THE MAGNETIC FIELD OF THE EARTH

In 1600, *William Gilbert*, an English scientist, published an essay in which he claimed that the earth behaved like a giant magnet. To support his view, he shaped a piece of lodestone into a sphere resembling the earth. He then demonstrated that a compass needle, placed anywhere on the sphere, took a north-south position. Recall that the same observation can be made when we suspend a bar magnet from a string. The freely suspended magnet also takes a north-south position.

If we represent the earth with a cardboard sphere, and place a bar magnet inside the sphere as in Fig. 16-9, the lines of force

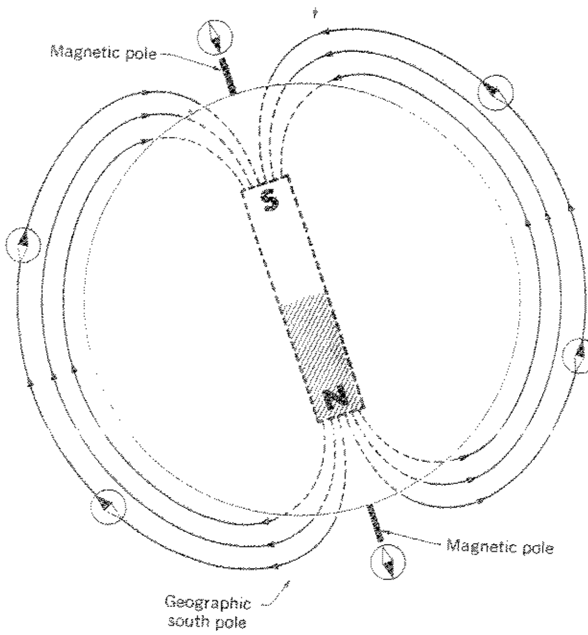

Fig. 16-9. The earth's magnetic field.

around the bar magnet will correspond to the magnetic field of the earth. We can demonstrate the earth's magnetism by holding an iron rod in a north-south position and then gently tapping the rod with a hammer. Tapping apparently agitates the magnetic domains. If the rod is held in the direction of the earth's magnetic field, the domains line up in a north-south position. The rod then becomes magnetized by induction.

The response of the compass to the earth's magnetism makes the compass useful as a navigational instrument. However, in most places on earth, the compass needle does not point to true north, by which we mean the geographic north pole. Instead, the compass needle points to the north magnetic pole, as shown in Fig. 16-9, which is located in northern Canada, about 1200 miles south of the geographic north pole.

The angle made by lines from the observer to these poles is called the **magnetic declination** of the particular location of the observer. In a few places on earth, the declination is 0°. In these places only, the compass needle assumes a true north-south position. This means that when the declination is 0°, the geographic north pole, the magnetic north pole, and the observer are all aligned in a straight line. Navigators use special maps that show the declination in different locations. By knowing the proper declination, and by using a compass, one can then determine the direction of true north, that is, the geographic north pole.

The north and south magnetic poles of the earth can be located by using a **dipping needle** (Fig. 16-10). This device is a compass needle suspended so that it rotates in a vertical plane; a protractor that is part of the instrument permits us to measure the angle through which the needle moves. This angle, called the **angle of dip,** is the angle that the magnetic field of the earth makes with the horizontal at any specific location on the earth. At the equator, the angle of dip is 0°. As we move from the equator closer to the earth's north magnetic pole, the angle of dip increases until it reaches 90°—a vertical position at the magnetic north pole. At the magnetic south pole, the dipping needle also indicates a 90° angle of dip.

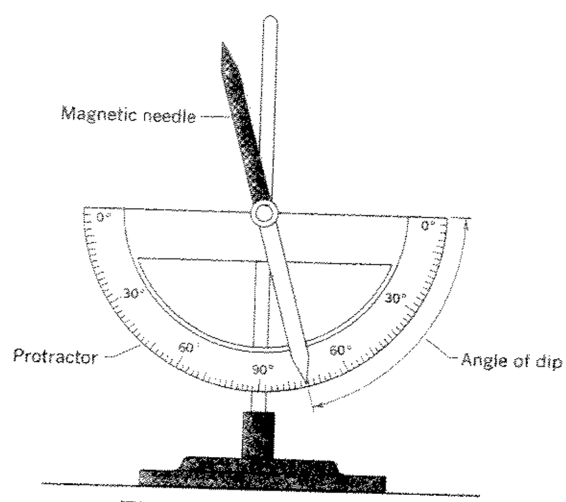

Fig. 16-10. The dipping needle.

From measurements of magnetic inclination and dip, it can be shown that the magnetic field of the earth is continually changing. Although these changes are slight, they make it necessary for map makers to undertake regular magnetic surveys of the earth to keep their maps up to date.

Much still remains to be learned about the earth's behavior as a magnet.