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Fatal attraction

Earth's magnetic field is showing strong signs that the poles are due to switch over. It could be the end of the world as we know it, writes Paul Simons

Paul SimonsThe Guardian, Thursday 4 July 2002 02.48 BST

The Earth could be about to turn upside down. The planet's magnetic field is showing signs of wanting to make a gigantic somersault, so that magnetic north heads towards Antarctica, and magnetic south goes north. Compasses will point the wrong way, and migrating birds, fish and turtles are going to be very confused.

Just when this will happen, how long it will take and what the consequences will be, is difficult to fathom. What is not in doubt, though, is that it will happen. About every half a million years or so, the Earth's magnetic field flips upside down.

The story begins in 1600, when Sir William Gilbert, physician to Queen Elizabeth I, suggested that the Earth was a giant magnet. At the magnetic poles, a compass needle would stand up and point straight down into the Earth. And he was right, up to a point. The magnetic poles are where all the lines of force of Earth's magnetic field are drawn together. It does not coincide with the geographic poles, the axis on which the Earth spins, but it is close.

Yet the Earth is not a solid magnet. For one thing, its magnetic poles are constantly drifting around. At present, magnetic north is heading out of Canadian territory into the Arctic Ocean at about 10 miles per year. Also, a bar magnet quickly loses its power, yet the Earth's magnetic field has been around for billions of years, so something is regenerating it. This is why Einstein remarked that the origin of the Earth's magnetic field was one of the greatest mysteries of physics.

Today, we think that magnetic power comes from the Earth's hot outer shell of molten iron sloshing around a solid inner core. As this subterranean ocean of liquid metal slowly whirls around, it behaves like a dynamo generating electrical currents and magnetic fields. Just like the flickering light on a bicycle powered by a dynamo, the Earth's currents are a little erratic, and so the magnetic field at the surface of the Earth fluctuates.

We know the magnetic polarity goes topsy-turvy from rocks on the bed of the Atlantic Ocean. Along the middle of the Atlantic runs a gigantic crack from which lava oozes. As the lava solidifies into rock, it records the Earth's magnetic polarity at the time. These records show that we are due for another flip about now. But the Earth does not keep a regular rhythm, so no one could make a prediction based on past performance alone. There is, however, more convincing proof that we are heading for a tumble. Each time

the magnetic field heads for a reversal, it grows weaker over several thousand years until it almost disappears. Then it switches and starts up again with renewed vigour.

Magnetism trapped in ancient pottery shows that over the past 4,000 years, the magnetic field has weakened by more than 50%. This past century, the strength has dropped by 5%. At this rate, the field might disappear in the next few hundred or thousand years. Another warning sign of an imminent flip has come recently from satellite measurements of the Earth's magnetic field.

A team led by Gauthier Hulot, of the Institut de Physique du Globe de Paris, has spotted patches of reversed magnetism concentrated in two places just underneath the Earth's outer mantle. In the largest patch, beneath the southern tip of Africa, the magnetic field is pointing towards the centre of the Earth, instead of outwards. The other patch is near the north pole.

Some experts have stuck their necks out to predict that we can expect the next reversal some time in the next 2,000 years. The process would probably then take anything between 100 and a few thousand years - not even a blink in the history of Earth. We can only guess what life would be like during that reversal. Anyone trying to navigate with a magnetic compass is going to have a tough time, but what is going to happen to all those birds, fish and other animals that migrate vast distances using their own internal magnetic compass? Will they have time to re-draw their magnetic maps and get new bearings?

Even more creatures such as bees and some bacteria use a sense of magnetism for finding their way around their local territories, for a north/south or up/down axis. The Earth's magnetic field also stretches several hundred miles into space and protects us from the sun's charged particles and cosmic rays by focusing them towards the poles. This is where they appear as the northern and southern lights as they excite gases in the atmosphere. As the magnetic poles migrate across the world, those night lights are going to light up some very strange places where they have never been seen before. During a field reversal, this protective magnetic shield is going to be weak and might even disappear for a century or more. That might drastically affect the weather. There is a growing body of evidence that the sun's highly charged particles batter the upper atmosphere so hard that some of the assault filters down into the atmosphere around us, influencing the wind, atmospheric pressure and temperature.

Without our magnetic shield, those solar particles might create havoc with the weather. That cosmic radiation blasting the Earth's surface could cause genetic mutations and cancers. Yet when palaeontologists scoured the fossil records looking for signs of mass extinctions or bursts of evolution during previous magnetic field flips, they found nothing. Living organisms seem to have survived intact. But what will happen next time?

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