Scientific Analysis of Neolithic Period Ceramics from Fars, Iran.

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Abstract

This thesis forms the first application of scientific analysis (thin section petrography, electron microprobe and scanning electron microscopy) to Neolithic ceramics from Fars province, Iran. The research specifically addresses the questions surrounding the choice of raw materials, production techniques and the use and consumption of ceramic vessels at these village sites. I have sought to attempt a deeper understanding of the past socio-economic context of ceramic production and consumption, as well as draw comparisons with wider ceramic technologies in the surrounding regions of Iran, Mesopotamia, Anatolia and Central Asia.

Analysis and interpretation of decorated ceramics from Neolithic Southwest Iran has traditionally focused on decorative designs, where coloured pigments have clearly played an influential role. However, very little was specifically known about the raw materials, manufacture, and production stages of these wares. The samples selected for analysis include newly excavated and previously unpublished ceramics that have been incorporated into an updated typology. This is then used to provide detailed characterisation of the materials and techniques employed by past potters to create the wares.

Ceramics from different sites and valley locations were compared, and the development and changes in pigment raw materials and painted motif selection is demonstrated across different village sites and throughout the Neolithic time period. The introduction of manganese black and bichrome designs at Tol-e Nurabad is particularly interesting amidst the widely used iron oxide pigments and monochrome designs recorded from other sites.

The choice of these raw materials is considered in respect to potters' interaction with their surrounding landscape and in the context of other crafts and productive technologies. The transfer of potting knowledge is also considered, with visible evidence of a range of skill levels and marked corrections and adjustments made to painted motifs on the vessels studied.

The use and consumption of vessels in Neolithic Fars is based on the remains of kitchen hearths and cooking equipment, namely clay balls and river cobbles, combined with

use-wear analysis to show that plain wares were not subjected to direct heat and that painted wares were most likely used in the presentation and consumption of food.

The painted motifs and decorative designs created on Neolithic vessels in this study are compared to other excavated sherds and whole or reconstructed vessels and show a broad similarity in apparent manufacture and painted designs. I suggest that this is evidence of the capacity of ceramics to store visual information, and to signify the Neolithic style of design that was actively shared and participated in across village sites in Fars. This was potentially done to demonstrate group membership and contribute to the construction of community, perhaps at feasting events which have been proposed across this region during the Neolithic, which would have provided venues for the consumption of such ceramics alongside the transference of decorative schemes between villages.

Wider comparisons with contemporary Neolithic wares in the surrounding Iranian region, as well as Mesopotamia, Anatolia and Central Asia are also drawn, linking the communities of Fars with wider Neolithic technologies and styles.

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I started my first foray into this research area at a time when British and Iranian relations were at a low. No British archaeologists were being granted visas to visit the country and I was faced with specialising in a beautiful area I may not get experience for myself. I took inspiration from the phenomenal work of William Sumner who conducted his doctoral thesis on survey archaeology of the Marv Dasht in Fars, where he recorded Neolithic ceramics similar to those studied here. He finished his thesis the same year as the Iranian Cultural Revolution, yet went on to have a flourishing career in Iranian archaeology, becoming one of those giants on whose shoulders the rest of us stand. I have always received wonderful hospitality, generosity and wisdom from Iranian friends and archaeologists as I have studied the material culture of the stunning Zagros Mountains. Thankfully, British and Iranian political relations have improved, and I hope these cultural bridges will carry on being extended, particularly when our political ones may sometimes fail.

Table of Contents.

Introduction…… 1

1. The sites and material culture of Neolithic Fars…….. 7

1.1 Introduction…….. 7

1.2 Site specific description of Neolithic Fars…….. 11

1.3 Summary……..30

2. Neolithic ceramic typologies from Fars…….. 35

2.1 Introduction…….. 35

2.2 Mushki ware…….. 35

2.3 Bashi ware…….. 46

2.4 Jari ware…….. 54

2.5 Conclusion…….. 60

3. The identification of style: its reconstruction and analysis…….. 61

3.1 Introduction…….. 61

3.2 A history of identification and interpretation…….. 61

3.3 The *chaîne opértoire*…… 64

3.4 Archaeological science…….. 65

3.5 Conclusion…….. 67

4. Review of previous ceramic investigations…….. 68

4.1 Introduction…….. 68

4.2 How have previous analytical studies of Neolithic pottery from Southwest Iran characterised ceramic production?..... 69

4.3 What questions have so far been investigated for Neolithic ceramic production in Iran and Central Asia, and what questions could still be addressed?..... 81

4.4 How have other studies addressed these questions?..... 85

4.5 Conclusion..... 94

5. Sampling strategy and Methodology..... 95

5.1 Aims and Objectives..... 95

5.2 Site selection process and sampling strategy..... 96

5.3.1 Contextual descriptions..... 96

5.3.2 Tol-e Nurabad..... 96

5.3.3 Tepe Rahmatabad..... 98

5.3.4 Qasr-e Ahmad..... 99

5.3.5 Kazeroun Valley..... 99

5.4 Geology of Fars province..... 100

5.4.2 Methodology employed to create and analyse samples..... 103

5.4.3 Thin-section analysis..... 103

5.4.4 Techniques used to examine and record thin sections..... 105

5.4.5 The electron microprobe..... 108

5.4.6 Scanning electron microscopy..... 109

5.5.1 Typology of samples..... 109

5.5.2 Unpainted wares..... 110

5.5.3 Painted motif wares..... 119

5.6 Summary of research and analytical methods..... 127

6. Results of analysis..... 128

6.1 Introduction..... 128

6.2 Thin section analysis..... 128

6.3 Fabric description for Fine grained plant tempered ware, with abundant well sorted calcite and mica..... 128

6.4 Electron microprobe and SEM results..... 130

6.5 Unpainted wares..... 131

6.6 Painted motif wares..... 140

6.7 Conclusion…….. 159

7. Reconstruction of the potting sequence……..160

7.1 Introduction…… 160

7.2 Clay raw materials…….. 161

7.3 Temper materials…… 162

7.4 Forming methods…… 163

7.5 Forming of carinations/ bases/ rims…….. 165

7.6 Slipping and burnishing…….. 166

7.7 Pigments…… 168

7.8 Painted motifs…… 171

7.9 Firing…… 179

7.10 Conclusion…….. 181

8. Comparison of results with other ceramic studies in Iran, the Middle East and Central Asia…… 182

8.1 Introduction…… 182

8.2 Comparison with earlier studies of Mushki, Bashi and Jari ware…….. 182

8.3 Comparison with Neolithic wares from Iran and the wider Middle East and Central Asia…….. 185

8.4 Conclusion…….. 188

9. Consumption of ceramics in Neolithic Iran…….. 190

9.1 Introduction…….. 190

9.2 Depositional contexts of ceramic sherds…….. 190

9.3 Raw material and use-wear analysis…… 193

9.4 Significance of pottery decoration…… 194

9.5 Socio-economic reconstruction of the Southwest Iranian Neolithic based on the evidence from ceramic production and consumption…….. 197

9.6 Conclusion…… 202

10. Conclusion…….. 204

10.1 Introduction…… 204

10.2 What are the characteristics of Neolithic ceramics within this assemblage?

…… 204

10.3 What range of raw materials was used in the creation of clay bodies, slips and pigments?..... 204

10.4 What economic information can we infer regarding the choice and use of plant temper?..... 206

10.5 What technological methods and bodily gestures were employed to transform these raw materials into material culture objects?..... 206

10.6 What can we learn about the transmission of knowledge and the learning process of this craft?..... 207

10.7 What spatial and temporal patterns, if any, can be discerned in the assemblage based on this raw material characterisation?..... 208

10.8 How were the ceramic vessels used and consumed within village sites?. 209

10.9 How does the production and consumption of ceramics fit into the larger socio-economic context of Neolithic Iran and the Middle East?..... 210

10.10 Conclusion…….. 211

References…… 213

Appendix A: thin section results…….. 229

Appendix B: electron microprobe results…….. 248

List of Tables and Figures

Tables

Table 1.1 Raw and calibrated radiocarbon dates from Tol-e Nurabad and Rahmatabad sites with related chronological phases labelled……9

Table 1.2 Calibrated radiocarbon date ranges using OxCal and IntCal13 calibration curve of dates presented in Table 1.1 and arranged chronologically…….. 10

Table 1.3. Decorative wares previously recorded for Neolithic ceramics in Fars. Kutahi and Kazerun wares are still only known from survey data and are similar to painted bichrome wares so have been placed next to them chronologically, while all other wares have been excavated from numerous dated contexts. …… 11

Table 1.4. Chart detailing the percentage of various species of animals present at sites mentioned in text during the Neolithic period to the Post- Achaemenid period. Note the abbreviations TS- Tol-e Spid, NB- Tol-e Nurabad Trench B, NA- Tol-e Nurabad, Trench A…….. 15

Table 2.1. Mushki typology of shape…….. 40

Table 4.1 Overview of ceramic wares related to those studied in this thesis and their chronological placement…….. 72

Table 6.2 Electron microprobe analysis of TNP 4942, showing an FeO enrichment in the pigment layers.

Table 6.3. Electron microprobe results for TNP 2391 showing an FeO enrichment for the black pigment layer.

Figures

Figure 1.1 Map of Iran and surrounding countries, with Fars province indicated in grey and sites mentioned in the text…….. 8

Figure 1.2 Jari ware (a-c), Mushki (d-e), Kutahi (f-j), Kazerun (k-m)…….. 12

Fig. 1.3 select blades from Tol-e Mushki…… 16

Figure 1.4 A; flint microliths and B; obsidian blades from Tol-e Mushki…….. 17

Figure 1.5 Plan of Unit C, Layer 3 at Tol-e Bashi indicating wall architecture, pits, hearth and associated artefacts…….. 20

Figure 1.6 Reproduction of select blades, some of which retouched, from Tol-e Bashi…….. 21

Figure 1.7 Plan of excavated rooms at the site of Tol-e Jari B…….. 25

Fig. 1.8 Sherds from the excavation of Tol-e Nurabad representing the Mushki phase (TNP 1764), and Jari phase…… 27

Fig. 1.9 Local tradition of Neolithic painted ceramic from Tol-e Nurabad…….. 27

Fig. 1.10 Chart showing the structural remains in each phase of excavation in Trench B at Tol-e Nurabad…….. 29

Figure 2.1. Buff coarse ware bowl from Tol-e Mushki…….. 37

Figure 2.2. Coarse ware bowl from Tol-e Mushki…… 38

Figure 2.3. Red slipped bowl from Tol-e Mushki with “honeycomb and terminal dot” decoration. This is the only colour image of the ceramics to have been published with the report…… 38

Figure 2.4. Double carinated form decorated with p14 and p44…….. 39

Figure 2.5. Two Mushki vessels displaying characteristic decoration from rim to shoulder and common open forms…….. 39

Figure 2.6. Mushki vessel with p-18 decoration and Mushki sherds with p-31 crosshatching and p-20 hatched line infill…….. 41

Figure 2.7. Two Mushki vessels decorated with P13, vessels are also red-slipped….. 42

Figure 2.8. Sherd TNP 1764 from Tol-e Nurabad with Mushki decoration…… 42

Figure 2.9. Illustrations of Mushki period sherds from Tol-e Nurabad…… 43

Figure 2.10. Jalyan ceramics from Fasa and Darab valleys with parallels to Mushki and Jari period decoration…… 45

Figure 2.11. Sherd decorated with the Bashi motif from Tol-e Bashi…….. 46

Figure 2.12. Illustration of a partially re-constructed vessel from Tol-e Bashi, decorated with the Bashi motif…….. 47

Figure 2.13. Jari A, level 7 sherd decorated with the Bashi motif…….. 48

Figure 2.14. Bowl from Tol-e Bashi, described as "bag shaped"…….. 48

Figure 2.15. Open bowl from Tol-e Bashi, labelled under the class of "vats"…….. 49

Figure 2.16. Surface of a Vegetal tempered sherd with visible white grains in the top right hand corner…….. 50

Figure 2.17. Break of an organic tempered sherd showing impression from coil building…… 51

Figure 2.18. Tol-e Bashi ceramics with the ladder motif on a buff slip, and a white wash, and the hook motif…… 52

Figure 2.19. Sherd from Tol-e Bashi showing clearly the outer layer of fine organic tempered clay coming away from the coarser tempered core…….. 53

Figure 2.20. Reconstructed Jari B typology including stratigraphy of site. The letters in brackets refer to Maeda's initial grouping, and which have been referred to in my own text…… 55

Figure 2.21. Continuation of Nishiaki and Maeda's typology of Jari B ceramics…….. 56

Figure 2.22. Three examples of unstratified and unclassified vessels from Jari B…….. 58

Figure 2.23. Examples of local decorative traditions from Tol-e Nurabad during the Jari phase…….. 59

Figure 4.1 Map detailing the position of Iran within the Middle East and Central Asia, including Neolithic sites discussed in this thesis…….. 68

Figure 4.2 *Left*: Sherd from Tepe Yahya with a stepped fracture that Vandiver describes as being caused by the weakness of two slab joins. *Right:* Small bowl fragments, again from Tepe Yayha, that show the use of slabs in making the base and bottom half of the vessel in the cross-section of the break…….. 70

Figure 4.3 X-radiograph and reconstructed profile of a Neolithic vessel from Seh Gabi…… 71

Figure 4.4 Reconstructed body of above Seh Gabi vessel from x-radiographs…..…… 71

Figure 4.5 Examples of Late Neolithic Painted Buff ware from Tepe, Pardis, Tehran Plain, Northern Iran…….. 74

Figure 4.6 Examples of Neolithic decorative wares from the Kopet Dagh with evident similarities in form and decorative traditions to Neolithic Iranian wares of the North and South…….... 78

Figure 4.7 Dense, vitrified microstructures of Chalcolithic ceramics from Rahmatabad…….. 81

Figure 4.8 Calcareous clay in high magnification thin section, note the abundant crystals of microcrystalline calcite in this example of Neolithic pottery from Greece, XP, field width 1mm……..... 86

Figure 4.9 Extensive vitrification in calcareous clay refired at 900˚C in an oxidising atmosphere…….. 87

Figure 4.10 Continuous vitrification with fine bloating pores in a calcareous clay, shown with an archaeological sherd from Egypt…… 88

Figure 4.11. Initial vitrification in a non-calcareous clay shown with an archaeological sample from Yugoslavia…….. 89

Figure 4.12 Extensive vitrification in a non-calcareous clay refired at 900˚C in an oxidising atmosphere, shown in an archaeological sherd from Romania…… 90

Figure 4.13 Continuous vitrification in a non-calcareous clay refired at 1020˚C shown in an archaeological sherd from Romania…….. 91

Figure 4.14 Compositional relationships between body and slip clays established with electron microprobe analysis, with the body clay low in iron concentration, and the slip layer low. Each point represents several analyses and error bars are equivalent to plus or minus one standard deviation. 1- Roman Samian ware, 2- Greek Attic black, 3- Greek Early Bronze Age, 4 and 5- Greek Attic bichrome read and black, 6- Roman local red slip, Algeria…….. 92

Figure 5.1. Trench A of Tol-e Nurabad, Mamasani region, from which samples within this study derive…… 97

Figure 5.2. The site of Rahmatabad with the Trench H excavations indicated…… 98

Figure 5.3. Contextual information for each sherd sampled from Qasr-e Ahmad……. 99

Figure 5.4 Geological map of SW Iran…… 101

Figure 5.5 Geological map of Fars province with sampled sites indicated…….. 102

Figure 5.6. Comparison chart for the visual estimation of percentage area of inclusions…….. 105

Figure 5.7. Comparison chart for estimating the degree of inclusion sorting in clast sediments and sedimentary rocks, applicable for the description of inclusions in archaeological ceramics…….. 106

Figure 5.8 Terminology for the description of void shapes in archaeological ceramics…….. 107

Figure 5.9. Selected terminology for the characterisation of argillaceous inclusions… 107

Figure 6.1 Thin section micrograph of SK5 88.7 which shows the fine calcareous body…….. 132

Figure 6.2 Nurabad 001 in thin section with slip layer applied to the burnished exterior surface on the right hand side of the photomicrograph…….. 133

Figure 6.3 Qasr-e Ahmad 389 in thin section which shows very fine calcareous body clay of sample…….. 134

Figure 6.4 Backscattered electron photomicrograph using SEM of QA 334 showing the surface application of a clay layer that is texturally similar to the body clay, but has an increased concentration of ochre particles…… 136

Figure 6.5. Element maps of iron for sherd QA 334 that show the slight iron enrichment in the burnished surface layer and in the large ochre grains…… 136

Figure 6.6. A large, rounded ochre grain in the surface application of sherd QA. 334. The presence of grains like this in this sherd suggests the clay was not ground down into a pigment, but has been burnished into the surface when the vessel had reached a leather-hard state…… 137

Figure 6.7. Backscattered electron photomicrograph of sherd SK. 21.43 that illustrates the surface layer that has been applied to the vessel using a different clay to the body material…… 138

Figure 6.8. Element maps of the surface of sherd SK. 21.43 that illustrate an FeO enrichment, slight Al_2O_3 enrichment and depletion in CaO and SiO_2…… 139

Figure 6.9. SEM photomicrograph of sherd R8555 that illustrates the coarse nature of the body clay in comparison to other sherds that were sampled. No surface application of clay was added to this vessel, the parallel fracture on this sample is the surface of the sherd lifting off…… 140

Figure 6.10. Backscattered electron image using an SEM of R 8526, showing the applied pigment layer to the surface…… 141

Figure 6.11. Element map using an SEM showing an FeO enrichment creating the black coloured pigment layer…… 141

Figure 6.12. Element maps of R8655 showing no enrichment in FeO pigment at the surface, but an application of a coarser clay with quartz (Si) and carbonate (Ca) grains that differ from the fine grained body clay in texture, but which is otherwise compositionally similar…… 143

Figure 6.13. A backscattered electron photomicrograph with SEM of R 8655 showing the surface application of a coarser clay layer with carbonates, quartz and mica grains…….. 143

Figure 6.14. Initial vitrification in the core microstructure of TNP 3856, indicative of an estimated firing temperature around 700°C in a calcareous clay…… 143

Figure 6.15. Clear transition between fine slip clay and organic tempered body in TNP 3856. …….. 146

Figure 6.16. Magnified image of plant tempering particles in sherd TNP 3856……. 147

Figure 6.17. Backscattered electron micrograph of TNP 2607 showing the application to the surface of the sherd of a slightly coarser clay. This clay includes larger quartz grains than the body clay, but is still compositionally similar…… 149

Figure 6.18. Two element maps for sherd TNP 2607. The left hand side shows a slight enrichment in FeO on the surface of the applied clay, which accounts for the red colouration. This has been edited in blue tone to highlight the enrichment. The vessel had been burnished once the clay was applied, and therefore, became enriched at the surface. The right hand side image shows the silica in the medium to large sized quartz grains. These are located towards the surface of the sherd, rather than across the entire cross section included in this image, as the layer is composed of a compositionally similar, yet coarser clay…… 150

Figure 6.19. This is a larger scale photomicrograph of a backscattered electron image captured with an SEM that illustrates the difference in grain size between the body and surface clays. This image also illustrates and size and nature of the organic temper used in this sherd, note that the plant material is specifically from the stem…….. 151

Figure 6.20. Backscattered electron photomicrograph of TNP 5671's red pigment layer on top of a thick, burnished slip which can be seen at the base of the image. A relic burnished surface can be identified through the parallel orientation of grains in the top 20μm surface of the sherd underneath the pigment layer. A burnished sheen on the surface of the sherd is visible in-hand inspection and the matte painted decoration has been applied on top of this. The pigment layer itself appears to be a calcareous marl

paste with small and large ochre grains, contributing to the high calcium and iron results in microprobe SEM analysis…… 152

Figure 6.21. Spectrum 1 taken from TNP 5671, see fig.1. These results correlate with the microprobe results in that the pigment layer is enriched in iron and calcium…… 153

Figure 6.22. The surface of the black pigment of TNP 5671 appears to have sintered and vitrified, creating a gloss that has subsequently cracked. The SEM results for this area of analysis show it to have a similar chemical composition to the rest of the marl past, see figure 6.4…… 153

Figure 6.23. SEM analysis if the composition of the slagging gloss on TNP 5671…. 154

Figure 6.24. Backscattered electron photomicropraph of the thickly applied black coloured pigment on sherd TNP 5667. A burnished relic surface is also visible through the alignment of particles on the surface of the vessel and underneath the coloured clay layer…… 154

Figure 6.25. Backscattered electron photomicrograph of the thinly applied red coloured pigment on sherd TNP 5667…….. 155

Figure 6.26. Backscattered electron photomicrographs of the surface pigment on TNP 5428. The element map for manganese shows the concentration of the element in the pigment which created the black colouring…….. 157

Figure 6.27. This elemental map is located at a different surface point of TNP 5428. The element selected for this map is iron (shown in green), and a clear concentration in the pigment layer is evident, which has been highlighted in the cameo viewing mode… 157

Figure 7.1 Plant temper stem fragment in TNP 291…….. 163

Figure 7.2 Production stages of Neolithic ceramics from Fars…….. 164

Figure 7.3. Suggested reconstruction of body coils/ slabs of a carinated vessel in profile…… 166

Figure 7.4 Backscattered electron image of sherd R 8655 showing the surface application of a coarser clay layer with carbonates, quartz and mica grains…….. 168

Figure 7.5 TNP 2430 and TNP 2363 both within the same decorative class but displaying different shades of red pigment…….. 172

Figure 7.6 TNP 4761 also in the same decorative class as the above sherds, showing the creation of a more orange shade of iron oxide pigment…….. 173

Figure 7.7 Iron oxide and manganese bichrome…… 174

Figure 7.8 Sequence of decoration production is evident on TNP 4915 with a red peripheral band applied first and black decoration for the main motifs after this. A small area of decoration shows the overlap of pigments…….. 175

Figure 7.9 TNP 5428 decorated in black and red. Thin black outlines are still visible under the infill of black pigment, highlighting how the potters organised their designs…… 177

Figure 7.10 R8527 and R8606 demonstrating the same design, but with variation in execution and skill…… 178

Figure 7.11 Decoration on sherd TNP 5667 that shows the painter has revisited and adjusted lines, adding more pigment to some areas of the decoration, and thickening lines…….. 178

List of Abbreviations

KRB- Kur River Basin

SEM- Scanning electron microscopy/ microscope

XRD- X-ray diffraction

XRF- X-ray fluorescence

Introduction

The aim of this project is to produce a comprehensive primary investigation of Neolithic ceramic production in Fars province, Southwest Iran. The main objective of the project is to characterise the production sequence of each of the different plain and decorated wares, producing a working typology that encompasses the previously known and newly excavated ceramic designs that have been uncovered for the first time. In tandem to this, the application of different analytical methods to reconstruct the raw materials alongside accessible actions and choices undertaken by Neolithic potters highlights the complex network of influences at work in this past technological context. These span from technical and aesthetic choices, transmission of knowledge and innovation, economic organisation and other social forces, through to the use and cultural significance of the vessels themselves. Such a reconstruction will be the first of its kind on material of this date from Fars, and it is intended that the results of this study will be comparable with wider Neolithic potting practices across Iran and the Middle East. It will also contribute to being able to distinguish if the different ceramic wares their relevant chronological phases within the Neolithic represent styles of pottery decoration or different technological traditions.

The archaeological sites in this study are all Neolithic period village sites, spanning from 7140- 7050 cal. BC to c. 5500- 5650 cal. BC. The economic subsistence strategies at most of the sites has been established as agricultural, with evidence of domesticated caprids and cereals, alongside continuing exploitation of hunted animals and wild, gathered plants. The occupation duration at the excavated sites also suggests year-round habitation for at least the majority of the village communities, although some sites appear to be seasonal encampments. Archaeological ceramics are present at all sites throughout this time period, and can be seen to show a developmental sequence of red exterior decoration through to the addition of red and/or black decoration on buff surfaces. Potters unanimously created open bowl forms and tempered the body clay with plant material. The pottery assemblage of this project is on the whole, representative of typical Neolithic ceramic types recorded from across Fars province.

Numerous questions have been raised for the production of Neolithic ceramics in this area, including their technological origins, provenance, basic production technology and specific use and consumption. Archaeologists have not reached a consensus on whether slips, washes or clay layers were applied to the surface of vessels (Alizadeh 2006), whether a distinction between coarse and fine wares is apparent, and the estimated firing temperatures. Select publications have created detailed typologies based on the chronological development of decorative motifs, but a main disadvantage is that these have been limited to published type-sites for each of the traditionally established wares, although broad parallels with the latest excavated ceramics exist. Some technological studies have also been attempted through macroscopic investigation of wares excavated from the type-sites of Tol-e Mushki and Bashi, but these have been unable to neither access certain raw material choices, preparation and use in any real detail, nor embellish the known production stages in the same way scientific analysis is able to.

However, by building on the main themes of these basic typologies, and incorporating additional wares that have recently been unearthed, Neolithic ceramics were selected for further analytical work in this project. The following research questions were identified in order to approach the overarching question of this thesis: how Neolithic ceramics from Fars were produced, and what the socio-cultural context of their production and consumption was within communities:

- What are the characteristics of Neolithic ceramics within this assemblage?
- What range of raw materials was used in the creation of clay bodies, slips and pigments?
- What economic information can we infer regarding the choice and use of plant temper?
- What technological methods and bodily gestures were employed to transform these raw materials into material culture objects?
- What can we learn about the transmission of knowledge and the learning process of this craft?
- What spatial and temporal patterns, if any, can be discerned in the assemblage based on this raw material characterisation?

- How were the ceramic vessels used and consumed within village sites?
- How does the production and consumption of ceramics fit into the larger socio-economic context of Neolithic Iran and the Middle East?

The scope of these questions requires an analytical investigation into the individual elements of ceramic manufacture, such as the clay paste, slip and pigments using chemical and petrographic techniques. The results of which can then be used to build up as full a picture as possible of the different raw material, technical and aesthetic choices available to Prehistoric crafters. Their exact choices can be reconstructed against a backdrop of available options which will allow us to highlight some of the motivation and governing principles behind ceramic manufacture. This in turn helps to contextualise the production alongside other productive technologies and socio-cultural life in the Neolithic of the Zagros Mountains in Fars.

The main limitation of this thesis is the small sample size, although having acquired a representative sample of each of the different decorative designs and coarse unpainted wares, in the Later Neolithic a fluorescence of Late Neolithic designs has been recorded at Tol-e Nurabad. I have been able to focus sampling on the main category of pottery-bichrome and a newly labelled "black decoration on buff with orange reduction clouds" ware, but with extended excavation, it may be possible to produce a more detailed typology with further sub-divided designs in the future.

Another limitation is the level of contextual information. All excavated samples come from securely-dated contexts, however, the horizontal exposure at the sites can be limited, and none of the excavations have wide exposures covering a large enough section of the site to allow for detailed discussions of *eg*. house structure and organisation, settlement layout, pottery production areas or physical evidence of kiln structures. This has meant that any conclusions I have drawn about the wider consumption of ceramics at Neolithic sites has been hampered by these limiting factors and are therefore preliminary, awaiting further investigation through increased exposures.

A further potential difficulty within this study is the lack of opportunity to take geological reference samples. Most scientific ceramic studies refer to samples of clay deposits or rock formations within the region of the sites they are investigating so as to compare to the material within the ceramic samples (Abbott *et al.*, 2007: 51, Reedy, 2008: 124). However, reliance on purely archaeological information has also been used to define production and consumption centres (Abbott *et al.*, 2007: 52). Fortunately, the well-mapped geology of Iran and the Zagros Mountains (Haynes and Mcquillan, 1974, Falcon, 1974, Stöcklin, 1974) means essential comparisons may still be possible for non-plastic materials in the ceramics. However, if this turns out not to be the case, the archaeological abundance of certain fabric groups at each site sampled will be used to investigate potential models of the production and exchange of decorated ceramics, leaving for future study the task of tying patterned compositional differences in the assemblage to specific raw material deposits (eg. Rands and Bargielski- Weimer, 1992: 32). Not only will this study aim to contribute to the reconstruction of manufacturing stages of ceramics in Neolithic Southwest Iran and the possible behavioural characteristics which may be evident, important comparisons can also be made with similar studies on Neolithic wares from nearby or connected regions, *e.g.*, the Northern Iranian Zagros and Kopet Dag Mountain's archaeological cultures, whose ceramics have also been studied petrographically (Coolidge, 2005, Tonoike, 2009).

Research of Neolithic potting in Iran had been undertaken for few wares considering the size of the region and the number of recorded wares from the period. Select studies have tended to focus on raw material identification and concluded ceramics were produced and consumed on a local level (Fazeli *et al.* 2001; 2010; Hancock *et al.* 1989; Noll 1991). While it is necessary to characterise ceramics on a regional level in order to communicate their various aspects of production in order to compare and contrast them with other regional styles of potting, scientific analysis allows for investigation of the variations in craftsmanship and the potential socio-cultural/economic reasons for this. In this manner, it has been possible to compare the assemblages studied in this thesis from Fars province with those from the Central and Northern Zagros as well as the Iranian Plateau, to explore if similar socio-economic reconstruction can be applied to the Southwest Iranian region I am investigating. Hypotheses about the cultural boundaries and type of interaction that can exist around differences in production, such

as pigment raw materials (Shepard, 1939), can lead to complex reconstructions of trade and exchange networks (Bowser, 2005: 27- 28). Differential organisation, networks of interaction and trade of material culture can be expected to have existed across the different environments in Iran, types of sites and material cultures, and it is an aim of this analytical work to contribute to our understanding of the Neolithic potting process of Fars and how this is contextualised within the wider geographical region.

A combination of petrographic and chemical analysis proved to be the best methods to answer the above questions posed for this ceramic assemblage. Ceramic thin section analysis allowed for the first investigation of Neolithic clay raw materials from Fars province and was able to distinguish between the different structural phases of the ceramic, such as body, slip and pigment layers. The recorded raw materials were compared with geological information of the area in order to discuss potential local production and imported ceramics, as well as different aspects of the production process. Chemical analysis, combining scanning electron microscopy (SEM) and electron microprobe analysis were the most efficient means of establishing the chemistry of the different technical areas of the sampled vessels and allowed for the capturing of visual information with backscattered electron photomicrographs. The chemical analysis also allowed for any potential contamination of sherds to be evaluated, of which there was none. There are many other techniques that could have been applied to this assemblage, however, the combination used provided the types of data required to answer my research objectives (above), were mainly available on-site, relatively cost effective and have a history of being applied within Prehistoric ceramic research.

Chapter Summary

Chapter One provides an overview of the sites and material culture of Neolithic Fars, situating the research material in its geographical and archaeological context.
Chapter Two presents a description of the ceramics recorded from Neolithic Fars and a detailed discussion of the current typologies in use for this material.
Chapter Three is an overview of the identification of "style" in archaeology and its reconstruction and analysis.

Chapter Four reviews the scientific analysis already undertaken on Neolithic ceramics from Iran, and also the wider Middle East to provide comparative material for my own analysis

Chapter Five explains the practical methodologies that are applied in this thesis and the sampling strategy employed. A detailed description of the contexts sampled at each site and a working typology are also presented.

Chapter Six includes a detailed presentation of the results of the three techniques employed within the bounds of the typological groupings.

Chapter Seven presents a reconstructed *châine opératoire* process, building on the results presented in the previous chapter.

Chapter Eight concludes with a discussion of the socio-cultural context of production and consumption and reviews the evidence for the use of ceramics in Neolithic Fars. This is further explored with a discussion and comparison of these aspects of ceramic research for a wider Iranian, Middle Eastern and Central Asian context.

Conclusion This chapter briefly reviews the results of the thesis and returns specifically to answer the research questions set out in this Introduction.

Appendix A is the entire collection of thin section samples photographed and labelled in the typology set out in chapter five.

Appendix B Contains the tables of electron microprobe data for the samples that were analysed and is again, organised by the typology set out in chapter five.

1. The sites and material culture of Neolithic Fars

1.1 *Introduction*

This chapter reviews the archaeological sites and material culture as recorded from the Neolithic period in Fars, Iran. It is presented in a chronological format with necessary reference to decorative ceramic wares that have helped define the different phases of the Neolithic and have now been defined with radiocarbon dating. The ceramic Neolithic deposits from the sampled sites in this study have been recalibrated using the most recent published calibration curve (Reimer *et al.,* 2013), and are displayed below (tables 1.1- 1.2). The rest of the following chapter details the ceramic typologies used for this period in detail.

In light of the large-scale survey that has been conducted over this region (Heydari *et al.* 2007; Zeidi *et al.* 2009; Sumner 1972; Vanden Berghe 1952; Stein 1936), contemporary researchers are now able to construct an albeit patchy narrative of the social past of the region (Matthews and Fazeli Nashli 2013), basing their organisation of time on the presence of specific artefacts (Alizadeh 2006; Weeks *et al.* 2009). While ceramics are the most common artefact class to employ in this type of discussion, the Zagros region was most intensively surveyed and excavated during a period of time that focused intensely on archaeobotanical remains and the reconstruction of past environments (1960s-1970s). Therefore, archaeological work was concentrated on collecting information on ancient plant and animal remains as a means to infer diet and subsistence strategies, and in extension the type of mobility and/or social structure of Neolithic communities (Hole 1984; Hole, Flannery and Neely 1969; Smith 1978). By placing the differing subsistence strategies along a continuum representing the transition from hunting and gathering to herding and farming, it seemed possible to order the sites chronologically. Ceramics were also used as a means of dating sites due to stratified deposits excavated at limited settlement sites providing "chronological markers", which have since been reinforced or scrapped altogether by the addition of radiocarbon dates (see Tables 1.1- 1.3).



Figure 1.1 Map of Iran and surrounding countries, with Fars province indicated in grey and sites mentioned in the text.

The appearance of ceramics in Fars, and the communities and mechanisms behind this, is still a matter up for debate. Until relatively recently there had been no known aceramic deposits in this province, but excavations at select sites have now uncovered pre-pottery layers indicating the presence of non-ceramic-using groups and which document the transition to the use of pottery (Bernbeck *et al.*, 2008; Tsuneki 2013; Azizi 2013). Theories of migration and colonisation have recently been questioned (Weeks 2013), with the evidence of almost continuous occupation in Fars through the early to mid- Holocene at Tang-e Bolaghi cave sites in the tenth to eighth millennia BC (Tsuneki *et al.*, 2007, Tsuneki and Zeidi, 2008; Tsuneki 2013), and the mounded site of Rahmatabad in the late eighth to early seventh millennia BC (Bernbeck *et al.*, 2008, Hossein Azizi pers. comm.). This change in perception of the spread and development of Neolithic

Site	Name	C14 Date	Uncertainty	Material	Calibrated Age (2σ, CalBC)	Period	Context	Notes
Nurabad	WK13989	6488	54	Charcoal	5541 – 5330 (95.4%)	Muşki	Locus: 174; Phase: A27	
Nurabad	WK13990	6977	56	Charcoal	5984 – 5742 (95.4%)	Neolithic	Locus: 170; Phase: A26	
Nurabad	OZI128	6950	50	Charcoal	5976 – 5949 (6%) 5920 – 5731 (89.4%)	Neolithic	Locus: 167; Phase: A25	
Nurabad	WK13991	6952	61	Charcoal	5982 – 5942 (9.5%) 5929 – 5726 (85.9%)	Neolithic	Locus: 163; Phase: A24b	
Nurabad	WK13992	6938	54	Charcoal	5977 – 5948 (5%) 5921 – 5722 (90.4%)	Neolithic	Locus: 147; Phase: A23	
Nurabad	WK13993	6810	56	Charcoal	5810 – 5623 (95.4%)	Neolithic	Locus: 123; Phase: A20	
Nurabad	WK13994	5850	49	Charcoal	4835 – 4581 (94.8%) 4566 – 4559 (0.6%)	Late Neolithic	Locus: 117; Phase: A19	
Nurabad	OZI129	5910	50	Charcoal	4932 – 4919 (1.3%) 4913 – 4688 (94.1%)	Late Neolithic	Locus: 113; Phase: A19	
Nurabad	WK13995	NO DATA	NO DATA	Charcoal	NO DATA	Late Neolithic	Locus: 111; Phase: A19	Insufficient organic material for dating
Nurabad	OZI130	6290	60	Charcoal	5464 – 5444 (1.5%) 5421 – 5409 (0.8%) 5381 – 5197 (79.3%) 5179 – 5064 (13.8%)	Early Bakun	Locus: 109; Phase: A18	Contaminated / residual?
Rahmatabad	Beta - 310998	8120	40	Charred material	7294 – 7269 (2.2%) 7256 – 7226 (2.7%) 7189 – 7042 (90.6%)	Early Pottery Neo	RAHMATAB8039	
Rahmatabad	Beta - 311002	8120	40	Charred material	7294 – 7269 (2.2%) 7256 – 7226 (2.7%) 7189 – 7042 (90.6%)	Early Pottery Neo	RAHMATAB8053/02	
Rahmatabad	TKa-15311	7245	45	Charcoal	6217 – 6028 (95.4%)	Mushki	Rahmat Abad 2009: Trench: G; Context: 7029	
Rahmatabad	TKa-15313	7970	45	Charcoal	7047 – 6746 (91.1%) 6727 – 6701 (4.3%)	Mushki / PPN Mix layer	Rahmat Abad 2009: Trench: G; Context: 7032	
Rahmatabad	TKa-15306	7955	45	Charcoal	7039 – 6698 (95.4%)	Mushki	Rahmat Abad 2009: Trench: C; Context: 3035	
Rahmatabad	UBA-17788	7777	54	Cremated bone	6735 – 6727 (0.5%) 6700 – 6471 (94.9%)	Mushki	Tr1Cont9006RN9030; RA 2010	

Table 1.1 Raw and calibrated (using OxCal and IntCal13 calibration curve: Bronk Ramsey and Lee 2013; Reimer et al., 2013), radiocarbon dates from Tol-e Nurabad and Rahmatabad sites with related chronological phases labelled.

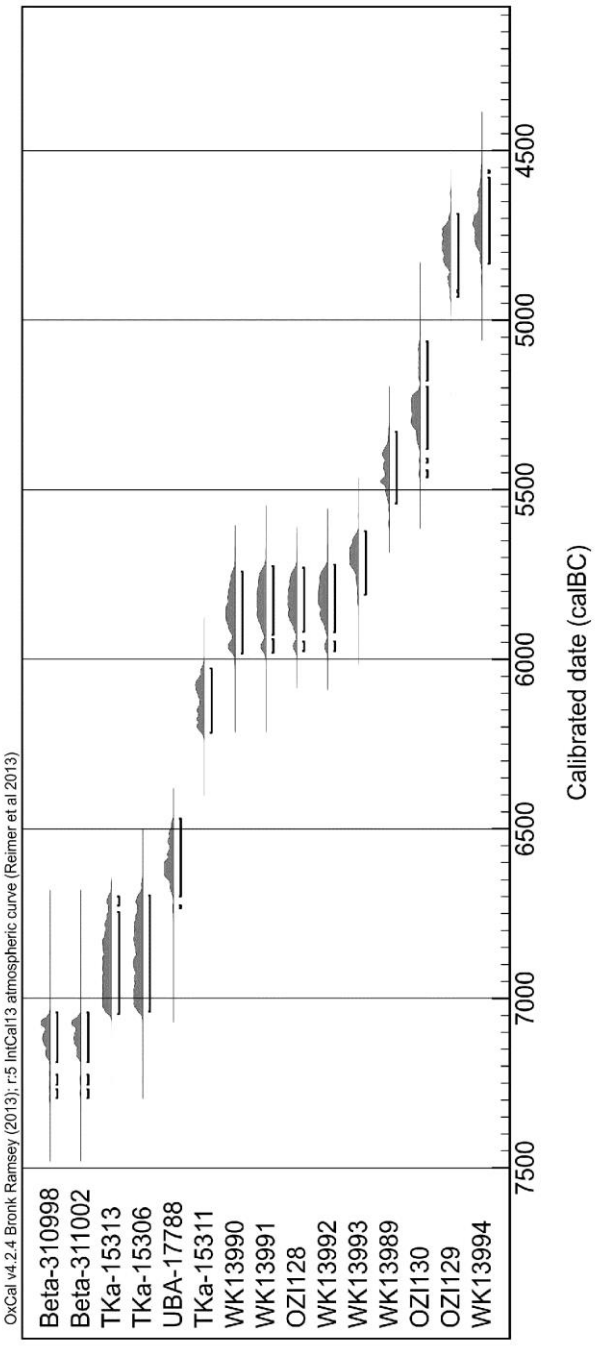


Table 1.2 Calibrated radiocarbon date ranges using OxCal and IntCal13 calibration curve (Bronk Ramsey and Lee 2013; Reimer *et al.,* 2013), of dates presented in Table 1.1 and arranged chronologically.

communities in Fars allows for investigation of the role of farming practices, the social organisation and changing social roles attributed to such activities and attendant material culture that appears alongside farming groups, including ceramics. Therefore study of these early ceramics from sites such as Rahmatabad and Qasr-e Ahmad, as well as those vessels that are part of the traditionally earliest ceramic phase labelled Mushki, may highlight new technical processes and/or social roles related to the changing lifestyle in the Late Neolithic.

1.2 *Site specific description of Neolithic Fars*

Relative sequences of decorated ceramics have traditionally been used to order cultural phases in Neolithic Fars, and this is how my description of sites will be ordered, starting with the first ceramic phase previously known- Mushki ware (table 1.3).

Date	**Decorative Ware**
Late 7th- Early 6th millennium BC	Black painted Mushki
Early 6th millennium BC	Red painted Mushki
Late 6th- Early 7th millennium BC	Black painted Jari
Neo. Survey data	Kutahi
Neo. Survey data	Kazerun
Early 5th millennium BC	Painted bichrome
Mid-5th millennium BC	Black painted mottled

Table 1.3. Decorative wares previously recorded for Neolithic ceramics in Fars. Kutahi and Kazerun wares are still only known from survey data and are similar to painted bichrome wares so have been placed next to them chronologically, while all other wares have been excavated from numerous dated contexts.

In a short but informative article written in the late 1970s, William Sumner described the Neolithic ceramics of Fars as technologically similar painted soft wares (1977: 293). Their main difference lies in the decorative styles within

which five main groups could be distinguished at this time- Mushki, Jari, Kutahi, Bizdan and Jalyan (1977:293- 299).

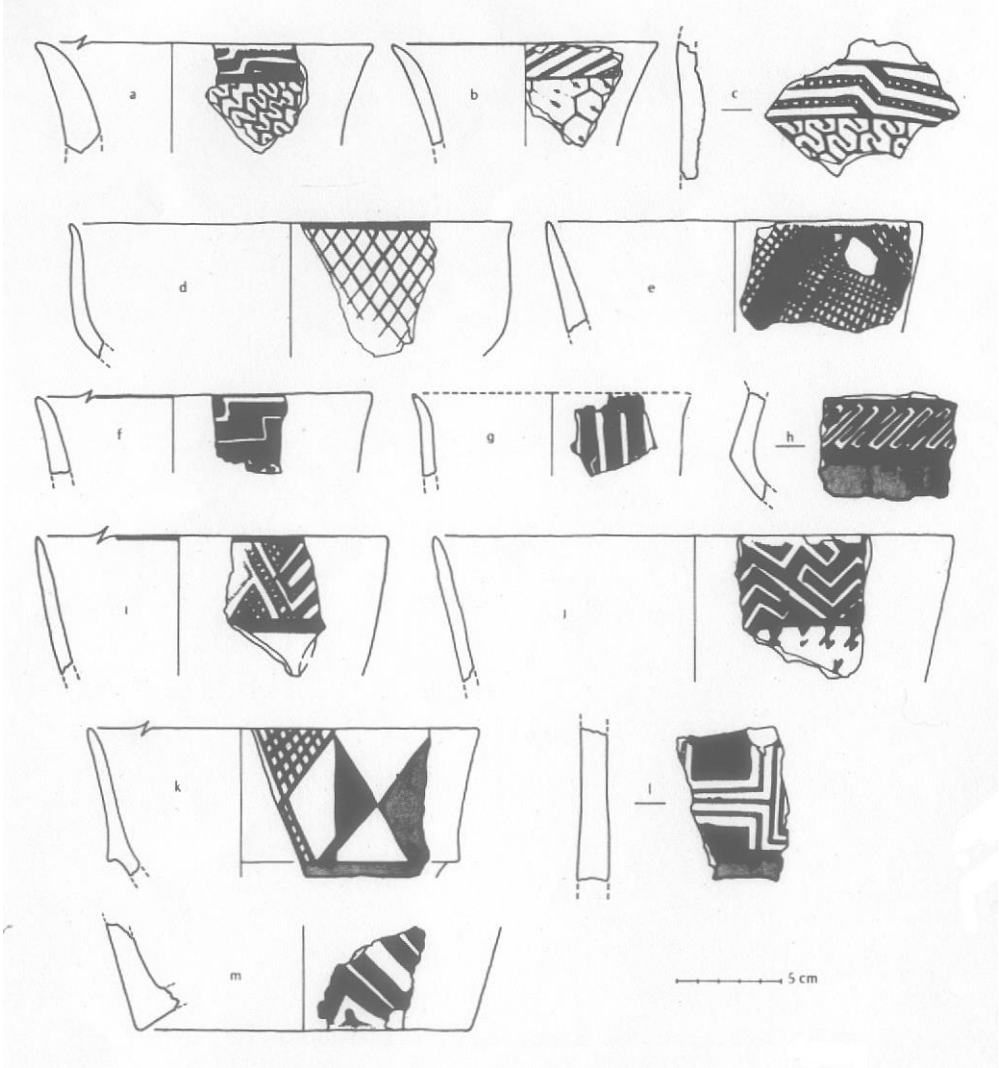


Figure 1.2 Jari ware (a-c), Mushki (d-e), Kutahi (f-j), Kazerun (k-m) (Sumner 1977: fig. 4).

It is these first two groups that we know most about as the excavations that have taken place in Fars have provided stratigraphic sequences incorporating Mushki, Jari, and an additional ware unknown to Sumner at the time of writing- Bashi ware. Kutahi, Bizdan and Jalyan wares are unfortunately still only represented by the initial surface surveys that originally identified them (Sumner 1972)(see figure 1.2 for select wares), although parallels can be seen with other surveyed remains at the site of Kushk-e Hezar and excavations at Tol-e Nurabad (see

Chapter 2). There have been various adjustments to these chronological sequences (Alizadeh 2004: 6; Sumner 1972: 29, table II; Vanden Berghe 1954: 400- 401; Weeks *et al.* 2006: 13; Potts *et al.* 2009: fig. 1.3), and it is now generally accepted that Mushki ware is the earliest form of ceramic in Neolithic Fars province, followed by Bashi, Jari, Shamsabad and Bakun, alongside numerous local traditions, such as the aforementioned Kutahi, Bizdan and Jalyan wares.

Layer 8039 in Trench H of the recently excavated site of Rahmatabad in the Kamin Valley (Azizi *et al.* 2013), also yielded pottery with similar stylistic traits to those from Tol-e Mushki main trenches and a pit at the site labelled TMB (Fukai *et al.*, 1973). Rahmatabad has been excavated both by a German-American team (Bernbeck *et al.*, 2005), and a subsequent Iranian team, due to the encroachment of a large highway between Isfahan and Shiraz. A collection of three radiocarbon dates by the German-American team for the aceramic levels span 7040- 6690 cal BC (Bernbeck *et al.*, 2008: 38, table 1), while the dates by the Iranian team for the earliest ceramic levels have been recalibrated (tables 1.1- 1.2) to fall across 7189- 7042 cal. BC. This potentially places Rahmatabad as an earlier ceramic Neolithic site than Tol-e Mushki. Although no architectural features have been recorded by either team for aceramic and ceramic deposits, an oven and numerous ash lenses were present within the depth of cultural material, the size of which suggests a relatively long-term settlement interpreted as seasonal (see below) (Bernbeck *et al.*, 2008: 39, Hossein Azizi pers.comm.) Studies of other cultural material are currently underway and will provide more detailed information regarding the economic subsistence at this site across the aceramic/ceramic Neolithic transition.

The site of Qasr-e Ahmad also spans the aceramic/ceramic transition in deep Neolithic levels of continuous occupation at the large site of 7 hectares. Radiocarbon dates are still being processed from this recent Iranian-led excavation, and post-excavation study currently being undertaken in preparation for publication. Therefore, discussion is currently limited to internal developments recorded in the Neolithic material and general comparisons with other sites. An interesting divergence in the material record from Qasr-e Ahmad

from the general narrative of Neolithic Fars, is the presence of complete aceramic architectural structures made of *chineh* and ochre plaster (Hossein Azizi pers. comm.). Other differences in material culture, economic subsistence etc. may also come to light in the further post-excavation study that is currently being undertaken.

Therefore, the development from an aceramic way of life during the Neolithic of this area is still to be explored due to an historical lack of excavated sites that had deposited cultural layers from this era. The trajectories of change that characterise the adoption of a traditional Neolithic agricultural package are yet to be studied in detail and fully understood. This situation is mirrored in our current state of knowledge for many of the transitions that took place during the course of the Neolithic, including the adoption of domesticates, settling to permanently occupied sites and mud-brick architecture (Weeks, 2013).

Radiocarbon dates associated with this early ceramic Neolithic horizon have recently been published for the type-site of Tol-e Mushki (Nishiaki 2010a: 5, table 1). The dates correspond with the five stratigraphic layers of the site, and complement other radiocarbon dates previously obtained from smaller soundings on the site (Alizadeh 2006: table 10 and 11). The lowest level of cultural deposit has no associated radiocarbon date due to a lack of suitable dating material, yet the stratigraphy and development of ceramic decoration suggest no temporal gap (Nishiaki, 2010: 5). The date range of 6350 to 6050 cal. BC for the succeeding level 4, is presumed to be close in range (Nishiaki 2010a:5).

Analysed faunal samples from Tol-e Mushki show that a large proportion of remains from the site are of aurochs, equids, gazelles, and wild goats (Mashkour 2006: 103- 104; Payne 1991: 139). Compared to the later faunal assemblages of Tol-e Bashi and Jari A and B, the material from Tol-e Mushki suggests a more prevalent hunting tradition (Mashkour 2006:104; Mashkour and Bailon 2010: 220) (See Table 1.2. for comparison of sites in discussion). A similar pattern has

also emerged amongst the lithic assemblage from the site, which will be discussed below.

The cultural assemblage at the site of Tol-e Mushki seems to diverge drastically from modes of living at other sites elsewhere in the province. This has prompted notions of a Mesolithic-type hunting and gathering community (table 1.4), in touch with surrounding groups whose lifeways otherwise correspond to the common notion of the agricultural Neolithic (Mashkour 2006: 105).

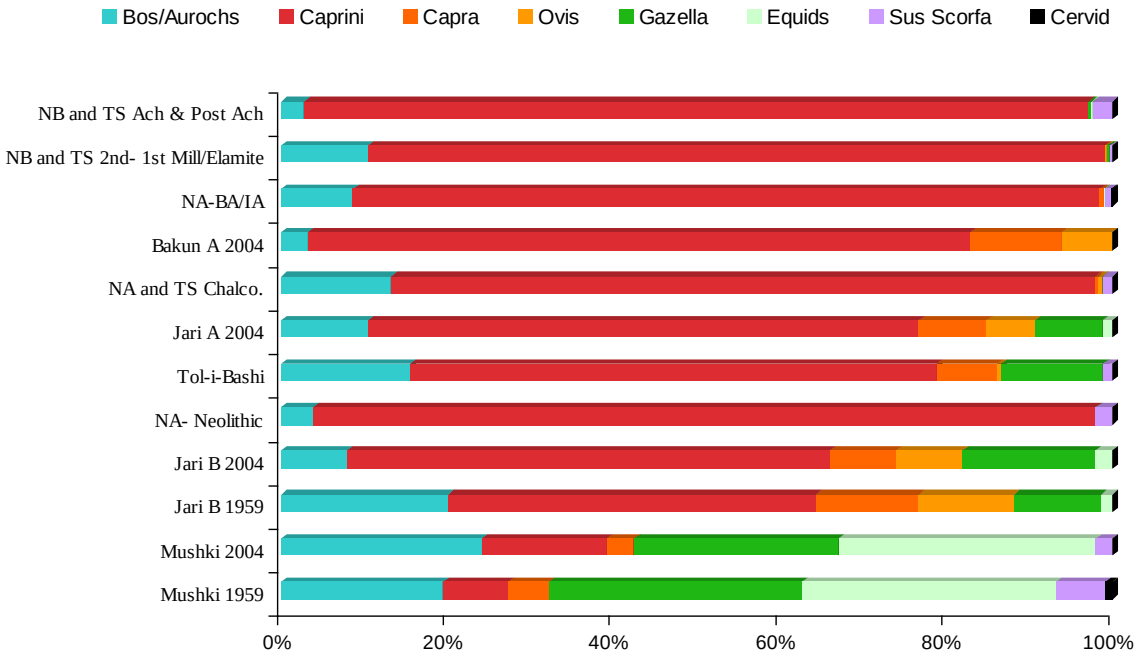


Table 1.4. Chart detailing the percentage of various species of animals present at sites mentioned in text during the Neolithic period to the Post- Achaemenid period. Note the abbreviations TS- Tol-e Spid, NB- Tol-e Nurabad Trench B, NA- Tol-e Nurabad, Trench A (Mashkour 2009: fig. 5. 15).

Flint and obsidian tools were also recorded from Tol-e Mushki (Fukai *et al.* 1973: 37). Notched blades, scrapers, awls, denticulated blades, lunar and trapezoid blades were recorded, as well as material relating to the working of flints on site (Fukai *et al.* 1973: 37- 50) (see Figures 1.3-1.4). Small lunate microliths of obsidian were also recorded (Fukai *et al.* 1973: 72) (see figure 1.5). It seems

from this assemblage that the majority of material belongs to a repertoire where hunting (and possibly gathering) practices are of primary importance (Alden *et al.* 2004: 42; Mashkour 2006: 105).

The raw materials used for the flint tool types were all locally sourced and while neutron activation analysis (NAA), demonstrated the trade and exchange of this non-local material that originates from Nemrut Dagh, Turkey (Mahdavi and Bovington 1972: 149). This suggests a degree of cultural contact between communities in Fars with wider regions, that may be paralleled with other materials, such as sea shells, native copper, and bitumen (Weeks, 2013: 65).

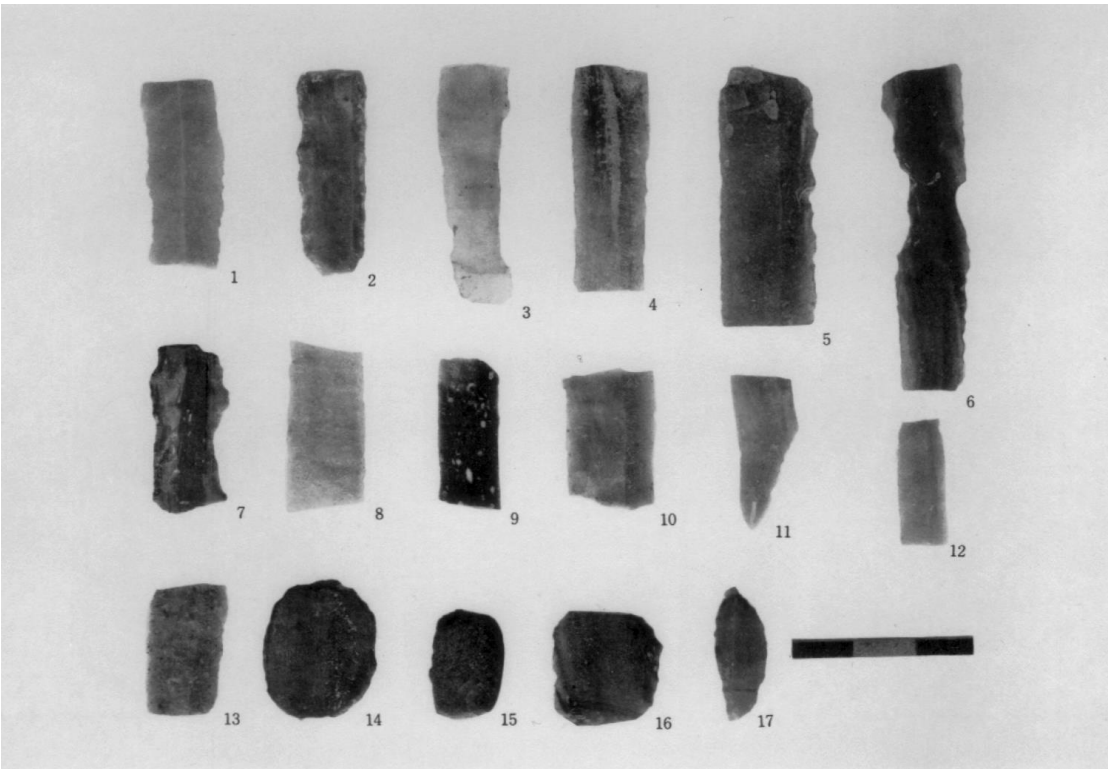


Fig. 1.3 select blades from Tol-e Mushki (Fukai *et al.* 1973: pl. XXXI. 1).

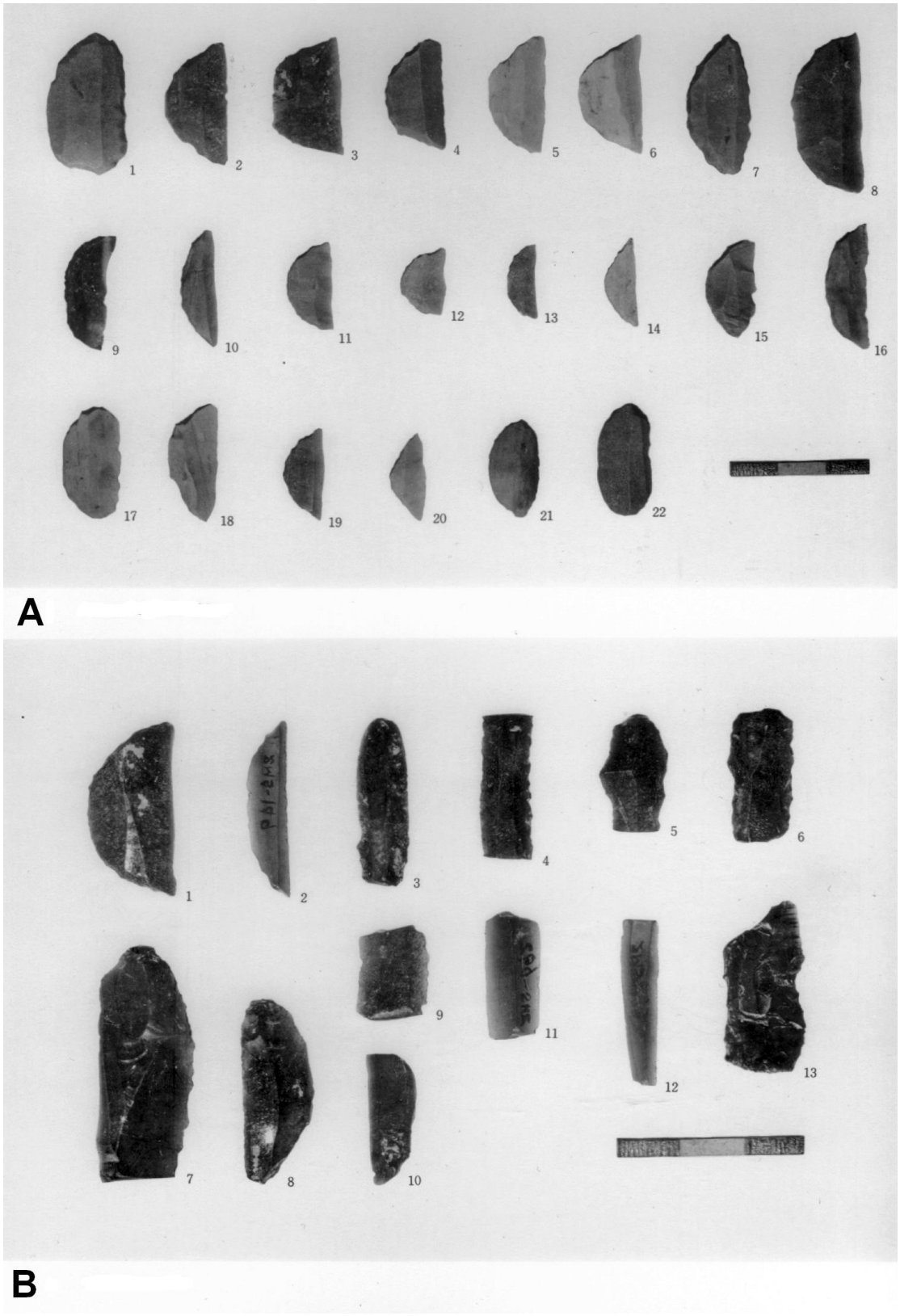


Figure 1.4 A; flint microliths and B; obsidian blades from Tol-e Mushki (Fukai *et al.* 1973: pl. XXXIII).

The most recent excavations at Tol-e Mushki, Jari A and B and Bakun B conducted by Abbas Alizadeh (Alizadeh, 2006), collected soil samples for flotation in order to recover botanical remains. However, this was such a small data set it was not possible to make very firm conclusions, particularly for any in-depth understanding of the paleoenvironment and human- landscape interaction during specific cultural phases such as Mushki, Jari and Bashi (Miller and Kimaie 2006: 113). Stone querns and pestles indicate the processing of plant material at Tol-e Mushki with the latter made from intentionally split/shaped or naturally shaped stone (Fukai *et al.* 1973: 50- 53). A small sample of cultivated cereals were recorded from Alizadeh's excavation at Tol-e Mushki, as well as wild/weedy plants brought into the site accidentally on clothing etc. (Miller and Kimiaiae 2006: table 8). The collection of such plants could have been undertaken with the use of sickle blades which were also recorded in the flint assemblage and one example of a bone haft (Egami *et al.* 1977: 49). Key questions related to characterising the material assemblages at sites of Mushki period occupation are the degree to which Tol-e Mushki is an exemplary site at this time, in terms of its economic subsistence and material record. Little or no cultural material has been intensively studied from sites with Mushki-related ceramics, and the degree to which the ceramic production of these sites is indicative of this period also remains unknown. Organic temper in the ceramics from this site may also be related to plant processing, but without a modern study on the botanical remains, it is still unclear.

Mushki period occupation has also been recorded in the neighbouring Kazerun valley system, with a total of 6 Mushki/ Jari period sites located near water sources (Rezaei *et al.*, in press). The size of sites varied from a couple of hectares to over ten hectares (Rezaei *et al.*, in press), although the extent of Late Neolithic occupation is as yet unknown, as is the contextual detail of the material culture recorded from this survey.

The excavation of the site Tol-e Bashi in the Ramjerd Plain of the Kur River Basin's steppic environment, close to Tol-e Mushki, has recently introduced another chronological phase supported by radiocarbon dates and a ceramic

typology (Pollock *et al.*, 2010: 6). A repeated preparation of surfaces in the site and the low density of artefacts led the excavators to assume it was occupied successively and for short periods of time. Due to the high density of fire installations recorded at the site, as well as large accumulations of ash debris, the excavators have postulated the site was occupied mainly during the winter months (Pollock 2010: 64). A further nine sites, recorded in a 10km radius of Tol-e Bashi and all with remains of contemporary ceramics, highlight the potentially complex use of sites in a system of shifting habitation (Pollock and Bernbeck 2010: 278). Interestingly, this is perhaps a similar reconstruction of past mobility that could be put forward for the previous Mushki phase in the Kur River Basin. Factors that hamper the detailed investigation of such issues include much of the excavated material from Tol-e Bashi being taken from outdoor spaces, and little or no whole buildings unearthed to establish their plan (Pollock 2010: 33). Additionally, artefact density was low in much of the excavated area (Pollock 2010: 45). However, the excavators were still able to ascertain substantial changes in the use of space over time (Pollock 2010: 64), with some indoor spaces and room partitioning evident, although only limited and incomplete plans can be reconstructed, these show multi-roomed buildings, some including small courtyard walls (eg. Pollock 2010: 61, fig 4.33) (see figure 1.4).

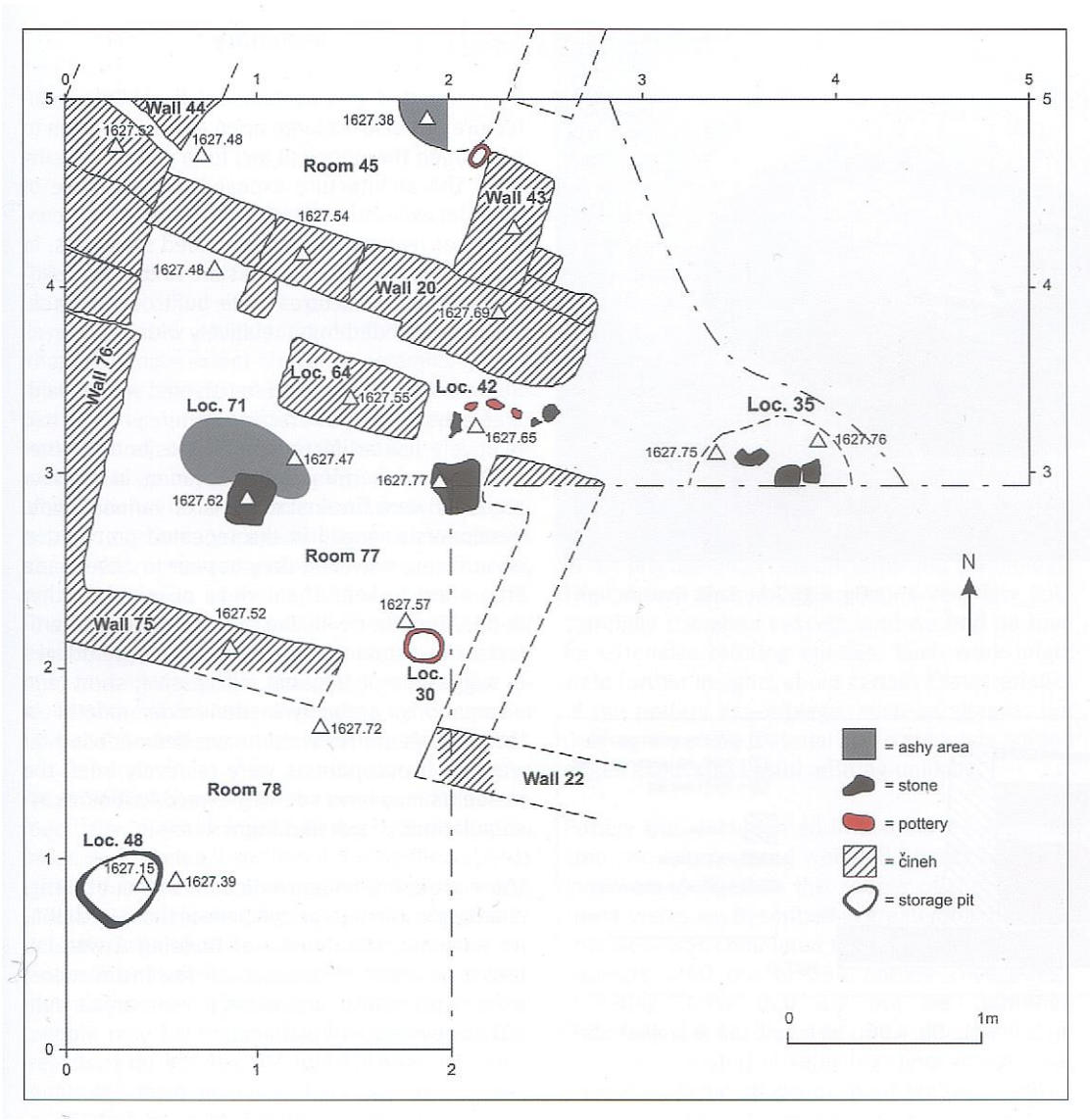


Figure 1.5 Plan of Unit C, Layer 3 at Tol-e Bashi indicating wall architecture, pits, hearth and associated artefacts (Pollock 2010: Fig. 4.33).

The chipped stone assemblage from Tol-e Bashi is small and with limited debitage, therefore the excavators have reconstructed a scenario whereby the past inhabitants relied solely on locally sourced raw materials, presumably that needed little if any working and included no obsidian (Ghasidian *et al.,* 2010: 173). They may also have used perishable materials, such as fire-hardened wood, for tasks usually requiring stone tools. Those tools that were recorded have been noted to be similar to the assemblage from the earlier site of Qal'e Rostam in the Bakhtiari mountains, in that they are mainly blades (Ghasidian *et al.,* 2010: 173). Some sickle blades, notched pieces, geometric microliths,

perforators and truncated blades were all recorded (Ghasidian *et al.,* 2010: 167-170) (see figure 1.6).

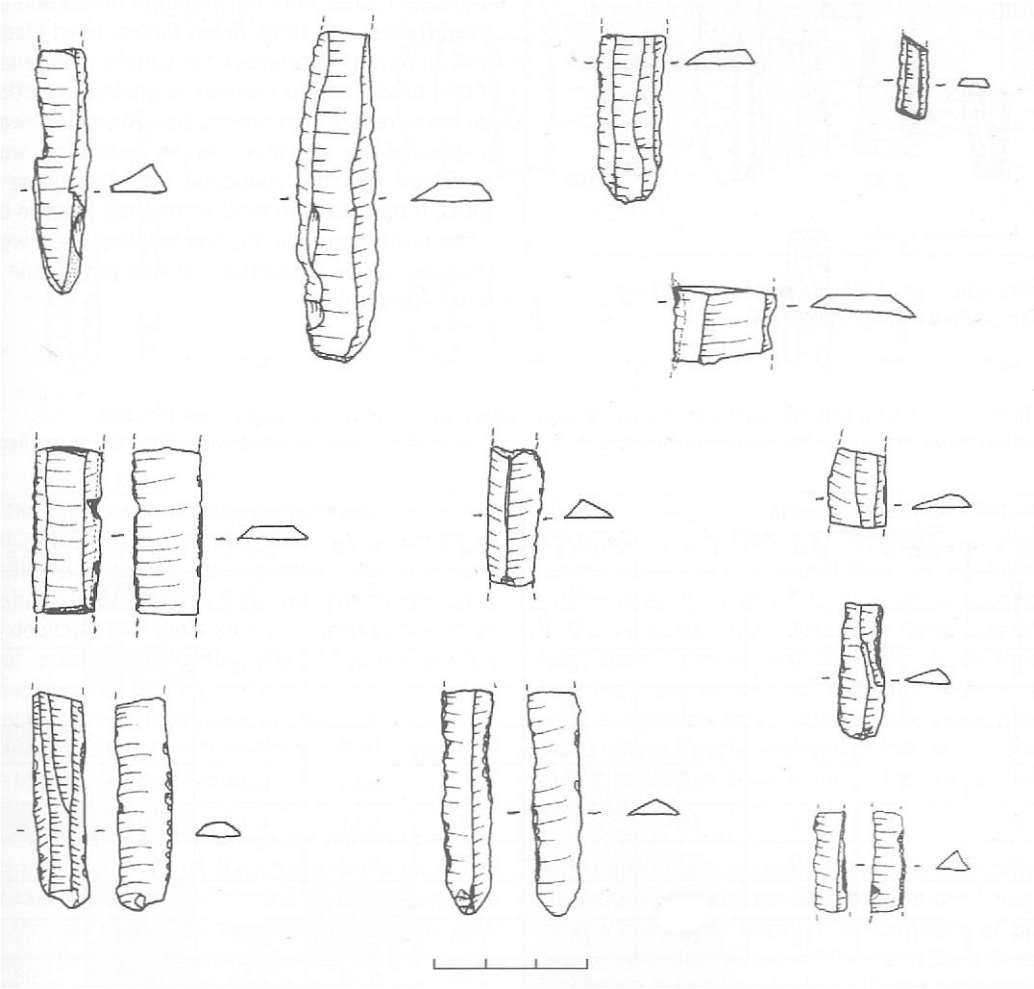


Figure 1.6 Reproduction of select blades, some of which retouched, from Tol-e Bashi (Ghasidian *et al.* 2010: fig. 7.9).

The animal remains from Tol-e Bashi suggest that the repertoire of species exploited by hunting was very different to that at Tol-e Mushki, despite some cultural similarities in the Bashi phase (Mashkour and Bailon 2010: 228). The collection of animal remains has been described as a restricted diversity in comparison with the Mushki assemblage, there are no equid remains and only limited caprid bones (Mashkour and Bailon 2010: 220). Unfortunately, the large majority of the animal remains were very poorly preserved, the surfaces of the bones were heavily deteriorated due to chemicals in the soil and surrounding roots, digestive acids, mechanical factors such as trampling, cut marks and intentional breaking (Mashkour and Bailon 2010: 217). Therefore, much of the

material has remained unidentified. However, the degree of destruction on some bones has proved interesting in itself, as the deliberate breaking of larger bones for marrow extraction has been recorded (Mashkour and Bailon 2010: 217). The poor preservation has also hampered understanding of the degree of domestication of goat and sheep remains; domestic sheep are recorded from Units A and E of the excavation but in limited amount and only from the later Jari phase (Mashkour and Bailon 2010: 227). Interestingly, although wild forms of these animals are present in the region around the site, from the excavated areas so far, only the later domestic form is represented (Mashkour and Bailon 2010: 227), suggesting these species were for some reason not consumed as wild species but later in time, only when they were domesticated are they eaten by the community. This adds a complex and somewhat confusing aspect to the motivation of initial herd management and domestication arguments for this area (Zeder 2008; Zeder and Hesse 2000).

The animal remains are still somewhat problematic to use in reconstructing this past community as the material represents only a small proportion of the site and is also very badly preserved. This limits the reliability of any reconstruction and no statistical analysis was carried out. However, broad similarities and differences have been tracked with the two contemporary and nearby sites of Tol-e Mushki and Tol-e Jari.

Archaeobotanical analysis of remains from the site have recorded domestic wheat and barley which occur in most contexts and are the most common taxa present at Bashi (Kimiaei 2010: 234). The wheat samples included several einkorn varieties, and the free-threshing variety of bread/hard wheat. In addition, two spikelet forms of einkorn were recorded- a result of threshing at the site (Kimiaei 2010: 234). Wild grasses and weeds occur in all sampled contexts as well as domesticated cereals although the range is very limited compared to other sites in Southwest Iran which have lentils, flax, 2 and 6 row barley which suggests an incomplete sample from Bashi (Kimiaei 2010: 235).

The sites of Tol-e Jari A and B are located in the Marv Dasht plain and both have Prehistoric cultural levels (Egami 1967: 2936). The occupation at Jari B began towards the end of the Mushki phase according to developments in ceramic decoration (Maeda 1986: 55; Nishiaki 2010b: 124). A commonly used typology of ceramics from Tol-e Jari B is that constructed by Maeda, and which encompasses the Neolithic periods. This has been adapted after later excavations at Tol-e Bashi by Bernbeck and the result is that the stylistic developments in the ceramics are closely paralleled by their stratigraphic development (Bernbeck 2010: 94), lending considerable weight to chronological schemes organised around changes in ceramic decoration.

The stratigraphy of Jari A is split into three phases which mirror the three levels of occupation recorded from the site (Egami *et al.,* 1977: 1, 3). Level I is from the Early Chalcolithic period and contemporary with Bakun A and therefore outside of the scope of this discussion, Level II is contemporary with Bakun B1 and is known colloquially as the Shamsabad period, and Level III part of the Jari phase. Jari B falls chronologically within the first and latest levels of Jari A and has only Jari period ceramics present (Egami 1967: 2936), suggesting a short and limited occupation compared to other sites in this study. However, detailed excavation reports of these two sites remain unpublished and only a limited explanation of the finds and stratigraphy are in print (Egami 1967; Egami *et al.,* 1977; Nishiaki 2010b; Nishiaki and Mashkour 2006).

The lowest level of Jari A contains painted pottery similar to the upper levels of Tol-e Mushki (Egami 1967: 2936), and straw tempered coarse ware (Egami *et al* 1977: 2). Bernbeck has since stated that this earliest Jari level is in fact akin to the TMB pit material from Mushki, which is later than the main excavated area of the site, and the earliest levels of Tol-e Bashi (2010: 94). The fact that the TMB pit and early Bashi levels are contemporary and form what we now know as the Bashi phase has been explored above. Other material also occurs at the site of Jari A, after the Bashi/ TMB sherds occur layers with what Bernbeck (2010: 94), has called early and late Jari wares based on limited published stratigraphic information and traditions of "design development" which chart the evolution of

decorative motifs on the ceramics. An alternative interpretation to the early/ late Jari chronology is also considered by Bernbeck, whereby the stylistic differences are due not to chronological factors, but spatial (2010: 94). The two sites of Tol-e Jari and Tol-e Mushki are separated only by a few hundred metres which is considered by Bernbeck too small a distance to affect ceramic variability (2010: 94). Whether this is indeed the case is difficult to ascertain, especially as more recent excavations at the site failed to locate the Level III (Alizadeh 2006: 41-42).

At Jari A, remains of rectilinear dwellings were recorded in numerous strata, with rooms containing millstones, stone pestles and large vessels potentially used for storage (Egami 1967: 2936). Sickle blades were recorded as part of the chipped flint assemblage throughout the occupational layers at the site, with one example having remains of bitumen-like material that would have held it in place in the haft of the sickle (Egami *et al.* 1977: 6). This factor, taken with the paucity of microlith blades recorded at the site, suggested to the excavators that agricultural practices dominated at the site, rather than the prevalent hunting tradition that is evident from the faunal and lithic assemblages of Tol-e Mushki (Egami *et al.* 1977: 6). In addition, survey material of the KRB has suggested an expansion of canal based irrigation during the Jari phase (Sumner 1990: 97- 98), which would have facilitated the cultivation of the cereal crops that have been recorded from the site (Miller and Kimiaie 2006: table 8). These include emmer wheat, six-row barley, two-row barley, bread/hard wheat, and einkorn and pulses, the latter of which remain unidentified (Miller and Kimiaie 2006: table 8).

The faunal remains from both Jari A and B show an increase in goat and sheep through time compared to the preceding Mushki phases, where no sheep bones were found at all (Mashkour 2006: 104). There is also a marked decrease within the Jari assemblage of gazelle compared to the earlier Mushki site (Mashkour 2006: table 3), which has led to tentative explanatory schemes of early pastoralist economies in these Neolithic sites (Miller and Kimiaie 2006; Weeks 2013b).

Ceramic figurines of animals and stylised females were recorded, as were marine sea shells, lumps of copper and copper pins (Egami 1967: 2936- 2937). Worked flint consisted of blade cores, core tablets, sickle blades, burins, borers, geometric microliths, coarse stone flakes, and obsidian blades (Egmai *et al* 1977: 4- 6). Two burials were found at the site, one from Level II and the other from the later Level I, accompanied with a painted ceramic vessel (Egami *et al* 1977: 7).



Figure 1.7 Plan of excavated rooms at the site of Tol-e Jari B (Nishiaki 2010: fig. 3).

Jari B contains the remains of multi-roomed, pisé structures, some with additional ovens and chimneys (Egami 1967: 2938) (see figure 1.7), and from the more recent analysis of the stratigraphy (Nishiaki and Mashkour 2006: 79), seems to have been occupied intensively and continuously with no hiatus between the building levels, suggestive of year-round occupation. Items indicative of participation in long distance trade networks, such as obsidian, metal, and marine shells that are recorded from Mushki, Bashi and Jari A in the KRB, are recorded but in much higher numbers from Jari B (Egami *et al.* 1977: 6). However, no obsidian was recorded at all from Jari B (Egami *et al.* 1977: 6), but

the flint industry included a small proportion of geometric microliths, sickle blades, burins and cores (Egami 1967)

Ceramic animal figurines were present, but articles of personal adornment which were prevalent at Jari A, were scarce at Jari B (Egami 1967: 2939), although these patterns may be linked to sampling strategies.

The surveyed site of Kushk-e Hezar is an additional Neolithic site with ceramic parallels to surveyed material from Tal-e Kutahi near the modern city of Shiraz (2004: 38). This material has been described as "almost identical to Jari ware" in paste, surface treatments and form (Sumner 1977: 295). Other artefacts that were gathered in this survey are a chipped stone assemblage which also seems to fall chronologically between the occupation of sites Mushki and Jari B based on the proportion of geometric blades (Alden *et al* 2004: 42). Excavation at this site and the undertaking of deep soundings with the collection of archaeobotanical and ceramic material from all phases so far recorded for the Neolithic of this region, would greatly enhance the current state of knowledge regarding economic adaptations and cultural interaction. At present, the site contributes to our understanding of the number of sites in the Mushki, Bashi and Jari periods and in a limited capacity, the nature of participation in an interaction sphere that potentially included ceramics moving across sites in this region.

Deep soundings at the site of Tol-e Nurabad, to the west of the Mushki, Jari and Bashi sites (see map 1), unearthed Mushki period occupation (a hearth in Phase A27,) and subsequent Neolithic deposits including traditional rectilinear *chineh* buildings with a covering of mud plaster (Weeks *et al.* 2006: 6). Flint tools are also present, such as blades, bladelets, and scrapers, as well as considerable amounts of debitage (Weeks *et al.* 2009: 63). Clay labrets were common, ochre coloured beads, and possible fragments of human figurines also occurred (Weeks *et al.* 2009: 65).

The first occupation of the site in phase A27 (see figure 1.10), features typologically similar ceramics to the Mushki phase (Weeks *et al* 2006: 41). Phase

A26 also continues with Mushki ceramics, with an additional layer of mixed deposits from Phases A27/26 where new decorative motifs seem to be introduced to the Neolithic repertoire and exclusively to this site (Weeks *et al.* 2006: 42). Mushki ceramics remain at the site in a residual capacity through to Phase A25, indicating to the excavators there was significant occupation of that period (Weeks *et al.* 2006: 73) (see figure 1.8).



Fig. 1.8 Sherds from the excavation of Tol-e Nurabad representing the Mushki phase (left) (TNP 1764), and Jari phase (right).



Fig. 1.9 Local tradition of Neolithic painted ceramic from Tol-e Nurabad

Phases A28- 20 fall chronologically within the early Jari period or even a transitional Mushki/Jari interface, similar to the place occupied by Tol-e Bashi, followed by a period of localised wares that are unparalleled at other sites (figure 1.9) (Weeks *et al* 2006: 74).

Occupation at Nurabad continues through the Neolithic/ Chalcolithic transition (phases A19-18), characterised by the presence of Gap/ Bakun B2 wares alongside typical Neolithic decorated wares (Weeks *et al.* 2009: 34).

The variety of tool types within the chipped stone assemblage is very limited, most being retouched flakes of debitage (Weeks *et al.* 2009: 63). However, blades, bladelets, truncated bladelets, scrapers, two points, one burin, and one notched blade were recorded amongst the material (Weeks *et al.* 2009: 63). Chert material was available locally, and with the remains of cores with cortex, the working of the tools was clearly undertaken at the site (Weeks *et al.* 2009: 63). In the later phase of the Neolithic a coarse type of unidentified stone was introduced as a material for chipped stone tools which may have come from outside of the immediate area of the site. Other material that must have been introduced through a wider network is obsidian but only one tool was excavated- a blade fragment (Weeks *et al.* 2009: 63). Unusually, flake cores are completely absent from the site although they are present at other sites in the region, which may be a result of the trench placement or limited horizontal excavation (Weeks *et al.* 2009: 63).

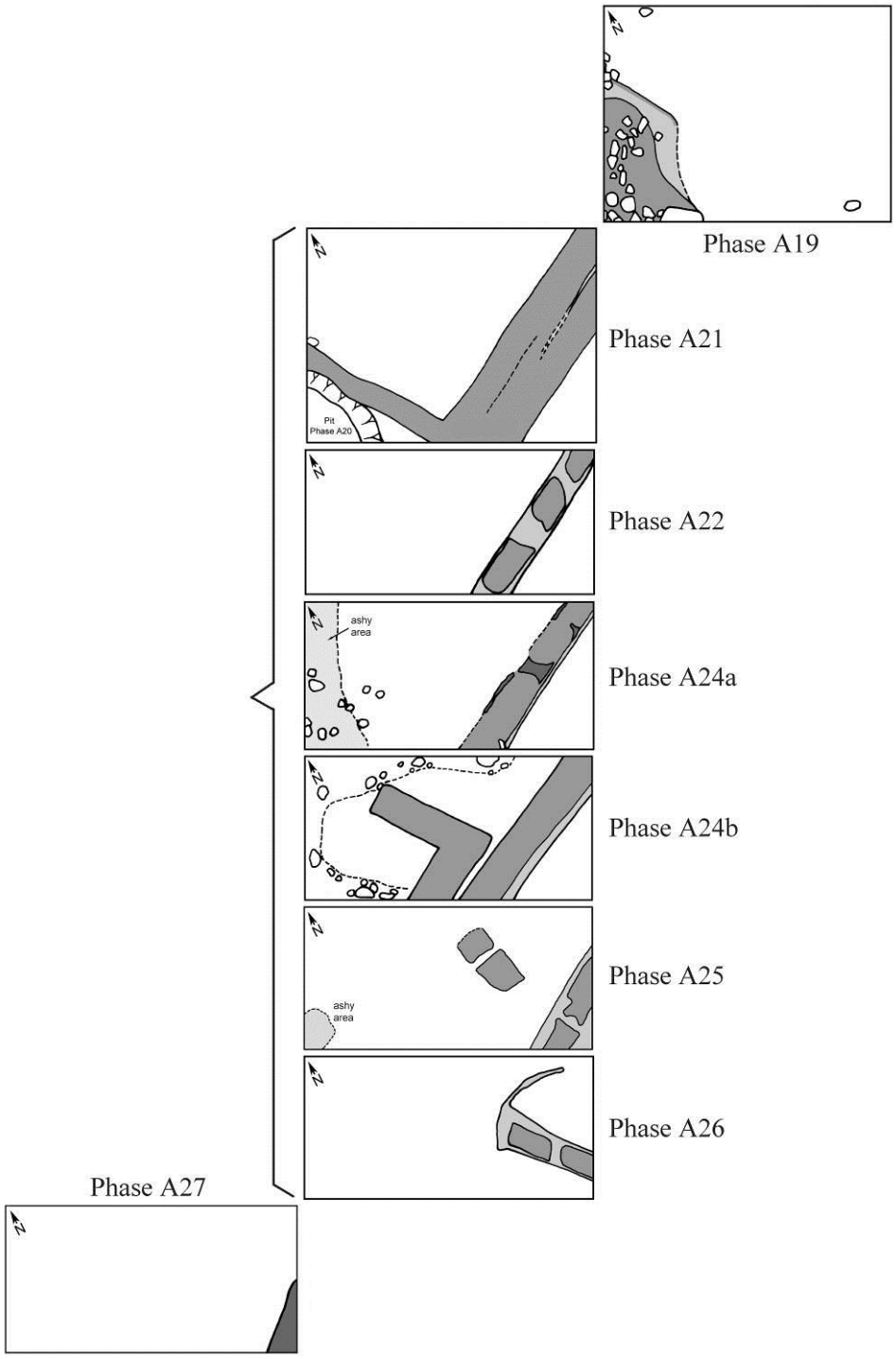


Fig. 1.10 Chart showing the structural remains in each phase of excavation in Trench B at Tol-e Nurabad (Weeks *et al.* 2006: fig.5).

Analysis of the faunal remains shows that occupants of Nurabad in the Neolithic period adhered to the economic adaptation of other communities in the region and engaged in pastoralism, as caprid remains are the most common taxa in the assemblage (Mashkour 2009: 136). In addition, the sheep/ goat ratio seems to be

equal indicating the community specialised in managing both species in order to lower the risk of disease spreading through an entire herd and wiping out one of their main meat sources. No wild remains were included in the assemblage and an extremely low quantity of gazelle bones, lending strong support to the reconstruction of a specialised economy (Mashkour 2009: 137). In comparison to the surrounding sites in its vicinity, Nurabad has a very distinct assemblage due to this apparent concentration of domestic caprid remains (Mashkour 2009: 138). In the Bashi and Jari phases of contemporary sites, evidence for the hunting of gazelle and equids was a strong component of the assemblages, yet at Nurabad there seems to be a distinctly different cultural preference for caprids and therefore a different approach to economic subsistence (Mashkour 2009: 138). Additional aspects of research that are related to these issues are that of management of local environments and notions of ownership and/or shared resources for flocks with other pastoralists or hunters (Mashkour 2009: 138). Negotiation on any level with other communities is intensely complex and interesting for all of these sites in this period, given the spatio-temporal variability in faunal assemblages but also material culture generally, which all lie at the heart of research into this period.

1.3 *Summary*

The dominant themes of research for any location in the Neolithic period have usually dealt with issues of domestication, sedentarisation, population increase, climate change and social organisation. The Iranian dataset that has been summarised above offers new trajectories for understanding these themes in that they provide differing accounts of the process of Neolithisation to the more widely understood Mesopotamian and Levantine evidence in the Near East. The precise meaning and material correlates of the term "Neolithic" and the time period it represents are continually undergoing change (Weeks *et al.* 2006: 1), and so, therefore, are our reconstructions of the past communities and their actions also continually evolving (Matthews 2003: 39).

Neolithic Fars has already been noted for its paucity of excavation in relation to its size, and the perhaps unfortunate location of all of this work in the north of

the province (Weeks 2013). However, within the datasets from this area, important and relevant information on a micro- regional level can be discerned and compared to other areas in Iran and the Middle East/ Western Central Asia to further understand regional lifeways of this period.

Economic activities that developed throughout the early Holocene culminated in morphologically domesticated plant and animal species. However, this is not the result of a fast-paced "revolution" as previously thought (Childe 1942: 48), but more a long enduring shift in relationships between humans, animals and their environment (Smith 2001). Indeed the Fars material initially suggests animal domesticates were present in the aceramic site of Tepe Rahmatabad (northeast of the KRB), yet in the later site of Tol-e Mushki a strong preference for hunting is evident (Mashkour 2006: 104) and the Bashi and Jari phases are dominated by domesticated species and a pastoral economy (Mashkour 2010: 229). While in some cases this is envisioned as a long and varied journey between opposing poles, these sites from Southwest Iran are well dated and appear to show fairly quick responses to change.

There are also many different routes that can be taken between the landscape of wild/ domestic (Wendrich and Barnard 2008: 3- 6), which remain to be explored for the faunal assemblages from Mamasani and the KRB through such means as isotope analysis *etc*. Mashkour has also noted that cultural preferences are evident across the collections, such as a lack of sheep remains from Mushki (Mashkour 2006: 104), gazelle at Nurabad (Mashkour 2009: 137), and certain domesticated animals eaten at Bashi, that were not utilised in the earlier periods as wild species (Mashkour and Bailon 2010: 227). In the case of the Jari period and later, the faunal assemblages seem to suggest reliance on a pastoral economy, with a small amount of supplementary hunting, yet it is still unclear as to exactly how this would have worked when combined with agricultural activities (Miller and Kimiaie 2006: 113). Organising areas for the cultivation of fodder for herd animals would have sacrificed areas for the cultivation of food for the community. Additionally, the combination of herd animals and cultivated land requires strict control of the flock's movements and from ethnographic

examples, is usually balanced by grazing the animals in a remote location from the fields and settlement of the community (Wendrich and Barnard 2008: 7). At Ganj Dareh in the Central Zagros, caprine herds were evidently around the site for some part of the year as their hoof marks are clearly impressed in the mud bricks that were made and dried at the site. Additionally, the animal bones from this site have evidence of kill-off patterns and domesticated male horn cores indicating herd management (Zeder and Hesse 2000: 2255; Smith 1974: 207). But how the communities in Fars organised their domesticated herds is still unknown, as is where and how they integrated these animals with the grazing of the wild species that they still occasionally hunted. Miller and Kimieiai (2006: 113) have questioned how this relationship was negotiated based on the plant remains from sites which indicate that six-row barley may have been cultivated, of which the secondary products from processing may have been used as fodder for domestic herds. Communities in this area of Fars would clearly have had to restructure their activities and relations with each other to have adopted these new methods of food production, and it is hoped that further work on the animal assemblages and botanical specimens combined with detailed examination of patterns and changes in other realms of material culture will bear out these adaptations.

With the development of new social and economic roles in the Levant and Northern Mesopotamia during the Neolithic, new forms of material culture were used to emphasise and solidify these relationships while also being manipulated as a mechanism for exerting authority (Twiss 2008: 418). Mortuary remains featured heavily in reconstructing notions of kinship and group identify, as well as the possibility of individual specialisation (Kuijt 2000: 78), which resulted in a more restricted social network for sharing production and consumption activities (Byrd 1994: 639). While the transition to domestic plant and animal species may also be taking place in Southwest Iran, the restructuring of social relations and the symbolic meaning of these relationships has yet to be investigated. One probable reason for this is the lack of mortuary data compared to other regions of the Near East. While there are examples of burials of whole or part of individuals, the Southwest of Iran has been broadly described as lacking

in symbolic material culture (Pollock and Bernbeck 2010: 283), yet rather than seeing these past communities as people devoid of symbolically relevant artefacts, it would be worthwhile to envision this utilitarian material culture as capable of holding complex symbolic meaning as well (see Gorring-Morris and Belfer- Cohen 2001: 257, 264). Therefore, understanding the process of Neolithisation for Southwest Iran can still be attempted within the bounds of social meaning and symbolism but by accessing a dataset that is also well equipped to answer such questions, albeit a departure from Levantine and Mesopotamian sources and at a very different scale.

Of particular focus within the Fars material should be the intra-site variability of material culture and an investigation of interconnected networks of communication and trade. Communication and relations between sites would have been instrumental in managing access to certain areas for either pasture or hunting, which would have changed throughout the year but also across larger spheres of time (Mashkour and Bailon 2010: 215). Structuring and representing these organisations and relationships would have been commonplace and a range of artefacts exists to explore these, as have been suggested for anthropomorphic and animal figurines (Wengrow 2003) and personal adornment (Weeks *et al.* 2009: 65). The ceramic datasets from each of these sites and their development and change through time in tandem with these shifting economic practices would also reflect changes in the preparation, serving and consumption of foodstuffs. The lithic material also necessarily transforms from one equipped for a prevalent hunting tradition at Tol-e Mushki, to one more reliant on sickle blades and other processing tools at the sites of Tol-e Bashi, Jari A and B and Nurabad. As the Neolithic period most likely involved a restructuring of roles alongside these economic changes, including the re-organisation of time, people, labour *etc*., cultural meaning attached to artefacts will also have been shifting which may be evident in their wider production, consumption and deposition within sites.

The presence of non-local material culture is another example of communication networks across this region. Changing patterns of movement related to the

pastoral economy may shed some light on the fluctuating presence of metal, obsidian and marine artefacts that appear as non-locally sourced material at village sites. Presumably with extended excavation areas at the sites in Fars a larger dataset would add further clarity to the exact nature of this fluctuation. Yet in the Central and Northern Zagros, where sites are well sampled, such fluctuation still exists across the Neolithic and also the Near East generally, suggesting either changing intensification of participation in an extended trade network across both time and space, or shifting needs in a supply-and-demand situation. With either explanation for the change in quantity of these material at the sites in Fars, what remains evident is the meaning attached to these artefacts would have also been shifting as access to the material varied, and further, that this meaning would be different at each site due to the different quantities present (Gorring-Morris and Belfer- Cohen 2001: 259).

Clearly, further investigation into the material culture of Fars would provide a more well-rounded understanding of economic change and the repercussions of this in the Neolithic social sphere. Additionally, the impetus for such change has still to be addressed as climatic events may have affected communities in the area (Weeks 2013) but cannot still be seen as the main reason this area of Fars was colonised (as in Hole 1987: 88).

In conclusion, research lies in tracking the multivariate and locale specific adaptations to Neolithic life, which the sites in the KRB and Mamasani are well positioned to do. Not only do they have a rich collection of material culture, but one that varies from our current understanding of Neolithisation in the Near East which can only be productive and interpretatively challenging to explore. This chapter has therefore reviewed such evidence, and will be followed in the succeeding chapter with a detailed description of Neolithic ceramic typologies used in Fars.

2. Neolithic ceramic typologies from Fars

2.1 *Introduction*

This chapter details the current published typologies for Neolithic ceramics excavated from Fars province. No current typology incorporates all the published wares from Fars, nor some recently excavated wares that form part of this study. I therefore synthesise below the current ones in use, based largely on the excavation of "type-sites" and incorporate the uncategorised ceramic wares into a new working typology later in this thesis.

2.2 *Mushki ware*

Until the recent Iranian excavations at Neolithic sites that witness the transition from aceramic to ceramic traditions (Azizi 2013), very limited research was possible on the few isolated deposits of aceramic material culture and the advent of pottery vessels. However, with such recent deep soundings that reveal numerous stratigraphic layers, it may be possible to begin to chart and better understand the introduction of ceramic vessels at these sites. Prior to these discoveries, traditional relative sequences of ceramics placed Mushki period vessels as the primary ceramic "type" witnessed in Fars, and can be demonstrated as such in their stratigraphic placement below other Late Neolithic decorated wares at the sites of Rahmatabad and Tol-e Nurabad (Weeks *et al.*, 2009, Weeks *et al.*, 2006, Hossein Azizi pers. comm.) Comparing the decorative styles, forms and visible production techniques of ceramics from the earliest deposits at Rahmatabad, Nurabad and Tol-e Mushki, it seems there is evidence for a shared tradition of decorated and plain buff wares, with motifs including those recorded and classified in detail from Tol-e Mushki. It is this latter site that the most detailed research into ceramic classification on this ware has been conducted which will therefore provide the main focus for my description of Mushki phase ceramic wares.

Mushki period ceramics were first recorded from some of the earliest surveys in Fars during the 1930s (Stein 1936), and were described as a chronological and cultural horizon

later in the 1950s by Vanden Bergh (1954). Since the excavation of the type-site by a Japanese team in the 1960s, they have formed part of a chronological scheme incorporating ceramics from this southwest region of Iran (Egami 1967: 2939; Fukai *et al.* 1973: 25- 31).

Mushki ware, as well as all other Late Neolithic decorated wares in Fars are commonly described as belonging to the "soft-ware" horizon (Dyson 1965). This description was originally coined for Iranian Neolithic ceramics from Tepe Guran in the province of Luristan (Meldgaard *et al.* 1964: 113- 118), the two caves of Hotu and Belt on the Northeast Caspian shore (Coon 1957: 78), and Tol-e Bakun in Fars (McCown 1942). When initially describing stylistic and cultural horizons of Ancient Iran, Dyson employed this term to distinguish what he presumed to be the locally-made, organic tempered wares, from decorated Mesopotamian examples that were envisaged as spreading from Northern Iraq through the central Zagros, and along the Western face of the mountain range towards the Iranian province of Khuzistan in a diffusionist model popular at the time of his writing (Dyson 1965: 217- 219). While the term "soft-ware horizon" is still employed in contemporary literature, the emphasis is not placed on these ceramics as distinct from those that may/may not have been introduced from Mesopotamia at this time (*eg*. Petrie 2011) (indeed, our more detailed understanding of the relative dating sequences is much improved and now places soft ware traditions in a period where there seems to be no established ceramic trade networks with Mesopotamia), but is used simply to describe a supposed technical aspect of production which such a name implies: heavily organic tempered and seemingly low-fired ceramic.

The most in-depth description and classification of Mushki ware is from the type site of Tol-e Mushki itself (Fukai *et al.*, 1973). These ceramics are described as coil made, although this is not evident from the surface of the vessels but from joins near the base. It is unfortunate that the one sherd from the excavation which apparently showed clear coil joins in the fracture, has not been illustrated in the report (Fukai *et al.* 1973: 22). It may

also be possible that a sequential slab construction technique was used as a study of other Neolithic soft wares across the Middle East has shown this to be a pervasive technique in this region (Vandiver 1987: 20), although no samples from the sites in this study were analysed.

These ceramics have been grouped in different ways according to shape and decoration (Fukai *et al.* 1973: 23- 29). All are either coarse or fine grained chaff-tempered wares. The firing temperatures have been suggested to be low (Fuakai *et al.* 1973: 25), and it certainly appears so with the coarse wares, although further scientific inspection of both wares would be needed to ascertain a more complete understanding of the past firing atmosphere. Buff coarse wares have been described as retaining a black core (Fukai *et al.* 1973: 25), suggestive of either an incomplete firing that did not fully burn the organic material at the centre of the vessel, or an initial reducing firing atmosphere followed by an oxidising one that has not fully oxidised these specific sherds.

The majority of coarse grained wares were made in a bowl form with either a straight (see Figure 2.1.- 2.2.), or outwardly flaring rim described as having been wet-smoothed with a palm (Fukai *et al.* 1973: 23).

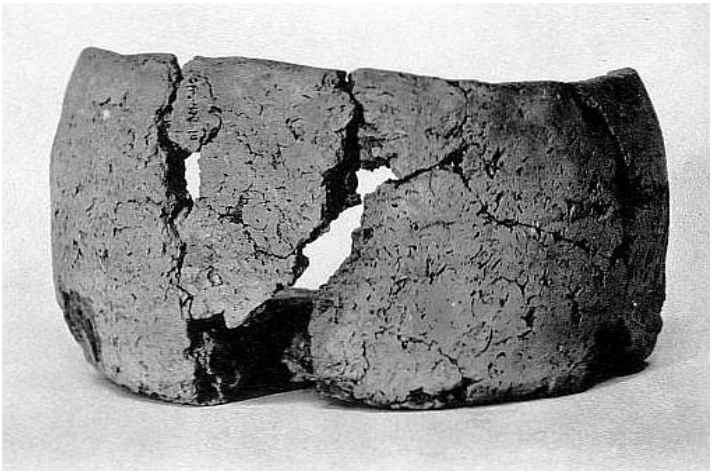


Figure 2.1. Buff coarse ware bowl from Tol-e Mushki (Fukai *et al.* 1973: pl. XVIII).



Figure 2.2. Coarse ware bowl from Tol-e Mushki (Fukai *et al.* 1973: plate XVIII).

Two different coloured pigments were applied separately to burnished fine grained wares, which are decorated with either a red slip ranging from a red brown through to pink and brown (see Figure 2.3.), and/or a buff slip (Fukai *et al.* 1973: 24). Red slipped vessels are usually burnished, while in the buff slipped repertoire this is very rare. A rare example of decoration is a fine ware with buff slipped exterior and a red slipped interior, where again, the red slip is burnished (Fukai *et al.* 1973: 24).



Figure 2.3. Red slipped bowl from Tol-e Mushki with "honeycomb and terminal dot" decoration. This is the only colour image of the ceramics to have been published with the report (Fukai *et al.* 1973).

Red slipped wares decrease and Buff slipped wares increase in quantity through the levels identified at the site, although any chronological development of motifs or forms does not seem to have been evident (Fukai *et al.* 1973: 32). A detailed typology of shapes of all buff and red slipped sherds, as well as coarse ware sherds, was constructed by the excavators of Tol-e Mushki, which is described below. However, some general comments can also be applied to the assemblage regarding form: open bowl and jar forms predominate in ceramics from the site, with exterior decoration from the shoulder to the rim, carinated and double carinated forms are common (see Figures 2.4. and 2.5.) (Fukai *et al.* 1973: 23, 32).

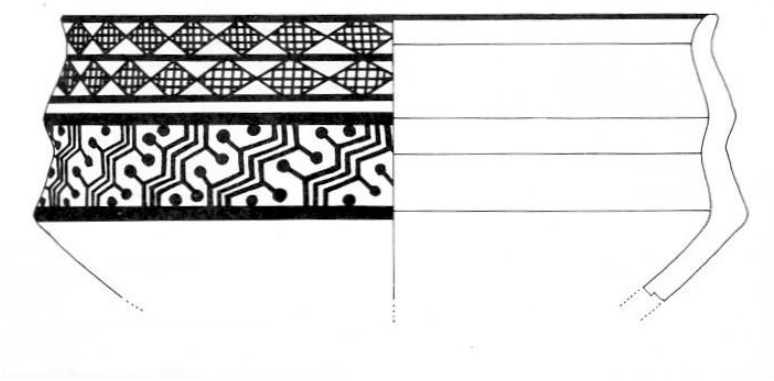


Figure 2.4. Double carinated form decorated with p14 and p44 (Fukai *et al.* 1973: pl. XLVII, 11).

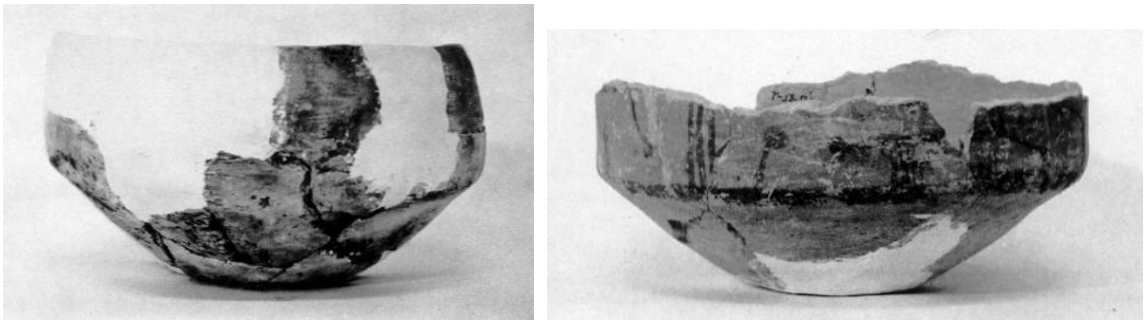


Figure 2.5. Two Mushki vessels displaying characteristic decoration from rim to shoulder and common open forms (Fukai *et al.* 1973: plate XVII).

Typology	Vessel shape description
A	the width of the shoulder as wide as the rim when in profile, with an additional everted rim (Fukai *et al.* 1973: Pl. XLVVII 1,8,10).
A'	as with A, but with a straight rim (Fukai *et al.* 1973: Pl. XLVIII 5)
B	the width of the shoulder is wider than the rim which is everted (Fukai *et al.* 1973: Pl. XLVII 9, XLVIII 2, 11)
B'	the width of the shoulder is greater than the width of the body with a straight rim (Fukai *et al.* 1973: Pl. XLVII 2, 7, XLVIII 8
B1	as with B, but with a wavy shoulder and double-stepped outward flare (Fukai *et al*. 1973: Pl. XLVII 11, XLVIII 10).

Table 2.1. Mushki typology of shape (Fukai *et al.* 1973: 23).

An additional typology has also been developed based on the decorative motifs, where designs have been reduced to 47 whole "elements" identified from sherds and reconstructed whole vessels (Fukai *et al.* 1973: 25).

Within the 47 identified motifs, six categories have been defined- H, S, C, Y, N, P, (Fukai *et al.* 1973: 26). The classification of motifs can be divided into two, representing those designs on red slipped wares (P1- P29), and those on buff slipped (P30- P47) although there are limited occurrences of designs appearing on both types of slip (Fukai *et al.* 1973: 25, plate L). The P1- P29 group contains designs with a common theme- horizontal lines terminating in dots in various combinations and/or with slight alterations to the theme, while group P30- P47 contains designs based around triangular and diamond patterns with linear crosshatching and infill (see Figure 2.6. for examples from both groups).

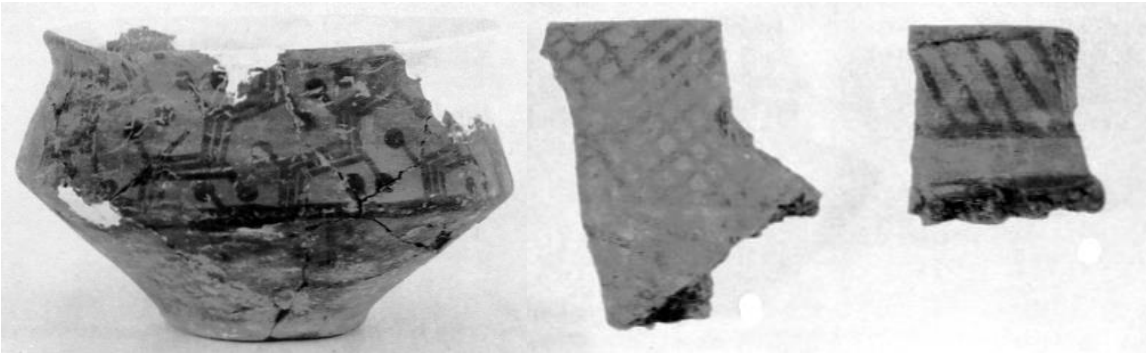


Figure 2.6. Mushki vessel (left), with p-18 decoration and Mushki sherds (right), with p-31 crosshatching and p-20 hatched line infill (Fukai *et al.* 1973: plate XXIII).

Red slipped designs (P1- P29) have been further grouped into six categories due to the difference in the main construction of the motif (Fukai *et al.* 1973: 26), while the decoration of buff-slipped ware (P30- P47) has also been divided into singular pattern elements, although these have a tendency to occur alongside other pattern elements from the buff slipped repertoire. Examples of red slipped wares however, only tend to include one pattern from the group P1- P29 on each vessel at a time (Figure 2.7. for P13 on red slipped wares), illustrating a further difference in the chaine opératoire of these two wares (Fukai *et al.* 1973: 29). One exception to this is P31, the "palisade pattern", which is one of the few motifs that occurs on both red and buff slipped vessels (Fukai *et al.* 1973: 29), although only two examples of this have been noted and illustrated in the report, both of which are bowl fragments (Fukai e*t al.* 1973: plates XIX 6, XXI 3,9).

Mushki ceramics have also been recorded from 8 surveyed sites in the Kur River Basin in and around the sites of Tol-e Muski and Jari (Sumner 1990: table 2), a valley system to the north of Fasa (Stein 1936: 95- 100), Tall-i Morge near the Kazerun valley in Western Fars (Sumner 1977: 300) and excavated at the type- site of Rahmatabad (Azizi 2013), and Tol-e Nurabad in Mamasani (Weeks *et al.* 2006: 3) (see figure 1.1 and 1.2 for locations on maps).

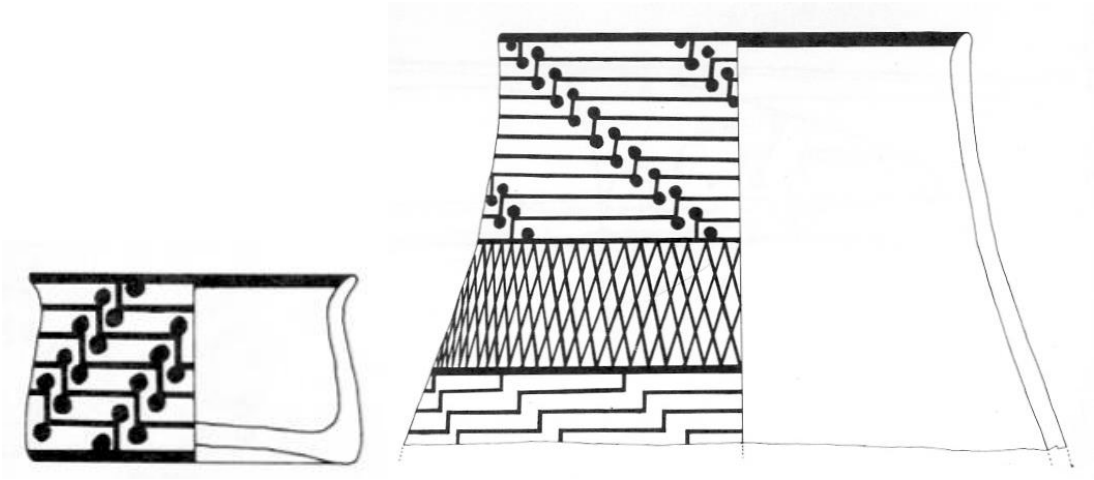


Figure 2.7. Two Mushki vessels decorated with P13, vessels are also red-slipped (Fukai *et al.* 1973: plates XLVII- XLVIII).

Tol-e Nurabad's phase A27 represents the first occupation of the site and includes typologically similar ceramics to the Mushki phase (Figures 2.8. and 2.9.), including well fired, chaff tempered, slipped and burnished bowls, with dark brown/ black paint and typical Mushki decoration (which equates to a diagonal line with a terminal dot- S1- of Fukai's typology) (Weeks *et al* 2006: 41). Mushki type ceramics remain at the site in a residual capacity through to Phase A25, indicating to the excavators there was significant occupation of that period (Weeks *et al.* 2006: 73).



Figure 2.8. Sherd TNP 1764 from Tol-e Nurabad with Mushki decoration (Potts *et al.* 2009: plate 6).

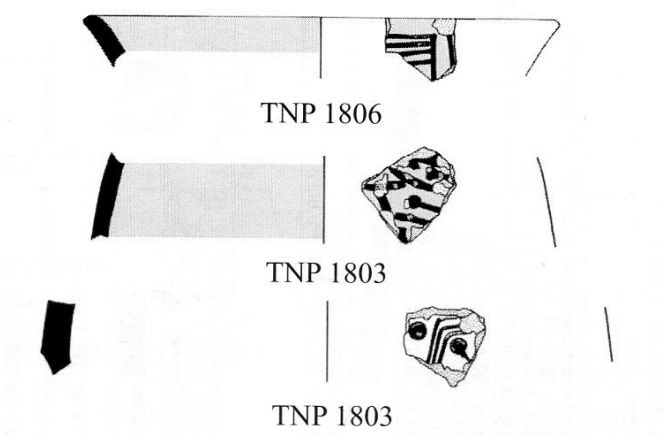


Figure 2.9. Illustrations of Mushki period sherds from Tol-e Nurabad (Potts *et al.* 2009: figure 3.65).

A potentially contemporary site with ceramics of this period is Qasr-e Ahmad. Although radiocarbon dates are currently being established with charred botanical material from sealed deposits (Hossein Azizi, pers.comm.), the stratigraphy covers the aceramic into the ceramic period. As at Rahmatabad, these deposits were laid down before those at Tol-e Mushki, and while the latter two sites closely share ceramic parallels, Qasr-e Ahmad stands apart in its decorative traditions. While other examples of Mushki ware include both red and black pigments on either red and buff slips, the ceramics from Qasr-e Ahmad are only ever painted with red pigments on either red or buff slips. Further, the most widely recognised series of motifs, commonly described as "typical" Mushki period decoration, are not recorded from Qasr-e Ahmad. Nor are any similar dotted linear designs recorded, as approaches to ceramic decoration at this site incorporate only linear and hatching designs. Such designs also feature within the Mushki repertoire but occur at other sites alongside other motifs and combinations of designs that are part of a larger decorative aesthetic characteristic of the ware.

Undecorated buff slipped and burnished vessels also occur and the indications of forms tend to be like other Late Neolithic forms, mainly open bowls with everted rims, although

no carinated bowls have yet been recorded from Rahmatabad, a feature very typical of Mushki ware at Tol-e Mushki.

Carinated Mushki ware has been recorded however in a survey of the Southwest edge of the Kur River Basin, at the site of Kushk-e Hezar (Alden *et al.* 2004). Kushk-e Hezar's "buff ware" has been described in a similar manner to the buff slipped ceramics from Tol-e Mushki, as both have carinated forms, are heavily organic tempered and decorated with black geometric designs (Alden *et al.* 2004: 31- 32). However, the decorative motifs used are similar to those that appear on Bashi and Jari ware (described below), and Tal-e Kutahi near Shiraz (Alden *et al* 2004: 38; Sumner 1972: plate III, F). The firing process may also differ to that at Tol-e Mushki as Alden and colleagues (2004: 31) note that the firing of all sherds was uniform with fully oxidised cores whether they were "highly or poorly fired". The Buff ware category makes up the majority of the collection from Kushk-e Hezar, with only a small collection of "slipped, burnished red painted wares" (Alden *et al.* 2004: 31). There were also a few examples of red slipped unpainted and white slipped, black geometric painted wares (Alden *et al.* 2004: 36). Decorative designs labelled "swoosh" by the team and found on small, incurving beakers (Alden *et al.* 2004: 36), may have parallels at Chogha Bonut and the rock shelter A4-1 in Arsanjan, Southeast of the Persepolis plain (Alizadeh 2006: 7). Stepped horizontal lines are another common design at Kushk-e Hezar (Alden *et al.* 2004: 36) which are similar to parts of designs from the later Jari B typology (Maeda 1986: fig. 4:8, 6:3,4 and 7:6), suggesting this site may fall in a Mushki/ Jari interface in a similar position to the site of Tol-e Bashi.

The preference for buff slipped ceramics at Kushk-e Hezar may be a result of the sampling strategy employed at Kushk-e Hezar, especially as the areas subject to concentrated collection were all located on one half of the mound (see Figure 1.13) but with detailed stratigraphic excavation, a more detailed understanding of the wares at this site, their quantity, and any patterns in relation to the excavation of Tol-e Mushki would be realised. This would also allow for any necessary refinement in the Mushki typology.

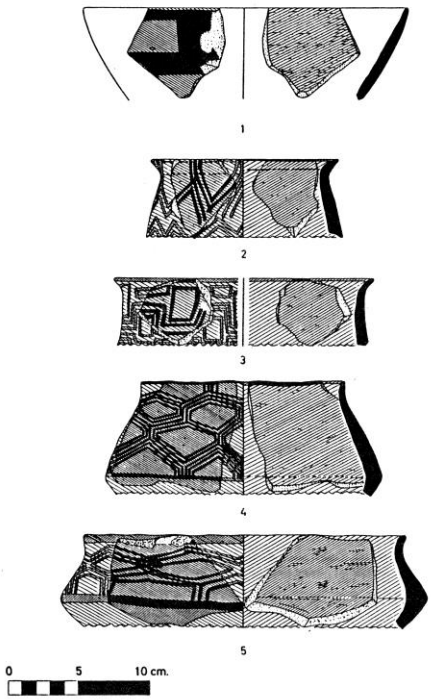


Figure 2.10. Jalyan ceramics from Fasa and Darab valleys with parallels to Mushki and Jari period decoration (Dittman 1986: figure 10).

A ceramic tradition with noted similarities to the more uncommon vessels recorded from Tol-e Mushki is that of Jalyan (Figure 2.10.), which occurs in the valleys of Fasa and Darab in Southern Fars but is currently only known from survey data (de Miroschedji 1972: 2, figure 2; Sumner 1977: 299). This ware also has a step-design and zig-zag patterns executed in black on a burnished red slip, but the implications of what these similarities mean between the two areas of Fars is uncertain until more data is acquired for Jalyan ware and scientific analysis is conducted on the sherds to further understand the relationship between the two.

Contemporary ceramics for the Mushki period have been reported from a survey in the Kazeroun valley, and are grouped alongside Jari ware (see below for full description), as a

Neolithic tradition (Rezaei *et al.*, in press). Despite Sumner's description of highly decorated Late Neolithic wares from the area (Sumner, 1977: 299- 300), this most recent survey has no painted Neolithic examples, only red slipped or plain buff open form bowls. These have also been heavily tempered with organic material and much thicker than other examples of Late Neolithic wares from Fars.

2.3 *Bashi*

The Bashi phase of the Late Neolithic has strong parallels with an area of the excavations from Tol-e Mushki, namely a pit that was excavated outside of the main trenches (labelled TMB), which seems to show a later stage of occupation than other trenches at Tol-e Mushki (Fukai *et al.* 1973: 33- 34).



Figure 2.11. Sherd decorated with the Bashi motif from Tol-e Bashi (Bernbeck 2010: figure 74).

Since the 2006 excavations at Tol-e Bashi, this "later" Mushki phase has become much better understood and has been described by the excavators as a chronological phase in itself (Pollock 2010: 264; Weeks *et al.* 2006: 13), due to the ceramic parallels between the TMB pit at Mushki and the Bashi phase at Tol-e Bashi (Bernbeck 2010: 93). Similarities can be seen between the shared TMB, Bashi (Figures 2.11 and 2.12.), ladder and lozenge motifs (the lozenge motif is not included in Fukai *et al.*'s typology, but illustrated in the plates of

TMB pit material in their report 1973: pl. XXIII, XXIV), and possibly also the hatching motif [1] (Bernbeck 2010: 93).

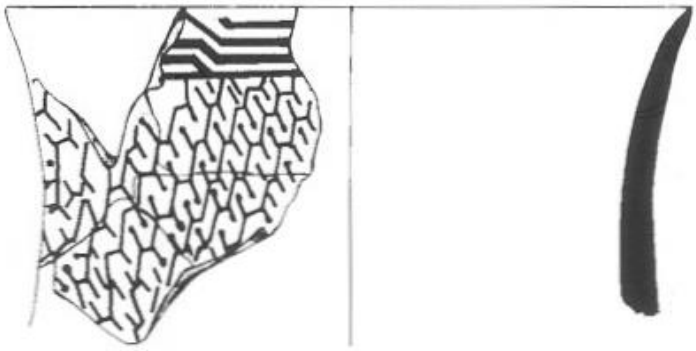


Figure 2.12. Illustration of a partially re-constructed vessel from Tol-e Bashi, decorated with the Bashi motif (Bernbeck 2010: figure 5. 52).

The more southern sites of Tol-e Jari A and B in the Marv Dasht also have Bashi phase ceramics recorded from level 7 of the excavations[2] at Jari A, and levels 8-7 at Jari B (Egami *et al.* 1977: 2-3; Egami 1967: 2936; Nishiaki 2010: 120- 121, fig. 10). The ceramics with the Bashi motif occur in level 7 of Tol-e Jari A (see Figure 2.13.), alongside "typical" Jari period ceramics, but seem to represent an earlier, yet uninterrupted, occupation of the site as these ceramics occur before typical Jari designs at other sites such as Tol-e Bashi and Tol-e Nurabad (Bernbeck 2010: 94; Weeks *et al.* 2009: 41- 43).

[1] The hatching motif occurs in baked-in wall fill of Level V, therefore possibly predating this level, but which it has been assigned to. If this motif does indeed belong to an earlier fill, this may suggest that the 3 levels of the TMB pit have wide ranging dates, with the TMB and lozenge motifs earlier than the Bashi and hatching motifs (Bernbeck 2010: 93).

[2] Previously termed level III by the excavators (Egami *et al.* 1977: 2-3), after condensing their original seven layers into three. However, recent reconsideration of the material has confirmed to others the validity of the original use of seven layers and is also used by the excavators of Tol-e Bashi (Bernbeck 2010: 94; Nishiaki 2003; Nishiaki and Mashkour 2006: 79).



Figure 2.13. Jari A, level 7 sherd decorated with the Bashi motif (Egami *et al.* 1977: plate V).

Within the Bashi phase, manufacturing practices still seem to be similar to those in the Mushki period. Bernbeck describes coarse coil made open forms that have been wet smoothed, as well as decorated red and buff slipped vessels, and concave and flat bases amongst the assemblage (Bernbeck 2010: 69, 78). The range of shapes among both collections can be described as similar- open forms of globular jars, carinated bowls (Figure 2.14.), with straight or everted rims (Bernbeck's "bag shaped" pots (2010: 77)), and wide-straight rim bowls ("vats" as in Figure 2.15.) (Bernbeck 2010: 74).

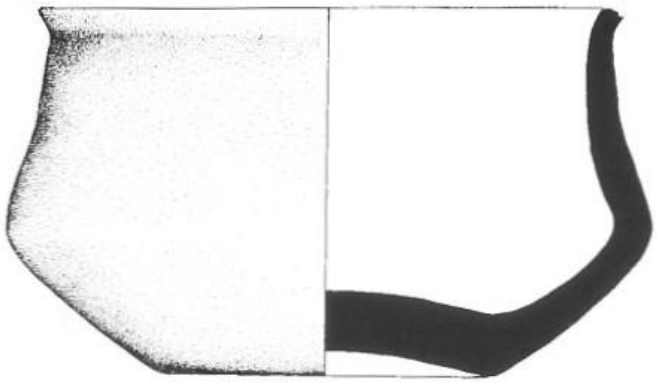


Figure 2.14. Bowl from Tol-e Bashi, described as "bag shaped" (Bernbeck 2010: 147, no. 5.43)

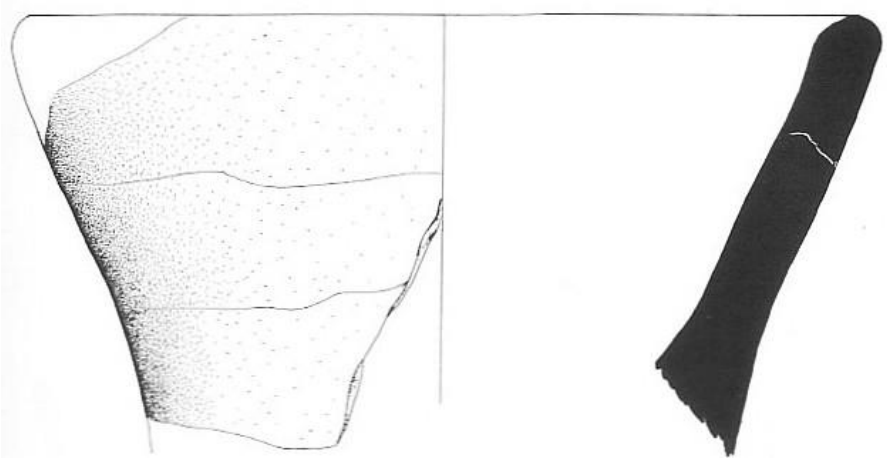


Figure 2.15. Open bowl from Tol-e Bashi, labelled under the class of "vats" (Bernbeck 2010: 145, no. 5.9)

However, there are some clear differences that emerge in the Bashi period at Tol-e Bashi. Double carinated bowls are no longer seen in the Bashi phase and the construction techniques begin to differ. Bernbeck describes slab built wide-straight rim bowls, hole-mouth jars, and everted bowls deposited in the site alongside coil built coarse, organic tempered vessels (Bernbeck 2010: 69, 78). Examination and comparison of these wares with what are described as "coil made" organic tempered coarse wares from Mushki, would provide an interesting insight into regional variation of ceramic production that produced essentially similar looking wares.



Figure 2.16. Surface of a Vegetal tempered sherd with visible white grains in the top right hand corner (Bernbeck 2010: figure 5.6).

In addition, Bernbeck has separated a class in his typology for Vegetal mineral tempered wares (Bernbeck 2010: 71), which are apparently distinct from the more commonly recorded organic tempered wares at Bashi and at sites across Fars in the Late Neolithic. Vegetal mineral tempered wares have been described as containing sparsely occurring, sometimes large white minerals, "most likely limestone", and a "gray-reddish finer material" (Figure 2.16.), combined in the clay paste as temper (Bernbeck 2010: 71). Bernbeck suggests the presence of mineral temper in some ceramics from Bashi is due to a different location of the clay source, or different levigation/ cleaning practices undertaken on the clay for this ware (2010: 71). Yet the forms, pigment colour and decorative schemes are identical to the Vegetal tempered class, so to fully understand the distinction between these classes and identify what has been added, including the potential reasoning behind this, further analytical work would need to be undertaken to identify the temper and establish the validity of this classification.

Bernbeck also distinguishes a "straw tempered" class at Tol-e Bashi which combines coarse clay with very coarse organic temper to form coil built trays with thick walls

(Bernbeck 2010: 69). The voids of the burnt out organic inclusions are aligned parallel to the surface of the vessel and sherds often break off to form wedge or "U- shaped" breaks along the coil joins which have been clearly illustrated in his report (Figure 2.17.), indicative of this process of manufacture (Bernbeck 2010: 69).



Figure 2.17. Break of an organic tempered sherd showing impression from coil building (Bernbeck 2010: figure 5.5).

Among the organic tempered slab built forms, numerous decorative traditions were noted, such as black or red painted decoration on buff slips, bichrome black and red pigments on a buff slip, black or red pigments on a red slip and finally, black pigment on a white slip (Bernbeck 2010: 70). Decorative motifs on ceramics across the Bashi phase were numerous, as 181 individual motif elements were identified at the type-site Tol-e Bashi, amongst which three main types of this period emerged- the "Bashi", "Ladder" and "Hook" motifs (Bernbeck 2010: 80).

The Bashi, Hook and Ladder motifs occur at Jari B where they have formed a part of another distinct typology based on the wares from this site (see Figures 1.13. and 1.14.) (Maeda 1986: fig. 7). Maeda's typology is based on decorative motifs alone, with general subsequent groupings suggested for the technological differences that occur through time

within the ceramics from Jari B (Maeda 1986; Nishiaki 2010: 120- 123). Although some of these ceramic types fall into later chronological phases, some evidently coincide with the Bashi period, although exact dating of each layer of Jari B and comparison with other layers at sites is still problematic due to the lack of published material from this excavation (Nishiaki 2010: 124).

Certain motifs described by Bernbeck from his excavation at Tol-e Bashi have parallels within the Jari B material and have been labelled D-a (Bashi), D-d (Ladder) and D-i (Hook) (see Figure 2.18. for the Ladder and Hook motifs) (Nishiaki 2010: fig. 10). Additionally, Layer III of Jari A also seems to coincide with the Bashi phase (levels IV- VI) due to similar ceramic decorations, as does the TMB pit of Tol-e Mushki (Weeks *et al.* 2006: figure 12).

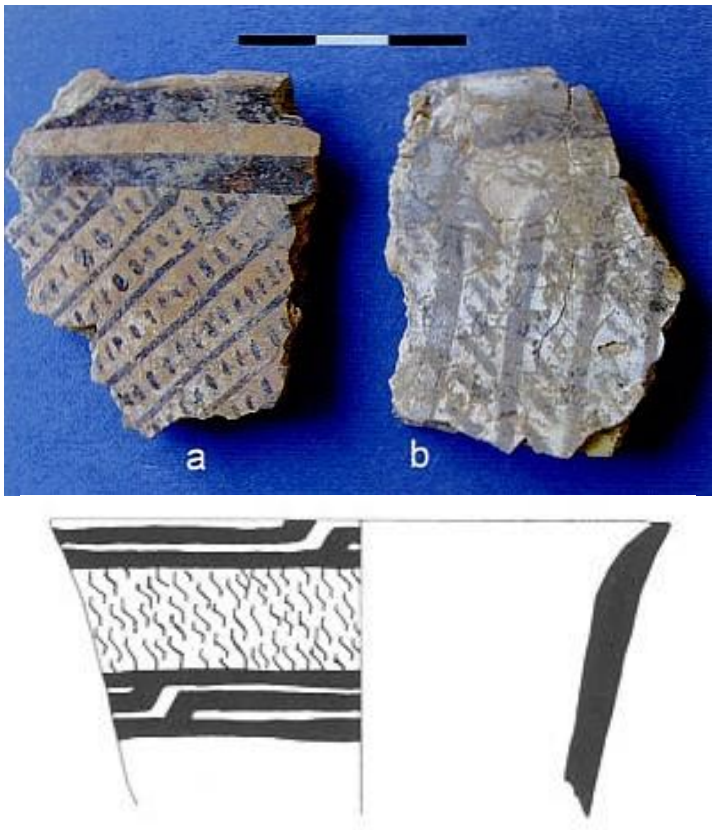


Figure 2.18. Tol-e Bashi ceramics with the ladder motif on a buff slip (upper left) and a white wash (upper right), and the hook motif (bottom) (Bernbeck 2010: figs. 5.61, 5.114).

The manufacturing process and fabric composition have not been as well described for Bashi ware at Jari B as it has for contemporary sherds from Tol-e Bashi, however some points have been noted. Common features of Bashi wares at Jari B tend to be a lack of slip and burnishing (Nishiaki 2010: 123), rendering them very different to Bernbeck's description of contemporary Bashi wares which he describes as covered with a white wash (although this may be a light slip), over a thin layer of buff clay with a organic tempered core (Figure 2.19.) (2010: 71, 142).



Figure 2.19. Sherd from Tol-e Bashi showing clearly the outer layer of fine organic tempered clay coming away from the coarser tempered core (Bernbeck 2010: figure 5.7).

Therefore, within the decorative traditions that were shared between sites at this period, there seem to be technologically different potting practices across the ceramics deposited at each site.

During phase A26 at Tol-e Nurabad, Bashi ware is first introduced, with larger amounts of Jari ware excavated in A25 (Weeks *et al.* 2009: 42). These were decorated with the Hook and Ladder motifs on slipped vessels with strong parallels at Jari A level III and upper levels at Tol-e Bashi and rarely at Jari B (Weeks *et al.* 2009: 73, figure 3.67). Changes in the form of vessels are also evident throughout this period at Nurabad as the common carinated forms of the Mushki period are replaced with more straight sided bowls and jars

in the Bashi period and on into the following Jari phase (Weeks *et al.* 2009: 74). Sinuous sided decorated bowls and closed or necked forms also become more common in these later layers at the site (Weeks *et al.* 2009: 45).

2.4 *Jari*

The core typology for Jari ceramics is that based on material from Tol-e Jari B (Maeda 1986). This has recently been re-studied in light of new insights into the stratigraphy of the site[3] so that the ceramic typology has been overlaid onto the known sherd counts for each stratigraphic layer (Nishiaki 2010: figures 9-11), providing useful information regarding the development of decorative styles over time at Jari B (Figures 2.20 and 2.21.).

As well as a typology based on decorative patterns, an additional grouping of Jari ware has been constructed considering the shape as well as the decoration of vessels through the layers at the site (Nishiaki 2010: 123). Nishiaki's Group 2 represents the typical Middle Jari ware recorded from the site (with Group 1 designated as the previous Bashi phase), in that the slip colour usually varies from a pink- buff to yellow, with no surface burnishing. Ceramic forms from this group tend to be deep bowls or jars. Group 3 includes vessels with a finer slip in white- pink/ grey, formed into more shallow bowls and carinated bowls. Group 4 is characterised by vessels with a thinner wall and finely smoothed and slipped shallow bowls or plates, sometimes carinated (Nishiaki 2010: 123). These groups can be overlaid onto the motif typology so that Bashi designs, such as D-a are seen in Group 1, middle- late Jari designs are split between D-b and D-I (Nishiaki 2010: 123).

[3] The death of the site director and the subsequent loss of the majority of the excavation records and field notebooks have caused the final publication of the material from this site to be limited, with an exact understanding of the stratigraphy unavailable until very recently (Nishiaki 2010: 114).

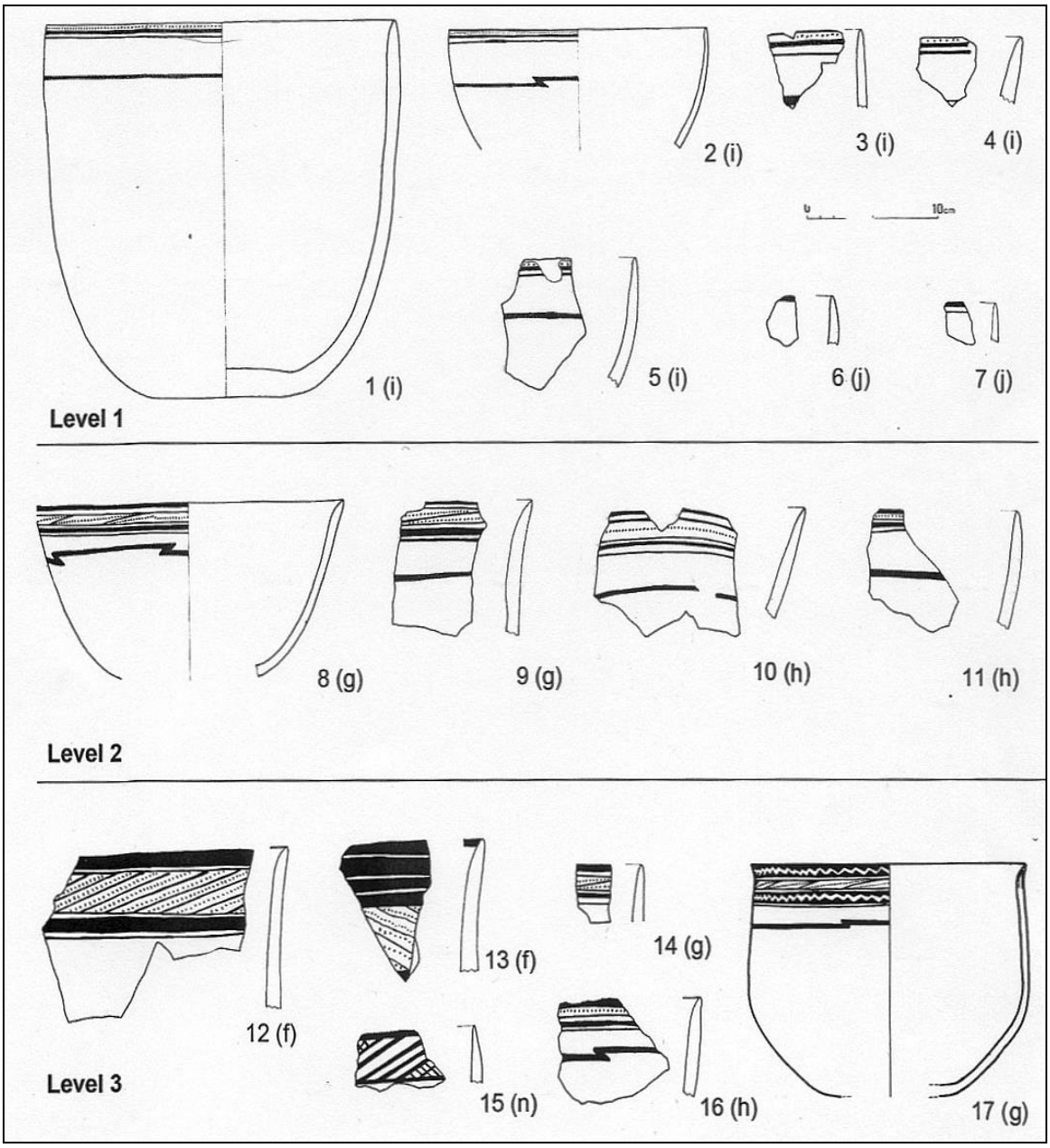


Figure 2.20. Reconstructed Jari B typology including stratigraphy of site (Nishiaki 2010: fig. 11). The letters in brackets refer to Maeda's initial grouping, and which have been referred to in my own text.

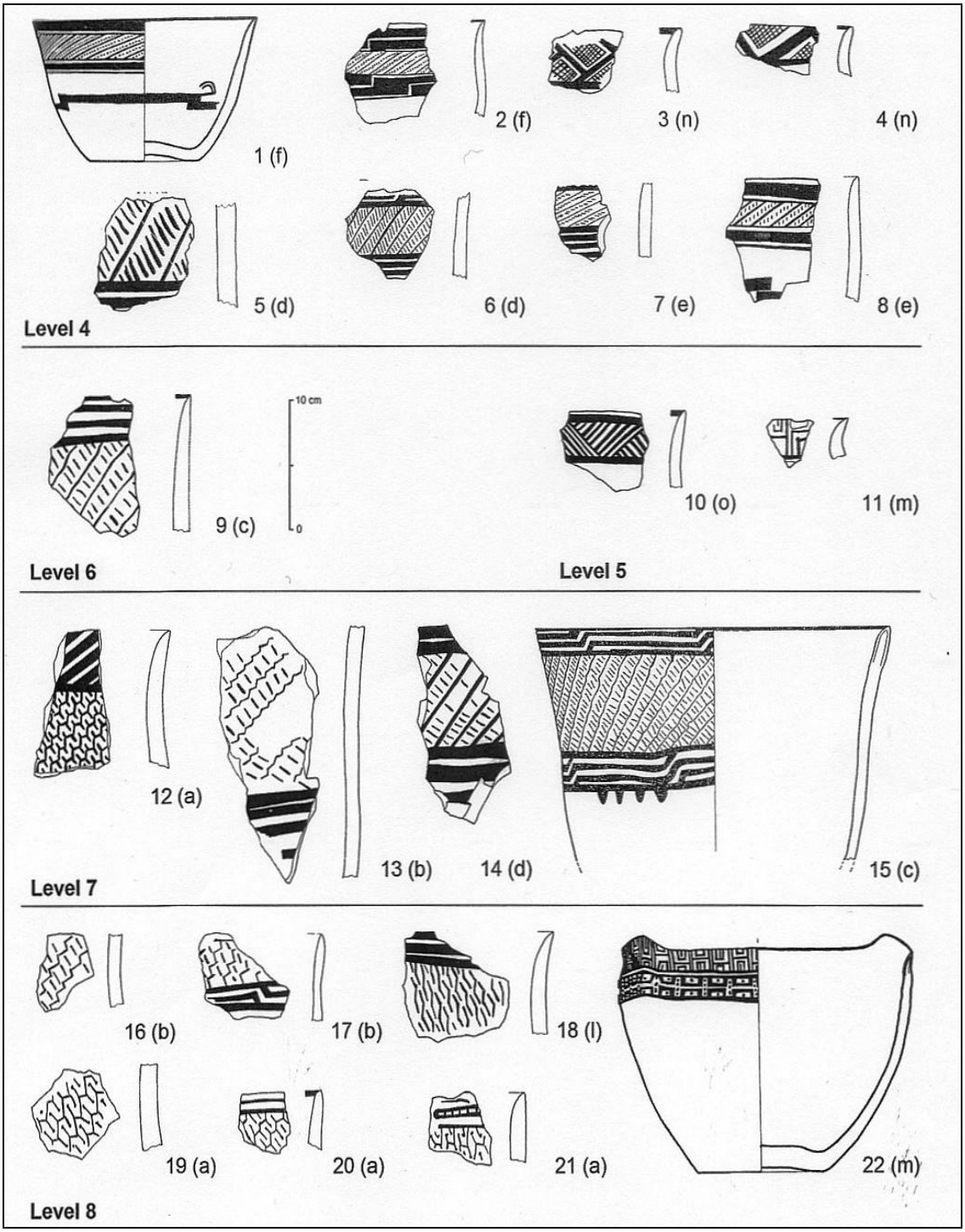


Figure 2.21. Continuation of Nishiaki and Maeda's typology of Jari B ceramics (Nishiaki 2010: fig. 10).

While Nishiaki's grouping of the wares is useful in summarising the ceramics from this site and conveying succinctly the similarities between certain wares, his grouping leaves three additional categories unaccounted for which do not fit into his evolutionary scheme of design which has driven the construction of the latter typology. Types D-l, D-m, and D-n occur in the Bashi and Jari phases, and have been described as either a type that becomes extinct, and that does not progress or evolve into another design (D-l), or simply as a foreign element within the repertoire at the site (D-m, and D-n) (Maeda 1986: 55; Nishiaki 2010: 120). The wares that have not been incorporated or illustrated in this typology are reproduced below, unfortunately they remain unstratified, but have strong parallels with Neolithic ceramics from the North Iranian province Zanjan (Valipour *et al.* 2013) (Figure 2.22.). In addition, the exact nature of the transition between middle and late Jari designs is undefined and the reader is left unaware of where it may fall within the typology. Therefore, problematic elements exist in current typologies which could be addressed with a detailed study incorporating Jari period ceramics from more recently excavated sites. Scientific analysis of the vessels and a reconstruction of the raw materials and the production stages would cross-cut schematic divisions based on decorative motifs alone to provide patterns of similarities/differences based on a greater number of factors of ceramic design and manufacture, highlighting in more detail the specific nature of Jari period ceramic industries and geographical trends.

The Jari period at Tol-e Nurabad is represented with minimal ceramic parallels with other sites and only shares the Chain/ Hook motif of Jari ware (Weeks *et al.* 2006: 13). Nurabad Jari sherds also lack the common Jari white slip that other vessels of this period have in the Kur River Basin (Weeks *et al.* 2006: note 9).



Figure 2.22. Three examples of unstratified and unclassified vessels from Jari B (Nishiaki 2003: plates 26, 28 and 30).

However, the presence of a white slip has also been suggested to be a feature of Late Jari ware which may mean the Nurabad deposits are equivalent to an Early Jari period. Further clarification of Nishiaki's grouping and a larger dataset may help clarify some of these issues. The small number of Jari ware sherds at Nurabad, and their use of only one motif from the Jari repertoire has been suggested to indicate a location of the manufacture of Jari ware outside of the Mamasani region, possibly in the Kur River Basin, and the select movement of this specific category of vessel to Tol-e Nurabad (Weeks *et al.* 2006: 13).

It has been noted there are significant parallels amongst organic tempered coarse wares at Tol-e Nurabad, Tol-e Bakun B level 1 and Jari A level 2. These are unpainted, slipped and burnished vessels which occur as a component of most assemblages from Fars and are referred to as Shamsabad ware (Weeks et al. 2009: 43).

This period at the site generally, is one of new and expanding traditions of decoration, with very few parallels to known sites. These new designs are the mainly bichrome panels of stepped lines interspersed with filled blocks, outlined with bands in red/brown, and monochrome panels filled with stepped lines and meandering painted red bands with a dark brown border (Weeks *et al* 2006: 43- 45). Hatched standing and hanging triangles with black painted meandering diagonal lines and cross hatched columns were also recorded (Figure 2.23.) (Weeks et al. 2009: 43).

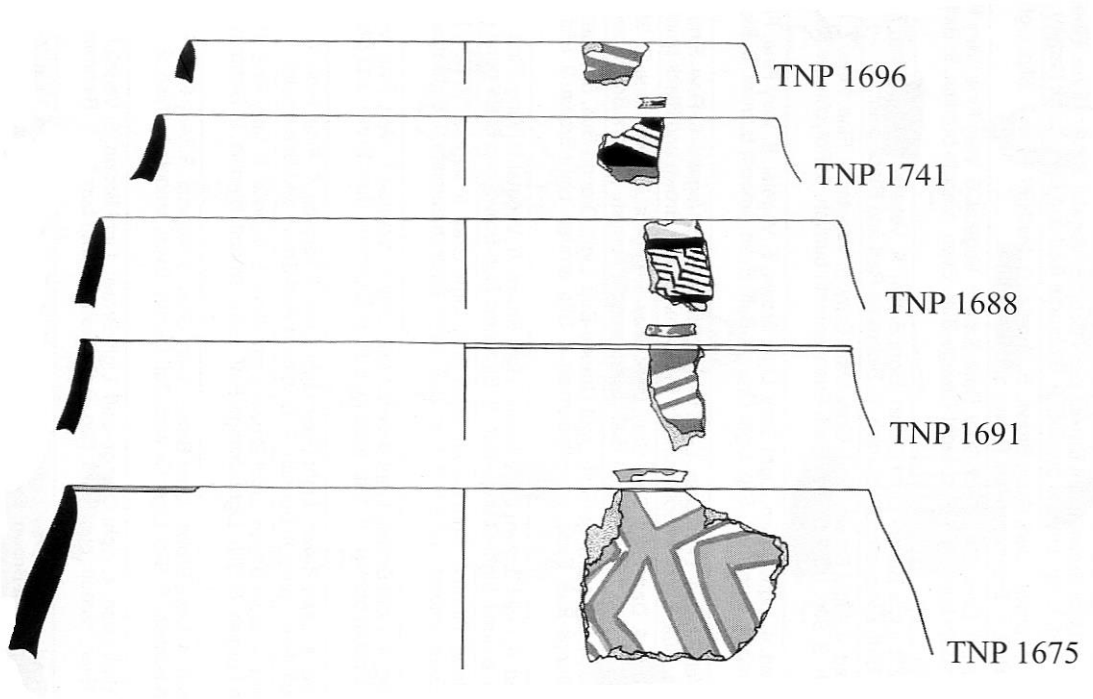


Figure 2.23. Examples of local decorative traditions from Tol-e Nurabad during the Jari phase.

Aside from new decorative designs, the forms of some vessels are also new to the Late Neolithic repertoire in this area. Nurabad's phase A24b yielded new closed forms (jars with inverted or slightly out flaring rims), in addition to the predominant open bowls at the site (Weeks et al. 2009: 43).

2.5 *Conclusion*

From the above description it will be evident that current knowledge of the Neolithic ceramics from Fars is limited to typological descriptions based on decorative motifs, forms and stylistic parallels. While this has served to establish chronological positioning of the excavated and surveyed sites in Fars, for a more detailed understanding of this productive technology, past communities and their socio-cultural framework, more analytical work must be undertaken on these assemblages. It is therefore necessary to assess these ceramics in a manner that cross-cuts the current divisions of typologies which are mainly based on decoration alone, and investigate such areas as clay selection and processing, the forming techniques, the choice of raw materials for decoration, and the firing processes. This will provide new insights into the ceramic groupings that are currently used to define different chronological phases and contribute to a more detailed understanding of the potting traditions for each of the sites included in this study. This will allow for a refined understanding of the different socio-cultural actions of these communities across space and time.

The following chapter is a review of archaeological and theoretical approaches to the concept of style. This sets out the background to some of my research questions and will be followed by a review of previous research into Neolithic ceramics in Fars and wider Iran, the Middle East and Central Asia.

3. The identification of style: its reconstruction and analysis

3.1 *Introduction*

This chapter is a review of the definition of style, the history of how it is identified amid archaeological material culture, analysed and interpreted.

3.2 *A history of identification and interpretation*

"Style" is a thorny issue to pinpoint and describe, in any discipline as much as in Archaeology (Rice 1987: 245). Numerous publications have been devoted to its discussion, identification and relevance in theoretical debate (*e.g*. Conkey and Hastorf 1989), and it has long been grappled with as a concept that directly impinges on the categorisation and interpretation of material culture within the discipline. Nineteenth century culture historical explanations revolved around the recognition of certain styles of artefacts to define the geographical extent of ethnically-derived "cultures". The notion of "culture" as a conceptual tool is still commonly used to envisage collections of past communities (Kozlowski and Aurench 2005), and is used for ease of clarity to describe such notions in this thesis). With the growing awareness during the twentieth century of geographical variability in the archaeological record, interpretation focused on the more detailed classification and comparison of archaeological finds which eventually built up into relative cultural chronologies, feeding into evolutionary arguments of the development of cultures (Childe 1942; Daniel 1968). This approach was heavily embedded in contemporary European nationalism, where most European nation states came to be viewed as political expressions of an ethnic identity that was grounded in linguistic, cultural and racial unity, as well as in a shared history (Trigger, 2006: 212). Artefacts and specific technologies were believed to have spread across the globe after being invented in primary civilisations, diffused with the movement of entire populations through warfare, colonisation or the movement of traders and merchants, eventually leading to stagnation in secondary civilisations as they were cut off from the primary centre of invention or re-colonised by a successive culture (Childe, 1942, Smith, 1915,

Leeds, 1913). The categorisation of artefacts based on similarities of style, which in this sense was their visual appearance, heavily influenced and guided the divisions of chronological time and geographical space (based on the Montelian system of artefact classification developed in the 1880s), which is of course still a central tenet of archaeological practice, despite the use of radiocarbon dating (Rice, 1981:245). This system was devised after the comparison of hundreds of artefacts and their division based on style and association with other classes of artefacts which were recorded from closed contexts, such as rooms and graves, by the Swede Gustav Montelius (Trigger, 2006: 223- 225).

The later use of culture historical arguments to advance theories of nationalistic and racist land or state ownership were largely due to the work of Gustaf Kossina (Veit, 1989: 38). Otherwise known as his "settlement archaeology" theory, he stated that clearly defined, sharply distinctive, bounded archaeological provinces correspond unquestionably to the territories of particular peoples and tribes, an argument which was adopted by the German National Socialist popular prehistory, particularly after the Nazi seizure of power (Veit, 1989: 38).

From this early involvement in typological studies, the concept of "style" was not formally discussed in an analytical sense until the New Archaeology of the 1960s which aimed to explain the reasons behind material culture variation (Stark, 1998: 4). Understanding variation on the material record was seen as taking the discipline of archaeology away from its previously historical aims, and attempted to align with anthropology and the sciences in general (Pluciennik, 2011: 35- 36). For this to take place, archaeologists endeavoured to make the subject increasingly systematic, ambitious, and more "scientific", not least for American archaeologists to take advantage of funding from the National Science Foundation and European equivalents (Pluciennik, 2011: 36). This therefore involved the creation of a more demonstrable and robust theoretical basis with which to dissect cultural phenomenon (Shennan, 2001: 17). Previous culture historical theories not only had an unfortunate association with pre- war aims of nationalistic states, but which also lacked the ability of understanding the processes responsible for the identified change and diversification in material

culture. Ethnicity still had a strong role to play in the theorising that took place in the following decades (Shennan, 2001: 14- 17, Sackett, 1990), but in this new context both style and ethnicity became interlinked with the specifics of their technical production of artefacts in the past.

New Archaeologists split material culture analysis into three key areas of concern, derived mainly from the typological investigation of stone tools. These included technology (raw materials and production steps), function (associated with utilitarian or instrumental purposes) and style (being the residual and passive elements of the artefact). The key concept around which the various interpretations of style revolve is information exchange, first discussed by Wobst (Wobst, 1977). He argued that stylistic variation underlies the transmission of messages of one kind or another which facilitate social interaction (Wobst, 1977: 317- 318).

The nature and significance of this stylistic variation can be divided between different types of active or passive style represented in past material culture. Emblemic style is the formal variation in culture that has a distinct referent and transmits a clear message to a defined target audience about conscious affiliation or identity (Wiessner, 1982: 257). Assertive style on the other hand is more personally based and individual, with no distinct referent and does not directly symbolise individual identity as it can be employed consciously or unconsciously (Wiessner, 1982: 258). These two concepts have helped define an understanding of the variation within San projectile points that correlates well with linguistic group boundaries, but does not address the process of learning within different communities and the transmission of such technical knowledge, itself a process embedded within social processes. Ethnographic studies soon showed the blurred lines between these elements of material culture variation and importantly that style is not simply decoration, nor technical choices governed only by environmental pressures (Stark, 1998: 4- 5). These behaviours were recognised to be socially informed actions that reflect a shared understanding of how things are done. It is clear that the tripartite division of

which style forms a part is an artificial separation that severely limits the possibility of understanding social and technical domains of action.

While the debate within Anglo-American New Archaeology discussed the division of variation, a separate but related school of thought within French Anthropology was discussing variation from the point of view of processes and stages within technological techniques- or the chaîne opératoire (Lévi-Strauss, 1972, Stark, 1998: 5, Johnson, 2011: 471). Widely read and applied within Anglo-American archaeology are the works published in English by Leroi- Gourhan, Lévi- Strauss and Pierre Lemonnier, who drew on and were an intrinsic part of the post-war structuralist French tradition within anthropology (Kambouchner, 2013: 19- 20, Ellen, 1994: 652; Leroi-Gourhan 1965).

This school of thought centred on the concept of a link between anthropology and the structure of linguistics, which was explored to suggest that culture was structured in a similar way to language made up of individual phonemes and ordered by a specific grammar (Lévi-Strauss, 1972, Hawkes, 1989). It therefore seeks to explain social and cultural phenomena with models influenced by structural linguistics (Giddens 1979: 9). Lévi-Strauss perceived the constituents of cultural behaviour - ceremonies, rites, kinship relations, marriage laws, methods of cooking, totemic systems *etc.,* as discrete entities that have specific relationships to each other analogous to the phonemic structure of a language (Lévi-Strauss, 1972: 34). In this sense, the individual elements can only acquire meaning if they are integrated within a system, *i.e.* culture (Lévi-Strauss, 1972: 34). Although in the strictest sense, this interpretation does not allow for different individual cultural competencies or different, contradictory interests in the production of material culture (eg. Hodder, 1982: 125- 180), if adapted to focus more on the actual sequence of production, such individual agency becomes evident.

3.3. *The châine opératoire*

This kind of theorising led to the later realisation that technology was a social production, and that craftspeople could act with a sense of agency rather than

being passive producers with no choice or control over their craft, as previous environmentally deterministic explanations had suggested. (Leroi-Gourhan 1982: 8; Lemonnier 1986: 153- 154).

The range of choices available to craft producers and the variability within and across different types of artefact are where important social information resides. Lemmonier sees that "to try to explain these variants is to explore their socio-cultural context, which generally leads to revealing pertinent links between a technical phenomenon and factors of social order. Better still, the irregularity observed in technology sometimes points towards socio-cultural differences which have hitherto escaped observation" (Lemonnier 1986: 155). Leroi-Gourhan introduced the concept of the *châine opératoire* and applied it to the reconstruction of prehistoric art and technology. This essentially broke down the different stages involved in making artefacts and described the as sequential steps and illustrated the range of choices available to crafters (1964; 1965). The use of the *châine opératoire* concept has best been applied to the analysis of stone tool production, primarily because chipped lithic artefacts retain a visual record of each strike in the production process and also the physical waste material, *debitage*, which can be used in the same manner. Lemonnier additionally promotes a more bodily form of reconstruction that integrates the gestures and actions, which are part of the craft learning process and that individuals habitually perform in the transformation of natural materials to human products, the process by which social groups are identified in the past (Lemonnier 1992: 5).

3.4 *Archaeological Science*

The application of archaeological science to the analysis of material culture has helped if not explicitly in the development of theoretical structures, such as that pioneered by Leroi-Gourhan and Lemonnier, then certainly in the application of such approaches. Scientific analysis of archaeological materials began in 1796 with the specific question of establishing provenance to metal artefacts and raw materials , but throughout the twentieth century a growing concern has been in understanding the technology and raw materials in use by past societies (Pearce

2016: 46). Although such concerns did not develop in tandem with theoretical archaeology, by the 1950-60s, large-scale projects investigating the technology of ancient metalwork from the European Bronze Age appeared in publication, but suffered from similar issues that sometime plague contemporary work, mainly that they were purely descriptive exercises that consisted of documenting the composition of ancient materials (Pollard *et al.* 2007: 9).

For most productive technologies, such as ceramics, metalwork and glass, which have less visible stages evident on the artefact itself in comparison to stone tools, scientific methods must be applied to reconstruct a fuller production process in order to build up a biography of the materials and finished object (Sillar and Tite 2001: 15- 16). This is the most socially informative aspect of such analysis and where the discipline of archaeological science really comes into its own, allowing us to focus on the important point raised by Pollard and colleagues (2007: 3), that "it is a common fallacy that archaeology is about things- objects, monuments, landscapes. It is not: archaeology is about people", and indeed the full range of past human experience (Renfrew and Bahn 1996: 3). This is perhaps the best use with which to put stylistic analysis, and one which builds upon past theoretical models and overcomes their short-comings, in order to apply an adapted theory of the reconstructed production cycle (Leroi-Gourhan 1964; Lemonnier 1993a; 1993b). This kind of analysis expands on the theoretical scope of the traditional *châine opératoire* from its purist, structuralist sense to draw on the additional aspects of narrative, scale, action and agency. Although post-processual theory has been suggested to have become a marginal phenomenon (Bintliff and Pearce 2011: 3), with the material record subject to a "pick and mix" approach from various and contemporary theoretical standpoints; the trajectory of the development of technological and material studies is a clear one, as has been outlined above. This has stemmed from various archaeologists who had asked why a unified theory of style was being sought after at all (Stark 1998: 8). Indeed, Pluciennik notes (2011: 44), "while there may be moments of particular polemic in which it is useful to place oneself or one's work under one rubric or another, one suspects that many archaeologists have a relatively eclectic

approach to theory as much as method, in the best sense of the word: that new approaches may stimulate different questions (and *vice versa*)".

3.5 *Conclusion*

My own investigation using scientific analysis and approach to *châine opératoire* reconstruction follows that described in the last sections of this chapter, in that I am applying analytical methods to reconstruct Prehistoric potting technology that will be contextualised with the wider socio-cultural framework of Neolithic Fars and Iran. This will be outlined in greater detail in later chapters, but I have here synthesised previous research into this process as a method of archaeological inquiry to illustrate the history of such an approach.

The following chapter details previous analytical work undertaken on Neolithic assemblages from Fars and related wares before describing my own sampling strategy and methodology.

4. Review of previous ceramic investigations.

4.1 *Introduction*

No previous analytical studies have been undertaken on Neolithic ceramics from Southwest Iran. This may be due to the limited scale of excavation and survey in Fars province that characterised much of the twentieth century which has only recently been addressed in the last decade with the emergence of large-scale excavation projects. It is the deep soundings of the Mamasani district excavations in Fars (Potts and Roustaei, 2009) that established the first stratified and radiocarbon dated ceramic sequence which accurately structured the relative Late Neolithic wares (see Chapter Two for a description and discussion of Late Neolithic wares in Fars).



Figure 4.1 Map detailing the position of Iran within the Middle East and Central Asia, including Neolithic sites discussed in this thesis.

For these reasons, analytical work on ceramics outside of the immediate study region in the Central and Northern Zagros Mountains, Northern Plains of Iran, Azerbaijan and the

Kopet Dagh Mountians of Turkmenistan will be discussed in order to contextualise the reconstructed vessel production of Fars province, and situate this within the wider ceramic technologies of Neolithic Iran and Central Asia.

4.2 *How have previous analytical studies of Neolithic pottery from Southwest Iran characterised ceramic production?*

A study of central importance to the investigation of forming techniques of Neolithic vessels is the doctoral research of Pamela Vandiver (Vandiver, 1987). This concentrated on the reconstruction of ceramic production technology primarily located in the Zagros mountain range but also included samples from the wider Near East, Northeast Africa and Central Asia across ca. 7000-3000 B.C. (Vandiver, 1987: 10; 1995). Sites of relevance for this study that were investigated by Vandiver are the Central South Iranian site of Tepe Yahya, the collection of Central and Northern Zagros sites of Ali Kosh, Ganj Dareh, Sarab, Godin Tepe, Dalma and Hajji Firouz and the Northern Mesopotamian sites Hassuna, Chagar Bazar and Halaf (see figure 4.1 for location). This geographically wide study included not only examples of large basins, storage jars and smaller open bowls, but also forms made from different tempering materials, including coarse organic tempered wares and fine grit tempered wares (Vandiver, 1987: 20). There are however common attributes shared across potting traditions in this area, such as the use of coarse organic temper and montmorillonite clays (Vandiver, 1987: 17).

Vandiver argued that the construction method of the Neolithic vessels followed the same pattern of "sequential slab construction" (SSC), namely the building up of vessels from the base with preformed elements, or slabs, using variations of butt and bevel joins (Vandiver, 1987: 15, 1988: 149). Inspection and recording of both whole vessels and sherds was undertaken in the application of this technique by using a binocular zoom microscope at x10 magnification in raking light in order to examine the surface texture of vessels, the nature of sherd fractures, cracks and voids at joints, and the orientation of porosity from the oxidised organic temper (Berg 2008; Braun 1982; Foster 1985; Lang *et al.* 2005; Pirret *et al.* 1996). This analyses was then combined with detailed inspection of radiographs of the nearly intact and whole vessels (Vandiver,

1987: 15, pl. 2). The surface cracks and indentations that were examined gave some indication of the location of preformed elements, and the nature of the breaks on sherds, such as step fractures, were interpreted as an indication of the breaking apart of two distinct layers (as in figure 4.2) (Vandiver, 1987: 11, pl.1.1). The interpretation of radiograph images rely on the orientation and elongation of the oxidised organic temper, and in some cases seem to indicate the boundaries of slab elements that have been used to build up the vessel (see figures 4.3 and 4.4).

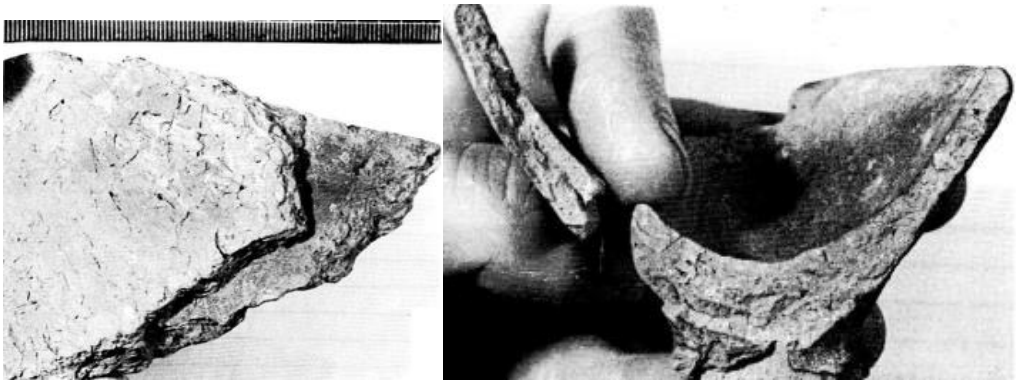


Figure 4.2 *Left*: Sherd from Tepe Yahya with a stepped fracture that Vandiver describes as being caused by the weakness of two slab joins. *Right:* Small bowl fragments, again from Tepe Yayha, that show the use of slabs in making the base and bottom half of the vessel in the cross-section of the break (Vandiver 1987: pl. 1.1,2).

Vandiver's study also included an investigation of clay sources in the vicinity of the Southern Iranian site of Tepe Yahya which formed part of an experimental study of the behavioural properties of montmorillonite rich clay (Vandiver, 1987: 16- 17). This study explored the working, drying and firing properties of this clay, such as a 20% shrinkage rate and a small particle size for a pure and untempered montmorillonite (Vandiver, 1987: 14). Due to the small particle size of this clay, there is a larger number of water films which occur between particles than in a coarser tempered clay, and these are lost in the drying and firing processes, creating a high shrinkage rate. Therefore, the addition of a coarse temper to reduce cracking during drying was necessary, and also to increase the yield point which would add a stiffness and toughness to the material when it is formed (Vandiver, 1987: 25). However, Vandiver found coils difficult to make

successfully as the organic temper consistently delaminated the particles of the clay and fractured the coil (Vandiver, 1987: 25).

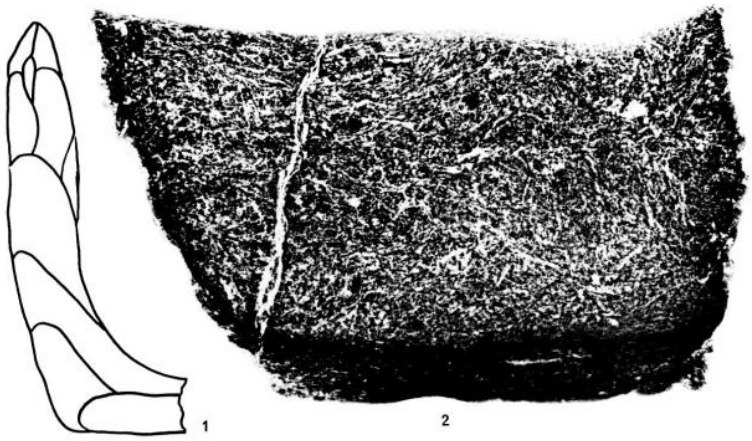


Figure 4.3 X-radiograph and reconstructed profile of a Neolithic vessel from Seh Gabi (Vandiver, 1987: pl. 2).

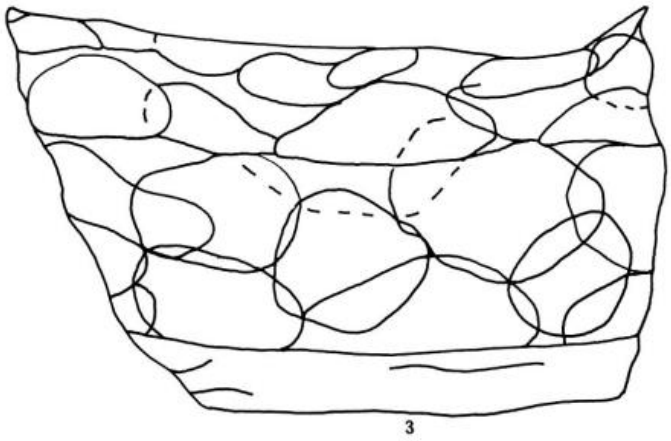


Figure 4.4 Reconstructed body of above Seh Gabi vessel from x-radiographs (Vandiver, 1987: pl.2).

Vandiver's study highlighted various different approaches to slab building, and combinations of SSC with other manufacturing techniques. Basket mould had been used in 20 samples from Hajji Firouz in Azerbaijan, leaving woven reed impressions (Vandiver, 1987: 18), and also from the site of Mehrgarh in Pakistan, where only the base and lower section had been moulded and left to partially dry, while the upper half

and rim were constructed with slabs (Vandiver, 1987: 18). This can be compared to similar impressions on the bases of recently excavated Neolithic ceramic vessels at Tepe Khalesh in the northern province of Zanjan (Valipour *et al.* 2013: figs. 11.26, 11.32). Differences in the size of construction slabs within her assemblage were noted by Vandiver (1987: 18, 20), with some sites using the same size for the whole vessel, as at Ganj Dareh, while others use a size gradation with largest at the base and smallest at the rim. Additionally, Hajji Firouz vessels were made of slabs the size of a palm's width, while long rectangular strips were used for vessels from Mehrgarh (Vandiver 1987: 16).

Due to the difficulties in identifying SSC without employing x-radiography, recent excavations of Iranian Neolithic ceramics have described their ceramic material vaguely along the same lines as Vandiver's terminology, using such phrases as "(vessels being formed using) a combination of SSC and coiling" (Petrie, 2011: 151, Weeks *et al.*, 2009: 73, Fazeli *et al.*, 2010: 100). The main drive of Vandiver's research had been in exploring the similarities of production across the Middle East, rather than the temporal and spatial differences that are evidently incorporated into this technological class.

	Study	Marghussian et al. 2009	Fazeli et al. 2001; 2010	Vandiver 1987	Noll 1991	This Study
Time period	Early Neolithic			C &N Zagros sites	Tepe Guran Red on buff ware	Rahmatabad Red wares
	Late Neolithic		Tehran Plain ware	Yayha, C &N Zagros sites		Mushki, Jari, Bashi, bichrome, orange mottled
	Trans. Chalcolithic Early Chalcolithic	Bakun				

Table 4.1 Overview of ceramic wares related to those studied in this thesis and their chronological placement.

It is perhaps because of this, and that no detailed work addressing just such a question has since been undertaken on Iranian material, that a large amount of ambiguity lies in descriptions of vessels as either SSC or coiled, and that the relatively large amount of published descriptions and commentaries on Neolithic ceramics from this region regard them as technologically conservative (Voigt and Dyson, 1992, Fazeli *et al.*, 2001, Fazeli Nashli, 2001, Petrie, 2011, Fazeli *et al.*, 2010).

A pioneering German study of Prehistoric pigments included ceramic samples from Iran (Noll *et al.* 1975; Noll 1991: 261). While these are not from the decorative classes of ceramics recorded from Fars province, they do incorporate ceramics from the Central Zagros and North Iran dating to the Neolithic and Chalcolithic. Sherds sampled from the Neolithic Central Zagros site of Tepe Guran were analysed, although no description or images of the sherd and its decoration were published. There is currently no typology for Central Zagros Neolithic ceramic material, however, parallels have been described with the similar buff pastes and red and black geometric decoration (Hole 1987), that has parallels to the material in Fars. Electron microprobe analysis was used to establish the calcareous nature of the paste which had been fired in the region of 850° with the microstructure showing initial vitrification (Noll 1991: 267- 268). Red, ochre-rich clay was used to create the pigments for decoration (Noll 1991: 267). A wider programme of analysis applied, once a typology of Central Zagros ceramic wares, would be of great use to compare to the results of this study. This would allow comparison between potting technologies and the use of raw materials between these two large areas of the Zagros Mountains which may have bearing on the reconstruction of socio-economic organisation and interaction in these two zones defined by ceramic decoration.

Detailed analytical work has also been undertaken on Late Neolithic ceramics from the excavated site of Tepe Pardis in the Tehran Plain, Northern Iran (figure 1)(Fazeli *et al.*, 2010). Brown painted Buff wares (illustrated in figure 4.5), have been analysed selectively with Scanning Electron Microscopy (SEM), X-ray diffraction (XRD) analyses and thin section petrography, to further understand the production process of this localised industry (Fazeli *et al.*, 2010).

For Fazeli and colleagues (Fazeli Nashli, 2001), the emphasis of their study has been on the development of craft specialisation from the Late Neolithic through the Transitional, Early and Late Chalcolithic periods at Tepe Pardis. They therefore had three samples prepared from the same sherd of Late Neolithic Painted Buff ware which were suitable for SEM, XRD and thin-section. During the Late Neolithic, two wares have been recorded from Tepe Pardis, a Plain Buff ware and Painted Buff ware (Fazeli *et al.*, 2010: 92). Both of these are coarsely tempered with plant material and have a crumbling texture that has caused Fazeli and colleagues to class them as "soft wares" (Fazeli *et al.*, 2010: 92). Although the description as soft wares describes the friable sherds, the meaning is distinct from that previously applied to Iranian ceramics which implies a Mesopotamian origin, as discussed in chapter 2. The Plain Buff ware is not slipped, but the Painted Buff ware has a thick slip (0.7- 1.2mm), and is decorated on the interior and exterior with a dark grey- grey brown pigment (Fazeli *et al.*, 2010: 92).

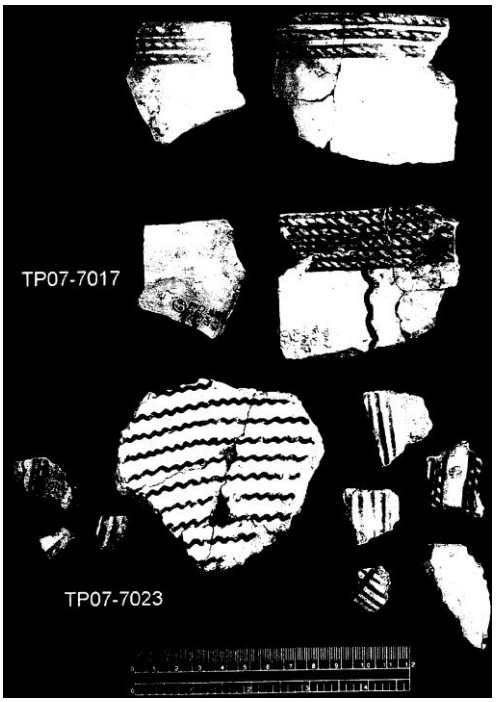


Figure 4.5 Examples of Late Neolithic Painted Buff ware from Tepe, Pardis, Tehran Plain, Northern Iran (Fazeli *et al.*, 2010: fig. 2).

The petrographic analysis revealed the ware to have a yellow paste, with scattered iron oxide particles, very fine microcrystalline quartz, angular feldspar grains (average

50μm), coarse silt particles (0.06- 0.04mm), and fine sand particles, as well as the evident, coarse plant temper (Fazeli *et al.*, 2010: 94). A relatively high firing temperature of 850˚C was interpreted from the decomposition of the calcium-rich particles and their reaction with the aluminium-silicate fraction, and secondary phases including calcic plagioclase, diopside pyroxenes, and gehlenite determined from the XRD analysis (Fazeli *et al.*, 2010: 95).

Unfortunately Fazeli and colleagues publication of their study does not distinguish between the Late Neolithic and Transitional Chalcolithic samples in their description of the SEM results, despite their being significant differences between some of the samples (Fazeli *et al.*, 2010: 95). Description of the pigments on the Chalcolithic Black on Red Painted sherds includes iron-manganese oxides in a layer 100μm thick (Fazeli *et al.*, 2010: 95), which may or may not be of a similar chemical composition to the Late Neolithic dark grey pigment on the Painted Buff ware from Tepe Pardis.

Due to the small sample size (x1 sherd sampled for SEM, XRD and thin section analysis), it is not possible to gauge the extent of homogeneity/heterogeneity in Late Neolithic raw material use at Tepe Pardis, nor sufficiently characterise the variety within the ware in terms of a fabric group classification. This hampers any detailed comparison with analyses of further examples of this ware from Tepe Pardis or elsewhere in the Tehran Plain, as well as comparison between other known wares in the area. This therefore makes investigation of the trade and exchange of vessels and the presence of production and consumption centres within and around the Tehran Plain very difficult without adding to the sample set from the Buff wares of Tepe Pardis.

Additional work on the Later Neolithic ceramic assemblages from the Tehran Plain in Northern Iran as part of this project can be used to further understand the nature of these industries. Five Late Neolithic samples from the surveyed site Sadeghabadi in the Tehran Plain were analysed alongside a collection of sixty nine samples from six Transitional Chalcolithic- Late Chalcolithic surveyed sites, also in the Tehran Plain, for a range major, minor, and trace element compositions using Inductively- Coupled-Plasma- Atomic Emission Spectrometry (ICP-AES) (Fazeli *et al.*, 2001: 55). The samples selected are from a single decorated ware that has parallels to other sites in Northern

Iran including Cheshme Ali and Sialk I (Fazeli Nashli *et al.*, 2009: fig. 18, Fazeli *et al.*, 2001: fig. 2). These can also be compared with the thin section study of Transitional Chalcolithic ceramic samples taken from Cheshme Ali (Wong *et al.* 2010).

The major (Al, Fe, Ca and K), minor (Ti, P, Mg, Mn and Na) and trace (Ba, Co, Cr, Cu, Li, Ni, Sc, Sr, V, Y, Zn and Zr), elements chosen represent a range of the composition of geological silicate samples, and were used to form ware groups to compare to the depositional site of the sherds (Fazeli *et al.*, 2001: 56). In this manner, Fazeli and colleagues were able to establish that the raw material selection of the Late Neolithic sherds was similar across the sample set, suggesting production at a single location, with change from calcareous to non-calcareous clays between the Late Neolithic and Transitional Chalcolithic (Fazeli *et al.*, 2001: 61, fig. 7). This study, combined with the thin-section analysis of a Late Neolithic Painted Buff ware sherd from nearby Tepe Pardis, suggests that ceramic production in the Tehran Plain was organised on a local, site level. However, increasing the sample size within these two investigations would allow this initial suggestion to be tested more rigorously and contribute to establishing a characterisation of potting practices in a larger area of Northern Iran.

A further site in the Northern Zagros Mountains that can be brought into this discussion is that of Hajji Firouz. It is located in the Solduz Valley of Azerbaijan , where Late Neolithic ceramics have been subjected to neutron activation analysis (NAA), in order to address the question of provenance (Hancock *et al.*, 1989). Fifty One samples were tested from Hajji Firouz in the Solduz Valley of Azerbaijan by removing 25- 500mg of ceramic from the sherd section and cleaning off the outer surface with a carborundum bit (Hancock *et al.*, 1989: 114). The range of elements tested is as follows, Na, Al, K, Ca, Ti, V, Mn, Sm, Eu, and Dy (Hancock *et al.*, 1989: 115). Uranium, magnesium and barium were not included as their concentrations were at, or close to, the NAA detection limit, while chlorine was also discarded as it had been accumulated from the burial environment and did not reflect the natural composition of the ceramic raw materials or behaviour of the potter (Hancock *et al.*, 1989 115).

The results of the sherds from Hajji Firuz showed a high concentration of Mn when compared to those from Chalcolithic sites also included in this study (Dalma Tepe and

Pisdeli Tepe), with ratios of 1.41 and 1.43 respectively (Hancock *et al.*, 1989: 116, table 1). Samples from Hajji Firouz also showed a significantly lower average level of Al (Hancock *et al.*, 1989: 120), which was interpreted by Hancock and colleagues as indicative of a different clay source used by the Hajji Firouz potters to the later deposits exploited by potters in the Chalcolithic (Hancock *et al.*, 1989: 116). Unfortunately, no sampling strategy was outlined in the publication, nor images given of the sherds that were sampled, so difficulty arises in re-contextualising this analysis with the Hajji Firouz ceramic typology (Voigt, 1983), and wider wares known from Northern Iran. Further, no other NAA study has yet been conducted on Iranian Neolithic material and there would be inevitable difficulties in combining results from different laboratories using different calibrations and control standards (Pollard *et al.*, 2007: 63, Jones, 1986: 38, 40).

A detailed petrographic study has been conducted on the Neolithic ceramic wares from Northeastern Iran/ Turkmenistan in the Kopet Dagh region (Coolidge, 2005). During the Neolithic period, the south of this area was occupied by a group of agricultural communities characterised by their material culture, particularly their organic tempered, painted ceramics known primarily from the type-site of Djeitun (Harris, 2010: 59). This ware has also been excavated at the basal levels of the Iranian sites Yarim Tepe and Tureng Tepe on the Northeastern Gorgan Plain (Crawford, 1963), and Tepe Sang-e Chakhmaq (Thornton 2013: figs. 15.5- 15.7). The Djeitun ware is characterised by its organic temper, grey, buff, red, orange and white wares in a range of forms including open bowls with round bases, outwardly flaring, flat based, shallow bowls, carinated, shallow bowls, and taller bowls with outflaring rims (Coolidge, 2005: figs A2.1, 2, 16, 21, 29).

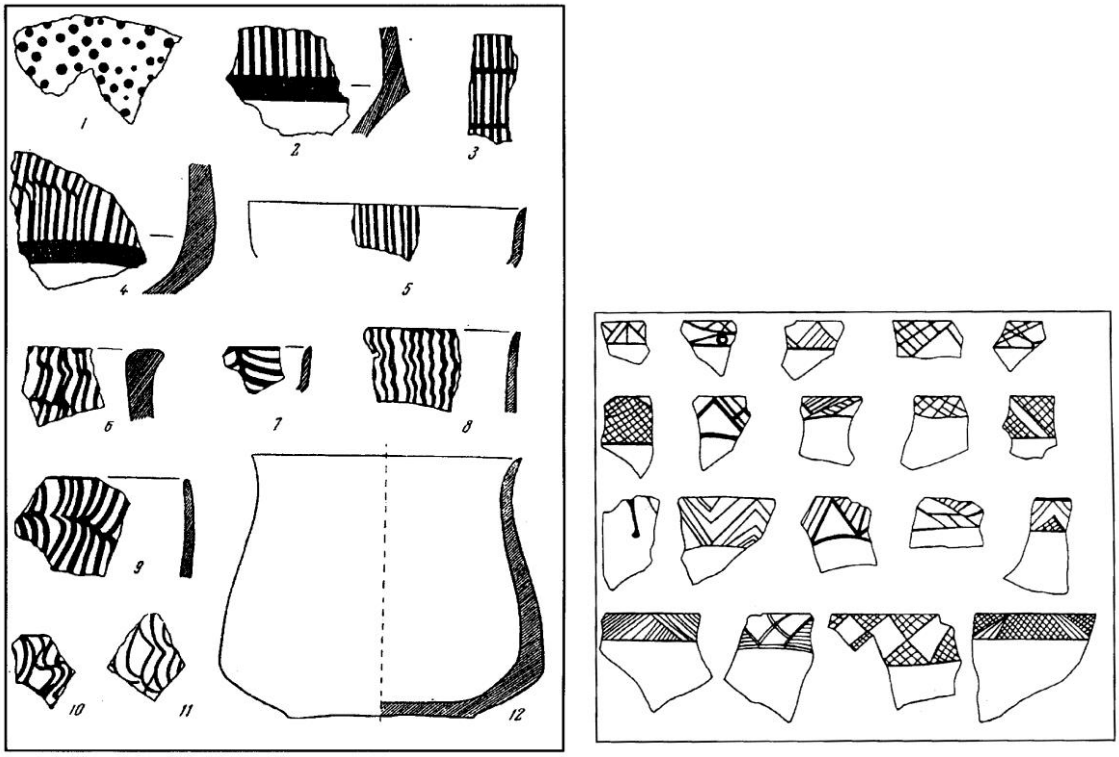


Figure 4.6 Examples of Neolithic decorative wares from the Kopet Dagh Mountains (Coolidge, 2005), with evident similarities in form (left), and decorative traditions (right), to Neolithic Iranian wares of the North and South.

The breadth of painted decoration within this ware has no specific typology, but includes various linear designs, cross-hatching striped and triangular decoration with strong similarities to the Northern Iranian wares in the Tehran Plain (figure 4.6) (Coolidge, 2005: figs. A2. 11, 12, 13, 14, 43, 44, 45). In a petrographic study of samples from sites across the Kopet Dagh piedmont, Coolidge established that these ceramics are part of the material culture assemblage in this period that is labelled the "southern super-zone" (Coolidge, 2005: 99), which she equates with material from Iran, Pakistan, Baluchistan, Afghanistan, and the wider Mesopotamian area. While this has not been universally agreed upon in the past (Lamberg-Karlovsky, 1973: 44), due to Late Djeitun and Central Iranian parallels being less strong, there are broadly distinct parallels between ceramic wares in this region in the Neolithic. By comparing the raw material use that Coolidge describes for the manufacturing economy in the Kopet Dagh, Neolithic vessel production in Fars can be widely contextualised with such contemporary industries, and therefore characterised in much more detail.

Across each of the different wares studied by Coolidge from the Kopet Dagh, (established by categorisation of form), a marked overall trend of mineral homogeneity was recognised (Coolidge, 2005). As well as the organic plant material added as a temper to clay, identified minerals included mono and polycrystalline quartz, plagioclase feldspar, potassium feldspar, muscovite mica, biotite mica, amphibole, epidote, and chert (Coolidge, 2005: 100). Significant distinctions among the material was seen through the presence or absence of loess or loess intraclasts, clay/sediment pellets, sandstone, limestone and calcite fragments (Coolidge, 2005: 99). In the eastern zone of the study area, the Late Neolithic ceramic industry witnessed a change from plant to sand temper, distinguishing it from the southern super-zone and bringing it more in line with the sand tempered, incised wares of the "northern super-zone" (Coolidge, 2005: 99). This "zone" is represented by the Keltiminar and Keltiminar-related sand tempered and incised wares that are recorded from the Kara-Kum and Kyzyl Kum deserts, as well as the desert areas of Uzbekistan, and the steppes of Kazakhstan, Western Siberia and the Urals (Harris, 2010: 59, Masson and Sarianidi, 1972). Therefore, part of the wider Kopet Dagh community in the Late Neolithic changed its focus from participation in a southern style of Neolithic material culture to a northern one, although any investigation of further change in material assemblages from sites in the eastern Kopet Dagh has not yet been considered in order to better understand this change in ceramic manufacture.

Coolidge's fabric classification and textural descriptions (Coolidge, 2005: 149- 152), are organised by region within the Kopet Dagh (Neolithic central, eastern and western zones), and by site. These descriptions form more a catalogue of mineral inclusions for each sample, as groupings based on similar fabrics are no larger than three samples, all of which are from the same sites due to production being characterised as at a site and household level (Coolidge, 2005: 113). This interpretation also influences the reconstruction of Neolithic trade and exchange practices in this area, as Coolidge suggests there is "limited contact and exchange of ceramics (which) points to the existence of a homogenous, domestic, generally non-pottery exchanging Neolithic adaptation among the Djeitun culture agriculturalists" (Coolidge, 2005: 115). Unfortunately, this does not address the material culture similarities across the Kopet

Dagh, and does not explore the technological variations that may have been exploited to create the aesthetically similar vessels of the Djeitun repertoire. However, Coolidge's study does include a detailed description of the plant temper impressions (Coolidge, 2005: 153- 154), that may be important to compare with the Fars assemblage in order to provide more detail and differentiation to the broad "soft-ware" category that Neolithic wares from Mesopotamia, Iran, Azerbaijan, Turkmenistan, Afghanistan and Pakistan have been classed as (Dyson, 1954: 217, Lamberg-Karlovsky, 1973: 44).

While the above reviewed studies have been comprised of analysis of contemporary Late Neolithic material, chemical and mineral characterisation of Chalcolithic Bakun ware ceramics from the site of Rahmatabad will also be considered (Marghussian *et al.*, 2009). The author's own archaeometric investigation includes samples from the Late Neolithic levels of this site, and in order to understand the types of raw materials that were available in the vicinity of the site, and how these may have changed over time, Marghussian and colleagues' study will be included.

XRD, SEM/EDX and XRF analysis were used to understand the chemical composition of the sherds, and examine the clay micromass (Marghussian *et al.*, 2009: 736- 737). Results from these combined methodologies revealed that potters were using calcareous clays for vessel production at the site (Marghussian *et al.*, 2009: 737). This is in agreement with the studies of clays used by earlier Neolithic potters in the Zagros Mountains (Vandiver, 1987), and also other Chalcolithic sites in the north and south of Iran, as at Tepe Yahya (Vandiver, 1987) and the cluster of Transitional-Late Chalcolithic sites in the Tehran Plain (Fazeli *et al.*, 2010), which have also undergone chemical and mineralogical analysis in the form of XRD, SEM and thin section petrography.

SEM analysis also showed all samples to exhibit quite dense, vitrified microstructures with relatively little porosity (figure 4.7), they also included calcium-magnesium-iron silicate, mullite and an absence of unreacted CaO particles indicating a relatively high firing temperature (Marghussian *et al.*, 2009: 742). The estimated firing temperature has been suggested to be in the range of 950- 1050˚C due to the absence of high temperature phases such as anorthite and hedenbergite (appearing usually in the 1100˚C + range), and presence of MgO which may have lowered the melting point and

viscosity of the liquid phase (Marghussian *et al.*, 2009: 744). This temperature range could have been achieved in the updraught double-chamber kiln excavated in Trench A at the site and which was found alongside largely complete vessels, misfired vessels, kiln bricks, stones, burnt clay and slag (Marghussian *et al.*, 2009: 735).

Potential comparisons with the Late Neolithic wares from this site would add more chronological depth to this resource exploitation and will help define the dynamics of technological change through this period, as has been illustrated for Tehran Plain wares throughout the Neolithic to Chalcolithic periods (Fazeli *et al.*, 2001: 65).

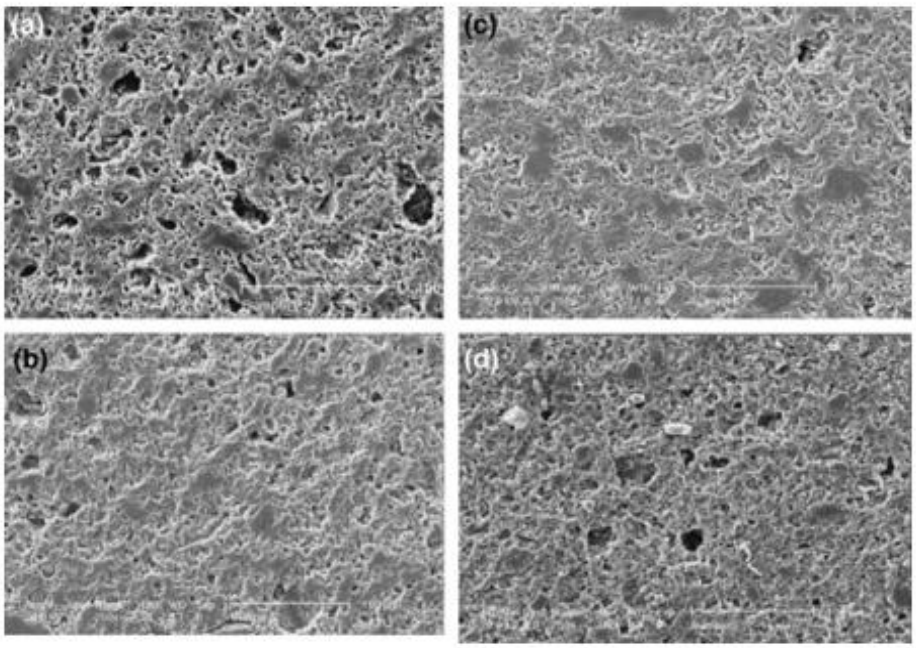


Figure 4.7 Dense, vitrified microstructures of Chalcolithic ceramics from Rahmatabad (Marghussian *et al.*, 2009: fig. 5).

4.3 *What questions have so far been investigated for Neolithic ceramic production in Iran and Central Asia, and what questions could still be addressed?*

The above synthesis of work on Iranian and wider Central Asian Late Neolithic wares has highlighted the various analytical methods and research agendas of past investigations. While some of these have been keen to assess the traditional question of provenance (Hancock *et al.*, 1989), most have aimed to explore the socio-economic organisation of production and the nature of exchange (Fazeli *et al.*, 2001, Fazeli *et al.*,

2010, Marghussian *et al.*, 2009). This informative line of questioning has led to important discoveries relating to the Transitional and Early Chalcolithic nature of production in Northern Iran, which witnessed an increasing scale and intensity to organisation through the use of larger and more numerous kilns, as well as specialist areas of vessel production at sites (Fazeli Nashli, 2001: 60- 68). As has been mentioned above, the size of the sample set for the Late Neolithic component of this research is regrettably small, one sherd from the Buff Painted ware class at Tepe Pardis, and five decorated sherds from Sadeghabadi (Fazeli *et al.*, 2001: fig. 2, Fazeli *et al.*, 2010: 94). This makes sufficient characterisation of the Late Neolithic wares from the Tehran Plain difficult, and hard to compare with other wares that have been recorded from sites in this region, such as at Cheshme- Ali (Fazeli Nashli, 2001: 58).

In terms of addressing the key question of trade and movement of vessels, all the studies established that vessels that were sampled had been made locally to the sites where they had been consumed and finally deposited (Hancock *et al.*, 1989, Fazeli *et al.*, 2001, Coolidge, 2005, Marghussian *et al.*, 2009, Fazeli *et al.*, 2010). Such an assumption is based on imported vessels being produced with distinct raw materials and/or with a production sequence that is different to the locally made wares. This is significant for the reconstruction of trade and interaction between communities as this item of material culture does not seem to have been physically moved across sites as part of an exchange network. However, the existence of similarly produced and decorated vessels at each of the sites in the Tehran Plain and across the Kopet Dagh suggests a deliberate participation in a shared culture of producing aesthetically similar ceramics, indicative of a certain level of communication and interaction between potters across a quite vast area. However, with such a small sample set, it is not possible to fully investigate exactly how similar these examples of certain wares are across the region, and how many localised production techniques/industries existed that were able to produce an aesthetically similar product that actively participated within this wider "culture", but yet made with subtly different techniques. No explicit attempt at reconstructing the production sequences of ceramic manufacture has been attempted, which is a technique of investigation that would allow meaningful differences and similarities in past choices made by potters to become obvious.

The petrographic casestudy of Kopet Dagh Neolithic ceramics included a large dataset of sampled wares from different sites (Coolidge, 2005: appendix 5). Due to Coolidge's petrographic methodology, her analysis however is limited to a presence/absence count of rock and mineral inclusions, with any inference of technological behaviour, reconstructed firing temperature and pigment application relying on anthropological and ethnographic accounts of production (Coolidge, 2005- 104). Any identification of "temper" as an inclusion deliberately added by the potter is also not explored, nor is the differential use of materials across sites, or the consideration of the socio-cultural nature of technological behaviour inherent in craft production. This approach to thin-section analysis is at odds with that applied to other archaeological ceramic studies (Whitbread, 1995: appendix 3), where the focus has been as much on the description of established fabric groups as it has on the technological behaviour evident from the samples (Whitbread, 2004: 449- 450; Reedy, 2008: 173).

Future analysis of slip and pigment layers of decorated wares within the above ceramic traditions would contribute to a more detailed reconstruction of the *chaîn opératoire* at each site, and therefore allow added scope for the comparison of different production centres within the region. A number of the above studies (Marghussian *et al.*, 2009, Fazeli *et al.*, 2001, Fazeli *et al.*, 2010), incorporated bulk chemical characterisation techniques (XRD, XRF), in which a sample of the ceramic body was ground down to homogenise the material. In this instance, slip and pigment layers do not form part of the analysis (Pollard *et al.*, 2007: 107), and cannot therefore be considered in the reconstructed production sequence, nor used to compare and contrast with other site production sequences. SEM analysis of Chalcolithic Bakun wares from Rahmatabad (Marghussian *et al.*, 2009), was applied only to the ceramic body rather than slip and pigment layers, despite this being an ideal technique with which to address such a question.

Vandiver's exploration of the forming techniques used across the Middle East during the Neolithic incorporated a vast dataset of 40,000 sherds (Vandiver 1987). While this study usefully identified broad similarities in production across many different forms of vessels and decorative wares, it is a study that is essentially a product of its time, and

does not therefore focus in detail on the important differences within these individual industries. The radiographic method proposed by Vandiver is a useful and non-invasive approach to investigating forming practices, but is unfortunately only suitable in applying to largely complete vessels (Dipilato and Laneri 1998, Fazeli *et al.* 2010: 98-100), which are for most Neolithic sites in Iran, a variety. The adoption of Vandiver's techniques of identification of individual clay slab/coil elements in hand-held specimens, such as consideration of crack formation on the sherd surface and the nature of the fracture edge and profile are also hampered by the size of sherds, again requiring quite large examples which often do not survive in the archaeological record.

Contemporary scholarship has preferred to elaborate on the distinctive differences within localised industries in order to categorise different production centres contributing to a widespread ware class (Quinn 2013: 151, Whitbread 1995). The different stages of production and incorporated techniques utilised by potters are indicative of the embedded knowledge of each individual and the wider community (Dietler and Herbich 1998), the learning and development of this knowledge being both a personal and a social practice that is governed by the socio-cultural parameters afforded by the community (Castro Gessner, 2010: 100, Bernbeck, 1999: 102). Investigation of divergent practices within the reconstructed pottery production sequences of a range of sites producing and consuming an aesthetically similar "ware", will highlight socially meaningful practices in ceramic production that allow us to sub-divide the current broad groupings and consider the different social meanings within the production of this essentially utilitarian artefact. This can include social identity as expressed through ceramic production, transmission of technology, and the artisan's knowledge of technological processes and raw material behaviour, all of which can be explored both spatially and temporally (Castro Gessner, 2010: 100- 101, Petrie, 2011: 152- 153, Quinn, 2013: 151).

Therefore, key aspects of research that are necessary to explore ceramic production in greater detail are the broken down sequences of the *chaîne opératoire* that includes consideration and characterisation of the slip and pigment layers of the vessel. How is the preparation of the clay used in the slip layer different from the body fabric? How

have the raw materials for the pigment been prepared, applied and fired? What are the raw materials of the pigments? Additional questions that can be built into fabric classifications include the investigation of production sources (as opposed to clay source provenance), and the possible exploration of production and/or consumption sites, as well as the movement and trade of vessels and/ or raw materials. An important consideration must also be the estimated firing temperatures and atmospheres which will help inform the reconstruction of firing structures that have so far not been recorded within a Late Neolithic Iranian context. All of these aspects of investigation into ceramic production can then be brought together into a discussion of the socio-cultural parameters governing this craft industry and the potential meaning associated with the production and use of such vessels.

4.4 *How have other studies addressed these questions?*

The most commonly applied technique to establish compositional groupings and characterise fabrics within a ceramic assemblage has been thin-section petrography. This has often been combined with various techniques capable of producing information on chemical composition (Ionescu *et al.*, 2011, Shriner and Dorais, 1999). A well- known study is that conducted in the 1980s of Greek transport amphorae (Whitbread, 1995), which established provenance and technological groupings of sherd material based on fabric and inclusion characteristics typical of production centres across the Aegean (Whitbread, 1995: 349- 352). This made possible the examination of the movement of transport amphorae in order to reconstruct trade networks from the latter half of the eighth to the middle of the second century B.C. (Whitbread 1995: 3, 347).

While it is not possible to precisely determine the clay mineral composition of the matrix in thin section, the presence and abundance of calcite and iron can be established and is used to distinguish between calcareous and non-calcareous clays used (figure 4.7) (Quinn 2013: 93- 94). Thin section analysis also contributes important information regarding the homogeneity and heterogeneity of the clay matrix, which is not possible in bulk chemical analysis, and is used to infer natural compositional differences as well as intentional mixing of materials (Quinn 2013: 94). Finally, an

assessment of the mineralogical alteration and contamination from the burial environment is possible, although comparative chemical research is best used in combination to fully appreciate such issues (Cau Ontiveros *et al.*, 2002, Buxeda I Garrigos *et al.* 2001).

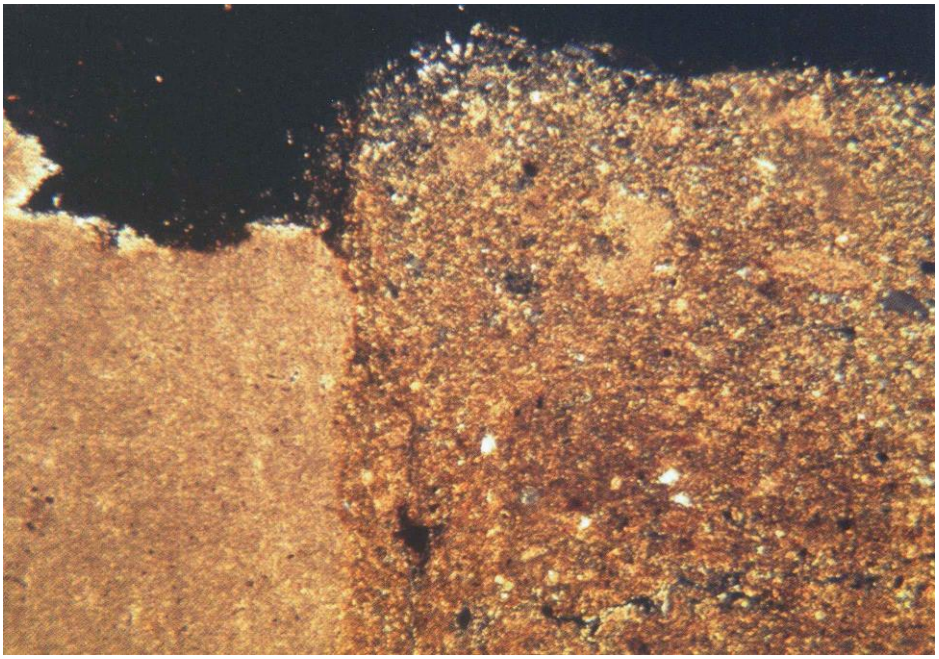


Figure 4.8 Calcareous clay in high magnification thin section, note the abundant crystals of microcrystalline calcite in this example of Neolithic pottery from Greece, XP, field width 1mm (Quinn 2013: 4.21).

Detailed levels of information on raw material use and firing procedures can also be obtained from SEM and electron microprobe analysis in a manner that allows for not only a better understanding of the clay matrix, but also the processes it has undergone during firing (Maniatis *et al.* 2002, Kilikoglou 1994, Freestone 1982, Maniatis and Tite 1981: 59- 60). The mineral composition of the raw clay and/or preparatory stages undertaken by the potter, namely the concentration of calcium in the clay, have a clear effect on the temperatures required to vitrify ceramics (Maniatis *et al*, 1983). For both calcareous and non-calcareous clay, the specific mineralogical changes include the breakdown of minerals with the decomposition of calcite, either in aragonite at about 400˚C or in calcite above 825˚C (Tite 1995: 37). This leads to the formation of high temperature phases including spinel, gehlenite, wollastonite and mullite and can be measured using x-ray diffraction, infa-red spectroscopy, various thermal analyses, or by

noting changes in aspects of the clay which are related to mineralogy, such as colour and magnetic parameters (Tite 1995: 37). These changes, which can be tracked in the ceramic once it has been exposed to heat above 450- 600˚C (Rice 1987: 103), are also dependant on the composition of the clay as well as the firing atmosphere and length of time it is exposed (Gosselain 1992: 224; Livingstone- Smith 2001: 991; Tite 1995: 40).

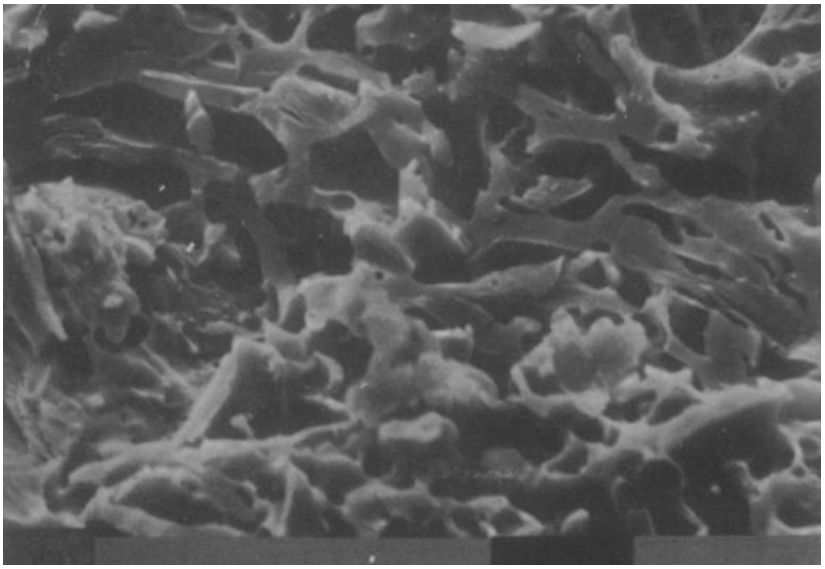


Figure 4.9 Extensive vitrification in calcareous clay refired at 900˚C in an oxidising atmosphere (Maniatis and Tite 1981: figure 7).

In Tite and Maniatis' study, they noted that calcareous clays (defined as containing more than 6% Ca) can become extensively vitrified at the relatively low temperature of 850˚C in an oxidising atmosphere (figure 4.9), and in addition to this, that the cellular structure can remain at this stage across a temperature range of approx. 200 ˚C (Tite and Maniatis 1975b: 21). However, the concentration of calcium oxide necessary to form an extensive vitrification structure depends on particle size and distribution within the clay (Maniatis and Tite 1981: 66). Therefore, vitrification can take place with as little as 5% Ca if it is fine grained and evenly distributed, but for the average concentration of Ca (15%), a sufficient concentration of crystalline phases are formed for the vitrification structure to be stable over 850- 1050˚C (Maniatis and Tite 1981: 66). When the Ca content is below average and also coarse grained (when part of the Ca has been included in the clay paste as an additive by the potter), then the vitrification

structure can vary across the ceramic, with areas of glass being less fragmented and containing fine bloating pores (Maniatis and Tite 1981: 66).

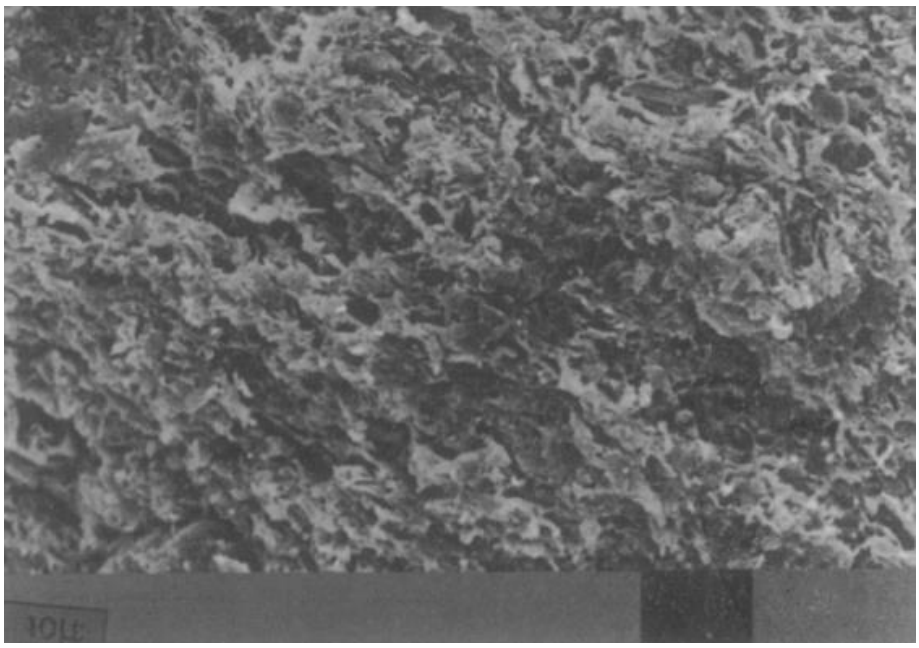


Figure 4.10 Continuous vitrification with fine bloating pores in a calcareous clay, shown with an archaeological sherd from Egypt (Maniatis and Tite 1981: figure 10).

Further, when viewed with a Scanning Electron Microscope (SEM) the areas of vitrified glass became smaller and increasingly fragmented as the Ca content increased from 6-38% (Maniatis and Tite 1981: 65) (see Figure 4.10 for Ca content above 15% in the continuous vitrification stage). Areas of glass are therefore coarser for lower concentrations (5-10%), while those that contain higher levels exhibit a completely distributed structure where no smooth-surfaced areas of glass can be observed (Maniatis and Tite 1981: 65). Firing above 1050 ˚C in this experimental study showed that the amount of glass increased rapidly with continuous vitrification of unconnected, coarse bloating pores established by 1150 ˚C (Maniatis and Tite 1981: 65). The temperature at which initial vitrification took place in calcareous clays fired in an oxidising atmosphere is reduced by 50 ˚C if the atmosphere is changed to a reducing one (Maniatis and Tite 1981: 65). However, the temperatures at which each of the other identified vitrification stages are reached remain the same in both an oxidising and reducing atmosphere. An additional difference in the development of vitrification

between firing atmospheres is the size of fine bloating pores during the extensive vitrification structure (see figure 4.12 for an example of calcareous clay), which remain the same throughout the temperature range of 850- 1050 ˚C as the amount of glass increases (Maniatis and Tite 1981: 66).

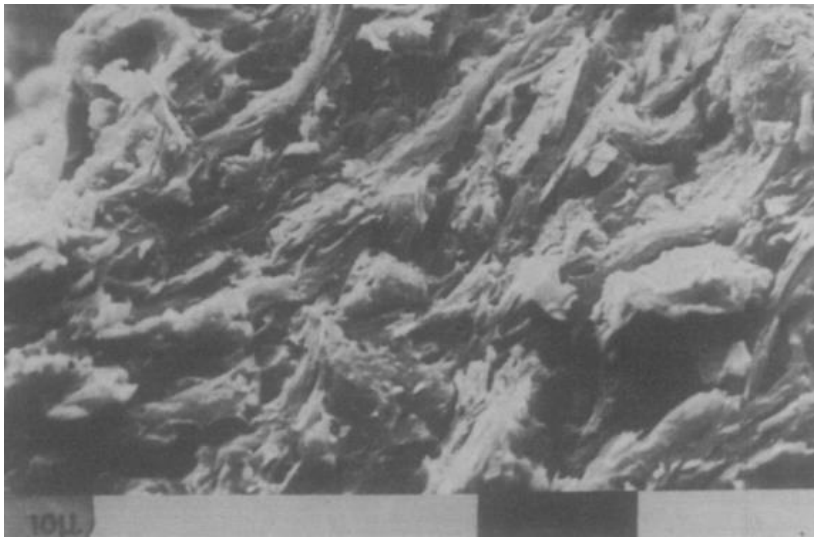


Figure 4.11. Initial vitrification in a non-calcareous clay shown with an archaeological sample from Yugoslavia (Maniatis and Tite 1981: figure 1).

Non-calcareous clay (less than 6% Ca), however, displays an increasing state of vitrification with an increase in temperature until the isolated areas of glass coalesced to form a smooth, continuous layer which is visible across the entire fracture surface (Maniatis and Tite 1981: 61). Therefore, non-calcareous clays are more sensitive to temperature and can vary drastically across a range of only 50˚C (Tite and Maniatis 1975: 123). The separation of vitrification stages in Maniatis and Tite's classification is, for non-calcareous clay, only 150 ˚C between initial vitrification (see figure 4.11) and continuous vitrification which occurs at 1150 ˚C in an oxidising atmosphere (figure 4.13) (Maniatis and Tite 1981: 61).

Firing non-calcareous clays in a reducing atmosphere reduces by 50 ˚C the emerging stages of vitrification compared to the temperature of equivalent stages in an oxidising atmosphere (Maniatis and Tite 1981: 61). This is due to the reducing atmosphere

having a stable crystalline phase of fayalite, rather than ferric iron-bearing spinels in an oxidising atmosphere, so the temperature that rapid melt is achieved is lowered (Maniatis and Tite 1981: 61).

The development of bloating pores in the continuous vitrification stage are also more highly concentrated in a reducing atmosphere, which can be further increased when a faster heating rate is used, eg. 800 ˚C per hour, with 1 min soaking time at the maximum temperature, compared to 200 ˚C per hour, with 1 hour soaking time (Maniatis and Tite 1981: 61). Therefore, the complete vitrification of samples in a reducing atmosphere took place at 1050- 1100 ˚C. In addition, prior to this final phase, a high concentration of fine bloating pores also occurs (Maniatis and Tite 1981: 61).

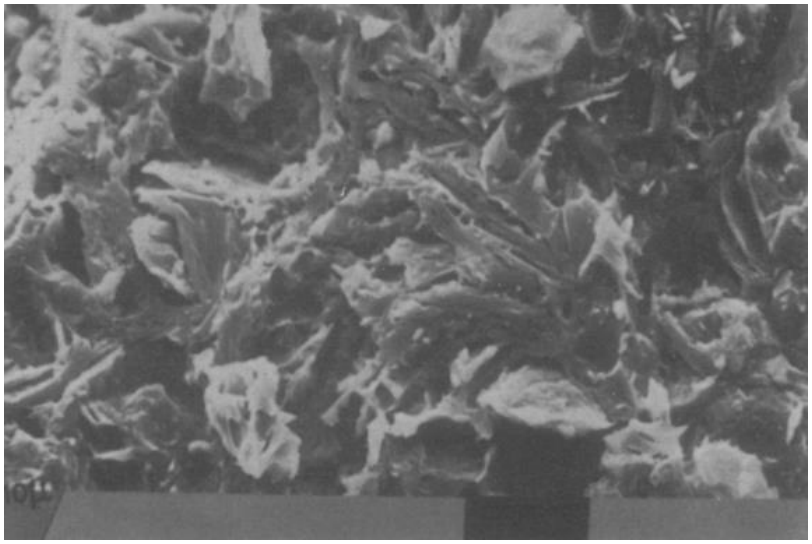


Figure 4.12 Extensive vitrification in a non-calcareous clay refired at 900˚C in an oxidising atmosphere, shown in an archaeological sherd from Romania (Maniatis and Tite 1981: figure 2).

The reconstruction of firing practices and the structures used in the past can be partly understood through the level of vitrification of clays, but due to the temperature overlap between open and kiln firings, and the need to consider firing atmosphere and duration, reconstructions have instead focused on firing *procedures* rather than temperatures (Livingstone Smith, 2001, Tite, 1995, Gosselain, 1992). Ethnographic research has also highlighted the importance of firing duration, the heating rate and soaking time, as well as the fuel, schedule and scale of the firing (Livingstone Smith, 2001: 993), highlighting

that temperature alone does not necessarily reveal the kinds of structures used (Gosselain, 1992: table 1).

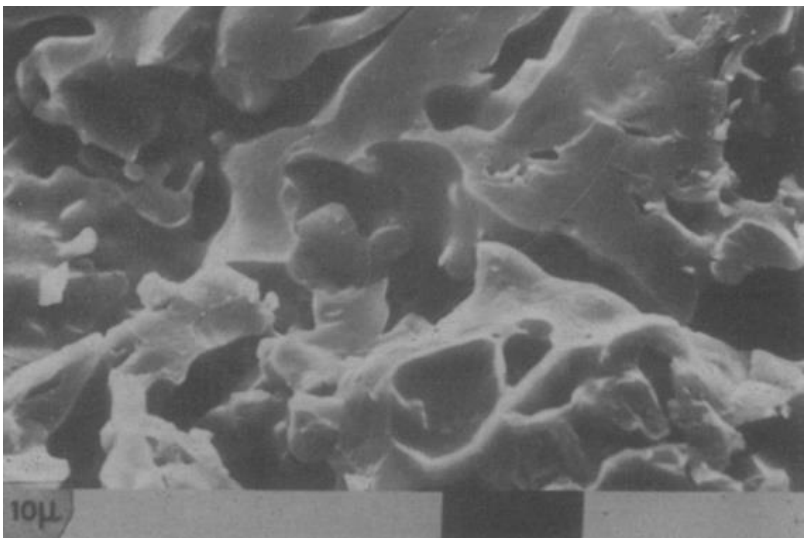


Figure 4.13 Continuous vitrification in a non-calcareous clay refired at 1020˚C shown in an archaeological sherd from Romania (Maniatis and Tite 1981: figure 3).

Analysis of ceramics from the above ethnographic studies estimated an average firing temperature of 800˚, with the majority of data falling between 600- 900˚ (Livingstone Smith, 2001: 997). However, the range and variation of firing practices could not be reconstructed from temperature estimates alone, and could not discern between interrupted firings, where the vessels were removed from the structure when red-hot, and slow cooling firings where the vessels were left within the structure while it and its contents reduce in temperature until they are removed by hand (Livingstone Smith, 2001: 997). General patterns in the data were also relevant to the reconstruction of past firing events, 1) recorded average maximum temperatures did not always correlate to the duration of firing, 2) shorter firings allowed for a higher heating rate and shorter soaking time (above 700˚C), and 3) longer firings allowing for slower heating rates and longer soaking times (above 700˚C) (Livingstone Smith 2001: 997). Therefore the characterisation of firing procedures using ceramic materials must consider a combination of parameters rather than estimated firing temperatures in isolation.

The formation of production groups based on technological style and processes have also incorporated the raw material selection, preparation and application of slip/glaze

layers, smoothing and burnishing layers, and painted pigments (Inanez *et al.*, 2013, Papachristodoulou *et al.*, 2010, Faber *et al.*, 2009, Speakman and Neff, 2005: 5, Faber *et al.*, 2002, Speakman and Neff, 2002). Quantitative chemical characterisation can be undertaken with techniques that allow for the direct analysis of pigment surfaces in cross-section and therefore isolation from the surrounding slips, clay matrices, or other pigment layers (as with eg. electron microprobe analysis, Freestone, 1982, or Laser Ablation ICP-MS, Speakman and Neff, 2005) (figure 4.14). The advantages such techniques have over other bulk chemical methods, provides an additional way to explore the link between technology and society in the same way compositional and temper studies address questions about the nature and significance of resource selection and use in the past.

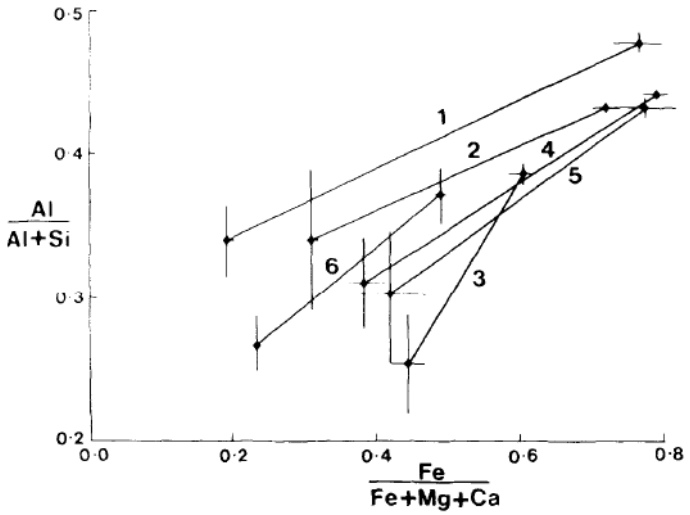


Figure 4.14 Compositional relationships between body and slip clays established with electron microprobe analysis, with the body clay low in iron concentration, and the slip layer low. Each point represents several analyses and error bars are equivalent to plus or minus one standard deviation. 1- Roman Samian ware, 2- Greek Attic black, 3- Greek Early Bronze Age, 4 and 5- Greek Attic bichrome read and black, 6- Roman local red slip, Algeria (Freestone, 1982: fig. 3).

If one presumes that finishing techniques can be separated from those of forming, and therefore that moulded decoration or paddle and coiling techniques did not also include materials to give a deliberately desired surface finish (Quinn, 2013: 181), the finished

surface/ surfaces of a vessel can be investigated separately to the clay body. Studies researching the technological practices involved in creating a slip layer, and the possible differential treatment of the clay for such a use, have added a more detailed understanding of the production process, particularly in some cases the reconstructed firing procedure (*eg*. Day *et al.*, 2006: 51- 54).

An interesting and related study to Southwest Iran is that undertaken on Late Neolithic-Chalcolithic wares in Mesopotamia (Diebald *et al.*, 2005). This uncovered a distinction between mineral and organic paints using Laser Ablation ICP-MS for Halaf and Ubaid pigments through manganese concentrations and other transition metals (Diebald *et al.*, 2005). The Ubaid mineral pigment groups are enriched in manganese and iron oxide, whereas Halaf organic pigment groups are relatively diluted in transition metals (Diebald *et al.*, 2005: 132). Within these two wider groupings based on chronological placement, there were further distinctions across sherds of both Half and Ubaid date. Halaf red pigments could not readily be distinguished from each other, nor from Halaf black pigments, but were clearly separated from Ubaid black groups (no red pigment being used in this later period) (Diebald *et al.*, 2005: 134). The few distinctions that could be made between the compositionally similar Halaf pigments are based on their rare earth element concentrations. The Halaf red shades all have generally lower concentrations of manganese, but the creation of different shades with pigments of a similar recipe has been suggested to be linked to a manipulation of firing temperature or atmosphere (Diebald *et al.*, 2005: 134). The Halaf black pigments also show source variation across the sample set from Western and Northeastern Syria to Southern Turkey based on divergent concentrations of vanadium and lanthanum oxides and rare earth elements (Diebald *et al.*, 2005: 133).

Therefore, as has been shown above, while pigment recipes can be compositionally similar, production groups can still be recognised based on the preparation of materials that can create different colours, or differentiate between different locations and groups of artisans. These groupings have helped detail a production process that pulls apart current typologies of Halaf ceramics that have previously relied on the few aesthetic

differences in decoration, and have produced reconstructions pertaining to the past ideology of ceramic production, movement and consumption.

4.5 *Conclusion*

In reviewing both the previous methodologies applied to studies of Neolithic and Chalcolithic ceramics in Iran and the wider Middle East and Central Asia as well as the various approaches to analytical research that can, in theory, be applied to each of the visible stages of the production chain, detailed levels of characterisation can be achieved. In bringing together all of these aspects of past production, an idea of technological style can be developed and explored for spatial and temporal variation. Such investigation allows a better understanding of the social values associated with materials, technologies and the finished artefacts themselves. Past craft industries, as representative of social values and belief systems, are therefore a valid and important area of study to contribute to our reconstruction of ancient societies, their organisation and interaction. This necessarily treats artefacts as far more than utilitarian objects devoid of meaning, but resituated them in a context of social and symbolic meaning within which they were originally created and used (Goring-Morris and Belfer- Cohen, 2001).

The following chapter details the sampling strategy and methodology this thesis will employ in order to answer the questions outlined in the Introduction. These all conform to a general aim of attempting to further understand the production processes in Neolithic ceramic manufacture to highlight the range of choices available to past crafters and therefore contextualise their decision-making process.

5. Sampling Strategy and Methodology

This chapter describes the samples that have been selected to address the specific research questions of this study, and includes a description of the methodologies employed to address them.

5.1 *Aims and Objectives*

This study is the first scientific analysis of Neolithic ceramics from Fars province, and the first detailed examination of the combination of decorated and undecorated wares. It is hoped this will highlight a broad range of different technical approaches to potting within the geographical area, and allow for examination and discussion of further areas of prehistoric technology, such as the transmission of specialist knowledge, the creation and maintenance of technical identities and any parallels with other contemporary Neolithic productive technologies. This is in accordance with the overarching question of this thesis: how Neolithic ceramics from Fars were produced, and what the socio-cultural context of their production and consumption was within communities.

The research questions as set out in the Introduction are as follows:

- What are the characteristics of Neolithic ceramics within this assemblage?
- What range of raw materials was used in the creation of clay bodies, slips and pigments?
- What economic information can we infer regarding the choice and use of plant temper?
- What technological methods and bodily gestures were employed to transform these raw materials into material culture objects?
- What can we learn about the transmission of knowledge and the learning process of this craft?
- What spatial and temporal patterns, if any, can be discerned in the assemblage based on this raw material characterisation?
- How were the ceramic vessels used and consumed within village sites?

5.2 *Site selection process and sampling strategy.*

Three sites from Fars province were selected for ceramic analysis, alongside the selection of survey material from a nearby valley system. Locations for sampling were chosen due to their previous lack of scientific analysis on Neolithic ceramic material, availability and recent excavation date, as well as on-going post-excavation study that would ensure the most recent methods of recording were adhered to. The sites targeted also yielded comparable ceramic material to previous excavations, which will enable broad comparisons between ceramics under study here and other existing typologies based on decoration. A focus has been placed on acquiring samples that reflect the range of decorative types available within Neolithic Fars (see chapter 2), and for this reason samples have been selected from Tol-e Nurabad which has a long sequence of occupation throughout the ceramic Neolithic and includes designs from all of the known ceramic phases (Mushki, Bashi, Jari), as well as its own distinctive Late Neolithic bichrome wares. Very early ceramic Neolithic styles have also been included from the site of Rahmatabad to investigate production of the earliest decorative wares. Additional examples of each of these ceramic designs have been included with samples selected from Qasr-e Ahmad, in order to increase the number of samples of some decoration and to investigate any geographical differences in raw materials or production techniques.

Unpainted ceramic sherds have also been sampled to investigate potentially different raw material and production methods of cooking wares. There samples were included from each of the excavated sites and also sourced from a survey of the Kazerun valley.

5.3.1. *Contextual descriptions*

The following sections include contextual information for the samples selected from each of the sites and survey.

5.3.2. *Tol-e Nurabad*

Material from Tol-e Nurabad is represented in this study by twenty one decorated ceramic sherds from Trench D (see figure 5.1.), that the author

received as sherds, and an additional collection of seven thin sections that were made in Iran in 2004 after the excavation season. These latter seven were derived from two Late Neolithic contexts in Trench A, phases A26 and A19, including five plain ware and two decorated examples. These sherds were selected by the excavators for sampling to illustrate some of the decorative types that were recorded in Trench A during that season, including plain buff wares and "red slipped/ painted" ware. The rest of the Tol-e Nurabad sherd collection derives from the 2008- 2010 excavation seasons. These samples span the Late Neolithic phases at Tol-e Nurabad and represent examples of ceramic decoration that in some cases fits within existing typologies outlined below, but also includes new and unparalleled designs that have not been recorded from excavations in Fars.

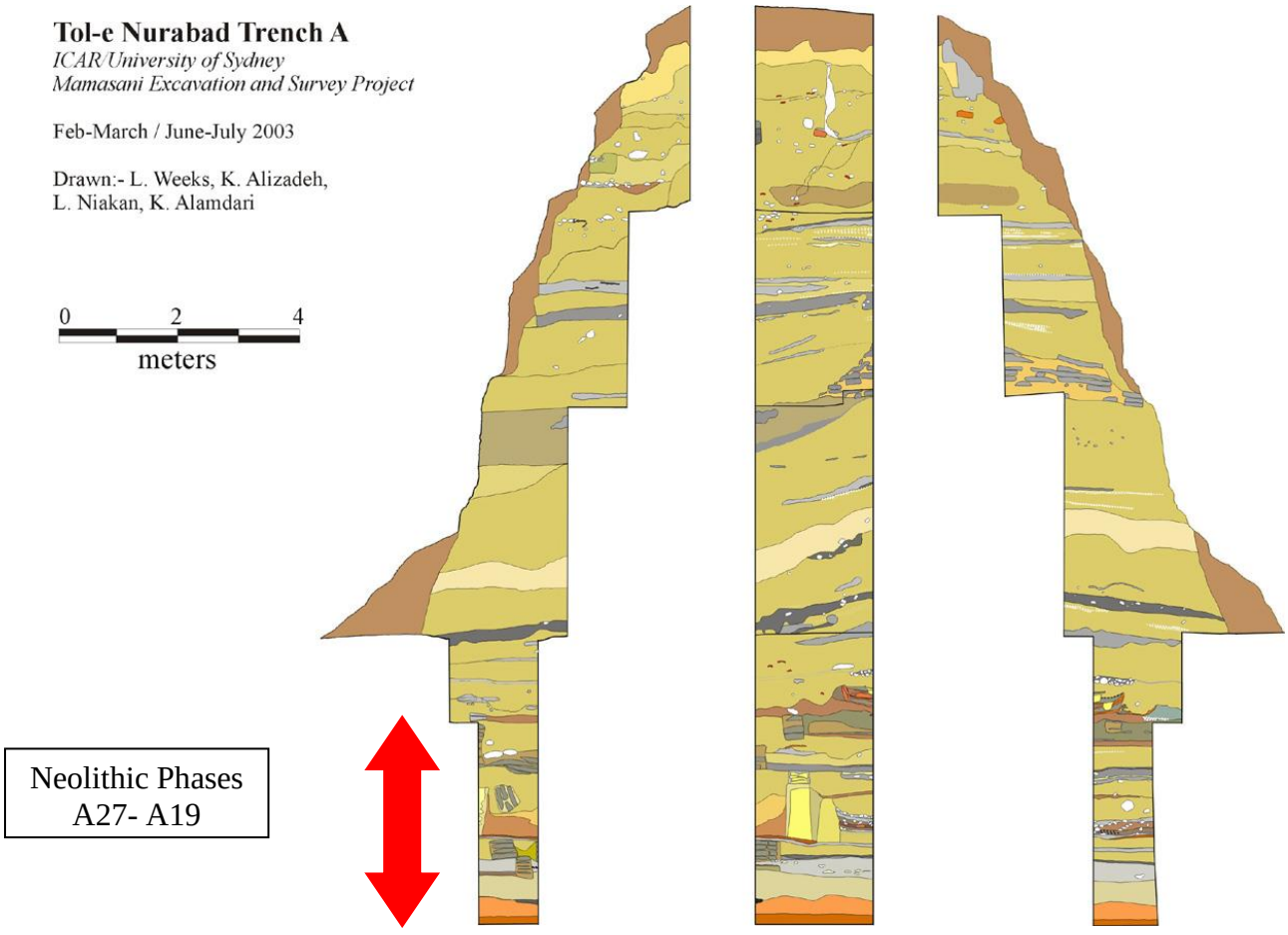


Figure 5.1. Trench A of Tol-e Nurabad, Mamasani region, from which samples within this study derive.

5.3.3. *Tepe Rahmatabad*

Ten samples selected from Tepe Rahmatabad derive from two contexts in Trench H of the most recent excavation season (see figure 5.2 for trench plan). These sherds included fragments of unpainted vessels, red-orange coloured interiors and buff surfaces painted with black motifs. The motifs represented in the samples correspond to typologies created using excavated material from Tol-e Mushki, Tol-e Bashi and Tol-e Jari B (level 8) (Azizi Kharanaghi *et al.*, 2013: 112-113, Nishiaki, 2010b: fig. 10, Fukai *et al.*, 1973: 25). Samples were included from two contexts, seven from context 8039 which belongs to the early pottery Neolithic phase. Three samples were selected from context 8032 which is the last layer of the Neolithic period at this site.

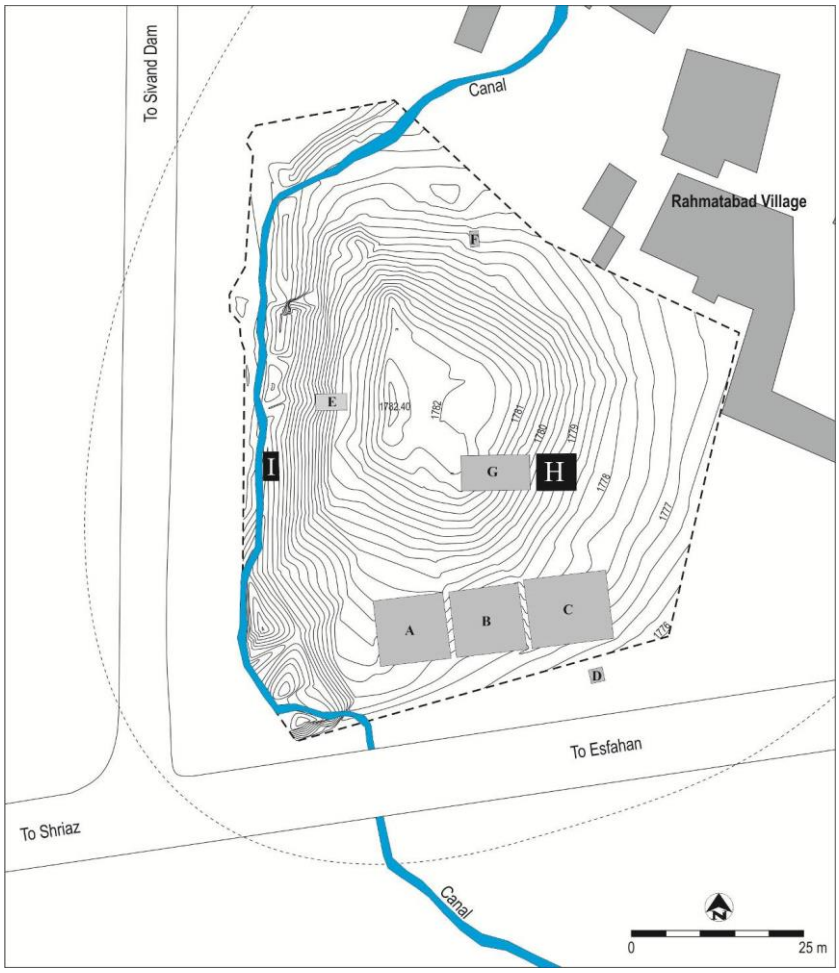


Figure 5.2. The site of Rahmatabad with the Trench H excavations indicated (Azizi Kharanaghi *et al.*, 2013)

5.3.4. *Qasr-e Ahmad*

Samples selected from the unpublished excavations of Qasr-e Ahmad include seven stratified samples from Neolithic deposits, and two surface survey sherds dated to the Neolithic based on stylistic traits, namely the presence and Mushki black painted decoration (P20) and carinated forms which are distinctly Neolithic. The samples all derive from a range of contexts, illustrated in figure 5.3. Samples include plain buff wares, buff burnished wares, those decorated with an exterior red wash, or red decoration on a buff or light orange-red surface that has been burnished, and black decoration on a buff surface. The decoration can be fitted into current typologies due to its similarity with the linear decoration at Tol-e Mushki and Tol-e Jari B, although there are no comparative samples from this site representing the more complex geometric designs as very few were found at this site and only in contexts 1005, 1009, 1012 (Hossein Azizi *pers. com.*) (Nishiaki, 2010, Fukai *et al.*, 1973).

Context NO.	RN	Sherd NO.
1004	1020	99
1005	1093	267
1009	1077	312
1012	1103	334
1013	1119	336
1017	1138	381
1019	1145	389

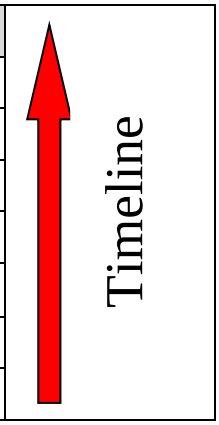


Figure 5.3. Contextual information for each sherd sampled from Qasr-e Ahmad.

5.3.5. *Kazerun Valley*

Neolithic ceramic material from this survey was collected from multi-period mounded sites within the Kazerun valley in Fars province (Rezaei *et al.*, in press). Estimated dating of the collected sherd assemblage has been conducted by the surveyors and is based on the inclusion of organic plant temper, the friable nature of the fabric and the thick profiles of sherds. These traits are uncommon in later ceramic production and are hallmarks of Neolithic period potting. All

sites were located in similar environments to the other Neolithic settlements recorded from Fars, in that they were in intermontane valleys, closely connected to rivers and springs (Rezaei *et al.*, in press). The sherd material contributed to this project includes plain buff wares, sherds with red and orange surface colours, but does not include any material with painted motifs.

5.4 *Geology of Fars province*

The Zagros Mountains are made up of several tectonic zones, including the main Zagros Crush zone and the Zagros Folded belt. Fars province stretches across both of these main zones (see figure 5.4 with the location of Fars province indicated), and includes common parallel limestone anticlines, oriented northwest to southeast. This area is comprised of an Upper Jurassic to Upper Cretaceous sequence of shallow shelf sediments, and structurally, is a zone of folding. Ceramic samples deriving from the Mamasani district, Kazeroun, Kamin and the Qara Aghaj valleys are located entirely within the Folded belt which occupies most of the Zagros mountains and their foothills (Falcon 1974: fig 1; Roustaei *et al.* 2009: 17). Thick layers of limestone were deposited during long periods of quiet, with occasional bodies of limey clays. Sandstone and shale underlie these, above a formation of salt, calcium sulphate and dolomite. In the foothills area of the mountain range, a thick mantle of sandstone and conglomerates, with a mix of salt and gypsum was deposited on top of the limestone. Regional folding later distorted this, resulting in the gypsum, marls and silts acquiring the properties of plastic flow in the strata with much more contorted folds compared to the round-topped and smooth limestone below (Harrison 1968: 166).

Therefore, the Zagros arc crust is made up of essentially sedimentary rocks, without any volcanics (Harrison 1968: 111). Additional soil surveys have highlighted localised sheet wash erosion in the Mahidasht, Kermanshah area, north of Fars, from which terra rossa clays have been reported, as well as the above mentioned calcareous, limey clays. Similar deposits in upland Pleistocene terraces of limestone gravel have been reported from the Shahrizor plain in the western edge of the Zagros mountains of Iraq (Altaweel *et al.* 2010: 5-6). The

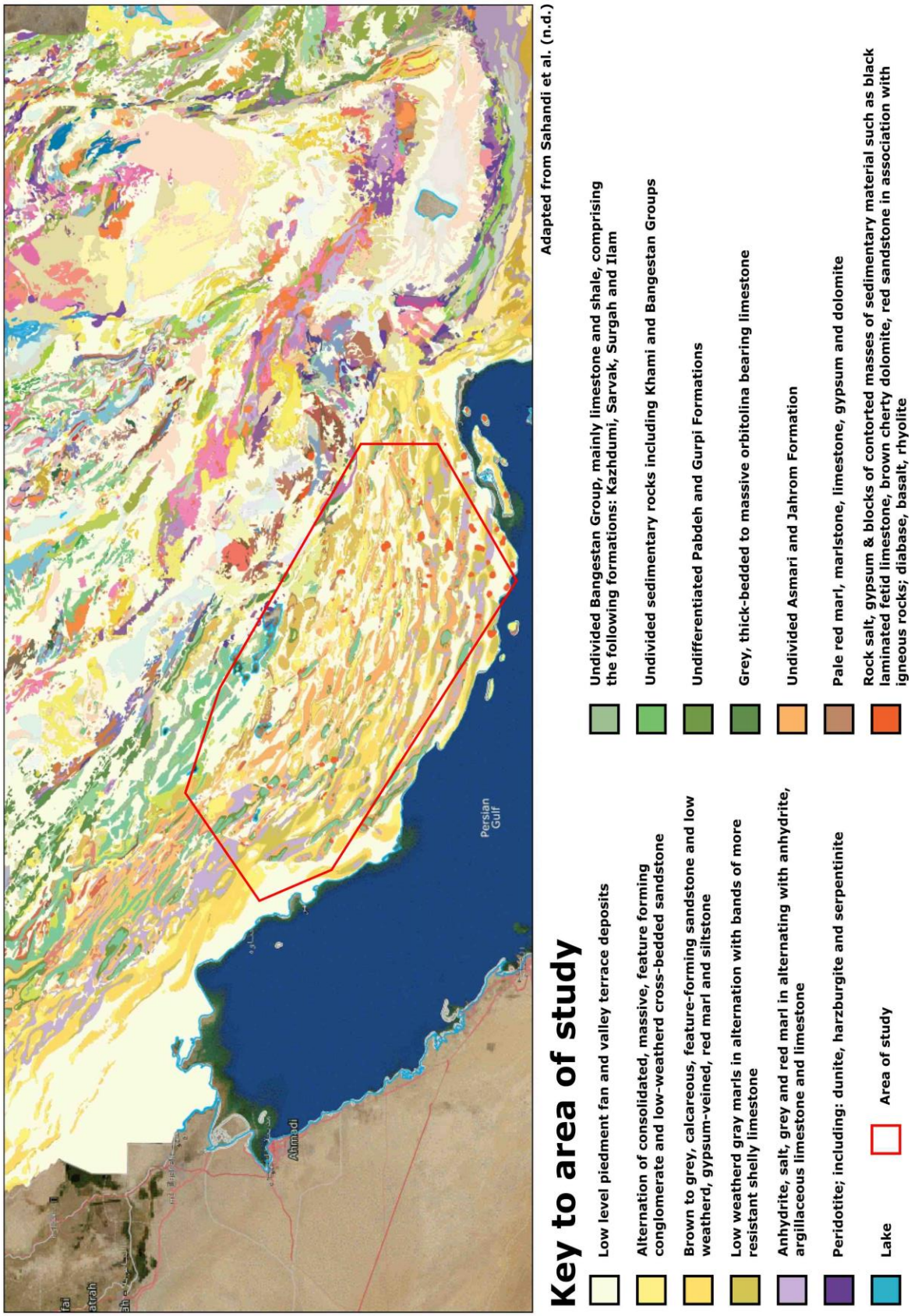


Figure 5.4 Geological map of SW Iran

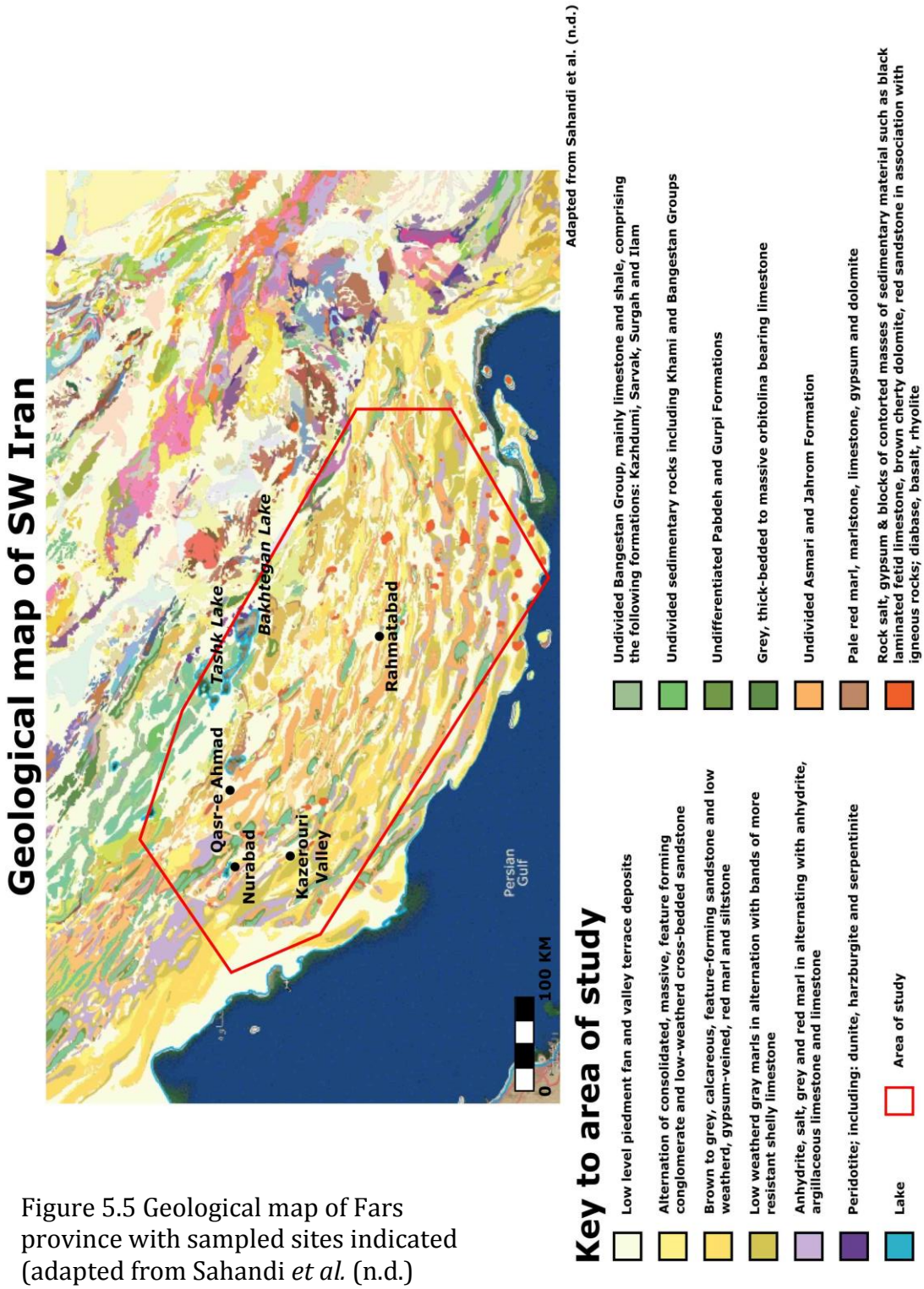


Figure 5.5 Geological map of Fars province with sampled sites indicated (adapted from Sahandi *et al.* (n.d.)

exact origin of terra rossa soils is still debated, they either developed through a result of carbonate dissolution and subsequent accumulation and transformation of limestone residue, or as unrelated to underlying rock and being allochthonous in origin (Merino and Banerjee 2008). However, they are recorded as forming on top of limestone deposits and is one of the most common paleosols in the Middle East (Lucke *et al.*2012: 21). Terra rossa therefore often contains inclusions of calcium carbonate in a wide range of grain sizes from 2- 200μm and hematite, the latter of which is responsible for the red colour. In the only available comparative study of the soil profiles in Western Iran, the remains of a weathered, fine grained terra rossa deposit had been removed by sheet wash and redistributed over the surface of gravel fans and lowlands by perennial streams during overbank floods (Brookes *et al.* 1982: 289). Such alluvial deposits have been described in the vicinity of the site of Tol-e Nurabad and traversed by rivers which ultimately join up and flow into the Persian Gulf. Colluvial and alluvial fans mark the edges of each plain (Roustaei *et al.* 2009: 17).

Having established the geology of the region in question, the methodology for creating and analysing samples will now be described.

5.4.2. *Methodology employed to create and analyse samples.*

This section details the methods used to make the samples for each analytical technique, as well as the standards used to analyse and record information from them.

5.4.3. *Thin-Section Analysis*

The use of this technique in archaeology has been derived from geological procedures and its application to archaeological materials was first pioneered in the work of Anna Shepard (1939), and David Peacock (1968). The advantages for those studying ceramic artefacts are that this technique allows for the characterisation and description of 1) the clay micromass, including potential clay mixing and sorting procedures, 2) the number and nature of non-plastic inclusions and their preparation by the potter, and 3) the forming techniques of vessels which can be deduced from paste porosity, and using samples taken at

different orientations (Gerrard, 1991: 190- 191, Whitbread, 1989: table 1, 1995: 374- 375). This approach allows the potential differentiation between characteristics inherent in raw materials and those that have been purposefully added, removed or manipulated by the potter, thus contributing to our understanding of the various technological steps taken in manufacture (Reiderer, 2004: 143, Whitbread, 1989: 128). The provenance of these raw materials can also be investigated by comparing to known geological sources (Reedy, 2008: 124), or by calculating the abundance of certain fabrics or temper inclusions.

Preparation of thin-section samples is necessarily destructive as part of the cultural object is permanently removed before being mounted, ground and polished onto a glass slide (Reiderer, 2004: 144). These samples are then kept alongside the original artefact in museum storage so that future analysis can be conducted in light of new techniques, more detailed research potential and fresh information relating to their time period or region of origin etc. (Institute of Archaeology Collections Group, 1999).

The assemblage of sherds was sampled using a Beuhler low-speed precision saw with a diamond tipped blade and sent for preparation into thin sections at the Fitch Laboratory of the British School at Athens. The cut sections of sherds were then impregnated with low viscosity two part resin, used to fill the pores in the clay body and those from the organic temper. Once dry, the surface of the sample is ground and polished flat to a thickness of 30μm to provide a suitable surface for the bonding of a glass microscope slide. This was performed manually by rotating the sherd slice downwards on a glass surface in a mixture of water and silicon carbide, 10-16 μm in size. The sherd slice was then bonded to the glass microscope slide using a synthetic optical adhesive, ensuring minimal air bubbles were trapped within the slide. This covering ensures that the sample remains protected and can be further studied in the future. An Olympus BX51 polarising microscope was used to study the thin section samples in the Archaeology department of the University of Nottingham for analysis with a range of x5, 10, 25 objectives .

5.4.4 *Techniques used to examine and record thin sections*

The recording criteria used to analyse the thin section in this study is based on the system proposed by Whitbread (1995: Appendix 3), and modified to closer describe ceramic compositions (Quinn 2013: 81).

Clay micromass and inclusions: The clay micromass was recorded using both plane and cross polarized light. Terminology used to broadly describe the fabric include terms such as silty, fine *etc.,* and which refer to how the clay appeared in thin section and the quantity of inclusions and voids. Optical activity of the clay micromass was determined under cross polarized light and was based on the colour and presence/absence of interference colours (Arnold 1974; Whitbread 1995: table A3.5; Quinn 2013: 81).

Inclusions: Different factors were used to identify inclusions in the clay, including colour, pleochroism, cleavage, birefringence and extinction angle. Comparison charts for the visual estimation of percentage area of inclusions (figure 5.6), and categories for the description of shape and angularity were used from Quinn (2013: figs. 4.9, 4.11). The following frequency scale was used from Whitbread (1995: table A3.1).

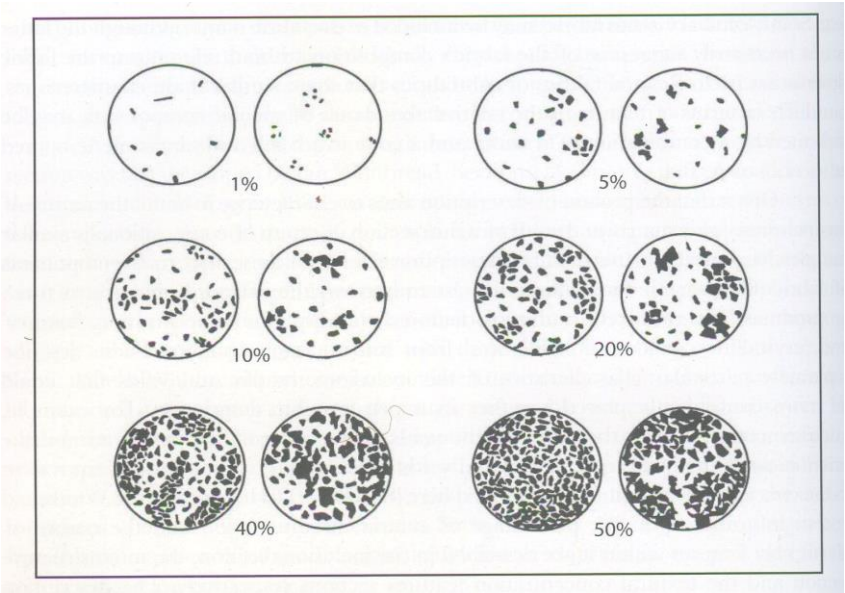


Figure 5.6. Comparison chart for the visual estimation of percentage area of inclusions (Quinn 2013: fig 4.9).

- Predominant: >70%
- Dominant: 50-70%
- Frequent: 30-50%
- Common: 15-30%
- Few: 5-15%
- Very few: 2-5%
- Rare: 0.5-2%
- Very rare: <0.5%

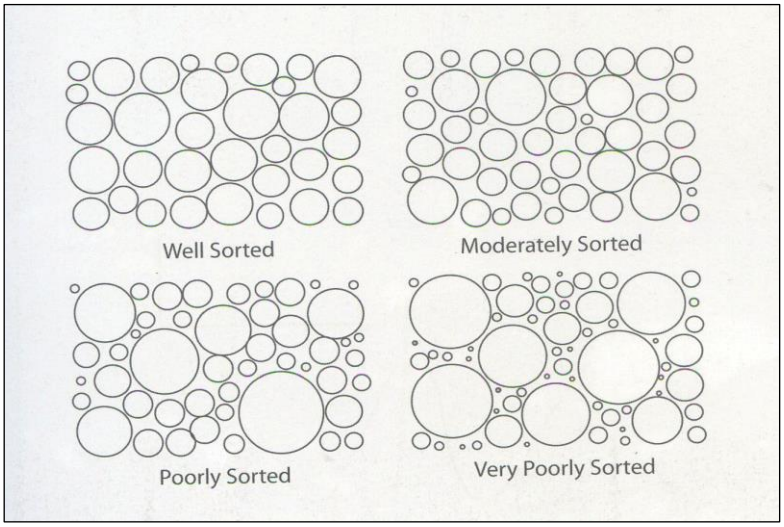


Figure 5.7. Comparison chart for estimating the degree of inclusion sorting in clast sediments and sedimentary rocks, applicable for the description of inclusions in archaeological ceramics (Quinn 2013: fig. 4.15).

The degree of inclusion sorting was determined using the above visual identification chart (Figure 5.7). Voids can be characterised and described using the following descriptive categories (and illustrated in Figure 5.8) (Quinn 2013: 4.25).

- Vesicles: regular and with some degree of roundness
- Channels: linear in thin section, but cylindrical in three dimensions
- Vughs: large, irregular voids
- Planar Voids: linear but can be three-dimensional, variable and irregular

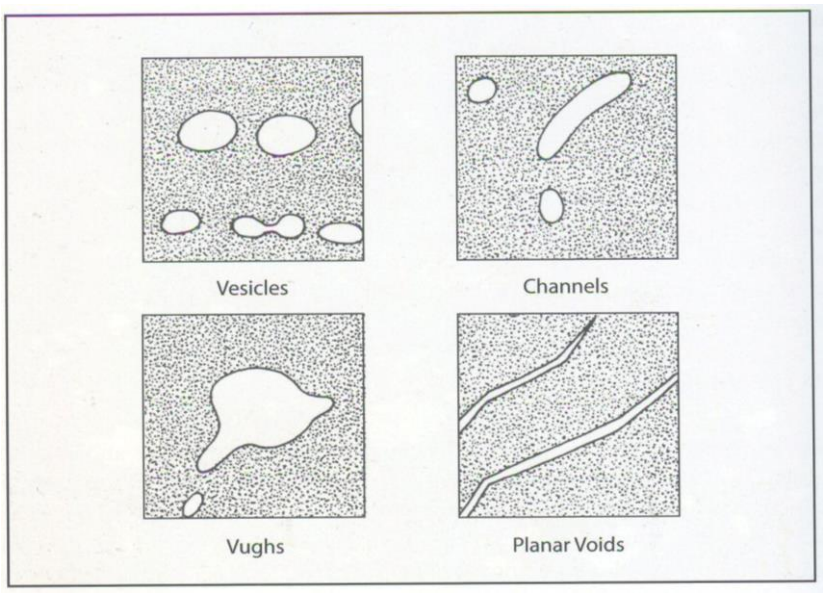


Figure 5.8 Terminology for the description of void shapes in archaeological ceramics (Quinn 2013: fig. 4.25).

Argillaceous inclusion terminology is based on optical density, the nature of grain boundaries and shape (Figure 5.9) (DiCaprio and Vaughan 1993). I have followed the descriptive terminology outlined by Whitbread (1986: table 1).

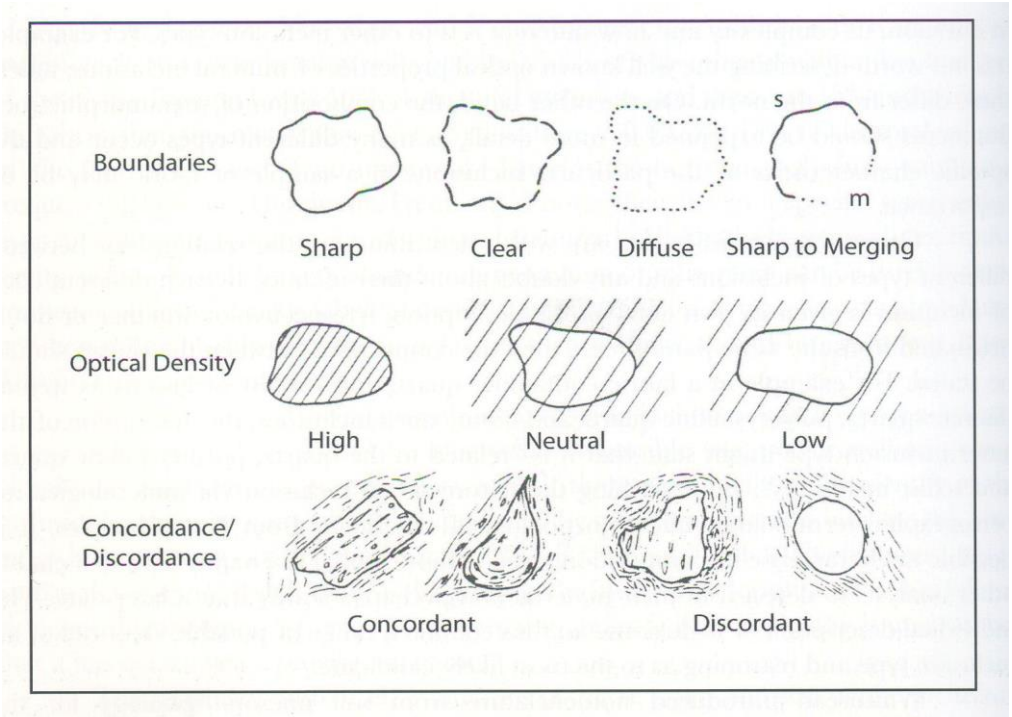


Figure 5.9. Selected terminology for the characterisation of argillaceous inclusions (Quinn 2013: fig. 4.19).

5.4.5 *The electron microprobe*

Preparing samples for this technique is another destructive process, but one that enables the finished samples to be re-used many times using either an electron microprobe or an SEM. A small slice of the ceramic sherds is sliced off with an electric diamond saw in a similar manner to thin section preparation. This was then mounted within the microprobe sample block moulds. Attention was paid specifically to retaining the surface edges of both the interior and exterior of the sherd sample, and a record was kept of the position of the sherd in the mould, with reference to interior and exterior surfaces and the location of specific painted and coloured surfaces. Once the sample was placed within the mould, resin was poured in under vacuum and the sample left to cure overnight in a fume cupboard.

A Cameca sx100 electron microprobe was used at The Open University's CEPSAR: Research Centre for the Physical and Environmental Sciences, set up with a beam size of 5µm to analyse Al, Si, Na, Mg, Mn, Fe, K, Ca, Pb, Cl, Ti, Cr and P, using wavelength dispersive x-ray fluorescence. This magnification was selected to avoid the numerous pores occurring in the ceramic fabrics and the occasional, larger inclusions occurring in the fabric. In addition, this is an appropriate beam size to focus on the slip and pigment layers to characterise the raw materials for each individual layer and independently of the surrounding paste. A focus on the analysis of the body clay was also intended, as this would build on the information gathered with petrographic analysis and provide further detail into the chemical composition of the clays and any notable differences among the assemblage.

The principle of this technique is to direct a beam of electrons at a flat sample held under vacuum (Freestone, 1982: 99, Froh, 2004: 159- 160; Reed 2005). This focused beam of electron bombardment rasters the surface and excites a specific spot on the sample, while the x-rays generated are analysed by energy-dispersive or wavelength-dispersive means. These x-ray emission lines are produced by the ejection of an electron from the inner atomic shell, known as "characteristic radiation" due to the wavelength of the lines being specific to the

element emitting them (Reed, 1993: 4-5). Therefore, depending on the wavelength (or photon energy), and intensity of the lines in the X-ray spectrum, the identification and concentration of the elements present is possible. This is achieved by correcting for background interference, derived mainly from the continuous X-ray spectrum, and then comparison with a set of known standards to give a fully quantitative analysis of the excited volume (Reed, 1993: 3).

The advantage of electron microprobe analysis over other techniques such as X-ray fluorescence analysis or neutron activation analysis, is the opportunity to select small areas of a sherd cross section for analytical work. In this manner, the clay paste can be analysed separately from temper grains, slip and pigment layers, giving chemical data independent of each of these aspects of the ceramic and helping understand the spatial variation in composition (Abbott and Watts, 2010: 1616, Pollard *et al.*, 2007: 109). The chemical data generated was tabulated, with the respective areas of the sample that had been analysed indicated. Backscattered electron images were also used in identification of different structural layers and phases (Josa *et al.* 2009).

5.4.6. *Scanning Electron Microscopy*

SEM analysis works along similar principles to an electron microprobe in that they both utilise the principles of electron beam microanalysis (Pollard *et al.* 2007: 111). The instrument used in this study was a JEOL JSM 5910 with an accelerating voltage 0.3 to 30kv, magnification of up to 300,000 and a resolution 3.0 at 30kv. Secondary electron and backscattered electron imaging was used with energy dispersive x-ray for microanalysis. The same samples that were prepared for electron microprobe analysis were used with the SEM.

5.5.1. *Typology of samples*

In this typology I have made a distinction between those wares that include painted motifs and those that do not, despite some wares including painted surfaces, such as potential wash applications. All of the wares in the Painted Motif category have designs that have been painted with pigments and brushes into individual design motifs. In studying the decorative motifs of the sherds in

this assemblage, new motifs, or adapted versions of existing ones can be seen. Rather than employ vague terms such as "Mushki-related", Mushki "influenced" etc., which add little to our understanding of the assemblage, I have grouped them together with the Mushki repertoire and acknowledge that we are not yet capable of recording the entire collection of similarly executed designs that conform to a specific style. This is largely due to limited excavation of similar age sites and therefore a lack of understanding of the spatial and chronological extent of this cultural phase, and how it differs from other contemporary or later groups.

The Unpainted Plain Ware category below includes sherds that do not exhibit painted motifs.

5.5.2. *Unpainted wares*

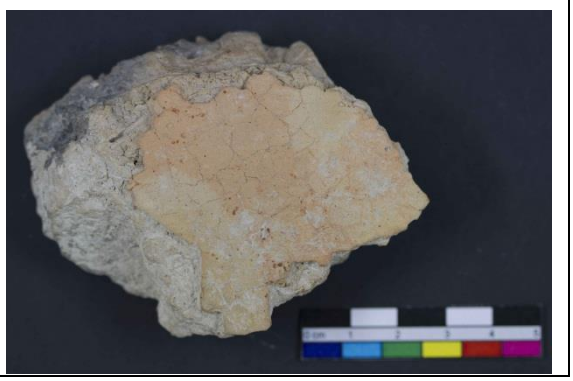
Buff with exterior burnish

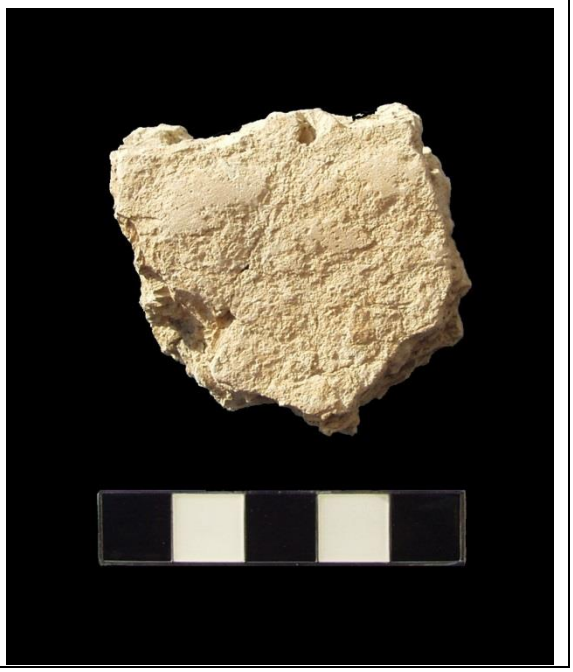
Sherd	Site	Trench	Phase	Context	Sherd Photograph
381	Qasr-e Ahmad	A		1017	

88.7	SK5				

Buff interior and exterior

Sherd	Site	Trench	Phase	Context	Sherd Photograph
389	Qasr-e Ahmad	A		1019	
8595	Rahmat-abad	H		8039	

8487	Rahmat-abad	H		8039	
63	SK 21				
65	SK 21				
88.4	SK 6				

001	Nurabad	A	A26	170	
0002	Nurabad	A	A26	170	

003	Nurabad	A	A26	170	
004	Nurabad	A	A19	116	
006	Nurabad	A	A19	116	

Buff exterior, red interior

Sherd	Site	Trench	Phase	Context	Sherd Photograph
8543	Rahmat-abad	H		8039	
8695	Rahmat-abad	H		8039	

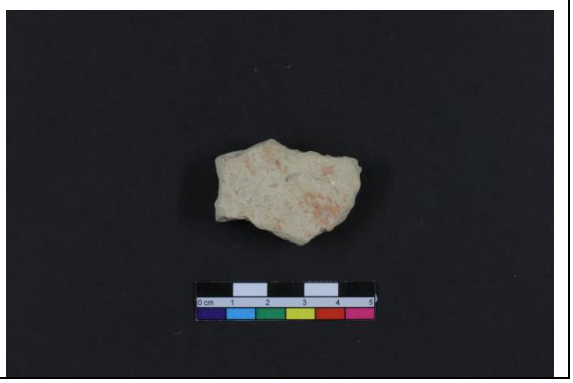
Red exterior and buff interior

Sherd	Site	Trench	Phase	Context	Sherd Photograph
334	Qasr-e Ahmad	A		1012	

12	SK18				
11	SK17				
005	Nurabad	A	A19	116	

007	Nurabad	A	A19	116	

Red interior and exterior

Sherd	Site	Trench	Phase	Context	Sherd Photograph
8555	Rahmat-abad	H		8039	
14	SK 17				

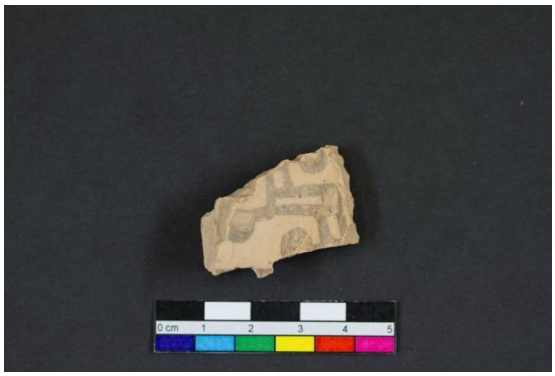
23	SK 20				
43	SK 21				
34	SK 21				
44	SK 21				

5.5.3. *Painted Motif Wares*

Black Mushki decoration on Buff

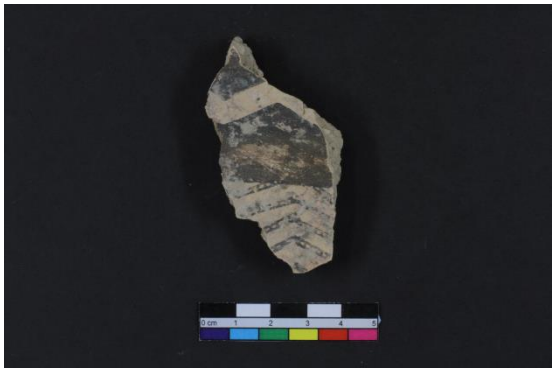
Sherd	Site	Trench	Phase	Context	Sherd Photograph
8526	Rahmat-abad	H		8039	
S.1	Qasr-e Ahmad				
S.2	Qasr-e Ahmad				

Black Mushki decoration on buff with a red interior

Sherd	Site	Trench	Phase	Context	Sherd Photograph
8655	Rahmat-abad	H		8039	
8706	Rahmat-abad	H		8032	

Black Jari decoration on buff

Sherd	Site	Trench	Phase	Context	Sherd Photograph
8707	Rahmat-abad	H		8032	
8575	Rahmat-abad	H		8039	
5327	Nurabad	D	D5A	1073	

3856	Nurabad	D	DNU	1059	
3883	Nurabad	D	DNU	1059	

Painted Red linear and crosshatching motifs on a buff surface with buff interior

Sherd	Site	Trench	Phase	Context	Sherd Photograph
2363	Nurabad	D	D2	1007	

4942	Nurabad	D	D2-3	1066	
2430	Nurabad	D	D2	1007	
5134	Nurabad	D	D3	1069	
4964	Nurabad	D	D4B	1025	

4761	Nurabad	D	D5A	1046	

Painted bichrome linear and zigzag motifs on buff with red interior

Sherd	Site	Trench	Phase	Context	Sherd Photograph
5671	Nurabad	D	DS	1096	
5667	Nurabad	D	DS	1096	

Painted bichrome linear and zigzag motifs on buff surface with buff interior

Sherd	Site	Trench	Phase	Context	Sherd Photograph
3865	Nurabad	D	DNU	1059	
5428	Nurabad	D	D6	1084	
4915	Nurabad	D	DNL	1064	

Black decoration with red interior and exterior reduction clouds

Sherd	Site	Trench	Phase	Context	Sherd Photograph
2391	Nurabad	D	D2	1007	
2484	Nurabad	D	D2	1007	
2592	Nurabad	D	D2	1007	

5.6. *Summary of research and analytical methods*

This chapter has outlined the sampling strategy and methodology for analysis undertaken for this project. All ceramic samples have been detailed above, with

contextual information of each of the sites sampled. The following chapter (Chapter 7) details the results of all analysis and presents this in the same format as this typology to aid in the understanding of ware groupings. Working from this newly devised typology, I have selected sherds from each class for investigation and characterisation through thin section, scanning electron microscopy and electron microprobe analysis. This was based on their suitability for sampling which included their larger size, the retaining of slip or wash surfaces on both the interior and exterior, and specifically applicable to bichrome ware was the close proximity of both coloured pigments on the surface to ensure that the sample taken would include examples of both pigments.

6. Results of analysis.

6.1 *Introduction*

This chapter describes the results of thin section, electron microprobe and SEM analysis undertaken on select samples from each category of the typology. A discussion of these results will follow in the subsequent chapter.

6.2 *Thin section analysis*

All sherds were sampled for thin section analysis and conformed to predicted expectations of raw materials based on a review of the local geology of the Zagros region. The sites incorporated in this study all fall within the Main Thrust zone of the folded belt of the Zagros mountain range, an area geologically characterised by sedimentary carbonates, of which are typically shallow marine limestone and marl with pockets of limey clays overlying a sandstone, shale and dolomite base (Roustaei *et al.*, 2009; 17, National Iranian Oil Company, 1959, 1977). A single ceramic petrographic description is presented below which encompasses the fabric of all of the sherds sampled in this study, with variations described in the comments section. While the petrographic grouping describes similar material used for all the body clays, it does not take into account the different slip treatments that have been applied. Differentiation of post-forming materials is described in the results of the chemical analysis.

6.3 *Fabric description for Fine grained plant tempered ware, with abundant well sorted calcite and mica*

The format taken for this fabric description is an updated version of the Whitbread system that is now commonly applied in descriptions of archaeological ceramics (Quinn, 2013, Whitbread, 1995). The addition of a comments section highlights the main areas of variation within the group, and further petrographic details of sherds are described alongside the description of results for SEM and microprobe analysis within the ware groupings below.

Microstructure	The fabric has common channel voids, 1-4mm oriented to the planar surface.
Groundmass	The composition is a crystallitic birefringent fabric, which is optically active. The groundmass is calcareous and micritic. The fabric is dark brown/orange to yellow/orange in XP x20, and dark red/brown to light yellow/orange in PPx20
Inclusions:	Mineral inclusions make up 15-20% of the ceramic (x20). The inclusions are well sorted (fine sand to silt), throughout the fabric.
Fine Fraction <100µm	Predominant equant sub-angular to rounded opaques, microfossils, muscovite laths, elongate to equant sub-rounded biotite micas, feldspar, and iron oxide. Occasional hornblende.
Coarse Fraction >100µm	Frequent sub-rounded calcium carbonate grains, sub-angular quartz and opaques (organic roots).
Comments:	Variation within the fabric group lies within the coarseness of this fine fabric, with samples from Qasr-e Ahmad (381, 389 and 334), consisting of virtually no inclusions and made with a very fine, silty mud. These were still tempered however, with same ratio of organic material. Despite the difference in size between some non-painted sherds and painted sherds, the amount of organic temper remains the same throughout all of the samples. Post-forming slip applications can be detected in some sherds very clearly (e.g. Rahmatabad 8695 and SK17. 11), while in others a slight difference in texture is noted at the surface (e.g. Rahmatabad 8655), but no confirmation of a separate addition of clay was possible until investigated with chemical analysis.

6.4 *Electron microprobe and SEM results*

The results below are presented in the format of the typology outlined in the sampling strategy and methodology of chapter six. During the microprobe analysis, it was found that spot analysis was not the best technique with which to analyse slip and pigment layers. The totals obtained for this area of the samples were very low, or missed the pigment layer entirely, analysing resin alone. It is suggested that the main cause of this was a combination of the sample edge having been partially lost during sample preparation and the heterogeneity of the clay raw material. In addition, some points focused on the clay body were also very low, although three tables of data that are of reasonable data have been discussed in this chapter; the others feature in Appendix B. These low results may have been due to the highly calcareous nature of the clay, with the calcium carbonate not having been converted to lime because of a low firing temperature and/ or soaking time. Pure limestone is 56% CaO and 44% CO2, but as the latter cannot be measured by microprobe (WDS) or SEM (EDA) the maximum total for analysed limestone can never exceed 56%. This, combined with high porosity of the samples, has meant totals were very low in the analytical runs and that the technique was not successfully employed on this type of material.

A focus was therefore moved to creating elemental maps, which was very time consuming and could be better and faster achieved using an SEM. The advantages of using a microprobe were that it had a lower detection limit which could help differentiate between subtle chemical differences. Thin section analysis revealed all samples to be from very similar clay deposits, with the results from the microprobe runs that were undertaken showing no differentiation in minor elements across samples in each group. This is understandable due to the underlying geology of the area under study in Fars province, and the wider Zagros Main Thrust belt running from north to south of the country, being part of the same geological zone (National Iranian Oil

Company, 1959). It was also decided to undertake SEM analysis on the excavated material only since they are securely dated and include surface modifications, such as slip/wash layers and painted motifs, which are the main focus of this chemical work.

6.5 *Unpainted Plain Wares*

This class of wares includes examples of vessels that have not been painted with motifs. However, in some cases the colour of an internal or external surface may have been applied as a separate layer of clay, or as a wash. From inspection in-hand and with a binocular zoom microscope of some sherds, it is impossible to tell if a wash has been applied onto a very fine slip, a hard vitrified surface layer, or onto a wet-smoothed surface. If the colour has been applied as a wash, it is likely this will have been undertaken with a brush and could therefore be labelled a "painted" ware. However, I have chosen to distinguish painted and unpainted wares by the presence of painted motifs only for the ease of describing this typology. Further, I have also chosen to label this class of wares as "plain" due to the absence of painted motifs.

Buff with exterior burnish

The two sherds in this group have distinct calcareous body clays, with QA 381 (see Appendix B), containing very few small inclusions, while SK5. 88.7 contains an increased amount of carbonate grains, including microfossils. These conformed to the expected species commonly found within micritic limestone fragments, mainly foraminifera (Quinn 2013: 140). The finer sediment of QA 381 has most likely contributed to the extremely successful burnish on the surface which has no trace marks of the process, but is a continuous, uninterrupted sheen.

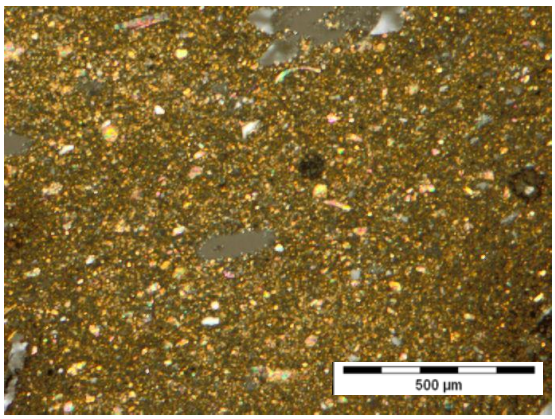


Figure 6.1 Thin section micrograph of SK5 88.7 which shows the fine calcareous body.

Buff interior and exterior

This plain buff class includes thin section samples of unpainted ceramics from a range of sampled sites. All have been made with buff firing calcareous clays, and it is presumed all have been slipped based on their surface appearance when inspected in-hand and visible surface layers seen in profile in thin section (Figure 6.2). Not all of the thin sections can be investigated for surface treatment, as the surface of samples did not always survive the sample preparation undertaken in Tehran for five of the samples included in this group. However, comparison of the surface appearance of the sherds in this category shows that all have a similar smooth surface, with inspection of sherd profiles showing a clear slip layer. For some of the Nurabad samples (002 and 006), this is not possible to see in thin section, but is presumed therefore to be the same as the other samples in this category.

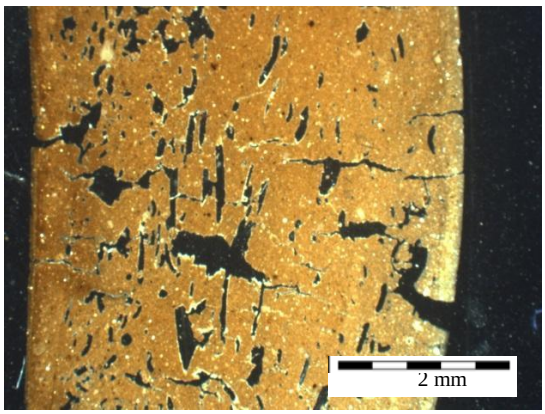


Figure 6.2 Nurabad 001 in thin section with slip layer applied to the burnished exterior surface on the right hand side of the photomicrograph.

Inspection of the clays used in slipping appear to correlate with other results found in this assemblage, in that compositionally similar clays are used with the main difference to the paste clay being the absence of organic temper. In some cases, the slip clay is slightly coarser, as in 003, and the surface has been burnished before the application of the slip, 001 (see Figure 6.2).

The paste of QA 389 (see Figure 6.3), and SK21. 63 are the finest in this category, and conform more to the descriptions of very fine calcareous mud or swamp clays. Thin section slides show these ceramic bodies to be extremely fine in texture compared to other some of the other fine pastes, which were analysed with an electron microprobe (see Appendix B).

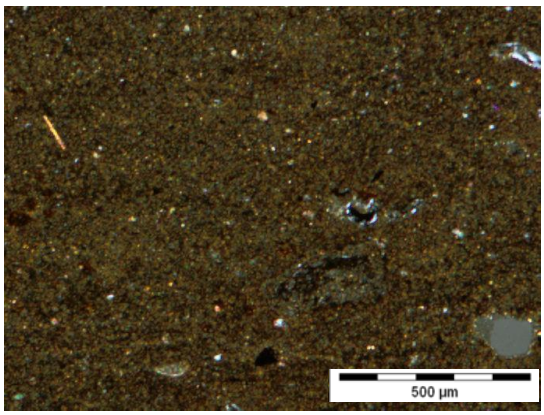


Figure 6.3 Qasr-e Ahmad 389 in thin section which shows very fine calcareous body clay of sample.

Buff exterior, red interior

This buff class has an additional red interior that has been created through a localised oxidation on the interior of the vessel when it was fired. This is a different approach to the creation of other red surfaces in this study, as these have been created by painting the exterior of the vessel to create the red coloured surface.

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
0.34595	0.54074	2.1745	2.71383	13.2716	0.03092	3.96408	0.01931	8.546	0.033	43.89458	0.24279	0.14862	75.92594	body
0.22659	0.34407	2.269	1.69971	4.25612	0.01916	2.24326	0.00001	6.93389	0.03999	68.08491	0.1621	0.04439	86.32318	body
0.62866	0.71484	2.8728	4.03911	13.63007	0.11541	8.09798	0.04402	11.86524	0.04558	38.409	0.61892	0.14561	81.22723	body

Table 6.1. Electron microprobe results of analysis of the body of R 8543.

Calcareous buff firing clays were still used (table 6.1), and these were also slipped. In the case of R 8695, fine clay was applied (1.5mm), with a higher concentration of carbonate inclusions than the body, which was more iron rich, giving a very clear indication of the two layers in thin section.

Red exterior and buff interior

The red exterior, buff interior group is again made from compositionally similar calcareous clays. The creation of a red exterior was achieved in different ways, and can be identified visually on the sherd, for example QA 334 has a distinct layer applied onto a buff firing clay, while the remaining sherds have a thicker slipped surface. The red exterior of QA 334 was created by the application on an iron rich clay applied as a pigment layer that is approximately 20-30μm thick in thin section. SEM backscattered electron images showed the slip and burnished body layers to be very similar in texture (figure 6.4).

Ochre particles were identified through elemental mapping of iron however and show the material to most likely be a terra rossa clay, based on its recording from the area (chapter five, section 5.3.6), which was fired in an oxidising atmosphere (figure 6.5). The larger, rounded grains resisted grinding which suggests the material underwent little processing before it was burnished into the vessel surface (figure 6.6). This method ensures maximum coverage of the red colouring and is a more economical approach than creating a suitably thick pigment in enough quantity to cover what we presume to be the entire exterior of the vessel.

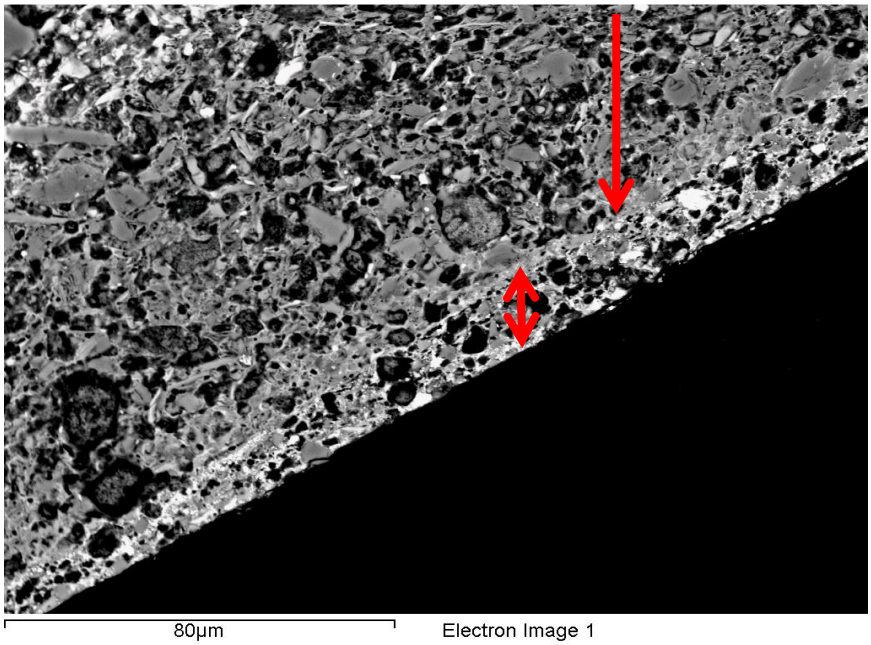


Figure 6.4 Backscattered electron photomicrograph using SEM of QA 334 showing the surface application of a clay layer that is texturally similar to the body clay, but has an increased concentration of ochre particles.

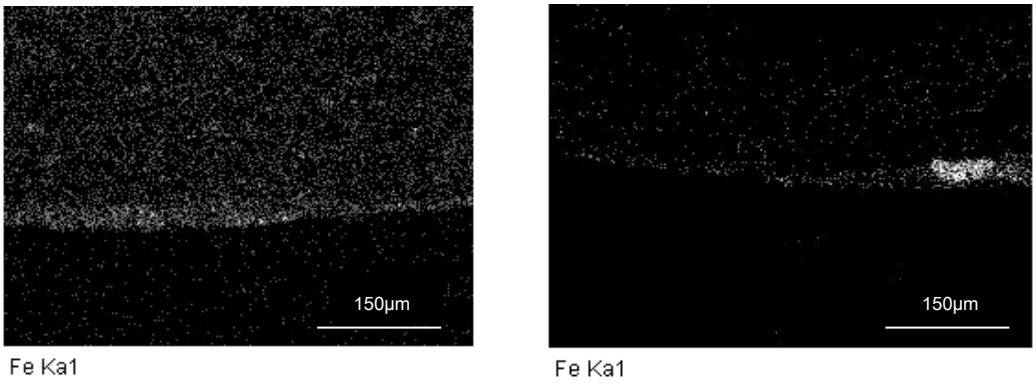


Figure 6.5. Element maps of iron for sherd QA 334 that show the slight iron enrichment in the burnished surface layer (left), and in the large ochre grains (right).

Also, the potter has chosen to burnish a red firing clay into what we may presume was the entire exterior surface and into the interior rim, which would have required a significant amount of pigment preparation. Burnishing ochre-rich clay into the vessel surface creates the same effect as a vessel that has been slipped with an iron rich clay, such as sherd SK17. 11 in this group. Thin section analysis of SK17. 11 and SK18.12 shows that the sherds have been burnished first and then slipped with a red iron rich clay, demonstrated by the migration of finer particles to the surface and slanting orientation of grains at this relic surface when inspected in profile in thin section This typological group therefore represents another example of aesthetically similar vessels being created using different techniques.

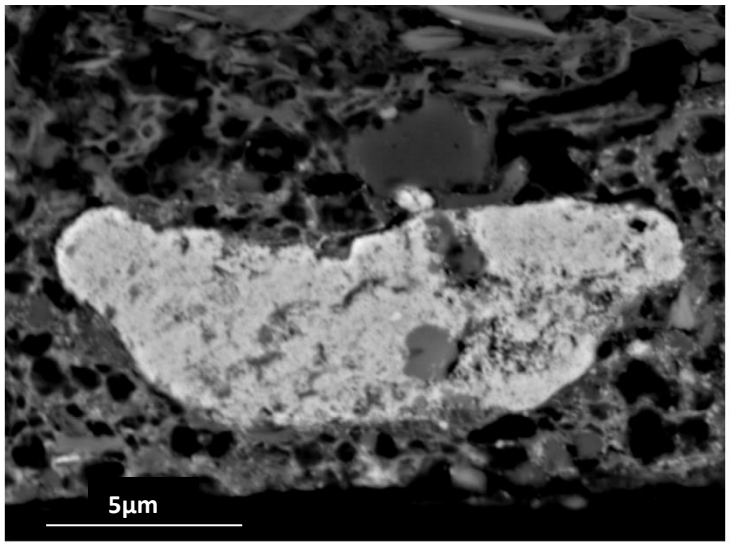


Figure 6.6. A large, rounded ochre grain in the surface application of sherd QA. 334. The presence of grains like this in this sherd suggests the clay was not ground down into a pigment, but has been burnished into the surface when the vessel had reached a leather-hard state.

Red interior and exterior

The creation of a red interior and exterior has been managed in different ways as shown by the samples in this category. Vessel pastes are similar across the group, with a range of buff colours seen in thin section. In some instances, a separate slip and pigment layer have been added, as has been done for SK21. 43. This vessel was made with the local calcareous clay, has a compositionally similar thick slip applied (approximately 1mm), and then painted with an iron rich pigment (150- 175µm, evident in figure 6.7), that has fired red, possible during a single oxidising firing. Elemental mapping undertaken with an electron microprobe clearly shows the enrichment of iron and aluminium in this pigment layer, and its depletion of calcium and silica compared to the body clay (figure 6.8).

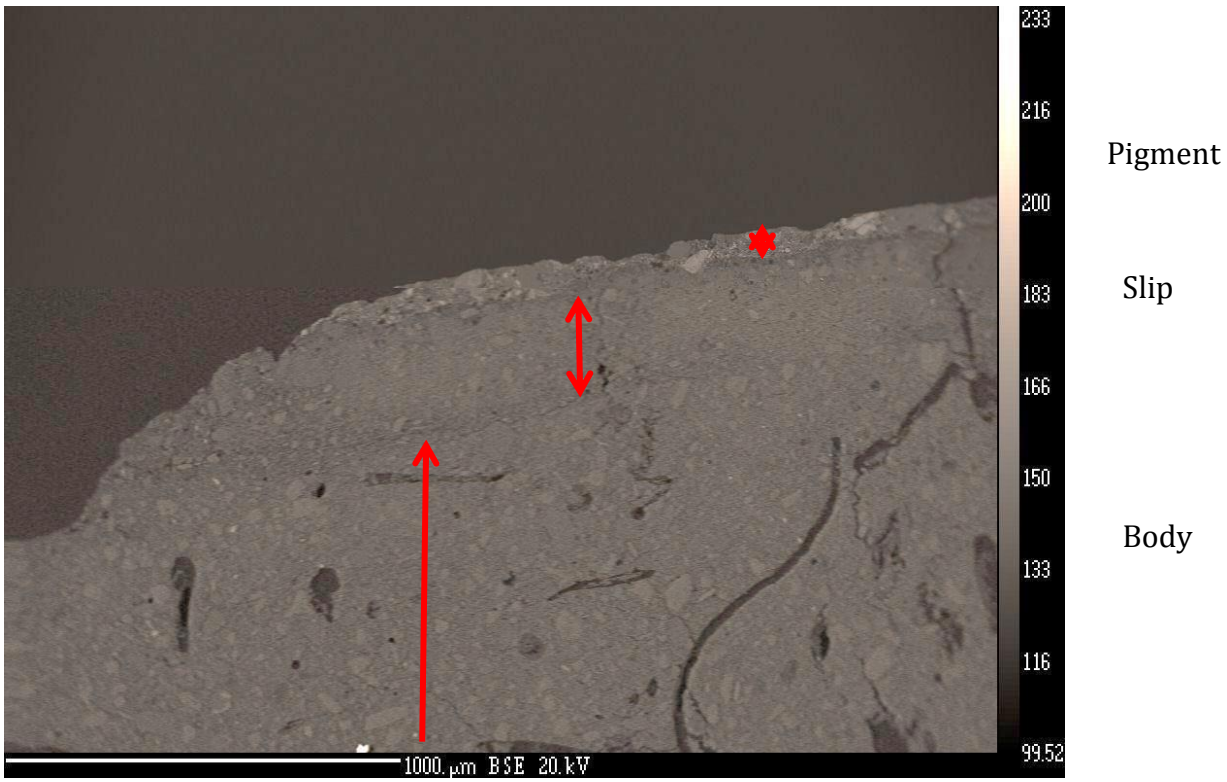


Figure 6.7. Backscattered electron photomicrograph of sherd SK. 21.43 that illustrates the surface layer that has been applied to the vessel using a different clay to the body material.

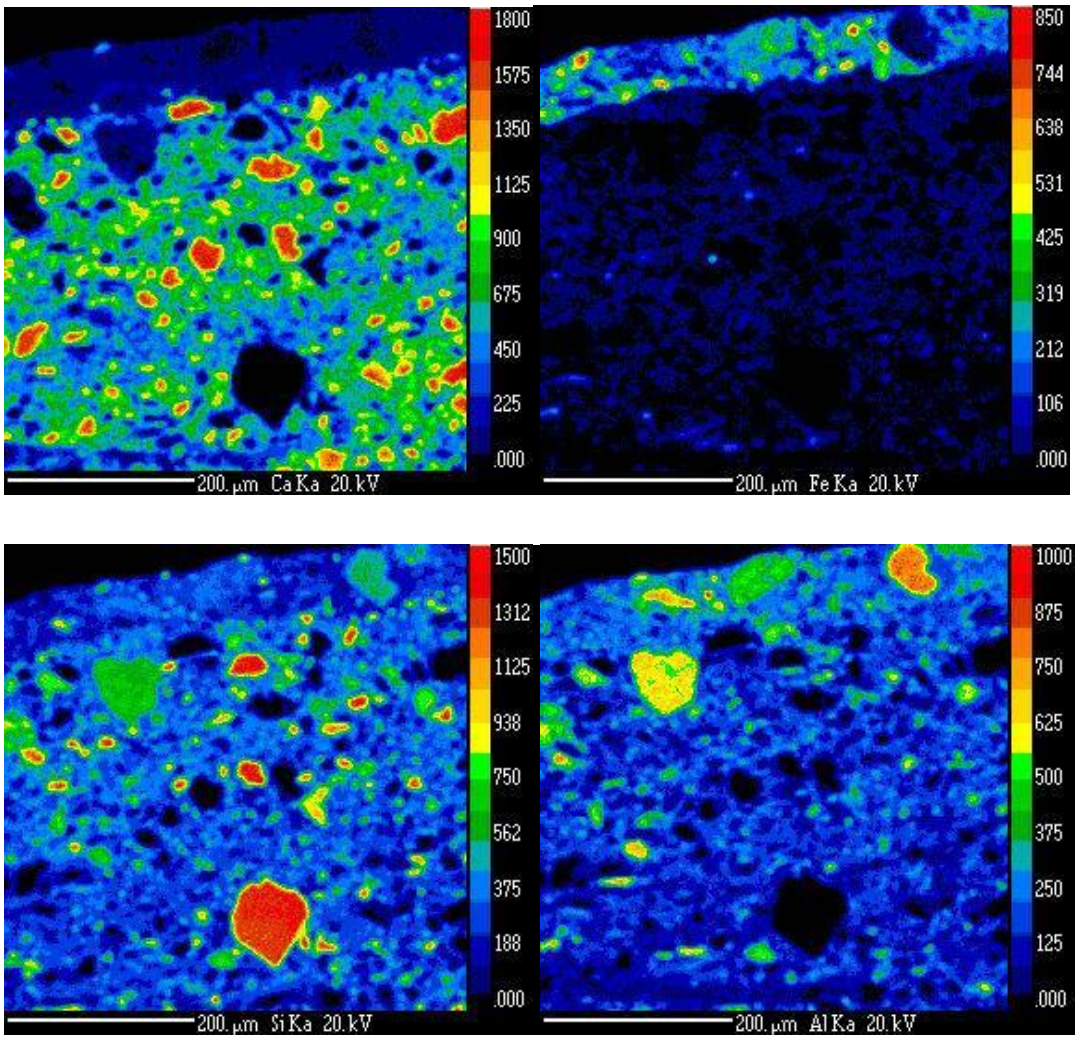


Figure 6.8. Element maps of the surface of sherd SK. 21.43 that illustrate an FeO enrichment, slight Al_2O_3 enrichment and depletion in CaO and SiO_2.

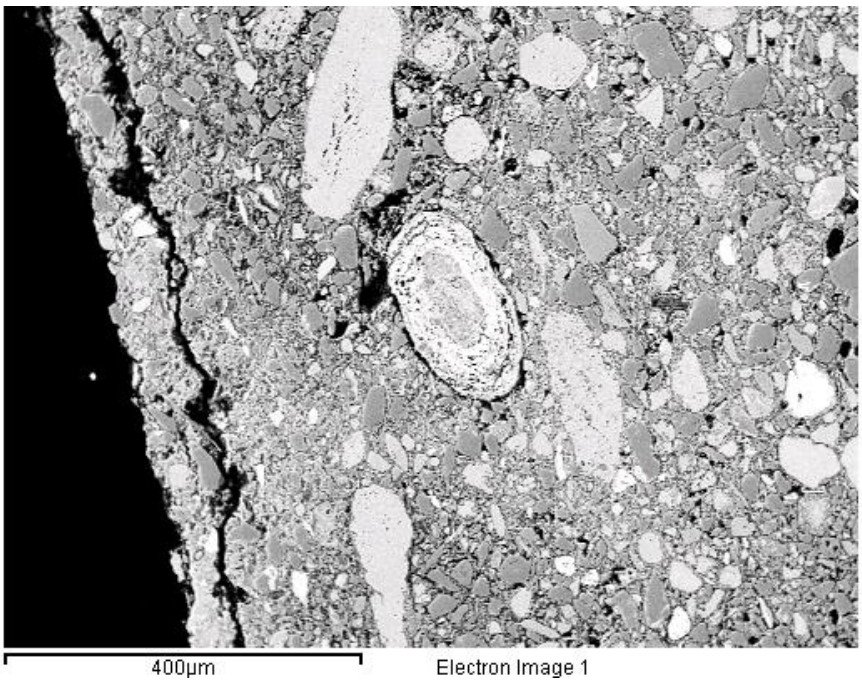


Figure 6.9. SEM photomicrograph of sherd R8555 that illustrates the coarse nature of the body clay in comparison to other sherds that were sampled. No surface application of clay was added to this vessel, the parallel fracture on this sample is the surface of the sherd lifting off.

6.6 *Painted motif wares*

Black Mushki decoration on buff

The sherds in this group are both made from calcareous marl clays and slipped with a similar material. R 8526 has a particularly thick slip at approximately 500µm (figure 6.10), while the remaining two from Qasr-e Ahmad are much thinner (100µm).

Iron oxide has also been used to create the black pigments (figure 6.11), which would have been achieved in a single, oxidising firing.

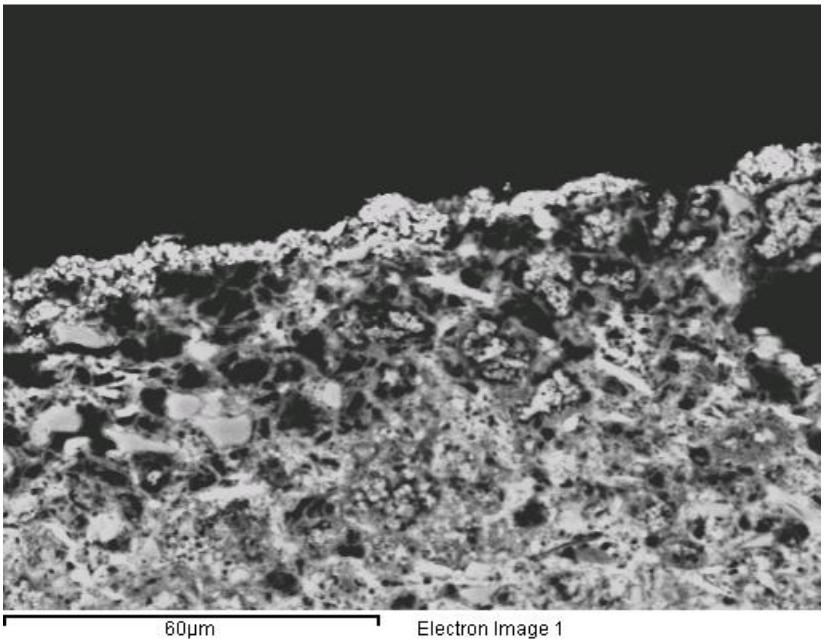


Figure 6.10. Backscattered electron image using an SEM of R 8526, showing the applied pigment layer to the surface.

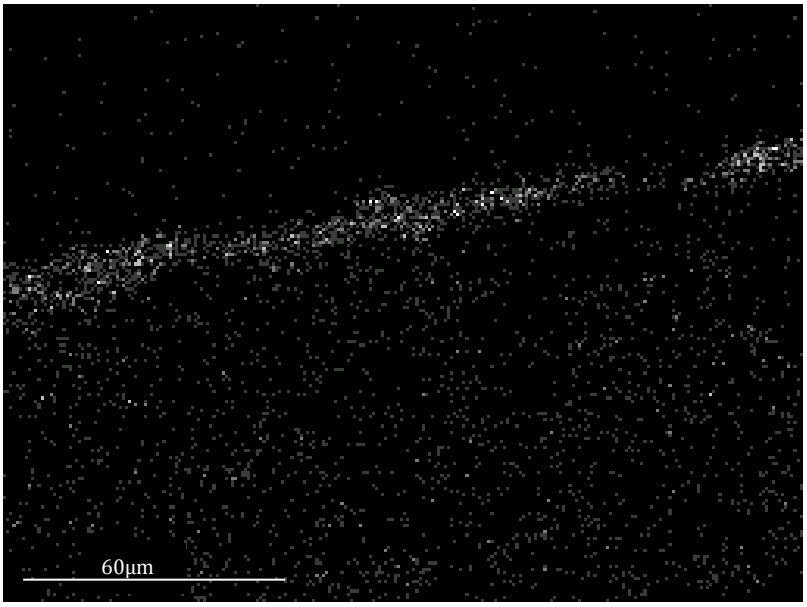


Figure 6.11. Element map using an SEM showing an FeO enrichment creating the black coloured pigment layer.

Black Mushki decoration on buff with a red interior

This class of decoration was specifically interesting due to its parallels with the site of Tol-e Mushki. Unfortunately, all microprobe points were unsuccessful in identifying pigment layers in the polished sample (see Appendix B). R 8655 is particularly abraded and an iron oxide enrichment could not be detected in element mapping (Figure 6.12), while R 8706 shows very sophisticated skill in painted decoration, but very thin lines of paint to find in backscattered images for electron microprobe point analysis.

Other interesting aspects that were unveiled in analysis was the application of a slip to both vessels, R 8706 is easily identified in thin section, while R8655 becomes very clear in backscattered imaging (figure 6.13). The latter figure shows the application of a much coarser clay to the surface of the vessel, which without burnishing, had begun to crack apart from the body. The decorative lines on this sherd are also painted in a thicker manner, and the abrasion of the pigment may be due to its preparation which was not as successful as that of R 8706, perhaps indicating a difference in competence between the two potters responsible for these vessels.

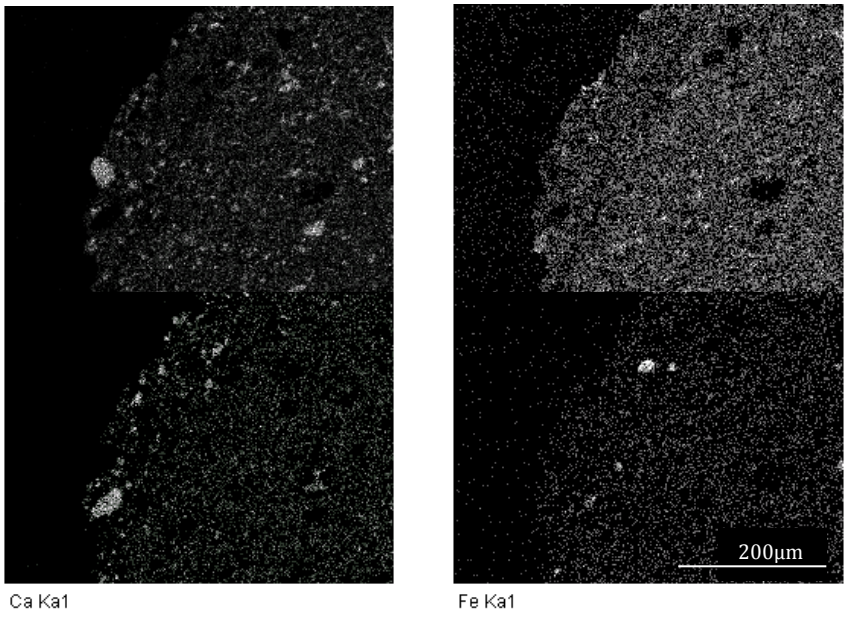


Figure 6.12. Element maps of R8655 showing no enrichment in FeO pigment at the surface, but an application of a coarser clay with quartz (Si) and carbonate (Ca) grains that differ from the fine grained body clay in texture, but which is otherwise compositionally similar.

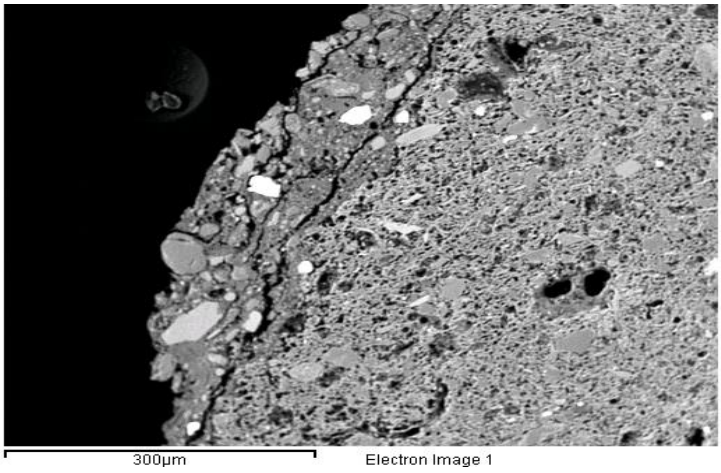


Figure 6.13. A backscattered electron photomicrograph with SEM of R 8655 showing the surface application of a coarser clay layer with carbonates, quartz and mica grains.

Black Jari decoration on buff

Variations in the texture of the calcareous clays can be noted in the thin section analysis, with particularly coarse carbonate grains in R 8707, and very fine micritic mud in TNP 3883. TNP 3883, 5327 and 3856 have been slipped with a medium and thick slip respectively (approximately 100 μm for 338, 5327and 400μm for 3856), while the remaining sherds were painted straight onto the smoothed body clay.

This class again suffers from a lack of successful pigment analysis, with sherds R 8707 and 8575 being particularly abraded. Thin section analysis shows the pigment layers to be particularly small on all the sherds within this class, which is taken to be the same materials employed for the other sherds in accordance with the rest of the black monochrome painted vessels in this study.

Fresh Fracture analysis using a microprobe was undertaken on sherd TNP 3856 in this category. The nature of the analytical techniques undertaken in this study means that investigation into firing temperature is based on the vitrification structures of sherd pastes and comparing these with clays fired at known temperatures and environments (oxidising or reducing). The central area of the core shows a vitrification microstructure that reached initial vitrification, which in a calcareous clay can be around 700°C (Tite 1969: table 3). The calcium content of these ceramics is high and also fine grained, as has been established with thin section and chemical analysis, so it can be proposed that these factors may have aided in the vitrification process and thus reduced the required temperature or length of firing required for Neolithic potters. Further, the presence of organic temper particles and some incompletely oxidised cores may suggest a quick exposure to heat rather than a lengthy duration of firing, or a rapid cooling from a reducing or neutral atmosphere, which is also supported by the range of vitrification structures noted within a single sample (see below).

Such faster heating rates and shorter firings than normal cause the organic component in the core to not fully burn away during the initial stages of the firing. This causes an intense, localised reducing atmosphere in the core that enables vitrification to occur at a lower temperature. The clay on the edges of the ceramic is not exposed to this intense reducing atmosphere and therefore does not develop the same degree of vitrification due to rapid changes in firing environment and/or temperature.

Some areas of melt can be seen in figure 6.14, where clay flakes have joined together and formed smooth glassy areas, but this is not consistent, nor widespread. There are also no visible bloating pores that indicate continuous or extensive vitrification. A quick firing is suggested for this sherd, and most likely the other very similar sherds in this group, due to the preserved carbonated organic temper particles (figure 6.15). Once added to the clay, they did not have time to burn out during the firing and have been well preserved and ideal for examining with the microprobe. Figure 6.15 shows the size as well as triangular shape of some plant stem fragments that occur in the body clay, while the top slip layer of the sherd consists of just fine clay.

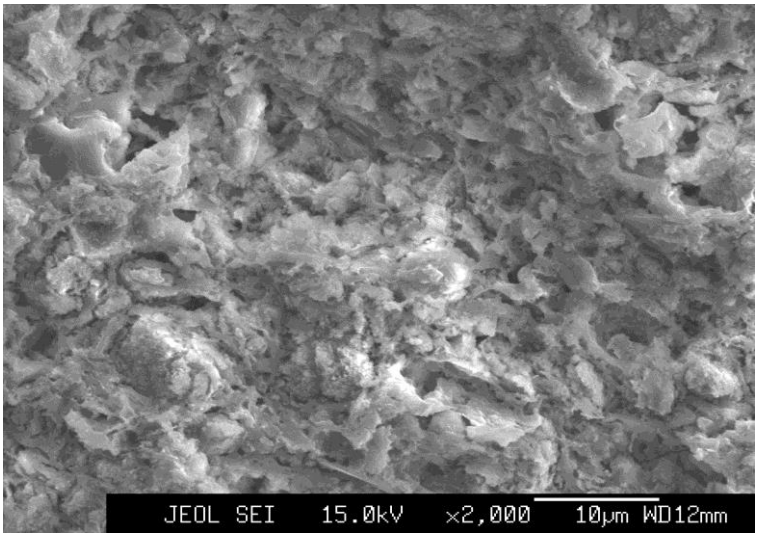


Figure 6.14. Initial vitrification in the core microstructure of TNP 3856, indicative of an estimated firing temperature around 700°C in a calcareous clay.

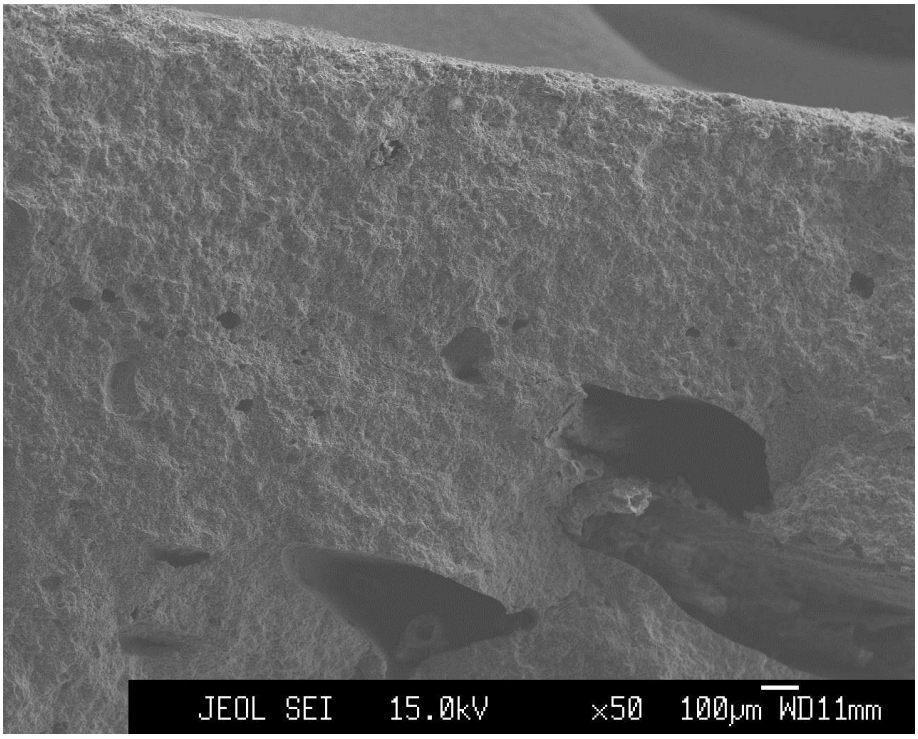


Figure 6.15. Clear transition between fine slip clay and organic tempered body in TNP 3856.

Closer examination of plant remains shown in figure 6.16 further demonstrates the stem material and also highlights the presence of plant particles with a circular profile, suggesting the incorporation of different species as tempering agents. Despite looking for diagnostic areas of plants that may have been incorporated into the clay when tempering, none were found in the breaks studied in this collection of sherds, leaving identification inconclusive.

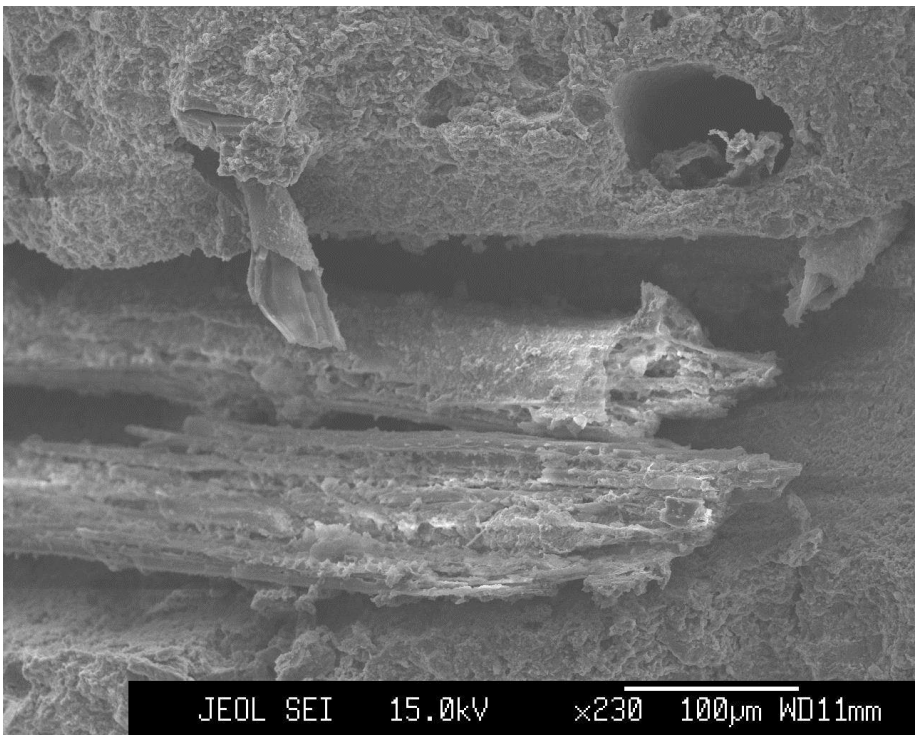


Figure 6.16. Magnified image of plant tempering particles in sherd TNP 3856.

Painted Red linear and crosshatching motifs on a buff surface with buff interior

All sherds in the red linear and crosshatching on buff group demonstrate a similar selection of calcareous clays and iron rich pigments. All sherds are from the site of Nurabad and demonstrate a similar use of raw materials and decorative designs across a range of contexts. The clay is very fine with very few inclusions and has been tempered with linear organic material. This group also shows a varied approach to slipping and burnishing in thin section, with TNP 2363, 2430 and 4761 showing combinations of slipping and burnishing, while the others in this group have decoration painted straight onto a smoothed surface.

Electron microprobe results show that the red coloured decoration has been created with an iron rich pigment (tables 6.15- 6.17). There are a range of red colours represented in this group and while the microprobe analysis has not

been able to contribute quantifiable data for discussing this, it is presumed the variety is a result of differences in composition and texture of different deposits of terra rossa, or difference in degrees of pigment grinding employed by potters. Other analytical studies have shown red iron-rich pigments of variable shades to be indicative of variability in raw materials but also levels of competence across production sites (Day *et al.,* 2006). The buff coloured surface of the vessels and the red iron rich pigment suggest that the vessels were painted after other post-forming stages and then fired in an oxidising atmosphere to retain the red colour on a buff background.

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
0.24126	0.46923	1.27883	0.78704	2.22118	5.12822	40.49722	0.0248	5.60265	0.00001	13.73906	0.3883	0.4467	70.77006	pigment 1
0.31358	0.58956	1.73219	2.2906	1.95087	2.85398	22.6799	0.06041	6.89245	0.00604	14.59672	0.36302	0.45031	54.70889	pigment 1
0.28803	0.6463	2.29412	1.39854	2.28188	6.63537	16.3792	0.00184	8.36011	0.02451	26.2744	0.2936	0.69791	65.51081	pigment 1
0.15432	0.51949	3.17911	2.70392	4.03716	0.02926	6.78973	0.00001	17.88398	0.00668	43.96315	0.66104	0.07281	79.96583	body
0.1005	5.98654	1.46835	0.90808	3.81991	0.02377	3.13588	0.01164	17.70171	0.00001	53.30855	0.69101	0.12671	87.25999	body
0.20971	0.29416	2.19356	1.30007	12.8361	0.10757	5.33886	0.03444	12.4175	0.02474	30.54588	0.38613	0.13205	65.77344	body

Table 6.2 Electron microprobe analysis of TNP 4942, showing an FeO enrichment in the pigment layers.

<u>Painted red linear and crosshatching motifs on a buff surface with red interior</u>

This ware group includes sherds that have various post-forming applications, and are all made with the locally available calcareous marl clay. Some sherds are made with slightly coarser clay, such as QA 312, while others contain very few mineral inclusions, *e.g.* TNP 2607. Consultation of the thin section images shows that TNP 2607 and QA 267 were both slipped before being decorated. Backscattered electron images (figure 6.17) show that TNP 2607 was slipped with slightly coarser clay that contained more iron oxide than the body. The body material is a very fine mud sediment and contains fewer mineral inclusions than the surface clay layer, namely sub-angular to angular quartz, despite the slip still being a relatively fine grained material for slip applications. A less magnified

image of TNP 2607 clearly distinguishes between the texture of the clay slip and fine clay of the body. Large organic inclusions can be seen in this image as well and conform to the other organic particles recognised in these samples, that of plant stem material (figure 6.19).

Element mapping on TNP 2607 also highlighted iron oxide pigments used to create the red decoration on this sherd (figure 6.18).

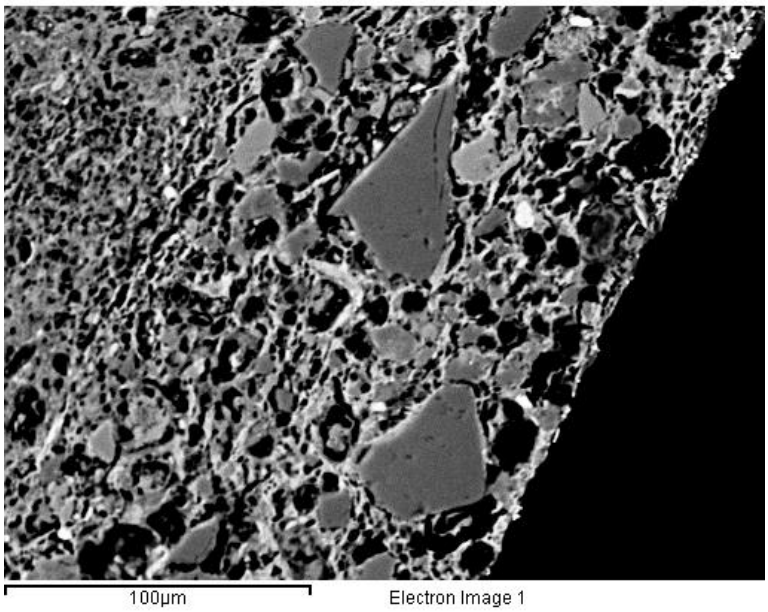


Figure 6.17. Backscattered electron micrograph of TNP 2607 showing the application to the surface of the sherd of slightly coarser clay. This clay includes larger quartz grains than the body clay, but is still compositionally similar.

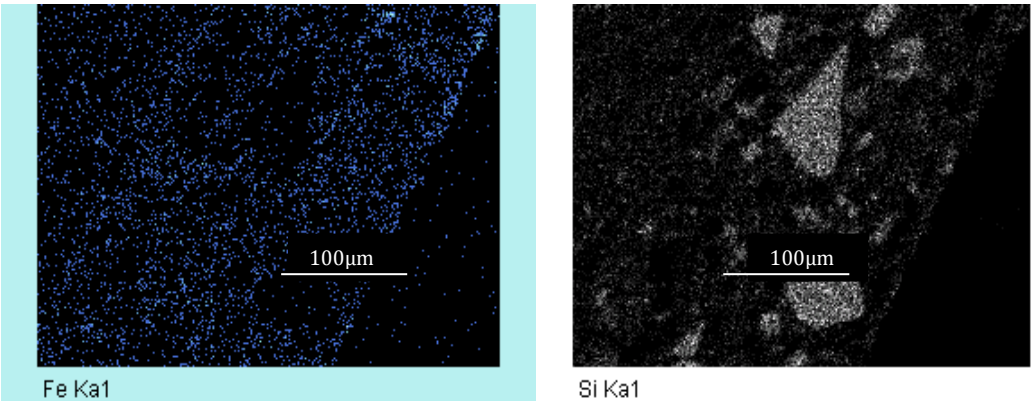


Figure 6.18. Two element maps for sherd TNP 2607. The left hand side shows a slight enrichment in FeO on the surface of the applied clay, which accounts for the red colouration. This has been edited in blue tone to highlight the enrichment. The vessel had been burnished once the clay was applied, and therefore, became enriched at the surface. The right hand side image shows the silica in the medium to large sized quartz grains. These are located towards the surface of the sherd, rather than across the entire cross section included in this image, as the layer is composed of compositionally similar, yet coarser clay.

Sherd QA 312 shows an interesting approach to pigment decoration, as the potter has chosen to burnish over the painted decoration once leather hard, and then fire the vessel. This is the only example of such an organisation of tasks and has resulted in very smudged decoration, which is unusual, as painted lines are usually drawn with care and returned to in order to be thickened or straightened as if the potter specifically desired neat and straight lines. This sherd is therefore somewhat of an exception within the collection.

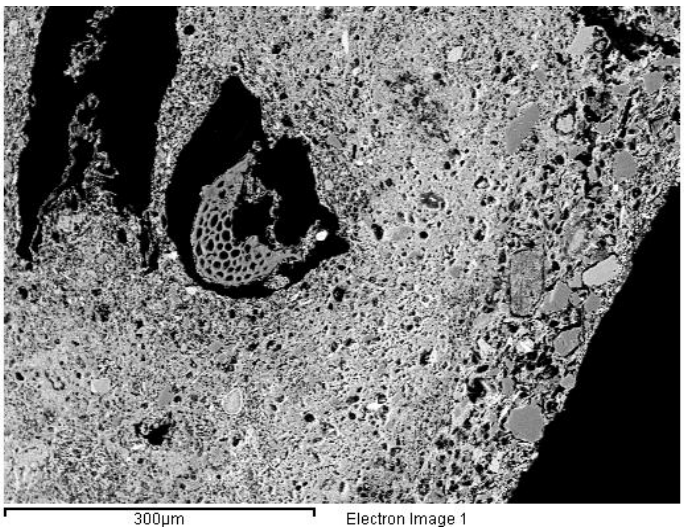


Figure 6.19. This is a larger scale photomicrograph of a backscattered electron image captured with an SEM that illustrates the difference in grain size between the body and surface clays. This image also illustrates and size and nature of the organic temper used in this sherd, note that the plant material is specifically from the stem.

Painted bichrome linear and zigzag motifs on buff with red interior

Both sherds in this group conform to a similar composition of raw materials and forming methods. TNP 5667 appears in thin section to be made from slightly coarser clay and includes more quartz and carbonate inclusions than TNP 5671, while the clays contain the same range of inclusions.

Despite the similar surface appearance of the two sherds, TNP 5667 has been burnished after drying to a leather hard state and then painted, while TNP 5671 has been additionally slipped after burnishing, burnished again, and then painted. This is evident from the thin section image which shows each of these layers, and even more clearly in the SEM photomicrograph (figure 6.20).

Both sherds have been decorated with red and black pigments that appear thicker in the black areas and thinner on the red coloured areas through

examination in thin section. Consultation of backscattered electron images shows the red pigment to be approximately 25µm thick while the black pigment is approximately 30-40µm thick. The latter pigment is shown in figure 6.20 and is seen to be a highly calcareous paste that has been applied to the burnished surface of TNP 5671, where a parallel orientation of particles can be identified at the relic surface. This paste also includes coarse medium- large ochre grains. Analysis using the SEM is presented in spectrum 1 (figure 6.21), and thus shows the paste to be rich in iron and calcium. The surface of the pigment appears to have sintered and vitrified, creating a gloss that has subsequently cracked (figure 6.22). The black gloss has sintered and sealed off the black iron oxide from contact with oxygen in the air which therefore makes it stay black throughout remaining stages of the three stage firing that has been used to create bichrome decoration using similar iron-rich pigments (see below).

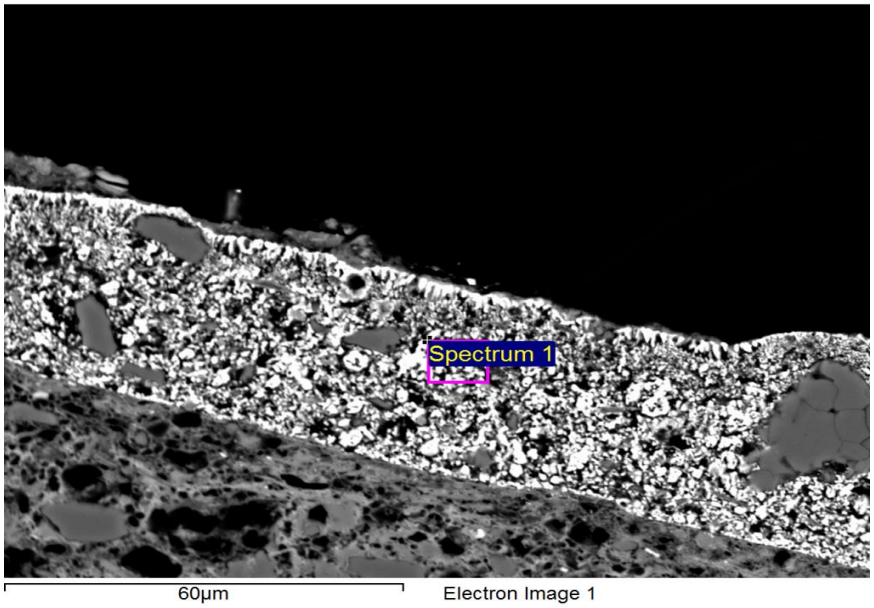


Figure 6.20. Backscattered electron photomicrograph of TNP 5671's red pigment layer on top of a thick, burnished slip which can be seen at the base of the image. A relic burnished surface can be identified through the parallel orientation of grains in the top 20µm surface of the sherd underneath the pigment layer. A

burnished sheen on the surface of the sherd is visible in-hand inspection and the matte painted decoration has been applied on top of this. The pigment layer itself appears to be a calcareous marl paste with small and large ochre grains, contributing to the high calcium and iron results in microprobe SEM analysis.

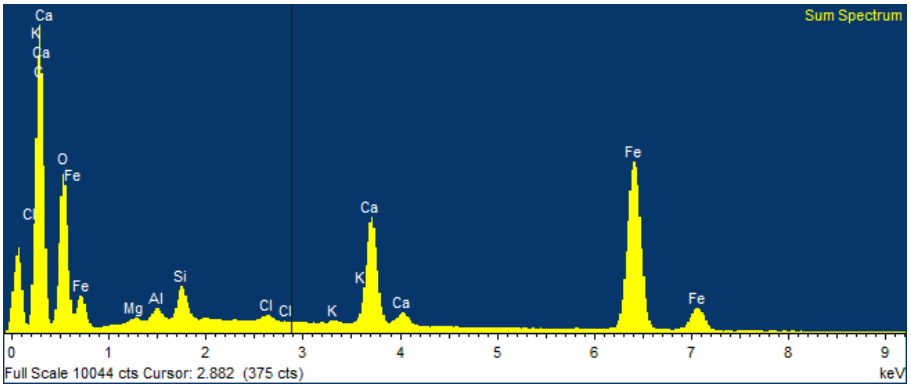


Figure 6.21. Spectrum 1 taken from TNP 5671, see fig.1. These results correlate with the microprobe results in that the pigment layer is enriched in iron and calcium.

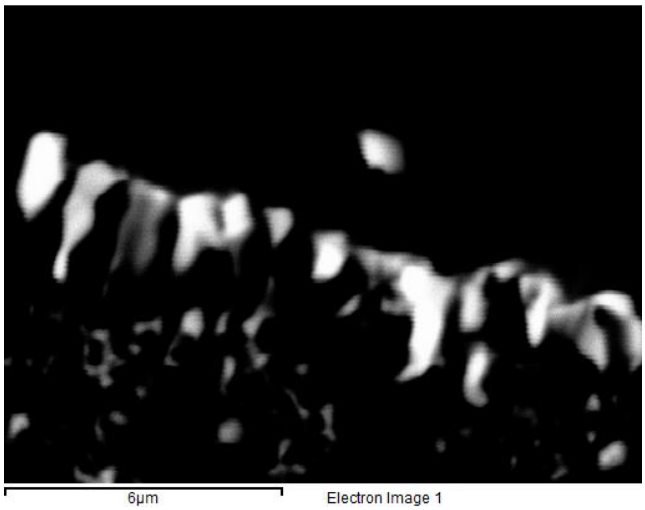


Figure 6.22. The surface of the black pigment of TNP 5671 appears to have sintered and vitrified, creating a gloss that has subsequently cracked. The SEM

results for this area of analysis show it to have a similar chemical composition to the rest of the marl past, see figure 6.4.

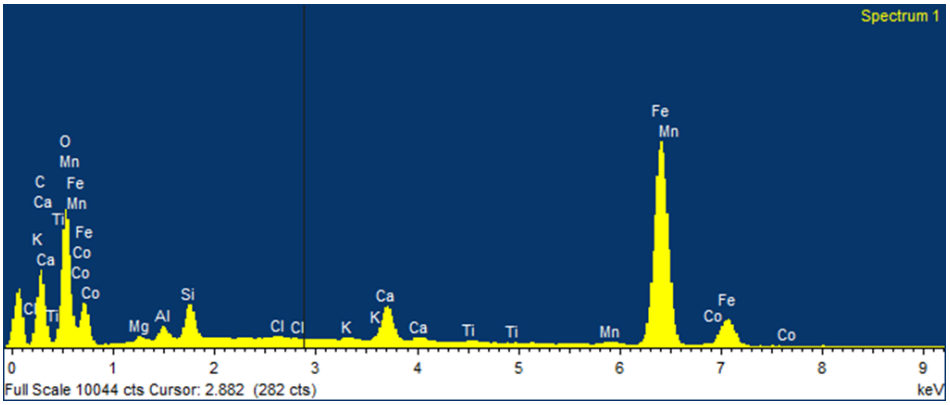


Figure 6.23. SEM analysis if the composition of the slagging gloss on TNP 5671.

Both images indicate that the pigment layers are compositionally distinct from the body clay, but also highlight the methodology employed by potters to create two different colours using similar, iron- rich clays.

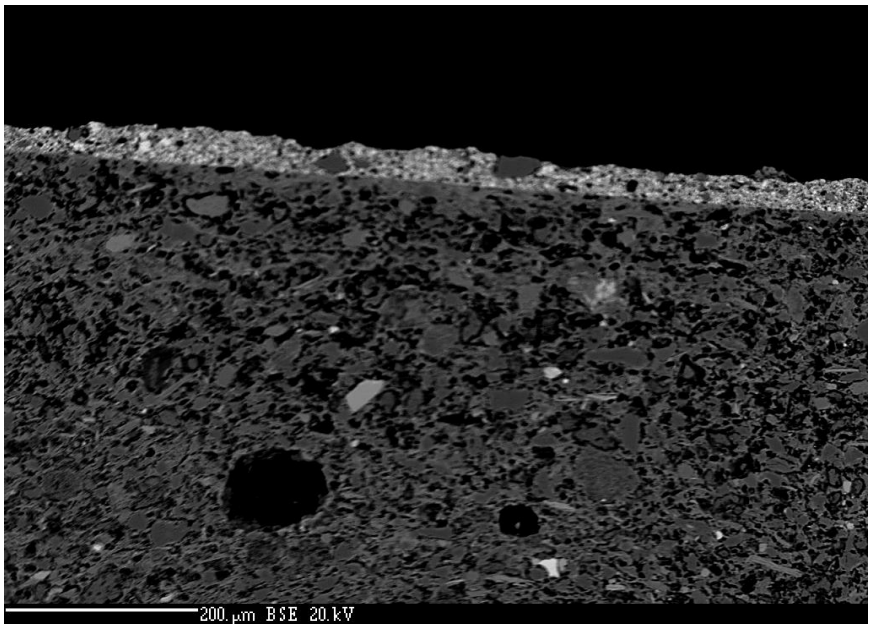


Figure 6.24. Backscattered electron photomicropraph of the thickly applied black coloured pigment on sherd TNP 5667. A burnished relic surface is also visible

through the alignment of particles on the surface of the vessel and underneath the coloured clay layer.

To create two different colours on a vessel using iron oxide pigments, manipulation of the materials in their preparation and a three stage firing is required (Noll 1977). Particle grain size of the pigment material may also be a factor that contributes to the creation of specific colours, with black pigments containing finer ground ochre particles . By grinding pigments to a fine paste, potters ensure that the smaller grain size allows for a quicker reoxidation due to decreased particle surface area.

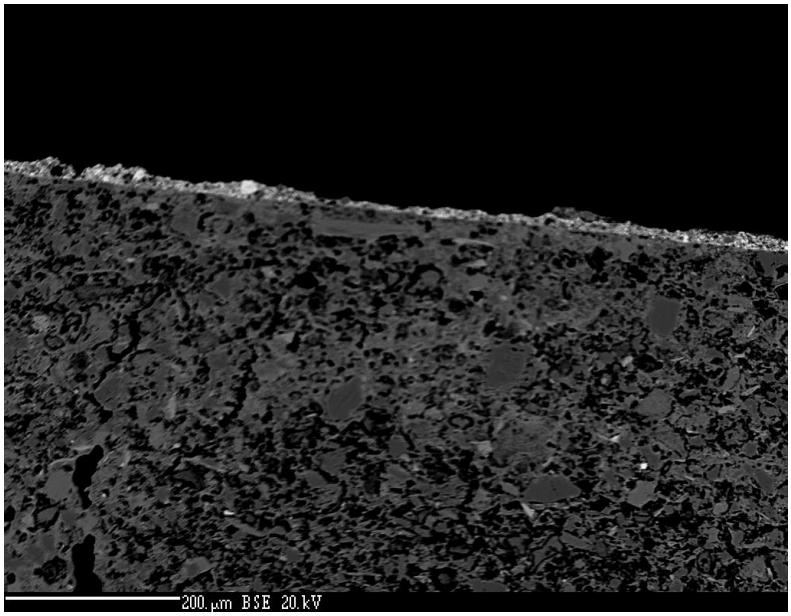


Figure 6.25. Backscattered electron photomicrograph of the thinly applied red coloured pigment on sherd TNP 5667.

This process requires a three stage firing with an oxidation, reduction, oxidation cycle, so that the pigments oxidise red, followed by a reduction stage which turned all decorated areas black. The final oxidation stage reoxidised the red pigment.

Other compositional factors can aid in this process, such as increased amounts of potassium acting as a flux in the black pigment to help achieve a non-porous and melted state and would not reoxidise in the final firing stage and remain black. Conversely, higher levels of aluminium act as a refractory would slow the effects of reduction and would help revert red pigments in the final reoxidising stage (Steinberg and Kamilli 1984).

Painted bichrome linear and zigzag motifs on buff surface with buff interior

Fine, calcareous clays are also used in this group. Thin section analysis shows that all sherds were slipped before decoration and TNP 4915 was also burnished before being slipped.

These sherds are also from the Late Neolithic deposits at Nurabad, but create a bichrome effect by employing manganese black. Elemental mapping using an SEM was able to demonstrate the two chemically distinct black and red pigments on the surface of the sherd (figures 6.26 and 6.27). The implications for the use of manganese pigments to create a black colour on these bichrome wares from Nurabad highlight that potters would have been able to create this effect with a single oxidising firing that fired both black and red pigments with the reconstructed estimated temperatures possible in Prehistoric kilns.

The choice of manganese black pigments at Nurabad occur on bichrome wares with a buff interior rather than a red interior, which is the main distinction between the other above bichrome class that uses iron oxide and a three stage firing to produce both black and red colours on the same vessel. This method shows an excellent control by Late Neolithic potters of ceramic technology and highlights that they successfully identified and utilised different resource deposits available to them.

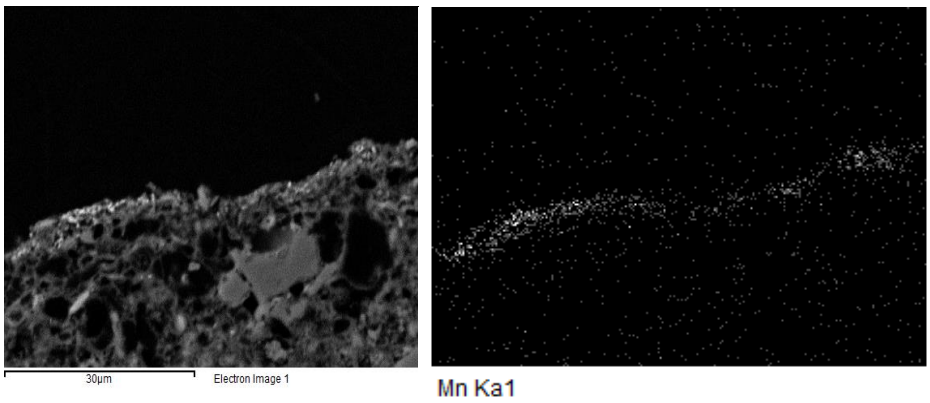


Figure 6.26. Backscattered electron photomicrographs of the surface pigment on TNP 5428 (left). The element map for manganese (right), shows the concentration of the element in the pigment which created the black colouring.

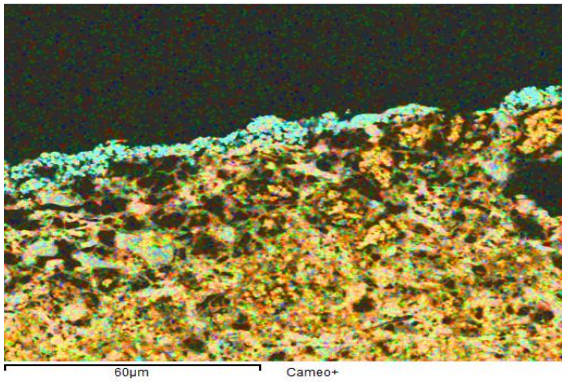


Figure 6.27. This elemental map is located at a different surface point of TNP 5428. The element selected for this map is iron (shown in green), and a clear concentration in the pigment layer is evident, which has been highlighted in the cameo viewing mode.

Black decoration with red interior and red exterior mottling clouds

The sherds in this group demonstrate unusual decoration unique to the site of Tol-e Nurabad, consisting of an unevenly coloured orange surface which partially obscures the black painted decoration. TNP 2391 and 2592 have both had very thick (over 500µm), iron rich clays applied as a slip over the calcareous body clays. TNP 2391 has a far smaller iron slip application (approximately 50µm). Electron microprobe analysis on the pigment layer of TNP 2391 (table 6.3), shows the black coloured pigment to be created with iron oxide. The creation of orange mottled effects on the surface could be linked to the burnishing process, as Rice has stated that " the uneven compaction of the clay particles in careless burnishing occasionally results in slight colour differences between burnished and unburnished areas; especially true in areas of fireclouding" (1987: 150-151). However the quality of burnish on these mottled sherds does not seem to particularly correlate with the mottled areas on these sherds. It is not clear how this surface effect was created, but it seems likely it was done by manipulating the firing process in some way as the mottled colours are not painted onto the surface, but intended to shadow over the black painted decoration. The creation of this effect however seems to have been a deliberate one based on the quantity of material excavated with this style, and its duration throughout phase 2 of Trench D (Weeks pers.com). In addition, it may be a simpler method for creating both red and black colours on the surface of a vessel in a phase of occupation that has no bichrome material recorded from it.

Wt% Oxide Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
1.0606	0.00046	0.12491	0.18228	0.67278	0.00451	0.38613	0.00001	0.29652	0.00001	1.29264	0.02658	0.04092	3.84903	pigment 1
0.15938	0.12286	2.01799	5.24146	16.18503	0.07635	10.51228	0.0591	10.70307	0.01454	38.8645	0.32865	0.3975	84.64673	pigment 1
0.23735	0.50057	4.07567	2.80304	12.04106	0.12857	11.17543	0.00001	10.87279	0.00175	35.68116	0.52991	0.7008	78.69456	pigment 1
0.17008	0.53502	2.03324	2.05946	15.08304	0.02308	5.23657	0.00001	7.40389	0.00001	27.70908	0.17508	0.17814	60.56832	body
0.24044	0.08039	0.95823	2.09901	18.58879	0.04578	5.08288	0.0619	7.6253	0.00001	22.13659	0.14464	0.14011	57.14982	body
0.03139	9.56572	1.11218	0.35749	2.31156	0.00001	0.47824	0.00001	18.84228	0.00001	63.88727	0.01358	0.01706	96.60972	body

Table 6.3. Electron microprobe results for TNP 2391 showing an FeO enrichment for the black pigment layer.

6.7*Conclusion*

This chapter has set out to present the results of the different analytical techniques that have been undertaken on the sherd assemblage of Neolithic ceramics from Fars. The following chapter will build on these results to characterise each ware and reconstruct the different production stages that can be evidenced through the above analytical work, followed by a discussion of, and comparison to, previous studies of related Neolithic wares in Iran and the wider Middle East and Central Asia.

7. Reconstruction of the potting sequence.

7.1. *Introduction*

This chapter uses the previously described analytical results to discuss and compose a sequence of production activities for the creation of Neolithic wares. The main focus of an investigation into the production stages of material culture establishes that artists and craftspeople working in different physical and social environments will enact gestures and produce artefacts in different ways. In moving away from the concept of disembodied ways of making and doing, emphasis becomes placed on how human cognition and technical choice can lead to a deeper understanding of the variation that occurs during the manufacturing process, which contributes to the overall style of the artefact interpreted by archaeologists (Stark, 1998: 1, Dobres and Hoffman, 1994: 215, Lemonnier, 1986). This can lead to meaningful reconstructions of embodied communities of practice and an informed understanding of the sociocultural meaning behind production stages. By following the *châine opératoire* process, it is possible to see how such choices and actions reflect in both the appearance of the object and the society in which it was created (Farbstein 2011: 125-126).

My own interpretation of the *châine opératoire* approach, and the one used throughout this thesis, is of a production sequence that can characterise a technological style to be used in discerning socially meaningful cultural groups within the archaeological record. It can also be used to highlight instances of individual agency which, when viewed alongside the wider community style is a useful tool in discussing the social, aesthetic and stylistic consequences of such technological choices.

This approach is the first attempt to detail the range of production stages available to potters in Neolithic Fars. Other analysts have focused on the detailed investigation of painted decorative motifs (Maeda 1986; Nishiaki 2010; Bernbeck 2012), or a macroscopic attempt at understanding production, splitting their reconstruction into broad categories such as shape and decoration to define their ware groups (Bernbeck 2012; Fukai *et al.* 1973). Despite such attempts at reconstruction, no explicit theoretical methodology of ancient technology has been applied, and no specific consideration of

the *châine opératoire* to enable the documentation of sequential technical operations and gestures of artefact manufacture. Therefore, this application of the study of production stages will highlight below, and in further chapters, the deeper understanding of individual preferences and group priorities seen through the recovery of Prehistoric decision-making.

I have presented the outline of the reconstructed stages of the *châine opératoire* below starting with the acquisition of raw materials and forming methods, before detailing the range of post-forming surface modifications that were available to Neolithic potters, including slipping, burnishing, and painting decoration.

7.2. *Clay raw materials*

Clays selected for potting were fine calcareous alluvial clays that would have been located within each of the valley systems with easy accessibility to the village sites. Potters would have been aware of the watery swamp clays near their main water source and may have come across the finer, more settled clay deposits located at higher altitudes as they seasonally moved herds of animals between the upper reaches of the highlands and back down to winter pastures. Before the adoption of ceramic vessels, Neolithic communities were already exploiting clay raw materials to make figurines and small objects that may have functioned as items of personal adornment. Lime plaster was also used as a covering surface for mudbrick house walls which included a calcareous clay component (Hiemann and Maggetti 2014: 148).

Thin section analysis presented in the previous chapter has highlighted the selection of similar clays that would have been available to potters within each of the valley systems represented in this study. Geological prospection and mapping of Fars province has not been conducted to the level at which discussion can be held around the differences between and within clay deposits, hampering any detailed investigation of site-specific production and the extended issue of ceramic vessel trade and exchange. Despite this, a more detailed understanding of the production sequence (see figure 7.2) may yet furnish reconstructions of production identity and style that may refer back to these issues.

Each of the sites represented in this study was located in valleys with easy access to watercourses, as is a feature of Neolithic settlement patterns (Sumner 1990: 97). It is not possible to ascertain specific locations of clay collection based on variations in paste textures as while these differences could be based on clay location, it will also include deposition depth, with notable changes in texture through the deposit of clay at the same geographical point. The finer texture of some pastes does not correlate with specific wares, chronological phases or sites, as most typological classes have at least one example of a fine textured ceramic, therefore, the paste variation does not seem to be affected by location or chronology, and is most likely due to the variation within local clay deposits.

7.3. *Temper materials*

Collection of raw materials for tempering would have been required of potters when the raw clay was collected. Identification to species level of the plant remains has not been possible as the stem fragments that have been located in the pastes are not part of diagnostic areas of plants (figure 7.1). Stem material may have been extracted from the chaff material left over from winnowing and threshing processes of grains, although it would be expected that some parts of grain, rachis or glume base fragments may also have made it into the ceramics, but none so far have been noted. The inclusion of triangular and rounded profiles of the plant stems may be related to the selection of reed and sedge material, in which case the temper material could therefore have been collected along stream and river beds when collecting clay material. The processing of the fibres once back at the sites may have included chopping into shortened lengths using flint tools to mixed in with the clay by methods such as wedging (Rice 1987:119).

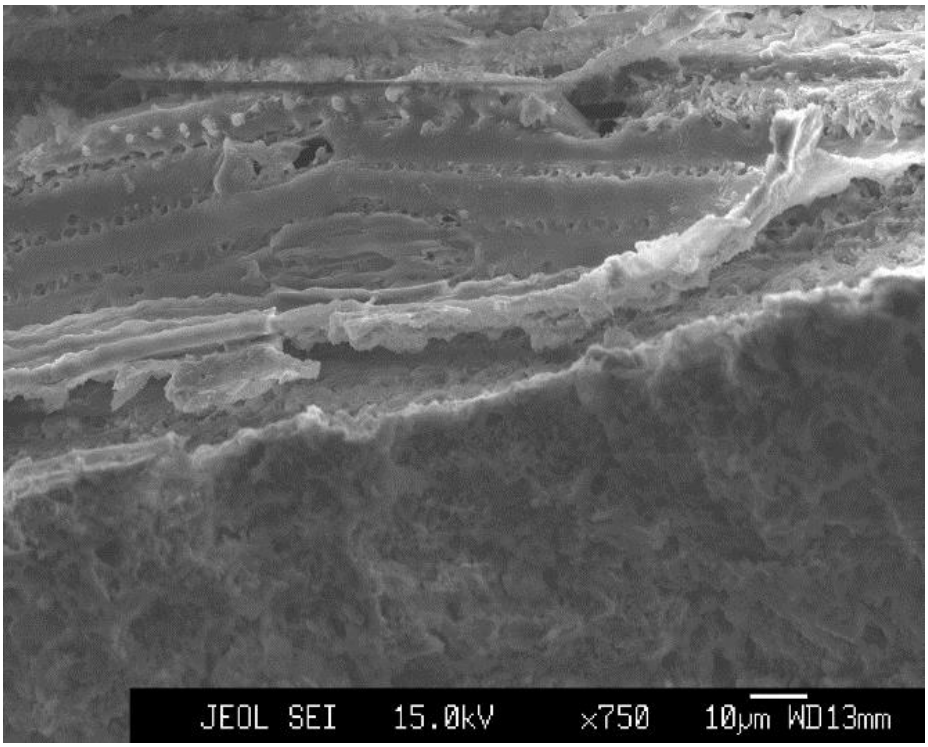


Figure 7.1 Plant temper stem fragment in TNP 291.

7.4. *Forming methods*

A combination of sequential slab construction and coiling has been reconstructed for contemporary Neolithic wares outside of Fars using x-radiography. Vandiver's study (1987), used a data-set of complete or near-complete vessels to investigate surface markings and the orientation of organic temper particles, identified through x-ray, to reconstruct individual coils and slabs that were built up to create each vessel. This approach, although successful at the time, has been difficult to incorporate into future ceramic studies as most sherd material from excavations has not survived in large enough pieces to allow any identification of large enough coil or slab elements. This renders this specific method of investigation into forming techniques therefore very hard to adopt with sherd assemblages.

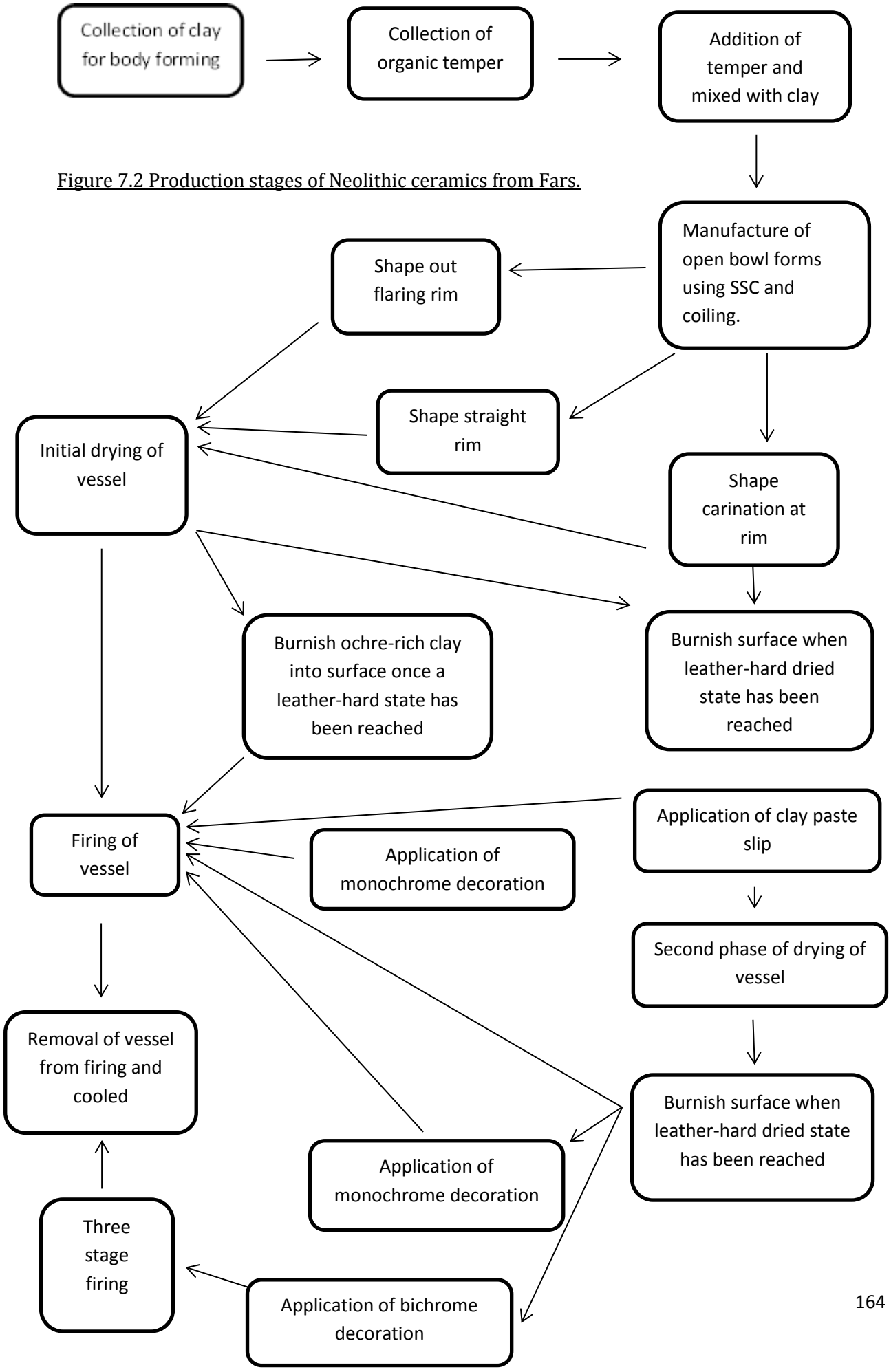


Figure 7.2 Production stages of Neolithic ceramics from Fars.

The preparation of thin section samples can sometimes allow instances of clear visibility of coil or slab joins, but none have been noted for the assemblage under study when actively looked for. Inspection of sherd surfaces does in some cases show joins of two clay elements but whether this is a join of two coils, or two slabs, is not possible to state with confidence.

No impressions of matting have been recorded on sherds investigated in this study, so no indication of basket moulding can be suggested for production at these sites. The Late Neolithic site of Tepe Khalesh in Zanjan province includes excellent preservation of basket or matting impressions on the base of vessels that clearly illustrates their use in the production process (Valipour *et al.* 2013: fig. 11.32). What is most likely the case for Neolithic sherds under analysis here is that they conform to the hand building techniques proposed for other contemporary ceramics in Iran, which is a combination of coiling and slab building. The application of slip layers to this material, or the smoothing and burnishing of some vessels would obscure any impressions left from items that were used to shape the vessels, or on which the vessels sat whilst being formed. Only one base sherd is included in this assemblage (SK21. 43), and it was slipped with a pigment layer painted onto the surface, obscuring any remaining impressions.

7.5 *Forming of carinations/bases/rims*

The only definite carinated sherd in this assemblage is a surface sherd from Qasr-e Ahmad with Neolithic black decoration on the surface (QA sur.2). Thin section analysis did not show a discernible orientation of inclusions that suggests the manufacturing technique used to create this shaping, but an increase in thickness of the profile is evident at the carination angle. Potential building techniques are suggested in figure 7.3, with the carination angle created through the use of a larger coil/ slab section which is later smoothed into a flat surface with the rest of the vessel. Future X-ray studies of more complete vessels may be a productive route for understanding this issue in more depth.

A singe base (SK21. 43), is also included in the assemblage. Unfortunately, no orientation of the organic particles speak to a visible join of two separate clay elements. The base is much thicker than the wall which has been built up from it, and although this is at a much sharper angle on the exterior, the interior meeting of base and wall is at a much shallower angle.

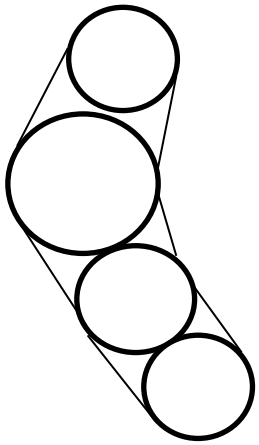


Figure 7.3. Suggested reconstruction of body coils/ slabs of a carinated vessel in profile.

7.6 *Slipping and burnishing*

Once the initial forming had been completed, vessels were left to dry before being either burnished, slipped, both or neither. It seems the process of burnishing was an additional stage of the production sequence that some potters undertook before or after slipping. Other potters did not burnish or slip their vessels at all, but went straight onto painting decoration onto a wet-smoothed surface. When burnishing was undertaken, it compacted and aligned the fine clay particles at the surface of the vessel and was undertaken once the pot had reached the leather hard state using a smooth edged tool (Rice 1987: 150). This creates a lustre on the surface, and was then painted over with pigments by some potters. Others chose to undertake the burnishing stage once a slip has been applied, which not only added a shine to the surface that would later be painted with decoration, or in other cases left plain, this step also helped with adhesion of the slip (Rice 1987: 150). If the body and slip clays have different rates of shrinkage, which would have been very possible for Neolithic potters in Iran that who were using differently textured clays for both potting and slipping, they would likely shrink

differentially. Some slips are actually coarser than the paste as they include a higher quantity of larger mineral grains. This also suggests that slip clays were not created through the elutriation of body clays and that potters did not undertake a levigation process (Heinnman and Maggetti 2014: 38), and therefore most likely used the same material as the body but refrained from adding plant temper. The depth of clay deposits and natural variation within can also contribute to differences in texture between those selected for the body and slip. Potters in the Late Neolithic at Tol-e Nurabad, selected less calcareous slips which contained a slightly higher iron content in order to create a different surface colour and effect to the usual buff firing calcareous slips widely used. The slightly higher iron content and incomplete burnishing undertaken on the vessels, has helped to create an orange stained appearance to the surface.

Examples of poorly adhering slip layers exist within this assemblage, notably sherd QA 267 which has been painted with simple iron oxide crosshatching onto an unburnished slip that has since lifted from the surface of the sherd almost completely. The backscattered image of R 8655 (figure 7.4), also highlights differential shrinkage of vessel and slip leading to poor adhesion and cracking (Rice 1987: 150). To overcome this problem, burnishing before and after the slip application was the most successful variant in the production sequence and was undertaken on those vessels which could be deemed to be the most successful in terms of the survival of their slip and pigment layers, as well as the execution of painted designs.

Variation in skill can also be witnessed within the assemblage, with some vessels burnished to a lower standard than others with visible burnishing marks rather than the glossy sheen that is typical of skilled craftsperson and evident with sherd QA 381. This range of quality is most likely reflective of the range of skill and experience within the community producing vessels, rather than different vessel functions, with younger crafters still learning to perfect their skills. Potentially significant is the fact that all bichrome sherds were carefully burnished before and after slipping, as were most of the sherds from Tol-e Nurabad (where all of the bichrome material is recorded from). This suggests potters at Tol-e Nurabad had a prescriptive formula for producing ceramics that was not just successful, but displayed a high level of proficiency with materials and production techniques. It is perhaps not a coincidence that this is also the only site

within this assemblage that also has bichrome pottery recorded in its ceramic corpus, indicative of very skilled craftspeople.

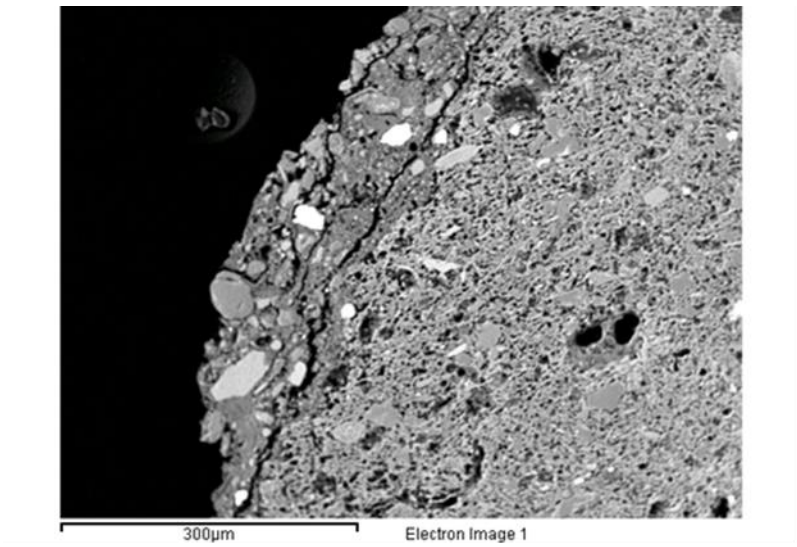


Figure 7.4 Backscattered electron image of sherd R 8655 showing the surface application of a coarser clay layer with carbonates, quartz and mica grains.

Unpainted wares were sometimes also slipped, indicating that despite a lack of painted decoration, the creation of a smooth and sometimes burnished outer surface on vessels was also desirable to Neolithic communities. When analysing an assemblage of sherd material it may be difficult to determine if a burnished body sherd was originally from a plain, unpainted vessel, however, the plain burnished sherds in the collection under study are rim sherds. This is an area of vessels that is normally decorated in Neolithic Fars ceramic production, and although it cannot be suggested with certainty that burnished unpainted rim sherds had decoration located on the lower part of the vessel, this would be an exception within the known examples currently recorded.

7.7 *Pigments*

The next stages of the production process involve the creation of red surface colours and/or coloured motif designs on the vessel. These occur in the form of pigment washes, burnishing pigment into the exterior surface and the painting of motifs.

The presentation of this section follows a chronological order to demonstrate the change in the raw materials used in pigment preparation over time, and the types of

decoration executed. All other previous production stages represented in this assemblage remain the same throughout the Neolithic. There has previously been a chronological development identified for some of the decorated material within this study, namely those sherds that exhibit motifs that form part of already established decorative typologies (Mushki, Jari and Bashi wares, see Chapter 2 for discussion). However there are also sherds included that currently have no securely dated decorative parallel away from the site they were found on, such as the black painted-orange clouded sherds from Tol-e Nurabad. The latter have been dated securely from this excavation and are therefore included in the sequence of development alongside the other sherds.

Red ochre-rich pigments painted onto the exterior surface of vessels were the first to be used to change the overall colour of vessels in Iran during the Neolithic (Heimann and Maggetti 2014: 144; Noll 1982: 3-11). The earliest sherds included in this assemblage include those from Qasr-e Ahmad and Rahmatabad dated to 7140-7050 cal BC. The decoration of surfaces includes a painted red iron oxide surface that is presumed to have covered most of the vessel.

To create this effect, potters selected iron rich clays and applied them to a burnished surface (sherd QA 334). The grain size of this pigment layer is of the same coarseness as the paste and has not therefore been ground down by the potter, as also indicated by the sub-angular shape of individual grains. The red firing clay has most likely been wetted to a consistency that allows it to be applied with a brush-type tool to the surface. The same method has been applied to the red pigment decoration of SK21. 43 which has also been painted with pigment on the interior and exterior surfaces. This example differs from that of Qasr-e Ahmad in that the vessel has been slipped before the pigment application, and has a thicker application (approx. 100µm). Again, the pigment has not been ground to a fine paste but is a similar texture to the body paste with few larger sub-rounded grains.

It has briefly been pointed out that Neolithic potters in Iran continually chose to slip pottery with iron rich clays or paint the ochre-rich pigment onto the surface rather than form the entire vessel with iron rich clay (Heimann and Maggetti 2014: 144). This may have developed out of older practices utilising red ochre pigments for cave painting and

decoration of human bones before burial (Noll 1982: 121). Cave paintings and art are yet to be discovered in Iran relating to the Neolithic period, although cave occupation in the limestone mountain ranges is a common feature of the landscape at this time (Heydari 2007). Red ochre stained long bones do feature in Neolithic archaeology of the Zagros Mountains, and have been recorded from burial remains at Ali Kosh (Hole *et al.* 1969: 40), Chagha Sefid (Hole 1977: 91), Hajji Firouz (Voigt 1983: 71).

It is likely that the continued use of locally available iron rich clays for pigment painting, and the thicker application as a slip atop a buff calcareous body, is an example of habitual choices that are evidence of socially engrained practices (Farbstein 2011: 135), that have possibly been influenced by the raw material properties themselves. These would have influenced the choice of particular techniques for certain raw materials, such as the appropriate way to use iron rich or calcareous clays based on their raw material handling. This may also have had an effect on the potential relationship between chosen production sequences in pottery manufacture and other Neolithic Iranian craft production. It is for this reason that buff firing clays are continually used to form ceramic bodies, and red firing clays are used to adapt the surface colour by either slipping or burnishing a small amount into the surface, and painting designs with them. These repeated choices of raw materials and production stages indicate that the perceived technical uses and bodily gestures associated with red clay were reserved for socially specific actions associated with post-forming modifications, rather than the actual hand building of a vessel using coils and/or slabs. Red clay was therefore conceived of in the Neolithic mind as a decorative material instead of a forming one.

Other technologies that may have influenced ceramic production and certainly share very obvious similarities are the production of clay figurines and earplugs, mudbrick architecture and fired plaster smoothed over wall and floor surfaces. All of these features are commonly recorded aspects of Neolithic lifeways in Iran, and the similarities in the productive technologies should be addressed at this point before discussion of the production stages in ceramics moves onto painted motif decoration that do not generally feature in the afore mentioned artefacts.

Anthropomorphic and animal figures are also recorded as a common feature of pre-ceramic Neolithic communities in Iran (*eg.* Conard *et al.* 2013: 77- 79). Close inspection

of some figurines allows for the identification of organic tempering, and later ceramic Neolithic figurines that are decorated with black pigments (Pollock 2010: fig. 10.7).

Neolithic mudbrick production has not been studied in detail, but is a feature of dwelling construction at the earliest village sites in the Central Zagros (Smith 1990: 325). Although unfired, some excavators have commented on the type of clayey sediment used and its tempering with plant material (Fukai *et al.* 1973: 16-17), presumably used in a similar manner to ceramic production where it is included to stop structurally detrimental cracking during drying.

Copious quantities of ceramic earplugs have been recorded from Neolithic sites (Azizi 2014: fig. 9.6; Pollock 2010: 182, fig 9.6; Weeks 2006: 64), with the largest collection coming from Tol-e Mushki, Fars province (Fukai *et al.* 1973: 62). The same raw materials and production techniques can be noted between earplug and vessel production, such as tempering with plant remains, burnishing of surfaces and application of red ochre pigment (Fukai *et al.* 1973: 62- 63, fig. 2, pl. LIV). It was noted by the excavators of Tol-e Mushki that those earplugs that had not been tempered with plant material and burnished, crumbled away at the surface (Fukai *et al.* 1973: 62). It appears that the earplugs were most likely fired in bonfires as they exhibit black and grey staining on the surface where the object would have come into contact with the burning fuel (Fukai *et al.* 1973: 62). The behaviour of fired clay and the successful survival of some earplugs through their use-life, notably those that were tempered and burnished, is perhaps where knowledge for ceramic vessel production originated. Clay earplugs have been recorded from Pre-pottery Neolithic sites in Iran where the first ceramics are plant tempered, burnished and painted or burnished with red ochre-rich clay (Azizi 2013).

It is certainly apparent that the same raw materials and technical behaviour of craftspeople can be applied to a range of technologies, perhaps strongly linking houses, figurines, personal adornment and ceramic vessel creation in the Neolithic mind.

7.8 *Painted motifs*

Pigments used to decorate vessel surfaces as a wash or burnished into the surface were also used to paint designs onto vessels. Red linear stripes and crosshatching are the

earliest form of such ceramic decoration and are recorded from Qasr-e Ahmad, as well as thicker red linear zig- zag designs that occur at Tol-e Nurabad (figures 7.5 and 7.6), and remain in use alongside the entire developmental sequence of decoration for the Neolithic. Both of these red decorative categories are manufactured with a similar technique of using iron oxide pigments applied in a thickness of 20- 30μm. These are then fired in a single oxidising firing that vitrifies the pigment (as seen in thin section images), and creates a permanent red colour on a buff coloured background. The different shades of red zig zag designs can be seen to demonstrate a range of variables that potters contended with in attempting to conform to conceptions of Neolithic ceramic design (figure 7.5). Variation in firing conditions, temperature, time and atmosphere would impact on the shade of red created and is indicative of the non-specialised ceramic production undertaken in the Neolithic of Southwest Iran.

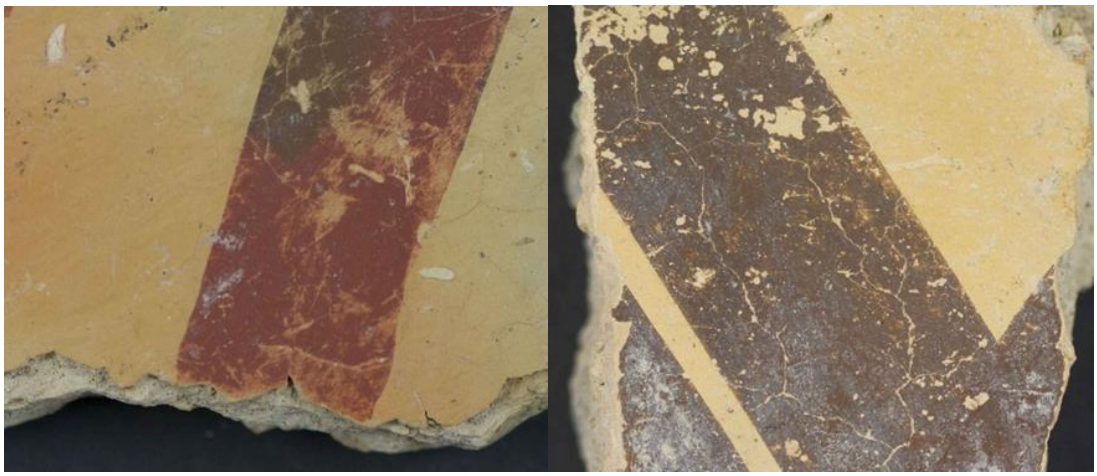


Figure 7.5 TNP 2430 (left) and TNP 2363 (right), both within the same decorative class but displaying different shades of red pigment.

Black decoration is introduced in the Mushki phase of the Neolithic and includes similar crosshatching, but also distinctive line and dot motifs that are built up from simpler zig-zag designs. Black coloured pigments were also created with iron oxide and applied in a similar thickness to red monochrome decoration (20- 30μm). The texture of black pigments has not been possible to explore in detail and it is presumed that differences in the preparation, grain size and degree of sintering account for the black colour

achieved on these sherds (Noble 1988: 79-80), as has been recorded for later Middle Eastern ceramic industries (Wright 1986: 8).

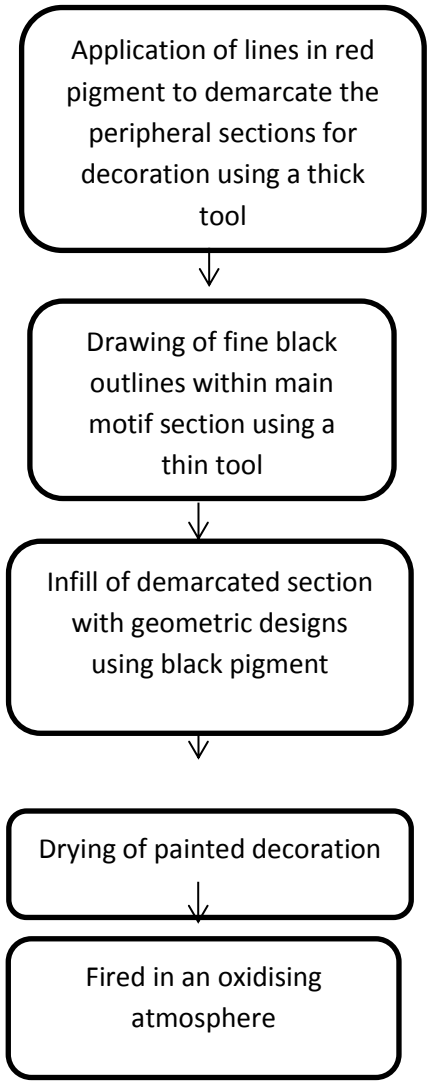
Potters had therefore deliberately manipulated the preparation of iron oxide materials to successfully create different pigment colours (see Figure 7.7 for flowchart).



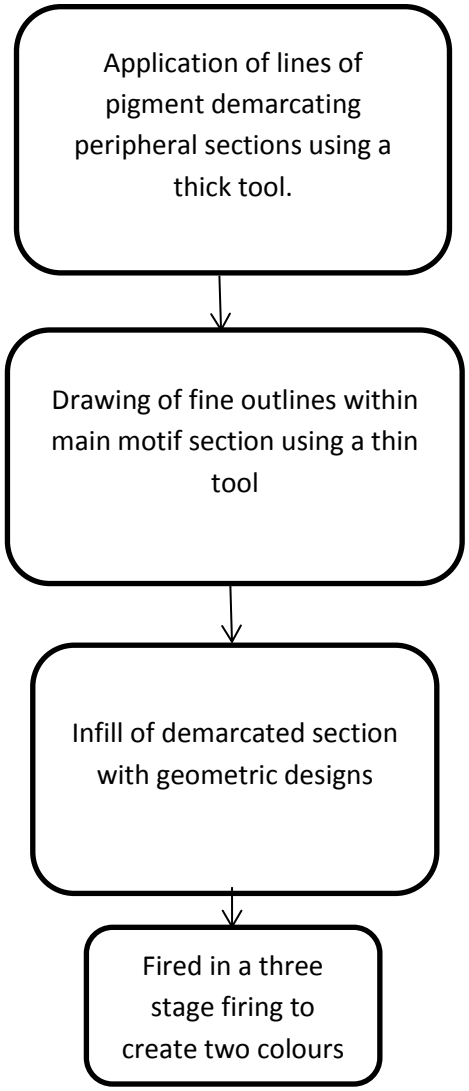
Figure 7.6 TNP 4761 also in the same decorative class as the above sherds, showing the creation of a more orange shade of iron oxide pigment.

Alternative strategies were also employed at Tol-e Nurabad in creating bichrome wares. Manganese was used as a black pigment in creating the same designs as iron oxide bichromes, but creates a black with a more purple hue.

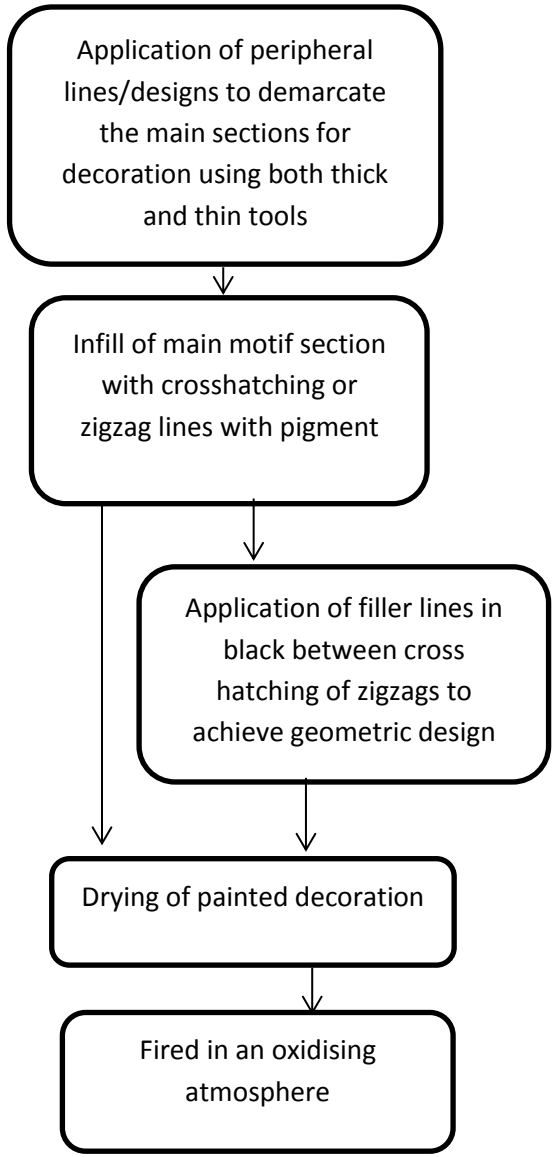
Figure 7.7 Iron oxide and manganese bichrome



Iron oxide bichrome



Iron oxide monochrome



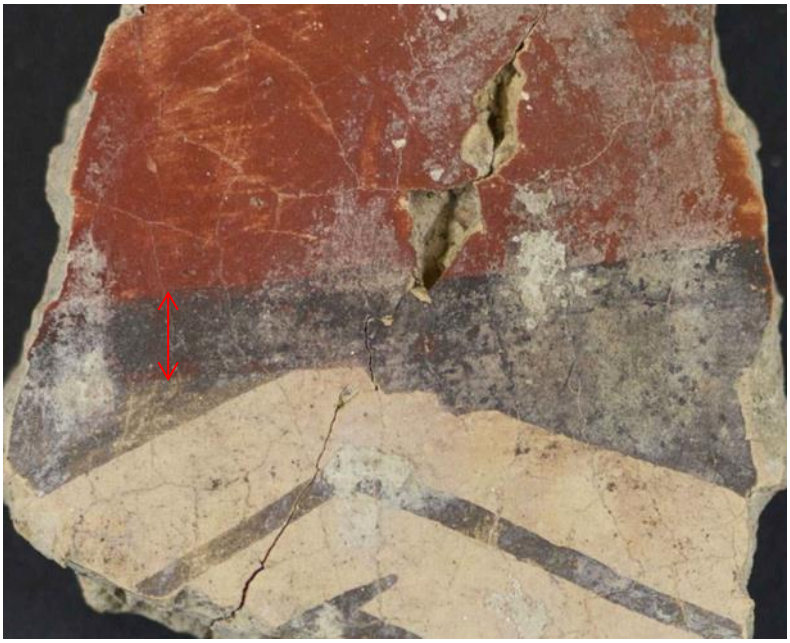


Figure 7.8 Sequence of decoration production is evident on TNP 4915 with a red peripheral band applied first and black decoration for the main motifs after this. A small area of decoration shows the overlap of pigments.

The manganese pigment was applied to the same thickness as the iron oxide on monochrome wares. The texture of the manganese pigment is difficult to ascertain as the remaining pigment layer is very thin on analysed samples (TNP 5428) and was identified through elemental mapping, but inspection of the backscattered electron images appears to indicate a finely textured pigment which suggests it has been ground in preparation and re-hydrated to be applied as a paint. The different stages involved in creating this version of bichrome wares required potters to prepare two separate pigments, thus taking more time. The firing of manganese and iron bichromes would only have required a single oxidising firing to render the pigments permanent.

The organisation and execution of designs is organised in a similar manner across most decorative classes in this typology of Neolithic wares. The areas of the vessel painted with motifs can be split into main and peripheral designs, originally discussed by Bernbeck for the ceramic assemblage excavated at Tol-e Bashi (Bernbeck 2012: 48). Peripheral motifs are bands of decoration that run round the circumference of the vessel or just below the rim, and border the space in which more complex geometric motifs are painted. Main motifs, however, are those that are painted below this, and

possibly in the space between two peripheral areas of decoration. Peripheral motifs tend to be organised around linear designs that are oriented around the circumference of the vessel, while main motifs are more complex geometric schemes that are based on zig zag or crosshatching designs.

Potters first blocked in peripheral and main areas of design with lines of pigment. A thick, peripheral band of pigment would not only have emphasised the shape of the vessel, but helped delineate the space that was to be filled with geometric decoration. This practice is most evident on bichrome wares, as the different colours allow for the identification of layering of one pigment on top of the other. Bichrome vessels therefore usually include a black demarcation line with finer painted black geometric decoration over a wide peripheral line of red pigment (figure 7.8). It is likely that different sizes of tools, perhaps brushes, were used for these two tasks as the infilling wash of colour for the thick peripheral bands would be time consuming with a brush the size used for the finer lines. The exact tools used in painting have not been recorded from any of the excavations, and it is most likely they were made of organic materials that have not survived archaeologically, similar to ones that have been noted in ethnographic research of household pottery production (Hardin 1974: 119, fig. 6.4). Hardin also recorded that brushes for the painted decoration of vessels were tools of great significance to the craftswomen in San José, with apprentices borrowing the brushes of other family members in order to emulate their painting style. This may have featured as an aspect of the socialisation of Neolithic individuals into the household potting traditions, helping to teach designs through the sharing of tools and materials to help replicate bodily gestures and the associated aesthetic style.

From detailed inspection of the sherds, it can be seen that the red band has been applied first, with the later addition of black (figure 7.8). The outlines of black designs were then sketched onto the vessel, using the red band as a starting point to work from (figure 7.9).



Figure 7.9 TNP 5428 decorated in black and red. Thin black outlines are still visible under the infill of black pigment, highlighting how the potters organised their designs.

Motifs corresponding to the typical Mushki, Jari and Bashi ceramic phases demonstrate variations of execution that is indicative of a flexible approach to creating Neolithic styles, without a strongly prescribed method for achieving them, as well as evidently different painting skill levels. This can be seen within the assemblage when comparing various sherds of the same design (figure 7.10). Different degrees of skill and competence can be witnessed through the thickness and stability of lines, while the craftsperson responsible for R8527 has chosen to paint two thin lines close together rather than the simpler approach on R8606 that has a single thick line. The quality of the pigment preparation is also notable, with dark dense lines of a true black on the more complex and well executed design and a lighter brown-black coloured pigment applied that appears more like a thin wash than a good quality pigment. Such instances of variation that have been recorded from the same archaeological context at Rahmatabad, is indicative of the involvement of numerous individuals at different stages of learning that were actively engaged with this craft. Where potters have chosen to approach the execution of a design in different ways is an example of individual agency operating alongside prescribed actions, both of which interact in a fluid way to comprise past social behaviour.

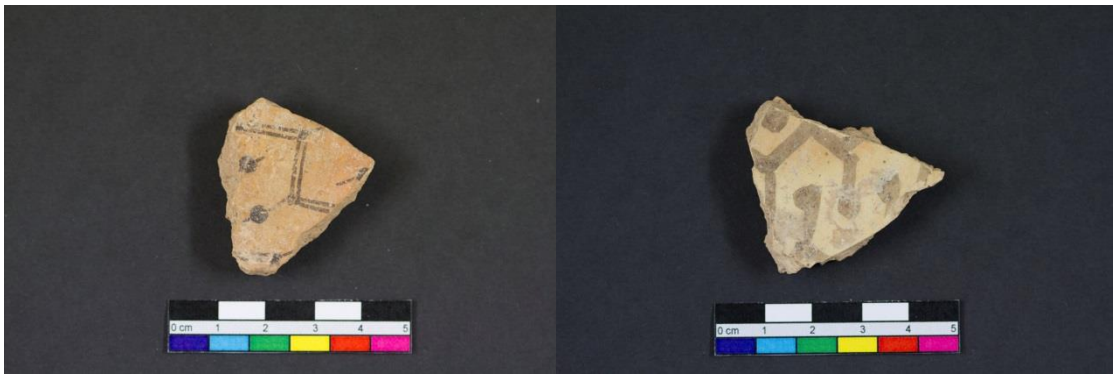


Figure 7.10 R8527 (left), and R8606 (right), demonstrating the same design, but with variation in execution and skill.

There is also evidence of practice and adjustment in the execution of designs evident within the sherd material, as some painting has been revisited to thicken or straighten lines. By attempting to cover any perceived flaws, it is clear that potters were trying to make their vessels correspond with the socio-culturally mediated designs and quality of execution of the wider Neolithic community. A good example of this is the decoration of TNP 5667 (figure 7.11), that shows evidence of the painter revisiting the design to thicken the finer lines, adjust the edges of the wider black lines and apply extra pigment. The ways in which these different painting techniques were maintained and modified signifies the deliberate attempt at creating painted designs that ascribed to the regional style that was culturally mediated through individual methods.



Figure 7.11 Decoration on sherd TNP 5667 that shows the painter has revisited and adjusted lines, adding more pigment to some areas of the decoration, and thickening lines.

This is perhaps evidence of mistakes or a potter still perfecting their painting skills; some of the diagonal lines have been repeatedly painted and are not as cleanly executed as others within the assemblage. As pottery production was most likely undertaken at a household level during the Late Neolithic (Bernbeck 2010; Alizadeh 2006), it is possible younger generations were involved early on and socialised through practising different aspects of the production sequence (Minar and Crown 2001). Ethnographic research of ceramic production in the Ecuadorian Amazon has shown that ceramic painting is the first stage of the *châine opératoire* female potters are introduced to as young children (Bowser and Patton 2008: 111). It is not hard to imagine apprentices preparing pigments for a more experienced potter (possibly an older family member), or infilling designs that had been previously planned out onto a vessel before being able to make their own pots and undertake the whole production process for themselves. This type of learning ingratiates apprentices into the socio-cultural world of ceramic production of their community (Dobres and Hoffman 1994: 212), making them competent and skilled craftspeople which acts as a marker for their socio-cultural membership to their community (Bowser and Patton 2008: 113).

7.9 *Firing*

To achieve the relatively high firing temperatures and close control of the firing atmosphere, particularly at Nurabad where iron oxide bichrome was produced, kilns would most likely have been used by potters in the Neolithic. No localised reduction clouds have been noted on any of the sherds, including a base sherd, where such evidence would be expected. A double chamber updraft kiln would have had a work chamber above the firebox with a perforated clay separation between these two chambers. The perforations would have generated a draft from the opening in the firebox through the chamber where pottery vessels could be stacked and up (Heimann and Maggetti 2014: 108). The updraft system would have enabled potters to build and maintain more economical fires in the chamber that would have been fed by air through the firebox opening and creating hot combustion gases that would have risen through the perforations into the floor of the kiln (Heimann and Maggetti 2014: 108). It is most likely a kiln of this type was used by Neolithic potters to create their vessels. Similar, although few, such structures have been recorded from the Neolithic Middle East, but

no evidence of the actual firing structures remain from Fars province. There is a notable range of vitrification microstructures within samples, but also a degree of homogeneity across the assemblage, which suggests a common practice and technique to firing vessels that was shared across the community. Areas of both the body and surface of samples can exhibit extensive vitrification with connected areas of liquid phase and fine unconnected bloating pores, alongside areas of initial vitrification where individual clay flakes are still readily visible. Therefore, the range of temperature being achieved by potters firing calcareous clay vessels could range from 700°C for those exhibiting initial vitrification, to in excess of 900°C for those with continuous vitrification (Tite 1969: table 3; Tite and Maniatis 1975b: 123). The cellular structure of calcareous clays remains stable across a 200°C threshold, so these temperatures are estimated ranges, especially in light of prehistoric updraft kilns in the Middle East suggested to be capable of large temperature gradients within the structure (Heinmann and Maggetti 2014: 108).

Having established the most likely type of kiln required for firing the ceramic wares that survive from the Neolithic, certain production aspects can be discussed. Kilns required fuel for a firing, and all of the sites studied in this thesis were constructed in valley locations primarily for ease of access to water. These highland valley systems were dominated by oak and pistachio woodland which are both hard woods that need to be combined with other materials to produce a high temperature fire. It is possible that dung cakes were used, alongside dried grasses or other organic materials to produce an effective fire (Gosselain 1992: 244, table 3; Witcha Kansa et al. 2009: 908). In either case, kindling and a main fuel would need to be collected and/or retrieved from storage at the site, as would have the fuel for household fires for cooking and warmth. It is not possible to offer any idea of kiln location for any of the sites in this study, therefore, the ownership of specific kilns cannot be discussed, nor the relative size of the structures to gauge the scale of firing operations other than these brief suggestions.

An additional stage in the firing process must have been undertaken when required to fire iron oxide bichrome. The texture of the pigment material requires a change through an oxidising to reducing and back to oxidising environment to create black and red colours on the same vessel painted with iron oxide, indicating that potters would have

to shut off the opening to the firebox and restrict the flow of oxygen through the kiln. Potters would have been required to be present for the duration of the firing and have a good knowledge of the timing needed for the different pigments they had chosen to use and how they had prepared and applied them. Potters would most likely have gained this knowledge through a combination of learnt techniques and their own experience.

7.10 *Conclusion*

The above discussion and reconstruction has demonstrated that the application of thin section analysis, SEM and electron microprobe analysis have helped discern the production stages of Neolithic potting. By incorporating both plain and painted wares from a range of typological classes, a broad similarity in raw materials and forming techniques has been witnessed across the range of wares sampled. Post-forming surface modifications, both their raw materials and techniques of manufacture, highlight the various past approaches to creating these Neolithic styles, evidencing a negotiating of regional group membership and individual agency.

The following chapter is a consideration of the evidence for the use and consumption of ceramic vessels during the Neolithic period, and helps contextualise this production sequence within the socio-cultural environment it operated in. References are made to other contemporary sites in Fars, wider Iran and related Neolithic cultures in Mesopotamia and Central Asia.

8. Comparison of results with other ceramic studies in Iran, the Middle East and Central Asia

8.1 *Introduction*

This chapter returns to the description of previous research undertaken on contemporary Neolithic wares from Iran (Chapter three), in order to contextualise the results presented in the last two chapters. The most relevant comparisons of these results can be made with studies that have been undertaken Mushki, Jari and Bashi wares by previous excavators. As I have stated before, no direct comparative work on the raw materials has been undertaken, such as geological or chemical analysis. However, some work was undertaken on painting and motif analysis, as well as brief statements on raw materials. This mainly took the form of microscopic inspection of sherd breaks to describe body fabrics of sherd material from the type sites of these respective wares. It will be investigated below whether any direct parallels or similarities may be seen between this work and that presented in this thesis.

8.2 *Comparison with earlier studies of Mushki, Bashi and Jari ware*

The most recent excavations and detailed ceramic report for comparable Neolithic ceramics are the 2003 excavations of Tol-e Bashi (Pollock *et al.* 2010). These yielded what the excavators divided as Plant tempered and Mineral and Plant tempered wares (Bernbeck 2010: 69- 71). No similar fabric group to Bernbeck's Mineral tempered ware has been recorded in this assemblage, which was proposed after his hand inspection of sherd material from Tol-e Bashi. My own petrographic research has shown that all sherds from different sites and phases of the Neolithic were made with fine clay that is found locally in the Zagros belt. A difference in paste texture can be seen across the sherds, but this is slight, with all samples being grouped in a single fabric ware that cross-cuts decorated and plain vessels.

It is therefore possible that the Plant and Mineral fabric group identified by Bernbeck for the Tol-e Bashi ceramics may be composed of a slightly coarser deposit of similar buff firing clay that was preferentially used by potters in the Neolithic, thus having larger grains that are evident to the human eye when inspecting the sherd break.

Further petrographic work would confirm if a local clay was used, however, the suggested household production for these wares (Bernbeck 2010: 134), and available raw materials in the vicinity of the site suggest the clay used is the similar marly limestone clays that are used for the vessels in this thesis. Consultation of the geological map included in Chapter Five, (volume 1), demonstrates the underlying geological similarity of the area in which these sites are situated.

Therefore, application of techniques such as SEM or Electron microprobe analysis would allow a more detailed reconstruction of the production stages and aid in more direct comparisons with not just the wares that exhibit Bashi motifs recorded and analysed from the sites in this study, but also the earlier and later Neolithic wares as well. This would add greater depth to Bernbeck's own discussions of raw materials and their preparation (2010: 134- 136).

Mushki and Jari sherds have had the least amount of investigation into raw materials and production stages, as well as suffering from a lack of detailed description of raw materials and technological process in excavation reports and publications (Fukai 1973; Egami 1967). A greater focus however, has been on the typology and development of their characteristic decorative motifs, which will be returned to below.

The pottery report of Tol-e Mushki explicitly states that there was no distinction in the assemblage based on mineral temper, and that all sherds were tempered with plant material (Fukai 1973: 22), while the Jari reports also state the ware conforms to the plant tempered software tradition of Fars (Egami 1967: 2936). It can therefore be summarised that no distinction between wares based on fabric inclusions was noted in the Neolithic wares, which is now understood to be due to Neolithic potters' preferential selection of fine buff firing clays that they tempered with plant inclusions, that are ubiquitous across Neolithic Fars and potentially across a much wider sphere of cultural interaction witnessed through similar ceramic raw material preparation. This includes the Central and Northern Zagros Mountains and Northern Iran.

Previous examination of forming techniques of these wares has suggested that combinations of coiling and sequential slab construction were employed at Tol-e Mushki and Bashi for their respective wares (Fukai 1973: 22- 23; Bernbeck 2010: 69). For wares at Tol-e Mushki, sherd breaks were inspected for evidence of coiling which has been suggested to have been built up from the base (Fukai 1973: 22), while at Tol-Bashi, the curved profile of breaks were suggested to have been the result of breakage along coil edges and joins (Bernbeck 2010: fig. 5.5). The size of the sherds in my own study did not allow for any real clarification as to which technique had been used on the wares sampled (a problem that is shared with other researchers attempting to apply Vandiver's techniques of analysis, summarised in Chapter 3 (Dipilato and Laneri 1998)). However, it is evident from the few joins that remained on two of the sherds, that separate coil or slab elements had been joined together to form the upper wall sections of the vessels.

No previous analysis of pigments had taken place specifically for these wares so there can unfortunately be no comparison with the results of the analysis undertaken on these sherds. This would be especially interesting for the bichrome wares recorded from Tol-e Mushki and Bashi, as this study has found that both iron and manganese were used to create black shades, requiring manipulation of the preparation and application of iron rich pigments a three stage firing, or the application of manganese rich pigments to be fired in a single, oxidising firing. This difference in production, while creating aesthetically similar designs, is interesting as it may represent different production groups and be evidence of trade and exchange of ideas, people and/ or vessels across Fars at this time.

A question of central importance that has so far hampered understanding of Neolithic lifeways in this area has been whether each of these different decorative traditions should be seen as evidence of separately produced wares with very different production stages. Additionally, it was not known if ceramics within each of the different decorative wares was produced the same at the different sites that have yielded such remains. This was particularly important based on the different subsistence practices evidenced across Neolithic sites, as described in Chapter 1. Therefore, an interesting aspect of

Neolithic ceramic manufacture is that it is remarkably similar in raw material choice and production stages, with individual agency seen in the various methods used to build up painted designs but which is otherwise difficult to distinguish in the earlier stages of the *châin opératoire.* Mushki, Bashi, Jari and Nurabad bichrome wares can therefore be suggested to form part of the same potting technology, but are distinguished on the basis of decoration.

8.3 *Comparison with Neolithic wares from Iran and the wider Middle East and Central Asia.*

Neolithic potting traditions across such a wide area are similar in terms of raw material selection and production methods. Decorative motifs and effects have allowed researchers to partition different cultures both across time and space, but from a review of other analytical studies undertaken on Neolithic ceramic wares from other areas of Iran and beyond, broad parallels can be witnessed and discussed in order to reconstruct wider traditions of clay crafting for the Middle East and Central Asia.

Neolithic ceramics from the Central Zagros also incorporated the use of local fine calcareous clays, analysed with SEM, differential thermal analysis and x-ray diffraction (Vandiver 1987: 9-10). Select SEM analysis has also been undertaken on sherds from Tepe Guran, as part of a wider study in Prehistoric ceramic pigments (Noll 1975: fig.1; 1991: 261- 268). These samples were from calcareous pastes tempered with plant material and decorated with red, ochre-rich pigments (Noll 1975: 604- 605; 1991: fig. 73). They also display similar vitrification microstructures as the sherds analysed in this study, suggesting the same firing practices were undertaken to those in use in Fars (Noll 1991: fig. 70). No typology been constructed for the Central Zagros ceramics that have been recorded from the Neolithic phase, and Vandiver unfortunately did not distinguish between different decoration, shapes *etc.* in her study and did not publish images of the ceramic sherds she analysed (Vandiver 1987). Ceramic wares from the Central Zagros have stronger parallels with more northern sites and the Central Plateau sites compared to material from Fars (Meldgaard *et al.* 1964; Hole *et al.* 1969). Publication of ceramic remains from the Central Zagros sites are also few, with emphasis on plant and animal

remains, largely due to the period in which the research was being undertaken (1960s-1970s), with the only previous research in the area being the passing through and early forms of survey undertaken by Sir Auriel Stein (1936), who also passed through and was the first to record and describe Neolithic ceramics from Fars province. Therefore, little discussion or comparison can be made with the area immediately west and north of the study area.

In Northern Iran, thin section, SEM and XRD analysis of a Painted Buff ware has highlighted the use of a local, calcareous, buff clay tempered with plant material used to form ceramics that were thickly slipped (0.7- 1.2mm), decorated with a dark brown pigment and fired at 850° (Fazeli *et al.* 2010: 95). The repertoire of decoration also includes vessels with a red slip, although these have not yet been analysed. Earlier, separate analysis was conducted on pigments in this area, and manganese black was applied with iron oxide red on bichromes from Cheshme Ali when painted with iron oxide red on bichromes and also at Tepe Sialk (Anderson *et al.* 2014; Noll 1975; 1999: fig. 74; Wright 1986: 8, table 1). Northwest Iranian and Azerbaijani sites also utilised calcareous clays (established through bulk analysis), that were tempered with plant material, slipped and decorated with pigments (Hancock *et al.* 1989: 115- 116, 123), although no separate analysis has yet been undertaken on these different elements of the sherd. In addition, potting cultures to the Northeast in the Kopet Dagh Mountains of Turkmenistan, have a similar exploitation of calcareous clays tempered with plant material (Coolidge 2005: 99). This was used to form vessels decorated with black and red pigments in a similar manner to the Northern Iranian region (Coolidge 2005: 99). Again, no comparative work on pigments has been undertaken, however the same preferential selection of raw materials for potting can be established.

Combinations of coiling and slab construction have been suggested for the whole range of Neolithic wares across Iran, as well as into Azerbaijan and Turkmenistan (Vandiver 1987; Coolidge 2005: 99). This practice showed considerable variation in the exact combination, with potters at some sites choosing to coil bases in order to build up the sides of vessels with slabs, other sites exhibiting a range of different sized slabs for different ware shapes or for the same forms produced at different sites (Vandiver 1987:

18). This is an aspect of manufacturing variability that may prove fruitful to pursue, but necessarily relies on the survival of near-whole or complete vessels from excavations that were unfortunately not often recorded from the sites sampled for this study.

While the Neolithic use of certain raw materials for ceramic manufacture is clear, different regional cultures are evident in the painting effects across the region. It must also be borne in mind that the meaning and perception of ceramic manufacture and consumption would have differed across such a vast area, as can be witnessed in the subtle differences of forming and execution of painted designs.

Contemporary Mesopotamian ceramic cultures also have broad similarities to the ceramic production reconstructed for Fars. Mesopotamian wares have been shown to have been produced on a local scale and traded within the region (Davidson and McKerrell 1976; Akkermans and Schwartz 2003: 138). The wares produced in this region have a much wider array of forms and sizes compared to that recorded from contemporary Fars, including more elaborate rim shapes and closed vessels (*e.g*. examples of Samarran fine ware (Niuwenhuyse *et al.* 2001: fig. 3), as well as different decorative traditions, including anthropomorphic and animalistic designs. However, the geometric repertoire across the Hassuna, Halaf and Samarra cultures uses similar motifs executed in red, black, and or red and black bichrome combinations, including cross-hatching, zig zag motifs, stepped lines and red burnished surfaces (Akkermans and Schwartz 2003: 134- 138). These wares also incorporate mineral tempered fabrics (Van As and Jacobs 1999:215), and have been made in a combination of coiling, slab and pinching construction (Castro-Gessner 2010: 104- 105).

The most detailed comparative research, and that with the most relevance to this study, is the analytical work on pigment raw materials and use in Late Neolithic Mesopotamia, the most common form of which for both black and red was iron oxide (Wright 1986: 8). Manganese was also occasionally used as a primary source of black pigment when combined with iron oxide reds in bichrome decoration (Wright 1986: 10). The iron oxide pigments fire to a dark reddish- brown in oxidising conditions which seem to have prevailed in Mesopotamia through the relatively simple firing installations in use there.

Syrian and Northern Mesopotamian firing technology underwent a radical change around 6100 B.C. with the introduction of updraft kilns that allowed for alternating reduction and oxidation cycles. This new technique meant that pigment firing colours could be controlled through the kiln atmosphere, and dependent on their chemistry, could fire to different colours creating bichrome decoration (Steinberg and Kamilli 1984: 192, table 2), which gave rise to the elaborately decorated Hassuna, Halaf and Samarra cultural wares. The introduction of these specific wares is more readily visible in the archaeology of Mesopotamia than Southwest Iran, with plain and coarse early ceramics recorded from sites along the Euphrates and Balikh rivers in Northern Syria and Iraq (Akkermans and Schwartz 2003: 133).

Further exploration of social organisation has been possible with Mesopotamian datasets compared to Iranian assemblages, and the introduction of updraft kilns has been suggested to be an indication of a move towards ceramic specialisation in the Halaf period, alongside centrally stored food sealed with clay stamp seals that is re-distributed in an egalitarian organisation of society (Frangipane 2007: 155- 164). Opinions differ as to the organisation that such kiln designs may represent, with some arguing this evidence documents the beginning of production specialisation and social differentiation that become widely evident in the succeeding Chalcolithic period of the Middle East (Hansen Streily 2001: 72), or that it is representative of increased productivity in a horizontally organised egalitarian community, through kin relations with a few central figure heads that negotiate the equal distribution of goods (Frangipane 2007: 164). A main divergence in arguments seems to be between the Neolithic material culture of Northern and Southern Mesopotamia, which is perhaps echoed specifically in the two different sizes of updraft kiln remains- Samarra kilns are larger than Hassuna ones and are suggested to be indicative of a more economical firing system that can fire more vessels at a time compared to the organisation of Hassuna production, although the updraft method is the same in both (Hansen Streily 2001: 73).

8.4 *Conclusion*

Distinct differences fracture the regional clusters of potting traditions of the Middle East and Central Asia, most often centred around differences in decoration that allow

cultural and chronological phases to be distinguished. The selection of buff firing, calcareous clays tempered with plant material unites all of the Iranian and Central Asian sites in the Neolithic that have been published (including Southern Azerbaijan and Turkmenistan), while Neolithic Mesopotamian potters also tempered fabrics with mineral inclusions and included a much larger repertoire of forms and decoration than the latter group. This broad distinction echoes that suggested by Coolidge in her labelling of Turkmenistan and Iranian sites as part of a "Southern Super-Zone" (2005: 99), the creation of which falls in line with the reconstruction of regional cultures represented by chipped stone tools (Kozlowski and Aurenche 2005). Important to remember in the carving up of Prehistoric cultural maps is the site and community level at which each of these cultural groups operated. Whilst Archaeology may sometimes struggle in some instances to reconstruct personal and individual biographies of people in the past, it has not been impossible to uncover instances of individual agency whilst reconstructing potting production sequences reconstructed in this thesis.

The different technical aspects of ceramic production, and potters individual responses to creating vessels that conform to these larger ideas of appropriate crafting, are therefore negotiated with village producers and consumers across networks of exchange that in some cases seem to have identifiable boundaries. The characteristic Mushki, Bashi and Jari wares have so far not been recorded outside of Fars province, although elements that make up their designs can be seen up to Northern Iran and into Central Asia, as well as across to Northern Mesopotamia. The exact form of exchange this took seems to have been ideas, knowledge and/or people only, rather than the ceramic vessels themselves as all sites so far studied, as well as the other research discusses in this chapter, demonstrate village communities in the Middle East and Central Asia engaged in local production that spoke to a number of wider spheres of cultural similarities at different levels. These included small regional styles, wider regional styles, and a pan-Neolithic technology of potting that broadly united the region.

The following chapter investigates the reconstructed use and consumption of ceramic vessels based on the analytical results previously presented.

9. Consumption of ceramics in Neolithic Iran.

9.1 *Introduction*

This chapter discusses the social meaning of ceramics in Neolithic Fars by investigating the use-wear analysis and depositional contexts of the sherds analysed (Tite 1999), before turning to a wider reconstruction of socio-economic organisation in the immediate area of Fars and also the wider Middle Eastern context during this period.

9.2 *Depositional contexts of ceramic sherds*

Investigating ceramic consumption practices of Late Neolithic Iran is a challenge due to the limited exposures at the excavated sites in this study. Other sites such as the type sites of Tol-e Mushki and Tol-e Jari A and B have larger exposures that have unearthed numerous individual dwellings, but have not published contextual information of the sherds in sufficient detail to explore any spatial relationships. The excavation of Tol-e Bashi included largely external spaces and a restricted diversity of contexts (Pollock 2010: 31- 64), with other sites with contemporary ceramics are the result of intensive surveys. Tol-e Nurabad and Qasr-e Ahmad levels are exposed in 2x2m trenches (Weeks et al. 2009: 31), with a slightly larger 7x7m trench at Rahmatabad (Azizi pers. com.) Material from survey collections in the Kazerun valley was collected from mounded sites where no contextual information is yet available (Rezaei et al. 2014).

The contexts that were sampled for ceramics from Qasr-e Ahmad and Rahmatabad contained no architectural features but have ash lenses recorded from them, representing the remains of hearths and cooking activity (Azizi pers. com.) Charcoal and ash concentrations with associated river cobbles and burnt animal bone have also been recorded from the earliest layers of the Late Neolithic at Tol-e Nurabad (Phases A27- A24b) (Weeks *et al.* 2009: 33). These appear to be the remains of cooking activities, as many river cobbles and/or clay balls are recorded from Neolithic sites in association with burnt animal bones and phytolith evidence, the most notable parallels being at the contemporary Neolithic site of Tol-e Bashi (Pollock and Bernbeck 2010: 274- 275). Cobbles and clay balls can be placed in a ceramic container, clay lined basket or skin bag when heated in a fire and continuously stirred, being replaced with more

hot balls or stones on a regular basis until the water is boiling (Atalay and Hastorf 2006: 293).

From Phase A24a at Tol-e Nurabad, there is the first evidence of a possible hearth/ oven structure consisting of four courses of mudbrick standing to a height of c. 20cm with a fill of brown sandy clay, and including concentrations of ash, charcoal, river cobbles and ceramics decorated with Mushki and Jari designs (Weeks *et al.* 2009: 33). A more definite example of a Neolithic hearth occurs in the slightly later Phase A20, which is a palimpsest of construction phases of burnt orange clay and ashy charcoal filled deposits, again with Mushki and Jari decorated ceramics (Weeks *et al.* 2009: 34). The hearth remained in the southwest corner of the trench during the next Phase A19 where it was not so elaborately constructed but is still associated with a matrix of ashy clay and charcoal, as well as burnt river cobbles and ceramics (Weeks *et al.* 2009: 34). A limestone slab is also recorded from this feature (Weeks *et al.* 2009: 34, fig. 3.30), which could be similar to examples from Aşiklihöyük and Çatalhöyük used for the parching of grain and/or seeds in the further processing undertaken before storage (Atalay and Hastorf 2006: 299). Although this a contemporary site at some distance to Southwest Iran, there is suitable evidence for a range of cooking activities that could help understanding of possible activities being undertaken and suggested by the patchy evidence from sites included in this study.

An understanding of household structures and spaces within village sites of the Neolithic is crucial to unravelling the use and discard of ceramics at this time. All analysed sherds derive from fill deposits in both internal and/or external spaces (undefined in some cases), and often within layers associated with ash lenses or hearths. Although distinguishing between internal and external spaces is difficult due to the lack of fully exposed structures, some aspects of daily food preparation and cooking routines remain identifiable and will be explored below.

Despite the range of methods for cooking foodstuffs that have been proposed for the Neolithic Near East (Atalay and Hastorf 2006), such as pit roasting joints of meat, drying and smoking fish and meat over outdoor open fires and parching or boiling of grains, pulses and nuts *etc*., there is evidence in the Late Neolithic Middle East that indicates many preparation and cooking tasks were undertaken at household hearths. These

include the boiling of foods using heated river cobbles and clay balls at hearths within individual house structures, the toasting or boiling of grains, pulses and seeds using woven or clay trays placed over clay balls/ cobbles before being ground and stored (Atalay and Hastorf 2006: table 2). Sustained boiling of cereal grains or pulses to make a porridge or gruel may have used Neolithic ceramics from the Zagros sites of Hajji Firouz, Tepe Sarab and Tol-e Bashi as suggested by residue analysis, or the use of the pots to store plant oils once processed (Gregg 2010: 57- 58). The serving of meals within houses may have occurred using decorated ceramics due to the broken and discarded sherds that were deposited close to hearth structures at Tol-e Nurabad and Rahmatabad where they were perhaps stored when empty for ease of access when serving, or used to store foodstuff that were cooked with. The location, and potential ownership, of such fire installations is difficult to ascertain in some Iranian excavations due to their presence in outside areas between houses, as at Tol-e Bashi (Pollock 2010: 48- 64). Such an oven was located outside of Building A at this site, which included a room (78) with a high concentration of burnt stone and phytolith remains (Pollock 2010: 60-61), suggesting some households organised their food processing and storage in a designated room. However, the rarity of microbone within house structures and the complete absence of burnt microbone has prompted the excavators to suggest that butchery, processing, cooking and consumption may have largely taken place outside of house structures (Pollock and Bernbeck 2010: 275). In addition, where it has been possible to discern indoor and outdoor spaces at Tol-e Bashi, ceramic sherds were more numerous in outdoor contexts suggesting either that residents performed some food related activities with ceramics indoors, but the majority of activities were located outdoors in communal contexts (Pollock and Bernbeck 2010: 277), or that indoor areas were regularly cleaned of debris. If food was mainly prepared, served and consumed in outdoor spaces, visible to the wider community, then this would accord with egalitarian practices that aim to cultivate social control of preparation and consumption of food resources (Pollock and Bernbeck 2010: 277). This remains to be investigated for the sites under study in this thesis where increased exposures or initial excavation would allow identification of indoor and outdoor spaces.

Food preparation and cooking are repeated activities that communities in the Zagros have continually returned to designated spaces to perform (Matthews 2012: 183). This

is suggested by the repeated building up of hearth areas over time, starting from the point of semi-sedentary groups returning sporadically to sites, as possibly evidenced in the earliest contexts of Tol-e Nurabad (Weeks *et al.* 2006: 71), Tol-e Bashi (Pollock 2010: 64), and numerous sites in the central and northern stretches of the Zagros Mountains (Matthews *et al.* 2013: 4). The repeated preparation of surfaces, including fire pits, ashy areas and hearths is recognised as evidence of focused and important activities at seasonal encampments that developed into household units focused around hearths with the preparation and consumption of food (Matthews 2012: 188- 189). The excavation of ceramic sherds in or near ash and hearth contexts in this study, demonstrates their role in the habitual cooking practices that are well-defined patterns of socialisation which help to foster continuity and stability in communal life, thus reducing social tensions Matthews 2012: 189; Bowser and Patton 2004: 178- 179). There is also limited evidence that suggests the organisation of specific food processing and cooking tasks is located in specific areas of houses and outside spaces that may also have involved ceramic vessels. Further excavation of increased areas of Neolithic remains may allow for the investigation of depositional patterns correlated with ceramic typologies to explore any specific deposition of different wares. This may lead to a more detailed understanding of use and consumption practices.

9.3 *Raw material and use-wear analysis*

Despite the presence of hearths and fire installations at the sites, the ceramics sampled have not been involved in the actual cooking of foodstuffs over a fire or the direct application of heat. The scientific analysis undertaken on these sherds shows them to be organic tempered, slipped, and in some cases painted with decoration (see Chapters 6 and 7 for details of the results). On nearly all of the sherds analysed, a clear concern with the overall surface finish is evident, with care taken to smooth external surfaces, most likely for further decoration, and to create a water-tight surface that can be used for the cooking and serving of liquids and wet food (Tite and Kilikoglou 2002). The only vessels that have not had burnishing or slipping treatment applied to them are some of the thicker walled vessels in the assemblage, SK 20. 23 and QA 389. These two vessels were most likely larger storage containers and could not have been intended for storage of liquids or boiling of foods due to their porous, un-slipped bodies and no current evidence of organic sealants. Application of direct heat for boiling the contents of a

vessel would seem contrary to the aim of the pottery production sequence that for the vast majority of sherds has focused on final surface finishes. Therefore, the use of ceramic vessels at the sites represented in this study likely included storage and food/drink presentation based on a number of factors. The sherds are all open bowl forms, with all complete or near-complete published vessels and diagnostic sherds conforming to this shape. An example of a ceramic tray is also recorded from Hajji Firuz Tepe in the Northern Zagros Mountains (Voigt 1983: 161), and a very shallow open bowl from a rare burial context at Tol-e Nurabad (Weeks pers. com.), but these are currently the sole exceptions to this trend. There are differences of design in the open forms, with some vessels including single or double carination, and minimal size differences indicated by the thickness of some sherds. Open bowl forms may have been preferable as the shape leaves vessel contents in full access and view of the user, which for ease of access with hands or utensils to the food is crucial, but can also leave vessel contents in full view of other nearby people. This can help to maintain egalitarian social relations by ensuring all individuals are served the same types of foods and amounts if communities are concerned with keeping equality amongst its members, or can also be used to differentiate between individuals by serving some differently.

An additional aspect of raw material use that should be addressed at this point is the notably friable nature of Neolithic ceramic sherds in general. As has been presented in previous chapters, this is a common aspect of ceramic technology in this period. The difficulties faced with the adherence of the slip and surface layers has been addressed in Chapter 8, and the explanation for this behaviour in the raw materials and production process. Of interest, is that Neolithic potters did not seek to address this issue, but seemed content to use friable ceramics that included labour intensive decoration and possibly multi-staged firing processes. This may be related to their potential short-term use as objects within village communities, which would not have allowed them to be curated as family heirlooms or long-term personal property. Aspects of this argument will be explored in more detail below.

9.4 *Significance of pottery decoration*

Ceramic vessels can be decorated in a multitude of ways, and it is this decoration that often forms the basis of investigations into “style” (Rice 1987: 244). It is the analysis of

such styles that has allowed for the inference of different socio-economic interactions, transmission of technical and artistic knowledge and dating of Prehistoric sites in the Middle East. As has previously been outlined in Chapters 1-3, ceramic decorative styles have formed the basis of relative dating in Fars, which has since been refined with radiocarbon dating. The division of the Neolithic ceramics into different ware groups is based on differences in decorative motifs and in some instances the colour of pigments used, rather than vastly different raw materials and production sequences. Although the ceramic designs have been split into and discussed as separate wares, the development of motifs can be seen to be instances of innovation that fit within the previous decoration and technological frameworks (Gibbs 2015: 341). It therefore remains to explore any evident social meaning in these different decorative traditions.

As has been stressed above, contextual information is relatively limited and no patterning concerning the differential use of vessels has so far been identified for any wares in the Neolithic Iran, in fact, residue analysis prompted analysts to suggest vessels may have been involved in a range of food storage and presentation tasks (Gregg 2010: 58) (see below). Therefore, while the specific meaning of different motifs and colour combinations may not be accessible to us, a wider appreciation of the cultural significance of ceramic design is possible. Each of the different decorative wares in the typology of this thesis conforms to designs that have been recorded from a range of sites in Fars. That these ceramics are part of Neolithic styles of decoration is clear, but the original development of such a style remains to be investigated, as the earliest ceramics, which occur at Rahmatabad, are buff wares decorated with red slips or red painted pigments in recognisable designs that feature throughout the period, and with the same raw material selection and production stages as the later Neolithic styles. This can be taken to suggest that these ceramic designs emerged as a fully developed technology with styles of decoration that went on to be used for the few thousand years of the Neolithic period. Active participation and maintenance of this style seems to have been undertaken by the strong sense of appropriate designs that were negotiated by individual potters in their own variables based on experience and skill in raw material preparations, giving different shades of pigments or a range of detail and accuracy in painting. Motivation to create and perfect ceramic designs would have been driven by an individual's desire to be a group member by achieving competency as is defined by

the wider community (Bowser and Patton 2008: 108). This culminated in creation of vessels that contributed to Neolithic ideals of ceramic vessel decoration across the province.

Whether this decoration had any more specific meaning other than that suggested above is harder to discern. This is, again, mainly due to small exposures with a lack of diverse contexts that has not allowed any valid spatial patterning to be discerned. Ethnographic examples show us that geometric designs can hold significant culturally specific meaning and messages. For example, studies within the Ecuadorian Amazon document the use of decorated pottery bowls to display political affiliation to other community and immediate family members (Bowser and Patton 2004: 176). In this instance, women produce beer bowls and deliberately decorate and use them in politically meaningful ways;

"Generally, a woman uses a painted beer bowl to serve her husband first, then she brings painted bowls of beer to high status male guests who are closely allied to her household, and others are served in order by status and alliance, or in order by seating when groups are large. People are aware of the expected order of serving, and any change may signify the guest's involvement in a public controversy, a dispute between host and guest, or other shift in relationships. A woman's style of serving signals the seriousness or joviality of discussions and the beginning and end of events" (Bowser and Patton 2004: 176).

While it is not being suggested that this documentation of the meaning and use of painted ceramic vessels may be directly mapped onto Late Neolithic Iranian archaeology, the above quoted example serves to highlight the significance of painted decoration during the consumption of food even on a household level, as well as that which may occur at the larger community-wide events such as feasts. In addition, geometric decoration and the competence of its execution can highlight familial relations, maturation into adulthood (Wallaert 2008: 188- 192), post-marital re-socialisation into ceramic crafting (Herbich and Dietler 2008:235), and inheritance of technological styles (Gosselain 2008:152).

Mealtimes are important activities that repeatedly bring people together, allowing for the playing out of family politics, reinforcement of social values and sharing and

participation in traditions (Mills 1999). It is at these kinds of events that social relations become evident and can be highlighted through the differential selection, preparation, cooking and serving of foods (Atalay and Hastorf 2006: 284). If these are activities that took place in Late Neolithic Fars, the use of open form decorated bowls would enable these kinds of relationships to be acted out.

Communal ideologies can perhaps therefore be seen to be materialised in the production and use of painted ceramics. Household hearths/ovens and external fire features would have acted as a venue for both family and wider community social, economic and ritual activities, where decorated ceramics would have been distributed and consumed. Access and consumption of these goods unified members of Neolithic Fars society, whose interaction may have been well-established through family links between communities as new village sites were settled during the Neolithic (Sumner 1972; Matthews *et al.* 2013: 28), and also through the sharing and participation in cultural relations at regular contact at specific events.

9.5 *Socio-economic reconstruction of the Southwest Iranian Neolithic based on the evidence from ceramic production and consumption*

The range of ceramic wares studied in this thesis have been shown to conform to a local raw material use, and geological materials of the Zagros Mountains conforming to a conservative range of production stages that are very similar across the sites sampled. Very few examples of ceramics have been highlighted as potential imports throughout the recent survey and excavation history of Fars province, despite no petrological or chemical analysis previously having been undertaken. This is partly due to the similar decorative traditions pervasive across sites at this time that generally allow confident dating of Neolithic sherd material. To date, three examples of ceramic vessels that have been potentially identified as non-local products from the 1960s excavations at Tol-e Jari B are from unstratified contexts (Nishiaki 2003: plates 26, 28 and 30). These were not able to be included in this study but are presented here for the purpose of discussion of non-locally produced objects. If they are indeed of Neolithic date (which is suggested by the use of buff clay tempered with plant material and vessel form), only one of these three vessels appears without any current similarities to known designs (Nishiaki 2003: plate 30). The two other examples could potentially represent

variations of zigag and crosshatching designs that have been recorded from other sites and surveys, and also demonstrates similarities with North Iranian sites. In any case, so few examples of unusual styles for the region does not correspond with a strong argument for the long-distance trade of ceramic vessels. The appearance of the buff surface and black pigments, a tall sided open vessel form, with vague similarities in decorative motifs may be the result of potters requiring vessels for a different function, or be examples of experimentation with painted designs, rather than evidence of trade networks stretching outside of the Fars region. This may also be evidence of a decorative ware that has so far not been excavated or recorded in surveys within the province.

Without a larger sample set and an increased number of sampled sites, it is not possible to reconstruct potential trade relationships between sites that may have used predominantly manganese blacks and sites that used predominantly iron oxide blacks. At the same time as the introduction of manganese black at Tol-e Nurabad, new ceramic parallels can be documented with the Kutahi valley in the Kur River Basin. This is a valley that also has Mushki, Jari and Bashi designs recorded from surface surveys (Gotch 1969: 190; Sumner 1972: pl. 3). Before the excavation of Tol-e Nurabad, the designs at Kutahi were thought of as local traditions, but with excavated parallels it now seems that networks of interaction were fluid across the province. Additionally, in Sumner's description of wares included in the illustrative plates from the Kutahi valley, he describes one sherd as decorated with a purple coloured pigment on a buff surface (Sumner 1972: 69, pl.3). This may be indicative of the use of manganese black which can create a purple coloured pigment compared to iron oxide black that creates a darker, truer black, and may be further support for interconnections between the Mamasani and Kutahi areas.

The local scale of production and consumption of ceramics correlates with the lack of participation in long distance exchange networks of other material culture items. The main material evidence during the Neolithic period and preceding Epi-Palaeolithic in this presence of obsidian, bitumen and Persian Gulf Sea shells within village sites. The earlier aceramic Neolithic period in Iran, and the wider Middle East, has evidence for a more intense exchange system with obsidian being traded from Nemrut Dagh in Turkey

and other currently unidentifiable sources (Asouti 2007), across the Zagros Mountains, down to the Persian Gulf shore and into Eastern Iran.

In the later ceramic Neolithic, this trade has all but disappeared, with only scant obsidian tools recorded from sites across Iran during this period (Matthews *et al.* 2013: 28). Watkins (2005: 231), has suggested that the organisation and nature of Middle Eastern society had become very different in the later ceramic Neolithic, with a decreased consumption of obsidian, less emphasis on mortuary ritual and specialised ritual buildings. Persian Gulf Sea shell jewellery is also scarcely recorded (Pollock and Bernbeck 2010: 276), and bitumen only at a few sites in the Zagros Mountains. Examples were found at Kushk-e Hezar in Fars province (Alden 2004: fig 9:3), and remains studied using lipid analysis from ceramic sherds excavated at Ali Kosh and Chagha Sefid (Gregg 2010: 57- 58).

The depositional contexts of the few obsidian tools that have been recorded from Neolithic Fars are in rubbish middens and floor fills, and have therefore not been curated or deposited in extra ordinary contexts, including burials. There is also a marked decrease in burial remains and objects included in graves compared to previous periods, which has prompted numerous researchers to begin to describe society in Neolithic Southwest Iran as egalitarian and based around the sharing of material culture and a lack of elite consumption of exotic or non-local goods (Pollock and Bernbeck 2010: 284).

Two Late Neolithic burials were recorded from Tol-e Nurabad in association with a near-complete painted ceramic bowl (Weeks pers.com.) This example of the use of vessels in burials may be similar to that documented in another rare discovery of burial remains at the contemporary site of Tepe Abdul Hossein, where a barely mature female was laid beneath a series of plastered floors with the bones of a foetus resting on a stone dish above her head as well as the recording of a crouched burial located in the initial architectural layer underneath a later sealed doorway (Pullar 1990: 10, 47). It is difficult to discuss the significance of the association of ceramics in burials based on two known examples. However, it may be possible to further explore this with increased excavation in order to investigate possible patterns of gender, age, interred vessel type *etc.*

Such an absence of funerary data may be related to the scale and nature of archaeological investigation in the Zagros Mountains, which for Fars province in particular has focused to a large extent on surveys and small horizontal exposures, with very few large-scale excavations. In comparison to other Near Eastern Neolithic cultures in the Levant, Turkey and Iraq (and specifically the pre-pottery horizons), there certainly seems to be a paucity of skeletal remains. This may be explained by a change in cultural practice, with domestic internments becoming a discontinued practice in Late Neolithic Iran, or alternatively, a different approach to the treatment and internment of the dead, one that does not leave evidence of elaborate funerary rituals or include numerous intramural burial practices.

Building remains have also been used to investigate social differentiation, with the recording of non-domestic buildings and speculation as to their function. This is, again, difficult to apply specifically to the Fars Late Neolithic dataset in this study as few whole buildings have yet to be exposed. There is some evidence that "ritual" buildings existed within some other Late Neolithic communities in Iran, as at Hajji Firuz Tepe (Voigt 1983: 314- 316), Ganj Dareh (Smith 1990), and Sheikh-e Abad (Matthews *et al.* 2010). These consisted of structures that incorporated ochre decorated animal skulls, plastered podiums, and at Hajji Firuz in the northern Zagros mountain range, human skeletal remains as well.

The apparent paucity of data with which to distinguish social differentiation is perhaps explained by Sassaman's (1998: 94), suggestion that differentiated and hierarchical societies are easier forms of organisation to identify than actions and structures that govern egalitarianism. He also makes the point that it requires specific social structures that individuals and communities must engage in to maintain their social order. All societies can be seen to have an inherent desire for luxury goods that must either be attempted to be met or deliberately eschewed (Van der Veen 2003: 408- 409). In deliberately eschewing material culture that allows for formalised differentiation between members of society based on wealth, power *etc.* ,further structures must have been put in place and negotiated, whether archaeologically visible or not, as even within an egalitarian society, processes of dynamic of social obligation and debt still occur that individuals can manipulate for various purposes (Sassaman 1998: 94). In addition, the act of generosity can also encourage competition, economic intensification and

potentially institutions of inequality if uncontrolled, as notions of sharing, humility and unity are crafted rather than occurring naturally or being inevitable (Sassaman 1998: 94). This creates a platform for various conflicts and compromises that must be kept in check on a household, village-wide and regional level. Some authors have suggested that it is precisely at mealtimes that these negotiations are played out, as they are events that repeatedly bring people together allowing for the social renewal and sharing, as well as being a venue for small scale familiar politics, and wider regional ones (Atalay and Hastorf 2006: 292). Organisation of Neolithic life would have resulted in the partitioning of organised tasks to some extent, with a certain level of unspoiled labour division necessary for livestock husbandry and agriculture, as well as craft specialisation (Peterson 2002: 38).

Social- levelling feasting events have already been suggested for this period of Iran, which would have mediated any nascent specialists during this time when villagers engaged in an increasing capacity with mixed farming and material culture production (Matthews *et al.* 2013: 27- 28). Such types of societies tended to focus on the quantity of food consumed at events, rather than the quality or status of certain goods that were of restricted availability as in ranked societies (Goody 1976: 97). Goody further noted that egalitarian societies built up little material wealth, tend to be associated with exogamy, polygamy, bridewealth, corporate land tenure and with little emphasis on inheritance of land or personal property (1976: 97).

Crafting for reciprocal exchange, is another means of establishing and maintaining egalitarian relations in society (Sassaman 1998: 94), Pollock and Bernbeck suggests that the highly restricted repertoire of pottery shapes and decorations when compared to contemporary wares across the Middle East, coupled with the absence of human and animal representations across mediums points to a deliberate avoidance of material objects that can lend themselves to being treated as personal possessions or as a means to mark distinctions (2010: 276). They have also proposed a minimal attribution of value to material items based on a lack of evidence for the storing of artefacts in discrete locations, an emphasis on sharing and a deliberate attempt by the community to limit the amount of material culture they were producing (Pollock and Bernbeck 2010: 285-286).Reciprocity of vessels and production knowledge could also be included in this scenario as a means of social levelling, which would support the local nature of

production and conservative and similar production stages across the sites sampled in this thesis. The noted fragility of vessel slip and pigment surfaces that were studied in this project may also have discouraged the long-term build-up of meaning and/or value to ceramic vessels, association with specific individuals or the curation of heirlooms.

The local level of production and exchange that has been reconstructed with material analysis, combined with the depositional contexts of sherds in hearth and house structures, as well as some possible outdoor spaces, suggests use in daily cooking and serving events. Ceramic vessels may also have been used in feasting activities including the involvement of large numbers of people from surrounding villages, although no direct evidence of this has yet been recorded. This would include large cooking vessels, great quantities of animal bone and plant remains as indications of food consumption on a grand scale (Twiss 2008). The distribution and consumption of vessels at these events would have facilitated the transmission of production knowledge, with individuals able to experience slightly different decorative motifs and conceptualise how they could create similar effects. The production process involving the selection of materials, tempering and vessel forming was already a well- established method of ceramic manufacture that was shared across communities and maintained for over two thousand years. However, aesthetically similar designs were created with a variety of production methods evident in just the relatively small sample of sherds in this thesis. This indicates individuals were actively engaging with and reproducing a regional style by transferring decorative schemes as ideas, people or vessels themselves across village sites. Craft production and exchange could therefore have been used to link and maintain relations between village communities across the region. It has already been postulated that the Neolithic villages in this region occur in close-knit groups due to the minimum size of population needed to maintain a viable and self-perpetuating local population (500 persons) (Hole 1987: 83). The movement of people as marriage partners may also have been an avenue for the spread, maintenance and/or adoption of ceramic painted designs.

9.6 *Conclusion*

In many ways it is frustrating to attempt to reconstruct and understand what social processes were at work at this time, based on the current ceramic data set. This is

largely due to the nature of the archaeological excavation that has taken place to date and would be greatly improved by including a wider range of contexts and whole house structures in larger exposures. However, preliminary discussion can still be made with the results of the analysis presented in previous chapters, which has allowed for the rediscovery of production methods and characterisation of potting technology at this time. The production and consumption of these Neolithic wares show no signs of elite consumption, indeed material remains of society as a whole in the Southwest Zagros Mountains seems to be devoid of cultural remains that have been interpreted as evidence for social differentiation in this period. This, in combination with a very strongly transferred production process and aesthetic design within Fars, suggests very good communication and transference of production knowledge that has perhaps been used to maintain egalitarian social ideals.

The following concluding chapter will review the content of this thesis and re-visit the initial questions set out in the introduction.

10. Conclusion

10.1 *Introduction*

This thesis has provided the first technological insight into the production of Neolithic ceramics from Fars province, Iran, and has raised issues central to the understanding of the technology, society and archaeology of this period. The chosen research methods of thin section petrography, SEM and electron microprobe analysis have helped highlight raw material selection and use that had previously been unknown, as well as discern individual stages of the production process in order to characterise a technological style of the Neolithic alongside highlighting instances of Prehistoric agency. This has allowed insights into a reconstruction of social organisation across the sites sampled.

The focus of the thesis has been on reconstructing ceramic raw materials and production technology to characterise Neolithic potting at each of the different sites sampled. This was achieved by creating a new typology of wares that incorporated previously defined ware groups based on decoration which reflected newly excavated styles from recent excavations and surveys within the province. This basis of categorisation then allowed for a refined sample selection on which to conduct scientific analysis on Neolithic pastes, slips and pigments. Further comparisons with other analytical studies were then possible to better understand and situate Fars Neolithic potting within not just the broader Iranian region, but the wider Middle Eastern and Central Asian context in this period. As the first such scientific analysis conducted on Fars Neolithic ceramics, this study also forms a basis for comparison with further analysis on other contemporary ceramic assemblages from the province.

The research questions set out at the beginning of this thesis are addressed below.

10.2 *What are the characteristics of Neolithic ceramics within this assemblage?*

This question was addressed by synthesising previously published typologies and research into the production of ceramics and undertaking new scientific analysis on the assemblage. This revealed fresh information regarding the selection of raw materials particularly the strong preference for locally sourced buff-firing calcareous clays that were very fine and tempered with plant material. Most vessels were slipped, with a few being self-slipped, it had been unclear through hand inspection of ceramics from

different excavations and surveys if vessels were slipped, self-slipped or had a thin wash applied to their surface. The majority of sherds in this study had been slipped with a similar clay used to form the body, minus the organic temper particles. This was difficult to identify in some cases, even in thin section or in backscattered electron imaging, due to similar clays being used for both bodies and surface application to vessels. It is therefore suggested that differentiation between slipping and self-slipping will not readily be understood from hand inspection alone in any future studies, despite slipping being the main method used across this assemblage.

Decoration of ceramics with painted motifs was executed in a range of ways that can be chronologically partitioned. Initial ceramic production in the province included decoration with red-ochre by burnishing into the surface of vessels or painted into hatched or zig-zag designs. Some of these linear designs continued in use throughout the Neolithic, and the repertoire was added to with the introduction of black iron oxide pigments in the form of Mushki and Jari designs. More complex bichrome ware created with a three-stage firing of iron oxide pigments as well as through the use of manganese black and iron oxide red in linear designs. An additional decorative ware appears to have utilised orange mottling on a buff surface decorated with an iron oxide black pigment as a deliberate effect but has so far only been recorded at one site within the province (Tol-e Nurabad).

10.3 *What range of raw materials was used in the creation of clay bodies, slips and pigments?*

It is now known that potters repeatedly selected very similar fine, buff-firing clays at each of the sites, indicating that a very strong sense of appropriate materials and recipes was evident during the Neolithic and shared across Fars province. Tempering material was always plant stem material, and no indication of tempering with mineral temper was recorded. Similar clay was used for slipping clay bodies as chemical analysis has shown similar minor elements as well element maps demonstrating the visual similarities. Pigments were largely created with local iron-rich terra rossa clays and used to create both black and red colours. Manganese was also sometimes used to create black on bichrome wares, although iron oxide bichrome vessels were also made. Further work would ideally focus on re-firing experiments to better understand the

range of vitrification microstructures evident in the sherds studied, so that more precise temperatures could be reconstructed, as well as ones that were specific to the clay sources used for the production of Neolithic sherds from the sites sampled. This would allow further exploration into the kiln and firing technology of the period and add further detail to the reconstructed production stages. This may be a relevant factor that distinguishes Fars ceramic production from contemporary ceramic cultures in the wider region, based on the identification of decorative wares that are unparalleled outside of this province, and have been created by manipulating the firing atmosphere.

10.4 *What economic information can we infer regarding the choice and use of plant temper?*

Although good quality visual information was attained through backscattered electron images of the individual fibres, no diagnostic material was noted in the assemblage. This made it difficult to identify on a species level, as no diagnostic features characteristic of different species was present. However, no additional remains from the winnowing or threshing process was evident in the sherds studied, so it seems likely that potters were selecting grass/ sedge material rather than specifically using the secondary product of chaff. It is likely these materials were readily available plants that were selected along the lines of being in close vicinity to the production location, ease of transportation back to the site, and/ or were materials that were already available in the village context. This does not support the argument of potting being undertaken as a seasonal activity based on the requirement of chaff as a central component to vessel production. Such a reconstruction fits better with the economic reconstruction for sites such as Tol-e Mushki, which undertook more hunting and gathering practices rather than agricultural ones, yet still has a rich ceramic record. Other raw materials used in the potting process have been shown to be locally available, as well as decorative parallels being restricted within the province, it therefore seems ceramic production was organised on a local scale.

10.5 *What technological methods and bodily gestures were employed to transform these raw materials into material culture objects?*

The clays selected were very fine, therefore no cleaning of large mineral inclusions or levigation was required. The mixing of clay with plant temper was undertaken and the formation of clay bodies with pre-formed coils and slabs has been suggested based on the limited evidence of forming techniques evident in this assemblage. Post-forming modifications show a variety of combinations of techniques such as burnishing-slipping-burnishing-painting, slipping- burnishing-painting, and self-slipping-painting which perhaps reflect the quality of craftsmanship. If the variation in the quality of finished vessels is indeed related to whether potters undertook such additional stages of manufacture and were experienced in the creation of pigments and execution of designs, it is possible those still learning the craft may have been distinguished on the basis of their inclusion, and number of, burnishing and slipping stages.

Iron rich clays were used in ceramic decoration of Fars and the wider Iranian region as decorative pigments and to colour the vessel surface by burnishing or painting as a pigment. The application of ochre-rich pigments and burnishing are also found in related productive technologies, such as lime plastering walls and the creation of ceramic ear plugs. Therefore, the specific bodily gestures associated with this material in its general use within sites and specifically within the potting process, would not have included vessel forming. Terra rossa clay deposits are less numerous than the marly, calcareous clays that dominate the Zagros Mountains, which may in part have shaped this use and conception of the material. Further, it seems only to have been used and therefore conceived of as a decorative material, rather than a primary forming one. These habits and bodily movements associated with working specific materials have been possible to reconstruct by the application such methods as have been used in this study.

10.6 *What can we learn about the transmission of knowledge and the learning process of this craft?*

The transmission of knowledge and learning process of potting in the Neolithic period of Fars has been shown to be very conservative. Through the analysis and reconstruction of raw materials and production stages, similarities in the choice of raw materials, preparation methods and forming techniques have been re-discovered. This suggests widely accepted, potentially rigidly proscribed, ideas of correct raw materials,

recipes, forming techniques and decorative methods to be used. It also emphasises the strong regional ceramic technological style operating within Fars during the Neolithic, which must have been actively engaged with and maintained by potters. Such a robust method of ceramic production can be suggested to be due to significant socialisation of craft learners, most likely from a young age. Indeed, the variation of quality in the execution of designs suggests learners were trained by other more experienced potters and practised on vessels to improve their skill. Evidence of the revisiting of painted designs and differences in the ordering of execution suggest potters were adjusting and improving designs to fit into already established ideals of ceramic styles. Additionally, different production methods for decorative designs can also be correlated with different production groups based on the household level. Whether these apprentices were younger potters new to the craft, or were new community members, such as marriage partners being trained in the ceramic decoration techniques of their in-laws, was not possible to establish. What can be suggested is that the learning of this craft was highly structured as community styles across the region were very similar, with potters deliberately ascribing to a discernible style, and achieving this through different negotiated methods of painted designs.

10.7 *What spatial and temporal patterns, if any, can be discerned in the assemblage based on this raw material characterisation?*

Despite having ceramic Neolithic phases based on decoration and the contextual ordering of the deposition of such phases, the raw materials and production stages remain the same throughout the wider Neolithic period. As has been noted above, this is indicative of a unified ceramic tradition that was relatively conservative. The apparent exception to this is the introduction of manganese black pigments at Tol-e Nurabad in the later Neolithic, in order to create bichrome wares that can, in combination with iron oxide red pigments, be fired in a single oxidising firing, compared with the alternative method in evidence in the assemblage, of manipulating iron oxide pigments and firing in a three-stage firing to create both black and red colours on the same vessel. The production process associated with iron red and manganese black on the same vessel includes a more economical firing compared to the three stage firing required for iron oxide bichrome vessels.

An additional ware that has been excavated in a large quantity from the site of Tol-e Nurabad, is a previously uncategorised design that has no current parallels in Fars province or wider Iran. This is the decoration using iron oxide black on a buff surface, with orange reduction clouds. This therefore appears a very localised ware, specific to the site of Tol-e Nurabad, but may yet have parallels within the region with the further excavation of Neolithic sites dating to the latest phase of this period prior to the transition into Chalcolithic ceramic designs and production. Therefore, while currently an anomaly within Neolithic potting of the region, it may yet prove to be an additional regional style shared across other sites.

10. 8 *How were the ceramic vessels used and consumed within village sites?*

In order to fully investigate this issue, further excavation and sampling is required of Neolithic deposits in Fars, as only limited remains allow for preliminary suggestions to be made. Depositional contexts have been difficult to characterise for the excavations sampled, due to currently small exposures. However, association with hearth and ash deposits was identified, and correlated with other nearby excavations, as well as lipid analysis conducted on Neolithic sherds from the Central Zagros site of Tepe Guran and the Fars site of Tol-e Bashi to suggest ceramic vessels were used in the storage and preparation and potential cooking of foodstuffs. Use-wear analysis also showed vessels were not exposed to direct heat sources, but could have been used to cook food with the associated river cobbles and clay balls in some contexts at the sites sampled. This method involves boiling liquids in vessels by re-inserting heated cobbles and clay balls into the containers with the cooking food and stirring until the contents is boiling.

The nature of the decoration on sherds sampled and comparison with complete or near-whole vessels recorded from other contemporary excavations suggests they hold a capacity to store visual information. This has been suggested in this thesis to have signified a Neolithic style of ceramic design that was shared and actively participated in at village sites across the region to demonstrate their group membership and contribute to this cultivation of a community. The feasting events suggested as socially-levelling practices in these communities (Fazeli Nashli and Matthews 2013), could have been ideal venues for the consumption of decorated ceramics, alongside the transference of decorative schemes between villages.

Ceramic bowls have also been recorded from the few burial contexts that have been so far discovered, indicating they may have played a role in ritual events and were associated with a Neolithic conception of an afterlife. However, the small sample set of burial data advises against any firm conclusions regarding ceramics as burial goods.

More extensive archaeological exposure may highlight possible patterns in the deposition of ceramic wares at sites and/or across the Neolithic. A more coherent understanding of household structures and their organisation as domestic spaces is required to build-up a picture of food preparation and cooking practices and the role of ceramics within this. Further, future identification of pottery working areas would greatly aid in adding detail to the production sequence as the recording of tools, raw materials and work spaces would uncover further practices and activities associated with potting in these communities.

10.9 *How does the production and consumption of ceramics fit into the larger socio-economic context of Neolithic Iran and the Middle East?*

The raw material and production stages of the Fars Neolithic assemblage can be seen to be broadly similar to the other Iranian and wider Middle Eastern and Central Asian ceramic cultures through the preferential selection of fine, buff firing clays and plant temper. Iron oxide and manganese pigments were also employed across this larger region to execute painted styles that have shared similarities in motifs, such as areas of cross-hatching, zig-zag and linear designs. However, as has been reconstructed for the Fars assemblage, it must be acknowledged that regional and local differences may occur in the execution of designs that would represent divergent technological styles. Therefore, despite being able to group the ceramic wares from the Middle East and Central Asia along broad lines of similarity that construct a general Neolithic potting technology for the area, localised traditions of manufacture and style must also have existed.

Different consumption practises must also have existed across such a large area as different socio-economic organisation of communities has been suggested for Neolithic Mesopotamia and Anatolia compared to Iran. The presence of ritual buildings, centralised storage, indistinguishable individual dwellings, a lack of exotic material culture and sealing practices have been used to reconstruct a horizontal egalitarian

organisation of society. A heavier presence of ritual activity and buildings is also notable in comparison to Iranian Neolithic society, which also seems to demonstrate a lack of exotic objects and any cultivation of elite material culture. However, archaeological inquiry outside of Neolithic Fars can be identified as having a wider recovery of a range of different contexts with much larger sections of sites uncovered and whole clusters of buildings recorded. Additionally, the lack of burial remains is unfortunate in Fars for attempting to address this kind of an issue, but may be an artefact in itself of egalitarian social organisation, as intra-mural burials would give rise to claims of inheritance and ownership through the presence of ancestor burials.

Local trade and exchange of ceramic vessels has been evidenced within the Mesopotamian, North Iranian and Kopet Dagh Neolithic, which is an aspect of the village community life for the sites sampled in this thesis that remains to be positively identified.

The material evidence therefore seems to reconstruct potentially different forms of egalitarian social-order that make up a mosaic of subtly different lifeways within the Neolithic period of this region. These different social adaptations would have reflected on the various ways of producing and consuming ceramics. An enlarged study incorporating ceramic samples from Mesopotamia, Anatolia, the Zagros Mountains, Central Iran and Central Asia (incorporating Turkmenistan, Afghanistan and Pakistan), subject to thin section and chemical analysis with SEM and/ electron microprobe would allow not only for different raw materials to be discerned in the production of wares that would be easier to identify across these different geological areas and clay deposits, but would also highlight in greater detail the variety of consumption practices that were present in the Neolithic. Using the results of the analytical research to reconstruct production processes for ceramic wares across this wider area would uncover exactly how different/ similar Neolithic potting is across this region. This could further be conducted on a site specific level by targeting different depositional contexts, as well as a much larger scale across different regional zones.

10.10 *Conclusion*

The application of the scientific methods that have been used in thesis have a long history of application within ceramic research, however, within an Iranian Neolithic

context, it could be argued that they been used in a limited manner to reconstruct production stages and wider socio-cultural and economic issues. Studies have previously been content with raw material identification and little evaluation beyond the local/non-local reconstruction. This thesis has shown not only the value in applying these techniques to the identification and characterisation of clay bodies, slips and pigments, but also their ability to allow researchers to take interpretations beyond raw material inventories and access realms of Prehistoric meaning for material culture.

The main limitation to my study has been that of scale, with an increased size of sampled wares ideally reflecting different geological zones and therefore extending beyond the bounds of Fars province, would greatly help my characterisation of Neolithic potting in Iran. Despite this, and as the first study to scientifically analyse and characterise ceramics of this period from Southwest Iran, the aims of this thesis have been met. This research resulted in knowledge of the raw materials used to produce different ceramic wares, the production process undertaken by potters, reconstruction of the use and consumption of vessels within sites and contextualisation within the wider Neolithic region.

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Appendix A

A.1 *Introduction*

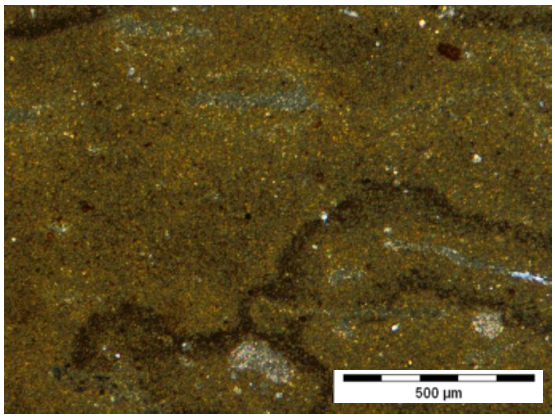
This appendix includes the Thin Section photomicrographs of samples organised by ware groups (see typology in Chapter Five), and discussed in Chapter six “Results of analysis”.

A.2 *Thin section photomicrographs*

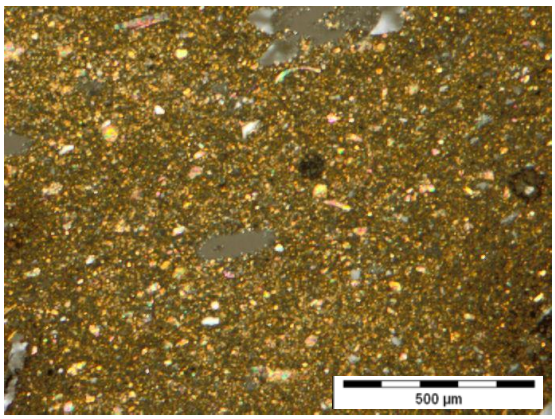
<u>Buff with exterior burnish</u>

Sherd no.

Qasr-e Ahmad 381

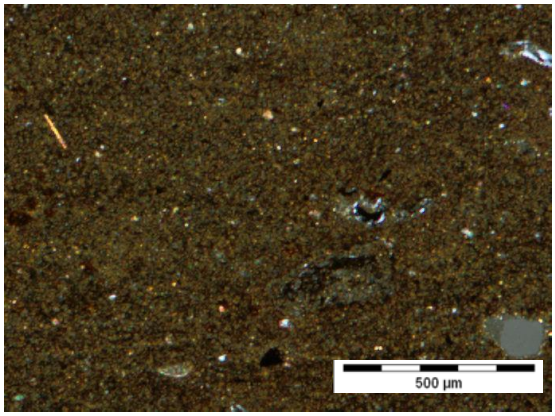


SK5 88.7

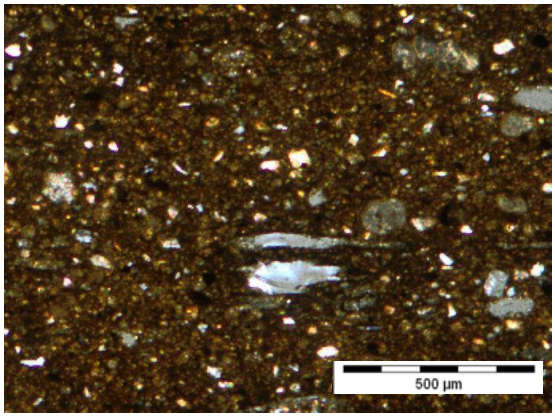


Buff interior and exterior

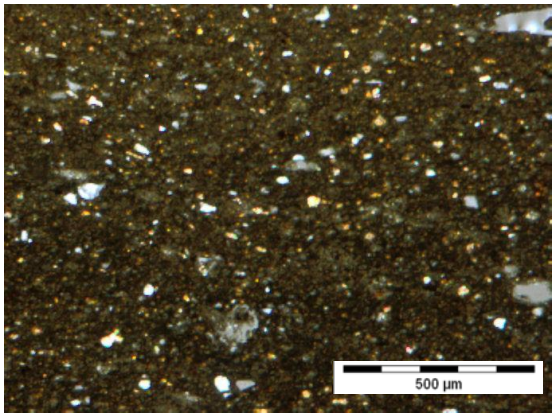
Qasr-e Ahmad 389



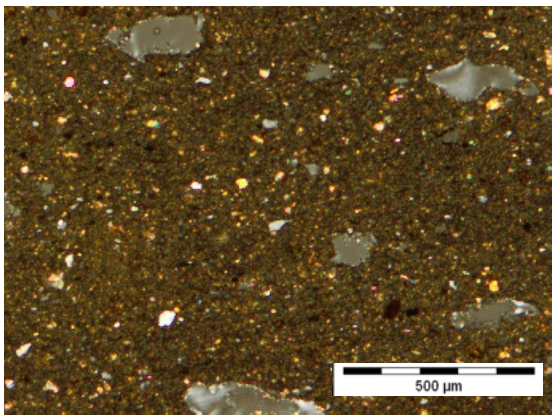
Rahmatabad 8595



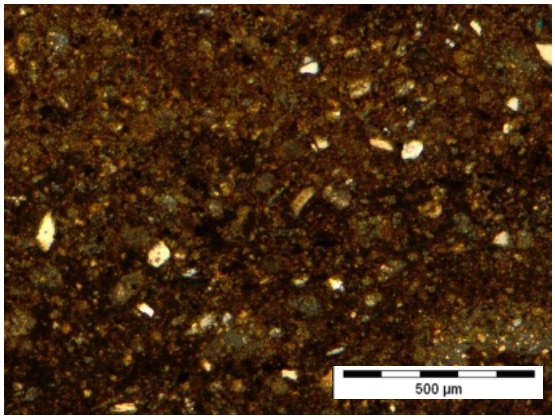
Rahmatabad 8487



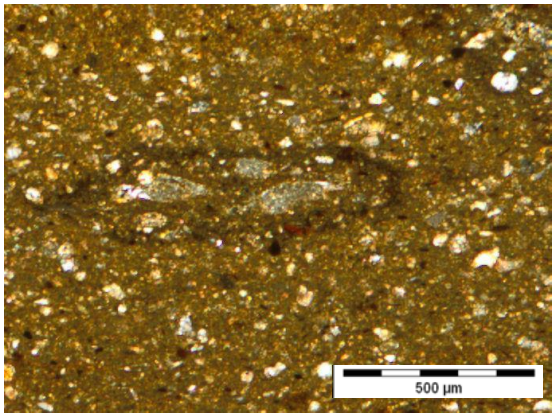
SK21 63



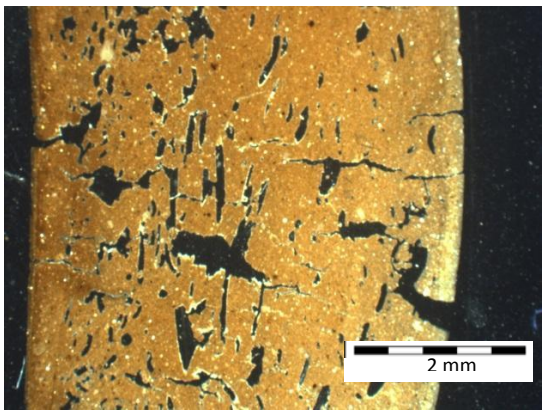
SK21 65



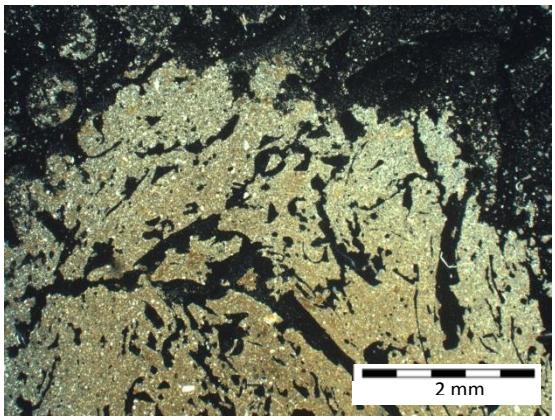
SK6 88.4



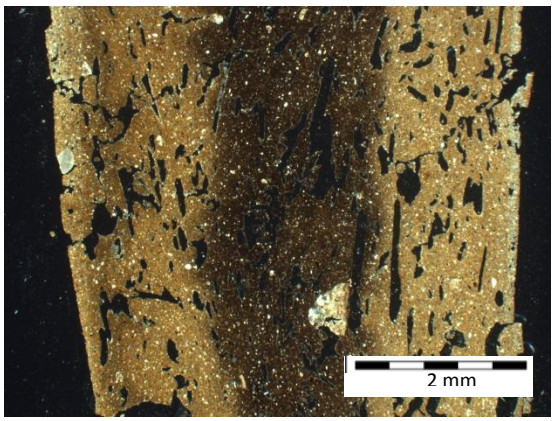
Tol-e Nurabad 001



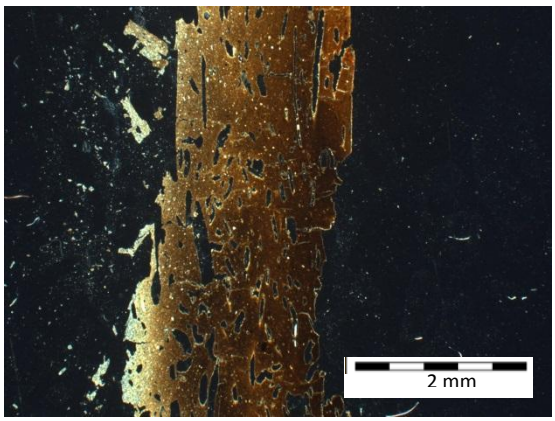
Tol-e Nurabad 002



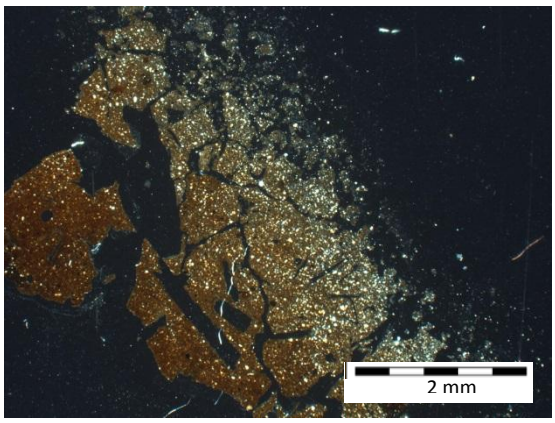
Tol-e Nurabad 003



Tol-e Nurabad 004

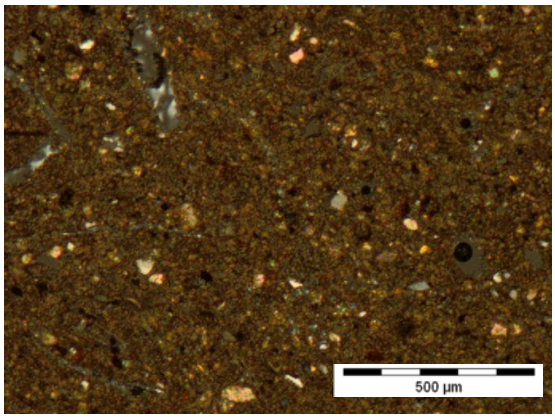


Tol-e Nurabad 006

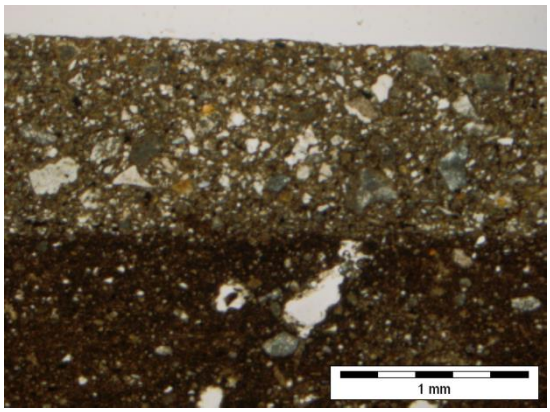


<u>Buff exterior, red interior</u>

Rahmatabad 8543

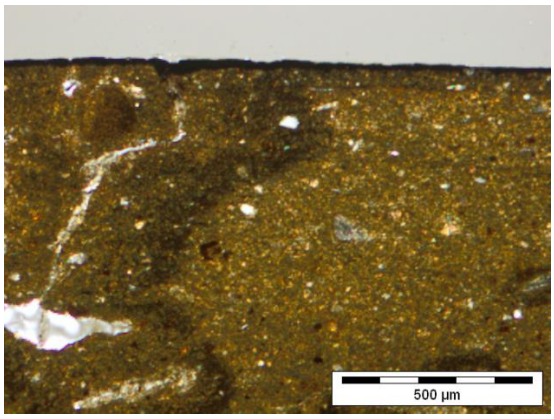


Rahmatabad 8695

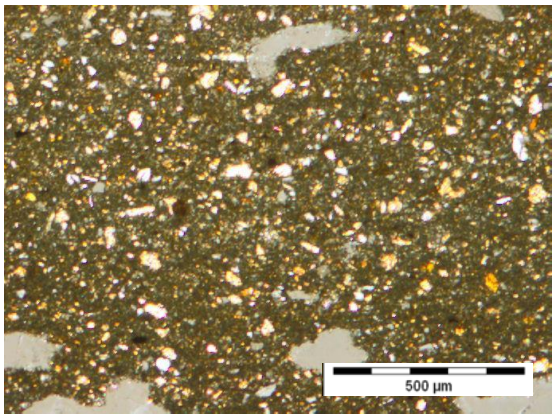


Red exterior and buff interior

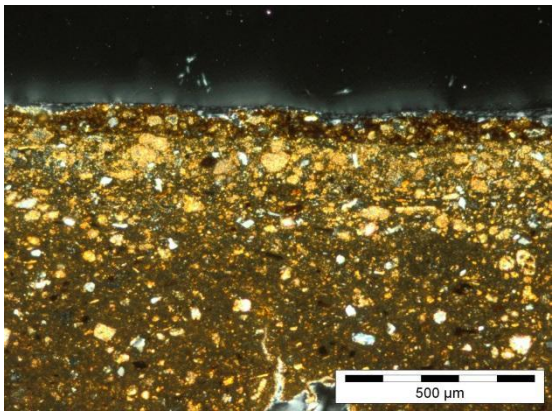
Qasr-e Ahmad 334



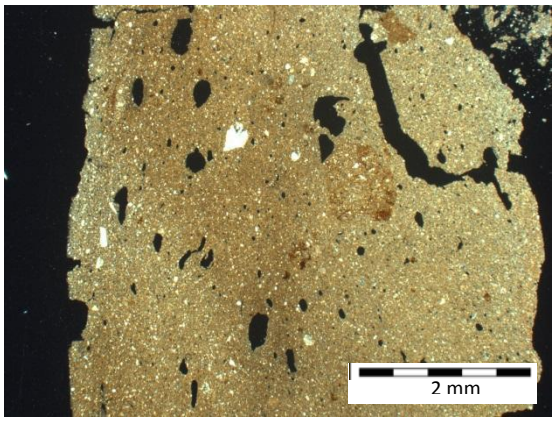
SK18 12



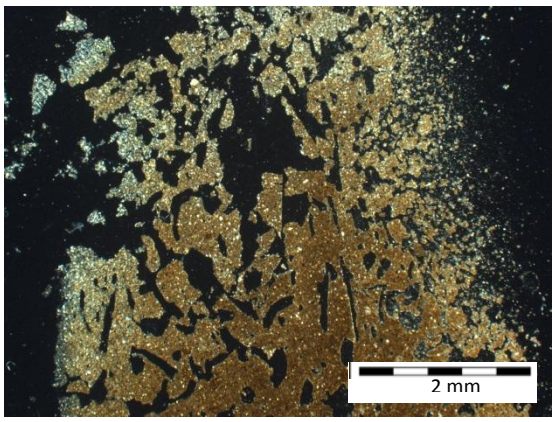
SK17 11



Nurabad 005

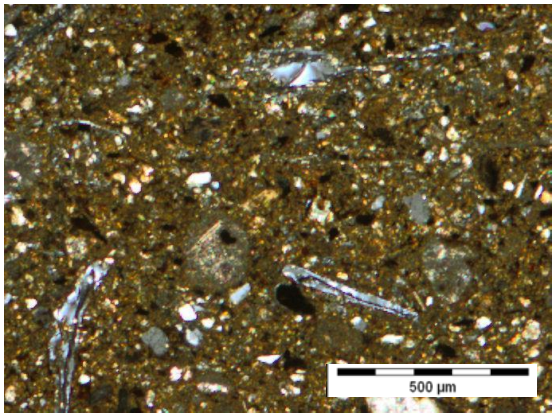


Nurabad 007

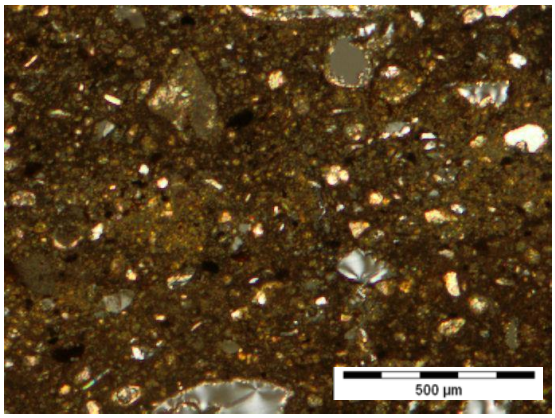


Red interior and red exterior

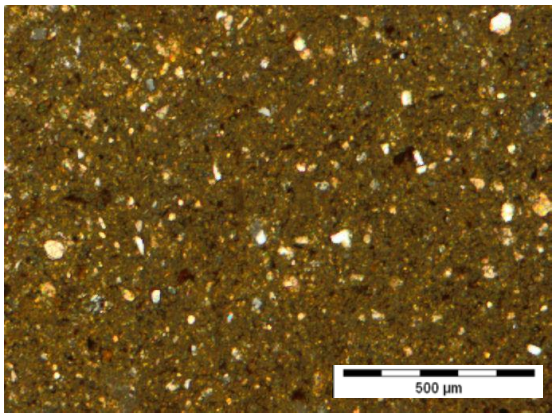
Rahmatabad 8555



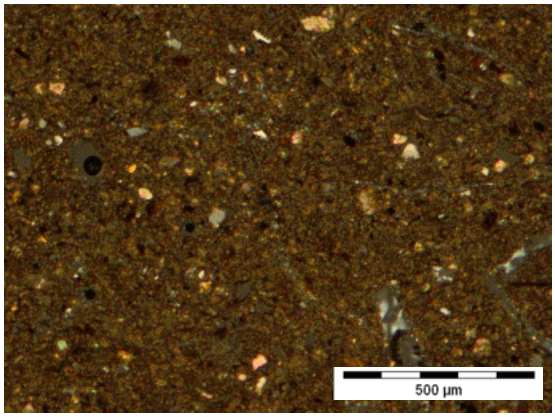
SK17 14



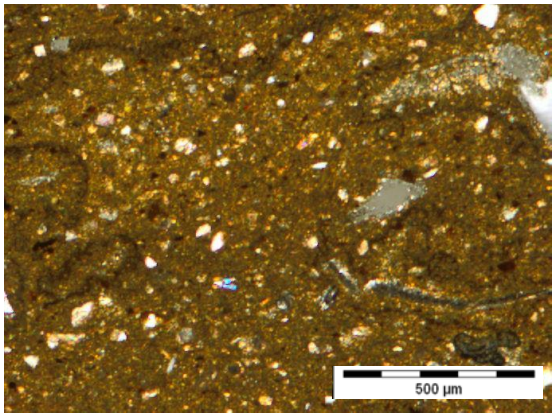
SK20 23



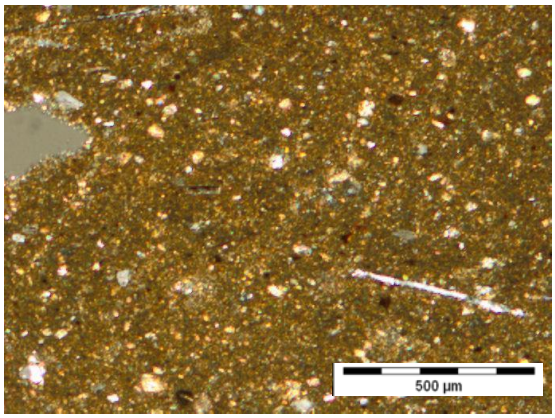
SK21 43



SK21 34

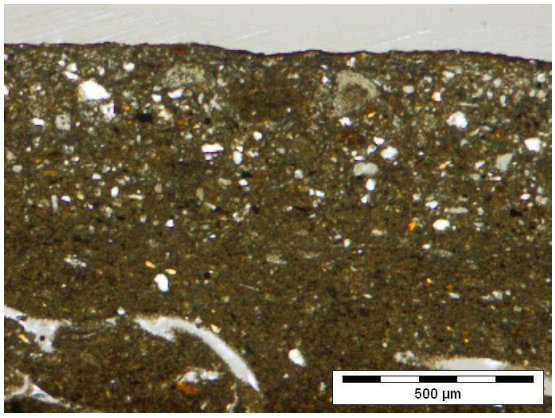


SK21 44

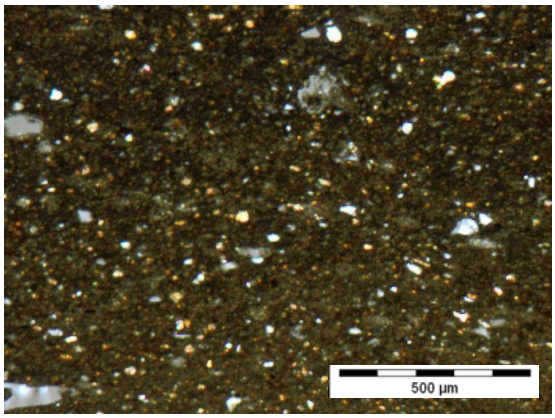


Black Mushki decoration on buff

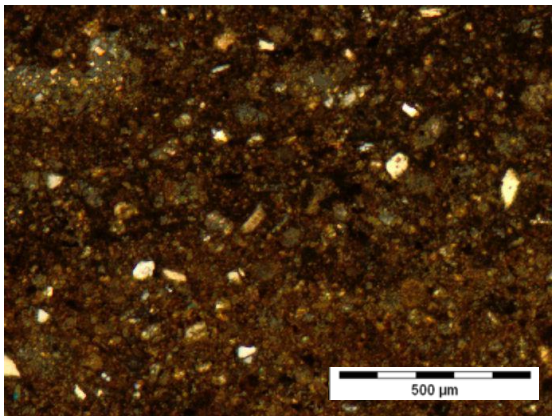
Rahmatabad 8526



Qasr-e Ahmad surface 1

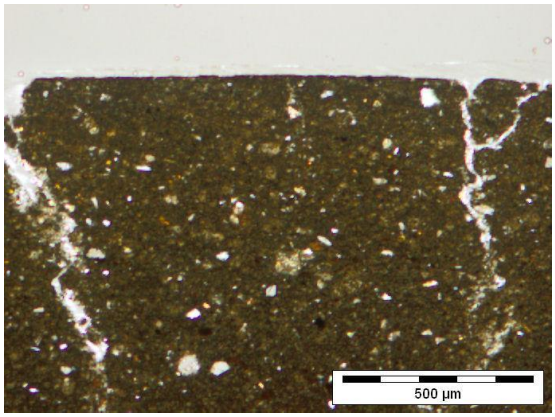


Qasr-e Ahmad surface 2

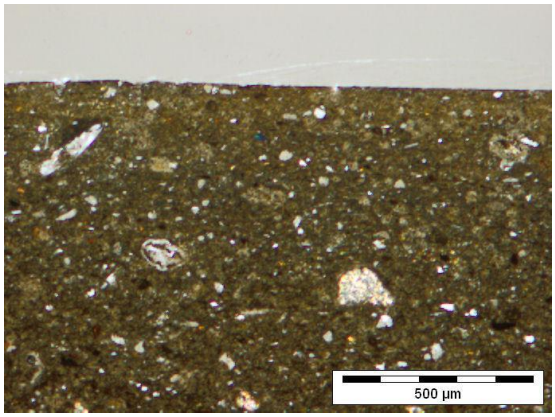


Black Mushki decoration on buff with a red interior

Rahmatabad 8655

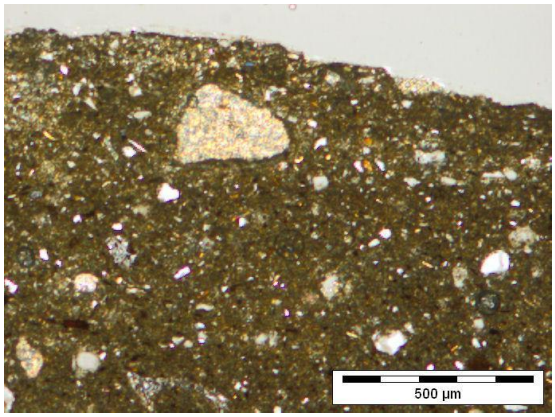


Rahmatabad 8706

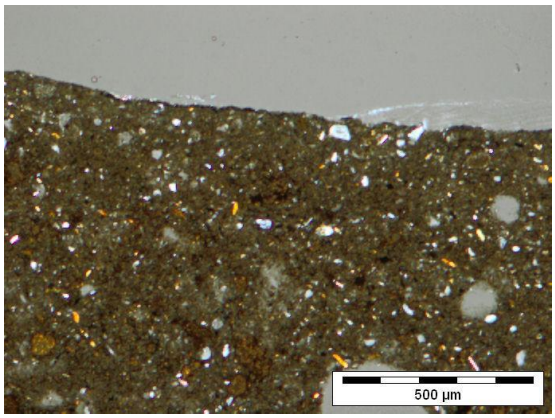


Black Jari decoration on buff

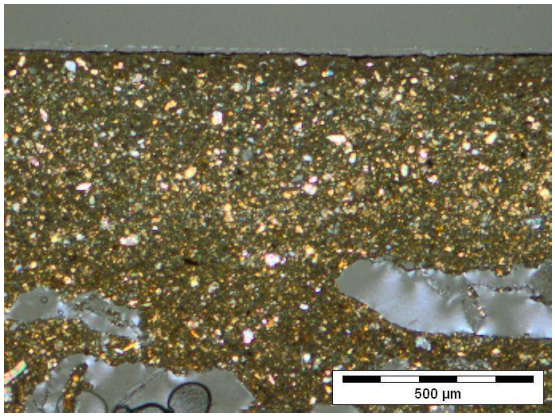
Rahmatabad 8707



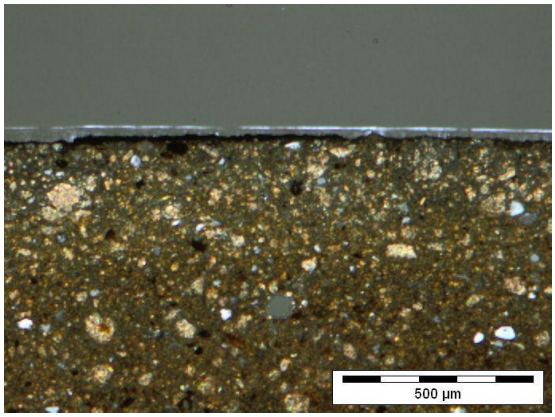
Rahmatabad 8575



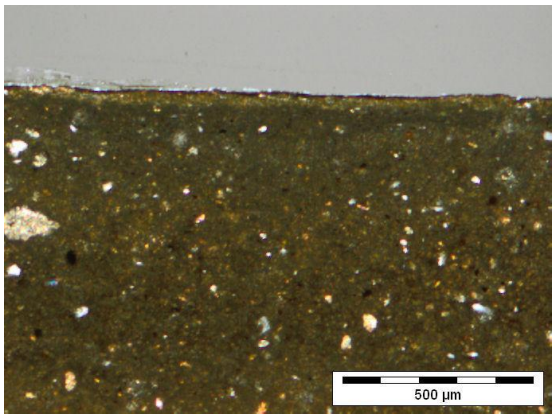
TNP 5327



TNP 3856

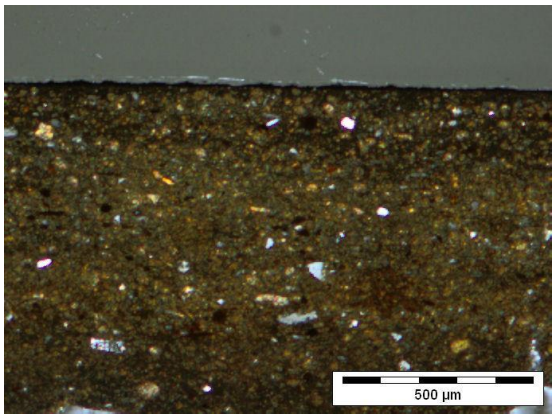


TNP 3883

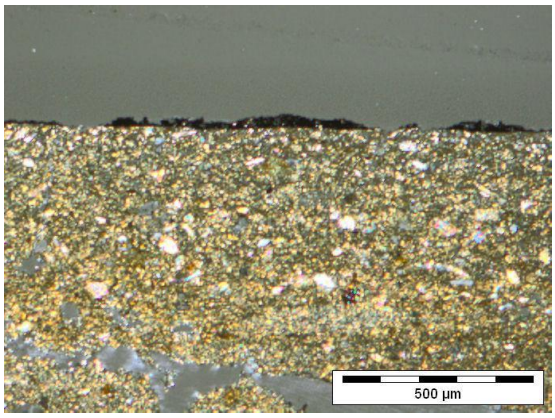


Painted red linear and crosshatching motifs on a buff surface with a buff interior

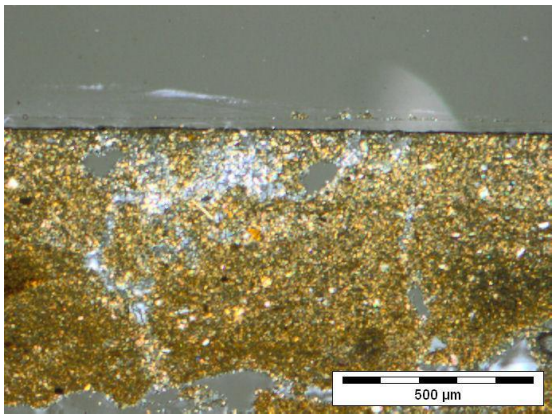
TNP 2363



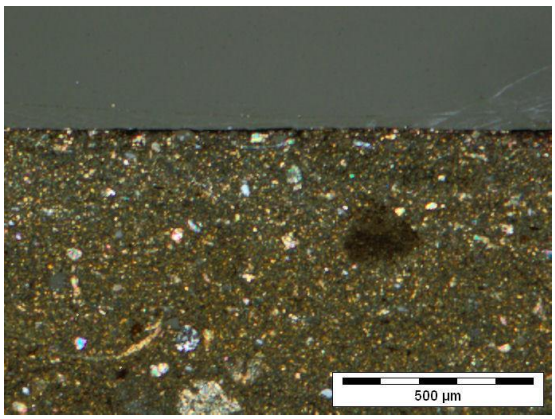
TNP 4942



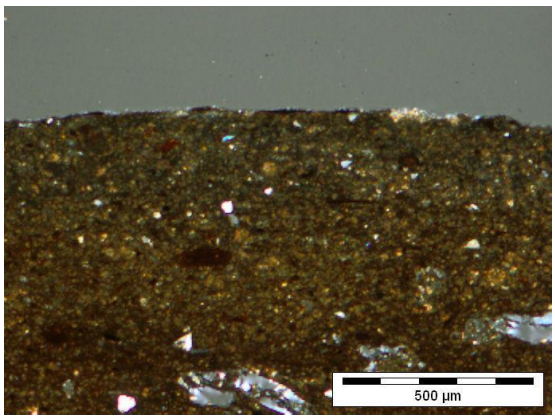
TNP 2430



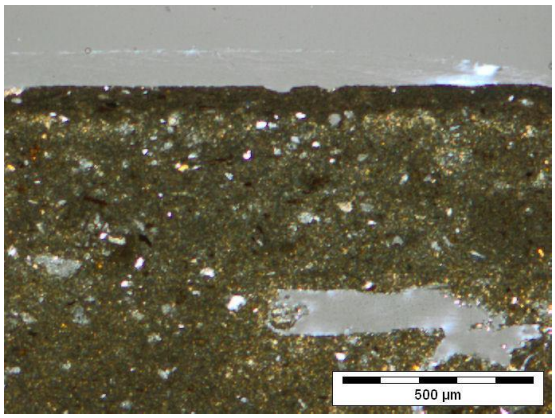
TNP 5134



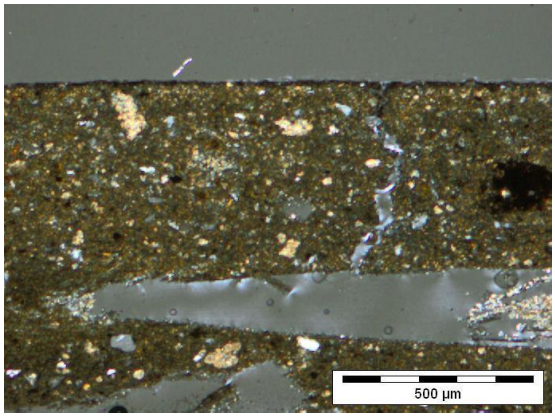
TNP 4964



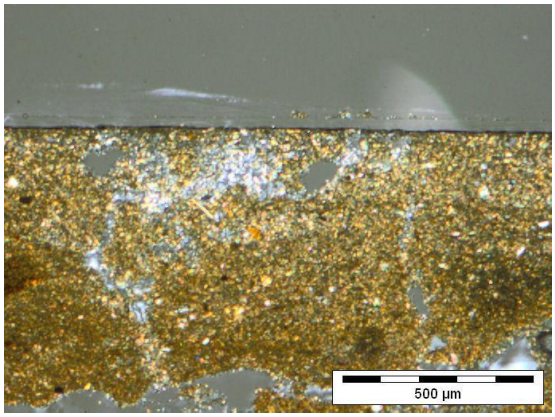
TNP 4761



TNP 5138

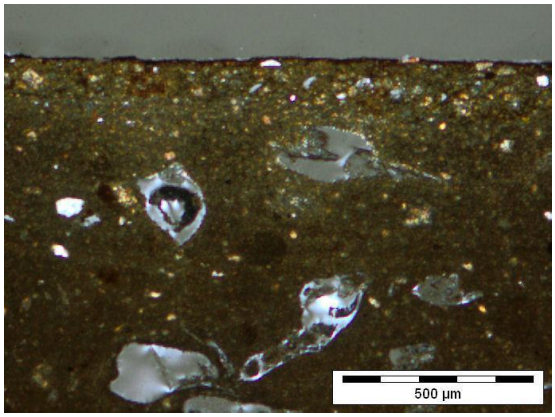


TNP 2440

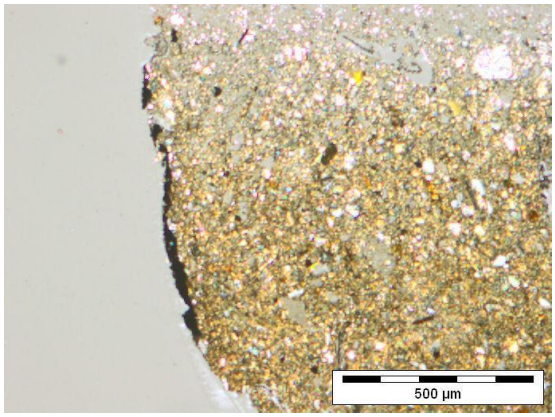


Painted red linear and crosshatching motifs on a buff surface with red interior

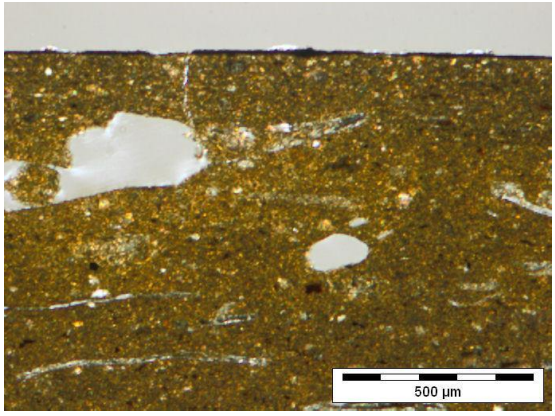
TNP 2607



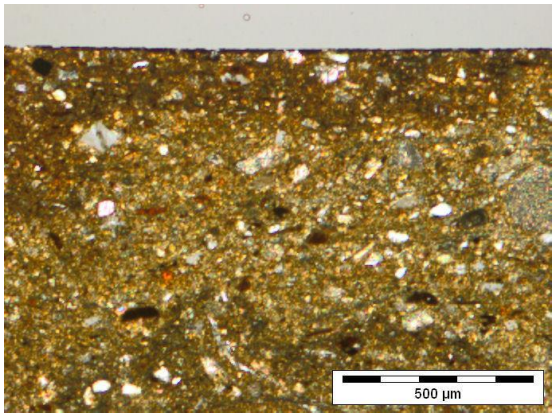
Qasr-e Ahmad 99



Qasr-e Ahmad 267

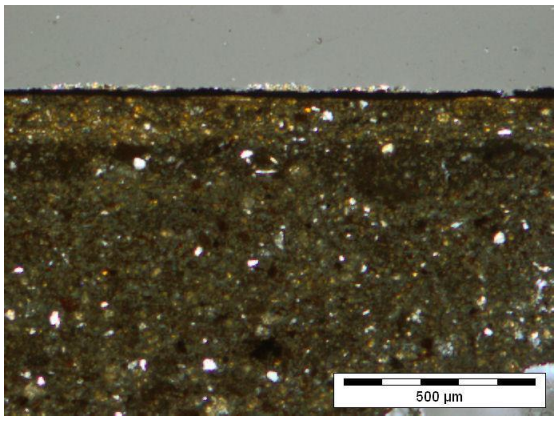


Qasr-e Ahmad 312

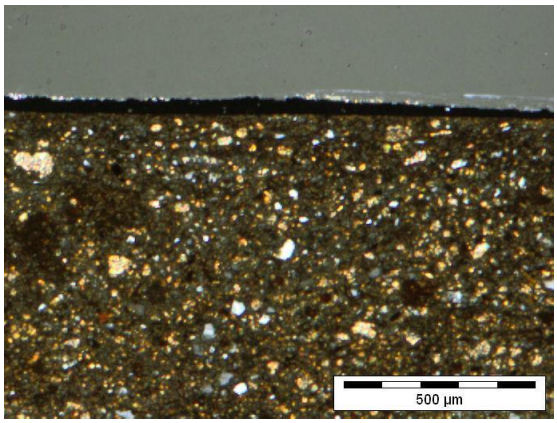


Painted bichrome linear and zigzag motifs on buff with red interior

TNP 5671

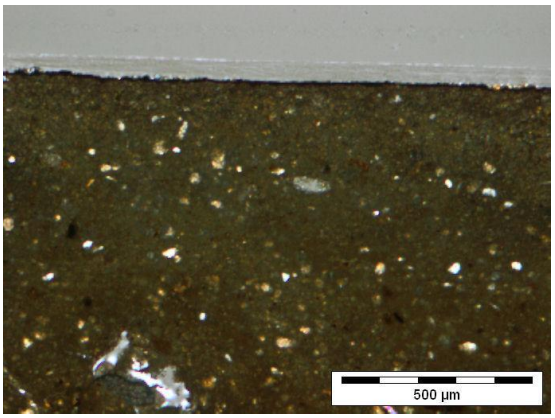


TNP 5667

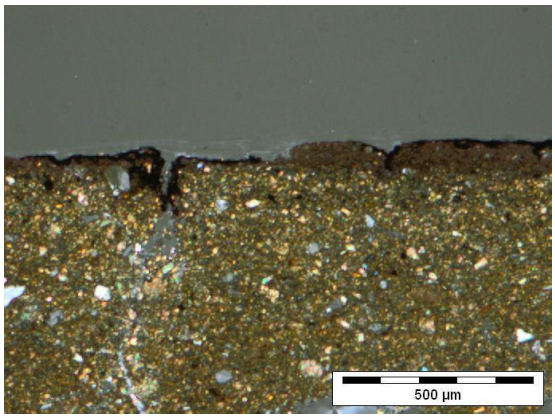


Painted bichrome linear and zigzag motifs on buff surface with buff interior

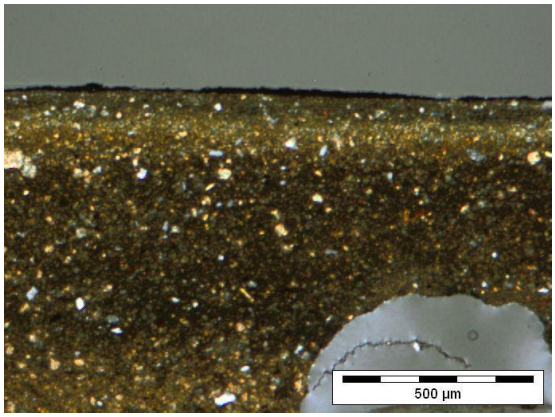
TNP 3865



TNP 5428

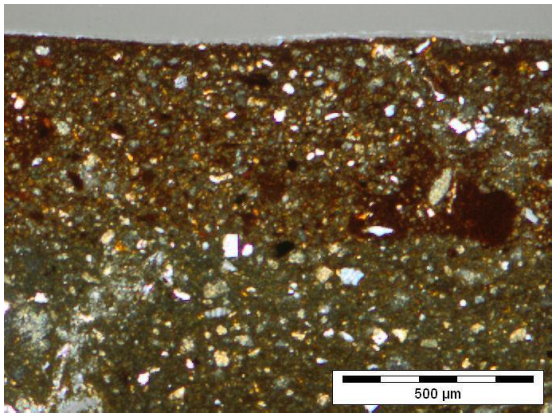


TNP 4915

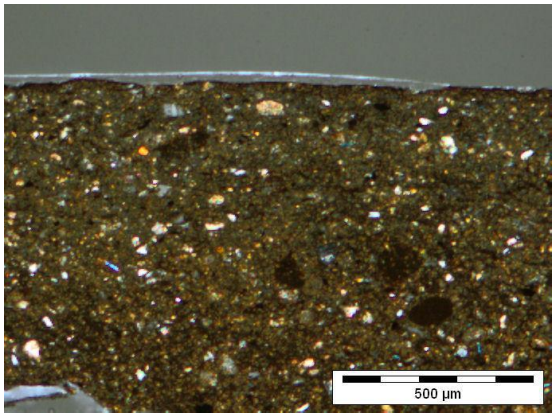


Black decoration with red interior and exterior red mottling

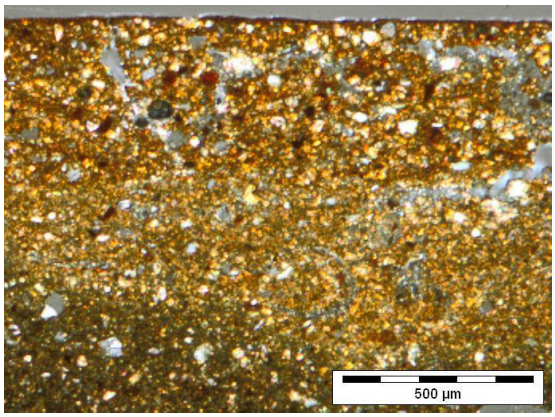
TNP 2391



TNP 2484



TNP 2592



Appendix B

B.1 *Introduction*

This appendix lists the Electron microprobe data presented for analysed samples, grouped by ware group (see typology in Chapter five), and discussed in Chapter six "Results of analysis".

Buff with exterior burnish

QA 381

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
0.12179	0.16297	2.89575	6.41856	22.09398	0.02824	3.19292	0.01546	6.62929	0.01954	22.88239	1.06237	0.13481	65.6581	body
0.09502	0.19769	3.99313	5.64191	11.6345	0.01913	4.65184	0.00001	11.27654	0.02422	40.48856	0.35683	0.14672	78.5261	body
0.12914	0.18752	3.95824	5.22724	15.9326	0.04728	4.75365	0.00001	8.71096	0.0453	29.42314	0.63623	0.26064	69.31194	body

Buff interior and exterior

QA 389

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
0.3831	0.12696	3.38793	0.54532	9.99585	0.09314	3.03557	0.00001	3.61321	0.01645	23.97906	0.16224	0.16811	45.50695	body
0.19501	0.14851	2.22503	1.42738	27.90201	0.01782	2.99778	0.00001	4.28034	0.00001	16.49121	0.91144	0.26852	56.86506	body
0.24748	0.10214	1.70303	1.51733	25.06833	0.01386	2.21955	0.02296	3.92568	0.05103	15.08602	0.31743	0.17077	50.44562	body

R 8595

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
0.52079	0.71963	1.93333	1.70065	25.5159	0.06395	3.93101	0.00001	7.57012	0.00001	21.4909	0.3801	0.46546	64.1743	body
0.35593	0.16216	0.07971	0.39974	47.6349	0.0113	0.09004	0.01135	0.00076	0.0051	0.06801	0.00002	0.15478	48.8935	body
1.32045	0.74738	2.33183	4.5189	13.0265	0.09776	5.89892	0.00001	8.36249	0.04075	44.7727	0.25556	0.20223	81.2775	body

Buff exterior and red interior

R8543

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
0.34595	0.54074	2.1745	2.71383	13.2716	0.03092	3.96408	0.01931	8.546	0.033	43.89458	0.24279	0.14862	75.92594	body
0.22659	0.34407	2.269	1.69971	4.25612	0.01916	2.24326	0.00001	6.93389	0.03999	68.08491	0.1621	0.04439	86.32318	body
0.62866	0.71484	2.8728	4.03911	13.63007	0.11541	8.09798	0.04402	11.86524	0.04558	38.409	0.61892	0.14561	81.22723	body

Red exterior and buff interior

QA 334

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
0.18703	0.95152	3.85656	2.61841	9.43738	0.02614	4.83951	1E-05	10.1711	0.0094	32.8198	0.57904	0.2284	65.7243	ext surface
0.32433	0.01514	0.2535	0.1524	0.22653	0.02008	0.26548	0.0151	0.51604	0.00321	1.67173	0.00002	0.01144	3.47499	ext surface
0.2035	0.28369	3.51629	2.20473	8.39124	0.01371	5.41833	1E-05	8.58343	0.00001	41.2318	0.43567	0.22793	70.5103	ext surface
0.17196	0.24682	3.30129	3.61918	4.25846	0.04153	5.23039	1E-05	10.0954	0.01428	52.6039	0.38011	0.15856	80.1219	body
0.15052	0.28262	2.60798	2.50918	11.9362	0.02793	3.99519	1E-05	7.89291	0.02707	47.0944	0.20666	0.22716	76.9578	body
0.17763	0.29669	2.96354	2.3239	18.7501	0.04682	3.64679	0.0011	10.6004	0.00001	30.6984	0.35659	0.24862	70.1105	body

Red interior and red exterior

R8555

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
0.43088	0.22064	0.75322	1.07814	52.09035	0.00697	0.39364	0.00001	1.10336	0.00001	6.55905	0.06674	0.51492	63.12069	ext. surface
0.11656	0.10858	0.22874	1.19477	55.97474	0.08871	0.1082	0.00001	0.13393	0.04597	0.2477	0.04482	0.38605	58.65247	ext. surface
0.32108	0.2048	0.59933	1.65631	50.14233	0.01952	0.39737	0.00001	0.55445	0.02044	3.092	0.00002	1.01248	57.94769	ext. surface
1.06003	0.16779	1.47261	1.79661	33.21442	0.02219	2.02757	0.01142	4.39024	0.04198	14.39655	0.01209	0.15597	58.53029	body
0.64325	0.50434	3.7133	3.3526	4.55495	0.09892	6.5404	0.00001	16.90313	0.04641	41.10519	0.38299	0.0755	77.77583	body
0.15859	0.08433	0.19144	3.7812	53.36377	0.00001	0.37712	0.0246	0.55285	0.00568	2.15844	0.02965	0.22532	60.91722	body

Black Mushki decoration on buff

R 8526

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
1.52659	0.12123	0.55554	0.23015	1.12212	0.01895	0.40355	0.02191	1.13088	0.00001	2.76872	0.00425	0.06207	7.62149	pigment 1
2.04758	0.22116	2.44025	2.78901	5.36786	0.05384	3.89803	0.00001	6.10423	0.04926	30.49877	0.34691	1.17304	54.52789	pigment 1
0.8038	0.01559	0.03827	0.03525	0.0335	0.00394	0.05685	0.00001	0.05504	0.00272	0.28605	0.01901	0.00002	1.16867	pigment 1
1.34203	0.25908	0.70033	0.56575	4.78481	0.05211	1.13829	0.02226	1.59732	0.00456	6.86484	0.01663	0.22157	17.26675	body
0.33963	0.30723	3.54629	3.81824	17.31299	0.15477	5.77054	0.02638	11.4569	0.03234	30.89761	0.29235	0.4265	74.30513	body
0.38895	0.62859	4.92365	1.82128	10.08315	0.06566	3.36549	0.00001	18.37793	0.0161	33.71155	0.25412	0.15361	73.70233	body

Qasr-e Ahmad surface 1

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
0.20758	0.23153	1.99372	1.76881	2.67952	17.1682	21.66471	0.00001	4.29487	0.00221	23.35584	0.13158	0.25081	73.7494	pigment 1
0.54903	0.17041	0.40932	0.87419	2.68198	23.6441	19.22349	0.00001	2.00099	0.03886	5.95139	0.16739	0.51729	56.22846	pigment 1
0.15155	0.36457	0.3414	0.98354	1.93949	37.76506	20.80773	0.02471	1.78038	0.00001	9.13043	0.16403	0.18495	73.63786	pigment 1
0.17753	0.18773	4.32477	3.90916	14.98129	0.0385	4.95231	0.04523	10.5481	0.04957	35.54822	0.28273	0.30822	75.35334	body
0.15653	0.17729	2.81731	3.15098	9.11378	0.04117	6.29303	0.00001	8.676	0.00001	33.61462	0.23871	0.18179	64.46124	body
0.18684	0.29543	2.88499	1.68486	5.35819	0.01634	3.08993	0.00001	6.80194	0.00001	59.5881	0.70439	0.10705	80.71808	body

Qasr-e Ahmad surface 2

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
0.41031	0.7441	2.18254	2.37878	10.07927	0.06014	4.3947	0.00001	10.14752	0.04074	44.12209	0.17835	0.21017	74.94873	pigment 1
0.22399	0.72991	3.7798	2.52543	7.80411	0.02631	3.89835	0.00001	13.07819	0.00001	45.95839	0.14147	0.21547	78.38144	pigment 1
0.35177	0.18193	2.15408	1.9836	11.40875	0.03607	3.55833	0.01331	7.30185	0.00264	36.44559	0.35671	0.29376	64.08839	pigment 1
0.22904	0.48166	1.74901	5.58865	14.7383	0.0421	4.70642	0.00001	10.65194	0.01083	32.45	0.28389	0.26032	71.19216	body
0.27298	0.19551	2.26447	1.61539	24.25167	0.10325	2.82607	0.01825	4.99068	0.01281	17.20926	0.13811	12.55547	66.4539	body
0.28447	0.39158	2.10205	2.91427	12.12017	0.05781	5.09364	0.00001	7.809	0.02976	29.29031	0.1914	0.28429	60.56878	body

Black Mushki decoration on buff with a red interior

Rahmatabad R6555

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
1.44824	0.00001	0.00698	0.00622	0.01891	0.00001	0.05342	0.00182	0.01407	0.00001	0.03399	0.00486	0.01485	1.27661	pigment 1
0.98134	0.02256	0.18416	0.03202	0.19058	0.00001	0.12973	0.00001	0.14185	0.00001	0.54459	0.01848	0.00002	2.02396	pigment 1
1.44329	0.00015	0.00645	0.00276	0.02821	0.00001	0.05554	0.00001	0.00032	0.00001	0.04057	0.00002	0.00359	1.25526	pigment 1
0.55182	0.43622	2.41897	1.75117	11.15837	0.13435	4.26763	0.00692	8.08928	0.00001	22.3097	0.21051	0.28674	51.49716	body
0.37674	0.72017	1.49168	3.05368	19.5539	0.08345	5.32788	0.01472	10.62849	0.00001	36.09641	0.13274	0.25002	77.64488	body
0.36997	0.35945	1.92824	1.902	12.64332	0.03743	3.65719	0.00001	11.01149	0.00139	32.03165	0.1662	0.19214	64.217	body

Rahmatabad 8706

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
1.17687	0.00796	0.01349	0.00002	0.01536	0.00001	0.04694	0.00001	0.01807	0.00001	0.0398	0.0218	0.00002	1.0748	pigment 1
0.98395	0.01969	0.08954	0.06144	0.20834	0.0759	0.39934	0.01246	0.15486	0.01639	0.60941	0.01482	0.04756	2.47167	pigment 1
0.76043	0.03854	0.20978	0.07973	0.40842	0.04839	0.22107	0.00001	0.22631	0.00001	0.73823	0.02122	0.03442	2.61498	pigment 1
0.28668	0.63641	1.69289	3.06424	15.64804	0.05657	4.85127	0.00001	8.44375	0.00001	31.53697	0.39841	0.21223	66.76278	body
0.22317	0.63371	3.34881	3.88486	13.79722	0.1552	6.75415	0.01381	12.59708	0.01536	28.78334	0.46423	0.36089	70.98148	body
0.30453	0.61337	2.1441	2.0318	13.3352	0.05519	4.4034	0.00404	10.97273	0.00201	32.48352	0.17568	0.13082	66.58768	body

<u>Black Jari on buff</u>

Rahmatabad 8575

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
0.82502	0.07064	0.24892	0.26615	0.34415	0.0009	0.36131	0.03006	0.33451	0.02843	1.98122	0.02804	0.16763	4.68697	pigment 1
0.55689	0.48566	3.73934	2.34657	3.02687	0.33953	4.16867	0.03954	8.94319	0.03287	44.20667	0.23711	0.18579	68.30869	pigment 1
0.50953	0.15408	1.4739	2.52408	7.30214	0.04788	2.51407	0.04703	5.68547	0.00001	19.40002	6.68794	0.19909	46.54525	pigment 1
0.85586	0.51741	2.34383	2.57084	19.66583	0.05803	3.66028	0.00001	9.42262	0.02517	31.32581	0.24537	0.51264	71.2037	body
0.88325	0.98108	2.20768	1.98462	19.78762	0.23027	3.19635	0.01075	7.81627	0.00956	29.73705	0.20159	1.22775	68.27383	body
0.42071	0.43795	1.96202	2.10091	13.54118	0.04999	3.33531	0.03301	5.42406	0.0012	45.30302	0.21396	0.23155	73.05487	body

Rahmatabad 8707

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
0.39557	0.73717	7.37848	1.26536	19.20171	0.08545	2.99979	0.00819	13.30142	0.00569	30.31658	0.99996	0.53428	77.1404	pigment 1
0.14866	0.25143	1.19861	0.64951	48.14691	0.09311	0.4981	0.00001	0.81481	0.04557	5.61187	0.00856	0.73239	58.16599	pigment 1
0.38279	0.69897	9.57499	2.26404	16.46314	0.05551	4.00881	0.00001	12.54387	0.03846	30.06183	0.27723	0.33458	76.61787	pigment 1
0.39639	1.10221	4.08449	2.4027	15.40598	0.08337	4.43802	0.01933	9.73821	0.00001	48.7304	0.15202	0.12933	86.59302	body
0.8895	1.19301	4.12061	3.80749	20.50549	0.03268	4.39744	0.00001	11.37496	0.02148	35.00959	0.7881	0.26553	82.20517	body
0.60541	0.62566	2.00602	2.64747	35.44648	0.08959	2.99782	0.00001	2.48894	0.03875	11.07523	0.03961	0.22481	58.14918	body

TNP 5327

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
0.5386	0.52918	0.73358	1.42121	3.19759	32.58003	14.61389	0.04653	3.84495	0.00001	6.69919	0.13362	0.54756	64.7644	pigment 1
0.54486	0.45247	0.73432	1.91824	5.87004	23.88386	25.5613	0.0644	3.08728	0.00001	9.28916	0.1284	0.31708	71.72848	pigment 1
1.35378	0.03367	0.22805	0.31722	1.58595	5.0031	4.02679	0.02219	0.89265	0.00001	2.78056	0.00002	0.16663	16.10513	pigment 1
0.04254	0.26928	3.19274	2.30278	13.31614	0.00997	3.90405	0.00001	9.30788	0.00683	52.51089	0.26872	0.07606	85.19829	body
0.08419	0.12149	3.2454	1.85728	26.87692	0.01315	3.36687	0.00078	6.82525	0.00001	24.6136	0.16567	0.22016	67.37179	body
0.20311	0.03285	2.46472	1.10781	19.69085	0.00577	2.34884	0.00001	4.60366	0.00097	24.69397	0.04877	0.16021	55.3157	body

Painted Red linear and crosshatching motifs on a buff surface with buff interior

TNP 4942

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
0.24126	0.46923	1.27883	0.78704	2.22118	5.12822	40.49722	0.0248	5.60265	0.00001	13.73906	0.3883	0.4467	70.77006	pigment 1
0.31358	0.58956	1.73219	2.2906	1.95087	2.85398	22.6799	0.06041	6.89245	0.00604	14.59672	0.36302	0.45031	54.70889	pigment 1
0.28803	0.6463	2.29412	1.39854	2.28188	6.63537	16.3792	0.00184	8.36011	0.02451	26.2744	0.2936	0.69791	65.51081	pigment 1
0.15432	0.51949	3.17911	2.70392	4.03716	0.02926	6.78973	0.00001	17.88398	0.00668	43.96315	0.66104	0.07281	79.96583	body
0.1005	5.98654	1.46835	0.90808	3.81991	0.02377	3.13588	0.01164	17.70171	0.00001	53.30855	0.69101	0.12671	87.25999	body
0.20971	0.29416	2.19356	1.30007	12.8361	0.10757	5.33886	0.03444	12.4175	0.02474	30.54588	0.38613	0.13205	65.77344	body

TNP 4761

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
0.15671	0.18799	2.15207	8.52477	3.03415	0.04851	31.03391	0.01296	5.08313	0.01421	32.63226	0.11303	0.08346	83.07715	pigment 1
0.88905	0.00897	0.08328	0.62846	3.03086	0.01365	8.24358	0.02638	0.8373	0.00001	2.17955	0.0493	0.13063	16.121	pigment 1
1.24259	0.00001	0.0159	0.02733	0.21848	0.00832	0.64042	0.00001	0.0645	0.00001	0.23943	0.00002	0.04481	2.50183	pigment 1
0.11184	0.63973	1.25371	1.40839	21.74646	0.04702	3.28591	0.00001	10.27456	0.01465	39.83369	0.19598	0.17968	78.99163	body
0.52077	0.03125	0.48517	0.54037	13.22147	0.00084	0.77358	0.00001	1.49371	0.00001	14.13054	0.03663	0.0952	31.32955	body
0.29086	0.108	0.95938	1.90819	19.56573	0.04537	4.20668	0.00001	6.54644	0.01146	18.70687	0.56385	0.24879	53.16163	body

TNP 5138

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
0.68298	0.18931	1.65918	4.04809	1.24751	0.0125	7.19633	0.02629	6.04058	0.02493	24.066	0.19792	0.84413	46.08163	pigment 1
0.85021	0.17493	0.65721	1.04151	3.89629	0.00187	4.21809	0.00471	2.02509	0.0413	5.02587	0.22153	0.17593	18.14267	pigment 1
0.8275	0.18115	0.69539	1.81025	15.02002	0.0174	4.90561	0.00001	3.12781	0.00001	9.82825	0.09761	0.2832	36.60748	pigment 1
0.07812	0.12604	3.44349	1.24061	29.16819	0.01889	2.19191	0.00001	11.70159	0.00001	22.19911	0.16925	0.15813	70.47774	body
0.21665	0.11882	0.83209	1.31854	25.88952	0.14744	2.72663	0.00001	5.83569	0.00628	19.21979	0.18631	0.20632	56.6552	body
0.02616	0.24744	1.86141	0.48433	6.68951	0.01839	0.94291	0.01518	2.87914	0.00016	71.81019	8.33861	4.04007	97.34758	body

Painted Red linear and crosshatching motifs on a buff surface with red interior

Qasr-e Ahmad 267

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
0.16416	0.36815	5.38842	3.89773	3.33296	0.04593	13.17232	0.00001	12.64592	0.02488	38.50159	0.90771	0.2774	78.72719	pigment 1
0.24425	1.21897	3.0608	3.63386	5.57167	0.07937	14.57144	0.06635	11.93021	0.03802	31.66579	0.35257	0.20163	72.63493	pigment 1
0.13944	3.01814	2.25	1.80856	8.32729	0.07143	8.95806	0.03316	13.07422	0.01513	40.63305	0.1898	0.27381	78.79208	pigment 1
0.10071	0.09754	0.86553	1.08698	33.16317	0.00342	1.655	0.00001	3.06669	0.00471	23.83074	0.44684	0.10154	64.4229	body
0.11131	0.43274	2.75052	3.14436	7.77365	0.03792	4.57668	0.01153	9.47139	0.03117	53.54788	0.46345	1.02738	83.37996	body
0.19441	0.22852	1.99008	2.22614	16.00562	0.00001	3.42091	0.01003	7.24602	0.0082	28.03096	1.01584	0.25284	60.62955	body

Painted bichrome linear and zigzag motifs on buff with red interior

TNP 5671

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
0.2331	0.0675	0.4717	0.92456	2.84031	0.06019	44.92593	0.03825	2.95661	0.00654	6.76873	0.12771	0.08285	59.45138	pigment 1
0.21357	0.01545	0.04481	0.38766	3.07133	0.05339	58.72591	0.03185	1.74801	0.00001	3.69974	0.19835	0.07813	68.22003	pigment 1
0.21095	0.023	0.1037	1.04029	3.33004	0.08539	62.73599	0.08673	2.49977	0.00001	4.68452	0.20296	0.04985	75.00562	pigment 1
0.19634	0.14507	0.23331	0.44317	2.70787	0.07936	66.40631	0.03048	1.62111	0.04042	3.39399	0.21255	0.12952	75.59519	pigment 2
0.16961	0.20478	1.16189	3.47336	8.21227	0.07076	30.99784	0.02686	5.27864	0.02674	19.88517	0.31891	0.64769	70.43625	pigment 2
0.13802	0.02108	0.25843	0.74069	2.59236	0.02406	66.75609	0.00018	2.44556	0.02593	6.24079	0.19825	0.19363	79.60391	pigment 2
0.05169	0.64569	4.14531	5.15665	8.35342	0.05781	6.06348	0.01322	12.87026	0.00001	54.76546	0.22984	0.04299	92.38416	body
0.07861	0.28261	11.76889	0.55726	5.91674	0.01357	1.67577	0.05843	16.06559	0.00606	55.59841	0.07267	0.05374	92.13061	body
0.13459	0.16993	0.6389	2.36467	30.91722	0.00113	2.7238	0.00001	7.70897	0.05826	19.50979	0.14215	0.22993	64.56897	body

TNP 5667

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
1.40706	0.08643	0.50453	0.80471	1.7099	0.0485	35.96903	0.00001	2.36946	0.01974	5.15678	0.17009	0.14131	48.07004	pigment 1
0.23876	0.08787	0.26208	0.78326	3.10115	0.07873	49.50544	0.00336	1.60901	0.00682	6.84677	0.11342	0.12163	62.70443	pigment 1
0.15968	0.13194	0.27999	0.77177	44.73862	0.00673	1.18972	0.00001	0.89391	0.00001	3.23984	0.05843	0.5278	51.96243	pigment 1
0.97608	0.01222	0.02558	0.05143	0.11879	0.00692	1.15647	0.00572	0.12021	0.00001	0.38845	0.03452	0.00123	2.67738	pigment 2
1.71325	0.00001	0.00001	0.00002	0.04269	0.00001	0.17461	0.0079	0.00002	0.00001	0.06398	0.00002	0.00002	1.61597	pigment 2
1.0908	0.00001	0.00001	0.00002	0.02445	0.00001	0.17495	0.00453	0.01856	0.00485	0.02857	0.00002	0.00422	1.10486	pigment 2
0.32598	0.07776	0.95593	1.48298	15.79346	0.00776	2.73796	0.00001	5.08814	0.00827	24.50621	0.24675	0.14422	51.30187	body
0.22552	0.33071	3.07303	2.30352	9.73948	0.03619	3.82082	0.02851	9.92708	0.00952	51.00537	0.14636	0.08537	80.68059	body
0.2581	0.36753	1.49153	2.03001	12.65082	0.01643	5.37245	0.01384	7.99354	0.00001	32.97351	0.20812	0.16394	63.4816	body

Painted bichrome linear and zigzag motifs on buff surface with buff interior

TNP 5428

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
0.93548	0.01174	0.12163	0.06717	0.4394	0.33178	0.1774	0.02958	0.23389	0.00238	0.9196	0.00346	0.05453	3.32802	pigment 1
1.0507	0.04229	0.26398	0.19415	1.15782	2.84719	0.52684	0.00001	0.72994	0.00001	1.58495	0.00002	0.0468	8.4447	pigment 1
0.36216	0.16714	0.76218	0.83528	14.05748	0.09472	32.0201	0.0432	2.69815	0.01539	9.6386	0.21492	0.63765	61.54697	pigment 1
0.10341	0.00991	0.59354	1.02983	46.51977	0.02475	0.39243	0.00001	0.46702	0.01846	2.97184	0.00002	0.85626	52.98724	body
0.14112	0.09639	3.04331	1.55396	26.89686	0.00001	2.22283	0.00001	3.86916	0.00241	18.20813	0.20209	0.48863	56.72491	body
0.00356	0.00095	0.08404	0.25976	58.75297	0.00001	0.06509	0.00001	0.00002	0.00001	0.16917	0.00002	0.10895	59.44455	body

Black decoration with red interior and exterior red mottling

TNP 2391

Wt% Oxide														
Cl	Na2O	K2O	MgO	CaO	MnO	FeO	PbO	Al2O3	Cr2O3	SiO2	TiO2	P2O5	Total	Location
1.0606	0.00046	0.12491	0.18228	0.67278	0.00451	0.38613	0.00001	0.29652	0.00001	1.29264	0.02658	0.04092	3.84903	pigment 1
0.15938	0.12286	2.01799	5.24146	16.18503	0.07635	10.51228	0.0591	10.70307	0.01454	38.8645	0.32865	0.3975	84.64673	pigment 1
0.23735	0.50057	4.07567	2.80304	12.04106	0.12857	11.17543	0.00001	10.87279	0.00175	35.68116	0.52991	0.7008	78.69456	pigment 1
0.17008	0.53502	2.03324	2.05946	15.08304	0.02308	5.23657	0.00001	7.40389	0.00001	27.70908	0.17508	0.17814	60.56832	body
0.24044	0.08039	0.95823	2.09901	18.58879	0.04578	5.08288	0.0619	7.6253	0.00001	22.13659	0.14464	0.14011	57.14982	body
0.03139	9.56572	1.11218	0.35749	2.31156	0.00001	0.47824	0.00001	18.84228	0.00001	63.88727	0.01358	0.01706	96.60972	body