

CERAMED

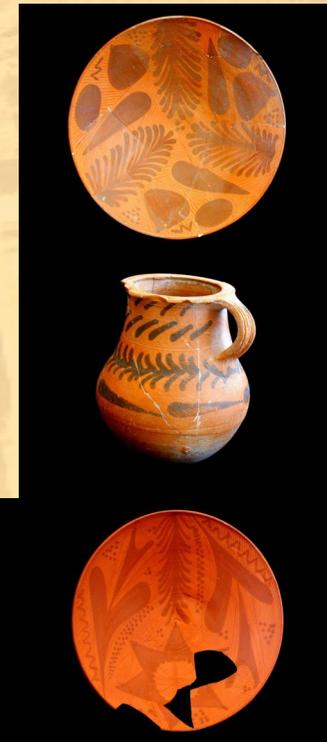
EC/INCO-MED Project (ICA3-CT-2002-10018)

*Archaeometric Investigation,
Typology, &
Reproduction Technology
of
Nabataean Painted Fine Ware*

*Queen Rania Institute of Tourism and Heritage
The Hashemite University*

Zarqa, Jordan

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Introduction

Understanding the reproduction technology starts from the knowledge of the nature of all materials involved in different stages of production process and all processes applied on these materials. Nabataean Painted Fine Ware (NPFW) is one of the high quality ceramics in the Mediterranean region. Archaeometric investigation of NPFWs, different raw clay minerals, and colored sandstones from Petra-Jordan were all performed aiming at better understanding the nature of materials, and ancient production technology.

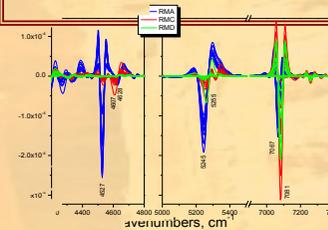


Provenance Study

Through Fourier Transform Infra Red Spectroscopy (FTIR) applied as Attenuated Total Reflectance (ATR) Spectroscopy in the MID-IR region and Near-Infrared (NIR) Spectroscopy with data acquisition via optical fibers for different raw minerals sampled from several sites near Petra, results proved that clays from Ayn Attinah site give the best match with ancient sherd samples.



FTIR absorbance spectra of the 2nd derivative of unfired and fired clays (Blue: raw samples, Red: fired at 800 °C, Green: fired at 900 °C).



Applied Techniques

Optical Microscopy (OM), Fourier Transform Infra Red Spectroscopy (FTIR), Nondestructive Raman Spectroscopy, Nondestructive Energy Dispersive X-Ray Fluorescence (ED-XRF), Scanning Electron Microscopy (SEM), X-Ray Powder Diffraction (XRPD), Computerized Axial Tomography Scan (CT-Scan), Wet Chemical Analysis (AES and AAS).

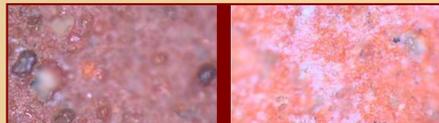
These techniques were used testing sherd samples from different excavation sites in Petra including kilns and tombs, whereas complete objects were subjected to nondestructive portable X-Ray Fluorescence Spectrometry.



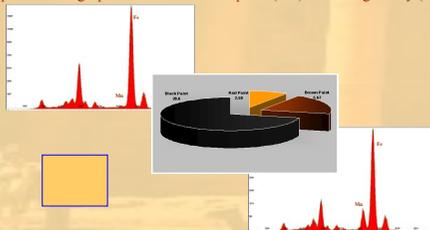
Materials Identification

Body Material

X-Ray Diffraction (XRD) and Scanning Electron Microscopy (SEM) results indicate that the red to dark brown paints are composed of large coarse grains of well crystallized hematite ($\alpha\text{-Fe}_2\text{O}_3$) as a major constituent, with only some quartz and plagioclase. Carbonates (Calcite and Dolomite) were present as well. The background is silica-rich amorphous meta-phases and glasses. This is also confirmed by Optical Microscopy (OM). More iron content was also observed in the paint than in the body.

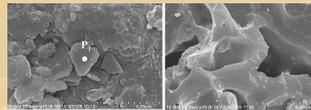


Optical micrographs of NPFW-brown paint (left) and orange body (right)

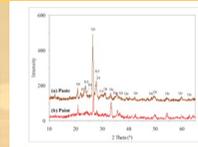


XRF Spectra and semi-quantitative analysis of NPFW

X-Ray Diffraction (XRD) patterns for both paint and body of a NPFW



Secondary electron images obtained with field emission scanning electron microscopy (FE-SEM) for NPFW paint (left) and body (right).



Paint

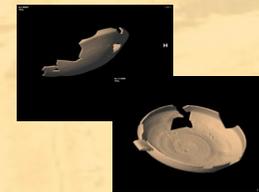
Several colored sandstones from Petra were used raw or treated with hydrogen peroxide or sodium carbonate alone or in the presence of clays, and the results indicate that Limonite is the best option to match adhesion, color, and texture of Nabataean paints. Some prototypes matched with the color of limonite alone, other types needed a mixture of limonite and goethite or sometimes with clay. This was confirmed by Raman spectroscopy where peaks due to the Nabataean red paint matched spectra of fired Limonite and Goethite (FeO-OH). The Limonite, when treated with hydrogen peroxide was shown to yield Fe_2SiO_3 by XRD.

Energy Dispersive Spectroscopy (EDS) also showed that paints contain Potassium and Aluminum, probably due to the addition of clays (such as Illite) as binders.

From Energy Dispersive-X-Ray Fluorescence (ED-XRF) results, the darker red, brown and black colors of the paints show higher iron content in this order, but also higher manganese to iron ratio with the same order. Manganese was also found in even light red paints but in much smaller quantities.

Modeling

In general SEM and XRD analyses could not distinguish between various types of Nabataean Ceramics. CT-Scan experiments indicate that production was accomplished on a potter's wheel and not in molds, the wheel marks being obvious in the 3D rendering of the scans. Thus the Nabataean painted fine ware was produced by skilled potters.



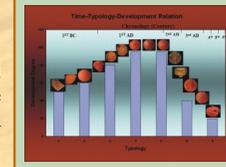
Nondestructive CT-Scan Analysis of Complete NPFW

Thermal (Firing) Techniques

A series of thermal treatment experiments were applied for raw minerals following different firing programs and conditions. Results show the best temperature to be 800°C but for painting adherence the temperature was raised up to 950°C under completely oxidation conditions.

Typology

Large number of experimental trials was conducted to match specific characters in original NPFW. Thinness, fine texture, adherence and color were all characteristic features that varied from period to another throughout Nabataean civilization. Hence, we have categorized the NPFW into six well-distinguished types that differ slightly in the above-mentioned features in addition to the chronological factor. A Typology Data Base was established (as shown below) by our team within this project covering all these types for documentation of NPFW.



Type 1

Starting from the first half of the first century BC Type One raised with very fine but relatively thick fine ware, that are Pink/light red fabric, red paint. The shape is semi-globular bowl with ring base. Decoration are wide bands or wavy lines intersecting at the base, and fine dots arranged in bands.



Type 4

(Middle-late 1st century AD) Very fine, thin and metallic hard fabric was found characteristic in this type. Light red and yellowish-red fabric color, whereas the paint was red and reddish-brown. Painting on closed forms such as small vases and flared



Type 2

Later half of the first century BC was the time when Type Two was raised with the following characteristics: Very fine (almost as thin as the classical wares), Light red fabric, Red Paint, decorated as delicate naturalistic leafs radiating from the center. The shape was open rounded bowl with simple rim, ring bases are very rare.



Type 5

(Late 1st-2nd AD) Fine, very thin and metallic hard. The fabric was red and the paint was brown and black. The decoration was stylized and solid in comparison with the earlier types. Earlier examples have hatched backgrounds that disappear later. Animal representations especially birds eating bunches of grapes start to appear. The shape was open rounded bowls with small rolled rim, and painted closed forms are more common.



Type 3

Type Three appeared in the first half of the first century AD, very fine and thin, Light red and yellowish-red body color, Deeper red paint color. Decoration was complex and the naturalistic leaf designs evolved into wreaths and clusters. Rounded bowl evolved into a "stepped" form then a more open form with simple, slightly in curving rim was the predominant shape.



Type 6

(Late 2nd-3rd AD through to 5th/6th AD) This type was characterized for progressive deteriorations, with thicker walls and more temper in the fabrics. Fabric was red, sometimes with cream-fired surfaces. Paint was duller black. Decoration was with solid areas often applied on an obvious red slip. The shape was mainly open rounded bowl with small rolled rim continues, but painting is also applied to other forms both open and closed that are usually unpainted.



Reproduction Technology

Finally, reproduction process which started from the endpoint of previous research results took a considerable time and effort. With the cooperation of Attaybeh craftswomen from national pottery workshop near Petra, real reproductions were successfully achieved considering all experimental and technical points. Firing process was very critical issue considered in this stage.

Green clay from Ayn Attinah site near Petra was used for the reproduction process. Clay preparation included: cleaning, washing, wet sieving then partial drying. Photos next represent these main steps.

Electric wheel was used for modeling and shaping, then drying till leather hard. Natural minerals were used for slipping or painting directly. Natural hair brushes were used for painting. Firing under complete oxidation conditions was performed up to 950°C-1000°C.

The best match material for slip recovery is found to be from the original clay after deflocculating with soda ash and sodium silicate then sterilization by hydrogen peroxide.

Paint study was categorized according to the typology of NPFW since each type has almost different color degree characterizing its type.

Type 1: Finest clay of the dark red sand from Petra with Wadi Araba red clay, (1:1).

Type 2: Finest size of Limonite with Wadi Araba red clay, (1:1).

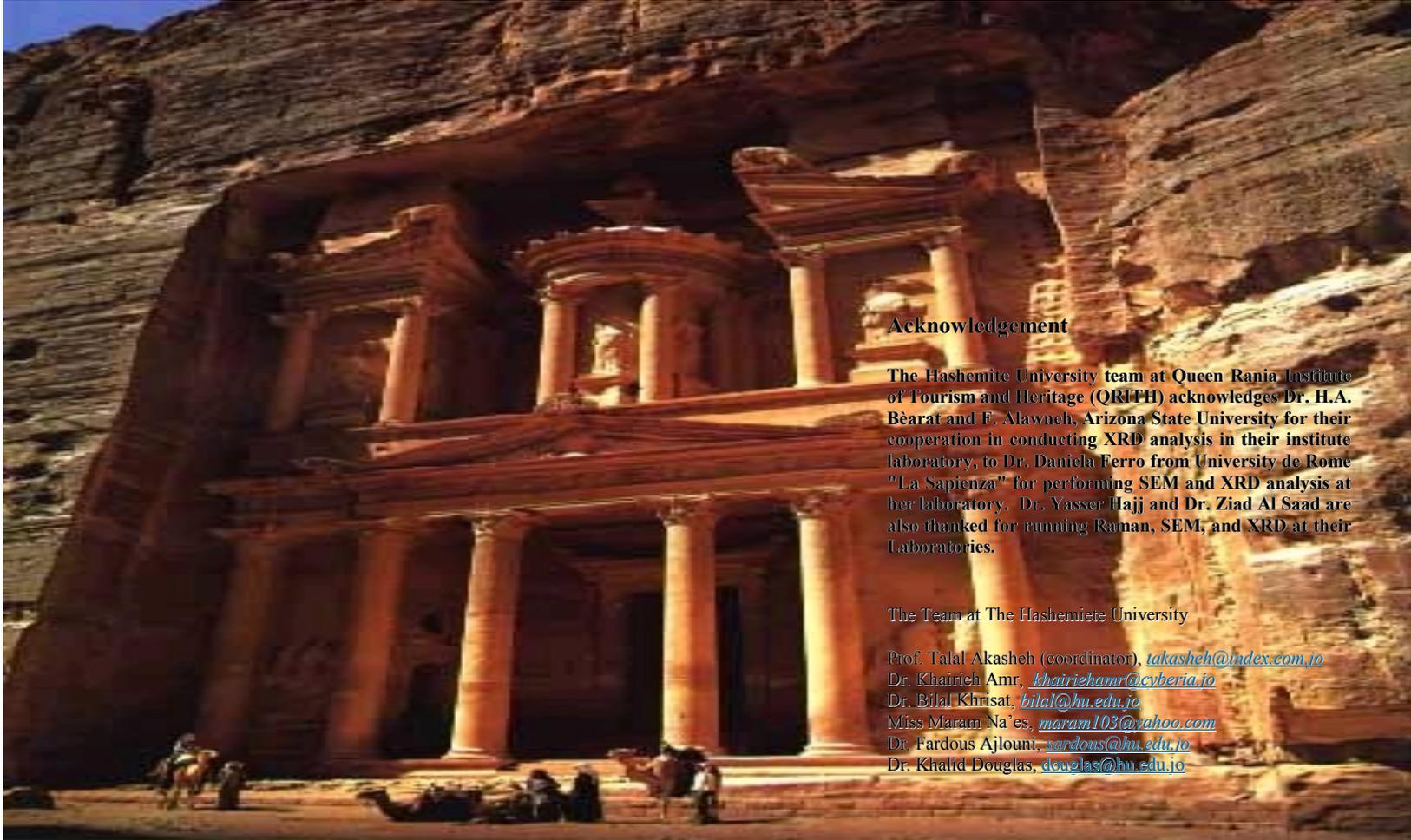
Type 3: Finest clay of the orange sand from Petra with the finest size of Limonite (2:1).

Type 4: Finest clay of the dark violet sand from Petra with Wadi Araba red clay, (1:1).

Type 5: Both mixtures: Limonite finest size with very dark violet sand (1:1), and Limonite finest size with dark violet and deep brown sand (1:1).

Type 6: Limonite finest size with sodium carbonate and manganese oxide, all very well grinded and homogenized then fired at 1000°C. Since a manganese ore mineral was not found at the area of Petra or its surroundings, so commercial manganese oxide was used.





Acknowledgement

The Hashemite University team at Queen Rania Institute of Tourism and Heritage (QRITH) acknowledges Dr. H.A. Béarat and E. Alawneh, Arizona State University for their cooperation in conducting XRD analysis in their institute laboratory, to Dr. Daniela Ferro from University de Rome "La Sapienza" for performing SEM and XRD analysis at her laboratory. Dr. Yasser Hajj and Dr. Ziad Al Saad are also thanked for running Raman, SEM, and XRD at their Laboratories.

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