

Earth's magnetic field could flip within a human lifetime

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By: Robert Sanders

Imagine the world waking up one morning to discover that all compasses pointed south instead of north.

It's not as bizarre as it sounds. Earth's magnetic field has flipped – though not overnight – many times throughout the planet's history. Its dipole magnetic field, like that of a bar magnet, remains about the same intensity for thousands to millions of years, but for incompletely known reasons it occasionally weakens and, presumably over a few thousand years, reverses direction.



Left to right, Biaggio Giaccio, Gianluca Sotilli, Courtney Sprain and Sebastien Nomade sitting next to an outcrop in the Sulmona basin of the Apennine Mountains that contains the Matuyama-Brunhes magnetic reversal. A layer of volcanic ash interbedded with the lake sediments can be seen above their heads. Sotilli and Sprain are pointing to the sediment layer in which the magnetic reversal occurred. Photo: Paul Renne

Now, a new study by a team of scientists from Italy, France, Columbia University and the University of California, Berkeley, demonstrates that the last magnetic reversal 786,000 years ago actually happened very quickly, in less than 100 years – roughly a human lifetime.

"It's amazing how rapidly we see that reversal," said UC Berkeley graduate student Courtney Sprain. "The paleomagnetic data are very well done. This is one of the best records we have so far of what happens during a reversal and how quickly these reversals can happen."

Sprain and Paul Renne, director of the Berkeley Geochronology Center and a UC Berkeley professor-in-residence of earth and planetary science, are coauthors of the study, which will be published in the November issue of *Geophysical Journal International* and is now available [online](#).

Flip could affect electrical grid, cancer rates

The discovery comes as [new evidence](#) indicates that the intensity of Earth's magnetic field is decreasing 10 times faster than normal, leading some geophysicists to predict a reversal within a few thousand years.

Though a magnetic reversal is a major planet-wide event driven by convection in Earth's iron core, there are no documented catastrophes associated with past reversals, despite much searching in the geologic and biologic record. Today, however, such a reversal could potentially wreak havoc with our electrical grid, generating currents that might take it down.

And since Earth's magnetic field protects life from energetic particles from the sun and cosmic rays, both of which can cause genetic mutations, a weakening or temporary loss of the field before a permanent reversal could increase cancer rates. The danger to life would be even greater if flips were preceded by long periods of unstable magnetic behavior.

"We should be thinking more about what the biologic effects would be," Renne said.

Dating ash deposits from windward volcanoes

The new finding is based on measurements of the magnetic field alignment in layers of ancient lake sediments now exposed in the Sulmona basin of the Apennine Mountains east of Rome, Italy. The lake sediments are interbedded with ash layers erupted from the Roman volcanic province, a large area of volcanoes upwind of the former lake that includes periodically erupting volcanoes near Sabatini, Vesuvius and the Alban Hills.



Leonardo Sagnotti, standing, and coauthor Giancarlo

Scardia collecting a sample for paleomagnetic analysis.

Italian researchers led by Leonardo Sagnotti of Rome's National Institute of Geophysics and Volcanology measured the magnetic field directions frozen into the sediments as they accumulated at the bottom of the ancient lake.

Sprain and Renne used argon-argon dating, a method widely used to determine the ages of rocks, whether they're thousands or billions of years old, to determine the age of ash layers above and below the sediment layer recording the last reversal. These dates were confirmed by their colleague

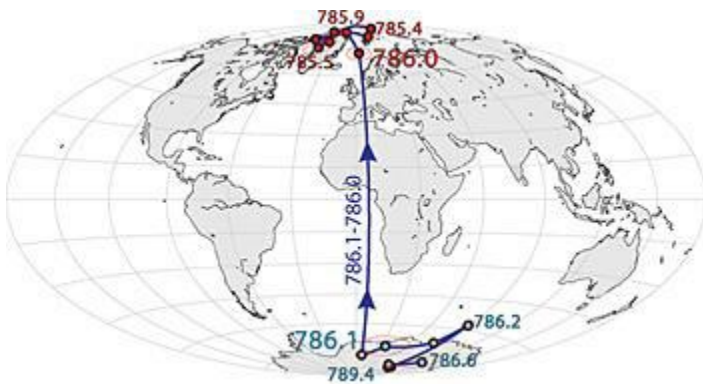
and former UC Berkeley postdoctoral fellow Sebastien Nomade of the Laboratory of Environmental and Climate Sciences in Gif-Sur-Yvette, France.

Because the lake sediments were deposited at a high and steady rate over a 10,000-year period, the team was able to interpolate the date of the layer showing the magnetic reversal, called the Matuyama-Brunhes transition, at approximately 786,000 years ago. This date is far more precise than that from previous studies, which placed the reversal between 770,000 and 795,000 years ago.

“What’s incredible is that you go from reverse polarity to a field that is normal with essentially nothing in between, which means it had to have happened very quickly, probably in less than 100 years,” said Renne. “We don’t know whether the next reversal will occur as suddenly as this one did, but we also don’t know that it won’t.”

Unstable magnetic field preceded 180-degree flip

Whether or not the new finding spells trouble for modern civilization, it likely will help researchers understand how and why Earth’s magnetic field episodically reverses polarity, Renne said.



The ‘north pole’ — that is, the direction of magnetic north — was reversed a million years ago. This map shows how, starting about 789,000 years ago, the north pole wandered around Antarctica for several thousand years before flipping 786,000 years ago to the orientation we know today, with the pole somewhere in the Arctic.

The magnetic record the Italian-led team obtained shows that the sudden 180-degree flip of the field was preceded by a period of instability that spanned more than 6,000 years. The instability included two intervals of low magnetic field strength that lasted about 2,000 years each. Rapid changes in field orientations may have occurred within the first interval of low strength. The full magnetic polarity reversal – that is, the final and very rapid flip to what the field is today – happened toward the end of the most recent interval of low field strength.

Renne is continuing his collaboration with the Italian-French team to correlate the lake record with past climate change.

Renne and Sprain’s work at the Berkeley Geochronology Center was supported by the Ann and Gordon Getty Foundation.

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