and his colleagues and published in standard issues of the journal were originally submitted to its special issues and were accepted by guest editors, “but were subsequently published in regular issues, at the authors’ request”, the statement says. These papers are already part of Elsevier’s investigation, it adds.

Elisabeth Bik, a research-integrity analyst in California known for her skill in spotting duplicated images in papers, says that the findings of Cabanac’s research are “shocking”. “This is a very new and disturbing type of fabricated paper,” she adds.

Jennifer Byrne, a molecular-oncology researcher at the University of Sydney, Australia, who also works on spotting fabricated papers, says that this is probably the tip of the iceberg because the researchers looked in depth at only one journal from one publisher. “There could be more plausible AI-generated papers within the literature that are harder to detect,” she adds.

WOOLLY MAMMOTH’S EPIC WANDERINGS PRESERVED IN TUSK

Chemical analysis of ice-age mammoth’s tusk reveals the huge distances it travelled during its lifetime.

By Ariana Remmel

Researchers have reconstructed the geographical movements of a single woolly mammoth (*Mammuthus primigenius*) using chemical ‘GPS tags’ preserved in one of its tusks. The findings show that the animal travelled so widely across what is now Alaska that it could have circled Earth almost twice.

Although researchers know a fair amount about the diet, genetics and ecology of woolly mammoths, insights into the life histories of individual animals are scarce.

“We can’t go back and watch these things like a modern ecologist might, but we can use chemistry to come up with good proxies,” says Chris Widga, a palaeontologist at East Tennessee State University in Johnson City.

Every place on Earth has a distinct chemical signature based on differences in its geology. The ratios of various isotopes of elements such as strontium and oxygen in the bedrock and water create a unique profile specific to that location that remains consistent over millennia, and is incorporated into soil and plants. As mammoths grazed on the Arctic plains, these isotopic signatures were integrated into their ever-growing tusks, creating a permanent record of the animals’ whereabouts with almost daily resolution.

Until now, no one had analysed these chemical GPS tags across the full length of a tusk, which reflects the mammoth’s entire life. “This is by far the largest and most comprehensive study of its kind,” says Matthew Wooller, a palaeoecologist at the University of Alaska Fairbanks, who co-led the study with geoscientist Clement Bataille at the University of Ottawa in Canada and colleagues.

Their findings provide a glimpse of the life and death of a single woolly mammoth during the last ice age (M. J. Wooller *et al. Science* https://doi.org/grbz; 2021).

Previous analysis of the 1.7-metre-long tusk had shown that it belonged to a male mammoth that died around 17,100 years ago, when it was at least 28 years old. The researchers split the tusk down the middle to reveal the layers of growth, and used lasers to sample the chemical composition at approximately 340,000 points along the tusk’s full length. They then compared the isotopic profiles at each of these data points with a geological map of Alaska and northwest Canada, and used a computer algorithm to map out the most probable routes for the mammoth to have travelled, backtracking from where its remains were found.

“It’s a total soap opera, all the way up to the day it died,” Wooller says.

The bull spent much of its early life in the Yukon River basin and wider Alaskan interior, where it made repeated, long-distance journeys between smaller territories. The migratory behaviour is similar to that of modern elephant groups, which suggests that the young mammoth was moving with a herd.

At about 16 years old, the isotopic pattern in the tusk becomes more variable. The mammoth seems to have wandered over longer distances in less regular patterns than during its juvenile years. This could indicate that it left its herd to roam freely, as has been observed in mature male elephants. For around a decade, it travelled widely, sometimes visiting areas where mammoth remains have been found.

In the last year and a half of the animal’s life, its stamping grounds shrank to a single region near the northern coast of Alaska. A distinctive isotope pattern recorded at the base of the tusk showed the “telltale hallmark of starvation in mammals”, which was probably what caused its death, says Wooller.

“The fact that this study presents an ‘iso-biography’ for a single individual is part of what makes it so exciting,” says Kate Britton, an archaeological scientist at the University of Aberdeen, UK. “We are gaining individual insight into the behaviour of an animal that roamed Alaska more than 17,000 years ago, and the strontium isotopes allow us to follow in its footsteps.”

ORLA/GETTY

Woolly mammoths (illustration) roamed throughout the Arctic Circle during the last ice age.