CORPUS OF POTTERY FROM LEPTIMINUS: COMPARATIVE ANALYSES OF POTTERY DATING METHODS

by

Pierre Desrochers

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Thesis directed by Prof. Martin F. Kilmer

My research plan was to use *consensus analysis* to compare three methods of pottery analysis, working with a corpus of pottery sherds for Leptiminus, Tunisia. The methods are carbon-14 dating by Accelerated Mass Spectroscopy, Thermoluminescence dating and Typology. Some of the limitations, difficulties and costs associated with these methods was further analyzed.

Due to problems with the corpus, as well as severely limited budget, analyses by Accelerated Mass Spectroscopy and Thermoluminescence could not be made. In lieu of this, I present a review of the collection and laboratory procedures for use by an archaeologist.

This research also identified problems that need to be addressed immediately by archaeologists in the field for future research in chronometric pottery dating.

Dedication

To the people who inspired me over the years, my parents Suzanne and Yves. And of course, to the great mfk.

> The study of Truth is in one sense difficult, in another easy. This is shown by the fact that whereas no one person can obtain an adequate grasp of it, we cannot all fail in the attempt, each thinker makes some statement about the natural world, and as an individual contributes little or nothing to the inquiry; but a combination of all conjectures results in something considerable.
>
> ἡ περὶ τῆς ἀληθείας θεωρία τῇ μὲν χαλεπὴ τῇ δὲ ῥᾳδία. σημεῖον δὲ τὸ μήτ' ἀξίως μηδένα δύνασθαι θιγεῖν αὐτῆς μήτε πάντας ἀποτυγχάνειν, ἀλλ' ἕκαστον λέγειν τι περὶ τῆς φύσεως, καὶ καθ' ἕνα μὲν ἢ μηθὲν ἢ μικρὸν ἐπιβάλλειν αὐτῇ, ἐκ πάντων δὲ συναθροιζομένων γίγνεσθαί τι μέγεθος: ὥστ' εἴπερ ἔοικεν ἔχειν καθάπερ τυγχάνομεν παροιμιαζόμενοι, τίς ἂν θύρας ἁμάρτοι·

Aristotle's Metaphysics, tr. by W.D. Ross, Oxford: Clarendon Press, 1948, lines 993a-993b.

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My close friends, and fellow students who helped me keep it all together during my M.A., either at the comprehensive exams or the thesis. In order of appearance: Lisa St. Louis, Jacques Vincelette, Pascal Richer, Martin Bourgie, Geneviève Trottier, Donna Veale, and to Anneh Vanessa Czop while at the Canadian Museum of Civilization.

A special thanks go to my Editorial Board: Marie-Hélène Boyer, Marilyn Brooks, Lucie Dufresne, Beth Gazzola, Agnes Kowalska, and Johanna Persohn.

A special mention to my family....for having endured me while writing the thesis.

I would also like to thank all the Spirits that helped me with the writing of this thesis.

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Introduction and Research goals

Research goals were initially proposed in early 1997, as part of my proposal for graduate research. Subsequently, new publications, and various discussions[1] modified the scope of my research to now include various dating techniques useful to ceramic studies.

1.1 Research goals

I use a technique know as consensus analysis to compare the accuracy of dating results.[2] Using the assemblage of sherds from Leptiminus, various scientific dating techniques are therefore used to date the sample population. The methodology, the strength of the results, and the feasibility of applying each dating techniques are discussed and whenever possible, problems and successes of each dating technique are identified. While it was not possible to use *consensus anlysis* to compare the accuracy of the dating results, the theory and procedures are documented for further research.

It is worth noting that the comparative results furnished from coins were not available for study, and further analysis is required using the information provided by the numismatics. Preliminary information (gathered at the thesis defence) indicate that

[1] Discussions between Roelf Beukens from the IsoTrace Laboratory at the University of Toronto and Dr. D.I. Godfrey-Smith from the TOSL Research Laboratory at Dalhousie University influenced this research (see appendix E on pages 132).

[2] Orton et al. 1993, pp. 149–151; McMorris 1990, p. 78.

only few coins were found in site 290, none of them providing the needed information for cross-analysis (see also Lazreg et al. (2001, p. 457-464)).

1.2 Research overview

Scientific analysis of pottery is a broad term best described as an integrated approach to obtaining answers to a set of established questions. Greene (1992, p. 34) has a broad definition:

> Pottery cannot be presented to a laboratory for analysis; archaeological science requires an integrated approach, combining archaeological information about kilns and production techniques with problem-oriented investigation.

The scientific dating techniques used in the analyses are both chronometric and relative.[3] The Relative dating is based on the comparative age of one object to another - typology being the most commonly used method, and one used in this research project. Chronometric, or “absolute”dating, provides dates in years (before present) for the object. Two techniques discussed in this research paper are the common technique of thermoluminescence dating and AMS Carbon-14 dating.

These dating techniques are all considered to be scientific analysis techniques. When using scientific dating techniques, proper attention must be paid to the methodology which is used to obtain the results. A commentary from Gallagher (1987, p. 6) states that:

> Archaeological interpretation often relies on data which cannot meet the rigorous demands of modern scientific inquiry, conducted under the ideal conditions obtainable in laboratory. The best one can achieve in certain situations is a plausible explanation. This is true for provenience studies.

While comments like this hold true for provenience studies, they can also hold true for pottery dating. This point was emphasized by Kolic (1996, p. 54) when she demon-

[3] Rice 1987, pp. 436–445.

strated problems with performing comparative laboratory analyses on identical sherds, and the validity of their results:

> On constate, avec G2, que malgré sa faible teneur en carbone, le mélange industriel contribue, du fait de sa très basse activité, au vieillisement des poteries. Il est également intéressant de signaler que la comparaison de l'activité obtenue pour G2 avec les activités obtenues pour les échantillons composés de mélanges industriel et de calcite (type CG) ne corrobore pas les résultats de M. Gabasio et J.C. Lefebvre qui avaient noté un veillissement pouvant aller jusqu'à 40% de l'activité du combustible pour les poteries à dégraissant calcitique . . . Les poteries expériementales de M. Gabasio et J.C. Lefebvre avaient été élaborées dans des conditions similaires aux nôtres mais non rigoureusement identiques compte tenu de ce type d'expérimentation.

On this subject, Kingery (1982, p. 43) stated some problems with archaeological interpretation.

> The principal deficiencies preventing highly credible interpretations of artifacts have been (1) a lack of sufficiently different sorts of tested consequences (i.e. dependence on only one kind of test or several very similar tests); (2) a lack of interpretations based on a combined knowledge of measurement techniques, physical chemistry, and ceramic technology; and (3) an almost complete lack of satisfactory comparison reference standards, most particularly in the areas of raw materials (including their chemical and trace element variability), fine-scale microstructure and fine-scale chemical analyses on which to base interpretations.

These problems have yet to be addressed in full; However, Kingery does acknowledge that the strength of the results is always a matter of judgement.

1.3 Terminology overview

Pottery is among the most abundant materials to be found on dig sites -so abundant that it can overwhelm the excavators. Pottery was used for a variety of purposes in Roman life: fired clay was used for a range of activities from building materials, through cooking, food storage and for vessels used in the transportation of goods. The study of pottery is properly known as ceramic studies.

The term ceramic derives from ὁ Κέραμος which the Liddell-Scott lexicon translates as "potter's earth, potter's clay; anything made of this earth as earthen vessel, wine-jar in collective sense, pottery".[4]

In order to better understand ceramic studies, we must first define terms associated with archaeometry and dating. While I am more conversant with the French terminology , I will use the English terminology[5] because I am writing my dissertation in English. And I will define the terms in their proper contexts.

Modern definitions of the term "ceramic studies", are based on formulation of New-World archaeologist Anna Shepard.[6] Shepard (1956) saw three phases[7] of development in the study of ceramics:

- the study of its function, the symbolism in its design and the manufacturing process;
- the study of sherds to establish chronological sequence;
- the study of technology in terms of its materials and methods of manufacture.

While these phases are useful in the context of assemblages, they do not provide information regarding the chronometric dating of the material.

Research progressed over the years and in 1986 Prudence M. Rice produced her *magnum opus* which provided the first overlapping definition for pottery.

[4] Liddell and Scott 1948, p. 941.

[5] At the 2001 AIA meeting in San Diego, the members of the workshop entitled "Databases and the Field Archaeologist: Standards and Practices" discussed at length the difficulty in American museums, publications and universities in adopting a common terminology for ceramic studies. The Translation Bureau of Canada adopted a standard set of terminology for use in their archaeological publications (see Translation Bureau 1978).

[6] Shepard 1956, pp. 3–4.

[7] Orton et al. 1993, p. 3 gives us a different summary of these phases, but attentive reading of Shepard 1956, pp. 3–4, will offer us a more thorough, and correct, understanding.

> . . . one set common to material science and another employed in art and archaeology . . . In material science ceramics is a broad generic term, referring ... to the entire range of compounds manufactured from silicates (usually clays) and hardened by applying heat.[8]

Her first definition is rather useful when describing the modern uses of ceramic studies, such as for space age materials, yet it is too generic when applied to an ancient history context. Therefore she also produced a definition for archaeological ceramics:

> [. . . This definition adheres] more closely to the dictionary definitions . . . within these fields ceramics refers to cooking and serving utensils and *objets d'art* manufactured from clay.[9]

The review by Tomber (1990, p. 217) of Rice (1987) is not favourable on account of the amount of information on Roman ceramic studies: "Romanists will need to make a concerted effort to relate the material presented to their own field: it is a useful sourcebook but not requisite reading."

While these definitions are useful for materials used for art and for cooking ware, they do not include building materials such as as bricks and roof tiles. For further information on these subjects, an introduction can be found in Adam (1984, pp. 61–68; pp. 230–231).

While these definitions demonstrate the evolution of our understanding of ceramic studies for the past decade and a half for Rice and close to the half-century for Shepard, they are still incomplete for the purposes of this study. To this day, these definitions, as reformulated by Sinopoli,[10] are still circulated despite their shortcomings.

Since Shepard and Rice a number of new theories and definitions have emerged in ceramic studies. They are necessary to provide an adequate balance between context and dating. An overview of the new concepts used in ceramic studies can be found in Orton et al. (1993, pp. 3–4).

[8] Rice 1987, p. 4.
[9] Rice 1987, p. 4.
[10] Sinopoli 1991, p. 9.

Orton provides fascinating discussions on: ethnography, technology, archaeometry and quantification. While I will not define and use each of these topics, I will reformulate Orton's definition[11] of archaeometry in a manner pertinent to Roman pottery. Archaeometry is best defined as the application of the natural sciences to the problems of archaeology rather than by the generic application of scientific techniques to these same archaeological problems. This generic definition of the term is too broad as it includes dating, provenance studies, typology, and function studies.

I have decided to put emphasis on the topic of chronometric dating using archaeometric techniques as applied to ceramic studies. The subject of chronometric dating is discussed further in the section entitled "Research Goals" (see page 1).

I obtained the pottery used in this research project from the Leptiminus Archaeological Project (LAP) located in the modern city of Lamta, Tunisia. Lea M. Stirling from the University of Manitoba and Nejib Ben Lazreg from l'Institut National du Patrimoine de la Tunisie kindly granted me permission to use the material.

1.4 Presentation of the site

The Byzacene port city of Leptiminus,[12] known today as the modern city of Lamta , is situated on the east coast of Tunisia, 35 kilometres south of Hadrumetum (Sousse). This well situated Roman site is in close proximity to other port cities such as Thapsus (Ras Dimas), and Sullecthum, (Salakta). Leptiminus was also linked to the city of Thysdrus, the region's olive capital, which is in the Sahel hinterland (see figure 1.1 on page 18).

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[11] Orton et al. 1993, p. 18.
[12] Lazreg and Mattingly 1992, p. 9.

Leptiminus is known to scholars through literary,[13] epigraphic,[14] numismatical[15] and archaeological[16] evidence. The literary and archaeological evidence suggests that Leptiminus was a Punic town founded in the middle of the first millenium BC.[17] By 111 BC, it was listed as one of the *populi liberi*.[18] When Julius Caesar arrived in Africa in 46 BC it had become a *civitas libera et immunis*. Pliny the Elder described

[13] The following list in not exhaustive but represents a significant number of finds: in *Bellum Africum*, 7, section 1 line 2 (Leptim); book 9, section 1 line 1 (Lepti); book 10, section 1 line 2 (Lepti); book 29, section 2 line 1 (Leptim); book 61, section 5 line 3 (Leptim); chapter 62, section 4, line 1 (Leptim); chapter 62, section 5, line 3 (Leptim); chapter 63, section 1, line 4 (Leptim); chapter 67, section 1, line 3 (Lepti); chapter 97, section 3, line 1 (Leptitanos); *Bellum Civile*, book 2, chapter 38, section 1, line 3 (Leptitanorum); M. Tullius Cicero, *In Verrem*, actio 2, book 5, section 155, line 6 (Lepti); Iustinianus, *Digesta Iustiniani*, book 28, chap 6, par 30, sect pr, line 4 (Leptitanorum); Sex. Iulius Frontinus, *Strategemata*, book 2, chapter 5, section 11, line 1 (Leptines); Iustinianus, *Digesta Iustiniani*, book 50, chap 15, par 8, sect 11, line 2 (Leptis magna); T. Livius, *Ab Urbe Condita*, book 30, chapter 25, section 12, line 2 (Leptim); M. Annaeus Lucanus, *Bellum Civile*, book 9, verse 524 (Lepti); verse 948 (Leptis); Pomponius Mela, *De Chorographia*, book 1, section 34, line 9 (Leptis); book 1, section 37, line 2 (Leptis); C. Plinius Secundus, *Naturalis Historia*, book 5, section 25, line 1 (Leptis); section 27, line 7 (Leptis); section 32, line 1 (Lepti); section 76, line 3 (Lepti); book 18, section 188, line 2 (Leptimque Magna<m>); book 31, section 94, line 8 (Leptis); book 32, section 18, line 3 (Leptim Africae); C. Sallustius Crispus, *Bellum Iugurthinum*, chapter 19, section 1, line 3 (Leptim); section 3, line 3 (Leptis); chapter 77, section 1, line 1 (Lepti); chapter 77, section 2, line 1 (Leptitani); chapter 79, section 1, line 1 (Leptitanorum); *Scriptores Historiae Augustae*, Aeli Spartiani Severus, chapter 1, section 2, line 1 (Lepti); chapter 15, section 7, line 2 (Leptitana); Silius Italicus, *Punica*, book 3, verse 256 (Leptis); P. Papinius Statius, *Silvae*, book 4, poem 5, verse 30 (Leptis); C. Suetonius Tranquillus, *De Vita Caesarum*, life Jul, chapter 39, section 1, line 5 (Leptinus); Cornelius Tacitus, *Annales*, book 3, section 74, line 4 (Leptitanos); Valerius Maximus, *Facta et Dicta Memorabilia*, book 5, chapter 7(ext), section 1, line 12 (Leptinis). These citations of Leptiminus can also report to Lepcis Magna. The distinction between the two is discussed by Gascou 1972b, p. 79 For the Greek literary evidence we have: Λέπτις ἡ μικρά in Ptolemaeus, *Geographia*, book 4, chapter 3, section 10, line 1; Λέπτις in Polybius, *Historiae*, Book 1, chapter 87, section 7, line 3; μικρὰ Λέπτις in *Geographi Graeci minores*, ed. Müller K., vol. 2, section 205, line 2; ἡ μικρὰ Λέπτις Νέα πόλις in *Geographi Graeci minores*, ed. Müller K., vol.2, vita-verse of Orbis descriptio 205, line of scholion 1; Λεπτὶς δὲ πόλις Λιβύης in *Suda Lexicon*, alphabetic letter kappa, entry 2098, line 17; Λέπτιν τὴν μικρὰν in *Stadiasmus sive periplus Maris Magni*, section 113, line 1.

[14] Gascou 1972a, p. 137 discusses the epigraphic evidence, which can also be found in XII^{2}August Friedrich Pauly 1893, § 2076; in C.I.L., I^2, 585, I, 79 (Leptitanos) ; in C.I.L., VIII, 16542 and 16543 (reg(ionis) Leptiminensis); in C.I.L., VIII, 11105 (regionem Leptitanam); in I.L.A.f., 135 (proc(urator) diocoesis Leptitanam); in C.I.L. VIII, 22902 (flaminica perpetua Leptitana); in C.I.L. VIII, 18085 and 18087 (Lep.); in C.I.L., III, 13583 (...Mariolus Leptiminus); in Bohec 1989. Inscriptions on amphorae also attest the name of Leptiminus such as in Gascou 1972a, 138 and also in Zevi and Tchernia 1969.

[15] Burnett et al. 1992, § 784-791 mentions coins struck with ΛΕΠΤΙΣ under Augustus as well as under Tiberius.

[16] Stillwell et al. 1976, § Leptis Minor.

[17] Stirling et al. 2000, p. 179.

[18] C.I.L. I^2, 585, 1. 79.

Leptiminus as an *oppidum liberum* before his death in 76 AD.[19] Recently[20] it has been demonstrated that the site was elevated to the status of *colonia* by the time of the emperor Trajan. Furthermore, the city was not only a source of high-quality garum[21] but also a prime olive orchard. It was the olive culture and its related industry which produced vast quantities of amphorae, as recorded by Zevi and Tchernia 1969 and subsequent publications.[22]

The area surrounding Leptiminus is essentially an agricultural basin divided by two wadis (seasonal watercourses), the wadi Lamta and the wadi Bou Hajar. Both the modern site, as well as the ancient site were principally devoted to the growth and export of the olive. Besides olive culture, modern agricultural production includes pomegranates, almonds, barley and a variety of vegetables.[23]

This area of Tunisia, known as the Sahel region, was formed by lacustrine, alluvial and continental deposits which date to the Miocene and Quaternary eras (30 to 15 million BC).[24] Possible source locations of the clay used by the Leptiminus potteries and their petrological composition has been discussed by Barbara Sherrif and Shannon Johnston in Stirling et al. (2000, p. 205). The type of temper and clay was the same for all pottery types (amphorae, coarseware and fineware) but in varying amounts to accommodate different vessel forms. From the petrographic analyses done by Sheriff and Johnston the tempering material consists primarily of rounded grains of quartz sand, calcite grains, limestone fragments and crushed pottery fragments. The raw clay used for the locally produced pottery came from various sites around Leptiminus. (see the preliminary results published by Sheriff and Johnston, figure 1.2 on page 19.)

[19] see footnote 13.

[20] Gascou 1972a, p. 137; Beschaouch 1991, and Lazreg and Mattingly 1992, p. 9.

[21] C. Plinius Secundus, Naturalis Historia, book 31, section 94, line 8 “laudantur et Clazomenae garo Pompeique et Leptis, sicut muria Antipolis ac Thurii, iam vero et Delmatia”.

[22] Lazreg et al. 2001, p. 75; Lazreg and Mattingly 1992, p. 115; Lazreg et al. 1998, p. 305; Stirling et al. 2000, pp. 174–216.

[23] Lazreg et al. 1998, p. 306.

[24] Stirling et al. 2000, p. 206.

For pottery production, a preferable setup would include the clay source close to the area of production.[25] It would be highly unlikely that people would cross large distances to acquire the raw materials.[26] This information is useful for studying the provenience of ceramic. Rice (1987, pp. 418–419) mentions the caveats of provenience study for pottery:

> Indeed, vessels made from the same clay may differ compositionally. For this reason efforts to link pottery (even fine-textured, untempered pottery) to specific clay resources by chemical composition alone have experienced considerable difficulties, and most provenience studies have instead compared unknown pottery with pottery from known locations.

This information can prove useful in distinguishing local from imported wares. Yet, as mentioned above, it must be treated with scepticism.

1.5 Assemblage/corpus

The assemblage which constitutes my sample population is from the Leptiminus Archaeological Project (LAP) and was excavated between 1990 and 2000.

The assemblage was randomly chosen by the LAP team without knowledge of the types of analyses to be conducted on the pottery. A sample population had been narrowed down to pottery produced locally, by typology (see chapter 2 on page 25). N. Ben Lazreg of the Institut National du Patrimoine de la Tunisie (INPT) and Lea Stirling of the University of Manitoba (UofM) allowed me to perform laboratory analyses on 40 sherds which they provided. I could not be present for the collection of the fragments and the soil surrounding them. Table 1.1 on page 10 lists the corpus materials.

In table 1.1 on page 10 the year represents the year that the material was excavated. The featured vessel number (FVN) is an unique identifier and is used to cata-

[25] For the latest information concerning the pottery kilns and clay deposits in Leptiminus (see Stirling et al. 2000, pp. 179–224 and Lazreg et al. 2001).

[26] For information about the problem of distance of the clay sources to the potter's workshop, see Rice 1987, pp. 116–117.

Sample Number	Year	Featured Vessel Number	Site location	Locus	Soil Characteristics (where recorded)
01	1990	1880	Urban Survey	F0032	
02	1991	9500	Urban Survey	F0098	
03	1992	35329	Urban Survey	F0331	
04	1992	32335	Urban Survey	F0363	
05	1992	24944	Urban Survey	F0298	
06	1992	22883	Urban Survey	F0289	
07	1992	26097	Urban Survey	F0323	
08	1992	26126	Urban Survey	F0312	
09	1992	20492	Site 1 & C2098	N.A.	
10	1992	31762	Urban Survey	F0366	
11	1992	31242	Urban Survey	F0383	
12	1994	60571	Urban Survey	F0776	
13	1994	47635	Urban Survey	F0596	
14	1995	79534	S290, T400	3066	Sandy soil
15	1995	68884	S290, T400	3017	
16	1995	74381	S290, T400	3050	Some black ash
17	1995	70937	S290, T400	3003	Topsoil
18	1996	81611	S290, T410	4048	
19	1996	84311	S290, T400	3090	
20	1996	83983	S290, T400	3090	
21	1996	87238	S290, T400	3134	Fill - packed brown sandy loam
22	1996	95200	S290, T410	4108	
23	1996	92994	S290, T400	3197	Ashy, clayish soil with pebbles
24	1998	114671	S290, T410	4458 or 4459	
25	1998	99552	S290, T400	3262	
26	1998	114616	S290, T410	4458 or 4459	
27	1998	114083	Unknown	4477	
28	1999	121506	S290, T470	7538	Loose sandy soil
29	1999	121508	S290, T470	7538	Loose sandy soil
30	1999	115395	S290, T440	4503	Topsoil
31	1999	116377	S290, T450	5526	Loose sandy soil
32	1999	115182	S290, T440	4051	
33	1999	114335	S290, T410	4473	Fill - clayish sand
34	1999	119113	S290, T450	5580	
35	1999	117857	S290, T440	4529	Robber trench
36	N.A.	1265	Urban Survey	F0022	
37	N.A.	2702	Urban Survey	F0040	
38	N.A.	3576	Urban Survey	F0052	

Table 1.1: Assemblage from Leptiminus, discussions with Lea Stirling, 2000.

logue the material. It was placed on the vessel by the LAP team and will be kept as a secondary reference number. The primary reference number in all the analyses will be the sample number (SN). The sample number issued by myself during the preliminary sorting, is ordered by dig year and was issued as part of the analyses.

Table 1.1 on page 10 lists some items from the urban survey. Most sherds of the materials sampled come from a kiln site found on area 290 of the Leptiminus excavation site, excavated from 1995 to 2000.[27] Site 290 is an industrial kiln complex located on the outskirts of the ancient town (see figure 1.3 on page 20). Lazreg et al. (2001, p. 221-235) gives an overview of the recent work done in Site 290. The industrial kiln complex was in use from the later 1st through the 3rd century AD. The entire complex itself was still in use in the 6th century AD, but not necessarily as an industrial kiln complex.

Site 290 is further divided according to trenches, so that the trench area 440 (or T440) is an area west of T450 and north of T430. The trenches are surrounded by olive trees and farmer's field fences or field boundaries (see figure 1.4 on page 21).

The Urban Survey materials are from surface finds, or from material easy to collect from the surface.

The information needed for the soil characteristics of the locus were not always provided along with the initial information from LAP.

Pottery fragments gained from the urban survey are without soil sample characteristics, since the sherds are found upon the surface of the soil. The sherds lacking vital contextual soil characteristic information are considered of secondary importance in the sample population selection criteria. The importance of the soil characteristics in the dating techniques will be discussed further. The Table 1.1 is based on the information provided by the LAP in 2000 regarding the soil characteristics of the various loci in the trenches (see table 1.1 on page 10).

[27] Stirling et al. 2000, p. 182.

As in most archaeological sites[28] , Leptiminus' pottery assemblage includes: storage, cooking, transportation and serving vessels. Because Leptiminus was an economic hub, as attested by the pottery kilns and the epigraphic evidence[29] , as well as a port, vessels for transportation and storage are the predominant vessel types in the assemblage.

1.5.1 Physical properties

Physical properties are measured using descriptive standards including measurements of sherds, Munsell analysis of colour, and inspections of inclusions. Measurements are given in millimetres, and refer to the dimensions of each fragment. Colour analysis, when appropriate, is performed on both the slip and the paste. Finally a visual inspection is performed to search for inclusions in the clay visible with the aid of a binocular microscope. A description of the methodology used in these measurements is found below.

The fragments range from 25 mm to 75 mm in length. Fragments are further categorized as diagnostic or non-diagnostic: diagnostic sherds include rims, handles, bases or other distinguishing features, whereas non-diagnostic sherds lack distinguishing features. Various inclusions are present in the assemblage and through close visual inspection are identifiable without the aid of the binocular microscope. Inclusions are defined as grains or particles of varying sizes which are naturally present in the clay. Inclusions from the temper, which is an additive used to improve plasticity, drying and firing properties. These inclusions include some calcium concretions formed after the sherd was buried.

The Munsell Color Order System is used to describe the various colours of the clay (see table 1.2 on page 14) and is a collection of painted samples intended to de-

[28] Rice 1987, p. 238.
[29] See footnote 14.

scribe all possible colours. Three attributes -Hue, Value and Chroma- are compared to various painted samples.[30] Hue (H) is described as the quality of the colour viewed. Value (V) is described as the quality of lightness or darkness. Chroma (C) is the quality which describes the degree of purity of a color and a gray of the same value or lightness. The system is written in the form H V/C with the title: Munsell Notation.[31] To ensure consistent descriptions, measurements are done under two Photo-ELA Sylvania 250 Watt light bulbs at 3200 degrees Kelvin with equal distance from the light source. Measurements are done on fresh breaks or cleaned surfaces of the exterior of the fragments unless noted otherwise.

Figure 1.5 on page 22 gives a more visual representation of the data found in the table 1.2 on page 14.

Using colour as a physical characteristic of pottery, we may draw inferences regarding the general composition of the clay and about the firing technique. Since known changes[32] occur during the firing process, it is possible to make conclusions pertaining to oxidization and atmospheric reduction in the kiln, as well as, about the general properties of the clay. For example, we can determine the presence or absence of organic matter (which burns off). Materials such as calcite will change the homogeneity of the clay particles.[33]

A binocular microscope, a Leica Zoom 2000 at 45x magnification was used to identify the type of inclusions in the fragments. The inclusion analysis is divided by identity, frequency, size, sorting, and roundness. The methodology is based on a slightly modified one, proposed by Orton et al. (1993, pp. 138–139), and described as follows: identity is obtained from visual identity of the fragments, as used by Gallagher (1987, p. 144; pp. 173–176). The inclusions I analyse are sorted by frequency, size and

[30] N/A 1966.

[31] For further information on the use of the Munsell Color Order System (see Shepard 1956, pp. 107–113).

[32] For further information on this subject (see Rice 1987, p. 423; pp. 118-119).

[33] Rice 1987, pp. 93–98.

Sample Number	Year	Featured Vessel Number (FVN)	Munsell Notation	Color Name
01	1990	1880	2.5 YR 6/6	light-red
02	1991	9500	2.5 YR 4/6	dark-red
03	1992	35329	2.5 YR 4/6	dark-red
04	1992	32335	2.5 YR 4/8	dark-red
05	1992	24944	2.5 YR 4/6	dark-red
06	1992	22883	2.5 YR 4/8	dark-red
07	1992	26097	2.5 YR 5/6	red
08	1992	26126	2.5 YR 6/6 (7.5 YR 7/2 int.)	light-red (pinkish-grey)
09	1992	20492	2.5 YR 5/6	red
10	1992	31762	2.5 YR 4/8	dark-red
11	1992	31242	2.5 YR 4/8	dark-red
12	1994	60571	2.5 YR 4/6	dark-red
13	1994	47635	2.5 YR 5/6	red
14	1995	79534	2.5 YR 5/6	red
15	1995	68884	2.5 YR 5/8	dark-red
16	1995	74381	2.5 YR 4/8	dark-red
17	1995	70937	2.5 YR 5/8	dark-red
18	1996	81611	2.5 YR 4/6	dark-red
19	1996	84311	2.5 YR 5/6	red
20	1996	83983	2.5 YR 5/6	red
21	1996	87238	2.5 YR 4/8	dark-red
22	1996	95200	2.5 YR 4/8	dark-red
23	1996	92994	2.5 YR 4/6	dark-red
24	1998	114671	2.5 YR 5/6	red
25	1998	99552	2.5 YR 5/6	red
26	1998	114616	2.5 YR 4/8	dark-red
27	1998	114083	2.5 YR 4/6	dark-red
28	1999	121506	2.5 YR 4/6	dark-red
29	1999	121508	2.5 YR 4/6	dark-red
30	1999	115395	2.5 YR 3/6	dark-red
31	1999	116377	2.5 YR 4/6	dark-red
32	1999	115182	2.5 YR 4/8	dark-red
33	1999	114335	2.5 YR 5/6	red
34	1999	119113	2.5 YR 6/6	light-red
35	1999	117857	2.5 YR 4/8	dark-red
36	N.A.	1265	2.5 YR 5/8	dark-red
37	N.A.	2702	2.5 YR 4/8	dark-red
38	N.A.	3576	2.5 YR 5/8	dark-red

Table 1.2: Munsell notation of all samples

sorting obtained by guess estimation with the aid of charts published by Orton et al. (1993, pp. 238–239) and found on page 23 and 24. On page 23 the percentile of various inclusions is guess estimated, along with the relative size of the inclusions. The roundness is obtained from guess estimation with the help of charts found on page 24. For the roundness, a measurement is taken of the largest grain inclusion, which is then compared against a specific chart (on page 24). The following values are given in the classification system: very-angular, angular, sub-angular, sub-rounded, rounded, well-rounded. The following values were used for the assemblage: angular, sub-angular, sub-rounded and rounded. The sphericity of the inclusions is based on the shape of its shadow.

The sorting was measured with the binocular microscope at 45x magnification at the established range of 0.5 mm to 2.0 mm. The values for the classification system range from “Very Good” to “Very Poor”. The “Very Good” value infers a value in which the number of inclusions are relatively standard in appearance. The “Very Poor” value is where the inclusions are non-standard in appearance.

In table 1.3 on 16, Roundness is measured from 1 to 6 where 1 is very-angular and 6 is very-rounded and the the sphericity is given in capital letters such as L-S for Low-Sphericity; H-S for High-Sphericity. Where information about the sphericity of the inclusions could not be established, a value of N.A. (not applicable) was given.

Identity was obtained from the binocular microscope at 20x and 45x magnification on a section where a clean break has occurred on the fragments. The minerals were compared with standard visual mineral identification charts, such as those found on page 23.

The inferences which may be drawn from the identity, frequency, size and roundness of the inclusions are twofold. The first is that common fabric identification can limit the sample population to a target population, such as local production wares. The second is that knowledge of the characteristics of the inclusions can lead to a greater

SN	Year	FVN	Size	Percentile	Roundness	Sorting
01	1990	1880	0.5-2.0	30	L-S-4	Fair
02	1991	9500	0.5-2.0	20	H-S-6	Good
03	1992	35329	0.5-2.0	30	H-S-5	Fair
04	1992	32335	0.5-2.0	30	H-S-5	Fair
05	1992	24944	0.5-2.0	30	H-S-5	Good
06	1992	22883	0.5-2.0	30	H-S-5	Poor
07	1992	26097	0.5-2.0	30	H-S-5	Fair
08	1992	26126	0.5-2.0	20	H-S-5	Good
09	1992	20492	0.5-4.0	30	H-S-4	Poor
10	1992	31762	0.5-2.0	20	H-S-4	Fair
11	1992	31242	0.5-4.0	30	H-S-4	Poor
12	1994	60571	0.5-2.0	30	L-S-4	Poor
13	1994	47635	0.5-2.0	30	L-S-4	Good
14	1995	79534	0.5-2.0	30	L-S-2	Poor-Fair
15	1995	68884	0.5-2.0	30	L-S-4	Fair
16	1995	74381	0.5-2.0	30	L-S-4	Fair
17	1995	70937	0.5-2.0	30	L-S-5	Good
18	1996	81611	0.5-2.0	30	H-S-5	Poor
19	1996	84311	0.5-2.0	30	H-S-4	Poor
20	1996	83983	0.5-2.0	30	H-S-4	Poor
21	1996	87238	0.5-2.0	30	H-S-4	Poor
22	1996	95200	0.5-2.0	30	H-S-4	Poor
23	1996	92994	0.5-2.0	30	H-S-5	Poor
24	1998	114671	0.5-2.0	30	L-S-2	Poor-Fair
25	1998	99552	0.5-2.0	30	H-S-4	Poor-Fair
26	1998	114616	0.5-4.0	30	L-S-3	Poor
27	1998	114083	0.5-3.0	30	H-S-4	Poor
28	1999	121506	0.5-1.0	30	N.A.	Very-Good
29	1999	121508	0.5-1.0	30	N.A.	Very-Good
30	1999	115395	0.5-1.0	30	N.A.	Very-Good
31	1999	116377	0.5-1.0	30	N.A.	Very-Good
32	1999	115182	0.5-4.0	30	H-S-5	Poor
33	1999	114335	0.5-4.0	30	H-S-4	Very-Poor
34	1999	119113	0.5-2.0	30	H-S-2	Good-Fair
35	1999	117857	0.5-2.0	30	H-S-5	Poor-Fair
36	N.A.	1265	0.5-4.0	30	H-S-4	Very-Poor
37	N.A.	2702	0.5-3.0	20	H-S-5	Poor
38	N.A.	3576	0.5-2.0	30	H-S-4	Good-Fair

Table 1.3: Binocular analyses of all samples

knowledge of the use of the ware, and thus further limit the sample population. For example of very poorly sorted fabric with large inclusions, ranging from 0.5 to 3.0mm at 30% in frequency with angular roundness, would suggest a ware that was not used for transportation, but for cooking.

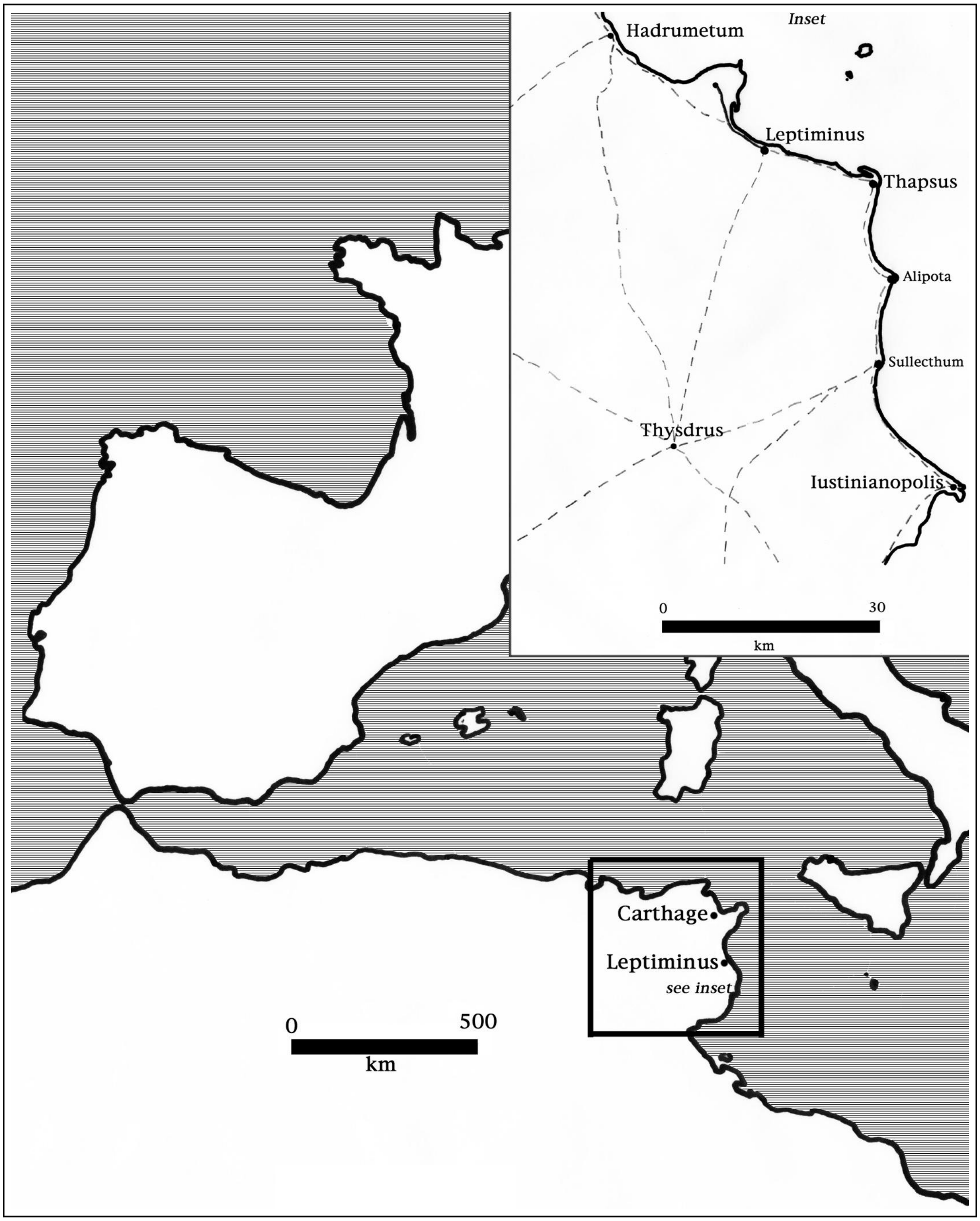

Figure 1.1: Leptiminus, based on maps from Barrington and LAP.

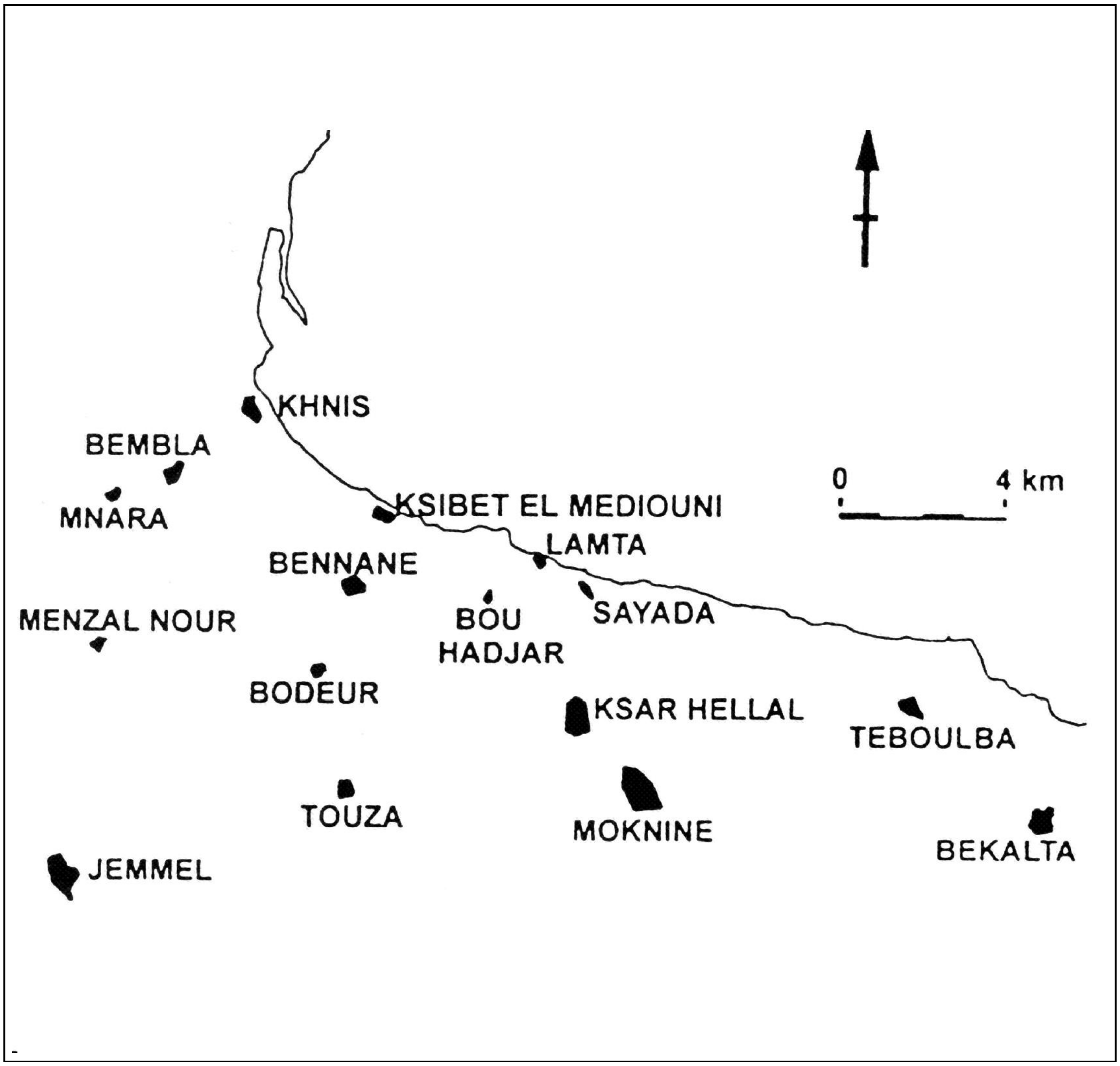

Figure 1.2: Possible location of clay deposits, after Stirling et al. (2000, p. 207). The size of the black "lumps" represent possible clay locations.

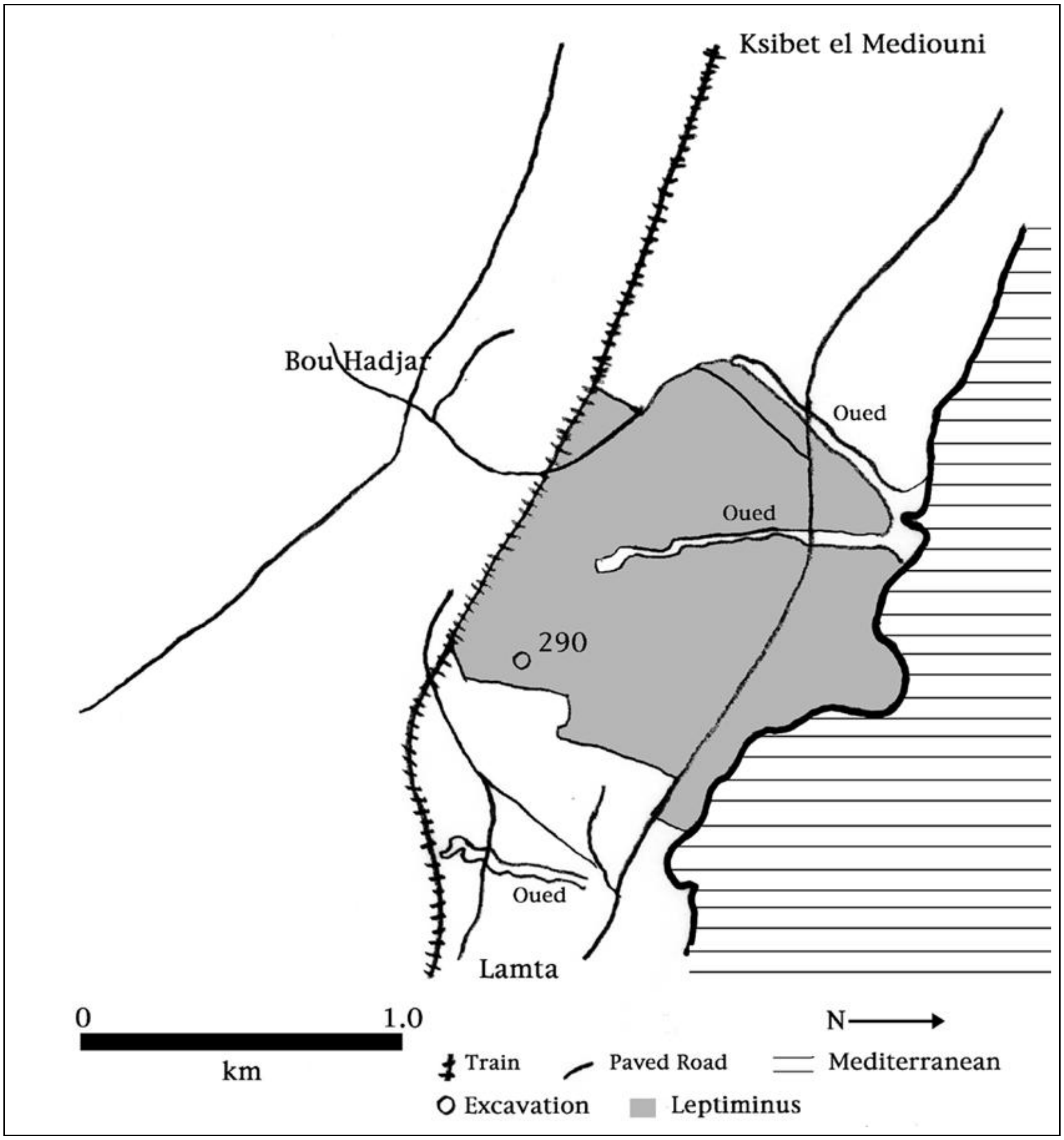

Figure 1.3: Site 290 - overview, modified from Stirling et al. (2000, p. 181).

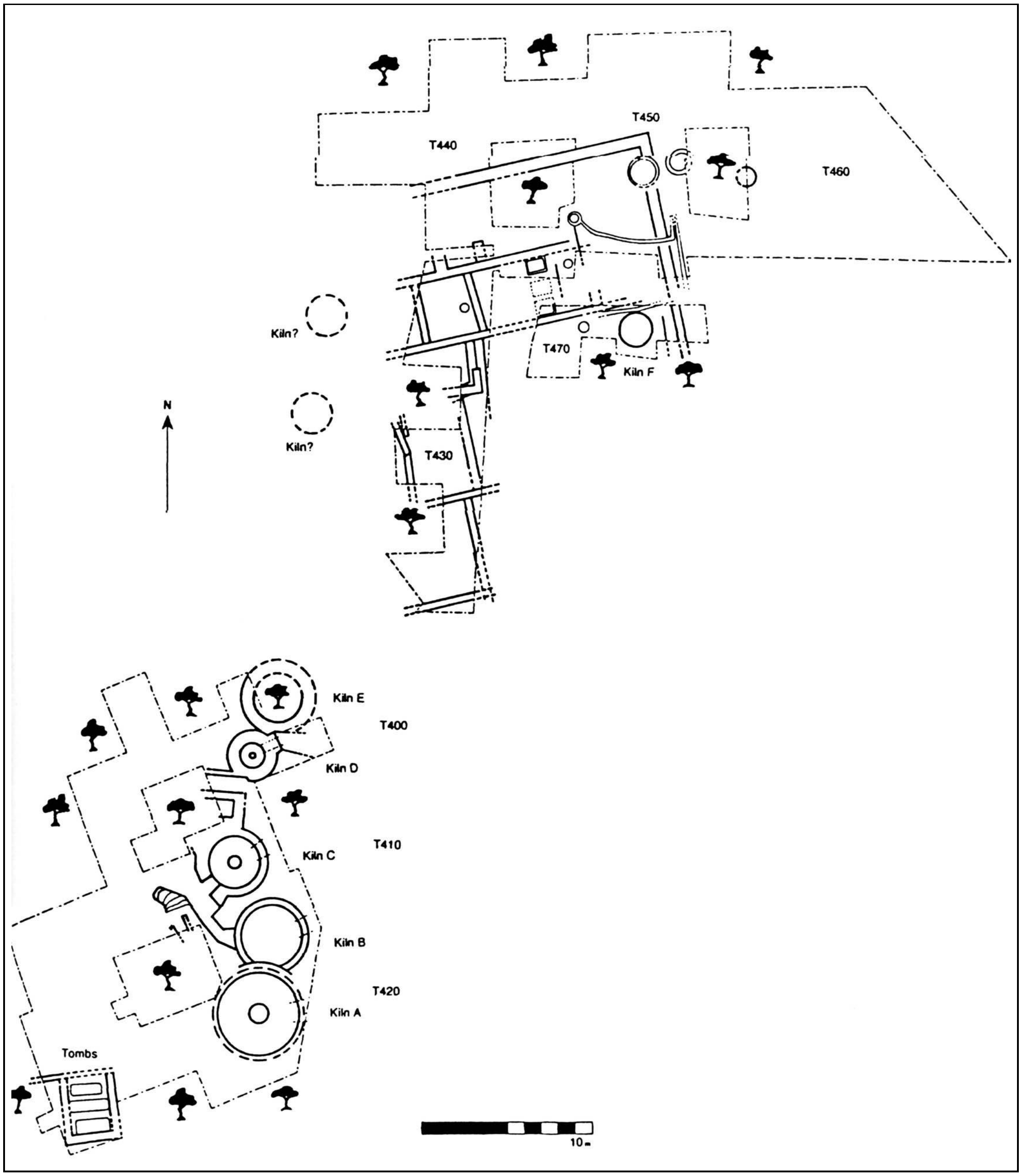

Figure 1.4: Detail of site 290, Stirling et al. (2000, p. 183).

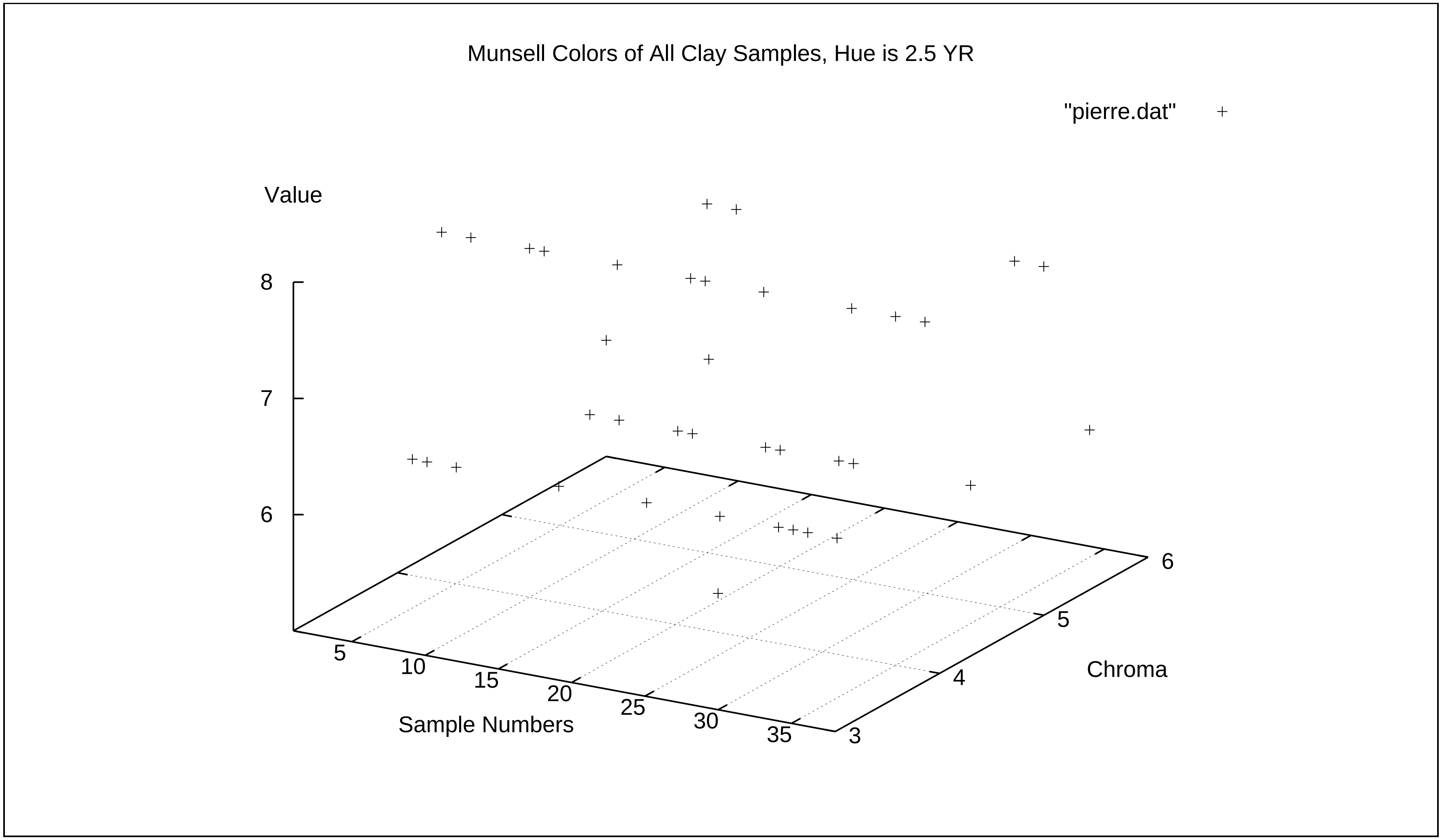

Figure 1.5: Munsell Colors of All Samples. Plot by gnuplot 3.7.1 software on Macintosh (http://homepage.mac.com/gnuplot, accessed on the 2nd of May 2002).

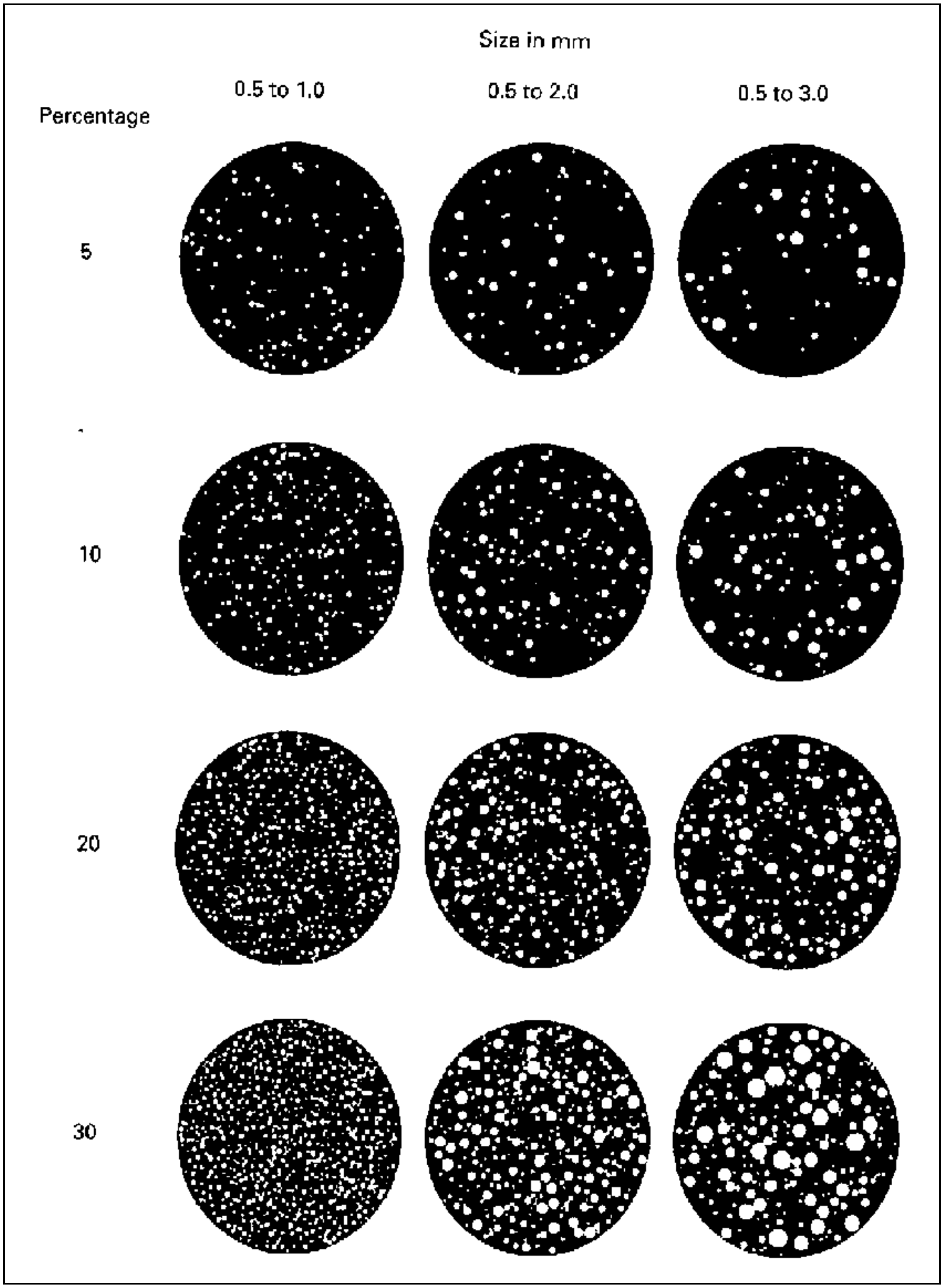

Figure 1.6: Percentile inclusion estimation chart, from Orton et al. (1993, p. 238).

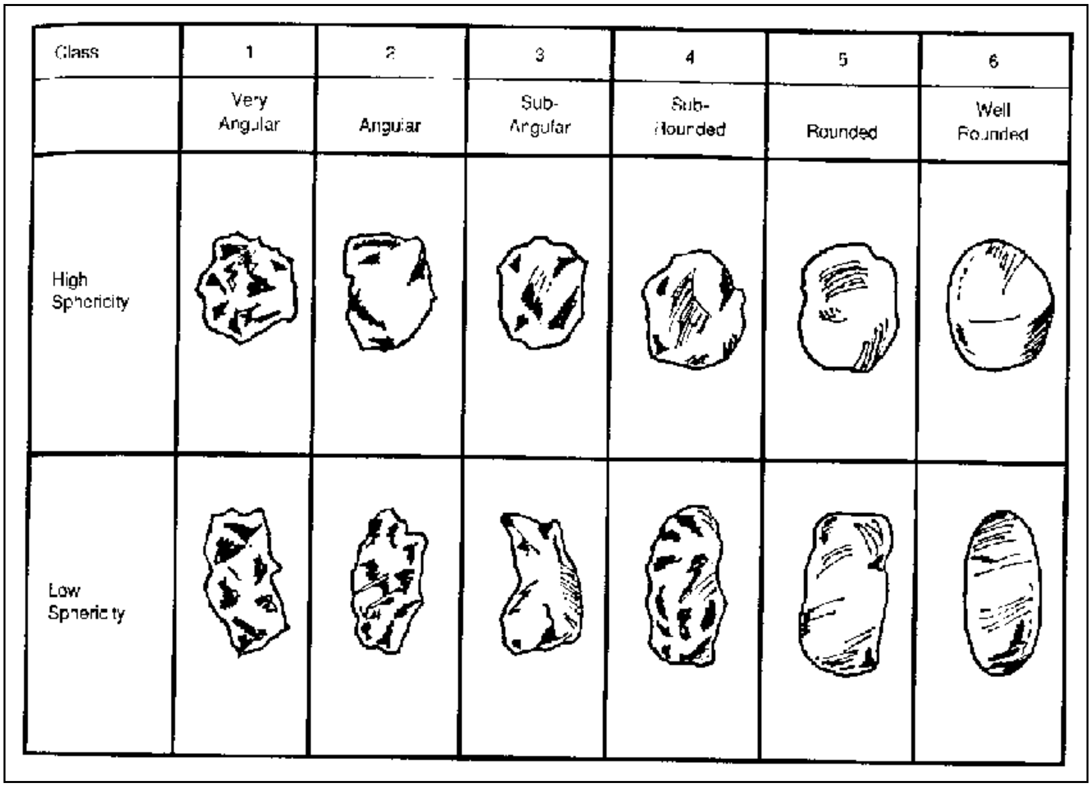

Figure 1.7: Roundness estimation chart, from Orton et al. (1993, p. 239).

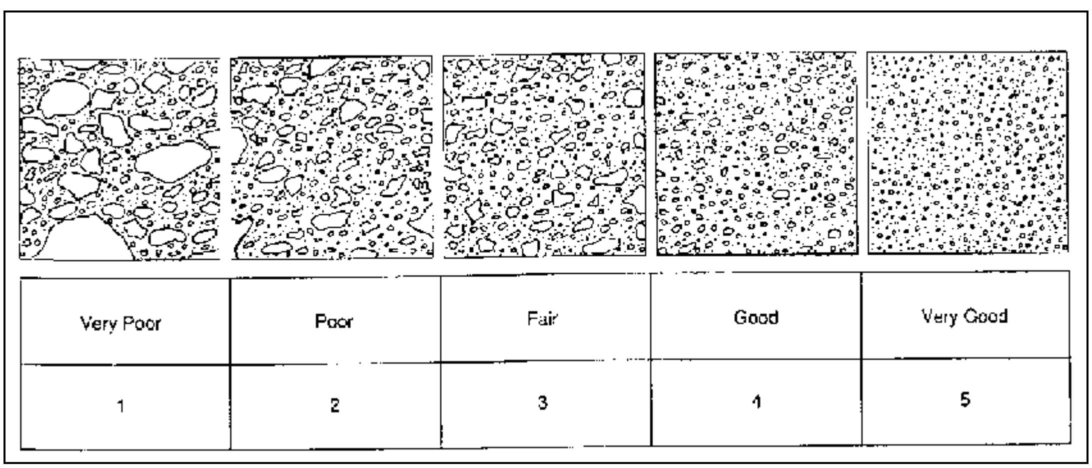

Figure 1.8: Scale for pebble sorting, from Orton et al. (1993, p. 239).

Chapter 2

Typology

Work has been done in the past on ceramic studies on the site of Leptiminus (see Dore (2001) and Dore (1992)). With this background information present it will be possible to classify the sample population into ware-types. In this chapter I will order the sample population into a relative dating classification system.

2.1 Research methodology

While the sample population was presented in the Introduction (see page 9), I did not order them into a classification system. I only presented the material in a quantitative matter, not allowing for its interpretation. In this section, I classify the sample population by typology, while giving a basic overview of the concept of typology. In the chapters on TL and AMS, I explain how typology relates to dating provided by these "chronometric" techniques.

2.1.1 History

An in-depth overview of the history and development of pottery classification can be found in Orton et al. (1993, pp. 8–15) and Renfrew and Bahn (1996, pp. 114–116). For more information on the theory of typology, a good introduction can be found in Sinopoli (1991, p. 43). Various discussions have taken place on the theory and