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Preserving Endangered Cultural Heritage Through 3D Scanning. The Case of the Banqueting Tokens from Palmyra, Syria

DATA PAPER

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ABSTRACT

The dataset presented here are the first ever 3D scans and models of the so-called banqueting tesserae from Palmyra. These clay tokens were used as entrance tickets to religious banquets hosted by Palmyrene priests. Today more than 1300 different types are known. These tokens have been collectors' items since the late 19th century, coinciding with the beginning of systematic archaeological work at the site. Today, the tesserae are spread across the world in public and private collections. The Ny Carlsberg Glyptotek in Copenhagen holds a collection of 92 tesserae of which we present five 3D-scanned examples here.

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KEYWORDS:
3D scanning; 3D modelling; Roman Palmyra; Near Eastern cultural heritage; small finds; tesserae; religious banqueting tickets

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(1) OVERVIEW

CONTEXT

When civil war broke out in Syria in 2012, the cultural heritage of Syria came under massive threat, including the UNESCO world heritage site, Palmyra [1, 2, 3]. Fieldwork, which had been intense until then, has not been conducted since the outbreak of the war, dramatically limiting research possibilities. At the same time, illegal trade with cultural heritage objects from the site has intensified [4]. In order to continue meaningful research on Palmyra, other (re)sources thus need to be utilized and new paths sought to study this important site. Through the decade-long *Palmyra Portrait Project* [5] and the *Archive Archaeology Project* [6] archival materials stemming from the Danish archaeologist Harald Ingholt have been made openly available [7, 8]. With the scanned tesserae presented in this contribution, we now contribute an entirely new, and different, openly available dataset linked to the oasis city.

The so-called banqueting tesserae or tokens from Palmyra were used as tickets to gain entrance to religious banquets. Their original Palmyrene Aramaic name remains unknown [9]. They were typically made of terracotta; only a few tesserae produced in other materials exist today: lead (9 pieces), glass (3 pieces), bronze (1 piece) and iron (1 piece) [10]. Naturally many more might have existed, but this sort of material – glass and metals – was recyclable and could be remelted and smelted in order to be reused for other purposes, which might well have happened to the tesserae in these materials.

In 1955, an overview of all known types was published in the *Recueil des Tessères de Palmyre* [10]. This publication included a description of a total of 1132 types (henceforth called RTP types), as well as images of the majority of these. This thorough overview work still provides the basis for research on the tokens, but numerous new finds have been published over the years [11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21] and over the last decade new research on the tesserae has been undertaken [22, 23, 24]. The production of a new corpus of types emergent since 1955, many of which have gone unpublished, is currently underway. This corpus will add 175 new types not known in 1955 [25].

Although the tesserae were produced in series of most likely differing sizes, depending on the size of the event, only one surviving example of what is interpreted as being a full series has survived. This is a series found in the Temple of Arsu, where 125 tesserae of the same series were found in a jar during excavations in 1980 (RTP 174) [26]. However, more than 100 examples of one other series are also known, RTP 422, found in the Sanctuary of Bel [10, 22]. The serial production required moulds, used to imprint the single terracotta pieces repeatedly on both sides, with different motives – one for each side. Each tesserae type/series had its own unique mould and the iconography on the tesserae is diverse and so are the shapes of the tesserae of which 97 have been counted [23]. However, no mould has ever been recorded in Palmyra.

The smallest tokens measure less than 1 cm in diameter; the larger examples measure up to 3.6 cm. Despite their small size, the rich iconography of the tokens offer insight into the religious and social life in the city. Their iconography mainly depicts Palmyrene priests, deities, plants, animals, and abstract symbolism connected to the religious life of the city. They also hold very small inscriptions, almost exclusively in Palmyrene Aramaic. Out of all 1307 types, over 400 carry a signet seal impression, an impression pressed directly into the clay before firing, adding a high degree of iconographic complexity to a small surface.

Inscriptions inform us about the individual(s) who were paying for the banquets. Only in four cases, a specific year is mentioned (RTP 737 = 107/108 AD, RTP 691 = 118/119 AD, RTP 777 = 130/31 AD, RTP 32 = 132/33 AD). With this as the only reliable source, it is difficult to date the tesserae overall. Regardless, a study of some of the available epigraphic, iconographic, and archaeological evidence by Jean-Baptiste Yon has shown that the tesserae must have been made and used in the first three centuries AD [22].

The tesserae presented in this paper were all scanned in 2023 in the Ny Carlsberg Glyptotek in Copenhagen. The scanned tesserae are of the RTP types 343, 381, 725, and 773. One tessera has not been published in RTP and thus does not have a RTP number. All five tesserae entered the collection of the Ny Carlsberg Glyptotek through the Danish archaeologist Harald Ingholt, who excavated in Palmyra in the 1920s and bought the tesserae from the locals during his fieldwork campaigns in Palmyra [9]. In total, the museum has 92 tesserae in their collection, though none of them are currently on display.

The 3D digital models produced (Figures 1 and 2) have proven to be useful in many regards. First and foremost, they allow the objects to be completely accessible even outside of the collection, as the models are available online and free of charge.

Second, the models can be moved around and seen from all sides. The virtual enlargement allows for in-depth studies of the iconography and small details, such as the seal impression on one of the narrow sides of IN 3208. This impression measures only 0.7 × 0.3 cm but clearly shows a bust in profile (Figure 2). This adds important information that could not be provided by the high quality photos that were taken for the most recent collection catalogue (Figures 3–7) [9]. In these photos, only the front and back sides were captured, while the side profile remains entirely unpublished. The digital scans are thus extremely valuable for the study and understanding of the material's complexity and further manipulation that can be undertaken will only enhance the visibility of the iconography even more.

Figure 1 Screenshot of the 3D model of IN 2771 (side A), showing a priest under winding wines (cf. Figure 4). 33 × 33 mm. Ny Carlsberg Glyptotek, Copenhagen, I.N. 2771 (Scan produced by Derek Parrott, with permission from the Ny Carlsberg Glyptotek).

Figure 2 Screenshot of the 3D model of the narrow side of IN 3208. 29 × 8 mm. Ny Carlsberg Glyptotek, Copenhagen, I.N. 3208 (Scan produced by Derek Parrott, with permission from the Ny Carlsberg Glyptotek).

Figure 3 Side A: Reclining priest and a floating bust of Malakbêl above. Inscription under the kline. Side B: Arch with a seal impression of a goddess, a garland, and an inscription. 36 × 25 mm. Ny Carlsberg Glyptotek, Copenhagen, I.N. 2770 (Courtesy of the Ny Carlsberg Glyptotek; Photo: A. Sune Berg).

The scans also make it possible to study the so-far underexplored production techniques. It is possible to create a digital negative of the scan [35, 36], providing us with a representation of the mould that was used to produce the depiction in clay, bringing us closer to understanding the making of the tiny objects. Small variations can thus, in future research, also be seen through the lens of production, and we can start untangling the meaning, value, and making of the tesserae from a new point of view.

Spatial coverage

Description: Syria, Homs, Palmyra

Latitude: 34 33 12 N degrees *minutes* / 34.5530 *decimal degrees*

Longitude: 038 16 05 E degrees *minutes* / 38.2680 *decimal degrees*

Temporal coverage

App. 1–3rd century AD

Figure 4 Side A: Reclining priest under winding vines and an inscription under the kline. Side B: Seal impression of standing male figure surrounded by animal heads. 33 × 33 mm. Ny Carlsberg Glyptotek, Copenhagen, I.N. 2771 (Courtesy of the Ny Carlsberg Glyptotek; Photo: A. Sune Berg).

Figure 5 Side A: Bust of Poseidon. Side B: Bust of Beltî. 15 × 12 mm. Ny Carlsberg Glyptotek, Copenhagen, I.N. 3196 (Courtesy of the Ny Carlsberg Glyptotek; Photo: A. Sune Berg).

Figure 6 Side A: Reclining priest under winding vines and an arch. Inscription under the kline. Side B: Two servants mixing wine and a seal impression of Apollo above. 19 × 28 mm. Ny Carlsberg Glyptotek, Copenhagen, I.N. 3208 (Courtesy of the Ny Carlsberg Glyptotek; Photo: A. Sune Berg).

Figure 7 Side A: Seal impression of a seated figure. Side B: Seal impression of an eagle sitting on a column. 21 × 16 mm. Ny Carlsberg Glyptotek, Copenhagen, I.N. 3259 (Courtesy of the Ny Carlsberg Glyptotek; Photo: A. Sune Berg).

(2) METHODS

We choose five different objects, varying in size and state of (surface) preservation and quality in order to test the overall usefulness of the scans across varying quality and state of preservation.

The tesserae were scanned by Derek Parrott with an AutoScan-DS-MIX blue light scanner, manufactured by Shining 3D. An SLS operates by emitting an LED light pattern on an object. This light can be either white or blue: the AutoScan-DS-MIX uses a blue light source, which is less disturbed by surrounding environmental lighting. The light pattern emitted by an SLS forms a grid which is used to map object features and morphology, which are then captured by a camera (or cameras) and triangulated between the light source, camera, and object, to form a polygon-based mesh [37]. Used for high-precision dental scan applications, this scanner possesses two 5.0 MP high resolution cameras capable of an accuracy of ≤ 7 μm, or 7 microns, and is designed for scanning objects up to 10 centimetres [27]. It is thus an ideal choice for scanning small objects such as the tesserae.

To produce the scans, the tesserae were mounted onto an articulated arm on the machine using a small clamp, which swings underneath the two cameras at various angles in an automated process that allows for all faces of the objects to be scanned. This process is quite safe and well-suited for material such as the tesserae: foam padding protects the object from the metal edges of the clamp and ensures that it can be secured tightly enough that it does not fall out during the scanning process. However, if a fall does occur, cloth padding is also placed underneath the scanning arm to provide a soft landing. A single scan took approximately 13 seconds and resulted in the production of a dense point cloud in the built-in Ultrascan software. Due to the presence of the clamp, only one side of a tessera could be scanned at a time, and the object was hence flipped in the mounting to scan the opposite side. This was done using the "Flip scan" function in UltraScan, which simply allows for multiple scans from different angles to be made within the same project. Once a point cloud had been generated of each side of the object, they could be aligned into a single point cloud of the entire tessera. This was done using the "Alignment" function of UltraScan. This function is a completely automatic point registration feature, which did not require manual point registration or merging. The automated nature of both the scanning process itself and the post-processing alignment functions in the UltraScan software allowed for the scan of an entire tessera to be produced in under a minute. Once the alignment had been completed, the "Datawrap" feature of UltraScan was used, which processed the combined point cloud into a triangular mesh in both STL and PLY file formats [38].

Once produced, the meshes were analysed in the open-source 3D mesh editing software MeshLab [28]. Here, several radiance scaling shaders were applied to the models; radiance scaling shader with inverted normal were briefly applied but it did not make a difference in readability for this material. Radiance scaling adjusts reflected light and shading to enhance the surface detail of scanned objects and was used on the tesserae models to both enhance already identified features, as well as assess for features that might not have been visible to the eye.

(3) DATASET DESCRIPTION

OBJECT NAME

3D scans of Palmyrene Banqueting tesserae from Ny Carlsberg Glyptotek.

DATA TYPE

The high-resolution 3D-scans were stored in the repository "Figshare" as STL files (see link below). This file type "is an openly documented format for describing the surface of an object as a triangular mesh, that is, as a representation of a 3-dimensional surface in triangular facets" [29].

FORMAT NAMES AND VERSIONS

stl files – I.N. 2770, I.N. 2771, I.N. 3196, I.N. 3208, I.N. 3259.

CREATION DATES

The 3D-scanning was undertaken in the study collection at the Ny Carlsberg Glyptotek, Copenhagen, 22nd February 2023.

LICENSE

REPOSITORY LOCATION

Figshare; DOI: 10.6084/m9.figshare.23586984

PUBLICATION DATE

27/11/2023

(4) REUSE POTENTIAL

One of the main challenges for researchers is often the lack of access to material because in-person visits to museums and their study collections are not always possible. Moreover, if objects are not on display, the public has no option to see the material at all. Publications of material are limited to the choice of images by the authors/editors and not all publications are easily accessible either. This can lead to missing or incomplete information, for example when only one view of an object is photographed or when the quality of the photograph is poor.

In accordance with the FAIR principles [30, 31], the present dataset of 3D scans is freely available online. The scans have multiple advantages. First and foremost, they show the tesserae from all possible sides and angles, allowing for a comprehensive study of both main sides as well as the edges of the object. In the specific case of IN 3208, the only photos available in catalogues of the Palmyra collection [9, 32] do not show the narrow sides of the tessera – and neither do other publications of the same piece [10, 33, 34]. However, the right narrow side has a seal impression imprinted. The 3D scan is the only possibility to see this impression without seeing the object in person. 3D test-prints of two of the scans have shown that, after the application of colour, the iconography is reproduced quite accurately, and 3D prints could thus be used as visual examples for e.g. outreach or during presentations of the material.

Second, the 3D scans allow for manipulation of the image, which can help to fully utilize the material and enhance the depictions on it. As the objects only measure 1–3 cm and have been exposed to weathering, the surface is affected and often heavily weathered and chipped. By digitizing the tesserae, the models can be enlarged and by applying certain filters, the images become way clearer, helping our understanding and interpretation of the material.

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COMPETING INTERESTS

The authors have no competing interests to declare.

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38. **Two scans per object, 10 frames per scan.** Polygon counts: I.N. 2770: 808,630 faces/ I.N. 2771: 922.682 faces/ I.N. 3196: 236,828 faces/ I.N. 3208: 769,436 faces/ I.N. 3259: 271,368 faces. Lower polygon counts are the result of the poorer preservation or overall quality of the tesserae/ tesserae surface.

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