The Earth's magnetic field is on the move

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Living on Cape Ann, there is a good chance that somehow you are involved with boating. If you travel for any distance in a boat, you need to understand the basic principles of navigation. This includes how to use a compass to get you from point A to point B. When you follow your compass as you steer, you are depending on the fact that the earth has, effectively, a giant, bar magnet generally aligned with its north-south, rotational axis.

It may be surprising to some people that the Earth's bar magnet has its south pole located near the true North Pole. Opposite poles attract, so that's why the north pole of your compass magnet points to it.

For centuries, mariners have depended on the Earth's magnetic field for navigation. In the 19th century, they began to realize that the magnetic field was moving and changing, and the movement affected their long-range navigational accuracy. The government of Great Britain, a seafaring nation, established a program to monitor and track the changes in the magnetic field.

Dr. Isaac Adams, the inventor of nickel plating, lived in Annisquam during that period. In about 1898, he built a specially designed magnetic observatory in his back yard on Adams Hill. He used the instruments he also designed to make very sophisticated measurements of the changes in the local, Earth's magnetic field. That information, along with the results from hundreds of other observatories around the world, were used by the British to build a model for navigators that forecast how the magnetic field would further change over time. The mariners could then adjust their courses appropriately.

The Earth's magnetic field, however, is much more useful to us than just for navigation. In fact, without it we wouldn't exist.

Life, as we know it, was able to develop on Earth only because our magnetic field was generated soon after the Earth was formed 4 billion years ago. The Earth's magnetosphere extends about 20 thousand miles above the surface of the planet.

There are two major reasons the magnetic field is essential to our existence. First, it protects we humans from dangerous, solar and cosmic particles that bombard the Earth constantly, and that would eventually kill us if they reached the surface. But, fortunately, the energetic, charged particles interact with the magnetic shield and are diverted away. Near the poles, where the magnetic field lines enter the Earth, we can see the results of these particles spiraling in. We call the phenomena the northern and southern lights.

A second benefit we receive from having the charged particles diverted from the Earth's surface is that, over time, these particles would have stripped away our atmosphere. This is exactly what happened on the air-less, planet Mars, which doesn't have a magnetic field.

Why does Earth have a magnetic field and Mars does not? The difference is in their cores. At the center of both Earth and Mars are solid iron cores. But, in Earth's case, there is also an outer core of liquid, molten iron alloy. It is the sloshing around of this liquid metal that ultimately forms our magnetic field.

As it turns out, the Earth's north magnetic pole is not exactly lined up with the Earth's true north pole. That's why your marine charts have two compass roses. The inner one is the magnetic, while the outer one is the true north rose.

The north magnetic pole is the point on the globe where a compass needle points straight down. The effective dipole magnet created in the Earth's core is tilted at about an 11 degree angle compared to the Earth's rotational axis. So, when the exact location of the north magnetic pole was first identified in 1831, it was at Cape Adelaide on the Boothia peninsula in the northern part of the Canadian Arctic. This placed it several hundred miles from the geographic, or true north pole located in the middle of the Arctic Ocean. The magnetic pole, however, hasn't remained at Cape Adelaide.

Geologists who study the history of the earth's magnetic field have been tracking the movement of the magnetic north pole over time. When they first started tracing the pole's progress in the nineteenth century, it was only moving at a rate of six miles per year. But, during the 20th century, scientists were shocked to find that the pole movement had accelerated to a much faster rate, about 30 miles per year. This was the fastest rate observed in the last four centuries.

The pole has now wandered more than 1,400 miles since 1831. Most recently, it is near Ellesmere Island in Nunavut, Canada. And it is headed toward Siberia in Russia.

For the average Cape Ann boater, this movement of the magnetic pole doesn't make that much of a difference to our relatively short-distance navigation. Whenever we get a new set of charts, they include the latest information on the location of magnetic north, and that is usually good enough.

But for large commercial ocean-going vessels and sophisticated military ships, the relatively rapidly changing field does have an impact. To be accurate enough in their long-range navigation, they need to use the world magnetic model to adjust their courses. This is the current version of the model first developed by the British. It is now maintained by NOAA and is updated at least every five years, or more often depending on how fast the pole is moving.

One of the concerns because of the faster movement of the magnetic pole is that it may be foretelling an even more dramatic change. Evidence of magnetization in rocks indicate that about every 450,000 years, the magnetic poles have flipped. The north pole has switched to the south pole and visa versa. The last time was 780,000 years ago. So, we could be due for another flip. No one really knows when it might occur.

The flip does not happen instantaneously. In fact, it could take about a thousand years. In the meantime, the result would be a dramatic decrease in the strength of the Earth's magnetic field.

As the north magnetic pole began to move faster during the twentieth century, scientists saw the first hints of such a decrease. They have measured a 10% decline in the overall magnetic field strength. This could signal the beginning of a long-term switch. And this event could lead to serious problems for us.

The first thing that would affect us is the impact of energetic, charged particles on our satellite systems. The on-board electronics would be destroyed by the particles, causing the satellites to malfunction. In the later stages of the pole switch, when the magnetic field strength is reduced to a small fraction of its current value, the impact of the solar and cosmic particles on humans would become deadly.

The good news is that the process of flipping is so slow, that we would have time to prepare for those changes. Shielding would be provided on the satellites to protect the electronics. The effect of the particles on humans depends on the dosage, or the level of exposure. As the problem of decreasing magnetic field strength got worse, humans would develop shielding solutions for their structures that would protect the species.

The Earth's magnetic field has been of great value to humans since the dawn of creation. Scientists are now paying close attention to how it is changing and, you can rest assured, that they will direct us to make the necessary adjustments for dealing with those fluctuations.

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