

3D Neutron Imaging of a XVIIIth Dynasty Egyptian Sealed Pottery

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Forever, art scientists, historians and museum curators are interested in the precise determination of the material composition and substructure analysis of historic objects. This scientific approach is essential as it can be employed to reveal the history of the sample, investigate the original material properties and even discover how the object has been restored in the past.

In this field of cultural heritage research, we recently investigated a sealed Ancient Egyptian pottery from the XVIIIth Dynasty (New Kingdom period), stored in the Museum of Aquitaine in Bordeaux, France. The object (inventory number 8608) is 97 mm in height with a maximum diameter of 64 mm. The original use of this jar remains a mystery for curators. Without any specific decoration, it looks like a simple red clay vessel hermetically sealed with a clay cork. Its shape (a jar with a neck) indicates that it was most likely used for liquids, not ointment, perfumed cream, or unguent, because it would not allow easy access to these less liquid contents for skin application. However, the existence of Menkheperre Tuthmosis III's cartouche (1479–1425 B.C.) on the pottery's clay cork allows us to infer that this object was probably very important, perhaps linked with the funeral ritual of this pharaoh. Indeed, a sticker under the object indicates that it was purchased in 1861 in Gournah, on the famous necropolis of Thebes (on the west bank of Luxor). According to experts, this nearly 3500-year-old pottery bottle probably did not contain viscera —usually preserved in canopic jars—but most likely offerings of food to the dead during his funeral.

In the framework of the CHARISMA project (Cultural Heritage Advanced Research Infrastructures, Synergy for a Multidisciplinary Approach to Conservation/Restoration), we analyzed the Egyptian jar with complementary techniques such as X-ray, terahertz (THz) radiation and neutron beam. The use of non-invasive THz radiation, 2D and 3D imaging revealed an internal mobile content inside the jar. This content was also visualized using an X-ray scanner, with the limitation that the measurement can alter the integrity of the object owing to the irradiation action.

Recently, we analyzed the jar at the Budapest Neutron Centre using the NIPS-NORMA instrument installed at a guided cold neutron beam, in order to determine the physical properties of the object with a complementary physical approach. The experimental setup consists of the Neutron Induced Prompt Gamma Spectrometer (NIPS), equipped with "NORMA" neutron radiography and 3D tomography system. The neutron beam with a cross section of 40×40 mm² has been used to perform 3D neutron imaging of a selected region of the sample. Although the object was about 10 cm tall, by systematically moving the object, we were also able to create a composite 2D image of the whole jar from a set of tile images, in order to visualize its structure with a spatial resolution of 0.3 mm. The main results are the precise identification of the cork stopper hidden by a clay cork. 3D neutron imaging clearly reveals that this stopper is made of a ball of linen or any other string-like organic material. This observation was not possible with both X-rays and THz radiation owing to insufficient spatial resolution and contrast. Neutron imaging also confirmed the presence of cracks in the wall of the pottery bottle, as already discovered with X-rays. 3D neutron imaging also provides some representations of the mobile content which is constituted of inhomogeneous dried materials. By semi-quantitative analysis of the (n,γ) spectra taken at NIPS, we concluded that the jar content is mainly composed of H, C, N, S and Cl elements, which supports the assumption about its organic nature. Without certitude, we can assume that this content could consist of germinated seeds of any other dried organic material.

As a result, these measurements performed at the Budapest Neutron Centre provide complementary information about this Ancient Egyptian jar: the way it has been closed by a double stopper (clay and probably linen) and the organic and inhomogeneous nature of the mobile content. These partial conclusions might be a prime importance for historians and museum curators.

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Summary

3D and 2D neutron imaging and non-destructive position-sensitive elemental analysis by PGAI were performed at the Budapest Neutron Centre on a XVIIIth Dynasty (15th c. B.C.) Egyptian sealed pottery. The

result of the neutron tomography revealed that a ball of linen was most probably used to seal the jar. Furthermore, finer structural details of the inner content were made visible, which was not possible to find out in earlier attempts using X-ray and THz imaging methods. In addition, with the help of highly penetrating and well collimated neutron beam, local elemental composition was determined that allowed us to conclude about the nature of the inner content, which is supposed to be a dried organic material.

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