Moon rocks offer new view of lunar dynamo

Process that generated magnetism lasted 160 million years longer than previously thought.

Alexandra Witze

06 May 2013

NASA/Sean Smith

Molten rock churning in the Moon's core created its ancient magnetic field.

The Moon clung to its magnetic field until at least 3.56 billion years ago, a study suggests — about 160 million years longer than scientists had thought.

That small change may be enough to rule out some ideas about how the Moon generated and held onto its ancient magnetism, through a process known as a dynamo.

“It seems like the lunar dynamo lasted very late in the Moon’s history,” says Benjamin Weiss, a palaeomagnetics expert at the Massachusetts Institute of Technology (MIT) in Cambridge. “That’s a very surprising result.”

Weiss and his colleagues, led by MIT planetary scientist Clément Suavet, report the findings today in the *Proceedings of the National Academy of Sciences*[1].

Although the Moon has no global magnetic field today, rocks collected during the *Apollo* missions show that it once did. Molten rock churning in a planet’s interior can generate a dynamo, and researchers have suggested several possible triggers for this stirring. An extraterrestrial impact — from chunks of rock left over from the Solar System’s formation, for example — could have smashed the Moon hard enough to jolt liquid in its interior. Or heat differences caused by radioactive decay could have prompted liquid to shift in great convective movements, like a pot of water boiling on the stove.

To know which option is correct, scientists must first determine how long the dynamo lasted and how strong it was at various points in history. Suavet and his team tackled these questions by re-analysing two 3.56-billion-year-old rocks collected by the *Apollo 11* astronauts in 1969.

Using several techniques, the scientists found that the rocks had magnetic fields of 13–70 microtesla. The higher end of that range is comparable to Earth’s magnetic field today.

The fact that the Moon still had a magnetic field 3.56 billion years ago should rule out impact as the origin of the Moon’s dynamo at that time, says Suavet. The dates do not line up: lunar impacts large enough to stir up a core dynamo dropped off around 3.72 billion years ago, and any dynamo created this way would have also soon faded.

A better option, Weiss says, may be a theory proposed in *Nature* in 2011 by Christina Dwyer, a planetary scientist at the University of California, Santa Cruz, and her colleagues[2]. It holds that Earth’s gravitational tug may have caused the Moon’s solid mantle and liquid core to separate and move in such a way as to keep stirring the fluid. “I’ve been hoping to see measurements like this,” Dwyer says of the latest study. “It really does help differentiate among different models for how the dynamo occurred.”

Those who support an impact-driven dynamo aren’t giving up so easily. Michael Le Bars, a fluid dynamicist at the Non-Equilibrium Phenomena Research Institute in Marseille, France, published an impact explanation for the lunar dynamo in the same issue of *Nature* in which Dwyer's paper appeared[3]. He says that extraterrestrial impacts could have kicked off a dynamo earlier in the Moon’s history. “We are convinced, from fluid-mechanics arguments, that impacts indeed produced a magnetic field at some point,” Le Bars says.

Indeed, the Moon could have had different dynamos generated through different mechanisms at different times, Suavet and Weiss say. They are now looking at other, even younger, Moon rocks to try to pin down whether the dynamo lasted beyond 3.56 billion years ago.

References

1. Suavet, C. *et al*. *Proc. Natl Acad. Sci. USA* http://dx.doi.org/10.1073/pnas.1300341110 (2013).
2. Dwyer, C. A., Stevenson, D. J. & Nimmo, F. *Nature* **479**, 212–214 (2011).
3. Le Bars, M., Wieczorek, M. A., Karatekin, Ö., Cébron, D. & Laneuville, M. *Nature* **479**, 215–217 (2011).