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A NON-MAGNETIC EARTH?

Ken Tapping, 6th March, 2018

Most of us have seen references in the media to reversals in the Earth's magnetic field, usually with dire prophesies of climatic and environmental crises, dangers to life, and technological disaster. Like most of these reports, some of the content is right; a lot isn't. Here is an attempt to summarize the state of knowledge at the moment, and how we got here. It is the result of a lot of work over many years. However, one key result emerged in the 1960s from measurements of the strength and direction of the Earth's magnetic field made from ships and aircraft crossing the Atlantic east-west.

About 210 million years ago, all the land masses of the world were joined together into one supercontinent, Pangaea. Africa was attached to North America, and Scotland and Nova Scotia were very close together. Then around 65 million years ago, around the end of the Age of Dinosaurs, a crack appeared, and filled with seawater. As the crack widened, molten rock came up from below, forming new seabed. The Atlantic Ocean was born. Since then, it has been widening at about the speed fingernails grow, as new rock emerges from below, along what has become known as the Mid-Atlantic Ridge. That molten rock is rich in iron, and solidifies to form basalt, a dark-coloured volcanic rock. Iron atoms are magnetic, and while the rock is molten they are free to move, and they line up with the Earth's magnetic field. Then, when the rock solidifies, they form a record of what the Earth's magnetic field was at the time. The studies of the Earth's magnetic field across the Atlantic showed a series of reversals in the direction of the magnetic field, with the most recent changes being recorded close to the Mid-Atlantic Ridge. As the distance from the Ridge increases, we see records of older and older changes. For at least the last 20 million years the magnetic field has reversed every 2-300,000 years, with each transition taking hundreds to thousands of years. The last reversal was about 700,000 years ago, so one is badly overdue.

We believe a planet's magnetic field is generated by the flow of molten, iron-rich material in a liquid core, combined with the planet's rotation. The faster the rotation, the better. All the rocky planets probably started off magnetically similar, but only the Earth has a strong field today. The others have lost theirs: Mercury – solidified core, slow rotation, Venus – very slow rotation, Mars – solidified core. In addition, only our world has plate tectonics, which require seawater as a lubricant. So do we have to worry if we find ourselves facing a magnetic field reversal? Firstly, a magnetic field reversal does not mean the Earth's magnetic field vanishes, leaving us magnetically naked for a time. It is more likely that patches of the new orientation appear, growing bigger and more numerous, while the old field patches become smaller and rarer.

Life has been on Earth for billions of years. There is no sign in the fossil record that the magnetic field reversals had any effects on living creatures. Since the magnetic field was never really zero, the atmosphere was not stripped off; it is obviously still here, and will be after the next reversal.

Our technological way of life could be affected. Power outages and communications blackouts could be more severe, and satellites will be more vulnerable to bad space weather. Astronauts and passengers on high-altitude aircraft could be exposed to higher levels of radiation. However, we have control over technology, how we use it, and how we can improve it. We know what is coming, and know what to do. It's up to us.

Jupiter rises about midnight. In the early hours, the giant planet lies in the south, with Mars low in the southeast and Saturn to its left and lower. The Moon will reach Last Quarter on the 9th.

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