

Recovery and Reproduction Technology of Nabataean Painted Fine Ware

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Abstract

Nabataean fine painted pottery is one of the most intriguing products of ancient technology in Jordan, it was therefore chosen for the Jordanian component of the CERAMED Project, which is a Euro-Mediterranean project aimed at "The identification, recovery and improvement of ancient and traditional manufacturing technologies used for the production of historical as well as archaeological value ceramic artifacts in the Mediterranean". Six partner institutions from Greece, Turkey, Spain, Morocco and Jordan worked together under CERAMED.

The project involved archaeological research, field survey for raw materials, scientific analyses for the identification of materials, practical experimentation for the recovery or reconstruction of the ancient pottery production technology, improvement of the manufacturing methods through the application of new scientific methods and technologies, and finally the dissemination of information.

This paper is mainly concerned with the practical steps that led to the recovery of the Nabataean painted fine wares, which was achieved in close cooperation with a local women cooperative at at-Tayyiba, near Petra.

CERAMED

CERAMED is a project that was started in 2003 under the umbrella of the Euro-Mediterranean partnership (EC/INCO-MED Project ICA3-CT-2002-10018). It lasted till June 2006 and aimed at the "identification, recovery and improvement of ancient and traditional manufacturing technologies used for the production of historical as well as archaeological value ceramic artifacts in the Mediterranean".

Fine Nabataean painted pottery is one of the most intriguing products of ancient technology in Jordan, it was therefore chosen for the Jordanian component of CERAMED.

The project objectives were: 1. the identification of the raw materials; 2. the recovery of the manufacturing processes; 3. the production of high quality decorated ceramics; 4. the improvement of the manufacturing process through the application of new scientific methods and technologies; and 5. the valorization, dissemination and marketing.

Six partner institutions from Greece, Turkey, Spain, Morocco and Jordan (represented by the Queen Rania Institute for Tourism and Heritage/ The Hashemite University) worked together under CERAMED, while each country worked on one of its historical/ archaeological ceramics.

The historical background

The Nabataean tribes came into southern Jordan sometime during the sixth century BC. Their first concrete mention in history, however, was in 312 BC when they were already mentioned as traders.

They established their kingdom during the second century BC. With its capital at Petra in southern Jordan, it spread from the Sinai in the west, through the Negeb and the northwestern parts of modern Saudi Arabia in the south, across all of south and eastern Jordan up to the Hawran Plains and extended north to include Damascus during the first century BC/ AD. The riches of the Nabataean state came from its control of the overland incense trade across Arabia up to the end of the first century BC, when the Romans diverted the route to cross the Red Sea.

Following the northern trade route, the Nabataeans moved their capital to Bostra (now in southern Syria) during the reign of Rabel II (AD 75-106). Soon afterwards, in AD 106, the Roman emperor Trajan annexed the Nabataean Kingdom, Arabia Petraea, into the Roman Provincia Arabia, with its first capital at Petra then again at Bostra.

The Roman annexation, however, did not mean an end to the Nabataean culture or the importance of Petra. By the end of the third century AD, Petra became the capital of Palestina Tertia that included southern Palestine, Moab, Edom, Negeb and Sinai, i.e. *most of Nabataea where the Nabataean culture continued under Roman political domination*.

The Nabataeans adopted Christianity during the fourth century AD. *Petra, however, gradually lost its importance, and was not mentioned in the Annals of the Muslim Conquests* in the 630s AD. Around then, the seat of the Bishop was transferred to Rabba further north.

The majority of historians and archaeologists believe that the Nabataean society was originally nomadic, similar to modern day Bedouins. The archaeological evidence indicates that large-scale sedenterization of the Nabataeans started by the end of the second century BC [1]. *From then onwards, characteristically Nabataean material cultural objects appear in the archaeological record (inscriptions, coins, pottery, etc.).*

In conclusion: The Nabataean culture is a prime example of a material culture that does not coincide with historical domination [2]. Typical Nabataean material objects – including pottery – appeared several centuries after the appearance of the Nabataeans in history, and continued to be produced several centuries after the fall of their kingdom.

The clay sources

Several provenience studies concluded that Nabataean painted fine wares were only made in the Petra area [3, 4, 5], where there is abundance of clay in the ash-Sharah mountains to the north and east of Petra.

The analyses of clay samples from the Petra region, done under CERAMED, concluded that the site of 'Ayn at-Tinah is the most probable source used by the Nabataean potters [6, see also H. Bearat and F. Alawneh, "Preliminary Examination of the Nabataean Painted Pottery from Petra, Jordan"; and T.S. Akasheh, B. Khrisat, M.N. Na'es, K. Amr and D. Ferro, "Archaeometric Investigation of Nabataean Painted Fine Ware"; both in this volume).

The 'Ayn at-Tinah clay was deposited in shallow waters during semi-arid geological periods (during the Cenomanian 98.9-93.5m yrs ago). The clay has a high expansion/shrinkage rate, and is extremely plastic thus enabling the manufacture of the characteristic "egg-shell" Nabataean wares under proper manufacturing procedures. The high iron contents of the clay result in red coloured pottery that is also typical of the Nabataean wares.

The archaeological production centre

The manufacturing workshops of the Nabataean painted fine wares, like the clay sources, are within the ash-Sharah Mountains to the northeast of the ancient city of Petra. Pottery kilns were first discovered there, at the az-Zurraba district of Wadi Musa, in 1979 during the construction of the road connecting Wadi Musa with Umm Sayhun. Since then, salvage work by the Department of Antiquities of Jordan revealed 12 kilns and parts of several workshops at the site, which is now within the tourist services area next to the entrance to Petra [7-13].

The importance of the site lies in its being one of the largest and the longest operating industrial areas known in Jordan, as pottery was produced there for six centuries – from the first and up to the sixth centuries AD – within an area of around half a square kilometre. It is also the only centre for the production of Nabataean painted fine wares known with certainty up until now.

Nabataean painted fine wares

The Nabataeans produced varied types of pottery during their long existence as a (settled) culturally distinct group. The pottery vessels may be divided into two main categories: coarse common wares, and fine, often “egg-shell” wares of 1-3mm thickness and metallic hardness. Distinctive Nabataean pottery is found in large quantities throughout Nabataea, but it rarely appears beyond its boundaries.

Although forming less than 10% of the Nabataean repertoire at the height of production, and only 2% during the late phases (unpublished data from az-Zurraba excavations), Nabataean painted wares are the most distinct and most extensively studied of all Nabataean pottery productions ([14], referred to as Schmid 1996 hereafter, and [15] present the most thorough typology published so far as well as references to other studies on the subject).

Most painted forms are open bowls with rounded bases, although other forms such as juglets and cups are also found. For our study purposes, we expanded on the typology of the az-Zantur repertoire presented in Schmid 1996, as the samples we examined included wares that are not present at az-Zantur. The fabrics and painting styles are defined here by six main, chronologically significant, types. It should be noted that overlaps between these types have been observed, indicating an evolution of styles rather than abrupt breaks.

Nabataean Painted Fine Pottery: Type 1

Dated to the first half of the first century BC. The ware is very fine but relatively thick in pink/light red fabrics, with red paint in wide bands or wavy lines intersecting at the base (=Schmid 1996: Phase 1). Later examples also have decorations of fine dots arranged in bands (Figure 1). The most common form is a semi-globular bowl with ring base.

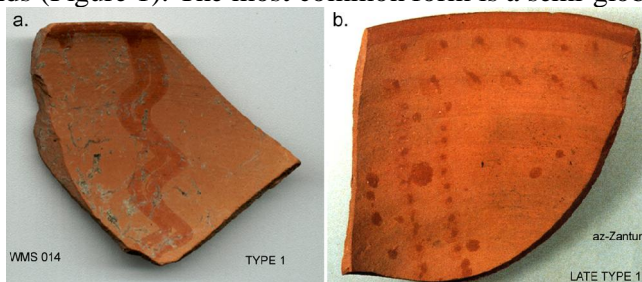


Figure 1. Nabataean painted fine bowl sherds, Type 1: a. from the “Wadi Musa Water Supply and Wastewater Project”; b. from az-Zantur/ Petra, courtesy of Rolf Stucky.

Nabataean Painted Fine Pottery: Type 2

Dated to the later half of the first century BC. The ware is very fine in light red fabrics, and some examples are almost as thin as the classical wares. The designs – in red paint –

usually represent delicate naturalistic leafs radiating from the center, replacing the earlier lines (=Schmid 1996: Phase 2a).

The most common form is an open rounded bowl with simple rim, ring bases are very rare (Figure 2).

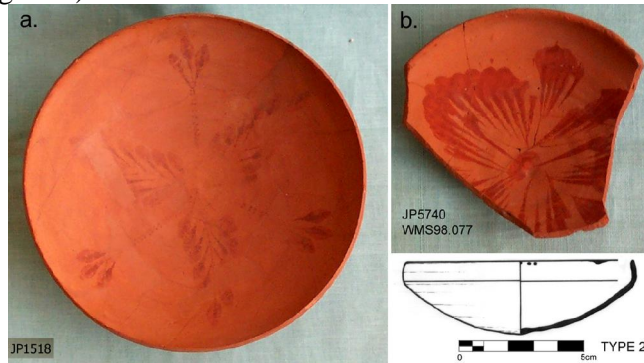


Figure 2. Nabataean painted fine bowls, Type 2: a. from az-Zantur/ Petra, Petra Museum no. JP1518, courtesy of Rolf Stucky; b. from the “Wadi Musa Water Supply and Wastewater Project”, Petra Museum no. JP5740 (profile drawing by Qais Tweissi).

Nabataean Painted Fine Pottery: Type 3

Dated to the first half of the first century AD. The ware is very fine and thin in light red and yellowish-red fabrics. The designs – in deeper red paint – became more complex and the naturalistic leaf designs evolved into wreaths and clusters (=Schmid 1996: Phase 2b).

The common form of the rounded bowl evolved into a “stepped” form then a more open form with simple, slightly incurving rim (Figure 3).

The wreaths were sometimes restricted to the rim area and the center filled with horizontal fields of small leaf clusters defined by lines and dots (=Schmid 1996: Phase 2c), while in the later examples the fields were sometimes filled with lattice designs (=Schmid 1996: Phase 3a).

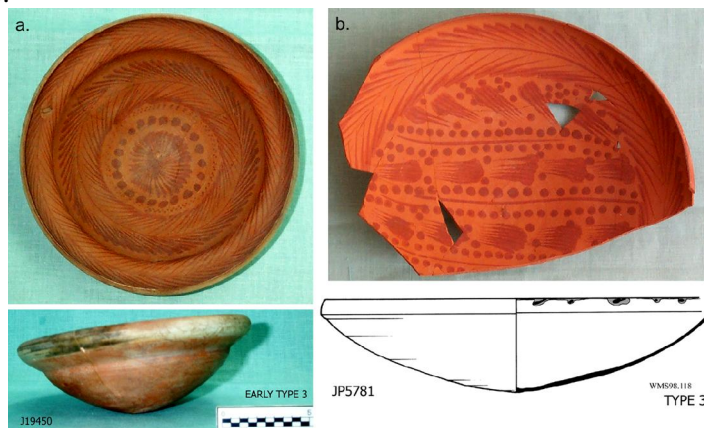


Figure 3. Nabataean painted fine bowls, Type 3: a. unknown provenience, Jordan Archaeological Museum no. J19450; b. from the “Wadi Musa Water Supply and Wastewater Project”, Petra Museum no. JP5781 (profile drawing by Qais Tweissi).

Nabataean Painted Fine Pottery: Type 4

Dated to around the middle-late first century AD. The ware is very fine, thin and metallic hard, in light red and yellowish-red fabrics. The designs – in red and reddish-brown paint – became more stylized and varied but still mainly vegetal (Figure 4).

The most common form is a rounded bowl with small upright rim, but sometimes the rim was elongated and finely trimmed on the exterior.

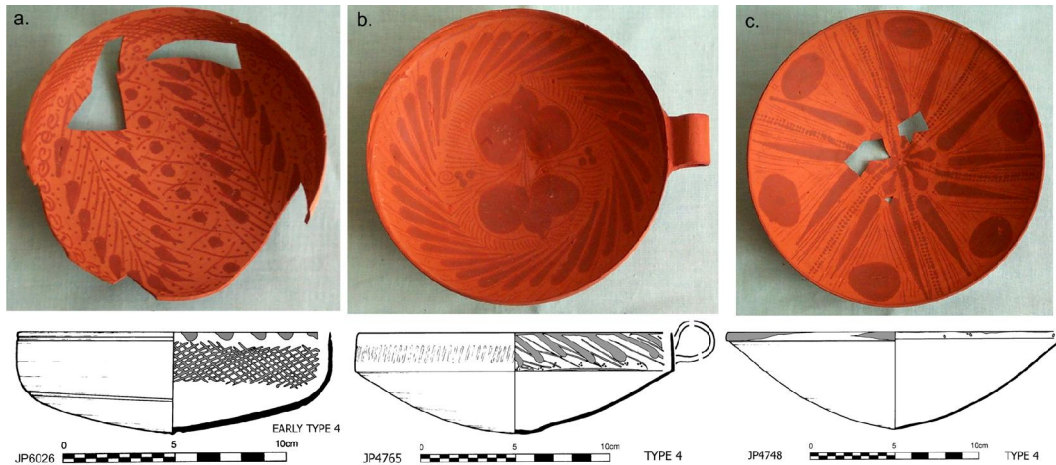


Figure 4. Nabataean painted fine bowls, Type 4: a. from the “Wadi Musa Water Supply and Wastewater Project”, Petra Museum no. JP6026; b, c. from the “Wadi Musa Salvage Excavation 1997”, Petra Museum nos. JP4765, JP4748 (profile drawings by Qais Tweissi).

Painting on closed forms – such as small vases and flared cups – started with this type (Figure 5).



Figure 5. Nabataean painted fine vessels, Type 4: unknown provenience, Jordan Archaeological Museum no. J19452 (“honey-pot”) and J19453 (flared cup).

Nabataean Painted Fine Pottery: Type 5

Dated to around the end of the first and into the second centuries AD. The ware is fine, very thin and metallic hard, in red fabrics. The designs – in brown and black paint – are stylized and solid in comparison with the earlier types.

The earlier examples have hatched backgrounds (=Schmid 1996: Phase 3b) that disappear later (=Schmid 1996: Phase 3c). Animal representations – especially birds eating bunches of grapes – start to appear. (Figure 6).

The most common form is an open rounded bowl with small rolled rim, and painted closed forms are found as well.

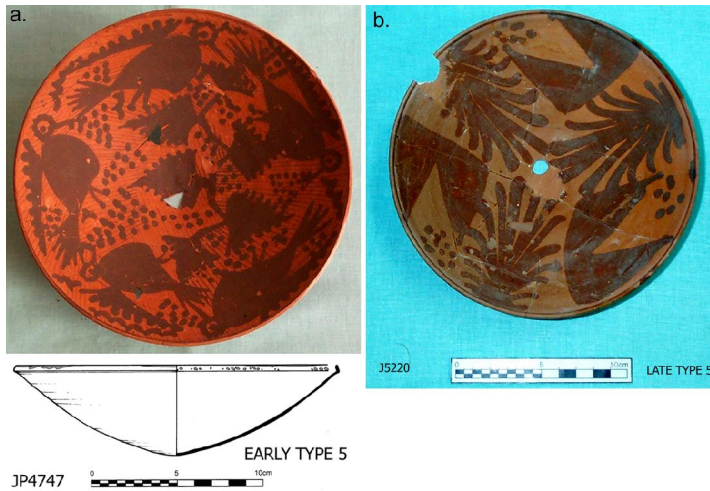


Figure 6. Nabataean painted fine bowls, Type 5: a. from the “Wadi Musa Salvage Excavation 1997”, Petra Museum no. JP4747 (profile drawing by Qais Tweissi); b. from Dhiban, Jordan Archaeological Museum no. J5220.

Nabataean Painted Pottery: Type 6

Dated from the end of the second/beginning of third through to the fifth/sixth century AD. The ware deteriorates progressively, with thicker walls and more temper in the fabrics that are still red but sometimes also with cream-fired surfaces.

The designs – in progressively duller black paint – are solid areas often applied on an obvious red slip (=Schmid 1996: Phase 4).

The open rounded bowl with small rolled rim continues, but painting is also applied to other forms – both open and closed – that are usually unpainted (Figure 7).

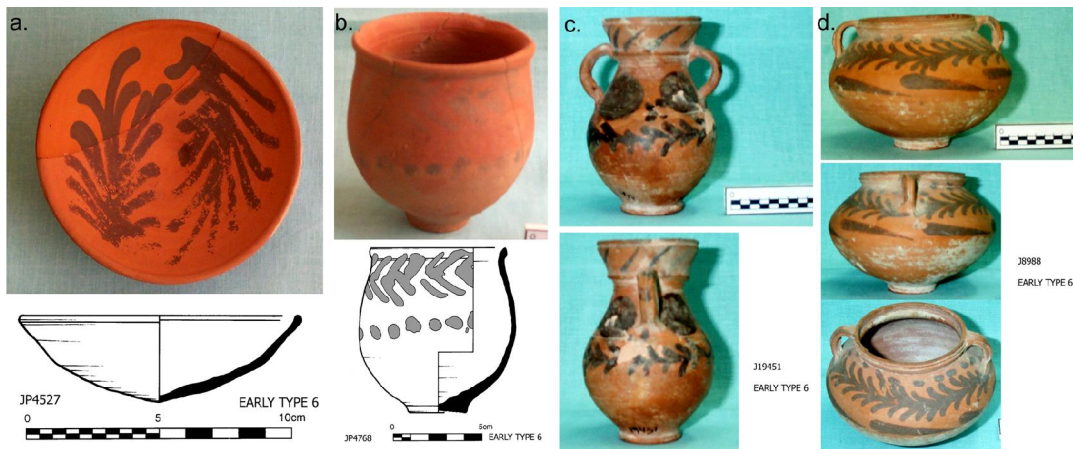


Figure 7. Nabataean painted fine vessels, Type 6: a, b. from the “Wadi Musa Salvage Excavation 1997”, Petra Museum nos. JP4527 (small bowl) and JP4768 (cup) (profile drawings by Qais Tweissi); c, d. unknown provenience, Jordan Archaeological Museum nos. J19451 and J8988.

Nabataean Painted Pottery: Towards the last products

After reaching technological fine heights during the first and early second centuries AD, the Nabataean painted wares started declining with Type 6 (Figure 8). This was followed by the very last stages of production, when the tradition deteriorated to rough designs on rough wares that are known in the Late Byzantine repertoire [16].

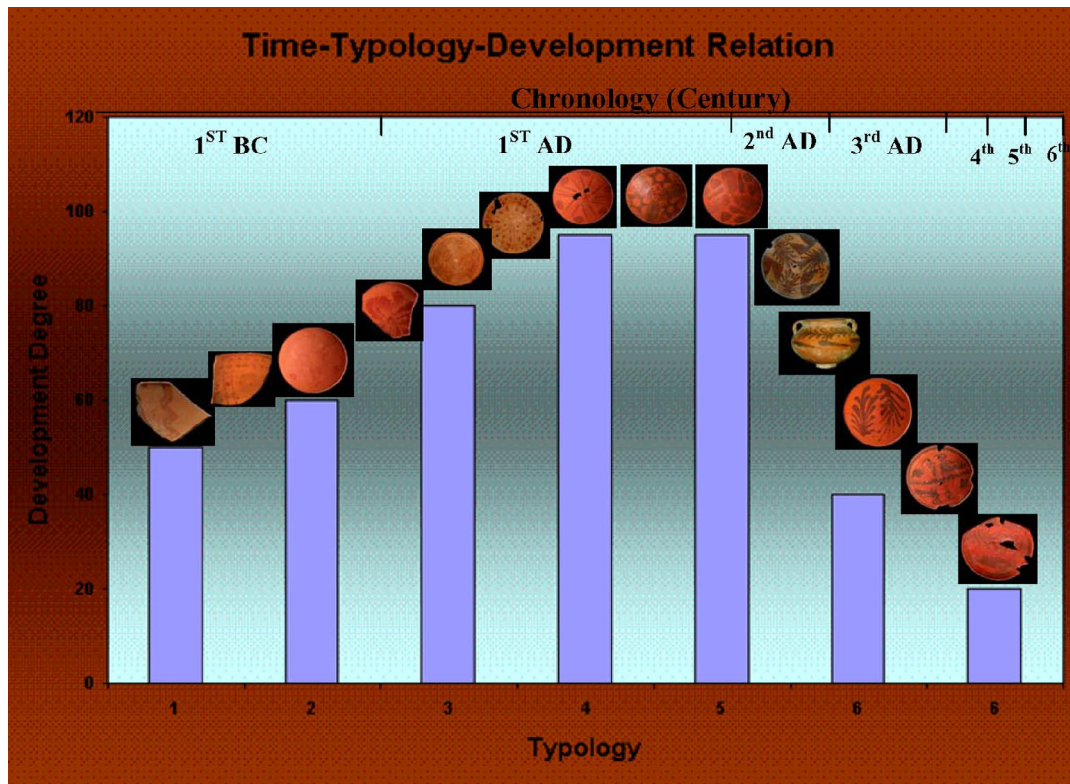


Figure 8. Nabataean painted fine wares, Time-Typology-Development relation.

The use of the Nabataean painted pottery is debatable, the classical bowls with their curved bases and intricate designs on the interiors are too awkward for practical use. The recent excavations at the al-Khazna Plaza confirmed that one use was ritual [17].

The conformity to the typology is amazing aspect of such a creative medium. This may be explained by there being a single source/ workshop for the production, and very probably one family of master potters who carried on the tradition over several generations.

Previous study on Nabataean painted fine ware manufacture

Between 1989 and 1992, the Department of Antiquities of Jordan and Yarmouk University/ British Institute in Amman for Archaeology and History carried out an experimental project on the study of the Nabataean pottery manufacturing techniques, based on earlier Instrumental Neutron Activation Analysis (INAA) results [4].

The project, combining archaeological knowledge with practical skills, enabled us to discover the properties of the local clay, the treatment methods, and to produce wheel-made vessels with walls only 1-2mm thick. The experiments also allowed us to understand the use of several tools that were discovered during the excavations at az-Zurraba, initially thought unimportant (these included tools for gauging the thickness of the vessel wall and trimming tools), and they explained the subterranean rooms at the workshops, which have low walls of just over 2m height, no windows or doors, and whose floors were covered with a thick layer of raw clay. These were slow-drying rooms needed to avoid the cracks in the vessels due to the high shrinkage rate of the clay [18, 19].

The experiments also included firing. We constructed and fired a model kiln at a third of the size of the az-Zurraba Kiln I. The experimental kiln was used to test various types of fuel, and we found olive waste to be the most appropriate for the design. Charred olive stones were

found in large quantities at az-Zurraba, and more recently Nabataean olive presses were discovered in the Petra region, one in close proximity to az-Zurraba [20].

The experimental project went a step further by transferring the results to local village women, who were trained to make the pottery using clays that are accessible to them. The women showed individuality in their products, and went on to produce “Nabataean inspired” pots rather than replicas. Their products, however, lacked the finesse of the ancient wares [21].

CERAMED Nabataean painted fine ware manufacture

The initial project reached an acceptable method for the basic manufacture of the pottery body but stopped at a very early stage of research into the surface finish and decoration. This formed part of the scope of the Jordanian component of the CERAMED Project that started with a thorough survey of Nabataean painted fine wares in Jordanian Museums, the clay sources and raw minerals suitable for painting in the Petra region, and obtaining original sherds for comparative analyses.

The physiochemical analyses comparing the composition of the pottery and local clays allowed for better confidence in the determination of the ancient materials. Using Computed Tomography (CT) scans of bowls, it was also proved that the bowls were wheel-made rather than slip-cast, as had been proposed for some time [e.g. 22].

The village women of Petra (at-Tayyiba), who after 13 years from the initial investigation project are now very skilled potters but unfortunately had to close shop due to economic reasons, were also involved in the CERAMED project. Our reproductions are the result of combining the archaeometric investigations in the laboratory with their practical skills.

CERAMED pottery reproduction

- 1- The raw clay collected from ‘Ayn at-Tinah was carefully levigated at least four times then wet-sieved, excluding all coarse particles. After partial drying of the slurry, the clay was wedged and kneaded repeatedly. No addition of temper was involved as the clay is more workable when “pure”.
- 2- The prepared clay was then thrown on a fast electric wheel. The rim and upper walls of vessels were thrown as thin possible, while the bases were left thick for support (Figure 9).



Figure 9. Throwing the vessels on a fast wheel. Note the thick bases that are left to support the vessel bodies.

- 3- The thrown vessel were left to dry to leather-hardness, slowly and carefully over several days and mostly under thin plastic sheeting, as necessitated by the high shrinkage rate of the clay.
- 4- The pots were then turned and trimmed to the required form and thickness on the wheel (Figure 10). This process produced pots that are 1-2mm thick. The village potters were originally trained to gauge the thickness using a special tool before trimming, but now they can “feel” the thickness and thus eliminate one stage in the production process.



Figure 10. Trimming the base of a leather-hard bowl to the required thickness and form.

- 5- The exterior was at times polished depending on the potter's judgment, then left to dry slowly, again for several days and mostly under thin plastic sheeting, to bone-dryness. The potter's judgment also confirmed the scientific conclusion that the 'Ayn at-Tinah clay is the most suitable – among several experimented with – for producing fine wheel-thrown vessels.
- 6- A slip formed from the same clay, with the addition of small amounts of sodium carbonates and silicates (easily available to the ancient potters as ash from kiln firing) was originally used and the surface re-polished. However, it was found that the potter's slip, simply formed from excessive clay during work left to stand in water, gave the same results. Evidence for the turning, slipping and wheel-polishing stages in the reconstruction can be seen on some Nabataean vessels.
- 7- The paint would have also been readily available from the mineral-rich coloured rocks of Petra, which were subjected to analyses as well. The minerals were simply extracted by crushing the stones, fine sifting, and suspending in water to obtain the fine mineral particles. Other than the scientific analyses, experiments were carried out on the extracted minerals to determine the colours and adherence upon firing at different temperatures. After the vessels were bone-dry, the mineral paints were applied over the slip, using tap water and hair brushes, in accordance with the type being reproduced (Figure 11).



Figure 11. Applying the extracted mineral paint to a bone-dry bowl.

- 8- The firing was carried out in an electric kiln. Many experimental trials showed that a maximum temperature of 950°C reached over 8 hours was the best program for obtaining the colour, paint adhesion and metallic hardness of the fine ancient pots (Figure 12). This was a surprise as investigations for the original firing temperature determined it to be 800-

850°C. The answer came from the previous firing experiments that used olive waste as fuel. Introducing olive waste into the electric kiln (and thus creating a somewhat reducing firing atmosphere) when the kiln temperature was just under 800°C produced the same results at 850°C as those obtained at 950°C under full oxidizing conditions.

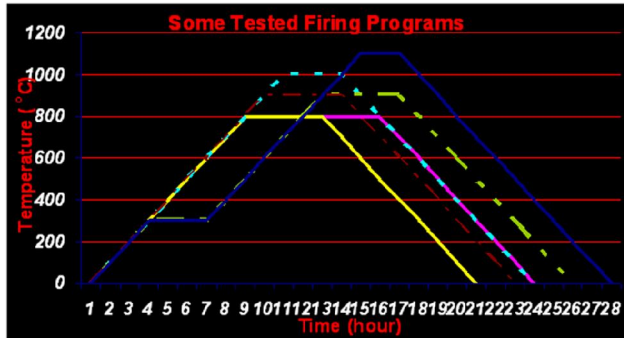


Figure 12. Experimental firing programs (under full oxidizing conditions) for obtaining the optimum colour, paint adhesion and metallic hardness of the pottery.

CERAMED pottery insights

Like the previous project, working with the potters explained several features of Nabataean pottery.

- Some bowls with extremely fine walls and ring bases cracked where the base got “too thick” despite careful drying. This may explain the even wall thickness and impractical rounded bases of most Nabataean fine bowls (Figure 13).



Figure 13. An unfired thin-walled bowl that cracked at the area where the body thickens to form a ring base.

- A feature of many Nabataean bowls is an un-even whitish band on the exterior, thought to be a poorly adhering applied slip. A chance finding of its nature came from our attempt at a smoother surface by hand-polishing the dry pots with a damp cloth. This would have been caused by salts at the surface transmitted from the cloth (Figure 14).



Figure 14. Fired vessels with uneven whitish surfaces due to deposited salts from polishing with a damp cloth. The “rings” at the rims of the bowls to the right are identical to those commonly found on Nabataean bowls.

- Another feature noted were very fine even horizontal lines that are somewhat common on Nabataean vessels and usually described by archaeologists as “fine rouletting”. The potters

explained that they appear on vessels that are slightly warped – common in Nabataean egg-shell wares – or trimmed when “too dry” (Figure 15).



Figure 15. Fine trimming marks on the exterior of an unfired bowl. Such marks are rather common on Nabataean fine wares and are sometimes described as “fine rouletting”.

- An interesting feature we noted is that the modern right-handed potters preferred drawing palmettes/ wreaths opening to the right, while there is a prominence of left-facing palmettes/ wreaths in the ancient pottery. Were most of the ancient Nabataean potters left-handed? Generations of the same family perhaps?

In conclusion

The main modern improvement on the technology that we introduced was the use of an (oxidizing) electric kiln, and the elimination of the hazards resulting from the use of olive waste.

At this stage, we think we got acceptable results for the reproduction of Nabataean painted fine wares, using original materials and techniques. One of the goals of CERAMED is to bring the results of the research to the market by sensitizing the public to the importance of technologically authentic reproductions of archaeological value objects. Exact replication and marketing in Jordan, however, are not considered at this stage.

Three years of CERAMED have offered us a chance to revive an aspect of our material cultural heritage that was Arabian specific yet part of the melting pot that is the Mediterranean “world”. To the women of at-Tayyiba, the technology transfer is offering them a new chance at establishing their role as active contributors to the economic and social structure of the community.

Acknowledgements

Thanks to the Department of Antiquities for allowing us access to the collections at the Petra and the Jordan Archaeological Museums, and to the staff at both museums for their great help while recording and conducting non-destructive *in-situ* analyses of the objects.

To Dr Fawzi Zayadine of the Department of Antiquities, and Prof Rolf Stucky, Dr Bernhard Kolb and Dr Stephan Schmid of the ez-Zantur team, who allowed us access to their excavated material.

To Dr Patricia Bikai of the American Center of Oriental Research, who provided us with samples for analysis.

References:

1. Schmid, S.G. 2001. The Nabataeans: Travellers between Lifestyles. Pp. 367-426 in B. MacDonald, R. Adams and P. Bienkowski (eds.), *The Archaeology of Jordan*. Sheffield: Sheffield Academic Press.
2. Parr, P.J. 1978. Pottery: People and Politics. Pp. 202-209 in R. Moorey and P. Parr (eds.), *Archaeology in the Levant: Essays for Kathleen Kenyon*. Warminster, England: Aris & Phillips.
3. Dentzer, J.-M. 1985. Céramique et environnement naturel : la céramique nabatéenne du Bosrâ. Pp. 149-153 in *Studies in the History and Archaeology of Jordan* 2. Amman: Department of Antiquities, and London: Routledge & Kegan Paul.
4. 'Amr, K. 1987. 1987. *The Pottery from Petra. A Neutron Activation Analysis Study*. BAR int. ser. 324. Oxford: BAR.
5. Gunneweg, J., Perlman, I. and Asaro, F. 1991. The Origin, Classification and Chronology of Nabataean Painted Fine Ware. *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 35.1 (1988): 315-345.
6. 'Amr, K. 1997. The Changing Landscape of the Clay Deposits at 'Ayn at-Tinah, Wadi Musa. Pp. 121-126 in *Studies in the History and Archaeology of Jordan* 6. Amman: Department of Antiquities.
7. Zayadine, F. 1981. Recent Excavations and Restorations of the Department of Antiquities (1979-80). *Annual of the Department of Antiquities of Jordan* 25: 341-355.
8. Zayadine, F. 1982. Recent Excavations at Petra (1979-81). *Annual of the Department of Antiquities of Jordan* 26: 365-393, 541-568.
9. Zayadine, F. 1986. The Pottery Kilns of Petra. Pp. 185-189 in D. Homès-Fredericq and H.J. Franken (eds.), *Pottery and Potters – Past and Present*. Tübingen: Attempto.
10. 'Amr, K. 1991. Preliminary Report on the 1991 Season at Zurrah. *Annual of the Department of Antiquities of Jordan* 35: 313-323.
11. Zayadine, F. and 'Amr, K. 1997. Nabatäisches Unternehmertum und Massenproduktion. Pp. 137-140 in T. Weber and R. Wenning (eds), *Petra, Antike Felsstadt Zwischen Arabischer Tradition und Griechischer Norm*. Mainz: Philipp von Zabern.
12. 'Amr, K. and al-Momani, A. 1999. The Discovery of Two Additional Pottery Kilns at az-Zurraba/ Wadi Musa. *Annual of the Department of Antiquities of Jordan* 43: 175-194.
13. 'Amr, K. and al-Momani, A. 2001. Preliminary Report on the Archaeological Component of the Wadi Musa Water Supply and Wastewater Project (1998-2000). *Annual of the Department of Antiquities of Jordan* 45: 253-285.
14. Schmid, S.G. 1996. Die Feinkeramik. Ch. 6 in A. Bignasca et al., *Petra – Ez Zantur I. Ergebnisse der Schweizerisch-Liechtensteinischen Ausgrabungen 1988-1992*. Mainz: Philipp von Zabern.
15. Schmid, S.G. 2000. *Petra ez-Zantur II. Ergebnisse der Schweizerisch-Liechtensteinischen Ausgrabungen, Teil I: Die Feinkeramik der Nabatäer: Typologie, Chronologie und kulturhistorische Hintergründe*. Mainz: Philipp von Zabern.
16. 'Amr, K. 2004. Beyond the Roman Annexation: The Continuity of the Nabataean Pottery Production Tradition. Pp. 237-245 in *Studies in the History and Archaeology of Jordan* 8. Amman: Department of Antiquities.
17. Farajat, S. and Nawafleh, S. 2005. Report on the al-Khazna Courtyard Excavation at Petra (2003 Season). *Annual of the Department of Antiquities* 49: 373-393.

18. Mason, J.R.B. and 'Amr, K. 1990. A Study of Nabataean Pottery Manufacturing Techniques: An Experiment for Reconstructing the Production of Fine Bowls. *Aram* 2 (1&2): 287-307.
19. Mason, J.R.B. and 'Amr, K. 1993. Nabataean Bowl Production: Interim Summary of Developments. *Levant* 25: 207.
20. Mason, J.R.B. and 'Amr, K. 1995. An Investigation into the Firing of Nabataean Pottery. Pp. 629-636 in *Studies in the History and Archaeology of Jordan* 5. Amman: Department of Antiquities.
21. 'Amr, K. and Mason, J. 1992. Remaking Nabataean Fine-Ware Bowls. *Ceramic Review* 134: 11-12.
22. Bresenham, M.F. with editorial collaboration by G. Chimienti, 1985. Descriptive and Experimental Study of Contemporary and Ancient Pottery Techniques at Busra. *Berytus* 33: 89-101.

FIGURES

Figure 1. Nabataean painted fine bowl sherds, Type 1: a. from the “Wadi Musa Water Supply and Wastewater Project”; b. from az-Zantur/ Petra, courtesy of Rolf Stucky.

Figure 2. Nabataean painted fine bowls, Type 2: a. from az-Zantur/ Petra, Petra Museum no. JP1518, courtesy of Rolf Stucky; b. from the “Wadi Musa Water Supply and Wastewater Project”, Petra Museum no. JP5740 (profile drawing by Qais Tweissi).

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Figure 5. Nabataean painted fine vessels, Type 4: unknown provenience, Jordan Archaeological Museum no. J19452 (“honey-pot”) and J19452 (flared cup).

Figure 6. Nabataean painted fine bowls, Type 5: a. from the “Wadi Musa Salvage Excavation 1997”, Petra Museum no. JP4747 (profile drawing by Qais Tweissi); b. from Dhiban, Jordan Archaeological Museum no. J5220.

Figure 7. Nabataean painted fine vessels, Type 6: a, b. from the “Wadi Musa Salvage Excavation 1997”, Petra Museum nos. JP4527 (small bowl) and JP4768 (cup) (profile drawings by Qais Tweissi); c, d. unknown provenience, Jordan Archaeological Museum nos. J19451 and J8988.

Figure 8. Nabataean painted fine wares, Time-Typology-Development relation.

Figure 9. Throwing the vessels on a fast wheel. Note the thick bases that are left to support the vessel bodies.

Figure 10. Trimming the base of a leather-hard bowl to the required thickness and form.

Figure 11. Applying the extracted mineral paint to a bone-dry bowl.

Figure 12. Experimental firing programs (under full oxidizing conditions) for obtaining the optimum colour, paint adhesion and metallic hardness of the pottery.

Figure 13. An unfired thin-walled bowl that cracked at the area where the body thickens to form a ring base.

Figure 14. Fired vessels with uneven whitish surfaces due to deposited salts from polishing with a damp cloth. The “rings” at the rims of the bowls to the right are identical to those commonly found on Nabataean bowls.

Figure 15. Fine trimming marks on the exterior of an unfired bowl. Such marks are rather common on Nabataean fine wares and are sometimes described as “fine rouletting”.