THE FRANCO-GERMAN FIGURINES PROJECT (FGFP)

Regine Hunziker-Rodewald, Astrid Nunn and Thomas Graichen

Introduction

(Regine Hunziker-Rodewald)[1]

A comprehensive study of Transjordanian iconography and its classification, from a comparative and contextual as well as from a typological and chronological point of view, has never been conducted. The few first steps in this direction resulted in the publication of a monograph (Dornemann 1983: 30 pages on small objects and sculpture) and some exhibition catalogues (e.g. Amiet 1986; Bienkowski 1991).

With regard to iconography, Iron Age II (c. 9th-6th centuries BC) is a crucial period. The whole of the Southern Levant was under neo-Assyrian hegemony from the second half of the 8th century BC. Foreign supremacy transformed artistic production in the small kingdoms which were integrated into the Assyrian Empire; local ideas shifted to an 'international' perspective with an adapted thematic scope (Beaulieu 2005; Keel 2008). This substantial change became apparent, *inter alia*, in the influences on glyptic imagery (Ornan 1993; Hunziker-Rodewald 2015a). Until the 6th century BC, a specific cultural and ideological amalgam is well attested from this area, which was later superimposed by the Achaemenid and Hellenistic art styles, each featuring a new scope of reference.

The Female Terracotta Figurines from the Southern Levant

In recent books on the history and culture of the kingdoms in Iron Age Transjordan (Bartlett 1989; Gass 2009; Tyson 2014), iconography has simply been treated as a companion of archaeology; its particular evidence has not been properly researched. In-depth studies on topics such as the *'atef* crown, the statuary of particular sites, the iconic repertoire of seals or small objects excavated at certain sites (Horn 1973; Abou Assaf 1980; Huebner 1993; Dabrowski 2009) are *per se* thematically limited and restricted to a specific geographical area.

Towards the end of the 20th century, two doctoral theses (both unpublished) were dedicated to the anthropomorphic and zoomorphic representations in the plastic art from Palestine and Transjordan (Holland 1975; Amr 1980). These clay objects, which are frequently found in excavations, often appear in archaeological reports as a few lines, sometimes accompanied by a photo; however, these publications are usually known only to specialists.

Among the terracotta figurines from the southern Levant, those depicting females gained in importance after the discovery of inscriptions from the 8th century BC mentioning the biblical God, together with "his Ashera" (Naveh 1979). While trying to determine the identity of Ashera, scholars brought a long known group of iconic objects back into focus: the Judean Pillar Figurines (Pritchard 1943; Kletter 1996). The debate triggered by the Ashera inscriptions mainly centered on the known Levantine goddesses (*Athirat, Anat, Astarte*) and the "fertility cults" condemned in the Bible (Hadley 2000; Dever 2005). As the contemporaneous female figurines from Transjordan were poorly known, attention focussed on the figurines from the western side of the River Jordan (Paz 2007; Sugimoto 2008).

1. I am grateful to Maria-Louise Sidoroff, Hobe Sound FL, for reading the manuscript for the first part of this article. Her valuable comments and suggestions are highly appreciated.

The Female Terracotta Figurines from Transjordan

The female terracotta figurines from Transjordan have many details in common with the western corpus, while at the same time displaying various characteristics of their own (Hunziker-Rodewald 2012). In addition, the eastern figurine corpus is not homogenous; a large variety and significant regional characteristics can be observed.

The assumption that clay figurines, male as well as female, were linked to cultic activities in both the private and the public sector, is supported by the discovery of shrine models (fenestrated or box-shaped) with open fronts, with figurines attached to the façade or at the entrance (Daviau 2008). In addition, the accumulation of objects, primarily female figurines but also ceramic sherds, in an isolated wayside shrine located on a hilltop and enclosed by a temenos wall (Daviau 2012), attests to the connection between figurines and some kind of ritual. The evidence should be compared with other sources from the Levant in order to refine our knowledge of ritual practices performed in Transjordan during Iron Age II. Oral or literary sources are either lost or hidden behind biblical polemics (Hunziker-Rodewald 2016a), and epigraphic sources are still rare. However, the theophoric names for example contain valuable information on ideological and religious practices and conceptions (Albertz 2012; Hunziker-Rodewald 2015a, 2015b).

Artefacts featuring expressions of ritual or cult in Iron Age II Transjordan were exposed to outside influences, and may also attest reactions to these influences (Feldman 2014). The details of the corresponding shared repertoire of imagery and style, and the manner of its adoption, reaction and counter-reaction, still await scientific exploration.

Another major challenge is the definition of the Transjordanian pantheon during the Iron Age. To date, the very few potential references to a goddess in Ammon and Moab remain highly ambiguous (Albertz 2012). Nevertheless, based on old Canaanite traditions, a link between the female figurines and the El cult is conceivable (Hunziker-Rodewald 2015a). Of major importance, and definitely needed, is a systematic comparative analysis of the ensemble of objects associated with female figurines (libation vessels, animal figurines, clay rattles, amulets, lamps etc.).

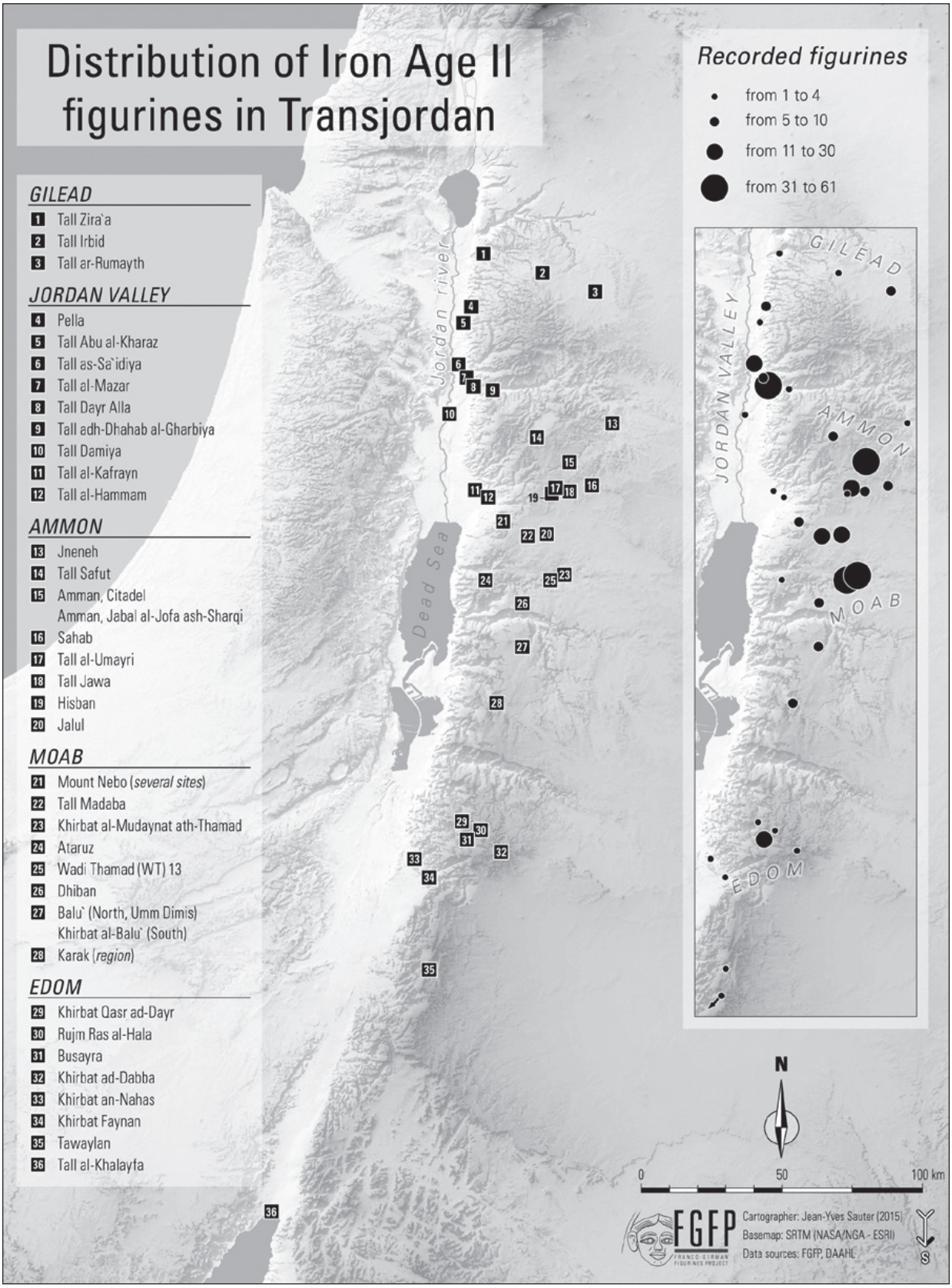
The Franco-German Figurines Project: Campaigns 2012-2014

The Franco-German Figurines Project (FGFP) is financially supported by the Universities of Strasbourg (France) and Wuerzburg (Germany). Its primary goal is to document the Iron Age female terracotta figurines found in Transjordan, and create a refined typology of these objects. Between spring 2012 and summer 2014, the project team (Regine Hunziker-Rodewald, Astrid Nunn and Thomas Graichen) carried out several preparative and five research sessions in France, Germany, Jordan, the United States and Canada. The team works exclusively on material held in museums, storage facilities and university collections. To date, 423 female terracotta figurines (96% of them fragments) have been registered, and 229 figurines have been documented using a computational photography method (RTI; see below).

For each figurine, the Hunziker-Rodewald/Nunn/Graichen team records the characteristics (object type, state of preservation, origin, archaeological context, current location, excavation and museum numbers, dimensions, clay quality and color, fabrication technique, painting, detailed description) in searchable files, complimented by plates, photos and geographical and archaeological maps. See Part II of this article, written by Astrid Nunn, for a preliminary evaluation of the data which has been gathered so far, and Part III, written by Thomas Graichen, for the computational photography methodology, called Reflectance Transformation Imaging, which was adopted for the project.

The Franco-German Figurines Project: Activities in 2015

This was a year of preliminary evaluation and publication, technical planning, and identification of further financial resources, which will ensure the continuation of the project. First results were presented at international conferences in the United States, Israel, France, England and Estonia. From



Distribution of Iron Age II female terracotta figurines found in Transjordan.

April 8 to May 14, 2015, an Experimental Archaeology Workshop, jointly financed by the Franco-German University Saarbruecken and the University of Strasbourg, was undertaken at the University of Strasbourg, France. Its educational and scientific goals were to achieve practical and theoretical insights into raw material processing, kiln construction, tool manufacture, master figurines and mold production, as well as molding and firing procedures. The model for the reconstructed kiln was excavated in Mari (Beyer/Laroche-Traunecker 2006), and the originals for the reproduced figurines were discovered in Syria and on both sides of the River Jordan. The workshop was an FGFP project, directed by two local potters and the ceramic technologist Maria-Louise Sidoroff, who is associated with the Mudayna-Thamad Regional Survey Project in Jordan. The sessions were recorded for a documentary film, which was registered as a candidate for the 2016 French Festival of Research Movies in Vandœuvre-lès-Nancy (https://vimeo.com/150722204).

In June 2015, an International Colloquium on nude female figurines from The Ancient Near East, Egypt, Nubia, Mediterranean and Central Asia (Neolithic – 3rd century AD) was also organized at the University of Strasbourg, France. The presentations focused primarily on "Figurines in Context: Archaeological and socio-cultural aspects" and "Interpreting Nude Female Figurines". The accompanying exhibition offered an additional opportunity to examine photos of Mesopotamian figurines provided by the Louvre Museum in Paris, a 3-D animation of an Old Egyptian figurine held by the Institute of Egyptology at Strasbourg University, three RTI presentations of female terracotta figurines held in museums in Jordan (http://www.stephane-ostertag.fr/rti/), the film created during the Strasbourg Experimental Archaeology Workshop, and some of the replicas produced during the workshop. The conference volume is in preparation.

In July 2015, FGFP was selected as one of three pilot projects by the team in charge of realizing the Open Archives Initiative (Archives Ouvertes de la Connaissance [AOC]) at the University of Strasbourg, France. This project will enhance the value of the collected data with an interactive database in French, English and Arabic, including RTI files. FGFP will also develop programs for RTI static images as a replacement for freehand line drawings, virtual reconstructions of original figurines from existing fragments, and virtual reconstitutions of original colours from traces of paint or pigments still detectable on the surface. Excavators for all of the figurines, as well as the Department of Antiquities in Jordan (DoA), will be asked for official permission before the FGFP data is posted on the web.

Key Issues Still to Explore

Further research includes FGFP sessions in Europe and Jordan, in order to complete the RTI files, create the interactive database, and explore the corpus of female terracotta figurines which have been recorded and photographed since 2012 in several archaeological, socio-cultural and religious respects. The results of these research activities will be integrated into the database primarily as PDF files, which will be cross-referenced with the photos and other material; our Jordanian colleagues will translate the French and English documents into Arabicto complete the database. A lavishly illustrated monograph, with high quality RTI static images, is envisaged for the second phase.

The following is an incomplete, but progressively evolving list of research procedures which will be performed in the near future:

- Comparative research on the geographical distribution, regional particularities, commercial exchange and import (e.g. from Cyprus, Palestine/Israel/Juda, Phoenicia, Aram, Mesopotamia) of female terracotta figurines, in collaboration with directors of recent excavations in Jordan; creation of geographical maps in collaboration with the AOC team.
- Identification and evaluation of ensembles of objects and pottery excavated in the same loci and squares; creation of archaeological maps in collaboration with the directors of recent excavations in Jordan and the AOC team.
- Specification and adjustment of the dating and relative chronology for regional and trans-regional types of figurines, in collaboration with directors of recent excavations in Jordan

and adjacent regions (e.g. the Araba, Jordan Valley, northern Gilead) to the west of the River Jordan.
- Identification of clay texture and analysis of specific paint pigments, compared with painted pottery from the same find spot or site; hypothetical reconstitution of the original appearance of female figurines, in collaboration with experts in ancient ceramics and the AOC team; comparison of all contemporaneous female figurines from the southern Levant.
- Comparative studies of iconographic details: hairdo, headdress, facial features, gesture, musical instruments, jewelry, hand position, dress, baby; comparison with Syro-Palestinian and Egypto-Phoenician representations of females (e.g. on ivories and seals) from the Late Bronze and Iron Ages.
- Comparative ethno-archaeological, socio-cultural and anthropological studies for the ritual usage of figurines in societies in the Ancient Near East and Mediterranean region from the Late Bronze Age to the Hellenistic period; research on the relationships between woman-figurine, goddess-figurine, god-figurine and social agency.
- Evaluation of links connecting figurine molds on both sides of the River Jordan (Hunziker-Rodewald 2016b), in collaboration with directors of recent excavations in Jordan and the adjacent regions west of the River Jordan; identification of mold generations by enhanced measuring techniques.
- Creation of a refined typology, building on previous research, e.g. by Holland 1975, Amr 1980, Kletter 1996.
- Iconological analysis and critical examination of proposed identifications for Levantine female figurines, building on existing research, e.g. by Kletter 1996, Daviau 2014, Darby 2014.

Significance

To date, the corpus of female terracotta figurines from Transjordan has never been compiled. Preserved in museums and collections in Jordan, Europe, Canada, Australia and the United States, the 423 female figurines currently known to the FGFP team are distributed over widely dispersed geographic locations. The publication which includes some of these figurines is of a rather mediocre quality, and some of the earlier articles and reports are not easily accessible. A Franco-German-Canadian collaboration was established in 2014, with Michèle Daviau, who excavated almost 25% of all known Transjordanian female figurines, as an associate member of the FGFP team; this collaboration combines specialized knowledge with practical know how. Furthermore, our ongoing collaboration with the directorate and staff of the DoA, as well as with the directors and curators of local museums and international excavation teams, means our work cannot be overestimated. We have met with a friendly reception and strong support everywhere. For example, in August 2013, we were accompanied by Omar Nofal, a member of staff and DoA representative for three weeks. We hope our work will ensure these figurines will soon be available for ongoing research, not only in Jordan, but also abroad. It goes without saying that the corpus of female figurines from the Iron Age should be extended to include those from the Late Bronze Age, and also by male figurines; but let's take one step after the other!

Part II: Geographical Distribution and Archaeological Context

(Astrid Nunn)

Geographical distribution and archaeological context will be discussed in this section, which also includes our latest information.

Historical and Geographical Division of the Territory

The material has been arranged according to historical provinces. Gilead was situated in the most northern part of Jordan. The "Jordan Valley" was densely settled and extends to the north of Ammon, which roughly begins at the Wādī az-Zarqa. The border between Ammon and Moab was approximately from the northern shore of the Dead Sea, running southeast to the Wādī al-Hasa. The most southern province is Edom, which extends to the Red Sea.

Number of Figurines and Distribution (Table 1)

This paper is based on the 415 figurines which are currently known to us and whose

Table 1: Distribution of Iron I-II Figurines According to Region and Site.

Region	Gilead	Jordan Valley	Ammon	Moab	Edom
Number of figurines per region	9	99	140	135	32
Number of sites excavated	3	9	8	7	6
Sites recorded				• Mount Nebo (*several sites*) • Karak (*region*)	• Khirbat Qasr ad-Dayr • Rujm Ras al-Hala
Site names with number of figurines recorded, from north to south	• Tall Zira'a: 2 • Tall Irbid:2 • Tall ar-Rumayth: 5	• Pella: 6 + 13? • Tall Abu al-Kharaz: 1 • Tall as-Sa'idiya: 15 • Tall al-Mazar: 9 • Tall Dayr Alla: 42 • Tall adh-Dhahab al-Gharbiya: 2 • Tall Damiya: 7 • Tall al-Kafrayn: 1 • Tall al-Hammam: 3	• Jneneh: 1 • Tall Safut: 6 • Amman, Citadel and Jabal al-Jofa ash-Sharqi: 61 • Sahab: 5 • Tall al-Umayri: 26 • Tall Jawa: 9 • Hisban: 1 • Jalul: 31	• Mount Nebo (*several sites*): 6 • Tall Madaba: 15 • Khirbat al-Mudaynat ath-Thamad: 42 • Ataruz: 1 • Wādī Thamad (WT) 13: 50 • Dhiban: 9 • Balu' (north, Umm Dimis) and Khirbat al-Balu' (south): 6 • Karak (*region*): 6	• Khirbat Qasr ad-Dayr: 1 • Rujm Ras al-Hala: 1 • Busayra: 21 • Khirbat ad-Dabba: 2 • Khirbat an-Nahas: 1 • Khirbat Faynan: 1 • Tawaylan: 2 • Tall al-Khalayfa: 3

provenance is secured. This number will certainly be amended; some figures may be late Bronze Age (as in Pella), while assignment to a specific gender may not be possible for others. Nevertheless, the current distribution reflects general tendencies, which probably correspond to a historical reality. The number of figurines varies considerably, both between regions and between different sites. The regional distribution ranges from nine figurines in Gilead to 140 in Ammon. Amongst all the sites, Amman with 61 figurines is currently the place of origin of the highest number of figurines. At the other end of the scale, a few places are represented by only one figurine.

Thus, the regions with the largest quantity of figurines are Ammon and Moab, where 275 out of 415 were discovered. There are as many as 374 figurines if we add the Jordan Valley. This area, extending over 70 km from north to south, can be regarded as the core area for this type of female figurine, although we are not yet able to determine possible places of production or distribution patterns.

Contexts for Archaeological Finds

Further light can be shed on the identity of these women by the information we gain from the archaeological context, including the stratigraphy (this still needs further study) as well as structural features, which may lead to an interpretation of the original architectural environment of the figurines. This latter aspect is discussed here.

The context is "undetermined" for 166 figurines. "Undetermined" comprises several possibilities; either information is missing, the piece has no precise origin (Karak region), or was retrieved from the surface (Tall Dayr Alla, Amman, Khirbat al-Balua'). Moreover, the figurines may indeed have been excavated, but either the figurines were not found in situ (Amman), or the original function of the excavated context is unclear.

Find locations have been divided into five categories for the remaining 249 figurines; these also include the pieces we have not been able to categorise with certainty. Domestic (100 objects); domestic and/or administrative (48 objects); domestic and industrial (24 objects); cultic (62 objects) and funerary (15 objects). Domestic settings are clearly best represented; the combined total for wholly residential, residential/administrative and residential/ manufacturing is approximately 172 pieces (100 + 48 + 24).

Examples now follow for each category. Three significant sites have been chosen for the *domestic* context. In Busayra, 19 of the 21 figurines were found in Area B. Excavations there revealed a sequence of perimeter walls and a number of rectangular structures, with a possible courtyard associated with plaster floors, benches or shelves, storage and cooking; all suggesting a domestic occupation (Bienkowski 2002: 111-147). In Iron Age II Tall Dayr Alla, mostly flimsy structures, courtyards and walls of a single layer mud-brick were found, as well as small, enclosed rooms, which were covered annually with layers of reed. These were erected, destroyed, levelled and rebuilt; therefore, discerning the sequence of construction and destruction is intricate and difficult to follow. Storage rooms, pits and finds hint at mainly agricultural and domestic activity (van der Kooij 2001). Dhiban and Tall al-Mazar both suggest an *administrative* structure with a *domestic aspect*. To date, ten figurines are known from Dhiban, six of which originate from two adjacent rooms (LII and LIIIA) in the "Moabite Palace" in Area L (Routledge 2004: 161-173). The nine figurines from Tall al-Mazar were all found in Field I, where the construction phases of a large building can be followed through all strata. This building may have been an administration centre or a "Palace Fort" according to the excavator, but may also have had a private function (Yassine/van der Steen 2012). Two figurines were uncovered in the rectangular fortress on top of the Lower Tall of Tall as-Sa'idiya (Pritchard 1985).

On Tall Jawa, all buildings have a *domestic and industrial* character, with no buildings or architectural features of explicit religious character found. In Building B204 (Field B), vessels and a modest number of food preparation tools hint at a domestic context. Ovens, large amounts of pottery, spindle whorls, loom weights and grinding tools are characteristic of domestic food preparation and storage, as well as household-level textile production in Buildings B800, B900 and B910 (Field C). B300 (Field E) had cooking areas and food processing tools such as cook pots, craters, bowls, lamps, storage jars and pithoi, strainers, basalt tools, mill stones, querns, pestles, pounders and mortars (Daviau 2002, 2003).

In Khirbat al-Mudaynat ath-Thamad, excavation campaigns revealed a casemate wall with a six-chambered gate and small shrine, where figurines were discovered; however, they were even more numerous in several buildings which were rather industrial in nature. As in Tall Jawa, pounders, grinders and querns, stoppers, polishing stones and slingstones clarified that the function of B200, B 205, B210 and B 400 was the production, manufacture and processing of textiles. Pottery sherds, grinding tools, mortars, millstones and limestone basins all clearly hint at industrial activities such as food processing in buildings B300 and B303 (Daviau *et al.* 2006: 261, 264. Daviau, *et al.* 2008: 348-349).

The *cultic* context of the figurines is noteworthy, in as much as the vast majority of them (49 out of 62) were discovered in the only sanctuary at Wādī Thamad (WT) 13. The architectural remains of this isolated shrine consist of one rectangular structure, surrounded by walls of limestone. As well as clay and limestone figurines, 20 large, hollow male and female statues, together with architectural models, jewellery and more than 25,000 ceramic sherds demonstrate the unusual wealth of the shrine (Daviau 2012). The second most important sanctuary in relation to figurines is located in Khirbat al-Mudaynat ath-Thamad, about three km to the east of Wādī Thamad (WT) 13. Seven figurines were discovered in the main room and an adjacent room (Daviau/Steiner 2000). A *funerary* context is rare. While most of the Amman figurines seem to have been originally used on the citadel, eight were found in two tombs located on Jabal al-Jofa ash-Sharqi, 300 m east of the Roman theatre (Dornemann 1983: 47). Mount Nebo's peak rises around 800 m above sea level, some seven km west of Madaba. Of the several other peaks surrounding Mount Nebo, the two most historically important are Jabal Siyagha on its western spur and, three km to the south east, (Khirbat) al-Mukhayyat. Two tombs dating to the Iron Age were excavated there, one of them with two figurines (Benedettucci 1998).

There may be different archaeological find contexts within one site. Buildings are domestic and industrial as well as religious in Khirbat al-Mudaynat ath-Thamad. In addition to the "Moabite Palace" in Dhiban, one figurine was found in a grave (Tushingham 1972: 115).

Preliminary Conclusion

The figures presented here lead us to two conclusions, which will probably remain unchallenged by further research. Firstly, the area which includes the Jordan Valley, Ammon and Moab must be regarded as the core area for Iron Age II female figurines; the density of sites not only reflects modern archaeological activity, but also the density of ancient settlement. The second conclusion concerns the context. Many figurines come from an everyday living and working context, be it a palace or a house, while evidence for a cultic context is currently limited to a few sites; amongst these, Wādī Thamad (WT) 13 is by far the most important. According to our present knowledge, only six sites indicate a funerary/tomb context.

Part III: The Technical Aspects of Image Acquisition for the FGFP

(Thomas Graichen)

Inherent project limitations and adverse conditions were the main factors defining requirements for documentation methodology. Firstly, we were aware that acquisition time would be limited by departmental working hours; hence, relatively large numbers of objects would have to be captured in a short time frame. Our work would be carried out in various departments, museums and storage facilities; therefore, the dimensions of available workspace would vary. It also meant that ambient light conditions would be unpredictable and for the most part uncontrollable; and as our destinations would probably include rural sites, reliable and constant mains power supply could not be guaranteed either. Considering these factors, the setup had to be simple and able to be deployed quickly, allow for time-efficient acquisition of images, and able to function with or without electricity on site.

After careful consideration, the decision was made to use Reflectance Transformation Imaging (RTI), which produces dense surface data for captured objects, far surpassing traditional photographs for versatility of output format, and requiring a relatively simple setup. With only a few additions to conventional photographic equipment and slight adjustments to shooting technique, a captured object's surface orientation and reflective properties can be computed per pixel and displayed in conjunction with its color value. This is achieved by examining each pixel's behavior under different known lighting angles, assuming a perfectly diffuse surface and constant lighting temperature, intensity and distance[2].

In practice, an object view is captured from a fixed perpendicular position under varying lighting directions, with two or more reflective spheres in the frame (**Fig. 1**). These pictures are then processed by the RTI-Builder (**Fig. 2**). The resulting file can be visualized with an RTI-Viewer (**Fig. 3**); color, topography information and reflective properties can be processed by visualization filters to accentuate certain surface characteristics (**Fig. 4**). This opens up many possibilities for subsequent virtual analysis of the artifacts.

This method has been used with great success in numerous other heritage projects. In one of its earlier forms, it played a crucial role in the discernment of previously undetected inscribed letters on the Antikithera-Mechanism[3], and has since been adopted by a number of heritage projects[4]. The latest publicly available version of this technology was released by Cultural Heritage Imaging, a San Francisco based non-profit organization[5]. Developed in collaboration with Tom Malzbender from HPLabs in Palo Alto, California, the Hemispherical Harmonics Algorithm increased portability of the acquisition setup, while simultaneously improving data accuracy[6].

In addition to meeting the requirements imposed by the adverse circumstances mentioned above in relation to data acquisition for our project, files generated using RTI offer significant advantages to photographs and hand drawings. A regular photograph is limited

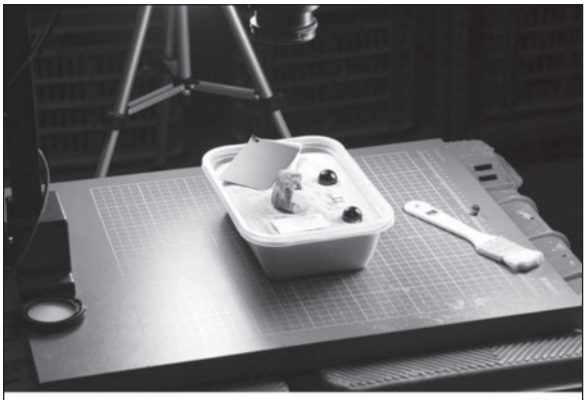
2. See <http://culturalheritageimaging.org/Technologies/RTI/> (accessed Jan 6th 2016) for further details on the theory and practice of RTI-photography.

3. See <http://www.antikythera-mechanism.gr/data/ptm/full-resolution-ptm> (accessed Jan 6th 2016) for the full resolution PTMs of the mechanism.

4. Among the most noted collaborators are the Metropolitan Museum of Art in New York, the Smithsonian Institution, the Staatliche Museen zu Berlin, as well as the British Museum in London. For a full list, please refer to

5. <http://culturalheritageimaging.org/About_Us/Collaborators/> (accessed Jan 6th 2016).

6. <http://culturalheritageimaging.org/> (accessed Jan 6th 2016).



1a. The project's RTI setup; the external flash unit and wireless remotes are not shown. (Photograph: Regine Hunziker-Rodewald).

1b. RTI capture setup, from the camera's point of view. The figurine is nested in chemically neutral sand in the center, framed by two or more black reflective spheres (corners), cards for white-balance correction (right, top), and a note with the object's identification number.

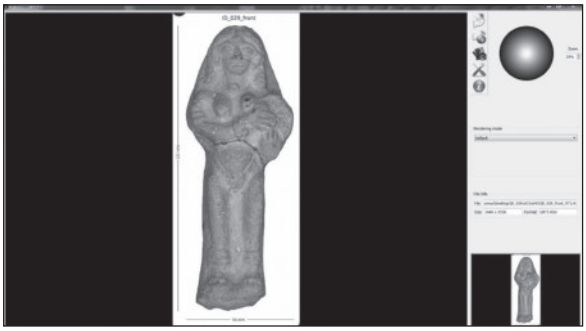
to a representation of an object under a fixed light cadence. An RTI-file, on the other hand, allows for a seamless dynamic variation of lighting angles. Although between 24 and 60 pictures per object view are needed for reliable computation of the RTI-file[7], the shooting itself doesn't factor heavily on the total acquisition time. Since positioning of the object and camera setting remain the same for RTI-capture and classical photography, the total difference in time between the two processes is negligible. When confronted with objects of varying sizes, textures and reflectance properties, RTI can even be more time efficient than traditional photography, since the latter requires, depending on each object's characteristics, adjustments to lighting position, temperature and hardness; all features which can be retroactively emulated within the RTI-Viewer. Since a widely accepted standard practice has yet to be established for object photography in archeological disciplines, photographs of the same archaeological artifact can differ considerably, depending on hardware, shooting technique and circumstances. Drawings can be very detailed and rich in information, especially as a complement to photographs, emphasizing surface characteristics not visible in the latter. Nevertheless, their use as a scientific tool is questionable at best. They are inherently interpretative, and can differ substantially between artists. RTI efficiently captures surface characteristics, which can be processed using an array of visualization filters, thus facilitating the discernment of color and topography features. This largely eliminates the need for interpretative feature accentuation via drawings. It even offers benefits compared to naked eye examination of the actual object, where many features can go unnoticed, even under magnification and varying light cadence. From a digital heritage point of view, the RTI-Builder and the produced file format comply with the standards for digital files and methods defined by nestor[8].

The pictures for RTI processing can be acquired either by a light dome (**Fig. 5**) or a hand held light source. A dome setup offers

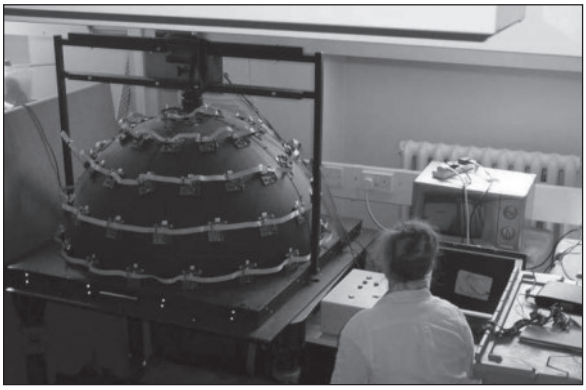
7. <http://culturalheritageimaging.org/What_We_Do/Publications/vast2006/VAST2006_final.pdf> (accessed Jan 6th 2016).

8. <http://culturalheritageimaging.org/What_We_Offer/Downloads/RTI_Hlt_Capture_Guide_v2_0.pdf> p. 30. (accessed Jan 6th 2016).

2. *A screenshot of one of the post processing steps inside the RTI Builder.*



3. *The finished file loaded, as displayed by the RTI Viewer. The lighting angle can be manipulated using the virtual trackball (top, right), and a collection of visualization filters can be accessed via a drop-down menu (middle, right).*



5. *An RTI-dome with 64 flash units (*http://ewic.bcs.org/upload/pdf/ewic_ev11_s8paper4.pdf. *accessed Jan 6th 2016).*

4. *An overview of the surface characteristics discernible through RTI-data. From top to bottom: color, surface orientation, topography (extrapolated from surface orientation) and reflectance.*

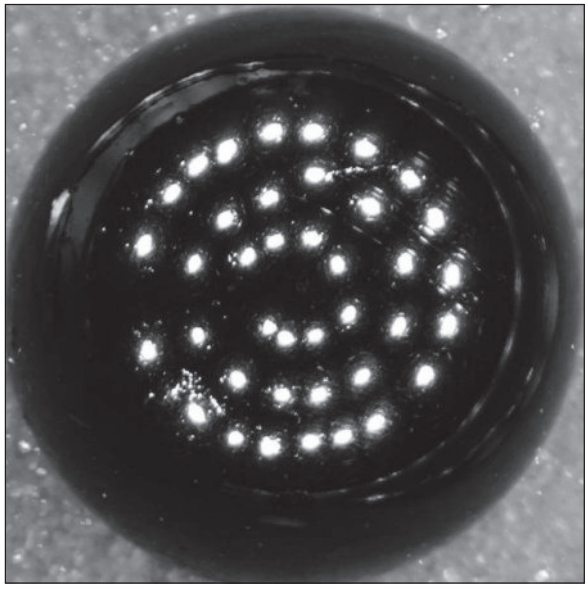
some benefits in terms of faster and less tedious acquisition, and therefore potentially more images per view, which in turn can increase data precision[9]. However, those benefits come at a cost. Since commercial solutions are not

9. <http://vcg.isti.cnr.it/Publications/2006/DCCS06/Dellepiane_et_al_High_quality_PTM.pdf> (accessed Jan 6th 2016).

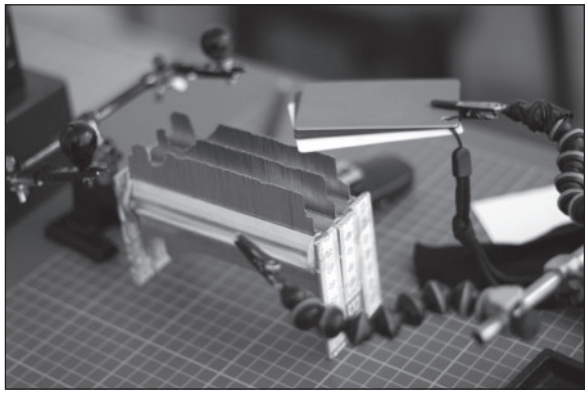
available, the development and construction of such a device can be costly and time-consuming. Spare parts are almost unobtainable in Middle Eastern countries, especially on short notice, and ensuring a sufficient base of spare parts can be a very expensive matter. Furthermore, the intricate wiring of the light sources and micro-controller can require occasional on-site maintenance by a technical expert, the dome′s fixed diameter narrows the size range of objects that can be captured, and its relatively large size can restrict its portability. This can be compensated by a modular setup, but assembling and disassembling on site can be time consuming, and lead to a lower structural integrity of the whole setup. Lastly, entering Near Eastern countries with electronic appliances of ambiguous origin and function can sometimes be difficult.

A free handed acquisition approach, on the other hand, offered many advantages for our project. The components on the whole are very little more expensive than regular photographic equipment, consisting of a DSLR camera, a hand held external flash unit, two wireless transmitter/receiver pairs, a copy stand and different sized reflective spheres. The equipment is inconspicuous enough to raise no flags at customs, and it is easy to ensure sufficient spare parts. It is structurally robust and can be adapted to a broad range of object sizes. As mentioned above, a manual approach means tedious and physically strenuous data acquisition[10]. In our case, this was compensated by a reduced number of shots per object view[11].

A copy stand was chosen over a conventional tripod, because the single vertical mounting arm and resulting top-to bottom-view allows better light distribution around the object (**Fig. 6**). Furthermore, the camera can be focussed accurately by sliding the camera mounting plate down the mounting arm. As well as the camera fixture, stable positioning of the object is crucial, as the smallest movement can result in blurred RTI-files. After some trials with plasticine, a small box filled with chemically neutral sand was used to nest the objects and the reflective spheres. In cases where our own chemically neutral sand could not be imported due to national restrictions, a self-made contraption of three pottery gauges fitted in a row proved to be equally efficient (**Fig. 7**).



6. Light distribution using a copy stand. The stand's arm prevents lighting from its direction, leaving a slight gap (horizontal, left).



7. A contraption made of aligned pottery gauges, used as a fixture for the figurines.

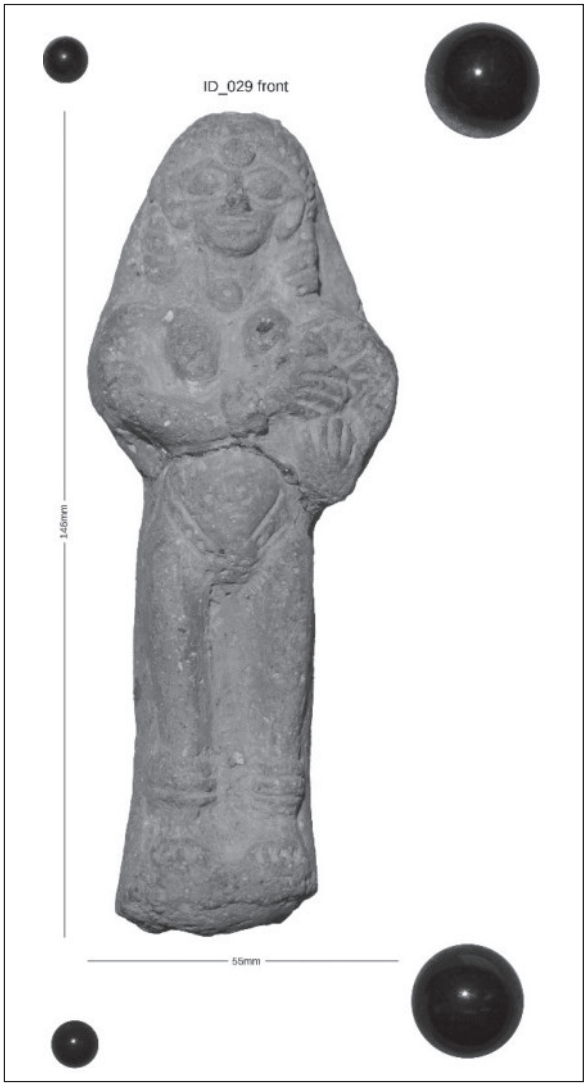
Concerning the camera itself, shooting with a DSLR is preferable, as it allows precise manual control for virtually all camera settings. Although we encountered many small figurine fragments, using a macro lens would have resulted in a much higher image distortion, as well as a very narrow depth of field. A standard kit zoom lens (18-55mm) was used initially, but we quickly observed significant image misalignment between pictures during post-processing, probably caused by vibration from the shutter

10. About 160 pictures were captured per figurine for this project.

11. However, given stationary use and nonrecurring import of the equipment (i.e. an excavation project), a dome's benefits outweigh its disadvantages.

slightly shifting the lens's zoom tube. For this reason, the kit lens was replaced by a 50mm fixed focal length lens, thus eliminating image misalignment, as well as minimizing distortion. Since the focus ring still tends to shift between shots in a vertical setup, tethered shooting using the camera manufacturer's photo studio software is advised. This way, the lens's internal servo motor can be used to fix the focus for the duration of a shoot, without the use of external mechanical aids. A hand-held wireless flash unit serves as the light source, enabling shorter exposure times. This means that ambient lighting can be largely disregarded. Additionally, higher f-stop values can be set, thus increasing the depth of field. In addition to the figurine itself, several objects have to be placed in the frame. These include at least two reflective spheres for the RTI-computation[12], grey cards for white balance correction, as well as a label containing the object's ID-number. As mentioned above, 40 pictures with different lighting angles are taken for the obverse, reverse, and side views of the object; top and bottom views are captured as photographs only. In roughly ten to fifteen minutes, a figurine can be prepared, positioned and captured accordingly. During post processing, the alignment between the images for each series is checked and, if necessary, corrected. Prior to processing in the RTI-Builder, a composite mask is applied to each image series, removing the background and adding the text formatted ID-number and dimensions of the object (**Fig. 8**). Post-processing of each figurine takes roughly two and a half hours, with most time spent on manual background masking. However, adding this step allows for easy extraction of publication ready RTI-screenshots.

The process described here leaves much room for improvement. In retrospect, automatic acquisition would have been favorable, given slightly different circumstances. Some of the repetitive steps in our custom post-processing could surely be further automated using high level programming languages, depending on the availability of time and financial resources. Since the RTI-method does not return real 3D-data (i. e. surface points with x, y and z values in space), combining it with photogrammetry could close the gap between 2.5D and 3D-data. Both methods could easily be implemented as standard procedure in museums and excavations, regardless of individual technical sophistication or budgetary constraints. However, if projects do not have an open data policy[13] for their files, they are of little or no value to researchers. For this reason, FGFP aims to make its RTI-files available online in the near future.



8. A composite mask is applied to all photographs before further processing, discarding the background and adding the figurine's identification number and measurements.

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12. See FN 6.

13. Please refer to <http://www.openoasis.org/index.php?option=com_content and view=article and id=130 and Itemid=390> (accessed Jan 6th 2016) for an introduction into the subject.

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