

ARCHAEOLOGY

Iceman's preservation was not a freak event

Body's survival without lucky accidents of climate suggests more ice mummies await

By Andrew Curry

In 1991, hikers in the Alps came across a sensational find: a human body, partly encased in ice, at the top of a mountain pass between Italy and Austria. Police initially assumed the man had died in a mountaineering accident, but within weeks archaeologists were arguing he was actually the victim of a 5100-year-old murder.

They were right: Later dubbed Ötzi after the Ötztal Valley nearby, the man's body is the oldest known "ice mummy" on record. His physical condition, equipment, and violent death—confirmed when scans revealed an arrowhead embedded in his shoulder—have opened a window into life in prehistoric Europe. But Ötzi's preservation may not be as unusual as it seemed, archaeologists argued this week. And that could mean more bodies from the distant past are waiting to emerge as the climate warms and ice melts.

Ötzi "was such a huge surprise when he was found people thought he was a freak event," says Lars Pilø, an archaeologist working for the Oppland County Glacier Archaeological Program in Norway. But many of the original assumptions about how weather, climate, and glacial ice conspired to preserve him were wrong, Pilø and other researchers write in the journal *The Holocene*. "This paper sheds new light on the interpretation of this exceptional archaeological find," says Matthias Huss, a glaciologist at ETH Zürich who was not part of the team.

The first archaeologist on the scene 30 years ago was a researcher at the nearby University of Innsbruck named Konrad Spindler. Stunned by the body's remarkable preservation, he came up with a plausible explanation. Damage to Ötzi's backpack and other equipment led Spindler, who died in 2005, to suggest he was fleeing a conflict and had taken refuge in the mountains late in the year. After dying on a high mountain pass, he was quickly covered by winter snow. A climate shift soon sent temperatures plunging for centuries or longer, preserving the body in an icy glacial "time capsule."

Spindler credited the shallow stone gully where hikers found the iceman with shielding him from the relentless flow of glacial ice just a few meters above. The ice must have remained intact until a warm summer in 1991 melted it away, exposing the mummy. "The general understanding was that Ötzi marked this beginning of a cooler period," Huss says, "as people were sure that [he] must have been within the ice without interruption since his death."

But with the retreat of glaciers and ice patches around the world over the past few decades, other ancient remains have emerged, including bodies, hunting

ments. Radiocarbon dates from grass, dung, moss, and other organic material from the bottom of the gully are younger than Ötzi's body, an indication that the site was open to the air. "This idea he was frozen in a time capsule isn't right," Pilø says.

That undercuts the idea that a climate shift or cold period set in 5100 years ago, enclosing the body in ice that stayed intact for millennia. "I've myself made this case in courses with students—which I will need to revise," Huss says.

Periodic exposure could also explain why the upper parts of Ötzi's body—particularly the back of his head and his fur cape—are partially decomposed, whereas the lower parts are intact. "If he had been immediately buried in ice he would have been better preserved," Pilø says.

Nor was Ötzi quickly buried where he died, the authors suggest. "There's no way he could have died in the gully," Pilø says. Instead, his missing and scattered belongings, some found 6 meters away, suggest he died on the spring snow above the gully and was later washed into it by meltwater.

That scenario—and not a fight before the mortally wounded victim fled to higher ground—may explain the damaged equipment. Ancient skis, arrowheads, and hunting equipment discovered in

Norway, Canada, and elsewhere also show breakage and wear. The similarities suggest shifting ice, or the tumbling of Ötzi's body and equipment by meltwater, splintered or snapped the artifacts.

The new analysis suggests the iceman's dramatic death, shot in the back with an arrow, remains the most unusual aspect of the find. "What is unique—so far—is there was a person shot up there and preserved," Pilø says.

Even that could change. Evidence from other sites in the Alps now suggests mountain passes were often border lines and conflict zones between prehistoric groups. "There's a chance similar sites have preserved parts of human corpses," Reitmaier says. "We have to stay keen in the next years, because ice patches are melting very rapidly everywhere." ■



The iceman was found in a gully, still partly embedded in ice.

equipment, horse manure, and skis. "No one expected similar sites," says Thomas Reitmaier, an archaeologist at the Archaeological Service of the Canton of Grisons in Switzerland and a co-author of the new study. "Now, we have lots, and we find this one fits quite well with the picture of glacial archaeology we've developed."

Many of the lucky accidents thought to have preserved Ötzi never happened, the researchers concluded after re-evaluating some 30 years of research on the site and its famous occupant. For example, recent analyses by other researchers of seeds and leaves on and around the body point to a death in spring rather than fall, perhaps leaving Ötzi's body partially exposed in snow over an Alpine summer.

In the centuries that followed, the authors argue, he was repeatedly bared to the ele-



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