Activity 6 - Geomagnetism I: Polar Wander

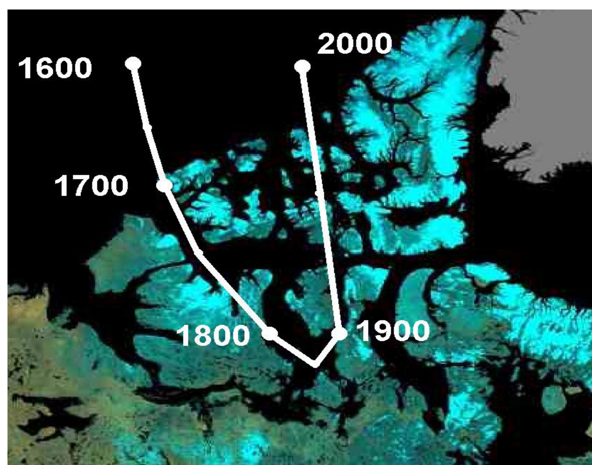
Teacher's Guide

In the previous exercise, students became aware of how a compass operates, and how it relies on the fact that it points in the same direction at all times (Magnetic Pole in the Northern Hemisphere) in order to calculate a "bearing." This exercise introduces students to the idea that our magnetic poles are not fixed in space and time. Since the 1700's, map-makers have known that the bearings for seaports and other fixed landmarks change in a varying manner from decade to decade, so that maps often have to be re-drawn to reflect the new bearings. Geologists call this phenomenon "polar wander." The graph below shows how the magnetic pole in the Northern Hemisphere has moved since 1600 AD.

An alternative, interactive map is provided at:
http://bbs.keyhole.com/ubb/showflat.php/Cat/0/Number/200028/an//page//vc/1
which allows students to measure the polar locations with higher resolution than from the graph provided here.

Goals

1) Students will know Earth's magnetic field is not fixed in space or time.
2) Students will recognize how the magnetic poles of Earth move in complex ways over time.
3) Students will solve equations which demonstrate that the speed of these changes is not constant.



A plot of the movement of Earth's magnetic pole in the Northern Hemisphere since 1600 AD (From http://geo.phys.uit.no/articl/roadto.html)

Materials

- String or wire

Procedure

Ask students to study this figure and answer some quantitative questions related to the distance and speed of the movement of Earth's magnetic pole in the Northern Hemisphere. To measure the distance (along the time track) that the magnetic pole has wandered, have students use a piece of string laid along the track, and then measure the length of the track in centimeters. The scale of their figure is about 163 km/cm, so multiplying the string length by this scale factor, they can compute the track length and answer the questions. Students will also need to compute the speed of the pole movement between the years indicated on the map, by dividing the relevant track interval they measured by the difference in the years.

Wire may be substituted for string to improve measurement accuracy to the nearest millimeter. Have students work in teams of three or four, each taking a turn at measuring the distances in centimeters. Have each team average their answers to each question before reporting a final value. The answers from each team may then be averaged together to obtain a class average. This also allows for a discussion of measurement significant digits. You could also calculate the standard deviation from the average to show the students how to determine a good measurement.

TEACHER ANSWER KEY

1) What is the total distance that the magnetic pole wandered from 1600 AD to 2000 AD? **Answer:** About 13.5 cm x 163 km = 2,200 km.

2) What is the average speed of the wander from 1600 AD to 2000 AD? **Answer:** Speed = 2,200 km/400 years = 5.5 km/year.

Inquiry Problem: The probability of seeing an aurora is highest in a circular belt centered on the Magnetic Pole, with a radius of 800 km. Explore how the viewing of aurora will change over the next 100 years, at the present rate of polar wander.
Answer: Students will notice that the Magnetic Pole will shift to Siberia, and that the auroral oval will no longer be over Canada by about 2050, making the current auroral sightings much less frequent in North America.

Student Name ______________________________ ***Date*** ________

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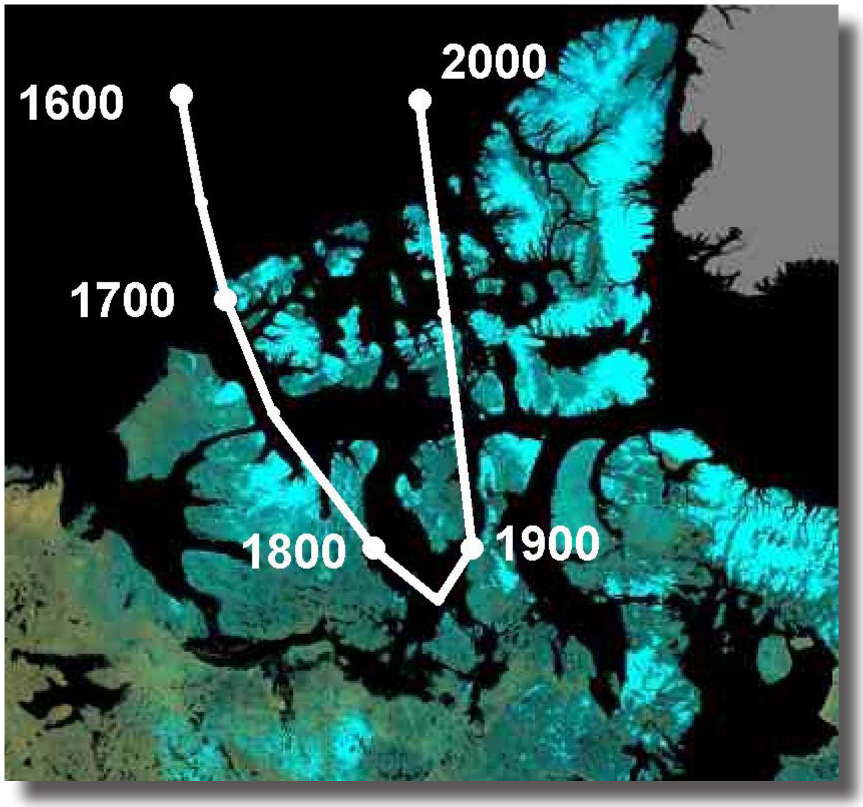

The Earth rotates around an axis through its center. This axis passes through the surface at the North and South Geographic Poles. The magnetic North and South poles are not the same as the geographic poles. In fact, the magnetic poles change in strength and move over time. The curve in the figure above gives the location of Earth's magnetic pole in the Northern Hemisphere as it has moved during the last 400 years! The scale of the above plot is approximately 1 centimeter represents 163 km.

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