Name: ______________________ Date: ______________

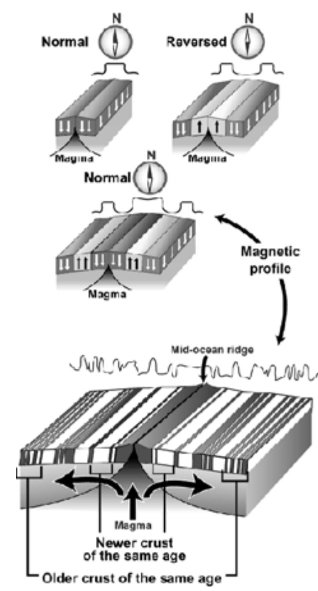
Magnetic Earth

READ

Earth's magnetic field is very weak compared with the strength of the field on the surface of the ceramic magnets you probably have in your classroom. The gauss is a unit used to measure the strength of a magnetic field. A small ceramic permanent magnet has a field of a few hundred up to 1,000 gauss at its surface. At Earth's surface, the magnetic field averages about 0.5 gauss. Of course, the field is much stronger nearer to the core of the planet.

PRACTICE

1. What is the source of Earth's magnetic field according to what you have read in chapter 16?
2. Today, Earth's magnetic field is losing approximately 7 percent of its strength every 100 years. If the strength of Earth's magnetic field at its surface is 0.5 gauss today, what will it be 100 years from now?
3. Describe what might happen if Earth's magnetic field continues to lose strength.
4. The graphic to the right illustrates one piece of evidence that proves the reversal of Earth's poles during the past millions of years. The 'crust' of Earth is a layer of rock that covers Earth's surface. There are two kinds of crust—continental and oceanic. Oceanic crust is made continually (but slowly) as magma from Earth's interior erupts at the surface. Newly formed crust is near the site of eruption and older crust is at a distance from the site. Based on what you know about magnetism, why might oceanic crust rock be a record of the reversal of Earth's magnetic field? (HINT: What happens to materials when they are exposed to a magnetic field?)



5. The terms *magnetic south pole* and *geographic north pole* refer to locations on Earth. The magnetic south pole is the point on the surface above Earth's magnetic south pole is if you think of Earth as a giant bar magnet. Geographic north is the point on the surface that we think of as 'north.' Explain these terms by answering the following questions.
   a. Are the locations of the magnetic south pole and the geographic north pole near Antarctica or the Arctic?
   b. How far is the magnetic south pole from the geographic north pole?
   c. In your own words, define the difference between the magnetic south pole and the geographic north pole.
6. A compass is a magnet and Earth is a magnet. How does the magnetism of a compass work with the magnetism of Earth so that a compass is a useful tool for navigating?

7. The directions—north, east, south, and west—are arranged on a compass so that they align with 360 degrees. This means that zero degrees (0°) and 360° both represent north. For each of the following directions by degrees, write down the direction in words. The first one is done for you.

   a. 45° *Answer:* The direction is northeast.

   b. 180°

   c. 270°

   d. 90°

   e. 135°

   f. 315°

Magnetic declination

Earth's geographic north pole (true north) and magnetic south pole are located near each other, but they are not at the same exact location. Because a compass needle is attracted to the magnetic south pole, it points slightly east or west of true north. The angle between the direction a compass points and the direction of the geographic north pole is called *magnetic declination*. Magnetic declination is measured in degrees and is indicated on topographical maps.

8. Let's say you were hiking in the woods and relying on a compass to navigate. What would happen if you didn't correct your compass for magnetic declination?

9. Are there places on Earth where magnetic declination equals 0°? Research on the Internet where on the globe you would have to be to have 0° magnetic declination.

16.3 Magnetic Earth

1. Scientists believe that the motion of molten metals in Earth's outer core create its magnetic field.
2. Seven percent of 0.5 gauss is 0.035 gauss. In 100 years, Earth's strength could be 0.465 gauss.
3. The poles could reverse within the next 2,000 years. During a reversal, the field would not completely disappear. The main magnetic field that we use for navigation would be replaced by several smaller fields with poles in different locations.
4. Rock provides a good record because as the rock is made, atoms in the rock align with the magnetic field of Earth. (Actually, oceanic rock is made of a substance called magnetite!) Rock that was made 750,000 years ago would have a north-south orientation that is exactly opposite the north-south orientation of rock that is made today. Therefore, we can use the north-south orientation of bands of rock on the sea floor to understand how many times the poles have reversed over geologic time.
5. NOTE: In many references, magnetic south pole is referred to as "magnetic north pole" because it is located at the geographic north pole. This terminology can be confusing to students who know that opposite poles attract. The north pole of a compass needle is in fact the north end of a bar magnet. This is why we think it is best to use the term magnetic south pole as the point to which the north end of a compass needle is attracted. For more information about Earth's magnetism see http://www.ngdc.noaa.gov/.

   Answers are:
   a. Both the magnetic south pole and geographic north are located at the Arctic.
   b. The magnetic south pole is about 1,000 kilometers from the geographic north pole.
   c. Magnetic south pole is the point on Earth's surface that corresponds to Earth's south pole if you think of Earth's core as a bar magnet. Magnetic south pole is located at a distance from the geographic north pole or 'true north.' True north is a point on Earth's surface that we call north. 'True north' and 'true south' follow Earth's axis. If we want to go north, we need to head toward Earth's geographic north. The tool we use to head north, however, points us toward the magnetic south pole. We use magnetic declination to correct for this.
6. A compass needle is a bar magnet. It's north pole is attracted to Earth's magnetic south pole (if you consider the interior of Earth is like a bar magnet). Using magnetism, we can find our way using north as a reference point. However, using magnetism actually points us a bit off course because the magnetic south pole is not located at the same position as true north.
7. Answers are:
   a. Example problem: northeast.
   b. south
   c. west
   d. east
   e. southeast
   f. northwest
8. If you didn't correct your compass for magnetic declination, you would be off course and possibly get lost.
9. Yes, magnetic declination equals zero on Earth's surface along a line that goes from New Orleans through the eastern edge of Minnesota up through Churchill, Canada. However, the location of the zero-degree line is always changing. For more information about Earth's magnetic declination and magnetism, see http://www.ngdc.noaa.gov/.