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HEROM

The journal is open to international research submitted by individual scholars as well as by interdisciplinary teams, and especially wishes to promote work by junior researchers and new and innovative projects. Challenging research themes can be explored in dedicated issues, and theoretical approaches are welcomed. Book reviews and review articles further screen the pulse of the field.

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Edited by

Jeroen Poblome
Daniele Malfitana
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EDITORIAL PREFACE

John Lund, Jeroen Poblome and Daniele Malfitana
THE NATIONAL MUSEUM OF DENMARK, UNIVERSITY OF LEUVEN, AND IBAM-CNR-ITALY

The first two issues of HEROM were dedicated to specific research themes related to the theory and practice of material culture studies. The present issue and the next ones will offer contributions on a wide variety of subjects, linked, however, by the authors' ambition to throw light on the complexities of past life departing from a study of artefacts.

It is hardly coincidental that three out of the four articles in this issue deal with ceramic evidence (in very different ways it must be said). Rather, it reflects the huge research potential of ancient pottery.[1] By now, this proposition may be commonly accepted, but such was not always the case. The eminent historian Moses I. Finley thus complained in 1965 that: "We are too often victims of that great curse of archaeology, the indestructibility of pots".[2] Finley's influence on the study of ancient economy (or rather economies)[3] can hardly be overestimated.[4] But, as argued by Ian Morris, he was inclined to overemphasize the problems involved in interpreting archaeological material, which led him to virtually ignore archaeological data.[5] We are, in a sense, still living with the consequences of this, Finley's blind spot, because other ancient historians have until relatively recently also tended to be disinterested in material culture.[6] This is somewhat ironic, because Finley himself

1. Poblome *et al.* 2012; Poblome *et al.* 2013; Poblome *et al.* 2014.
2. Finley 1965, p.41. Note, however, the comments by Brian A. Sparkes (Sparkes 1996, pp. 1-2) and the response by Kevin Greene (Greene 2000, pp. 48-49).
3. See for instance Reger 1994, 3, pp. 273-276; Davies 2009; Archibald 2013.
4. Harris 2013.
5. Morris 2005, pp. 102-104.
6. As noted, for instance by Morris 2005, pp. 102-104; Shipley 2013, p. 5.

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acknowledged towards the end of his life with regard to archaeology and history: "There can thus be no question of the priority in general or of the superiority of one type of evidence over the other; it all depends in each case on the evidence available and the particular questions to be answered".[7] James Whitley recently made a similar point: "Archaeology is surrounded by misconceptions. One is that archaeology exists to confirm or deny the narratives of historians; another, that the material record exists to fill in 'gaps' in the literary. My argument here is that the archaeological record has first to be explained in its own terms before it can be used for any purpose related to narrative history".[8] The editors of this journal could not agree more.

It is not our intention to re-ignite the old debate about the relationship between archaeology and history,[9] but to make two other points, which seem obvious but are nevertheless essential. The first is that material culture studies are central to all research into ancient societies.[10] The second is that all scholarly disciplines involved in this endeavour should take heed of the results obtained in other disciplines instead of carrying out discussions in closed circuits among themselves, as often happens even now. As noted by Graham Shipley, recent anthologies published by historians are mainly filled with contributions by fellow historians,[11] and conversely it is equally true that those edited by archaeologists are largely filled with contributions by fellow archaeologists.[12] This is not to cast doubt on the value of the publications in question or to deny the existence of exceptions to this rule. Indeed, the very same criticism might be levelled against the current issue of HEROM. But we - as editors - remain committed to bridging the interdisciplinary gaps that continue to mar the field of ancient research.[13] In short, it is *one* of our ambitions to contribute in a small way to breaking the Finleyan curse.

Finally, we are happy to announce that from 2015 onwards, HEROM will appear bi-annually. We encourage scholars of all disciplines, who wish to contribute to the fulfilment of the editorial vision, to submit manuscripts for the forthcoming issues. And last but not least, we extend our thanks to Leuven University Press for its continued support and belief in our project.

7. Finley 1985, p. 20.
8. Whitley 2009, pp. 732-733. Cf. also Hurst 2010, p. 92 on the distinction between history and archaeology.
9. See now Hall 2014.
10. For recent surveys of material culture studies, see Hodder & Hutson 2003, p. 14; Tilley *et al.* 2006; Hicks and Beaudry 2010; Basu 2013.
11. Shipley 2013, p. 5.
12. See for example Fenn and Römer-Strehl 2013, and the entire ReiCretActa series.
13. As set out in Poblome *et al.* 2007, pp. 17-18. For a broader explanation of the editorial goals, see Poblome *et al.* 2012.

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STRUMENTI DA LAVORO, MACCHINE E APPRESTAMENTI FUNZIONALI NEGLI IMPIANTI PER LA PRODUZIONE DI ANFORE DELL'ITALIA ROMANA

RIFLESSIONI PRELIMINARI

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I grandi impianti per la produzione delle anfore che, tra la fine del II secolo a.C. e la prima metà del I secolo d.C., si sviluppano nelle aree più fertili del territorio italiano, costituiscono realtà molto complesse e articolate, sulla cui struttura e organizzazione interna negli ultimi anni si è molto scritto e discusso e il cui ruolo nell'economia antica si va rapidamente definendo[1]. Ciò nonostante, esistono alcuni aspetti che, pur avendo avuto un ruolo centrale nell'ambito della produzione antica, continuano ad apparire sfuggenti. E' il caso, ad esempio, degli strumenti adoperati dai vasai, addetti alla preparazione dei manufatti, dai fornaciai, addetti alla gestione del fuoco nelle fornaci, e dagli operai, adibiti ad una serie di altre operazioni generiche – ma necessarie – nella conduzione degli impianti (estrazione dell'argilla, trasporto delle materie prime, assistenza alla manodopera specializzata ecc.). Di questi strumenti, che sicuramente esistevano e che di certo avevano un ruolo di prima

1. Gli studi degli ultimi anni, in particolare, grazie al moltiplicarsi delle indagini archeologiche e al perfezionamento dei metodi di intervento, hanno potuto affrontare temi come l'estensione complessiva degli impianti, la distribuzione dei locali al loro interno, le modalità di organizzazione del lavoro, il numero delle maestranze necessarie e la produttività complessiva, argomenti che contribuiscono a migliorare l'inquadramento generale di queste realtà nell'ambito del panorama economico, politico e culturale da cui furono generate. Cfr., tra gli altri, Manacorda 2012c.

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importanza nell'ambito della produzione, ad oggi si conosce pochissimo e non esiste un lavoro di sintesi che li raccolga, li ordini e li analizzi[2].

La causa principale della attuale lacuna di conoscenze è forse da ricercare nel fatto che, mentre degli impianti produttivi si conoscono nel dettaglio le fornaci, che costituiscono il segmento produttivo relativo alla cottura dei manufatti, si continuano per lo più ad ignorare gli ambienti circostanti, nei quali avvenivano le altre operazioni connesse con la produzione e nei quali, verosimilmente, doveva essere maggiore l'impiego di strumenti. La situazione è ulteriormente complicata dal fatto che, come avviene ancora oggi nei laboratori ceramici che adottano tecniche tradizionali, gran parte degli strumenti utilizzati nell'ambito degli impianti di cui stiamo parlando era probabilmente realizzata in materiali deperibili e, per questo, potrebbe non essersi conservata; allo stesso tempo, gli strumenti eventualmente fatti in metallo, potrebbero essere stati asportati al termine della produzione per essere riusati, ri-funzionalizzati o reimpiegati come materia prima. E' possibile, inoltre, che alcuni degli strumenti in uso all'interno di questi stabilimenti fossero prodotti a partire da materiali comunemente presenti sul sito, appena riadattati per poter servire all'uso e che, per questo, risultino di difficile individuazione e riconoscimento. Per tutte queste ragioni, mi sembra utile proporre una riflessione preliminare che, pur senza pretesa di esaustività, provi a porre l'attenzione sulla qualità e sulla potenzialità informativa delle tracce archeologiche da cui questo aspetto, che è tra i meno noti e studiati della complessa realtà di questi impianti, potrebbe essere testimoniato.

Gli indizi di cui possiamo disporre per tentare una operazione del genere sono costituiti:
- da un insieme di evidenze dirette, cioè da una serie di manufatti rinvenuti nel corso dello scavo di stabilimenti per la produzione di anfore, che sono stati interpretati come strumenti da lavoro e posti in relazione con le attività produttive che si svolgevano sul sito;
- da alcune evidenze indirette, cioè da una serie di tracce che possono riscontrarsi sui manufatti prodotti dagli impianti di questo genere e che sono interpretabili come tracce dell'utilizzo di particolari strumenti;

2. La situazione è leggermente migliore nel caso delle fornaci che producono ceramiche fini per le quali, pur non esistendo lavori di sintesi, si conoscono, ad esempio, numerose matrici e punzoni decorativi che, per il materiale con cui sono fatti – la terracotta – e per le loro caratteristiche morfologiche, hanno buone possibilità di conservarsi e, al tempo stesso, ottime probabilità di essere riconosciute in fase di scavo. Un quadro interessante e ben organizzato dello strumentario in uso negli impianti di questo genere è fornito dalle fornaci di Scoppieto, per le quali cfr. Bergamini and Gaggiotti 2011.

- da alcuni indizi indiretti, come tracce di compattamento o di usura differenziata delle superfici d'uso, che potrebbero costituire chiavi di lettura fondamentali per ipotizzare la presenza e le modalità di utilizzo di alcuni particolari apprestamenti e macchinari;
- da alcune tracce logiche, relative a dettagli costruttivi e dimensionali degli impianti, che potrebbero trovare giustificazione nell'utilizzo di particolari strumenti o macchine;
- da poche fonti iconografiche, che associano la produzione di manufatti ceramici con l'immagine di determinati strumenti;
- da alcuni confronti con realtà produttive, antiche e moderne, che siano meglio conosciute.

Le riflessioni che presento sono ordinate seguendo le tappe principali della produzione dei materiali ceramici, così come sono state codificate nel corso degli studi: approvvigionamento e preparazione delle materie prime necessarie alla produzione, modellazione, essiccazione dei manufatti, cottura[3].

L'approvvigionamento delle materie prime. I grandi impianti per la produzione delle anfore dovevano, almeno in parte, integrarsi nella complessa economia produttiva delle grandi proprietà terriere gestite con il sistema dell'agricoltura intensiva, di cui andavano a costituire un segmento economico importante, funzionale ad ammortizzare sia i costi per la produzione della strumentazione ceramica utile alle ville sia, soprattutto, quelli per la fabbricazione dei contenitori per l'esportazione dei prodotti alimentari[4]. Per questa ragione, è possibile immaginare che l'attività di questi impianti fosse organizzata in maniera da potersi armonizzare con gli altri segmenti produttivi che si svolgevano all'interno della stessa proprietà con cui, probabilmente, condividevano parte della manodopera e, forse, parte del ciclo produttivo. Penso, ad esempio, alla questione dell'approvvigionamento del combustibile necessario per l'alimentazione delle fornaci. Le analisi condotte sui carboni prelevati nel corso dello scavo di alcuni di questi impianti, infatti, dimostrano che all'interno delle grandi fornaci che caratterizzano queste strutture le essenze consumate non erano quelle che, in linea teorica, potrebbero ritenersi più indicate allo scopo ma, piuttosto, quelle più immediatamente disponibili, prelevate da ambienti di diversa natura, comprese le aree coltivate[5]. E' possibile, quindi, che l'approvvigionamento del combustibile

3. Una prima serie di osservazioni sullo strumentario delle officine ceramiche in relazione alle diverse fasi di lavorazione dell'argilla è già presente in Peacock 1997, pp. 71-96.
4. In questo senso cfr., ad esempio, Manacorda 2012c.
5. Chabal and Laubenheimer 1994, con ulteriore bibliografia; Chabal 2001 Per una riflessione simile, cfr. anche Manacorda 2012b, pp. 99-101.

fosse gestito, almeno in parte, in maniera per così dire *diffusa* nell'ambito della proprietà e non facesse necessariamente capo all'impianto delle fornaci: durante le attività di potatura dei coltivi, il legname di risulta poteva essere raccolto e forse stoccato a stagionare all'interno di magazzini che potevano trovarsi nelle immediate pertinenze degli impianti delle fornaci; a questo materiale poteva essere aggiunto quello derivante dalle pulizie stagionali della vegetazione spontanea e la riserva poteva essere integrata con l'aggiunta di legname appositamente tagliato o acquistato, in preparazione della produzione. E' per questo che, in mancanza di evidenze dirette, in questa sede ho scelto di non trattare degli strumenti per il taglio e la preparazione del legname necessario all'alimentazione delle fornaci, operazioni che potevano svolgersi all'esterno degli impianti, in aree anche molto distanti da essi.

La questione dell'approvvigionamento dell'argilla si presenta, invece, in maniera completamente differente: il fatto che la cava di argilla si trovasse nelle immediate vicinanze dell'impianto è, infatti, uno dei prerequisiti fondamentali per la buona resa, in termini economici, degli impianti stessi e lo strettissimo rapporto tra l'impianto e la cava è attestato, oltre che dall'evidenza archeologica, anche dalle fonti antiche[6]. Per questo mi sembra lecito immaginare che, a differenza dell'approvvigionamento del combustibile, le attività di estrazione dell'argilla, dal punto di vista organizzativo e logistico, facessero direttamente capo agli impianti. Più difficile è stabilire se il ritmo di attività di queste operazioni si armonizzasse con quello della produzione degli impianti o se si trattasse di segmenti indipendenti, magari distanziati nel tempo. Sappiamo, ad esempio, che per poter essere utilizzata l'argilla di solito necessitava di una stagionatura che lasciasse macerare eventuali elementi organici al suo interno, rinforzandone la struttura. E' possibile quindi, che il ciclo dell'approvvigionamento dell'argilla, così come quello dell'approvvigionamento del combustibile, si svolgesse, almeno in parte, durante stagioni in cui non si procedeva alla foggiatura e alla cottura dei manufatti. Quali che fossero il ritmo e la tempistica dell'estrazione, possiamo immaginare che all'interno degli impianti si trovassero sia i locali adibiti allo stoccaggio e alla stagionatura dell'argilla sia, forse, i depositi degli strumenti che erano utilizzati per le attività di cava. Questi utensili, probabilmente piuttosto semplici e poco specializzati, non si sono conservati o, forse, non sono stati identificati nell'ambito degli stabilimenti per la produzione delle anfore. E' possibile, però, che proprio a questa fase della produzione possano essere riferiti due strumenti a manico corto raffigurati sul coronamento di

6. Varrone, *r.r.,* 1.2.23. Per l'evidenza archeologica, cfr., ad esempio Aldini 1981, p. 14 (Forlimpopoli); Pallecchi 2008, p. 248 (Albinia); Manacorda 2012b, pp. 97-98 (Giancola). In generale, cfr. Pallecchi 2010a, p. 614, con ulteriore bibliografia.

un monumento funerario datato al I secolo d.C., rinvenuto ad Aquileia e attribuito proprio ad un fabbricante di anfore[7] (FIG. 1).

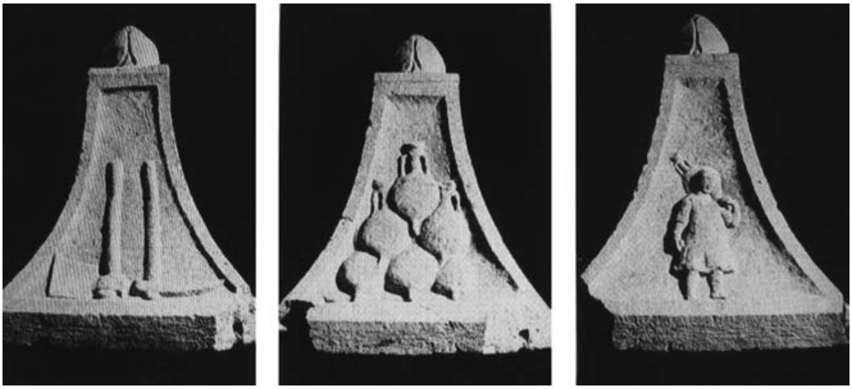

FIG. 1. Particolare di un monumento funerario attribuito ad un fabbricante di anfore, Aquileia, I secolo a.C. (da Buchi 1987, p. 158).

FIG. 2. L'estrazione dell'argilla. A sinistra, scena dipinta su un *pinax* da Penteskouphia (da Cuomo di Caprio 2007, p. 143): a destra, estrazione dell'argilla presso l'Hausa village di Tasmaske, Niger (da Gosselain and Livingstone Smith 2005, p. 35, fig. 2).

Si tratta di uno strumento a lama verticale e di una specie di piccone, dotato di una lama con taglio orizzontale, forse identificabile come una *dolabra*, usata anche in agricoltura[8] (FIG. 2). Se poi, come è verosimile, le modalità di estrazione dell'argilla proprie degli stabilimenti per la produzione di anfore non si differenziavano troppo da quelle dell'estrazione dell'argilla nell'ambito

7. Buchi 1987, p. 18; Buora 1987, pp. 30-31.
8. A proposito di questo strumento cfr. anche Guidone 2009, pp. 204-205. Strumenti simili sono talvolta posti in relazione con la lavorazione del legno (Champion 1916, p. 25).

degli impianti per la produzione di ceramiche di altro genere, allora un altro strumento di frequente utilizzo poteva forse essere un puntale in ferro, montato su una specie di vanga in legno, di cui è attestato un esemplare nell'ambito di un impianto per la produzione di terra sigillata gallica[9].

Una volta estratta, l'argilla veniva forse stoccata in sacche, gerle o cassette e trasportata all'interno degli impianti a dorso di mulo o con l'uso di carri a traino animale come avveniva ancora, fino a pochi decenni fa, nell'ambito di alcuni laboratori ceramici che operavano con tecniche tradizionali[10]. Non si conoscono tracce dirette che possano testimoniare questa pratica che, tuttavia, potrebbe costituire una valida spiegazione per un piano di frammenti ceramici, molto frammentati e compattati, rinvenuto presso l'impianto di fornaci di Albinia, in Toscana[11]. Questo piano, stratigraficamente relazionabile alle ultime fasi di frequentazione del sito e, quindi, a momenti in cui l'attività era ormai incentrata sulla produzione di vasellame di uso domestico, si trovava a poca distanza dalla grande cava di argilla utilizzata sin dalle fasi centrali dell'attività degli impianti e, in linea di ipotesi, potrebbe essere interpretato come lacerto di un sentiero carrabile usato forse sia per l'approvvigionamento della materia prima sia per il trasporto dei prodotti finiti.

Un'altra delle materie prime necessarie per la lavorazione dell'argilla è l'acqua, che negli impianti per la produzione di anfore di cui stiamo parlando doveva essere consumata in grande quantità[12]. L'acqua necessaria alle produzioni poteva, almeno in parte, essere attinta attraverso dei pozzi scavati all'interno degli impianti o nelle loro immediate vicinanze, oppure poteva essere trasportata dai vicini corsi fluviali, magari a dorso di mulo[13]. Le tracce di pratiche così svolte sono labili e di difficile interpretazione: per estrarre l'acqua dai pozzi si saranno forse utilizzati secchi in legno o generici con-

9. Chenet and Gaudron 1955, fig. 8a (II-III secolo d.C.). Più in generale, nelle operazioni di estrazione dell'argilla si può immaginare che potessero venire utilizzati anche altri strumenti, comunemente usati in ambito agricolo per la lavorazione della terra. Per questi strumenti cfr., ad esempio, Champion 1916, pp. 227-233.
10. Per un esempio, cfr. Combès and Louis 1967, p. 39, che descrive il trasporto dell'argilla, stoccata all'interno di sacche in fibre vegetali e caricata sul dorso di un cammello, dall'area della cava fino ai laboratori ceramici di Djerba (Tunisia).
11. Pallecchi 2010b, pp. 271-272.
12. A proposito del consumo di acqua negli impianti per la produzione di manufatti ceramici, cfr. Echallier and Montagu 1985, p. 145; Revilla Calvo 1993, p. 19, nota 21.
13. Per alcuni esempi di pozzi connessi ad impianti per la produzione di anfore, cfr. Aldini 1981, p. 5; Laubenheimer 1990, pp. 47-48. Per l'ipotesi relativa al trasporto di acqua su carovane di muli: Manacorda 2012b, p. 99. Sistemi simili sono attestati nell'ambito dei cicli produttivi di manifatture che adottano tecniche tradizionali (cfr., ad esempio, le carovane di cammelli che approvvigionano di acqua le manifatture ceramiche di Djerba: Combès and Louis 1967, p. 40).

tenitori in ceramica o metallo, legati a corde e issati a mano o con l'aiuto di carrucole, magari in legno[14]. Nell'ambito dell'impianto, l'acqua sarà stata probabilmente conservata all'interno di vasche o altri contenitori e da lì distribuita nelle aree di lavorazione[15]. Considerando, però, le dimensioni e il carattere manifatturiero degli impianti di cui stiamo parlando e la loro costante vicinanza a corsi d'acqua di discreta entità, mi sembra che non si possa neppure escludere che, per l'approvvigionamento idrico, si utilizzassero anche sistemi di sollevamento e di trasporto più sofisticati di cui, per altro, i Romani avevano ottima conoscenza[16]. Mi domando, in particolare, se non sia possibile pensare che i grandi impianti di fornaci potessero approvvigionarsi di acqua attraverso vere e proprie macchine idrauliche, come le norie o i timpani, comunemente utilizzate dai Romani in agricoltura e nelle opere di drenaggio[17]. Macchine di questo genere, connesse a fossati o a semplici condotte inclinate, sfruttando la forza dei corsi d'acqua o attivate da semplici meccanismi a trazione animale, avrebbero potuto rifornire gli impianti in maniera abbondante e continua, limitando sia l'impiego della manodopera sia il tempo necessario all'approvvigionamento[18]. Ad oggi, non

14. A proposito delle carrucole e, più in generale, dei sistemi di sollevamento dei pesi in età romana, cfr. Adam 1984, pp. 44-49; Pisani Sartorio 2009, pp. 90-94.
15. Si può, forse, interpretare come riserva d'acqua, ad esempio, una grande vasca individuata nell'area delle fornaci di Pian di Spille (VT), che furono attive nella produzione di anfore greco-italiche, Dressel 1A e Dressel 1B (Incitti 1986, p. 198). Sistemi analoghi sono attestati anche nell'ambito delle produzioni moderne gestite con sistemi tradizionali per le quali cfr., ad esempio, Tekkök-Biçken 2004, p. 112, fig. 7.
16. Per la definizione del carattere manifatturiero di questi impianti cfr., da ultimo, Manacorda 2012c, p. 518-521.
17. A proposito delle tipologie e delle modalità di impiego di queste macchine presso i Romani, cfr. Tölle-Kastenbein 1993, pp. 199-200; Nuovo 2009, pp. 124-125, con bibliografia ulteriore e con alcuni casi di testimonianze archeologiche di norie romane connesse all'agricoltura, al drenaggio delle miniere e a pratiche di altro genere. Per quanto riguarda il funzionamento del timpano e i suo impieghi nel mondo romano, vedi anche: Vitr., *De Arch*., 10. 4. Nell'area dell'impianto di Sallèles d'Aude, al momento dell'intervento esisteva ancora un pozzo, utilizzato per l'irrigazione dei campi, da cui l'acqua veniva estratta con l'utilizzo di una ruota idraulica. L'antichità di questa struttura non è stata dimostrata ma la sua posizione, perfettamente compatibile con l'articolazione dell'impianto produttivo e, anzi, ben allineata con le sue strutture, potrebbe costituire un elemento a favore per una ipotesi di questo genere (Laubenheimer 1990, p. 48).
18. Nel corso delle indagini presso l'impianto produttivo di Pauvadou è stato parzialmente indagato un fossato piuttosto profondo, dal profilo inclinato secondo il naturale declivio del terreno, che correva parallelo alla muratura di recinzione del complesso e che, come dimostra la stratigrafia, durante tutte le fasi di vita del sito fu sottoposto a continua e accurata manutenzione. Questo fossato, tuttavia, corre ad una distanza molto ridotta dalle murature dell'impianto (circa 0.5 m) e pare difficile immaginare che potesse accogliere un flusso continuo e abbondante di acqua – sia pure solo nelle stagioni di attività dello stabilimento – senza causare danni alle strutture. Per questa ragione, preferisco accogliere l'interpreazione di Brentchaloff, che lo pone in relazione ad operazioni di drenaggio, più che di adduzione dell'acqua (Brentchaloff 1980, p. 79).

esistono prove archeologiche dell'uso di macchine di questo genere nell'ambito del ciclo produttivo di cui stiamo parlando; se ho scelto di affrontare comunque il problema è perché se è vero che macchine di questo tipo potevano essere interamente costruite in legno e che, per questo, potrebbero aver lasciato tracce difficilmente identificabili e interpretabili, il problema principale, ancora una volta, mi sembra costituito dal fatto che in nessun caso le indagini condotte sugli impianti di questo tipo e sugli impianti ceramici in genere hanno previsto una analisi delle eventuali pertinenze esterne. E' difficile che si possa trovare una buona chiave di lettura per realtà economiche complesse e articolate come i grandi impianti manifatturieri di cui stiamo parlando, finché non si riesce a pensarli e a indagarli nella loro interezza.

La preparazione delle materie prime. Le procedure per la preparazione dell'impasto utilizzato nella fabbricazione delle anfore dovevano variare a seconda della qualità dell'argilla che si impiegava[19]. Questo, probabilmente, influiva sulla qualità degli apprestamenti strutturali predisposti all'interno dello stabilimento e forse, almeno in parte, anche sullo strumentario impiegato e sui tempi di lavorazione. In generale, comunque, anche sulla base di confronti etnografici, si può pensare che l'argilla venisse prima essiccata, poi frantumata – talvolta molto finemente – con mazzuoli che potevano essere in pietra, ma pure interamente in legno, entro un contenitore o su un piano in legno o in pietra[20], e infine disposta per la depurazione e la stagionatura all'interno di apposite vasche[21]. Al termine della stagionatura, l'argilla veniva battuta, forse con i piedi, come accade ancora oggi nelle manifatture che adottano sistemi tradizionali (Fig. 3); veniva poi addizionata di acqua e di eventuali correttivi e impastata perché assumesse la consistenza adatta alla foggiatura[22].

L'attenzione all'approvvigionamento idrico e, in particolare, l'esistenza di apprestamenti idraulici anche piuttosto sofisticati, in grado di semplificare l'operazione e di diminuire la manodopera necessaria è evidente, per altro, nell'impianto produttivo di Scoppieto, attivo nella produzione di ceramiche fini (Bergamini 2007, p. 66).

19. A proposito della lavorazione cui era sottoposta l'argilla prima della tornitura, cfr. Cuomo di Caprio 2007, pp. 141-153.

20. Il procedimento è ben attestato dalle fonti etnoarcheologiche tra le quali, ad esempio: Combès and Louis 1967, p. 40 (Tunisia); Gosselain and Livingstone Smith 2005, pp. 37-39 (varie comunità africane); Livingstone Smith 2007, p. 52 e tav. IV, figg. 14-25 (Togo e Camerun).

21. Peacock 1997, p. 72; per una descrizione di operazioni analoghe nell'ambito del ciclo produttivo di manifatture moderne, che adottano sistemi tradizionali, cfr. Combès and Louis 1967, pp. 40-41 (Tunisia).

22. Resti di vasche per la preparazione dell'argilla sono talvolta attestati nell'ambito di stabilimenti che producevano manufatti ceramici diversi dalle anfore (cfr., ad esempio, Arubas and Goldfus 1995, p. 100; Mezquíriz Irujo 1982, p. 33, fig. 5). A proposito delle testimonianze etnoarcheologiche di questa pratica cfr., ad esempio, Handler 1963,

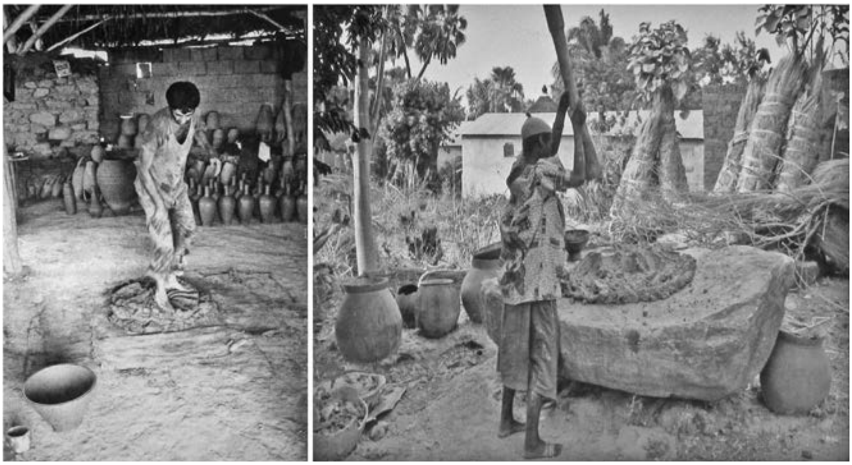

FIG. 3. A sinistra, la battitura dell'argilla nella Turchia occidentale (da Crane 1988, p. 11); a destra, battitura dell'argilla con un pestello nel Togo settentrionale (da Gosselain and Livingstone Smith 2005, p. 37, fig. 7).

Non si può escludere che, in alcuni casi, per ottenere un impasto omogeneo e, al tempo stesso, per velocizzare e ottimizzare il processo di preparazione della materia prima, si facesse uso di vere e proprie macchine impastatrici a trazione umana o animale, che avrebbero potuto funzionare con principi simili a quello della macchina per impastare il pane raffigurata a Roma sulla tomba del fornaio *Eurysaces*[23]. Macchine di questo genere avrebbero potuto essere in gran parte costruite in legno ma, probabilmente, avrebbero avuto bisogno di una solida e fissa base di appoggio, che si può forse immaginare simile alle basi in pietra delle macine utilizzate per i cereali[24]. Per una maggiore stabilità, la base di appoggio per la macchina impastatrice avrebbe potuto anche essere incassata nel pavimento, come avveniva negli ultimi decenni del Novecento per le impastatrici a trazione animale utilizzate nel Portogallo centrale, per la cui tradizione più volte si è ipotizzata un'origine romana[25] (FIG. 4).

pp. 316-317, Pl., 1 (Barbados); Combès and Louis 1967, pp. 41-42 (Tunisia); Crane 1988, p. 11 (Turchia); Tekkök-Biçken 2000, p. 97 (Turchia).

23. Per il sepolcro di *Eurysaces*, cfr. Ciancio Rossetto 1973. A proposito dell'ipotesi sull'utilizzo di macchine impastatrici nell'ambito degli impianti romani per la produzione di manufatti ceramici, cfr. Ribeiro 1972, p. 304; Peacock 1997, pp. 74-75.
24. Ad una macchina di questo genere Peacock ipotizza che possa essere riferita una struttura di pietra di forma cilindrica rinvenuta in una officina di ceramisti nabatei a Oboda, in Israele, precedentemente messa in relazione con un tornio (Negev 1974; cfr. Peacock 1997, pp. 74-75).
25. Ribeiro 1972, pp. 303-304; Peacock 1997, pp. 74-75.

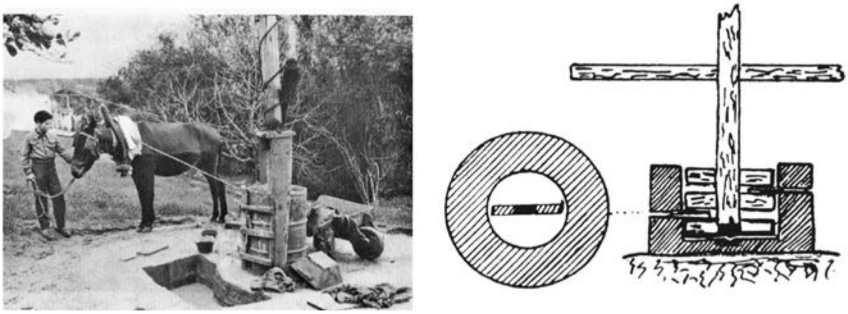

FIG. 4. A sinistra, impastatrice per argilla a trazione animale da Melides, Portogallo (da Ribeiro 1972, tav. V, fig. 2); a destra, ipotesi ricostruttiva di macchina impastatrice romana (da Ribeiro 1972, tav. XII, fig. 10).

E' proprio ad una macchina di questo tipo che possono forse essere riferite le "tracce di uno strumento circolare a dinamica rotante" identificate sulla pavimentazione di una vasca all'interno del complesso di fornaci di Ronta di Cesena, attivo a partire dalla fine del II secolo a.C. e specializzato nella produzione di laterizi[26].

La foggiatura. Tra gli strumenti in uso negli stabilimenti per la produzione di manufatti ceramici, il tornio è quello più noto e, in definitiva, quello di cui è più semplice identificare l'utilizzo. Alle tracce di tornitura facilmente individuabili sulle superfici interne delle anfore, fanno infatti un buon riscontro le conoscenze dirette di torni noti dalle fonti iconografiche, dalle indagini archeologiche e dai confronti etnografici[27] (FIG. 5).

Molto meno noti sono, invece, gli strumenti che i vasai e i loro aiutanti utilizzavano durante le operazioni di tornitura. Per trasportare l'acqua dai depositi all'area dei torni, ad esempio, si saranno usati secchi, otri o altri contenitori

26. Le tracce, ipoteticamente attribuite ad "una ventola per impastare l'argilla", sono descritte in un articolo preliminare comparso sul sito della Soprintendenza per i Beni Archeologici dell'Emilia-Romagna (Maioli and Conti 2006). Per una notizia generica sul sito cfr. anche Montevecchi 2009, pp. 41-42.
27. Per le fonti iconografiche, cfr. Desbat 2004; Cuomo di Caprio 2007, pp. 179-208, con ulteriore bibliografia. A proposito delle tracce di torni nell'ambito di stabilimenti per la produzione di manufatti ceramici in età romana cfr., tra gli altri, Arubas and Goldfus 1995, p. 100, fig. 5; Desbat 2004, pp. 141-148; Laubenheimer and Gisbert-Santonja 2001. Più in generale: Peacock 1997, pp. 75-79, con ulteriore bibliografia; Crispino 2009, pp. 242-243; Bergamini and Gaggiotti 2011, pp. 360-366.

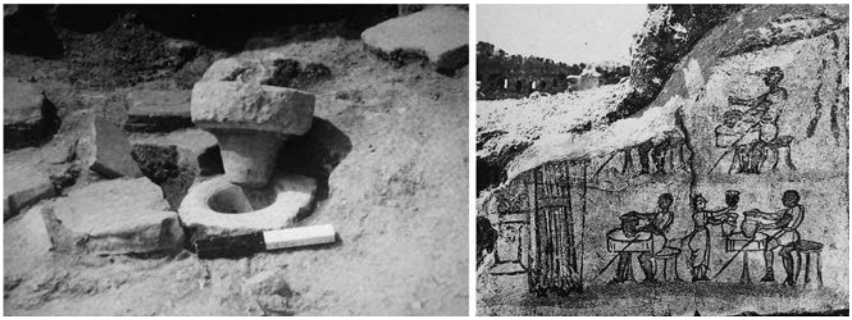

FIG. 5. A sinistra, base di tornio dagli impianti produttivi legati alle attività della *Legio X Fretensis,* alla periferia di Gerusalemme (Arubas and Goldfus 1995, p. 100, fig. 5); a destra, affresco raffigurante l'interno di una bottega di vasai, da Pompei (da Sampaolo 1990, p. 827, fig. 1).

in materiali deperibili, in ceramica o, più difficilmente, in metallo con i quali possiamo immaginare che gli operai rifornissero le riserve usate dai vasai durante la foggiatura. Queste riserve, a loro volta, erano forse costituite da contenitori in legno o in ceramica, magari di reimpiego, posti a poca distanza da ciascuna stazione di tornitura[28].

Nelle fasi di tornitura delle singole parti dell'anfora e in quelle del loro assemblaggio, erano forse usati dei supporti, che conferissero stabilità a quelle parti dei manufatti, come i puntali, che non ne avevano di propria. Non è escluso che parte di questi strumenti fosse realizzata in legno, ma è probabile che siano da interpretare come supporti anche alcuni manufatti in ceramica, spesso rinvenuti nell'ambito dello scavo delle fornaci (FIG. 6). Si tratta di cilindri ceramici dalle estremità smussate e variamente sagomate, che talvolta sembrano adattarsi in maniera perfetta alle dimensioni dei fondi e dei puntali delle anfore[29].

Durante la modellazione dei manufatti, per uniformare l'aspetto delle superfici, il vasaio poteva utilizzare stecche e lisciatoi. Gran parte degli strumenti

28. La presenza di contenitori di questo tipo in prossimità delle postazioni degli artigiani tornitori è attestata chiaramente all'interno degli impianti di Scoppieto (Bergamini 2007, p. 66). Per allestimenti analoghi in contesti moderni cfr., ad esempio, Nicholson and Patterson 1985, p. 230, fig. 4 (Egitto); Crane 1988, p. 12 (Turchia); Tekkök-Biçken 2000, pp. 96, 98 (Turchia).
29. Si interpretano così, ad esempio, i supporti rinvenuti nell'ambito delle fornaci da anfore di Giancola, in Puglia (Firmati 2012a, con ulteriore bibliografia).

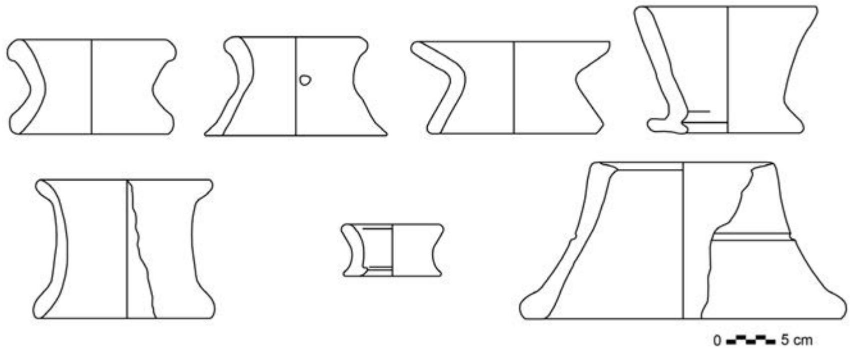

Fig. 6. Alcuni dei principali tipi di supporti rinvenuti presso gli impianti di Giancola, Brindisi (rielaborazione da Firmati 2012a, p. 175, scala 1:3).

di questo tipo era probabilmente in legno e, per lo più, sarà andata perduta[30]; esistono, però, anche strumenti interpretati come lisciatoi e realizzati reimpiegando frammenti ceramici. Casi di questo tipo sembrano attestati per le fornaci di Albinia, in Toscana, dove sono stati rinvenuti alcuni frammenti di parete di anfora, conformati in maniera da poter essere facilmente impugnati e che presentavano margini smussati, forse funzionali a facilitarne la presa e l'utilizzo[31]. Strumenti simili, in pietra levigata, in osso o, talvolta, in scisto o in terracotta, sono del resto piuttosto comuni nell'ambito delle fornaci romane che producono ceramiche di altro genere[32] (Fig. 7).

Anche per la fase della modellazione delle anse è stata suggerita la possibilità dell'impiego di una macchina, cui sono stati ipoteticamente riferiti due curiosi manufatti in ceramica, rinvenuti in superficie nell'area del sito delle fornaci romane di Giancola (Brindisi, Puglia). Si tratta di due oggetti piuttosto massicci, seppur frammentari, dal profilo troncoconico e dalle superfici

30. Strumenti del genere sono, comunque, attestati nell'ambito di manifatture ceramiche che producono manufatti diversi dalle anfore come, ad esempio, a Lavoye (Chenet and Gaudron 1955, fig. 8c; Desbat 2004, p. 152, fig. 27). In generale, cfr. anche Peacock 1997, p. 81. Per alcuni casi moderni cfr., ad esempio, Combès and Louis 1967, p. 50; Petrucci and Poteur 1976; Annis 1985, p. 247; Crane 1988, pp. 11, 15 e 17.
31. L'uso di lisciatoi del genere è attestato anche nell'ambito delle produzioni ceramiche che operano con sistemi tradizionali. Per un esempio, cfr. Gosselain 2010, p. 683-684, fig. 7, n. 9 (Niger).
32. A proposito dei lisciatoi in pietra levigata e in osso cfr., ad esempio, Peacock 1997, p. 81, fig. 45, n. 4 (da Rheinzabern); Terrisse 1968, p. 129, fig. 45.5 e p. 131 (da Martres-de-Veyre, Puy-de-Dôme, in Francia); Young 1977, p. 17 (da Churchill, Oxford) e, in generale, Desbat 2004, pp. 140-141. Per un lisciatoio in scisto cfr. Chenet and Gaudron 1955, fig. 8c (da Lavoye). Per un lisciatoio in terracotta, cfr. Mesplé 1957, p. 51, Pl. V, n. 3 (da Lombez).

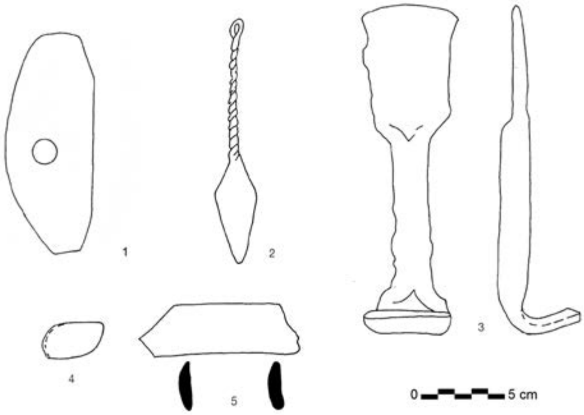

Fig. 7. Esempi di strumenti da vasaio romani (rielaborazione da Peacock 1997, p. 81 fig. 45). 1) lisciatoio in legno da Lavoye; 2) spatola in ferro da Compiègne; 3) raschietto in ferro da Aspiran 4) lisciatoio in pietra da Rheinzabern; 5) frammento di osso levigato da Churchill, Oxford.

caratterizzate da profonde solcature con andamento a spirale (Fig. 8). In questi oggetti, simili a due grosse viti ceramiche, secondo questa ipotesi si dovrebbe riconoscere parte degli ingranaggi interni di una macchina, che si immaginava completata da una vasca di alimentazione, da una manovella e da un foro di uscita, e che sarebbe stata utilizzata per produrre dei cilindri d'argilla dai quali ricavare le anse[33]. L'uso di una macchina di questo tipo non desterebbe sorpresa nell'ambito del quadro che stiamo provando a ricostruire e, per altro, potrebbe trovare un buon riscontro anche nell'aspetto delle anse delle anfore di Giancola, che presentano un diametro piuttosto standardizzato. Tuttavia, sulle superfici di questi due oggetti non si rileva traccia degli alloggi per il fissaggio di manovelle o per il collegamento alle altre parti della macchina e, tutto sommato, è anche difficile comprendere la ragione per cui un meccanismo del genere, per il quale la facilità di movimento costituiva un requisito importante, avrebbe dovuto essere fabbricato in ceramica, piuttosto in un materiale più leggero, come ad esempio il legno. Per queste ragioni, mi sembra più verosimile l'ipotesi di Daniele Manacorda, che pone questi due oggetti in relazione con il ciclo della cottura dei manufatti e, in particolare, con la gestione della temperatura dei forni[34].

33. Cucci 1970, pp. 184-186; cfr. Manacorda 2012a, p. 202.
34. Secondo D. Manacorda, i due manufatti, alloggiati in una madrevite da essi stessi creata nella volta provvisoria dei forni prima dell'accensione, potevano funzionare come valvole per regolare il tiraggio delle fornaci e, quindi, la temperatura di cottura (Manacorda

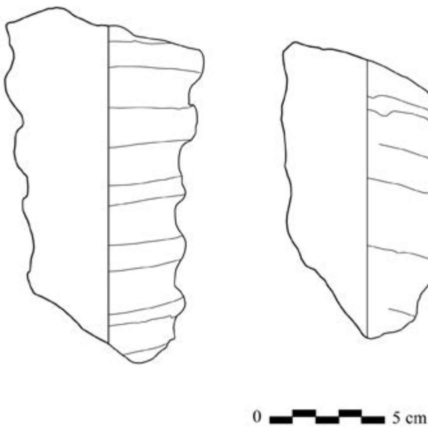

FIG. 8. Viti in ceramica da Giancola, Brindisi.

Per staccare dal piano del tornio le varie parti dell'anfora, dopo averle modellate, il vasaio poteva utilizzare coltelli in metallo o in legno, cordicelle o fili di metallo[35]. Dell'uso di questi strumenti costituiscono traccia indiretta le superfici di giuntura che a volte si osservano tra le varie parti dell'anfora modellate separatamente.

Dopo esser state staccate dal piano del tornio, al termine della prima fase di foggiatura, le diverse parti dell'anfora erano probabilmente adagiate su grandi vassoi o piani mobili in ceramica o in legno, sui quali erano trasportate nei locali di primo essiccamento[36]; terminata anche questa operazione, venivano di nuovo posizionate sul tornio e assemblate con l'uso di argilla umida.

In alcuni casi, durante la fase del primo essiccamento, con l'utilizzo di apposti punzoni si procedeva alla bollatura delle anfore. Una testimonianza inequivocabile dell'uso dei punzoni e delle modalità del loro impiego è rappresentata dai bolli delle anfore, che costituiscono rinvenimenti piuttosto comuni nei

2012a, pp. 201-203). Per manufatti analoghi, rinvenuti nel contesto di una fornace romana a Chios, per i quali è stata proposta una interpretazione simile, cfr. Opait and Tsaravopoulos 2011, p. 284, fig. 9.

35. A proposito di coltelli in metallo rinvenuti dell'ambito di fornaci per la produzione di manufatti ceramici, cfr. Swan 1984, p. 51; cfr. Cuomo di Caprio 2007, pp. 203.
36. A proposito dell'utilizzo di questi vassoi, cfr. Cuomo di Caprio 2007, pp. 203-204. Manufatti del genere sono, per altro, ampiamente attestati nell'ambito dell'impianto produttivo di Scoppieto, attivo nella produzione di manufatti in terra sigillata (Bergamini and Gaggiotti 2011, p. 345). Per un esempio moderno, nell'ambito di laboratori ceramici che adottano tecniche tradizionali, cfr. Combès and Louis 1967, p. 51 (Tunisia).

contesti di età romana. Questi bolli permettono di ricostruire, talvolta con un altissimo grado di dettaglio, le caratteristiche della superficie del punzone che veniva impressa sull'argilla cruda delle anfore registrandone, oltre alla forma, anche eventuali imperfezioni, usure e fratture. Dal momento, però, che a fronte dell'enorme quantità di bolli noti, sono pochissimi i punzoni per i quali è stato possibile ipotizzare un utilizzo nell'ambito della bollatura delle anfore[37], in realtà gli aspetti relativi alla forma complessiva di questi strumenti e al materiale con cui erano fabbricati sono ancora oggetto di discussione.

E' probabile che, almeno in alcuni casi, i punzoni fossero realizzati in legno, come sembrano suggerire i segni di lavorazione che si conservano sulla superficie di alcune serie di bolli[38] (Fig. 9). Questi segni, uguali a sé stessi su tutti i bolli prodotti dallo stesso strumento, sono riconducibili al momento della fabbricazione del punzone e sembrano identificabili come tracce dell'utilizzo di piccoli scalpelli. Così come non sono stati rinvenuti i punzoni, che sicuramente c'erano, negli stabilimenti per la produzione delle anfore non sono stati ritrovati neppure gli utensili adoperati per la produzione dei punzoni, che erano probabilmente in metallo. Del resto, se è naturale che la bollatura avvenisse all'interno degli impianti, i punzoni potevano anche essere fabbricati in altri laboratori facenti capo alla stessa proprietà o, eventualmente, commissionati ad artigiani esterni.

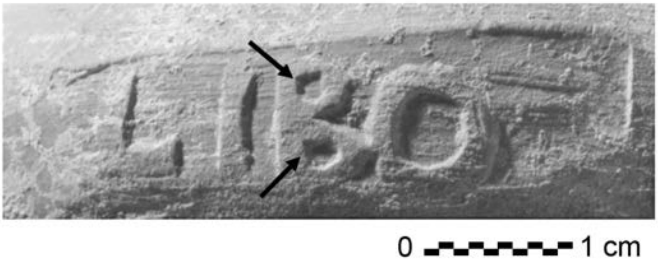

Fig. 9. Bollo di anfora prodotta negli stabilimenti di Giancola, Brindisi. Le frecce indicano alcune anomalie nel tratto delle lettere, che costituiscono una eloquente testimonianza degli strumenti utilizzati nella fabbricazione del punzone.

37. Per una ipotesi di identificazione di un punzone ceramico da anfore, cfr. Grace and Salviat 1962 e, più in generale, Grace 1935. Più di recente, l'ipotesi di identificazione di questo strumento con un punzone per la bollatura delle anfore è stata ripresa in Debidour 1999, p. 308; Garlan 1999, p. 294. Per una ipotesi di interpretazione in funzione della bollatura delle anfore di un punzone in argilla rinvenuto a Napoli, tra i materiali dello scavo della metropolitana, cfr. Olcese 2010, p. 68.
38. Pallecchi 2012b, pp. 365-366.

Dopo l'assemblaggio, la superficie esterna delle anfore poteva essere uniformata con l'uso di panni, pelli, spugne o muschio inumiditi[39]. L'uso di questi strumenti, di cui non rimangono tracce dirette, è testimoniato dall'aspetto della superficie esterna di alcune anfore, che appare liscia e uniforme e, talvolta, rivestita da una sottilissima pellicola, simile a un ingobbio[40].

Non è escluso che nella fase della tornitura fossero in uso anche utensili in metallo, come spatole o raschietti, che avrebbero potuto essere utilizzati sia come ausilio alla modellazione, sia per asportare l'argilla in eccesso dal vaso in rotazione o per pulire il piatto del tornio da eventuali residui, al termine della lavorazione. Strumenti di questo genere costituiscono rinvenimenti piuttosto rari negli impianti per la produzione di anfore[41] mentre sono, invece, abbastanza frequenti in relazione alla produzione di altri tipi di prodotti ceramici[42].

Mi chiedo, poi, se non possa essere riferita a questa fase della lavorazione anche parte dei pesi da rete e da telaio che si rinvengono talvolta nell'ambito delle fornaci ceramiche[43]. Questi manufatti potrebbero, in particolare, essere stati appesi a tende o a teli utilizzati per schermare i prodotti dall'esposizione diretta al sole, o potrebbero essere stati usati per tenere in posizione le pezze di tessuto bagnate che, come avviene ancora oggi nell'ambito dei laboratori che adottano tecniche tradizionali, potevano essere usate per proteggere e per mantenere al giusto grado di umidità le riserve di argilla da tornire[44].

Le aree della tornitura dovevano, inoltre, essere allestite con elementi di arredo che, pur non essendo inquadrabili tra gli strumenti o tra le macchine, costituivano comunque ausili di cui difficilmente si sarebbe potuto fare a meno nel corso della lavorazione. Penso, ad esempio, agli sgabelli o alle panche per i tornitori e ai tavoli per la preparazione e la eventuale bollatura delle anfore. Gran parte di questi arredi era sicuramente in legno e le loro tracce andrebbero cercate sia nelle usure differenziate dei piani di calpestio

39. Cuomo di Caprio 2007, p. 173. Per qualche esempio moderno, cfr. Crane 1988, p. 18 (Turchia); Gosselain 2010, p. 668, fig. 2, n. 6 (Niger).
40. Schreiber 1999, p. 16.
41. Per un caso cfr., ad esempio, Brentchaloff 1980, p. 106 e p. 113, tav. VII, n. 2 (spatola in bronzo dalle fornaci di Pauvadou).
42. Champion 1916, pp. 244-246 (da Compiègne); Mesplé 1957, p. 51, Pl, V, nn. 12 e 16 (da Lombez); Genty 1980 (da Aspiran); cfr. anche Schreiber 1999, p. 16; Luginbühl 2001, p. 335; Desbat 2004, pp. 150-151 (da Bavay e da Beuvraignes) e p. 152 (da Lyon). In alcuni casi, nell'ambito delle manifatture ceramiche, questi oggetti sembrano costituire un reimpiego (Démesticha and Kourkoumélis 1997, p. 556). In generale, cfr. Cuomo di Caprio 2007, p. 173.
43. Cfr., ad esempio, Firmati 2012b.
44. Per un esempio di questa pratica, cfr. Handler 1963, p. 316.

sia, forse, negli alloggi che, per il loro posizionamento, potrebbero essere stati ricavati nelle strutture adiacenti[45].

L'essiccazione dei manufatti. Dei locali adibiti all'essiccazione dei manufatti si ha un buon esempio nelle fornaci di Albinia, in Toscana[46]. Lo scavo di questi ambienti, purtroppo parziale, non ha portato alla luce resti degli strumenti usati in questa fase del ciclo produttivo. E' probabile, tuttavia, che si trattasse di strumenti poco specializzati che, ancora una volta, avrebbero potuto essere completamente o quasi completamente in legno. All'interno degli essiccatoi, le anfore erano forse disposte su più livelli sovrapposti, sorrette da strutture di carpenteria, stabili o provvisorie, che avrebbero potuto essere ancorate ai pilastri che sorreggevano la copertura. Queste strutture possono forse essere immaginate simili alle scaffalature ancora oggi osservabili negli essiccatoi di alcune officine ceramiche che lavorano con sistemi tradizionali (Fig. 10) ma, effettivamente, potevano anche essere costituite da semplici gabbie lignee, sufficienti a mantenere in posizione i vari gruppi di manufatti, evitando rivolgimenti e crolli che avrebbero potuto danneggiarli[47]; per il loro allestimento e per la loro manutenzione possiamo forse immaginare che l'impianto fosse dotato di una strumentazione base da carpenteria[48]. Per posizionare le anfore su queste strutture, si sarebbero potute usare scale, ponteggi o, eventualmente, anche veri e propri strumenti di sollevamento, come piccoli argani o semplici carrucole[49]. Questi strumenti, mobili o sospesi, che potevano essere fatti in materiale deperibile, potrebbero aver lasciato tracce labilissime e difficilmente distinguibili sui piani di calpestio degli essiccatoi.

45. E', ad esempio, ipoteticamente posto in relazione con la panca di un vasaio, la cui seduta poteva essere in legno, un alloggiamento rilevato nei pressi dei resti di un tornio nelle fornaci inglesi di Alice Holt (Swan 1984, p. 50).
46. Vitali 2005, pp. 270-275; Vitali 2007, pp. 33-34; cfr. Pallecchi 2008, p. 327.
47. A proposito delle soluzioni adottate nei laboratori moderni che lavorano con sistemi tradizionali, cfr., ad esempio, Tekkök-Biçken 2000, p. 96 (Turchia); Tekkök-Biçken 2004, p. 112, fig. 8 (Eceabat, Turchia); Hasaki 2005, p. 160 e p. 162, fig. 26 (Moknine, Tunisia); Hasaki 2011, p. 21, fig. 7 (Moknine, Tunisia).
48. A proposito della strumentazione dei carpentieri romani, cfr. Diosono 2009, pp. 222-227.
49. L'uso di scale e ponteggi era assolutamente comune in età romana come testimoniano le fonti iconografiche, ad esempio in relazione alle attività dei muratori e degli imbianchini (cfr., ad es., Adam 1984, pp. 84-90, con ulteriore bibliografia). Un argano è, invece, raffigurato in un affresco della villa di S. Marco a Stabia: a proposito dell'interpretazione delle pratiche e degli strumenti rappresentati in questo affresco e, più in generale, dell'utilizzo di macchine e congegni per il sollevamento in età romana, cfr. Pisani Sartorio 2009, pp. 90-94.

Fig. 10. Disposizione delle anfore su piani e mensole all'interno dell'essiccatoio di un laboratorio ceramico a Moknine, Tunisia (da Hasaki 2005, p. 162, fig. 26).

Non è escluso che, anche durante la fase dell'essiccamento, si facesse uso dei supporti in ceramica di cui si è parlato a proposito delle fasi di modellazione dei prodotti. Particolarmente adatti all'utilizzo durante le fasi di essiccamento potrebbero essere, ad esempio, quei supporti che presentano un foro sulla parete, che potrebbe essere funzionale alla circolazione dell'aria e, quindi, all'essiccamento della parte dell'anfora alloggiata al loro interno[50].

La cottura. Le fornaci in cui avveniva la cottura dei manufatti sono tra le realtà più studiate e più note nell'ambito degli stabilimenti per la produzione di anfore. Anche in questo caso, però, non si può dire altrettanto dello strumentario utilizzato per il loro allestimento e per la loro gestione.

All'interno degli impianti, la distanza tra i locali in cui le anfore venivano essiccate e l'area dei forni in cui venivano cotte era probabilmente coperta con l'utilizzo di carri o carretti, forse a trazione animale, come lascia immaginare l'ampiezza dei varchi che si aprono verso le corti di carico[51].

Gran parte delle fornaci, negli impianti di cui stiamo trattando, era caratterizzata dall'uso di volte di copertura provvisorie, costruite con un impasto

50. Per questo genere di supporti confronta, in generale, Cuomo di Caprio 2007, pp. 528-529.
51. Manacorda 2012d, p. 72 (Giancola); Vitali 2007, pp. 36-37 (Albinia).

di argilla e frammenti di ceramica. Non è chiaro se queste strutture, che al termine di ogni ciclo produttivo venivano smantellate per poter prelevare le anfore cotte, venissero allestite direttamente sopra al carico, come accade ancora oggi nell'ambito di alcune produzioni artigianali di tipo tradizionale[52] o se fossero, invece, sorrette da una qualche forma di centina leggera, che proteggeva il carico fino al momento in cui il calore della fornace le consolidava. In ogni caso, per l'allestimento delle volte di copertura saranno servite scale o ponteggi oltre, forse, ad una strumentazione base da muratore costituita, per lo meno, da qualche contenitore per il trasporto dell'impasto e da qualche spatola, anche in legno, per la sua posa in opera. All'interno delle fornaci, le anfore dovevano essere disposte su più livelli sovrapposti e questa, forse, è una delle ragioni principali che motivano l'utilizzo delle volte provvisorie. L'assenza di una copertura stabile, infatti, avrebbe potuto permettere, durante le operazioni di carico e scarico della fornace, l'utilizzo di ponteggi, argani e altri sistemi di sollevamento. Ancora una volta, si può supporre che, a causa del materiale con cui erano costruiti e della loro mobilità, questi strumenti abbiano lasciato tracce difficilmente distinguibili e interpretabili. Credo, tuttavia, che sarebbe buona norma analizzare nel dettaglio le usure eventualmente conservate sui lati lunghi delle fornaci, al livello dell'imposta delle volte provvisorie, valutarne estensione e posizione e valorizzare l'eventuale presenza di pietre, pilastri o altri apprestamenti, che avrebbero potuto essere utilizzati come basi per l'allestimento dei ponteggi o per il posizionamento degli argani e delle scale. Se, infatti, è vero che strumenti di questo genere, in sé, possono essere considerati leggeri e si può immaginare che abbiano un impatto relativo sulle strutture e sui piani di calpestio, la questione si complica se valutiamo che, durante le fasi di utilizzo, al loro peso doveva sommarsi sia quello delle maestranze impegnate nella disposizione o nello smontaggio del carico, sia quello delle anfore.

All'interno delle fornaci, per migliorare la stabilità del carico venivano usati dei distanziatori, di solito costituiti da piccoli grumi di argilla cruda, che si cuocevano insieme ai manufatti. Uno di questi oggetti è stato identificato presso le fornaci di Giancola: era stato posizionato a contatto con la parte superiore di un'ansa e conservava, in negativo, l'impronta di un bollo[53] (Fig. 11). Non è escluso che, in alcuni casi, potessero essere usati come

52. Per alcuni esempi di coperture provvisorie delle camere di cottura, direttamente allestite sopra al carico, nell'ambito di impianti moderni che adottano tecniche tradizionali cfr., tra gli altri, Handler 1963, pp. 327-328 e Pl. 3 (Barbados); Annis 1985, p. 250, Pl. 5 (Italia).
53. Pallecchi 2012a, pp. 287-288, fig. 3.59. Distanziatori del genere, utilizzati a crudo, sono attestati anche nell'ambito degli impianti che producevano manufatti ceramici di altro genere come, ad esempio, negli impianti per la produzione di terra sigillata di Martres-de-Veyre, in Francia, attivi fino al II secolo d.C. (Terrisse 1968, p. 129, fig. 45.4 e p. 131),

distanziatori anche quei cilindri di ceramica che abbiamo identificato come supporti e che abbiamo immaginato in uso sia nelle fasi di assemblaggio dei manufatti, sia in quelle di essiccamento[54].

Fig. 11. Distanziatore in argilla dalle fornaci di Giancola, Brindisi. Sulla superficie si riconosce l'impronta negativa di un'ansa bollata.

L'ambiente in cui si aprivano i prefurni delle fornaci poteva essere attrezzato con un grande contenitore d'acqua, di solito un dolio, che era forse utilizzato sia per il refrigerio delle maestranze e per restituire all'aria un grado di umidità che la mantenesse respirabile, sia per questioni di sicurezza. In relazione con la movimentazione dell'acqua, e quindi con la sicurezza dell'area dei prefurni e con la gestione del fuoco o, forse, con la pulizia dei prefurni e

nelle officine di *Ateius* ad Arezzo che, in età augustea, producevano terra sigillata (notizia in Cuomo di Caprio 2007, p. 370) e negli impianti di Scoppieto, attivi, tra il I e l'inizio del II secolo d.C., nella produzione di terra sigillata (Bergamini 2006, p. 294, fig. 24). A proposito di distanziatori a crudo di forma differente, probabilmente usati nei carichi di materiali da costruzione, cfr. invece Petracca and Vigna 1985, pp. 135-136 e fig. 104.

54. In questo senso cfr. Chenet and Gaudron 1955, p. 90, fig. 42, nn. 17-21 e p. 91, fig. 43 (nell'ambito delle fornaci di Lavoye, in Francia); Lutz 1959, pp. 143, 155-157 (nell'ambito delle officine di Mittelbronn, in Francia); Vernhet 1981, p. 36 (nell'ambito delle officine della Graufesenque, in Francia); Papadopoulos 1992, pp. 214-215, fig. 7 (dall'agorà di Atene); Aprosio 2003, pp. 269-270 (a proposito delle fornaci di Chiusi, in provincia di Siena); González Muro 2006, pp. 46-47 (a proposito delle fornaci di Alcamo). L'uso di questi oggetti come distanziatori è testimoniato anche in età più antiche (cfr. ad es., il caso dei distanziatori di Metaponto, provenienti da contesti di VI-IV secolo a.C., in Cracolici 2003, pp. 53-54 e fig. 14). A proposito dei distanziatori di questo genere confronta, in generale, anche Cuomo di Caprio 2007, pp. 528-530.

delle camere di combustione al termine del ciclo di cottura, può forse essere interpretato un oggetto in ferro, costituito da una barra della lunghezza di 23 centimetri terminante, ad entrambe le estremità, con due anelli (Fig. 12). Questo oggetto, rinvenuto all'interno del prefurnio di una delle fornaci del complesso di Pauvadou (Francia), attivo tra la seconda metà del I secolo d.C. e la prima metà del secolo successivo, può forse essere interpretato come maniglia di un contenitore, magari in legno, o come barra di aggancio per una coppia di secchi[55].

Fig. 12. Barra in metallo rinvenuta all'interno del prefurnio di una delle fornaci del complesso di Pauvadou, Francia (da Brentchaloff 1980, p. 92, fig. 16).

Per la gestione del fuoco, i fornaciai facevano uso di alcuni strumenti, simili a lunghe pertiche, che si distinguono con chiarezza nelle fonti iconografiche. Non è chiaro se si trattasse di strumenti in metallo o in legno e nessuna loro traccia diretta è stata riconosciuta nello scavo degli impianti di cui stiamo parlando. Nell'ambito degli stabilimenti moderni che operano con sistemi tradizionali, l'uso di lunghe pertiche in legno per la gestione del fuoco, soprattutto nelle fasi terminali della cottura è, comunque, piuttosto ben attestato[56].

55. Brentchaloff 1980, p. 92, fig. 16 e p. 106. Nella pubblicazione del contesto di Pauvadou, questo oggetto è stato messo in relazione con un sistema di chiusura dell'imboccatura del prefurnio pensando, evidentemente, ad una specie di porta in legno. Anche se non si dispone di elementi per confutare questa interpretazione, si sottolinea che l'utilizzo del legno per la chiusura dell'imboccatura dei prefurni avrebbe potuto comportare ovvi problemi di sicurezza e che, invece, esistono concrete tracce archeologiche ed etnoarcheologiche dell'utilizzo, a questo scopo, di materiali non infiammabili, come l'argilla e la pietra. Per un caso del genere in contesto archeologico cfr. Firmati 1999, p. 16; Firmati 2012c, pp. 81-82, che cita anche un caso moderno, documentato nell'ambito di un laboratorio nell'area di Calatafimi.
56. Cfr., ad esempio, Cuomo di Caprio 1984; Hasaki 2012, p. 261, fig. 13.2 e 13.3 (Grecia, VI sec. a.C.). Strumenti simili sono attestati anche nell'ambito delle produzioni ceramiche moderne che operano con sistemi tradizionali (cfr., ad esempio, Crane 1988, pp. 19-20 (Turchia)).

Al termine della cottura, dopo il raffreddamento della fornace, la volta provvisoria delle camere di cottura veniva frantumata e progressivamente smontata, forse con l'utilizzo dei medesimi strumenti utilizzati nelle operazioni di cava o, eventualmente, anche con semplici pietre, usate come percussori[57]. In seguito alla demolizione della volta o forse, almeno in parte, contestualmente ad essa si procedeva anche allo smontaggio del carico, operazione che possiamo immaginare avvenisse con l'uso degli stessi sistemi e strumenti con cui le anfore erano state posizionate all'interno della camera di cottura. Le anfore erano poi, verosimilmente, caricate sugli stessi carri sui quali, prima della cottura, erano state trasportate alle corti di carico e venivano quindi avviate ai magazzini di stoccaggio.

Prima dell'inizio del nuovo ciclo produttivo, sia l'area delle camere di combustione sia quella delle camere di cottura dovevano essere pulite, liberate dalla cenere, dai residui di cottura, dai resti della demolizione della volta provvisoria e dalle anfore mal cotte. Tutti questi materiali saranno probabilmente stati raccolti con l'utilizzo di pale, palette, scope, gerle e secchi e, caricati su carri, carretti o carriole a trazione umana o animale, saranno stati avviati alle discariche o alle aree in cui potevano essere riutilizzati. Contestualmente o, magari, in sequenza con le operazioni di pulizia si procedeva forse al controllo e all'eventuale ripristino delle strutture della camera di combustione e della camera di cottura che, per effetto del fuoco e del calore, potevano aver subito danneggiamenti. Queste operazioni potevano essere condotte con l'utilizzo dei medesimi strumenti che erano impiegati nella costruzione della volta provvisoria delle fornaci e marcavano, al tempo stesso, la fine di un ciclo di produzione e l'inizio del ciclo seguente.

Molto altro si potrebbe ipotizzare, immaginare e ricercare sul tema; questo lavoro, tuttavia, raggiungerà il suo scopo se riuscirà a porre l'attenzione sulla complessità dello strumentario necessario al funzionamento di queste realtà produttive e sulla enorme potenzialità informativa che potrebbe ancora celarsi dietro agli indizi – forse poco evidenti e non immediatamente interpretabili – della presenza e dell'uso di attrezzi, arredi, macchine e altri apprestamenti funzionali che, sottoposti ad analisi mirate, potrebbero dischiudere nuove linee di ricerca, contribuendo a una definizione più viva e completa dell'intero segmento produttivo.

57. La pratica è stata osservata nell'ambito di alcuni laboratori moderni che lavorano con tecniche tradizionali (cfr., ad esempio, Handler 1963, p. 324, Pl. 4, figg. a, b).

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EXPERIMENTS WITH DIACHRONIC DATA DISTRIBUTION METHODS APPLIED TO EASTERN SIGILLATA A IN THE EASTERN MEDITERRANEAN

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Introduction

The use of quantification in the study of ancient pottery helps to reveal patterns in the archaeological data and serves to answer a variety of questions about the data.[1] The ability to present the classification of material in a readable graph provides a quick insight in the nature of the data. In order to see what the data represents over time, one can resolve to sequence the material from closed contexts, but when dealing with ceramics the majority of material derived from open contexts of secondary deposition and for this material a diachronic data distribution method is useful. To this end, a method was proposed in the 1980's by Elizabeth Fentress and Philip Perkins for African Red Slip Ware, which was applied in other Roman pottery studies.[2] This method distributes the data in a linear way over time-intervals, resulting in a curve or bar chart, representing the diachronic distribution a given data set.[3] The peaks and valleys in the curve indicate a higher and lower distribu-

1. Sinopoli 1991, p. 171; Rice 1987, pp. 288-289; Orton *et al.* 2007[1993], pp. 166-167.
2. Fentress and Perkins 1988, pp. 207-208; Fentress *et al.* 2004; Lund 2005, p. 239; Bes and Poblome 2008, pp. 506-507.
3. E.g. Fentress and Perkins 1988, Fig. 2; Lund 2005, Fig. 10.3.

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tion of the studied material category in the corresponding periods and these fluctuations are often linked to changes in the scale of production, changes in connectivity of the production centres with the export markets, etc.

The problem with diachronic data distribution is that they rely on assumptions on the probability of dating of types. The linear method assumes an equal probability over the dating-range of a type, whereas other probabilities are just as likely and were suggested early on by Clive Orton in 1980. These other probabilities have not been used in diachronic data-distribution methods, except for the linear one. Therefore in this paper, the linear distribution method will be applied to the Eastern Sigillata A (ESA) as recorded in the database of the ICRATES project (=Inventory of Crafts and Trade in the Roman East).[4] Additionally, two other probabilistic distribution methods are tested and evaluated, namely a Gaussian and gamma based method. The latter differ from the linear method in that they model a growth and decline in the deposition per type over time. The introduction of two new methods demonstrates the variations and discrepancies resultant from different underlying assumptions and a combination of multiple methods can be used as a control for interpretation. Furthermore the usage of multiple assumptions on the introduction and distribution of types can, when used with caution, allow for greater diachronic detail to be derived from the data.

The data

Since 2004 the ICRATES project has been building a detailed database of published tableware from the Roman East (roughly Libya, Egypt, Israel, Palestine, Jordan, Syria, Turkey, Cyprus, Greece and Macedonia) datable to period from the second half of the second century BC and the seventh century AD. At present, 30,000+ records of individual sherds are available in the database derived from 357 publications with the aim of approaching ancient patterns of artisanal production and exchange in the Roman East.[5] From the start, the project also strived towards calibrating published data with original fieldwork results and has (gratefully) received data from projects such as at Sagalassos (Turkey), Boeotia (Greece) and Amata (Jordan) to add and use in the database. Currently this database is made available in an on-line environment.

In this paper the focus lies on the Eastern Sigillata A (ESA), which is well attested in archaeological records of the eastern Mediterranean in the

4. Bes and Poblome 2006; Willet 2012.
5. Bes and Poblome 2008.

Hellenistic and Imperial periods and was widely distributed from the second half of the second century BC onwards.[6] The circulation of the ware begins somewhere before the middle of the second century BC, albeit in a black gloss phase at first.[7] The distribution of ESA seems to have continued until the end of the second century AD or the beginning of the third, although recent work at Beirut reveals a presence of the ware as late as the mid third century AD.[8]

Although the kilns and workshops for the production of ESA have not been found, the area of production has been narrowed down to the coastal area between Latakia in Syria and Tarsus in Turkey. This was based on the presence of rare shapes, stamps and a greater variety of earlier shapes at Hama, Antioch and Tel Anafa in the south, suggesting a closer proximity to the source.[9] Analyses of the clay fabrics of ESA originally suggested a source on Cyprus, although this source was rejected by Kathleen Slane, suggesting a north Phoenician or Syrian source, and Gerwulf Schneider, who suggested a source between Latakia and Tarsos.[10] The compatibility of the results of the two separate studies, further strengthens the suggested provenances.

Narrower demarcation of the source of ESA has been attempted by the identification of *rhosica vasa* as ESA, a term mentioned by Cicero (6.1.13) and later by Athenaeus (*Deipnosophistae* VI.229c).[11] The town of Rhosos has been inferred as possibly one of the sources for ESA from this textual evidence, although the association of *rhosica vasa* with ESA was disputed recently.[12] Further archaeological work in this region will undoubtedly shed more light on the location and nature of the centres of production for ESA.

In the ICRATES-database, ESA-data are standardized conform the typology presented by John Hayes in "Enciclopedia dell'Arte Antica" (EAA).[13] The number of ESA sherds used this paper is 7,649 pieces derived from 223 sites, which is the amount of ESA represented in the database by the beginning of 2012. This data will be used as to experiment with different diachronic distribution methods and will also provide an overview of ESA in the Roman

6. Lund 2005, p. 240.
7. Slane *et al*. 1994, p. 62; Slane 1997, pp. 275-282; Lund *et al*. 2006, pp. 491-492, Hayes 2008, p. 19.
8. Hayes 1985, p. 13; 2008, p. 30; Reynolds 2010, p. 90.
9. Lund 2005, p. 237; Slane 1997.
10. Gunneweg *et al*. 1983, pp. 11-14; Slane *et al*. 1994, pp. 63-64; Schneider 1995, p. 416.
11. Malfitana *et al*. 2005, pp. 199-212; Lund *et al*. 2006, pp. 491-507; Lund *et al*. 2008, pp. 217-219; Høgel 2008, pp. 221-223.
12. Romeri 2008, pp. 225-230; Greene 2007; 2008, pp. 231-233.
13. Hayes 1985, pp. 9-48 and Tavola I-XI.

East, which is augmented by specifically using the material from Antioch, Athens and Berenice case studies, since they are located in different parts of the eastern Mediterranean with distinct histories and connections with the production area of ESA, thereby providing a differentiated perspective on the local influence of ESA in comparison to the entire Roman East.

Diachronic data distribution using three methods

The methodology consists of the application of descriptive statistical techniques on the ESA data. The objective of these techniques is to quantify the data and to describe the distribution of ESA over time. First, the data need to be quantified using a frequency table per type/variant present in the data, i.e. how many are present of each type. From this the next step is to reveal the chronological component of the data, i.e. when was ESA produced, distributed and ultimately deposited.

As stated before, ideally, material derived from closed contexts of primary deposition is used to diachronically describe the deposition of a ware (they provide the most closely datable contexts) but in practice such contexts are rare and the ESA used here is primarily derived from open contexts of secondary deposition, even palimpsest surface survey contexts. To model the diachronic distribution of ESA in the East, John Hayes' typo-chronological dates are used for the methods below. This is not without its problems, as it was pointed out by Kathleen Slane in a review of Philip Kenrick's publication on the finewares of Berenice that the dating of the eastern sigillatas found at this site (based on the EAA) was early in comparison to the western sigillatas.[14] As recently pointed out by John Lund, the dates for types may be dependent on the distance of the artefacts found in respect to their provenance.[15] Although this study provides in no way a method of making this chronology more accurate, it rather provides an analytical tool based on an accepted typo-chronological framework, by presenting and comparing three diachronic data distribution methods, which model the distribution of ESA over time.

Typological dating always needs to be used with caution, since the criteria for dating are indirect (such is the case especially for survey-material).[16] For Roman ceramics, Typological dates are rarely given in single years or even

14. Slane 1992, p. 192; Kenrick 1985.
15. Lund 2009, pp. 65-72.
16. Cf. Orton 1980, p. 98.

decades, but rather in periods of likely dating, such as the reign of an emperor ('Augustan') or a part of a century ('early to middle first century AD').

For the exercises presented here, it is necessary to have a numerical chronology. To make a conversion from verbal dates, which are often ambiguous, towards numerical dates, it is necessary to make interpretations, for example, a type dating mid second century AD, is dating to a wider period encapsulating the year 150 AD. In this paper the period is set at 50 years or a quarter of a century on each side of the middle of the century, which results (for 'mid second century AD) in a numerical date of 126 - 175 AD. In cases where it is stated that a type (e.g. ESA Hayes Form 18) occurs from the late second century BC until beginning of the first century BC, a numerical chronology of 125 - 76 BC is used. Undoubtedly this is a wider period than may have been intended, but the benefit of taking a wide period is that the intended dating is certainly encapsulated.

Although variation is possible in interpretation of what is numerically meant by for example 'Augustan date', using it is impossible to hold that a vessel classified as an 'Augustan' type is not made in 20 AD (after the reign of Augustus), unless the workshops are well studied and its history closely dated, which is not the case for ESA. However, the likelihood of the same vessel dating to the second century AD would not be seriously considered, without substantial revisioning of the typo-chronology based on (new) evidence. This reveals a grey area where a numerical conversion from the statement 'Augustan' becomes less and less likely.

The issue of probability and chronology is far from new and is already elaborated upon by Clive Orton in 1980 (although it can be traced further back), where he describes the use of three probability curves to describe the dating of archaeological contexts.[17] His first curve for a conventionally expressed date, regards a dating as a uniform continuous probability, meaning the probability is spread equally over the suggested dating-range. His second proposed curve models essentially a bell-curve, with a most likely date in the middle of the dating-range. A third probability curve models a *terminus post quem* dating, which places the highest probability early in the chronological date-range. The principle of a uniform continuous probability curve has been used to diachronically describe the distribution of ceramics in various studies (see above). But to the author's knowledge, the other probability principles have never been implemented in order to describe the chrono-

17. Orton 1980, pp. 99-100.

logical distribution of ceramics. As a methodological experiment, all three probability principles are used on the data of ESA, although Orton's *terminus post quem*-model is altered. (see Fig. 1 for an example of the different probability curves for a hypothetical type dating 150 BC to 100 AD). Instead of an absolute beginning date, the weight of the distribution is skewed towards the beginning date. This to simulate the rapid introduction of a new type and a slower decline as the novelty factor wears off and the end of use-life is reached.

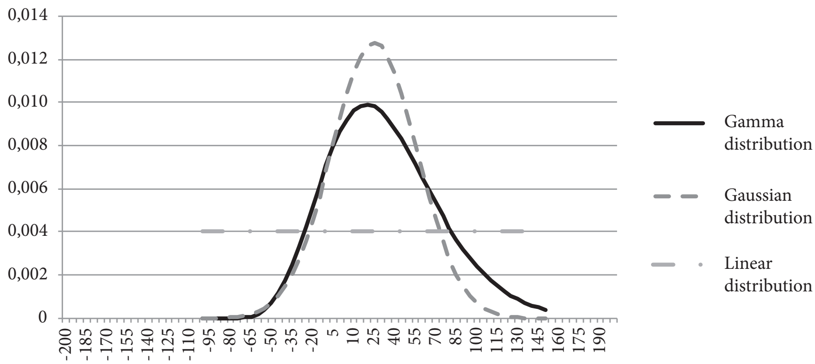

Fig. 1. Examples of the probability curve used for the distribution methods for a hypothetical type dating 100 BC to AD 150. The Gaussian distribution focuses the weight of the probability in the middle of the dating-range, resulting in a bell-curve; the gamma distribution skews the weight of the probability slightly to the beginning date; the linear distribution considers the probability equal over the dating-range, resulting in a straight horizontal line. Note that for clarity of the graph, intervals of one year are used, which are not further applied. This lowers the value for (especially) the linear curve, which would increase when larger intervals are used.

Linear distribution method

The first method is based on a uniform continuous probability and is in this paper referred to as a linear method. This method regards the probability of a vessel as equally spread over the range of dating. In other words: the probability for an individual vessel of an 'Augustan' type (27 BC – AD 14) dating to 20 BC is the same as the probability for AD 1 or AD 12, namely 1/41. If two vessels of the same type are considered, the chances would be twice as high, namely 2/41. If larger intervals are used of 25 years, than the probability of a single vessel of this type dating to the period 25 BC – 1 BC is 25/41. Although smaller and larger intervals are possible, 25 year intervals are used in this paper, since they are practical to calculate with and a smaller division, although possible and statistically sound, would suggest a level of accuracy of the chronology of pottery, which is simply not available.[18] The choice for a level of accuracy of a quarter of a century is defensible for ESA, considering the used typo-chronological framework.[19] To establish the distribution of a ware, such as ESA, one has to a make an addition of all the calculations per type and per chosen time-interval. (Table 1) This entails per time-interval making the calculation, multiplied by the frequency of the occurrence of the type. E.g. if ESA Hayes Form 12 (dated c. 40 BC – 10 AD or a running time of 50 years) is occurring 123 times, than the calculating for interval 50-26 BC is 15/50 * 123 = 36.9 (see Table 1 for more examples). This calculation needs to be done for all time intervals and all types, which results in a table with all the values of probability according to per time interval and per type according to their frequency. (This step in the process is similar in the other two methods, although, as we shall see, the basis for the primary calculation is different.)

Table 1. Examples of calculations for the linear distribution of ESA.

Ware	Type	Date range	Frequency	50 - 26	25– 0 BC	AD 1 - 25	26-50
ESA	EAA12	40 BC – AD 10	123	15/50 * 123	25/50 * 123	10/50 * 123	
ESA	EAA13A	50 BC – AD 25	10	1/3 * 10	1/3 * 10	1/3 * 10	
ESA	EAA107	AD 1 – 25	1			1/1 * 1	
ESA	EAA29	30 BC – AD 25	68	5/55 * 68	25/55 * 68	25/55 * 68	
ESA	EAA32	AD 1 - 30	10			25/30 * 10	5/30 * 10
ESA	EAA 104A	50 BC – AD 50	2	1/4 * 2	1/4 * 2	1/4 * 2	1/4 * 2
ESA	EAA 28	10 BC – AD 30	111		10/40 * 111	25/40 * 111	5/40 * 111
..	..	..	..	..	..	..	..
etc.							
Total			325	46.91515152	123.9924242	138.0507576	16.04167

The addition of all these values per time-interval (e.g. for Table 1 the addition for interval 50-26 BC for all the types, according to frequency is c. 46.9) can be regarded as an indicator of probability for all types combined, which translates to a curve of probability for the occurrence of the ware as a whole. Records of ESA in the database, which do not have a typological identification and cannot be more closely dated than between the earliest and latest

18. Although Allard Mees used a 5 year interval for the chronological distribution of stamped (closely datable) Terra Sigillata from southern Gaul; Mees 2011, pp. 200-202. The Gaussian and gamma methods (see below) would be skewed by smaller larger intervals and for these a 5 year interval is used.
19. E.g. Form 3, dated late second century BC until circa the latest decennium of the first century AD; Hayes 1985, p. 15.

date of the ware, are not taken into account for any of the chronological distribution methods. (n=4,680 closely datable on basis of typology out of the total of 7,649 or 61 %. See Fig. 2; note for comparison a second curve using 5 year intervals, but following the same method and data is plotted)

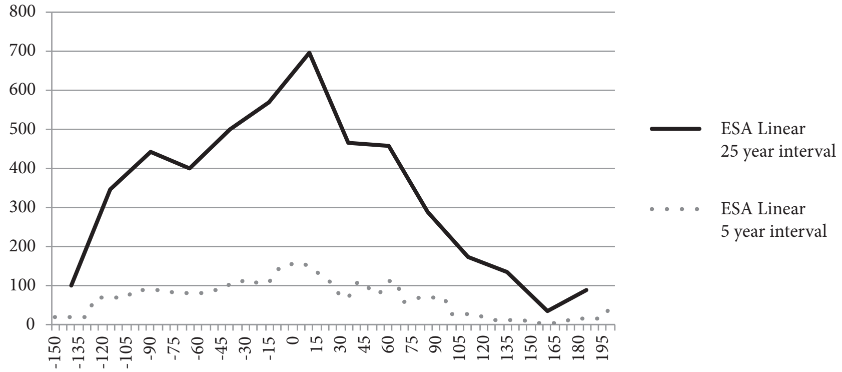

Fig. 2. The cumulative curves for ESA using the linear distribution method using 25 year intervals (dark grey) and 5 year intervals (dotted light grey) for comparison. n=4,680 for each curve.

Gaussian distribution method

As stated above, the use of a bell-curve for probability of dating is discussed by Orton as well and this unevenness in probability is reflected in the archaeological data, i.e. periods can be identified when the types are relatively common or rare.[20] Variation in the distribution of a type over time is likely, something already noted by Fentress and Perkins, where they suggested shifting the weight of the distribution to the mid-point of production.[21]

The Gaussian method is, like the linear method, a modern extrapolation to model pottery diachronic distribution. Still in various branches of statistics, natural science and social science, the Gaussian distribution is widely used as a describing model of probability.[22] The continuous probability of the linear method, on the other hand, is much less widely adopted. The Gaussian method projects a Gaussian or bell curve of the probability between the earliest and latest date of the type, multiplied with the frequency of the type.[23]

20. E.g. ESA Hayes Forms 5 and 6; Hayes 1985, p. 17.
21. Fentress and Perkins 1988, p. 207 footnote 12.
22. Orton 1980, pp. 90-91; Fletcher and Lock 1994, pp. 51-73; Drennan 2009, pp. 107-132.
23. This results in lower values for the Gaussian curve, since each value is the probability at a point (say the year AD 25), which is lower than the accumulated probability over an

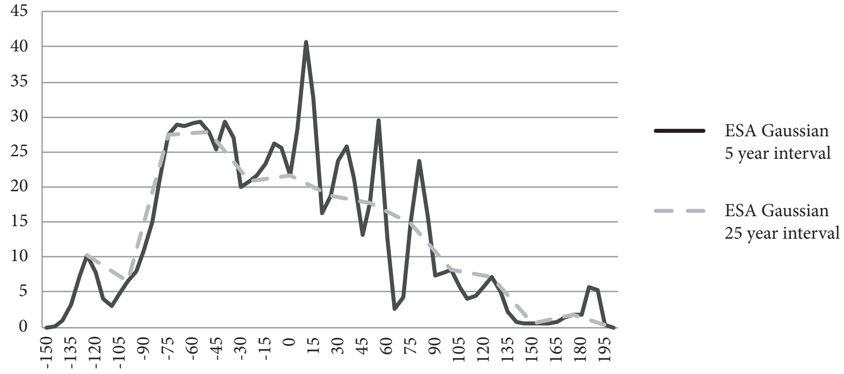

Fig. 3. Comparison of cumulative curves for ESA, using the Gaussian distribution method on a 5 year (dark grey) and 25 year interval (dashed light grey). n=4,680 for each curve.

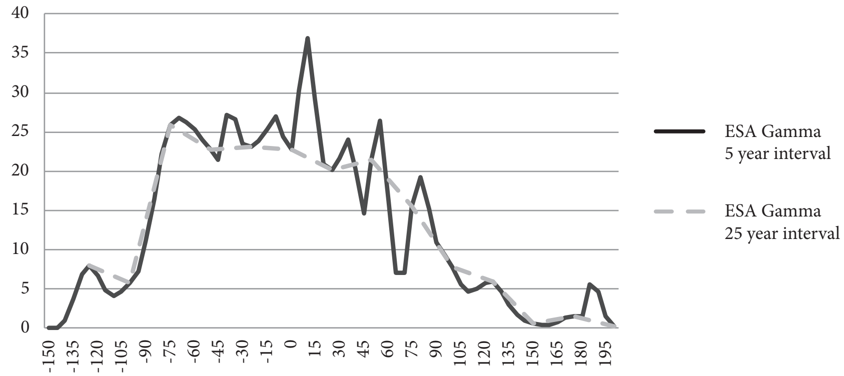

Fig. 4. Comparison of cumulative curves for ESA, using the gamma distribution method on a 5 year (dark grey) and 25 year interval (dashed light grey). n=4,680 for each curve.

In the case for the Gaussian and gamma methods, 5 year intervals are used and the overall developments are similar in comparison to a 25 year interval (compare the two curves in Fig. 3 and 4), since the Gaussian and gamma methods project a probability curve dependent on beginning and ending date of a type, the values remain the same on, say 25 AD, independent of the intervals. The linear method calculates probability on the basis of the span of the interval, thereby lowering probability if the value as the interval becomes smaller. Using larger intervals with the Gaussian method, narrower dated

interval of time (say AD 1-25) as used by the linear method.

types would not appear in the curve, for the peak of its bell-curve would lie within the interval, thereby only adding nothing to the accumulative values at the points of the interval.

The Gaussian distribution (as applied in MS Excel 2007/10) uses the following formula:

$$f(x,\mu,\sigma)=\frac{1}{\sqrt{2\pi\sigma}}e^{-\left(\frac{(x-\mu)^2}{2\sigma^2}\right)}$$

The function NORMDIST is used to distribute the data in a Gaussian curve over time. The value for x (representing the year for which the value is calculated), is determined by subtracting the earliest date of the type from the designated date.[24] The next step is to establish the mean or μ, which is done by subtracting the latest date from the earliest date divided by two. (Mean = (ending date – beginning date) / 2 = μ).[25]

As a third factor the standard deviation or σ must be set. Although in a normal distribution practically all values should be located within three times the standard deviation from the mean, some experimenting indicated that the probability curve would extend beyond the typological dates, especially for the types with a high frequency.[26] The solution is applying the formula only to the period to which a type is dated and to use a more concentrated bell-curve by dividing the dating-range of a type into eight as a standard deviation.[27]

This choice prevents types with high frequencies being distributed outside any reasonable dating range, but focuses the weight of the distribution more to the centre (Fig. 5). However, it does simulate a period of 'popularity' better especially for types with a longer period of distribution. In similar fashion to the linear method, when the distributions are made for all types, the addition per chosen interval will result in a curve, which represents the diachronic distribution of ESA, indirectly indicating production as well as use-life and the systematic context, albeit based on a different method (Fig. 3; see also

24. E.g. for hypothetical type dated 50 BC - 100 AD, the calculation for 40 BC is x= -40 - -50 = 10, while for the year AD 40 it would be x= 40 - -50 = 90. The non-existent year 0 was added to the time-line, since it proved difficult to alter the formula to cope with this mathematical inconsistency.
25. E.g. for a type dated 50 BC - 100 AD: (100 - -50) / 2 = 75.
26. Fletcher and Lock 1994, p. 59.
27. E.g. for a type dated 50 BC - 100 AD: (100 - -50) / 8 = 18,75; This means that the deviation fits eight times in the period from 50 BC to AD 100.

Table 1 and above for the process of adjusting calculation according to frequency of occurrence per type and the addition of values per time-interval).

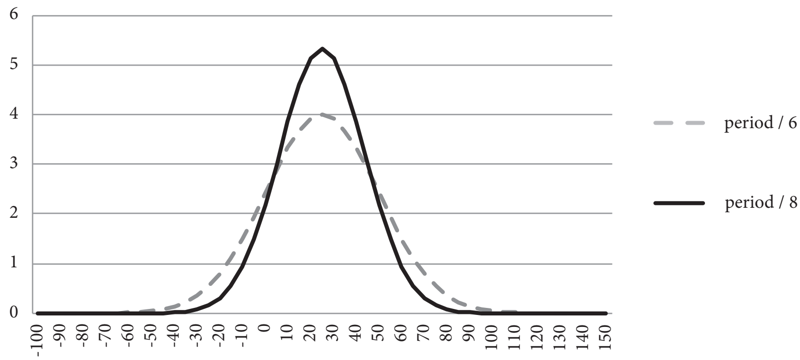

FIG. 5. A comparison of a plot of hypothetical type X (n=250) between standard deviation = period of distribution / 6 (dashed light grey) and standard deviation = period of distribution/ 8 (dark grey).

Gamma distribution method

The third probability curve discussed by Orton describes the probability in dating for a context with a clear *terminus ante quem*, such as a coin find, with highest probability at the beginning date. Since typological dating is mostly less precise than numismatic evidence, a different curve is proposed here, which does, however, skew the weight of the probability earlier in the dating-range. To accomplish this, a gamma distribution curve is implemented on ESA data. This is distribution uses the following formula (in EXCEL 2007/10):

$$f(x;\alpha,\beta) = \frac{1}{\beta^{\alpha}\Gamma} x^{a-1} e^{-\frac{x}{\beta}}$$

The function GAMMADIST is used to distribute the data in a gamma curve over time. This needs a value for α and β. α determines the shape of curve, while β determines the length over which the curve is stretched. For this experiment, these have been set at α=2, after testing multiple values, which either resulting into concentrating the probability early to an unlikely degree or spread the probability severely beyond the dating-range. The value for β has been made proportional to the dating-range, using the following formula:

(upper date – lower date)/18.8

The factor of ca. 18.8 has been obtained through experimenting, which resulted in an equal spread of the curve over the various dating-ranges. The resulting curve grows steeply early on in the dating-range and reaching the highest point before the mean of the range, after decline sets in which continues until the ending date. (Fig. 1) For similar reasons as for the Gaussian method, 5 year intervals are used. As with the linear and Gaussian methods, an addition per chosen interval results in the total ESA curve. (Fig. 4; see also Table 1 and above))

Comparison - differences and similarities

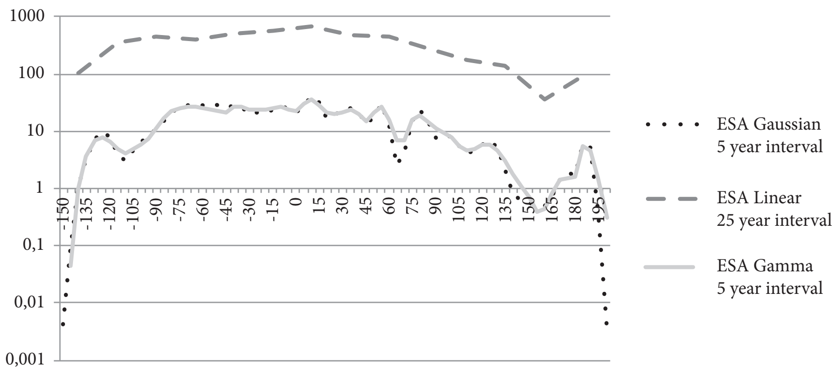

Fig. 6. Comparison of the cumulative curves for ESA on a logarithmic scale for the Y-axis, using the linear (25 year intervals, dashed grey), Gaussian (5 year intervals, dotted grey) and gamma (5 year intervals, light grey) distribution methods. n=4,680 for each curve.

The resultant curves show similarities, but clear differences as well, which is especially clear if the curves are plotted on a logarithmic scale. (Fig. 6) The Gaussian and gamma curves are broadly similar and the differences with the linear curve can in part be explained by the higher resolution (time-intervals of 5 instead of 25 years). However, if the same resolution is applied to the linear distribution method, there are still striking differences between the three graphs. The linear graph shows steep rises and descents, whereas the Gaussian and gamma curves reflect a more gradual course. The linear curve accumulates in a substantial peak at the beginning of our era in comparison to far less climactic peaks in the Gaussian and gamma curves. Rather, the peaks in the beginning of the first century AD in the latter curves seem anomalous in comparison to the rest of the curve: the growth in the Gaussian and gamma curves occurs in the first half of the first century BC and the curves remain fairly stable until the first half of the first century AD, after which a gradual decline sets in, while the peaks are all slightly earlier in the linear curve. This can be explained for the Gaussian method, which concentrates the counted types in the centre of the typological dating. The gamma method skews the probability more towards the beginning of the dating-range, but the curve is not high from the beginning. The 5-year interval linear curve seems more artificial looking than the Gaussian curve, with steep climbs and falls in the curve. (Fig. 7)

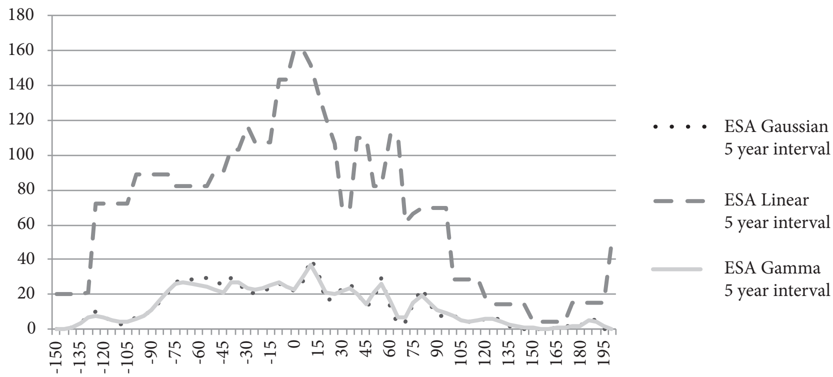

Fig. 7. Comparative plot for ESA distribution for all three distribution methods, using a higher resolution of 5 year time-intervals for the linear method. n=4,680 for each curve.

The three curves display general similarities such the highest peak of the distribution, which is located early in the early first century AD. The climb towards this peak starts in all graphs in the late second century BC, although the Gaussian and the gamma curves ascend later than the linear curve. The curves descent after the first quarter of the first century AD and stabilize around the middle of the second century AD. The differences are striking though, particularly between the linear curve on the one hand and the gamma and Gaussian curves on the other. The gamma and Gaussian curves are more gradual, basically levelling off from the middle of the first century BC until the middle of the second century BC, but they are beset with more fluctuations, which are not present or less pronounced in the linear method at 25 years. The Gaussian and gamma curves also show a minor peak in the period 135-105 BC, although the minor peak in the last quarter of the second century AD is visible in all curves. An interesting drop is present in the third quarter of the first century AD in the Gaussian and gamma curve, which is not pronounced in the linear curve.

Three curves from the same data – significance of the results

The preceding paragraphs are of a rather abstract nature and the archaeological significance of these resultant curves needs to be addressed. In other words do these differences and similarities matter archaeologically? First of all, the distribution of ESA throughout the eastern Mediterranean seems to have been on a much larger scale from the late second/early first century BC onwards, yet the distribution of the material seems to grow until the early first century AD, especially in the linear curve. (Fig. 2 & 6) This can be interpreted as an increasing demand for these red slipped vessels in the eastern Mediterranean, which reaches its peak during the Early Imperial period, after which the demand drops. Such a long period of growing demand could be explained by changing dining practices in which red slipped tableware was used, changes in economic growth/connectivity or by a growth in population during this period. This long period is one of political and societal transition and one is tempted to make a connection with increased Roman influence in the eastern Mediterranean and ESA.[28]

However, the weight of the Gaussian and gamma curves lies more strongly (and with more stability) in the first century BC. For these curves there is not a continuous rising trend towards the early first century AD for these curves (this is especially obvious if the 25 year interval is observed in Fig. 4 and 5) and the highest peaks of the early first century BC seem somewhat anomalous in comparison. An earlier popularity of ESA is of interest, since the earlier spread of this ware may have set a trend which was picked up by other producers of Sigillata products, particularly in Italy (Italian Terra Sigillata) and possibly slightly later in the region of Ephesos (Eastern Sigillata B). Andrew Wallace-Hadrill regards the transformation of the tablewares of Italy, from Campana Ware to Italian Terra Sigillata, during the second half of the first century BC as one of the most remarkable aspects of the Roman consumer revolution, which he attributed partly to imported ESA in Italy.[29] In an article on the impact of ESA in Italy, Daniele Malfitana, Jeroen Poblome and John Lund argued that the economic conditions created by the Roman influ-

28. Dunbabin 2003 for changing dining habits; Scheidel 2007, p. 341 & 2008, p. 64 records a moderate demographic growth for Italy during the second century BC to the Imperial period; Roth 2007, p. 194 suggests changes in black gloss pottery as the partial result of economic and demographic changes.
29. Wallace-Hadrill 2008, pp. 407-417.

ence in the East with a growing number of Italian merchants present from the last decades of the second/early first century BC onwards (as attested in epigraphic data at Delos), may have propelled the production output and consumption of ESA, an eastern product, rooted in Hellenistic traditions.[30] Such growth in the early first century BC for ESA is particularly clear in the Gaussian and gamma curves, whereas the linear curve shows earlier growth, which shows a slight drop around the middle of the first century BC.

The introduction of other wares in the eastern Mediterranean affected the distribution of ESA as well, which is also clear from the curves. The introduction of Eastern Sigillata B from the region of Ephesos or Tralleis during Augustan times, the introduction of Eastern Sigillata C which was produced in the region of Pergamon and Çandarlı and exported in numbers from Augustan times onwards, and the introduction of Italian Terra Sigillata from the 40s BC onwards, meant that new players were present on the tableware markets of the eastern Mediterranean.[31] The influence of Italian Terra Sigillata on other tablewares is exemplified by morphological similarities (although distinct shapes continue to play an important role) and the appearance of stamps on ESB and to a lesser extent ESA.[32] The dramatic decrease observed in linear curve during the early first century AD could be interpreted as the result of the introduction of these new products. The Gaussian curve also shows erratic behaviour during the first century AD. The gamma curve is also erratic, yet of less severity and in general shows a more gradual decline over the first and second centuries. This erratic nature can again in part be explained by innovation of types at the end of the first century BC/early first century AD, yet it is also a clear reflection of the success of some types over others. Realistically, some fluctuation is to be expected on a smaller scale: demands can fluctuate and access to the products could change as well as production itself.[33] The introduction of other wares in the eastern Mediterranean and potentially the innovation of types possibly influenced by these new wares is reflected in the most balanced way in the gamma curve. This demonstrates the usefulness of testing the three methods. In this instance, the author is of opinion that the gamma curve reflects the development of ESA in the Roman East the best, since it shows the most gradual development, while at the same time revealing fluctuations that are also present in the Gaussian curve.

30. Malfitana *et al.* 2005, pp. 202-203.
31. Japp 2009, p. 200; Poblome and Zelle 2002, pp. 275-277.
32. Zabehlicky-Scheffenegger 1995; Poblome *et al.* 2000.
33. Bang 2008; even in the highly integrated economies of present time, product sales are often erratic; see for another example Wilson 2009, pp. 237-243.

Practicalities

A practical benefit of the Gaussian and gamma methods to the linear method is the permutation itself. For the linear method, potentially different calculations for each time-interval must be made dependent on dating per type, whereas the Gaussian formula remains the same for all points. This reduces the amount of work for creating the curve significantly, which is especially helpful when wares are described in which many types/variations are present. For MS Excel, the functions for the Gaussian and gamma distributions at point AD 25 for a hypothetical type dating 50 BC to AD 100 are described in Table 2. This scheme can be taken over as is in Excel and expanded, adjusted etc. according to need. If calculations are executed on standardized spreadsheets, it becomes possible to add new data at any later stage, effectively automatically 'updating' the results.

Table 2. An example of the MS Excel functions used for the Gaussian and gamma distributions. Note that the upper functions refer to the cells and (for clarity) the lower functions include the figures derived from aforementioned cells.

	A	B	C	D	E	F	G	H
1	Type X dating 50 BC - AD 100							
2								
3		lower date	upper date	method	count	Year:	25	30
4		-50	100	Gamma distribution	3		=GAMMADIST(g$3-$B4;10;($C4-$B4)/18,8;FALSE) * $e4	
5		-50	100	Gaussian distribution	3		=NORMDIST(g$3-$B5;($C7-$B7)/2;($C5-$B5)/8;FALSE) * $e5	
6								
7		-50	100	Gamma distribution	3		=GAMMADIST(25--50;10;(75--50)/18,8;FALSE) * 3	
8		-50	100	Gaussian distribution	3		=NORMDIST(25--50;(75--50)/2;(75--50)/8;FALSE) * 3	

Eastern Sigillata A at Antioch, Athens and Berenice

The graphs described above depict the diachronic distribution of the ESA in the eastern Mediterranean recorded in the ICRATES database, according to three different methods. The majority of ESA is recorded in the Levant, Cilicia and Cyprus (6,097 records out of 7,649). The sites with the highest amount of ESA are Apamea, Epiphaneia, Antiocheia ad Orontem, Tel Anafa, Gindaros, Nessana and Petra, all located in the Levant, Paphos, located on Cyprus and Tarsos, located in Cilicia. (Table 3) The only outlier in this list is Athens, which is located farthest away from the production area of ESA. This geographical distribution reflects in part the status of research and publication in the Roman East, however, for an exploratory comparison, this does not oppose the objective of this study. Therefore the distribution graphs for Antioch, located in the north-western Levant, Athens, located in the Aegean, and Berenice, located in eastern Mahgreb, are compared to the totality of ESA in the East to see how these individual cities relate to the general pattern of distribution. Obviously, there is a numeric discrepancy in the number of ESA records between these sites (Antioch(422), Athens(217) and Berenice(84)) but for a diachronic comparison, this is less problematic.

TABLE 3. Ten sites with the highest number of records.

Site	**Count**
Apamea	1204
Epiphaneia	1032
Tarsos	545
Antiocheia ad Orontem	422
Tel Anafa	398
Gindaros	273
Paphos	248
Nessana	235
Athens	217
Petra	212

The ESA from the city of Antioch is derived from two older publications.[34] Of the total 422 records, 264 are typologically classified and closely datable (63 %). The 10 most common types at Antioch account for 136 records (32 %). The ESA from the city of Athens is derived from six publications.[35] Of the total 217 records, 180 are typologically classified (83 %). The 10 most common types at Athens account for 101 records (47 %). The ESA from the city of Berenice is derived from a single publication.[36] Of the total 84 records, 80 are typologically classified (95 %). The 10 most common types at Berenice account for 46 records (55 %).

34. Waagé 1934; 1948.
35. Oxé 1927; Waagé 1933; Thompson 1934; Robinson 1959; Vogeikoff-Brogan 2000; Hayes 2008.
36. Kenrick 1985.

TABLE 4. Ten most common types/variants of ESA in the total data, at Antioch, Athens and Berenice.

Ten most common types overall	Count	Ten most common types at Antioch	Count	Ten most common types at Athens	Count	Ten most common types at Berenice	Count
EAA24	475	EAA47	53	EAA4A-B	22	EAA4B	6
EAA22A-B	246	EAA9	14	EAA22B	12	EAA101	5
EAA4A	243	EAA22A-B	13	EAA2-3	11	EAA26A-D	5
EAA47	204	EAA3	9	EAA22A	9	EAA3	5
EAA3	201	EAA12	8	EAA9-10	9	EAA45	5
EAA48	166	EAA28	8	EAA12	8	EAA28	4
EAA22A	165	EAA30	8	EAA29	8	EAA37A-B	4
EAA4A-B	139	EAA48	8	EAA47	8	EAA12	3
EAA12	132	EAAtarda-e	8	EAA4A	7	EAA22A	3
EAA28	116	EAA29	7	EAA65	7	EAA30	3
						EAA35	3

There are differences between the most common types of ESA in Antioch, Athens and Berenice and the overall most common types. (Table 4) Most notably, hemispherical cup Hayes Form 24 and plates Form 4 are not as well represented in Antioch, whereas Form 4 is common in Athens and Berenice and in the total dataset. Plate Hayes Form 9 is a common type for ESA at Antioch and Athens, but not in the total data. Other types, such as cups Hayes Form 22, dish Form 3 and flat based dish Form 12 are common for all three sites and in the total dataset. Berenice is differing in common shapes from both the other two cities and the total dataset with the presence of jug Form 101, bowl/krater Form 26, cup Form 45 and plates Form 35 and 37 being less common at Athens and Antioch and the total. For Antioch, the hemispherical cup or bowl Form 48, plate Form 29 and the late dish Form tarda-e are more common than for the other sites or dataset, while for Athens, cup Form 65 is more common. Overall, there is commonality in the presence of ESA types over the three cities, but Antioch and Berenice seem more dissimilar to the other cities and the dataset, while at Athens the common types are more comparable to the main dataset and some of the common types are present at either Antioch or Berenice.

The resulting graphs (FIG. 8-10) show dissimilarities especially between Antioch and the other two cities. The large peak present in the Antioch ESA material in the first half of the first century AD is not present for Athens and Berenice, which reach their highest point in the first quarter of the first century AD after which decline begins. Athens seems to have had an early access to ESA, with a significant growth in the first century BC, although the ESA of Antioch follows and supersedes Athens in the second half of the first century BC Although for Berenice and Athens, the distribution of ESA seems to disappear after the first century AD, but for Antioch a revival of the ESA distribution in the fourth quarter of the second century AD is caused by the later ESA forms (mostly Forms tarda-e,f,g,h).

Berenice has an early peak in the Gamma and Gaussian curves caused mostly by mastos/cup Hayes Form 16. Although clearly an early form, the beginning of ESA was probably later than the mid second century BC date of Form 16 (as suggested by the EAA). Therefore this early peak is disregarded for the moment. The overall picture of ESA at Berenice seems to be one of slightly later access in comparison to Antioch and Athens and one of a lower scale: the peaks are present in the same years as the other two curves, but they are lower to the point of hardly being present at all, such as the peak in the third quarter of the first century BC or the peaks of the fourth quarter of the first century AD. Only a slight peak and drop are present at around 40 and 25 BC respectively in the gamma and Gaussian distributions. This is especially apparent in the Gamma curves. The curves reach a maximum in the early first century AD, after which the curves display a rather erratic decline until ca. AD 70, after which a growth in the import of ESA can be seen. After AD 90 decline in import for ESA takes place and continues until the import of ESA virtually ceases after the first quarter of the second century AD.

For Athens, the highest peak is located in 40 BC for the Gaussian and Gamma curves and in interval AD 1-25 for the linear curve, albeit with a very slight difference to the 50-26 BC peak. The distribution grows gradually in the first century BC in the Gaussian and Gamma curves, whereas the linear curve seems to grow from the second half of the second century BC in two stages. The decline after the first quarter of the first century AD is erratic in the Gaussian curve and less erratic in the gamma curve. Both curves decline until distribution ceases after AD 125. The linear curve declines steeply, only to gradually descend after AD 100. Still, the linear curve shows some distribution of ESA throughout the second century AD. The weight of the Gaussian and gamma curves is lying in the first century BC until ca. the second quarter of the first century AD. This seems to be confirmed by observations made in the field. John Hayes writes that "The chief contribution of the Agora finds to an understanding of the ware is in the evidence provided for the developments of the period ca. 100 BC to AD 50" and "The peak in importation in the Agora is attested, broadly speaking, in the Augustan period (between ca.

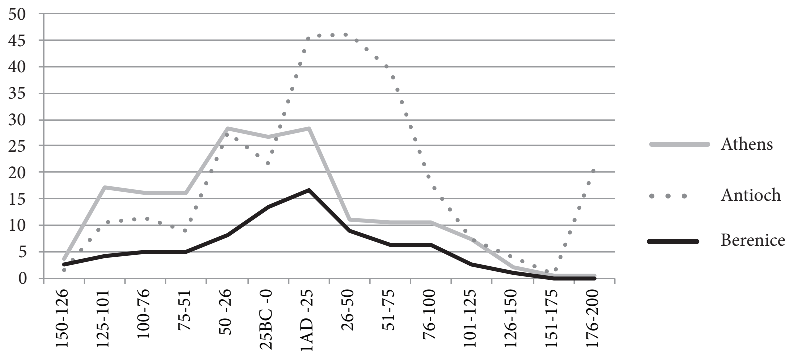

Fig. 8. Comparative plot for the ESA from Antioch (n=264), Athens (n=180) and Berenice (n=80), using the linear distribution method.

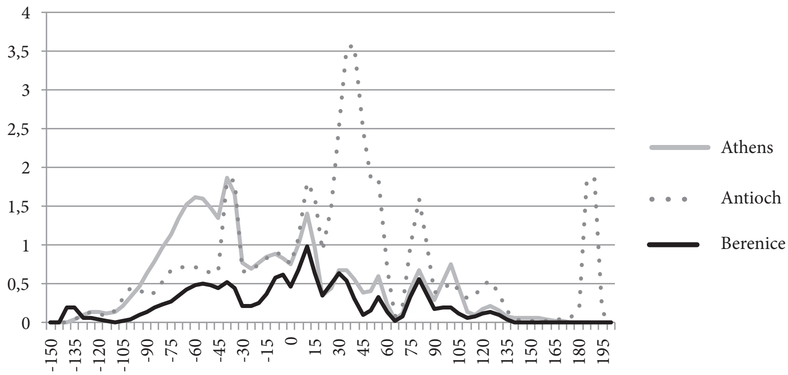

Fig. 9. Comparative plot for the ESA from Antioch (n=264), Athens (n=180) and Berenice (n=80), using the Gaussian distribution method.

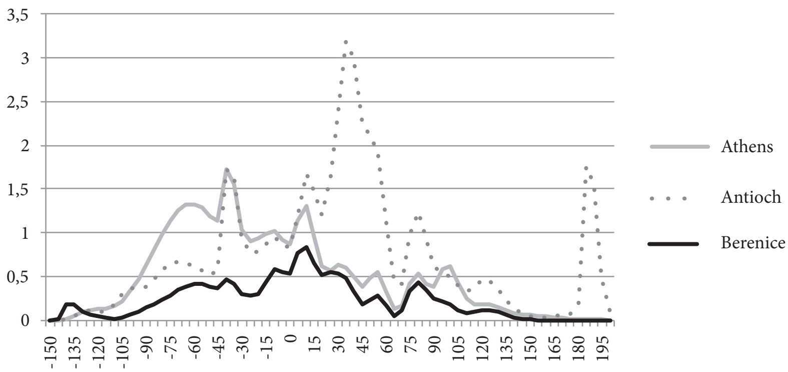

Fig. 10. Comparative plot for the ESA from Antioch (n=264), Athens (n=180) and Berenice (n=80), using the Gamma distribution method.

50/40 BC and AD 20)".[37] The weight of the linear curve seems to be spread more widely. Generally speaking, the gamma curve for Athens is less erratic and smoother in than the Gaussian curve.

The linear curve of Antioch shows multiple stages of growth (and even decline) in the first century BC only to grow to its highest point in AD 1-25. This peak continues, although decline sets in during the second half of the first century AD, which continues into the second century AD, only to grow again in the last quarter. The Gaussian and gamma curves show this general pattern as well, although the peak present at 40 BC and at AD 15 show a more nuanced picture. Also, the largest peak is slightly later and shorter-lived in these curves, declining rapidly in around AD 50-60 only to rise again after AD 70. Again, the gamma distribution seems to result in a less erratic pattern, especially with the drop at AD 70 being less severe when compared to the Gaussian curve. After AD 85 decline continues with only a slight peak present around AD 125, after which the distribution of ESA seems to virtually halt until the last quarter of the second century AD. It seems somewhat unlikely that a market close to the supposed area of production has no ESA circulating for half of a century.

The three methodologies all show that ESA distribution for Antioch, Athens and Berenice over time varied and differed from each other. The different levels of detail provided by these methods are still providing a similar overall picture. This gives hope to the validity of the distribution methods, especially when used in tandem. But the most important question remains: what do these curves mean?

Three cities, one ware

Athens

Although the author does not want to imply that the peaks and dips in the curves are all connected to major events in (socio-economic) history, the sample-size and the apparent randomness of artefactual conservation and recovery prohibit this, the general trends may be explained by the historical framework. Of course, it is necessary to remember that these curves constitute the results of a single ware, derived from excavations, each with its own history (and selection (?) biases), which did not cover the entirety of each city.

37. Hayes 2008, pp. 19-20.

These studies cannot hope to be anything but a general sample of the ESA for each city. Ofcourse, the issue of representation tends to be a problem for many quantified studies of small finds (or any statistical analysis of a sample) and yet it is necessary not to ignore the data, but to proceed with caution and take new data into account wherever possible.[38] The usage of Excel-sheets with structured set formulae (cf. Table 2) capable of automatically updating the graphs when new data is added, facilitates the addition of new data from future studies. The following passages must, however, be regarded as a preliminary and cautionary assessments of the ESA data in relation to other tablewares found and set to the backdrop of the history of each city.

The curves display a period of growing import of ESA to Athens from especially the second quarter of the first century BC, which continues to grow until the third quarter of the first century BC. The distribution declines from the first quarter of the first century AD until it peters out in the second century AD. The nature of the chronology of these vessels makes it very difficult to see whether historic events had an influence on this import. The curves do not reveal any effect of the sack and subjugation of Athens by Sulla in 86 BC for instance, although most of the growth occurs after this date for both curves.[39] However, the resolution and the methods employed are in all likelihood incapable of identifying catastrophic events clearly. Rather they reveal more general trends.

For Athens, the sack and Roman conquest of the city can be seen as a milestone in a longer process of Roman incursions in Greece and elsewhere in the Mediterranean.[40]This had influence on the political, social, cultural, demographic and economic situation of Greece, but for other regions as well. For the matter of tableware-production in the Roman world, it can be observed that around the middle of the second century BC, red slipped tableware came in fashion.[41] ESA and Eastern Sigillata C were produced and exported on a large scale and as time progressed, other centres of production started to export red slipped tableware, such as the Italian workshops (Italian Sigillata) or the workshops of the Meander Valley (Eastern Sigillata B).[42] Athens represents a site of import for all these wares and the curves discussed here represent the rise and fall the import of one of these products. The decline of ESA in the first century AD does not represent a decline in

38. Willet and Poblome 2011.
39. Camp 2001, p. 184.
40. Eckstein 2008; Shipley 2000, pp. 368-99; Alcock 1993, pp. 8-13.
41. Poblome and Zelle 2002, p. 275.
42. Ladstätter 2007, pp. 208-210; Schneider 1996, p. 189.

the need for red slipped tableware products, but it represents a new influence of other production-centres on the import of Athens. ESA was supplanted by Italian Sigillata at Athens from the second quarter of the first century AD.[43] In the ICRATES-database 322 pieces of Italian Sigillata alongside 264 pieces of Eastern Sigillata B are recorded for Athens, indicative of a significant import from other production-centres as well. This process seems to have happened on the regional level as well, with the appearance of Italian Sigillata and Eastern Sigillata B on numerous sites in Greece from the late first century BC onwards.[44]

Berenice

Berenice, located in Cyrenaica, underneath the modern city of Benghazi, was (partially) excavated between 1971 and 1975, uncovering houses, remains of defensive walls and public buildings, dating to the Hellenistic to Byzantine and later periods, but many to the Roman period.[45] The area of Cyrenaica became part of the Roman empire after it was bequeathed by Ptolemy Apion to the Roman people in 96 BC.[46] In 74 BC Cyrenaica, including the city of Berenice, became a Roman province, only to be independent shortly as a separate kingdom under Cleopatra Selene, assigned by Marc Anthony. During the Principate, Cyrenaica underwent relative stability, only broken by tribal uprisings and the Jewish revolts. During the reign of Hadrian, stability and many damaged buildings are restored and control is further consolidated by the foundation of Hadrianopolis between Berenice and Taucheira.[47] During the third century AD, Cyrenaica experiences economic decline and depopulation in line with empire-wide tendencies, but also exacerbated by an earthquake in AD 262. This decline seems to continue, although by now, ESA has long ceased to play a role in Cyrenaica. Possibly the newly acquired lands were mismanaged, as attested by the epigraphic evidence mentioning commissioners send by Claudius and Vespasian being send to demarcate the boundaries of the lands and to vacate squatters in these areas and by the dwindling export of *Silphium*, a plant native to the area and of significant value for culinary and medicinal purposes.[48] Pliny the Elder reports that only a single stalk of *Silphium* was found in the region, which was presented

43. Hayes 2008, p. 40.
44. Bes 2007, pp. 41-45; Bes and Poblome 2006, p. 146.
45. Lloyd 1977.
46. Jones 1971, p. 358.
47. Di Vita *et al*. 1998.
48. Jones 1971, p. 371; Blas de Roblès 2005, pp. 136-137.

to emperor Nero as a curiosity, indicating the rare nature of this plant in the middle of the first century AD.[49]

The city, originally founded as Euhesperides located to the east of Berenice founded by Greek colonists in the early sixth century BC, was relocated probably during the third century BC to the west (probably in 246 BC), where the city continued as 'Berenice' until Islamic times and, no longer as Berenice, habitation continued until the modern city of Benghazi.[50] During the excavations, a Hellenistic city-wall was encountered, as well as a grid-plan with several court-houses and signs of industrial activity of various periods. During the first century AD rebuilding took place and many buildings can be dated from the middle of the century until the Flavian period. Prosperity continues until the middle of the third century AD, as indicated by the adornment of the houses, after which Berenice suffered decline with many buildings demolished or abandoned. Possibly caused by insecurity, it is also during this period that a new defensive wall is erected.[51]

For Berenice, ca. 50 % of the finewares were used as the basis for the study by Philip Kenrick, which accounts for all the stratigraphically important material. The inclusion of the rest of the material would offer diminishing rewards (according to Kenrick) and was not taken into account.[52] The data for Berenice discussed here will therefore be based on a sample of the excavations. Still it is obvious that ESA constituted a relatively low portion of all the red slipped wares found at Berenice. As for Athens, the decline of ESA after the first century AD does not represent a decline in the need for red slipped tableware products, but it represents a new influence of other production-centres on the import. ESA was can be considered an early forebearer of sigillata at the site, since for Berenice, 296 pieces of Italian Sigillata are recorded in the ICRATES-database alongside 35 pieces of Eastern Sigillata B and 25 pieces of Eastern Sigillata C. A significant import of western products was taking place, which is supplemented by products from Asia Minor. It is ESA which is the first of the Sigillatas to enter the Berenice market and to be surpassed during the first century by other products. This is clearly reflected by the curves, although interestingly the slight revival at the end of the first century is perhaps a indication of continued need for slipped tableware, while the Italian influence diminishes by this time. Although potentially, the curve

49. Plinius, N.H. 19.15.
50. Blas de Roblès 2005, p. 138.
51. Kenrick 1985, p. 3.
52. Kenrick 1985, p. 4.

of ESA must be placed later, as suggested by Kathleen Slane's comments on the used chronology of the eastern sigillatas at this site.[53]

Antioch

Antioch is only partially excavated between 1932 to 1939 and the description of the monuments and larger public buildings rely on textual evidence, for the site is covered by the modern city of Antakya and by large deposits of silt. Originally founded as a Hellenistic capital by Antigonus around 300 BC, this prosperous and large city became part of the Roman hegemony during the annexation of Syria by Pompey in 64 BC. Many buildings were being donated to the city, which functioned as provincial capital for Roman Syria ensuring its continued prosperity beyond the third century AD.[54]

The size of Antioch's population and the city's proximity to the supposed source of ESA may explain in part why it is here that the most pieces of ESA are recorded for these three cities in the ICRATES-database. Other (more or less) contemporary tableware products play a lesser role in Antioch (Italian Sigillata=124 pieces; Gaulish Sigillata=102; Eastern Sigillata B=12). It is however interesting that, although the first century BC saw a growing presence of ESA, it reaches its zenith during the first half of the first century AD, somewhat later and to a far greater extent than at Athens or Berenice. Although this is not very clear in the linear distribution method, it is an obvious feature of the Gaussian and gamma distribution curves. It is also noteworthy, though perhaps less surprising given the proximity of the city to the supposed production area, that at Antioch ESA continues to play a role of importance into the second century AD.

Conclusion

This paper demonstrated the possibilities of three diachronically descriptive statistical techniques for archaeological data and in particular the usage of a Gaussian and gamma distribution techniques. The methods discussed here allow for quantified diachronic comparison of ceramics. They can be employed to investigate the trends in distribution of a single site, make comparisons on a site-to-site basis and compare general trends to a single site.

53. Slane 1992, pp. 191-192.
54. Jones 1971, pp. 255-260; Kondoleon 2000, pp. 13-14.

Furthermore, it is possible to make diachronic comparisons between multiple wares of ceramics.[55]

The three curves are indicative for the relative distribution of ESA within the eastern Mediterranean and show similar patterns, although the Gaussian and gamma curves show a more gradual development and reveal more detail. Especially when fewer records are involved (as for Athens or Berenice), the linear distribution curve seems to display less complexity, while the other methods continue to do so. The Gaussian and gamma curves can be used on a higher chronological resolution, while remaining more gradual (and an intuitively more realistic). The linear method shows steep jumps and falls if a higher chronological resolution is applied, which would equate in unrealistically fast and enormous changes and distribution and production of ESA.

At this point, the methods are best and easily used in tandem, if only to have a means to critically evaluate the results.[56] The Gaussian and gamma methods do have some practical benefits over the linear method and moreover the gamma and Gaussian curves model the development of a type of ceramic tableware potentially more realistically, resembling somewhat more closely the empirically verified archaeological "battleship shape" as the most likely trajectory of artefact types rather than an equal distribution between all possible dates for a type.[57] As stated above, this proposition was already suggested in the original paper by Fentress and Perkins, although, as Clive Orton already pointed out, these probability curves are in fact belief-statements.[58] It is however remarkable that up to now (30 years after the fact), only the linear method was uncritically applied. This paper provides a test bed for other diachronic distribution methods, showing that different and easier methods of data analysis are possible, thereby also allowing for a more critically informed interpretation.

As an interpretative tool, these methods rely on typological chronology, which is useful to study those ceramics which are not derived from a closed and dated deposits or residual material. Even in an ideal situation where all the pottery or other artefacts derive from closed deposits with accurate dating, the (re)use-life of the material would still result in a chronological range rather than a single dating.[59] For the interpretation, the results for the

55. E.g. Bes 2007; Bes *et al.* 2011.
56. E.g. Poblome *et al.* 2013.
57. Renfrew and Bahn 2000, pp. 122-124.
58. Orton 1980, p. 101.
59. Peña 2007

individual sites are helpful, but it is, due to the level of detail of the used typo-chronology, too much to hope for a precise reflection of the logic of individual historical events in these curves. Rather, these curves provide an extra insight into the medium term socio-economic connectivity and socio-cultural development of these sites.

As a last remark that, although these methods were applied to ESA, equally successful results were achieved with other wares of Roman ceramics, both tableware as other ceramic categories.[60] Potentially these methods are applicable to other material categories as well and these do not necessarily have to originate from the Roman world or from the Mediterranean, but can potentially be applied to the materials of different epochs and geographical settings. Further testing is being carried out on onomastic data of ancient Pisidia, which seem to confirm the usefulness of these distribution methods (drs. Rob Rens pers. comm.).

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60. Poblome *et al.* 2013.

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BLACK-GLOSS WARE, NORTH ETRURIAN RED-SLIP WARE, AND ITALIAN TERRA SIGILLATA FROM CETAMURA DEL CHIANTI

COMPOSITION, PROVENANCE, SUPPLY, AND CONSUMPTION

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1. Introduction

The past fifteen years have seen the publication of several studies that analyze assemblages of Black-Gloss Ware from archaeological sites in Etruria with a view to documenting the geography of the production and distribution of this class of high-end tableware within this historically important

1. SCG undertook the characterization of the ceramic thin sections reported on in this article. All other elements of the program of analysis were undertaken by JTP. The collection of the pottery and clay specimens subjected to compositional analysis was undertaken with the support of a National Endowment for the Humanities Travel to Collections Grant. The neutron activation analysis portion of the program was undertaken in course of a post-doctoral fellowship held in 1990 by JTP at the Smithsonian Institution's Conservation Analytical Laboratory (now known as the Museum Conservation Institute) under the supervision of M. James Blackman and Pamela Vandiver. JTP would like to express his sincere appreciation to Blackman, Vandiver, and Nancy T. de Grummond, the director of the Cetamura excavations, for their generous and crucial support with various aspects of the program of analysis, and to Jordi Principal for sharing with him his knowledge of various aspects of the production of Black-Gloss Ware. Earlier treatments of some portions of the work reported in this article appeared in Peña 1993 and Peña and Blackman 1994.

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region of the Italian peninsula.[2] While some of these studies have sought to shed light on these matters as an end in and of itself, others have been concerned with enhancing our understanding of general patterns of economic developments in Etruria during the Hellenistic/republican period, while others again have sought to mobilize this evidence to elucidate aspects of the Romanization of Etruria.

This article reports the results of a program of analysis undertaken with a view to contributing to this body of scholarship. The program involved the compositional analysis of examples of three classes of slipped tableware: Black-Gloss Ware, North Etrurian Red-Slip Ware – a medium to low-quality tableware produced during the second century B.C. – and Italian Terra Sigillata – the successor to Black-Gloss Ware as the dominant high-end tableware in Etruria during the early imperial period – from the site of Cetamura del Chianti, a low-order Etruscan/Roman settlement situated in the Monti del Chianti area of northern Etruria.

In more specific terms, the program of analysis entailed the application of three techniques – optical microscopy, neutron activation analysis, and petrographic analysis – to identify distinct compositional groups within sets of vessels belonging to each of these three pottery classes and to determine the likely provenances of these groups. Towards the second of these two goals the program also involved the compositional analysis of fired specimens of clay obtained from several locations in northern Etruria. This element of the program was undertaken on the assumption that by comparing the compositional data for the various pottery groups with those for the fired clays it might be possible to determine the general types of clay employed for the manufacture of the former and, perhaps in some cases, to identify the specific source from which the clay utilized for this purpose had been obtained.

While it proved possible to identify multiple compositional groups within the sets of vessels belonging to all three classes, the determination of the proveniences of the majority of these was problematic due to the non-diagnostic nature of the mineralogical composition of most groups, the limited number of clay specimens on hand for comparison, and the paucity of detailed form and compositional information available from production sites. Despite these limitations, it was possible to venture some general observations regarding the geography and chronology of the manufacture of these three classes of pottery in northern Etruria, the organization of

2. Palermo 1998; 2003a; Pasquinucci *et al.* 1998; Gliozzo and Memmi Turbanti 2004; Di Giuseppe 2005; Roth 2007; Di Giuseppe 2012.

the systems employed for their distribution to Cetamura del Chianti, and patterns in the consumption of slipped tablewares at Cetamura del Chianti over the period ca. 350 B.C. to A.D. 100.

The program of analysis also shed light on certain technological aspects of the manufacture of Black-Gloss Ware and Italian Terra Sigillata at the important production centers of Arezzo (Roman Arretium) and Volterra (Roman Volaterrae). Most significant in this regard is the fact that it pointed to efficiencies in the manufacture of gloss-slipped tablewares available to potters at Arezzo that may well have played an important role in the emergence there of the Italian Terra Sigillata industry during the third quarter of the first century B.C., a development that has long been of interest to students of Roman ceramics and of the Roman economy more generally.

2. The settlement at Cetamura del Chianti

The site of Cetamura del Chianti (henceforth Cetamura) is a small Etruscan/Roman settlement situated in the Monti del Chianti area of northern Etruria (*comune* of Gaiole in Chianti, *provincia* of Siena; 32T 696635 m E 4818498 m N, elevation ca. 670-685 m a.s.l.).[3] It is located on the summit of a heavily wooded, NE-SW oriented ridge. The site, whose Etruscan and Roman names remain unknown to us, has been the focus of a program of archaeological investigations carried out by Florida State University since 1973.[4] It appears to have been occupied from at least the sixth century B.C. to the second century A.D., with perhaps periods of interruption during the fifth-fourth century and the first century B.C. The features excavated to date have been assigned to five phases, designated Archaic Etruscan, Late Classical, Hellenistic Etruscan 1, Hellenistic Etruscan 2, and Roman. There was also a medieval occupation on the site that does not concern us here. The Archaic Etruscan phase, which spanned some portion of the 7th and 6th centuries B.C., and the Late Classical phase, which can be dated ca. 350-300 B.C., are both poorly attested, being represented by only a few isolated features. During the Hellenistic 1 phase, which can be dated ca. 300-150 B.C., the site appears to have been a center for craft production, including the manufacture of archi-

3. All UTM coordinates and elevations reported in this article were obtained from Google Earth.
4. See de Grummond ed. 2000, 6 and 2009, 24-25 for the history of research at Cetamura and de Grummond 2000, 7-22 and 2009, 17-23 for an overview of the remains at the site and its occupational history. The address of the project web site is http://www.fsu.edu/~classics/cetamura/.

tectural ceramics (brick, tile, and loom weights), the weaving of textiles, and probably also iron working. During the Hellenistic 2 phase, which can be dated roughly 150-75 B.C., it was the locus of a sanctuary. Whether the site was already a sanctuary during the Hellenistic 1 phase and whether it continued to function as a craft production center during the Hellenistic 2 phase, and whether it was a residential settlement and/or a market center during either or both of these phases all remain unclear. The nature of occupation during the Roman phase, which extended from at least ca. 20 B.C. to ca. A.D. 100, is similarly enigmatic, although the presence of a structure with hypocaustal heating suggests that it was perhaps the site of a modest villa. While the work carried out at Cetamura to date has not established the boundaries of the built-up area of the site during any of the phases recognized, the extent of surface remains suggests that at no point did this occupy an area of more than ca. 1 hectare. This suggests that at no time was the resident population more than a few score individuals, and perhaps considerably less than this.

The ridge on which Cetamura is situated lies in the eastern sector of the Monti del Chianti, roughly 12 km to the west of the Fiume Arno (Arno River). During the Hellenistic, late republican, and early imperial periods the nearest major centers were (employing these settlements' Roman names) Volaterrae, 46 km to the WSW, Saena (modern Siena), 20 km to the SSW, Arretium, 37 km to the E, Faesulae (modern Fiesole) 37 km to the NNW, and, beginning at some point in the second half of the first century B.C., Florentia (modern Florence), 35 km to the NNW. The settlement at Cetamura lay near the junction of several roads that would have provided fairly direct access to all of these centers.[5] Of particular note for the purposes of the present study is Cetamura's proximity to both Volterra and Arezzo, since the former was an important center for the manufacture of Black-Gloss Ware and probably also North Etrurian Red-Slip Ware during the Hellenistic period, while the latter was a major center for the manufacture of Black-Gloss Ware during the Hellenistic period and Italian Terra Sigillata during the early imperial period. Figure 1 is a map indicating the locations of the various ancient settlements mentioned in the text.

5. See Tracchi 1978, 119-124 for the road network in the area around Cetamura.

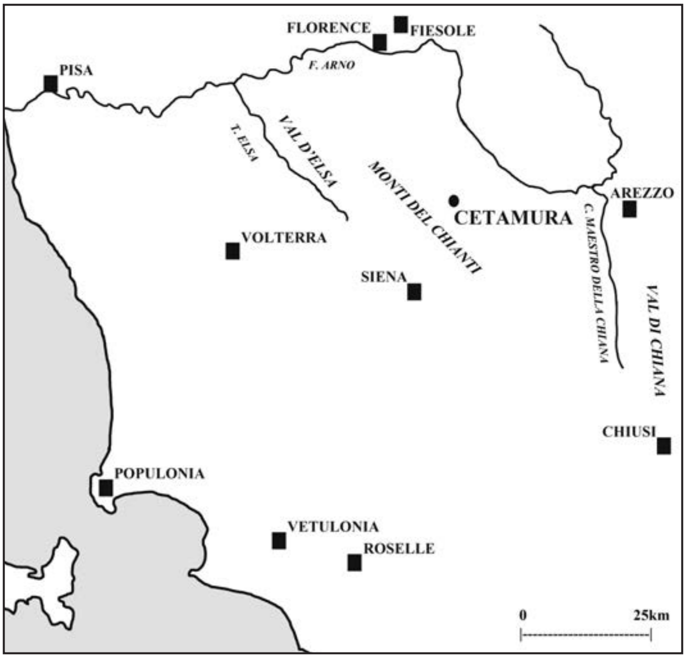

FIG. 1. Map of Northwestern Etruria showing location of major settlements and geographical features mentioned in text.

3. The three pottery classes

The three classes of tableware that constitute the focus of this study represented the high-end segment of the set of ceramic wares in use at Cetamura over the course of the Hellenistic and early imperial periods.[6] While archaeological evidence demonstrates that architectural ceramics and perhaps also utilitarian pottery were manufactured at Cetamura, it seems unlikely that any of these three classes of pottery was produced either at Cetamura or at some other location in its immediate environs.[7]

6. See Appendix 1 for the approach employed for form citations for each of these three classes of pottery.
7. See Ewell 2000 and de Grummond 2001 for the evidence for the manufacture of ceramics at Cetamura.

3.1 Black-Gloss Ware

The term Black-Gloss Ware (henceforth BGW) is employed to refer to a family of tablewares characterized by the presence of a matte to glossy, dark gray, dark reddish gray, or black slip (henceforth referred to as black) that was widely manufactured and consumed in the western Mediterranean, including Italy, from the fourth to the first century B.C.[8] Its glossy black surface, which may have been regarded as conferring an appearance similar to or suggestive of that of silver plate, was attained by applying to the vessel when in a leather-hard state a coating of fine-grained, non-calcareous slip containing a fluxing agent, and then firing the vessel in a reducing atmosphere until the slip sintered.[9]

In northern Etruria BGW normally constitutes the most abundant class of high-end tableware in pottery assemblages at sites occupied from the second half of the fourth to the middle of the first century B.C.[10] While the pottery assemblages from some sites in northern Etruria contain small amounts of BGW certainly or likely manufactured outside the region – e.g., by workshops operating in Latium, northern Campania, and/or the Bay of Naples – the bulk of the vessels belonging to this class consumed in northern Etruria appear likely to have been manufactured within the region. Direct evidence for the manufacture of BGW in the form of the remains of production facilities and/or production waste (i.e., pottery with manufacturing defects, kiln furniture and other production equipment, structural elements of kilns) has been reported from 16 locations in northern Etruria. These include the following: Volterra – Acropoli,[11] Montaione (two locations: Bellafonte,[12] il Muraccio[13]), Donoratico – Casa Giustri,[14] Roselle – Collina di Sud Est,[15] Arezzo (five locations: Godiola,[16] I Capannoni,[17] Orciolaia,[18] Piazza San Francesco,[19] Ponte a

8. See Stanco 2009a, Di Giuseppe 2012, and Principal and Ribera i Lacomba 2013 for recent overviews of this class of pottery.
9. Winter 1978; Mirti and Davit 2001, 20; Gliozzo *et al.* 2004.
10. For BGW from Cetamura see Houston 1978 and Curry 1996.
11. Olcese 2011-2012, 82-84 T099.
12. Olcese 2011-2012, 33-34 T048.
13. Olcese 2011-2012, 34 T067.
14. Di Giuseppe 2012, 106.
15. Olcese 2011-2012, 61-62 T081.
16. Olcese 2011-2012, 12 T091.
17. Olcese 2011-2012, 12 T093.
18. Olcese 2011-2012, 13 T076.
19. Olcese 2011-2012, 14-15 T061.

Buriano[20]), Montepulciano – Casa al Vento,[21] Chianciano Terme – Incrocio SS146/Via Vecchia Senese,[22] Chiusi (three locations: Orto del Vescovo,[23] Badiola,[24] Marcianella[25]) and Sovana – Cattedrale.[26] Chiusi – Marcianella is the only one of these locations at which a production facility has been the subject of systematic excavation and publication.[27] Indirect evidence, including the distribution of forms, fabrics, and decorative techniques/elements/schemes, suggests that BGW was manufactured at several other locations in northern Etruria, including the area around Livorno, Pisa, Lucca, and perhaps also Populonia and Cosa.[28]

3.2 North Etrurian Red-Slip Ware

The term North Etrurian Red-Slip Ware (henceforth NERSW) is here employed to refer to a family of tablewares characterized by the presence of a dull to glossy reddish slip that was manufactured at several locations in northern Etruria from the late third century B.C. to the second half of the second century B.C.[29] The slip generally exhibits poor adhesion to the ceramic body, and is frequently only poorly preserved. These characteristics indicate that this class was not manufactured employing the distinctive slipping/firing technique employed for the manufacture of BGW noted above. A very substantial portion of the vessels belonging to this class are examples of a distinctive bowl with an everted, sometimes thickened rim with a furrow immediately inside it, a low wall, and a broad, flat base.[30] This form is morphologically identical to a BGW form designated Morel F1211, and is here referred to by this designation.

In northern Etruria this class represents a significant, though often only minor component of the high-end tableware assemblage at many sites occupied

20. Olcese 2011-2012, 16 T102.
21. Paolucci 2003, 11-12. The evidence for the specific wares produced at this locale is weak, and neither Olcese 2011-2012 (p. 109 T073) nor Di Giuseppe 2012 list it as a locus for BGW production.
22. Olcese 2011-2012, 98-99 T027.
23. Palermo 1998, 122. This location is not listed in either Olcese 2011-2012 or Di Giuseppe 2012, 106.
24. Olcese 2011-2012, 100-101 T023.
25. Olcese 2011-2012, 101-107 T011.
26. Olcese 2011-2012, 63 T046.
27. Pucci and Mascione 2003.
28. Di Giuseppe 2005, 37; Principal 2005, 50.
29. See Stanco 2009b for a recent overview of this class of pottery.
30. Following Cristofani and Cristofani Martelli 1972 this series of vessels is sometimes referred to in the literature as “Volterran presigillata”. See Lippolis 1984, 33; Wells 1990; and Palermo 1990b, 114 for the problematic nature of this term.

from the late third to the second half of the second century B.C.[31] There is direct evidence for the manufacture of NERSW from the pottery production facility at Chiusi – Marcianella that also produced BGW.[32] Indirect evidence, including the distribution of forms and fabrics and onomastic evidence provided by stamped maker's marks that very occasionally occur on vessels of this class, suggest that it was probably also manufactured at Volterra, Fiesole, Perugia, and one or more locations in the Val d'Elsa.[33]

3.3 Italian Terra Sigillata

The term Italian Terra Sigillata (henceforth ITS) is here used to refer to a family of tablewares characterized by the presence of a glossy, reddish slip manufactured at several locations in central Italy from the last third of the first century B.C. to the first half of the second century A.D. that was distributed throughout much of the Roman world and beyond.[34] Its glossy red surface, which may have been regarded as conferring an appearance similar to or suggestive of gold, was attained by the same technique as that employed for producing the glossy black surface of BGW, save that firing was carried out in an oxidizing atmosphere.[35] Examples of this class commonly bear one or more stamped maker's marks, on the basis of which it has been possible to identify numerous workshops, determine the locus of their activity, and draw inferences about their internal organization.[36]

In northern Etruria ITS invariably constitutes the dominant element of the high-end tableware portion of pottery assemblages at sites occupied from the last quarter of the first century B.C. to the first half of the second century A.D. While some of the ITS consumed in northern Etruria may have been manufactured by workshops operating outside the region – e.g., in the Po Valley, the Tiber Valley, and/or the Bay of Naples – the bulk was presumably manufactured within the region. Direct evidence for the manufacture of ITS has been reported for 22 locations in northern Etruria. These

31. For NERSW from Cetarmua see Williams 1995.
32. Olcese 2011-2012, 101-107 T011; Aprosio 2003, 155-156.
33. Palermo 1990b, 114-5; 2003b, 346-348. Cristofani and Cristofani Martelli 1972, 511 states that an example of the Morel F1211 bowl belonging to this class from Volterra is a waster, although the basis for this identification is unclear. Olcese 2011-2012, 83 lists "*ceramica a vernice rossa*" and "*presigillata*" among the wares for which there is production evidence from Volterra – Acropoli, citing in this regard Palermo 2003b.
34. See Ettlinger 1990a and Gazzetti 2009 for overviews of this class of pottery.
35. Winter 1978; Ettlinger 1990b, 34; Gliozzo *et al.* 2004.
36. Oxé *et al.* 2000; Fülle 1997.

include Pisa (three locations: Isola di Migliarino,[37] Via Santo Stefano,[38] Via San Zeno[39]), Arezzo (16 locations: Carciarelle,[40] Cincelli,[41] Convento dei Passionisti/San Bernardo,[42] Fonte Pozzuolo,[43] Orciolaia,[44] Piaggia di Murello,[45] Piazza San Francesco,[46] Piazza Sant'Agostino,[47] Ponte a Buriano,[48] Porta San Lorentino,[49] San Domenico,[50] Santa Maria in Gradi,[51] Teatro Petrarca/Via G. Monaco,[52] Via degli Albergotti,[53] Via dei Cenci,[54] Via Nardi[55]), Capolana – Casa Rossa,[56] Montepulciano – Poggetti,[57] and Cinigiano – Podere Marzuolo.[58] Montepulciano – Poggetti is the only one of these locations at which a production facility has been the subject of systematic excavation and publication.[59]

4. The program of compositional analysis

The program of compositional analysis involved nine operations carried out in the following order:

1. The selection of pottery specimens for analysis.
2. The collection of clay specimens for analysis.
3. The fabrication of tiles and pellets from the clay specimens.
4. The characterization of the untreated fracture surface of a chip detached from each pottery specimen and tile (optical microscopy).
5. The creation of a provisional fabric classification on the basis of these characterizations.

37. Olcese 2011-2012, 80 T013.
38. Olcese 2011-2012, 81 T014.
39. Olcese 2011-2012, 81 T015.
40. Olcese 2011-2012, 9 T012.
41. Olcese 2011-2012, 10 T090.
42. Olcese 2011-2012, 11 T054.
43. Olcese 2011-2012, 11 T055.
44. Olcese 2011-2012, 13 T076.
45. Olcese 2011-2012, 14 T095.
46. Olcese 2011-2012, 14-15 T061.
47. Olcese 2011-2012, 14 T100.
48. Olcese 2011-2012, 16 T102.
49. Olcese 2011-2012, 17 T103.
50. Olcese 2011-2012, 17 T104.
51. Olcese 2011-2012, 17-20 T105.
52. Olcese 2011-2012, 20-21 T106.
53. Olcese 2011-2012, 21 T107.
54. Olcese 2011-2012, 21-22 T108.
55. Olcese 2011-2012, 22 T109; Sternini 2012.
56. Olcese 2011-2012, 23 T040.
57. Olcese 2011-2012, 109-112 T024.
58. Vaccaro *et al.* forthcoming.
59. Pucci 1992.

6. The neutron activation analysis (henceforth NAA) of each pottery specimen and pellet.
7. The analysis of the NAA data.
8. The creation of a final fabric classification taking into account the results of NAA
9. The petrographic analysis of selected pottery specimens and tiles.

It was assumed that the various fabric groups identified and characterized by means of this set operations would correspond to some appreciable degree to production groups, that is, sets of vessels manufactured by the same workshop or by multiple workshops located in the same general area employing similar raw materials and processing techniques to prepare the ceramic paste from which they formed the vessels that they manufactured.[60]

The sections that follow describe in turn the methods employed for each of these operations.

4.1 Selection of Pottery Specimens

The sampling design employed for the selection of pottery specimens for analysis was drawn up with the goal of yielding data that would provide insight into patterns in the consumption of the three classes of pottery in question at Cetamura during the Late Classical, Hellenistic 1, Hellenistic 2, and Roman phases. It was also shaped by two considerations linked to the NAA component of the project, namely the requirement that the program of analysis be limited to no more than ca. 100 specimens, and the requirement that the analytical results include data pertaining to one or more groups consisting of at least ca. 20 pottery specimens having a common provenance (or, more correctly, specimens manufactured from a ceramic paste consisting of raw materials from the same source processed in the same manner). As explained below, the second of these two considerations was linked to the requirements of MADCORR, one of the computer programs employed for the analysis of the chemical data generated by NAA. Given Cetamura's location, it was thought likely that a significant portion of the BGW from the site originated at Volterra and a significant portion at Arezzo, that at least some of the NERSW originated at Volterra, and that most or all of the ITS originated at Arezzo. In light of these assumptions it was decided that a sampling program that included ca. 40 specimens of BGW, ca. 15 specimens of NERSW,

60. A single workshop may employ multiple ceramic pastes with distinctive working properties or that result in finished vessels with different characteristics with the result that it turns out vessels belonging to multiple fabric groups.

and ca. 25 specimens of ITS would likely guarantee that the program of NAA analysis would yield compositional groups of the minimum required size for materials originating at both Volterra and Arezzo (and possibly one or more other locations). This sampling scheme would also allow for the analysis of several tiles manufactured from regional clay specimens and a small number of replicate analyses of pottery specimens, the latter undertaken with a view to generating data that would aid with the interpretation of analytical results.

Table 1: Summary of information for Deposits 1-3. (f-t = fine-textured; i/g-t = intermediate-/gritty-textured).

Deposit	Loci	Phase	Weight sherds (kg)	Count sherds	Count f-t BGW	Percent f-t BGW	Count i/g-t BGW	Percent i/g-t BGW	Count NERSW	Percent NERSW
Deposit 1	Test Trench AA 6, 7	Late Classical	ca. 5.1	592	30	5.1	0	0.0	0	0.0
Deposit 2	Structure B 4	Hellenistic 1 (middle)	ca. 2.4	194	25	12.9	0	0.0	2*	1.0
Deposit 3	Structure B 1, 2, 2/4	Hellenistic 1 (late)/Hellenistic 2 (initial)	ca. 16.0	2453	337	13.7	8	0.4	21	0.9

* One of two specimens perhaps poorly fired BGW.

The pottery specimens selected for analysis were drawn from the sets of materials recovered in the course of the 1987 and 1988 excavation seasons at the site. The specimens of BGW and NERSW included in the program of analysis were selected primarily from among the sets of materials belonging to three fairly large deposits that could be associated one with the site's Late Classical phase and the initial portion of the Hellenistic 1 phase (ca. 350-250 B.C.), one with the middle portion of the Hellenistic 1 phase (ca. 250-200 B.C.), and one with the late portion of the Hellenistic 1 phase and initial portion of the Hellenistic 2 phase (ca. 200-150/125 B.C.). The basic information regarding the size and makeup of these deposits, here referred to as Deposits 1, 2, and 3, respectively, is presented in Table 1. The date ranges suggested for the deposits should be regarded as approximate. It should also be noted that one of the loci constituting Deposit 3 (Structure B, Locus 2/4) was situated at the boundary between Deposit 2 and Deposit 3, and its excavation may have entailed the recovery of some materials belonging to the locus constituting Deposit 2 (Structure B, Locus 4). As the 1987 and 1988 excavations yielded no similarly large deposits that could be associated with the Roman phase the ITS specimens included in the program of analysis were selected without regard to stratigraphic context.

In selecting specimens for analysis priority was given to choosing sherds that belonged each to a different vessel as this could be determined on the basis of fragment morphology and the appearance of body and slip. A secondary consideration was the selection of sherds that could be assigned with a high degree of confidence to a recognized form in the standard typology or typologies for the class in question, with priority given to rim fragments when these were available. In the event, the limited amount of materials available combined with the fairly high degree of brokenness exhibited by these meant that in many cases the specimens of BGW and in a few cases the specimens of NERSW selected for analysis could not be assigned to a specific form or could be assigned to a specific form with something less than a high degree of confidence. This unavoidable and regrettable circumstance has had the effect of diminishing to some extent the utility of the results obtained for these two classes.

For sampling purposes the BGW was divided into two general categories on the basis of its texture as this could be observed in the hand specimen – fine-textured and intermediate-/gritty-textured. The former category was thought likely to include the materials originating at Volterra and Arezzo, while the latter was thought likely to consist of materials manufactured at one or more other locations. It should be pointed out that intermediate-/gritty-textured BGW is exceedingly rare at Cetamura compared to fine-textured BGW, representing only a very small fraction of the BGW in the site assemblage. A total of 28 fragments of fine-textured BGW were selected for analysis, including seven from Deposit 1 (representing all seven vessels attested in this deposit), four from Deposit 2, and 17 from Deposit 3. All 12 fragments of intermediate-/gritty-textured BGW among the materials excavated in 1987 and 1988 that appeared to represent a distinct vessel were selected for analysis. These included eight specimens from Deposit 3, two from other loci comparable in date to Deposit 3, and two residual sherds from Roman or post-Roman loci. A total of 14 specimens of NERSW were selected for analysis with no consideration given to the texture of their fabric, including two specimens from Deposit 2 (representing both vessels attested in this deposit), nine from Deposit 3 (representing all nine vessels represented in this deposit), and three from other loci comparable in date to Deposit 3. Finally, 24 specimens of ITS were selected for analysis, some from Roman-phase contexts and some from contexts of apparent post-Roman date.

Appendix 1 presents a catalog of the pottery specimens included in the project.

4.2 Selection of Clay Specimens

The selection of clay specimens was guided in large measure by the evidence for clay formations presented on the relevant *fogli* (map sheets; henceforth Fg) of the standard geological map for the region, the *Carta Geologica d'Italia*, which is produced at a scale of 1:100,000.[61] Figure 2 is a map indicating the locations where the various clay specimens were obtained.

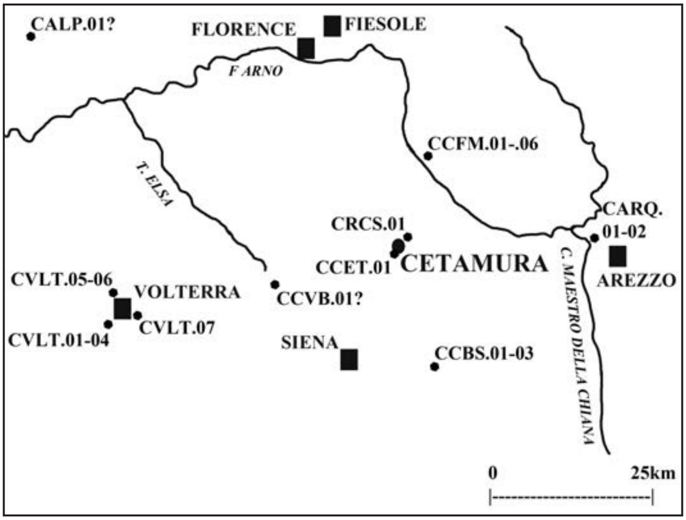

Fig. 2. Map of Cetamura area showing provenances of clay specimens (? = uncertain provenance).

Given the assumption that a substantial portion of the ITS, BGW, and NERSW originated at Arezzo and/or Volterra, a particular effort was made to collect specimens of clay suitable for the manufacture of ceramics from the areas of these two towns. In the case of Arezzo, an evaluation of the relevant map sheet (Fg 114) suggested that the workshops located there that manufactured BGW and/or ITS likely employed clay obtained from the formation designated agQ (*argille di Quarata*/Quarata clays), a bed of fine-grained sediment deposited on the floor of the lake that occupied a basin situated to the west of Arezzo during the Plio-Pleistocene period. The geologic map shows outcrops of this formation occurring over a narrow band running along the banks of the Canale Maestro della Chiana – an artificial watercourse initially excavated during the medieval period that serves to

61. The Fgs consulted included the following: 105 Lucca; 112 Volterra; 113 Castel Fiorentino; 114 Arezzo; 119 Massa Marittima; 120 Siena; 121 Montepulciano.

drain a large portion of the Val di Chiana northward into the Arno, which it joins in the vicinity of Ponte a Buriano – and the banks of the Torrente Castro, a small perennial that flows in a NW direction, passing immediately to the south of Arezzo and emptying into the Canale Maestro della Chiana from the east at a point ca. 3.5 km upstream of the latter's confluence with the Arno.[62] The exposures of this formation occur upstream along the Castro as far as Montione, roughly 2 km to the NW of Arezzo (taking as the city's boundary the circuit of the medieval fortification wall). Although a brief reconnaissance of the area failed to identify any extensive exposures of this formation, it was possible to obtain two specimens of agQ clay (henceforth Arezzo – Quarata clay) suitable for compositional analysis, one from a bank at the side of an unpaved road running along the left bank of the Canale Maestro della Chiana (specimen CARQ.01), and the other from the plow zone of an agricultural field a short distance back from this bank of the Canale Maestro della Chiana (specimen CARQ.02).

An evaluation of the map sheet for the area of Volterra (Fg 112) suggested that any workshops located at Volterra or in the environs of the town that manufactured fine-textured BGW and/or NERSW likely employed clay from the formation designated Pag (*argille azure e cenerine*/blue and gray clays), a thick bed of sediment deposited during an episode of marine transgression that occurred in the Pliocene period. This formation constitutes the end of the geologic sequence over much of the hilly terrain in the area around Volterra, with extensive outcrops occurring from elevations ranging from ca. 90 m a.s.l. to ca. 450 m a.s.l. A comprehensive sampling of the exposures of this formation was beyond the means of the project, and a limited program of adventitious sampling was undertaken with a view to obtaining evidence for the general characteristics and the range of compositional variability exhibited by clay from this formation in the area around the town.[63] This involved the collection of four specimens of clay from four different locations to the SW of the town that lie within the formation's lower and middle sections (specimens CVLT.01-04), the collection of two specimens of clay from two different locations to the NW of the town that lie within its middle and upper sections (specimens CVLT.05-06), and the

62. The course of the Canale Maestro della Chiana between the Castro confluence and the point where it empties into the Arno presumably follows more or less what was the lower course of the Castro prior to the former's excavation. The outcrops of the agQ formation along the Canale Maestro della Chiana thus presumably correspond more or less to outcrops that occurred along the lower course of the Castro in antiquity.
63. See Ostman 2004, 191-204 for a study of clay specimens obtained from several different parts of this formation in the area around Volterra, with particular emphasis on the suitability of these for the manufacture of ceramics during antiquity.

collection of a specimen of clay from a location to the ESE of the town that lies within its upper section (specimen CVLT.07).

More or less sandy marine clays of Pliocene date occur over a significant portion of the interior of northern Etruria, including an area on the south side of the Middle Arno Valley between the Fiume Era to the west and the Torrente Pesa to the east, and an area extending from the environs of Siena eastward and southward to the southern edge of the Chianti Mountains, the Val di Chiana, and the northern edge of Monte Amiata. In order to obtain some idea of the composition of these clays three specimens were collected from the face of the clay pit operated by Laterizi Arbia, a concern that manufactures architectural ceramics, located at Castelnuovo Berardenga Scalo, ca. 21 km to the SSE of Cetamura (specimens CCBS.01-03). This material belongs to the formation Fg 121 P^{2-1}ag (*argille ed argillle sabbiose*/clays and sandy clays).

More or less coarse lacustrine clays laid down during the Plio-Pleistocene period occur along the margins of the Upper, Middle, and Lower Arno Valley.[64] In order to obtain some idea of the composition of these clays, six specimens were collected from the storage area on the grounds of Cotto Pratigliolmi, a concern that manufactures architectural ceramics located at Castelnuovo di Franco – il Matassino, ca. 15 km to the NNE of Cetamura (specimens CCFM.01-06). These clays, which were said by an employee of the concern to have been excavated from the clay pit located on the premises, presumably derive from the formation Fg 114 Vag (*argille di Figline*/Figline clays).

Since it could not be completely excluded that some of the pottery included in the project was manufactured at or near Cetamura, specimens of clay were obtained from formations exposed in the immediate environs of the site that are known to contain clay suitable for the manufacture of ceramics. An evaluation of the relevant map sheet of the geologic map (Fg 113) and the relevant map sheet in the 1/25,000 series of topographic maps (*Tavoletta F.* 113 II N.E. "Radda in Chianti") for indications of ceramic manufacturing activity during the modern period revealed two such formations. The first of these, designated csp (*calcareniti degli scisti policromi*/calcarenites derived from polychrome schists), comprises the northeast end of the

64. For the purposes of this study the term Upper Arno Valley is used to refer to the portion of the Arno Valley extending from the confluence of the Canale Maestro della Chiana downstream to the confluence of the Sieve, the term Middle Arno Valley to refer to the portion extending from the confluence of the Sieve downstream to the confluence of the Elsa, and the term Lower Arno Valley to refer to the portion extending from the confluence of the Elsa downstream to the river's mouth.

NE-SW ridge on which Cetamura is situated and the saddle that separates this height from the hill located immediately to its east. This formation, of Paleogene date, consists of alternating beds of limestone, shale, and argillite, with associated deposits of clay that presumably derive from the weathering of the last of these rock types. The presence of standing water at a location on the eastern slope of the hill at an elevation of ca. 651 m a.s.l. revealed the presence of a sizable deposit of this clay, and a specimen of this material was recovered by excavation into the subsoil (specimen CCET.01). Experiments carried out with a portion of this specimen revealed that it possessed good working properties. The presence of an abandoned architectural ceramics production facility from the modern period ca. 200 m to the NW of the location where the specimen was obtained (*Tavoletta F.* 113 II N.E. UTM 967189 "*Fornace*") suggests that this deposit is substantial enough to support ceramic production on a moderate scale, and it seems likely that the manufacture of a portion of the utilitarian pottery and architectural ceramics produced at or near Cetamura during the Etruscan and Roman periods involved the use of this material.

The second formation of interest in the environs of Cetamura, designated c' (*complesso caotico – argille scagliose*/caotic complex – platy clays), is a marine formation of Holigocene date that is represented by three distinct outcrops lying within ca. 3-5 km of the site. One of these is situated ca. 2 km to the NW of Cetamura in the bottom of the valley immediately to the north of the hill on which the site is located that constitutes the upper end of the basin of the Pesa. The presence of an abandoned architectural ceramics production facility of the modern period atop this outcrop at *località* Castiglioni (*Tavoletta F.* 113 II N.E. UTM 943191 "*Fornace*") again suggests that this deposit is substantial enough to support ceramic production on a moderate scale. A specimen of this clay was obtained from a cut at the side of an unpaved road (specimen CRCS.01). The portion of the bed from which this specimen was recovered was in contact with a bed of limestone, and the specimen had a conspicuous component of fragments of calcareous rock that is probably not representative of the clay from this formation in general. In order to remove some of this material the specimen was disaggregated and sifted through a 0.5 mm steel mesh. Experiments carried out with a portion of the specimen after this procedure revealed that it possessed only moderate working properties, presumably due at least in part to an extremely high calcium content.

Additional clay specimens were obtained adventitiously from Ceramica Vulcania, an industrial cookware manufacturing concern located in Colle Val d'Elsa, a town situated ca. 26 km to the W of Cetamura. According to the plant manager, the paste employed by this concern consists of a mixture of three clays in strictly determined proportions, including a clay imported from France, a clay obtained from Altopascio, a town ca. 55 km to the NW of Colle Val d'Elsa, and a clay obtained from a source at *località* Belvedere, which he placed with some degree of uncertainty ca. 4-5 km outside Colle Val d'Elsa along the road to Monteriggioni. The plant manager stated that the Altopascio clay can be used by itself for the manufacture of cookwares if the coarse fraction is first removed. An evaluation of the relevant map sheet (Fg 105) and satellite imagery available through Google Earth suggests that this material was likely obtained from a clay pit located on the grounds of a factory for the manufacture of architectural ceramics situated ca. 2 km to the NNE of Altopascio. The material obtained at this location presumably consists of Plio-Pleistocene lacustrine sediments generally similar to those obtained farther up the Arno Valley at Castelfranco – Il Matassino. They probably belong to the formation designated Ql (*argille lignitifere, argille sabbiose, e sabbie di ambiente lacustre*/lignite bearing clays, sandy clays, and lacustrine sands). A specimen of this clay was obtained from the clay store on the Ceramica Vulcania premises (specimen CALP.01). For analysis, the coarse fraction was removed by disaggregating the specimen and sifting it through a 0.5 mm steel mesh. The plant manager indicated that the clay from *località* Belvedere was the clay employed in the past by traditional pottery producers at Colle Val d'Elsa. While there is a locale known as Belvedere ca. 2.5 km outside Colle Val d'Elsa along the road to Monteriggioni, the relevant map sheet (Fg 113) shows that the geology of this area, which consists of marine sediments and travertines and fluvial sediments derived from these, is not compatible with a material of the kind collected (as described below, a fairly coarse, non-calcareous clay). There is, however, a second locale known as Belvedere ca. 6 km to the NE of Colle Val d'Elsa, situated at the western edge of an area of lacustrine sediment of the Upper Miocene. The immediate area of this Belvedere consists of an exposure of the Mlc_2 (*conglomerati lacustri*/lacustrine conglomerates) formation, which is made up of alternating beds of calcareous material, sands, and clays. It seems possible that a formation of this kind could yield material of the sort in question, and, if so, it likely represents the place closest to Colle Val d'Elsa where clay of this kind could have been obtained. The best explanation may thus be that the clay in question derived from this second Belvedere, and that the workshop foreman, who seemed not to have direct personal knowledge of the place where it was obtained, confused a locale of this name with which he was familiar with another locale of the same name with which he was not.

This set of specimens represents only a portion of the array of clays available to potters in northern Etruria for the manufacture of the three classes of pottery under consideration. It does not, for example, include a specimen of clay formed through the alteration of ophiolitic gabbros such as occur in the vicinities of Impruneta, Figline di Prato, and Montaione;[65] a specimen of lacustrine blue clay of the Upper Miocene that outcrops over an extensive area to the East of Poggibonsi and Monteriggioni; or a specimen of fluvial clay of recent date, which occurs on the floodplains of watercourses throughout the region.

Appendix 2 presents a catalog of the clay specimens included in the project.

4.3 Fabrication of Tiles and Pellets

Circa 50 grams of material from each clay specimen was placed in a clean plastic bag and pulverized by being crushed against an aluminum plate with a rubber mallet. As previously noted, for two specimens (CRCS.01, CALP.01) the pulverized material was passed through a 0.5 mm steel mesh to remove the coarse fraction. The pulverized material was hydrated by adding de-ionized water and mixing until it became plastic. A portion of the plastic clay was modeled into a cylindrical pellet ca. 1 cm long with a diameter of ca. 0.5 cm and a flat tile ca. 1 cm wide by 4 cm long by 0.5 cm thick by being pressed into a plastic mold. The tiles and pellets were air dried and then fired in an electric muffle for two hours at 900 degrees C to convert them into a ceramic the composition of which could be usefully compared with the pottery specimens.

4.4 Optical Microscopy

A more or less flat chip measuring ca. 0.5 x 0.5 cm was detached from each pottery specimen and tile with pliers and the fresh fracture surface examined under a binocular microscope offering magnifications of 20X and 40X. Each chip was characterized for overall texture, matrix, and identity, size, condition, and abundance of inclusions. A detailed description of the methods employed for this operation appears in the introduction to Appendix 4.

4.5 Creation of Provisional Fabric Classification

The various chips were each assigned to a provisional fabric group on the basis of the results of the program of optical microscopy, with each of these fabric groups consisting of the chips within each pottery class or clay source

65. See Pallecchi 2006 for this clay.

area judged likely to represent specimens manufactured either from the same ceramic paste or from compositionally similar ceramic pastes.

4.6 Neutron Activation Analysis

Material removed from each pottery specimen and pellet was subjected to NAA at the facility formerly operated by the Smithsonian Institution's Museum Conservation Institute at the National Institute of Standards and Technology in Gaithersburg, Maryland to determine the specimen's bulk chemical composition. The material was prepared by employing a tungsten carbide burr to remove the surface from a portion of each specimen, breaking the prepared area away from the specimen, and then pulverizing this fragment in an agate mortar. The pulverized material was dried in an electric oven for 24 hours at 110 degrees C and allowed to cool in a desiccator. One hundred +/- 5 mg of this material was transferred to a cleaned polyethylene microcentrifuge tube, weighed to +/- 0.01 mg, and the tube capped. Batches of 18 specimens were packed into a polyethylene rabbit for irradiation along with two standards consisting of SRM 1633b Coal Fly Ash and a check standard consisting of SRM 679 Brick Clay. Each rabbit was irradiated for four hours at a flux of 5×10^{13} neutrons per cm^2 per second. The irradiated specimens, standards, and check standard were subjected to a one-hour count after 5 days and a two-hour count after 30 days. Concentrations were determined for 28 elements, including Na, K, Ca, Sc, Cr, Fe, Co, Zn, As, Br, Rb, Sr, Zr, Sb, Cs, B, La, Ce, Nd, Sm, Eu, Tb, Yb, Lu, Hf, Ta, Th, U.[66] For two elements important for understanding the composition of ceramics – Ca and Zr – concentrations were in many cases below the detection limit (ca. 1.8 percent for Ca and ca. 65 ppm for Zr).

Replicate analyses were carried out for five of the pottery specimens with a view to obtaining information regarding the scale of the combination of compositional heterogeneity within individual specimens and analytical error (including inter-batch analytical error) and the possible effects of these factors on the structure of the NAA dataset.

4.7 Analysis of Neutron Activation Analysis Data.

Three methods were employed for the analysis of NAA data. The first of these was the simple evaluation of the values for calcium in order to determine whether the specimen was manufactured from a paste that was

66. For the analytical parameters associated with this procedure see Blackman 1984, 23-5; Blackman *et al.* 1989, 64-65.

non-calcareous (here defined as < ca. 1.8 percent in the fired state), low calcium (ca. 1.8-4 percent), moderately calcareous (ca. 4-9 percent), or highly calcareous (> ca. 9 percent).[67]

The second method employed for the analysis of the NAA data was cluster analysis. This was used to explore the gross structure of the data set and to identify groups of specimens (including both pottery specimens and tiles) possibly manufactured with clay obtained from the same source or from highly similar and thus possibly neighboring sources. This operation involved the use of two programs originally developed by the archaeometry group at the Brookhaven National Laboratory (BNL) and later revised by the Missouri University Research Reactor (MURR) archaeometry group. These were MCONDIST, which calculates a distance matrix for the specimens included in the analysis for a suite of elements selected by the user employing one of six distance measures also selected by the user; and MAGCLUS, which employs the distance matrix produced by MCONDIST to generate clusters of specimens having similar chemical compositions using one of seven agglomeration procedures selected by the user.[68] The result of each analysis (known as a clustering solution) is displayed in the form of a dendrogram.

Since the results of cluster analysis tend to vary substantially and often significantly (from an archaeological point of view) as a function of the distance measure and agglomeration procedure employed, and/or as a function of the suite of elements and/or set of specimens included in the analysis, numerous analyses were carried out employing different combinations of sets of specimens, suites of elements, distance measures, and agglomeration procedures. The suites of elements, distance measures, and agglomeration procedures utilized were for the most part ones known from previous experience to provide good partitioning between sets of fine-textured ceramics manufactured at different locales and/or from ceramic clays obtained from different sources in west-central Italy. In light of the variable nature of the results of cluster analysis, one of the main goals of this work was the identification of sets of specimens that tend to cluster together under a variety of different analytical parameters, the assumption being that there is a high likelihood that any such specimens were manufactured from clay obtained either from the same

67. In practice, when chips of specimens in which the concentration of calcium was ca. four percent or greater as determined by NAA were examined under the binocular microscope the matrix displayed a readily discernible pattern of dense white stippling. For specimens in which the concentration of calcium was less than ca. four percent this pattern was not usually apparent.
68. See Sayre 1980, 3-6 for descriptions of the BNL versions of these two programs.

source or from highly similar sources. Particular attention was accorded to the locations within the dendrogram of the five pairs of replicates, since this information aids in the identification of elements of the clustering solution that should not and perhaps should be regarded as archaeologically significant. The specific clustering solutions discussed and illustrated below represent what are regarded as the most representative results obtained in the substantially broader program of cluster analysis. They should not be viewed as constituting in a straightforward manner a definitive representation of the structure present either in the data set or in the set of specimens analyzed.

The third method employed for the analysis of the NAA data was that of calculating multivariate probability scores of group membership. This method was used to evaluate the statistical probability that individual specimens belonging to sets of specimens identified as constituting a compositional group by means of cluster analysis actually belong to the group, and to evaluate the probability that other specimens might belong to that group. This operation involved the use of a third program developed by the BNL/MURR archaeometry groups, MADCORR.[69] This routine calculates the variance-covariance matrix for a reference group of specimens defined by the user (termed the core group) for up to 15 elements specified by the user, then employs Hotelling's T^2 parameter to determine the probability that each specimen in the group might actually belong to a group having those compositional characteristics. Specimens scoring below some arbitrarily selected level – the figure most commonly employed is 5 percent – can be removed from the core group and the calculation repeated until a group displaying what the user regards as a satisfactory degree of homogeneity is obtained. The same calculation can then be carried out for specimens of unknown origin, assigning probabilities of membership in the core group to these. The program requires that the core group contain at least one more specimen than the number of elements being employed for the calculation, and tends to perform best when at least 10 elements are used and when the number of specimens in the core group is at least twice the number of elements being employed. A core group consisting of at least 20 specimens is thus preferred. Since the set of specimens included in the analysis and the number and suite of elements employed substantially affect the results, as was the case with the program of cluster analysis, several trials were carried out employing various sets of specimens and elements with a view to identifying significant patterning in the data set, with just one of these trials here presented as a representative example.

69. See Sayre 1980, 9-12 for a description of the BNL version of this program.

4.8 Creation of Final Fabric Classification

The preliminary fabric classification was revised in light of the results of the program of NAA.

4.9 Petrographic Analysis

In order to obtain a more systematic characterization of the texture of the various fabrics identified and more secure and specific identifications of the various inclusions present in these thin sections were fabricated for 17 of the pottery specimens (as possible, one representative specimen from each fabric group) and these subjected to petrographic analysis. Thin sections were also fabricated and analyzed for two tiles (those manufactured from the two specimens of Arezzo-Quarata clay) so that it would be possible to perform more detailed comparisons between the texture and mineralogy of the ceramic clays in question and pottery specimens judged likely to have been manufactured from these.

5. Results

The values obtained by NAA for all specimens of BGW and BGW fabric groups, all specimens of NERSW and NERSW fabric groups, and all specimens of ITS and ITS Fabric Groups are presented in Table 2-4, respectively. The values obtained by NAA for all pellets manufactured from clay specimens are presented in Table 5. Appendix 3 presents a discussion of the methodology employed in the program of petrographic analysis and the results obtained. Appendix 4 presents the final fabric classification for both pottery and tiles, and includes the results of the program of optical microscopy.

The three subsections that follow discuss the results of the program of compositional analysis relating to each of the three classes of pottery that were the focus of the project. These are followed by a fourth subsection that discusses the results of analyses of NAA data involving pottery specimens belonging to all three classes.

TABLE 2. NAA data for all specimens of BGW with values for the arithmetic mean, standard deviation, and standard deviation as percent of arithmetic mean for fabric groups. Replicate analyses identified as A and B (Anal id = analytical identifier, Arith = Arithmetic, bdl = below detection limit, pct = percent, ppm = parts per million, S D = standard deviation).

Catalog number	Anal id/ Fabric group	Na pct	K pct	Ca pct	Sc ppm	Cr ppm	Fe pct	Co ppm	Zn ppm	As ppm	Br ppm	Rb ppm	Sr ppm	Zr ppm
BGW1.01	CAL099	0.601	2.24	6.84	19.0	179	5.00	22.7	138	2.98	05.1	156	310	109
BGW1.02	CAL093	0.522	1.91	8.34	19.1	187	5.18	23.3	137	3.43	11.2	126	455	bdl
BGW1.03	CAL088	0.501	2.00	7.03	18.7	187	4.98	23.1	134	2.81	08.8	133	403	bdl
BGW1.04	CAL084	0.514	1.94	8.69	18.7	182	5.16	22.5	137	2.13	08.1	138	383	bdl
BGW1.05	CAL090	0.541	1.97	9.86	18.0	168	4.94	22.3	132	5.02	03.9	130	417	bdl
BGW1.06	CAL089	0.482	1.95	8.11	18.5	183	5.14	22.7	132	3.88	07.9	142	341	bdl
BGW1.07	CAL003	0.670	2.16	7.10	19.3	189	5.21	24.5	143	4.48	13.0	136	342	bdl
BGW1.08	CAL002	0.679	2.14	6.34	19.5	195	5.25	22.1	108	3.72	24.8	150	138	bdl
BGW1.09A	CAL006	0.733	2.07	7.01	18.7	182	5.16	23.1	137	4.67	22.3	131	295	136
BGW1.09B	CAL598	0.719	2.04	7.40	18.3	178	5.08	22.4	132	3.65	23.8	132	230	bdl
BGW1.10	CAL007	0.659	2.07	7.40	19.1	191	5.22	25.4	132	4.45	16.7	146	333	bdl
BGW1.11	CAL092	0.679	2.14	6.34	19.5	195	5.25	22.1	109	3.72	24.8	150	138	bdl
BGW1.12	CAL096	0.527	1.92	8.68	18.2	175	4.89	24.4	131	2.20	03.6	141	277	bdl
Arith. mean	BGWFG1	0.591	2.03	7.90	18.8	183	5.11	23.1	133	3.54	12.1	138	238	-
S D		0.090	0.10	1.13	00.4	007	0.12	01.0	008	0.95	07.5	009	083	-
S D percent		15.2	5.1	14.4	2.4	3.9	2.3	4.4	6.2	26.7	62.2	6.2	25.4	-
BGW2.01	CAL095	0.537	1.83	7.24	18.6	183	4.89	27.2	152	4.32	6.49	111	483	139
BGW2.02	CAL097	0.355	1.80	6.22	19.9	203	5.45	23.6	156	5.00	14.9	125	324	160
BGW2.03	CAL083	0.516	1.79	6.01	18.7	181	5.11	22.8	127	3.68	7.08	114	207	bdl
BGW2.04	CAL085	0.468	1.88	6.90	18.9	184	5.08	23.9	136	4.51	14.9	100	337	bdl
BGW2.05	CAL091	0.480	1.67	6.31	19.2	187	5.24	23.3	141	3.25	7.69	099	326	bdl
BGW2.06	CAL080	0.533	1.95	7.74	18.9	187	5.15	23.7	137	2.57	4.44	115	407	169
BGW2.07	CAL082	0.440	1.66	7.13	18.8	182	5.18	22.4	158	3.05	11.3	102	366	bdl
BGW2.08	CAL081	0.439	1.67	8.24	18.1	175	5.07	23.5	141	6.65	15.1	115	303	bdl
BGW2.09	CAL078	0.493	1.75	7.62	19.3	188	5.33	23.6	136	5.15	9.04	121	323	bdl
BGW2.10	CAL098	0.430	1.76	5.28	19.6	195	5.28	23.5	138	2.42	17.9	126	234	bdl
Arith. mean	BGWFG2	0.469	1.78	6.87	19.0	186	5.18	23.7	142	4.06	10.9	113	331	-
S D		0.056	0.09	0.91	00.5	008	0.16	01.3	010	1.32	4.58	010	079	-
S D percent		13.3	5.4	14.5	2.7	4.2	3.1	5.4	7.2	38.5	58.1	9.2	27.7	-
BGW3.01	CAL005	0.570	1.85	3.86	20.2	203	5.41	21.9	107	7.43	22.8	107	bdl-	bdl
BGW3.02	CAL001	0.547	1.81	3.36	20.0	195	5.40	21.3	109	5.57	30.0	101	bdl	bdl
BGW3.03	CAL004	0.519	1.72	4.14	20.6	203	5.36	23.8	107	7.78	22.9	097	116	bdl
BGW3.04	CAL100	0.461	2.22	4.54	20.7	201	5.57	24.2	139	4.23	27.0	105	141	122
Arith. mean	BGWFG3	0.524	1.90	3.98	20.4	200	5.43	22.8	115	6.25	25.7	102	-	-
S D		0.047	0.22	0.50	00.3	004	0.09	01.4	016	1.66	03.5	004	-	-
S D percent		9.0	11.5	12.5	1.6	1.8	1.7	6.3	13.6	26.6	13.5	4.3	-	-
BGW4.01	CAL086	0.519	1.73	4.48	19.5	190	5.22	19/8	116	4.34	12.5	97.3	382	bdl
BGW4.02A	CAL087	0.354	1.40	4.97	20.3	195	5.24	23.8	146	5.56	16.9	72.9	447	bdl
BGW4.02B	CAL600	0.357	1.52	5.00	20.4	201	5.16	24.0	158	5.28	16.0	64.7	184	bdl
Arith. mean	BGWFG4	0.410	1.55	4.81	20.1	195	5.21	22.5	140	5.06	15.1	78.3	338	-
S D		0.094	0.17	0.29	00.5	005	0.04	02.4	022	0.64	0 2.3	16.9	137	-
S D percent		23.0	10.8	6.1	2.5	2.8	0.7	10.5	15.5	12.6	15.4	21.6	40.5	-
BGW5.01	CAL094	0.904	2.00	7.74	16.2	166	4.66	16.9	106	1.95	9.06	148	389	213
BGW5.02	CAL106	0.991	2.43	5.65	16.9	169	4.69	18.5	114	0.92	4.85	145	354	159
BGW5.03	CAL079	0.871	2.04	8.11	16.6	165	4.55	17.7	131	2.81	10.5	142	433	bdl
BGW5.04	CAL104	0.891	2.27	6.47	17.9	177	4.93	18.5	194	2.28	7.24	137	676	171
BGW5.05	CAL107	0.899	2.25	5.77	17.7	171	4.74	18.5	126	1.86	6.28	129	455	161
BGW5.06	CAL110	0.977	2.38	4.24	17.3	167	4.60	19.1	116	1.88	8.34	160	338	168
Arith. mean	BGWFG5	0.922	2.23	6.33	17.1	169	4.70	18.2	131	1.95	7.71	143	441	-
S D		0.049	0.18	1.44	00.7	004	0.13	00.8	032	0.62	2.02	010	124	-
S D percent		5.4	7.9	22.7	3.8	2.6	2.8	4.3	24.5	31.8	26.2	73	28.0	-
BGW6.01A	CAL077	0.938	1.92	2.74	16.9	172	4.86	17.0	115	5.94	18.6	111	241	176
BGW6.01B	CAL599	0.953	1.84	3.11	18.9	194	5.30	19.1	133	6.05	20.8	124	250	241
Arith. mean	BGWFG6	0.945	1.88	2.93	17.9	183	5.08	18.0	124	6.00	19.7	117	246	209
S D		0.011	0.06	0.26	01.4	015	0.31	01.5	013	0.08	01.5	009	006	046
S D percent		1.1	2.9	8.9	7.8	8.5	6.0	8.3	10.2	1.3	7.8	7.8	2.6	22.0
BGW7.01	CAL105	0.450	1.45	bdl	19.1	193	5.46	30.0	138	3.84	19.1	108	bdl	221
BGW8.01	CAL102	1.270	2.17	bdl	19.1	257	4.04	23.5	136	3.24	6.15	118	169	137
BGW8.02	CAL108	0.910	2.79	bdl	23.2	308	4.68	25.9	171	6.59	5.15	203	bdl	145
BGW8.03	CAL109	0.920	2.60	bdl	22.0	313	4.31	23.8	154	7.85	12.1	184	bdl	194
BGW8.04	CAL103	1.130	2.32	bdl	20.6	273	4.27	25.1	142	5.41	9.02	145	bdl	132
Arith. mean	BGWFG8	1.06	2.47	-	21.2	288	4.32	24.6	151	5.77	8.11	162	-	152
S D		0.17	0.28	-	01.8	027	0.27	01.1	015	1.96	3.13	038	-	029
S D percent		16.6	11.3	-	8.3	9.5	6.1	4.5	10.2	34.0	38.6	23.5	-	18.8

Catalog number	Sb ppm	Cs ppm	Ba ppm	La ppm	Ce ppm	Nd ppm	Sm ppm	Eu ppm	Tb ppm	Yb ppm	Lu ppm	Ha ppm	Ta ppm	Th ppm	U ppm
BGW1.01	0.796	7.45	0850	47.5	81.7	32.6	7.50	1.43	0.944	3.23	0.470	4.07	1.49	13.9	2.09
BGW1.02	0.697	5.88	0840	47.9	81.7	31.0	7.28	1.48	1.030	3.26	0.400	4.14	1.40	13.7	2.59
BGW1.03	0.706	6.86	1190	47.0	80.4	40.2	7.21	1.42	0.912	3.23	0.433	4.10	1.37	13.8	2.49
BGW1.04	0.731	6.41	0890	46.5	81.1	36.4	7.05	1.42	0.995	3.07	0.386	4.13	1.43	13.6	2.03
BGW1.05	0.793	6.21	1090	45.9	75.7	36.6	6.90	1.33	0.845	3.05	0.443	3.79	1.31	13.1	2.27
BGW1.06	0.755	6.65	1100	48.2	80.2	38.1	7.19	1.43	1.030	3.15	0.394	3.94	1.34	13.6	2.25
BGW1.07	0.760	6.30	0510	46.7	81.1	36.6	7.24	1.42	0.573	3.15	0.437	4.42	1.55	14.6	1.84
BGW1.08	0.774	6.86	0760	49.3	80.7	45.0	7.82	1.49	1.021	3.39	0.494	4.60	1.47	14.4	2.16
BGW1.09A	0.813	6.31	0570	43.6	76.4	35.2	7.06	1.40	0.927	3.23	0.450	4.62	1.47	14.3	1.64
BGW1.09B	0.836	6.12	0470	42.6	75.3	34.3	6.87	1.36	0.573	3.01	0.384	4.43	1.47	13.6	1.46
BGW1.10	0.885	6.37	0700	46.7	80.5	37.8	7.18	1.41	1.180	3.32	0.415	4.45	1/53	14.5	1.86
BGW1.11	0.671	6.89	0980	47.3	80.2	35.7	7.21	1.42	0.935	3.05	0.422	3.89	1.42	13.6	2.46
BGW1.12	0.721	7.01	0710	45.5	78.3	35.2	6.97	1.41	0.979	2.93	0.378	4.25	1.39	13.2	2.12
Arith mean	0.764	6.56	0820	46.5	79.5	36.5	7.19	1.42	0.919	3.16	0.424	4.22	1.43	13.8	2.10
S D absolute	0.060	0.43	0230	1.8	2.3	3.5	0.25	0.04	0.173	0.13	0.035	0.27	0.07	0.5	0.33
S D percent	7.9	6.6	27.9	3.9	2.8	9.5	3.5	2.9	18.8	4.2	8.4	6.4	5.0	3.4	15.8
BGW2.01	0.578	4.62	0980	46.0	80.7	30.8	7.01	1.43	0.95	3.37	0.379	4.15	1.39	13.5	2.16
BGW2.02	0.635	5.86	1810	49.2	87.1	29.4	7.53	1.51	1.00	2.99	0.417	4.32	1.47	24.6	2.87
BGW2.03	0.608	5.18	0980	47.5	80.9	36.5	7.14	1.43	0.96	2.85	0.389	4.28	1.36	13.8	2.11
BGW2.04	0.586	3.57	1670	47.5	81.8	36.0	7.26	1.44	1.01	3.18	0.421	4.21	1.39	23.6	2.68
BGW2.05	0.650	4.47	1220	50.2	81.7	40.7	7.46	1.47	1.22	2.92	0.423	4.39	1.44	13.9	2.63
BGW2.06	0.809	4.99	1530	47.6	81.1	35.3	7.36	1.44	1.07	3.08	0.469	4.28	1.48	13.8	2.04
BGW2.07	0.714	4.30	1550	46.5	80.5	33.7	7.05	1.42	0.90	3.14	0.430	3.96	1.38	13.7	2.64
BGW2.08	0.628	5.49	0590	44.6	77.3	34.2	6.87	1.33	0.98	2.71	0.385	4.13	1.35	13.3	2.86
BGW2.09	0.719	5.04	1470	49.8	83.6	35.7	7.66	1.49	1.06	3.16	0.469	4.38	1.44	14.2	2.14
BGW2.10	0.711	5.73	1280	48.6	83.9	39.7	7.46	1.45	0.94	3.30	0.439	4.30	1.51	14.4	2.34
Arith mean	0.664	4.93	1310	47.8	81.9	35.2	7.28	1.44	1.01	3.07	0.422	4.24	1.42	13.9	2.45
S D	0.073	0.70	0370	1.8	2.6	3.5	0.26	0.05	0.09	0.21	0.032	0.13	0.05	0.4	0.32
S D percent	11.0	14.3	28.4	3.7	3.2	9.9	3.5	3.4	8.9	6.7	7.5	3.1	3.8	2.9	13.2
BGW3.01	0.632	4.66	0970	49.0	84.5	42.5	7.67	1.49	0.830	3.66	0.493	4.53	1.57	15.1	2.23
BGW3.02	0.653	4.18	0910	47.9	82.0	39.6	7.73	1.52	1.030	3.66	0.516	4.81	1.51	14.7	2.64
BGW3.03	0.665	4.42	1270	50.0	87.7	35.5	7.73	1.52	0.585	3.51	0.515	4.71	1.49	15.3	2.29
BGW3.04	0.708	4.53	1160	52.2	88.3	40.1	8.38	1.61	1.119	3.53	0.479	4.54	1.56	15.1	2.48
Arith mean	0.664	4.44	1200	49.8	85.6	39.4	7.88	1.54	0.891	3.59	0.501	4.65	1.53	15.1	2.41
S D	0.032	0.20	0330	1.9	2.9	2.9	0.33	0.05	0.237	0.08	0.018	0.14	0.04	0.3	0.19
S D percent	4.8	4.6	27.6	3.7	3.4	7.4	4.2	3.4	26.6	2.2	3.6	2.9	2.5	1.7	7.8
BGW4.01	0.608	3.85	2120	50.5	84.5	35.0	7.80	1.52	0.955	3.56	0.480	4.89	1.47	14.4	1.86
BGW4.02A	0.553	2.07	2190	50.8	87.7	41.6	7.82	1.56	0.893	3.08	0.463	4.69	1.51	14.8	3.56
BGW4.02B	0.711	2.12	2210	51.1	86.9	29.4	7.87	1.57	0.589	3.44	0.426	4.59	1.51	15.0	3.24
Arith mean	0.624	2.68	2170	50.8	86.4	35.3	7.83	2.55	0.812	3.36	0.456	4.72	1.50	14.7	2.89
S D	0.080	1.01	50	0.3	1.6	6.1	0.04	0.03	0.196	0.25	0.028	0.15	0.02	0.3	0.90
S D percent	12.9	37.8	2.2	0.6	1.9	17.3	0.5	1.7	24.1	7.4	6.1	3.2	1.6	2.1	31.2
BGW5.01	0.466	7.13	0530	43.9	75.0	36.4	6.38	1.26	1.030	2.71	0.400	4.81	1.34	12.3	2.70
BGW5.02	0.501	7.45	0420	44.6	77.3	30.5	6.64	1.26	0.944	3.24	0.438	4.93	1.43	13.0	2.23
BGW5.03	0.619	6.79	0760	44.7	75.2	33.0	6.78	1.30	0.966	2.84	0.457	4.80	1.34	12.8	2.49
BGW5.04	0.552	6.09	1150	47.4	82.6	36.1	6.73	1.33	1.040	3.38	0.488	4.74	1.51	13.8	7.64
BGW5.05	0.515	5.93	0850	47.6	81.7	33.3	6.59	1.31	0.982	2.81	0.408	4.74	1.50	13.7	5.81
BGW5.06	0.502	8.19	0510	45.7	79.1	35.6	6.87	1.32	0.879	3.18	0.372	4.73	1.46	13.2	1.96
Arith. mean	0.522	6.93	0700	45.6	78.5	34.1	6.66	1.30	0.974	3.03	0.427	4.79	1.43	13.1	3.80
S D	0.058	0.85	270	1.6	3.2	2.3	0.17	0.03	0.059	0.27	0.042	0.08	0.08	0.6	2.35
S D percent	11.2	12.2	38.8	3.5	4.1	6.7	2.6	2.4	6.1	9.1	9.9	1.6	5.3	4.3	61.7
BGW6.01A	0.644	4.67	1770	45.0	76.7	32.7	6.92	1.35	1.040	3.18	0.393	6.07	1.46	13.6	1.95
BGW6.01B	0.750	5.21	1690	46.0	87.9	42.4	7.14	1.55	0.871	3.21	0.423	6.52	1.67	15.6	2.55
Arith. mean	0.697	4.94	1730	45.5	82.3	37.5	7.03	1.45	0.956	3.20	0.408	6.29	1.57	14.6	2.25
S D	0.075	0.39	0060	0.7	7.9	6.8	0.16	0.14	0.120	0.03	0.021	0.32	0.15	1.4	0.43
S D percent	10.8	7.8	3.3	1.6	9.6	18.1	2.3	9.8	12.5	0.8	5.2	5.0	9.6	9.6	18.9
BGW7.01	0.682	5.38	0520	51.1	84.9	35.6	6.61	1.14	0.764	3.18	0.463	6.92	1.66	15.0	2.55
BGW8.01	0.532	4.90	0830	48.8	86.5	37.2	7.03	1.37	1.00	3.35	0.586	5.52	1.46	17.7	6.22
BGW8.02	0.718	9.35	0710	55.1	95.3	37.8	9.06	`.65	1.24	3.99	0.590	4.88	1.70	19.4	3.82
BGW8.03	0.748	8.63	0930	56.6	99.1	41.5	9.10	1.71	1.32	4.02	0.592	4.99	1.53	18.7	4.07
BGW8.04	0.678	6.34	1150	52.4	90.2	36.5	8.38	1.55	1.17	4.04	0.541	5.41	1.65	17.8	2.74
Arith mean	0.669	7.31	0900	53.2	92.8	38.2	8.39	1.57	1.18	3.85	0.577	5.20	1.69	18.4	4.21
S D	0.096	2.06	0190	3.5	5.5	2.2	0.97	0.15	0.14	0.33	0.024	0.31	0.11	0.8	1.46
S D percent	14.3	28.1	20.5	6.6	6.0	5.8	11.5	9.4	11.6	8.6	4.2	6.0	6.9	4.4	34.6

TABLE 3. NAA data for all specimens of NERSW with values for the arithmetic mean, standard deviation, and standard deviation as percent of arithmetic mean for fabric groups. Replicate analyses identified as A and B (Anal id = analytical identifier, Arith = Arithmetic, bdl = below detection limit, pct = percent, ppm = parts per million, S D = standard deviation).

Catalog number	Anal id/ Fabric group	Na pct	K pct	Ca pct	Sc ppm	Cr ppm	Fe pct	Co ppm	Zn ppm	As ppm	Br ppm	Rb ppm	Sr ppm	Zr ppm
NERSW1.01	CAL120	0.516	1.92	9.14	19.2	182	4.95	22.8	132	7.13	22.3	125	286	bdl
NERSW2.01	CAL101	0.495	2.03	6.25	19.6	183	5.35	26.5	213	5.71	07.9	118	703	103
NERSW3.01	CAL111	0.461	2.12	3.90	20.7	203	5.64	22.9	117	8.40	33.2	141	bdl	bdl
NERSW3.02	CAL112	0.538	2.07	2.86	19.9	195	5.64	28.7	137	5.14	20.7	155	bdl	200
NERSW3.03	CAL116	0.483	2.21	2.74	19.9	195	5.42	22.6	120	8.89	34.3	145	bdl	135
NERSW3.04	CAL114	0.449	2.04	bdl	20.7	188	5.71	21.5	185	4.38	15.2	130	bdl	159
NERSW3.05A	CAL122	0.310	1.92	bdl	22.3	219	6.08	21.1	132	8.77	28.3	114	bdl	bdl
NERSW3.05B	CAL123	0.282	1.64	1.85	21.5	214	5.94	24.3	126	7.41	29.6	096	310	067
Arith Mean	NERSWFG3	0.420	2.00	-	20.8	202	5.74	23.5	136	7.16	26.9	128	-	-
S D		0.102	0.20	-	00.9	012	0.24	02.8	025	1.95	07.5	022	-	-
S D percent		24.2	10.0	-	4.4	5.9	4.1	11.9	18.4	27.2	27.8	17.3	-	-
NERSW4.01	CAL115	0.891	2.15	bdl	18.0	163	4.97	16.8	196	4.91	26.5	138	bdl	061
NERSW4.02	CAL121	0.834	1.97	bdl	17.8	146	5.09	19.1	343	4.80	09.9	138	619	110
NERSW4.03	CAL124	0.887	2.25	bdl	20.0	183	5.37	16.9	124	8.41	44.0	137	bdl	212
Arith Mean	NERSWFG4	0.871	2.12	-	18.6	164	5.14	17.6	221	6.04	26.8	138	-	128
S D		0.032	0.14	-	01.2	018	0.21	01.3	112	2.06	17.0	001	-	077
S D percent		3.7	6.7	-	6.6	11.3	4.0	7.4	50.5	34.1	63.6	0.4	-	60.2
NERSW5.01	CAL118	0.706	1.58	bdl	19.1	180	4.19	15.0	143	5.60	09.3	117	bdl	200
NERSW6.01	CAL119	1.130	1.70	bdl	15.9	169	3.90	15.6	160	2.61	05.8	117	bdl	231
NERSW7.01	CAL125	5.470	1.74	2.31	17.5	180	4.92	17.7	112	6.61	14.3	102	324	135
NERSW8.01	CAL113	0.689	1.58	3.76	18.0	162	4.83	18.7	169	7.08	13.9	84.7	780	177

Catalog number	Sb ppm	Cs ppm	Ba ppm	La ppm	Ce ppm	Nd ppm	Sm ppm	Eu ppm	Tb ppm	Yb ppm	Lu ppm	Ha ppm	Ta ppm	Th ppm	U ppm
NERSW1.01	0.879	5.60	1220	47.3	81.1	38.4	7.41	1.48	1.04	3.00	0.483	4.02	1.39	14.0	2.67
NERSW2.01	0.706	5.82	1280	47.9	84.3	31.3	7.57	1.47	1.07	3.18	0.474	4.38	1.52	14.6	2.48
NERSW3.01	0.836	6.47	0760	50.3	86.1	37.3	7.91	1.53	1.059	3.31	0.514	4.57	1.57	15.0	2.06
NERSW3.02	0.752	7.03	1230	47.3	83.4	38.9	7.57	1,47	0.820	3.27	0.505	4.44	1.45	14.6	2.44
NERSW3.03	0.918	6.71	0590	49.4	81.5	32.9	7.82	1.49	0.962	3.34	0.516	4.42	1.44	14.6	2.25
NERSW3.04	0.782	5.49	2090	47.9	84.3	36.9	7.83	1.54	0.906	3.44	0.480	4.42	1.57	14.9	2.86
NERSW3.05A	0.746	4.84	1180	54.8	95.1	40.4	8.69	1.70	1.169	3.80	0.525	4.86	1.88	16.1	3.43
NERSW3.05B	0.736	3.61	1790	52.8	92.5	42.3	8.43	1.63	1.050	3.75	0.518	4.86	1.52	15.7	2.88
Arith mean	0.795	5.69	1270	50.4	87.1	38.1	8.04	1.56	0.994	3.49	0.510	4.59	1.53	15.1	2.65
S D	0.070	1.31	0580	02.9	05.4	03.2	0.43	0.09	0.124	0.23	0.016	0.22	0.08	00.6	0.50
S D percent	8.8	22.9	45.4	5.8	6.2	8.5	5.3	5.6	12.5	6.6	3.1	4.7	5.4	4.1	18.9
NERSW4.01	0.436	5.98	0570	34.8	67.8	29.6	6.09	1.18	0.942	3.16	0.481	5.43	1.60	14.9	2.41
NERSW4.02	0.394	4.98	0330	49.9	84.7	38.2	7.38	1.41	0.397	3.40	0.468	4.99	1.58	14.8	2.04
NERSW4.03	0.667	4.93	0630	48.2	85.9	38.5	7.89	1.51	1.099	3.44	0.552	5.73	1.57	15.1	2.94
Arith mean	0.499	5.30	0151	44.3	79.5	35.4	7.12	1.37	0.813	3.33	0.500	5.38	1.58	14.9	2.46
S D	0.147	0.59	0157	08.2	10.1	05.1	0.92	0.17	0.368	0.15	0.045	0.37	0.02	00.2	0.45
S D percent	29.5	11.2	104	18.6	12.8	14.3	13.0	12.4	45.3	4.5	9.0	6.9	1.0	1.1	18.3
NERSW5.01	0.624	5.11	1960	50.9	85.7	35.6	7.55	1.46	0.634	3.26	0.533	5.49	1.49	14.3	2.79
NERSW6.01	0.600	4.28	1880	42.6	71.4	30.1	6.34	1.22	0.830	3.03	0.389	6.19	1.38	13.2	1.64
NERSW7.01	0.659	4.47	1140	46.8	78.9	32.7	6.93	1.34	0.506	3.14	0.449	5.47	1.43	13.3	3.13
NERSW8.01	0.449	1.51	1420	46.0	78.7	36.1	7.21	1.36	0.650	3.18	0.505	5.07	1.47	13.8	2.43

TABLE 4. NAA data for all specimens of ITS with values for the arithmetic mean, standard deviation, and standard deviation as percent of arithmetic mean for fabric groups and for all specimens. Replicate analyses identified as A and B (Anal id = analytical identifier, Arith = Arithmetic, bdl = below detection limit, pct = percent, ppm = parts per million, S D = standard deviation).

Catalog number	Anal id/ Fabric group	Na pct	K pct	Ca pct	Sc ppm	Cr ppm	Fe pct	Co ppm	Zn ppm	As ppm	Br ppm	Rb ppm	Sr ppm	Zr ppm
ITS1.01	CAL187	0.619	2.13	6.62	19.6	193	4.93	25.2	144	5.14	10.3	156	225	bdl
ITS1.02	CAL194	0.573	1.98	7.10	19.7	195	5.00	25.9	148	5.28	06.0	155	349	bdl
ITS1.03	CAL199	0.426	1.94	5.51	19.7	199	5.60	24.9	144	7.74	46.0	141	bdl	bdl
ITS1.04	CAL191	0.675	2.12	6.18	19.0	186	4.84	24.4	147	4.20	bdl	159	269	bdl
ITS1.05	CAL192	0.681	2.13	6.08	19.7	196	5.00	24.9	147	4.52	14.6	150	226	bdl
ITS1.06A	CAL198	0.608	2.02	5.68	19.3	191	5.45	25.6	141	5.45	bdl	166	286	bdl
ITS1.06B	CAL486	0.607	1.95	6.95	19.1	187	5.24	26.1	139	4.82	bdl	147	320	bdl
ITS1.07	CAL190	0.587	2.25	4.42	20.0	197	5.12	25.9	141	6.35	32.8	151	bdl	bdl
ITS1.08	CAL564	0.511	1.94	5.93	19.1	184	5.02	23.1	129	7.31	31.8	147	bdl	bdl
ITS1.09	CAL197	0.556	1.87	6.53	18.9	187	5.30	23.7	143	4.13	07.3	163	210	bdl
ITS1.10A	CQL196	0.604	1.99	6.56	19.4	192	5.32	24.7	144	5.57	04.6	163	311	bdl
ITS1.10B	CAL478	0.608	2.09	6.37	19.4	191	4.94	24.9	141	5.47	04.7	149	258	bdl
ITS1.11	CAL188	0.628	1.96	6.76	19.5	193	4.80	24.7	148	4.72	08.1	155	313	bdl
ITS1.12A	CAL186	0.540	2.12	6.59	20.2	199	4.94	25.4	149	6.01	18.4	155	342	bdl
ITS1.12B	CAL485	0.527	2.04	5.98	20.0	195	5.35	25.3	145	5.35	18.2	156	141	bdl
ITS1.13	CAL184	0.634	2.02	6.98	19.1	188	4.81	24.2	146	4.62	11.5	147	319	bdl
ITS1.14	CAL185	0.535	2.06	5.25	20.0	201	5.04	24.6	145	4.73	17.3	163	279	114
ITS1.15	CAL179	0.551	2.13	4.66	20.2	198	5.07	27.0	145	5.49	17.1	154	bdl	bdl
Arith mean	ITSFG1	0.582	2.04	6.12	19.5	193	5.10	25.0	144	5.38	-	154	-	-
S D		0.062	0.09	0.77	00.4	005	0.23	00.9	005	0.98	-	007	-	-
S D percent		10.7	4.6	12.6	2.1	2.6	4.5	3.6	3.2	18.2	-	4.4	-	-
ITS2.01	CAL180	0.547	1.91	8.30	19.7	194	4.90	25.3	146	5.47	08.7	151	163	bdl
ITS2.02	CAL181	0.637	2.06	9.10	19.4	195	4.97	24.7	141	5.65	24.3	146	368	bdl
ITS2.03	CAL193	0.607	1.86	7.74	19.4	191	4.90	25.4	145	4.42	05.2	134	330	bdl
ITS2.04	CQL182	0.570	2.03	8.18	19.1	189	4.89	23.3	138	6.84	15.9	136	302	bdl
ITS2.05	CAL183	0.678	2.15	6.89	18.5	185	4.63	23.1	139	4.13	15.4	144	309	bdl
ITS2.06	CAL178	0.690	2.09	8.28	18.9	187	4.71	23.4	145	4.60	04.9	150	249	bdl
ITS2.07	CAL200	0.624	1.98	7.69	19.1	187	5.12	23.6	133	5.73	27.5	148	426	121
ITS2.08	CAL195	0.796	2.11	8.11	17.9	180	4.84	24.0	140	5.73	0.95	138	273	bdl
Arith mean	ITSFG2	0.644	2.02	8.04	19.0	188	4.97	24.1	141	5.32	11.6	143	302	-
S D		0.078	0.10	0.63	00.6	005	0.15	00.9	004	0.89	8.45	007	079	-
S D percent		12.2	4.9	7.9	3.0	2.6	3.0	3.8	3.1	16.7	72.8	4.6	26.1	-
ITS3.01	CAL189	0.653	2.07	6.92	19.0	185	4.79	24.9	143	4.36	bdl	128	361	209
Arith mean	ITSFG1-3	0.603	2.04	6.72	19.4	191	5.02	24.7	143	5.33	-	150	-	-
S D		0.071	0.09	1.13	00.5	005	0.23	01.0	004	0.94	-	009	-	-
S D percent		11.8	4.6	16.9	2.7	2.8	4.6	3.9	3.1	17.6	-	6.2	-	-

Catalog number	Sb ppm	Cs ppm	Ba ppm	La ppm	Ce ppm	Nd ppm	Sm ppm	Eu ppm	Tb ppm	Yb ppm	Lu ppm	Ha ppm	Ta ppm	Th ppm	U ppm
ITS1.01	0.933	7.91	575	47.1	83.9	39.1	7.34	1.45	1.31	3.18	0.440	4.28	1.52	14.4	2.17
ITS1.02	0.804	7.48	511	46.2	83.4	39.8	7.16	1.45	1.29	3.04	0.445	3.93	1.50	14.1	1.88
ITS1.03	0.815	6.87	408	45.4	78.5	36.1	7.40	1.49	0.73	3.23	0.475	4.35	1.53	14.5	2.07
ITS1.04	0.881	7.76	503	45.6	82.4	37.7	7.14	1.44	1.21	2.99	0.418	4.32	1.40	13.8	1.99
ITS1.05	0.865	7.21	665	47.0	84.1	37.4	7.46	1.52	0.85	3.02	0.478	4.32	1.49	14.1	1.79
ITS1.06A	0.769	8.00	472	46.0	81.8	34.4	7.10	1.46	0.95	3.05	0.439	3.85	1.58	13.9	2.18
ITS1.06B	0.820	7.83	431	45.9	81.3	33.7	7.08	1.43	0.92	2.94	0.438	3.79	1.40	13.9	1.78
ITS1.07	0.891	7.45	617	48.3	83.2	38.0	7.89	1.57	1.60	3.37	0.532	4.60	1.59	14.3	2.06
ITS1.08	0.975	7.32	473	45.5	81.7	39.4	7.48	1.48	0.93	3.24	0.493	4.15	1.38	13.9	1.48

ITS1.09	0.706	7.83	520	45.6	80.7	33.6	7.03	1.43	1.03	3.08	0.441	3.78	1.38	13.6	1.79
ITS1.10A	0.726	8.23	573	47.2	82.2	34.8	7.31	1.51	1.01	3.16	0.490	3.82	1.44	14.1	2.01
ITS1.10B	0.843	8.13	566	47.1	82.6	40.3	7.60	1.48	1.07	3.16	0.432	3.83	1.38	14.0	1.23
ITS1.11	0.789	7.69	424	46.0	81.7	37.0	7.13	1.43	1.23	2.96	0.437	3.91	1.38	14.0	1.94
ITS1.12A	0.750	8.09	358	47.5	85.1	36.4	7.41	1.49	1.30	3.09	0.429	4.32	1.57	14.6	2.20
ITS1.12B	0.953	8.09	473	48.0	84.1	36.4	7.62	1.51	0.98	3.48	0.453	3.92	1.48	14.7	1.89
ITS113	0.966	7.41	370	45.6	80.7	36.6	7.21	1.46	1.26	3.08	0.436	4.25	1.47	13.9	2.00
ITS1.14	0.780	7.98	374	46.6	82.6	34.6	7.23	1.48	1.09	2.94	0.430	3.93	1.49	14.2	1.91
ITS1.15	0.855	8.03	551	47.9	84.5	35.7	7.52	1.54	1.19	3.35	0.481	4.06	1.54	14.5	1.92
Arith mean	0.840	7.73	492	46.6	82.5	36.8	7.34	1.48	1.11	3.13	0.456	4.08	1.47	14.1	1.90
S D absolute	0.082	0.37	088	00.9	01.6	02.1	0.23	0.02	0.21	0.16	0.029	0.25	0.07	00.3	0.24
S D percent	9.7	4.8	17.9	2.0	2.0	5.6	3.1	2.7	18.9	5.0	6.5	6.1	5.0	2.1	12.7
ITS2.01	0.869	7.50	446	46.2	81.5	34.9	7.31	1.46	1.36	2.95	0.442	3.85	1.47	13.9	2.18
ITS2.02	0.865	7.33	545	46.7	82.0	37.8	7.34	1.47	1.18	3.11	0.434	4.30	1.60	14.2	2.54
ITS2.03	0.759	6.46	344	46.3	82.6	35.2	7.08	1.45	1.10	3.20	0.382	3.99	1.55	13.9	1.70
ITS2.04	0.748	6.84	501	45.6	81.3	39.9	7.21	1.47	1.14	3.01	0.436	4.11	1.47	13.6	1.91
ITS2.05	0.745	7.08	415	43.9	78.9	36.1	7.05	1.45	0.57	3.08	0.440	4.55	1.49	13.6	2.29
ITS2.06	0.938	7.66	410	45.9	81.5	36.1	7.19	1.42	1.18	3.16	0.420	4.22	1.55	13.9	2.03
ITS2.07	0.759	6.59	452	44.3	79.8	37.2	7.26	1.46	1.03	3.38	0.504	4.37	1.50	14.3	2.05
ITS2.08	0.871	6.67	460	43.7	78.5	35.0	6.87	1.36	0.84	2.71	0.389	4.62	1.44	13.5	2.0-
Arith mean	0.810	7.01	447	45.3	80.8	36.5	7.16	1.44	1.05	3.08	0.431	4.25	1.51	13.9	2.10
S D	0.075	0.45	060	01.2	01.5	01.7	0.16	0.04	0.24	0.20	0.038	0.27	0.05	00.3	0.25
S D percent	9.1	6.3	13.5	2.7	1.9	4.7	2.2	2.5	23.3	6.4	8.7	6.3	3.5	2.0	12.0
ITS3.01	0.656	6.04	509	44.1	79.2	36.2	6.64	1.36	1.19	2.77	0.350	4.06	1.45	13.0	1.60
Arith. mean	0.827	7.45	479	46.1	81.9	36.7	7.26	1.46	1.09	3.10	0.445	4.13	1.48	14.0	1.95
S D	0.084	0.58	081	01.2	01.8	01.9	0.25	0.05	0.21	0.18	0.038	0.26	0.07	00.4	0.26
S D percent	10.2	7.7	16.9	2.6	2.2	5.1	3.5	3.2	19.5	5.7	8.5	6.2	4.6	2.6	13.4

TABLE 5. NAA data for all pellets manufactured from clay specimens. Analysis of fine fraction obtained through levigation identified as FF (Anal id = analytical identifier, bdl = below detection limit, pct = percent, ppm = parts per million).

Catalog number	**Anal id**	**Na pct**	**K pct**	**Ca pct**	**Sc ppm**	**Cr ppm**	**Fe pct**	**Co ppm**	**Zn ppm**	**As ppm**	**Br ppm**	**Rb ppm**	**Sr ppm**	**Zr ppm**
CCET.10	CAL388	0.630	1.74	bdl	20.7	149	4.90	25.5	124	2.81	bdl	129	bdl	139
CRCS.01	CAL337	0.273	1.07	28.9	20.4	072	5.52	25.4	110	2.02	bdl	087	421	106
CCVB.01	CAL331	0.641	1.35	bdl	13.3	191	4.41	16.4	081	54.2	bdl	141	bdl	233
CVLT.01	CAL450	0.659	2.17	16.1	14.8	226	3.91	21.9	144	8.34	bdl	132	741	Bdl
CVLT.02	CAL451	0.946	2.33	12.1	17.4	214	4.70	21.7	111	11.3	bdl	147	653	Bdl
CVLT.03	CAL452	1.360	1.99	12.2	15.7	163	4.06	18.0	111	10.2	1.03	117	615	Bdl
CVLT.04	CAL453	0.973	2.65	7.87	17.0	165	4.44	19.8	121	5.72	bdl	177	424	129
CVLT.05	CAL455	0.752	1.73	13.6	13.8	140	3.57	16.3	105	8.91	bdl	117	656	075
CVLT.06	CAL454	1.170	1.98	9.10	12.8	134	3.42	15.0	089	7.23	bdl	132	414	117
CVLT.07	CAL347	0.741	2.28	11.2	15.6	156	4.46	18.9	117	14.5	1.15	161	481	147
CVLT.07FF	CAL414	0.664	2.31	9.68	16.5	162	4.26	18.8	122	11.6	bdl	167	256	179
CCBS.01	CAL367	1.410	2.58	3.56	17.7	196	5.00	23.1	130	17.9	1.14	196	251	119
CCBS.02	CAL368	1.090	2.54	4.55	17.5	191	5.53	21.9	128	15.3	bdl	182	258	Bdl
CCBS.03	CAL393	1.611	2.68	4.13	17.6	187	4.98	21.6	126	18.0	12.1	179	264	Bdl
CALP.01	CAL382	0.264	1.97	bdl	10.4	126	0.97	00.3	055	1.28	bdl	122	bdl	224
CCFM.01	CAL384	0.723	2.38	bdl	16.6	149	4.17	22.6	123	2.47	bdl	179	259	152
CCFM.02	CAL334	1.550	1.97	bdl	11.9	165	3.23	16.0	080	5.62	bdl	133	135	156
CCFM.03	CAL335	1.460	2.38	bdl	15.3	259	3.91	43.5	1570	8.95	bdl	163	351	2440
CCFM.04	CAL336	1.542	1.84	bdl	09.8	149	2.60	13.7	061	3.31	bdl	121	bdl	197
CCFM.05	CAL385	1.460	2.34	bdl	16.3	213	4.37	21.5	109	7.03	bdl	167	144	180
CCFM.06	CAL386	0.968	1.87	bdl	16.4	177	4.49	21.6	116	5.41	bdl	151	122	179
CARQ.01	CAL456	0.507	2.38	4.00	19.1	203	4.59	20.9	143	2.87	bdl	174	bdl	107
CARQ.02	CAL457	0.483	2.29	6.79	19.1	193	4.74	19.4	130	4.23	bdl	158	333	Bdl

Catalog Number	Sb ppm	Cs ppm	Ba ppm	La ppm	Ce ppm	Nd ppm	Sm ppm	Eu ppm	Tb ppm	Yb ppm	Lu ppm	Ha ppm	Ta ppm	Th ppm	U ppm
CCET.10	0.638	14.3	bdl	36.7	77.4	24.8	4.91	0.95	0.518	2.42	0.321	4.30	1.32	10.7	1.14
CRCS.01	0.424	5.61	0328	39.8	68.7	36.1	13.2	3.60	2.51	2.59	0.433	1.92	0.47	06.2	0.86
CCVB.01	2.240	37.5	0581	41.7	70.0	30.0	5.42	1.00	0.656	2.43	0.316	7.16	1.27	17.1	1.98
CVLT.01	1.060	10.8	0208	34.8	62.2	26.2	5.15	1.01	0.718	2.37	0.364	3.47	0.96	10.2	3.88
CVLT.02	bdl	8.41	bdl	40.8	72.8	28.4	5.70	1.15	0.773	2.81	0.365	3.79	1.09	11.7	3.54
CVLT.03	0.810	5.02	bdl	40.4	70.6	31.5	5.72	1.08	0.834	2.19	0.337	3.66	1.15	11.6	0.57
CVLT.04	0.750	9.66	0336	42.9	74.5	34.0	5.75	1.21	0.762	2.48	0.384	3.84	1.15	12.4	5.49
CVLT.05	0.682	6.19	0313	36.7	62.5	28.1	5.74	1.13	0.708	2.45	0.338	3.78	1.13	10.2	1.25
CVLT.06	0.652	6.31	0301	33.4	59.0	24.4	4.95	1.00	0.716	2.25	0.330	4.79	1.00	10.1	2.37
CVLT.07	0.893	9.18	0275	41.2	70.8	31.6	6.08	1.17	0.893	2.81	0.378	3.92	1.14	11.7	2.43
CVLT.07FF	0.798	9.35	0356	42.4	74.0	36.2	6.25	1.23	1.05	2.74	0.383	4.05	1.16	12.2	2.38
CCBS.01	1.060	10.4	bdl	42.4	77.1	34.9	6.30	1.20	0.479	2.84	0.372	4.20	1.35	13.2	1.40
CCBS.02	0.966	10.8	0402	41.7	75.2	34.4	6.19	1.19	0.378	2.74	0.404	4.72	1.26	12.9	1.49
CCBS.03	1.040	11.1	bdl	42.5	75.5	36.6	6.19	1.19	0.849	2.60	0.393	4.39	1.33	13.2	2.00
CALP.01	0.542	4.63	0318	37.0	69.2	28.1	5.64	0.92	0.746	2.62	0.419	8.22	1.09	10.3	2.44
CCFM.01	0.750	9.29	0408	43.4	80.4	30.7	6.52	1.24	0.873	2.86	0.428	5.46	1.46	13.9	2.25
CCFM.02	0.447	5.35	0457	31.4	57.3	26.5	4.78	0.95	0.649	2.27	0.321	5.41	1.01	10.8	2.29
CCFM.03	13.50	8.43	1009	37.9	70.1	44.8	5.92	1.16	0.851	4.37	0.723	86.1	1.29	14.5	2.49
CCFM.04	0.445	4.47	0438	36.6	64.9	26.4	4.70	0.85	0.608	2.19	0.258	7.11	0.98	11.3	1.50
CCFM.05	0.748	7.48	0632	39.3	70.8	32.0	6.17	1.20	0.927	2.88	0.442	5.31	1.21	14.2	2.43
CCFM.06	0.538	7.26	0453	46.0	82.2	33.8	6.64	1.29	0.802	2.94	0.429	5.38	1.24	15.3	2.45
CARQ.01	0.867	10.3	0364	51.2	93.1	39.5	8.00	1.57	1.080	3.33	0.463	4.11	1.53	15.4	1.37
CARQ.02	0.780	8.55	0352	45.5	81.3	37.0	7.28	1.41	0.979	3.12	0.430	3.84	1.36	13.8	1.97

5.1 Black-Gloss Ware

The optical microscopy of the 40 specimen chips revealed the presence of what were judged to be six distinct fabrics:

- Preliminary Fabric A: a fine, pink fabric with a slightly to distinctly calcareous matrix (26 specimens);
- Preliminary Fabric B: a fine, pink fabric with a slightly calcareous matrix containing abundant, minute, light, glistening particles (mica) (2 specimens);
- Preliminary Fabric C: an intermediate-textured, pink or light red fabric with a distinctly calcareous matrix (6 specimens);
- Preliminary Fabric D: an intermediate-textured, light red fabric with a non-calcareous or slightly calcareous matrix containing abundant, small, colorless grains (quartz) (1 specimen);
- Preliminary Fabric E: an intermediate-textured, reddish brown fabric with a non-calcareous matrix containing frequent, small, colorless grains (quartz), frequent, small, reddish brown bodies (sedimentary rock fragments), and frequent, small, reddish brown, glistening plates (mica) (1 specimen); and
- Preliminary Fabric F: a gritty, pink or reddish yellow fabric with a non-calcareous matrix containing abundant, small to medium, colorless grains (quartz) (4 specimens).

Preliminary Fabric Groups A-B correspond to the specimens classified as fine-textured BGW for sampling purposes, while Preliminary Fabric Groups C-F correspond to the specimens classified as intermediate-/gritty-textured BGW at that juncture.

The NAA data indicate that the specimens assigned to the Preliminary Fabrics A-C were manufactured with a moderately calcareous paste, while those assigned to Preliminary Fabrics D-F were produced with a non-calcareous or low calcium paste.

Cluster analysis was carried out using a variety of different parameters for the 34 moderately calcareous specimens (including two pairs of replicates) (i.e., the specimens assigned to Preliminary Fabrics A-C) and the 12 specimens of moderately to highly calcareous clay (seven specimens from Volterra, three specimens from Castelnuovo Berardenga Scalo, two specimens from Arezzo – Quarata).[70] The representative clustering solution presented here (Fig. 3) is probably best interpreted as containing seven clusters:

- Cluster 1, composed of 12 of the specimens assigned to Preliminary Fabric A (including one pair of replicates) and the two examples of Arezzo – Quarata clay;
- Cluster 2, composed of 10 of the specimens assigned to Preliminary Fabric A;
- Cluster 3, composed of four of the specimens assigned to Preliminary Fabric A;
- Cluster 4, composed of the two specimens assigned to preliminary Fabric B (including one pair of replicates);
- Cluster 5, composed of the three specimens of Castelnuovo Berardenga Scalo clay;
- Cluster 6, composed of the six specimens assigned to Preliminary Fabric C; and
- Cluster 7, composed of the seven specimens of Volterra clay.

70. The specimen of clay from Radda – Castiglione was excluded from this procedure due to its extremely high calcium value (28.9 percent).

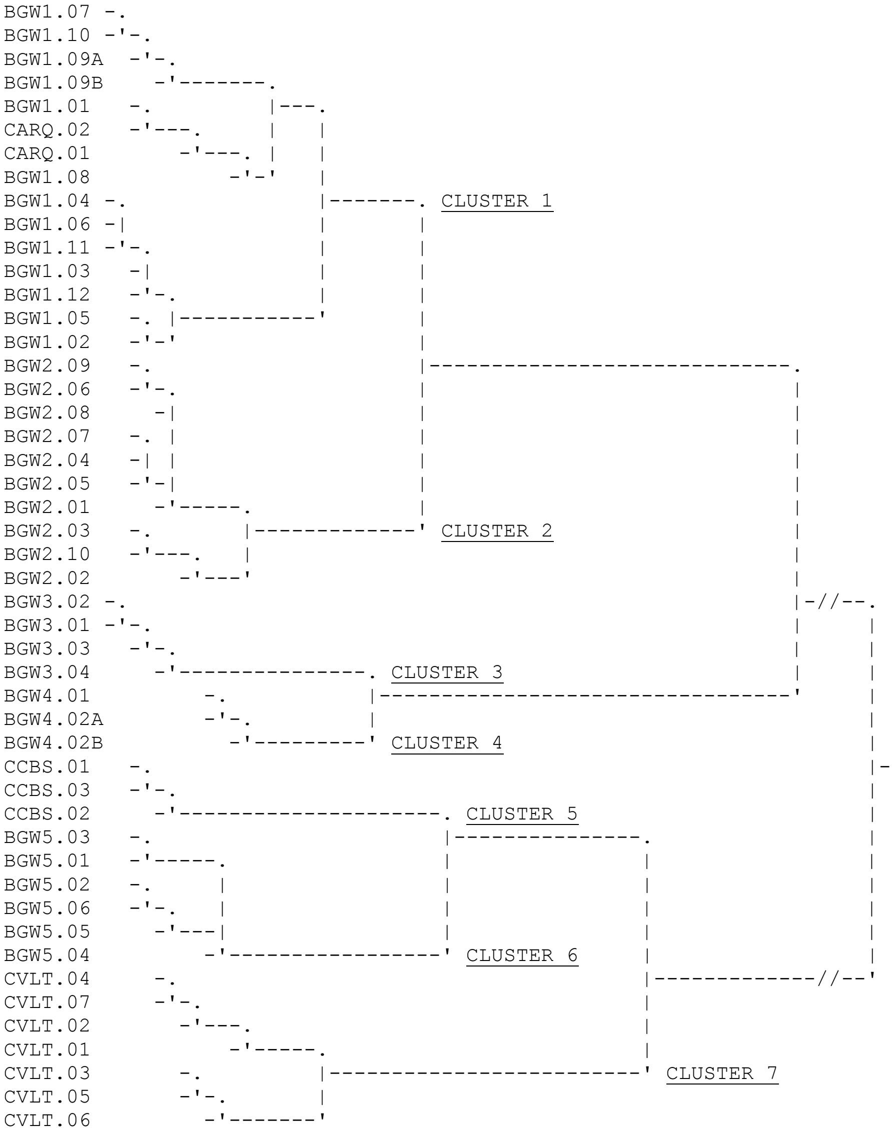

FIG. 3. Dendrogram displaying representative clustering solution for cluster analysis carried out for NAA data for all moderately calcareous BGW specimens (Fabric Groups 1-5) and all test tiles manufactured from calcareous clay specimens. Elements used: Na, K, Ca, Sc, Cr, Fe, Co, Zn, Rb, Sr, Zr, Cs, La, Ce, Nd, Sm, Eu, Yb, Lu, Hf, Ta, Th. Data transformation: log. Distance measure: mean Euclidean. Agglomeration procedure: Nature's Groups.

Cluster 1 is composed of two sub-clusters, one consisting of seven specimens of BGW analyzed in the same batch, and the other of five specimens of BGW (including one pair of replicates) and the 2 specimens of Arezzo – Quarata clay, which were analyzed in four different batches, all different from the batch in which the specimens in the first sub-cluster were analyzed. This suggests that the division of these specimens into two sub-clusters is the product of analytical error. The fact that the two specimens of Arezzo – Quarata clay are included in this cluster suggests that the examples of fine-textured BGW included in this cluster were manufactured from a clay similar to this material. Clusters 3 and 4 are linked at a relatively low level of dissimilarity, raising the possibility that the sets of specimens of BGW included in these are related to one another. The fact that the clays from Volterra and Castelnuovo Berardenga Scalo are clustered separately from the pottery specimens is not surprising, given the clays' significantly coarser texture.

Cluster analysis was also carried out using a variety of different parameters for the six low-calcium and non-calcareous specimens (including one pair or replicates) (i.e., the specimens assigned to Preliminary Fabrics D-F). The representative clustering solution presented here (FIG. 4) is probably best interpreted as containing three clusters:
- Cluster 1, composed of the four specimens assigned to Preliminary Fabric F;
- Cluster 2, composed of the pair of replicates assigned to Preliminary Fabric D; and
- Cluster 3, composed of the one specimen assigned to Preliminary Fabric E.

```
BGW8.02 -.
BGW8.03 -'-----.
BGW8.01 -.     |------------. CLUSTER 1
BGW8.04 -'-----'            |
BGW6.01A  -.                |-
BGW6.01B  -'---. CLUSTER 2  |
BGW7.01        -'------------' CLUSTER 3
```

FIG. 4. Dendrogram displaying representative clustering solution for cluster analysis carried out for NAA data for non-calcareous and low-calcium BGW specimens (Fabric Groups 6-8). Elements used: Na, K, Sc, Cr, Fe, Co, Zn, Rb, Zr, Cs, La, Ce, Nd, Sm, Eu, Yb, Lu, Hf, Ta, Th. Data transformation: log. Distance measure: mean Euclidean. Agglomeration procedure: Nature's Groups.

Cluster analysis was also carried out using a variety of different parameters for the same six pottery specimens and the nine specimens of non-calcareous clay (one specimen from Cetamura, six specimens from Castelfranco di Sopra – il Matassino, one specimen from Altopascio, one specimen from

Colle Val d'Elsa – Belvedere). This analysis failed to identify any apparent relationship between the pottery and clay specimens.

In light of these results, the set of specimens assigned to Preliminary Fabric A are here presented as Fabric Groups 1, 2, and 3 in accordance with their assignment to Clusters 1, 2, and 3, respectively, in the representative clustering solution, while those assigned to Preliminary Fabrics B-F are here presented as Fabric Groups 4-8, respectively. Fabric Group 5 should perhaps be divided into two sub-groups, one consisting of two specimens (BGW5.01, BGW5.03) that display a highly similar chemical composition (and were accordingly linked at a low level of dissimilarity in the cluster analysis) and under the binocular microscope are distinguished from the other four specimens by their higher concentration of calcareous material and lower concentration of medium and coarse inclusions.

The program of petrographic analysis allowed this picture to be developed in somewhat greater detail. The specimens from Fabric Groups 1-4 and the two specimens of Arezzo – Quarata clay have a generally similar composition and texture, with an inclusion component consisting exclusively or almost exclusively of monocrystalline quartz and mica predominantly of silt size, ranging in some cases up to very fine sand size. The fabric groups to which the pottery specimens belong were apparently manufactured from either a fine, moderately calcareous clay, such as Arezzo – Quarata clay, or a less fine moderately to highly calcareous clay, such as Volterra clay or Castelnuovo Berardenga Scalo clay, subjected to levigation. The specimens from Fabric Groups 2-4 proved to contain slightly more material of very fine sand size than those from Fabric Group 1, including grains of monocrystalline and polycrystalline quartz, laths of mica, and, in one case, fragments of siltstone. This observation is in line with the results obtained from the optical microscopy of the specimens belonging to these same four fabric groups, which revealed that, while only one of the 12 specimens assigned to Fabric Group 1 contained rare, small, reddish brown to dark gray inclusions – probably to be identified as fragments of mudstone and/or siltstone – five of the 10 specimens assigned to Fabric Group 2 contained inclusions of this kind, as did two of the four specimens assigned to Fabric Group 3 and both of those assigned to Fabric Group 4. These observations suggest that Fabric Group 1 was manufactured from a clay different from the clay or clays employed for the manufacture of Fabric Groups 2-4.

The specimen from Fabric Group 5 contained inclusions in the silt to medium sand size range, including monocrystalline and polycrystalline quartz, mica, siltstone, and perhaps also a fragment of microfauna. This indicates that the fabric group to which it belongs was manufactured from a sandy, moderately calcareous clay, probably of marine origin. The specimen from Fabric Group 6 had a generally similar composition, though with no evidence of microfauna, and this specimen/fabric group was likely manufactured from a less calcareous clay of marine or continental origin.

The specimens from Fabric Groups 7 and 8 contained inclusions in the silt to coarse sand size range, including grains of monocrystalline and polycrystalline quartz, laths of mica, and fragments of mudstone. The fabric groups to which they belong were manufactured from a continental clay similar to, though less coarse than the lacustrine clays from Catelfranco Di Sopra – il Matassino and Altopascio or the probable lacustrine clay from Colle Val D'Elsa – Belvedere, or from clays similar to these that were subjected to levigation.

5.2 North Etrurian Red-Slip Ware

The optical microscopy of the 14 specimen chips revealed the presence of six distinct fabrics:

- Preliminary Fabric A: a fine, red or reddish yellow fabric with a distinctly calcareous matrix (two specimens);
- Preliminary Fabric B: a fine, pink, reddish yellow or reddish brown fabric with a non-calcareous matrix (five specimens);
- Preliminary Fabric C: an intermediate-textured, pink or reddish yellow fabric with a non-calcareous matrix containing abundant, small colorless grains (quartz) and sparse to abundant glistening plates (mica) (three specimens);
- Preliminary Fabric D: a porphyritic, light red fabric containing abundant, minute to medium colorless grains (quartz), sparse glistening plates (mica), and rare, small, and reddish bodies (fragments of sedimentary and igneous rock) (one specimen);
- Preliminary Fabric E: a gritty pink fabric containing very abundant, minute to small, colorless grains (quartz) (two specimens); and
- Preliminary Fabric F: a gritty pink fabric containing abundant, small white bodies and reaction rims (calcium carbonate) and sparse, small colorless grains (quartz) (one specimen).

The NAA data indicate that the one of the specimens assigned to Preliminary Fabric A was manufactured from a moderately calcareous paste and the other from a highly calcareous paste, those assigned to preliminary Fabric B with a low-calcium to non-calcareous paste, those assigned to Preliminary Fabrics C-D with a non-calcareous paste, and those assigned to Preliminary Fabrics E-F with a low-calcium or non-calcareous paste.

Cluster analysis was carried out for the 12 non-calcareous and low-calcium specimens (including one pair of replicates) (i.e., Preliminary Fabrics B-F). The representative clustering solution presented here (Fig. 5) is probably best interpreted as containing three clusters:
- Cluster 1, composed of the specimens assigned to Preliminary Fabric B;
- Cluster 2, composed of the specimens assigned to the Preliminary Fabrics C-E; and
- Cluster 3, composed of the single specimen assigned to Preliminary Fabric F.

```
NERSW3.02  -.
NERSW3.03  -'---.
NERSW3.01  -.   |-------.
NERSW3.04  -'---'       |
NERSW3.05A -.           |-------------. CLUSTER 1
NERSW3.05B -'-----------'             |
NERSW5.01   -.                        |-
NERSW7.01   -'-.                      |
NERSW6.01   -' -.                     |
NERSW4.02  -.   |---------. CLUSTER 2 |
NERSW4.03  -'-.-|         |           |
NERSW4.01  -'-'           |           |
NERSW8.01                -'-----------' CLUSTER 3
```

Fig. 5. Dendrogram displaying representative clustering solution for cluster analysis carried out for NAA data for all low-calcium and non-calcareous NERSW specimens (Fabric Groups 3-8). Elements used: Na, K, Ca, Cr, Fe, Rb, Sr, Cs, La, Ce, Yb, Hf, Ta, Th. Data transformation: log. Distance measure: mean Euclidean. Agglomeration procedure: Nature's Groups.

Cluster 2 contains two sub-clusters, one consisting of the three specimens assigned to Preliminary Fabric C, and the other consisting of the one and two specimens assigned to the Preliminary Fabrics D and E, respectively. The two specimens assigned to Preliminary Fabric E are significantly different in texture, with one non-calcareous and the other low calcium.

Cluster analysis was carried out using a variety of different parameters for these same 12 pottery specimens and the nine specimens of non-calcareous clay included in the project. This analysis failed to identify any apparent relationship between the pottery and clay specimens.

In light of these results, the two specimens assigned to Preliminary Fabric A are here presented as Fabric Groups 1 and 2, those assigned to the Preliminary Fabrics B-D presented as Fabric Groups 3-5, the two specimens assigned to Preliminary Fabric Group E presented as Fabric Groups 6 and 7, and the specimen assigned to Preliminary Fabric Group F presented as Fabric Group 8.

The program of petrographic analysis did not include a specimen of either Fabric Group 2 or Fabric Group 6 due to the absence of a fragment of a size sufficient for sectioning. The specimen from Fabric Group 1 had an inclusion component consisting of silt-sized monocrystalline quartz and mica, with small amounts of material of fine sand size, including monocrystalline and polycrystalline quartz, mica, and fragments of siltstone and mudstone. This is similar to the specimens from BGW Fabric Groups 2-4 (the specimen from Fabric Group 2, in particular), and it seems likely that this specimen/fabric group was manufactured using the same raw materials and processing techniques as these other fabric groups (i.e., fine calcareous clay or levigated, less fine calcareous clay).

The specimen from Fabric Group 3 had a notably sparse inclusion component consisting of silt-sized monocrystalline quartz and mica, with a very small amount of these materials in the fine sand range. This fabric group was likely manufactured from unusually fine, low-calcium clay or very thoroughly levigated, less fine calcareous clay.

The specimen from Fabric Group 4 had an inclusion component consisting of monocrystalline and polycrystalline quartz and mica in the silt to very fine sand size-range. This fabric group was manufactured from a fine, non-calcareous continental clay, or a coarser, non-calcareous continental clay similar to those employed for the manufacture of BGW Fabric Groups 7 and 8 subjected to levigation.

The specimen from Fabric Group 5 had an inclusion component consisting of monocrystalline and polycrystalline quartz, mica, feldspar, granite, mudstone, and siltstone in the silt to coarse sand size-range. Its composition is generally similar to those of the specimens from BGW Fabric Groups 7 and 8, and the fabric groups to which they belong were manufactured employing materials and processing techniques similar to those employed for the manufacture of these fabric groups.

The specimen from Fabric Group 7 had an inclusion component consisting of monocrystalline and polycrystalline quartz, mudstone, siltstone and mica in the silt to coarse sand size-range. It was manufactured from a sandy, low calcium clay of either marine or continental origin.

The specimen from Fabric Group 8 had an inclusion component consisting of monocrystalline and polycrystalline quartz, feldspar, mica, mudstone, and perhaps also microfauna in the silt to fine sand size-range. This is generally similar to the composition of the specimen from BGW Fabric Group 5, and this fabric group was probably manufactured from material similar to that employed for the manufacture of this other fabric group (i.e., sandy marine clay).

5.3 Italian Terra Sigillata

The optical microscopy of the 24 specimen chips revealed the presence of a single fine, reddish fabric with a distinctly calcareous matrix. It subsumes two more or less distinct variants that almost certainly reflect differences in the temperature and perhaps also the duration of firing. Variant 1, which was presumably fired at a temperature range similar to that employed for firing the four fabric groups of fine, calcareous BGW, has a light red to pink body that displays a smooth to slightly irregular fracture surface, with a slightly irregular and less distinctly calcareous matrix that contains sparse, small, glistening plates (mica). Variant 2, which was presumably fired at a somewhat higher temperature and perhaps also for a longer period of time, displays a somewhat darker range of colors (light reddish brown, reddish brown, light red) and a smooth, often conchoidal fracture surface, with a compact matrix containing well rounded voids and prominent, small, white, calcareous bodies and reaction rims. A small number of specimens display characteristics that place them between the two variants just described, supporting the inference that the differences between the two represent the results of variability in firing conditions.

The NAA data indicate a fairly homogeneous set of specimens manufactured using a moderately calcareous paste.

Cluster analysis was carried out for the set of 24 specimens (including three pairs of replicates) and 2 specimens of Arezzo – Quarata clay using a variety of different parameters. The representative clustering solution presented here (Fig. 6) is probably best interpreted as containing two clusters:

- <u>Cluster 1</u>, composed of 16 specimens of ITS – including all three pairs of replicates – and both specimens of Arezzo – Quarata clay; and
- <u>Cluster 2</u>, composed of the remaining eight specimens of ITS.

```
ITS1.12A -.
ITS1.01  -'---.
ITS1.04    -. |-.
ITS1.05    -'-' |
ITS2.05  -.     |---.
ITS1.13  -'-----'   |
ITS1.03      -.     |---.
ITS1.08      -'-----'   |
ITS1.11  -.             |-------------------------.
ITS1.02  -'---.         |                         |
ITS1.10A -.   |---.     |                         |
ITS1.09  -'-. |   |     |                         |
ITS1.06B   -'-'   |     |                         |
ITS1.12B   -.     |-----'                         |
ITS1.10B   -'---. |                               |
CARQ.02        -'-'                               |
ITS1.14  -.                                       |-//-. CLUSTER 1
ITS1.06A -'-----------.                           |    |
ITS1.15    -.         |---.                       |    |
ITS1.07    -'---------'   |                       |    |
CARQ.01                  -'-----------------------'    |
ITS2.06    -.                                          |-
ITS2.02    -'-.                                        |
ITS2.01      -'---.                                    |
ITS2.04      -.   |-----.                              |
ITS2.07      -|   |     |                              |
ITS2.03      -'---'     |                              |
ITS3.01        -.       |---------------------------//-' CLUSTER 2
ITS2.08        -'-------'
```

Fig. 6. Dendrogram displaying representative clustering solution for cluster analysis carried out for NAA data for all ITS specimens and test tiles manufactured from Arezzo – Quarata clay specimens. Elements used: K, Ca, Sc, Cr, Zn, Rb, Cs, La, Ce, Nd, Sm, Eu, Yb, Hf, Ta, Th. Data transformation: log. Distance measure: mean Euclidean. Agglomeration procedure: Nature's Groups.

Multiple examples of both Variant 1 and Variant 2 were assigned to either cluster, confirming the assumption that this distinction relates to firing regimen rather than to composition. The positioning of the three pairs of replicates in different sub-clusters within Cluster 1 indicates that the internal structure of this cluster likely should be attributed in substantial measure to non-significant compositional variability between specimens and/or analytical error. Both of the specimens of Arezzo – Quarata clay link into their sub-cluster at a fairly high level of dissimilarity, indicating that they are not highly similar to the pottery specimens in these sub-clusters.

There is a clear compositional distinction between the Cluster 1 specimens and the Cluster 2 specimens, with those in the former set displaying values for Ca at the low end of the range attested for this element (< ca. 7 percent) and those in the latter displaying values at the high end of this range (> ca.

7 percent). The Cluster 2 specimens also display higher values for Sr and slightly lower values for the other elements, with the exception of Hf. The higher values for Sr in the Cluster 2 specimens can be attributed to the fact that this element commonly occurs in calcium carbonate and thus normally shows a positive correlation with Ca. The higher values for Hf in these specimens should probably be attributed to the presence of a somewhat more substantial presence in the fabric of fine-grained quartz, since Hf regularly occurs in zircon, a common accessory mineral in quartz sand. The relatively low values for the other elements in the Cluster 2 specimens can be attributed to minor dilution produced by the greater concentration of Ca and perhaps also the conjectured greater concentration of quartz. These observations indicate that the Cluster 1 specimens and Cluster 2 specimens were manufactured from similar, if somewhat different clays, with the clay employed for the production of the latter set perhaps deposited in a somewhat higher energy environment that resulted in a more substantial aplastic component.

One of the two specimens of Arezzo – Quarata clay (CARQ.02) has a Ca value that falls at the boundary between the Cluster 1 specimens and Cluster 2 specimens, with the values for most of the other elements falling within the range attested for the specimens in these two groups. The other clay specimen (CARQ.01) has a Ca value somewhat below the minimum attested for the specimens in Clusters 1 and 2 and values for several alkali metals (Rb, Cs) and rare earths (La, Ce, Sm) that greatly exceed the maximum value attested for these specimens. These observations suggest that the first specimen (i.e., CARQ.02) is generally similar to the clay employed for the manufacture of the specimens of ITS, while the other (CARQ.01) is not.

The calculation of multivariate probability scores of group membership (henceforth referred to as MADCORR trials) elucidates somewhat – if not in a definitive manner – the significance of the compositional variability present within the set of specimens of ITS and the relationship between these and the two specimens of Arezzo – Quarata clay. A set of MADCORR trials using various numbers and sets of elements was first carried out employing the entire set of specimens of ITS as the core group (treating each of the three pairs of replicates as two different specimens), evaluating the statistical probability that the two clay specimens might belong to this group. The representative trial indicates a fairly homogeneous core group, with nine specimens assigned scores in the 90-99 percent range, five in the 80-89 percent range, six in the 70-79 percent range, three in the 50-55 percent range, and three in the 40-49 percent range. (TABLE 6) Another expression of this within-group compositional homogeneity is the fact that just three of the specimens registered values two standard deviations or more beyond the core group mean for two or more elements. Clay CARQ.02 was assigned a score of 9.7 percent, while clay CARQ.01 was assigned a value so low that it rounded to 0. While none of the values for CARQ.02 lay two or more standard deviations beyond the core group mean, no fewer than eight of those for CARQ.01 differed from this value by this amount or more. These results confirm the inference that CARQ.02 is generally, if not highly similar to the core group, while CARQ.01 is not related to it.

TABLE 6: Results of MADCORR trial for NAA data, with all ITS specimens employed as core group and pellets manufactured from specimens of Arezzo – Quarata clay treated as unknowns. Elements used: Ca, Sc, Cr, Fe, Rb, Cs, La, Ce, Sm, Eu, Yb. Replicate analyses identified as A and B.

Core group	Probability	Core group	Probability	Unknowns	Probability
ITS1.01	95.8	ITS2.01	70.3	CARQ.01	00.0
ITS1.02	97.8	ITS2.02	89.0	CARQ.02	09.7
ITS1.03	41.3	ITS2.03	70.4		
ITS1.04	97.8	ITS2.04	92.5		
ITS1.05	74.6	ITS2.05	54.4		
ITS1.06A	91.8	ITS2.06	87.6		
ITS1.06B	77.8	ITS2.07	55.4		
ITS1.07	49.7	ITS2.08	54.2		
ITS1.08	76.6				
ITS1.09	91.6	ITS 3.01	46.2		
ITS1.10A	73.5				
ITS1.10B	89.3				
ITS1.11	94.9				
ITS1.12A	92.0				
ITS1.12B	92.1				
ITS1.13	99.1				
ITS1.14	82.2				
ITS1.15	84.2				

A second set of MADCORR trials was carried out employing Cluster 1 specimens as the core group, evaluating the statistical probability that the Cluster 2 specimens and the two clay specimens might belong to this group. These trials permitted some minor adjustments to the membership of the two groups (accounting for the differences between the final fabric classification presented here and in Appendix 1 and the representative clustering solution presented in Figure 6). The representative trial indicates a highly homogeneous core group, with 17 specimens assigned scores in the 90-99 percent range and just one specimen assigned a score below this, at 89.3 percent. For the Cluster 2 specimens, one specimen was assigned a value in the 60-69 percent range, one in the 50-59 percent range, two in the 30-39 percent range, two in the 20-29 percent range, two in the 5-10 percent range, and one in the 0-5 percent range (TABLE 7). Clay CARQ.01 was again assigned a value so low that it rounded to 0, while clay CARQ.02 was assigned a value of 10.6 percent. This suggests that all but one Cluster 2 specimen is highly to somewhat related to the set of Cluster 1 specimens and that clay CARQ.02 is somewhat related to these, while the remaining Cluster 2 specimen and clay CARQ.01 are not related to the Cluster 1 specimens.

TABLE 7: Results of MADCORR trial for NAA data, with ITS Cluster 1 specimens employed as core group and the ITS Cluster 2 specimens and pellets manufactured from specimens of Arezzo – Quarata clay treated as unknowns. Elements used: Ca, Sc, Cr, Fe, Rb, Cs, La, Ce, Sm, Yb, Hf, Th. Replicate analyses identified as A and B.

Core group	Probability	Unknowns	Probability
ITS1.01	97.8	ITS2.01	27.2
ITS1.02	96.8	ITS2.02	51.8
ITS1.03	89.4	ITS2.03	06.3
ITS1.04	97.7	ITS2.04	28.5
ITS1.05	92.8	ITS2.05	30.8
ITS1.06A	98.7	ITS2.06	63.7
ITS1.06B	90.2	ITS2.07	35.1
ITS1.07	91.6	ITS2.08	08.7
ITS1.08	92.8		
ITS1.09	97.0	ITS 3.01	01.3
ITS1.10A	98.6		
ITS1.10B	90.9	CARQ.01	00.0
ITS1.11	94.9	CARQ.02	10.6
ITS1.12A	90.9		
ITS1.12B	96.8		
ITS1.13	98.1		
ITS1.14	95.3		
ITS1.15	91.4		

The scores assigned to the three pairs of replicates by this method in the two representative trials provide some idea of the combined effects of within-specimen inhomogeneity and analytical error in the outcome of MADCORR trials, and thus some broader insight into the significance of the scores assigned by this operation. In the first of the two trials these three pairs were assigned values of 92.0/92.1, 73.5/89.3, and 91.8/77.8, while in the second – in which all three pairs were members of the core group – they were assigned values of 91.0/96.9, 98.9/90.9, and 98.7/90.2.

As just noted, the results of the first set of MADCORR trials are compatible with the inference that the set of ITS specimens represent a single compositional group related to clay CARQ.02, while those of the second set of trials suggest that these specimens represent three compositional groups, two of which are related to one another and to clay CARQ.02. A consideration of the vessel forms, vessel form dates, and fabric variants represented in the three possible compositional groups neither supports nor weakens either interpretation, and on the basis of the information currently available it is impossible to choose between these alternative conclusions. The possibility that the Cluster 1 specimens and Cluster 2 specimens represent distinct compositional groups, however, is suggested by the fact that the Cluster 2 specimens that received the highest scores in the second trial are those with the highest values for Ca – the opposite of what one would expect if the distinction between the two sets of specimens was simply a question of variability in the concentration of Ca. Further, the possibility that ITS3.01 represents a distinct compositional group is suggested both by the fact that its fabric displays a concentration of white, calcareous inclusions substantially greater than that displayed by any of the other specimens of ITS,[71] and by the fact that it has values substantially lower than those for the other specimens of ITS for several alkali metals (Rb, Cs) and rare earths (La, Ce, Sm, Eu, Yb, Lu), and a value that is substantially higher for Zr.

In light of these results, the Cluster 1 specimens and Cluster 2 specimens less the one anomalous specimen are here presented as Fabric Group 1 and Fabric Group 2, respectively, with the anomalous Cluster 2 specimen presented as Fabric Group 3. Due to the uncertainty regarding the significance of this division, however, fabric group data are also presented in Table 4 for the entire set of specimens of ITS.

The program of petrographic analysis did not include the specimen constituting Fabric Group 3 due to the fact that the fragment was too small to permit sectioning. The specimen from Fabric Group 2 displays a very slightly coarser inclusion component than that from Fabric Group 1, perhaps accounting for the elevated values for Hf and the depleted values for many other elements in the former relative to the latter fabric group. There is also a slight textural difference between the two specimens of Arezzo – Quarata clay, as one would expect, given the differences in their chemistry. It should be noted, however, that CARQ.02, the clay specimen that is the closest chemical match to the

71. Unfortunately, the specimen for ITS3.01 was not large enough to permit the fabrication of a thin section, thus precluding the possibility of carrying out a detailed comparison of its fabric with that of the other specimens of ITS. Klynne 2006 169 reports the existence of an Arretine ITS fabric characterized by a substantial concentration of large, calcareous inclusions. That this does not correspond to the fabric in question, however, is suggested both by the fact that it is associated with the forms Conspectus Form 3 and 34, and by the fact that it apparently has a chemical composition similar to that of standard Arretine ITS.

two fabric groups, appears to represent a less perfect textural match to the two pottery specimens analyzed in thin section than does CARQ.01.

5.4 Combined Analysis of NAA Data for All Three Pottery Classes

Cluster analysis was carried out using a variety of different parameters for the 34 specimens in BGW Fabric Groups 1-5 (including two pairs of replicates), the one specimen in each of NERSW Fabric Groups 1 and 2, and the eight specimens in ITS Fabric Group 2 in order to test for possible relationships between these fabric groups, all of which were manufactured using a moderately calcareous paste. The representative clustering solution presented here (Fig. 7) is probably best interpreted as containing five clusters:

- Cluster 1, composed of all of the specimens of BGW Fabric Group 1 and all of the specimens of ITS Fabric Group 2;
- Cluster 2, composed of all of the specimens of BGW Fabric Group 2 and the specimen of NERSW Fabric Group 1;
- Cluster 3, composed of all of the specimens of BGW Fabric Group 5 and the specimen of NERSW Fabric Group 2;
- Cluster 4, composed of all of the specimens of BGW Fabric Group 3; and
- Cluster 5, composed of all of the specimens of BGW Fabric Group 4.[72]

The association of BGW Fabric Group 1 with ITS Fabric Group 2 in Cluster 1 suggests that the former group is of Arretine origin. The specimen of NERSW Fabric Group 1 is linked to three specimens of BGW Fabric Group 2 at a low level of dissimilarity, and there seems a reasonable likelihood that this association is a significant one. The same cannot be said for the placement of the specimen NERSW 2, which is linked to a single specimen of BGW Fabric Group 5 (one of the two that displays a somewhat finer body and may represent a distinct compositional group) at a fairly high level of dissimilarity.

Cluster analysis was also carried out using a variety of different parameters for the 13 specimens in NERSW Fabric Groups 3-8 and the six specimens (including 1 pair of replicates) in BGW Fabric Groups 6-8 in order to test for possible relationships between these fabric groups – all manufactured from a non-calcareous or low calcium paste. This analysis failed to reveal any apparent relationships between these groups.

72. Cluster analysis was also performed for the entire group of 60 pottery specimens manufactured using a moderately calcareous clay (i.e., the specimens in question plus the 15 specimens comprising ITS Fabric Group1 and the one specimen comprising ITS Fabric Group 3). The clustering solutions obtained were problematic, however, embodying considerable mixing of the specimens in BGW Fabric Groups 1, 2 and 4.

```
BGW1.07 -.
BGW1.10 -'-.
BGW1.09A  -|-.
ITS2.05   -' |
BGW1.01     -'---.
BGW1.09B  -.     |-----------.
ITS2.08   -'-.   |           |
ITS2.06     -'---'           |
BGW1.08         -.           |-----.
ITS2.01         -'-----------'     |
BGW1.04 -.                         |---//--. CLUSTER 1
BGW1.06 -'-.                       |       |
BGW1.11   -'-.                     |       |
BGW1.12     -|                     |       |
ITS2.04   -. |---.                 |       |
ITS2.03   -| |   |                 |       |
ITS2.02   -'-'   |                 |       |
BGW1.03   -.     |-----------------'       |
ITS2.07   -'-.   |                         |
BGW1.05     -|---'                         |
BGW1.02     -'                             |
BGW2.09   -.                               |-----------.
BGW2.06   -'-.                             |           |
NERSW1.01   -|                             |           |
BGW2.08     -'-----.                       |           |
BGW2.07   -.       |---.                   |           |
BGW2.04   -|       |   |                   |           |
BGW2.05   -'-----. |   |                   |           |
BGW2.01         -'-'   |                   |           |
BGW2.03     -.         |---------------//--' CLUSTER 2 |
BGW2.10     -'---.     |                               |
BGS2.02         -'-----'                               |
BGW5.03   -.                                           |-------------.
BGW5.01   -'-------.                                   |             |
BGW5.02     -.     |-------------.                     |             |
BGW5.06     -'-.   |             |                     |             |
BGW5.05       -'---'             |                     |             |
BGW5.04           -.             |-----//--------------' CLUSTER 3   |
NERSW2.01         -'-------------'                                   |
BGW3.02   -.                                                         |-
BGW3.01   -|                                                         |
BGW3.03   -'---.                                                     |
BGW3.04       -'---------------------. CLUSTER 4                     |
BGW4.01           -.                 |-//----------------------------'
BGW4.02A          -'---.             |
BGW4.02B              -'-------------' CLUSTER 5
```

FIG. 7. Dendrogram displaying representative clustering solution for cluster analysis carried out for NAA data for BGW Fabric Groups 1-5, NERSW Fabric Groups 1-2, and ITS Fabric Group 2. Elements used: Na, K, Ca, Sc, Cr, Fe, Co, Zn, Rb, Sr, Zr, Cs, La, Ce, Nd, Sm, Eu, Yb, Lu, Hf, Ta, Th. Data transformation: log. Distance measure: mean Euclidean. Agglomeration procedure: Nature's Groups.

A comparison of the individual and group mean values for the two fabric groups of apparent Arretine origin included in the clustering solution discussed above, namely BGW Fabric Group 1 and ITS Fabric Group 2, confirms that the two sets of specimens are, in fact, highly similar to one another. In light of this similarity, it was judged appropriate to combine these two fabric groups to produce a composite Arezzo Fabric Group consisting of 20 specimens (including one pair of replicates).

TABLE 8: Results of MADCORR trial for NAA data, with composite Arezzo Fabric Group specimens (BGW Fabric Group 1, ITS Fabric Group 2) employed as core group and all other moderately calcareous pottery (BGW Fabric Groups 2-5, NERSW Fabric Groups 1-2, ITS Fabric Groups 1 and 3) and pellets manufactured from Arezzo – Quarata clay treated as unknowns. Elements used: Ca, Sc, Cr, Fe, Rb, Cs, La, Ce, Sm, Yb, Hf, Th. Replicate analyses identified as A and B.

Core group	**Probability**	**Unknowns**	**Probability**	**Unknowns**	**Probability**
BGW1.01	81.1	BGW2.01	01.6	NERSW1.01	00.8
BGW1.02	91.1	BGW2.02	09.5	NERSW2.01	02.3
BGW1.03	88.7	BGW2.03	03.5		
BGW1.04	96.5	BGW2.04	00.0	ITS1.01	55.4
BGW1.05	74.9	BGW2.05	00.3	ITS1.02	36.7
BGW1.06	95.8	BGW2.06	02.0	ITS1.03	03.1
BGW1.07	90.1	BGW2.07	00.7	ITS1.04	30.2
BGW1.08	80.3	BGW2.08	21.7	ITS1.05	63.1
BGW1.09A	91.1	BGW2.09	01.2	ITS1.06A	00.2
BGW1.09B	94.6	BGW2.10	29.6	ITS1.06B	04.0
BGW1.10	92.4			ITS1.07	10.6
BGW1.11	96.2	BGW3.01	00.3	ITS1.08	41.4
BGW1.12	89.6	BGW3.02	00.2	ITS1.09	00.9
		BGW3.03	00.9	ITS1.10A	03.2
ITS2.01	83.9	BGW3.04	00.1	ITS1.10B	26.7
ITS2.02	96.0			ITS1.11	39.1
ITS2.03	95.1	BGW4.01	00.1	ITS1.12A	17.8
ITS2.04	99.3	BGW4.02A	00.0	ITS1.12B	06.2
ITS2.05	94.8	BGW4.02B	00.0	ITS1.13	98.8
ITS2.06	96.5			ITS1.14	01.4
ITS2.07	81.1	BGW5.01	01.8	ITS1.15	02.7
ITS2.08	79.1	BGW5.02	00.9		
		BGW5.03	12.9	ITS3.01	03.2
		BGW5.04	04.5		
		BGW5.05	01.4	CARQ.01	00.1
		BGW5.06	00.7	CARQ.02	28.0

A set of MADCORR trials was carried out employing this composite fabric group as the core group, evaluating the statistical probability that the other fabric groups consisting of specimens manufactured with a moderately calcareous paste (BGW Fabric Groups 2-5, NERSW Fabric Groups 1 and 2, ITS Fabric Groups 1 and 3) and the Arezzo – Quarata clay specimens might belong to this group. The representative trial presented here indicates a fairly homogenous core group, with 13 specimens assigned scores in the 90-99 percent range, six in the 80-89 percent range, and two in the 70-79 percent range. (Table 8) For BGW Fabric Group 2, two specimens were assigned a score in the 20-29 percent range, one specimen a score in the 5-10 percent range, and seven specimens a score in the 0-5 percent range. The 4 specimens in BGW Fabric Group 3 and the 2 specimens (including one pair of replicates) in BGW Fabric Group 4 were all assigned scores in the 0-5 percent range, while for BGW Fabric Group 5, one specimen was assigned a score in the 10-20 percent range and the remaining five specimens scores in the 0-5 percent range. The two specimens in NERSW Fabric Groups 1 and 2 were both assigned scores in the 0-5 percent range. For ITS Fabric Group 1, one specimen was assigned a score in the 90-99 percent range, one specimen a score in the 60-70 percent range, one specimen a score in the 50-60 percent range, one specimen a score in the 40-50 percent range, three specimens scores in the 30-40 percent range, one specimen a score in the 20-30 percent range, two specimens a score in the 10-20 percent range, one specimen a score in the 5-10 percent range, and seven specimens scores in the 0-5 percent range. The one specimen in ITS Fabric Group 3 was assigned a score in the 0-5 percent range. One of the two specimens of Arezzo – Quarata clay (CARQ.01) was assigned a score of 0.1 percent, while the other (CARQ.02) was assigned a score of 30.0 percent.

These results suggest that BGW Fabric Groups 3-5, NERSW Fabric Groups 1-2, and ITS Fabric Group 3 are not of Arretine origin. They further suggest that BGW Fabric Group 2 is mostly or entirely not of Arretine origin and confirm that ITS Fabric Group 1 is of Arretine origin. These results also suggest that these two fabric groups and the composite Arezzo Fabric Group (and the two fabric groups of which it is composed) each probably subsume specimens belonging to two or more distinct production groups that it might be possible to recognize as such in a program of analysis involving a substantially larger number of specimens. The results also highlight the compositional similarity between the two fabric groups that compose the Arezzo Fabric Group and BGW Fabric Group 2, and flag certain specimens assigned to the latter (BGW2.02, BGW 2.08, BGW2.10) that should perhaps be reassigned to BGW Fabric Group 1. Finally, the results indicate that there is a general similarity between clay CARQ.02 and not just the ITS manufactured at Arezzo, but also the BGW produced there. The results of the program of petrographic analysis support this last observation, in that they demonstrate a general similarity in composition and texture between the two specimens of BGW Fabric Group 1 and the specimens of ITS Fabric Groups 1 and 2 that were subjected to analysis, and between these four pottery specimens and the two specimens of Arezzo – Quarata clay.

Similar MADCORR trials were undertaken employing as the core group a possible Volterra Fabric Group composed of BGW Fabric Groups 2-4 and NERSW Fabric Groups 1-2, but the results obtained strongly suggested that this combination of specimens does not constitute a valid core group.

6. Interpretation

The two sections that follow interpret the evidence for, in the first instance, the production of the three classes of pottery that are the focus of this study and, in the second, the evidence for the distribution to and consumption at Cetamura of these pottery classes. These are followed by a section that considers various implications of this project for methodological approaches to the compositional study of these three classes of tableware.

In interpreting the results obtained in this project it is important to keep in mind three considerations. First, the spans of time associated with the manufacture and consumption of the four groups of materials included in the study, that is those associated with Deposits 1-3 – ca. 350-250 B.C., 250-200 B.C., and 200-150/125 B.C. – and that associated with the set of specimens of ITS – ca. 40/10 B.C. and ca. A.D. 100/150 – are all fairly long, and may well subsume and possibly obscure two or more distinct moments in the manufacture of the three pottery classes in question and/or in their supply to/consumption at Cetamura. Second, it is not possible to specify the extent to which Deposits 2 and 3 contain residual examples of BGW and/or NERSW, that is, vessels acquired, used, and discarded well before the period during which that stratigraphic unit in which they were recovered was deposited. Third, the small number of vessels subjected to analysis and the modest size of the groups of materials from which these were selected leave open the possibility that the results obtained are not closely representative of general patterns of production and/or supply/consumption. On account of these considerations it is prudent to view the results as generally indicative of qualitative patterns of production and supply/consumption, and, perhaps to some more limited extent, generally indicative of quantitative patterns in these. With regard to qualitative patterns, it is important to keep in mind that in some cases the examples of a particular fabric group or form attested in Deposit 2 or Deposit 3 may be residual. At the same time, the absence of any examples of a particular class, fabric group, or form from any of the four groups may not be significant.

6.1 Production

The three subsections that follow are each dedicated to one of the three pottery classes that are the focus of this study. Each subsection discusses the evidence for the various fabric groups identified for that class, considering for each of these the overall quality of the vessels, the set of forms attested, the dates of its production, possible relationships with variants, fabric groups, etc. for that class previously recognized in the literature, and its likely provenance. Table 9 provides a synopsis of this information for convenient reference. These three subsections are followed by a subsection that considers the implications of the results of the program of analysis for certain technological aspects of the manufacture of these three classes of pottery.

6.1.1 Black-Gloss Ware

In order to interpret the evidence for the production of eight BGW fabric groups identified it is necessary first to review the results of recent research projects undertaken with a view to identifying and determining the provenance of the several variants of BGW certainly or likely manufactured in northern Etruria.

The most comprehensive study of a sub-assemblage of BGW from a site in northern Etruria carried out in recent years is Palermo's treatment of the materials from the Volterra – Acropoli excavations.[73] Palermo, building on earlier efforts to classify BGW from Volterra by Cristofani and Pasquinucci,[74] classified 2010 sherds, including 1960 that he judged likely to have originated in Etruria, assigning these latter to 12 different groups on the basis of form and the megascopic characteristics of fabric and slip. A synopsis of the results of this work is presented in Table 10.A. Six of these groups (Groups A-C, U, T, Z), accounting for 1887 sherds, he judged to be of certain or probable Volterran origin. One of these (Group T) was distinguished by having a distinctly grittier fabric than the others and a lower-quality, matte, uneven slip. Perhaps worth noting is the fact that this was the only of the BGW groups represented in the site assemblage that included multiple examples of the Morel

73. Palermo 2003a.
74. Michelotti *et al.* 1973; Montagna Pasquinucci 1972.

TABLE 9. Synopsis of information pertaining to the production of various fabric groups identified in study (C = Conspectus, L = Lamboglia, M = Morel).

Fabric group	Number specimens	Forms represented	Quality	Chronology*	Provenance
BGW1	12	L5, L28, M80, M83, thin cup with handle(s), closed	high	by 250 B.C.; until at least 175/150 B.C.	Arezzo
BGW2	10	L5, M80, M83, L10?, M82?, closed, lamp	high	by 200 B.C.; until at least 150 B.C.	probably Volterra
BGW3	4	thin cup/bowl, cup/bowl, dish/plate, lamp	high	by 250 B.C. until at least 200 B.C.	probably Volterra
BGW4	2	M83, M82?	high	by 200 B.C.	probably Volterra
BGW5	6	vessel with everted rim, bowl/dish, dish/plate, closed	medium	by 150/125 B.C.	western Val di Chiana? Val d'Elsa (Montione – Bellafonte?)? Siena?
BGW6	1	cup/bowl/dish	medium/low	by 150/125 B.C.	area of sandy, low-calcium sediments
BGW7	1	open	medium/low	by 50 B.C.	Monti del Chianti? Upper Arno Valley?
BGW8	4	L23?, cup/bowl/dish, vessel with loop handle(s)	low	by 150/125 B.C. (by 180 B.C.?)	Monti del Chianti? Upper Arno Valley?
NERSW1	1	MF1211	medium?	by 180 B.C.	probably Volterra
NERSW2	1	cup/bowl/dish (misfired BGW?)	high	by 200 B.C.	not Volterra? Volterra?
NERSW3	5	MF1211	medium	by 180 B.C.	upper Val d'Elsa?
NERSW4	3	MF1211	medium/low	by 180 B.C.	upper Val d'Elsa? Monti del Chianti? Upper Arno Valley?
NERSW5	1	MF1211	medium/low	by 180 B.C.	Populonia? Vetulonia? Roselle?
NERSW6	1	closed	medium/low	by 150/125 B.C.	upper Val d'Elsa? Monti del Chianti? Upper Arno Valley?
NERSW7	1	closed	medium/low	by 150/125 B.C.	area of sandy, low-calcium sediments
NERSW8	1	cup or closed	medium/low	by 200 B.C.	Volterra? Western Val di Chiana? Val d'Elsa? Siena?
ITS1	15	C1, C3, C4, C12, C14, C18, C19, C20, C29, C34, C37	high	by 10 B.C. until at least A.D. 40	Arezzo
ITS2	8	C3, C4, C6, C12, C20, C21?, C23	high	by A.D. 15 until at least A.D. 40	Arezzo
ITS3	1	C20 or 21	high	by A.D. 90	not Arezzo?

* All dates approximate. Dates based on combination of inferred dates for loci in which examples are attested (for BGW and NERSW) and evidence for dating of forms represented.

F1211 bowl, the most common form in NERSW.[75] A seventh group (Group S), accounting for just 2 sherds, he believed might have originated at Roselle.[76] Palermo was unable to specify more precisely the origin of the remaining five groups (Groups D, E, R, V1, V2), which accounted for 71 sherds.

Palermo carried out similar studies of the BGW recovered in the excavations at Fiesole – Via Marini/Via Portigiani[77] and in the excavations at Chiusi – Orto del Vescovo.[78] In the case of the materials from Fiesole, he assigned ca. 2080 sherds to 13 fabrics. A synopsis of the results of this work is presented in Table 10.B. Seven of these fabrics, accounting for ca. 1175 sherds (Fabrics 1-6, 9-10, 13), he judged to be of certain or possible Arretine origin, while one (Fabric 7), accounting for 665 sherds, he thought was Volterran. He was unable to specify the origin of the other three fabrics (Fabrics 8, 11-12), accounting for 240 sherds. In the case of the materials from Chiusi, he assigned ca. 3000 sherds to four different groups. A synopsis of the results of this work is presented in Table 10.C. Two of these groups (Groups B, C), accounting for ca. 2010 sherds, he judged certain to be of local origin, while the other two (Groups A1, A2), accounting for 910 sherds, he thought highly likely to be Arretine.

De Marinis provided brief descriptions of the different BGW groups manufactured at the Montaione – Bellafonte production facility based on the megascopic characteristics of fabric and slip.[79] He identified two groups, which he termed First Type and Second Type. The vessels in the First Type group, which were relatively rare, had a fine, light-colored fabric and a high-quality black, slightly glossy to glossy slip. Those in the Second Type group, which were much more abundant, displayed a less fine, light-colored fabric and a medium- and/or low-quality, matte, black to brown or brownish, poorly adhering slip. Given the location of this establishment (situated on the western margin of the Val d'Elsa, ca. 3 km NE of Montaione) at the edge and the roof of an extensive outcrop of Pag marine clay, it seems likely that the First Type group was manufactured with material obtained from a relatively fine bed within this formation or, perhaps more likely, with clay from this formation that was subjected to thorough levigation, while the Second Type group was manufactured with material obtained from a relatively coarse bed

75. Palermo 2003a, 315-6 n. 70, 326 tab., 490 fig. 21.10-15, documenting 24 examples as Morel F1210. Palermo 2003a, 292 no. 6, 309 tab, 486 fig. 17.10 documents a single example, again as Morel F1210, for Group B.
76. For BGW from Roselle see Michelucci and Romualdi 1974, especially pp. 102-108, Group RII.
77. Palermo 1990a
78. Palermo 1998.
79. De Marinis 1977, 208-211 tav. XXIV; Olcese 2011-2012, 33.

TABLE 10. Synopsis of results of Palermo's studies of BGW from Volterra – Acropoli (Palermo 2003a), Fiesole – Via Marini/Via Portigiani (Palermo 1990a), and Chiusi – Orto del Vescovo excavations (Palermo 1998). Phases/dates (all B.C.): Volterra: 7: end 4th /beginning 3rd; 8: second quarter 3rd; 9: second half 3rd ; 10: end 3rd ; 11: beginning 2nd ; 12: mid 2nd ; 14: first half 1st. Fiesole: E: 150-125; R: Caesarian and later. Chiusi: 1: 350-280; 2: 280-200; 3: 200-170; 4: 170-140; 5: 110-50.

Group	Body	Slip	Number sherds	Phases	Provenance
A. Volterra					
A	ochre or brown (5YR 6/8); hard, slightly granular	black or bluish black; metallic luster, thick, regular	1258#	7-12, 14#	Volterra*
B	beige (10YR 8/4); hard, compact	black or bluish black ; partially glossy or glossy, thick, regular	See note #	See note #	Volterra*
C	hazel or pinkish hazel (7.5YR 7-8/4); hard, compact	black or bluish black; sometimes metallic appearance, thick, regular	See note #	See note #	Volterra*
D	pink (7.5YR 7/4); hard, compact	black or brown ; glossy, thick, regular	2	8, 12	Etruria?
E	beige or hazel (10YR 7/4); hard, slightly granular	bluish; partially glossy or glossy, thick, regular	13	11-12, 14	Coastal Etruria, Campana B
R	whitish (2.5YR 8/2); hard, compact	black; matte. thin, regular, not resistant	42	11-12	Etruria?
S	brown gray with uneven tones; hard; small, white inclusions, vesiculated	black; thin, uneven, not resistant	2	11	Roselle?
T	Body 1: brown (5 YR 6/4), reddish brown (7.5YR 5/4), or leather (7.5YR 6/4); soft, granular; numerous small white inclusions and voids.	Slip 1: gray or brown; iridescent spots, thin, rough, uneven	597	10-12, 14	Volterra*
		Slip 2: brown or brown black, sometimes with hints of gray; matte, thin, rough, uneven			
	Body 2: orange hazel (7.5YR 6/6, 7.5YR 7/6) or pink (7.5YR 7/4); hard, granular; inclusions and voids	Slip 3: brown black, sometimes tending to gray; glossy or slightly glossy, sometimes slight iridescence, smooth, adherent			
		Slip 4: gray or brown; glossy, thick, rough, resistant			
U	Body 1: dark red; hard, very fine, compact; regular break	Slip 1: brown black; matte or partially glossy, smooth, adherent	19	8-9, 11-12	Volterra
	Body 2: hazel; hard, fine, compact; regular break	Slip 2: gray or brown; metallic, glossy, thick, rough, resistant			

V1	Gray; soft, granular; somewhat regular break	black; matte, thin, not adherent	8	14	Northern Etruria
V2	Grayish	black or gray black	6	9, 11-12, 14	Northern Etruria
Z	beige, pinkish hazel, or leather, sometimes with hints of gray; hard, compact	brown or gray brown; glossy, thick, uneven	13	7, 9-12	Volterra
B. Fiesole					
	Body 1: pinkish orange (5YR 7/6), hazel (7.5YR 7/4), or tan (7.5YR 7/6); smooth, hard, compact, very rare cracks; somewhat regular break; very rare, small, white inclusions Body 2: dark brown (7.5YR 5/4); slightly granular , hard, smooth, compact; regular break Body 3: tan (7.5YR 7/6) ; hard, smooth, compact; somewhat regular break Body 4: pinkish orange (5YR 7/6), orange (5YR 6/8); smooth, hard, compact; regular break Body 5: hazel (7.5YR 7/4), smooth, hard, compact, rare cracks; regular break; very rare, small, brown, granular inclusions Body 6: gray hazel (5YR 7/1-7/3); smooth, hard, compact; somewhat regular break Body 9: intense pink (5YR 7/4); smooth, hard, compact, rare cracks; regular break Body 10: hazel (7.5YR 7/4) somewhat hard; platy, rough, rare cracks; irregular break Body 13: pinkish orange (5YR 7/6), smooth, hard, compact; regular break	Slip 1: black, sometimes tending to gray; matte, thick, even, adherent (Goes with Bodies 1-3, 5-6) Slip 2: black-brown; matte to slightly glossy, sometimes with areas of iridescence, thick, even, adherent (Goes with bodies 4, 9) Slip 5: black, tending to metallic gray on exterior; glossy, strongly iridescent, thick, uneven, flaky/resistant (Goes with Body 10) Slip 8: greenish; glossy, thick, even, adherent (Goes with Body 13)	1175	E, R	Arezzo (Bodies 10&13 Arezzo?)

	Body 7: hazel (7.5YR 7/4) with grayish hints; smooth, hard, compact; regular break	Slip 3: blue-black, sometimes with grayish haloes and brown hints at rim; glossy or partially glossy, sometimes matte, thick, even, adherent	665	E, R	Volterra
	Body 8: yellow-beige (10YR 7/3), smooth, hard, compact; somewhat regular break; very rare, medium-sized, brown, granular inclusions	Slip 4: black or bluish, sometimes with blue-gray hints; matte, thick, somewhat even, adherent (Goes with Body 8)	240	Body 8, 11: E, R	Undetermined
	Body 11: light gray (10YR 7/1) smooth, hard, compact, rare cracks; somewhat regular break	Slip 6: black; matte, thin, uneven, not adherent; (goes with Body 11)		Body 12: E?, R	
	Body 12: dark gray (10YR 6/1; smooth, hard, compact, rare cracks; somewhat regular break	Slip 7: black or gray; matte, thin, even, adherent (goes with Body 12)			
C. Chiusi					
A1	grayish hazel, pink (5YR 7/4), reddish yellow (7.5YR 7/4); hard, compact; regular break	black, bluish black, rarely greenish black; glossy, rarely matte, even, adherent,/resistant;	819	3-5	Arezzo?
A2	pink, hazel, tan, orange, ochre; hard, compact, slightly granular, somewhat regular to regular break; sometimes abundant, very small, white inclusions	black or greenish black; sometimes with brown patches; matte or partially glossy, smooth, adherent/resistant;	91	5	Arezzo?
B	orange/reddish bichrome, light/hazel/pinkish; hard, compact, slightly granular; rare inclusions	silvered bluish gray, metallic gray, greenish gray, smooth bluish, satiny black with bluish reflections, matte black, matte and glossy brown	ca. 2090@	1-4?	Chiusi*
C	pinkish/orange bichrome, hazel, yellowish ; soft to somewhat hard, somewhat regular break; various inclusions	brown, gray, greenish, yellow, purplish, sometimes varying on vessel; matte, rough, sometimes not resistant	See above	?	Chiusi*

Combined figure for Volterra Groups A-C.
* Group represented by certain or possible waster sherds.
@ Combined figures for Chiusi Groups B and C.

within this formation or, perhaps more likely, with clay from this formation subjected to only cursory or no levigation.

Turning now to programs of compositional analysis, Pasquinucci and collaborators carried out a program of petrographic analysis involving the characterization of 30 specimens of BGW from several sites in the territory of Pisa and the coastal zone of the territory of Volterra.[80] Twenty-three of these specimens, belonging to four general petrological groups or subgroups, they judged likely to have originated in northern Etruria or adjacent regions.[81] These groups include the following:

- Group O (ophiolitic) (one specimen), probably originating somewhere in the vicinity of one of the various outcrops of gabbro that occur from the area of Livorno south to the northern sector of the Colline Metallifere.
- Group MA (acid metamorphic) (six specimens), likely manufactured with alluvial sediments from the valley of the Fiume Serchio, in the vicinity of Lucca.
- Subgroup G (generic) – non-calcareous matrix (14 specimens), perhaps manufactured with alluvial sediments from the valley of one or more of various watercourses in northern Etruria, including the Arno.
- Subgroup G – calcareous matrix (two specimens), manufactured employing marine sediments or continental sediments from an area of limestone lithology.

Gliozzo and collaborators undertook a program of compositional analysis involving 22 specimens of pottery and two specimens of architectural ceramic from the Chiusi – Marcianella pottery production facility, including four specimens of BGW and three specimens of NERSW, and nine specimens of clay from two sources in the vicinity of the production facility and three more distant sources, one situated ca. 8.5 km to its N, one ca. 15 km to its NNE, and one ca. 14.5 km to its NW.[82] This involved petrographic analysis, scanning electron microscopy, x-ray diffraction (XRD), and x-ray fluorescence (XRF). Petrographic analysis and scanning electron microscopy revealed that the specimens of both pottery classes contained quartz, quartzite, feldspar, mica, fragments of limestone, foraminifera, and, in some cases, fragments of flint and siltstone.[83] The composition of these specimens is generally compatible with that of the clay specimens taken from the two sources in the vicinity of

80. Pasquinucci *et al*. 1998.
81. Pasquinucci *et al*. 1998, 102-104.
82. Gliozzo *et al* 2003.
83. Gliozzo *et al*. 2003, 286 Tab. 2, 287, 291-292.

the production facility.[84] These belong to a formation of marine sediment of middle to lower Pliocene date designated P_s^{2-1} (*sabbie e sabbie argillose*/sands and clayey sands) on the relevant sheet of the *Carta Geologica d'Italia* (Fg 121).

Elsewhere, Frontini and collaborators completed a program of analysis involving the chemical characterization of BGW from Volterra, Arezzo, and several sites in northern Italy by means of XRF.[85] This included the analysis of 26 vessels from the Museo di Arezzo (presumably recovered in excavations in and around Arezzo) and 23 specimens recovered in the Volterra – Acropoli excavations,[86] and was carried out with a view to establishing chemical reference groups for BGW manufactured at these two centers. By using a combination of principle components analysis and linear discriminant analysis these researchers were able to define distinct, if highly similar chemical reference groups for Arezzo and Volterra,[87] and to assign some of the vessels recovered at the sites in northern Italy to one or the other of these with a high degree of confidence.

Gliozzo and Memmi Turbanti undertook a program of chemical analysis involving 149 specimens of BGW from several sites in northern Etruria – including Arezzo – Oriente (30 specimens), Volterra – Castello (31 specimens), Volterra – Museum (including vessels from various sites at or near Volterra) (32 specimens), the Chiusi – Marcianella pottery production facility (30 specimens), Chiusi – Orto del Vescovo (15 specimens), and Populonia (11 specimens) – and 10 specimens of clay from the two previously mentioned sources in the vicinity of the Marcianella production facility.[88] This project involved the combined use of NAA, XRF, inductively coupled optical emission spectroscopy (ICP-OES), and inductively coupled plasma mass spectroscopy (ICP-MS). Applying cluster analysis to the resulting data Gliozzo and Memmi Turbanti identified eight different compositional groups.[89] One of these (Group 6) consisted of the Marcianella specimens. This displayed values closely similar to those of the clay specimens, and it appears certain that the manufacture of BGW at this establishment involved the use of this clay.[90] They were able to assign one of the remaining seven groups (Group 1) to Arezzo and another (Group 2) to Volterra on the basis of the criterion of abundance, the suite of forms represented, and these groups' general

84. Gliozzo *et al.* 2003, 311.
85. Frontini *et al.* 1992.
86. Frontini *et al.* 1992, 351-360.
87. Frontini *et al.* 1992, 338 Tab. 3.
88. Gliozzo and Memmi Turbanti 2004.
89. Gliozzo and Memmi Turbanti 2004, 206-210.
90. Gliozzo and Memmi Turbanti 2004, 211.

compositional similarity to groups of BGW and ITS attributed to these centers in previously published studies, including that carried out by Frontini and collaborators. Another group (Group 8) consists in large measure of materials of probable Chiusine origin, while another (Group 4) consists of Campana A BGW from the Bay of Naples region.

We can now turn to the consideration of the eight BGW fabric groups identified in the current program of analysis. The vessels in Fabric Group 1 are of high quality, with a slip that is even, glossy to very glossy, and dark gray to very dark gray, often with bluish tones. Four of the 12 specimens are from Deposit 1, one from Deposit 2, and the remaining seven from Deposit 3. Six distinct forms are attested: a dish/plate (Lamboglia Form 5), three cups/bowls (Lamboglia Form 28, Morel Form 80, Morel Form 83), a thin-walled cup with one or two probably vertical handles, and a closed form of some kind. The presence of examples of this group in Deposit 1 indicates that its manufacture commenced prior to ca. 250 B.C., while the fact that it includes examples of the Lamboglia Forms 5 and 28, and Morel Form 83 strongly suggests that this continued down at least to the second quarter of the second century B.C. The four examples from Deposit 1 are somewhat softer than those from Deposits 2 and 3 and should perhaps be classified as *ceramica protocampana*, the predecessor of true BGW.[91] Two of these (BGW1.07, BGW1.09) have notably thin walls, while a third (BGW1.08) is embellished with freehand incised decoration. At least one of the examples of this fabric group from Deposit 3 (BGW 1.01, an example of the Lamboglia Form 5) can be classified as belonging to the distinctive set of vessels now widely referred to as the *Cerchia della Campana B*.[92]

The chemical and textural similarity of Fabric Group 1 with ITS Fabric Groups 1-2 and the two specimens of Arezzo – Quarata clay leave little doubt that this fabric group was manufactured at Arezzo using clay obtained from the agQ formation.

Fabric Group 1's megascopic characteristics, including the color and texture of the body and the appearance of the slip, correspond fairly well with those reported for Palermo's fabrics of assumed Arretine origin at Fiesole – Via Marini/Via Portigiani (Fabrics 1-6, 9) and his groups of assumed Arretine origin at Chiusi – Orto del Vescovo (Groups A1 and A2). Three of the four

91. See Stanco 2009a, 20-21 for *ceramica protocampana*, where the somewhat unwieldy "*imitazione della ceramica attica a vernice nera*" is recommended as a more accurate term.
92. Cibecchini and Principal 2004; Principal 2005; Morel 2009, 128-130.

recognized forms represented are attested in these fabrics at Fiesole and all four for these groups at Chiusi. One of the variants of the Morel Form 83 attested is, however, not represented among the materials at either site, as is also the case with the open vessel with handles.

Fabric Group 1 would fall within Pasquinucci and collaborators' Subgroup G – calcareous matrix. Given its Arretine origin, it should display a chemical composition similar to that of Frontini and collaborator's Arezzo reference group and Gliozzo and Memmi Turbanti's Arretine group. Since no study has been performed to evaluate the extent to which the data presented here can be intercompared with the data presented in these two other programs of analysis, however, it is unclear what degree of similarity one should expect.[93] Frontini and collaborators' Arezzo reference group displays close (here defined as within one standard deviation) mean values for several of the elements for which comparisons can be made (Ca, Cr, Fe, Co, Rb, Sr), though not for others (Na, K, Zn, Ba). Similarly, Gliozzo and Memmi Turbanti's Arretine group displays mean values that fall within one standard deviation from the mean value for this fabric group for several elements (Na, K, Ca, Fe, Co, Zn, As, Sr, Sb, Yb, Lu, Th) and beyond one standard deviation for several others (Sc, Cr, Rb, Cs, Ba, La, Ce, Nd, Sm, Eu, Hf, U). Perhaps worth noting is the fact that all four minor constituents for which a comparison can be made display a high level of agreement with the corresponding value for this fabric group (Na: 0.57:0.59 percent; K: 2.00:2.03 percent; Ca: 6.97:7.90 percent; Fe: 5.21:5.11 percent).

The specimens in Fabric Group 2 are of high quality, with a slip that is usually even, glossy to very glossy, and dark gray to very dark gray, sometimes with bluish tones. In some cases it is matte, tends to a dusky red color, or has reddish blotches. One of the 10 specimens is from Deposit 2 and the remaining nine are from Deposit 3. Seven distinct forms are attested: a dish/plate (Lamboglia Form 5), two cups/bowls (Morel Form 80 and Form 83) two forms that may be cups (perhaps Lamboglia Form 10 and Morel Form 82), a closed form of some kind, and a lamp. The presence of examples of this group in Deposit 2 indicates that its manufacture commenced prior to ca. 200 B.C., while the fact that it includes examples of the Lamboglia Form 5 strongly suggests that this continued down at least to the middle of the second century B.C. Three of the vessels from Deposit 3 (BGW 2.01 and 2.03, the two examples of the

93. Any effort to compare the data generated by these two programs of analysis with the data obtained in the current program of analysis requires the conversion of the values for the four minor constituents (Na, K, Ca, and Fe) from oxide form to the equivalent elemental value, as has been done for the discussion presented here.

Lamboglia Form 5, and BGW 2.03, the one possible example of the Lamboglia Form 10) should be classified as belonging to the *Cerchia della Campana B*.

The chemical and petrographic evidence indicate that Fabric Group 2 was manufactured from a fine, moderately calcareous clay or a less fine calcareous clay subjected to levigation. The differences in the chemical composition between this fabric group and the materials of Arretine origin included in this study suggest that it did not originate at Arezzo. Since it seems likely that a substantial portion of the BGW in Deposit 3 was of Volterran origin, the fact that all but one of the examples of BGW in this deposit that were subjected to analysis that proved to be of apparent non-Arretine origin belong to Fabric Group 2 suggests that this fabric group is from Volterra. This inference is supported by the fact that the cluster analysis of the combined NAA data assigned the specimens in Fabric Group 2 to the same cluster as the sole specimen in NERSW Fabric Group 1, as the latter may well be of Volterran origin (see below). The form evidence for this fabric group is also compatible with a Volterran origin, with all of the forms represented certainly or possibly attested for one or more of Palermo's fine-textured groups of Volterran origin from the Volterra – Acropoli assemblage and two of these forms attested for his fabric of Volterran origin from Fiesole – Via Marini/ Via Portigiani assemblage. The fact that the fabric group's chemical composition differs substantially from those of the several specimens of Volterra clay does not preclude this possibility, given the latter's appreciably coarser texture and the possibility that the manufacture of this fabric group involved the levigation of the clay employed for this purpose.

The vessels in Fabric Group 3 are of high quality, with an even, glossy, dark gray to very dark gray slip. Three of the four specimens are from Deposit 1, while the fourth is from Deposit 3. Four distinct forms are attested: a thin-walled cup/bowl, a cup bowl with a curved wall and stamped decoration, a dish/plate with incised decoration, and a lamp. The presence of examples of this group in Deposit 1 indicates that its manufacture commenced prior to ca. 250 B.C., while the fact that it includes examples of a lamp suggests that this continued down at least to ca. 200 B.C. The three vessels from Deposit 1 (BGW 3.01-3) have a notably soft body (in one case not fully oxidized) and thin walls, and should perhaps be classified as *ceramica protocampana*. One of these (BGW.02) bears stamped decoration and a second (BGW 3.03) freehand incised decoration.

The two vessels in Fabric Group 4 are of high quality, with an even, slightly to very glossy, very dark gray slip. Both specimens are from Deposit 2. Two forms are attested: the Morel Form 83 cup and an open form with steep walls that may be the Morel Form 82 cup. The presence of examples of this group in Deposit 2 indicates that its manufacture commenced prior to ca. 200 B.C. As the manufacture of the Morel Forms 82 and 83 bracketed this date the form evidence does not allow any further observations regarding the chronology of this fabric group.

The chemical and petrographic evidence indicate that Fabric Groups 3 and 4 were manufactured from either fine, low-calcium or moderately calcareous clay or less fine calcareous clay subjected to levigation. As previously noted, the fact that Fabric Groups 3 and 4 are generally linked at a fairly low level of dissimilarity in cluster analysis suggests that they may be related to one another. Fabric Group 4 has a mean value for Ca that is ca. 0.8 percent higher than that for Fabric Group 3, and it appears possible that the differences in chemical composition between the two groups are in large measure the result of dilution effects produced by the higher concentration of this element in Fabric Group 4. The more prominent presence of mica in Fabric Group 4 may be the result of a lower maximum or soaking temperature in the firing process.

Since it seems likely that some of the BGW in Deposit 1 was from Volterra, the fact that the only BGW vessels in this deposit that are not of apparent Arretine origin belong to Fabric Group 4 suggests that this fabric group is likely from Volterra. The similarity of its chemical composition with that of Fabric Group 3 raises the possibility that this other fabric group is also from Volterra. The form evidence for these two fabric groups is compatible with a Volterran origin, with the Morel Form 82, Morel Form 83, and lamps all attested for one or more of Palermo's fine-textured groups of Volterran origin. One possibility is that these two fabric groups represent some expression of Volterran production that existed prior to ca. 200 B.C., with Fabric Group 2 representing some different expression of Volterran production that existed subsequent to this point. Whether these distinct expressions of Volterran production should be understood as reflecting the activity of different workshops, the exploitation of different clay sources, the use of different manufacturing techniques, or some combination of these is unclear.

Fabric Groups 2-4 have megascopic characteristics that correspond fairly well with those reported for Palermo's fine-textured BGW groups of certain or likely Volterran origin from the Volterra – Acropoli assemblage and the Fiesole – Via Marini/Via Portigiani assemblage. They would fall within Pasquinucci and collaborators' Group G – calcareous matrix. Given their conjectured Volterran origin, one or more of these three fabric groups might be expected to display a chemical composition similar to that of Frontini and collaborator's Volterra reference group and Gliozzo and Memmi Turbanti's Volterra group. Frontini and collaborators' Volterra reference group displays mean values within one standard deviation for very few of the elements for which comparisons can be made (Fabric Group 2: Ca, Cr, Sr; Fabric Group 3: Zn; Fabric 4: Sr), and greater than this for the bulk of these (Fabric Group 2: Na, K, Fe, Co, Zn, Rb, Ba, La, Ce; Fabric Group 3: Na, K, Ca, Cr, Fe, Co, Rb, Sr, Ba, La, Ce; Fabric Group 4: Na, K, Ca, Cr, Fe, Zn, Rb, Ba, La, Ce). Gliozzo and Memmi Turbanti's Volterran group displays mean values that fall within one standard deviation from the mean value for several elements for Fabric Group 2 (Sr, Co. Cr, Rb, Sc, Nd, Eu, Yb, Lu) and greater than this for several others (Fe, Ca, Na, K, Zn, As, Ba, Cs, Sb, La, Ce, Sm. Hf, Th, U). In contrast, this group displays mean values that fall within one standard deviation from the mean value for only a few elements for Fabric Groups 3 and 4 (Fabric Group 3: K, Z, Co; Fabric Group 4: Sr, Zn, C, Nd, Lu, U) and greater than this for the bulk of the elements (Fabric Group 3: Fe, Ca, Na, Sr, As, Cr, Rb, Sc, Ba, Cs, Sb, La, Ce, Nd, Sm, Eu, Yb, Lu, Hf, Th, U; Fabric Group 4: Fe, Ca, Na, K, As, Cr, Rb, Sc, Ba, Cs, Sb, La, Ce, Sm, Eu, Yb, Hf, Th). The level of agreement in this case may be substantially lower than that attested in the case of the groups of Arretine origin due to the possibility that Frontini and collaborators' Volterra reference group and Gliozzo and Memmi Turbanti's Volterra group include vessels belonging to two or more compositionally distinct fabric groups originating at or near Volterra, with their mean values thus representing a conflation of data for multiple fabric groups.

The megascopic characteristics of Fabric Groups 2-4 may also correspond fairly well with those of Montaione – Bellafonte Group 1. Production at this establishment does not appear to have commenced until ca. 150 B.C., however, meaning that these groups begin too early to have originated at this facility.

The vessels in Fabric Group 5 are of medium quality, with a matte to slightly glossy, dark gray slip that is sometimes thin, mottled, uneven, and/or poorly preserved. As noted above, the chemical and textural evidence suggests that this fabric group should perhaps be divided into two sub-groups, one consisting of specimens BGW5.01 and 5.03, and the other consisting of specimens BGW5.02 and 5.04-5.06. These two sub-groups may represent distinct productions that are linked only by the fact that they were both manufactured employing a sandy, moderately calcareous clay. Four of the six vessels in this fabric group were recovered in Deposit 3, one from a locus comparable in date to Deposit 3, and one in a locus of Roman or post-Roman date. Four distinct forms are attested: a vessel with a steep upper wall and an everted rim, a bowl/dish with a thickened rim, a dish/plate with groove and chatter decoration, and a closed form with a ring-footed base. Although the quality of this fabric group's slip is second rate, the fact that one of the specimens bears groove and chatter decoration demonstrates that those who manufactured it were aiming for a market that desired at least some modest embellishment of its tablewares. The presence of examples of this group in Deposit 3 indicates that its manufacture commenced prior to ca. 150/125 B.C.

The chemical and petrographic evidence indicate that Fabric Group 5 was manufactured from sandy, moderately calcareous clay probably of marine origin. This fabric group would fall within Pasquinucci and collaborators' Group G – calcareous matrix. It is impossible to specify its point or points of origin, other than to indicate that it/these presumably lay somewhere within the area of marine sediment that extends across much of northern Etruria. While it is thus possible that it was manufactured at or near Volterra, given the location of Cetamura, the Val d'Elsa, the area around Siena, and the western side of the Val di Chiana also represent plausible possibilities. The megascopic characteristics of this fabric group appear to be generally similar to those of the Montaione – Bellafonte Second Type group, its chronology is compatible with the period of operation of the Montaione-Bellafonte production facility (which appears to have been active ca. 150-80 B.C.), three of the four specimens in the larger of the two possible sub-groups (5.02, 5.04, 5.05) may belong to forms that were manufactured by this establishment in the medium- or low-quality Second Type fabric, which also executed groove and chatter decoration on an open form in the high-quality First Type fabric and manufactured a form with a foot profile similar to that of the fourth specimen in this sub-group (5.06) in this same fabric, raising the possibility that this sub-group, or perhaps the entire group originated there. The forms represented are not attested for Palermo's group of Volterran origin with an intermediate fabric and matte, uneven slip from the Volterra – Acropoli assemblage (Group T), nor does this group include any vessels that bear groove and chattering decoration. A Volterran origin for Fabric Group 5 thus appears unlikely. While one of the specimens (5.03) belongs to a form similar to one manufactured at the Chiusi – Marcianella pottery production facility, the extensive BGW assemblage from this establishment includes no vessels of apparent local origin that bear groove and chattering decoration. Further, the BGW vessels manufactured at Chiusi – Marcianella have a fabric characterized by the regular presence of microfauna, which is not the case with the specimens in Fabric Group 5. An origin at the Chiusi – Marcianella pottery production facility can thus also be ruled out.

The sole specimen assigned to Fabric Group 6, a cup, bowl, or dish with a curved wall of low or medium quality, is from Deposit 3, indicating that this fabric group's manufacture commenced at some point prior to ca. 150/125 B.C. The chemical and petrographic evidence indicate that this fabric group was manufactured from sandy, low-calcium clay, though whether this was of marine or continental origin remains unclear. It would fall within Pasquinucci and collaborators' Group G – calcareous matrix. Nothing can be said regarding its point of origin, except that this was likely situated near a deposit of sandy, low-calcium clay.

The sole specimen in Fabric Group 7 is of low or medium quality, with a poorly preserved, matte, dark brown slip. It belongs to a cup or bowl with a ring foot, and was recovered in a Roman or post-Roman context. Nothing can be ventured regarding this fabric group's chronology, other than to say that it should be assigned to the period during which BGW was manufactured.

The specimens in Fabric Group 8 are of low quality, with a matte, poorly preserved, dark gray or dark reddish gray slip. Three of the four specimens are from Deposit 3, and the fourth in a locus comparable in date to Deposit 3. Three distinct forms are attested: an open form with a hanging rim that is probably the Lamboglia Form 23 plate, a cup/bowl/dish with a curved wall, and a vessel with one or more loop handles. The fact that three of the specimens of this group are from Deposit 3 indicates that its manufacture commenced prior to ca. 150/125 B.C. If one of the vessels represented is, indeed, an example of the Lamboglia Form 23, this would suggest that its manufacture commenced by at least the early second century B.C.

The chemical and petrographic evidence indicate that Fabric Groups 7 and 8 were manufactured from an intermediate, gritty, or coarse continental clay, perhaps subjected to levigation. Both would fall within Pasquinucci and collaborators' Group G – non-calcareous matrix. Little can be said about their likely points of origin, except that these must have lain in an area where there was access to clay of this kind and perhaps not convenient access to calcareous potting clay. Given the low quality of the vessels in these two fabric groups (particularly in comparison with the quality of those in the roughly contemporaneous Fabric Groups 1-2 and 5), it seems unlikely that the workshops that manufactured them normally distributed their products over a large market area. In light of these considerations, their points of origin should probably be sought in the Monti del Chianti or the Upper Arno Valley.

On the basis of this evidence it is possible to formulate the following outline of the development of BGW production in northern Etruria: Beginning at some point prior to ca. 250 B.C. and perhaps as early as ca. 350 B.C. two workshops – one at Arezzo and the other probably at Volterra – produced a high-quality version of BGW that we can characterize as *ceramica precampana*. This consisted in substantial measure of thin-walled forms which were sometimes (regularly?) embellished with freehand incised decoration and, in the case of the vessels originating at the second production locus, stamped decoration. The fact that freehand incised decoration was sometimes, perhaps regularly executed by workshops at both production loci suggests that the manufacture of BGW at this time involved a skill set somewhat different from and labor inputs perhaps somewhat greater than those associated with its manufacture at these same two loci during later periods. The manufacture of two other classes of high-end tableware produced at Volterra during this period – Red-Figure Ware and Overpainted Ware – involved substantial inputs of a somewhat analogous form of labor (free-hand painting with slip), and this practice should perhaps be considered in relation to these two wares. On the one hand, there may have been a general connection, with BGW producers pitching their output to meet the expectations of consumers accustomed to using high-end tablewares embellished with linear surface decoration of some sort. On the other hand, in the case of BGW from Volterra there may have been a direct connection, in that it seems possible that the workshops responsible for manufacture of these two wares also manufactured BGW or shifted their operations from the manufacture of one or both of these wares to the production of BGW. The manufacture of high-quality BGW continued at Arezzo down through at least ca. 175/150 B.C., with the introduction by 200 B.C. and perhaps as early as 250 B.C. of new forms with thicker walls (and presumably bearing stamped and incised concentric grove and chatter decoration and devoid of freehand incised decoration), including towards the end of this period some of those recognized as constituting the production termed the *Cerchia della Campana B*. This production appears to have involved clay obtained from the same source as that exploited during the earlier period, pointing towards continuity of manufacturing techniques and, along with this, perhaps also productive units and the specific location of production. The production of high-quality BGW appears to have continued at the other locus of production thought likely to be Volterra through at least ca. 150 B.C., though with apparent shifts in the clay source, paste preparation practices, and/or firing technique, pointing towards possible discontinuity in productive units and/or the specific location of production. The workshop or one of the multiple workshops responsible for this production may also have manufactured medium-quality NERSW for part or all of the period ca. 200-150 B.C.

Beginning at some point before ca. 150/125 B.C. and probably after ca. 200 B.C. workshops located in three or perhaps four different places in northern Etruria, probably neither Arezzo nor Volterra, initiated the production of medium- and low-quality BGW. These establishments may have been located in the Val di Chiana, the Val d'Elsa, the area around Siena, and/or the Monti del Chianti, with one perhaps situated at Montaione – Bellafonte on the western margin of the Val d'Elsa. How much later than ca. 150/125 B.C. this production continued is unclear. The workshops that operated at the Montaione – Bellafonte and Chiusi – Marcianella production facilities may offer a model for the organization of production of this kind. The first of these two establishments, which operated ca. 150-80 B.C., manufactured a strikingly wide variety of wares, including both high- and medium- and/or low-quality BGW, commonware, and roof tiles, and perhaps also cookware, lamps, amphoras, spindle whorls, and loom weights. The other, which operated from the late third century to the late second or early first century B.C., manufactured a similarly diverse range of products, including medium- to low-quality BGW, NERSW, thin-walled ware, commonware, cookware, and amphoras.

This evidence suggests that the second century B.C. saw the extension of a decorative technique – surfacing with a glossy black slip – associated with high-quality vessels (perhaps manufactured by specialized – in the sense that they normally manufactured only a limited range of wares – potters working in the context of workshops that produced only a limited range of high-end products) to products of more modest associations, perhaps manufactured by establishments that turned out a wide array of products through the labor of non-specialized potters. However, the fact that one of the vessels of medium-quality BGW included in the study had its floor decorated with grooves and chattering suggests that in some instances, at least, the potters who manufactured vessels of this kind did so with the intention of supplying the same market niche as that supplied by the producers of high-quality BGW. This may have occurred at the Montaione – Bellafonte production facility, where the workshop also manufactured small amounts of high-quality BGW, some with groove and chatter decoration. We may conjecture that, whereas the workshops that manufactured high-quality BGW needed to be located at or near concentrations of consumers that could generate sufficient demand to support the operation of such (specialized?) high-end production – namely the major demographic and political centers, including specifically Arezzo and Volterra – establishments that manufactured medium- to low-quality BGW within a mixed production strategy could have been located elsewhere – at or near lower-order centers (as Chiusi – Marcianella) or in the countryside at an appreciable distance from any sizable settlement (as

Montaione – Bellafonte), and, since the quality of the finished product was in some cases, at least, not a major consideration, in areas that did not enjoy convenient access to fine-grained calcareous clay.

6.1.2 North Etrurian Red-Slip Ware

As was the case with BGW, it is necessary to review the results of recent research projects undertaken with a view to identifying and determining the provenance of the several variants of NERSW before considering the evidence for the eight fabric groups recognized for this class. As with BGW, the most comprehensive recent study of a site sub-assemblage of this class is Palermo's study of the material from the Volterra – Acropoli excavations.[94] He classified 289 sherds of NERSW, assigning these to two different groups on the basis of the megascopic characteristics of fabric and slip. A synopsis of the results of this work is presented in Table 11.A. Palermo's Group 1, which accounted for 64 sherds, was attested in just two forms, a bowl identical to the Morel F1211 in BGW and an *askos* identical to the Morel F8251 in BGW, with the later form represented by just two sherds. His Group 2, which accounted for 225 sherds, was attested in a variety of open and closed forms, including the Morel F1211 bowl, which form accounted for one-quarter of the total number of sherds. He equated Group 1, which has a finer body and more thick and regular slip than Group 2, with the production group that scholars have generally termed "Volterran pre-sigillata", noting that while a portion of the vessels that scholars have assigned to this class does, in fact, originate at Volterra, some portion was manufactured by s situated elsewhere, most likely, in his view, at Perugia and Chiusi. Palermo distinguished four distinct bodies within his Group 2, all characterized by a texture less fine than that associated with Group 1 and a thin, uneven slip that is powdery to the touch, and believed that this group likely subsumed the products of multiple workshops located in different places. A substantial portion of this group (probably including the vessels in Palermo's Body 3, though also perhaps those in his Body 1 and Body 2) has a fabric and slip with characteristics similar to those of his Volterra – Acropoli BGW Group T and Palermo believed that these vessels may well have been manufactured by the workshop or workshops responsible for the manufacture of this production group, which operated at Volterra. This inference is supported by the fact that, as previously noted, Group T was the only one of Palermo's BGW groups of presumed Volterran origin that included multiple examples of the Morel F1211.

94. Palermo 2003b.

TABLE 11. Synopsis of results of Palermo's studies of the NERSW from the Volterra – Acropoli excavations (Palermo 2003b), Fiesole – Via Marini/Via Portigiani excavations (Palermo 1990b), and the Chiusi – Orto del Vescovo excavations (Palermo 2003b, 147 n. 725). Phases: As for Table 10.

Group	Body	Slip	Number sherds	Phases	Provenance
A. Volterra					
Group 1	hard; pinkish hazel (7.5 YR 6/6); compact	Red or orange red; somewhat glossy to glossy, thick, regular, resistant	64	10-12, 14	Volterra?
Group 2	Body 1: orange or red orange (2.5YR 5/6-6/8); hard, compact; sometimes rare, white or glistening inclusions	Slip 1: red or orange; mate, thin, regular, powdery, resistant	225	10-12, 14	Volterra?
	Body 2: hazel (7.5YR 7/4); hard, compact	Slip 2:red, brown or black with patches and discolorations; thin, uneven, powdery, not resistant			
	Body 3: brown (7.5YR 7/6-5YR 6/4); hard, granular; numerous, small, white inclusions				
	Body 4: yellowish (7.5YR 8/4); hard, compact; rare, small, white inclusions				
B. Fiesole					
	Body 1: orange (2.5YR 6/8), orange brown (5YR 6/8), brown (5YR 6/8), reddish (2.5YR 5/8), or light orange (5YR 7/8, 7.5YR 7/6) with gray core; hard to very hard, compact, rough, granular with cracks; somewhat regular to regular break	Slip 1: red or red-brown; matte, thin, uneven, adherent	2255	E, R	Fiesole
		Slip 2: red or red-orange; matte, thin, uneven, not adherent			
		Slip 3: red or red-orange; slightly glossy to glossy, thick, regular, adherent			
	Body 3: orange (5YR 7/8), orange brown (5YR 6/8); somewhat hard to hard, compact, rough, granular; somewhat regular break; numerous, small to medium, light and rare, large, brown, granular inclusions	Slip 5: red orange or reddish black; matte, thin, powdery, not resistant	190	E, R	Fiesole
		Slip 7: red or orange red; matte, medium thickness, regular, smooth, adherent/resistant			
		Slip 8: orange or brown orange			

Group	Body	Slip	Number sherds	Phases	Provenance
	Body 4: hazel (7.5YR 7/4), hard, smooth, compact; regular break	Slip 9: red; glossy, thick, regular, smooth, adherent	30	E, R	Volterra
	Body 5: orange (5YR 7/8); hard, slightly granular, rough, compact; regular break; very rare, small, white and granular brown inclusions	Slip 10: red-orange; matte, thin, even, smooth, adherent	15	E, R	Northern Etruria?
	Body 6: orange (2.5YR 6/8); hard, rough, granular, slightly compact; regular break; numerous, small, white, granular and rare, large, dark, granular inclusions	Slip 11: red; matte, thin, not adherent	215	E, R	Undetermined
C. Chiusi					
	Hazel or pinkish hazel; compact, fine; sometimes rare, small, white inclusions	dark red or coral red, sometimes with yellowish patches; somewhat glossy to glossy; thin	No information	No information	Chiusi?

Palermo carried out a similar study of the NERSW from the Fiesole – Via Marini/Via Portigiani excavations.[95] In this instance he classified 2705 sherds, assigning these to five fabrics. Two of these (Bodies 1, 3), together accounting for 2445 sherds, he identified as being of local origin. One of these two bodies (Body 1) was attested in both the Morel F1211 bowl and various other open and closed forms, while the other (Body 3) was attested in various open forms, none of which was the Morel F1211. A third fabric (Body 4), represented by 30 sherds, Palermo believed to be from Volterra, and a fourth (Body 5), accounting for 15 sherds, he believed originated somewhere in northern Etruria. Both of these latter two fabrics were attested exclusively in the Morel F1211. He declined to suggest a probable point of origin for the fifth and final fabric (Body 6), which was represented by 215 sherds belonging to one or more unidentified closed forms. Palermo also studied the NERSW from the excavations at Chiusi – Orto del Vescovo, and while the results of this work remain unpublished, he does indicate in passing in his study of the NERSW from Volterra – Acropoli that the vessels from this other site, presumably of Chiusine origin, can be distinguished from the vessels in his Volterra – Acropoli Group 1 on the basis of their slip, which is thinner, more uneven, and of a somewhat different color.[96]

95. Palermo 1990b.
96. Palermo 2003b, 347 n. 725.

A synopsis of the results of Palermo's work with the materials from these two sites is presented in Table 11.B-C.

In the area of compositional studies, as previously noted, Gliozzo and collaborators included three specimens of NERSW in their compositional study of materials from the Chiusi – Marcianella pottery production facility.[97] While petrographic analysis and electron microscopy indicated that these specimens had a mineralogical composition similar to that of the four specimens of BGW included in the program of analysis, XRF revealed that they had a distinctly lower composition for CaO than did the specimens of this other class - 8.4 percent mean CaO (= 6.0 percent Ca), as opposed to 11.1 percent mean CaO (= 7.9 percent Ca).[98]

It should be noted that the evidence from the Volterra – Acropoli excavations suggested that the Morel F1211 bowl was in use there mainly during the period ca. 200-180 B.C., with perhaps some continuing use into the period ca. 180-140 B.C.[99] The evidence from the Chiusi – Marcianella excavations indicated a closely similar range of dates for the manufacture of this form there, extending from the end of the third to the first quarter of the second century B.C.[100]

Turning now to the eight NERSW fabric groups identified in the current study, the sole specimen in Fabric Group 1 is of probable medium quality, with a poorly preserved, red slip. It is an example of the Morel F1211 bowl and was recovered in Deposit 3. The presence of this sherd in Deposit 3 indicates that the manufacture of this fabric group commenced prior to ca. 150/125 B.C., while the fact that it is an example of the Morel F1211 suggests that this date can be pushed back to ca. 180 B.C.

The chemical and petrographic evidence indicate that this specimen/fabric group was manufactured from a fine, highly calcareous clay or a less fine calcareous clay subjected to levigation. As noted above, cluster analysis assigned this specimen to the same cluster as the specimens in BGW Fabric Group 2, and it appears likely that it originated in the same place as this fabric group. As discussed above, various considerations suggest that BGW Fabric Group 2 originated at Volterra, and it thus seems likely that this specimen/fabric group was also manufactured there. The characteristics of the body of the sole specimen attested may correspond to those indicated by Palermo for a

97. Gliozzo *et al*. 2003.
98. Gliozzo *et al* 2003, 303 Tab. 17.
99. Palermo 2003b, 349, 357.
100. Aprosio 2003, 157.

group of assumed Volterran origin attested among the Volterra – Acropoli materials (Group 2, Body 2) and a fabric of assumed Volterran origin attested among the Fiesole – Via Marini/Via Portigiani materials (Body 4).

The sole specimen in Fabric Group 2 is of high quality, with a glossy red slip that is continuous on the interior surface and spotty on the exterior surface. It belongs to a cup, bowl or dish with an inflected wall that is probably not the Morel F1211 bowl, and was recovered in Deposit 2. The appearance of the body and slip are distinct from those of the other examples of this class in the Cetamura assemblage, and it seems possible that it is, in fact, an example of BGW that was fired (intentionally or otherwise) in an oxidizing atmosphere.[101] The presence of this sherd in Deposit 2 indicates that the manufacture of this fabric group commenced prior to ca. 200 B.C.

The chemical and optical microscopic evidence indicate that this specimen/fabric group was manufactured from a fine, moderately calcareous clay or a less fine calcareous clay subjected to levigation. Cluster analyses of the calcareous BGW and NERSW employing various suites of elements, distance measures, agglomeration procedures associate this specimen in some instances with BGW Fabric Group 5 (as discussed above) and in others (not presented here) with BGW Fabric Group 2. These results are somewhat contradictory with regard to the issue of this specimen's point of origin, since in the first case they suggest that it is not of Volterran origin, while in the second they suggest that it is. The fine texture of this specimen suggests, however, that it is more likely related to BGW Fabric Group 2.

The specimens in Fabric Group 3 are of medium quality, with a poorly preserved, glossy red slip. Four were recovered in Deposit 3, while the fifth was recovered in a locus comparable in date to Deposit 3. All are examples of the Morel F1211 bowl. The presence of examples of this fabric group in Deposit 3 and a locus of comparable date indicates that its manufacture commenced prior to ca. 150/125 B.C., while the fact these are examples of the Morel F1211 suggests that this date can be pushed back to ca. 180 B.C.

The chemical and petrographic evidence indicate that this fabric group was manufactured from a fine, non-calcareous to low-calcium clay or a less fine non-calcareous to calcareous clay subjected to unusually thorough levigation. The low Ca values and the absence of microfauna indicate that (despite some similarity in the rim forms attested) this fabric group is not a product

101. See Palermo 2003a, 348, 358 for an example of BGW with a red gloss from the Volterra – Acropoli excavations. See Morel 1994, 519-520 for BGW with a red gloss in general.

of the workshop that operated at Chuisi – Marcianella. The characteristics of the body and slip may correspond to those indicated by Palermo for a group of assumed Volterran origin attested among the Volterra – Acropoli materials (Group 2, Body 2, Slip 2). The low calcium content, low abundance of inclusions, and overall appearance of the fabric suggest that it was manufactured employing a material different from those utilized for the production of the other calcareous fabric groups examined in this study. One possibility worth considering is that it was manufactured using material obtained from the formation of lacustrine clay of the Upper Miocene located in the area to the E of Poggibonsi and Monteriggioni in the upper Val d'Elsa (Fg 113 formation Mla_2 [*argille azzurre lignitifere*/lignite-bearing blue clays]). If so, this fabric group may constitute all or part of the production of this class that has been posited for the Val d'Elsa on the grounds of distributional evidence.

The specimens in Fabric Group 4 are of either medium or low quality, with a poorly preserved red slip. Two were recovered in Deposit 3, and the third in a locus comparable in date to Deposit 3. All are examples of the Morel F1211 bowl. The presence of examples of this fabric group in Deposit 3 and a locus of comparable date indicates that its manufacture commenced prior to ca. 150/125 B.C., while the fact these are examples of the Morel F1211 suggests that this date can be pushed back to ca. 180 B.C.

The chemical and petrographic evidence indicate that this fabric group was manufactured from continental clay of intermediate texture or a gritty to coarse clay of this kind subjected to levigation. If the latter, it seems possible that this was the same clay as that employed for the manufacture of NERSW Fabric Group 6. The characteristics of the body and slip may correspond to those indicated by Palermo for a group of assumed Volterran origin attested among the Volterra – Acropoli materials (Group 2, Body 3, Slip 2) and/or for a fabric of assumed north Eturian origin among the Fiesole – Via Marini/Via Portigiani materials (Body 5/Slip 10). Little can be said about this fabric group's likely point of origin, except that this must have lain in an area where there was access to clay of the kind just indicated. Given the fact that there does not appear to be a strong association of calcareous clay with the manufacture of this class, there is a less strong basis for assuming that this fabric group was manufactured in an area that did not enjoy convenient access to calcareous potting clay than was the case with the non-calcareous fabric groups of BGW. For this reason an origin in the Upper Val d'Elsa as well as in the Monti del Chianti and Upper Arno Valley all seem possible. The possibility that there is a substantial amount of material perhaps belonging to this fabric group among the materials in the Fiesole – Via Marini/Via Portigiani assemblage is compatible with this inference.

The specimen in Fabric Group 5 is of medium or low quality, with a poorly preserved red slip. It is an example of the Morel F1211 bowl, and was recovered in Deposit 3. The presence of this sherd in Deposit 3 indicates that the manufacture of this fabric group commenced prior to ca. 150/125 B.C., while the fact that it is an example of the Morel F1211 suggests that this date can be pushed back to ca. 180 B.C.

The chemical and petrographic evidence indicate that this fabric group was manufactured from non-calcareous continental clay of a porphyritic texture. The characteristics of the body and slip may correspond with those indicated for Palermo's Volterra – Acropoli Group 2, Body 1, Slip 1 or 2. The presence of fragments of granite suggests that this fabric group originated somewhere along the coast of northern Etruria opposite Elba, the closest source of rock of this kind, thus perhaps somewhere in the territory of Populonia, Vetulonia, or Roselle.

The specimen in Fabric Group 6 is of medium or low quality, with a poorly preserved red slip. It is an example of a closed form of some kind, and was recovered in Deposit 3. The presence of this sherd in Deposit 3 indicates that the manufacture of this fabric group commenced prior to ca. 150/125 B.C.

The chemical and optical microscopic evidence indicate that this specimen/fabric group was manufactured from a gritty, non-calcareous clay of continental origin or a coarse clay of this kind subjected to levigation. For the same reasons as those indicated for NERSW Fabric Group 4, an origin in the Upper Val d'Elsa, the Monti del Chianti, or the Upper Arno Valley seems possible.

The specimen in Fabric Group 7 is of medium or low quality, with a poorly preserved red slip. It is an example of a closed form of some kind, and was recovered in a locus comparable in date to Deposit 3. This indicates that the manufacture of this fabric group commenced prior to ca. 150/125 B.C.

The chemical and petrographic evidence indicate that this specimen/fabric group was manufactured from a gritty, low-calcium clay or a coarse clay of this kind subjected to levigation, Nothing can be said regarding this fabric group's point of origin, except that this must have been situated near a deposit of sandy, low-calcium clay.

The sole vessel in Fabric Group 8 is of medium or low quality, with a poorly preserved red slip. It is an example of a deep/medium open form or a closed form of some kind, and was recovered in Deposit 2. This indicates that the manufacture of this fabric group commenced prior to ca. 200 B.C.

The chemical and petrographic evidence indicate that this specimen/fabric group was manufactured from a gritty, low-calcium clay, probably of marine origin, or a coarse clay of this kind subjected to levigation. It presumably originated somewhere in the area of marine sediments in northern Etruria. The characteristics of the body and slip of the sole example attested may correspond to those indicated by Palermo for a group of assumed Volterran origin attested among the Volterra – Acropoli materials (Group 2, Body 3, Slip 1 or 2). It may be effectively identical to Volterra – Acropoli BGW Group T (specifically, this group's Body 1 variant), an observation pointing to a possible Volterran origin.

On the basis of this evidence it is possible to formulate the following outline of the development of NERSW production in northern Etruria: At some point prior to ca. 200 B.C. a workshop, perhaps located at Volterra, began producing medium- to low-quality NERSW, including a cup or closed form of some kind. A second workshop, also perhaps located at Volterra, may have begun producing high-quality NERSW, including an open form of some kind, at some point prior to this same date. Beginning at some point prior to ca. 180 B.C. and perhaps as early as ca. 200 B.C. workshops located in four different places in northern Etruria began to manufacture medium- to low-quality NERSW, largely or exclusively examples of the Morel F1211 bowl, with this production perhaps continuing until as late as ca. 150/125 B.C. One of these establishments probably lay in the coastal zone near Populonia, Vetulonia and Roselle, another may have been located at Volterra, one in the upper Val d'Elsa, and one in the upper Val d'Elsa, the Monti del Chianti, or the upper Arno Valley. The establishment perhaps located at Volterra may have been the same workshop that produced high-quality BGW there during this period. At some point prior to 150/125 B.C. and perhaps as early as ca. 200 B.C. two workshops began to manufacture closed forms in medium-/low-quality NERSW. One of these establishments may have been the same the establishment that manufactured examples of the Morel F1211 bowl that was perhaps located in the upper Val d'Elsa, the Monti del Chianti, or the upper Arno Valley.

The emergence and spread across much of northern Etruria of the production of the Morel F1211 bowl in NERSW over the period ca. 200 – 180 B.C. (continuing perhaps with substantially diminished intensity until as late as ca. 150/125 B.C.) is a phenomenon of considerable interest. These vessels were manufactured by workshops in at least five different production loci (those documented in the current study, plus Chiusi – Marcianella), at least one of which (Chiusi – Marcianella) was, as noted above, the seat of operations of an establishment that turned out a variety of products, including also medium- to low-quality BGW.[102] These vessels, which are known from both domestic and funerary contexts across the region, were regularly embellished with stamped decoration and on some occasions were also provided with a maker's stamp. They must have proved strongly attractive to consumers for some reason or reasons that elude us, and one is tempted to characterize the phenomenon of their widespread production and use within northern Etruria over a period of perhaps no more than two decades as a fad. It would be interesting to know where the manufacture of this vessel type originated and why its manufacture and use spread across the region in the way that it did. It is perhaps worth noting in this connection that on the basis of the evidence currently available it appears that while this vessel type was likely manufactured by at least one workshop at or near Volterra, no pottery workshop at Arezzo would appear to have elected to produce some version of this form.

6.1.3 Italian Terra Sigillata

The vessels in the three fabric groups attested for ITS are all of high quality. There are 11 forms attested for Fabric Group 1: six platters/plates (Conspectus Form 1, 4, 12, 18, 19, 20), one dish (Conspectus Form 3), and four cups (Conspectus Form 14, 29, 34, 37). The chronologies of these forms suggest that its manufacture commenced prior to ca. 10 B.C. and continued through to at least ca. A.D. 40. There are six forms attested for Fabric Group 2: four platters/plates (Conspectus Form 4, 6, 12, 20), one dish (Conspectus Form 3), and one cup (Conspectus Form 23). The chronologies of these forms suggest that its manufacture commenced prior to ca. A.D. 15 and continued through to at least ca. A.D. 40. There is one form attested for Fabric Group 3 – the Conspectus 20 or 21 platter/plate. Its chronology suggests that the manufacture of this fabric group commenced prior to ca. A.D. 90.

The chemical and textural similarity of Fabric Groups 1-2 and the two specimens of Arezzo – Quarata clay leave little room for doubt that these two fabric groups were manufactured at Arezzo using clay obtained from this formation. The low score assigned to the sole vessel in Fabric Group 3 in the second set of MADCORR trials discussed above suggests that it was not manufactured using paste derived from Arezzo – Quarata clay, hence is probably not from Arezzo. The texture and mineralogical composition of

102. Aprosio and Pizzo 2003.

this vessel are compatible with the possibility that it originated somewhere other than Arezzo.

6.1.4 Technological Aspects of Manufacture

In thin section the two specimens of Arezzo – Quarata clay display a notably fine texture, with a sparse aplastic component consisting of fine-grained quartz and mica with the occasional fragment of mudstone or siltstone or polycrystalline quartz. Examples of the three fabric groups apparently manufactured from this clay (BGW Fabric Group 1 and ITS Fabric Groups 1 and 2) display a texture and mineralogy effectively identical to those of Arezzo – Quarata clay, indicating – as one might suppose, given the fine texture of this clay – that the workshops that manufactured these fabric groups employed this material more or less as it was extracted from the ground, having no need to improve the working properties of the paste or the performance properties of the finished products by removing the coarse fraction of its aplastic component through levigation.

As noted, the compositional distinction between the vessels in ITS Fabric Group 1 and those in ITS Fabric Group 2 appears to reside mainly in the fact that the former group displays relatively low Ca values (ca. 4.5 – 7 percent) and relatively high values for most of the other elements assayed and the latter group relatively high Ca values (ca. 7-9 percent) and relatively low values for most of these other elements. A program of analysis carried out by Schneider and Hoffmann that involved the characterization of 124 ITS vessels recovered at various of the production facilities at Arezzo (including the more distant Cincelli production facility) by means of XRF may further elucidate the nature of the distinction between these two fabric groups.[103] This set of materials can be readily divided into three groups on the basis of their CaO content. These include a group of 44 vessels recovered at the workshop of Ateius at Arezzo – Via Nardi and stamped with this maker's name, which display a relatively high CaO value (group mean 13.0 +/- 1.1 percent; = 9.29 +/- 0.8 percent Ca), a group of 15 vessels recovered at the workshop of Perennius at Arezzo –Santa Maria in Gradi (roughly 500 m to the SE of Via Nardi) and stamped with this maker's name, which display a relatively low CaO value (group mean 3.64 +/- 1.1; = 2.60 +/- 0.8 percent Ca), and the remaining 65 specimens, including various stamped and unstamped vessels from various production facilities, including the one at Cincelli, which display an intermediate CaO value somewhat closer to that of the first group

103. Schneider and Hoffmann 1990, 30-31, 37 Tabelle 3.

(group mean 9.73 +/- 0.7; = 6.95 +/- 0.5 percent Ca).[104] While these values cannot be directly compared with those obtained in the program of analysis reported here, it may be worth noting that the ratio of group mean Ca values for the two largest of the three groups – the first and the third (9.29/6.95 = 1.34) – is effectively identical to that for the ratio of the group mean Ca values for Fabric Group 2 and Fabric Group 1 (8.04/6.12 = 1.31). The compositional difference between Fabric Groups 1 and 2 may thus reflect the difference between a specific source of Arezzo – Quarata clay exploited by the Ateius workshop that yielded material with a high concentration of Ca and one or more other such sources exploited by various other workshops that yielded material with an intermediate concentration of Ca.[105] The Perennius workshop might have exploited yet some other source that yielded clay with a low concentration of Ca. It should be underscored that it is not here being suggested that the Fabric Group 2 vessels are all products of the Ateius workshop – this is impossible, given the fact that this establishment operated for a brief period between ca. 15 and 5 B.C., whereas several of the forms attested for Fabric Group 2 date to appreciably later than this[106] – but rather that these were perhaps manufactured from clay obtained from the same source as that exploited by the Ateius workshop. The difference in chemical composition between the two specimens of Arezzo – Quarata clay subjected to analysis is compatible with the assumption that compositional differences of this degree may characterize clay obtained from two different if not particularly distant parts of the agQ formation. While it cannot be excluded that these compositional distinctions might be the result of the levigation of Arezzo – Quarata clay, the fine texture of this clay and its textural and chemical similarity to Arretine ITS makes this seem improbable.

Worth noting is the fact that the beds of clay in the agQ formation are interleaved with and in some areas overlain by deposits of peat (*torba* in Italian) and peaty lignite (so-called "brown coal", a substance intermediate between peat and coal).[107] Beds of peat are extremely rare in peninsular Italy, and in the areas of northern Europe where peat is abundant it has been regularly

104. For the location of the Ateius and Perennius workshops see Fülle 1997, 130 fig. 2; Oxé *et al*. 2000, 27-28; Vilucchi 2012, 8-9 fig. 1.
105. Gliozzo and Memmi Turbanti 2004, 206-209, 215 Table A1, in their program of chemical analysis of BGW described above, identified what they believed were two distinct, though related subgroups of BGW vessels within their group of Arretine origin, one of which was characterized by a higher degree of compositional homogeneity. Both subgroups display a wide range of CaO figures that embody considerable overlap with one another, however, and it is clear that they do not correspond to ITS Fabric Groups 1 and 2.
106. See Oxé *et al*. 2000, 28 for the date of the Ateius workshop at Arezzo.
107. *Carta geologica d'Italia Foglio* 114 key agQ/Argille di Quarata; De Castro and Pilotti 1933, 59-60.

employed as a fuel for the firing of pottery. The digging of Arezzo – Quarata clay likely would have required the excavation of peat and lignite, or could have been carried out in concert with the excavation of peat and lignite, and it seems possible, perhaps even highly likely, that peat (or both peat and lignite) were employed as fuel for the firing of the pottery manufactured with this clay. The availability of this highly unusual fuel that could have been obtained at low costs in terms of labor input and transport would have represented a considerable advantage for tableware producers in the Arezzo area, and this, together with economies offered by ready access to Arezzo – Quarata clay, which, unlike the calcareous marine clay commonly employed for the manufacture of gloss-slipped pottery elsewhere in west-central Italy, could have been employed without recourse to the labor intensive practice of levigation, may have constituted a set of advantages that lay behind the development of the ITS industry at Arezzo in the third quarter of the first century B.C.[108]

The workshops in the Arezzo area that manufactured BGW and ITS would also have utilized a second clay – presumably non-calcareous and iron-rich – to produce the slip that they employed to surface their products. For this purpose they most likely employed material obtained from a source belonging either to the formation designated Qt (*argille sabbiose fluviali*) or to that designated Qt_1 (*argille e ciottoli arenacei fluviali*), both fluvial deposits of the Upper Pleistocene, which constitute the end of the geologic sequence over most of the Arezzo basin.[109] They presumably removed the fine fraction of what was likely a gritty to coarse clay through levigation, decanting the supernatant into tanks where it was reduced to a slurry through evaporation.

The specific locations of the several known production sites for BGW and ITS in the Arezzo area strongly suggest that the siting of these establishments was significantly affected by the geography of the exposures of Arezzo – Quarata clay, with an effort made to locate production facilities close to one of these outcrops in order to achieve economies in the use of this material. Particularly suggestive in this regard is the presence of production facilities on the right bank of the Arno at Ponte a Buriano and Cincelli, more or less directly opposite the westernmost exposures of this formation in the vicinity of the Canale Maestro della Chiana/Arno confluence. The production

108. See Peña 2013a for a fuller discussion of this set of inferences.
109. Clay obtained from a deposit lying within the Q_t formation was, for example, apparently employed in recent times by a factory for the manufacture of architectural ceramics located 6 km to the north of Arezzo at *località* Giovi Le Cave. On a visit to this facility by one of the authors (JTP) in 1991 an informant, who stated that her family had operated this establishment (which had ceased operations many years previously), indicated that it had employed clay excavated on the premises.

facilities at the other locations all lie to the southwest or west of the area occupied by the Roman-period (and presumably also pre-Roman) town,[110] and are thus closer to rather than farther from the exposures of the agQ formation that occur along the banks of the Castro. Of particular interest in this regard is the fact that possible production debris perhaps indicative of an ITS production facility has also been reported from Montione, located at the easternmost of these exposures, and thus the one situated closest to Arezzo.[111]

The NAA data pertaining to the five fabric groups of likely or possible Volterran origin, including BGW Fabric Groups 2, 3, and 4, and NERSW Fabric Groups 1 and 8, demonstrate no relationship to the seven examples of marine clay from outcrops of the Pag formation in the environs of Volterra. This is hardly surprising, as test tiles manufactured from these clay specimens all have a coarser texture than the vessels in all but the last of these five fabric groups. While it seems highly likely that clay from this formation was employed for the manufacture of these fabric groups, it is unclear whether the lack of any compositional correspondence between these fabric groups and the specimens analyzed stems from the fact that the clay employed for this purpose was obtained from one or more different parts of the formation that yielded material with a finer texture and substantially different chemistry (including, among other things, substantially lower Ca values) or from the fact that the clay employed was subjected to levigation.

In order to evaluate the second of these two possibilities one of the two less course-textured clay specimens of Pag clay, CVLT.07, was subjected to levigation. The fine fraction was then employed to produce a fired tile and pellet, which were then subjected to optical microscopy and NAA according to the set of procedures described above. The pulverized clay specimen was levigated by being poured into a beaker of de-ionized water and allowed to stand for 60 seconds. The supernatant was then decanted into a second beaker and allowed to dry by evaporation for seven days, with the water remaining at the end of this period removed by pipette and the sediment employed to fashion the tile and pellet. The tile (designated CVLT.07FF, with FF standing for fine fraction) displayed a texture only slightly less coarse than that of the test tile manufactured from the bulk clay specimen (Fig. 16B). The NAA data for CVLT.07FF are reported in Table 5 in the row immediately below those for CVLT.07 for ease of comparison. While most of the values for the levigated specimen differ substantially from those for the bulk specimen, with,

110. See Vilucchi 2012, 8-9 fig. 1 for a map indicating the locations of the known ITS production facilities in the Arezzo area.
111. Paturzo 1996, 36.

most notably, the Ca value declining from 11.2 to 9.28 percent, the overall chemical composition of the levigated specimen is still significantly different from that of any of the vessels belonging to the various fabric groups of possible Volterran origin. While it seems possible that a levigation procedure in which the clay was allowed to settle for substantially longer than 60 seconds might yield a material with a texture and chemistry similar to those of some of the vessels belonging to the fabric groups in question, the results of this trial do not permit one to decide between the alternative explanations noted above to account for the divergence in composition between the pottery of assumed Volterran origin and the tiles made from Pag clay.

As was the case with the BGW and ITS workshops at Arezzo, the establishments at Volterra that manufactured BGW and perhaps also NERSW would have required the use of a non-calcareous, iron rich clay to produce slip. They might have obtained this material from deposits of alluvial sediment (formation Q_2t [*depositi alluvionali terrazzati*]) that occur along the margins of the valley of the Fiume Cecina, ca. 7 km to the SW, S, and SE of the town.

There is at present no definitive information regarding the locations of the production facilities in the Volterra area that produced these two classes of pottery. As the evidence from Chiusi – Marcianella indicates, both classes might have been produced by a single establishment. While Palermo reports several examples of BGW with production defects from the Volterra – Acropoli excavations (terming these "*scarti di fabbrica*" [workshop or manufacturing discards]), he does not provide any details regarding the nature of these defects.[112] It is not possible to determine whether or not these should be considered wasters, that is, vessels with production defects of a kind that would have precluded their distribution, even as seconds, and thus whether the presence of these vessels should be taken as evidence for the manufacture of BGW somewhere in the immediate vicinity of the Volterra – Acropoli excavation.[113] In light of the fact that Volterra is situated atop a substantial hill (the area enclosed by the walls lies at ca. 500-540 m a.s.l.), the fact that the fabric groups of possible Volterran origin display substantial chemical variability, the fact that the outcrop of Pag clay that produced the most fine-textured material was, at ca. 120-125 m a.s.l., near the bottom of the exposure of this formation (and also the closest to the Cecina of the outcrops sampled),

112. Palermo 2003a, 296 nos. 16, 18, 304 no. 39, 306 no. 45, 317 no. 74, 318 no. 81, 321 no. 91, 323 n.97, 325 no. 105.
113. Palermo (2003a, 325 no. 105.) regarded at least one of the pieces with production defects as constituting evidence that the form to which it belongs (in this case a krater) was produced at Volterra.

and the possibility that the clay employed for slip was obtained from alluvial deposits along the valley of the Cecina, it seems possible that these vessels were produced by multiple workshops, some or all of which were situated outside Volterra, possibly well downslope to the SW, S, or SE of the town at no great distance from the Cecina.[114] These establishments might have been located even further afield within the territory of Volterra.

Potters in various locales in northern Etruria without access to fine-textured, moderately calcareous clays such as those available at Arezzo and Volterra employed the clays available to them locally to produce both BGW and NERSW. In the case of BGW, the resulting vessels tended to have what was likely regarded as a less esthetically satisfactory surfacing, with a slip characterized by a matte appearance, blotchiness, and at times a more reddish color that was prone to flaking. These vessels were rarely provided with incised or stamped decoration, probably due in part to the fact that this was difficult to execute on vessels manufactured in a paste having an intermediate, gritty, or coarse texture. It is possible that in some cases workshops enjoyed convenient access to multiple clay sources belonging to a single formation or to different formations that yielded clays with substantially different compositions, and it is thus possible that two or more of the fabric groups identified in this study originated at a single establishment. Sets of fabric groups that are particularly worthy of consideration in this regard are the non-calcareous BGW Fabric Groups 7 and 8 and NERSW Fabric Groups 3, 4, and 6, and the low-calcium BGW Fabric Group 6 and NERSW Fabric Groups 7 and 8. In the case of NERSW Fabric Groups 4 and 6, it appears possible that the former was, in fact, manufactured with a fine fraction of the clay employed for the manufacture of the latter, perhaps by the same workshop. It may even be the case that a single workshop produced vessels in both non-calcareous and calcareous fabrics.

6.2 Supply and Consumption

The mobilization of the results of the program of analysis to reconstruct patterns in the supply to Cetamura and consumption there of the three pottery classes that are the focus of this study is constrained not only by the three considerations noted at the beginning of this section (the breadth of the four time periods recognized, the possible effects of residuality, the limited number of specimens analyzed), but also by the fact that, as seen in

114. Ostman 2004, 195 reaches generally similar conclusions regarding the likely locus of pottery production in the vicinity of Volterra in antiquity basing her inferences on the working properties of the clay obtained from the various outcrops of the Pag formation that she sampled in her program of analysis.

the three preceding subsections, in the majority of cases it is not possible to determine the specific locus or in some cases even the general area where the various fabric groups recognized originated. The significance of the figures for the relative representation of the various classes and fabric groups is further constrained by the methods employed to select specimens for inclusion in the program of analysis. For Deposit 1, all seven of the BGW vessels in the deposit (all of which were fine-textured) were selected for analysis. For Deposits 2 and 3, in contrast, an adventitious selection of 21 specimens of fine-textured BGW (Fabric Groups 1-4) were chosen for analysis from among a substantially larger set of BGW vessels, along with all six specimens of intermediate-/gritty-textured BGW (Fabric Groups 5-8) and all eight specimens of NERSW. For the latter two deposits there is thus no way to judge the extent to which the figures for the relative representation of the various fabric groups of fine-textured BGW are representative of the figures for these deposits as a whole. Further, intermediate-/gritty-textured BGW and NERSW are both over-represented to some unspecifiable extent with respect to fine-textured BGW. Since all additional examples of intermediate-/gritty-textured BGW and some additional examples of NERSW recovered in other loci during the 1987 and 1988 field seasons were also selected for analysis, these two groupings are over-represented to some unspecifiable extent with respect to fine-textured BGW in comparison with their representation among the 1987 and 1988 pottery assemblages as a whole, with the former grouping (i.e., intermediate/gritty-textured BGW) also over-represented to some unspecifiable extent in comparison to NERSW. Finally, the specimens of ITS included in the program of analysis were selected adventitiously from among the substantially larger set of ITS vessels excavated during the 1987 and 1988 field seasons. There is thus no way to judge the extent to which the figures for the relative representation of the three ITS fabric groups attested are representative of their representation within the 1987 and 1988 pottery assemblages as a whole.

The interpretation of the evidence produced by the program of analysis is also rendered problematic by the difficulty in establishing the nature of the occupation at Cetamura during any one of the four phases to which it pertains. While it is clear that the site was the venue of various sorts of craft production during the Hellenistic 1 phase and considerable – one is tempted to say intensive – cult activity in the form of the deposition of votive offerings during the Hellenistic 2 phase, and while excavation at the site has yet to uncover any architectural remains that can be identified as residential structures, it seems a reasonable assumption that during each of the four phases under consideration there was some sort of residential community present on the site. The apparently small size of the site – never apparently more than ca. 1 hectare in area – suggests that this cannot have consisted of more than a few score individuals at any time, if not, indeed, considerably fewer than this. That the site also served as a local market center during the first three phases also appears possible, with the presence of a concentration of craftsmen of various kinds and/or the presence of a sanctuary perhaps amplifying its role as a central place beyond what otherwise might have been the case. Given the rugged terrain of the Monti del Chianti, which would have rendered movement time-consuming and difficult, and what was likely the low population density of the area relative to many other parts of northern Etruria,[115] unless the sanctuary drew large numbers of worshippers from beyond its immediate environs on a regular basis, the size of the population that the site might have served as a market center cannot have been very large, perhaps several hundreds of individuals at the most.

The artifactual and ecofactual content of the Hellenistic 2 votive features excavated at the Cetamura during the period 2005-2008 (utilitarian pottery, BGW, roof tiles, frequent iron nails, rare coins, animal bone, carbonized plant remains) is not dissimilar in many respects from domestic refuse, and it would be difficult to distinguish between deposits consisting or redeposited votive material and deposits consisting of domestic refuse. As a consequence, it is impossible to develop a clear idea as to whether the vessels recovered in loci datable to the Hellenistic 2 phase – and perhaps also those datable to the Hellenistic 1 and Late Classical phases – were acquired for what we might term domestic use or for use as a votive (not overlooking the fact that objects acquired for domestic use might later be employed as votives), and whether these were discarded at the conclusion of their use life as domestic equipment or were deliberately placed in votive deposits. In light of this circumstance the approach taken here will be to consider the materials from Deposits 1-3

115. The authors are aware of no settlement data that might permit a useful estimate of the density of the population of the area around Cetamura at any point during antiquity. Modern data suggest, however, that figures during antiquity were likely on the low side of the range. According to the *tuttiitalia* website (http://www.comune.gaiole.si.it/categoria/1-il-comune/il-comune), the *comune* in which Cetamura is located, Gaiole in Chianti, which has an area of 129 km^2 had 2,737 residents as of January 1, 2011, for a density of 21 persons/km^2. This figure placed Gaiole in Chianti 248th to 255th in density for the 287 *comuni* in the region of Tuscany. According to the *Comuni d'Italia* website (http://spazioinwind.libero.it/liberscuola/comunitaliani.htm), the highest population figure registered for Gaiole in Chianti in the national censuses that have been carried out in the first year of each decade since Italian unification occurred in the very first of these, that is, in the one undertaken in 1861, when it was credited with 4753 inhabitants. If the boundaries of the *comune* were the same as its current boundaries, this would represent a density figure of 37 persons per km^2.

TABLE 12. Synopsis of information pertaining to chronological groups recognized in study (C = Conspectus, L = Lamboglia, M = Morel).

Period	Fabric group	Number specimens	Forms	Quality	Provenance
Deposit 1	BGW1	4	thin cup with handle(s); cup/bowl/dish	high	Arezzo
	BGW3	3	thin cup/bowl, cup/bowl, dish/plate	high	probably Volterra
Deposit 2	BGW1	1	L28?	high	Arezzo
	BGW2	1	M80	high	probably Volterra
	BGW4	2	M83, M82?	high	probably Volterra
	NERSW2	1	open	high	Volterra?
	NERSW8	1	cup or closed	medium/low	Volterra? Western Val di Chiana? Val d'Elsa? Siena?
Deposit 3	BGW1	7	L5, L28, M80, M83, closed	high	Arezzo
	BGW2	9	L5, L10?, M82?, M83, closed, lamp	high	probably Volterra
	BGW3	1	lamp	high	probably Volterra
	BGW5	4	vessel with everted rim, bowl/dish, dish/plate	medium	western Val di Chiana? Val d'Elsa? Siena?
	BGW6	1	cup/bowl/dish	medium	area of sandy, low-calcium sediments
	BGW8	3	L23?, cup/bowl/dish	low	Monti del Chianti?Upper Arno Valley?
	NERSW1	1	MF1211	medium?	probably Volterra
	NERSW3	4	MF1211	medium	upper Val d'Elsa?
	NERWS4	2	MF1211	medium/low	upper Val d'Elsa? Monti del Chianti? Upper Arno Valley?
	NERSW5	1	MF1211	medium/low	Populonia? Vetulonia? Roselle?
	NERSW6	1	closed	medium/low	upper Val d'Elsa? Monti del Chianti? Upper Arno Valley?
ITS Group	ITS1	15	C1, C3, C4, C12, C14, C18, C19, C20, C29, C34, C37	high	Arezzo
	ITS2	8	C3, C4, C6, C12, C20, C21?, C23	high	Arezzo
	ITS3	1	C20 or 21	high	not Arezzo?

on the basis of the assumption that they were all acquired and employed for domestic uses by persons resident at Cetamura, and to then offer some additional comments based on the assumption that some or all were acquired and used as votives by persons not necessarily resident at Cetamura. This will be followed by a consideration of the Roman-period materials. TABLES 1 and 12 provide synopses of the information relevant to these discussions.

The supply to and consumption at Cetamura of the three classes of pottery that are the focus of this study for domestic uses would have been determined by the geography of their production, the mechanisms employed for the distribution of the products of the various establishments involved in this production, the geography of these distribution systems, and the choices made by the inhabitants of Cetamura to acquire specific vessels from among the set of those made available to them by the distribution system.[116] The vessels belonging to these three classes of pottery might have reached those who used them either through sale or gift exchange. In the case of sale, consumer choice would have been governed by considerations of the price and attractiveness of the vessels, with the latter a complex and difficult to define attribute embodying considerations of appearance, anticipated functionality/performance, and various other associations (e.g., stylishness). The exchange of vessels as gifts presupposes an arrangement whereby the craftsman producers were in some way socially and/or economically dependent upon elites, who received all or some portion of their output and disposed of this as gifts made either to other elites in the interest of cultivating their relations with these or to social inferiors in the context of the operation of their patronage network.[117] In situations of this sort consumer choice presumably would have played only a limited or no role. That pottery of the kind here under consideration reached consumers by means of this mechanism on a regular basis may be doubted, however, and it seems likely that sale represented the dominant means whereby it reached those who consumed it.

Vessels belonging to these three classes might have reached consumers via a variety of market mechanisms. The workshops that produced these wares might have marketed them to middleman wholesalers, to retailers, and/or directly to consumers. These establishments might have done this at one or more of three different loci: the production facility, a fixed facility (i.e.,

116. See Peña forthcoming for the effects of locational considerations on the production and distribution of pottery in Roman Italy.
117. Roth 2007, 87-88, 93-94 assumes that high-end BGW from Volterra, specifically vessels belonging to the so-called Malacena Group, were regularly distributed as gifts via mechanisms of this kind.

a shop) physically separate from though situated at no great distance from the production facility, or at some more remote location. In the last of these three possibilities workshop members might have sold their products either by participating in a periodic market or by peddling (i.e., selling to individual households or other groupings of consumers door-to-door in towns and/or at the farm gate in rural areas). Middlemen might have acquired the vessels that they marketed either directly from the workshop or from another middleman, and might have sold these either to another middleman or to a retailer. They might have accomplished the latter operation by sale at a fixed facility situated close to the production facility, at a fixed facility at some other location, by participating in a periodic market, or by peddling. Retailers might have acquired the vessels that they marketed either directly from the workshop or from a middleman, and would have sold these directly to consumers. They might have accomplished the latter operation by sale at a fixed facility situated close to the production facility, at a fixed facility at some other location, by participating in a periodic market, or by peddling. It would not be surprising if in some cases individuals combined the roles of middleman and retailer, selling sometimes to middlemen and/or retailers and sometime directly to consumers.

Persons resident at Cetamura might have acquired examples of these pottery classes at any or all of three different loci: at Cetamura, itself, by purchase from a retailer operating a fixed facility or from a workshop associate or retailer participating in a periodic market or operating as a peddler; at or near the production facility, either at the production facility, itself, at some other fixed facility operated by a workshop associate or a retailer, or from a workshop associate or a retailer participating in a periodic market; or at some third location, from a retailer operating a fixed facility, or from a workshop associate or a retailer participating in a periodic market. Small numbers of coins have been recovered at Cetamura in contexts dating to the Hellenistic 1/2 phases, suggesting that the local economy was to some extent monetized by the second century B.C., and we should remain open to the possibility that by this time and perhaps also earlier small-scale commercial transactions such as these involved the use of coin rather than or alongside barter.

The composition of Deposit 1 suggests that during the period of its formation (ca. 350-250 B.C.) the inhabitants of Cetamura consumed small amounts of high-quality BGW. This belonged to at least two different fabric groups from two production loci that both should probably to be classified as *ceramica protocampana*. The first of these (Fabric Group 1) originated at Arezzo. It is represented by four vessels belonging to at least two forms – a thin-walled cup and one or more bowls/dishes/plates, in one instance bearing incised decoration. The second (Fabric Group 3) most likely originated at Volterra. It is represented by three vessels belonging to three forms – a thin-walled cup/bowl, a cup/bowl with stamped decoration, and a dish/plate with incised decoration.

The composition of Deposit 2 suggests that during the period of its formation (ca. 250-200 B.C.) the inhabitants of Cetamura consumed substantial amounts of high-quality BGW and very small amounts of NERSW, some of medium/low quality and some perhaps of high quality. The BGW belonged to at least three fabric groups from perhaps just two production loci. The first of these (Fabric Group 1) is the fabric group of Arretine origin attested in Deposit 1. It is represented by at least one vessel that may be a Lamboglia Form 28 cup/bowl. The second (Fabric Group 2) is of probable Volterran origin. It is represented by at least one vessel that is a Morel Form 80 cup/bowl. The third (Fabric Group 4) is also probably of Volterran origin. It is represented by at least two vessels belonging to two forms – the Morel Form 82 cup and an open vessel that may be the Morel Form 83 bowl. While neither of the BGW fabric groups of probable Volterran origin is the same as the BGW fabric group of Volterran origin represented in Deposit 1, the second of these may perhaps be related to this other fabric group. The NERSW belonged to two fabric groups from one or two production loci. The first of these (Fabric Group 8) is of medium/low quality and may perhaps originate at Volterra. It is represented by a single vessel that is probably either a closed form or a cup. The second (Fabric Group 2) is of high quality and may also originate at Volterra. It is represented by a single vessel that is a cup, bowl, or dish. This may, in fact, be a misfired example of BGW, perhaps belonging to one of the two fabric groups of probable Volterran origin represented in this deposit (BGW Fabric Group 2).

The composition of Deposit 3 suggests that during the period of its formation (ca. 200-150/125 B.C.) the inhabitants of Cetamura consumed substantial amounts of high-quality BGW and very small amounts of both medium-/low-quality BGW and medium-/low-quality NERSW. The high-quality BGW belonged to at least three different fabric groups from two or three production loci. The first of these (Fabric Group 1) is the fabric group of Arretine origin attested in Deposits 1 and 2. It is represented by at least seven vessels belonging to at least five forms – the Lamboglia Form 5 dish/plate, the Lamboglia Form 28 cup/bowl, the Morel Form 80 cup/bowl, the Morel Form 83 bowl, and a closed form of some kind. The second (Fabric Group 2) is the fabric group of probable Volterran origin attested in Deposit 2. It is represented by at least nine vessels belonging to at least seven forms – the

Lamboglia Form 5 dish/plate, a form that may be the Lamboglia Form 10 cup, the Morel Form 80 cup/bowl, an open form that may be the Morel Form 82 cup, the Morel 83 bowl, a closed vessel of some kind, and a lamp. Some of the vessels belonging to both these fabric groups can be assigned to the so-called *Cerchia della Campana B*. The third fabric group (Fabric Group 3) is that of probable Volterran origin attested in Deposit 1. It is represented by at least one vessel that is a lamp. The medium-/low-quality BGW belonged to at least three (or possibly four) different fabric groups probably originating at three (or perhaps four) production loci. None of these is attested in either Deposit 1 or 2. The first (Fabric Group 5) is a medium-quality fabric group (or perhaps two compositionally similar fabric groups) that may have originated at a location (or two locations) in the western Val di Chiana, the Siena area, and/or the Val d'Elsa. One of these locations might well have been Montaione – Bellafonte on the western edge of the Val d'Elsa, 35 km WNW of Cetamura, where a rural workshop engaged in mixed production had recently been established. This fabric group is represented by four vessels belonging to at least three forms – a vessel with an everted rim, a cup, bowl, or dish with a thickened rim, and a dish or plate with groove and chatter decoration. An example of this fabric group recovered in a locus of a date similar to that of Deposit 3 is a closed form of some kind with a ring foot. The second of these fabric groups (Fabric Group 6) is a medium-/low-quality fabric group that presumably originated in an area of sandy, low-calcium clay. It is represented by a single vessel that is cup, bowl, or dish. The third of these fabric groups (Fabric Group 8) is a low-quality fabric group that may have originated in the Monti del Chianti or the Upper Arno Valley. It is represented by two vessels that belong to two forms – an open form that is probably the Lamboglia Form 23 plate and a cup, bowl or dish. An example of this fabric group recovered in a locus of a date similar to that of Deposit 3 is a vessel with one or more broad, loop-shaped handles.

The NERSW in Deposit 3 belonged to five different fabric groups of medium or medium/low quality from at least three and as many as five production loci. None of these fabric groups is attested in either Deposit 1 or 2. For all but the last of these the only form represented is the Morel F1211 bowl. The first (Fabric Group 1), represented by a single vessel, is a medium-quality fabric group that may be of Volterran origin and may be related to one of the two high-quality BGW fabric groups of probable Volterran origin represented in this deposit (Fabric Group 2). The second (Fabric Group 3), represented by four vessels, is a medium-quality fabric group that may have originated in the Val d'Elsa. The third (Fabric Group 4), represented by a single vessel, is a medium-/low-quality fabric group that may have originated in the Val d'Elsa, the Monti del Chianti, or the Upper Arno Valley. The fourth (Fabric Group 5), represented by a single vessel, is a medium-/low-quality fabric group that may have originated in the area of Populonia, Vetulonia or Roselle. The fifth and last (Fabric Group 6) is a medium-/low-quality fabric group that may have originated in the area of Upper Val d'Elsa, the Monti del Chianti, or the Upper Arno Valley, perhaps at the same location as NERSW Fabric Group 4. It is represented by single vessel that is a closed form of some kind. A locus of a date similar to that of Deposit 3 yielded a sherd of NERSW belonging to yet another fabric group (Fabric Group 7). This fabric group, of medium/low quality, originated somewhere in an area of sandy, low-calcium clay. The sole example is a closed form of some kind.

On the basis of this evidence we can make the following inferences regarding the supply to and consumption of slipped tableware at Cetamura over the site's Late Classical, Hellenstic 1 and Hellenstic 2 phases: During the period represented by Deposit 1 the inhabitants of the settlement consumed high-quality BGW manufactured at two production loci, Arezzo and probably Volterra. Whether the products of these two loci were distributed to Cetamura in sequence, in alternation, or to some extent simultaneously is unclear. The fact that four of the seven BGW vessels in this deposit originated at Arezzo and the other three at the other production locus may indicate that over the course of this period both of these production loci provided a significant portion of the BGW consumed at the settlement. While the small size of the deposit renders any inferences based on the absence of evidence extremely tenuous, the fact that the deposit contained no BGW originating elsewhere may indicate that no other production loci distributed BGW to Cetamura during this period, or at least that none provided a significant portion of the BGW consumed there. The evidence, though scant, suggests that a substantial portion of the BGW vessels consumed at Cetamura during this period were embellished with freehand incised decoration, the execution of which would have required somewhat greater effort, attention, and perhaps also skill than did the execution of the stamped decoration common on BGW vessels in the periods of Deposits 2 and 3. Deposit 1 also contained one sherd of Overpainted Ware and one sherd of Red-Figure Ware – both probably of Volterran origin – demonstrating that other classes of slipped tableware were consumed at Cetamura over at least some portion of the period that it represents, probably though in quantities significantly smaller than those in which BGW was consumed. Thus, while the producers of BGW perhaps invested more labor in its manufacture than they did during later periods, BGW did not represent the top end of the repertoire of slipped tablewares consumed at the site.

The consumption of slipped tableware originating at just two production loci, one or perhaps both of which corresponded with the major demographic, political and perhaps also religious centers in the region, does not presuppose the presence of complex distribution mechanisms. We might, for example, imagine that during this period the inhabitants of Cetamura acquired the BGW vessels that they used directly from the production facilities where they were manufactured in the context of occasional trips to Arretium and Volaterrae carried out primarily for social, political, religious, or other economic purposes. Alternatively, these vessels might have reached consumers at Cetamura through the activities of a numerically restricted group of peddlers (perhaps based at or near the two production loci), who supplied high-end tablewares (and perhaps other craft goods) to areas located far from the major population centers, where the inhabitants did not enjoy convenient access to higher-order fixed or even lower-order periodic markets.

It is difficult to say much regarding consumption of slipped tablewares at Cetamura during the period represented by Deposit 2 due to the extremely small size of the deposit and the small number of vessels from it that were included in the program of analysis. The consumption of BGW demonstrates both points of continuity and change with respect to the preceding period. The fabric group of Arretine origin attested in Deposit 1 continued to be consumed by the inhabitants of the settlement. The fabric group of probable Volterran origin represented in Deposit 1 is not represented, though two other high-quality fabric groups of probable Volterran origin are attested, one perhaps related to this fabric group. This situation might represent some change in the organization or technology of BGW production at Volterra rather than any change in the mechanisms whereby it became available to consumers at Cetamura or change in preferences on the part of consumers at Cetamura. The presence of NERSW in the form of one closed vessel and perhaps also one open vessel, both of possible Volterran origin, is of some interest, in that it indicates that the inhabitants of Cetamura were not entirely unfamiliar with or indifferent to the attractiveness of tableware decorated with a reddish slip in the period prior to the appearance of the Morel F1211 bowl.

While Deposit 3 displays elements of continuity with Deposits 1 and 2, it also shows some conspicuous differences. Both the BGW fabric group of Arretine origin attested in Deposits 1 and 2 and one of the two BGW fabric groups of probable Volterran origin attested in Deposit 2 continued to be consumed at Cetamura. The fact that the former accounts for seven of the 25 BGW vessels from this deposit subjected to analysis and the latter for nine of these vessels suggests that both production loci provided a substantial portion of the

BGW consumed by the inhabitants of the settlement during this period. The fabric group of probable Volterran origin attested in Deposit 1 though not Deposit 2 is represented by a single vessel, a lamp. This might be a residual vessel, represent ongoing production of this fabric group, or perhaps the ongoing limited or specialized production of this fabric group.

New in the period represented by Deposit 3, however, is the presence at Cetamura of BGW vessels belonging to three fabric groups of medium or medium to low quality that appear likely to have been manufactured somewhere in northern Etruria other than Arezzo or Volterra. These fabric groups, which cumulatively account for eight of the 25 BGW vessels in this deposit that were subjected to analysis, have fabrics that are distinctly coarser than those of the fabric groups attested in Deposits 1 and 2 and less glossy, less even slips that were less resistant to wear and chipping. Probably to be related to these fabric groups is an additional low-quality BGW fabric group represented by a single vessel that was recovered in a context deposited during the last quarter of the first century B.C. or later, presumably as a residual.

During the period represented by Deposit 3 these new medium- to low-quality productions constitute a minor, if perhaps significant portion of the BGW consumed by the inhabitants of Cetamura. This appears to represent the acceptance by at least some consumers of the application of a decorative technique previously associated with high-end vessels to vessels with more modest associations. While it seems possible that this development occurred within the context of emulation, a social strategy wherein persons of lower socio-economic status adopt cultural elements (sometimes including items of material culture) associated with persons of higher status for purposes of status enhancement,[118] more detailed analysis of status-specific mortuary and domestic assemblages will be necessary before this possibility can be properly considered.

Also new in the period represented by Deposit 3 is the appearance of the Morel F1211 bowl in NERSW, which constitutes a numerically minor (both in general and in comparison with BGW) if nonetheless significant element of the pottery assemblage. The eight examples of this form present in the deposit belong to four different fabric groups of medium to low quality. One of these might have originated at Volterra, while the other three presumably originated somewhere else in northern Etruria. As already noted, the fairly rapid and widespread adoption of this vessel type in northern Etruria

118. See Miller 1985, 185-187 for emulation.

suggests that it held some particular attractiveness for consumers, including apparently, some of the inhabitants of Cetamura. The only specimen of NERSW present in Deposit 3 that is not an example of the Morel F1211 is a closed form that perhaps originated in the Val d'Elsa, the Monti del Chianti, or the Upper Arno Valley, and may have been manufactured by the same workshop as one of the examples of the Morel F1211 from this deposit.

The period represented by Deposit 3 appears to differ from those represented by Deposits 1 and 2 by the presence of a substantially greater degree of richness in the set of slipped tablewares being consumed by the inhabitants of Cetamura. This greater richness is expressed in the number of classes, fabric groups within classes (reflecting, presumably to some extent, the number of workshops involved in supplying the site), and qualities of products available to the inhabitants of the settlement. While this is doubtless to some extent an apparent rather than a real difference determined by the substantially larger size of Deposit 3 and the large number of Deposit 3 materials selected for inclusion in the program of analysis – not to mention the authors' decision to regard NERSW as a class of pottery appropriate for consideration together with BGW and thus appropriate for inclusion in this study – various kinds of external evidence (e.g., the evidence for the periods of activity of the BGW workshops that operated at Chiusi – Marcianella, Montaione – Bellafonte, and Montaione – Il Muraccio; the chronology for the manufacture of the Morel F1211 in NERSW) support the assumption that this distinction is to some appreciable degree a real one. This is also expressed in the appearance in the Cetamura pottery assemblage (and also in that from the Volterra – Acropoli excavation) at this time of Internal Red-Slip Cookware cooking pans – items of apparent regional origin that appear to have been high performance vessels that were manufactured at a limited number of production loci and distributed over much of northern Etruria during the second century B.C.[119] This development can probably be associated in a general way with the intensification of the commercial economy that occurred in northern Etruria and other parts of peninsular Italy (e.g., Campania) during the decades following the end of the Second Punic War. It is interesting that the impact that this expansion in the intensity and complexity of economic activity in northern Etruria had on the material expression of day-to-day living was not limited to the major centers, such as Volterra, Fiesole, and Chiusi, but can also be discerned in the archaeological record of a marginal – probably not just in geographical, but also in economic, social and broader cultural terms – settlement such as Cetamura.

119. See Peña 1990 for Internal Red-Slip Cookware from Cetamura.

The distribution of this substantially wider array of craft goods to Cetamura presumably required a more developed and perhaps more complex set of mechanisms than that suggested for the period of Deposit 1. We may imagine, for example, that this involved a substantially more regular and intensive flow of peddlers into marginal areas of northern Etruria such as the Monti del Chianti or, alternatively, the establishment of a periodic market either at Cetamura or in some other locale close enough to Cetamura to allow persons resident there to frequent it on a regular basis. Less probable, given what was likely the very modest size of Cetamura's population, was the establishment there of one or more fixed retailers of craft goods, including non-local pottery. Alternatively, we may imagine that there was greater volatility in the arrangements for the provision of Cetamura with slipped pottery, with suppliers and, along with them, the products of different workshops replacing one another in more rapid succession than had been the case in earlier periods.

The significant possibility that some portion of the BGW and NERSW vessels contained in one or more of Deposits 1-3 – the last of these, in particular – were brought to Cetamura by persons not resident there to be left as a votive offering requires us to revise somewhat this picture, since this opens up the possibility that at least some of the examples of these two classes reached Cetamura through a process unrelated to the marketing mechanisms just considered. The apparent absence at Cetamura of elaborate religious structures and of large, elaborate, and costly votive offerings and the site's marginal location with respect to what were likely the region's major routes of travel and trade combine to suggest that the sanctuary located there was probably one of predominantly local importance (that is to say, that it drew few worshippers from any appreciable distance). If so, it may be doubted that the practice of bringing votive offerings to the sanctuary led to the introduction into the site assemblage of substantial numbers of vessels belonging to production groups with areas of market distribution that did not normally embrace the Cetamura area. The relative representation of high-quality versus medium-/low-quality vessels (and along with this, the relative representation of the various productions present in the site assemblage) may also have been determined to some extent by this practice, although it is impossible to say in which way, as the preponderance of worshippers may have thought it appropriate to leave attractive, high-quality vessels as offerings, or may rather have had regular recourse to the practice of leaving medium-/low-quality vessels, as these were more readily and/or cheaply available and performed equally well as a high-quality vessel as a votive offering.

Turning now to the Roman phase, the ranges of the manufacturing dates for the various ITS forms represented in the program of analysis suggest that these materials were produced over a span at time extending at the very least from ca.10 B.C. to ca. 40 A.D. One of the forms represented was manufactured beginning as early as ca. 40 B.C., several might have been manufactured as late as the second half of the first century A.D., and one as late as the first half of the second century A.D., raising the possibility that the materials analyzed were produced over a span of time substantially greater than this. Over the course of the period represented by these vessels the inhabitants of Cetamura consumed ITS belonging to two different fabric groups (Fabric Groups 1 and 2) (although, as discussed above, perhaps better regarded as a single fabric group) of Arretine origin, one of which (Fabric Group 2) appears to be more closely related to the BGW fabric group of Arretine origin (Fabric Group 1) than the other in terms of its compositional characteristics. The first of these fabric groups is represented by 15 vessels belonging to 11 different forms, including four cup forms (Conspectus Forms 14, 29, 34, 37), one dish form (Conspectus Form 3), and six platter/plate forms (Conspectus Forms 1, 4, 12, 18, 19, 20). The second is represented by eight vessels belonging to six or seven different forms, including one cup form (Conspectus 23), one dish form (Conspectus 3), and four or five platter/plate forms (Conspectus 4, 6, 12, 20, and perhaps also 21). One of the vessels analyzed, an example of the Conspectus Form 20 or 21 platter/plate, a form manufactured over the period ca. A.D. 40-90, belonged to a third fabric group (Fabric Group 3) that appears not to be of Arretine origin.

During the period of time spanned by the set of ITS specimens included in the program of analysis the slipped tablewares consumed by the inhabitants of Cetamura – probably by this time a substantially different kind of settlement than it had been during the earlier periods covered in this study – were almost exclusively of Arretine origin, with but one of the specimens analyzed – a platter/plate dating to the middle or second half of the first century A.D. – apparently manufactured somewhere other than Arezzo. This vessel was most likely manufactured at one of the other production loci for this class located in northern Etruria rather than somewhere outside the region. Given the prominent position of Arezzo in the manufacture of ITS and its proximity to Cetamura, it is hardly surprising that the near totality of the examples of this class consumed at Cetamura during this period were Arretine products. Indeed, it seems likely that very substantial amounts of Arretine ITS were transported to the Tyrrhenian coast for long-distance distribution by being moved north along the *Via Cassia Vetus* to Florence and then west along the *Via Quinctia* to Pisa. On the first leg of this route consignments of pottery would have passed within no more than ca. 12 km of Cetamura, and it seems quite possible that pottery sellers based in the region took advantage of this traffic to organize a distribution system that provided for the economical supply of Arretine products to settlements in the Monti del Chianti, including Cetamura.[120] The specific contours of any such system would likely be obscured by the uniformity of the supply.

6.3 Methodological Considerations

The results of the program of analysis permit various observations regarding the methods employed to study the three classes of pottery that are its focus, and, in particular, the analysis of their composition with a view to defining distinct production groups and determining the likely provenances of these.

First, it is worth noting that the inexpensive, low-tech technique of optical microscopy allowed the ready identification (if not the determination of the provenance) of several distinct fabric groups of BGW and NERSW that presumably correspond more or less to distinct production groups. NAA was essential only for the identification of discreet fabric groups within the set of fine-textured specimens for each of the three pottery classes. Petrographic analysis was employed with the limited goal of obtaining a more detailed textural/mineralogical characterization of the various fabric groups recognized by means of these other two forms of analysis, and its utility for the identification of fabric/production groups was not tested. While the fine-textured specimens represent the bulk of the materials (including all of the examples of ITS) and the results obtained by means of NAA are highly important within the larger program of analysis, the value of those obtained by means of optical microscopy should not be discounted. This is a point particularly worth making in light of the fact that two recent studies of the sizable sub-assemblage of BGW from the Volterra – Vallebuona site, one undertaken by Di Giuseppe, the other by Roth – assign these materials to putative production groups on the basis of the characteristics of their body and slip as these can be observed with the naked eye.[121] This effectively means dividing the sub-assemblage into two groups: – one consisting of fine-textured/high-quality vessels and the other of more coarse-textured/low-quality vessels – and these two authors' interpretations, which seek to mobilize their results to engage broad issues concerning the Romanization of northern Etruria, proceed on the basis of this representation of the material. The results of the current program of analysis suggest that the latter

120. See Mosca 2002, 191-195 for this section of the *Via Cassia Repubblicana*.
121. Di Giuseppe 2005, 37, 40; Roth 2007, 103.

grouping could likely be subdivided into multiple fabric groups by means of optical microscopy, leading to significantly more nuanced and verisimilar interpretations of this body of material. The use of optical microscopy is particularly attractive now that the wide availability of low-cost, easy-to-operate digital microscopes means that it is possible to produce images of the fabrics of large numbers of pottery specimens at magnifications of up to 40-50 X at effectively no cost and in a modest amount of time.[122]

Second, our ability to contextualize the results of the program of analysis reported here was been very substantially circumscribed by the difficulty encountered in associating the several fabric groups identified with specific production sites or general production areas. This highlights the pressing need for archaeology to identify, excavate, and study pottery production sites within northern Etruria and more generally with a view to determining the range of products manufactured, the compositional characteristics of these, the scale, organization and technology (including specific forming techniques the traces of which might be recognized on workshop products) of production, and the chronology of the establishment's activity.[123] Studies like Roth's of the materials from Volterra – Vallebuona that depend heavily on logical assumptions rather than concrete evidence regarding the organization and technology of production run the risk of being mistaken in ways that might invalidate them.[124]

Lastly, the utility of the program of analysis reported here is substantially circumscribed by its small size. As noted, the small size of the deposits from which materials were selected for compositional analysis and the limited number of specimens subjected to such analysis make for an appreciable likelihood that any patterns discernible in the results are not broadly indicative of the broader qualitative or quantitative patterns of production and consumption

122. One of the authors (JTP) has found that using a Dino-Lite 413T digital microscope with the associated DinoCapture software he can in the course of one hour produce and archive ca. 80-100 photomicrographs of prepared pottery chips suitable for use in optical microscopy of the kind employed in this study. This suggests that a team of two persons could readily prepare and photograph 500 specimens in the course of a single day's work. See Peña 2013b, 512-514 for more on this method.
123. To the authors' knowledge, in northern Etruria for the periods in question the set of pottery production sites that have been subjected to systematic excavation, study, and publication is at present limited to just three: Chiusi – Marcianella, Montepulciano – Poggetti, and Scandicci – Vingone. See Shepherd *et al.* 2008 for the last of these.
124. In the case of Roth's study, the assumption that the production of high-quality BGW at Volterra involved the use of both a kick wheel and a double-firing technique (Roth 2007, 82-84) appears to be unwarranted and, in the view of the authors, very probably incorrect on both counts.

that should be of interest to archaeologists. Of particular concern is the likelihood that NAA datasets such as the one generated in the course of this project may be too small to permit the recognition of the underlying compositional structure in all but the simplest sets of circumstances.

7. Conclusions

A group of 40 specimens of BGW, 14 specimens of NERSW, and 24 specimens of ITS from the site of Cetamura and 22 ceramic tiles/pellets fabricated from clay specimens obtained from eight different sources across the northern Etruria region were subjected to a program of compositional analysis that involved optical microscopy, NAA, and petrographic analysis. The aims of this work were to identify distinct compositional groups within each of these three classes of pottery, to determine the likely provenances of these groups, and to employ these results to elucidate patterns in the production of these three classes of pottery in northern Etruria and their supply to and consumption at Cetamura.

Optical microscopy proved effective for identifying compositional groups of pottery characterized by differences in gross fabric texture and mineralogy, while NAA, used in combination with cluster analysis and a computer program that calculates statistical probabilities of group membership, was able to identify distinct groups among the pottery specimens with a fine-textured fabric. Petrographic analysis permitted the generation of detailed descriptions of the fabrics of these groups. In all, it was possible to identify eight compositional groups of BGW, eight compositional groups of NERSW, and three compositional groups of ITS. Several of these groups are represented by but a single specimen. The effort to find matches between the compositional groups of pottery and the clay specimens was largely unsuccessful due to the fact that the clays analyzed were probably in many cases not those employed in antiquity for the manufacture of the pottery, the dearth of diagnostic rock and mineral inclusions in the pottery and clays, and the fact that in some cases the clays may have been subjected to levigation as part of the paste preparation process, significantly altering their texture, aplastic mineralogy, and chemistry. A robust textural and chemical match was, however, obtained between a clay specimen from the *argille di Quarata*, a lacustrine formation exposed over a narrow area immediately to the northwest of Arezzo and one fine-textured compositional group of BGW and two closely related fine-textured compositional groups of ITS, all plausibly of Arretine origin. Three groups of BGW and two of NERSW could be conjecturally assigned to Volterra on the basis of a combination of historical considerations and internal evidence, while one group of BGW could be tentatively assigned to the area of Populonia/Vetulonia/Roselle on the basis of possibly diagnostic rock fragments. The remaining three groups of BGW, six groups of NERSW, and one group of ITS could be speculatively associated with general zones within northern Etruria, including Volterra, the upper Val d'Elsa, the area around Siena, the Monti del Chianti, the upper Arno Valley, and the western Val di Chiana, on the basis of historical considerations and gross mineralogy. General similarities of form, fabric, and decorative technique suggest that one of the BGW groups may have originated at a workshop that operated at Montaione-Fontebella, on the western side of the Val d'Elsa.

The data regarding diachronic patterns in the production of these three classes of pottery in northern Etruria and their supply to and consumption at Cetamura must be treated with caution due to the small number of specimens analyzed and the limitations involved in dating these and the fact that some of the vessels included in the study may have reached the site as votive offerings. During the period ca. 350-250 B.C. the inhabitants of Cetamura consumed high-quality BGW from two sources, Arezzo and probably Volterra, with both apparently supplying a significant portion of the market. The Volterran potters likely employed marine clay, which they were obliged to levigate. The Arretine potters appear to have employed unlevigated clay from the *argilla di Quarata* formation, and perhaps also fired their kilns with peat, which they were able to excavate together with this clay. This may well have constituted a nexus of advantages that was instrumental in the later emergence of the Arretine ITS industry. During the period ca. 250 – 200 B.C. this pattern may have continued, with perhaps some alterations to the organization or technology of BGW manufacture at Volterra and the introduction of NERSW in the form of a medium- to low-quality production perhaps from Volterra.

During the period ca. 200 – 150/125 B.C. the inhabitants of Cetamura continued to consume significant amounts of high-quality BGW from Arezzo and probably Volterra, but also now consumed significant, if perhaps more modest amounts of medium- and low-quality BGW probably originating at three or four other locations in northern Etruria, including some situated in some of those areas listed above. They also consumed significant amounts of one particular vessel form in NERSW, the Morel From 1211 bowl, a high- to low-quality product manufactured at four different locations in northern Etruria, and small amounts of medium- to low-quality closed vessels in NERSW originating in two other locations, including perhaps Volterra and places in some of those areas listed above. The small amount of comparative evidence available suggests that these medium- to low-quality productions of BGW and North-Etrurian Red-Slip Ware may have been manufactured by workshops that turned out a wide range of products. Such a production model may contrast with that of the workshops that operated at Arezzo and presumably Volterra, where high-quality BGW originated, which may have been more specialized. The wide array of slipped tablewares consumed at Cetamura during this period points to the existence of a more developed and perhaps more complex set of distribution mechanisms than that in place during the earlier periods.

During the period ca. 40/10 B.C. – A.D. 100/150 ITS was the sole class of slipped tableware consumed at Cetamura, and virtually all of this originated at Arezzo. This is hardly surprising, given the prominent role of Arezzo in the ITS industry, the proximity of Arezzo to Cetamura, and the likelihood that the mechanisms for the distribution of Arretine ITS to overseas markets would have allowed for its economical distribution to settlements in the Monti del Chianti.

Appendix 1: Pottery Catalog

This appendix presents catalog entries for the 78 pottery specimens included in the program of analysis. These are arranged first by pottery class, then by fabric group, then by form. To refer to BGW forms the approach employed is to use the classificatory scheme presented in Lamboglia 1952 and then expanded in Morel 1963 (with citations appearing as e.g., "Lamboglia Form 5" and "Morel Form 80"), with recourse made to the more complex and less intuitive scheme presented in Morel 1994 (the second edition of this author's 1981 magnum opus) in cases in which there is need for the broader coverage and/or greater precision that this embodies (with citations appearing as e.g., "Morel F2255").[125] For the specimens of NERSW the sole form for which a typological designation is employed is drawn from the typological scheme for BGW published in Morel 1994 (Morel F1211). For ITS the typological scheme employed is that published in Ettlinger 1990c (with citations appearing as e.g., "Conspectus Form 3").

Each entry begins with the specimen's catalog number, followed in parentheses by its accession number, stratigraphic unit, and deposit number, as relevant. In cases in which a specimen was subjected to petrographic analysis this is also indicated. This is followed by a brief description of the piece and, where useful, additional information regarding its form, production, and/or date. All parts of a vessel between its rim and base are characterized as wall, with the area above/inside of a ring foot referred to as floor. Colors for ceramic bodies here and in Appendices 2 and 4 are given using the notation from the *Munsell Soil Color Charts*, interpolating between color chips as this seemed warranted. All dimensions are given in centimeters. The following abbreviations are employed to indicate dimensions: d. = diameter; ft.= foot; h. = handle; r. = rim; th. = thickness; w. = wall.

Drawings of the specimens of BGW Fabric Group 1 are presented in Figure 8, of BGW Fabric Group 2 in Figure 9, of BGW Fabric Groups 3-8 in Figure 10, of NERSW Fabric Groups 1-8 in Figure 11, of ITS Fabric Group 1 in Figure 12, and of ITS Fabric Groups 2-3 in Figure 13. No drawing is presented for two specimens (BGW2.10; BGW3.04), both BGW lamps. For rim or base fragments for which it was possible to establish the rim or base diameter with some degree of certainty both a section profile and an exterior view are presented (employing the figure for the mid-point in cases where a measurement was obtained as a range, e.g., 22 for a measurement of 21-23 cm). For those specimens too small to permit a determination of the rim or base diameter

125. See Principal and Ribera i Lacomba 2013, 51 for this practice.

but large enough to allow the determination of the proper orientation just the section profile is presented, with a top line or bottom line and lines showing interior features projected to the right and lines showing exterior features projected to the left. For specimens too small to permit a determination of the proper orientation, the section profile is presented in what is thought most likely to be the correct orientation, with the top line or bottom line omitted. A section profile is provided for specimens that are body sherds, with a drawing of the sherd also provided in cases where this bears incised decoration.

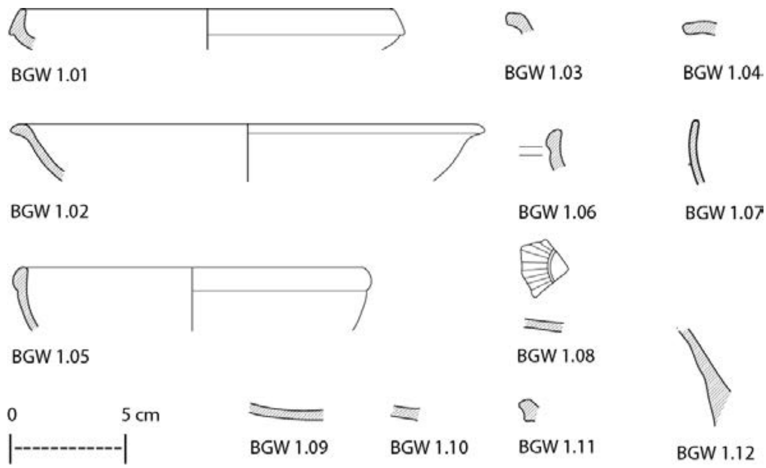

FIG. 8. Drawings of BGW Fabric Group 1.

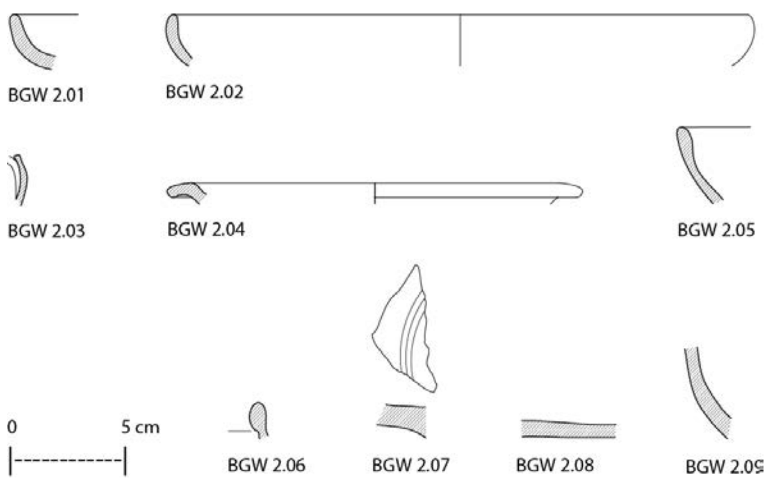

FIG. 9. Drawings of BGW Fabric Group 2.

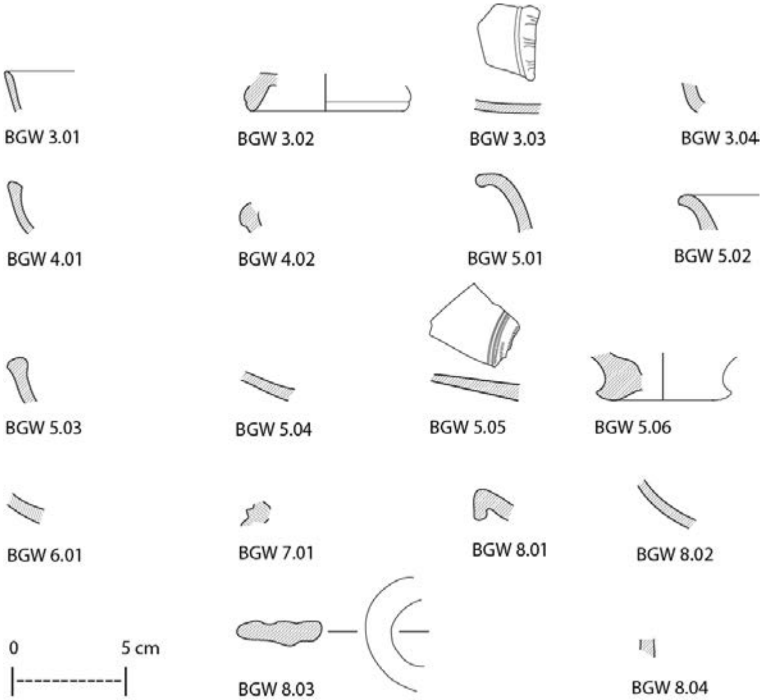

FIG. 10. Drawings of BGW Fabric Groups 3-8.

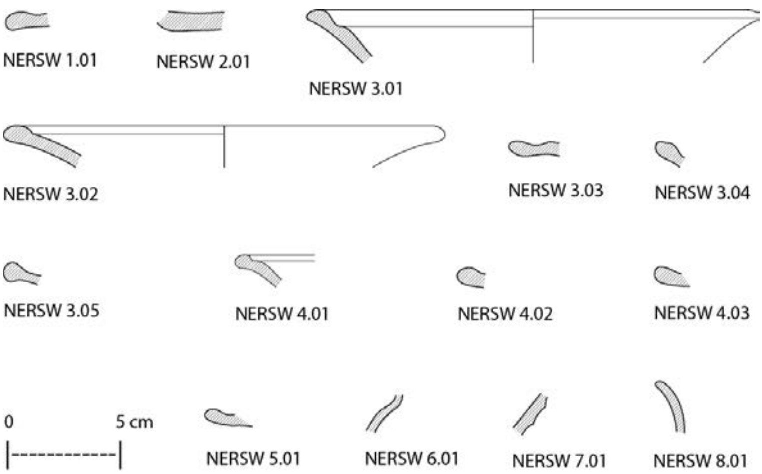

FIG. 11. Drawings of NERSW Fabric Groups 1-8.

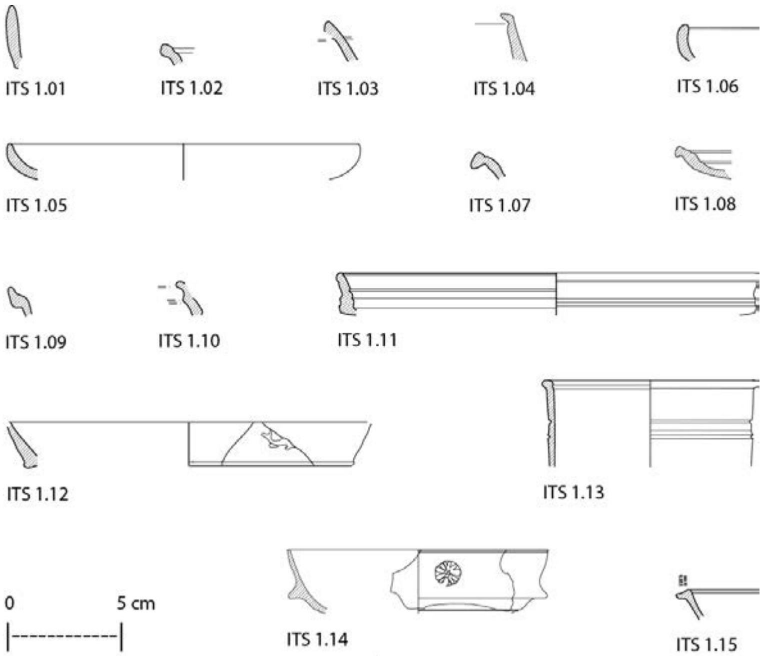

Fig. 12. Drawings of ITS Fabric Group 1.

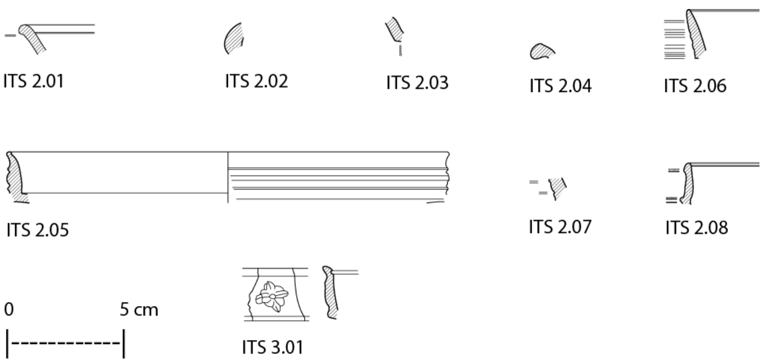

Fig. 13. Drawings of ITS Fabric Group 2-3.

Black-Gloss Ware

Black-Gloss Ware Fabric Group 1

Lamboglia Form 5 (dish/plate with broad, flat floor, low, more or less sharply curved wall with rounded rim, and ring foot)
BGW1.01 (C-87-085; Locus: Structure B 02 [= Deposit 3]; thin section) Fragment of rim and wall. Hard, pinkish gray (5YR 7/2) body with poorly preserved, matte, dark gray slip on both surfaces. D. r. ca. 16.
Form/production/date: Lamboglia Form 5/Morel F2255. This form attested for presumed Arezzo production at Fiesole – Via Marini – Via Portigiani (Body 3) in context dated 150-125 B.C. [126] and at Chiusi – Orto del Vescovo (Group A1) in small amounts in contexts dated 200-170 B.C. and in abundance in contexts dated 170-140 B.C.[127]

Lamboglia Form 28 (cup/bowl with gently curved wall with slightly everted rim and ring foot)
BGW1.02 (C-S-048; Locus: Structure B 02 [= Deposit 3]) Fragment of rim and wall. Soft, pink (4YR 7.2/4) body with glossy slip, very dark gray with bluish tones, on both surfaces. D. r. 20-21; th. w. 0.5.
Form/production/date: Lamboglia Form 28/Morel F2652-3. These forms attested for presumed Arezzo production at Fiesole – Via Marini – Via Portigiani (Bodies 1 and 3) in contexts dated 150-125 B.C.,[128] and at Chiusi – Orto del Vescovo (Group A1) in abundance in contexts dated 170-140 B.C.[129]

Open vessel with everted rim and steep upper wall (Lamboglia Form 28?)
BGW1.03 (C-S-039; Locus: Structure B 04 [= Deposit 2]) Fragment of rim and wall. Soft, pink (5YR 7.5/4) body with slightly glossy to glossy slip, dark reddish brown to very dark gray with bluish tones, on both surfaces. Th. w. 0.5.
Form/production/date: For date of Lamboglia Form 28 in Arezzo production see BGW1.02. This is too late for date posited for closing of Deposit 2.

Morel Form 80 (cup/bowl with shallow, gently curved wall with everted/downcurved rim and ring foot)
BGW1.04 (C-S-043; Locus: Structure B 02 [= Deposit 3]) Fragment of rim. Soft, pink/light brown (7YR 6.5/4) body with glossy slip, very dark gray with bluish tones, on both surfaces. Th. w. 0.5.
Form/production/date: Morel Form 80 produced by Arezzo and Volterra workshops throughout third century B.C.[130]

126. Palermo 1990a, 105 no.3, 112 tab.
127. Palermo 1998, 120 tab.
128. Palermo 1990a, 108-109 nos. 26 and 28, 113 tab, 348 fig. 26.
129. Palermo 1998, 120 tab., 128 fig. 18, 129 fig. 19.
130. Palermo 2003a, 293.

Morel Form 83 (bowl with moderately curved wall, thickened, undercut rim, and ring foot)

BGW1.05 (C-S-045; Locus: Structure B 02 [= Deposit 3]) Fragment of rim and wall. Soft, pink (4YR 7.2/2) body with glossy slip, dark gray to very dark gray with bluish tones, on both surfaces. D. r. 15-16; th. w. 0.3.

Form/production/date: Morel Form 83/F2536/F2538. These forms attested for presumed Arezzo production at Fiesole – Via Marini – Via Portigiani (Bodies 4, 13) in contexts dated 150-125 B.C.[131] and at Chiusi – Orto del Vescovo (Group A1) in abundance in contexts dated 170-140 and in small amounts in contexts dated 110-50 B.C.[132]

BGW1.06 (C-S-044; Locus: Structure B 02 [= Deposit 3]) Fragment of rim and wall. Broad groove on exterior surface immediately below rim. Soft, pink (5YR 7/4) body with glossy slip, very dark gray with metallic luster on both surfaces. Th. w. 0.5.

Form/production/date: Morel Form 83/F2563. This form is not attested for presumed Arezzo production at either Fiesole – Via Marini – Via Portigiani or Chiusi – Orto del Vescovo. It is attested for assumed Volterra productions (Groups A-C and T) at Volterra – Acropoli in small amounts in contexts dated to end fourth/beginning third century, second half third century, and mid second century B.C.[133]

Cup with thin, steep, slightly curved upper/middle wall and one or (most likely) two (most likely horizontal) handles attached to the wall well below rim

BGW1.07 (C-88-166; Locus: Trench AA 07 [= Deposit 1]) Ten fragments (some joining) of rim, upper wall, and handle attachment. Soft, pink (7.5YR 7.2/4) body with black slip on both surfaces. Th. w. 0.3/0.4.

Form/production/date: Level of handle attachment suggests form similar to Morel F4244 cup, attested in presumed Volterra productions from last quarter fourth and third centuries B.C.[134]

Open form (bowl/dish/plate) with flat floor with incised decoration

BGW1.08 (C-88-135; Locus: Trench AA 06 [= Deposit 1]) Fragment of floor. Soft, pink (7.5YR 7/4) body with slightly glossy, dark gray slip on interior surface and one patch on exterior surface. Incised decoration on interior surface consisting of circular groove with lines radiating from it. Th. w. 0.4/0.5.

Open form (dish/plate) with near horizontal, slightly curved lower wall

BGW1.09 (C-S-001; Locus: Trench AA 06 [= Deposit 1]; thin section) Fragment of lower wall. Soft, pink (4YR 6.8/4) body with glossy, dark gray slip on both surfaces. Th. w. 0.35-0.4.

131. Palermo 1990a, 107 no. 22, 112 tab.
132. Palermo 1998, 120 tab.1, 129 fig. 31.
133. Palermo 2003a, 296 no. 16, 309 tab.; 319 no. 84, 327 tab.
134. Morel 1994, 298, pl. 122.

BGW1.10 (C-S-002; Locus: Trench AA 07 [= Deposit 1]) Fragment of lower wall. Soft pink (4.5YR 7/4) body, shading to slightly grayer near interior surface, with glossy, black slip on both surfaces. Th. w. 0.5.

Vessel with everted rim with furrow in outer face

BGW1.11 (C-S-047; Locus: Structure B 02 [= Deposit 3]) Fragment of rim. Soft, pink (5YR 7/4) body with glossy to very glossy slip, very dark gray with bluish tones, on both surfaces.

Closed vessel with steep, straight lower wall

BGW1.12 (C-S-051; Locus: Structure B 02/04 [= Deposit 3]) Fragment of lower wall. Light wheel ridging on interior surface. Hard, pink (5YR 7/4) body with very glossy slip, very dark gray with bluish tones, on both surfaces. Th. w. 0.4.

Black-Gloss Ware Fabric Group 2

Lamboglia Form 5

BGW2.01 (C-S-050; Locus: Structure B 02/04 [= Deposit 3]) Fragment of rim and wall (Morel F2252). Hard, pinkish gray (5YR 7/2) body with very glossy slip, very dark gray with bluish tones, on both surfaces. Th. w. 0.6.

BGW2.02 (C-S-052; Locus: Structure B 02/04 [= Deposit 3]) Fragment of rim and wall. Medium hardness, pink (5YR 6.8/4) body with very glossy slip, very dark gray with bluish tones, on both surfaces. D. r. 25-26; th. w. 0.4. (Analysis of data for chemical composition suggests might belong to BGW Fabric Group 1.)
Form/production/date: Both probably Lamboglia Form 5/Morel F2250 series. Morel F2255 attested in presumed Volterra production at Fiesole – Via Marini – Via Portigiani (Body 7) in context dated 150-125 B.C.[135] Morel F2250 series attested in presumed Volterra production at Volterra – Acropoli (Group T) in contexts dated to mid-second and first half of first century B.C,[136] and Morel F2252 attested in presumed Volterra productions at Volterra – Acropoli (Groups A-C, U) in contexts dated to mid second and first half of first century B.C.[137]

Vessel with thin, steep, concave upper wall and single vertical handle (Lamboglia Form 10 cup?)

BGW2.03 (C-S-038; Locus: Structure B 02 [= Deposit 3]) Fragment of rim, wall, and attachment of strap handle. Soft, pink (5YR 7/4) body with poorly preserved, slightly glossy, reddish brown to very dark gray slip on interior surface and a few spots on exterior surface. Th. w. 0.3.

135. Palermo 1990a, 105 no. 4, 112 tab.
136. Palermo 2003a, 316 no. 71, 326 tab., 490 fig. 21.16.
137. Palermo 2003a, 292-293 no. 7, 309 tab., 486 fig. 17.9; 329 no. 113, 331 tab., 493 fig. 24.8.

Form/production/date: Probably Lamboglia Form 10/Morel F3450 series, especially F3451. These forms attested in assumed Volterran production at Volterra – Acropoli (Groups A-C) in contexts dated to beginning of second, mid second, and first half of first century B.C,[138] and at Fiesole – Via Marini – Via Portigiani (Body 7) in context dated 150-125 B.C.[139]

Morel Form 80

BGW2.04 (C-S-040; Locus: Structure B 04 [= Deposit 2]) Fragment of rim and wall. Soft, pink (5YR 7.5/3) body with glossy to very glossy slip, very dark gray slip with bluish tones, on both surfaces. D. r. ca. 18; th. w. 1.0-1.1.

Form/production/date: See BGW1.03. Probably Morel Form 80/F1262. This form attested in presumed Volterran production at Volterra – Acropoli (Group U) in contexts dated to beginning of the second century B.C.[140]

Open vessel with steep, gently curved middle/upper wall with rim slightly thickened on interior (Morel Form 82 cup?)

BGW2.05 (C-S-046; Locus: Structure B 02 [= Deposit 3]; thin section) Fragment of rim and wall. Soft, pink (7YR 7/4) body with glossy slip, very dark gray with bluish tones, on interior surface, and matte to slightly glossy slip, dark gray to very dark gray with reddish brown blotches on exterior surface. Th. w. 0.4

Form/production/date: Probably Morel Form 82/F4100 series. This series attested in presumed Volterran production at Volterra – Acropoli (Groups A-C) in abundance in contexts dated from end of fourth/beginning of third to middle of second century, and in small mounts in contexts dated to first half of first century B.C.[141]

Morel Form 83

BGW2.06 (C-S-035; Locus: Structure B 02 [= Deposit 3]) Fragment of rim and wall. Soft, pink (5YR 7.5/4) body with matte to slightly glossy, very dark gray to black slip on both surfaces. D.r. 14-17; th. w. 0.4.

Form/production/date: Morel Form 83/F2538. This form attested in presumed Volterran productions at Volterra – Acropoli (Groups A-C, T, U, and Z) in small amounts in contexts dated from end of fourth to second half of third century, in abundance in contexts dated from end of third to middle of second century B.C., and in small amounts in contexts dated to first half of the first century B.C.[142]

138. Palermo 2003a, 301 no. 31, 310 tab., 488 fig. 19.4.
139. Palermo 1990a, 110 no. 37, 113 tab.
140. Palermo 2003a, 329 no. 114, 331 tab., 493 figs. 24.9 and 24.11.
141. Palermo 2003a, 302-303 nos. 33-34, 310 tab., 488 fig. 19.11-15.
142. Palermo 2003a, 296 no. 15, 309 tab., 487 fig. 18.7-9; 312 no. 61, 314 tab.; 318-9 nos. 80-81, 327 tab., 492 fig. 23.1-2; 329-330 no. 116, 331 tab.

Open vessel (dish/plate) with flat, horizontal lower wall with concentric groove decoration

BGW2.07 (C-S-037; Locus: Structure B 02 [= Deposit 3]) Fragment of lower wall. Soft, pink/light reddish brown (5YR 6.5/4) body with glossy to very glossy slip, very dark gray to black with bluish tones, on both surfaces. Incised decoration on interior surface consisting of two circular grooves. Th. w. 1.0-1.4.

Open vessel (dish/plate) with straight, horizontal lower wall

BGW2.08 (C-S-036; Locus: Structure B 02 [= Deposit 3]) Fragment of lower wall. Soft, pink (7.5YR 6.8/4) to gray (10YR 5.5/1) body with glossy to very glossy, very dark gray slip on both surfaces. Th. w. 0.6. (Analysis of data for chemical composition suggests might belong to BGW Fabric Group 1.)

Closed vessel with steep, gently curved lower wall

BGW2.09 (C-S-033; Locus: Structure B 02 [= Deposit 3]) Fragment of middle/lower wall. Turning grooves on interior surface. Soft, pink (7.5YR 6.8/3.5) body with matte to slightly glossy slip, very dark gray to very dusky red, on exterior surface and one drip on interior surface. Th. w. 0.5-0.7.

Lamp

BGW2.10 (C-87-078; Locus: Structure B 02 [= Deposit 3]) Fragment of wall. Soft, pink (4.5YR 8/4) body with very poorly preserved, matte, dark gray to very dark gray slip on both surfaces. Th. w. 0.5. (Analysis of data for chemical composition suggests might belong to BGW Fabric Group 1.)

Form/production/date: Lamps attested in presumed Volterran production at Volterra – Acropoli (Groups A-C) in contexts dated to beginning and middle of second century B.C.[143]

Black-Gloss Ware Fabric Group 3

Open form (cup/bowl) with thin, straight, steep upper wall

BGW3.01 (C-88-173; Locus: Trench AA 07 [= Deposit 1]) Fragment of rim and upper wall. Soft, pink (7.5YR 7/4) body with black slip on both surfaces. D. r. ca. 14; th. w. 0.3.

Open form (cup/bowl) with curved lower wall and floor with stamped decoration and ring foot

BGW3.02 (C-88-125; Locus: Trench AA 06 [= Deposit 1]; thin section) Four fragments of wall, ring-foot, and floor. Soft, pink (7YR 7.5/4) body with no slip preserved

143. Palermo 2003a, 306 no. 45, 311 tab.

on either surface. Interior surface preserves traces of what appears to be stamped decoration consisting of palmettes. D. ft. 8; th. w. 0.4.
Form/production/date: Perhaps Pasquinucci Form 82/Morel F4115 or similar, which is attested at Volterra in presumed Volterran production (Pasquinucci Produzione D = Volterra – Acropoli Groups A-C) and dated to third to first half of second century B.C.[144]

Open form (dish/plate) with slightly curved, horizontal lower wall with incised decoration

BGW3.03 (C-88-168; Locus: Trench AA 07 [= Deposit 1]) Fragment of lower wall. Soft, pinkish gray (7.5YR 6.5/2) body with glossy, very dark gray slip on both surfaces. Incised decoration on interior surface consisting of radiating lines in groups of three enclosed by two circular grooves. Central line in each group of three straight, two flanking lines bent outward at their distal end. Th. w. 0.4.

Lamp

BGW3.04 (C-87-232; Locus: Structure B 02 [= Deposit 3]) Fragment of wall. Soft, pink (7.5YR 7/4) body with glossy, dark gray to very dark gray slip on both surfaces. Th. w. 0.6.
Form/production/date: For date of production of BGW lamps at Volterra see BGW2.10.

Black-Gloss Ware Fabric Group 4

Open vessel (cup/bowl/dish) with steep, gently curved upper/middle wall with rim coming to point at inner side (Morel Form 82 cup?)

BGW4.01 (C-S-041; Locus: Structure B 04 [= Deposit 2]; thin section) Fragment of rim and upper wall. Soft, pink (5YR 7.5/4) body with very glossy, very dark gray slip on both surfaces. Th. w. 0.4.
Form/production/date: For date of production of Morel Form 82 at Volterra see BGW 2.05.

Morel Form 83

BGW4.02 (C-S-042; Locus: Structure B 04 [= Deposit 2]) Fragment of rim and upper wall. Soft, pink (5YR 7/4) body with poorly preserved, slightly glossy, very dark gray slip on both surfaces. Th. w. 0.5.
Form/production/date: Morel Form 83/F2538. For date of production of this form at Volterra see BGW 2.06.

144. Montagna Pasquinucci 1972, 284 fig. 2.7 and 16, 365.

Black-Gloss Ware Fabric Group 5

Vessel with steep, concave upper wall with everted rim
BGW5.01 (C-S-049; Locus: Structure B 02 [= Deposit 3]) Fragment of rim and wall. Hard, pink (5YR 7/3) body with poorly preserved, matte, dark gray slip on both surfaces. Th. w. 0.5.

BGW5.02 (C-S-056; Locus: Trench 21.5N15W 06) Fragment of rim and wall. Slightly gritty, pink (5YR 7/4) body with matte, dark gray slip on both surfaces. Th. w. 0.6.
Form/production/date: The workshop that operated at Montione – Bellafonte manufactured what may be a generally similar form in the low-quality Group 2 fabric during the second period ca. 150-80 B.C.[145]

Open vessel (cup/bowl/dish) with steep, curved upper wall and thickened rim with pointed outer face
BGW5.03 (C-S-034; Locus: Structure B 02 [= Deposit 3]) Fragment of rim and wall. Hard, light reddish brown (5YR 6/3.5) body with poorly preserved, glossy slip, mottled dark brown to very dark gray, on both surfaces. Th. w. 0.5.
Form/production/date: The workshop that operated at Chiusi – Marcianella VN II.11.2 manufactured what may be a similar form during the first half of the second century B.C.[146]

Open vessel (bowl/dish) with straight, slightly inclined lower wall
BGW5.04 (C-S-054; Locus: Structure B 02/04 [= Deposit 3]) Fragment of wall. Slightly gritty, pink (4.5YR 7.5/4) body with dark gray slip on both surfaces. Th. w. 0.4-0.6.
Form/production/date: The workshop that operated at Montione – Bellafonte manufactured what may be a generally similar form (Lamboglia Form 5) in the low-quality Second Type fabric during the period ca. 150-80 B.C.[147]

Open vessel (dish/plate) with straight, slightly inclined lower wall with groove and chatter decoration
BGW5.05 (C-S-057; Locus: Structure B 01 [= Deposit 3]; thin section) Fragment of wall. Incised decoration on interior surface consisting of two circular grooves enclosing two or three rows of chattering. Slightly gritty, light red (3.5YR 6/4) body with matte to slightly glossy, dark gray slip, even on interior surface, uneven on exterior surface. Th. w. 0.3-0.8.
Form/production/date: The workshop that operated at Montione – Bellafonte produced a similar large open form (Lamboglia Form 5) in the lower quality Second

145. De Marinis 1977, 210 BE 23 tav. XXIV.23; Olcese 2011-2012, 33 tav. 1.VIII.4.
146. Aprosio and Pizzo 2003, 104-105, 114 tav. VII VN.II.1.2 (sic).
147. De Marinis 1977, 210 BE 6/11 tav. XXIV.6/11; Olcese 2011-2012, 33 tav. 1.VIII.2.

Type fabric and this same form with similar groove and chatter decoration in the high quality First Type fabric during the period ca, 150-80 B.C.[148]

Closed vessel with ring foot and steep lower wall
BGW5.06 (C-88-074; Locus: Trench +2R 8.5 01) Fragments of wall, ring foot, and floor. Slightly gritty, pink (6.5YR 7/4) body with poorly preserved, matte, reddish gray to dark reddish gray slip on exterior of wall and interior and exterior of foot. D. ft. ca. 5; th. w. 0.9.
Form/production/date: The workshop that operated at Montione – Bellafonte produced a vessel (whether an open or a closed form is unclear) with a similar foot profile in the high quality First Type fabric during the period ca. 150-80 B.C.[149]

Black-Gloss Ware Fabric Group 6

Open vessel (cup/bowl/dish) with curved wall
BGW6.01 (C-S-032; Locus: Structure B 02 [= Deposit 3]; thin section) Fragment of wall. Soft, light red (2YR 6/8) body with poorly preserved, glossy slip, mottled reddish brown/dark reddish brown, on both surfaces. Th. w. 0.5.

Black-Gloss Ware Fabric Group 7

Open vessel (cup/bowl) with ring foot and sloping floor
BGW7.01 (C-S-055; Locus: Trench 25N9E 04; thin section) Fragment of ring foot and floor. Slightly gritty, reddish brown (5YR 6.2/4) body with very poorly preserved, matte, dark brown slip on interior and exterior of foot and floor.

Black-Gloss Ware Fabric Group 8

Open vessel with shallow, slightly curved upper wall, vertical hanging rim (Lamboglia Form 23 plate?)
BGW8.01 (C-87-081; Locus: Structure B 02 [= Deposit 3]; thin section) Fragment of rim and wall. Gritty, pink (4YR 7.5/4) body with (matte?) gray slip on both surfaces. Th. w. 0.7.
Form/production/date: Lamboglia Form 23 (= Morel F1120-1130 series) widely attested in northern Etruria in late third and early second century B.C.[150]

Open vessel (cup/bowl/dish) with curved, moderately inclined middle/lower wall
BGW8.02 (C-S-058; Locus: Structure B 01 [=Deposit 3]) Fragment of wall. Gritty, reddish yellow (5YR 7/6) body with light gray core with very poorly preserved matte, dark gray slip on both surfaces. Th. w. 0.5

148. De Marinis 1977, 210 BE 6/11, 209 BE 6-36-37 tav. XXIV.6/11, 6-36-37; Olcese 2011-2012, 33 tav. 1.VIII.2, 1.
149. De Marinis 1977, 210 BE 29.
150. Aprosio and Pizzo 2003, 96-97.

Vessel with one or more broad, loop-shaped handles

BGW8.03 (C-88-068; Locus: Trench -1R8.5 01) Three joining fragments of strap handle. Two broad furrows on both surfaces from pulling. Slightly gritty, reddish yellow (4.5YR 6/6) body with poorly preserved, matte, dark reddish gray slip on all surfaces. Th. w 1.2; width h. 3.5.

Unidentified form

BGW8.04 (C-S-053; Locus: Structure B 02 [= Deposit 3]) Fragment of wall. Gritty, pink (4YR 7.5/4) body with very poorly preserved, matte, dark gray slip on one surface.

North Etrurian Red-Slip Ware

North Etrurian Red-Slip Ware Fabric Group 1

Morel F1211 (Bowl with everted rim with furrow inside, low wall, and broad, flat base)

NERSW1.01 (C-S-064; Locus: Structure B 01 [= Deposit 3]; thin section) Fragment of rim and wall. Soft, light reddish brown (5YR 6/3.5) body with poorly preserved, red (2.5YR 4.5/8) slip on both surfaces. Th. w. 0.6.
Form: Shape of rim perhaps very close to specimen from Volterra – Acropoli Group 1.[151]

North Etrurian Red-Slip Ware Fabric Group 2

Open vessel (cup/bowl/dish) with straight, horizontal lower wall and abrupt bend to steep middle wall

NERSW2.01 (C-87-338; Locus: Structure B 04 [= Deposit 2]) Fragment of floor of open form (not Morel F1211). Soft, reddish yellow (4YR 6.8/7.5) body with glossy red (2.5YR 4.5/6) slip on interior surface and matte, spotty, dusky red slip (2.5YR 3/1.5) on exterior surface. Th. w. 0.7. (Appearance and analysis of data for chemical composition suggest might belong to BGW Fabric Group 2 or 5.)

North Etrurian Red-Slip Ware Fabric Group 3

Morel F1211

NERSW3.01 (C-87-061; Locus: Structure B 02 [= Deposit 3]) Two joining fragments of rim and wall. Soft, pink (4YR 7.5/4) body with poorly preserved, reddish slip on both surfaces. D. r. 19-21.

NERSW3.02 (C-87-062; Locus: Structure B 02 [= Deposit 3]) Two joining fragments of rim and wall. Soft, reddish yellow (4YR 7/6) body with poorly preserved, slightly glossy, red (10R 4.5/8) slip on both surfaces. D. r. 18-21.

151. Palermo 2003b, 349 no. 1, 496 fig. 27.3.

NERSW3.03 (C-S-061; Locus: Structure B 02 [= Deposit 3]) Two non-joining fragments of rim and wall. Soft, reddish yellow (3.5YR 6.5/6) body with poorly preserved, slightly glossy, red (2.5YR 4.5/6) slip on both surfaces. Th. w. 0.5-0.6.
Form: Shape of rim very close to example from Volterra – Acropoli Group 2.[152]

NERSW3.04 (C-S-059; Locus: Structure B 02 [= Deposit 3]; thin section) Fragment of rim and wall. Soft, pink (6.5YR 6.5/4) body with poorly preserved, slightly glossy, red (3YR 4.5/6) slip on interior surface. Th. w. 0.4.

NERSW3.05 (C-S-066; Locus: Trench -1R8.5 02) Fragment of rim and wall. Soft light reddish brown (4YR 6/4) body with poorly preserved, red (2.5YR 5/6) slip on interior surface. Th. w. 0.5.
Form: Shape of rim very similar to that of two specimens from Chiusi – Marcianella.[153]

North Etrurian Red-Slip Ware Fabric Group 4

Morel F1211

NERSW4.01 (C-S-060; Locus: Structure B 02 [= Deposit 3]) Fragment of rim and wall. Soft, reddish yellow (4YR 6/7) body with poorly preserved, red (2.5YR 5/7) slip on interior surface. Th. w. 0.5.

NERSW4.02 (C-S-065; Locus: Structure B 01 [Deposit 3]) Fragment of rim. Soft body, pink (5YR 8/4), with light red (2.5YR 6/6) core, with poorly preserved, reddish slip on interior surface.

NERSW4.03 (C-S-068; Locus: Trench 76.5N4W 05; thin section) Fragment of rim. Soft reddish yellow (4YR 7/6) body with poorly preserved, red (3YR 5/6) slip on both surfaces.

North Etrurian Red-Slip Ware Fabric Group 5

Morel F1211

NERSW5.01 (C-S-062; Locus: Structure B 01 [Deposit 3]; thin section) Fragment of rim and wall. Soft body, light red (2.5YR 5.8/6) body with faint pink core with poorly preserved, red (2.5YR 5/6) slip on both surfaces. Th. w. 0.5.
Form: Shape of rim very close to that of specimen from Volterra – Acropoli Group 2.[154]

North Etrurian Red-Slip Ware Fabric Group 6

Closed vessel with curved shoulder and neck

NERSW6.01 (C-S-063; Locus: Structure B 01 [Deposit 3]) Fragment of shoulder. Soft pink (4.5YR 7/3.5) body with poorly preserved, reddish slip on exterior surface. Th. w. 0.3-0.4.

152. Palermo 2003b, 350 no. 2, 496 fig. 27.5.
153. Aprosio 2003, 159 tav. XXV VR I.1.2, VR I.1.4.
154. Palermo 2003b, 350 no. 2, 496 fig. 27.5.

North Etrurian Red-Slip Ware Fabric Group 7

Closed vessel with straight, inclined shoulder

NERSW7.01 (C-S-069; Locus: Trench 0.R6 02; thin section) Fragment of wall. Wheel ridging on interior surface. Soft pink (4.5YR 7/3.5) body with poorly preserved, red (2.5YR 5/8) slip on exterior surface. Th. w. 0.3-0.4.

North Etrurian Red-Slip Ware Fabric Group 8

Vessel with steep, concave upper wall or neck (deep/medium open or closed vessel?)

NERSW8.01 (C-87-330; Locus: Structure B 04 [= Deposit 2]; thin section) Fragment of rim and upper wall. Soft pink (4.5YR 7/3.5) body with poorly preserved, red (2.5YR 4.5/7) slip on both surfaces. Th. w. 0.4.
Form/production/date: Form perhaps close to deep/medium open vessel from Volterra – Acropoli Group 2 dated 150-50 B.C. and/or deep/medium vessel from Chiusi – Marcianella dated end third to first quarter second century B.C.[155]

Italian Terra Sigillata

Italian Terra Sigillata Fabric Group 1

Conspectus Form 1 (Platter/plate with sloping wall and plain rim)

ITS1.01 (C-87-261; Locus: Trench 29N18E 03) Fragment of rim and wall. Soft, light red (lighter than 10R 6/6) body with glossy, red (2.5YR 4.8/6) slip on both surfaces. D. r. 21.5; th. w. 0.5.
Form/date: Conspectus Form 1.1.1; ca. 40-10 B.C.[156]

Conspectus Form 3 (Dish with sloping wall with bead rim)

ITS1.02 (C-S-090; Locus: Trench 21.5N9W 06) Fragment of rim and wall. Soft, light red (1.5YR 7/6) body with glossy, red (10R 4.5/6) slip on both surfaces. Th. w. 0.5.
Form/date: Conspectus Form 3.1?; ca. A.D. 40 – first half of second century.[157]

ITS1.03 (C-S-091; Locus: Trench 26N10.5E 06) Fragment of rim and wall. Soft, pink (5YR 6.8/4) body with glossy, red (10R 4.8/8) slip on both surfaces. Th. w. 0.4.
Form: Conspectus Form 3.2? For date see ITS1.02.

ITS1.04 (C-87-380; Locus: Trench 21.5N15W 06) Fragment of rim and wall. Medium hardness, light red (1.5YR 6/7) body with glossy, red (1YR 4/8) slip on both surfaces. Th. w. 0.5.
Form: Conspectus Form 3.3. For date see ITS1.02.

155. Palermo 2003b, 353 no. 14, 497 fig. 28.6; Aprosio 2003, 158 no. VR VIII.1.1, 159 tav. XXV VR VIII.1.1.
156. Ettlinger 1990c, 52.
157. Ettlinger 1990c, 56.

Conspectus Form 4 (Platter/plate with curving wall and plain rim)
ITS1.05 (C-S-088; Locus: Trench 29N18E 03) Fragment of rim and wall. Medium hard, pink (4YR 7/4) body with glossy, red (10R 4.2/8) slip on both surfaces. D. r. 15-16; th. w. 0.4.
Form/date: Conspectus Form 4.3.1; ca. 10 B.C.-A.D. 15.[158]

ITS1.06 (C-88-013; Locus: Trench 21.5N15W 09) Fragment of rim and wall (Conspectus Form 4.6.1?). Light red (2.5YR 6.2/6) body with glossy, reddish slip on both surfaces. D. r. 12-16; th. w. 0.3.
Form/date: Conspectus Form 4.5/4.6; ca. A.D. 15-55.[159]

Conspectus Form 12 (Plate/platter with narrow hanging lip)
ITS1.07 (C-87-363; Locus: Trench 21.5N15W 06) Fragment of rim and wall. Soft, light red (2YR 6/6) body with glossy, red (2.5YR 4.5/8) slip on both surfaces. Th. w. 0.4.
Form/date: Conspectus Form 12.2.2; ca. 15 B.C. – A.D. 10.[160]

ITS1.08 (C-87-017; Locus: Trench 29N15E 03) Two joining fragments of rim and wall. Soft, pink/light reddish brown (4.5YR 7.5/4) body with glossy, red (10R 4.5/8) slip on both surfaces. Th. w. 0.4-0.6.
Form/date: Conspectus Form 12.1? For date see ITS1.07.

Conspectus Form 14 (Campanate cup with narrow hanging rim)
ITS1.09 (C-88-004; Locus: Trench 21.5N9W 06) Fragment of rim and wall. Medium hardness, reddish brown (2YR 5/4) body with glossy, reddish slip on both surfaces. Th. w. 0.3.
Form/date: Conspectus Form 14.1.3; ca. 15 B.C. – A.D. 10.[161]

Conspectus Form 18 (Platter/plate with concave vertical rim)
ITS1.10 (C-88-099; Locus: Trench 21.5N9W 07) Fragment of rim and wall. Medium hardness, reddish yellow (4YR 6/6) body with glossy, reddish brown/red (2YR 4/5) slip on both surfaces. Th. w. 0.3-0.4.
Form/date: Conspectus Form 18.2?; ca. 10 B.C. – A.D. 30.[162]

158. Ettlinger 1990c, 58.
159. Ettlinger 1990c, 58.
160. Ettlinger 1990c, 72.
161. Ettlinger 1990c, 76.
162. Ettlinger 1990c, 82.

Conspectus Form 19 (Platter/plate with concave vertical rim and quarter-round molding or step between wall and floor)
ITS1.11 (C-87-124; Locus: Trench 29N12E 03) Fragment of rim and wall. Medium hardness, light red (2.5YR 6/6) body with glossy, red (2.5YR 5/6) slip on both surfaces. D. r. ca. 18; th. w. 0.3-0.4.
Form/date: Conspectus Form 19.2.1; ca. A.D. 1-40.[163]

Conspectus Form 20 (Platter/plate with smooth or finely molded vertical rim or platter) or Form 21 (Plate with smooth or finely molded vertical rim and quarter-round molding or step between rim and floor)
ITS1.12 (C-88-202; Locus: Trench 23N9E 04) Fragment of rim and wall. Dolphin appliqué on exterior surface of wall. Soft, reddish yellow (4.5YR 6.5/6) body with glossy, red (2.5YR 5.2/8) slip on both surfaces. D. r. ca. 15-17; th. w. 0.5.
Form/date: Conspectus Form 20.4 or 21.3; ca. A.D. 40-90.[164]

Conspectus Form 29 (Cylindrical cup with hollow base)
ITS1.13 (C-88-193; Locus: Trench 23N9E 03) Fragment of rim and wall. Soft, light reddish brown (2YR 6/4) body with glossy, red (2YR 4.5/6) slip on both surfaces. D. r. 9.5; th. w. 0.3.
Form/date: Conspectus 29; ca. A.D. 15-95.[165]

Conspectus Form 34 (Hemispherical cup with short vertical rim and pronounced flange on wall)
ITS1.14 (C-88-194; Locus: Trench 23N9E 03; thin section) Fragment of rim and wall. Rosette appliqué on exterior surface of wall. Soft, pink (4YR 7.5/5) body with glossy, red (2YR 5/6) slip on both surfaces. D. r. 11-12; th. w. 0.3.
Form/date: Conspectus Form 34.1.2; ca. A.D. 30-100.[166]

Conspectus Form 37 (Hemispherical cup with articulated rim)
ITS1.15 (C-S-084; Locus: Trench 23N9E 03) Fragment of rim and wall. Two rows of chattering on upper surface of rim. Soft, pink (4YR 7.5/4) body with glossy, red (1YR 4.5/8) slip on both surfaces. D. r. 7-8; th. w. 0.3.
Form/date: Conspectus Form 37.1.2; ca. A.D. 25-100.[167]

163. Ettlinger 1990c, 84.
164. Ettlinger 1990c, 86, 88.
165. Ettlinger 1990c, 104.
166. Ettlinger 1990c, 112.
167. Ettlinger 1990c, 116.

Italian Terra Sigillata Fabric Group 2

Conspectus Form 3

ITS2.01 (C-S-085; Locus: Trench 23N9E 04) Fragment of rim and wall of dish. Medium hard, pale red (10R 5.8/4) body with glossy, red (10R 4.5/6) slip on both surfaces. Th. w. 0.4.
Form/date: Conspectus Form 3.1.2. For date see ITS1.02.

Conspectus Form 4

ITS2.02 (C-S-086; Locus: Trench 25N9E 04) Fragment of wall of platter/plate. Soft, pink (5YR 7/4) body with glossy, red (10R 4.2/6) slip on both surfaces. D. r. 7-8; th. w. 0.7.
Form/date: Conspectus Form 4.5.1? For date see ITS1.06.

Conspectus Form 6 (Platter/plate with plain curving wall and quarter-round molding between wall and floor or platter) or Form 21

ITS2.03 (C-S-089; Locus: Trench 21.5N15W 07) Fragment of wall. Medium hard, light red (2YR 6/6) body with glossy, red (10R 4.5/8) slip on both surfaces. Th. w. 0.6.
Form/date: Conspectus Form 6.1.3 or 21.1.2; ca. A.D. 1-60 or ca. 5 B.C.-A.D. 50.[168]

Conspectus Form 12

ITS2.04 (C-S-087; Locus: Trench 25N9E 04) Fragment of rim and wall. Soft, pink (4.5YR 6.8/4) body with glossy, red (2.5YR 4/7) slip on both surfaces. Th. w. 0.3.
Form/date: Conspectus Form 12.2.2? For date see ITS1.07.

Conspectus Form 20

ITS2.05 (C-88-192; Locus: Trench 23N9E 03/04) Five joining fragments of rim and wall. Soft, pink (4YR 7.5/4) body with glossy, red (1YR 4.5/8) slip on both surfaces. D. r. 18; th. w. 0.7.
Form/date: Conspectus Form 20.2.1; ca. A.D. 1-50.[169]

Conspectus Form 20 or Form 21

ITS2.06 (C-S-083; Locus: Trench 23N9E 03; thin section) Fragment of rim and wall. Soft, pink (4YR 7/4) body with glossy, red (2.5YR 4.2/6) slip on both surfaces. Th. w. 0.5.
Form/date: Conspectus Form 20.2.1?; ca. A.D. 1-50.[170]

ITS2.07 (C-S-092; Locus: Trench 26N10.5E 06) Fragment of wall. Soft, pink (4.5YR 7.5/4) body with glossy, red (10R 4.4/6) slip on both surfaces.

168. Ettlinger 1990c, 62, 86.
169. Ettlinger 1990c, 86.
170. Ettlinger 1990c, 86.

Conspectus Form 23 (Conical cup with smooth vertical rim)

ITS2.08 (C-88-098; Locus: Trench 21.5N15W 13) Fragment of rim and wall. Chattering on exterior face of rim and on carination. Medium hardness, pink (5YR 7/4) body with glossy, red (2.5YR 4.5/6) slip on both surfaces. Th. w. 0.4.
Form/date: Conspectus Form 23.2; ca. A.D. 25-75.[171]

Italian Terra Sigillata Fabric Group 3

Conspectus Form 20 or Form 21

ITS3.01 (C-87-314; Locus: Trench 18.5N12W 15) Fragment of rim and wall. Rosette appliqué on exterior surface of wall. Medium hardness, light red (2YR 6/6) body with glossy, red (1.5YR 4.5/7) slip on both surfaces. Th. w. 0.4.
Form/date: Conspectus Form 20.4 or 21.7; ca. A.D. 40-90.[172]

171. Ettlinger 1990c, 92.
172. Ettlinger 1990c, 86, 88.

Appendix 2: Clay catalog

This appendix presents catalog entries for the 22 clay specimens included in the program of analysis. These are arranged first by geologic period and then by source.

Each entry begins with the specimen's catalog number (referring to a larger corpus of potting clays from Toscana, Umbria, Lazio, and Campania collected by one of the authors (JTP)),[173] followed in parentheses by the map coordinates and elevation of the point where it was collected, where this information is known. This is followed by information regarding the nature of the specimen, the geologic formation from which it derives, the method of collection, the identity of the collector and the date of collection, the method employed to produce a test tile from it, and, finally, an indication of the material's color in its raw and fired states.

Paleogene Clay

Cetamura (Provincia di Siena)

CCET.01 (Clay 21) (ca. 0.2 km ENE of Cetamura; 32T 696805 m E 4818527 m N; 651 m a.s.l.) Clod of clay from formation Fg 113 csp (*calcareniti degli scisti policromi*/calcarenites belonging to the polychrome schists) recovered from pit dug into seep by JTP (11-8-90). Fired to 900 degrees C. Color: raw: mottled, mostly light gray (2/5Y 7/1); fired: reddish yellow (4YR 6/6).

Holigocene Marine Clay

Radda – Castiglioni (Provincia di Siena)

CRCS.01 (Clay 22) (ca. 2.75 km NE of Radda and ca. 2.0 km WNW of Cetamura; 32T 695120 m E 4818994 m N; 481 m a.s.l.) Clod of clay from formation Fg 113 c' (*complesso caotico – argille scagliose*/caotic complex – platy clays) recovered from road cut by JTP (11-8-90). Coarse fraction removed by sifting disaggregated bulk specimen through 0.5 mm steel mesh. Fired to 900 degrees C. Color: raw (bulk clay): very pale brown/pale brown (10YR 6.5/3); fired: light reddish brown (4YR 6.2/3.5).

173. The 22 clays considered in this article form part of a group of 120 ceramic clays that JTP has collected in west-central and southern Italy in the course of several research projects. He is currently preparing (in collaboration with H. Kane) a database that reports compositional and other information regarding these clays. This resource, titled "*La creta fatta concreta*: a database of Italian ceramic clays." will be made available through the website <u>Res Romanae</u>: *The University of California, Berkeley Roman Material Culture Research Laboratory*, scheduled for launch during Fall, 2014.

Upper Miocene Lacustrine Clay (?)

Colle Val d'Elsa – Belvedere (Provincia di Siena)

CCVB.01 (Clay 11) Clod collected from clay store on grounds of Ceramica Vulcania cookware factory (Colle Val d'Elsa) by JTP (8-8-90). Said to be from clay pit at località Belvedere, ca. 4-5 to SE of town, though more likely from locale of this name ca. 6 km to NE of town. Perhaps from formation Fg 113 Mlc_2 (*conglomerati lacustri*/ lacustrine conglomerates). Fired to 900 degrees C. Color: raw: brownish yellow (1Y 6/8); fired: light red (2.5YR 5.8/8).

Pliocene Marine Clay and Sandy Clay

Volterra (Provincia di Pisa)

CVLT.01 (Clay 53) (ca. 5.2 km SW of Volterra; 32T 647420 m E 4803450 m N; 125 m a.s.l.) Clod of clay from outcrop of formation Fg 112 Pag (*argille azzurre e cenerine*/ blue and gray clays) recovered from surface of plowed field by JTP (24-7-91). Fired to 900 degrees C. Color: raw: light gray/light brownish gray (2.5Y 6.5/2); fired: pink/ reddish yellow (4.5YR 7/5).

CVLT.02 (Clay 54) (ca. 4.5 km SW of Volterra; 32T 647765 m E 4803730 m N; 108 m a.s.l.) Clod cut from weathered scarp of outcrop of formation Fg 112 Pag (*argille azzuree e cenerine*/blue and gray clays) by JTP (24-7-91). Fired to 900 degrees C. Color: raw: gray (5Y 5/1); fired: pink (4.5YR 7.5/4).

CVLT.03 (Clay 55) (ca. 2.1 km SW of Volterra; 32T 649260 m E 4805820 m N; 248 m a.s.l.) Clod cut from unweathered scarp of outcrop of formation Fg 112 Pag (*argille azzurre e cenerine*/blue and gray clays) by JTP (24-7-91). Fired to 900 degrees C. Color: raw: light gray (5Y 6.5/1); fired: pinkish white (7YR 8/2).

CVLT.04 (Clay 56) (ca. 1.4 km SW of Volterra; 32T 649620 m E 4805820 m N; 286 m a.s.l.) Clod cut from weathered scarp of outcrop of formation Fg 112 Pag (*argille azzurre e cenerine*/blue and gray clays) by JTP (24-7-91). Fired to 900 degrees C. Color: raw: gray (5Y 5.5/1); fired: pink (4.5YR 7/4).

CVLT.05 (Clay 58) (ca. 4.6 km NW of Volterra; 32T 649400 m E 4811030 m N; 240 m a.s.l.) Clod cut from weathered scarp of outcrop of formation Fg 112 Pag (*argille azzurre e cenerine*/blue and gray clays) by JTP (24-7-91). Fired to 900 degrees C. Color: raw: gray/dark gray/olive gray (4Y 4.5/1.5); fired: pink (5.5YR 7/4).

CVLT.06 (Clay 57) (ca. 2.4 km NW of Volterra; 32T 649370 m E 4808970 m N; 291 m a.s.l.) Clod cut from weathered scarp of outcrop of formation Fg 112 Pag (*argille azzurre e cenerine*/blue and gray clays) by JTP (24-7-91). Fired to 900 degrees C. Color: raw: light olive gray (4Y 6/2); fired: light red/reddish yellow (3.5YR 6.5/6).

CVLT.07 (Clay 2) (ca. 3.4 km ESE of Volterra; 32T 653520 m E 4806090 m N; 321 m a.s.l.) Clod of clay from outcrop of formation Fg 112 Pag (*argille azzurre e cenerine*/ blue and gray clays) recovered from surface of plowed field by JTP (9-8-90). Fired to 900 degrees C. Color: raw: light gray (3.5Y 7/1); fired: light reddish brown (4YR 6.5/4).

Castelnuovo Berardenga Scalo (Provincia di Siena)

CCBS.01 (Clay 4) (ca. 0.8 km ENE of Castelnuovo Berardenga Scalo; 32T 702670 m E 4798125 m N; 255 m a.s.l.) Clod cut from face of Laterizi Arbia architectural ceramics factory clay pit cut into formation Fg 121 Pag^{2-1} (*argille ed argillle sabbiose*/clays and sandy clays) by JTP (10-8-90). Fired to 900 degrees C. Color: raw: light gray (2.5Y 7/1); fired: light reddish brown (4YR 6/4).

CCBS.02 (Clay 5) (ca. 0.8 km ENE of Castelnuovo Berardenga Scalo; 32T 702650 m E 4798140 m N; 253 m a.s.l.) Clod cut from face of Laterizi Arbia architectural ceramics factory clay pit cut into formation Fg 121 Pag^{2-1} (*argille ed argillle sabbiose*/clays and sandy clays) by JTP (10-8-90). Fired to 900 degrees C. Color: raw: light gray (5Y 7/1); fired: reddish yellow (4YR 6.2/6).

CCBS.03 (Clay 6) (ca. 0.8 km ENE of Castelnuovo Berardenga Scalo; Tav. 32T 702625 m E 4798150 m N; 252 m a.s.l.) Clod cut from face of Laterizi Arbia architectural ceramics factory clay pit cut into formation Fg 121 Pag^{2-1} (*argille ed argillle sabbiose*/ clays and sandy clays) by JTP (10-8-90). Fired to 750 degrees C. Color: raw: light gray (5Y 7/1); fired: pink/light reddish brown (4YR 6.5/4).

Plio-Pleistocene Lacustrine Clay

Altopascio (Provincia di Lucca)

CALP.01 (Clay 9) Clod collected from clay store on grounds of Ceramica Vulcania cookware factory (Colle Val d'Elsa) by JTP (8-8-90). Said to be from Altopascio, thus probably from formation Fg 105 Ql (*argille lignitifere, argille sabbiose, e sabbie di ambiente lacustre*/lignite bearing clays, sandy clays, and lacustrine sands). Fine fraction obtained by passing pulverized bulk specimen through 0.5 mm mesh. Fired to 900 degrees C. Color: raw (bulk clay): white (2.5Y 8/1), with surfaces oxidizing very pale brown/yellow (10Y 5.8/5); fired: pink (lighter than 7.5YR 8/4).

Castelfranco di Sopra – Il Matassino (Provincia di Arezzo)

CCFM.01 (Clay 14) (ca. 1.5 km NE of Figline Valdarno) Clod collected from clay store on grounds of Cotto Pratigliolmi architectural ceramics factory by JTP (10-8-90). Said to be from clay pit on premises, thus presumably dug from formation Fg 114 Vag (*argille di Figline*/Figline clays). Fired to 900 degrees C. Color: raw: gray/light gray (5Y 6.5/1); fired: reddish yellow (4.5YR 6.7/6).

CCFM.02 (Clay 15) (ca. 1.5 km NE of Figline Valdarno) Clod collected from clay store on grounds of Cotto Pratigliolmi architectural ceramics factory by JTP (10-8-90). Said to be from clay pit on premises, thus presumably dug from formation Fg 114 Vag (*argille di Figline*/Figline clays). Fired to 900 degrees C. Color: raw: light yellowish brown (2.5Y 6/4); fired: light red (2YR 6/8).

CCFM.03 (Clay 16) (ca. 1.5 km NE of Figline Valdarno) Clod collected from clay store on grounds of Cotto Pratigliolmi architectural ceramics factory by JTP (10-8-90). Said to be from clay pit on premises, thus presumably dug from formation Fg 114 Vag (*argille di Figline*/Figline clays). Fired to 900 degrees C. Color: raw: pale brown (10YR 6/4); fired: light red (2YR 5.8/8).

CCFM.04 (Clay 17) (ca. 1.5 km NE of Figline Valdarno) Clod collected from clay store on grounds of Cotto Pratigliolmi architectural ceramics factory by JTP (10-8-90). Said to be from clay pit on premises, thus presumably dug from formation Fg 114 Vag (*argille di Figline*/Figline clays). Fired to 900 degrees C. Color: raw: pale yellow (2.5Y 6.8/4); fired: light red (2YR 6/8).

CCFM.05 (Clay 18) (ca. 1.5 km NE of Figline Valdarno) Clod collected from clay store on grounds of Cotto Pratigliolmi architectural ceramics factory by JTP (10-8-90). Said to be from clay pit on premises, thus presumably dug from formation Fg 114 Vag (*argille di Figline*/Figline clays). Fired to 900 degrees C. Color: raw: 5Y 5.5/1 (gray); fired: reddish yellow (4YR 5.5/8).

CCFM.06 (Clay 19) (ca. 1.5 km NE of Figline Valdarno) Clod collected from clay store on grounds of Cotto Pratigliolmi architectural ceramics factory by JTP (10-8-90). Said to be from clay pit on premises, thus presumably dug from formation Fg 114 Vag (*argille di Figline*/Figline clays). Fired to 900 degrees C. Color: raw: light olive gray (5Y 6/2); fired: light red/red (2.5YR 5.5/8).

Arezzo – Quarata (Provincia di Arezzo)

CARQ.01 (Clay 59) (ca. 7.5 km NW of Arezzo; 32T 726150 m E 4819955 m N; 209 m a.s.l.) Clod cut from weathered scarp in formation Fg 114 agQ (*argille di Quarata*/Quarata clays) by JTP (26-7-91). Fired to 900 degrees C. Color: raw: dark brownish gray/very dark gray (2.5Y 3.5/2); fired: light red (2.5YR 6/7).

CARQ.02 (Clay 60) (ca. 6.0 km NW of Arezzo; 32T 726920 m E 4819660 m N; 210 m a.s.l.) Clod of clay from formation Fg 114 agQ (*argille di Quarata*/Quarata clays) recovered from surface of plowed field by JTP (26-7-91). Fired to 900 degrees C. Color: raw: light gray/light olive gray (5Y 6.5/2); fired: light red (2.5YR 7/8).

Appendix 3: Petrographic analysis

This appendix describes the program of petrographic analysis, discussing the methods employed, presenting its results in tabular form, and discussing these.

In order to obtain a more systematic characterization of the texture of the various fabrics identified in the project and more secure and specific identifications of the inclusions present in these thin sections were fabricated for 17 pottery specimens and subjected to petrographic analysis.[174] These included 2 specimens of BGW Fabric Group 1 and 1 specimen each of BGW Fabric Groups 2-8, 1 specimen each of NERSW Fabric Groups 1, 3-5, and 7-8, and 1 specimen each of ITS Fabric Groups 1-2. No thin section was fabricated for a specimen of either NERSW Fabric Groups 2 or 6 or of ITS Fabric Group 3 due to the lack of a sherd of the requisite size. Thin sections were also fabricated and analyzed for the tiles manufactured from each of the two specimens of Arezzo – Quarata clay (CARQ.01, CARQ.02) so that detailed comparisons could be made of the texture and mineralogy of these clays and pottery specimens judged likely to have been manufactured from them.

Methods

The analysis of each thin section involved the following operations:

1. An estimate was made of the percentage of area of the section occupied by the three basic components of the ceramic body – matrix (the micromass – that is, particles in the fine silt [ca. 10 microns] and smaller size range, presumably for the most part more or less completely transformed clay minerals and, in the case of calcareous ceramic bodies, calcium carbonate), inclusions (mineral grains and rock fragments in the coarse silt range [ca. 10 microns] and larger), and voids (cavities in the very fine sand size range [ca. 50-100 microns] and larger) – by reference to comparator charts.[175] The values reported should be regarded as highly approximate, with figures in the 1-3 percent range representing minor variability that can be apprehended at the low end of the scale.

2. The matrix was characterized for color in approximate terms utilizing the set of color names employed in the *Munsell Soil Color Charts* and for its level

174. The thin sections analyzed in this study were fabricated by Quality Thin Sections of Tucson, Arizona.
175 The charts employed were those published in Matthew *et al.* 1991, especially that on p. 241.

of optical activity. Since matrix color varies appreciably in accordance with the thickness of the section this information is intended to communicate only a general idea of the color of this component of the ceramic body. No concentration features (e.g. discreet areas of matrix exhibiting a distinct color or a distinctively higher or lower concentration of opaque and/or translucent bodies) were observed. In three specimens the matrix was found to be partially optically active, while in the rest it proved to be optically inactive.

3. The inclusion component was characterized for body identification (as this could be determined or inferred), abundance (percentage of area), condition, and size. For this the following methods were employed:

- Abundance: The percentage of area occupied by each kind of inclusion relative to that occupied by all inclusions was estimated using a comparator chart. The following frequency categories were employed: predominant (> 70 percent); dominant (50-70 percent); frequent (30-50 percent); common (15-30 percent); few (5-15 percent); very few (3-5 percent); rare (0.5-3 percent); very rare (< 0.5 percent).[176]
- Condition: The degree of angularity/roundedness was characterized using a comparator chart.[177] The following categories were recognized: angular, subangular, subrounded, rounded.
- Size: The size distribution for each kind of inclusion was estimated. The following set of size categories was employed: silt (ca. 10-50 microns); very fine sand (50-100 microns); fine sand (100-200 microns); medium sand (200-500 microns); course sand (500-1000 microns).[178]

An effort was also made to perform a rough quantitative assessment of the distribution of translucent inclusions across the set of size categories. For this, a DCM 130 digital video camera (resolution 1.3 megapixels) was employed to take two photomicrographs: one under plane-polarized light (PPL), the other under cross-polarized light (XPL) of an area of each thin section judged to be representative of the whole at a magnification of 40 times. The resulting images each covered an area measuring approximately 3.2 x 2.0 mm. The images were opened in Photoshop CS5 for analysis using the View/Show/Grid command, which overlays onto the image a grid composed of squares that at the scale employed have sides measuring ca. 75 microns. The Crop Tool cursor icon consists of a square with sides equal to ca. 50 microns at this scale, and this device was used to determine the approximate size of bodies or areas of interest. Using the XPL image (in which all voids

176. See Whitbread 1995, 379 table A3.1, 385-386 for the use of this scale in ceramic petrography.
177. Stoops 2003, 53 fig. 4.14.
178. See Stoops 2003, 49 for this set of size categories.

and some portion of the translucent mineral grains and rock fragments were extinguished) a count was made of the number of bodies visible in each of the five size intervals. (In the event, none of the images proved to contain any bodies in the coarse sand interval.) Reference was made to the PPL image in some cases to clarify the nature of a body visible in the XPL image. While the figures obtained in this way represent only a portion of the bodies present in the portion of the section included in the image, the relative proportions of the number of bodies in the various size intervals probably represent a useful approximation of their true overall representation.[179] The raw count data were converted to percentages of the total count in order to facilitate comparison between sections. Since, the visibility in thin sections of transparent bodies in the lower end of the silt interval varies according to the thickness of the section (and also the intensity of illumination), percentage figures were also produced for just the data pertaining to the four sand intervals.

4. The void component was characterized for shape, abundance, and size range. The following shapes were recognized: vesicles (regular, fairly spherical cavities), vughs (highly irregular, fairly spherical cavities) and channels (highly elongated cavities). The following two size categories were employed: meso (50-500 microns); macro (500-2000 microns).[180]

A summary of the results of the analysis of all 19 thin sections is presented in Table 13. A photomicrograph of a representative area of each of the thin sections taken at a magnification of 40X under PPL is presented in Figures 14A-E.

Table 13: Results of program of petrographic analysis. *Ceramic body components*: ma = matrix; in = inclusions; vo = voids. *Inclusions*: Identification: Ca = calcite; FO = orthoclase feldspar; FP = plagioclase feldspar; Mfn = microfauna; Mi = mica of indeterminate type; MiBi = biotite; MiMu = Muscovite; Mdst = mudstone; QM = monocrystalline quartz; QP = polycrystalline quartz; Sist = siltstone; SistMi = micaceous siltstone. Abundance: pr = predominant (> 70 percent); do = dominant (50-70 percent); fr = frequent (30-50 percent); co = common (15-30 percent); fe = few (5-15 percent); vfe = very few (3-5 percent); ra = rare (0.5-3 percent); vra = very rare (< 0.5 percent). Shape: a = angular; sa = subangular; sr = subrounded; r= rounded. Size: si = silt (10/20-50 μm); vfs = very fine sand (50-100 μm); fs = fine sand (100-200 μm); ms = medium sand (200-500 μm); cs = coarse sand (500-1000 μm). *Voids*: Shape: ch = channel; ve = vesicle; vu = vugh. Size: meso (50-500 μm); macro (500-2000 μm).

179. The data presumably over-represent somewhat certain kinds of bodies regularly present in the set of thin sections analyzed – in particular relatively large grains of polycrystalline quartz – which remain visible regardless of the orientation of the microscope stage under crossed polars.
180. See Whitbread 1995, 380 for these shapes and size categories.

Sample	Ceramic body components (percent area) ma:in:vo	Matrix	Inclusions (in descending order of abundance)@	Translucent bodies (count; percent all; percent sand size) cs:ms:fs:vfs:si	Voids
BGW1.01	98:01:01	Dark red; optically inactive	QM (do; si)	00:00:00:000:093	Ve (ra; meso)
			MiBi (vra, vfs)	% 00:00:00:000:100	
BGW1.09	97:02:01	Dark red; optically inactive	QM (do; si)	00:00:00:005:365	
			Mi (vfe; si)	% 00:00:00:001:099	Ve/Vu/Ch(ra; meso)
			QM (vra; vfs; sr)	% 00:00:00:100:----	
			MiBi (vra; vfs-fs)		
BGW2.05	95:05:00	Light reddish brown; optically inactive	QM (do; si)	00:00:00:003:117	Ves/Ch (vra; meso)
			MiBi+MiMu? (co; si-fs)	% 00:00:00:003:097	
			QM (ra, a-sr;vfs)	% 00:00:00:100:----	
			QP (vra; sr; vfs-fs)		
			Mdst (vra; sr; fs)		
			FP? (vra; sa; vfs)		
BGW3.02	96:05:01	Dark reddish brown to reddish brown; optically inactive	QM (do; si)	00:00:00:000:263	Ves/Ch (ra; meso)
			Mi (co; si)	% 00:00:00:000:100	
			QM (ra; sa; vfs)		
			QP (vra; sa; vfs)		
			MiBi (vra; vfs)		
BGW4.01*	96:03:01	Light reddish brown; optically inactive	QM (pr; si)	00:00:00:000:129	Ves (ra; meso)
			Mi (co; si)	% 00:00:00:000:100	
			MiBi (vra; fs)		
			QP? (vra; a; vfs)		

Sample	Ceramic body components (percent area) ma:in:vo	Matrix	Inclusions (in descending order of abundance)@	Translucent bodies (count; percent all; percent sand size) cs:ms:fs:vfs:si	Voids
BGW5.05*	89:10:01	Reddish brown; optically inactive	QM (do; a-sr; si-ms)	00:00:03:009:254	Ves/Cha (ra; meso)
			QP (co, a-sr; vfs-ms)	% 00:00:01:004:095	
			Sist (ra; sr; vfs-fs)	% 00:00:20:080:----	
			Mi (ra, vfs)		
			MiBi (vra; ms)		
			FO? (vra; a; vfs)		
			Mfn? (vra; fs)		
BGW6.01	87:08:05	Reddish brown; optically inactive	QM (do; sa-sr; si-vfs)	00:00:01:003:111	Ves (fe; meso)
			QP (fe; sa-sr; vfs)	% 00:00:01:003:096	
			QP (vra; sr; cs)	% 00:00:25:075:----	
			Mi (vra; si)		
BGW7.01	90:10:00	Light brown; optically inactive	QM (fr; a-sr; vfs-fs)	01:01:07:013:383	-
			QP (fr; a-r; vfs-ms)	% 00:00:02:003:095	
			Mdst (fe; sr-r; si-cs)	% 05:05:31:059:----	
			MiMu (vfe; vfs-fs)		
BGW8.01	84:15:01	Reddish brown; partially optically active	QM (fr; a-sr; vfs-fs)	00:03:16:010:133	Vu (ra; meso-macro)
			QP (fr; a-sa; vfs-cs)	% 00:02:10:006:082	
			MiBi (fe; vfs-ms)	% 00:11:56:033:----	
			Ca (ra; sr-r; fs-ms)		
			Mdst (vra; sr; cs)		
			FO? (vra; sa; cs)		

Sample	Ceramic body components (percent area) ma:in:vo	Matrix	Inclusions (in descending order of abundance)@	Translucent bodies (count; percent all; percent sand size) cs:ms:fs:vfs:si	Voids
NERSW1.01	96:03:01	Reddish brown	QM (pr; si)	00:00:00:000:051	Ve, Ch (ra; meso)
			Mi (fe; si)	% 00:00:00:000:100	
			QM (ra; a-r; vfs)		
			MiMu (vra; vfs)		
			Mdst (vra; sr; vfs)		
			SistMi (vra: r; ms)		
			Qp (vra; a; vfs)		
NERSW3.04	98:01:01	Light red;	QM (fr; si)	00:00:00:002:311	Ve, Ch (ra; meso)
		partially optically active	Mi (fr; si)	% 00:00:00:001:100	
			QM (vra; sa-r; vfs)		
			MiMu? (vra; vfs)		
NERSW4.03#	94:05:01	Reddish brown; partially optically active	QM (fr)	00:00:02:007:533	Ve (ra; meso)
			Mi (fr)	% 00:00:00:001:099	
			QM (ra; sa-r; vfs)	% 00:00:22:078:----	
			MiMu (vra; vfs)		
			QP (vr; sa-sr; vfs)		
NERSW5.01	85:12:03	Light red; optically inactive	QM (co; sa-sr; si-ms)	00:00:04:011:256	Ch, Ve (ra; meso-macro)
			QP (co; a-sr; fs-cs)	% 00:00:02:004:094	
			MiBi (fe; vfs-cs)	% 00:00:27:073:----	
			IgR (ra; sr-r; fs-ms)		
			Mdst (ra; sr-r; si-fs)		
			FO (vra[-fe?]; sr; cs)		
			Sist (vra; r; fs)		

Sample	Ceramic body components (percent area) ma:in:vo	Matrix	Inclusions (in descending order of abundance)@	Translucent bodies (count; percent all; percent sand size) cs:ms:fs:vfs:si	Voids
NERSW7.01	87:12:01	Reddish brown; optically inactive	QM (fr; a-sr; si-vfs) QP (co; a-sr; vfs) Mdst (vfe; sr-r; si-vfs) MiMu (vfe; si-vfs) Sist (vra; sa; fs)	00:00:00:014:257 % 00:00:00:005:095 % 00:00:00:100:----	Vu, Ve (ra; meso)
NERSW8.01	91:08:01	Reddish brown; optically inactive	QM (do; a-sr; vfs-fs) QP (co; sa-sr; vfs-fs) Mdst (vfe; r; si-vfs) MiMu (vfe; vfs-fs) FP (vra; a, vfs) FO? (vra; a, ms) Mfn? (vfa; ms)	00:00:02:029:584 % 00:00:00:005:095 % 00:00:07:093:----	Ve, Vu (ra; meso)
ITS1.14	97:02:01	Light red; optically inactive	Mi (do; si) QM (fr; si)	00:00:00:001:354 % 00:00:00:000:100 % 00:00:00:100:----	Ch, Ve (ra; meso)
ITS2.06	97:03:00	Reddish brown; optically inactive	QM (do; a-sr; si-vfs) MiMu (fr; si-vfs) QP (vra; sa; vfs)	00:00:00:000:130 % 00:00:00:000:100	Ve (vra; meso)
CARQ.01	95:02:03	Light reddish brown; optically inactive	QM (do; si) Mi (fr; si) Sist? (vra; r; fs)	00:00:00:000:178 % 00:00:00:000:100	Ve, Vu (vfe; meso-macro)
CARQ.02	94:01:05	Reddish brown; optically inactive	QM (do; si) Mi (fr; si) Mdst (vra; sa; fs)	00:00:00:000:109 % 00:00:00:000:100	Ve, Vu (fe; meso-macro)

@ Two entries provided for QM in cases where section contained dominant silt-sized grains and only very rare fine sand-sized grains.
* Section thicker than ideal.
# Section subject to plucking, reducing abundance of sand-sized inclusions and increasing abundance of voids.

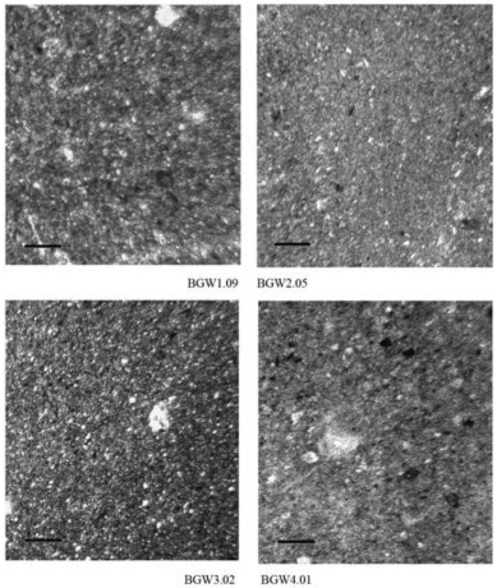

Fig. 14A: Photomicrographs of thin sections of representative examples of BGW Fabric Groups 1-4 (40X PPL). Bar in lower left 200 microns long.

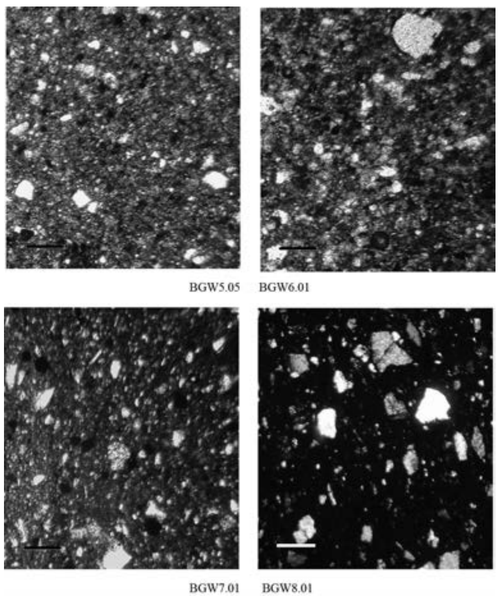

Fig. 14B: Photomicrographs of thin sections of representative examples of BGW Fabric Groups 5-8 (40X PPL). Bar in lower left 200 microns long.

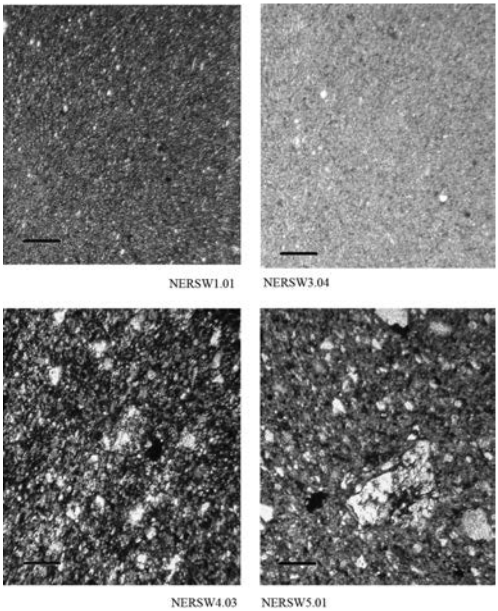

FIG. 14C: Photomicrographs of thin sections of representative examples of NERSW Fabric Groups 1, 3, 4, and 5 (40X PPL). Bar in lower left 200 microns long.

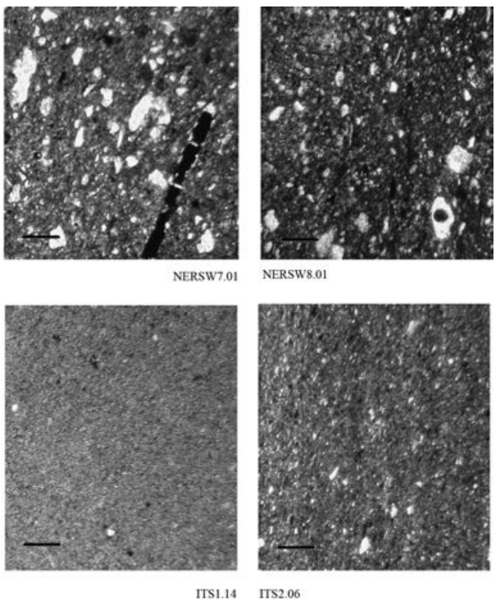

FIG. 14D: Photomicrographs of thin sections of representative examples of NERSW Fabric Groups 7and 8 and ITS Fabric Groups 1-2 (40X PPL). Bar in lower left 200 microns long.

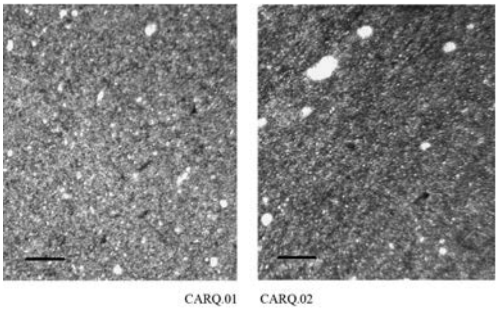

Fig. 14E: Photomicrographs of thin sections of test tiles manufactured from Arezzo – Quarata clays CARQ.01 and CARQ.02 (40X PPL). Bar in lower left 200 microns long.

Discussion of Results

The eight specimens with a fine texture and moderately to highly calcareous chemistry – including five of the nine examples of BGW (BGW1.02, 1.09, 2.05, 3.02, 4.01), one of the six examples of NERSW (NERSW1.01), and both of the examples of ITS (ITS1.14, 2.06) analyzed – display highly similar compositions, with their inclusion component comprised exclusively or almost exclusively of silt-sized (presumably monocrystalline) quartz and mica. In some examples there are also very rare occurrences of inclusions in the very fine to medium sand size-range, including grains of quartz and laths of mica, grains of polycrystalline quartz and possibly feldspar, and fragments of mudstone and siltstone. This composition indicates that these specimens were manufactured either from a fine calcareous clay or a less fine calcareous clay subjected to levigation. These might have been either a marine clay, such as the Volterra clays, Castelnuovo Berardenga Scalo clay, or Radda – Castiglione clay, or a continental clay laid down in a calcareous environment, such as Arezzo – Quarata clay. The inclusions represented in these specimens are all extremely common and do not shed light on their likely points of origin.[181]

Of these materials, the two specimens of BGW assigned to Arezzo on the basis of the chemical evidence (BGW1.02, 1.09) differ somewhat from one another, with one (BGW1.09) displaying a slightly coarser set of inclusions and a higher apparent ratio of mica to quartz. One of the two specimens of ITS (ITS2.06) – both also assigned to Arezzo on the basis of the chemical evidence – displays a somewhat coarser set of inclusions than the other, with a lower apparent ratio of quartz to mica. Between them, these four

181. See Garzanti *et al.* 2002 passim for the representation of various mineral grains and rock fragments in beach and river sands from several locales in northern Tuscany.

specimens contain only a single inclusion that can be identified as something other than monocrystalline quartz or mica – a grain of polycrystalline quartz present in one of the examples of ITS.

The tiles fabricated from the two specimens of Arezzo – Quarata clay (CARQ.01, 02) display characteristics similar to those of the two specimens of BGW and two specimens of ITS assigned to Arezzo on the basis of their chemical composition, although, in contrast to these specimens, they each contain a single rock fragment of fine sand size, in one case mudstone and in the other siltstone. The overall textural similarity of these two clay specimens to the four pottery specimens suggests that the latter were manufactured from unlevigated clay obtained directly from the same parent formation as the clay specimens. The two specimens of Arezzo – Quarata clay differ somewhat from one another, with one (CARQ.01) having an inclusion component that contains slightly more quartz grains at the coarse end of the silt size category. This observation is compatible with the fact that the two specimens display somewhat different chemical compositions.

The three specimens of BGW and the specimen of NERSW conjecturally assigned to Volterra on the basis of their chemical composition (BGW2.05, 3.02, 4.01; NERSW1.01) display relatively more (although still only very rare) inclusions in the very fine sand to fine sand size range (and, in one instance, a rock fragment of medium sand size) than do the specimens of BGW and ITS assigned to Arezzo, with a greater incidence of polycrystalline quartz and sedimentary rock fragments. All of the Volterra clays collected and analyzed have a substantially coarser texture than these specimens, suggesting either that there were one or more sources of very substantially finer clay known to Volterran potters that were not sampled, which must be regarded as a distinct possibility, given the very considerable extent and complexity of the beds of marine clay exposed in the environs of the town, or that the manufacture of these two classes of pottery at Volterra required the levigation of the clay employed for this purpose.

The specimen of NERSW with a fine texture and a low-calcium chemistry (NERSW3.04) has a matrix that is partially optically active, indicating a less than thorough firing regimen, and an unusually sparse inclusion component comprised of silt-sized (presumably monocrystalline) quartz and mica and a very few grains of monocrystalline quartz and laths of mica of very fine sand size. The specimen in question was probably manufactured from an unusually fine low-calcium clay or a less fine calcareous clay subjected to very thorough levigation.

The specimen of BGW with a body of intermediate texture and a moderately calcareous chemistry (BGW5.05) has an inclusion component characterized by a notable presence of grains of monocrystalline and polycrystalline quartz in the silt to medium sand size-range, some of this quite angular, with rare to very rare occurrences of other materials in this same size-range, including siltstone and mica, and perhaps also feldspar and microfauna. This composition indicates that this specimen was manufactured from a sandy, moderately calcareous clay, most likely of marine origin, suggesting that this fabric group originated somewhere in the area of marine sediment that extends across much of northern Etruria.

The specimen of BGW with a body of intermediate texture and a low-calcium chemistry (BGW6.01) has an inclusion component characterized by a notable presence of grains of monocrystalline and polycrystalline quartz in the silt to very fine sand size-range, with rare to very rare occurrences of silt-size mica and coarse sand-size polycrystalline quartz. In this case, whether this specimen was manufactured from a sandy clay of marine or continental origin is unclear.

One of the specimens of NERSW with a gritty texture and a low-calcium chemistry (NERSW8.01) has an inclusion component consisting of grains of monocrystalline and polycrystalline quartz and feldspar, laths of mica, fragments of mudstone, and perhaps also a fragment of microfauna in the silt to fine sand size-range. Here again, the possible presence of microfauna suggests that the specimen in question was manufactured from a sandy marine clay, indicating a point of origin somewhere in the zone of marine sediments.

A second specimen of NERSW with a gritty texture and a low-calcium chemistry (NERSW7.01) has an inclusion component composed of grains of monocrystalline and polycrystalline quartz, laths of mica, and fragments of mudstone and siltstone in the silt to fine sand size-range. In this case, whether this specimen was manufactured from a sandy clay of marine or continental origin is again unclear.

The specimens of BGW with an intermediate texture and a non-calcareous chemistry (BGW6.01) and a gritty texture and a non-calcareous chemistry (BGW8.01) have an inclusion component characterized by the presence of grains of monocrystalline and polycrystalline quartz, laths of mica, and fragments of mudstone in the silt to medium or coarse sand size-range. The first of these is distinguished by the presence of a substantially greater abundance of mudstone, the other by the presence of somewhat coarser inclusions, very small amounts of calcite and perhaps also feldspar, and a matrix that is partially optically active. The manufacture of these specimens presumably involved the use of a continental clay generally similar to, if substantially less coarse than the Plio-Pleistocene lacustrine clays from Castelfranco di Sopra – Il Matassino and Altopascio, or the possible Miocene lacustrine clay from Colle Val D'Elsa – Belvedere. Alternatively, their manufacture might have involved the use of clays generally similar to these subjected to levigation. Given the broad preference for calcareous clay for the manufacture of BGW, this suggests that these specimens likely originated in locales that did not enjoy convenient access to a calcareous clay suitable for the production of pottery. General geographical considerations suggest that these may have lain somewhere in the Chianti Mountains and/or the Upper Arno Valley. Specimens of various utilitarian wares from Cetamura of likely local manufacture display similar suites of inclusions when analyzed in thin section, underscoring the possibility that these specimens originated at no great distance from the site.

The specimen of NERSW with an intermediate texture and a non-calcareous chemistry (NERSW4.03) has a matrix that is partially optically active and an inclusion component comprised of grains of monocrystalline and polycrystalline quartz and laths of mica in the silt to very fine sand size-range. The specimen of this class with a porphyritic texture and a non-calcareous chemistry (NERSW5.01) has an inclusion component that is composed of grains of monocrystalline and polycrystalline quartz and feldspar, laths of mica, and fragments of mudstone, siltstone, and granitic rock fragments in the silt to coarse sand size-range. These two specimens are generally similar to the specimens of BGW Fabric Groups 6 and 8 analyzed in thin section, and were also presumably manufactured from continental clays generally similar to, though less coarse than, those from Castelfranco di Sopra – Il Matassino, Altopascio, and Colle Val d'Elsa – Belvedere, or from clays similar to these subjected to levigation. The presence of granitic rock fragments in the specimen with a porphyritic texture is a point of some interest. Rock fragments of this kind have not been observed in utilitarian wares from Cetamura of likely local origin that have been examined in thin section, and this specimen may well have originated beyond the site's immediate locale. The nearest source of granite is situated on the western end of the Island of Elba, ca. 125 km to the SW of Cetamura, and it may be that this specimen originated somewhere along the coast at no great distance from Elba.[182] It seems possible that the specimen with an intermediate texture was manufactured from a fine fraction of the clay employed for the production of the specimen

182. See Garzanti *et al.* 2002, 5, 7 fig. 3.A, 8, 10, 13 for granite fragments in beach sands from various locales in northern Tuscany.

with a porphyritic texture or, perhaps more likely, given the possibility that the latter originated at some considerable distance from Cetamura, the clay employed for the manufacture of the specimen with a non-calcareous fabric and a gritty texture (NERSW6.01), which was not analyzed in thin section.

Appendix 4: Pottery and tile fabrics

This appendix presents a catalogue of the 19 pottery fabrics and 14 tile fabrics recognized in the program of analysis. These are arranged first by material (with pottery preceding tiles), then ware (for pottery) and source (for tiles).

The description of each fabric is based on the results of the program of optical microscopy. This involved the observation of the untreated fracture surface of a freshly detached chip under a binocular microscope at magnifications of 20X and 40X. Chips were detached from the specimens by means of a pair of pliers, glued to a piece of notecard with the fracture surface facing up, and the notecard labeled with the specimen's accession number.

The attributes characterized and values employed for this operation include the following:

- <u>Fracture surface</u>: conchoidal (smooth, with distinct curved areas), regular (smooth and flat), slightly irregular, irregular (hummocky), highly irregular (cliffs and valleys).
- <u>Matrix composition</u>: non-calcareous (no light areas), slightly calcareous (some clearly discernible light areas), distinctly calcareous (extensive, clearly discernible light areas);
- <u>Matrix topography</u>: smooth, rough, coarse (rich in inclusions slightly too small to resolve under microscope, with no continuous glassy phase).
- <u>Inclusion/void abundance</u> (estimated as percent of area of chip fracture surface by reference to comparator charts):[183] sporadic (< ca. 1%), sparse (ca. 1-5%), frequent (ca. 5-10%), abundant (ca. 10-20%), very abundant (> ca. 20%).[184]

183. Matthew *et al.* 1991.
184. Readers should note that while these values can be compared to the figures presented for the percentage of the ceramic body represented by matrix, inclusions and voids in the program of petrographic analysis reported in Appendix 3 (Table 13, column 2), they cannot be compared with the values presented for the percentages of the various types of inclusions (Table 13, column 4), as these represent estimates for the percentage of the area in the thin section occupied by inclusions rather than the percentage of the total area of the ceramic body. In order to underscore the non-compatible nature of the results

- Inclusion/void size: Size: (estimated on basis of microscope reticule) fine (< ca. 0.2 mm; too small to measure), medium (ca. 0.2-0.50 mm), coarse (ca. 0.50-1.0 mm), very coarse (> ca. 1.0 mm).
- Inclusion roundedness (estimated by reference to comparator chart):[185] angular, subangular, subrounded, rounded.

The likely identifications of the various kinds of inclusions noted are indicated in parentheses.

Figures 15A-E present a photomicrograph of a representative example of each of the pottery fabrics at a magnification of 20X. Figures 16A-D present a photomicrograph of a representative example of each of the tile fabrics at the same magnification.

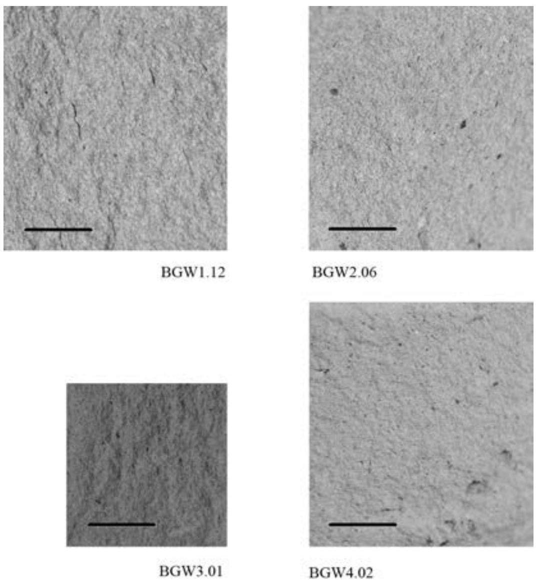

FIG. 15A: Photomicrographs of fracture surfaces of representative examples of BGW Fabric Groups 1-4 (20X). Bar in lower left 100 microns long.

obtained by means of these two characterization operations different sets of percentage ranges and associated names were employed.

185. Stoops 2003, 53 fig. 4.14.

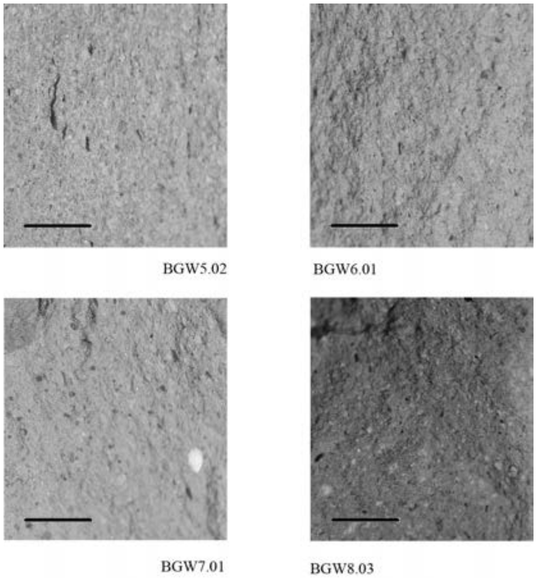

Fig. 15B: Photomicrographs of fracture surfaces of representative examples of BGW Fabric Groups 5-8 (20X). Bar in lower left 100 microns long.

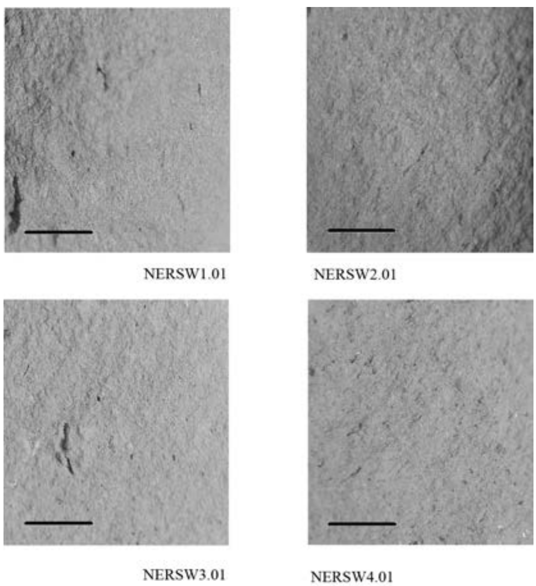

Fig. 15C: Photomicrographs of fracture surfaces of representative examples of NERSW Fabric Groups 1-4 (20X). Bar in lower left 100 microns long.

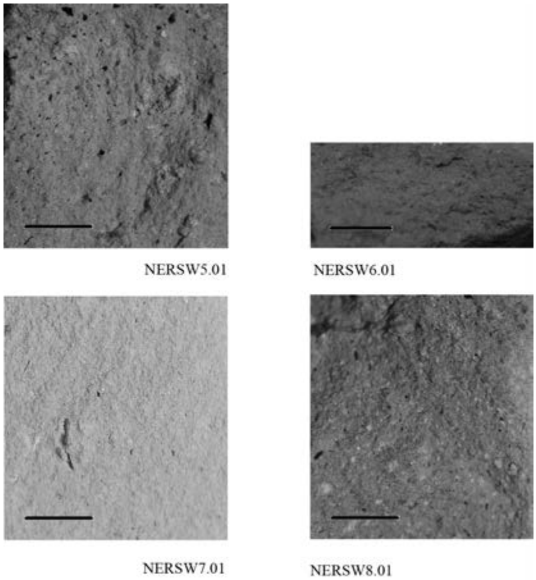

Fig. 15D: Photomicrographs of fracture surfaces of representative examples of NERSW Fabric Groups 5-8 (20X). Bar in lower left 100 microns long.

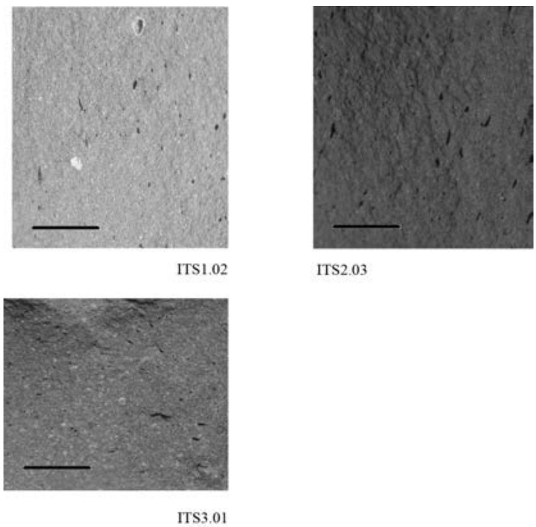

Fig. 15E: Photomicrographs of fracture surfaces of representative examples of ITS Fabric Groups 1-3 (20X). Bar in lower left 100 microns long.

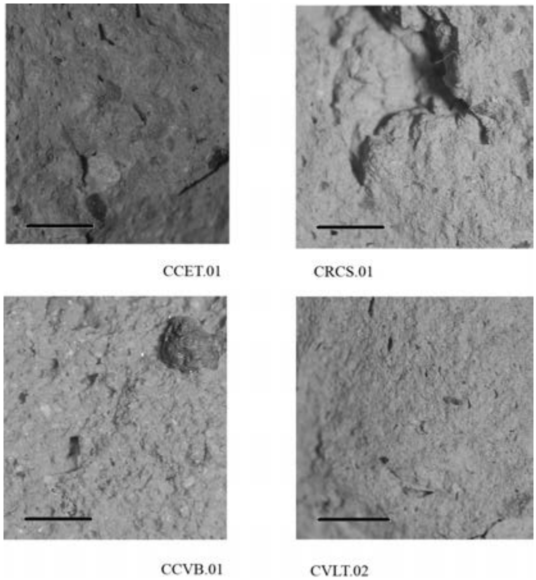

Fig. 16A: Photomicrographs of fracture surfaces of test tiles manufactured from clays from Cetamura (CCET.01), Radda – Castiglione (CRCS.01), Colle Val d'Elsa – Belvedere (CCVB.01), and Volterra (CVLT.02) (20X). Bar in lower left 100 microns long.

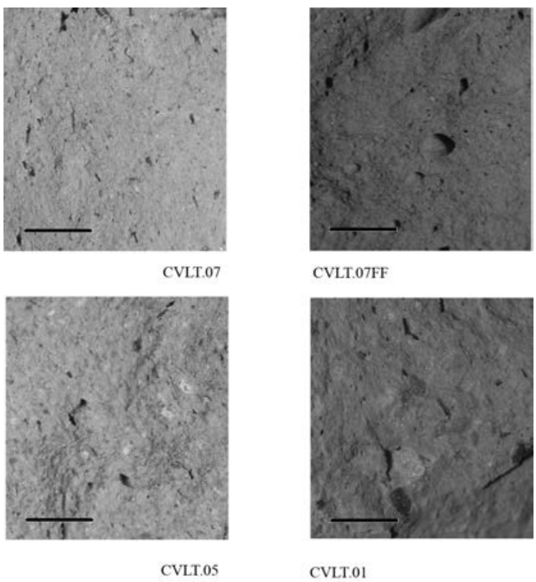

Fig. 16B: Photomicrographs of fracture surfaces of test tiles manufactured from clays from Volterra (CVLT.07, CVLT.07FF, CVLT.05, CVLT.01) (20X). Bar in lower left 100 microns long.

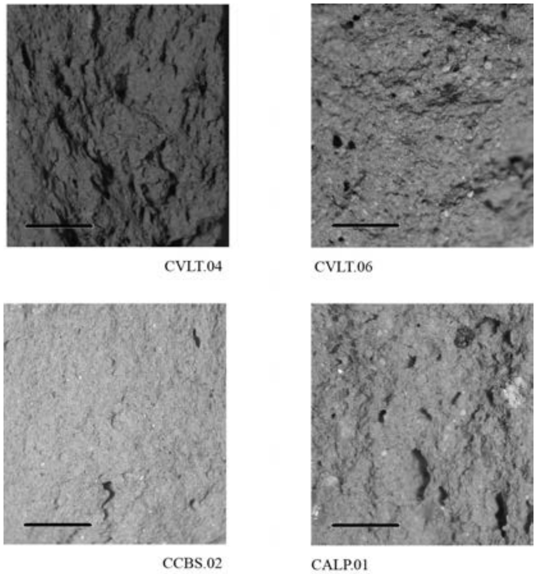

Fig. 16C: Photomicrographs of fracture surfaces of test tiles manufactured from clays from Volterra (CVLT.04, CVLT.06), Castenuovo Berardenga Scalo (CCBS.02), and Altopascio (CALP.01) (20X). Bar in lower left 100 microns long.

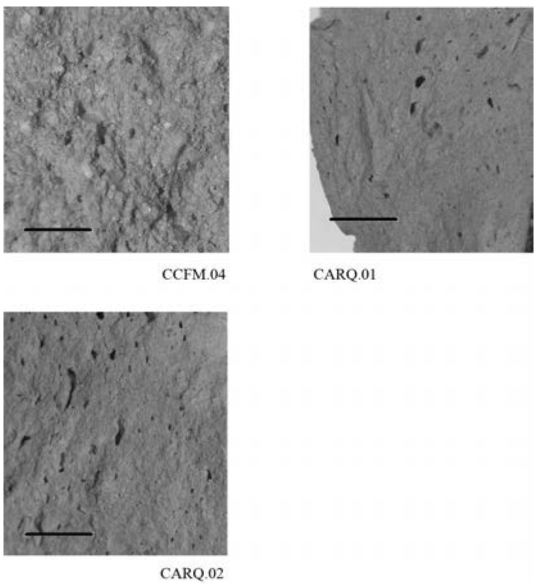

Fig. 16D: Photomicrographs of fracture surfaces of test tiles manufactured from clays from Castelfranco di Sopra – il Matassino (CCFM.04) and Arezzo – Quarata (CARQ.01, CARQ.02) (20X). Bar in lower left 100 microns long.

Black-Gloss Ware Fabric 1 (fine, moderately to highly calcareous)

Provenance: Arezzo.

Hand specimen (12 specimens):

Body: soft, occasionally hard; pink (4YR 6.8/4, 4YR 7.2/4, 4.5YR 7/4, 5YR 7/4, 5YR 7.2/4, 7.5YR 7.2/4), occasionally pink/light brown (7YR 6.5/4), or pinkish gray (5YR 7/2).

Slip: usually well preserved, occasionally poorly preserved; glossy to very glossy, occasionally matte; dark gray, very dark gray, or black, often with bluish tones, occasionally dark reddish brown varying to dark gray.

40X magnification (12 specimens):

Regular to slightly irregular, occasionally slightly conchoidal fracture surface with smooth to rough, slightly to distinctly calcareous matrix containing absent to frequent, minute, light glistening particles (mica), absent to sparse, minute to small, dark particles/plates (mica), and absent to sporadic, small voids.[186] (Fig. 15A)

Black-Gloss Ware Fabric 2 (fine, moderately calcareous)

Provenance: Area of calcareous sediment. Probably Volterra.

Hand specimen (10 specimens):

Body: soft, occasionally medium hardness to hard; pink (5YR 6.8/4, 5YR 7/4, 5YR 7.5/3, 5YR 7.5/4, 5YR 8/4, 7.5YR 6.8/3.5, 7.5YR 7/4), occasionally pinkish gray (5YR 7/2) or light reddish brown (5YR 6.5/4).

Slip: usually well preserved, occasionally poorly preserved; usually glossy to very glossy, occasionally matte or slightly glossy; dark gray, very dark gray or black, often with bluish tones, occasionally reddish brown or dusky red.

40X magnification (10 specimens):

Regular to slightly irregular fracture surface with smooth to rough, slightly to distinctly calcareous matrix containing absent to frequent, minute to small, light glistening particles/plates (mica), absent to sparse, minute to small, dark particles/plates (mica), absent to sporadic, small to medium, reddish brown to dark gray glistening bodies (fragments of mudstone and/or siltstone), and absent to sporadic, small voids. (Fig. 15A)

Black-Gloss Ware Fabric 3 (fine, low calcium to moderately calcareous)

Provenance: Area of calcareous sediment. Probably Volterra.

Hand specimen (4 specimens):

Body: soft, pink (7.5YR 7/4, 7.5/4) or pinkish gray (7.5YR 6.5/2).

Slip: usually poorly preserved; sometimes glossy; dark gray, very dark gray, or black.

186. One specimen, BGW1.05, displays sporadic, medium, subrounded, dark gray to reddish gray bodies (mudstone and/or siltstone).

40X magnification (4 specimens):
Regular to slightly irregular fracture surface with smooth to rough, non-calcareous to slightly calcareous matrix containing absent to abundant, minute to small, light glistening particles/plates (mica), absent to sparse, minute to small, dark particles/plates (mica), sporadic, small, reddish brown to dark gray, glistening bodies (fragments of mudstone and/or siltstone), and absent to sparse, small voids. (Fig. 15A)

Black Gloss Ware Fabric 4 (fine, moderately calcareous, micaceous)

Provenance: Area of calcareous sediment. Probably Volterra.
Hand specimen (2 specimens)
Body: soft; pink (5YR 7/4, 5YR 7.5/4)
Slip: well or very poorly preserved; slightly glossy to very glossy; very dark gray or black.
40X magnification (2 specimens):
Regular to slightly irregular fracture surface with smooth to rough, slightly calcareous matrix containing very abundant, minute, light, glistening particles (mica), frequent, small, dark plates (mica), sporadic, small, reddish brown to dark gray, glistening bodies (fragments of mudstone and/or siltstone), and absent to sparse, small voids. (Fig. 15A)

Black-Gloss Ware Fabric 5 (intermediate, moderately calcareous)

Provenance: Area of calcareous (probably marine) sediment. Not Arezzo. Not Chiusi – Marcianella. Probably not Volterra. Western Val di Chiana? Val d'Elsa, specifically Montaione – Belllafonte? Siena?
Hand specimen (6 specimens):
Body: hard, slightly gritty; pink (4.5YR 7.5/4, 5YR 7/3, 5YR 7/4, 6.5YR 7/4), light red (3.5YR 6/4), or light reddish brown (5YR 6/3.5).
Slip: often poorly preserved; matte, slightly glossy or glossy; dark gray, occasionally mottled reddish gray to dark reddish gray or dark brown to very dark gray.
40X magnification (6 specimens):
Slightly irregular to irregular fracture surface with rough to coarse, notably calcareous matrix (regular occurrence of distinct white areas) containing absent to sparse, small, colorless grains (quartz), absent to sparse, minute to small, dark, glistening particles/plates (mica), sporadic, small, reddish brown to dark gray, glistening bodies (fragments mudstone and/or siltstone), absent to sparse, small, white bodies and reaction rims (calcium carbonate), and absent to sparse, small to medium voids. (Fig. 15B)

Black Gloss Ware Fabric 6 (intermediate, low-calcium)

Provenance: Provenance: Area of calcareous sediment. Not Arezzo. Not Chiusi – Marcianella. Volterra? Val d'Elsa? Siena? Western Val di Chiana?

Hand specimen (1 specimen):
Body: soft; light red (2YR 6/8).
Slip: poorly preserved; glossy; mottled reddish brown/dark reddish brown.
40X magnification (1 specimen):
Irregular fracture surface with coarse, slightly calcareous matrix containing sparse, small, colorless grains (quartz), sporadic, medium, red bodies (fragments of mudstone and/or siltstone), sparse, small, round reaction rims (calcium carbonate), and sparse, small, voids. (Fig. 15B)

Black-Gloss Ware Fabric 7 (intermediate, non-calcareous, micaceous)

Provenance: Area of continental sediment probably far from area of calcareous sediment. Monti del Chianti? Upper Arno Valley?
Hand specimen (1 specimen):
Body: gritty, reddish brown (5YR 6.2/4).
Slip: poorly preserved, matte, dark brown.
40X magnification:
Irregular fracture surface with coarse matrix containing frequent, small, subangular to subround, colorless grains (quartz, perhaps some feldspar), frequent, small, rounded, reddish brown, glistening, bodies (fragments of mudstone and perhaps also siltstone), and frequent, minute to small, light, glistening particles/plates (mica). (Fig. 15B)

Black-Gloss Ware Fabric 8 (gritty, non-calcareous)

Provenance: Area of continental sediment probably far from area of calcareous sediment. Monti del Chianti? Upper Arno Valley?
Hand specimen (4 specimens):
Body: slightly gritty to gritty; pink (4YR 7.5/4) or reddish yellow (4.5YR 6/6, 5YR 7/6).
Slip: poorly preserved; matte; gray, dark gray, or dark reddish gray.
40X magnification:
Irregular to highly irregular fracture surface with coarse matrix containing frequent to abundant, small to medium, subangular to subround, colorless and milky grains (quartz, some probably polycrystalline, probably some feldspar), absent to sporadic, medium, reddish brown and dark plates (mica), absent to sporadic, medium to very large, reddish, glistening bodies (fragments of mudstone and/or siltstone), and absent to sparse, small to medium voids. (Fig. 15B)

North Etrurian Red-Slip Ware Fabric 1 (fine, highly calcareous)

Provenance: Area of calcareous sediment. Not Arezzo. Probably Volterra.
<u>Hand specimen (1 specimen):</u>
Body: soft, light reddish brown (5YR 6/3.5).
Slip: poorly preserved; red.
<u>40X magnification (1 specimen):</u>
Regular fracture surface with smooth, distinctly calcareous matrix. (Fig. 15C)

North Etrurian Red-Slip Ware Fabric 2 (fine, moderately calcareous)

Provenance: Area of calcareous sediment. Not Arezzo. Not Volterra? Volterra?
<u>Hand specimen (1 specimen):</u>
Body: soft, reddish yellow (4YR 6.8/7.5).
Slip: slightly glossy to matte; red.
<u>40X magnification (1 specimen):</u>
Regular fracture surface with smooth, distinctly calcareous matrix containing sporadic, small, reddish brown, glistening bodies (fragments of mudstone and/or siltstone). (Fig. 15C)

North Etrurian Red-Slip Ware Fabric 3 (fine, non-calcareous to low calcium)

Provenance: Area of calcareous sediment. Not Chiusi – Marcianella. Upper Val d'Elsa?
<u>Hand specimen (5 specimens):</u>
Body: soft, pink (4YR 7/4, 4YR 7.6/4, 6.5YR 6.5/4) or reddish yellow (3.5YR 6.5/6, 4YR 7/6).
Slip: poorly preserved; slightly glossy, red (2.5YR 5/6, 3YR 4.5/6, 4YR 7/6).
<u>40X magnification (5 specimens):</u>
Regular to slightly irregular fracture surface with smooth to rough, non-calcareous matrix containing absent to sporadic, small, colorless grains (quartz), absent to sporadic, small, dark plates (mica), absent to abundant, minute to small, light, glistening particles/plates (mica), absent to sporadic, small, dark gray to reddish brown, glistening bodies (fragments of mudstone and/or siltstone), and sporadic to sparse, small voids. (Fig. 15C)

North Etrurian Red-Slip Ware Fabric 4 (intermediate, non-calcareous)

Provenance: Area with access to continental clay. Upper Val d'Elsa? Monti del Chianti? Upper Arno Valley?

Hand specimen (3 specimens):
Body: soft; pink (5YR 8/4) or reddish yellow (4YR 6/7, 4YR 7/6).
Slip: poorly preserved; red (2.5YR 5/7, 3YR 5/6).
40 X magnification (3 specimens):
Slightly irregular fracture surface with rough to coarse, non-calcareous matrix containing abundant, minute to small, subangular to subrounded, colorless grains (quartz), abundant, minute to small, light, glistening particles/plates (mica), absent to sporadic, small to medium, reddish bodies (fragments of mudstone and/or siltstone), absent to sparse, small white bodies (calcareous?). (Fig. 15C)

North Etrurian Red-Slip Ware Fabric 5 (porphyritic, non-calcareous)

Provenance: Area of continental sediment containing fragments of granite. Coast of northern Etruria opposite Elba?
Hand specimen (1 specimen):
Body: soft; light red (2.5YR 5.8/6).
Slip: poorly preserved; red (3YR 5/6).
40 X magnification (1 specimen):
Irregular fracture surface with rough, non-calcareous matrix containing abundant minute to small, subangular to subrounded, colorless grains (quartz), sparse, minute to small, light, glistening particles/plates (mica), sparse, medium to large, subangular, colorless grains (quartz, some polycrystalline), sporadic, small to medium, subrounded, reddish bodies (fragments of mudstone and/or siltstone), sporadic, small to large subrounded, reddish brown, glistening bodies (igneous rock?), sporadic, medium to large, subrounded, white bodies (calcareous?), and sparse, medium voids. (Fig. 15D)

North Etrurian Red-Slip Ware Fabric 6 (gritty, non-calcareous)

Provenance: Area with access to continental clay. Upper Val d'Elsa? Monti del Chianti? Upper Arno Valley?
Hand specimen (1 specimen):
Body: soft; pink (4.5YR 7/3.5).
Slip: poorly preserved; reddish.
40 X magnification (1 specimen):
Irregular fracture surface with discontinuous matrix containing very abundant, minute to small, subangular to subrounded, colorless grains (quartz), sparse, minute to small, light, glistening particles/plates (mica), sparse, small, dark, glistening plates (mica), sporadic, small to medium, subrounded, reddish bodies (fragments of mudstone and/or siltstone), and sparse, small, rounded voids. (Fig. 15D)

North Etrurian Red-Slip Ware Fabric 7 (gritty, low calcium)

Provenance: Provenance: Area of calcareous sediment. Not Arezzo. Volterra? Val d'Elsa? Siena? Western Val di Chiana?
Hand specimen (1 specimen):
Body: soft; pink (4.5YR 7/3.5).
Slip: poorly preserved; red (2.5YR 5/8).
40 X magnification (1 specimen):
Irregular fracture surface with discontinuous matrix containing abundant, minute to small, subangular to subrounded, colorless grains (quartz), sparse, minute to small, light, glistening particles/plates (mica), sporadic, small to medium, subrounded, reddish bodies (fragments of mudstone and/or siltstone), sparse, small, rounded white bodies (calcareous?), and sparse, small, rounded voids. (Fig. 15D)

North Etrurian Red-Slip Ware Fabric 8 (gritty, low calcium)

Provenance: Area of calcareous (probably marine) sediment. Volterra? Western Val di Chiana? Val d'Elsa? Siena?
Provenance:
Hand specimen (1 specimen):
Body: soft; pink (4.5YR 7/3.5).
Slip: poorly preserved, red (2.5YR 4.5/7).
40X magnification (1 specimen):
Irregular fracture surface with coarse, slightly calcareous matrix containing abundant, small, white bodies and reaction rims (calcium carbonate), sparse, small, subangular, colorless grains (quartz), and sparse, small voids. (Fig. 15E)

Italian Terra Sigillata Fabric 1 (fine, moderately calcareous)

Provenance: Arezzo.
Two variants determined by degree of firing:

Variant 1 (regularly fired):
Hand specimen (7 specimens):
Body: hard, light red (lighter than 10R 6/6, 1.5YR 6/7, 2YR 6/6), pink (4YR 7.5/4, 5YR 6.8/4), pink/light reddish brown (4.5YR 7.5/4), or reddish yellow (4.5YR 6.5/6).
Slip: well preserved; glossy, red (10R 4.5/8, 10R 4.8/8, 1YR 4/8, 1YR 4.5/8, 2.5YR 4.5/8, 2.5YR 4.8/6, 2.5YR 5.2/8).
40X magnification (7 specimens):
Smooth to slightly irregular fracture surface with slightly to distinctly calcareous matrix containing absent to sporadic, small, rounded, white bodies and reaction rims, absent to sparse, minute to small, light, glistening plates (mica), and absent to sparse, small, voids. (Fig. 15E)

Variant 2 (highly fired):
Hand specimen (6 specimens):
Body: hard, light reddish brown (2YR 6/4), reddish brown (2YR 5/4), light red (1.5YR 7/6, 2.5YR 6/6, 2.5YR 6.2/6), or reddish yellow (4YR 6/6).
Slip: well preserved; glossy, red (10R 4.5/6, 2YR 4.5/6, 2.5YR 5/6) or reddish brown/red (2YR 4/5).
40X magnification (6 specimens):
Smooth, compact, often conchoidal fracture surface with smooth, distinctly calcareous matrix containing sparse, small, rounded white bodies and reaction rims (calcium carbonate) and sporadic to sparse, small, rounded voids.

Italian Terra Sigillata Fabric 2 (fine, moderately calcareous)

Provenance: Arezzo.
Two variants determined by degree of firing:

Variant 1 (regularly fired):
Hand specimen (6 specimens):
Body: hard, pink (4YR 7/4, 4YR 7.5/4, 4.5YR 6.8/4, 4.5YR 7.5/4, 5YR 7/4).
Slip: well preserved; glossy, red (10R 4.2/6, 10R 4.4/6, 1YR 4.5/8, 2.5YR 4/7, 2.5YR 4.2/6, 2.5YR 4.5/6).
40X magnification (6 specimens):
Smooth to slightly irregular fracture surface with calcareous matrix containing absent to sporadic, small, rounded, white bodies and reaction rims, absent to sparse, minute to small, light, glistening plates (mica), and absent to sparse, small, voids.

Variant 2 (highly fired):
Hand specimen (2 specimens):
Body: hard, pale red (10R 5.8/4) or light red (2YR 6/6).
Slip: well preserved; glossy, red (10R 4.5/6, 10R 4.5/8).
40X magnification (2 specimens):
Smooth, compact, sometimes conchoidal fracture surface with smooth, distinctly calcareous matrix containing sparse, small, rounded, white bodies and reaction rims (calcium carbonate) and sparse, small, rounded voids. (Fig. 15E)

Italian Terra Sigillata Fabric 3 (fine, moderately calcareous)

Provenance:
Hand specimen (1 specimen):
Body: hard, light red (2YR 6/6).
Slip: well preserved; glossy, red (1.5YR 4.5/7).

40X magnification:
Smooth, compact, conchoidal fracture surface with smooth, distinctly calcareous matrix containing frequent small, rounded, white bodies and reaction rims and sparse, small, rounded voids. (Fig. 15E)

Cetamura Clay (porphyritic, non-calcareous)

Hand specimen (1 specimen):
Body: reddish yellow (4YR 6/6).
40X magnification (1 specimen):
Irregular fracture surface with smooth matrix containing abundant, small to large, angular to well rounded, often platy, light brown to reddish brown bodies (siltstone or argillite) and sparse, small to large, angular to rounded, light gray to dark gray bodies (sandstone or limestone), and abundant, medium, voids. (Fig. 16A)

Radda – Castiglioni Clay (gritty, calcareous)

Hand specimen (1 specimen):
Body: light reddish brown (4YR 6.2/3.5).
40X magnification (1 specimen):
Irregular fracture surface with gritty matrix containing sparse, medium to large, rounded to well rounded, dull, porous, dark gray to reddish gray bodies (mudstone), sporadic, medium to large, light gray bodies (limestone?), and sparse, medium, voids. (Fig. 16A)

Colle Val D'Elsa – Belvedere Clay (coarse, non-calcareous)

Hand specimen (1 specimen):
Body: light red (2.5YR 5.8/8).
40X magnification (1 specimen):
Very irregular fracture surface with discontinuous matrix containing very abundant, small to medium, subangular to rounded, colorless grains (quartz), sporadic, small to large, subrounded to rounded, reddish brown and black bodies (fragments of mudstone and/or siltstone), and sporadic, medium voids. (Fig. 16A)

Volterra Clay 1 (fine, calcareous)

Hand specimen (1 specimen): (CVLT.02)
Body: pink (4.5YR 7.5/4).
40X magnification (1 specimen):

Slightly irregular fracture surface with smooth, calcareous matrix containing sparse, small to medium, subrounded to rounded, reddish brown, glistening bodies (mudstone and/or siltstone), sparse, small to medium, voids, some lined with white (calcareous) material. (Fig. 16A)

Volterra Clay 2 (fine/intermediate, calcareous)

Hand specimen (1 specimen): (CVLT.07)
Body: light reddish brown (4YR 6.5/4).
40X magnification (1 specimen):
Slightly irregular fracture surface with smooth matrix containing very abundant small, rounded colorless and milky grains (quartz), sparse, small to medium, subrounded to rounded, reddish brown, glistening, bodies (mudstone and/or siltstone), and frequent, small to medium, voids (Fig. 16B)

Volterra Clay 3 (intermediate, calcareous)

Hand specimen (1 specimen): (CVLT.05)
Body: pink (5.5YR 7/4).
40X magnification (1 specimen):
Irregular to highly irregular fracture surface with discontinuous matrix containing very abundant, small to medium, subrounded to rounded colorless grains (quartz), sparse, small, subrounded to rounded, reddish brown glistening bodies (mudstone), sparse, medium, angular to rounded white bodies (calcareous), sporadic, small, medium gray bodies (serpentine?), and sparse, medium, voids. (Fig. 16B)

Volterra Clay 4 (intermediate, calcareous)

Hand specimen (1 specimen): (CVLT.01)
Body: reddish yellow (4.5YR 7/5).
40X magnification (1 specimen):
Irregular fracture surface with smooth matrix containing abundant, small to medium, subrounded, colorless grains (quartz), abundant small to medium, subrounded, reddish brown glistening bodies (fragments of mudstone and/or siltstone), frequent, small, rounded medium to dark gray bodies (serpentine?), and sparse, small, white bodies (calcareous). (Fig. 16B)

Volterra Clay 5 (coarse, calcareous)

Hand specimen (2 specimens): (CVLT.03, CVLT.04)
Body: pinkish white (7YR 8/2), pink (4.5YR 7/4).

40X magnification (2 specimens):
Body: highly irregular fracture surface with discontinuous matrix containing sparse, small to medium, subrounded reddish brown bodies (fragments of mudstone and/or siltstone), absent to sparse, small to medium, subrounded white bodies (calcium carbonate), and sparse to frequent, medium, voids. (Fig. 16C)

Volterra Clay 6 (coarse, calcareous)

Hand specimen (1 specimen): (CVLT.06)
Body: light red/reddish yellow (3.5YR 6.5/6).
40X magnification (1 specimen):
Body: highly irregular fracture surface with discontinuous matrix containing sparse, small to medium, subrounded reddish brown bodies (fragments of mudstone and/or siltstone), and absent to sporadic, small to medium, rounded, white bodies (calcareous), and sparse to frequent, medium, voids. (Fig. 16C)

Castelnuovo Berardenga Scalo Clay (fine/intermediate, calcareous)

Hand specimen (3 specimens):
Body: pink/light reddish brown (4YR 6-6.5/4), reddish yellow (4YR 6.2/6).
40X magnification (3 specimens):
Slightly irregular granular fracture surface with discontinuous matrix containing very abundant minute to small, rounded, colorless grains (quartz; at lower end of visible range), sparse to abundant, minute to medium, light, glistening particles/plates (mica), sporadic, small to medium, subrounded to rounded, reddish brown, glistening bodies (fragments of mudstone and/or siltstone), and sparse, small to medium, voids, some line with white (calcium carbonate) material. (Fig. 16C)

Altopascio Clay (coarse, non-calcareous)

Hand specimen (1 specimen):
Body: pink (lighter than 7.5YR 8/4).
40X magnification (1 specimen):
Very irregular fracture surface with gritty matrix containing abundant, small to large, subangular to rounded, colorless grains (quartz; some polycrystalline), sporadic, small to large, subrounded to rounded, reddish brown and black bodies (mudstone and/or siltstone), sporadic, medium to large, subrounded, light gray bodies (calcareous?), and sporadic, medium, rounded voids. (Fig. 16C)

Castelfranco di Sopra – Il Matassino Clay (coarse, non-calcareous)

Hand specimen (6 specimens):
Body: light red/red (2-2.5YR 5.5-6/8), reddish yellow (4-4.5YR 5.5-6.7/6-8).
40X magnification (6 specimens):
Very irregular fracture surface with gritty to discontinuous matrix containing abundant to very abundant, small to large, angular to rounded, colorless and milky grains (quartz), and sporadic to sparse, small to medium, round voids. (Fig. 16D)

Arezzo – Quarata Clay (fine, calcareous)

Hand specimen (2 specimens):
Body: light red (2.5YR 6-7/7-8).
40X magnification (2 specimens):
Regular to slightly conchoidal fracture surface with smooth, weakly calcareous matrix containing sparse, small voids. (Fig. 16D)

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POTTERY AND ANIMAL CONSUMPTION

NEW EVIDENCE FROM THE 'EXCAVATING THE ROMAN PEASANT PROJECT'

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Introduction

Roman archaeology in Italy has generally paid little attention to the lifestyle, material culture, architecture and economic connections of rural communities both in coastal and inland regions, with most contributions being relegated to topographical evidence from systematic field surveys. Many hundreds of Roman peasant houses and farmsteads have been discovered and mapped in various regions of Italy, but they have rarely been excavated and never as the focus of a dedicated project.[1] As we know from the historical

1. This paper is not the occasion to list the many archaeological field surveys carried out in Italy. Nevertheless it is worth mentioning some of those which were particularly innovative both in terms of methodological and historical issues such as the South Etruria Survey (Potter 1979), the Albegna Valley Project (Carandini and Cambi 2002), the Tiber Valley Project (Patterson 2004 and Patterson *et al.* 2004) and the Carta Archeologica della Provincia di Siena (see for example, Valenti 1995, Cambi 1996 and Campana 2001) which in different ways influenced the development and improvement of landscape archaeology. While the study of Roman and late antique rural non-elites was not the central focus of study in any of these studies, each nonetheless provided an important contribution towards mapping and understanding the distribution of peasant sites, and in assessing their changing density over the long period, as well as in detailing relationships between villa sites and villages. In some cases, an attempt was

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research, peasant communities accounted for over 80% of the all population in the early and mid Roman periods,[2] with a possible increase up to some 90% in the early Middle Ages.[3] Thus it is quite clear that in missing the peasants we miss the vast majority of the Roman population.

Despite this, most of the Roman archaeology in Italy has concentrated on the study of that 1% or so of the Roman population represented by the wealthy elites. Indeed, large-scale excavation projects have mostly focused on public and private monuments and rich domestic buildings in the towns or on the luxury villa sites in the countryside.[4]

The ongoing 'Excavating the Roman Peasant Project' began as an international collaboration in 2009 between the Universities of Pennsylvania, Cambridge, and Siena[5] and is designed to shed light on the rural Roman population of an inland area of southern Tuscany through the excavation

made to test small and medium-sized peasant sites through excavation. A few examples are worth mentioning. The most pioneering attempt to dig a Roman small farmhouse is that at Monte Forco in the *Ager Capenas* in southern Etruria, where an 11 x 5m one-storey building with two doorways was investigated after its identification in the South Etruria Project. This small site, founded in the late 1st century BC and occupied with some transformations until the 2nd century AD, was one of five or six similar sites on the Monte Forco ridge (Jones 1963 and Rathbone 2008). A much bigger farmstead (20 x 24 m), dating to the 2nd to late 1st century BC, was excavated in 1981-1982 at Giardino Vecchio near Cosa, after its identification during the Albegna valley project (Carandini and Cambi 2002, pp. 142-143). Another interesting case study is the excavation in 1992 of two small domestic buildings in the locality of San Quirico e Pace (Castelnuovo Berardenga) on the occasion of the systematic field walking survey in the Chianti Senese, as part of the Carta Archeologica della Provincia di Siena Project. One 10 x7m habitation was stone-built, had a tiled roof and was dated between the mid 1st century BC and the beginning of the 1st century AD, whereas the other one (4.8 x 3.4m) was completely constructed in perishable materials, had a tiled roof and was dated to the 6th and 7th century AD. The latter has been considered as a kind of exemplar of the sparse small houses typical of the late antique settlement pattern in the Chianti Senese (Valenti 1995, pp. 360-364). During the mid 1990s systematic field survey in the Cecina valley, one late Republican to late Roman small building was excavated, as it represented the typical settlement typology of that area. It was a 20 x 10m habitation divided in two main rooms with stone footings, pisè walls and a tiled roof. A post-hole extension was constructed in the late Roman period and its occupation continued until the 6th century AD (see Motta 1997).

2. For this possible figure see Scheidel 2006.
3. Wickham 2009, p. 36.
4. Some interesting exceptions exist. For instance, it is worth noting the '100 Farms Project' in the Lucca Plain, in northern Tuscany, which focused on the excavation of a sample of Roman farmsteads, many of which seem to differ from those excavated in the Roman Peasant Project in terms of size, morphology, and duration of occupation (see Ciampoltrini 2004, Ciampoltrini and Zecchini 2005, and Ewell and Taylor 2010).
5. The project is co-directed by Kim Bowes, Mariaelena Ghisleni, Cam Grey and Emanuele Vaccaro.

of a wide variety of small and medium-sized sites recently discovered during an intensive and systematic field survey carried out between 2006 and 2008. Applying a holistic approach that includes architectural studies, pottery, archaeobotany, zooarchaeology, and geoarchaeology, we aim to explore the peasant microcosm and understand how it relates to the broader regional and extra-regional context.[6]

The choice of the territory of Cinigiano as the region of investigation is due to several reasons, including (i) its environmental variety, which includes both medium to high hills and plains, and (ii) the high level of preservation of the landscape as a consequence of the low impact of intensive agricultural practice (such as large scale wine and olive oil productions), and its rich archaeological potential (Fig. 1). The systematic field survey undertaken between 2006 and 2008 discovered over 300 Roman and late antique surface scatters, including sites and off-sites, mainly identifiable as houses and small farmsteads. The presence of only one certain villa site[7] in a landscape dominated by a widespread distribution of small houses, farms and some villages, and the distance of these sites from Roman towns made the territory of Cinigiano a quintessential peasant landscape and an ideal context to enhance our understanding of the Roman peasantry.

Peasants have been long associated with concepts of unchanging permanence, both in terms of economic strategy and topography. Immutability, low-level of economic complexity, and self-subsistence were also thought to characterize the Roman peasants.[8] Nevertheless recent reanalysis of textual sources and increasing archaeological data are revealing a somewhat different and more positive scenario in which the Roman peasants benefited from improved agricultural techniques (later typical of modern times) combined with intensive mixed farming (based on the widespread distribution of small farms) and animal husbandry, which ensured a significant access to meat consumption and a better diet than the 19th century peasants of central-southern Italy and England.[9] A more accurate analysis of the small archaeological evidence available for the Roman rural non-elites also reveals that peasants should not be considered as an immobile and undifferentiated mass but as a very differentiated group characterised by social mobility and awareness of economic strategies.[10] Aligned

6. On the 'Excavating the Roman Peasant Project', its research questions and methodologies, see Ghisleni *et al.* 2011.
7. Ghisleni 2009.
8. Chayanov 1966, Brunt 1971, and Blanton 1994.
9. Kron 2008.
10. Rathbone 2008.

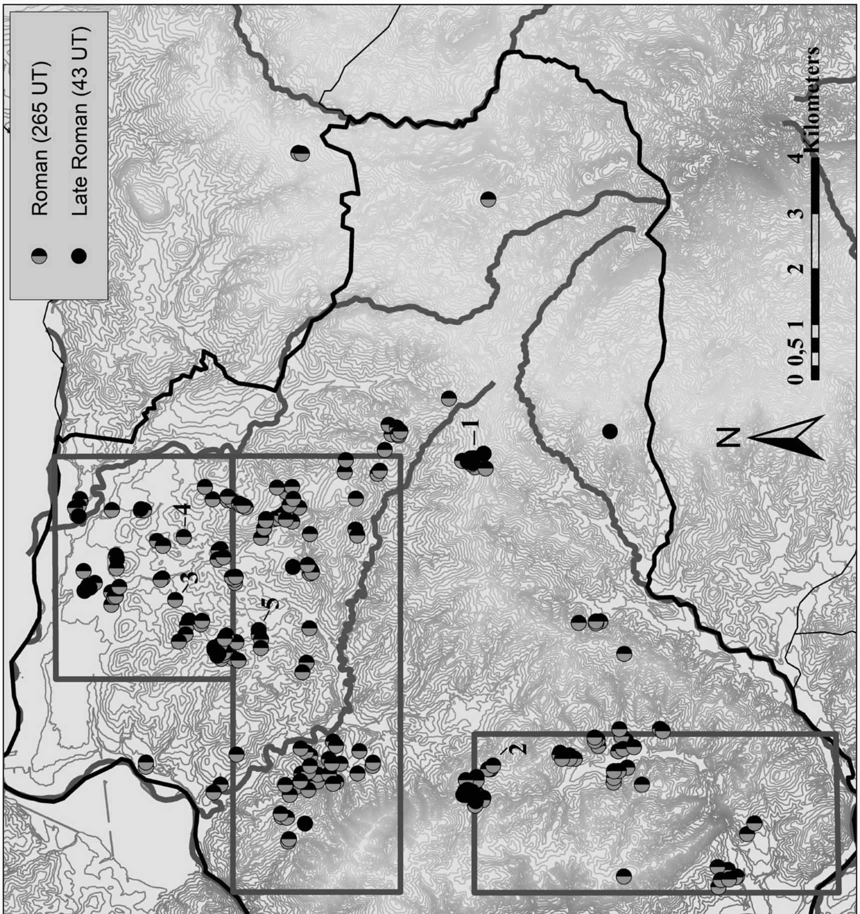

FIG. 1. The study area in southern Tuscany and sites excavated as part of the 'Excavating the Roman Peasant Project'. 1. Pievina; 2. Case Nuove; 3. San Martino; 4. Poggio dell'Amore; 5. Podere Terrato.

with these new interpretations of the Roman peasants lifestyle, the fresh data gathered by the 'Excavating the Roman Peasant Project' offer a more optimistic and complex picture of the Roman rural non-elites, which would be hardly achieved with the exclusive use of written sources.

This paper draws mainly on the potential of pottery to shed light on the way material culture reflects socio-cultural behaviours and economic connections, exploring if and how these changed over time in the context of rural inland communities. Another aspect examined is how the integration of the ceramic and zooarchaeological records can illuminate us about the transformation of peasant's diet over the long period 100 BC –500 AD. Both sources of data—pots and bones—are inextricably linked as economic and dietary markers, as astutely detailed inPaul Arthur's 2007 influential paper, in which he sketched a broad division between areas of central and northern Europe and areas of southern Europe which in the late Roman period apparently tended to further develop different culinary traditions based on pig-raising in the colder climates and sheep/goat raising in warmer climates which reflected a differentiation of the kitchenware repertoires (cooking pots in the North and casseroles or open vessels in the South, respectively better suitable to boil and braise or roast).[11] A central goal of this article is to test if this model applies or not to the evidence from the Roman Peasant Project.

New evidence on the Roman rural non-elites

So far, six sites have been excavated. Though the sample of excavated sites is still tiny, it already sheds light on the variety of peasant settlements, which in turn reflect socio-economic as well as functional differences (Table 1).

The first site, excavated in 2009, is that at Pievina, located in the hilly eastern part of the sample area, close to the Amiata Mountain. The site revealed two major periods of occupation: a possible large farmstead associated with a cistern, a granary, and a tile kiln and dated between the late 2nd/1st BC and the 1st century AD; then between the late 4th and late 5th century AD a new domestic occupation in the shape of a small house with a series of work-surfaces and systemisations. The site of Pievina was almost entirely excavated as regards the late Roman occupation, whereas only a portion of the late Republican to early imperial farmstead was unearthed. It was composed of seven large surface scatters disposed in a circle of some 2 ha, with a large empty space in

11. Arthur 2007.

the middle. Pottery dating to the 1st century BC-1st century AD was identified on each surface scatter whilst the late Roman ceramics were collected only on two scatters. In order to achieve a diachronic understanding of the site, it was planned to excavate only two (930 m^2 as a whole) of the seven clusters accounting for some 4,450 m^2.[12] For these reasons, the ceramic and animal bone assemblages available at Pievina are particularly rich for the late Roman occupation whereas they are smaller for the first period of occupation relating to the late Republican to early imperial farmstead.

Table 1. Sites excavated in the period 2009-2011 as part of the 'Excavating the Roman Peasant Project'.

Site	Year of excavation	Excavated area	Chronology	Function and actual size on the ground
Pievina	2009	c. 930 m^2	1st BC-1st AD; late 4th-5th AD	Late Republican and early imperial large farmstead (actual size unknown); late Roman small house with drains and working surfaces (c. 4.6 x 12.7m).
San Martino	2010	c. 270 m^2	Late 2nd BC to early 1st AD	Small house, possibly occupied on a seasonal basis (c. 6.5 x 7.3m).
Case Nuove	2010	c. 1000 m^2	1st BC to mid/late Augustan-Tiberian; late 2nd to mid 3rd AD; late 4th to mid 5th AD	Late Republican to early imperial olive oil and wine press with later uses possibly still relating to the processing of agricultural produce.
Poggio dell'Amore	2011	c. 210 m^2	Julio-Claudian period	Small house, possibly occupied on a seasonal basis (c. 4.6 x 2.9m).
Podere Terrato	2011	c. 640 m^2	Julio-Claudian period	Small/medium farm, possibly occupied on a permanent basis.One central room measuring 6.5 x 5.7m with an attached porch (5 x 5m) to the west and two small courtyards for keeping animals or storing products to the south, both open on one side. The overall surface of the built-up area is c. 90 m^2. One contemporary drain, aligned with the main building, was partly excavated some 45m to the east.
Colle Massari	2011	c. 300 m^2	Generic late Republican to early imperial	Field drain excavated for 13m.

12. A detailed report on the excavation at Pievina is in Ghisleni *et al.* 2011.

Two other sites were excavated in 2010. At Case Nuove, we dug a complex of structures which served as an agricultural facility for wine and olive oil processing in the late Republican to Augustan period and as a possible installation for winnowing between the late 4th and the mid 5th century AD.[13] After the end of each phase of use, the site was intermittently utilized as a garbage dump, which produced a large amount of findings, particularly useful for the purposes of this paper. At San Martino, a possible seasonal site characterised by stone-footings, pisè walls and a possible straw tile, located in a piece of landscape dominated by grazing, as reconstructed through pollen evidence, and functional to animal husbandry, whose occupation took place between the late 2nd century BC and the very beginning of 1st century AD, was unearthed. In this case the excavation produced a limited amount of pottery, whereas the zooarchaeological evidence is virtually non-existent. Such data, together with the small size of the building and its very humble architecture may point to a small house, likely to be only occupied sporadically and functional to animal husbandry. Comparatively, we could think of something like a cottage or one of those many small seasonal buildings that densely populated the Tuscan landscape until the 1950s and were used by commuting peasants and shepherds living in larger villages.

Finally in 2011 three more small rural sites were excavated. One, an early Roman drain/field system at Colle Massari, will not be discussed here. The remaining two were interpreted as domestic buildings, specifically a small house and a small/medium-sized farmstead, respectively located at Poggio dell'Amore and Podere Terrato, and both dating to the Julio-Claudian period.

The excavation at Poggio dell'Amore revealed a rectangular building measuring c.4.6x 2.9m, dating to the Julio-Claudian period but largely destroyed by modern ploughings. Despite its very poor preservation, some hypotheses can be made regarding the function of the site, particularly in comparison with San Martino, with which it shares a landscape and its small size. Although smaller than San Martino, the structure at Poggio dell'Amore probably had a tiled roof. Like San Martino, the tiny quantities of ceramic and faunal materials make it difficult to propose continued domestic occupation, and again suggest periodic or seasonal use. However, the material culture of Poggio dell'Amore was somewhat richer with 11 glass fragments, mostly of vessels, and a more varied pottery repertoire.

13. Vaccaro *et al.* 2013.

Again in 2011 we uncovered a small/medium-sized farmstead at Podere Terrato, situated in a rich archaeological landscape with the possible Roman and late antique village of Tombarelle 700m to the west, and a number of other smaller sites in the vicinity, including Poggio dell'Amore and San Martino. Unfortunately, as at Poggio dell'Amore, the shallow archaeological deposits at San Martino, coupled with the considerable extent of erosion, meant poor preservation in an area subject to frequent mechanic ploughings. Nonetheless, the plan and chronology of the site are clear. The structural remains reveal a single room, possibly residential, surrounded by open sheds/porches, which indicate the need for storage space. The presence of finewares and cooking pots, though in small quantities, indicates cooking and eating took place here, although we cannot be sure where, whereas the tiny quantities of faunal material refer to equids, possibly used as pack animals and would suggest that meat was not a main component of the local diet. A yard was identified to the southeast and interpreted as a simple work space.

Architectural analyses reveal the variety of typologies of domestic buildings, which themselves in size and complexity of the plan. The integrated study of architectural features and both pottery and faunal assemblages suggests a preliminary distinction between permanent sites like Pievina and Podere Terrato, and possible seasonal or periodic sites like San Martino and Poggio dell'Amore. One intriguing explanation for the latter sites would be that they represent seasonal shelters used in periods of more intensive field activity, both related to agriculture and animal husbandry, by commuting peasants who lived in villages or larger farmsteads, a model proposed by Peter Garnsey.[14] In the specific case of the landscape where the sites of Poggio dell'Amore and San Martino are situated, it is worth mentioning that systematic field surveys identified, the presence of three contemporary villages,[15] which may have hosted the habitations of commuting peasants. All of these sites were less than one km to two km apart.

Late Republican period (late 2nd to 1st century BC)

Late Republican occupation has been detected at three sites: Pievina, Case Nuove, and San Martino. A comparison of selected ceramic assemblages from Pievina and Case Nuove and the very few ceramic finds from the seasonal site of San Martino allow us to make some general observations.

14. Garnsey 1979.
15. Ghisleni 2010.

TABLE 2. Ceramics from the main late Republican contexts at Pievina and Case Nuove.

Ceramics	**Pievina dump (context 2003): second half of the 1st century BC**	**Case Nuove midden (contexts 5028, 5030, 5057): 1st century BC**
Cooking pots (KW)	7	8
Cooking jugs (KW)	1	2
Cooking bowls (KW)	0	1
Tegami/cooking dishes (KW)	1	1
Tegami/cooking dishes (VRI)	1	2
Lids (KW)	5	4
Table jugs/bottles (TableW)	3	2
Generic table pots (TableW)	0	1
Flasks (TableW)	1	0
Bowls (TableW)	1	5
Italic sigillata	2	1
Black Glaze ware	3	7
Thin-Walls	3	3
Amphorae	2*	4**
Storage or table amphorae	0	1
Large generic table/storage vessels	0	1
Mortaria	0	2
Total MNI	30	45

Key to the table: (KW) = kitchenware; (VRI) = *vernice rossa interna* ware; (TableW) = tableware; * = one regional Dressel 1 and one Campanian Dressel 1; ** = one regional Dressel 1, one Campanian Dressel 1, one small regional type, one Van der Werff 2.

If we compare a rubbish dump from Pievina, dated to the second half of the 1st century BC, and a sample of contexts from another midden at Case Nuove, resulting from a continuing discard activity over the 1st century BC and possibly completed late in that century,[16] we see some functional parallels (TABLE 2). As regards kitchen wares, the best-documented form is the cooking pot, attested at both sites in significant proportions and best suited to boiling meat and preparing soups. Looking at other functional vessels it

16. The presence of Italic sigillata in association with late Black Glaze Ware (itself characterised by low-quality slip), in both assemblages, suggests a deposition in the second half of the 1st century BC. The late Republican dump at Pievina (context 2003) yielded the Black Glaze ware forms Morel 2654 (two MNI) and one unidentifiable ring foot associated with the Italic sigillata forms Conspectus 1 (one MNI) and Conspectus K12 *similis* (one MNI). At the late Republican midden at Case Nuove (contexts 5028, 5030, 5057), the quantity of Black Glaze ware (seven MNI, including Morel 1174 (one MNI), Morel 2273 (one MNI), Morel 2272 (one MNI), Morel 2615 (one MNI), Morel 2783-2784 (one MNI) and two more unidentifiable vessels) was overwhelming compared with Italic sigillata (one MNI: a very worn fragment of Conspectus 3).

is evident that boiling was preferred to roasting and frying. Kitchen jugs are documented both at Pievina and Case Nuove, though in higher percentages at the former. Again these vessels are particularly suitable to heating soups. Open kitchen vessels play a more limited part in cooking at both settlements. They are represented by large cooking dishes or *tegami* manufactured both in kitchenware and in *vernice rossa interna*, a regional class with an internal red coat similar to Pompeian Red ware.[17] These vessels were better suited to roasting and braising food through water evaporation rather than water retention as in the case of cooking pots. A preference for cooking pots is also demonstrated by the little pottery evidence from the seasonal site of San Martino where kitchen ware is exclusively represented by some cooking pots associated with even rarer lids.

Also of interest is the quantitative relationship among finewares and kitchenwares as it may have some implications on eating habits and cultural behaviours. Case Nuove and Pievina yielded larger ceramic assemblages more suitable for a reliable quantitative analysis; the total amount of finewares (Black Glaze ware and Italic sigillata) is respectively 17.8 and 16.7%. These figures are quite lower than the large quantities of finewares in the Julio-Claudian contexts of Case Nuove and the other rural sites of Poggio dell'Amore and Podere Terrato (*infra*).

The trade connections emerging from the study of pottery are overwhelmingly regional. The pottery includes not only kitchenwares and coarsewares in more levigated fabrics but also Black Glaze ware, all manufactured regionally if not sub-regionally. The overall contribution of extra-regional and overseas sources together is only 4% across all the late Republican contexts at Pievina and Case Nuove. Two Campanian Dressel 1 amphorae (characterised by the significant presence of volcanic glass), one specimen from each site, are documented alongside a Tunisian Van der Werff 2 wine (?) amphora[18] from Case Nuove. No extra-regional pottery has been found at the seasonal site of San Martino. The marginal role of extra-regional and overseas commodities in supplying the two peasant sites is unsurprising given the vibrancy of the late Republican Tuscan economy, including wine production widely exported in Dressel 1 amphorae (Fig. 2).[19]

17. On the production of *vernice rossa interna* ware in southern Tuscany see Aguarod Otal 1991, pp. 51-59.
18. Fentress 2001.
19. Panella 2001.

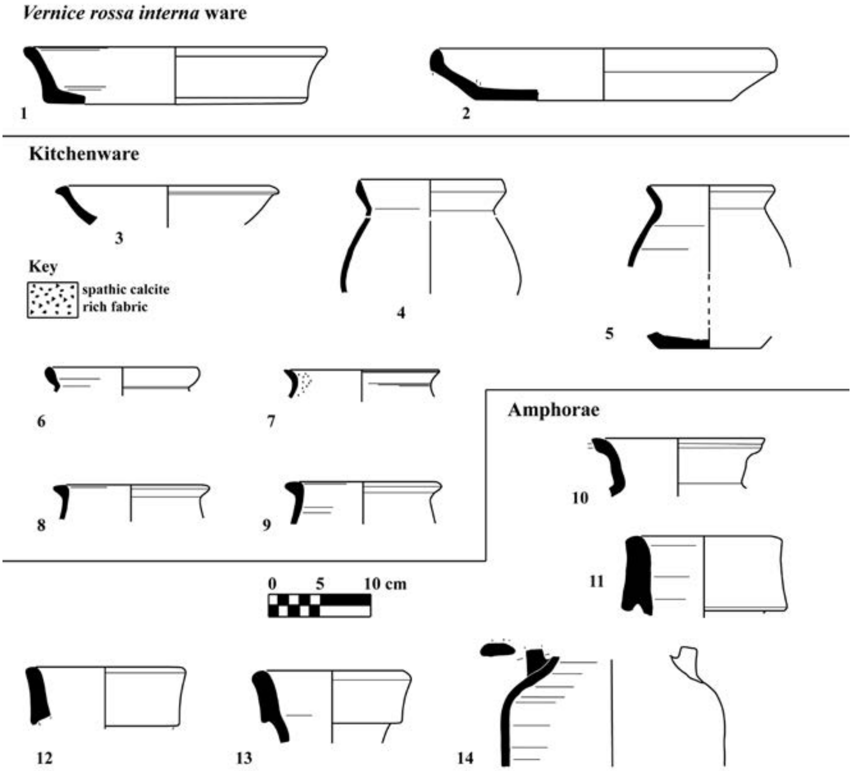

FIG. 2. Selected pottery from the late Republican (mostly 1st century BC) contexts at Pievina, Case Nuove and San Martino. *Vernice rossa interna* ware: 1-2. *Tegami*/ cooking-dishes. Kitchenware: 3. Cooking-dish; 4-9. Cooking-pots. Amphorae: 10. Van der Werff 2 amphora; 11. Campanian Dressel 1B amphora; 12-13. Regional Dressel 1B amphorae; 14. Regional Dressel 1 amphora.

Comparing the 1st century BC zooarchaeological assemblages from the two sites of Pievina and Case Nuove reveals interesting trends (TABLE 3). Case Nuove, in the 1st BC, shows the presence of all the three chief domestic mammals (cattle, ovicaprids, and pigs). While the sample is quite small, cattle account for 50% of these chief domesticates by NISP count, with pigs totalling 29% and sheep/goat 21%, even if all these mammals are attested by the same MNI count. At Pievina, still in the 1st century BC, the three chief domestic mammals are all documented together, although there is some preponderance of pigs (61% pig, 27% sheep/goat, 13% cattle, by NISP counts). Although the relative frequencies of each of the domesticates may vary between the two sites, overall the faunal records for both conform best with a mixed husbandry and dietary scheme, something that may be similar to typical, small-to-medium-scale practices in animal management and use for late Republican central Italy as a whole. This correlation extends as well in the close similarity of the ceramic repertoires between these sites during this time, especially as regards the varieties of kitchen vessels and in the generally low presence of finewares. A preference for boiled meat is confirmed by the high percentage of cooking pots versus open kitchen vessels. The pattern of butchery on the bones, with marked evidence for spiral fracturing (typical for marrow extraction) and chopping apart of the carcass into pot-sized fragments helps corroborate such a culinary practice. Examples of charred bones, moreover, as might result from roasting or grilling meat cuts over an open flame, are practically absent from the faunal samples across both sites.

TABLE 3. NISP values for faunal materials at sites considered in this paper.

Site	**Date (centuries)**	**NISP total (cattle+s/g+pig)**	**% cattle**	**% sheep/goat**	**% pig**	**NISP of other principal mammalian and avian taxa present**
Case Nuove	1st century BC	14	50.0	21.4	28.6	1 red deer, 1 roe deer, 14 domestic fowl
Case Nuove - 'basin'	1st century BC-1st century AD	73	-	34.2	65.8	35 domestic fowl, 3 song thrush, 3 galliform-style birds
Case Nuove	Late 2nd-mid 3rd century AD and 4th century AD	24	-	37.5	62.5	213+ dog (MNI=4), 69+ hare, 1 red deer, 1 roe deer, 1 domestic fowl
Case Nuove	Late 4th-mid 5th century AD	174	18.3	45.9	35.3	13 red deer, 8 dog, 20 domestic fowl
Pievina	1st century BC	23	13.0	26.9	60.9	1 dog, 1 red deer, 1 hare, 1 domestic fowl
Pievina	Late 4th-late 5th century AD	269	22.3	42.8	34.9	4 equid, 6 wild boar, 2 red deer, 1 roe deer, 2 badger, 2 domestic fowl, 5 tortoise
San Martino	Late 2nd century BC-very early 1st century AD	2	50.0	-	50.0	
Poggio dell'Amore	Julio-Claudian period	4	-	100.0	-	
Podere Terrato	Julio-Claudian period	-	-	-	-	3 equid (tooth fragments), various fragments of geological, fossilized marine shells

Julio-Claudian period

Pottery and faunal evidence for the Julio-Claudian period and specifically the mid/late Augustan to Tiberian age are mostly provided by the rubbish dump that dates the abandonment of the 'basin' at Case Nuove and, to a lesser extent, by the two small domestic sites at Poggio dell'Amore and Podere Terrato, although in the latter two cases faunal remains were noticeably scarce, perhaps a factor of separate disposal of ceramic and animal bone waste materials.[20] At Pievina, contexts dating from the Augustan period through to the 1st century AD were identified but only partially excavated as they were flooded by the rising water table. At San Martino this phase is almost non-existent due to the site's early abandonment.

A closer analysis of the pottery assemblage of Case Nuove emerging from the rich rubbish dump may reveal a marked variation in the mid/late Augustan to Tiberian period compared to the late Republic. The ratio of fine wares to other ceramic classes appears particularly significant: in late Republican contexts at Pievina and Case Nuove, the combined values of Black Glaze ware and Italic sigillata range from 16.6% to 17.7%, whereas the mid to late Augustan dump at Case Nuove produced up to 28% of Italic sigillata and another 2% of the highest quality slipped Thin-Walls (Table 4).[21]

From this point of view, the site at Case Nuove is not unique. Significantly high percentages of Italic sigillata are also documented at Poggio dell'Amore and Podere Terrato (some 42 and 33.8%, respectively), attesting to the widespread circulation of this class of pottery, which became largely available to any type of peasant site. Nevertheless, there are some other elements that stand for the higher sophistication of the ceramic repertoire at Case Nuove than at the other two peasant sites. At Case Nuove the range of tablewares and kitchen vessels is much broader than among other sites.

20. At Poggio dell'Amore, the Julio-Claudian date only relies on the small ceramic assemblages yielded by the excavation, whereas at Podere Terrato the same date is supported both by ceramics and five coins (one dupondius and one quadrans of the Augustan period, one ass of Drusus the Younger (AD 22-23), one dupondius of Caligula (AD 37-41) and one ass of Claudius (AD 41)).
21. Type Atlante II, Tav. XCIII, n.7, also documented in the town of Cosa in the Augustan period, see Atlante II, 292.

TABLE 4. Ceramics from the main Julio-Claudian assemblages at Case Nuove, Poggio dell'Amore and Podere Terrato.

Ceramics	**Case Nuove, mid/ late Augustan to Tiberian 'basin' dump (context 5014)**	**Poggio dell'Amore, various Julio-Claudian contexts (6001, 6002, 6004, 6005, 6011)**	**Podere Terrato, various Julio-Claudian contexts (8001, 8002, 8003, 8004, 8007, 8021, 8022, 8026)**
Cooking pots (KW)	7	2	3
Cooking jugs (KW)	0	0	2
Casseroles (KW)	2	2	1
Cooking bowls	0	1	0
Tegami/cooking dishes (KW)	1	0	1
Tegami/cooking dishes (VRI)	0	0	3
Lids (KW)	3	1	1
Clibani/baking pans	0	0	1
Table jugs/bottles (TableW)	3	3	17
Flasks (TableW)	1	0	0
Large bowls/dishes (TableW)	2	0	1
Bowls (TableW)	3	0	1
Unguentaria (TableW)	1	0	0
Lids (TableW)	3	0	0
Table/Storage jars (TableW)	0	1	2
Lamps	2	0	0
Italic sigillata	14*	9***	21*****
Bowl (high quality Thin-Walls)	1	0	0
Table pots/beakers (Thin-Walls)	2	0	2
Generic table pots (TableW)	0	0	1
Amphorae	4**	2****	5******
Amphora stopper	1	0	0
Total MNI	50	21	62

Key to the table: * Italic sigillata from Case Nuove: forms Conspectus 18 (one MNI), Conspectus 32 (one MNI), Conspectus 13 (one MNI), Conspectus 36 (one MNI), Conspectus 26 (two MNI), Conspectus 20 (four MNI), Conspectus 3 (one MNI), Conspectus R2 (one MNI), Conspectus 33 (one MNI), one unidentifiable form. ** Amphorae from Case Nuove: regional wine-amphora type, Pisan area (?) (one MNI), wine-amphora Oberaden 74/Dressel 28 type from *Hispania Tarraconensis* (one MNI), Bertucchi 6 wine-amphora type, from the area of Marseille (?) (two MNI). *** Italic sigillata from Poggio dell'Amore: forms Conspectus 3 (three MNI), Conspectus 26.2 (one MNI), Conspectus 14 (one MNI), Conspectus 34 (three MNI), one unidentifiable form. **** Amphorae from Poggio dell'Amore: regional Dressel 2/4 (one MNI). ***** Italic sigillata from Podere Terrato: forms Conspectus 34 (two MNI), Conspectus 26 (two MNI), Conspectus 11 (one MNI), Conspectus 32 (one MNI), Conspectus 20 (two MNI), Conspectus 3 (two MNI), Conspectus 22 (one MNI), Conspectus 21.3 (one MNI), Conspectus 20.4 (one MNI), Conspectus 27 (one MNI), Conspectus 14.2 (one MNI), Conspectus 20.4 (one MNI), Conspectus 4.3/4 (one MNI), Conspectus 3.1/2 (one MNI), Conspectus 18 (one MNI), two unidentifiable forms. ****** Amphorae from Podere Terrato: Campanian Dressel 2/4 (one MNI), regional (?) amphorae (three MNI), Betic fish-sauce type (one MNI).

The high number of Italic sigillata at a small and poorly preserved site like Poggio dell'Amore is very telling, as it clashes with the suggestion that most of the smallest peasant sites could not be detected in surface survey due to their ephemeral architecture and limited access to well-identifiable ceramics, such as fineware and amphorae.[22] Poggio dell'Amore with its 20 x 20m surface scatter, corresponding to a tiny building (4.6 x 2.9m) was clearly visible in the ploughsoil with a discrete association of Roman tiles, coarseware and occasional fineware; its excavation yielded a significant amount of Italic sigillata and one amphora despite the fact that its occupation was possibly sporadic.

It is worth noting that in Augustan to Tiberian period Case Nuove, the ratio of open to closed vessels (i.e. cooking pots to casseroles and cooking dishes) is more balanced than in earlier contexts from this site, although cooking pots still predominate. On the contrary, at Poggio dell'Amore and Podere Terrato the overall figure of cooking pots is smaller than open forms, such as casseroles, cooking bowls and *tegami*/cooking dishes. Speculatively, this may indicate some slight differences in culinary habits during Augustan/Tiberian times than during the 1st century BC in general, with a possible increase of roasting and baking to the detriment of boiling food.

Another element marking higher status at Case Nuove is their capability of accessing a series of imported amphorae that are otherwise quite rare in central Italy, apart from big trading hubs like Ostia and large consumption sites like Rome. Case Nuove yielded wine-amphora types such as a Tarraconese Oberaden 74/Dressel 28[23] and two southern Gaulish Bertucchi 6,[24] alongside one regional amphora, probably from northern Tuscany. By contrast, the other small peasant sites yielded only occasional Mediterranean or extra-regional imports, such as a Betic fish-sauce amphora and a Campanian Dressel 2/4 from Podere Terrato, with the remaining few examples deriving exclusively from regional, if not local, workshops (Fig. 3).

The zooarchaeological finds further support the somewhat high economic profile of the people at Case Nuove in the Augustan to Tiberian period (Table 3). The animal bones from the 'basin' consist, almost entirely, of ovicaprids, pigs, and domestic fowl. Pigs account for nearly twice as many ovicaprids, on the basis of NISP figures (48 NISP versus 25 NISP), but each taxon is attested with 3 MNI. Domestic fowl are quite plentiful, at 35

22. Rathbone 2008.
23. López Mullor and Martín Menéndez 2008, pp. 709-710.
24. Bertucchi 1992, p. 113, Fig.54, n.1 and p. 115, Fig.55.

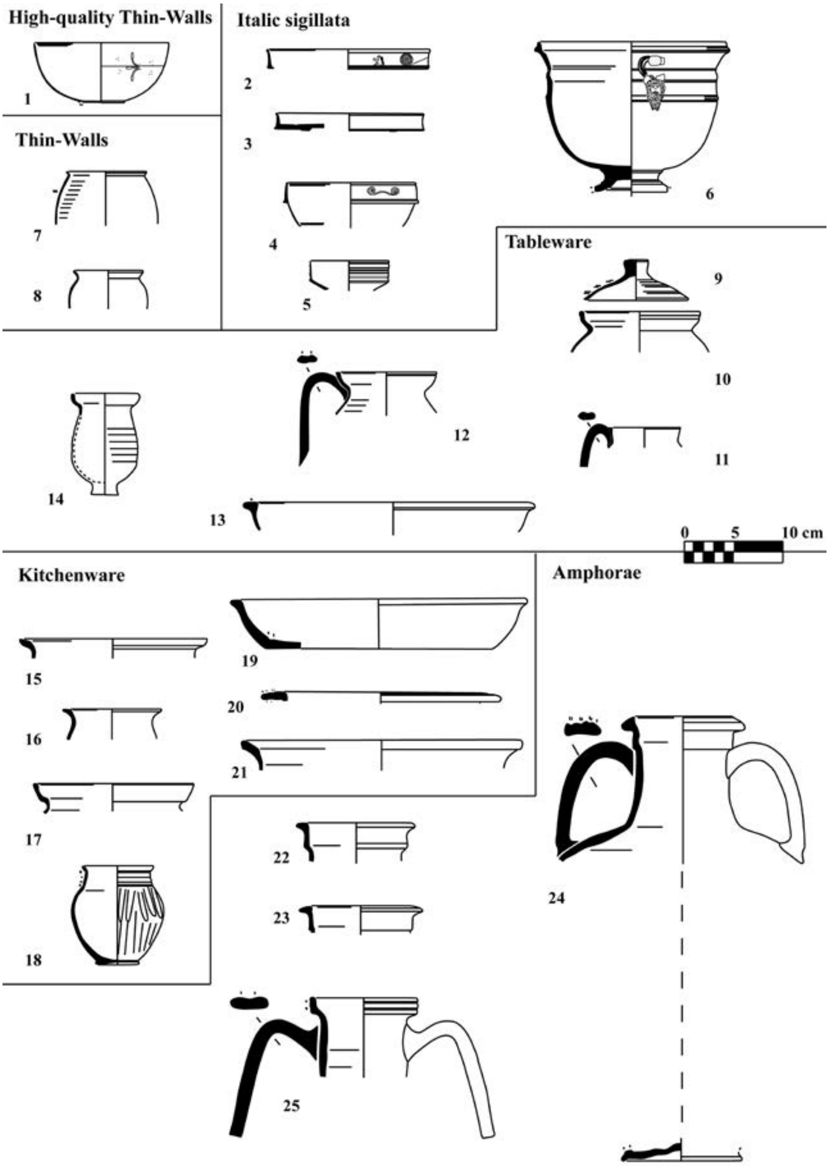

Fig. 3. Selected pottery from the mid/late Augustan to Tiberian dump at Case Nuove. High-quality Thin-Walls: 1. Type Atlante II, Tav. XCIII, n.7. Italic sigillata: 2-3. Conspectus 20; 4. Conspectus 33; 5. Conspectus 26; 6. Conspectus R2. Thin-Walls: 7-8. Beakers/small table pots. Tableware: 9. Lid; 10-12. Table jugs. 13. Large bowl/basin; 14. Table pot. Kitchenware: 15-18. Various-sized cooking pots; 19. Cooking dish; 20-21. Casseroles. Amphorae: 22-23. Bertucchi 6 type; 24. Oberaden 74/Dressel 28; 25. Regional wine type.

NISP and 5 MNI. Younger animals, across all three taxa (pigs, ovicaprids, and domestic fowl), are well represented. About 30% of the ovicaprids are under 1 year of age; 100% are under 2 years of age. As regards pigs, the majority of individuals are less than 1 year old. The marked abundance of younger animals in the 'basin' deposit at Case Nuove, including young domestic fowl, is significant, and clashes with the 1st century BC contexts at Pievina and at Case Nuove itself. Although Pievina records a similar number of identified specimens of pigs and sheep/goat compared with Case Nuove, far older ovicaprids and pigs comprise the Pievina sample. Moreover, at Pievina, domestic fowl are insignificant, whereas at Case Nuove they form a large portion of the bones retrieved from the 'basin' context. Available evidence, therefore, suggests a somewhat wealthier or privileged diet at Case Nuove, one where younger animals, particularly choice domestic meat animals, such as lamb, piglets, and younger domestic fowl, as well as a larger proportion of better-quality primary meat cuts from these animals formed a crucial component of the diet. At the same time, the increase of open kitchen vessels would correlate positively with an increase of other cooking practices like roasting and frying, although boiling continued to be preferred.

The Augustan to Tiberian change of meat consumption and ceramic assemblages at Case Nuove requires some further analysis, especially because it takes place over a short duration, perhaps even a few years. Such a change can be explained by contextualizing the peasant site in its landscape. The site of Case Nuove is only 500m as the crow flies from the Roman to late antique villa at Santa Marta, the only one identified by systematic field surveys in this inland area. Gridded collection at the villa site revealed that the establishment of a villa on an earlier less important settlement is likely to have taken place between the late 1st century BC and 1st century AD.[25] Economic and structural transformations at the villa site may have influenced the consumption of meat and pottery at nearby sites as well, as the case of Case Nuove seems to demonstrate. The development of a central place in this area may have led to the consumption of better-quality meat, and from younger animals at that, as well as in the availability of more variegated and sophisticated ceramic repertoires, from both regional and overseas sources, better able to meet the local elite's demand for high quality ceramic products. The peasant communities living close to the villa site and interacting with it may have taken advantage of the changed economic situation.

25. Ghisleni 2009.

Mid Roman period

Moving on to the mid Roman period, the field survey evidence shows it to be the least well-documented in this inland area. Only four sites continued to be occupied in the 2nd and 3rd centuries AD.[26] A settlement decrease, generally interpreted as an effect of the decline of the Italic economy, has frequently been detected in the most intensively surveyed parts of Italy.[27] The adjacent coastal areas, the object of systematic field surveys since 2000, also revealed a demographic decline, although the decrease is less marked than in the interior. The overall number of occupied sites declined from 217 to 78. The difference between the two areas is quite marked and requires further explanation. The identification of surface sites in the coastal areas of southern Tuscany is mostly based on the identification of well-known classes of imported fine wares and overseas amphorae, both particularly well attested given the volume of sea trade along Tyrrhenian routes and the presence of a series of sea-ports serving as redistribution points for imports. By contrast, only a few inland sites seem to have accessed these bulk goods in the mid Roman period. The far poorer identification of 2nd to 3rd century AD sites in the interior compared to the coast is probably due to the rarefaction and weakening of economic links between coastal and inland areas.[28]

Before the beginning of the 'Excavating the Roman Peasant Project', virtually nothing was known about the local and regional coarse wares of the mid Roman period. The excavation at Case Nuove was particularly fruitful because it began to shed light on the complexity of pottery trade and consumption during this period. It is worth noting that the peasant site of Case Nuove yielded no mid Roman fragments during the field survey whereas 2nd to 3rd century AD ARS and amphorae sherds were occasionally discovered at the nearby villa site. A large circular cistern, part of the agricultural production site at Case Nuove, was used after the abandonment of the early Roman installation, as we know from a very coherent and enlightening mid-Roman pottery deposit yielded by the abandonment and collapse layers. Though small and hitherto isolated, this late 2nd to mid 3rd century AD deposit is enormously important as it allows us to shed some light on the

26. Vaccaro 2008 and Vaccaro 2011, pp. 16-20.
27. In the *Ager Cosanus*, to mention one of many examples, of 109 villas occupied in the previous phase only 92 survived in the 2nd and 3rd centuries AD; farms and houses decreased from 195 in the late Republican and early Imperial periods to 92 sites; the number of villages also declined with only 66% surviving. See Celuzza 2002, pp. 196-209.
28. On the relationship between patterns of fineware and amphora supply and site recovery, see Millett 1991.

ceramic repertoire of mid Roman peasants and the somewhat unexpected variety of their trade connections (TABLE 5).

TABLE 5. Ceramics from the late 2nd-mid 3rd AD cistern dump at Case Nuove:

Ceramics	**Case Nuove, mid Roman cistern dump (contexts 5048 and 5058)**
Cooking pots (KW)	2
Casseroles (KW)	1
Tegami/cooking dishes (VRI)	1
Lids (KW)	2
Table jugs (CCW)	3
Large bowls/dishes (CCW)	2
Bowls (CCW)	1
Basins (CCW)	1
Lids (CCW)	1
Large storage basins (TableW)	1
Lamps	1
African Red Slip ware	1*
Sigillata chiara tarda dell'Italia centro settentrionale (regional fineware)	1
Amphorae	5**
Dolia	4
Total MNI	27

* African Red Slip: form Hayes 14B; ** Amphorae: Betic Dressel 20 (one MNI); Gauloise 4 (one MNI); Käpitan 2 (one MNI); generic Betic fish-sauce type (one MNI); local or sub-regional wine type (one MNI). KW=kitchenware; VRI=*vernice rossa interna* ware; CCW=colour-coated ware; TableW=tableware.

Overseas amphorae, though very fragmentary, are relatively abundant (14.8%) in this assemblage. They come from a variety of sources with three different production regions: Betica (Dressel 20 and a fish-sauce type), Gallia (a Gauloise 4) and Asia Minor (a Käpitan 2). Betic and Gallic products are abundant at coastal sites in Italy but rarely documented in the inland sites in this area according to the surface survey datasets. By contrast, mid Roman imports from Asia Minor, though documented at the sea-port at the mouth of the Ombrone river, have thus far never been identified in this inland area.[29] The presence of a partly recomposed, possibly local or sub-regional wine amphora indicates a continuing capacity to produce agricultural surpluses for inland sites.

29. Vaccaro 2010.

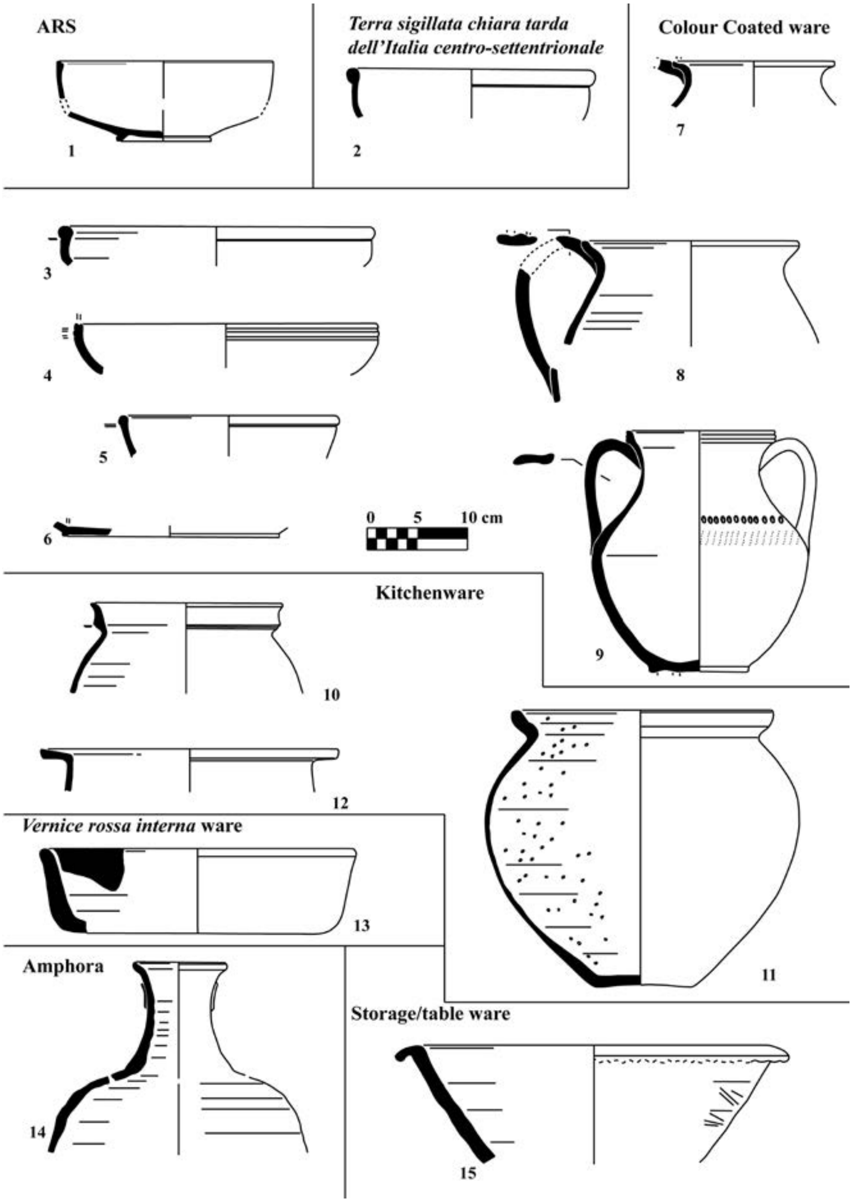

FIG. 4. Selected pottery from the mid-Roman dump at Case Nuove (late 2nd to mid 3rd century AD). African Red Slip ware (ARS): 1. Hayes 14B. *Terra sigillata chiara tarda dell'Italia centro-settentrionale:* 2. Large bowl. Colour-coated ware: 3-5. Bowls; 6. Flat-based dish; 7-9. Jugs. Kitchenware: 10-11. Cooking pots; 12. Casserole. *Vernice rossa interna* ware: 13. Tegame/cooking or baking pan. Amphora: 14. Local or sub-regional type. Storage/table ware: 15. Large storage basin.

Also of interest from this assemblage is the ratio of kitchen wares to fine, colour coated and table wares in the mid-Roman cistern dump at Case Nuove. The latter are almost twice as common as the former with a fairly wide variety of forms (dishes, basins, bowls and jugs) indicating the complexity of food consumption. Only one bowl is a Tunisian import, whereas the remaining tablewares were made at regional workshops. The quality of the slips is fairly variable, although only in the case of one bowl, which we attributed to the *sigillata chiara tarda dell'Italia centro-settentrionale* class, the macroscopic analysis revealed a higher quality brighter and thicker slip compatible with fineware products, whose manufacture entailed firing at higher temperatures (over 1000°) able to determine the slip sintering (Fig. 4).[30]

Zooarchaeology for mid-Roman contexts at Case Nuove reveals a similar situation to that observed in the Augustan period (Table 3). Although the faunal sample for edible taxa is smaller here (and excludes a large component of dog and hare remains, from animals that may have fallen into this structure), it consisted of bone of domestic fowl, ovicaprids, and pigs, all of younger ages. Even in this case, the evidence would support quite an elite diet, although such a sample is too small to confirm this point in a conclusive manner. Interestingly, there is a perfect balance between cooking pots and open kitchen vessels, attesting for the coexistence of different but complementary cooking practices.

In contrast to the demographic decline and weakening of trade connections emerging from the field survey in the mid-Roman period, the rubbish dump at Case Nuove is indicative of a peasant site that, possibly favoured by its proximity to the villa, continued to engage a complex range of overseas and regional connections and enjoyed a more elite diet than what we might expect in a peasant site.

Late Roman period

Thanks to the evidence from the farmstead at Pievina and a pottery-rich rubbish pit at Case Nuove, the late Roman period is well documented. According to the field survey in the interior, the 4th and 5th centuries AD witness slight demographic growth and intensification of trade links with coastal areas.[31] This is confirmed by the excavated sites, although if we look closely at the ceramic contexts from Pievina between the late 4th and the end of the 5th centuries AD,

30. Cuomo di Caprio 2007, pp. 314-317.
31. Ghisleni 2010.

and Case Nuove between the late 4th and mid 5th centuries AD we see regional manufacturing for the vast majority of all wares (Table 6).

Table 6. Comparison of pottery from the late Roman dumps at Pievina (context 1006, second half of the 5th century AD) and Case Nuove (late 4th to mid 5th century AD).

Ceramics	**Pievina late Roman dump (context 1006): second half of the 5th century AD**	**Case Nuove late Roman 'pit' dump: late 4th to mid 5th century AD**
Cooking pots (KW)	6	18***
Casseroles (KW)	1	1
Cooking bowls (KW)	1	0
Lids (KW)	3	5
Tegami/bread-baking pans (KW)	1	2
Tegami/cooking dishes (KW)	0	1
Amphorae	3*	1****
Flask (non-slipped tableware)	0	1
Small table pot (colour-coated ware)	0	1
Jugs (colour-coated and non-slipped table wares)	7	4
Jugs (*Sigillata chiara tarda dell'Italia centro-settentrionale*)	0	1
Table/storage jar (colour-coated and non-slipped table wares)	0	2
Various-sized bowls and dishes (colour-coated and non-slipped table wares)	21	15
Various-sized bowls and dishes (*Sigillata chiara tarda dell'Italia centro-settentrionale*)	0	10
Basins (colour-coated and non-slipped table wares)	14	5
Flanged bowls (non-slipped table-ware)	1	0
Sauce-bowls (colour-coated ware)	0	2
Table lids	1	0
ARS	6**	3*****
Lamp	1	0
Dolia	1	0
Total MNI	67	72

* Amphorae from Pievina: Almagro 51A/B (one MNI), Alamgro 51 C (one MNI), local or sub-regional type (one MNI). ** ARS from Pievina: Hayes 50B (one MNI); Hayes 61A/B4 (one MNI); Hayes 67C (three MNI); Hayes 57 (one MNI, residual). *** Cooking pots from Case Nuove: spathic calcite fabric (10 MNI), non-spathic calcite fabrics (eight MNI). ****Amphorae from Case Nuove: Empoli type (one MNI). ***** ARS from Case Nuove: Hayes 50B (one MNI); Hayes 64 (one MNI); Hayes 71B (one MNI).

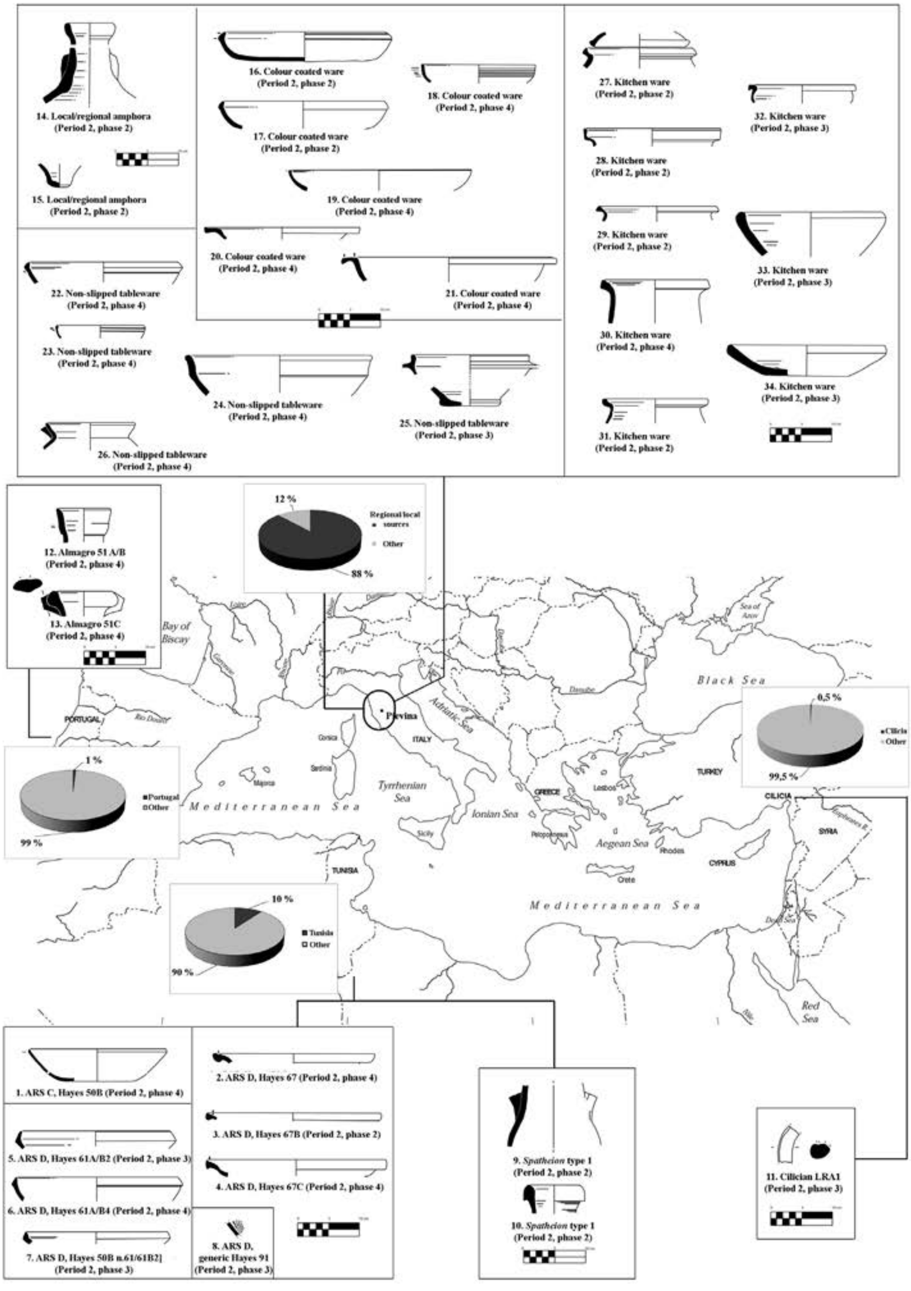

FIG. 5. Pottery and sources at late Roman Pievina. Chronologies: Period 2, phase 2 = late 4th to first half of the 5th century AD; Period 2, phase 3 = mid(?) 5th century AD; Period 2, phase 4 = second half of the 5th century AD.

At Pievina, 11.5% of imported pottery is documented across all the late Roman contexts analysed (1026, 1019, 1018, 1006; whereas it is 10.2% in context 1006), with ARS, occasional Tunisian kitchen wares, Tunisian amphorae Keay 25/26 and 26, Portuguese Almagro 51 A/B and C, and LR1 represented (Fig. 5). All the amphorae types documented are also attested in the town of Roselle, near the coast; more important is the high percentage of Portuguese amphorae in contemporary urban contexts.[32] This, alongside the presence at Roselle of all the ARS forms also documented at Pievina, may suggest that the town was a redistribution point for small inland farmsteads. Amphora finds at Pievina included a hitherto-unknown local or sub-regional amphora. At late Roman Case Nuove, overseas amphorae are only documented by isolated sherds belonging to a Tunisian and a Portuguese specimen, while one identifiable individual is a regional Empoli type.

It is interesting to note the presence of a Cilician LR1 amphora at Pievina and of a regional Empoli type at Case Nuove. Both types circulated intensively along central Tyrrhenian routes, as demonstrated by studies of the underwater ceramic assemblages at *Portus Scabris*, a sea-port located on the northern edge of the coastal area considered in our comparison. At *Portus Scabris*, the Empoli type is the best-documented amphora, and LR1, though in much smaller percentages, is also well represented in the overall late Roman amphora record.[33] Despite this, both types are rarely redistributed to nearby coastal sites; the Empoli type was largely targeted to Rome in order to contribute to its wine supply. The occasional presence of these two types at the inland peasant sites of Pievina and Case Nuove appears particularly significant as it tells us that even those varieties of amphorae that were typically the object of a low-intensity overland circulation in coastal areas were occasionally redistributed further inland towards our peasant sites

Some of the amphorae excavated at late Roman Pievina were tested with organic residue analysis.[34] The small sample includes two fragments (neck and bottom) of a local/sub-regional amphora type, one wall/bottom of a Tunisian spatheion Keay 26 and one bottom/spike of a more generic Tunisian Keay 25 or 26. The results of such analysis are particularly telling. The spatheion Keay 26 yielded wine markers, such as tartaric acid and malic, malonic, benzoic, and succinic acids as well as traces of resin, and similarly in the other Tunisian amphora some of the same residues were detected (malonic, ben-

32. Vaccaro 2014.
33. Vaccaro 2014 and Vaccaro 2011, pp. 116-151.
34. Residue analysis was carried out in 2010 in collaboration with A. Pecci and M.A. Cau Ontiveros (Universitat de Barcelona).

zoic, succinic, glutaric and vanillic acids) attesting for wine as the content with traces of a pitch coating.[35] The neck of the local or sub-regional amphora type did not yield any useful residue, possibly because it was not in contact with the content, whereas the base attributable to the same type showed compounds present in wine, such as malonic, benzoic, vanillic, succinic, and cinnamic acids. It all attests for the important caloric contribution of wine reaching Pievina from both overseas and local/sub-regional sources.

Returning to our close analysis of the late Roman pottery record we note that the overall quantity of ARS at Case Nuove is just over 4%, while at Pievina ARS accounts for over 8% across all the late Roman processed contexts (1026, 1019, 1018, 1006). The lower proportion of overseas fineware at Case Nuove is counterbalanced by the far higher quality of the regional tablewares used and dumped here. At both sites we found a very varied repertoire of regional table vessels with a broad range of functional types. While at Pievina table wares are represented by colour-coated wares with general low-quality slip, which often makes it impossible to distinguish examples from non-slipped productions, this is never the case at Case Nuove. Here, not only does the colour-coated ware have a better quality slip, but the site is also well supplied with *Sigillata chiara tarda dell'Italia centro-settentrionale* (about 15% of the total), with a lustrous semi-sintered or sintered slip, occasionally overpainted.[36] Interestingly this class is completely absent at Pievina.

The presence of high-quality regional Red Slip at Case Nuove and not at Pievina is remarkable given that in the coastal area this class has hitherto been identified only in towns, as well as in two major late Roman villa sites (Casette di Mota and Aiali) and one well-connected settlement on the sea (Scoglietto cave) (Fig. 6).[37] To explain this, we must bring into play the proximity of Case Nuove to the only villa site in the area. As in the Augustan period, the presence of the villa site, used at least up to the 6th century AD, is likely to have encouraged the establishment of a more sophisticated demand for high quality regional pottery, which consequently also became more easily accessible to peasants using the site of Case Nuove. Thus, the somewhat more sophisticated collection of regional tablewares at Case Nuove compared to Pievina should be seen in light of its proximity to this villa site.

35. On the debate concerning late Roman Tunisian amphorae and their contents see in particular Bonifay 2004 and Bonifay and Garnier 2007.
36. A survey of the production and circulation of regional Red Slip and colour-coated wares between the mid Roman period and late antiquity in Tuscany and an attempt to distinguish between higher and lower quality products on the basis of the slips are in Menchelli and Pasquinucci 2012.
37. Vaccaro 2011, pp. 72-112.

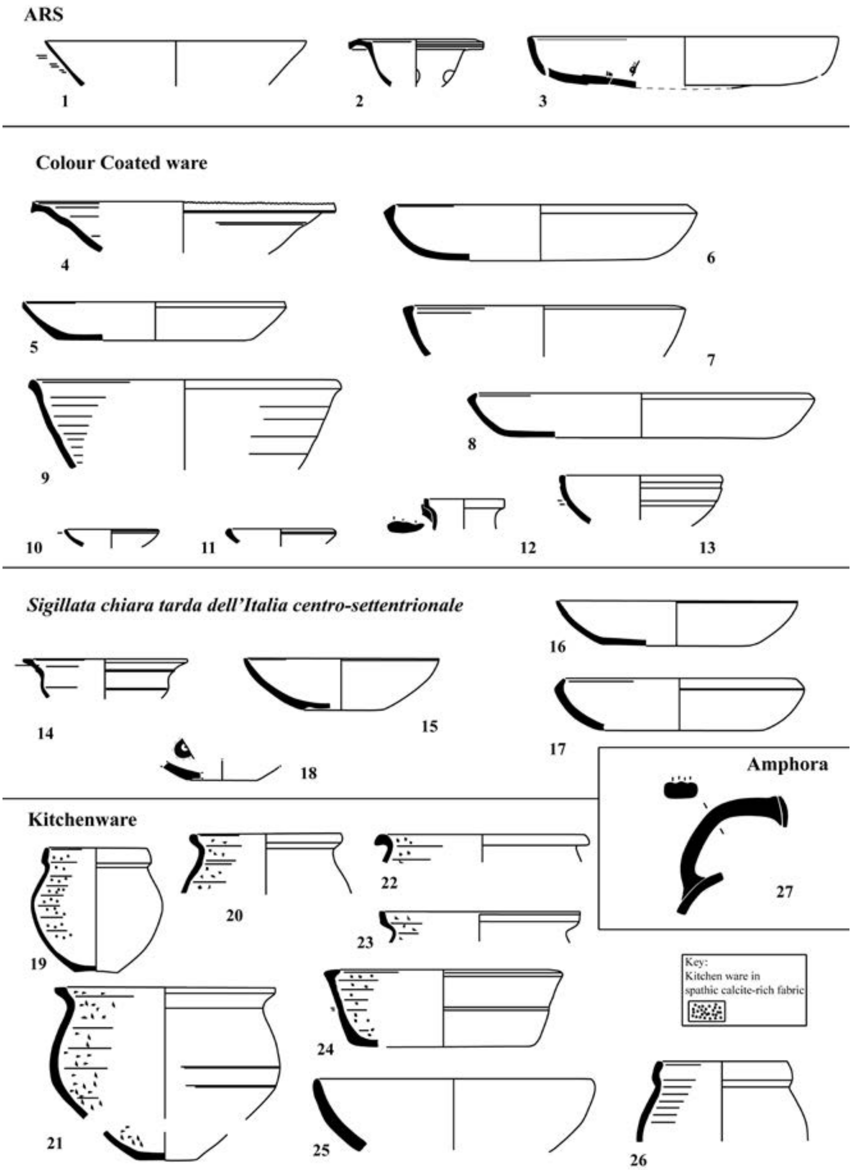

FIG. 6. Selected pottery from the late Roman dump at Case Nuove (late 4th to mid 5th century AD). African Red Slip ware (ARS): 1. Hayes 50B; 2. Hayes 71B; 3. Hayes 64. Colour-coated ware: 4. Large bowl; 5-7. Flat-based dishes; 8. Basin; 10-11. Sauce-bowl; 12. Table jug; 13. Small bowl. *Sigillata chiara tarda dell'Italia centro-settentrionale:* 14. Bowl; 15-17. Dishes; 18. Overpainted small bowl. Kitchenware: 19-24. Cooking pots; 25. Casserole; 26. *Tegame*/baking pan. Amphora: 27. Empoli type.

A similar interpretation can be advanced for the different distribution of the class of cooking pots tempered with spathic calcite, likely to be more resistant to thermal shocks than those wares manufactured with other fabrics.[38] About 55% of the cooking pots from Case Nuove are calcite-tempered, whereas only 24% of the cooking pots from Pievina present this technological feature. This difference requires further explanation. Were consumers aware of the thermal-shock resistance of different types of cooking pots? The generally higher technological quality of the kitchen wares documented at Case Nuove and the greater homogeneity of fabrics tentatively suggest a more careful and deliberate purchase of pottery by the people who dumped their rubbish at Case Nuove, which in turn may have been determined by the higher quality of local and regional products available to peasants living and working near the villa.

A comparison of the late Roman zooarchaeological finds from Pievina and Case Nuove further corroborates the socio-economic differences between the two sites (Table 3). The faunal assemblage from Case Nuove contains a mix of taxa, but it is clearly dominated by the basic domestic food animals. Similar to contexts from earlier time frames at Case Nuove, pigs, ovicaprids, and domestic fowl comprise a significant amount of the bones identified. Cattle, a taxon absent from earlier dietary deposits at the site, now registers, accounting for about 20% of the principal consumable domesticates by NISP and MNI counts. Demographic patterns provide further comparisons. Younger animals are notably common among late Roman contexts at Case Nuove, especially younger pigs and domestic fowl, although immature ovicaprids and cattle are also represented, and in numbers that suggest their contribution to diets, as opposed to simply bringing these taxa to older ages to exploit their secondary resources (i.e., milk, wool, traction, etc.). In fact, the high numbers of younger animals in the late Roman deposits suggests dietary wealth.

By contrast, late Roman Pievina reveals more zooarchaeological similarities with late Republican contexts at this site; its faunal assemblage does not attest an elite diet. The main change in late antiquity is the increase of sheep/goat and a decrease of the total NISP of pigs, a trend that appear to conform to general patterns for many sites (especially rural ones) in Tuscany (and more generally, Italy) over the same period.[39] The persistence of a large consumption of pork at rural sites in late antiquity is in fact a prerogative of elite sites, such as villas. As regards sheep and goat, aging patterns reveal an imbalance of adult to sub-adult individuals (4 to 1 ratio) among late antique phases at Pievina. The preponderance of adults suggests that farmers maintained the

38. Tite *et al.* 2001.
39. MacKinnon 2004.

bulk of their sheep and goats to maturity, presumably to exploit them more for secondary products (wool and milk) than for meat. A similar pattern has been revealed for cattle. The elevated values of cattle in late antique Pievina likely relate to smaller-scale agricultural and animal husbandry operations being practiced in this region at this time. Such a pattern correlates more with farmer self-sufficiency than to augmented specialization, and could imply less connection, at least as regards consumption of meat and other animal products, to any greater market. Age data for cattle at Pievina record a predominance of adults across all periods at the site. This pattern is somewhat expected, since adult cattle were generally exploited for work purposes and consumed at older ages. Still, the presence of some sub-adult cattle bones from late antique times at Pievina suggests that at least some cattle were consumed for veal. The presence of younger cattle in these late antique contexts also helps support the hypothesis of smaller-scale husbandry and mixed farming operations taking place at the site during this time.

At the same time, the greater availability, at the site of Case Nuove than at Pievina, of young animals, whose meat was more suitable for braising and frying than that from older animals, did not imply a transformation of the kitchen ware repertoires at Case Nuove. Cooking pots remained predominant and attest for a persisting preference for boiling meat whatever was the age of butchered animals.

Apart from a series of meaningful differences between the two sites, something shared by both of them is the variety and complexity of regional connections and the continuity in the supply of imports, albeit in lower proportions than at coastal sites. This is quite an unexpected phenomenon for two inland peasant sites about 40 aerial kilometres from the sea and distant from major roads. Those overseas products widely available at coastal sites and especially in the town of Roselle were more or less regularly re-distributed towards the interior.[40] Possibly the items to be shipped inland on overland routes were selected on the basis of size: the smaller the item the cheaper its transport costs. ARS vessels and small amphorae were particularly suited to this trade system. Probably it is no accident that heavier 5th and 6th century AD cylindrical Tunisian containers, documented at a series of coastal sites, are completely absent from excavated peasant sites inland. This supports the notion that if inland peasants still engaged in some long-distance trade connections, these were opportunistically limited to foodstuffs transported in small containers. The late Roman trade connections between coastal and inland areas

40. Vaccaro 2014.

of southern Tuscany suggest the existence of a still intense exchange system which continued to make large-scale use of late Roman small denomination bronze coins, as the evidence from inland peasant sites and particularly Pievina shows. These findings seriously challenge previous models forwarded by recent scholarship that would deny such linkages for this area of Tuscany.[41]

Conclusions

Though in its initial phase, the 'Excavating the Roman Peasant Project' is significantly contributing to our understanding of Roman rural communities in the interior of Italy. The large assemblages of animal bones yielded by two of the excavated sites are showing some meaningful differences in meat consumption, which imply different socio-economic status. The pottery repertoires indicate the complexity and sophistication of the material culture purchased and consumed by peasants. Although the majority of products came from regional sources, at all periods, these are of high quality and represent a wide range of functional vessels suggesting a certain variety of culinary and food consumption practices.

The identification of some new wine amphora types from the Augustan to late Roman periods, produced at a sub-regional if not local scale, indicate some agricultural specialization that was able to exceed the "boundaries" of self-consumption. However, small percentages of commodities, mostly finewares and a smaller number of amphorae, were imported, particularly in the late Roman period. The ceramic profiles of Case Nuove and Pievina, although in different ways, present a remarkable series of parallels with the contemporary ceramic contexts from the town of Roselle, near the coast. Though the town yielded an overall higher number of imports, the materials found here are also recovered inland. Goods circulated with some continuity along sub-regional routes and the town is likely to have played an important role as a hub for the redistribution of imports towards the interior.

Economic networks from this circulation of commodities show traces even beyond the ceramic and faunal records from the sites. For example, the important coin evidence from Pievina suggests a system of exchange, which, at least in part, was still based on the use of small denomination coins (*nummi*).[42] This preliminary picture clashes with the concepts of isolation,

41. Francovich and Hodges 2003, pp. 31-43 and Valenti 2009.
42. Ghisleni *et al.* 2011, p. 139.

low levels of economic complexity and immutability often associated with the peasantry, especially that of inland areas.

Acknowledgements

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