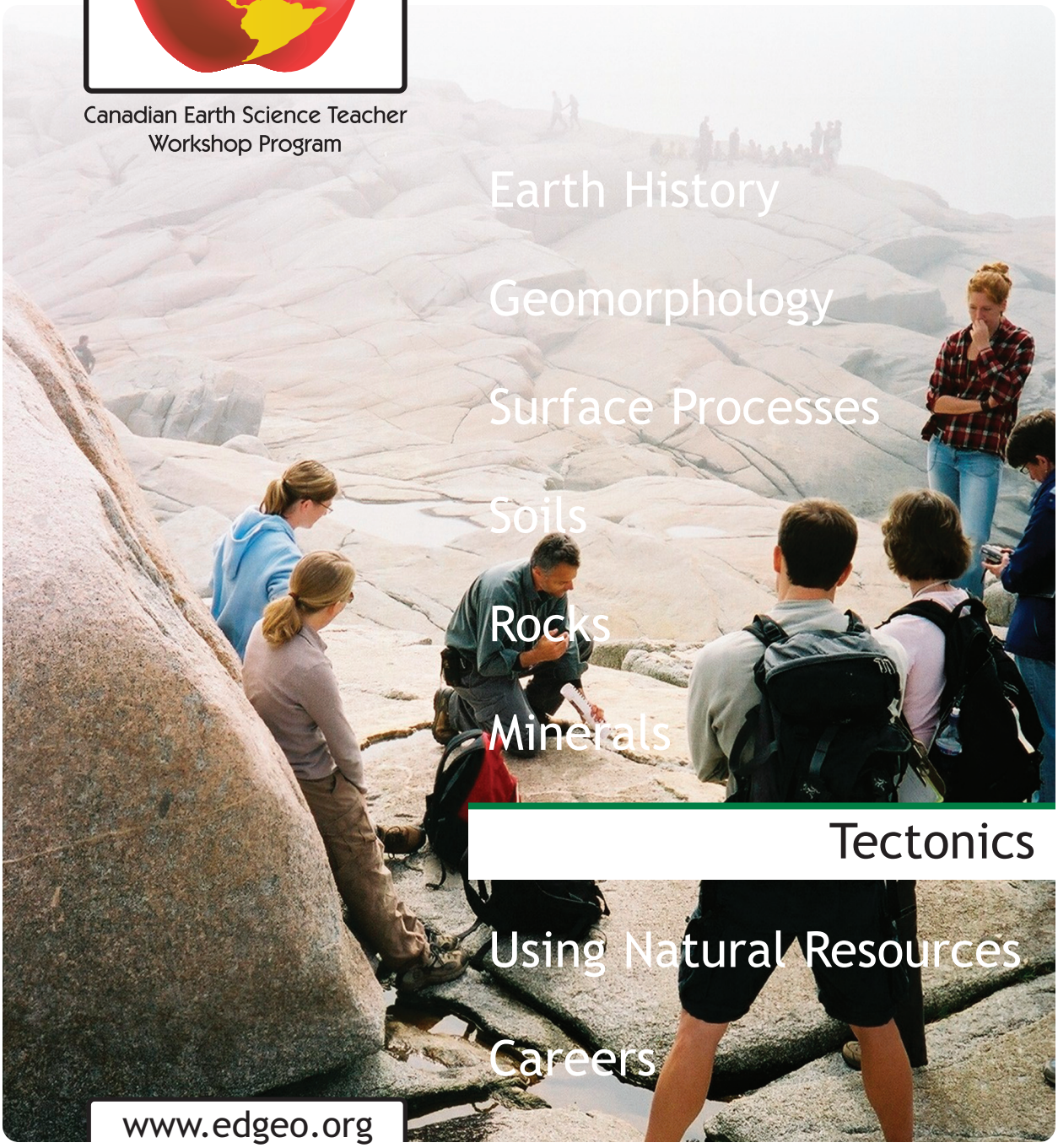
EdGEO

Canadian Earth Science Teacher Workshop Program

Bringing Earth Science to Life



Earth History

Geomorphology

Surface Processes

Soils

Rocks

Minerals

Tectonics

Using Natural Resources

Careers

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Mapping Surface Movement

Students map the distance and direction of surface movement at various locations around the Earth.

Explanation

Geological evidence shows that our present-day continents were once part of a single, giant land mass, which Earth scientists have named Pangea, and that there have been repeating cycles of continents splitting apart, moving together, joining and dividing again over the millennia. The continents that we know today have not always been the same, but are a result of these changes over time. The evidence can be found in fragments of one continent attached to another and by the existence of ancient, inactive plate boundaries within continents.

We now can precisely monitor surface movement using a network of satellites recording GPS (global positioning satellite) data transmitted to them from permanent GPS stations on the ground. The orbiting satellites create a fixed background, and we can tell how much and in what direction the ground stations move within this framework. This GPS data is primary evidence that helps us understand how the Earth's surface is moving. The data given for the activity is an average for each station over approximately the last 10 years.

It is important to know that plate motion is not in straight lines. It is most easily described as sweeping curves. As well, the directional arrows that the students will plot on the map are not constant over geological time. As a result of this activity students will observe that the surface of the Earth is moving as large sections and in opposing directions.

Materials

World Map (see Resources)
Student Activity Page
Coloured pencils
Protractor
Ruler
Atlas

Caution

None

Time

Medium

Grouping

Individual, pairs

Preparation

Reproduce Student Activity Page and maps on which they will plot the data.

Prompt

Show photographs or news stories of recent earthquakes. Ask students what they think is causing these earthquakes to happen.

Delivery

1. Distribute materials and describe the task. Show students how to measure a bearing from north using the protractor:
   a. Place the centre of the protractor on the city's location.
   b. Orient the zero line of the protractor to compass north on the map.
   c. Face the protractor left if the direction of motion is west of north, or right if it is east of north.
   d. Mark the correct angle from zero (north).
2. Allow students time to complete their maps and answer the questions on the student page.
3. As a whole group, discuss the patterns seen in the arrows on the maps. Depending on their prior knowledge, you may or may not refer to tectonic plates.

Questions for Discussion

What might be happening where the surface sections are moving together? Apart?

Where are the fixed points that we are comparing the surface motion to?

How reasonable is it to assume that the plates would move at the same speed throughout time?

Extensions

Download additional data from the NASA/JPL website in digital form and expand the map coverage: http://sideshow.jpl.nasa.gov/mbh/series.html

Compare the GPS motions to maps of the tectonic plates (see Tectonic Boundary Processes topic for related activities)

You are going to map the distance and direction of the movement of the Earth's surface at various locations around the world.

Materials

World map
Coloured pencils
Protractor
Ruler
Atlas

Instructions

1. Use the atlas to find the location of each city on the data chart.
2. Draw a small dot on your world map to mark each city.
3. Draw a line starting from the dot to show how that city moved in one year, using the data given in the chart. Use the protractor and ruler to make the line the correct length and angle.

Questions

1. What is the greatest distance moved by any of the cities in the last year?
2. Which compass direction (north, south, east or west) is the closest to the way each of the continents are moving?

Data

This chart provides GPS data from ground stations around the world showing the average distance moved by each station in 1 year and the direction it is moving. Note: the direction is given as degrees either east or west from north.

Location	Distance: mm per year	Direction: Degrees from N
Auckland, New Zealand	40	5 E
Bogotá, Columbia	13	2 E
Buenos Aires, Argentina	12	10 W
Canberra, Australia	58	18 E
Cape Town, South Africa	21	36 E
Denver, USA	17	103 W
Detroit, USA	17	87 W
Easter Island, Pacifica	67	93 W
Fairbanks, USA	23	159 W
Guam, Micronesia	11	77 W
Hawaii, USA	72	60 W
Lagos, Nigeria	13	34 W
Oslo, Norway	21	50 E
Pittsburgh, USA	16	81 W
Santiago, Chile	25	50 E
Seattle, USA	14	131 W
St Johns, Canada	19	51 W
Ulaanbaatar, Mongolia	25	100 E
Vladivostok, Russia	27	121 E
Yellowknife, Canada	21	125 W

Source: NASA and the Jet Propulsion Laboratory http://sideshow.jpl.nasa.gov/mbh/series.html

World Map