Rocks unravel the secrets of the Earth's magnetic field

July 6 2022

From the lab at the Centre for Earth Evolution and Dynamics at UiO. Credit: Gina Aakre/UiO

More than 350 million years ago something odd was going on with the Earth's magnetic field. Scientists now propose that the field was really weak, which may have affected life on our planet.

The Devonian period (420–360 million years ago) is filled with scientific questions. One of the big mysteries is why rocks from this time period don't seem to have traces from the magnetic field of the Earth. For a long time scientists have assumed this is due to the rocks having lost their "magnetic memory" for some reason.

"From many studies it seems that Earth's magnetic field was really weak at this time. And that this is the reason why the rocks don't have these traces," explains paleomagnetist Annique van der Boon from the Center for Earth Evolution and Dynamics at UiO.

The Earth's magnetic field plays an important role in our daily lives. It protects us from solar storms which consist of charged particles and can be harmful for modern technology. The Earth's magnetic field also protects our atmosphere.

Just before the pandemic hit, Van der Boon was doing fieldwork out in the far north of Canada. She was collecting Devonian rocks, and her aim was to look into how often the magnetic north and south poles flipped during this time.

"As we started to examine these rocks in the lab, it became clear to us that our results were very difficult to interpret. As I started writing up my research, I saw that many other scientists have also had a lot of trouble explaining their paleomagnetic data from the Devonian. As I read more papers, it gradually became clear to me that even though our rocks were nicely preserved, it was really hard to get reliable paleomagnetic data from them. What if this was because the magnetic field was too weak to affect them?"

A mysterious time period

For a long time scientists have thought that rocks from the Devonian had lost their magnetic memory.

"All the paleomagnetic data from the Devonian is very problematic. Scientists have suggested that rocks from this time period might have been heated when continents collided. This is something that will reset the magnetic memory," explains Van der Boon.

Previous studies have shown that Earth's magnetic field was very weak. What Van der Boon's review of Devonian paleomagnetic data concludes is that this could actually be the reason behind the lack of reliable data, hampering the understanding of how continental plates have moved through time.

In her research she shows that even those rocks that should have a good memory of Earth's magnetic field, still give troubling results.

"Now we are trying to understand when the field weakened, and how long it was weak for," explains Van Der Boon.

Other studies also fit with the idea of a weak magnetic field during the Devonian.

"During the Devonian we saw the emergence of plants. A different study shows that these plants were damaged by UV-B-radiation at the end of the Devonian. This fits with the idea of a weak magnetic field."

Rocks hold stories from the past

Van der Boon studies the magnetic field of the earth, but in the past. Her main research interest is the magnetic field of the earth 420–360 million years ago, the time of the Devonian.

"We know very little about the Earth's magnetic field over long timescales and why it behaves the way it does," says Van der Boon. Paleomagnetists study Earth's magnetic field in the past, by examining the magnetic memory of rocks.

"Rocks can remember the earth's magnetic field from the time the rocks formed. Magnetic minerals inside rocks align themselves to the magnetic field," explains Van der Boon.

Scientists can study rocks of millions, or even billions of years old to find out more about Earth's magnetic field at that time.

"This can give us information on the position of continental plates in the past, but it also tells us something about the very deep inner workings of the earth, as the magnetic field is formed by moving liquid iron in the Earth's outer core," says Van der Boon.

Directly affects our lives

Van der Boon's research has now given her some answers, but also raises more questions. The Earth's magnetic field in the Devonian was very weak. Why was it so weak, and how did this affect life on Earth? These are questions Van der Boon wants to pursue further.

The magnetic field directly affects our lives on earth, as it protects us from solar storms.

"The magnetic field extends out into space. The stronger the magnetic field, the further it extends into space, and the better it protects us from harmful radiation coming from our sun. The place where the magnetic field and the solar wind balance each other out is called the magnetopause. By examining rocks we can get a better understanding of how well the magnetic field protected life on Earth," Van der Boon explains.

The interaction between the Earth's magnetic field and solar storms is what creates the Northern lights.

"So as you can see it is important for us to have the nice and strong magnetic field that we have today. If the magnetic field would change and weaken to the strength that we saw during the Devonian we would experience some issues with our satellites," Van der Boon explains.

"This being said, we do have a really strong field today, so it can easily become a bit weaker and we would still be ok."

Even so, Van der Boon is confident that we need more knowledge when it comes to the magnetic field.

"Throughout human history, Earth's magnetic field has been strong and stable, but we are starting to understand that this was not always the case. Our research shows that when we look back in time, Earth's magnetic field behaved very differently from today. This new research can help us understand how and when Earth's inner and outer core have formed, which in turn can be used to improve computer models that can be used to predict Earth's magnetic field."

The study was published in *Earth-Science Reviews*.

More information: Annique van der Boon et al, A persistent non-uniformitarian paleomagnetic field in the Devonian?, *Earth-Science Reviews* (2022). DOI: 10.1016/j.earscirev.2022.104073

Provided by University of Oslo