11-1-2013

Evidence from Flaws: Hellenistic Ceramic Production at Podere Funghi (Vicchio di Mugello)

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DE GRUYTER DOI 10.1515/etst-2013-0012 — Etruscan Studies 2013; 16(2): 1–25

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Abstract: From 1996–2006, excavators of the Mugello Valley Archaeological Project documented two important contexts for understanding Hellenistic period ceramic production at Podere Funghi near the sanctuary at Poggio Colla: a kiln-waster midden, and a series of kilns located in the vicinity of a small residential structure. This article consists of the results of a visual and metric examination of the fineware material from the midden. The examination assessed the nature and prevalence of specific firing flaws associated with the productive process, and the data derived from this study are used to reconstruct some of the technical challenges faced by the Podere Funghi potters and their firing equipment. The study documents a high prevalence of flaws associated with a rapid rise in temperature within the kiln at the beginning of firing process, while cataloguing few flaws associated with excessive sustained temperatures. This combination of flaws suggests poor pre-production drying of the wares, or the use of a fuel source that would have produced an initial high heat spike in temperature. In addition, it tells us much about craft production at satellite communities associated with large settlements, in this case, Poggio Colla.

Keywords: Etruscan ceramics, kiln wasters, ceramic technology, metric analysis, Poggio Colla

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Introduction

Ceramic studies have occupied a position at the forefront of the scholarly analysis of Etruscan material remains since the inception of the discipline. Much of the initial work related to ceramics in Etruria focused on the development of typological sequences for decorated wares and establishing sound relative chronologies based on comparisons with better-documented imported vessel

types.[1] In recent decades, ceramic studies in Etruria have developed in exciting new ways. One of these trajectories has been an increased interest in the nature of the technology of ceramic production.[2] This sub-field has progressed in two related, but divergent directions. One method of analysis has been the direct examination and classification of remains of the firing and manufacturing process, as represented by an ever-growing dataset of well excavated ceramic kilns and workshops.[3] The development of archaeometry, and its method of applying frameworks of analysis from the physical sciences, such as chemical composition analysis, represents a second trend. The latter has facilitated a better understanding of the spread of manufactured wares, and has permitted the identification and study of raw materials employed in the production process.[4] Yet, despite this progress, a significant gap exists in the current scholarship when it comes to the productive process.[5] Few analyses have employed the direct evidence of production wasters to elucidate the technological challenges faced by Etruscan potters with respect to the firing of ceramics.[6] As an initial foray into this neglected area, this study employs a statistical analysis of sherds of the class of wares known as *ceramica acroma depurata*, a thin-walled quartz-tempered monochromatic fineware typical of Etruscan settlement sites, recovered from a midden in the immediate vicinity of a ceramic production workshop at Podere Funghi located near the Etruscan monumental center of Poggio Colla, Vicchio (FI). Ceramic production

1 A corollary of this focus has been that despite the measurable dominance of undecorated wares recovered in many archaeological excavations, most analyses of Etruscan ceramics have focused on decorated wares such as Attic black- and red-figure (and their Italian imitations), Italo-Corinthian wares, and Etruscan *bucchero* and *vernice nera*.

2 For a recent technological study of *vernice nera*, albeit on a peninsula-wide basis, see Di Giuseppe 2012.

3 For the classification of Italic kilns, see Cuomo di Caprio 1993, 2007. For workshop facilities, see Nijboer 1998; Brizzolara et al. 2004; Carafa 1995; di Gennaro and Iaia 2004; Mansuelli et al. 1978; Marchesi et al. 1997; Saronio 1965. For the organization of the chain of production, see Di Giuseppe 2012; Bon-Harper 2010.

4 For a sample of archeometric work, see Gliozzo et al. 2011; Ammerman et al. 2008; Gliozzo et al. 2005; Fermo et al. 2004; Gliozzo and Memmi Turbanti 2004; Maritan 2004; Pecchioni et al. 2007.

5 For a discussion of other areas of possible expansion of the field, see Acconcia 2004.

6 A number of studies have documented sherds recovered from the excavation of defunct kilns. In most cases, the wares recovered either do not bear marks sufficient to qualify them as kiln wasters, or the sample of sherds has been so small that no statistical analysis of firing flaws is possible: see Mansueli et al. 1978; Marchesi et al. 1997. Moorhouse (1981) and Rice (1987, 176–177) note the fact that few studies are able employ the method advocated here, since many excavations focus on the recovery of easily identifiable kiln structures to the neglect of associated middens that shed invaluable evidence on the remainder of the ceramic process.

wasters (vessels damaged during firing and bearing recognizable flaws such as spalling, bloating, overheating, or other characteristic firing defects) make up the sample population under consideration. Evidence from the midden suggests that the potters of the Podere Funghi struggled primarily with issues of temperature control and adequate pre-firing preparation of vessels, while maintaining a high degree of regularity in vessel shape.

The Archaeological Remains from the Podere Funghi

The fortified hilltop sanctuary of Poggio Colla, located ca. 35 km to the northeast of modern Florence and occupied from the seventh to the second centuries BCE, dominated the landscape of the Mugello val di Sieve and served as an outpost of Etruscan identity in the liminal zone that bordered the Apennine passes to the Po Valley (Fig. 1).[7] Excavations of the Mugello Valley Archaeological Project (MVAP) since 1995, sponsored by Southern Methodist University, Franklin and Marshall College, the University of Pennsylvania Museum of Archaeology and Anthropology, and the Center for the Study of Ancient Italy at UT Austin, have uncovered the remains of at least two structures that dominated the site throughout the sixth through fourth centuries BCE. A temple first dominated the *arx* at Poggio Colla, and later a monumental courtyard building with a central altar supplanted the earlier structure.[8] At some time during the fourth century BCE, the building underwent modifications that included the addition of storerooms around the courtyard before its ultimate destruction at the end of the third century BCE (Fig. 2).[9] MVAP excavators also unearthed the aforementioned archaeological context of the Podere Funghi in a field ca. 500 m to the southeast of the monumental center. Survey and excavation within the Podere Funghi have revealed a cluster of structures and deposits representing a zone of ceramic production contemporary with the later phases of architecture present on the *arx*.[10]

7 van der Graaff et al. 2010, 54; Warden 1996.

8 For the most recent chronology of the sites, see Thomas 2012, 21–23. For the overall history of the site and previous bibliography, see Warden et al. 2005.

9 Thomas 2012, 22–23.

10 For a recent discussion of the excavations in the Podere Funghi, see Meyers et al. 2010, 304–306; Bon-Harper 2011, 125–131.

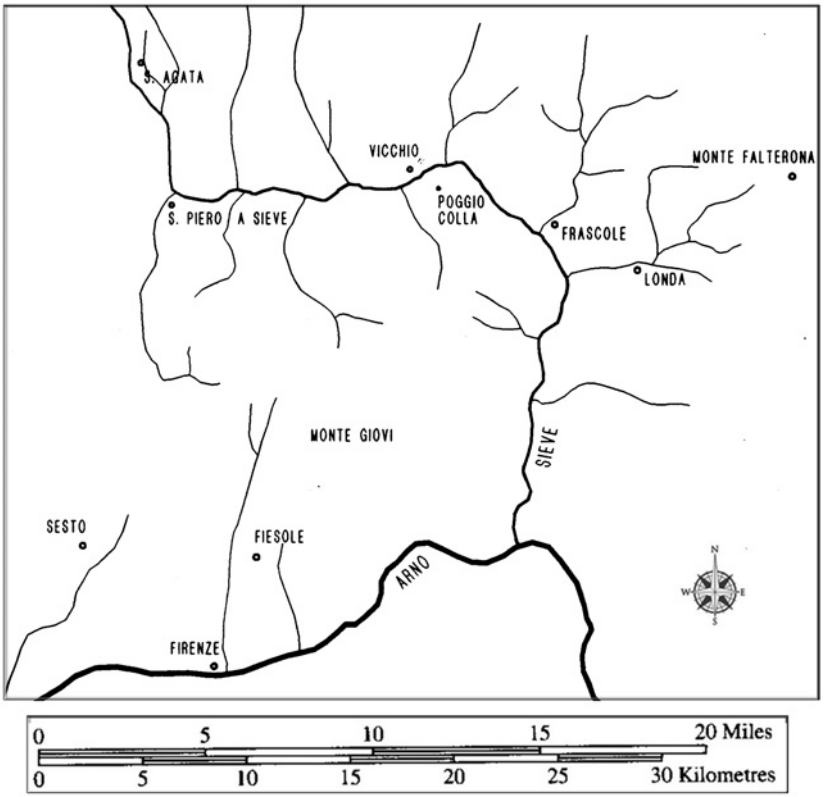

Fig. 1: Map of the Mugello Valley and Environs (Map by Jess Galloway after Warden et al. 1999).

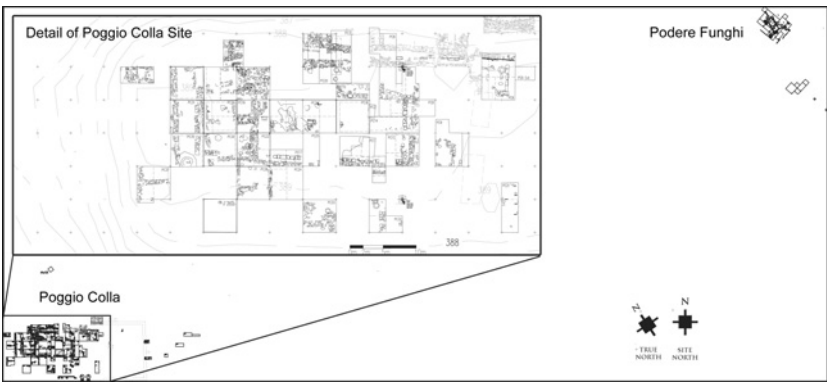

Fig. 2: Relative locations of Poggio Colla arx and Podere funghi with Detail of Poggio Colla (Plan by Jess Galloway, courtesy of the Mugello Valley Archaeological Project).

Local archaeologists notified MVAP of a dense scatter of ceramics located in the Podere Funghi after the field was mechanically plowed for the first time in the spring of 1998.[11] Initial excavations of the Podere Funghi conducted from 1998–2000 revealed a substantial midden containing material indicative of ceramic production (Fig. 3). The excavators originally interpreted the feature as the destruction debris of a small structure, but subsequent excavation failed to uncover any architectural evidence or a significant destruction layer and instead revealed a number of vessels with firing flaws indicative of ceramic production.[12] This prompted P. Gregory Warden and Michael L. Thomas to reinterpret the feature as a ceramic production midden.[13] The midden stretched out over an area of ca. 5 x 15 m at the western edge of the modern field. Extensive plowing had disturbed and mixed the upper 30–40 cm of the deposit, but more than 20 cm of undisturbed archaeological material remained in situ.[14] The material contained within the organically rich matrix of this midden included fragments of bone, as well as coarse and fineware ceramics, many of which showed evidence of being kiln wasters.[15] The layers undisturbed by the plow yielded 3,268 total sherds (40.475 kg) of ceramics (Fig. 4). The vast majority of the ceramics from the midden appear to date from the late fourth to the third centuries BCE.[16] Despite the abundance of ceramic material, which included roof tiles, there were no foundations or other evidence of buildings, prompting the excavators to seek architectural remains elsewhere in the field.

A shovel test pit (STP) survey conducted in 2000 in an area of high density surface scatter 20 m to the northeast of the midden revealed these types of remains.[17] Subsequent excavations documented the plan of a structure (ca. 10 x 4 m) situated on the crest of a low hill in the center of the modern field (see Fig. 3).[18] The building was comprised of at least two rooms, and one contained a central hearth.[19] In addition to the architectural remains, archaeologists have recovered a series of outdoor workspaces and four tear-drop shaped kilns whose

11 Warden et al. 1999, 244; Warden and Thomas 2002–2003, 103.

12 For the initial interpretation of the midden deposit and the remains of a structure destroyed by a conflagration, see Warden et al. 1999, 242–243.

13 Warden and Thomas 2000, 140.

14 Warden et al. 1999, 244–245.

15 Warden and Thomas 2002–2003, 103.

16 The dates for the midden ceramics are derived from a process of comparison with black-gloss exempla found at Monte Bibele and Monte di Savino, carried out by A. Steiner of Franklin and Marshall College. For the Monte Bibele ceramics, see Vitali 2003; 1990.

17 Warden and Thomas 2002–2003, 103.

18 Warden et al. 2005, 258–263.

19 Warden et al. 2005, 259.

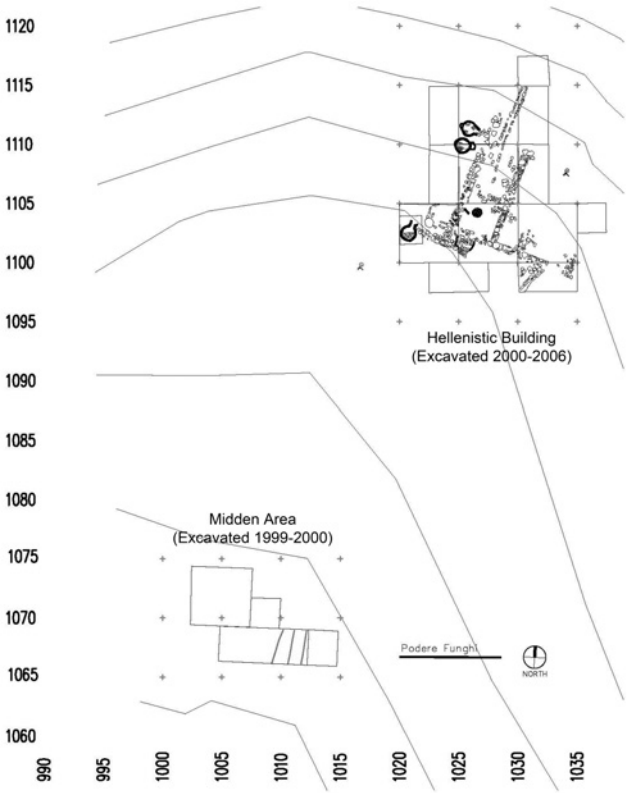

Fig. 3: Plan of Podere Funghi Production Zone with Building and Midden (Plan by Jess Galloway, courtesy of the Mugello Valley Archaeological Project).

firing chambers measure ca. 1.5 m in diameter.[20] At least one of the kilns certainly antedated the building whose southernmost wall cut its footprint. Although there is no in situ evidence of the earlier structure contemporary with the aforementioned kiln, the extensive reuse of terracotta pan tiles as a floor packing in the later building suggests that a predecessor may have existed nearby. Two additional kilns, whose relationship to the later phase of building is unclear, are situated

20 Warden et al. 2005, 259. Evidence from the excavation of the kilns will play a significant part in this analysis, but the full publication of the structures will occur in another venue. This study will limit its discussion to the impact of the kiln design and structure on the ceramic assemblage recovered from the midden. For a preliminary analysis of the kilns, see Bon-Harper 2011, 125–128. The kilns fall into the standard typology as Type I (see Cuomo di Caprio 1971–1972, 404–406). For the closest parallel to these structures from Verrucchio, see Malnati and Manfredi 1991, 207.

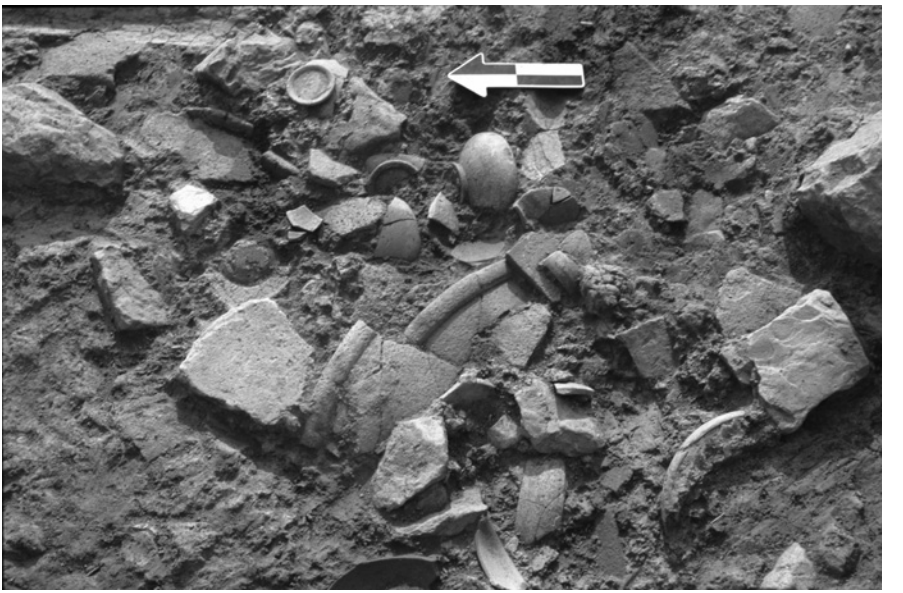

Fig. 4: View of the Podere Funghi Midden Assemblage in 1998 (Photograph by Michael Thomas, courtesy of the Mugello Valley Archaeological Project).

with their *praefurnia* facing the west wall of the structure.[21] The later building contained material approximately contemporary with that from the midden, spanning from ca. 400–200 BCE.[22]

In addition to the evidence for ceramic production, a series of recent survey projects have revealed extensive activity in the zone to the southeast of the *arx* of Poggio Colla, both in the Podere Funghi and adjacent fields. Based on the results of spatial auto-correlation of data derived from a second, more-intensive STP survey of the area, Sara Bon-Harper suggests that additional productive structures (perhaps those contemporaneous with the kilns abutting and beneath the later structure) occupied the western edge and southeastern corner of the modern field.[23] Geophysical prospection of the zone combined with a coring survey has revealed the remains of other anomalies consistent with the ceramic production process.[24] Of particular note is a probable kiln located immediately to the north of

21 Meyers et al. 2010, 305; Warden et al. 2005, 260.
22 Meyers et al. 2010, 305–306.
23 Bon-Harper 2011, 132–137.
24 Martino 2005; van der Graaff et al. 2010, 59–62.

the Podere Funghi midden.[25] Furthermore, bore holes have revealed the presence of several local beds of high quality clay, which, upon further testing, have been revealed to be similar in chemical composition to tile and ceramic wares excavated from Poggio Colla.[26] Evidence of multiple loci of productive activity on the basis of results achieved from an overlapping suite of geophysical methods strongly suggests activity and/or habitation in the zone to the southeast of the Poggio Colla *arx*. As a result, this new information tentatively suggests that a series of small workshops may have been located in relatively close proximity to each other.[27] If these structures are indeed workshops associated with the production of the ceramics found in the midden, they appear to have been ideally situated with respect to the natural resources necessary for production.[28] It is possible that the area represents an artisans' quarter that served the sanctuary atop Poggio Colla, its visitors, and the elite families who lived and buried their dead nearby.[29] A number of vessels macroscopically identical to those discarded in the Podere Funghi have been found within the remains of the open courtyard structure on the *arx* of Poggio Colla. Initial chemical characterization of these wares indicates that they were derived from a similar local clay source as the clay beds adjacent to the Podere Funghi.[30] These findings suggest that the Podere Funghi potters marketed their wares to those who frequented the nearby monumental ritual center at Poggio Colla.[31]

25 This anomaly was uncovered during a campaign of coring associated with the survey reported in van der Graaff et al. 2010.

26 van der Graaff et al. 2010; Weaver et al. (forthcoming); Didaleusky 2009.

27 This suburban arrangement of kilns contrasts strongly with the pattern seen in other northern sites like Murlo and Marzabotto, where production of ceramics took place within the heart of major settlements: see Saronio 1965; De Maria 1978; and Marchesi 1997. Instead, the pattern found at Poggio Colla echoes that documented at Acqua Acetosa-Laurentina and Satricum, where similar suburban production areas have been identified. During the Archaic period, the kilns at both sites were located within the settlement and only moved to the outskirts of the community after significant urban expansion: Nijboer 1998, 115–128; Bedini 1990. A similar move can be tentatively advanced for Poggio Colla, where the suburban kilns dominated production in the Hellenistic period following the closure of earlier kilns on the *arx* at Poggio Colla.

28 Arnold (1988, 20–35) documented a strong preference for close proximity between production facilities and their basic clay resources among both ethnographically and archaeologically documented potting communities.

29 Bon-Harper 2010, 129–130. As suggested by Bon-Harper, it is possible that the wares from the Podere Funghi workshop had an even broader distribution.

30 Weaver et al. (forthcoming).

31 Bon-Harper 2010, 130.

Characterization of the Podere Funghi Midden Assemblage

The following examination presents a visual and metric study of the production wasters of fineware ceramics recovered from the midden context within the Podere Funghi.[32] This approach seeks to reconstruct the technical processes associated with the manufacture of ceramics based on quantitative analysis of firing flaws evident on kiln wasters. The method relies heavily on comparisons between sherds derived from excavated contexts and similar wares documented in cross-cultural ethno-archaeological literature.[33] Such a study is particularly useful in revealing some of the regular successes and failures of the Podere Funghi potters, their kilns, and their raw materials. After an initial quantitative survey of the various fabrics represented in the midden context, the rim sherds of fineware vessels (the most frequently represented fabric within the midden) were evaluated for evidence of ethnographically or experimentally documented firing flaws, and features revelatory of the manufacturing process.[34]

Analysis of the midden assemblage as a whole determined the relative percentages of wares recovered from the context by count and weight (Fig. 5). The vast majority of the sherds (73% by count, 49% by weight) can be classified as local finewares (*ceramica depurata acroma*). This fabric consists of a fine-grained paste manufactured from the local sandy-clay soil with the addition of quartz, among other minerals, as a temper.[35] The presence of quartz-rich sand temper not only improves the properties of elasticity and plasticity of the clay for forming vessels, but also enhances resistance of finewares to mechanical shock.[36] Shapes utilized

32 The decision to base the study on finewares alone was based on the relative ease with which firing flaws are seen in fine tempered fabrics coupled with their abundance in the midden assemblage. In making this choice any conclusions must be considered preliminary.

33 For a similar approach, see Peacock 1982.

34 For the most extensive resource for the identification of firing flaws, see Rye 1981. See also Rice 1987; Shepard 1956.

35 Temper was determined by the examination of a sample of sherds under 10x magnification. Weaver et al. (forthcoming) confirmed this analysis on the basis of chemical characterization of a sample of sherds from the Podere Funghi structure and midden using XRD Analysis. Ethnographic studies suggest that temper materials are often secured locally: Arnold 1981, 36. The Poggio Colla Coring Survey (2007–2008) revealed the presence of clay/sand soils rich in both quartz and feldspar such as those employed for temper in the fineware paste over a large proportion of the survey area. The Poggio Colla Coring survey employed USDA soil guidelines for typing soil consistency: van der Graaff et al. 2010, 59.

36 For the properties of sand temper, see Bronitsky and Hamer 1986, 94–96; Steponaitis 1984.

Fabric Classification	Weight (kg)	Count
Black-Gloss (*Vernice Nera*)	.075	9
Fineware (*Ceramica depurata acroma*)	19.975	2408
Coarsewares	20.425	869
Totals	**40.475**	**3286**

Fig. 5: Fabric Classes from the Podere Funghi Midden by Weight and Count.

as drinking and serving vessels would require such resistance to avoid frequently breaking and cracking during daily use. In addition, the fine grained texture of the paste would have prevented the origination of cracks within the vessels.

Coarseware and black-gloss sherds have been recovered in lesser abundance.[37] Sherds decorated with the characteristic Etruscan black-gloss—*vernice nera*—are the least well represented category of wares, comprising less than 0.02% of the total assemblage by count.[38] These isolated sherds most likely represent household refuse, or production models, rather than the goods crafted in the Podere Funghi.[39] The coarseware vessels, comprising 26% of the total assemblage by count (51% by weight), although composed of a different fabrics than the undecorated finewares, share a similar chemical characterization with their fineware counterparts. This suggests that the macroscopic differences in the paste are due to the effects of intentionally added non-plastic inclusions rather than a substantially different clay source.[40] These coarsewares occasionally exhibit a number of flaws characteristic of misfiring, and thus likely represent local production.

After concluding a basic quantitative analysis of the midden material, a sample of sherds was selected for further analysis. Rim sherds were selected for

37 This study will not attempt to treat the production of the coarseware fabrics manufactured within the context of the Podere Funghi. The material is currently undergoing study and will be published elsewhere.

38 For a description of the technical processes involved in the manufacture of this category of wares, see Di Giuseppe 2012; Hayes 1991, 191–192. There is no reason to assume that post-depositional processes are the operative factor in the preservation of such a limited quantity of black-gloss vessels.

39 The presence of the black-gloss sherds suggests that although the midden here contains a large number of ceramic wasters, the assemblage is not comprised solely of this category of finds.

40 Weaver et al. (forthcoming).

additional scrutiny because they indicate vessel shape. Among the rim sherds, the ware classes discussed above were represented as follows: 4 black-gloss; 48 coarseware; 444 fineware. A series of measurements, such as height, diameter, thickness and percentage of circumference, were recorded for each piece, along with any information the sherds could yield on vessel shape or function as documented via direct observation. From these measurements, it is possible to calculate a minimum number of vessels present in the assemblage (Fig. 6.). The minimum number of vessels was calculated using the Egloff method, which entails adding together the percentage of the preserved rim circumference of all sherds from similarly shaped vessels with identical diameters.[41] These sums were then rounded up to the nearest integer in order to obtain the minimum number of vessels that could have produced the midden assemblage. Each rim sherd was examined for evidence of manufacturing techniques and firing flaws.

Due to the abundance of sherds of the fineware type commonly classified as *ceramica depurata acroma*, this category of ware was subjected to additional statistical analysis, the results of which will be detailed below. In addition, this fabric demonstrated the greatest number of observable firing flaws, and thus provides the greatest evidence for the process of production. The most common forms present among this fabric were pouring vessels (including large and small *olpai), piattelli, ollas,* and incurving rim bowls in several sizes. Visual and statistical analysis of the four most common morphological types reveals that some shapes occurred in standard sizes, while in others there was less drive to standardization. All shape categories displayed evidence of firing flaws. Below, the sherd assemblages are evaluated by shape category in order to derive meaningful data surrounding the production process for each shape represented.

Sherds recovered from bowls with incurving rims provide the largest sample present in the assemblage. Almost all of these fineware bowls display a markedly similar profile consisting of a slightly incurving rim and a ring foot. The smaller sized bowls often bear an almost hemispherical curve such as that seen in the profile of PC99-059, while the larger versions display a conical profile with an incurving rim such as that present in PC98-061 (Fig. 7). Within these established shape categories, the bowls have a high degree of internal consistency, with the most frequent variation occurring in the termination of vessel lip. Most lips are strongly tapered, but a few examples show edges that terminate in flat or rounded profiles resulting from the tools and techniques employed in the finishing process. As noted by Valentine Roux in an ethnographic study of ceramic standardization, rim termination, in many cultures, represents an area where potters often

41 Egloff 1973.

Fabric Type	Vessel Shape	Mimimum No.	% of Total Assemblage
Fineware	Bowl	173	59.4%
	Olla	30	10.3%
	Piatelle	29	9.9%
	Pouring Vessel	11	3.8%
	Unidentified	16	5.5%
Black-Gloss	N / A	4	1.4%
Coarseware	N / A	28	9.6%

Fig. 6: Minimum Number of Vessels by Fabric (Obtained by the Egloff Method).

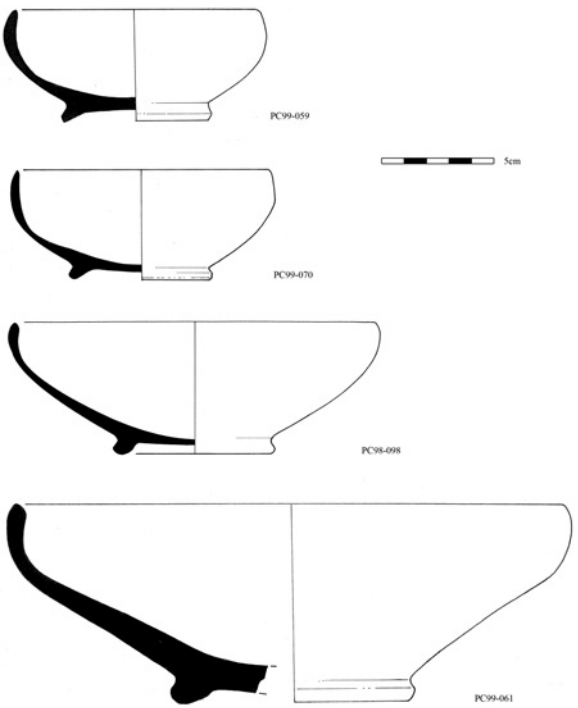

Fig. 7: Podere Funghi Incurving Rim Bowls (courtesy of the Mugello Valley Archaeological Project).

express their individuality.[42] Gretchen Meyers, Lauren Jackson, and Jess Galloway have noted a similar phenomenon occurring in the termination of the tile flanges recovered from the floor packing of the Podere Funghi workshop.[43]

Although there is a high degree of consistency in the profiles of the incurving-rim bowls, the Podere Funghi potters appear to have had little interest in following a set of consistent proportions with respect to the ratio between vessel circumference and wall thickness. The lack of a strong degree of positive correlation (.283) between values obtained for vessel diameter and rim thickness suggests that the termination of the vessel was largely dependent on the physical properties of the clay (such as plasticity) and on the limitations of the potter's skill rather than adhering to a set of conventional proportions which were adjusted for scale.[44] In other words, the thickness of vessel walls did not decrease at a rate that matched the decrease in vessel diameter. As a result, there are only a few vessels of an eggshell-thin variety. This trend is not unique to the incurving bowls, as all of the vessel shapes thrown from the fine-tempered fabric show a similar weak correlation between diameter and wall thickness.

The Podere Funghi potters manufactured the fineware bowls in three general size categories (Fig. 8).[45] The smallest of the three categories consists of a cluster of bowls that share diameters between 10–15 cm, with a strong peak between 12–13 cm. The medium category contains the greatest number of vessels, and ranges between diameters of 16–21 cm. The greatest proportion of vessels from this category shares a diameter between 18–19 cm. A third category of large bowls extends from 22–25 cm in diameter with a few vessels exceeding this range.[46] The *ollas* can likewise be grouped into discrete size categories. There appear to have been both large and small versions of the *olla*. The small version had a rim diameter of 7–11.5 cm while its larger counterpart measured between 21–27 cm. The pouring vessels are not grouped into standardized size categories. Few of them share a similar diameter, and thus each pouring vessel may have been

42 Roux 2003, 777.

43 Meyers et al. 2010, 311.

44 The distribution of rim thickness values for the fine tempered bowls, very tightly clustered with an inter-quartile range from 0.45 to 0.6 cm, reinforces this interpretation. The inter-quartile range is the marker of the points between which half of the values for a statistic lie. The figure is determined on the basis of median values, and thus is far more robust than the measure of standard deviation, which is highly susceptible to the influence of outliers: Shennan 1997, 44–45. The other fineware vessel shape categories exhibit similarly small ranges in values for rim thickness.

45 Warden and Thomas 2002–2003.

46 Warden et al. 2005, 258. Bon-Harper (2009) also identified the same size categories in a preliminary study on ceramic standardization at the Podere Funghi.

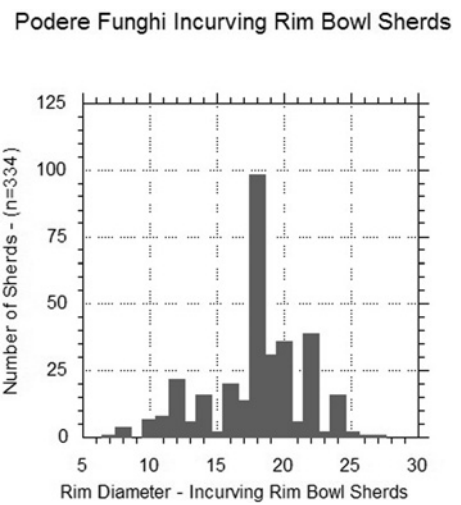

Fig. 8: Rim Diameters of Incurving Rim Bowls from the Podere Funghi Midden.

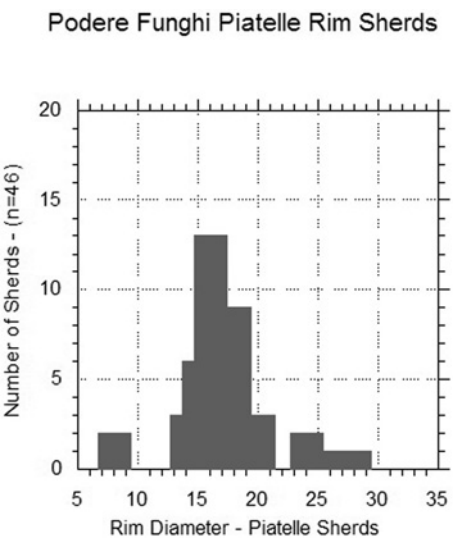

Fig. 9: Diameters of Piatelle Rim Sherds from Podere Funghi Midden.

manufactured to custom specifications, or produced infrequently. In contrast, the diameter values for *piatelli* form a normal distribution with a peak at 15 cm (Fig. 9). In sum, potters appear to have produced a limited number of shapes, with some falling into fairly consistent size categories and others in apparently more random sizes.

Vessel Finishing and the Firing Process

In addition to revealing details about the process of shaping and finishing vessels, a number of sherds recovered from the Podere Funghi midden preserve diagnostic firing flaws that can be used to reconstruct the firing conditions that produced the catastrophic events documented on the ceramics. Among the finewares 329/444 (74%) of the rim sherds showed evidence of a flaw that would have led to the deposition of the vessel in the waster midden. As a result, it is possible to reconstruct the firing sequence of the kilns in fairly extensive detail by comparing the assemblage with known firing practices of ethnographically-documented traditional potting communities.[47] In addition, because many of these identifiable production and firing errors are present in the assemblage of fineware rim sherds, it is possible to begin to explore the concerns that would have troubled the Etruscan potters who deposited their wasters in the Podere Funghi midden, and to mark out the areas where their technical skill or knowledge led to problems in production. We must be cautious, however, about any broad characterizations of the whole production assemblage, since the wares studied for the most part represent failures only, and thus merely a subset of the original universe of vessels produced.[48]

Just over 10% of the fineware rim sherds in the Podere Funghi midden show evidence of spalling, a type of breakage associated with the rapid escape of interstitial (mechanically rather than chemically combined) water, where a rapid burst of steam pops off a portion of the vessel surface in an attempt to exit the matrix of the ceramic (Fig. 10).[49] Spalling can be prevented through a number of mechanisms that allow the steam to escape through the pore structure of the wares in small increments. In successful firings, the evacuation of mechanically combined water from the fabric is achieved through a slow increase in temperature up to 200° C.[50] This gradual rise in temperature is usually achieved by warming vessels at the edge of a hearth or bonfire, a procedure called water-smoking, before insertion into the kiln (although the process can also be accomplished inside the

47 For the application of ethnographic observation to archaeological ceramics, see Rice 1987; Rye 1981; Sinopoli 1991; Shepard 1965; and Arnold 1981.

48 The assemblage of the Podere Funghi midden, is not a sealed context. The action of plowing, both ancient and modern, served to disturb the upper section of the context. In addition, the presence of bone and non-waster material, however limited, suggests that the assemblage is of a heterogeneous nature and an incomplete subset of the original.

49 Shepard 1956, 81; Rye 1981, 105–106; Rice 1987, 102–103. The first step in any successful pottery firing procedure is water-smoking, which may be considered part of the final process of drying.

50 Shepard 1956, 81.

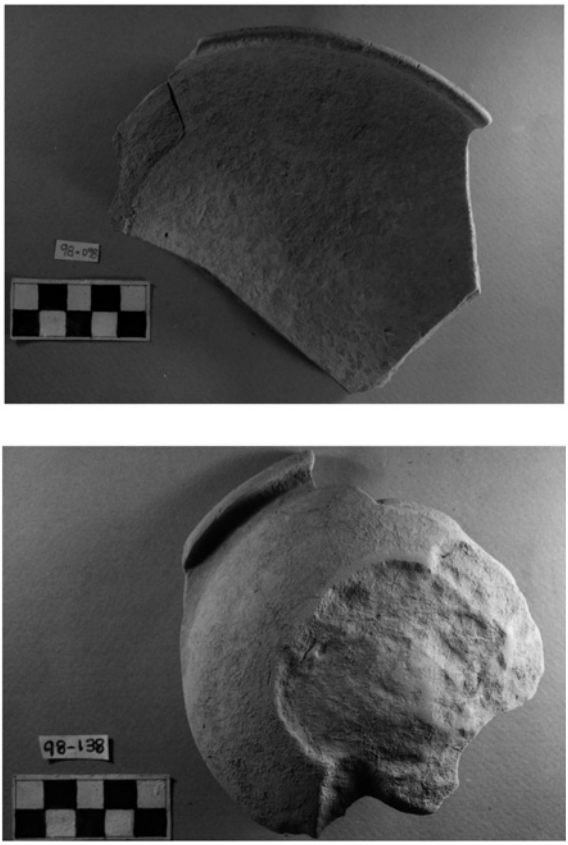

Fig. 10: Podere Funghi Midden Sherds with Evidence of Spalling (Photograph by Author).

loaded kiln, provided that the potter is able to raise the temperature slowly).[51] In the absence of proper water-smoking, there is still danger of spalling, even if wares have been dried at room temperature for extensive periods of time.[52] The occurrence of several spalls can lead to the failure of the vessel as a whole. This type of failure, although only occurring at a rate of one in ten vessels within the sample from the Podere Funghi midden, represents a far greater danger than these numbers suggest. Often pieces liberated through spalling fly off of the

51 Shepard 1956, 81.

52 The presence of a series of irregularly arranged post-holes in the outdoor work area on the east side of the extant Podere Funghi building suggest that the potters may have reserved this area for shelving used to house the drying wares produced in the area.

vessels at such a high velocity that they break several other pots in the kiln before coming to rest.[53] The high frequency of this type of firing flaw in the midden wasters suggests that the Podere Funghi potters were often cursory in their initial preparations of the pottery for insertion into the kiln, either raising the initial temperature of the vessels too rapidly in a loaded kiln, or removing them from a gentle heat source before they had the chance to evacuate all of their interstitial water via water-smoking.[54]

As we have seen from the large number of ceramics showing evidence of spalling, it is clear that the Podere Funghi potters may have struggled with their ability to control the rate of increase of temperature on their ceramics. This difficulty seems to have presented a far greater challenge than that of controlling the maximum heat reached in the kiln. Bloating, melting/warping, and fusion represent the most common flaws resulting from overheating or over-firing (Fig. 11). Bloating can be identified on the basis of a thickened vessel wall with tell-tale development of extensive spherical or rounded pores or voids within the ceramic matrix.[55] Warping manifests itself in the slumping or deformation of the clay body, while melting, a more extreme version of the same process, occurs when a portion of a vessel becomes fully pyroclastic.[56] A final characteristic flaw associated with overheating is the fusion of stacked vessels at their point of contact together into a single mass.[57] Within the Podere Funghi, a small fraction of the recovered wasters show signs of flaws associated with overheating (5%). Moreover, overheating flaws are frequently co-occurring (Yule's Q = .77), with many of the sherds showing evidence of more than one heat-related flaw.[58] Nevertheless, their sparse overall numbers suggest that the potters in the Podere Funghi rarely overheated their wares.[59] A second source of evidence supports this assertion as

53 Rye 1981, 106–107.

54 Mengarelli (1936, 72) documents a two-chambered kiln design at Vigna Parrochiale (Caere) that allowed for separate firing and water-smoking chambers. Such an expedient was lacking in the design of the Podere Funghi kilns.

55 Rye 1981, 110–111.

56 Rye 1981, 111–114.

57 Rye 1981,

58 For a detailed description of this measure, see Shennan 1997, 116–118. Values close to 1 or –1 indicate strong positive and negative correlations, while values close to zero indicate little association between variables.

59 For a discussion of the necessary design features of Etruscan kilns to provide the capability to overfire wares, see Nijboer 1998, 108–109. A number of round updraft kilns capable of producing the conditions required for the temperatures needed to produce these heat-related flaws have been excavated to the North of the midden. For a discussion of the typology of Etruscan and Roman kilns, see Cuomo di Caprio (1971–1972). The predominance of flaws associated with under-firing as

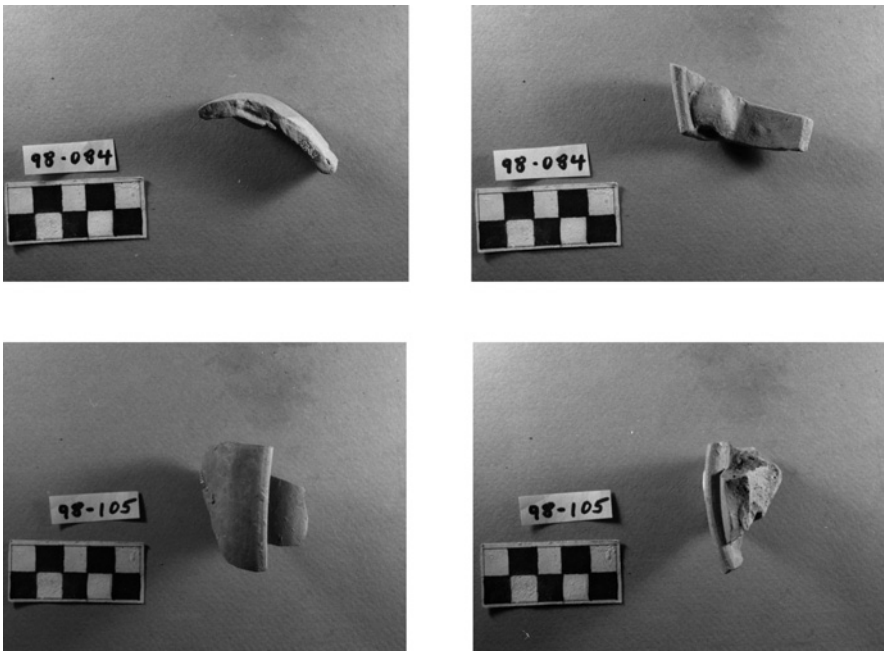

Fig. 11: Podere Funghi Midden Sherds with Evidence of Heat-related Flaws (Photograph by Author).

seen in a sample of sherds recovered from the Podere Funghi midden which show a range of apparent porosity from 15.5% to 49%.[60] The great majority of the wares cluster around the median score of 33% (a score well within the standard range for archaeological pottery), suggesting that the process of vitrification was rarely completed in the vessels fired in the Podere Funghi and signifying an inability of the Podere Funghi potters to maintain consistently high temperatures.[61]

opposed to over-firing suggest that although the equipment employed in the manufacture of the Podere Funghi wares was technologically capable of producing temperatures high enough for the production of black-gloss vessels, I am highly skeptical that the potters were able to control their fires to the degree necessary to produce the effects of black-gloss. This lack of control over the heating of the kiln serves as at least tangential confirmation that the black-gloss sherds present in the Podere Funghi midden are not an indication of local production of this ware class.

60 Porosity tests followed the water-saturation method described by Shepard 1965, 125–130. Sherds were weighed before and after being subjected to water saturation through lengthy boiling. The difference of these weights was divided by the volume of the sherd and then multiplied by 100. An average porosity of 33% is a common figure documented in ethnographic and archaeological contexts for unglazed kiln-fired ceramics. For porosity values and analysis, see Rye 1981, 121–122.

61 Rice 1987, 82; 352; Rye 1981, 121–122.

The combination of these two characteristics of the fineware wasters, a high degree of spalling coupled with a low incidence of over-firing flaws, may be a reflection of the type of fuel used to fire the ceramics. It is likely either that the potters of the Podere Funghi employed fast burning material such as straw, grass, or soft-woods, or manipulated hardwood fuel sources to increase surface area, such as using wood chips instead of logs. These types of fuel produce a characteristic quick initial rise in temperature, but do not produce the sustained high heat and lengthy soaking times that provide vessels with the opportunity to achieve the substantial vitrification of the clay lattice achieved through the use of hard-wood logs.[62] This finding has wider implications for the study of Etruscan kilns and ceramic production technology. The overwhelming majority of central Italian kilns have failed to yield concrete evidence for the type of fuel employed by the potters.[63] Such a lack of evidence is likely due to a combination of factors, including the poor state of preservation of many known exempla, and the excavation of many kilns in the early 20th century before the wide employment of modern paleo-botanical techniques that could serve to identify and assess fuel remains.[64] The quantitative technique applied above in assessing the relative frequency of firing flaws could provide an indirect indicator of materials used as kiln fuel in the absence of direct evidence. In the case of many early kilns, such a process, undertaken on preserved assemblages of wasters, could serve to fill in this gap in our knowledge.

By far the most common firing flaw, found on 40% of the fineware rim sherds recovered from the midden, is a powdery surface that tends to disintegrate easily (Fig. 12). Since the flaw is equally present on wares from different portions of the midden, as well on morphologically similar wares from Poggio Colla, it is highly likely that the flaw is a result of a pre-depositional process, as opposed to a differential post-depositional history among the sherds. One possibility is that the pottery was extremely low fired, and as a result the pots never reached temperatures that were able to completely remove chemically combined water from the

62 Rice 1987, 156–157; Shepard 1956, 77–80.

63 The excavators at Marcianella in the territory of Chiusi have recovered a number of charcoal samples from the vicinity of the kilns. This charcoal included samples of holm oak, deciduous oak, maple, hornbeam, and fir. Due to the complicated nature of the stratigraphy and the cycle of abandonment of the kilns, only the deciduous oak can be securely identified as having served as a fuel source for the kiln. For details of the excavations at Marcianella, see Pucci and Mascione 2003, 316–320. For bibliography on a significant number of excavated central Italian kilns, see Di Giuseppe 2012, 105–106, Table 7; Curri and Sorbelli 1973, 245–249. Orton and Hodges (2013, 124) lament the lack of attention paid to the remnants of fuel sources in most kiln excavations.

64 For a list of the usual range of fuel sources, see Cuomo di Caprio (2007, 125) and Nijboer (1998, 109).

Fig. 12: Podere Funghi Bowl, inv. 98-098 with Poor Surface Adhesion (Photograph by Author).

clay body. The corollary of this phenomenon would be that the firing process could not have caused the disintegration of the crystal lattice of the clay as a result of the removal of chemically combined water; the results of the aforementioned study of apparent porosity, however, would suggest otherwise, since the values obtained adhere to norms achieved in the firing of earthenwares (900–1200° C).[65] A second explanation stems from the formation process of the vessels rather than their firing. Incorrect timing of the application of a wash or slip to the exterior of a vessel often produces a similar effect to the poorly adhered and powdery surface seen on the Podere Funghi finewares. When examined in cross-section under low magnification, a number of the vessels recovered from the Podere Funghi midden appear to have been self-slipped, that is coated with a wash of the same clay used to create the ceramic paste. The application of such a wash to a bone-dry, rather than leather-hard, surface can lead to exactly the type of poor surface adhesion seen on the Podere Funghi finewares, since the differential rates of shrinkage between clay body and slip cause the latter to slough off when dried and fired.

During the firing process, vessels were fired to a light pink to peach color, which was obtained by opening the vents in the updraft kiln in order to create an oxidizing atmosphere within the kiln. An oxidizing atmosphere was maintained

65 Rice 1987, 82; 352.

long enough to burn out any carbon inclusions within the paste and transform iron within the ceramic paste into rust-colored ferric oxide.[66] In a number of cases, evidence of stacking of wares is preserved in the form of a purple band of color coating the surface of the lower portion of the exterior of the bowls. This feature resulted from the practice of stacking the vessels inside each other in order to fit vessels into the kiln efficiently. Thus in these instances, the bottom of the vessel above was sealed in an oxygen poor environment inside the bowl below it, causing a slightly reducing atmosphere. As a result, the lack of oxygen prevented the paste from achieving an oxidized firing.[67] This suggests that the Podere Funghi potters were more concerned with maximizing the use of space within the kiln than with ensuring a consistently oxidized product.[68]

Conclusions

The excavation of the midden located in the Podere Funghi allows scholars to understand better many of the technological aspects of the production of utilitarian ceramic wares during the Hellenistic period. Evidence from new work in the Podere Funghi and surrounding fields is beginning to reveal a vibrant potting community, perhaps organized in several small workshop structures like the building excavated down slope. Close observation of midden wasters, such as those excavated at Podere Funghi, also provides insight into the production process of ceramics. Firing flaws coupled with statistical analysis of such assemblages allow for the discussion of the standardization of vessel shapes and sizes, as well as the errors repeated through time in the production process.

The Podere Funghi potters produced an assemblage that is limited in the number of shapes present. The most frequently executed shapes, fineware incurving-rim bowls and *ollas* were manufactured in a series of size categories, while the potters did not adopt standard size categories for those shapes that are less well represented in the assemblage, such as pouring vessels. Often, the plastic

66 Shepard 1956, 38, 104; Rice 1987, 335–336; Hemelrijk 1991, 238–239.

67 The excavation team at the Podere Funghi originally believed that this bi-chrome ware was the result of misfiring because of the high quantity of bichrome vessels recovered from the midden deposit. The discovery of several bi-chrome vessels from the destruction levels on nearby Poggio Colla suggests that this was an intentional decorative technique.

68 Nevertheless, the presence of a number of the resulting "bichrome" vessels in contexts from the *arx* of Poggio Colla indicates that the creation of this dual color was not in and of itself sufficient enough to condemn a ceramic to the waster pile.

properties of the clay served as limiting factors in determining the shapes of vessels thrown and degree of wall thinness that could be achieved.

The Podere Funghi potters appear to have been hasty in their drying process and to have employed a fuel source with a rapid rate of combustion as suggested by the prevalence of sherds with evidence of spalling. Although the fuel used appears to have facilitated a quick rise to maximum temperature, the relative lack of overfiring flaws suggests that this temperature was not a high one. Finally, the Podere Funghi potters struggled to produce a hard and stable surface for their wares. This was the result of the incorrect timing of the application of the final wash to the vessels before drying. These results serve to highlight the production regime of a small potting community producing non-painted wares from the late fourth to the third centuries BCE. The visual and statistical analysis of their mistakes permits the archaeologist to envision the world of these potters and the repeated events of the routine of manufacture that accompanied their work.

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Acknowledgements

The fieldwork underlying this research was made possible by a pair of grants from the University of North Carolina at Chapel Hill Harland and Ullman Funds. The Mugello Valley Archaeological Project is grateful for the ongoing support of Fulvia Lo Schiavo, Superintendent for the Bene Archeologici della Toscana and Luca Fedeli, the archaeological inspector of the Mugello region. The help of P. Gregory Warden, Michael L. Thomas, and Ann Steiner has been invaluable throughout the research process, both in providing access to the collections and in commenting on early drafts of this work. I am indebted to Dr. Warden for his invitation to work at Poggio Colla for over a decade, and for permission to analyze the material at hand. The manuscript also benefited from comments by Sara Bon-Harper. Any errors that remain in the work are my own.