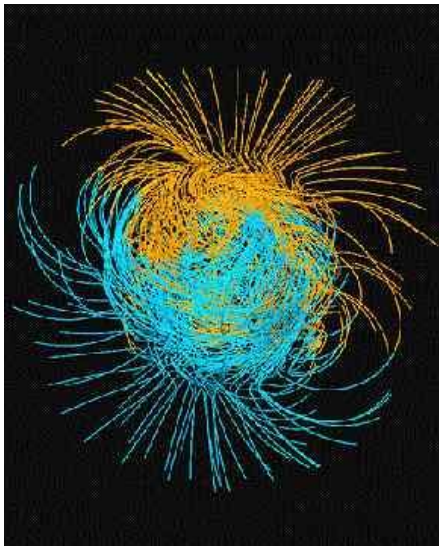
Earth's Magnetic Anomalies - Could the Poles Flip?



Computer-generated snapshot of lines of force in the Earth's magnetic field beginning at the Earth's surface from where they penetrate smoothly into the insulating mantle. The structure changes dramatically in the liquid core below the mantle where the magnetic field is generated by the convection of the core's melted iron. Graphic courtesy Gary A. Glatzmaier, EE-IGPP, Los Alamos National Laboratory and Paul Roberts, University of California-Los Angeles.

April 27, 2002 Cambridge, Massachusetts - Deep beneath our feet as we walk around in fact, 4,000 miles down is the center of the earth where an iron core is so hot it is liquid and boils around like cooking porridge. That moving, melted iron also produces the magnetic fields that surround the earth and upon which much of earth's surface life, satellites and space technology depend upon for orientation, and for protection. If magnetic fields did not trap highly energetic particles racing from the sun, all kinds of damage could be done to living organisms and space technologies. For nearly a million years, magnetic field lines have been coming out of the south pole and entering the north pole of the earth. That is called the magnetic dipole.

Now a science team from Paris, France led by Gauthier Hulot at the Institute of Earth Sciences in Paris - working with other scientists such as Harvard University's magnetic field expert, Dr. Jeremy Bloxham - have compared satellite measurements of the earth's magnetic field strengths 25 years ago and today. Their discovery was published in the April 2002 science journal *Nature* and it boils down to this: there are strange and not very well understood variations now in the earth's magnetic field. In fact, down in South Africa there is a large region that already has a magnetic field pointing in the *opposite* direction from the rest of the earth's field and is getting stronger all the time, according to new satellite data.

Further, the north and south pole magnetic fields have weakened in strength by about 10% of what they were. If the South African region continues to get stronger and the poles keep weakening, scientists think that within the next

millennia, the pole magnetic fields could disappear altogether, or flip so the magnetic field lines would leave the north pole and enter the south pole. Meanwhile, could magnetic field anomalies and changes in strengths and geographical locations persist during a transition period to an unknown outcome?

Based on ancient rock studies, geophysicists can say that such a situation happens three or four times every million years. There can even be a period when there are many magnetic poles all over the planet, not just at the poles. But no one knows for certain what the implications are for earth life and technology because it hasn't happened since 780,000 years ago.

Recently, I talked with Dr. Bloxham's graduate assistant, Mathieu Dumberry from Canada, who specializes in the dynamics of the earth's iron core. I asked him if the last time a pole reversal occurred was nearly a million years ago, wouldn't that mean current surface life, including humans and geophysicists, have no idea what actually happens if the poles reverse?

Interview:

Mathieu Dumberry, Graduate Assistant to Prof. Jeremy Bloxham, Department of Earth and Planetary Sciences, Harvard University, Cambridge, Massachusetts: "That's correct. The consequences for human life, in terms of what the actual exact sort of strength decrease in the overall magnetic field is and in terms of what the consequences are for the solar particles that are trapped in the magnetic field of the earth is, we don't really have a good idea on that.

The magnetosphere plays such a strange and mysterious, but important role between the ionosphere, outer space and here on the earth. There are aurora borealis and all kinds of magnetic field effects. If the North and South poles suddenly changed and the magnetic fields were coming out of the North Pole and entering the South Pole, wouldn't you think there might be some dramatic effects on earth life?

I think the most dramatic effects might occur during the reversal that is when the strength of the dipole field is going to be the weakest. Because if the dipole is oriented one way or another in terms I'm thinking in terms of the solar particles that are trapped in the magnetic field therefore, don't reach the surface of the earth. These sort of high energy particles could be damaging to life on the earth. If these particles are trapped by the fields, they don't reach the surface.

However, if the strength of the dipole field decreases, then the ability of the magnetic field to stop these highly energetic particles is weakened. And so this might have an affect on life.

But, as I said earlier, 780,000 years ago when it happened, of course, we did not have human society as we have now today, but the creatures that lived then in terms of humans and other animals have survived.

Some have. But there have been periods of unexplained extinctions in the history of the earth. If I understand what you are saying, strong solar particles could be able to reach the surface of the earth uninterrupted by strong magnetic fields as they are deflected today. Such energetic particles reaching the surface of the earth unimpeded could do damage on the surface during the collapse of the magnetic dipole?

Yes. But again, I can speculate on the strength of the magnetic pole much better than the affects on biology. But I would say that since these big mass extinction events one we know occurred 65 million years ago and another one more like 250 million years ago these mass events if you postulate they were caused by the magnetic field reversal, then you have to explain why in all reversals since I mean, there have been reversals it seems there are reversals in the magnetic field

two or four times every million years. So now you have to ask why there haven't been any mass extinctions when all the other reversals occurred?

That's a comforting point, given the fact that all of you are already picking up anomalies in the magnetic fields that suggest, as the French scientists have said, 'We know that something is happening and we speculate that we are in an unusual situation that might be related to a reversal.' Those are words of Dr. Hulot.

Yes. It's quite possible that this is happening, that we are in the middle of a reversal, at least at an attempt at reversal. But you know, we might also find that in 500 years that this small reverse patch (in South Africa) has shrunk and did not succeed in creating a reversal. We don't know, because the time scale of these magnetic field changes seems to be on the order of 300 to 500 years. It's difficult to say at this stage whether this is a feature that will definitely lead to a reversal of the dipole.

Have you talked with Dr. Bloxham (Harvard) about the entire issue that you and geophysics could be sitting on data that as the time line evolves in the future could become extremely relevant to earth life? So far modern humans have never experienced a magnetic field reversal nor the disappearance of the North and South poles.

Well, absolutely. It's essentially the reason why we study the magnetic field. In itself it's interesting from a mathematical point of view to understand the dynamics of how the field is generated. But in terms of human society perspective, the reason why we study the magnetic field is because it has an influence on our life and on our future. Yes, that is essentially why we are studying the magnetic field of the earth and its changes."

What about aerospace and satellites and military applications? Wouldn't a change in magnetic fields affect a tremendous amount of earth technology?

Yes. Fortunately these changes are occurring slow enough. The typical life time of a satellite is probably not going to be affected. But when we launch a new satellite, if we are aware of a changed magnetic field then probably during the life time of the satellite, (we would build the satellite) to operate functionally.

However, it's sort of ironic that the satellite which was used to produce the data and comparison between the last satellite mission...

Data was compared from two different satellites, one with data from 25 years ago and one that is current, to find these magnetic anomalies, correct?

Yes, so the current satellite mission (ERSTED) was originally built and the instruments were built to withstand a certain strength of the magnetic field. However, now trying to establish how the growth of the sort of reversed magnetic field patch in South Africa is growing, it is actually growing faster than the people who built the satellite originally thought. So, now the field might be too strong to really operate well. So, it's ironic that one of the reasons to launch that satellite mission was to monitor the growth of that field and now the field has grown to a point where it might be hard to measure accurately now.

Do any of you, whether it's based on speculation or hard data, have any idea when we reach a threshold in these magnetic field changes in which the North and South Pole fields are weakening and other areas on the planet such as South Africa are getting stronger do you know at what threshold these changes in the magnetic fields can affect earth life?

I would say currently no. What we see from the data is what the magnetic fields appear at the surface of the core. We have no idea what is going on inside the core. We do have an idea because we are producing mathematical models that mimic the generation of the magnetic field. So, by comparing what we see in the data to what we see in the results of the models, then you can guess, 'If we see this pattern of magnetic field at the surface, then this means what is happening

inside.'

To answer your question, essentially we don't really know for sure if we see a certain pattern at the surface that it means something directly that we can sort of look at the future 500 years or 1000 years and be certain, 'This is what is coming up.'"

Website:

http://www.psc.edu/science/glatzmaier.html

Credits