# Misha the elephant lived in zoos, but her tooth enamel helps reconstruct wildlife migrations

March 11 2025, by Brian Maffly

Misha at the Hogle Zoo in Salt Lake City. Photo courtesy of Hogle Zoo. Banner photo: A cross section of Misha's molar used in the research. Credit: Brian Maffly.

Teeth recovered from a beloved zoo elephant that died in 2008 are helping University of Utah geologists develop a method for tracking the movements of large herbivores across landscapes, even for animals now extinct, such as mastodons and mammoths.

Outlined in findings recently published in *Communications Biology*, the technique analyzes isotope ratios of the element strontium (Sr), which accumulates in tooth enamel. For large plant-eating land mammals, the relative abundance of two strontium isotopes in teeth and tusks reflects where the creature may have roamed during its lifetime.

"Our study not only adds to our understanding of how tooth enamel records an animal's Sr isotope exposure, but also helps to reconstruct animal migrations from Sr isotope analysis," lead author Deming Yang said in a posting about the research. "It can be applied to studies of paleobiology, to answer how megaherbivores migrated in the past. It can also be applied to studies of modern conservation and forensics, to trace the origins of the illegal ivory trade and other forms of wildlife trafficking."

The star of the study is Misha, a female elephant acquired by Salt Lake City's Hogle Zoo in 2005.

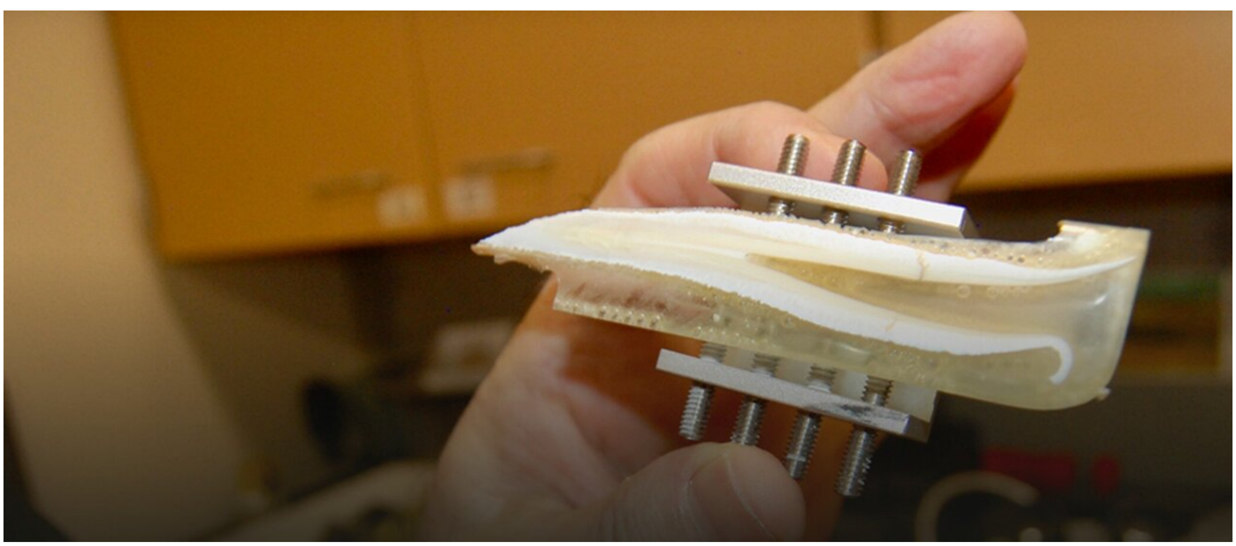
Chemically similar to calcium, strontium from the environment accumulates in highly mineralized tissues, such as animals' bones and teeth.

"As animals eat and drink, they pick up this environmental signature and store it in their teeth, preserving a series of environmental exposures like historic archives," Yang wrote. This is because the geology of different places presents different isotope signatures for 87-strontium/86-strontium [$^{87}Sr/^{86}Sr$] and those isotope ratios are reflected in plants and water.

"We use other elements, but in this case, we're focusing on strontium, which has proven to be really useful because of its strong link to geology," co-author Gabe Bowen said. "Ultimately it comes down to where that element comes from, how the animal gets it into their body and from what sources."

The isotope $^{87}$Sr is radiogenic, meaning it is produced from the decay of another element, in this case rubidium, found next door to strontium on the Periodic Table, whose half-life exceeds 49 billion years, about 10 times the age of Earth. While $^{87}$Sr increases over time, the abundance of other strontium isotopes remains fixed. Accordingly, isotope ratios are a proxy for the age of rocks and typically differ from place to place.

Co-author Thure Cerling, a highly decorated distinguished U professor of both geology and biology, is a pioneer in the use of isotope analysis to shed light on ecological questions such as soil formation, animal physiology, wildlife ecology and climate change.



A cross section of Misha’s molar used in the research. Credit: Brian Maffly.

Upon hearing of Misha's death in news reports in 2008, Cerling saw a rare chance to advance the science of isotope geology. He reached out to Hogle Zoo to get permission to extract the elephant's molars and a tusk before she could be buried. What made the teeth so useful to Cerling and his colleagues was the veterinary record of where Misha lived over the 27-year course of her life.

As a postdoctoral researcher, Yang led the research to investigate how Misha's tusk and teeth recorded her strontium exposures years before her death, including her relocation history. The elephant arrived in Salt Lake City in 2005 from Six Flags Discovery Kingdom in Vallejo, Calif.

"It's a very simple movement history. She lived in one location for a decade or more, and then moved here [to Salt Lake City], and we know the date of that move," Bowen said. "We don't have a lot of opportunities to see these kinds of natural experiments."

The team used laser ablation to sample material from various growth lines along the elephant's tooth enamel and tusk, which was measured using a mass spectrometer capable of identifying the amounts of strontium isotopes they contained.

The researchers found that the innermost layer of enamel best preserves the isotope record and is the ideal place for sampling.

"We determined the strontium isotopes from the top to the bottom of the tooth in different parallel lines and those represent different times in the growth of Misha," said geologist Diego Fernandez, who operates the U's mass spectrometry lab. "It captured the time when Misha was moved from California to Utah."

Undergraduate Katya Podkovyroff helped Fernandez refine the lab procedures for taking samples of bioapatite, the calcium material that makes up bone and enamel.

"It was in this lab where I got my first hands-on experience with scientific research, and I immediately fell in love. One of the most thrilling aspects of the job was learning that each sample carried a history, a mystery waiting to be unraveled through chemical signatures," said Podkovyroff, now a graduate student at the University of Oregon.

"This research was both exciting and challenging: sampling ivory required extreme precision, as even minor contamination could alter results, and isotope purification is a meticulous and time-consuming process," she continued. "The most rewarding aspect of this project was its broader implications beyond a single case study: it has applications in modern conservation efforts, with the ability to trace the origins of the illegal ivory trade."

**More information:** Deming Yang et al, Strontium isotope mapping of elephant enamel supports an integrated microsampling-modeling workflow to reconstruct herbivore migrations, *Communications Biology* (2025). DOI: 10.1038/s42003-025-07686-9

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