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AN ENTHRONED TYCHE STATUE FROM GADARA / UMM QAIS, JORDAN

Abstract: The round statue of enthroned Tyche was originally displayed in the middle of the front row of seats in the west theatre of Umm Qais. The statue of high quality is made of ivory coloured marble, while the theatre is constructed of black basalt stone. This contrast of colour and material made the statue stand out and intensified the beauty of the theatre. The statue has been moved by the Department of Antiquities of Jordan and displayed at Umm Qais Archaeological Museum, registered as number 13c. The Gadara Tyche appeared with one of the main symbols of the goddess, the cornucopia.

Highly realistic and geometric models of cultural heritage objects are attractive tools for documentation, preservation and promotion purposes. 3D imaging, using dense stereo matching techniques, is used for accurate and realistic modeling of the Tyche statue and the theatre of Umm Qais. Acquiring 3D surfaces with image matching solutions has many advantages related to the flexibility, cost effectiveness of, and need for short data collection time on the site without disturbance to the site's visitors.

Keywords: Roman sculpture, Umm Qais, Tyche, 3D digital documentation, photogrammetry

1. INTRODUCTION

The worship of gods or goddesses as patrons and guardians of a city was an ancient oriental tradition, especially in Mesopotamia and Egypt. It dates back to the Bronze Age, during the third millennium B.C. This practice long predated the arrival of Alexander the Great to the East in 331 B.C. Each city state had its own god or goddess. He or she was the primary and most popular among other dei-

ties. He or she had to protect the city from enemies, attacks from other cities, and represent its needs to the other deities.

This tradition transferred later to the Greeks and Romans. The goddess who played the city god or goddess role was often Tyche, as it was in the case of Gadara, the Greek/Roman predecessor of today's city of Umm Qais in Jordan.

2. THE TYCHE STATUE OF GADARA / UMM QAIS

In 1974 the German Protestant Institute of Archaeology (*Deutsches Evangelisches Institut für Altertumswissenschaft des Heiligen Landes*) uncovered the remains

of a Byzantine Church in Umm Qais. Shortly after, a fruitful cooperation started between this Institute and the German Archaeological Institute (*Deutsches Archäologisches Institut*), resulting in the discovery of several antique sites. Since 2001, the "Gadara Region Project" has been studying the area of Umm Qais. Apart from the two Institutes mentioned above, the Biblical-Archaeological Institute Wuppertal is also involved.¹

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Fig. 1. Statue of enthroned Tyche, originally in the west theatre of Gadara (Umm Qais, Jordan) (photo: <http://www.atlastours.net/jordan/u>)

Parallel to the archaeological researches restoration works of the ruins of Gadara were realized. During the restoration of the Roman west theatre of the town the monumental enthroned Tyche statue in the orchestra of the theatre (Fig. 1) had to be secured by the Department of Antiquities of Jordan on grounds of conservation. Displayed now in the Umm Qais Archaeological Museum, the statue of high quality is registered at inventory number 13c (Figs. 2–4). Based on the style and arrangement of the drapery, the statue has been dated to the Roman Period, specifically the second quarter of the second century A.D.²

Sculpted of ivory-coloured marble, the contrast of the material and colour of the statue, and the black basalt stone of the Roman theater (Fig. 5) – the original place of the statue – made it the focal point of the theater. This contrast caused the goddess to appear more vividly, like a queen or a bride among her people. The statue of the seated Tyche reveals a now headless, almost double life-sized version of the goddess, approximately 249 cm tall (height of the figure itself: 224.5 cm; plinth: 67 × 121 cm with a height of 11.8 cm; height of the 66.5 cm long little pedestal the figure is sitting on: 12.7 cm; width of the back of



Fig. 2. Statue of enthroned Tyche of Gadara, second quarter of the second century A.D.; Umm Qais Archaeological Museum, Jordan (photo: Eyad Almasri)

the statue: 83.5 cm). The goddess wears a thin chiton, buttoned on the shoulders, and has a heavier himation draped across the lower abdomen and lap, which spills over the left side of her body and hangs down onto the throne. She sits on a throne with back and arm resting (Fig. 6), holding a cornucopia in her left arm, leaned against her left shoulder (Fig. 7). Her feet are shod in sandals and rest on a footstool. Her left foot is extended forward, while the right foot is pulled back, nearly even with the front right leg of the throne (Figs. 8–9). Her right heel is pulled up off the footstool. Her long hair braids fall down on her shoulders reaching her breasts. The back of the throne is lightened by four square compartments carved out in two rows, with a fifth bigger square also deepened below them between the back legs of the throne (the measurements of the four upper squares are 40 × 40 cm, those of the bigger lower one are 80 × 80 cm; Fig. 10).³

The sources of the marble of this statue and other statues found in Philadelphia (today's Amman) and Gerasa in Jordan are in today's Turkey and Greece, the



Fig. 3. Statue of Gadara Tyche
(photo: Eyad Almasri)

possible quarries were in Prokonnesos (Marmara), Denizli, Afyon, Ephesos and Pentalikon. Transporting the marble from such far regions reflect the trade networks between the major quarries and various regions of the Roman Near East.⁴

The Tyche of Umm Qais was inspired by the Classical Period of Greek sculpture. The Roman sculptor gave attention to certain details, including the human anatomy, the proportions and movement of the body as it is shown on the legs, the movement of the folds of the clothes, details, and texture. Portraying the goddess seated on her throne helped in making the statue more balanced and stable. The whole pose of Tyche can be described as both pyramidal and triangular. Additionally, the sculptor succeeded in including each element or symbol in the appropriate place and size; the result being a harmonious art work, a meaningful statue.

The representations of Tyche usually appear with signs and badges, such as the mural crown (*corona muralis*),⁵ sheafs of wheat, a pomegranate or other fruit, a palm branch, a cornucopia or basket, a ship's rudder, a wheel, the zodiac, a spear, the victor's wreath, a stephane or polos, diadem, veil, an orb, a patera, a scepter, a torch, wings, an accompanying river or harbour god.⁶

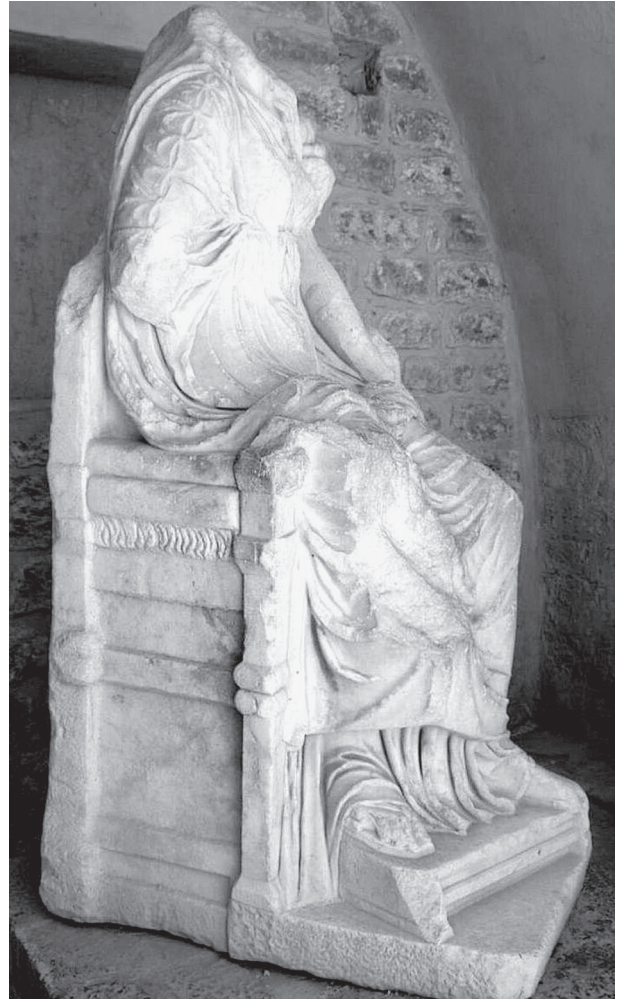


Fig. 4. Statue of Gadara Tyche (photo: Eyad Almasri)

The Tyche of Umm Qais appeared with one of her main symbols, the cornucopia, a horn of plenty, signifying abundance. In Greek mythology, the infant Zeus was entrusted with the care of the daughters of King



Fig. 5. The Roman west theatre of Gadara
(Umm Qais) after restoration (photo: Pál Lővei)

Melisseus and the goat-nymph Amalthea. In gratitude, Zeus broke off one of the goat's horns and gave it to Melisseus's daughters with the promise that it would be everlastingly full of food and drink. It was depicted brimming with fruit and grain and has been used as

a motif in art and architecture throughout the years, particularly on temples. Since ancient times, it has stood as a symbol of abundance and prosperity.⁷ Several round statues of cornucopia have been uncovered at different Roman sites (Fig. 11).⁸

3. TYCHE IN HELLENISTIC AND ROMAN PERIODS

References to monumental sculptures of Tyche earlier than the Hellenistic period are scarce. It is not until the early Hellenistic period that Tyche, as a visual image, becomes important in the Greek world. Most Greek cities in the east were new foundations, surrounded by strange native populations and with uncertain futures. Tyche became a personification of divine protection for the city.⁹ She went on to become a popular and common goddess among Hellenized inhabitants of the Levant and later among the Romans.

The best known and dated of all Tyche statues is the Tyche of Antioch (modern Antakya in Turkey), originally cast of bronze by Eutychides of Sikyon in the early years of the third century B.C. A series of statuettes, mostly in metal, as well as representations



Fig. 6. Left side of Gadara Tyche (photo: Eyad Almasri)



Fig. 7. Cornucopia, detail of Gadara Tyche (photo: Eyad Almasri)



Fig. 8. Detail of Gadara Tyche (photo: Eyad Almasri)

on coins, lamps and gems, repeated the same type, with some variations in both pose and attributes.¹⁰ In addition to that, Tyche representations can be seen on the first coinage of Tigranes I who ruled Syria from 83 to 69 B.C., before being deposed by the Romans. The type of Tyche of Antioch can be recognized in a series of bronze and silver statuettes, and some stone



Fig. 9. Detail of Gadara Tyche (photo: Eyad Almasri)



Fig. 10. Backside of Gadara Tyche (photo: Eyad Almasri)



Fig. 11. Sculpted cornucopia, Khirbeth el-Dharih, Jordan (VILLENEUVE et al. 2002, fig. 78)

replicas: sculpted of marble in the Vatican Museums (Fig. 12),¹¹ in the Museum of Fine Arts in Budapest,¹² in the Metropolitan Museum of Art in New York, carved of alabaster in the Thorvaldsen Museum in Copenhagen,¹³ and cast in bronze in the Louvre from the de Clercq collection in Paris (Fig. 13),¹⁴ all products of the Roman Empire.¹⁵ Although all these statues are connected with the original Antioch one but they differ in the drapery, the movement of the arms and feet, and in the attributes in the right hand. Most of the replicas show ears of wheat, or pomegranate symbolizing prosperity, or palm branch as symbol of victory.¹⁶

In the case of Tyche of Antioch, the god of the town's Orontes (today Asi) river is represented emerging from the water. The city goddess sits on a rock, with her right foot on the shoulder of Orontes. Her legs are crossed, her left hand is laid at her side on the rock, while the right arm rests with the elbow on the

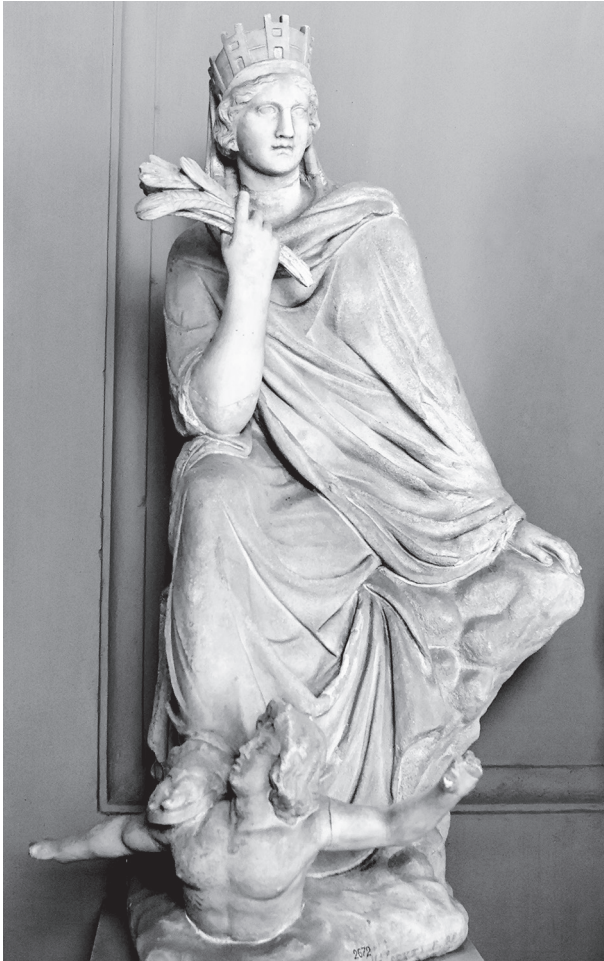


Fig. 12. Tyche (Fortune) of Antioch, Roman copy after a Greek bronze original by Eutychedes of the early years of the third century B.C., marble; Vatican Museums (photo: https://commons.wikimedia.org/wiki/File:Tyche_Antioch_Vatican_Inv2672.jpg)

right knee and the hand lifted, holding what appears to be a sheaf of wheat or a palm branch. The head of the river god is turned to the left while Tyche's faces the right. The drapery of Tyche is arranged so that the folds are clearly accentuated to emphasize the fact that the movement of Tyche is from her right to her left side, while the river god seems to swim in the opposite direction.¹⁷

Tyche, as a city goddess and the goddess of fortune, became especially popular and commonly worshipped in different parts of the Roman Empire. A wide scale of her representations is known, reflecting her importance during all the Roman period. A comprehensive study of her as a goddess of fortune has been undertaken by Barbara Lichocka.¹⁸ Tyche appeared on coins, gems, terracotta and bronze figurines, and stone statues, in different attributes and poses, such as sitting on a throne or on a rock, as the Tyche of Antioch



Fig. 13. Tyche (Fortune) of Antioch, Roman bronze statuette, first-second century A.D.; Musée du Louvre (BURN 2004, fig. 77)

(Figs. 12–13), or standing with a cornucopia held in her left, the primary symbol used to indicate her status as a goddess fortune.

3.1. Tyche on Roman Coins

The representations of Tyche on Roman coins have been discovered in various cities throughout the Roman Empire. A number of coins, uncovered at the Decapolis cities, and in other cities such as Petra and Khirbeth el-Dharih, in Jordan, date back to the second and third centuries A.D. Tyche appeared in various poses with different badges. Her representations can be classified as follows: Tyche sitting on a rock with the river god swimming below her feet, holding a mace and a cornucopia; standing Tyche with a cornucopia in her left hand (Fig. 14); as a profile head of the goddess with a mural crown; and her bust with a cornucopia above her shoulder.¹⁹ In general, the poses of her as a goddess sitting on her throne or on a rock, reflect her dignity. The names of the minting cit-



Fig. 14. Tyche representation on Roman coin, Khirbeth el-Dharieh (VILLENEUVE et al. 2002, fig. 130)



Fig. 15. Head of Tyche, Philadelphia-Amman, Jordan (photo: https://commons.wikimedia.org/wiki/File:Tyche_of_Amman_Archaeological_Museum_Amman_Citadel_Jordan0835.jpg)



Fig. 16. Tyche representation on the Byzantine mosaics of the Hyppolytus Hall in Madaba (Jordan) from the first half of the sixth century A.D. (photo: Pál Lóvei)



Fig. 17. Tyche representations on the Byzantine mosaics of the Hyppolytus Hall in Madaba from the first half of the sixth century A.D. (photo: Pál Lóvei)



Fig. 18. Nabataean coin (King Aretas III, 87–62 B.C.) representing Tyche of Damascus with the god of river swimming below her legs (photo: Ancient Coinage of Arabia, Nabataea – www.wildwinds.com/coins/greece/arabia/nabataea/i.htm)



Fig. 19. Relief of the winged Tyche, Petra Museum, Jordan (GLUECK 1965, pl. 185)

ies, like Rome, Antioch and Petra, also appear on the coins, as an indication of the protection provided for these cities by the goddess.

3.2. Tyche as a City Goddess

A well-known marble head of Tyche of Philadelphia, another Decapolis city, has been uncovered in the Citadel of the settlement (Fig. 15). It is almost a life-sized head, currently displayed in the Jordan Archaeological Museum.²⁰ The goddess can be easily recognized by her mural crown. She shows the classical expressive features of an attractive young woman.

In Gerasa, another important Decapolis city, a statue of Tyche has been uncovered. It is comparable to the statue found in Philadelphia.²¹ It is worth men-



Fig. 20. Remains of a Tyche figure in high-relief on the façade of the so-called Treasury at Petra (photo: Pál Lővei)

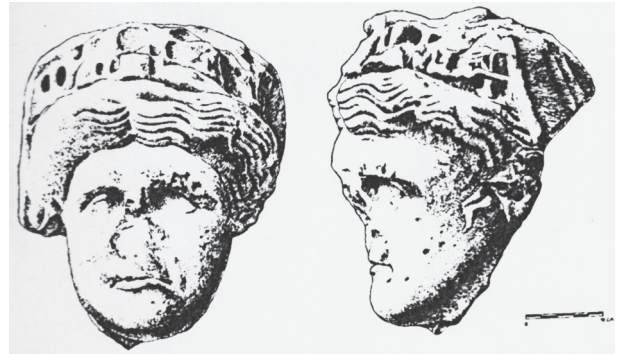


Fig. 21. Head of a Tyche statue, Petra (JOUKOWSKY 1996, figs. 22 a-b)

tioning here that Tyche representations appeared also in the Byzantine Period, on the mosaics of the Hypolytus Hall in Madaba from the first half of the sixth century A.D. (Figs. 16–17).²² She appeared with her divinity badges, sitting on her throne, holding a mace in her right hand, a cornucopia in her left hand, and crowned with mural crown.

4. TYCHE IN NABATAEAN AND OTHER CONTEMPORARY KINGDOMS

Tyche representations have been uncovered in different Nabataean sites in Jordan, and in other contemporary Kingdoms' centres like Palmyra, in today's Syria and Hatra, in modern Iraq. It seems that Tyche played several roles throughout the Nabataean Kingdom, specifically as: a goddess of fortune; a fertility goddess, a

goddess of plenty; a city protector; and a guardian to its people. Additionally, she also imbued holiness to specific people, places, or cities.

Nabataean coins representing Tyche have been discovered in Petra and elsewhere within the Nabataean Kingdom.²³ Christian Auge classified four kinds of Tyche



Fig. 22. Head of a Tyche in high relief, Petra (photo: <http://books.openedition.org/ifpo/docannexe/image/4896/img-6.jpg>)



Fig. 23. Bust-fragment of a Tyche in high relief, Khirbet et-Tannur, Jordan (GLUECK 1965, pl. 45 a)

portrayed on Nabataean coins as follows: on the first type she appeared winged, holding a cornucopia in her left hand, and sitting on a rock with the river god swimming below her feet (Fig. 18).²⁴ Another type shows her standing in profile and holding a mace.²⁵ Thirdly, she appeared winged and standing in profile, holding a palm branch and wearing a towered crown.²⁶ And, finally, she is represented in a profile pose, raising her hand in a blessing gesture.²⁷ In all cases, Tyche appeared with her commonly recognized signs and badges, the wings, palm branch, mace, mural crown and cornucopia.



Fig. 24. Bust-fragment of Tyche in high relief, Khirbet et-Tannur (GLUECK 1965, pl. 45 b)



Fig. 25. Bust-fragment of Tyche in high relief, Khirbet et-Tannur (GLUECK 1965, pl. 53 a)

The representation of Tyche on Nabataean coins, with the portrait of the king and in some cases of the queen, reflects the role of the goddess in providing protection, richness and prosperity to the king, his family, people, capital and kingdom.

A group of rounded, high-relief statues have been discovered in different parts of Petra, originating from the Temenos Gate, and found in its destruction debris. One of them is a full-length statue of Tyche (Fig. 19). Sculpted of sandstone, it is currently displayed in the Petra Museum.²⁸ Notably, the head and feet are missing. The winged Tyche is wearing a chiton, a clothing of Greek origin. She holds a raised palm branch in her right hand and a cornucopia in her left. The cornucopia is filled with a variety of fruits and a bunch of grapes. Another important representation of Tyche is a full-length, high-relief statue, carved into the center of the



Fig. 26. Zodiac Tyche supported by Nike from Khirbet et-Tannur (GLUECK 1965, pl. 48)

tholos on the upper portion of the so-called Treasury at Petra (Fig. 20). It is a female figure holding a cornucopia in her left hand. It may represent the goddess Isis/Fortuna, who may have been identified at Petra by the name of al-Uzza.²⁹ Regardless of the fact whether she

was identified as Isis or al-Uzza by the Nabataeans, she played the role of Tyche as a goddess of fortune and city protector, as she is holding the cornucopia in her left hand, one of the main badges of Tyche identifying her as a goddess of fortune. A three-dimensional head of Tyche (Fig. 21), was found at the Great Temple at Petra. It is made of sandstone and is approximately life-sized, the height being 38 cm, the width 35 cm, and the thickness 29 cm.³⁰ Here Tyche can be easily recognized again by her mural crown. The statue is currently displayed in the Petra Museum. In addition to these examples of Tyche from Petra, several reliefs (Fig. 22) and fragments of a Tyche head have been uncovered there.³¹

Five high-relief busts of Tyche have been found at the Khirbet et-Tannur Nabataean temple site also in Jordan. All are made of limestone (Figs. 23–25).³² As usual, she appears on them with her sign, the mural crown above her head, and at one of these examples, a cornucopia is laid across her right arm. One of these statues is a high-relief of Atargatis/Tyche, encircled by a zodiac and held by the winged Nike, the victory goddess (Fig. 26).³³

In Wadi Rum, in Jordan a rounded sandstone statue was uncovered which reveals the lower portion of a seated Tyche in the pose of Tyche of Antioch, with her right foot resting on the neck of the personification of the Orontes River (Fig. 27).³⁴

Various groups of representations of Tyche in round and relief have been found in Palmyra in today's Syria (Figs. 28–29). One of them is a relief depicting Tyche in the pose of the well-known statue of Tyche of Antioch, mentioned above,³⁵ with a round head and mural crown.³⁶ Tyche appeared in Dura-Europos also on a relief dated to 159 A.D., showing the guardian spirit of Palmyra in the pose of Tyche of Antioch, with a lion and a victory goddess on her left (Fig. 30).³⁷

A group of representations of Tyche, in both round and relief, have been found in Hatra in Iraq (Figs. 31–33). One of them is a head representing Tyche with mural crown,³⁸ similarly to the statue-heads of Philadelphia-Amman and Palmyra mentioned above (Figs. 15, 29).

5. DIGITAL DOCUMENTATION OF THE GADARA / UMM QAIS TYCHE

Digital documentation is a very useful tool in heritage conservation. It promises significant changes in restoration and conservation techniques for both archaeological sites and objects. Digital documentation technologies provide several useful tools as for example

storing a huge amount of accurate data with little cost. It can be employed for managing heritage sites and specifying priorities for conservation work. Digital documentation also gives the opportunity for institutions and scholars to exchange knowledge about any



Fig. 27. Fragment of a seated Tyche statue, Wadi Rum, Jordan (GLUECK 1965, pl. 52 c)



Fig. 28. Relief of Tyche in the pose of the Antioch statue, Palmyra, Syria (COLLEDGE 1976, fig. 38)



Fig. 29. Head of a Tyche statue, Palmyra (GLUECK 1965, pl. 52, b)



Fig. 30. A relief with Tyche in the pose of the Antioch statue, with bilingual inscription in Greek and Aramaic, 159. A.D., Dura-Europos, Syria (photo: <http://b02.deliver.odai.yale.edu/be/d6/bed627ee-0cac-445b-bf15-a62fe7174a1e/ag-obj-25182-001-pub-large.jpg>)

site or object without travelling directly there, saving time and money and encouraging global scientific research and cooperation.

Highly realistic, geometric models of historical architecture and objects are a fundamental prerequisite when reconstruction or restoration is needed. 3D models allow the visualization of scenes from different viewpoints for historical studies and archaeological inquiries, as well as virtual tourism and virtual museums. The technique offers the possibility of

making copies of any small or huge art or antiquity object. The copies can vary in technique, size, colour and material. Fragile materials can be changed to more resisting ones. These copies can be displayed at archaeological sites, in museums, and sold as souvenirs to tourists, offering more income to improve the site.

Photogrammetry helps experts to determine the geometric properties of objects by means of measuring and interpreting photographic images. Recent photogrammetric matching algorithms allow for an automatic production of highly dense 3D point clouds.³⁹ Acquiring 3D surfaces with image matching solutions has many advantages related to the flexibility, cost effectiveness of, and need for short data collection time on site, without disturbing the site's visitors. The system guarantees the realistic appearance of the final 3D model through the collection of images, with the flexibility of having close-up shots related to the fine details of the surfaces. Pierre Grussenmeyer points to the fact that dense image matching is appropriate for accurate sub-millimeter modeling.⁴⁰

The Dense Matching Technique can produce the detailed 3D point cloud set of data which is required to create high-resolution geometric models.⁴¹ The Institute for Photogrammetry of Stuttgart University (IFP) presents a new approach to this type of data collection, described as the Multi View Stereo (MVS) method. It is used to generate dense and precise 3D point clouds. The implementation is based on the



Fig. 31. Head of a Tyche statue, Hatra, Iraq (BASMACHI 1972, 234)



Fig. 32. A relief of Tyche carved on the front of a monumental statue, Hatra (BASMACHI 1972, Fig. 223)



Fig. 33. Seated Tyche, Hatra (BASMACHI 1972, 245)

Semi-Global Matching algorithm developed by Heiko Hirschmüller.⁴² This is followed by a fusion step to merge the redundant depth estimation across single stereo models. In order to reduce the time and mem-

ory, a hierarchical coarse to fine algorithm is used to derive search ranges for each pixel individually. The developed dense image matching algorithm has since been implemented in software called SURE.

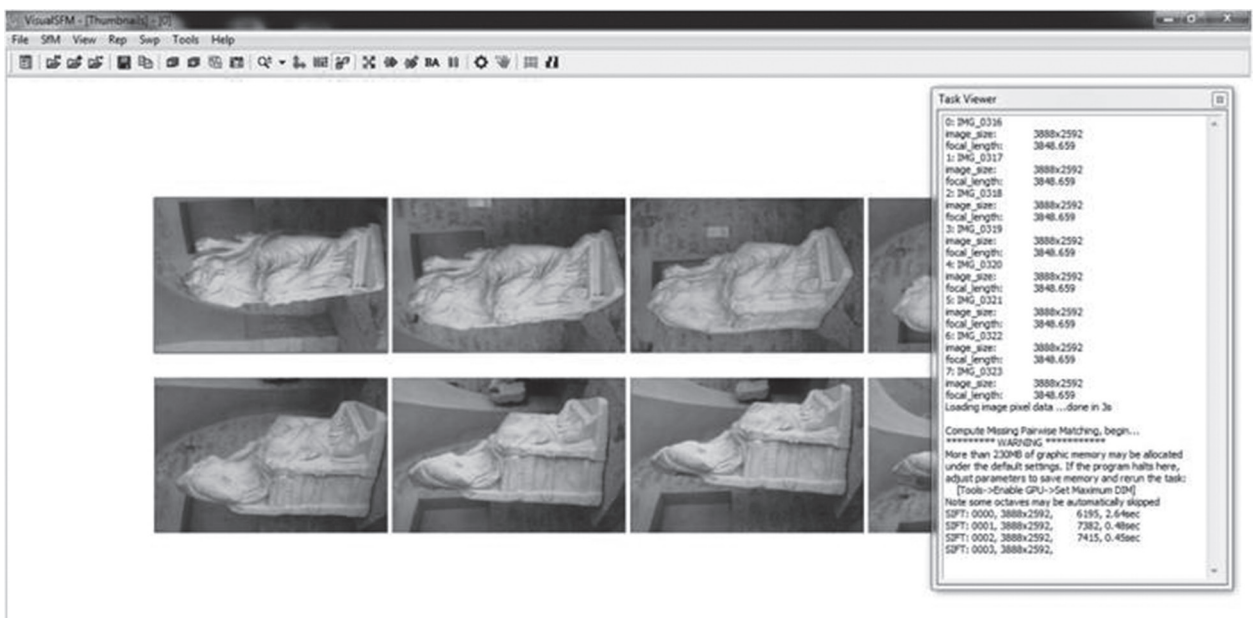


Fig. 34. Parameters of photos of the Gadara Tyche using VSF software

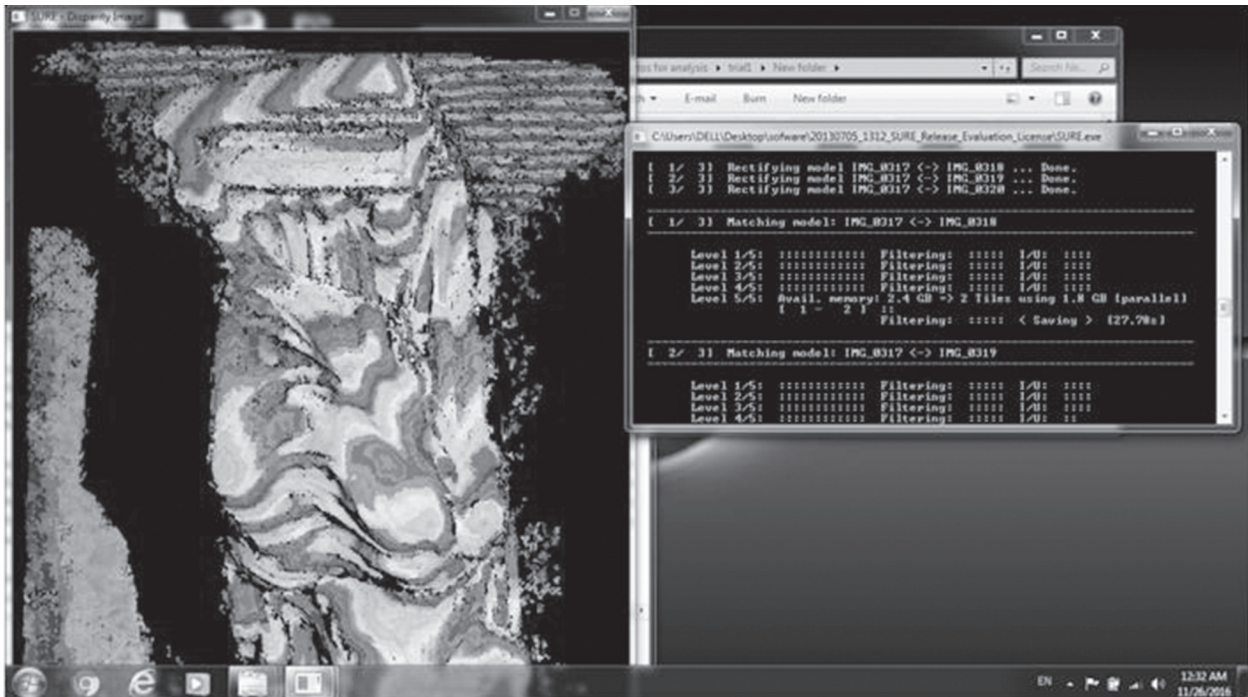
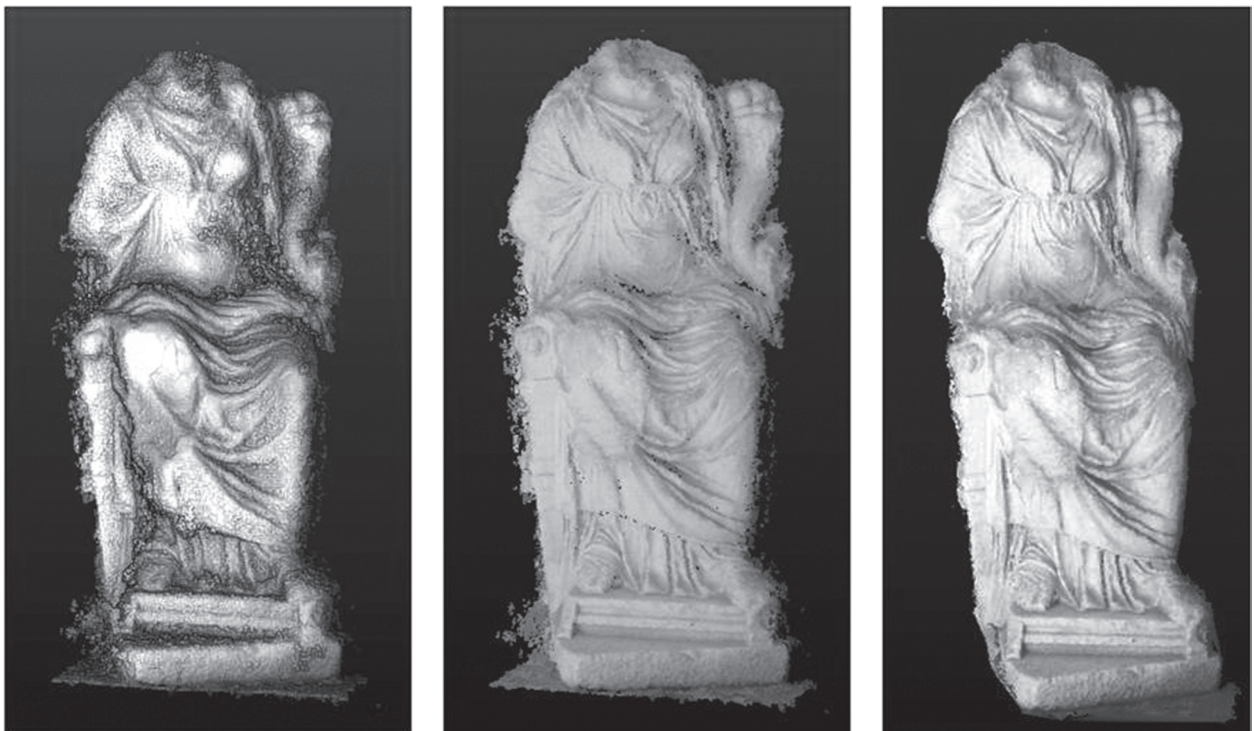


Fig. 35. Generating 3D point cloud using SURE software

This new and innovative approach begins by determining the interior and exterior camera parameters. For this purpose, Visual SFM software developed by Changchang Wu⁴³ was used in Umm Qais. The software improved the efficiency of the structure-

from-motion matching algorithm previously used by introducing a preemptive feature matching that provides good balance between speed and accuracy. In addition to the camera parameters, sparse point clouds for the surface features can be extracted (Fig. 34).



Figs. 36–38. Left: shaded point clouds, middle: coloured point cloud, right: 3D meshed model of the Gadara Tyche

Using the intrinsic and extrinsic camera parameters, IFP dense image matching software is used to produce points for each overlapping pixel, as depicted in Fig. 35. Post-processing steps may be needed for filtering the point cloud from remaining outliers. Finally, a meshing process is applied for surface generation. The final point clouds and meshed surface models are depicted in Figs. 36–38.

In the special case of Umm Qais, it is worth using these technics to produce a copy of the Tyche statue with the help of special kinds of 3D printers. A copy of high standard made of lasting material could be redisplayed at the statue's original place in the Roman theatre in order to reconstruct its original status and integrity.

6. CONCLUSION

Tyche was a popular and commonly-worshipped goddess in the Hellenistic and Roman Periods. She is a female deity associated with good fortune, plenty, fertility, and, in addition to that, she offers the patronage, protection, prosperity and holiness to the cities and its inhabitants. She reflects the dignity, power, richness, and the high status of the country. Therefore, she became a “national” figure for the city, the country, and its people.

The generation of virtual models of the Tyche statue at Umm Qais is of high interest for documen-

tation, restoration, and educational applications. 3D imaging, using the dense image matching approach, has been used for highly realistic and geometric recording of the statute. Such 3D models may allow decision makers, designers, architects, and art curators to make the correct measurements and obtain the necessary notes and information needed for their designs and future plans, without dealing directly with the object. This aids in preserving time, effort, and money while at the same time protecting the objects.

BIBLIOGRAPHY

- ALSHAWABKEH ET AL. 2010 – ALSHAWABKEH, Y. – BAL'AWI, F. – HAALA, N.: 3D Digital Documentation, Assessment, and Damage Quantification of the Al-Deir Monument in the Ancient City of Petra, Jordan, *Journal of Conservation and Management of Archaeological Sites* 12. 2. 2010. 124–145.
- AUGE 1990 – AUGÉ, Ch.: Sur la Figure de Tyche en Nabatene et dans la province d'Arabie, in *Petra and the Caravan Cities*, Amman: Department of Antiquities, 1990. 131–146.
- BALTY 1981 – BALTY, J. Ch.: Antiocheia, in *Lexicon iconographicum mythologiae classicae* 1., Zürich – München: Artemis & Winkler Verlag, 1981. 840–851.
- BASILE 1997 – BASILE, J.: A Head of the Goddess Tyche from Petra, Jordan, *Annual of the Department of Antiquities of Jordan* XLI. 1997. 255–262.
- BASMACHI 1972 – BASMACHI, F.: *Treasures of the Iraq Museum*, Baghdad: Department of Antiquities, 1972. (Art Series 17)
- BIEBER 1961 – BIEBER, M.: *The Sculpture of the Hellenistic Age*, revised edition, New York: Columbia University Press, 1961.
- BURN 2004 – BURN, L.: *Hellenistic Art, from Alexander the Great to Augustus*, London: British Museum Press, 2004.
- COLLEDGE 1976 – COLLEDGE, M.: *The Art of Palmyra*, London: Thames & Hudson, 1976.
- DELLEPIANE et al. 2013 – DELLEPIANE, M. – DELL'UNTO, N. – CALLIERI, M. – LINDGREN, S. – SCOPIGNO, R.: Archeological Excavation Monitoring Using Dense Stereo Matching Techniques, *Journal of Cultural Heritage* 14. 3. 2013. 201–210.
- DOHRN 1960 – DOHRN, T.: *Die Tyche von Antiochia*, Berlin: Gebr. Mann, 1960.
- FRIEDLAND–TYKOT 2010 – FRIEDLAND, E. – TYKOT, R.: The Quarry Origins of Nine Roman Marble Sculptures from Amman/Philadelphia and Gadara/Umm Qais, *Annual of the Department of Antiquities of Jordan* LIV. 2010. 177–188.
- GLUECK 1965 – GLUECK, N.: *Deities and Dolphins, The Story of the Nabataeans*, New York: Farrar, Straus and Giroux, 1965.
- GRUSSENMEYER ET AL. 2012 – GRUSSENMEYER, P. – ALBY, E. – LANDES, T. – KOEHL, M. – GUILLEMIN, S. – HULLO, J.-F. – ASSALI, P. – SMIGIEL, E.: Recording Approach of Heritage Sites Based on Merging Point Clouds from High Resolution Photogrammetry and Terrestrial Laser Scanning, *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences* XXXIX-B5. 2012. (XXII ISPRS Congress, 25 August – 01 September 2012, Melbourne, Australia) 553–558.
- HIRSCHMÜLLER 2008 – HIRSCHMÜLLER, H.: Stereo Processing by Semi-Global Matching and Mutual Information, *IEEE Transactions on Pattern Analysis and Machine Intelligence* 30. 2. 2008. 328–341.
- JOUKOWSKY 1996 – JOUKOWSKY, M.: 1995 Archaeological Excavation of the Southern Temple at Petra, Jordan, *Annual of the Department of Antiquities of Jordan* XL. 1996. 177–206.
- LICHOCKA 1997 – LICHOCKA, B.: *L'iconographie de Fortuna dans l'Empire Romain. Ier siècle de n.è. – IVe siècle de n.è.*, Varsovie: Zakład Archeologii Śródziemnomorskiej Polskiej Akademii Nauk, 1997. (Travaux du Centre

- d'Archéologie Méditerranéenne de l'Académie Polonaise des Sciences, Tome 29)
- LYTTELTON 1990 – LYTTELTON, M.: Aspects of the Iconography of the Sculptural Decoration of the Khasneh at Petra, in *Petra and the Caravan Cities*, Amman: Department of Antiquities, 1990. 19–29.
- MA'AYAH 1960 – MA'AYAH, F.: Recent Archaeological Discoveries in Jordan, *Annual of the Department of Antiquities of Jordan* IV, V. 1960. 114–116.
- MCKENZIE 2005 – MCKENZIE, J.: *The Architecture of Petra*, Oxford: Oxbow Books, 2005.
- MESHORER 1975 – MESHORER, Y.: *Nabataean Coins, Qedem* 3, Institute of Archaeology, Hebrew University of Jerusalem, 1975.
- MEYER 1996 – MEYER, M.: „Neue“ Bilder. Zur Verwendung und zum Verständnis von bildlichen Darstellungen in der Levante, in *Hellenismus. Beiträge zur Erforschung von Akkulturation und politischer Ordnung in den Staaten des hellenistischen Zeitalters, Akten des Internationalen Hellenismus-Kolloquiums 9. – 14. März 1994 in Berlin*, ed. FUNCK, B., Tübingen: Mohr, 1996. 243–254.
- NEX–RINAUDO 2008 – NEX, F. – RINAUDO, F.: Multi-Image Matching: An 'Old and New' Photogrammetric Answer to Lidar Techniques, *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences* XXXVII/B5. 2008. 621–626.
- PARR 1957 – PARR, P. J.: Recent Discoveries at Petra, *Palestine Exploration Quarterly* 89. 1957. 5–16.
- PATRICH 1990 – PATRICH, J.: *The Formation of Nabataean Art 2, Prohibition of a Graven Image among the Nabataeans*, Jerusalem: Magnes Press, 1990.
- RIDGWAY 1990 – RIDGWAY, B.: *Hellenistic Sculpture I, the Styles of ca. 331–200 B.C.*, Madison, Wisc.: The University of Wisconsin Press, 1990 [2001?]
- ROTHERMEL et al. 2012 – ROTHERMEL, M. – WENZEL, K. – FRITSCH, D. – HAALA, N.: SURE: Photogrammetric Surface Reconstruction from Imagery, *Proceedings LCD Workshop*, Berlin, December 2012. 1–9. – http://www.ifp.uni-stuttgart.de/publications/2012/Rothermel_et_al_lc3d.pdf
- STEWART 1998 – STEWART, W.: *Dictionary of Images and Symbols in Counseling*, Britain, Gateshead – Tyne and Wear: Athenaem Press, 1998.
- VILLENEUVE et al. 2002 – VILLENEUVE, F. et al.: *Khirbeth al-Dharih from Nabataeans to the Beginning of Islam*, Amman, 2002. (in Arabic; French version: *Khirbet edh-Dharih: des Nabatéens au premier Islam*, Catalogue de l'exposition à la mairie d'Amman, octobre-décembre 2002, Amman)
- WEBER 2002 – WEBER, T.: *Gadara-Umm Qais I: Gadara Decapolitana. Untersuchungen zur Topographie, Geschichte, Architektur und der bildenden Kunst einer „Polis Hellenis“ im Ostjordanland*, Wiesbaden: Harrassowitz, 2002. (Abhandlungen des Deutschen Palestina-Vereins 30,1)
- WU 2011 – WU, C.: VisualSFM: A Visual Structure from Motion System, 2011. – <http://ccwu.me/vsfm/>

NOTES

¹ https://de.wikipedia.org/wiki/Gadara_Region_Project; for more information about the excavations and restoration works on the site see WEBER 2002.

² WEBER 2002, 298; FRIEDLAND–TYKOT 2010.

³ WEBER 2002, 298, 397, 398, Pl. 3, Taf. 38 A-D; FRIEDLAND–TYKOT 2010.

⁴ FRIEDLAND–TYKOT 2010, Tables 1, 183, 184.

⁵ Accurate discussion of the motive of the mural crown: MEYER 1996.

⁶ BASILE 1997, 259.

⁷ STEWART 1998.

⁸ VILLENEUVE et al. 2002, figs. 78–79.

⁹ BASILE 1997, 258, 259.

¹⁰ DOHRN 1960; RIDGWAY 1990, 233–238, 243–244.

¹¹ Vatican Museums, inv. no. 2672: Tyche (Fortune) of Antioch, reduced Roman copy after a Greek bronze original by Eutychides of the early years of the third century B.C., marble, height: 89 cm. DOHRN 1960, 23, no. 17, Taf. 2; BALTY 1981, 844, no. 27; RIDGWAY 1990, pl. 115; MEYER 1996, 244–245, Abb. 4.

¹² Budapest, Szépművészeti Múzeum, inv. no. 4742: patron goddess (Tyche) of Antioch, Roman marble copy of the original by Eutychides, first century B.C., height: 47 cm. BALTY 1981, 844, no. 19, pl. 672; RIDGWAY 1990, pls. 116a-b; www.szepmuveszeti.hu/adatlap_eng/patron_goddes_tyche_of_antioch_5613

¹³ Copenhagen, Thorvaldsens Museen, inv. no. H1428. DOHRN 1960, 25, no. 18, pl. 13; BALTY 1981, no. 20, pl. 673.

¹⁴ Paris, Musée de Louvre, inv. no. Br 4453, from the de Clercq collection, Boisgelin gift, 1967: Tyche of Antioch,

Roman bronze copy from Tortosa (ancient Antaratudus, present-day Tartus in Syria), first-second century A.D., height: 16.5 cm. DOHRN 1960, 17–18, no. 10, pls. 8, 9.1, 10.2, 32.2; BURN 2004, fig. 77.

¹⁵ BIEBER 1961, fig. 102; RIDGWAY 1990, 233–238, 243–244, pls. 115, 116a, b.

¹⁶ RIDGWAY 1990, 233–235.

¹⁷ BIEBER 1961, 40.

¹⁸ LICHOCKA 1997.

¹⁹ AUGÉ 1990, 134, 135; VILLENEUVE et al. 2002, figs. 128–130.

²⁰ Amman, Jordan Archaeological Museum, inv. no. J.6379: MA'AYAH 1960, 114, pl. 3; GLUECK 1965, 409, pl. 51.

²¹ GLUECK 1965, 409.

²² AUGÉ 1990, pl. III, figs. 23–24.

²³ MESHORER 1975, 9–16; PATRICH 1990, 75.

²⁴ AUGÉ 1990, 131, pl. 1, figs. 1a, b.

²⁵ AUGÉ 1990, 132, pl. 1, figs. 3a, b.

²⁶ AUGÉ 1990, 132, pl. 1, figs. 4a, b.

²⁷ AUGÉ 1990, 132, pl. 1, figs. 6a, b.

²⁸ PARR 1957, pl. 4a; GLUECK 1965, pl. 185; MCKENZIE 2005, pl. 59b.

²⁹ LYTTELTON 1990, pl. III.

³⁰ JOUKOWSKY 1996, figs. 22 a, b; BASILE 1997, figs. 2, 3.

³¹ BASILE 1997.

³² GLUECK 1965, 97, pls. 45 a, b, 53 a, 55.

³³ Limestone, c. 100. A.D.; the upper part with the rounded zodiac: Cincinnati Art Museum, inv. no. 1939.233; the Nike: Amman, Jordan Archaeological Museum. GLUECK 1965, pl. 48.

³⁴ GLUECK 1965, pl. 52c; AUGE 1990, 132.

³⁵ COLLEDGE 1976, fig. 38.

³⁶ GLUECK 1965, pl. 52 b.

³⁷ COLLEDGE 1976, fig. 146.

³⁸ BASMACHI 1972, figs. 202, 223, 234, 245.

³⁹ DELLEPIANE et al. 2013.

⁴⁰ GRUSSENMEYER et al. 2012.

⁴¹ ROTHERMEL et al. 2012.

⁴² HIRSCHMÜLLER 2008.

⁴³ WU 2011.