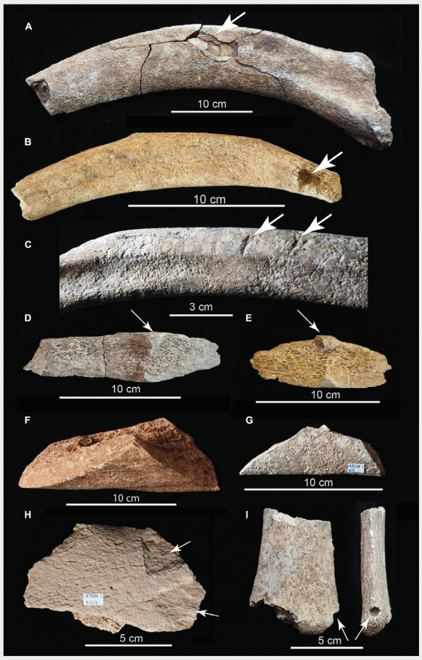
A Mammoth Whodunit

Hiking near his New Mexico home, Gary Hartley noticed pieces of what looked like tusk ivory in his path. He informed the landowner, vertebrate paleontologist Timothy Rowe, and together they found more tusk and bone fragments of what Rowe identified as a mammoth (*Mammuthus* sp.).



TIMOTHY ROWE ET AL./THE UNIVERSITY OF TEXAS AT AUSTIN

Bones of the Hartley mammoth from New Mexico with butchering marks

Rowe, a professor at the University of Texas at Austin (UT), usually studies more ancient specimens that depict the early evolution of mammals. For the Hartley mammoth find, however, he teamed with colleagues at UT and researchers at other institutions in the United States and Denmark to excavate the site and subject the bones and surrounding sediment to CT scanning and chemical analyses, respectively.

"The specimen is so badly broken apart," he said, which became key to the team's conclusions. The researchers detailed how the remains of an adult female mammoth and calf had been intensively bashed and butchered by people for meat, marrow, and fat. Other potential explanations—such as scavenging by carnivores, trampling by herbivores, or tumbling by flowing water—didn't fit the pattern of skeletal damage.

From a buried pile of broken ribs, facial bones sheared from the braincase, other skull parts, and bone scraps, plus fist-sized sandstone cobbles and a fifty-pound boulder, the team identified parallel chop marks on a rib, puncture wounds in grease-rich, spongy bone, and damage from blunt-force blows. More than thirty bone flakes had been removed from the mammoth and then deployed as knives. Six small chert flake tools were also part of the pile.

Rowe's CT scans of some bones revealed an additional line of evidence—fracture networks radiating from a single point of percussive impact. An apparent fire pit contained pulverized bone, exploded mammal teeth, and burnt bones and scales from fish.

Advanced radiocarbon dating by three labs on proteins isolated from mammoth bone collagen produced stunning results. Five dates indicated that the mammoths died between 34,650 and 31,300 years ago. A sixth date, obtained by measuring the collagen protein hydroxyproline unique to bone, thus considered to be more accurate, is older still—ranging from 38,900 to 36,250 years ago.

That makes the Hartley site more than twice as old as other widely accepted archeological evidence for the "first" Americans, the Clovis culture. The new evidence lends weight to an emerging hypothesis for an older, pre-Clovis presence of humans in North America.

"Regardless of the age, the evidence of butchery really stands," Rowe said. "The implication is that humans attained a global distribution far earlier than expected." (*Frontiers in Ecology and Evolution*)

—Blake Edgar

Thick microbial mats in steam vents that run along the East Rift Zone on the Big Island

JIMMY SHAW

Life in a Lava Tube

In lava caves, threaded below and through the Hawaiian Islands, microbes thrive—bustling, burbling communities of bacteria, microorganisms, and small multicellular organisms.

A team of microbial ecologists, including Penelope Boston of the NASA Ames Research Center, Diana Northup of the University of New Mexico, and NASA postdoctoral research fellow Rebecca Prescott, aimed to deepen our knowledge of these cave communities. With help and guidance from local Big Island cave conservationists to avoid caves that were *kapu* (culturally forbidden), they collected seventy samples from lava tubes and geothermal vents. Previous research had indicated that microbes thrive best when their communities are diverse, but why there was such high diversity in lava caves was unknown.

Prescott studies quorum sensing, the phenomenon that allows groups of microbes that live on surfaces—mats or biofilms—to act as a group instead of individual cells. "I needed to have a better understanding of the community structure in these lava tubes," Prescott said. "I wanted to understand who is hanging out with whom, and therefore who might be 'talking' to whom."

The researchers found that the caves were rich sources of ancient types of microbes that have existed on Earth since very early on, especially the phylum Chloroflexi. This group of microbes is associated with many other microbes in lava caves and geothermal vents, and therefore might be one of the "talkers," cooperating with other bacteria.

"These early Earth phyla have been around a really long time" according to Prescott. Lava caves are often considered extreme environments. "But many are very steady environments. The temperature tends to be very stable, they're humid, and great places for life."

The highest microbial diversity was found in the oldest caves, and lowest in the younger steam vents and geothermally active caves. The research team observed more complex interactions between microbial communities in geothermal vents, or fumaroles. As with human communities, microbes may rely on neighborly cooperation more in harsh or dynamic environments.

Understanding these microbes, their environments, and their communities can also inform studies of life on other planets—past, present or future. Because volcanic lava tube environments mimic geology known to occur on Mars and the Moon, these results can help astrobiologists look for and interpret life if they find it, not to mention assess the role of microbes in future human life away from Earth. "These microbes are responsible for turning lava flow into soil over time," Prescott said. "It's not just roots and wind and rain—microbes are also key to breaking down rocks . . . And to figure out how to live and grow food on Mars or the Moon, we need to better understand this process." (*Frontiers in Microbiology*)

—Brittany Steff