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Amphora Production in the Roman World: A View from the Papyri

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Amphora Production in the Roman World A View from the Papyri

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Abstract

Survey of the papyrological evidence for the various stages of the pottery production process in Graeco-Roman Egypt with a focus on wine amphorae. Where possible, evidence from excavations and ethnographical data are integrated into the discussion.

Pottery is the most common artifact recovered through excavation and survey of Roman sites. To analyze the immense ceramic record, archaeologists employ functional categories, identify the variety of wares, specify the individual forms present for each ware, quantify the entire assemblage and its subsets, and often sample part of it for archaeometric testing.¹ In short, whatever can be done to analyze pottery often is.

The dominant role of pottery in the archaeological record contrasts with its modest presence in the textual sources. Ancient writers did not consider pottery a significant component of the economy. No treatise on pottery production survives from antiquity, and literary and epigraphical sources preserve few mentions of potters, several of which are moreover ambiguous. The inscriptions from Korykos in Cilicia provide an example. While analyzing Late Antique epitaphs from Korykos to record attested occupations, Hopkins noted that approximately ten percent of the 328 epitaphs which mention the occupation of the deceased refer to the pottery trade.² This suggests something about the importance of the pottery industry in the Roman world. However, claiming

¹ I would like to thank Peter van Minnen, Melinda Dewey-Gallimore, and two anonymous readers for reading drafts of this paper and providing numerous helpful suggestions. They have saved me from making several careless mistakes and any errors that remain are my own.

² K. Hopkins, "Economic Growth and Towns in Classical Antiquity," in *Towns in Societies*, ed. P. Abrams and E. Wrigley (Cambridge 1978) 71-72. É. Patlagean, *Pauvreté économique et pauvreté sociale à Byzance, 4e-7e siècles* (Paris 1977) 158-169 and *passim*, also discusses these inscriptions.

that ten percent of the workforce were involved in the pottery trade goes too far, and this reminds us of the difficulty with generalizing from these sources.³

The fact remains that there are usable documentary sources capable of providing significant information towards our understanding of pottery production in the Roman world, and that these texts have by and large been ignored. Two examples are Talmudic sources and papyrus texts.⁴ With respect to papyrus texts, well over one hundred published examples refer to pottery production in some manner, including amphora, brick, and fineware production. However, there have been few attempts to exploit these documents. A lingering reluctance to rely on papyrological evidence for broaching larger economic, social, and political issues in the Roman world, a reluctance fostered by Finley, is part of the difficulty.⁵ Finley's specific attitude toward papyri was entrenched within a more general conviction that data from Roman Egypt were of little comparative value to other regions.⁶ A gradual change in this attitude over the past decade owes much to the perseverance of papyrologists and scholars of Roman Egypt in attempting to relate their own datasets to broader issues of the Roman world.⁷ Within this context, this paper aims to explore the papyrus evidence for pottery production, specifically amphora production. Focusing on the various stages of production, including obtaining raw materials, forming, firing, coating with pitch, and transporting, this study will attempt to provide a more nuanced picture of these manufacturing stages and

³ J.T. Peña, *The Urban Economy during the Early Dominate* (Oxford 1999) 52, n. 271, argues that this corpus of inscriptions reflects differential preservation.

⁴ D. Adan-Bayewitz, *Common Pottery in Roman Galilee* (Ramat-Gan 1993), and J.T. Peña, *Roman Pottery in the Archaeological Record* (Cambridge 2007), both use Talmudic sources for analyzing pottery production and use.

⁵ One can reconstruct Finley's views toward papyrology from comments in his publications. R.S. Bagnall, "Evidence and Models for the Economy of Roman Egypt," in *The Ancient Economy: Evidence and Models*, ed. J.G. Manning and I. Morris (Stanford 2005) 187-188, cites several such references from M.I. Finley's *Ancient History: Evidence and Models* (London 1985), and similar examples occur in Finley's *The Ancient Economy*. For instance, at one point in the latter work Finley writes, "I still prefer to judge the mentality of the later emperors from the practice of Constantinople, the second capital, rather than from what may have been done for a few years by the insignificant Egyptian village of Oxyrhynchus" (*The Ancient Economy*, updated edition [Berkeley 1999 (1985)] 204). For a reaction to this, see P. van Minnen, "Urban Craftsmen in Roman Egypt," *MBAH* 6.1 (1987) 31-88.

⁶ A good overview and discussion of this topic can be found in Bagnall (n. 5).

⁷ Bagnall (n. 5) 188 cites D.W. Rathbone, "The Ancient Economy and Graeco-Roman Egypt," in *Egitto e storia antica dall'ellenismo all'età romana*, ed. L. Criscuolo and G. Geraci (Bologna 1989) 159-176, as a good example of such a study.

to show that the data obtained and conclusions reached relate to the study of amphora production not only in Egypt, but also in other regions.

The Study of Papyrus Texts Related to Pottery

The effort of hundreds of pottery experts devoted to analyzing the ceramic record contrasts with the lack of attention paid to papyrological sources for pottery production. With respect to other crafts, Rathbone notes that only textile production has received detailed study.⁸ Several reasons account for this. Papyrus texts which relate to pottery production are dispersed throughout dozens of papyrological monographs, a fact which hinders attempts at study. How can one know if all relevant texts have been considered? Both Ruffing and Mees have compiled inventories of texts related to pottery production, but individually they represent only a portion of the pertinent documents.⁹ The relative lack of publications limited to papyrus texts related to pottery may also contribute to their overall low profile. Three such studies come to mind, although none has substantially impacted the study of ceramics.¹⁰

One publication, however, has made a notable impact. In 1981, Cockle published three mid-third century CE papyri from Oxyrhynchus with contracts for leasing pottery workshops, republished soon after as *P.Oxy.* 50.3595-3597.¹¹ Focusing on the first of these three almost identical texts, Cockle selected a venue for publication which ensured widespread visibility among Roman scholars.¹² Almost all subsequent studies which include papyrological

⁸ D.W. Rathbone, "Roman Egypt," in *The Cambridge Economic History of the Greco-Roman World*, ed. W. Scheidel et al. (Cambridge 2007) 707.

⁹ K. Ruffing, *Die berufliche Spezialisierung in Handel und Handwerk* (Rahden 2008) 582-591; 609; 632-633; 719-722; A.W. Mees, *Organisationsformen römischer Töpfer-Manufakturen am Beispiel von Arezzo und Rheinzabern* (Mainz 2004) 362-408. Much shorter inventories can be found in A.C. Johnson, *An Economic Survey of Ancient Rome, II: Roman Egypt to the Reign of Diocletian* (Baltimore 1936) 361-364, and A.C. Johnson and L.C. West, *Byzantine Egypt: Economic Studies* (Princeton 1949) 115-116.

¹⁰ A.E. Hanson, "Chaff and Pottery in the Oxyrhynchite Nome: P.Mich. inv. 157," in *Le monde grec: Hommages à Claire Préaux*, ed. J. Bingen et al. (Brussels 1975) 609-610; H.C. Youtie, "P.Mich. inv. 347, verso: The Stubborn Potter," *ZPE* 24 (1977) 129-132; P. Tidemandsen, "Contract for Delivery of Jars: P.Osl. inv. no. 1525," *Symbolae Osloenses* 71 (1996) 172-180.

¹¹ H. Cockle, "Pottery Manufacture in Roman Egypt: A New Papyrus," *JRS* 71 (1981) 87-97.

¹² *P.Oxy.* 50.3596 and 3597 were subsequently discussed in detail by J. Hengstl, "Einige juristische Bemerkungen zu drei 'Töpferei-Mieturkunden,'" in *Studi in onore di Arnaldo Biscardi*, ed. F. Pastori (Milan 1983) 4:663-673.

evidence for pottery production refer to these three texts. Finley notes that these papyri provide a more intricate picture of pottery production than archaeology alone can offer.¹³ Peacock and Williams refer to these texts in their study of Roman amphorae, stressing their importance for providing insight into estate production.¹⁴ Aubert, despite an “initial commitment not to bring in papyrological evidence from Roman Egypt,” makes an exception for these documents in his study of Roman business managers.¹⁵ Peña’s recent effort at modeling the life-cycle of Roman pottery refers to these texts for their evidence concerning repaired vessels.¹⁶

There is only one study which employs a corpus of papyrus texts to study pottery production in Egypt. Grace and Empereur, in the first publication of amphora stamps which are irrefutably Egyptian, use several texts which mention potters from the Zenon Archive to explore aspects of Hellenistic amphora production in the Arsinoite nome.¹⁷ They analyze the organization of production and the phases of production and suggest that the texts show a larger-scale industry in place than archaeological evidence alone demonstrates.

Scholars who study pottery production outside Egypt, particularly *terra sigillata* production in Italy and southern Gaul, have made most use of papyrological evidence. Strobel, while analyzing the organization of Gallic *sigillata* production, argues from *P.Oxy.* 50.3595-3597 that potters were not in control of pottery production sites and kilns.¹⁸ For the Arretine *sigillata* industry, Fülle uses several lease contracts for pottery workshops to suggest independent workshops clustered around viable sources of clay.¹⁹ A recent study by Mees

¹³ Finley (n. 5, *Ancient History*) 24. Finley goes on to say (p. 25) that it is likely that these leases from Oxyrhynchus do not represent the common way in which pottery workshops were put to use in the Roman world.

¹⁴ D.P.S. Peacock and D.F. Williams, *Amphorae and the Roman Economy* (London and New York 1986) 42.

¹⁵ J.-J. Aubert, *Business Managers in Ancient Rome* (Leiden 1994) 253-255.

¹⁶ Peña (n. 3) 299.

¹⁷ V. Grace and J.-Y. Empereur, “Un groupe d’amphores ptolémaïques estampillées,” *BIFAO* 81 (1981) 409-426.

¹⁸ K. Strobel, “Einige Bemerkungen zu den historisch-archäologischen Grundlagen einer Neuformulierung der Sigillatenchronologie für Germanien und Rätien und zu wirtschaftsgeschichtlichen Aspekten der römischen Keramikindustrie,” *MBAH* 6.2 (1987) 75-115.

¹⁹ G. Fülle, “The Internal Organisation of the Arretine *terra sigillata* Industry: Problems of Evidence and Interpretation,” *JRS* 87 (1997) 121-122. Papyri cited include *P.Oxy.* 50.3595-3597, *P.Lond.* 3.994, *P.Tebt.* 2.342, and *P.Mert.* 2.76.

provides the most exhaustive examination of papyri²⁰ related to pottery production and their potential for shedding light on *sigillata* production²¹ and aims at examining the internal organization of large-scale *sigillata* producers. Mees employs evidence from papyri, as well as legal sources and inscriptions, to contextualize production in Arezzo and Rheinzabern.

The limited use by pottery specialists of papyri as comparanda for their own examples of production comes out well in Mees' study. The potential of these documents for illuminating aspects of pottery production in their own right is overlooked and, instead, questions are asked of these texts for which there is insufficient evidence. Two such questions include the social status of potters and the presence of potters' guilds. Mees dedicates 22 pages to addressing these two issues.²² In contrast, the firing of pottery receives a single sentence.²³ Overall, Mees concentrates on legal and social matters related to the organization of production rather than on the actual stages of production.

Mayerson shows similar concern when he concludes that based on analysis of pay rates in *P.Oxy.* 16.1911, 1913 and 50.3595-3597 potters had a low economic status.²⁴ Ruffing has recently undertaken a study of many different types of craft production, including pottery production, in which he examines the organization of production and the trade in the goods produced.²⁵ Caution is necessary when relying on papyri to provide data for studying the social status and organization of craftsmen because they tend to preserve leases between estate owners and itinerant craftsmen. They do not account for craftsmen who operated their own workshops.²⁶

²⁰ Mees (n. 9) 362-408 includes translations (in German) of all of the papyri cited in his work.

²¹ Mees (n. 9).

²² Mees (n. 9) 212-233. The primary discussion of Egyptian papyri occurs on pp. 209-260.

²³ Mees (n. 9) 238.

²⁴ P. Mayerson, "The Economic Status of Potters in *P.Oxy.* L 3595-3597 & XVI 1911, 1913," *BASP* 37 (2000) 100.

²⁵ Ruffing (n. 9). Ruffing also catalogues numerous papyri which mention potters (including amphora potters, fineware potters, and brickmakers) in a section where he provides epigraphical and papyrological references for different Greek terms for craftsmen (pp. 582-591; 609; 632-633).

²⁶ For this sentiment see E. Wipszycka, *L'industrie textile dans l'Égypte romaine* (Warsaw 1965) 56-57, reinforced by van Minnen (n. 5) 56. T.C. Skeat (in *P.Lond.* 7, p. 185) argues that the majority of pottery production attested in the Zenon Archive was undertaken by itinerant craftsmen. However, this archive may not provide an accurate representation of pottery production throughout Egypt because the Arsinoite nome from which it derives was under development in the early Ptolemaic period.

Papyrologists have taken different approaches to papyri related to pottery production. Most of their studies, however, refer to these texts for a purpose unrelated to how they may shed light on aspects of pottery production.²⁷ Rowlandson in her sourcebook cites a lease contract for a pottery workshop, *P.Cair.Masp.* 1.67110 (565 CE), because it demonstrates female ownership of an estate.²⁸ While analyzing the Heroninos Archive, Rathbone uses references to newly purchased and reused vessels to suggest that the Appianus estate bought rather than produced amphorae.²⁹ Other scholars use these papyri to explore legal issues. Pringsheim in his study of the Greek law of sale makes an occasional reference to papyri which discuss pottery.³⁰ Hengstl employs *P.Oxy.* 50.3596 and 3597 to suggest that potters were transformed into hired laborers in lease contracts which stipulate work responsibilities.³¹ In a more general context, he uses several papyri referring to pottery production in an overarching discussion of work contracts in Ptolemaic and Roman Egypt.³²

Papyrologists have also examined these papyri for their potential to elucidate ancient terminology for vessel forms and measurements. Reil attempted to identify attested jar types and liquid measures in Greco-Roman Egypt.³³ Rathbone argues that several vessels named in papyri point to the consumption of imported wine in Egypt and the reuse of foreign wine jars.³⁴ Mayer-son combines archaeological data and papyrological evidence to suggest two amphora forms which could represent the attested jar names *Gazition* and *Askalonion*.³⁵ Kruit and Worp have recently produced several studies aimed at

²⁷ The recent republication by T. Wilfong, "A Coptic Account of Pottery from the Kilns of Psabt (*P.Lond.Copt.* 1.695)," *BASP* 45 (2008) 247-259 of *P.Lond.Copt.* 1.695 (6th-8th cen. CE), a text related to the firing of pottery, is an exception.

²⁸ J. Rowlandson (ed.), *Women and Society in Greek and Roman Egypt* (Cambridge 1998) 262-263. This text is no. 197.

²⁹ D.W. Rathbone, *Economic Rationalism and Rural Society in Third-Century A.D. Egypt* (Cambridge 1991) 167. This conforms to a general pattern of lack of long-term employment of craftsmen by Appianus.

³⁰ F. Pringsheim, *The Greek Law of Sale* (Weimar 1950). *BGU* 4.1143, a sale contract for pottery with deferred delivery, is an example (p. 277, n.4).

³¹ Hengstl (n. 12) 666. He compares this condition to wet-nursing contracts.

³² J. Hengstl, *Private Arbeitsverhältnisse freier Personen in den hellenistischen Papyri bis Diokletian* (Bonn 1972).

³³ T. Reil, *Beiträge zur Kenntnis des Gewerbes im hellenistischen Ägypten* (Borna and Leipzig 1913).

³⁴ D.W. Rathbone, "Italian Wines in Roman Egypt," *Opus* 2 (1983) 81-98.

³⁵ P. Mayerson, "The Gaza 'Wine' Jar (*Gazition*) and the 'Lost' Ashkelon Jar (*Askalônion*)," *IEJ* 42 (1992) 76-80. The two amphora types in question correspond to Killebrew's Types A and B respectively.

identifying different jar forms and measurements found in Hellenistic, Roman, and Byzantine papyri to provide a clearer picture of pottery types in Egypt.³⁶

Papyrological Evidence for Amphora Production

Few studies analyze papyri for evidence of the steps involved in manufacturing pottery. To make up for this deficit one must first address some difficulties. These texts form an assemblage of *disiecta membra*, with most being fragmentary and representing a wide chronological and geographical spectrum. As a result, the information requires critical sifting. Another difficulty is the kind of questions which interest pottery specialists, including division of labor, presence of guilds, and production of pottery classes other than amphorae. A lack of evidence makes discussing these issues difficult. Occasionally a text will mention a κοινὸν κεραμέων (*koinon* of potters), such as *O.Bodl.* 2.2143.4 (3rd/4th cen. CE), but such references are rare.³⁷ There are a few attestations of fineware potters (λεπτοκεραμεῖς), but little is mentioned concerning the production of these ceramics.³⁸ Evidence for amphora potters (κουφοκεραμεῖς, or alternatively κεραμεῖς οἰνικοῦ κεράμου) is more robust and relates to the attachment of amphora workshops to estates and the need for lease and sale contracts.³⁹

Papyri can be beneficial for analyzing many aspects of pottery production. This includes the topography of pottery workshops. Excavation tends to identify kilns, but not workshops, which limits our understanding of these facilities. Peña and McCallum include descriptions of several pottery workshops in a recent overview of pottery production in Pompeii, and their excellent preservation offers a useful foundation for examining how such facilities would

³⁶ N. Kruit and K.A. Worp, "Metrological Notes on Measures and Containers of Liquid in Graeco-Roman and Byzantine Egypt," *APF* 45 (1999) 96-127; "Geographical Jar Names: Towards a Multi-Disciplinary Approach," *APF* 46 (2000) 65-146; and "Two Notes on Byzantine Containers," *MBAH* 21 (2002) 44-52.

³⁷ For another apparent mention of a potters' guild see col. 26 in *P.Lips* 97 (338 CE).

³⁸ For attestations of λεπτοκεραμεῖς see Ruffing (n. 9) 633, n.74.

³⁹ P. Mayerson, "A Note on κοῦφα 'Empties,'" *BASP* 34 (1997) 47-48, 51, argues that κοῦφα were empty jars and were made by amphora potters. For two recent overviews of amphora production in Egypt see C. Dixneuf, "Productions d'amphores en moyenne Égypte au cours des périodes romaine et byzantine à la lumière des découvertes archéologiques," in *Actes du huitième congrès international des études coptes*, ed. N. Bosson and A. Boud'hors (Leuven 2007) 1:167-178, and F. Mahmoud, "Organisation des ateliers de potiers en Égypte du Bas-Empire à la conquête arabe: les productions céramiques égyptiennes," *ibidem* 1:267-278.

appear in other contexts.⁴⁰ In Egypt, the Dakhleh Oasis Project has identified a site, Amheida, labeled 33/390-L9-1, which has a pottery workshop with seven rooms and five kilns.⁴¹ Excavations at the monastery of St. Jeremia at Saqqara and at the site of Buto have produced similar evidence of workshops with several rooms and kilns.⁴² Potters' houses at Elkab which contain workshop installations also give us insight into these spaces.⁴³ When this material evidence is combined with papyrological references to features of *κουφοκεραμουργεία* (amphora workshops), a much more comprehensive understanding of these facilities emerges.⁴⁴

P.Oxy. 50.3595-3597 describe workshops with store-rooms and equipment such as pottery wheels.⁴⁵ *P.Tebt.* 2.342.16-19 (late 2nd cen. CE) stipulates a pottery workshop with fixtures (*χρηστ(ηρίοις)*), doors (*θύραις*), keys and swing-beam for watering (*κλεισὶ καὶ κηλωνεῖφ εἰ[ς] π[ο]τισμ(όν)*), and a basin (*φρέατι*). *P.Mert.* 2.76 (181 CE) specifies a workshop with four doors (l. 26) and requests that the tenant, who may be a potter, renovate and roof the facility, for which he will be reimbursed (ln. 31-34).⁴⁶ The workshop in *P.Cair. Masp.* 1.67110.33-38 includes fixtures (*χρ[η]στηρίων*), a kiln (*καμίνου*), and a pitch furnace (*πισσοκαμίνφ*). It has additional features which Rowlandson translates as long rooms, but which van Minnen reinterprets as long basins

⁴⁰ J.T. Peña and M. McCallum, "The Production and Distribution of Pottery at Pompeii: A Review of the Evidence: Part 1, Production," *AJA* 113 (2009) 64-76. Their discussion focuses on the Via di Nocera workshop (I.20.2-3) and the Via Superiore workshop (150m outside the Porta di Ercolano).

⁴¹ C. Hope, "Pottery Kilns from the Oasis of el-Dakhla," in *An Introduction to Ancient Egyptian Pottery*, ed. D. Arnold and J. Bourriau (Mainz 1993) 124-125; *idem*, "Pottery Manufacture in the Dakhleh Oasis," in *Reports from the Survey of the Dakhleh Oasis 1977-1987*, ed. C.S. Churcher and A.S. Mills (Oxford 1999) 215-243.

⁴² H. Ghaly, "Pottery Workshops of Saint-Jeremia (Saqqara)," in *Ateliers de potiers et productions céramiques en Égypte*, ed. P. Ballet = *Cahiers de la Céramique Égyptienne* 3 (Cairo 1992) 161; P. Ballet, "The Graeco-Roman Pottery Workshops of Buto," *Egyptian Archaeology* 24 (2004) 18.

⁴³ S. Hendrickx, "Habitations de potiers à Elkab à l'époque romaine," in *Egyptian Religion: The Last Thousand Years*, ed. W. Clarysse *et al.* (Leuven 1998) 2:1353-1376.

⁴⁴ *SB* 24.16115.1 = *P.Eirene* 1.27 (mid-7th cen. CE) mentions a *κουφοκεραμουργίον*. This term also appears in *CPR* 14.2.2-3, *SB* 1.4675.6, *SB* 1.4712.9, and *SPP* 3².104.3. *P.Flor.* 1.50.68 provides a more general term for a pottery workshop (*κεραμικὸν ἐργαστήριον*). Mees (n. 9) 247 and table 80 notes that several contracts include lists of supplies and equipment to be included along with the workshop.

⁴⁵ *P.Oxy.* 50.3595.7-9; 50.3596.8-9; 50.3597.6-7.

⁴⁶ Cockle (n. 11) 90 notes that *P.Mert.* 2.76 contains no words related to pottery and may not refer to a pottery workshop.

which functioned either as tubs or kneading troughs.⁴⁷ In *P.Lond.* 3.994.11-12 (517 CE), the workshop has four vaults (καμάραις τεττάρσι), a kiln (καμίνη), a basin (λάκκου), and all equipment and fixtures (πάσι ἔξαρτίω [l. -ίοις] καὶ χρηστηρίον [l. -ίοις]). Three other texts, *BGU* 19.2819.8 (442 CE?), *P.Flor.* 1.50.68 (269 CE), and *SB* 20.14300.10 (324 CE), also mention pottery workshops equipped with various features.

These references suggest that one could expect a set of common features in an Egyptian amphora production workshop including basins, kilns, and other fixtures which likely equate to benches, tables, cisterns, and areas for drying and storage. This compares well to the description of the Via di Nocera workshop. This facility had five rooms and included an area for wedging clay, a pit for mixing clay, a levigation basin, a cistern, two kilns, and a circle with a diameter of four meters which may have been where the pottery was thrown.⁴⁸

An additional consideration is the type of products packaged in Egyptian amphorae as this may have influenced certain production steps. The obvious answer is wine as this was produced on a large scale in Egypt and is often connected to amphora production in papyrus texts. Amphorae designated to carry wine would have required an interior coating of pitch. Other liquid commodities produced in Egypt may have also been packaged in amphorae. Johnson discusses a variety of these products including different types of oil.⁴⁹ Egyptian amphorae may have also been used to package foodstuffs other than liquids. In particular, literary sources point to salted fish as an important Egyptian export during the Roman period.⁵⁰ It was common practice to transport salted fish and fish sauces in amphorae, and examples of Nilotic fish possibly identified at Sagalassos, Turkey, and Vallerano, a few kilometers south of Rome, may be evidence of this trade.⁵¹

The discussion below is limited to the stages of amphora manufacture. According to Peña: “The manufacturing process for Roman pottery generally involved at least six discrete stages: raw material procurement, paste preparation,

⁴⁷ Rowlandson (n. 28) 262-263 reads μακρούς, while P. van Minnen, “Notes on Texts from Graeco-Roman Egypt,” *ZPE* 96 (1993) 117-118, reads μάκ(τ)ρα.

⁴⁸ Peña and McCallum (n. 40) 65-67.

⁴⁹ Johnson (n. 9) 3-4, 6.

⁵⁰ For instance, see Ath. 3.118f, 3.119c, 7.311f; Diod. Sic. 1.36.1, 1.52.5-6; Mart. 13.85; Lucian, *Nav.* 15; Strabo 17.2.4.

⁵¹ A. Arndt *et al.*, “Roman Trade Relationships at Sagalassos (Turkey) Elucidated by Ancient DNA of Fish Remains,” *JArchSci* 30 (2003) 1102; J. De Grossi Mazzorin, “État de nos connaissances concernant le traitement et la consommation du poisson dans l’antiquité à la lumière de l’archéologie,” *MEFRA* 112 (2000) 158-159.

forming, drying, firing, and postfiring handling and storage.⁵² The evidence in the papyri for each of these stages varies, and these texts also include information for two additional stages applicable to amphora manufacture, coating the interiors with pitch and transport of new, unused vessels.

(1) *Obtaining Clay Resources*

Clay is the *sine qua non* of pottery production and obtaining sufficient amounts would have been a chief priority for potters. A general condition, as suggested by Rye, is that potters followed the principle of least effort and would exploit sources of clay most accessible to production sites.⁵³ The archaeological record, however, provides little evidence of the activity of obtaining clay. Peacock summarizes, “Although a large number of Roman production sites is known, very few have produced evidence for the extraction of clay or of the coarse materials required for tempering heat-resistant cooking wares.”⁵⁴ The few exceptions represent only a sample of the extent of this activity. In Rome, excavations in 1888 and 1965 on the east slope of the Janiculum hill revealed cuttings into clay beds partially filled with sand and pottery production debris which appear to be clay pits.⁵⁵ Excavations in the Roman Agora at Thessaloniki have produced similar evidence from Hellenistic and Late Roman contexts.⁵⁶ For Roman Britain, Young has compiled an inventory of sites at which clay extraction occurred.⁵⁷ Peacock notes that almost no evidence for tool use to extract clay survives except for a possible digging tool found in Lavoye, France, consisting of an iron shoe which would have been attached to a wooden handle.⁵⁸ There is a possible reference to this type of tool in SB 12.11146 (1st/2nd cen. CE), which mentions a σκαφεῖον, an implement White interprets as some type of spade or mattock, in the context of pottery production.⁵⁹

⁵² Peña (n. 3) 33.

⁵³ O.S. Rye, *Pottery Technology: Principles and Reconstruction* (Washington 1981) 12.

⁵⁴ D.P.S. Peacock, *Pottery in the Roman World* (London and New York 1982) 52.

⁵⁵ For a discussion of these excavations see Peña (n. 3) 33 and associated bibliography.

⁵⁶ P. Adam-Veleni, “Thessaloniki: History and Town-Planning,” in *Roman Thessaloniki*, ed. D.V. Grammenos (Thessaloniki 2003) 146-147.

⁵⁷ C.J. Young, *Oxfordshire Roman Pottery* (Oxford 1977) 16.

⁵⁸ Peacock (n. 54) 53. For the original publication of this tool see G. Chenet and G. Gaudron, *La céramique sigillée d'Argonne des IIe et IIIe siècles* (Paris 1955) 32 and fig. 8b.

⁵⁹ K.D. White, *Agricultural Implements of the Roman World* (Cambridge 1967) 41.

In Egypt, archaeologists distinguish between Nile silt clays and marl clays.⁶⁰ Nile silt clays appear throughout the Nile river valley, while marl clays occur at locations along the river between Esna and Cairo and in secondary deposits such as at Wadi Qena.⁶¹ A third type known as kaolin clay, first exploited in the Early Roman period, was available in the territory of Aswan.⁶²

Several papyri mention the above clays, including *P.Oxy.* 50.3595-3597, which each list at least two different types. *P.Oxy.* 50.3595.13-14 is representative: *χοῦν χαυνόγιον καὶ ἀμμόγειον καὶ μελ[ά]γγειον* (friable, sandy, and black earths). Cockle in her commentary suggests that *χοῦν μελάνγγειον* is Nile silt clay, *χοῦν χαυνόγιον* is desert marl, and *χοῦν ἀμμόγειον* is sand or quartz temper.⁶³ A similar list of materials appears in *P.Tebt.* 2.342.27: *χοῶς καὶ χαυνογείου καὶ ἄμμου* (friable and sandy earth). Within the context of brick-making, a reference in *P.Ant.* 46.9 (ca. 337-348 CE) to *πηλοῦ λευκοῦ* (white mud) could be an additional allusion to marl clay.

Cockle's suggestion that *χοῦν ἀμμόγειον* refers to some type of inorganic temper is supported by descriptions of Egyptian amphorae of Roman date which often characterize the fabrics as containing large amounts of small quartz grains. Another option was chaff or some other type of organic material as noted by Peacock and Williams based on petrographic analysis of Egyptian amphorae.⁶⁴

Several papyri elucidate different strategies for obtaining the above clays. For example, *P.Oxy.* 50.3595-3597 include a clause indicating the estate owners would supply clay. How should we interpret this situation? Did estate owners organize shipments of clay to pottery workshops or compensate potters for clay they acquired? There is evidence for the latter interpretation in *P.Mert* 1.44 (5th cen. CE), in which brickmakers need funds to purchase clay to produce two *βαυκάλια* of bricks. A *βαυκάλιον* equals approximately 3000 bricks, suggesting that a substantial quantity of clay would be required.⁶⁵ A similar situation could be expected for amphora producers on estates. Evidence supporting the

⁶⁰ This dichotomy first developed during study of pottery of Pharaonic date (e.g. A. Lucas, *Ancient Egyptian Materials and Industries*, 4th edition, revised by J.R. Harris [London 1962] 368).

⁶¹ J.D. Bourriau *et al.*, "Pottery," in *Ancient Egyptian Materials and Technology*, ed. P.T. Nicholson and I. Shaw (Cambridge 2000) 121-122.

⁶² Bourriau *et al.* (n. 61) 122.

⁶³ Cockle (n. 11) 92-93. Cockle suggests these two clay types were often mixed for amphora production.

⁶⁴ Peacock and Williams (n. 14) 205.

⁶⁵ The *editio princeps* of this papyrus (p. 145) translates *βαυκάλιον* as a jug, but interprets the term in view of *P.Oxy.* 18.2197 (6th cen. CE) as a metrological unit.

interpretation that estate owners supplied clay in raw material form appears in the Zenon Archive. Grace and Empeureur, based on several references from the Zenon Archive, suggest that potters' assistants may have been in the employ of some estates to handle jobs such as collecting clay.⁶⁶ An ostrakon from La Graufesenque, France preserving a graffito, first published by Marichal and discussed by Aubert, provides comparable evidence. This graffito lists slaves belonging to the estate of a certain Aetelia who each possess a different job connected to a pottery workshop.⁶⁷ As this text pertains to several sections of this paper, it can be cited here in its entirety:

[?]a ATELIAE puerorum ex XI (Kalendas) August[is |] in X
K(alendas) Septe(m)bres | [SE]CUNDUS, AGILEIUS dies XIII
s(emis) ar[gilam | ?] dierum XXX, IIII ad |⁵ Capuries, XI [| CA]LIS-
TUS | [O]NESIMUS ad Sabros III, ad Crau[cinam |] ad Craucinam
III it(em) ONESIMUS[| mat]eriem erigenda I |¹⁰ [?] dierum XXX |
[?]ae III CALISTUS ad samiamdum [|]...EOS, UIGEDOS III mercatu
a[d |]s materi(em) erige(n)dam [|] argilam III di[es |¹⁵] [|]s ad a[?]

“[Account of the days] of the slaves of Aetelia from July 22 until August 23. Secundus, Agileius: 14.5 days collecting clay, ... during the period of 30 days, 4 days at the workshop of Capuries, 11 [days] ... Calistus, Onesimus: Onesimus for 3 days at the workshop of Sabri, [... days] at the workshop of Craucina ... the same Onesimus: 3 days at the workshop of Craucina, 1 day gathering material ... during the period of 30 days ... Calistus: 3 days at the place for polishing ... Uigedos: 3 days at the market, [... days] collecting material, 3 days collecting clay ...”⁶⁸

According to Aubert the graffito has some slaves performing tasks (*argilam* – collecting clay; *materiem erige(n)dam*) – gathering construction material or firewood; *mercaturam*) – transporting products to market) while others were assigned to workplaces (*ad samiamdum* – to the place for polishing?; *ad Ca-*

⁶⁶ Grace and Empeureur (n. 17) 421. These references include *P.Cair.Zen.* 3.59500.2-4 and *P.Lond.* 7.2038.25-28.

⁶⁷ R. Marichal, “Quelques graffites inédites de La Graufesenque (Aveyron),” *CRAI* (1971) 193-201; “Nouveaux graffites de La Graufesenque, IV,” *REA* 76 (1974) 266-277; and *Les graffites de La Graufesenque* (Paris 1988) 226-228. Aubert (n. 15) 210-211. This graffito is preserved on the recto (interior) of the sherd, but apparently has never received an *AE* number.

⁶⁸ Translation modified from Marichal (n. 67, *REA*) 276; (n. 67, *Les graffites*) 228.

puries, ad Sabros, ad Craucinam – to the workplaces of Capuries, Sabri, and Craucina).⁶⁹ The slave who collected clay is relevant to this discussion.

Many potters, even those attached to estate workshops, would have obtained their own clay, although they may have had assistants for this task. *P.Tebt.* 2.342.26-29 specifies a source of clay available for the potters to exploit south of the pottery workshop in a vacant lot.⁷⁰ Peacock records several ethnographic parallels, particularly in the context of household production where obtaining clay from public land on the outskirts of villages is common.⁷¹ Aubert notes that brickworks were often situated near extraurban clay sources to accommodate their immense requirements for clay.⁷² Sources of clay on private estates also may have been available for mining. A law in the *Digesta*, 7.1.13.5, codified by the mid-second century CE jurist Ulpian, begins with the phrase *inde est quaesitum, an lapidicinas vel cretifodinas vel harenifodinas ipse instituere possit* (“From this it is sought whether he is able to establish a quarry, clay pit, or sand pit”). This refers to a usufruct farmer who wanted to convert part of his land over to one, or perhaps all, of the above enterprises suggesting it was common enough to warrant treatment by the jurists.⁷³

Collection of clay by independent workers is another option. Ethnographic study of the potters’ village of Deir el-Gharbi in Upper Egypt has shown an intricate relationship between clay miners and potters.⁷⁴ The clay miners provide raw materials to potters, but are autonomous workmen and speak a slightly variant dialect.⁷⁵ According to Nicholson and Patterson, “The miners themselves told us that they had long (“for thousands of years”) been a profession separate from that of the potters.”⁷⁶ These miners use few tools and would be difficult to identify in the archaeological record. There are also no literary attestations for this profession in antiquity, but it may represent an ancient method for obtaining clay.

⁶⁹ Aubert (n. 15) 210.

⁷⁰ This contract is discussed by Mees (n. 9) *passim* in detail and also by Fülle (n. 19) 121 who notes the difference in clay provision between this text and *P.Oxy.* 50.3595-3597.

⁷¹ Peacock (n. 54) 17, 19, 21.

⁷² Aubert (n. 15) 217.

⁷³ See Aubert (n. 15) 166 for a discussion of this law.

⁷⁴ For a discussion of this project, known as the Ballas Pottery Project, see P. Nicholson and H. Patterson, “Pottery Making in Upper Egypt: An Ethnoarchaeological Study,” *World Archaeology* 17 (1985) 222-239; “Ceramic Technology in Upper Egypt: A Study of Pottery Firing,” *World Archaeology* 21 (1989) 71-86.

⁷⁵ Nicholson and Patterson (n. 74, 1985) 222-225.

⁷⁶ Nicholson and Patterson (n. 74, 1985) 224.

The purchase of prepared clay is a final option to consider. Talmudic sources contain several references to the purchase of potter's eggs, which were prepared balls of clay ready for throwing.⁷⁷ However, the amount of clay required for producing an amphora could suggest this method of procurement was viable only for smaller types of ceramics.

In sum, Egyptian potters would have employed several different methods for obtaining clay, whether it was desert marl or Nile silt clay. Estate owners could have supplied money for purchasing necessary stocks, or supplied the clay itself. Another option is that potters may have obtained their own from available sources. There is also some evidence to suggest that assistants or slaves may have been involved in collecting clay for workshops.

(2) *Forming*

Several papyrus texts contain references related to the actual steps involved in forming amphorae. This includes a reference to paste preparation in *P.Mich.* 5.241 (16 CE), an abstract for a contract which informs a would-be apprentice that kneading clay is one of the tasks he will perform.⁷⁸ The need for water for working with clay is apparent in the Oxyrhynchus lease contracts which stipulate that sufficient water be available at the workshops.⁷⁹ In *P.Tebt.* 2.342.19 the provision of a well and an apparatus for obtaining water shows similar concern. Drying is attested by mentions of drying floors (ψυγμούς).⁸⁰ The potter in *BGU* 4.1143.15 (19/18 BCE) is told to furnish the vessels with handles. In *P.Tebt.* 2.342.17 one finds a possible reference to two potters' tools (κεραμε[υ]τικ(οῖς) β), although the term is somewhat cryptic.⁸¹ If these implements are tools, they could be for forming. *P.Lond.* 3.994.12 provides another possible attestation of a forming tool when it mentions a ξυλικῶ ὄργάνῳ (wooden contraption).

There are further aspects of amphora forming on which papyri can shed some light. These include the rate of production per day. These rates must have been high based on the number of vessels recorded in contracts. The potter named in *P.Oxy.* 50.3595, for example, would have required a high daily production rate to produce the specified annual quota of 15,300 vessels, particularly if one factors in kiln wasters and breakage. Smaller consignments

⁷⁷ Adan-Bayewitz (n. 4) 24-25. Two references are *Tosefta Bava Mezi'a* 6.3 and *Bavli Bava Mezi'a* 74a.

⁷⁸ Mees (n. 9) 212 discusses this in the context of an apprenticeship contract.

⁷⁹ *P.Oxy.* 50.3595.15, 50.3596.15, 50.3597.24-25.

⁸⁰ *P.Oxy.* 50.3595.33, 50.3596.31, 50.3597.31, and *P.Tebt.* 2.342.22.

⁸¹ The editor of this text notes the overall awkward construction of this line and suggests that a word may have dropped out between κεραμε[υ]τικ(οῖς) and β.

of vessels demanded in *P.Oxy.* 50.3596 (4,115) and 3597 (8,130) could suggest lower production rates, or similar rates to 3595 but with fewer workers. Only one papyrus text, *P.Lond.* 7.2038 (mid-3rd cen. BCE), from the Zenon Archive, offers a specific account of daily production, a fact noted by Grace and Empereur.⁸² This letter preserves the complaints of two potters that their promised workspace was unavailable for four days and the associated loss in production amounted to approximately 30 vessels. This suggests a per diem production rate of roughly eight amphorae, but lack of comparanda makes it difficult to assess the relevance of this figure. Two other letters in the Zenon Archive offer general pictures of production rates. The first, *P.Cair.Zen.* 3.59500 (mid-3rd cen. BCE), informs Zenon that a potter will accept employment, but must begin soon to ensure completion of the specified vessels. The second, *P.Cair.Zen.* 2.59264 (251 BCE), is an update from a certain Sisouchos whom Zenon instructed to inquire into hiring potters. Sisouchos here advises Zenon to contact the potter himself if he wants the vessels to be manufactured in time.

Whether production was constant or fluctuated due to the loss of manpower to other tasks, such as the harvest, is another consideration. Evidence from the Via di Nocera pottery workshop (I.20.2-3) at Pompeii suggests the circumstances of reassigned labor.⁸³ Both of the workshop's kilns were functioning as storage areas at the time of the Vesuvian eruption. Kiln 1 contained several lamp moulds while the firing chamber of kiln 2 contained 61 unused lamps, in a pyramidal formation, and the combustion chamber contained 123 dice cups known as *fritilli*. Peña and McCallum interpret this storage as representing a temporary closing of the workshop to accommodate the harvest which may have occupied many of the workers.⁸⁴

Several papyri which request that amphorae be from winter manufacture may parallel the above situation.⁸⁵ The phrase "from the winter manufacture" (ἀπὸ χειμερινῆς πλάσεως) does not mean that amphora production only occurred during winter months, but suggests rather that production began following the harvest in anticipation of the next year's vintage. To produce the number of vessels required by contracts would be a substantial undertaking and would require several months of manufacture. It is possible, however, that potters could have been reassigned to different tasks when needed since,

⁸² Grace and Empereur (n. 17) 423-424.

⁸³ Peña and McCallum (n. 40) 68.

⁸⁴ Peña and McCallum (n. 40) 72. This idea relies on a recent reinterpretation of the timing of the eruption of Vesuvius by G. Stefani, "La vera data dell'eruzione," *Archeo* 22 (2006) 10-13, who prefers a date in October of 79 CE as opposed to August.

⁸⁵ *P.Oxy.* 50.3595.33-34, 50.3596.31-32, 50.3597.31-32, 58.3942.24-25, and *P.Tebt.* 2.342.23.

as Hengstl suggests, their contracts made them hired laborers of an estate.⁸⁶ An expenditure account for an estate in the Oxyrhynchite nome, *P.Oxy.* 16.1913.16-23, offers some supporting evidence. Among laborers who worked on an estate irrigation unit, this document specifies a potter.⁸⁷ Two interpretations are possible: (1) the potter received payment for providing ceramic parts for these units; (2) the potter received payment for aiding in the maintenance of these units. A later section in this account (lines 33-35) records a payment to the same potter for supplying 764 new wine amphorae; this could suggest his work on the irrigation units was not related to ceramics. Potters under contract to an estate, thus, may have been engaged both in manufacturing amphorae and in other activities when needed.

Papyrological evidence can give us insight into different aspects of the processes involved in forming amphorae including paste production, drying, handle attachment, and tool use. There is also evidence for daily rates of production, which must have been high, and for when production took place. The period of production would likely have followed the harvest when many of the workers attached to pottery workshops were no longer involved in other jobs around the estate.

(3) *Firing*

When potters had formed enough jars they would begin firing.⁸⁸ Individual firings of large quantities of vessels would have occupied several days and included loading the kiln, heating the pottery in stages at set temperatures for predetermined lengths of time, allowing the pottery to cool for several days, and unloading. Several papyrus texts attest ancient concern for firing with respect to amphora production.

We should first examine the vocabulary associated with the firing of pottery in papyrus texts. Two verbs, ὀπτῆσαι and ὑποκαῦσαι, appear interchangeable in this regard. Verb and noun forms of both appear in each of the Oxyrhynchus lease contracts and ὑποκαῦσαι is the verb for firing in *BGU* 4.1143.16.⁸⁹ One difficulty, however, is *P.Oxy.* 50.3595.9-10 where the potter must ὀπτῆσαι καὶ ὑποκαῦσαι the vessels in question. Why the redundancy?

⁸⁶ See at n. 31.

⁸⁷ Also mentioned are guards to watch the irrigation units (16-18) and a smith (19-20).

⁸⁸ P. Nicholson, "The Firing of Pottery," in Arnold and Bourriau (n. 41) 103-120, is a good introduction to the process of firing pottery.

⁸⁹ For ὀπτῆσαι and cognates: *P.Oxy.* 50.3595.9, 34; 50.3596.10, 15, 20, 32; 50.3597.13, 25, 29, 32. For ὑποκαῦσαι and cognates: *P.Oxy.* 50.3595.10, 14, 15, 19, 25; 50.3596.8;

Cockle interprets ὀπτήσαι “to be more significant than ὑποκαῦσαι” because it occurs more often in references to firing pottery.⁹⁰ She concludes that, in this instance, ὑποκαῦσαι refers to a secondary practice of smoking the jars to give them a dark grey or black exterior, a process which is described by Lucas.⁹¹ Cockle also cites *P.Oxy.* 50.3596.15-16 and 50.3597.20-21 as corroborating this process when they mention καπνισμὸν τῶν κούφων (smoking of the jars). Overall, however, it appears that either verb and its cognates can refer to the firing of pottery in papyrus texts.

Several papyri show concern for obtaining fuel for firing. In a letter from the Zenon Archive mentioned above, *P.Lond.* 7.2038, two potters inform Zenon they will soon begin firing, but need additional money. They may have needed funds for purchasing fuel for their kiln(s). This is the situation in *P.Theon.* 12 (156/157 CE), in which there is a request for payment for chaff (ἄχυρον) for firing pottery.⁹² In *P.Oxy.* 41.2996.10-12 (2nd cen. CE) chaff appears in a list of supplies purchased by a potter, and *P.Lond.* 3.1166.18 (42 CE) appears to preserve a similar request for chaff for brickworks suggesting need either for fuel or temper. The potters in *P.Oxy.* 50.3595.14-15, 3596.15-16, and 3597.20-22 had clauses in their contracts that fuel be provided at their respective workshops, although the type of fuel is unspecified. All of these references suggest that estate owners often provided fuel, or money for procuring fuel. They also suggest that obtaining fuel was a primary concern for firing.

An interesting papyrus related to firing is *P.Lond.Copt.* 1.695 (6th to 8th cen. CE), republished by Wilfong.⁹³ This document records the number of jars fired in thirteen kilns ranging from 760 to 840 per kiln for a total of 10,440 (incorrectly stated as 10,450 on the papyrus).⁹⁴ An abbreviated text on the verso which includes the number 65 may indicate five firings per kiln.⁹⁵ Wilfong uses this document to reconstruct kiln capacities for Byzantine Egypt, noting that contemporary kilns had average diameters of 1.5m which suggests typi-

50.3597.6, 19, 21. In *BGU* 4.1143.16 the phrase is κε[καυμ]ένα τῆ καθηκούση ὀπτήσαι (fired in proper heat).

⁹⁰ Cockle (n. 11) 94.

⁹¹ Lucas (n. 60) 372-376. Cockle (n. 11) 94 suggests that the purpose of smoking the pottery after firing was to cover up accidental smoke stains which occurred during firing.

⁹² Hanson (n. 10).

⁹³ Wilfong (n. 27).

⁹⁴ Wilfong (n. 27) 254-255 suggests that a contemporary Coptic papyrus, *P.Fay.Copt.* 54 = *P.Lond.Copt.* 1.694, preserves a similar account of jars fired per kiln.

⁹⁵ Wilfong (n. 27) 258. This short text translates as: “the ones we made: 65.”

cal kiln capacities ranged between 160 and 214 amphorae.⁹⁶ This estimate is informative, but earlier and contemporaneous amphora kilns in Egypt and the Roman world often had diameters exceeding 1.5m. Near Alexandria at Burg el-Arab, rescue excavations uncovered a possible Late Roman kiln with an internal diameter of 7.4m.⁹⁷ Another kiln discovered at the 203km marker along the highway between Alexandria and Cairo had a diameter of 9.6m.⁹⁸ Both could have held several hundred amphorae per firing. Peacock and Williams identify little standardization for amphora kilns, but suggest a variable diameter between 3.5 and 5.5 m.⁹⁹ The kilns specified in *P.Lond.Copt.* 1.695 may be smaller than average.

Few papyri mention the actual procedures of firing. Instead, references tend to relate to vessel quality following firing. The Oxyrhynchus lease contracts each incorporate the phrase καλῶς ὠπτημένα (well fired),¹⁰⁰ and in the delivery contract *BGU* 4.1143.16-17, the potter must ensure that the vessels are κε[καυμ]μένα τῇ καθηκούσῃ ὀπτήσι (fired in proper heat). As Mees shows, this concern with the firing of amphorae appears related to standards applied to individual vessels which determined their usability.¹⁰¹

⁹⁶ Wilfong cites kilns from four excavations as possible comparanda for this papyrus. These include 1st to 3rd century CE kilns at site 33/390-L9-1 in the el-Dakhleh Oasis (see n. 41), late Roman kilns at Tomb 54 in the Theban Valley of the Queens (G. Lecuyot and G. Pierrat, “À propos des lieux de production de quelques céramiques trouvées à Tôd et dans la Vallée des reines,” in *Ateliers de potiers et productions céramiques en Égypte*, ed. P. Ballet = *Cahiers de la Céramique Égyptienne* 3 [Cairo 1992] 173-180), and late Roman kilns at the Monastery of Saint Jeremias at Saqqara (Ghaly [n. 42]). He suggests the closest comparison is with eight kilns of 6th to 8th century CE date built among the ruins of the Seti I temple (K. Mysliwiec, *Keramik und Kleinfunde aus der Grabung im Tempel Sethos’ I. in Gurna* [Mainz 1987] 15-19). Another example could be the site of Buto where small kilns have been noted Ballet [n. 42] 19. His estimates at capacity are based on hypothetical jar measurements of 30cm diameter and 70cm height.

⁹⁷ F. el-Ashmawi, “Pottery Kiln and Wine Factory at Burg el-Arab,” in *Commerce et artisanat dans l’Alexandrie hellénistique et romaine*, ed. J.-Y. Empereur (Athens 1998) 58-60.

⁹⁸ J.-Y. Empereur and M. Picon, “La reconnaissance des productions des ateliers céramiques: l’exemple de la Maréotide,” in *Ateliers de potiers et productions céramiques en Égypte*, ed. P. Ballet = *Cahiers de la Céramique Égyptienne* 3 (Cairo 1992) 145-146.

⁹⁹ Peacock and Williams (n. 14) 47. Several kilns in Egypt have diameters falling within this same general range including a kiln uncovered at El Amreya with a diameter of approximately 5.0m (A. Abd el-Fattah, “Recent Discoveries in Alexandria and the Chora,” in *Commerce et artisanat dans l’Alexandrie hellénistique et romaine*, ed. J.-Y. Empereur [Athens 1998] 43-44).

¹⁰⁰ *P.Oxy.* 50.3595.34, 50.3596.32, and 50.3597.32

¹⁰¹ Mees (n. 9) 238.

Numerous papyri preserve some variation of a clause which requires that the finished vessels be of acceptable quality. The chronological and geographical range of these texts argues against this representing mere boilerplate. In *P.Tebt.* 2.342.25, for instance, the potter must provide 2000 κούφα ἀρεστά (acceptable empty jars). A variant of this word, εὐάρεστα, occurs in at least four papyri: *CPR* 10.39.10 (443 CE); *CPR* 14.2.16 (late 6th/early 7th cen. CE); *P.Cair.Masp.* 1.67110.41; *SB* 1.4675.1 (6th/7th cen. CE). This term represents a conscious reflection concerning the quality of the vessels after firing. In *P.Cair.Zen.* 3.59500.7, the potter informs Zenon of his desire to commence work as soon as possible for his undertaking to prove useful (χρήσιμα). The potter may have vessel quality in mind with this statement. Further evidence appears in *P.Oxy.* 14.1631.16 (280 CE), which includes the clause, ποι[η]σόμεθα τὴν τῶν χωρούντων εἰς τὸν οἶνον κ[ο]ύφων κομπασίαν (“we will undertake the ringing of the jars to be used for wine”), which indicates testing amphorae to ensure proper firing.¹⁰² Inferior clay quality in several regions of Egypt may have contributed to these legal considerations. Two examples, according to Ballet *et al.*, include Nile valley and Mareotic clays.¹⁰³ Clauses in contracts which ask for vessels of acceptable quality could imply ancient awareness of this situation.

Documents from the Oxyrhynchite nome provide explicit references to expectations of vessel quality. The lease contracts *P.Oxy.* 50.3595-3597 and *P.Oxy.* 58.3942 (606 CE) instruct the potters to exclude defective or repaired vessels.¹⁰⁴ The amphorae also must not leak. This suggests amphora potters would attempt to repair vessels or hand over jars with some defect.

Archaeological evidence for the maintenance of amphorae is rare compared with other pottery classes. Peña provides the most thorough discussion of maintenance of pottery including examples of repairs resulting from firing defects and from use-related damage. For amphorae, he relates a single example, a mending of a LRA type 1a amphora from the Yassi Ada B shipwreck which dates to the seventh century CE¹⁰⁵ One handle of this amphora broke off,

¹⁰² Cockle (n. 11) 89. The same clause appears in *P.Oxy.* 47.3354.16-17 (257 CE). *PSI* 8.953.3 (6th cen. CE) mentions a κομπαστ(ῆ) (ringer [of wine jars]). A good description of this process can be found in *Geoponica* 6.3.2.

¹⁰³ P. Ballet *et al.*, “Artisanat de la céramique dans l’Égypte romaine tardive et byzantine. Prospections d’ateliers de potiers de Minia à Assouan,” *Cahiers de la Céramique Égyptienne* 2 (1991) 131.

¹⁰⁴ *P.Oxy.* 50.3595.36, 3596.33-34, 3597.33-34. The clause is as follows: χωρὶς θεραπευσίμων καὶ ἐπισινῶν (without those that have been repaired or are defective). The clause in *P.Oxy.* 58.3942.25 is slightly different, πλάσεως ἀσινῆ ται καὶ ἀδιάπτωτα (both faultless and undamaged in their manufacture), but has the same sense.

¹⁰⁵ Peña (n. 3) 75-76, 232. For the original discussion of this amphora, see P.G. van Alfen, “New Light on the 7th-c. Yassi Ada Shipwreck: Capacities and Standard Sizes of

creating an opening in the shoulder and causing the loss of part of the rim. The entire damaged section has evidence of smoothing and, as van Alfen suggests, the opening in the shoulder was likely patched.¹⁰⁶ This damage occurred post-manufacture, probably during earlier transport of the amphora.

This situation contrasts with evidence for repairs to *dolia* or *pithoi* to which Peña dedicates much of his chapter on maintenance.¹⁰⁷ These large vessels required much more material and effort than other ceramics during production. In Diocletian's Edict on Maximum Prices, dating to 301 CE, the entry for a *doleum* holding 1000 Italian *sextarii* lists the maximum cost at 1000 *denarii communes*.¹⁰⁸ This price is high and suggests that any vessels deemed repairable would have been salvaged during production.

The Ballas Pottery Project supplies relevant ethnographic evidence for firing because the vessels made by these potters are similar to ancient amphorae.¹⁰⁹ Thus, kilns at Deir el-Gharbi had average capacities between 500 and 700 vessels, and whenever the potters reached this number of prepared vessels they purchased fuel and would begin firing. Unfortunately, the authors fail to specify kiln dimensions, making comparison with ancient kilns difficult. Potters would first stack vessels carefully in the kilns in an inverted position, packing them as densely as possible. Firing took three to four hours with the temperature reaching roughly 1000°C with no soak periods (phases during firing when potters maintain specific temperatures for extended periods of time before achieving the maximum temperature). Unloading took place after two days of cooling and potters expected approximately 5% to 10% of the vessels to be wasters. After one catalogued firing of 627 medium-sized Ballas jars stacked in five equal layers, the authors note that 31 jars were deemed wasters (4.78%).¹¹⁰ Of these, 21 were from the lowest layer, five from the second layer, two each from the next two layers, and none from the top layer.¹¹¹

Blitzer's study of storage jar production in the Koroni district of Messenia provides more ethnographic support for the careful loading of kilns.¹¹² Accord-

LRA1 Amphoras," *JRA* 9 (1996) 202.

¹⁰⁶ van Alfen (n. 105) 202.

¹⁰⁷ Peña (n. 3) 210-227.

¹⁰⁸ The entry for *doleum* occurs in section 15.97 (based on the layout proposed in M. Giaccherio, *Edictum Diocletiani et Collegarum de Pretiis Rerum Venalium* [Genoa 1974]). This is under the heading *De fictilibus* which incorporates section 15.88-101.

¹⁰⁹ Nicholson and Patterson (n. 74, 1985) 230-231.

¹¹⁰ Nicholson and Patterson (n. 74, 1989) 80.

¹¹¹ Nicholson and Patterson (n. 74, 1989) 82, fig.8.

¹¹² H. Blitzer, "Κορωεϊκά: Storage-Jar Production and Trade in the Traditional Aegean," *Hesperia* 59 (1990) 675-711.

ing to Blitzer, “As elsewhere, potters devoted a great deal of time to loading of the kiln, since carelessness could result in a ‘fall’ and the loss of income.”¹¹³ Potters were also cautious during unloading and would avoid this step on windy days because air introduced into the kiln could cause changes in temperature resulting in cracks and unusable vessels. Wasters were approximately 3% to 10% of fired vessels while in below average firings they exceeded 40%. The potters believed these averages were slightly higher than those at the beginning of the twentieth century.¹¹⁴

Blitzer advises caution for using Koroni as comparative evidence for ancient pottery production, because her study occurred at the end of the industry when the potters no longer took as much care during stages like firing.¹¹⁵ Nicholson and Patterson also studied the Deir el-Gharbi industry during its demise, which advocates caution when attempting to compare breakage and loss rates there with what may have occurred in antiquity.¹¹⁶ Nevertheless, as the above papyrological evidence for well-fired vessels suggests, ancient amphora producers would still have encountered kiln wasters and unusable vessels. When one considers ancient kiln sizes and vessel capacities along with assumed procedures for stacking vessels which would result in disproportionate heating of amphorae on lower levels, a hypothetical waster average of 5% to 10% should not be unreasonable.

Between papyrological evidence for quality specifications and the ethnographic evidence for a high percentage of wasters, we should expect a higher than average discard rate for ancient amphorae. Sherd dumps may, indeed, be evidence for precisely this. Ballet observes that *kôm al-ahmar* (with French variants *butte rouge* and *colline rouge*), translating to “red hill,” is a common toponym in Egypt.¹¹⁷ This refers to large mounds formed by tens of thousands of discarded sherds, particularly Roman amphorae, with other vessel classes sometimes represented on smaller scales.¹¹⁸ An exception is the area of Buto

¹¹³ Blitzer (n. 112) 696.

¹¹⁴ There is very little discussion of loss rates during firing for ancient pottery. Much of the discussion relies thus on ethnographic evidence. Peacock, for instance, mentions that wastage rates at British brickyards were around 4% (n. 54) 47-50, and household production in Berber society often resulted in losses of 10% (n. 54) 13-14.

¹¹⁵ Blitzer (n. 112) 686 and personal communication.

¹¹⁶ Nicholson and Patterson (n. 74, 1985) 224.

¹¹⁷ P. Ballet, “Dépotoirs culturels, domestiques et ‘industriels’ dans la *chôra* égyptienne à l’époque romaine,” in *La ville et ses déchets dans le monde romain: rebuts et recyclages*, ed. P. Ballet et al. (Montagnac 2003) 225.

¹¹⁸ P. Ballet, “Potiers et consommateurs dans l’Égypte ancienne: sites et tessons,” *Bulletin de la Société française d’égyptologie* 147 (2000) 40-49.

where large amounts of tableware wasters have been documented.¹¹⁹ These mounds have been a focus of numerous survey projects in Egypt interested in identifying centers of pottery production.¹²⁰ A similar situation occurs in other amphora producing regions of the Roman world. Peacock, for instance, undertook a survey in Tunisia which aimed at identifying amphora production sites (along with other pottery production sites) by first examining maps for toponyms associated with pottery and pottery production and by asking locals about locations of large pottery dumps.¹²¹ On Crete, several French archaeologists surveyed the entire island looking for amphora production sites by specifically seeking out known, and unknown, heaps of discarded pottery.¹²² As for the formation processes behind these discard mounds, amphora production was a large-scale industry and produced large vessels. *A priori* this implies that dumps of amphora sherds would be larger and more conspicuous than other pottery classes. However, contracts for amphora production which specify vessels of acceptable quality also may have contributed to the formation of large amphora middens in the landscape by forcing amphora potters to discard all vessels which did not meet the established standards.

Concerning fineware pottery, there is some evidence for a class of vessels often termed “seconds.” These “seconds” represent vessels which had some type

¹¹⁹ Ballet (n. 42) 18.

¹²⁰ Some survey projects which have used sherd heaps to pinpoint amphora production centers include: Ballet *et al.* (n. 103); P. Ballet and M. Vichy, “Artisanat de la céramique dans l’Égypte hellénistique et romaine. Ateliers du Delta, d’Assouan et de Kharga,” in *Ateliers de potiers et productions céramiques en Égypte*, ed. P. Ballet = *Cahiers de la Céramique Égyptienne* 3 (Cairo 1992) 109-119; G. Majcherek and A. el-Aziz el-Shennawi, “Research on Amphora Production on the Northwestern Coast of Egypt,” *ibidem* 129-136; Empereur and Picon (n. 98); *idem*, “Les ateliers d’amphores du Lac Mariout,” in *Commerce et artisanat dans l’Alexandrie hellénistique et romaine*, ed. J.-Y. Empereur (Athens 1998) 75-91; P. Ballet, “Un atelier d’amphores LRA 5/6 à pâte alluviale dans le Delta occidental (Kôm Abou Billou/Térénouthis),” in *Amphores d’Égypte de la basse époque à l’époque arabe*, ed. S. Marchand and A. Marangou = *Cahiers de la Céramique Égyptienne* 8 (Cairo 2007) 157-160.

¹²¹ D.P.S. Peacock *et al.*, “Roman Amphora Production in the Sahel Region of Tunisia,” in *Amphores romaines et histoire économique: dix ans de recherche* (Rome 1989) 179-222; *idem*, “Roman Pottery Production in Central Tunisia,” *JRA* 3 (1990) 59-84.

¹²² S. Markoulaki *et al.*, “Recherches sur les centres de fabrication d’amphores de Crète occidentale,” *BCH* 113 (1989) 551-580; J.-Y. Empereur *et al.*, “Recherches sur les amphores crétoises II: les centres de fabrication d’amphores en Crète centrale,” *BCH* 115 (1991) 481-523; *idem*, “Recherches sur les amphores crétoises III,” *BCH* 116 (1992) 633-648.

of production defect, but were still sent to market.¹²³ It appears that amphorae did not share this same classification, although most studies of amphorae do not consider the notion of “seconds,” thus making it difficult to judge whether there is an archaeological correlate.

With the exception of texts which mention fuel for firing and one document which records the number of vessels fired, the majority of papyrological references to the firing of pottery relate to vessel quality. Vessels had to be well fired and meet acceptable standards. Combined with evidence for wasters from ethnographic studies and with large amphora middens which appear in the Egyptian landscape, it is possible to suggest that amphora production in Egypt had a high discard rate related to the conditions of firing.

(4) *Coating with Pitch*

Coating amphorae with pitch is a common subject in papyri. Wine amphorae required interior surfacing with pitch to prevent absorption of liquid into the clay fabric, an occurrence which not only reduced the amount of wine but also degraded its taste. Archaeological evidence for pitch derives from residues on the interior of jars recovered from excavation. For instance, van Alfen records 13 amphorae preserving traces of pitch or resin on their interiors from the Yassi Ada B shipwreck.¹²⁴ Because of such evidence scholars appreciate that most, if not all, wine amphorae received interior coatings of pitch, but it is difficult to quantify the scale of pitching in antiquity.

Many of the texts which preserve contracts for production of amphorae include clauses which require that finished vessels be coated with pitch. These numerous references led Grace and Empereur to suggest that potters themselves were responsible for much of the pitching.¹²⁵ The Oxyrhynchus lease contracts each specify that finished vessels be *πεπισσοκοπημένα ἀπὸ πυθμένος*

¹²³ M. Bulmer, “The Samian,” in *Excavations at Chester: 11-15 Castle Street and Neighbouring Sites, 1974-8. A Possible Posting House (mansio)*, ed. D. Mason (Chester 1980) 87, suggests this may be the case for at least 26 or 27 Gallic *sigillata* vessels which present a variety of production defects recovered from the site of Chester in northwest England. J. Kütter, *Graffiti auf römischer Gefäßkeramik aus Neuss* (Aachen 2008) 80-99, makes a similar suggestion for *sigillata* vessels produced at Neuss which bear a graffito in the form of an X.

¹²⁴ van Alfen (n. 105) 203. From this evidence he extrapolates that the primary function of the entire complement of amphorae serving as cargo at the time of sinking was packaging for wine.

¹²⁵ Grace and Empereur (n. 17) 423.

μέχρι χειλῶν (coated with pitch from the base to the rim).¹²⁶ *P.Oxy.* 50.3597.23 shows added concern with the clause σοῦ ἐπακολουθοῦντος τῆ πισσῶσι (with you supervising the coating with pitch). A passage in Columella (12.18.2) shows that the “supervisor” could be a superintendent of some kind.¹²⁷ Inconsistent or improper coating of vessels must have been a common problem in antiquity. A letter from the Zenon Archive, *P.Cair.Zen.* 3.59481 (mid-3rd cen. CE), has a potter complaining to Zenon that other potters were double-coating vessels with pitch, resulting in wastage of time and material. These potters appear to have been unsupervised, a situation which may have eventually led to the above-mentioned requirement. A contrasting situation occurs in *BGU* 4.1143.15-16 where the potter must render the vessels διευγασ[μένα] καὶ ἐπιδιευγασμένα (perhaps “coated and recoated”) according to the contract. This clause provides no clear interpretation because the specific terminology is unique, but likely implies the potter must double-coat vessels with pitch and suggests no standard existed for the number of coats required per jar. Another letter from the Zenon Archive, *P.Cair.Zen.* 4.59611 (mid-3rd cen. BCE), records a progress report concerning vessels sent for pitching.

Two papyrus texts offer insight into the amount of pitch needed to coat a single amphora. The first, *P.Oxy.* 50.3595.16-17, specifies that 26 talents of pitch be provided to pitch 10,000 of the 15,000 four-chous jars mentioned in the contract. The second, *P.Oxy.* 50.3596.18-19, asks for 12 talents of pitch for 4,000 four-chous jars. Cockle notes that the emphasis on τῆς μυριάδος in *P.Oxy.* 50.3595 confirms that only two-thirds of the vessels required pitch and that the amount of pitch per 1,000 jars (2.6 talents) equates roughly with the 3.0 talents per 1,000 jars stipulated in *P.Oxy.* 50.3596.¹²⁸ In both contracts, the pitch is to be weighed out μέτρῳ Ἀλίνης (by the measure of Aline), suggesting a private measure, but if this equates to the Egyptian talent of 27 kilograms,¹²⁹ the amounts of pitch would be approximately 700 kilograms and 325 kilograms respectively. For *P.Oxy.* 50.3595, dividing 700 kilograms of pitch by 10,000 jars suggests that 0.07 kilogram (70 grams) of pitch was needed to coat a single vessel from bottom to lip, assuming no wastage and a single coating per jar. For

¹²⁶ *P.Oxy.* 50.3595.34-35, 50.3596.32-33, 50.3597.32-33. See also *P.Oxy.* 58.3942.23-24.

¹²⁷ This passage suggests different jobs for a superintendent of an estate to undertake in preparation for the vintage, including supervising the coating of vessels (specifically dolia) with pitch.

¹²⁸ Cockle (n. 11) 89. In l. 21, there is reference to a special payment for these 10,000 jars.

¹²⁹ J.W. Humphrey *et al.*, *Greek and Roman Technology: A Sourcebook* (London 1998) 487. Cockle (n. 11) 89 makes this same assumption.

P.Oxy. 50.3596, the amount would be 0.08 kilograms per jar (325 kilograms of pitch divided by 4,000 jars). If these amounts are accurate, it should be possible to calculate the amount of pitch needed to coat jars of many different sizes.

Several contracts for amphorae did not require pitched vessels. *P.Cair. Masp.* 1.67110.41 specifically asks the potter to deliver vessels ἄνευ πίσης (without pitch). An earlier section of this contract records a pitch-furnace in the workshop, suggesting the process could have occurred on site. Either the owners of the workshop required unpitched vessels or intended to send them elsewhere for pitching. Two letters from the Zenon Archive, *P.Cair. Zen.* 4.59611 and 4.59741 (both mid-3rd cen. CE), mention that finished jars would be transported to different locations for pitching. *P.Cair. Zen.* 4.59611, discussed above, implies similar circumstances. *P.Tebt.* 2.342 makes no mention of pitch whatsoever. However, a clause in line 23 which informs the potter that the delivered vessels be τύπω Ὀξυρρυγγ(εἰτικῶ) κεραμείων θεοῦ (in the Oxyrhynchite form of the pottery workshops of the god) could be a reference to the same conditions seen above in the Oxyrhynchite lease contracts.¹³⁰

The number of references to pitch suggests that obtaining it would have been a primary concern for amphora potters in Egypt. Many papyri preserve orders or contracts related to the sale of pitch for use by potters, indicating that purchase was the main option available.¹³¹ It fell to estate owners to either provide pitch to potters or give them money for obtaining it. One document with a reference to the sale of pitch, *P.Mich. inv.* 347.v (= *SB* 14.12107) (3rd cen. CE), published by Youtie, is interesting because it discusses how a potter selling an unspecified quantity of pitch to an estate later cancelled the sale. He realized that he needed the pitch for his own jars.¹³²

Modern research into sources of pitch demonstrates that much of the supply would have been imported into Egypt to meet necessary demand. White in his study of Roman farming offers a similar picture for Roman Italy and Sicily by naming only the Po Valley and Bruttium as two potential sources for pitch

¹³⁰ Cockle (n. 11) 95, suggests the alternative reading of Ὀξυρρυγγ(εἰτικῶ) compared to Ὀξυρρυγγ(εἰτη). For a discussion of pottery workshops associated with temples, monasteries, and churches see P. Ballet, “Temples, potiers et coroplasts dans l’Egypte ancienne,” in *Autor de Coptos* (Paris 2002) 147-159.

¹³¹ Some examples include: *BGU* 7.1547; *P.Cair. Zen.* 3.59417; *P.Oxy.* 1.159 = *SB* 22.15349; *P.Oxy* 14.1754; *P.Tebt.* 1.120; *SB* 14.12107; *SB* 20.14197.

¹³² Youtie (n. 10). Although the potter was present during the initial sale, his son formulated the agreement, and Youtie interprets the events as a case of “filial ambition and paternal resentment” (p. 129). However, why should we consider the rationale provided by the potter to be unreasonable? Only select regions produced substantial quantities of pitch for use by several industries and the potter in question may have faced a case of diminished supply and felt it prudent to retain his own stocks.

in Italy.¹³³ While discussing various plants and trees which served as ancient sources of pitch and resin, Serpico notes that Egyptian stocks would not have produced sufficient supplies to match demand.¹³⁴ *P.Oxy.* 50.3596.18-19 offers insight into ancient sources of pitch. In this contract the potter requests that the pitch be Τρωαδησίας τὸ ἥ[μι]σὺ Σιρητικῆς τὸ ἥμισυ (half Troadesian and half Siritic). Cockle remarks that the same descriptive markers for pitch appear in *P.Oxy.* 31.2570.23-25 (329 CE).¹³⁵ For Siritic, she suggests a provenance along the Nile between Syrene and Meroe. For Troadesian there is no geographical correlate since these papyri are the only attestation of the term.¹³⁶

A more definitive answer of the provenance of pitch used by Egyptian potters derives from two archaeometric studies. In the first study, the analysis of resin coating the bottom of two Egyptian made Late Roman amphorae (designated Late Roman Amphora 7) demonstrated an eastern Mediterranean origin for the pitch, possibly from the Levant, Anatolia, or the Aegean coast.¹³⁷ Support for the Levant as a primary supplier of this material to Egypt appears in the second study, an analysis of bitumen used for mummification.¹³⁸ The sample of Egyptian mummies included several of Roman date, all of which had bitumen from sources around the Dead Sea suggesting a preference for supplies from this region.¹³⁹

Mayerson also cites two Oxyrhynchus texts that offer support for the import of pitch to Egypt.¹⁴⁰ He interprets the large amount of pitch described in *P.Oxy.* 31.2580 as having “all the earmarks of the commodity having arrived at a port of entry where transport vessels unloaded large amounts of solid pitch.”¹⁴¹ This pitch was then transported to another boat, presumably for transport to market or to an estate. The second text, *P.Oxy.* 41.2996, has a potter attempting to excuse his failure to repay his debts on time because he had just returned

¹³³ K.D. White, *Roman Farming* (London 1970) 67, 75.

¹³⁴ M. Serpico, “Resins, Amber and Bitumen,” in *Ancient Egyptian Materials and Technology*, ed. P.T. Nicholson and I. Shaw (Cambridge 2000) 431-438.

¹³⁵ Cockle (n. 11) 94-95. The original publication of *P.Oxy.* 31.2570 does not clearly represent these two terms, but Cockle reconstructs their presence through examination of a photograph of this document.

¹³⁶ Cockle (n. 11) 95.

¹³⁷ C. Vogt *et al.*, “Notes on Some of the Abbasid Amphorae of Istabl ‘Antar-Fustat (Egypt),” *BASOR* 326 (2002) 72.

¹³⁸ J.A. Harrell and M.D. Lewan, “Sources of Mummy Bitumen in Ancient Egypt and Palestine,” *Archaeometry* 44 (2002) 285-293.

¹³⁹ Harrell and Lewan (n. 138) 291.

¹⁴⁰ P. Mayerson, “Pitch (πίσσα) for Egyptian Winejars an Imported Commodity,” *ZPE* 147 (2004) 203.

¹⁴¹ Mayerson (n. 140) 203.

home with his pitch. Both Mayerson and the editor of the papyrus suggest the potter was abroad given the lack of supplies produced in Egypt.

There is almost no reference in papyri to the actual process of coating jars with pitch. The technique is described in other sources, however, which offer evidence for methods employed by Egyptian potters and amphora potters in general. Most ancient attestations of pitching concern *dolia*. Peña provides a detailed description of the surfacing of these large vessels based on evidence from Columella and a panel from the Seasons Mosaic dating to the first quarter of the third century CE from Saint-Romain-en-Gal near Vienne.¹⁴² Columella (*Rust.* 12.18.5-7) proposes two techniques for the pitching of *dolia* including for those sunk into the ground (*dolia defossa*) and for those which were free-standing. The second account is relevant for comparison with amphorae. According to Columella (*Rust.* 12.18.6):

At quae supra terram consistunt, complures dies antequam curentur in solem producuntur. Deinde cum satis insolata sunt, in labra convertuntur, et subiectis parvis tribus lapidibus suspenduntur, atque ita ignis subicitur, et tamdiu incenditur, donec ad fundum calor tam vehemens perveniat, ut apposita manus patiens eius non sit: tum dolio in terram demisso, et in latus deposito, pix ferventissima infunditur, volutaturque, ut omnes dolii partes linantur.

“But vessels which stand above ground are put out in the sun for several days before they are treated; then, when they have been sufficiently exposed to the sun, they are turned with their openings downwards and raised from the ground by the placing of three small stones underneath them; then a fire is placed underneath and allowed to burn until so strong a heat reaches the bottom that a hand placed there cannot endure it. Then the vessel is let down on the ground and laid on its side, and very hot pitch is poured into it, and it is rolled round and round that every part of it is coated with pitch.”¹⁴³

A panel from the Seasons Mosaic, depicting one man using a long-handled tool to coat the interior of a *dolium* placed on its side with pitch while a man to the right stirs pitch in a pot over an open flame, corroborates this process.¹⁴⁴ Potters could have placed amphorae on their sides and rolled them

¹⁴² Peña (n. 3) 211-213.

¹⁴³ Translation from the Loeb edition.

¹⁴⁴ This mosaic, first identified in 1891, was originally discussed in detail by J. Lancha, *Recueil général des mosaïques de la Gaule, III: Province de Narbonnaise*, Vol. 2 (Vienne

to ensure complete coverage, and long-handled, thin tools would have been necessary to compensate for the narrow openings. One could argue, however, that rolling amphorae on the ground would result in a high degree of breakage and it is possible that amphora potters developed other methods for coating.

One papyrus from the Zenon Archive offers indirect evidence that Egyptian amphora potters employed a similar technique to that described above. *P.Cair.Zen.* 2.59271.8-10 (251 BCE) has the following phrase: κατασκευασθήτω δὲ εἰς τὴν | πίσσωσ[iv] τοῦ κεράμιου κλιβάνους δέκα (“prepare 10 ovens for pitching of the pottery”). Liquefaction of the pitch thus also occurred for pitching amphorae in Egypt. The attestation of a pitch-furnace in *P.Cair.Masp.* 1.67110.38 also shows that pitch would be heated before being poured into jars.

References to pitch are very common in papyri which relate to pottery production. Most contracts require that the vessels, which likely would have served as wine containers, be coated with pitch. One important fact we learn from these references is that the burden for obtaining pitch appears to have fallen on estate and workshop owners who either provided money or the substance itself. From several papyri it is also possible to begin calculating the amount of pitch required to coat a single vessel based on the quantities required for a set number of jars.

(5) *Transporting*

P.Mich. 11.615.4-6 = *SB* 24.16256.4-6 (ca. 259 CE) includes a clause which promises punctual delivery of new amphorae to an estate’s ληνόν (wine-vat). This suggests that transportation of finished jars for delivery was the final operation undertaken by amphora potters during manufacture to ensure fulfillment of the contract.¹⁴⁵ A similar conclusion is implied by *P.Oxy.* 47.3354.16-17 (257 CE), which specifies that laborers should test wine jars ἀφ’ οὗ τόπου μεταφέρεται (at the place where they are transferred). Mees suggests that Meesore was a common month for delivery in contracts.¹⁴⁶

1981) 208-225.

¹⁴⁵ Several different options for transport, including beasts of burden (donkey, oxen, camel, horse, mule), wagons, or ships, existed in antiquity. The literature concerning transport, including the advantages and disadvantages of land versus water transport, is vast. R. Laurence, *The Roads of Roman Italy: Mobility and Cultural Change* (London 1999) 98, notes, however, that both types were individual components of larger transport networks and schemes and should not be considered in isolation. For transport in Roman Egypt see C. Adams, *Land Transport in Roman Egypt* (Oxford 2007).

¹⁴⁶ Mees (n. 9) 249. For example, see *P.Oxy.* 58.3942.26-28.

Several papyri mention the transportation of empty jars (κοῦφα). One letter from the Zenon Archive, *P.Cair.Zen.* 4.59741 (mid-3rd cen. BCE), refers to wagons, while another letter from the same archive, *PSI* 7.859 (mid-3rd cen. BCE), has donkeys conveying wine vessels, although they may have been filled at the time. *P.Flor.* 3.364 (3rd cen. CE) from the Heroninos Archive mentions camels transporting several items including empty jars. *P.Oxy.* 16.1924.10-11 (5th/6th cen. CE), which includes empty jars of *Gazition* and *Askalonion* type as part of a river boat's cargo, attests water transport. Numerous references to pottery in customhouse receipts could also indicate transport of empty jars.¹⁴⁷

One document from the Zenon Archive, *P.Col.* 4.88 (243 BCE), preserves a complaint filed against a potter who, upon delivering his consignment of jars, failed to account for breakage which occurred en route. Breakage during transport must have been considered standard, and it would be interesting to know if the vessels which were broken were counted against the total required by the contract.¹⁴⁸

A provision for the delivery of pottery preserved in several papyri, ἐπὶ τῶν τοῦ αὐτοῦ κεραμείου ψυγμῶν (at the drying floor of the workshop), shows that, in some situations, delivery did not require transport.¹⁴⁹ This accords with a statement by Peña:

A significant portion of Roman pottery was probably consumed by the economic units that produced it, specifically *amphorae* manufactured in workshops operated either by agricultural estates that also produced the wine, oil, or fruit packaged inside them or by the *cretariae* (establishments for the confection of fish products) that produced the fish products packaged inside them.¹⁵⁰

In these instances, transport would occur only after the vessels had been filled. This would also explain why many contracts for pottery do not preserve requirements for delivery.

¹⁴⁷ Ruffing (n. 9) 319-357 charts the different products (including pottery) attested in customhouse receipts recovered from Soknopaiou Nesos and Philadelphia based on the evidence found in *P.Customs*.

¹⁴⁸ The loss of entire shipments due to a variety of factors could also occur during transport. M. Rhodes, "Roman Pottery Lost *en-route* from the Kiln Site to the User – a Gazetteer," *JRomPotStud* 2 (1989) 44-58, provides a gazetteer of examples of this phenomenon for Italy and the northern provinces.

¹⁴⁹ This phrase occurs in *P.Oxy.* 50.3595.32-33, 50.3596.31, 50.3597.31, and *P.Tebt.* 2.342.22.

¹⁵⁰ Peña (n. 3) 35-36.

Conclusions

There are numerous papyrus texts from Egypt which include information about the stages of production involved in amphora manufacture. These sources have hitherto been underused, or have been used as comparanda for the organization of production of mass-produced ceramics elsewhere such as *sigillata* wares. These texts offer important data in their own right, however, and are deserving of more attention.

The activities described above would not have been unique to amphora production in Roman Egypt. When one considers other amphora producing regions of the Roman world, regardless of the product meant to be packaged in these jars, many of the manufacturing steps would have been common there too. There would have been some geographical variation, but overall the activities would have been recognizable across the Roman world. One procedure, coating the interior of amphorae with pitch, would have been relevant only for wine amphorae, but these vessels were produced across the Mediterranean. There is only one papyrus text from outside of Egypt which refers to pottery production. This text, *P.Dura* 2.76 (235 CE) from the site of Dura Europus in Syria, records a legal decision preventing the eviction of a potter from his workshop because of an existing oral contract. There is, unfortunately, no reference to the actual manufacture of pottery, but it does suggest the possibility that such texts were much more widespread in the Roman world than current evidence implies. Ultimately, pottery production is recognizable as such across the world, and the fact that amphorae from different production centers had consistent shapes and functions suggests that references in papyri to the production of these vessels are capable of offering insight into aspects of amphora production across the Roman world.¹⁵¹

¹⁵¹ See now A. Wodzińska, *A Manual of Egyptian Pottery*, Vol. 4 (Boston 2009).

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