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Geophysicists Push Age of Earth's Magnetic Field Back 250 Million Years

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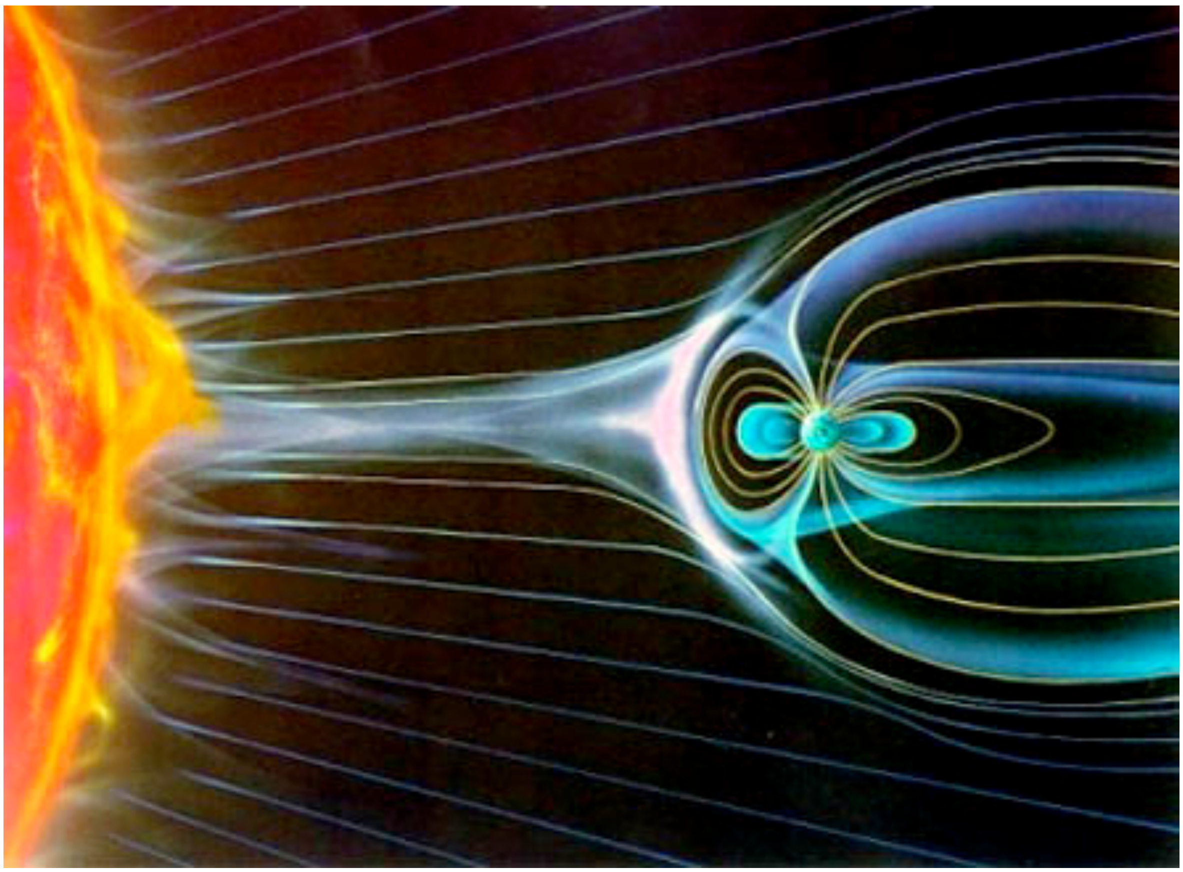

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By Lisa Grossman, Science News

Earth's magnetic field existed about 250 million years earlier than previously thought, new research suggests, which would make it old enough to have shielded life on the planet's surface from the sun's most harmful cosmic radiation.

Earth's magnetic field was born 3.45 billion years ago, a team including researchers from the University of Rochester in New York and the University of KwaZulu-Natal in South Africa report in the March 5 issue of *Science*.

That formation date falls during life's earliest stages of development, between the period when the Earth was pummeled by interplanetary debris and when the atmosphere filled with oxygen. Several earlier studies had suggested that a magnetic field is a necessary shield against deadly solar radiation that can strip away a planet's atmosphere, evaporate water and snuff out life on its surface.

"I think it's a magnificent piece of work, a real landmark," says geophysicist David Dunlop of the University of Toronto, who was not involved in the research. "It pushes the boundary back about as far back as you could reasonably expect to measure on Earth."

The researchers measured the magnetic strength of certain rocks found in the Kaapvaal craton of South Africa, a geologic region known to date back more than 3 billion years.

Just finding old rocks wasn't enough, though. "It's a Goldilocks theory of finding rocks," says John Tarduno of the University of Rochester, a coauthor of the new study. Iron minerals record the strength and direction of the magnetic field that was present during their formation. But when rocks are heated in subsequent geological processes, they can lose or overwrite that record.

"We had to find a rock that had just enough iron to record a magnetic signature, but not so much that it would be affected by later chemical changes," Tarduno says.

The Greenstone Belt in South Africa had rocks that were just right: crystals of quartz less than two millimeters long with nanometer-sized bits of iron-containing magnetite embedded in them.

"Quartz is the perfect capsule," Tarduno says. "It's not affected by later events, but it has these [iron] inclusions in it."

Tarduno and his colleagues had studied similar rocks in 2007 and found that a magnetic field half as strong as today's was present 3.2 billion years ago. Using a specially designed magnetometer and improved lab techniques, the team detected a magnetic signal in 3.45-billion-year-old rocks that was between 50 and 70 percent the strength of the present-day field, Tarduno says.

"When we think about the origin of life, there are two threads to follow," Tarduno says. "One obviously is water. But you also have to have a magnetic field, because that protects the atmosphere from erosion and the complete removal of water." Mars may be dry today because it lost its magnetic field early on, he adds.

To determine if the early magnetic field was enough to hold back the rain of radiation, the team needed to know what the sun was doing. Tarduno and Eric Mamajek, an astronomer at the University of Rochester, used observations of young sunlike stars to infer how strong a solar wind the Earth was up against.

The young sun probably rotated more quickly than it does today, Tarduno says. This quick rotation powered a strong magnetic field, which heated the sun's atmosphere and carried away mass and angular momentum in a strong solar wind of charged particles. The team calculated that the point where the Earth's magnetic field cancels out the solar wind would be only about five Earth radii above the planet's center, less than half of the 10.7 radii it is today.

The amount of radiation regularly reaching Earth from the sun 3.45 billion years ago would be comparable to what rains down on the planet during the most powerful solar storms today, Tarduno says. The aurora borealis, caused by solar wind particles accelerating along Earth's magnetic field, would have been visible as far south as present-day New York City.

The study "can be used to guide our searches for other life-bearing planets" as well, says astronomer Moira Jardine of the University of St. Andrews in Scotland. Astronomers might want to focus more on older, less active stars or search for planets with their own magnetic fields, she says.

Despite the fact that no extrasolar planets with magnetic fields have ever been detected, Jardine and Tarduno remain optimistic. "It's just another parameter we need to think about," Tarduno says.