Why Magnets and Magnetic Fields Attract New Age Flimfiam and Flapdoodle

THROUGHOUT THE LONG BUILDUP UP TO THE LATEST FAILED prediction of an global apocalypse on December 21, 2012, you would hear people claiming that the earth-shattering catastrophe would include "pole shifts," or "changes in the earth's magnetic field," and assorted other sciencey phrases, proclaimed by people with absolutely no idea what they were talking about.

The idea of "magnetism" is one of the most popular memes in the lexicon of pseudoscientists and New Agers, since magnets operate "mysteriously" and exert a force at a distance. From the days of Franz Mesmer who claimed he could exercise "magnetism" over people, to the trite phrase "animal magnetism," the concept of magnetism has always been mysterious and misunderstood. Hence we see a big market for sticking magnets on various parts of your body to "cure" you. All they do is waste money, and possibly demagnetize the magnetic strip on your credit cards. The idea that somehow the earth's magnetic field will shift abruptly or that the earth's core will stop rotating (as in the idiotic Hilary Swank movie "The Core") or even more wildly, that the earth's rotational pole will change, are all common ideas out there in Wacko-Land.

Most of us know enough about science and apocalyptic predictions to guess that such claims are not worth taking seriously, but very few people have bothered to debunk this stuff. Unfortunately, we saw lots of sad consequences of people who did take the ridiculous apocalyptic predictions seriously, often with tragic results.

Among my other specialties, my professional training is in paleomagnetism, and I've conducted over 35 years of published research in the field, so I'm very familiar with what we do and do not know about the earth's magnetic field and how it behaves.

First, some science

The earth's magnetic field has at least two components -- a dipolar field which makes up for about 90% of the magnetism we normally measure -- and a non-dipole field, which is normally hard to detect against the stronger field, but which makes up at least 10% of the total. The dipole field is not exactly lined up with the rotational axis of the earth (i.e., there is a small angle between magnetic north and true north), but over geologic spans of time, this magnetic north wanders around the rotational pole; this movement is known as secular variation. Studies have shown that over the long term, its position averages out to being identical to the rotational pole.

The field is generated by complex fluid dynamos operating within the outer core of the earth (made of iron and nickel). It operates a bit like a spinning dynamo made of copper wire (a good conductor), and generates a magnetic field and electrical current when it spins within a magnetic field. The exact nature of how this works is a matter of the complexities of geophysical fluid dynamics, so scientists are still working on modeling what kinds of dynamos are found in the outer core. But whatever their configuration, the model has to fit the constraints that the direction can be reversed (so a compass pointing north now would have pointed south 800,000 years ago), and also explain the odd behavior of the field when the dipole component weakens and the non-dipole component becomes visible.

Now let's consider some of the common false claims about magnets and magnetism that saturate the Internet:

1. Earth's field is about to reverse!

The earth's field does reverse direction, but normally the process takes 7,000-10,000 years to complete. It does not happen in days or weeks, as some claim. We know this from detailed studies of thick stacks of lava flows that erupted over the span of a reversal, as well as high-resolution deep-sea cores that span the interval as well. So if the field were beginning to reverse, we would not know for at least a few thousand years. And we cannot predict when this reversal will occur, since they have been occurring on an irregular basis for all of geologic history, and at least 300 times in the past 100 million years. Reversals typically occur roughly every 200,000-300,000 years, although the last reversal (the Brunhes-Matuyama boundary) was over 800,000 years ago. Some, however, are much shorter (less than 50,000 years), while in some cases the earth's field remained stable for 30 million years. This irregular pattern of field reversals is completely unpredictable, but it also gives

a nice non-periodic, non-repeating signal, like a bar code, that allows magnetic stratigraphers to correlate their local magnetic sequences with the global pattern.

2. When the field reverses and vanishes, we'll all be bombarded by cosmic radiation!

When the field slowly reverses over thousands of years, only the dipolar component of the field weakens. The non-dipole component of the field is always present, and there's no evidence that the earth has ever been unshielded from cosmic radiation or completely lacked a magnetic field. Nor is there any evidence that a slightly weaker magnetic field over the thousands of years when the dipole field is reversing will have any effect on life, or on our electrical grid, or anything else. Calculations show that during reversal, the field is only slightly weaker than we feel normally -- about the difference between the field we would feel at the equator and the field we would feel at the magnetic north pole. In other words, it is undetectable except by sensitive instruments. In fact, a former professor of mine (Jim Hays of Lamont-Doherty Earth Observatory, a micropaleontologist and my co-author on several papers) conducted the crucial experiment on the issue over 40 years ago. He was the first to see the evidence of field reversal in deep-sea cores from the Antarctic, and wondered if there was any effect on life. His first effort in 1971 (Hays, J.D. 1971. Faunal extinctions and reversal of the Earth's magnetic field. Geological Society of America Bulletin, 82, 2433-2447) found no association between field reversals and extinctions, and it has since been corroborated over and over again by a wide variety of statistical techniques. And why should there be any extinctions? If the difference in the field felt by organisms is so slight, and the effect on the cosmic ray influx is so tiny, there's no reason to expect otherwise. At very worst, a weaker magnetic field with a relatively strong non-dipole component might disorient animals (from bees to whales to birds) that navigate by the field direction, but there's no way to test that hypothesis in the fossil record, and no evidence that it's happening to organisms right now.

3. What about recent studies that showed much more rapid field changes?

These were conducted by my former colleague Scott Bogue at Occidental College. Bogue was looking at a set of lava flows that cooled as the field was reversing and weakening, and he focused on just the field recorded when the dipole field was nearly gone, and the non-dipole field was revealed. The non-dipole field does indeed move rapidly and in weird ways, but there's no evidence that anything has been affected by such weird field directions during the short period of time that it is the dominant field of the earth. And there's no evidence that the much stronger dipolar field will ever change that fast.

4. What about the evidence that the magnetic pole is rapidly changing direction?

This long-studied and well-known phenomenon -- secular variation -- is neither news nor some scandalously dangerous discovery being hidden by NASA. It is a constant feature of the earth's magnetic field, but over time the direction of the magnetic pole averages out to be approximately the same as the rotational pole. We can study secular variation over thousands of years as recorded in deep sea cores, lake sediment cores, and many other records. There is no scary change that threatens us, just a lot of noisy wobbling of the magnetic north that averages out to nothing in the long run.

So the next time you hear someone worrying about the earth's magnetic field, you can assume they have been misinformed and the information is false. There are plenty of real dangers be concerned about, like global climate change, so we don't need to scare people by hyping false ones.

Magnetic Time Scale

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By DONALD PROTHERO
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Name _____ Period ____ Date _____

Directions: Use complete sentences and evidence from the article to support your answers!

1. Defend or refute this statement “Earth's field is about to reverse!”

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2. When the field reverses and vanishes, we'll all be bombarded by cosmic radiation! True or False? Why?

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3. What, in recent studies, showed much more rapid field changes

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4. What evidence shows that the magnetic poles are rapidly changing direction?

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