Earth has a magnetic field similar to that of a bar magnet

The north and south poles of a small bar magnet are correctly described as the "north-seeking" and "south-seeking" poles. This description means that if a magnet is used as a compass, the north pole of the magnet will seek, or point to, a location near the geographic North Pole of Earth. Because unlike poles attract, we can deduce that the geographic North Pole of Earth corresponds to the magnetic south pole and the geographic South Pole of Earth corresponds to the magnetic north pole. Note that the configuration of Earth's magnetic field, pictured in **Figure 4,** resembles the field that would be produced if a bar magnet were buried within Earth.

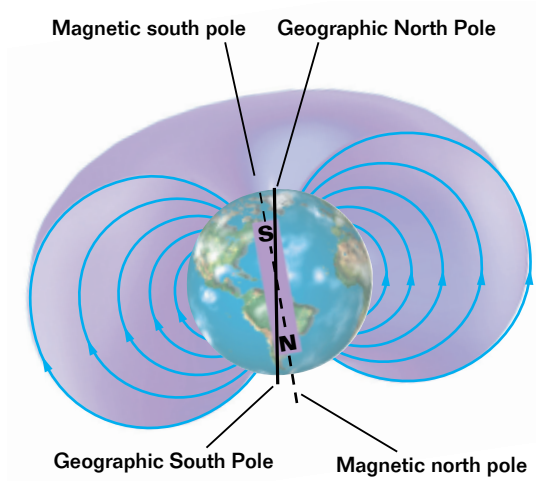

Figure 4
Earth's magnetic field has a configuration similar to a bar magnet's. Note that the magnetic south pole is near the geographic North Pole and that the magnetic north pole is near the geographic South Pole.

If a compass needle is allowed to rotate both perpendicular to and parallel to the surface of Earth, the needle will be exactly parallel with respect to Earth's surface only near the equator. As the compass is moved northward, the needle will rotate so that it points more toward the surface of Earth. Finally, at a point just north of Hudson Bay, in Canada, the north pole of the needle will point perpendicular to Earth's surface. This site is considered to be the location of the magnetic south pole of Earth. It is approximately 1500 km from Earth's geographic North Pole. Similarly, the magnetic north pole of Earth is roughly the same distance from the geographic South Pole.

The difference between true north, which is defined by the axis of rotation of Earth, and north indicated by a compass, varies from point to point on Earth. This difference is referred to as *magnetic declination.* An imaginary line running roughly north-south near the center of North America currently has zero declination. Along the line a compass will indicate true north. However, in the state of Washington, a compass aligns about 20° east of true north. To further complicate matters, geological evidence indicates that Earth's magnetic field has changed—and even reversed—throughout Earth's history.

Although Earth has large deposits of iron ore deep beneath its surface, the high temperatures in Earth's liquid core prevent the iron from retaining any permanent magnetization. It is considered more likely that the source of Earth's magnetic field is the movement of charges in *convection currents* in

Did you know?

By convention, the north pole of a magnet is frequently painted red. This practice comes from the long-standing use of magnets, in the form of compasses, as navigational aids. Long before Global Positioning System (GPS) satellites, the compass gave humans an easy way to orient themselves.

Quick Lab

Magnetic Field of a File Cabinet

MATERIALS LIST

- **compass**
- **metal file cabinet**

Stand in front of the file cabinet, and hold the compass face up and parallel to the ground. Now move the compass from the top of the file cabinet to the bottom. Making sure that the compass is parallel to the ground, check to see if the direction of the compass needle changes as it moves from the top of the cabinet to the bottom. If the compass needle changes direction, the file cabinet is magnetized. Can you explain what might have caused the file cabinet to become magnetized? Remember that Earth's magnetic field has a vertical component as well as a horizontal component.

Try tracing the field around some large metal objects around your house. Can you find an object that has been magnetized by the horizontal component of Earth's magnetic field?