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Ancient mariners reveal tales from the Earth's core

Ship logs and pottery show how the geomagnetic field has changed.

Philip Ball

While sailors plied the Seven Seas in the seventeenth and eighteenth centuries, little did they know that their ships' logs would one day help scientists to reconstruct the history of the Earth's magnetic field.

Old ship records of magnetic north have helped to unravel a record of our planet's field.

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Geophysicist David Gubbins and his co-workers at the University of Leeds in England have used old navigational data, combined with records taken from archaeological artefacts, to figure out how the direction and strength of the magnetic field changed between 1590 and 1840, roughly the time between Francis Drake's voyages on the Golden Hind and Charles Darwin's journey on the Beagle.

Systematic records of the geomagnetic field only exist from around the middle of the nineteenth century, when physicist Carl Friedrich Gauss devised a method to measure it. These measurements show that since that time the strength of the field has fallen gradually by around 0.05% per year.

"A lot of people have been getting very excited that the field strength has been decreasing at this high rate," says Cathy Constable, a geophysicist at the Scripps Institution of Oceanography in La Jolla, California. "They see it as evidence that we're headed for the next geomagnetic reversal."

At a reversal, the Earth's magnetic field fades briefly away before the north and south poles reverse. The process by which this happens is not fully understood, but probably involves changes in circulation patterns in the planet's molten core. Such reversals happen about once every million years.

Gubbins and his colleagues now report in *Science* that the recent decline only started, by coincidence, around the time the measurements themselves began[1]. By using navigational logs to extend the record back a further 250 years, they find that the geomagnetic field strength was almost constant until around 1840, and only then started to dip.

"This new record shows that the trend is only temporary," says Constable. So, she says, forecasts of an impending geomagnetic flip are premature.

Frozen in time

Before 1840, the best records we have of the planet's magnetic field strength are contained in rocks and archaeological artefacts. Atoms of magnetic material such as iron within the ground or pottery are frozen in line with the Earth's magnetic field when a rock or pot is heated and then cooled, revealing information about the field strength.

"It's surprising how accurate those old measurements are."

Jeremy Bloxham
Harvard University

Some researchers have found signs in this data that the Earth's magnetic field wasn't decaying as quickly as it is today between 1600 and 1800. But these records are patchy and calculating global field strength from them is fraught with inaccuracy.

To get a better estimate, Gubbins and colleagues have combined these data with

more precise information about the direction of the magnetic field over time. Together these data sets can then be plugged into a model of how the Earth's magnetic field is known to behave, to extract a global picture of field strength.

To get the directional information, the researchers raided ship logbooks. Mariners of several hundred years ago would use observations of the Sun or stars to determine 'true north', and then note the difference between this and 'magnetic north' as revealed by their compasses. "It's very surprising how accurate those measurements are," says Jeremy Bloxham of Harvard University, Massachusetts, who collaborated with Gubbins and co-worker Andy Jackson at Leeds in compiling the historical records in the late 1980s.

Historical re-enactment

Sailors would make measurements to the nearest degree, notes Bloxham, making for a relatively precise record. But there are often systematic errors in their notes, caused by the fact that the sailors didn't always know exactly where they were; not, at least, until reliable methods for determining longitude were devised in the eighteenth century. Researchers have spent some 20 years trying to clean up the sailors' data in this regard.

This long process has now revealed a detailed picture of our planet's magnetic field over time. It is not nearly so simple as the field around a traditional bar magnet. Field lines do not simply emanate from the poles of our planet. Instead the field is patchy, with regions of 'reverse flux' where the field lines go in the opposite direction. The Leeds researchers say these patches have altered over the past four centuries: spots in the southern hemisphere that are now clearly evident were barely present at all before 1840, they say.

It seems that something may have happened within the planet's core in the 1800s to change the field's behaviour, they say. The team suggests that the next step should be to look elsewhere in the historical record for other times when the rate of change in the field altered, to better understand what causes such changes.

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Top

References

1. Gubbins D., *et al*. *Science*, **312**. 900 - 902 (2006).

Top