Radiocarbon from a 42,000-year-old kauri tree in New Zealand helped unravel Earth's last magnetic upheaval. JONATHAN PALMER

Ancient kauri trees capture last collapse of Earth's magnetic field

By **Paul Voosen** | Feb. 18, 2021 , 2:00 PM

Several years ago, workers breaking ground for a power plant in New Zealand **unearthed a record of a lost time**: a 60-ton trunk from a kauri tree, the largest tree species in New Zealand. The tree, which grew 42,000 years ago, was preserved in a bog and its rings spanned 1700 years, capturing a tumultuous time when the world was turned upside down—at least magnetically speaking.

Radiocarbon levels in this and several other pieces of wood **chart a surge in radiation from space**, as Earth's protective **magnetic field weakened** and its poles

Europe. "We're only scratching the surface of what geomagnetic change has done," says Alan Cooper, an ancient DNA researcher at the South Australian Museum and one of the lead authors of the study.

The study not only nails in fine detail the timing and magnitude of the magnetic swap, the most recent in Earth's history, but is also among the first to make a credible, though speculative, case that these flips can affect the global climate, says Quentin Simon, a paleomagnetist at the European Center for Research and Teaching in Environmental Geoscience in Aix-en-Provence, France. But some paleoclimate scientists are skeptical of the team's broader claims, saying other records show few traces of climate upheaval.

Earth's magnetic field is created by the flow of molten iron in the outer core, which is prone to chaotic swings that not only weaken the field, but also cause the poles to wander and sometimes flip entirely. The magnetic orientations of minerals in rock record long-lasting reversals, but can't capture the details of a flip lasting hundreds of years, like the one 42,000 years ago.

Radioactive carbon-14, however, can mark these shorter fluctuations. The isotope is produced when cosmic rays—charged particles from outer space—slip past the magnetic field and strike the atmosphere. It is taken up by living things, and its specific half-life makes it a standard clock. The team used radiocarbon to date the kauri wood by lining it up with accurate, but coarse, radiocarbon **cave records from China**. And by measuring finer carbon-14 changes in the rings, they tracked how its production varied over 40-year intervals, as the magnetic field ebbed and surged. "It's just amazing you can do this back 42,000 years ago," says Lawrence Edwards, a geochemist at the University of Minnesota, Twin Cities, who worked on the Chinese cave records.

Spikes in radiocarbon indicated the magnetic field

weakened to some 6% of its present day strength by 41,500 years ago. At that point the poles flipped and the field recovered some strength, before crashing and flipping back 500 years later. Cooper notes that not only was Earth's cosmic ray shield down; the Sun's was, too. **Evidence from ice cores** suggests that, around this same time, the Sun was experiencing several "grand minima"—episodes of low magnetic activity. The resulting cosmic ray assault charged the atmosphere to a level that would have knocked out today's power grid and created aurorae in the subtropics, Cooper says. "What happens when the atmosphere is that ionized?" he asks. "God only knows." (The paper is the first Cooper has led since **he was fired** in 2019 from the University of Adelaide following allegations that he bullied staff and students; Cooper has denied the allegations.)

To explore the consequences, the team ran a climate model, which suggested the cosmic ray bombardment would have eroded the ozone layer, reducing the heat it normally captures from ultraviolet rays. The high altitude cooling would have changed wind flows, which in turn may have led to "drastic changes" on the surface, including a warmer North America and cooler Europe, says Marina Friedel, a team member and doctoral student in stratospheric chemistry at ETH Zurich.

This is where other scientists say the study gets too speculative. Ice cores from Greenland and Antarctica that span the past 100,000 years capture stark temperature swings every few thousand years. But they show no shifts 42,000 years ago. A few Pacific Ocean records do show swings. But even if the shift occurred mostly in the tropics, as Cooper and colleagues suggest, it should be seen in the ice, says Anders Svensson, a glaciologist at the University of Copenhagen. "We just don't see that."

The study team goes further to argue that a climate

shift could account for a spate of curious events 42,000 years ago. Most notably, large mammals in Australia went extinct around that time. Neanderthals vanished from Europe, and elaborate cave paintings began to appear in Europe and Asia. Still, neither milestone in human evolution lines up well with the flip 42,000 years ago, and neither was sudden, says Thomas Higham, an archaeologist and radiocarbon expert at the University of Oxford. Linking them to the field reversal, he says, "seems to me to be pushing the evidence too far."

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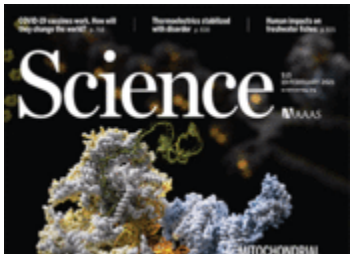

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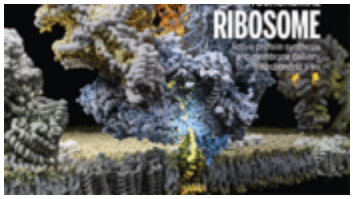

Table of Contents

ANTHROPOLOGY

England's Stonehenge was erected in Wales first

EPIDEMIOLOGY

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EPIDEMIOLOGY

France turns to citizens' panel to reduce vaccine skepticism