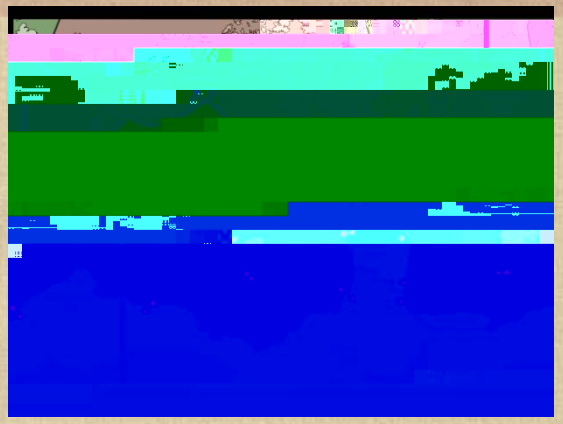
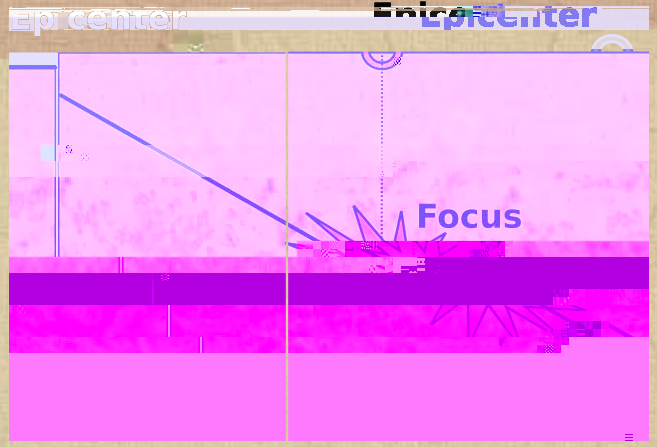
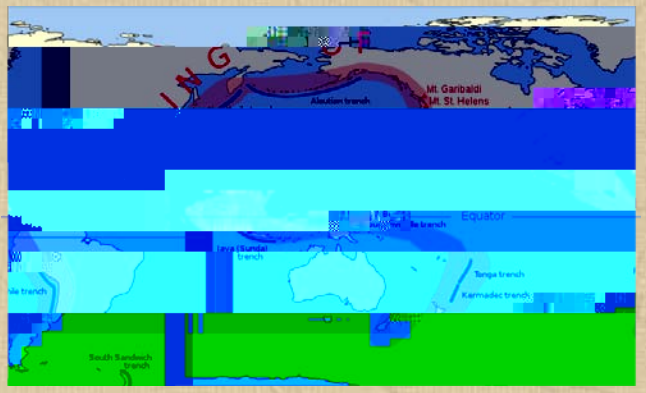




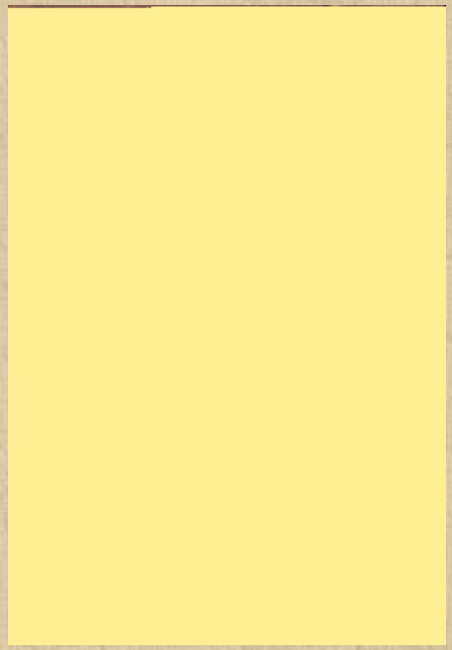
Earthquakes

Redpath Museum, McGill University



Earthquakes

- Parts of the Earth are always moving, usually so slowly that we do not feel anything.
- Most earthquakes happen when parts of the Earth move quickly: rocks break and slip along a fault (a crack in the Earth's surface).
- Aftershocks are the shocks that people feel for hours or even days after an earthquake.

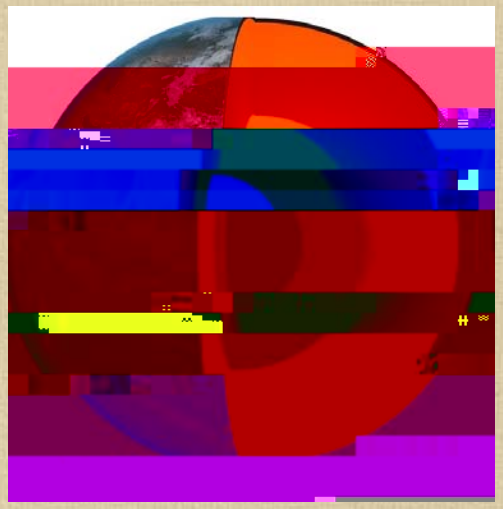


San Andreas Fault, California

www.wikipedia.org. Public domain.

How does the Earth move?

- The crust is the Earth's outermost layer.



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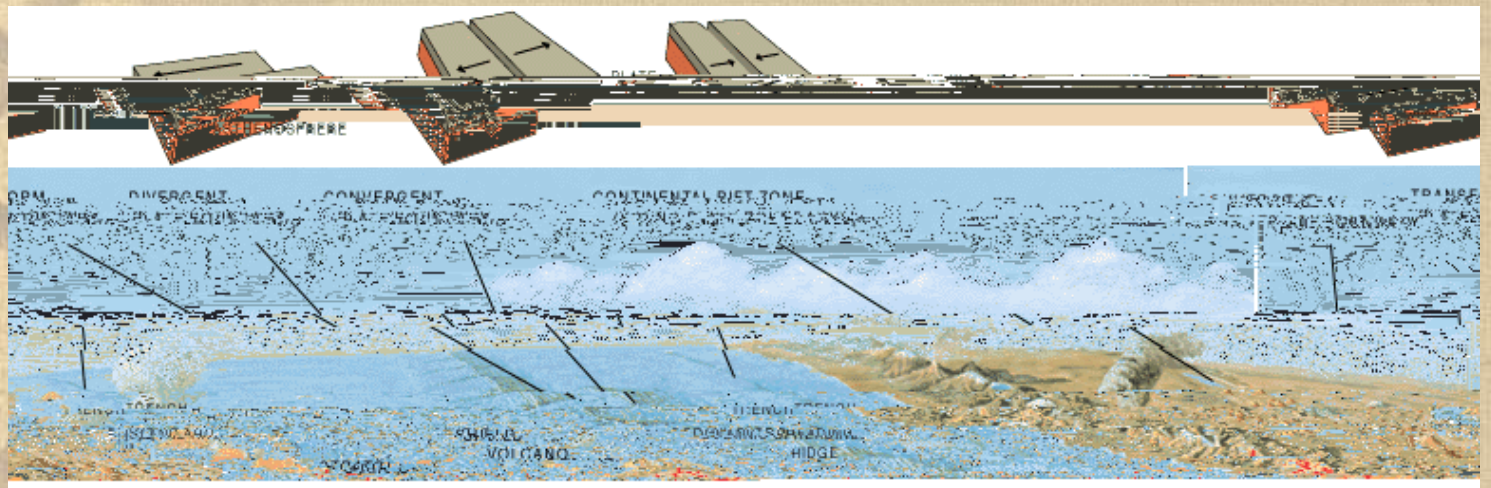
Tectonic plates (ii)

- The plates can separate, collide, or slide past one another.



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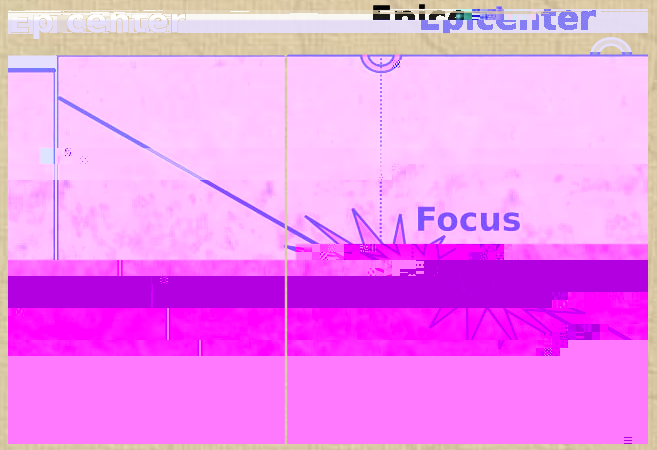
Tectonic plates (iii)

Hypocentre vs. epicentre (i)

- The focus, or hypocentre, of the

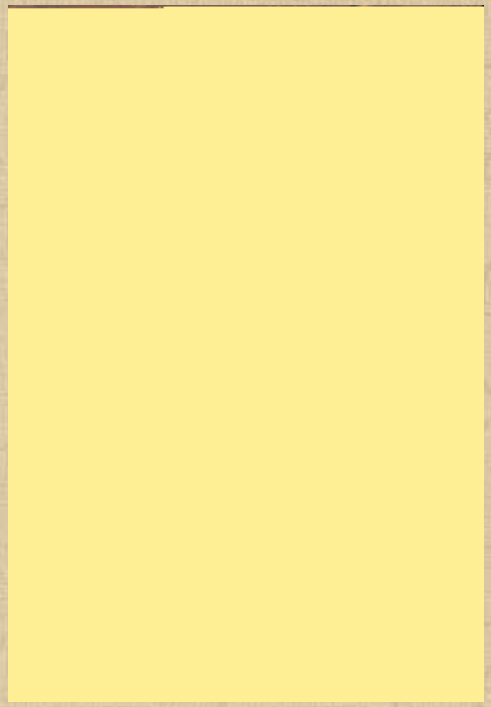


Hypocentre vs. epicentre (ii)

- Ground motions caused by seismic waves reaching the surface will depend on:
  - the depth of the focus
  - the type of rock found locally
  - the magnitude of the earthquake

Faults

- Faults, or breaks in the Earth's crust, form where rocks have broken from the forces created by the moving tectonic plates.
- Some faults are large enough that they split open the ground.
- Fault lines range in length from a few centimeters to hundreds of kilometers.



San Andreas Fault, California

www.wikipedia.org. Public domain.

Measuring an earthquake's magnitude (i)

- The magnitude is a measure of energy released by an earthquake.
- The magnitude scale first defined by scientist C.F. Richter has been replaced by the "Moment Magnitude Scale".
- Scientists determine the magnitude based on the measurement of the waves from earthquakes recorded by a seismograph.

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Measuring an earthquake's magnitude (ii)

- The largest earthquake ever recorded by seismographs occurred in southern Chile in May, 1960: its magnitude was Mw = 9.5.

- The second largest occurred near Anchorage, Alaska, in March, 1964: its magnitude was Mw = 9.2.

Measuring an earthquake's magnitude (iii)

- Each full step on the Moment Magnitude Scale (for example from Mw = 8 to Mw = 9) represents an increase by a factor of 32 in the "size" of the earthquake.

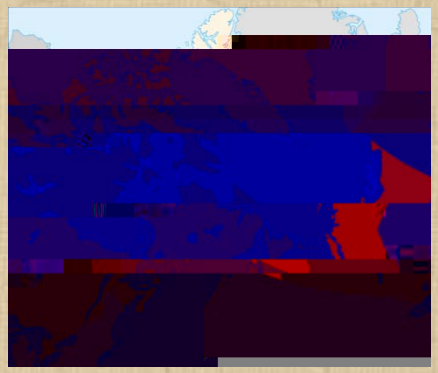
Earthquake monitoring

- Canada began recording earthquakes with instruments in the late 1890s.
- Today, the Geological Survey of Canada helps to operate approximately 220 stations equipped with seismographs.

Double-click or right-click on the image and open the hyperlink to view real- time seismograms from Collège Jean de Brébeuf.

Earthquakes in Canada (i)

- In Canada, most earthquakes are small. There are approximately 4000 earthquakes recorded here per year: only 50 are felt.
- From 1900-2000, only about 20 earthquakes caused significant damage in Canada.
- The Pacific Coast is the most earthquake-prone region, followed by Eastern Canada. Saskatchewan and Manitoba are the least earthquake-prone areas in the country.



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- The largest Canadian earthquake to date occurred off Vancouver Island on January 26, 1700. It was recorded in the oral traditions of Vancouver Island's First Nations, and the resulting tsunami was recorded by the Japanese when it reached their shores.
- This was one of the world's largest earthquakes in the world to date, with an estimated magnitude of 9.

Earthquakes in Canada: West Coast (i)

- The West coast of Canada is more prone to earthquakes because there are active faults there. Earthquakes occur in three major zones in southwestern British Columbia:
  1) in the North American Plate, relatively close to the surface
  2) deeper, in the Juan de Fuca Plate
  3) where the Juan de Fuca Plate is moving under the North American Plate) = the locked zone

Natural Resources Canada. Geofacts sheet "Earthquakes in Southwestern British Columbia". This reproduction is a copy of an official work published by the Government of Canada. This reproduction has not been produced in affiliation with, or with the endorsement of, the Government of Canada.

Earthquakes in Canada: West Coast (ii)

- The West Coast is part of the Pacific Ring of Fire, where approximately 90% of the world's earthquakes and 75% of the world's volcanoes occur.

- Eastern Canada is located in a stable continental area within the North American Plate: it is far from the plate boundaries that lie in the mid-Atlantic and on the Pacific coast.

Earthquakes in eastern Canada (ii)

- Then what causes earthquakes in Eastern Canada? Scientists do not yet have a complete explanation.
  - Stresses from pushing at the boundaries can build up within a plate: when that stress is relieved, an earthquake can occur.
  - Postglacial rebound can also cause earthquakes as the land that was depressed by glaciers slowly rises.

Postglacial rebound

- When a large mass such as an ice sheet covers part of the Earth, it causes that part of the crust underneath to depress, and the mantle to displace.
- When the glacier melts, the mantle slowly flows back to its original position: this pushes the crust back up to its original position as well.

Luis María Benítez. www.newworldencyclopedia.org. Public domain.

- Eastern Canada has relatively few earthquakes, however some large earthquakes have occurred here.
- Earthquakes in Eastern Canada are felt much further away from their source than

Earthquakes in the Montreal area (i)

- Montreal lies in the Western Quebec Seismic Zone, which includes the Ottawa Valley, the Laurentians and Eastern Ontario.
- Earthquakes in this zone are concentrated along the Ottawa River and the Montreal-Maniwaki axis.

Western Quebec Seismic Zone

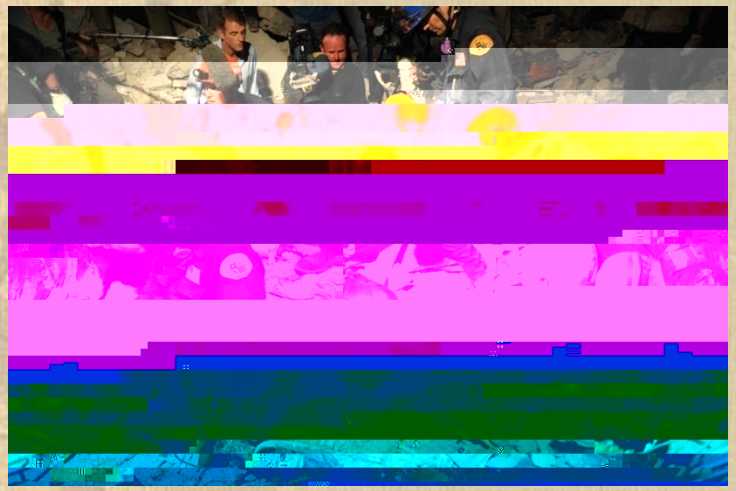
- On average, an earthquake occurs every 5 days in the Western Quebec Seismic Zone, some of which are felt by the population. Four large earthquakes of note include:
  - Montreal, QC in 1732: magnitude of 5.8
  - Temiscaming, QC in 1935: magnitude of 6.2
  -

Earthquakes in the Montreal area (iii)

- More recently – on June 23, 2010 – an earthquake with a magnitude of 5.0 hit south of Echo Lake, QC, 60 km north of Ottawa. It was felt across western Quebec, southeastern Ontario, Vermont, New Jersey, New York, Michigan, Ohio, and Pennsylvania.
- Buildings and roads suffered damages.

Earthquakes around the world (i)

- Recent large earthquakes in other countries include:
  - The January 12, 2010 earthquake in Haiti: magnitude 7.0; 3 million people affected; 230 000 people dead; 280 000 buildings destroyed.



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Earthquakes around the world (ii)

– The December 26, 2004 Indian Ocean earthquake off Sumatra: magnitude 9.1; devastating tsunami; 230 000 people dead; millions homeless.

www.wikipedia.org. Public domain.

Preparing for an earthquake (ii)

You can find out about earthquake risks in your 8(ea345D)2(nextBo3q2MCID 4 >>B2.467001Td [(o2(t)4(i)2(nextBo3q2>>BDC