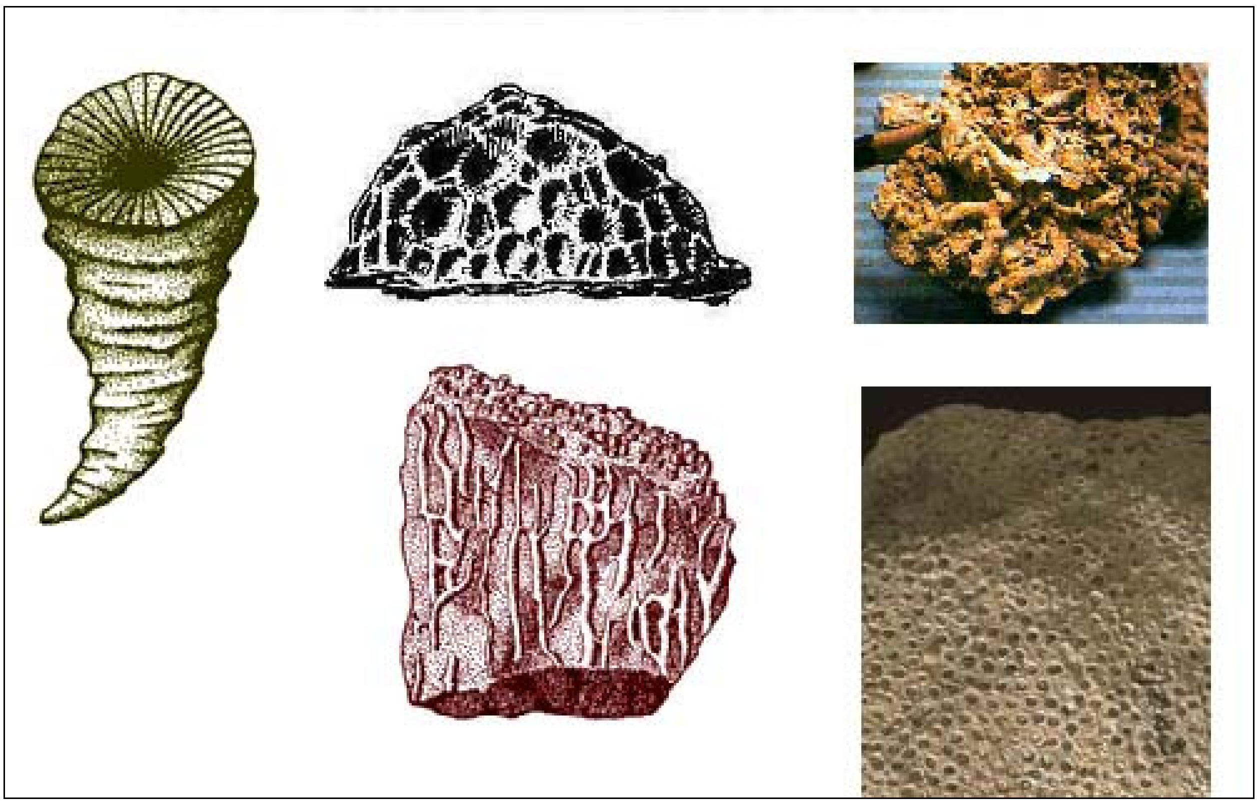
Corals

Corals are irregular colonial masses that contain radially symmetrical, cup-shaped, living platforms that are larger than 1 mm in diameter.

These aquatic organisms have hard limy skeletons and are considered “rock builders”.

Today, corals live in warm water with temperatures around 20^{o} C.

Many coral fossils are found in the Ottawa area, which suggest that the climate was very different compared to today.



http://www.uky.edu/KGS/fossils/

Student worksheet **Fossil Match Game**

Match the Ottawa Fossil with its possible modern day relative.

Trilobite	Nautilus
	Cuttlefish
Crinoid	Crab
	Star fish
Stromatolite	Modern reef building organism
	Sea urchin
Cephalopod	Squid
	Algae
Coral	Octopus
	Insect

2.4 Lesson 4: Inside the Earth

Brief Description
This lesson includes a worksheet that allows students to draw the interior layers of the Earth to scale.

Suggested Materials
Overhead: Earth's Interior
Student Worksheet
Calculator
Colouring pencils

Duration 40 minutes

Lesson Instructions

1. Overhead: Earth's Interior - Review with the students the structure and composition of the interior of the Earth and how this creates instability in the Earth's crust which cause mountain building, volcanic eruptions and earthquakes.

   Crust:
   - Also known as the lithosphere
   - Is solid but is broken into rigid pieces called tectonic plates
   - The mantle supports these plates
   - Plates move (about 1 – 2 cm / year) due to convection movement in the mantle below

   Mantle:
   - Not entirely in the liquid state
   - When temperature and pressure are great, the rocks flow and move like a liquid

   Core:
   - Consists of two regions: inner core (solid) and outer core (liquid)
   - Temperatures exceed 5000 degrees Celsius
   - Inner core is solid due to the extremely high pressure at the centre

2. Distribute worksheet and have students follow instructions.

Overhead: **Earth's Interior**

http://www.windows.ucar.edu/tour/link=/earth/Interior_Structure/earth_cutbk.html

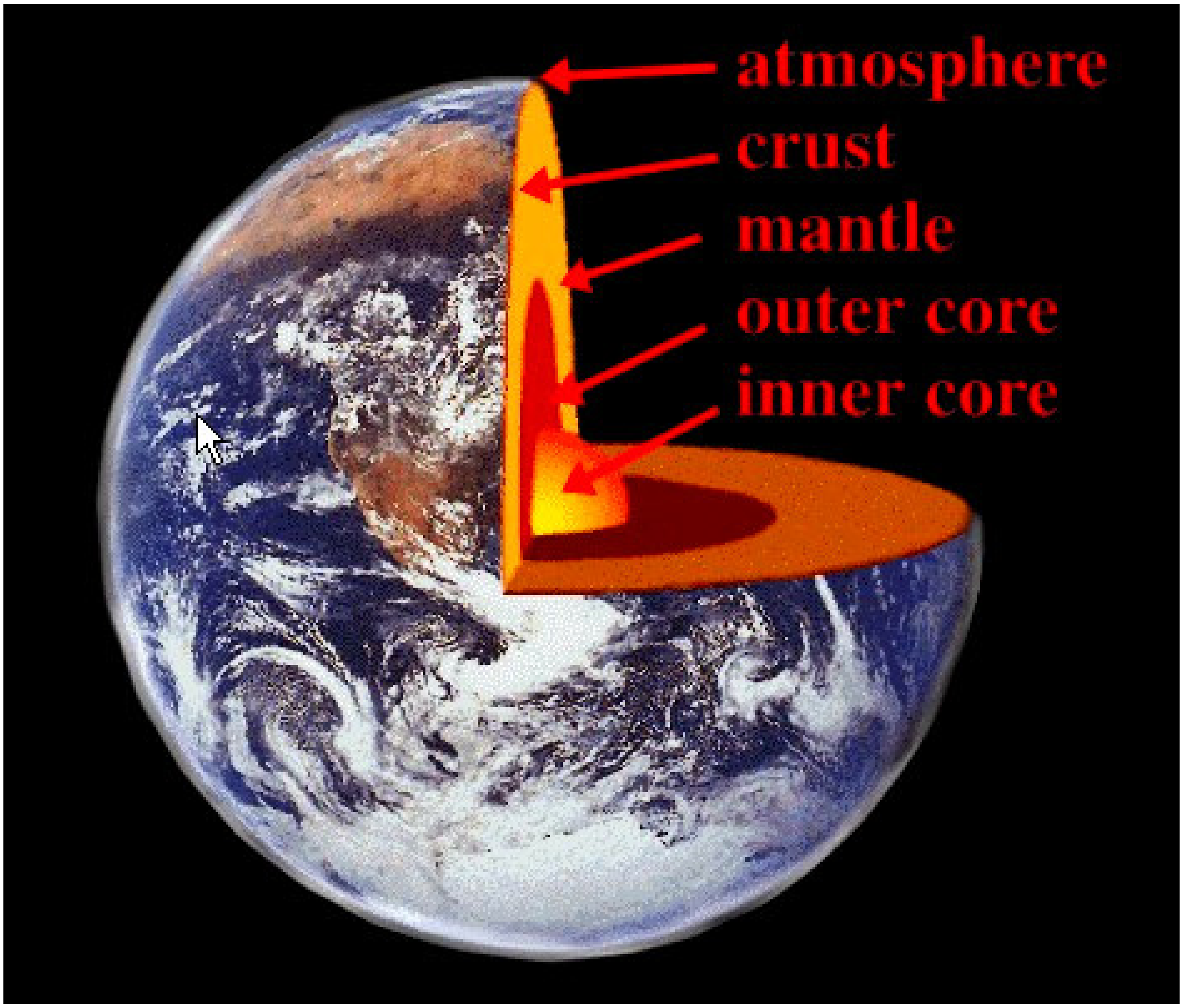


Image is courtesy of Windows to the Universe, http://www.windows.ucar.edu

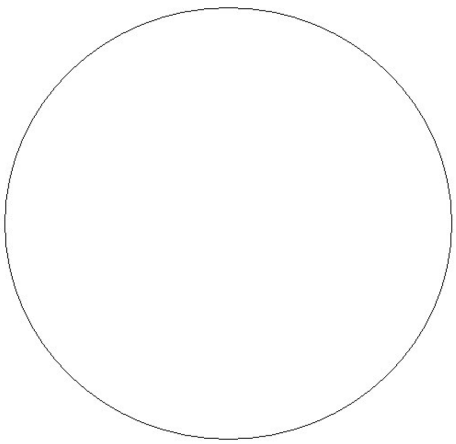
Student Worksheet:

Inside the Earth

Convert the measurements for the actual thickness of each section using a scale of 1cm = 1000km. (e.g. divide the thickness in km by 1000 to get the thickness in cm for diagram)

Section	Average Thickness (km)	Thickness on diagram (cm)
Inner Core	2,800 (total diameter)	
Outer core	2,000	
Mantle	2,800	
Crust	35	

Draw and label a diagram of the various layers of the Earth's interior.



1. Which layer is the thinnest?
2. Which layer is the thickest?
3. Which layer is the hottest?
4. Which layer is the coolest?
5. On which layer do we live?
6. Do you think that the Earth's crust (outer layer) is stable?
7. Not only is the Earth's crust very thin compared to the size of the Earth, but it is also cracked and broken up into interconnecting pieces called plates. These plates drift, or move around. Using the image of the Earth, how do you think they drift?

2.5 Lesson 5: As the Continents Drift

Brief Description
This lab activity demonstrates how convention currents from the Earth's interior cause the drifting of the continents.

Suggested Materials
Large beaker or heat resistant pot (1 litre)
Red food colouring
Electric hot plate
Scissors, colouring pencils, photocopy of continents
Four small pieces of masking tape or sticky paper

Duration 15 minutes

Lesson Instructions

1. Review the theory of continental drift with the students. (The Earth's crust is made up of plates that move (drift) as a result of forces caused by currents in the Earth's interior.)

2. Distribute materials and have students follow the procedure.

3. Ensure that precautions are taken and warnings are made to avoid burns.

Student Worksheet:

Lab: As the Continents Drift

Problem: How did the continents drift apart?

Hypothesis:

Material:
Large beaker or heat resistant pot (1 litre)
Red food colouring
Electric hot plate
Scissors, colouring pencils, photocopy of continents
Four small pieces of masking tape or sticky paper

Procedure
1. Colour and cut out the continents on the next page.
2. Draw a star at the approximate location of Ottawa.
3. Place the continents on the desk in their actual position with respect to one another.
4. Move the continents towards each other so they so they touch like pieces of a jigsaw puzzle.
5. Label each piece of tape with a different geographic direction (N, S, W, E) and stick these on the rim of the beaker in the appropriate position.
6. Fill the beaker 3/4 full of cold water. Add a few drops of red food colouring but do not stir.
7. Place the continent pieces connected together as in step three so that they are floating on top of the water surface at the center of the beaker.
8. Gently place the beaker on the hot plate.
9. Turn on the hot plate and observe what happens to the food colouring and to the continents as the liquid is heated. CAUTION: POSSIBILITY OF BURNS. DO NOT TOUCH THE HOT PLATE OR THE BEAKER AS THEY ARE HEATING.

Observation Questions:

1. In this model of plate tectonics, what is represented by:
    a) the red liquid?

    b) the initial supercontinent when all continents were joined together?

    c) the heat coming from the hot plate?

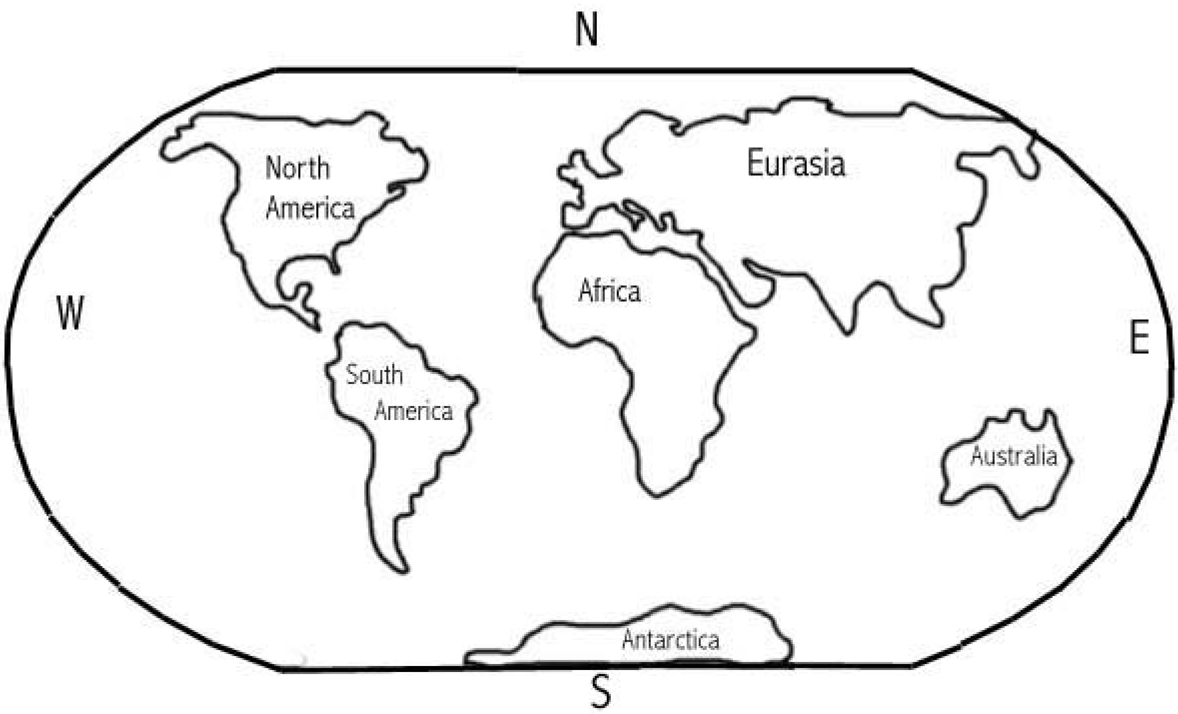
2. What happens to the food colouring in the water as it is being heated? Explain why?

3. Describe what happens to the continents as the water is being heated?

4. In terms of geographic directions, explain in what direction the star representing the Ottawa-Gatineau area has moved?

5. Your continents moved within seconds but in reality the continents move very slowly (about 1 cm per year). How long would it take for a continent to move:
    a) one metre?
    b) one kilometre?

Colour and cut out the continents.



2.6 Lesson 6: It's the graben's fault

Brief Description
This lesson consists of a quick presentation of notes on how grabens are formed. This is followed by a worksheet with a diagram of a graben system and questions pertaining to the movement along the faults and how they may cause earthquakes.

Suggested Materials
Overhead projector
Overhead: "Ottawa-Gatineau's Graben", cross-section of Ottawa
Worksheet

Duration 30 minutes

Lesson Instructions
1. Have students copy notes from overhead "Ottawa-Gatineau's Graben".
2. Show the students the accompanying cross-section of the many faults under Ottawa-Gatineau (*from Urban Geology project*)
3. Distribute worksheet and have students complete the work.

Overhead

Ottawa-Gatineau's Graben

The crust and the upper mantle are divided into many sections called plates.

These plates move very slowly (approx. as fast as your nails grow)

The plates move much like huge chunks of ice floating on water:
in many directions, pushing up against each other and colliding with one another.

The rocks that make up the plates can be cracked, forming faults.

Faulting is the movement of rocks along a fault. This movement causes displacements that may be vertical (up and down) or horizontal (side to side).

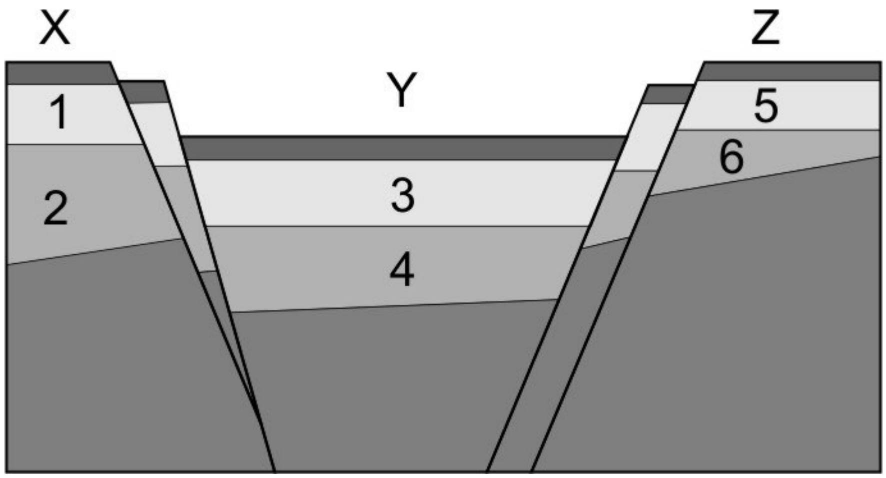
A graben is formed by the vertical displacement of a block between 2 others.

The Ottawa-Bonnechere Graben is the result of movement 175,000,000 years ago along a fault system. It continues to slip occasionally, causing earthquakes. The Ottawa River is within the graben.

Student Worksheet:

<u>The Ottawa Valley Drops</u>

Study the diagram of the layers carefully, then answer the questions



Which parts of block y were once parts of blocks X and Y.

layer 3 in block Y was once part of layer ____ of block X and part of layer ____ of block Z.

layer 4 in block Y was once part of layer ____ of block X and part of layer ____ of block Z.

1. In what direction has block Y moved relative to blocks X and Y?
2. How many faults are there in this graben system?
3. What type of faulting does this represent? (up and down or side to side)
4. Which rock type is the youngest, 1 or 2?
5. Which rock type is the oldest, 3 or 4?
6. The faulting above took place in the past. In your opinion, what do you think will happen in the future to this system?
7. Look at the N-S cross-section across Ottawa. How many faults are there?