Magnetic “noise” holds the key to catching clay counterfeits

The heat required to erase secondary magnetic signals in clay can aid researchers in distinguishing ancient pottery from modern forgeries.

By Laura Fattaruso

When museums and other institutions need to determine whether a clay artifact is truly ancient or merely a forgery, they have no foolproof method of confirming its authenticity. But now a new technique that uses secondary magnetization could help to root out the fakes.

Existing methods for evaluating the authenticity of ancient objects, such as characterizing the clay or using thermoluminescence, can be thwarted by skilled forgers, thus leaving large collections of items whose legitimacy is uncertain.

But the history recorded in an object’s magnetization is much harder to fake. When rocks, bricks, and clay pottery cool below a certain temperature, minerals can lock in a signature of Earth’s local magnetic field at that moment. Because a magnetic signature captures a snapshot in time, it can help scientists determine the age of some objects.

To measure a signature, researchers first typically remove a weaker, secondary magnetic component that accumulates in objects slowly over time. Now a research team at the University of California, San Diego, led by postdoc Yoav Vaknin and his adviser Lisa Tauxe, has shown how that secondary magnetization can actually reveal the authenticity of clay artifacts.[1]



Researchers used magnetic measurements of clay artifacts to determine whether each one was either a modern forgery **(left)** or an authentic item created more than 1000 years ago **(right)**. Some minerals in clay take on a magnetization determined by the orientation and strength of Earth’s magnetic field at the time they are fired and cooled. Over time, the clay objects accumulate an additional, weaker magnetic signature that is easier to remove from recently made pottery than from ancient artifacts. (Images adapted from ref. 1.)



Lisa Tauxe loads clay samples into a heating chamber. (Photo from Scripps Institution of Oceanography, UC San Diego.)

"It's funny because we're often trying to come up with experimental protocols that allow us to see past these secondary magnetizations. We don't really care about them, they're the noise," says Joshua Feinberg, director of the Institute for Rock Magnetism at the University of Minnesota Twin Cities. "What's kind of clever about this study is they're using the presence of that noise."

The team heated a clay sample in increments to slowly remove the secondary magnetization and measured how the strength and orientation of the total magnetic signature changed at each step. Eventually, the secondary magnetization was stripped away entirely, leaving only the primary magnetization that was locked in when the pottery first cooled.

Vaknin and colleagues used that protocol to examine a mix of 48 ancient and modern objects: clay artifacts from archaeological sites in the Levant in Asia, souvenirs purchased in Jerusalem, recently fired pottery, and three artifacts of unknown authenticity seized by the Israel Antiquities Authority.

Through computer simulations and lab work, the researchers discovered a key threshold: Clay objects more than 1000 years old require temperatures of at least 112 °C to remove their secondary magnetization. Modern pottery loses secondary magnetization at lower temperatures.

Although the method works well for distinguishing ancient objects from recent ones, it doesn't yield precise dates. "If it sat around for a thousand or 2000 or 3000 years, you can't really tell the difference in temperature," Tauxe says. "If it just sat around for 10 years, we can tell 10 versus a thousand years."

Confounding factors also present some limitations. The primary and secondary magnetizations add together as vectors to produce a single magnetic signature that changes angle and strength as the secondary signal is stripped away. If, by chance, a piece of pottery was buried at an orientation close to the one it had when it was fired, the signals become hard to distinguish. Additionally, the heat generated through exposure to fire later in an object's history can reset its magnetization.

Feinberg notes that it remains to be seen whether the method will work for regions outside the Levant that have different pottery traditions. The timing, mineral content of the clay, and processing techniques could all affect the way that magnetic signatures are retained.

As for the three artifacts of unknown authenticity, the data show that they are all ancient. "I was sure that at least one of them was a forgery," Vaknin says. "That was a big surprise." PT

Reference

1. Y. Vaknin et al., "Viscous remanent magnetization authentication method for archaeological artifacts," *Proc. Natl. Acad. Sci. USA* **123**, e2620397123 (2026).