ANCIENT CHARM
NEST ADVENTURE

Neutron-imaging techniques mean artefacts can be analysed without damaging them. © Hungarian National Museum

Neutrons help archaeologists to analyse their finds

Neutron-based imaging is an ideal, non-invasive technique for archaeologists to analyse the chemical composition of artefacts, although it is rarely used this way. The ANCIENT CHARM project partners will combine their expertise in different neutron-imaging methods to refine their technologies and develop new applications, particularly the 3D mapping of elements in objects. The NEST Adventure project aims to make such imaging more mainstream in archaeology, but could have applications in many areas of industrial materials analysis.

Kneeling on the muddy bottom of a deep trench, an archaeologist pulls out a brush and starts to flick at some dirt. He has been delicately excavating a small bone for several hours; this time it comes loose. He gently places it in a finds bag and labels it ready for further analysis.

Such painstaking excavations are just the beginning of a long process in which archaeologists try to find out about our heritage and past cultures. Much of the detective work takes place in high-tech laboratories. Laboratory analyses can help answer questions about an artefact's historical and cultural importance, and suggest methods for its preservation or restoration.

Chemical and structural analyses, for example, play a key role in understanding ancient fabrication techniques, the distribution of objects from production areas, and how they were used. However, the techniques commonly employed tend either to be invasive (requiring samples of material) or have limited penetrating power, so they are unable to probe the structure and composition of artefacts beyond a few micrometres.

Probing research

The application of neutron-based imaging and analysis techniques could avoid these limitations. Neutrons can penetrate thick layers of dense materials without substantial scattering or loss of energy. Furthermore, neutrons with energies similar to chemical bonds could be used to produce quantitative measures and even 3D images of the elemental composition and physical structure of artefacts.

The idea of developing an analysis technique based on neutron absorption is quite innovative in the field of archaeology, with a number of scientific and technical challenges. The ANCIENT CHARM project has therefore been established to tap into some of Europe's leading research on neutron-based imaging and to apply it to artefact analysis. The project is an exciting offshoot of the EU's leadership in the application of neutron sources, and will also reinforce Europe's strength in cultural heritage studies.

The multidisciplinary ANCIENT CHARM team includes neutron beam facilities,

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Recovering a find is the painstaking part of the work: only laboratory analyses can help answer questions about its heritage. © Hungarian National Museum

AT A GLANCE

Official title
Analysis by neutron resonant capture imaging and other emerging neutron techniques: new cultural heritage and archaeological research methods

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detector manufacturers, software engineers, physicists and representatives from the fields of archeology and cultural heritage.

The technical work draws on some of the partners' expertise in different neutron-based technologies. Neutron tomography, for example, is well established but cannot identify elements within materials. Measurements of the gamma emissions do identify elements but provide quantitative data only for bulk materials, rather than map elements throughout a single object. Meanwhile, neutron diffraction tomography can provide 2D maps of the strains and phases in materials, but only in simple metal objects.

Archaeological applications

The aim of ANCIENT CHARM is to further develop these and other neutron-imaging techniques and the associated equipment, and help establish neutron imaging as a mainstream archaeological analytical technique.

In particular, the partners hope to combine their expertise to develop a new imaging technique which they call neutron resonant capture imaging combined with neutron resonance transmission (NRCI/NRT). Both gamma-emission and neutron-transmission measurements will be used to determine the elemental composition of an object in 3D.

Therefore, this NEST project will open up an entirely new area of research, and aims to provide archaeologists with a powerful, new and entirely non-invasive analysis tool. Archaeologists will have the ability to obtain 3D maps of the elemental or phase composition of complex objects made from a variety of materials including metals, ceramics, marble and glass.

Indeed, the impact of ANCIENT CHARM could extend far beyond the archaeologist puzzling over his or her finds. Some of the imaging techniques could also be used in industry, for example to detect contaminants in materials, or metal enclosed in opaque, sealed containers.

ANCIENT CHARM aims to provide archaeologists with a powerful, new and entirely non-invasive analysis tool.

Perhaps one day a portable device might be developed too, enabling the archaeologist to map a site for objects and avoid much of the time-consuming and muddy digging.

SIXTH FRAMEWORK PROGRAMME