



Geoscape Ottawa-Gatineau

Grade 7 Lesson Plans to accompany the Geoscape Ottawa-Gatineau poster and website
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Theme Ten: Earthquakes

List of Expectations		
Grade	Strand and Topic	Expectations
7	Science: Earth and Space Systems The Earth's Crust	<ul style="list-style-type: none"> describe how humans are affected by natural events and how technology has helped humans adapt to these events explain the causes of some natural events that occur on or near the earth's surface and their effects.

Overview

The Geoscape "Earthquakes" theme consists of lessons which will enable students to understand the risk of earthquakes in the Ottawa-Gatineau area.

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

- understand how earthquakes are measured
- understand how to interpret a seismogram
- explain why Ottawa has earthquakes
- appreciate the risks of earthquakes in the Ottawa area and the precautions taken by governments to protect people

Suggested Lessons	Brief Description
Students Take Notes	Earthquakes: In Ottawa!
Key Word Game	Word Match Game
Lesson 1	Earthquakes and the Cities of Ottawa and Gatineau
List of related web sites and resources	<p>Geological Survey of Canada earthquake website (general information, frequently asked questions, maps of earthquakes in eastern Canada, recent and historic earthquakes, data) http://earthquakescanada.nrcan.gc.ca/index_e.php</p> <p>Links to lesson plans related to earthquakes and seismology: http://www.iris.washington.edu/edu/lessons.htm</p> <p>Excellent list of experiments and demonstrations: http://web.ics.purdue.edu/~braile/educindex/educindex.htm</p>

Students take notes:

Earthquakes: In Ottawa!

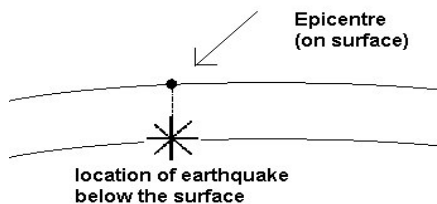
Why Do We Have Earthquakes?

Devastating earthquakes are unlikely, but there is some risk.

Earthquakes occur in the Ottawa-Gatineau region because:

- tectonic plates underlying this area are being compressed
- accumulated energy is released
- faults in the Ottawa-Bonnechere graben or Laurentian Highlands slip
- causes shaking of the ground: an earthquake!

What We Feel



The epicentre is the position on the surface of the Earth directly above the location of the earthquake.

The amount of ground shaking decreases as you move away from epicentre.

Earthquakes can be measured two ways:

	Intensity	Magnitude
What is measured	What we feel. - The amount of shaking felt at a specific location. (Each place feels the shaking differently.)	The amount of fault movement at the source (epicentre)
Which scale	Modified Mercalli scale	Richter scale
Range of Measurements	I – XII	From 1 (recorded but not felt) to 8 or even greater (seriously damaging)

*Each earthquake has only one magnitude but can have many intensities.

Earthquake Example: January 1,2000; Epicentre north of North Bay (300 km away).
Magnitude= 5.2 Intensity in Ottawa= III

Protecting Ourselves

- The National Building Code specifies the building standards required for earthquake-resistant buildings.
- Maps based on geological and seismological information can help predict ground motion.

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

name:

Earthquakes

1. Accumulate _____
2. Active _____
3. Building Code _____
4. Compress _____
5. Fault _____
6. Graben _____
7. Intensity _____
8. Reactivate _____
9. Risk _____
10. Seismogram _____
11. Seismograph _____
12. Seismologist _____
13. Slippage _____
14. Stress _____
15. Tectonic Plates _____

- a) large, rigid segments that make up the Earth's crust
- b) a hazardous situation where physical danger or economic loss could result
- c) a long break across layers of rock caused by the moving of the Earth's crust
- d) to start motion or activity after a period of inactivity
- e) force which can cause deformation
- f) instrument that records the motions (seismic waves) of the Earth's crust
- g) movement between two layers of rocks
- h) one who studies the science of earthquakes
- i) a measure of how an earthquake effects humans or structure in a specific location
- j) The paper or digital record made by a seismograph
- k) a block of land that has been downthrown along faults relative to the rocks on either side.
- l) to press, squeeze or force things together or into a smaller space
- m) still functioning or moving
- n) A list of government requirements for construction of buildings in Canada
- o) gather together or increase in quantity

Key word game solution

Earthquakes

- | | |
|---------------------|----------|
| 1. Accumulated | o |
| 2. Active | m |
| 3. Building Code | n |
| 4. Compress | l |
| 5. Fault | c |
| 6. Graben | k |
| 7. Intensity | i |
| 8. Reactivate | d |
| 9. Risk | b |
| 10. Seismogram | j |
| 11. Seismograph | f |
| 12. Seismologist | h |
| 13. Slippage | g |
| 14. Stress | e |
| 15. Tectonic Plates | a |

10.1 Lesson 1: Earthquakes and the Cities of Ottawa and Gatineau

Brief Description

This lesson consists of on-line research on earthquakes, followed by questions pertaining to earthquake causes, prediction and preparedness. Students will learn to read a seismograph and calculate the epicentre of the 2006 Thurso earthquake that shook Ottawa.

Suggested Materials

Computer
Student Worksheets

Duration 40 minutes

Lesson Instructions

1. Students research earthquakes on the Natural Resources Canada website http://earthquakescanada.nrcan.gc.ca/index_e.php
2. Distribute the worksheets and the students answer the questions. Question 4 could be a classroom discussion. - *“Design a plan with a list of suggestions for the municipal governments of Ottawa-Gatineau to minimize damage to buildings and structures, as well as injuries.”*

Student Worksheet: **Earthquakes and the Cities of Ottawa and Gatineau**

Research earthquakes on the Natural Resources Canada website, then answer the questions:

http://earthquakescanada.nrcan.gc.ca/index_e.php

1. What is the most likely cause of Earthquakes in the Ottawa-Gatineau area?

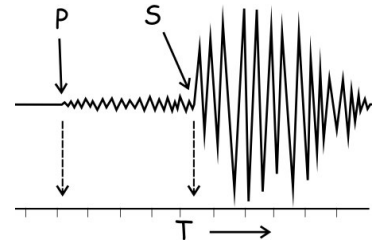
2. List the kinds of information needed to try to predict the possibility of an earthquake.

3. Find the epicentre of an earthquake. (see attached instruction sheets.)

4. Design a plan with a list of suggestions for the municipal governments of Ottawa-Gatineau to minimize damage to buildings and structures, as well as injuries.

Find the epicentre

When an earthquake occurs, seismic waves are generated. Direct compressional waves (**P-waves**) are faster moving and shear waves (**S-waves**) are slower. Each type appears as a unique signature on a **seismograph**.



At the recording station, the **difference in arrival time** of the direct P-waves and S-waves is used to calculate the **distance to the epicentre** of the earthquake. Using triangulation, the calculated distances from several different seismic recording stations can be plotted to locate the epicentre.

In eastern Canada, P-wave velocity = 6.2 km/s and S-wave velocity = 3.65 km/s
 Difference = 2.65 km/s

1. time taken by P-waves to travel a distance (D) from the epicentre to a seismic station : $T_P = D / 6.2$
2. time taken by S-waves to travel same distance from the epicentre to a seismic station : $T_S = D / 3.65$
3. difference in arrival time (lag time) between P- waves and S-waves is : $\Delta T = T_S - T_P$
 $= D/3.65 - D/6.2$
 $= 2.65 D / 22.63$
4. distance from the epicentre to the seismic station is: $D = 22.63 \Delta T / 2.65$

1. a. How long would it take P waves to travel 100 km? _____
 b. How long would it take S waves to travel 100 km? _____
 c. What is the lag time between the arrival of P waves and S waves over a distance of 100 km? _____
 d. If the difference in arrival time of P and S waves was 20 seconds, what is the distance between the epicentre and the seismograph location? _____
2. Four separate recording stations measured the time between the arrival of P-waves and S-waves. Identify the arrival of the P and S waves on the seismograms. Calculate the distance to the epicentre from each station.

Recording Station	Difference in arrival time	Distance
ALFO (Alfred)		
GAC (Glen Almond)		
OTT (Ottawa)		
TRQ (Tremblant)		

3. Calculate the epicentre: On a map of eastern Canada, inscribe a circle with a compass, such that the point of the compass is on the location of the recording station and the radius of the circle is equal to the calculated distance to the epicentre. Repeat for the other stations. The epicentre of the earthquake is located near the point at which the circles approximately intersect.

Where is the epicentre of this earthquake? _____
 What is the minimum number of stations that are necessary to find an epicentre? _____

4. The **magnitude** of this earthquake was 4.5. Some felt reports are attached here. Using information from the web (http://earthquakescanada.nrcan.gc.ca/index_e.php), what would be the **intensity** of this earthquake in the Ottawa area?

Felt Reports

Town	Heard	Felt	Saw	Damage
Carp	Sounded like rumbling of heavy equipment driving through our lot, or like distant thunder. Heard rattling of dishes.	Felt the house shaking	Saw nothing move	No
Rockland	Outside, trees were cracking, I heard the ground growl. Inside, the dishes were rattling, especially the glass and crystal.	Child was not awoken, but the house definitively shook. The outside deck and the floor were shaking. I had trouble getting the door knob and walking straight.	Deck and house shaking. Birds which are normally sleeping at this time of the night, were quite agitated outside. They were flying out of the cedar bushes. My cats went down to the basement and hid for a while. Glasses were displaced in my buffet	No
Hammond	Sounded like earth moving machine starting from rear of property towards the front.	Entire house shook. Lasted 15 seconds. Felt like there were heaving ocean waves under the floor the entire time.		No
Navan	At first we heard a low rumble that felt like it was coming towards us. Then we felt the whole house shake and there was a loud explosion-like sound	the whole house shook	Some pictures were a little crooked and items were knocked over on a bathroom shelf	No
Gatineau	Sounded like 2 large bangs. First one extremely loud followed by rumbling. Second bang also extremely loud followed by rumbling then easing into decreasing vibrations.	Whole house shook, everything was vibrating.	Lamps swayed and at one point the lights seemed on verge of going out as power was fluctuating.	No
Nepean	Sounded as if something had crashed into house or near it such as an airplane.	Entire house shook dramatically. it was very scary	Nail in the studs of our living room walls are now protruding from the wall. You can see all the heads of the nails just under the paint.	Yes, our living and dining room walls

