Medieval Muslim Monument Shown to Contain Bone Powder

Excavations carried out at the 14th Century city wall of Granada have unearthed a brick kiln located next to stratified layers of bones and ashes. According to researchers from the University of Granada (UGR), this in situ evidence suggests that this kiln was used to manufacture a coating for the wall, which incorporated powder made from burnt bones.

"The bricks from the kiln that was discovered showed evidence of melting (blackened surfaces and small bubbles), which indicates that temperatures inside the kiln were in excess of those needed to fire bricks and Nazari ceramics. The wall was built under the rule of the Nazari sultan between 1333 and 1354", Carolina Cardell, lead author of the study and a researcher at the UGR, tells SINC.

By using analytical techniques that have highlighted strong synergies between archaeology and other scientific disciplines, the researchers were quickly able to confirm their original theory, with the results appearing in the journal Analytical Chemistry.

Until now, the presence of burnt bone powder had been demonstrated in monuments of Greco-Latin, Celtic and Christian monuments (in the Middle Ages), but never before in Medieval Muslim constructions.

By subjecting the bricks to micro X-ray diffraction, a non-destructive technique, it was possible to quickly identify their mineral content using moderately high spatial resolution (around half a millimetre). By analysing the mineral cartography from the map of elements acquired through Scanning Electron Microscopy and EDX (SEM-EDX) microanalysis, the scientists were able to identify the distribution and morphology of the mineral phases within the patina on the wall, as well as their abundance.

The use of analysis techniques suited to the diverse archaeological materials yielded data about their micro-textural and structural characteristics. These provide key information about the manufacturing techniques used to construct the Nazari wall, and also provide clues about how to better preserve the structure.

Non-destructive techniques

Cardell and her team also applied complementary analysis techniques to the artefacts – micro X-ray diffraction, SEM-EDX, Fourier transform infrared spectroscopy, gas chromatography coupled with mass spectrometry and carbon-14 dating.

These tests helped to detect hydroxyapatite, which comes from bones, in the patina on the wall, as well as mineralogical changes that had taken place within the bricks as a result of being exposed to extreme heat, which showed the researchers that temperatures in the kiln reached a little over 1000ºC.

One of the most striking findings of this research project is that the bones were not used only as pigment (the calcination of bones at around 800-900ºC results in white or black bone pigments), but that, according to Cardell "the bone powder was added to make the patina of the wall stronger and more durable".

The results obtained could lead to these tools being used more widely in the study of cultural heritage artefacts. These "non-destructive" techniques have proved their effectiveness in the analysis of protected materials of great historical value, such as the wall of Granada, which is part of the Albayzín neighbourhood within the